ICE11-8IOL*-G60L-V1D

Fieldbus Module with Multiprotocol Technology and IO-Link
CC-Link
EtherCAT
EtherNet/IP
Modbus
PROFINET

Manual

IO-Link

Your automation, our passion.

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2024-04

2024-04

1 Introduction

1.1 Content of this Document

This document contains information required to use the product in the relevant phases of the product life cycle. This may include information on the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal

Note

For full information on the product, refer to the further documentation on the Internet at www.pepperl-fuchs.com.

Note

For specific device information such as the year of construction, scan the QR code on the device. As an alternative, enter the serial number in the serial number search at www.pepperl-fuchs.com.

The documentation comprises the following parts:

- This document
- Datasheet

In addition, the documentation may comprise the following parts, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Instruction manual
- Functional safety manual
- Other documents

1.2 Manufacturer

Pepperl+Fuchs Group Lilienthalstraße 200, 68307 Mannheim, Germany
Internet: www.pepperl-fuchs.com

1.3 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismounting of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

2024-04

1.4 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:

Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.

Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.

Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols

Note

This symbol brings important information to your attention.

Action

1. This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

2 Cybersecurity Information

The ICE11-8IOL-G60L-V1D is secure for the area of application defined here in accordance with IEC 62443-4-1. The operator must implement the measures defined in this section to ensure the secure operation and protection of the device while online.

Security Context

The ICE11-8IOL*-G60L-V1D is intended for use in an automation network. This is a secure network with known and trusted participants that is separated (physically or logically) from the company network.

A firewall must be configured so that only defined ports are forwarded to other subnets.

The device uses the following ports:

- Ports 49152, 34964 for PROFINET
- Port 2222 and port 44818 for EtherNet/IP
- Port 68 DHCP client
- Port 80 for the administration website using HTTP
- Port 1883 (factory default, changeable) for MQTT if enabled
- Port 4840 (factory default, changeable) for OPC UA if enabled
- Port 514 (factory default, changeable) for syslog if enabled
- Port 5683 for CoAP if enabled

To avoid losing packets, we recommend limiting the network load to < 5 % of the bandwidth. We recommend operating the gateway behind a network switch.

The device must be physically secured against unauthorized access and operated in a lockable switch cabinet or room that is only accessible to authorized personnel. Otherwise, there is a risk that some of the device settings can be changed via the "X3" service interface and the password[a] printed on the gateway.

The device contributes to the "defense-in-depth" strategy with the following security functions:

Security function	Addressed threat
Access control with single-factor authentication (SFA) and automatic time-based login lock in the event of incorrect authentication.	Protection against unauthorized access, brute-force attacks.
Deletion of all information stored in the device using the "Reset to factory settings" function.	Protection against information being subject to spying by physical access to the device after decommissioning and disposal by the system operator.
The access data is hashed by the SHA1 cryptographic hash function with salt and pepper.	Protection against reading and recalculation of a password or finding a collision, e.g., with "Rainbow table." Even in the unlikely event that this would be possible, this would have to be repeated for each individual device, since results cannot be transferred to other devices, even if the same password is used.

a. if left unchanged

The Following Measures Must Be Implemented on the Device for Commissioning:

- Hardening: Change the device-specific password printed on the device.
- Special security functions: Access control with single factor authentication (SFA)
  Automatic login lock if access data is entered incorrectly after the seventh attempt for a duration of 1 minute to protect against brute-force attacks.
  The access data is hashed multiple times by the SHA1 cryptographic hash function with salt and pepper.
  KeePass password manager for generating and storing passwords.

The Following Settings Must Be Implemented on the Device for Operation:

- Additional security layers: Password change: every 2 years.
- Servicing and management: Check the website regularly for the release of security advisories and subscribe to the RSS feed: https://www.pepperl-fuchs.com/global/en/29079.htm.

The Following Measures Must Be Implemented on the Device for Decommissioning:

- User access data: Delete using the "Reset to factory settings" function.
- Configuration: Delete using the "Reset to factory settings" function.
- Log data (history, historical data, and error data): Stored only temporarily and deleted after a restart.

Requirements for User Roles to Ensure Cybersecure Operation

- Administrator: Implement the measures defined in "The following measures must be implemented on the device for operation."
  If applicable: Update the firmware and install security patches.

User Account Privileges and Rights

- Administrator: Switching functions on and off
  Configuration
  Reset to factory settings
  Read the log and device status
  Firmware updates

3 Product Description

3.1 Use and Application

The module is a multiprotocol fieldbus module with 8 type A IO-Link master ports according to IO-Link standard V1.1.3.

The G60L design in fully cast metal housing is resistant to mechanical damage and environmental influences. The G60L has protection class IP65/IP67.

The fieldbus module serves as an interface between the controller of a fieldbus system and the field level. Due to its multiprotocol capability, the fieldbus module supports the Ethernet communication protocols PROFINET, EtherNet/IP, EtherCAT, CC-Link, and MODBUS TCP.

An L-coded M12 connector plug used for supplying power enables a current rating of up to 2 x 16 A. The inputs and outputs are equipped with A-coded M12 connector plugs. Connection to the fieldbus is achieved using a D-coded M12 connector plug.

The communication protocols are configured either manually via a rotary switch or automatically. The diagnostics display status information for each channel via LEDs. An integrated web server enables access to the fieldbus module. Information regarding the status of the module is also displayed and network parameters such as the IP address and subnet mask can be configured.

Multiprotocol (PROFINET, EtherNet/IP, EtherCAT®, MODBUS TCP, CCLink IE Field Basic)

The multiprotocol modules allow you to select different protocols for communication within a fieldbus system. As a result, multiprotocol modules can be integrated into different networks without the need to obtain specific modules for each protocol. Thanks to this technology, you can also use one module in different environments.

Using rotary coding switches in the lower area of the modules, you can conveniently and easily set both the protocol and the address of the module, provided that the protocol to be used supports this. If you have chosen a protocol and started the cyclic communication once, the module remembers this setting and uses the selected protocol from this point on. To use another supported protocol with this module, perform a factory reset.

Input/Output Channels for the Field Level

For the field level, the modules have the following input/output channels

- 4 x IO-Link Master Ports Class A
- 4 x IO-Link Master Ports Class B

If one or more of the IO-Link ports are not required, these can also be freely configured as digital inputs or outputs (SIO mode).

IO-Link Characteristics of the Modules

The modules support IO-Link Standard V1.1.3.

- Parametrization of IO-Link devices in PROFINET using Siemens IO_LINK_DEVICE function blocks for Step 7 and the TIA Portal

8 x IO-Link master ports

- **ICE11-8IOL1-G60L-V1D**
  4 class A connections and 4 class B connections
- **ICE11-8IOL-G60L-V1D**
  8 class A connections with additional freely configurable digital input/outputs at pin 2 of the I/O port

IO-Link connections

- 4-pin M12 connector

2024-04

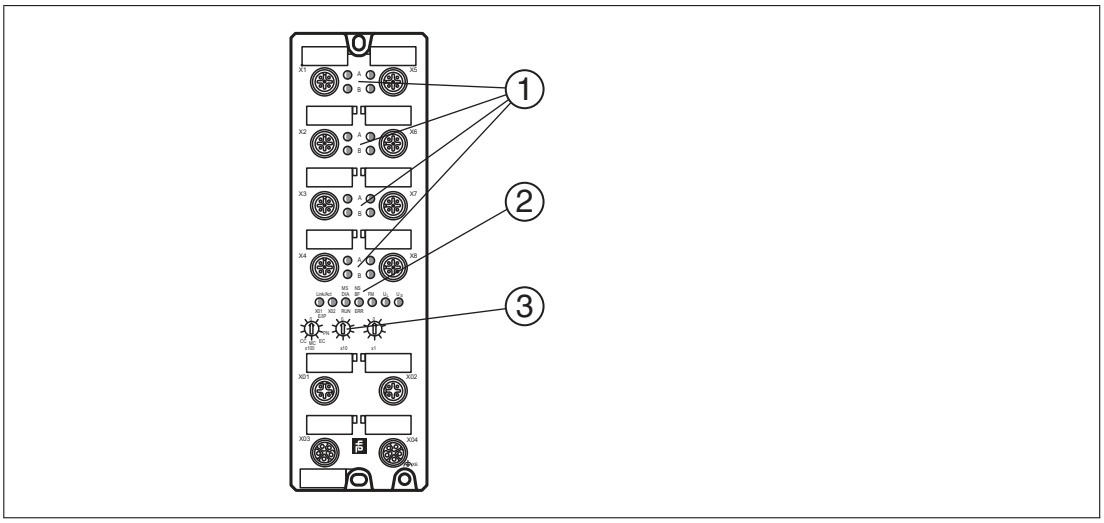
Parameter storage

- The Parameter Storage function stores and monitors the parameters of the IO-Link device and the IO-Link master.
- This function makes it possible for you to easily replace the IO-Link device or the IO-Link master.
  This is possible from IO-Link specification V1.1 onward and only if the IO-Link device and the IO-Link master support the function.

Special Product Features

- **Rugged design:**
  Connectivity options for the module series include the widespread M12 connector with A coding for I/O signals and D coding for the network. In addition, the connectors are color-coded to prevent users from using the wrong ports.
- **Integrated web server:**
  Network parameters such as IP address, subnet mask, and gateway can be adjusted via the integrated web server. The modules support the communication protocols BOOTP and DHCP for automated assignment of network parameters via the corresponding servers.
  You can read the parameters of the IO-Link device via the integrated web server and write new parameters to the modules in single-write mode. Single-write mode does not activate the automatic parameter storage mechanism.
- **Force Mode**
  In Force Mode, the module ports can be configured as digital inputs/outputs or IO-Link ports.
  "Force Mode" allows the simulation of process data at the digital inputs/outputs without the need to connect sensors and actuators. This means that you can test an application in advance without a full physical application. It is possible to simulate input switching states or to switch outputs even without a controller. This feature makes machine commissioning simpler and quicker and can be used to test new production plants.
- **Integrated network switch:**
  The integrated two-port Ethernet switch of the modules allows you to set up a line topology or a ring topology for the EtherNet/IP network or PROFINET network. The additional DLR or MRP protocol allows you to design a highly available network infrastructure.
- **Redundancy function:**
  The module firmware supports the redundancy function DLR (Device Level Ring) or MRP (Media Redundancy Protocol) for ring topologies. This means that if the connection is interrupted, the modules switch immediately to an alternative ring segment and therefore ensure interruption-free operation. The supported DLR class is "beacon-based" in accordance with the EtherNet/IP specification.
- **Fail-safe function:**
  The modules provide a fail-safe function. You can therefore choose the behavior of each individual output channel in the event of an interruption or a loss of communication.
- **QuickConnect:**
  QuickConnect allows the modules to record the communication in an EtherNet/IP network especially quickly through an accelerated boot-up process. This allows you to switch tools faster, for example.

3.2 Indicators and Operating Elements



(1) Channel indicator LED

(2) Status indicator LED

(3) Rotary switch

Note

The LEDs in the lower area of the Ethernet IO module have different names and functions depending on the selected protocol. The following LED descriptions are therefore divided into a general part (1), which is valid for all protocol settings, and LED descriptions for a specific protocol setting (2).

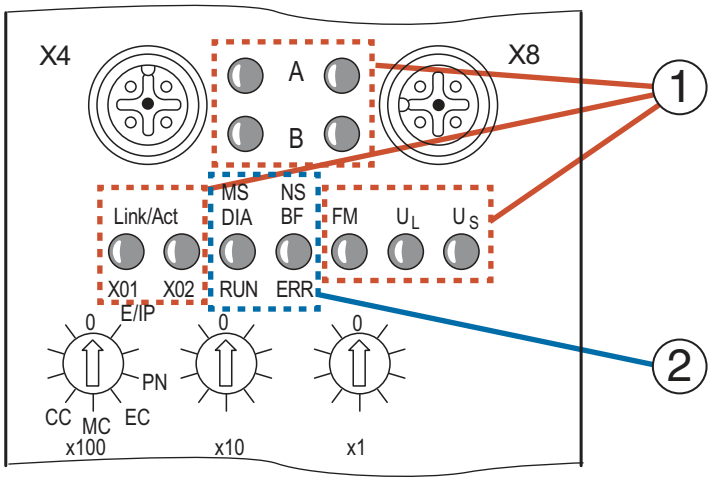


Figure 3.1

Indicators - General Part

Description for LED A, B, DIA, U_L/U_{AUX}, U_S

LED	Function
U_L/U_{AUX}	Green: Auxiliary sensor/actuator voltage OK • 18 V (± 1 V) < U_L/U_{AUX} < 30 V (± 1 V) Red[1]: Auxiliary sensor/actuator voltage too low or too high • U_L/U_{AUX} < 18 V (± 1 V) or U_L/U_{AUX} > 30 V (± 1 V) Off: No auxiliary sensor/actuator voltage
U_S	Green: System/sensor voltage OK • 18 V (± 1 V) < U_S < 30 V (± 1 V) Red: System/sensor voltage too low or too high • U_S < 18 V (± 1 V) or U_S > 30 V (± 1 V) Red flashing: The device is reset to its factory settings Off: No system/sensor voltage
A[2]	Green: IO-Link-COM-Mode • IO-Link communication present Green flashing: IO-Link-COM-Mode • No IO-Link communication Yellow: Standard I/O mode • Status of the digital input or output at C/Q Off: None of the states described above
B[2]	White: Status of digital input and digital output at pin 2 "On" Red • Overload or short-circuit at pin 4 and pin 2 • All modes: Overload or short-circuit at line L+ (pin 1) • Communication errors Off: One of the states described above.
FM	Blue: "Force Mode" active
Lnk/Act X01 Lnk/Act X02	Green: Connected to an Ethernet node Yellow flashing: Ethernet node data exchange Off: No connection

Table 3.1

1. If "Report U_L supply voltage fault" is enabled

2. X1– X8

EtherNet/IP Indicators

E/IP area: relevant LEDs Lnk/Act X01, Lnk/Act X02, MS, NS

LED	Function
BF	Red: No configuration, slow or no physical connection Red flashing: Link exists but no communication link to the Ethernet/IP controller is available Off: No error
DIA	Red: Ethernet/IP diagnostic alarm active Red flashing (1 Hz): Time-out or FailSafe mode is active Red flashing (2 Hz) for 3 s: DCP signal service is triggered via the bus Red double flashing: Firmware Update Off: No error
MS	Green: Module ready for operation Green flashing: Configuration missing Red/green flashing: Self-test Red: Non-recoverable, serious error Flashing red: Minor recoverable error (e.g., incorrect configuration) Off: Module is powered down
NS	Green: Module has at least one existing connection Green flashing: Module has no existing connections. IP address is available Red/green: Module is performing a self-test Red: Module has determined that the assigned IP address already exists Red flashing: The connection has timed out or been interrupted Off: Module is turned off or does not have an IP address.

Table 3.2

PROFINET Indicators

P area: relevant LEDs Lnk/Act X01, Lnk/Act X02, BF, DIA

LED	Function
BF	Red: No configuration, slow or no physical connection Red flashing: Link exists but no communication link to the PROFINET controller is available Off: No error
DIA	Red: Ethernet/IP diagnostic alarm active Red flashing (1 Hz): Time-out or FailSafe mode is active Red flashing (2 Hz) for 3 s: DCP signal service is triggered via the bus Red double flashing: Firmware Update Off: No error
MS	Green: Module ready for operation Green flashing: Configuration missing Red/green flashing: Self-test Red: Non-recoverable, serious error Flashing red: Minor recoverable error (e.g., incorrect configuration) Off: Module is powered down
NS	Green: Module has at least one existing connection Green flashing: Module has no existing connections. IP address is available Red/green: Module is performing a self-test Red: Module has determined that the assigned IP address already exists Red flashing: The connection has timed out or been interrupted Off: Module is turned off or does not have an IP address.

Table 3.3

EtherCAT Indicators

EC area: relevant LEDs Lnk/Act X01, Lnk/Act X02, BF, DIA

LED	Function
BF	Red: No configuration, slow or no physical connection Red flashing: Link exists but no communication link to the EtherCAT controller is available Off: EtherCAT control has established an active connection to the deviceNo error
DIA	Red: Ethernet/IP diagnostic alarm active Red flashing (1 Hz): Time-out or FailSafe mode is active Red flashing (2 Hz) for 3 s: DCP signal service is triggered via the bus Red double flashing: Firmware Update Off: No error
MS	Green: Module ready for operation Green flashing: Configuration missing Red/green flashing: Self-test Red: Non-recoverable, serious error Flashing red: Minor recoverable error (e.g., incorrect configuration) Off: Module is powered down
NS	Green: Module has at least one existing connection Green flashing: Module has no existing connections. IP address is available Red/green: Module is performing a self-test Red: Module has determined that the assigned IP address already exists Red flashing: The connection has timed out or been interrupted Off: Module is turned off or does not have an IP address.

Table 3.4

Modbus Indicators

MB area: relevant LEDs BF, DIA

LED	Function
BF	Red: Bus fault, no configuration, no or slow phys. connection Red flashing (2 Hz): Link present, but no communication connection to the Modbus-TCP controller Off: Modbus-TCP control has established an active connection to the device
DIA	Red: Ethernet/IP diagnostic alarm active Red flashing (1 Hz): Time-out or FailSafe mode is active Red flashing (2 Hz) for 3 s: DCP signal service is triggered via the bus Red double flashing: Firmware Update Off: No error
MS	Green: Module ready for operation Green flashing: Configuration missing Red/green flashing: Self-test Red: Non-recoverable, serious error Flashing red: Minor recoverable error (e.g., incorrect configuration) Off: Module is powered down
NS	Green: Module has at least one existing connection Green flashing: Module has no existing connections. IP address is available Red/green: Module is performing a self-test Red: Module has determined that the assigned IP address already exists Red flashing: The connection has timed out or been interrupted Off: Module is turned off or does not have an IP address.

Table 3.5

CC-Link Indicators

CC area: relevant LEDs BF, DIA

LED	Function
BF	Red: Bus fault, no configuration, no or slow phys. connection Red flashing (2 Hz): Link present, but no communication connection to the CC-Link IE controller Off: CC-Link IE control has established an active connection to the device
DIA	Red: CC-Link IE diagnostic alarm active Red flashing (1 Hz): Time-out or FailSafe mode is active Red flashing (2 Hz) for 3 s: DCP signal service is triggered via the bus Red double flashing: Firmware Update Off: No error
MS	Green: Module ready for operation Green flashing: Configuration missing Red/green flashing: Self-test Red: Non-recoverable, serious error Flashing red: Minor recoverable error (e.g., incorrect configuration) Off: Module is powered down
NS	Green: Module has at least one existing connection Green flashing: Module has no existing connections. IP address is available Red/green: Module is performing a self-test Red: Module has determined that the assigned IP address already exists Red flashing: The connection has timed out or been interrupted Off: Module is turned off or does not have an IP address.

Table 3.6

Operating Elements

Switch	Function
Rotary switch X100	Setting the fieldbus protocol Setting the IP address[1]
Rotary switch X10	Setting the IP address
Rotary switch X1	Setting the IP address

1. Only EtherNET/IP

2024-04

3.3 Interfaces and Connections

The contact arrangements below show the front view of the plug-in area of the connectors.

Fieldbus Connection X01, X02

Caution!

Risk of destruction!

Never route the power supply to the data cable.

- Connection: M12 socket, 4-pin, D-coded
- Color coding: green

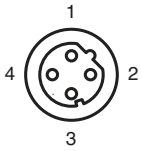


Figure 3.2 Schematic drawing of port X01, X02

Port	Pin	Signal	Function
Ports X01, X02	1	TD+	Transmit data +
	2	RD+	Receive data +
	3	TD-	Transmit data -
	4	RD-	Receive data -

Table 3.7 Assignment of port X01, X02

Connection for IO-Link, Digital Inputs/Outputs X1 ... X8

- Connection: M12 socket, 5-pin, A-coded
- Color coding: black

Caution!

Risk of destruction with external sensor supply!

The module infeed for the sensor supply U_S may only be provided over the specified power connection (Power X03/X04 >> U_S +24 V/GND_U_S) for the module. It is not permitted to supply external power via the IO-Port (port X1–X8 >> pin 1/pin 3) and this may destroy the module electronics through power feedback.

Caution!

Risk of destruction!

Never route the power supply to the data cable.

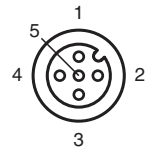


Figure 3.3 Schematic drawing of inputs/outputs 1–8

ICE11-8IOL-G60L-V1D

Port	Pin	Signal	Function
IO-Link Class A, inputs/outputs X1 ... X8	1	L+	IO-Link sensor power supply +24 V
	2	IN-x	Channel B: digital input/output (type 1)
	3	L-	Ground connection IO-Link sensor power supply GND_U_S
	4	C/Q	Channel A: IO-Link data exchange
	5	n.c.	not assigned

ICE11-8IOL1-G60L-V1D

Port	Pin	Signal	Function
IO-Link Class A, inputs/outputs X1 ... X4	1	L+	IO-Link sensor power supply +24 V
	2	IN/OUT	Channel B: digital input/output (type 1)
	3	L-	Ground connection IO-Link sensor power supply GND_U_S
	4	C/Q	Channel A: IO-Link data exchange
	5	n.c.	not assigned
IO-Link Class B, inputs/outputs X5 ... X8	1	L+	IO-Link sensor power supply +24 V
	2	AUX/OUT	Auxiliary power supply[1] +24 V or digital output
	3	L-	Ground connection IO-Link sensor power supply GND_U_S
	4	C/Q	Channel A: IO-Link data exchange
	5	GND AUX	Ground connection auxiliary voltage AUX/OUT

Table 3.8

1. galvanically isolated from the power supply U_S

Connection for Power Supply X03, X04

- Power supply with M12 power L-coded
- Color coding: gray

Note

For the system/sensor and actuator supply, use only power supplies that comply with PELV (protective extra-low voltage) or SELV (safety extra-low voltage). Power supplies according to EN 61558-2-6 (transformer) or EN 60950-1 (switching power supplies) fulfill these requirements.

Caution!

Loss of function when the system supply voltage is too low.

Ensure in all cases that the supply voltage measured at the most remote node (sensor/actuator) does not drop below 18 V DC in terms of system supply voltage.

Caution!

No galvanic isolation

If you operate devices with galvanic isolation and devices without galvanic isolation within a system, the galvanic isolation of all connected devices is canceled.

2024-04

Note

Power supply connection

When connecting the power supply, ensure a separate power supply to the sensor and system via U_s and auxiliary voltage via U_S for actuators, for example. Where the plant has a separate power supply concept for system current and load current, this means the sensor and system area of the Ethernet IO module can continue working even if there is a failure of the load power supply.

Where several Ethernet IO modules are connected in series, ensure the separate power supplies are connected properly U_s .U_L.

The IO-Link specification requires at least 20 V at the output supply of the I/O ports L+[1]. A minimum of 21 V is required at the power supply U_S for the IO-Link master to minimize the risk of internal voltage drops in the IO-Link master.

1. Pin 1

Figure 3.4 Schematic drawing of M12 L-encoding (plug); port X03 (IN)

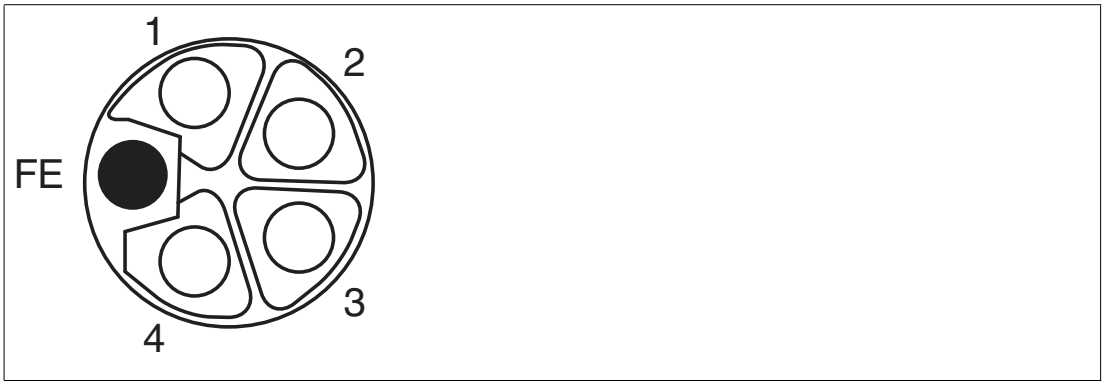


Figure 3.5 Schematic drawing of M12 L-encoding (socket); port X04 (OUT)

ICE11-8IOL-G60L-V1D

Port	Pin	Signal	Function
Voltage supply X03, X04	1	U_S(+24 V)	Sensor/system supply
	2	GND U_L	Ground/reference potential U_L
	3	GND U_S	Ground/reference potential U_S
	4	U_L (+24 V)	Auxiliary voltage
	FE (5)	FE (FE)	Functional earth

Table 3.9

ICE11-8IOL1-G60L-V1D

Port	Pin	Signal	Function
Voltage supply X03, X04	1	U_S(+24V)	Sensor/system supply
	2	GND U_{AUX}	Ground/reference potential U_{AUX}[1]
	3	GND U_S	Ground/reference potential U_S
	4	U_{AUX} (+24V)	Auxiliary voltage[2]
	FE (5)	FE (FE)	Functional earth

Table 3.10

1. galvanically isolated from GND U_S
2. galvanically isolated from U_S

3.4 Dimensions

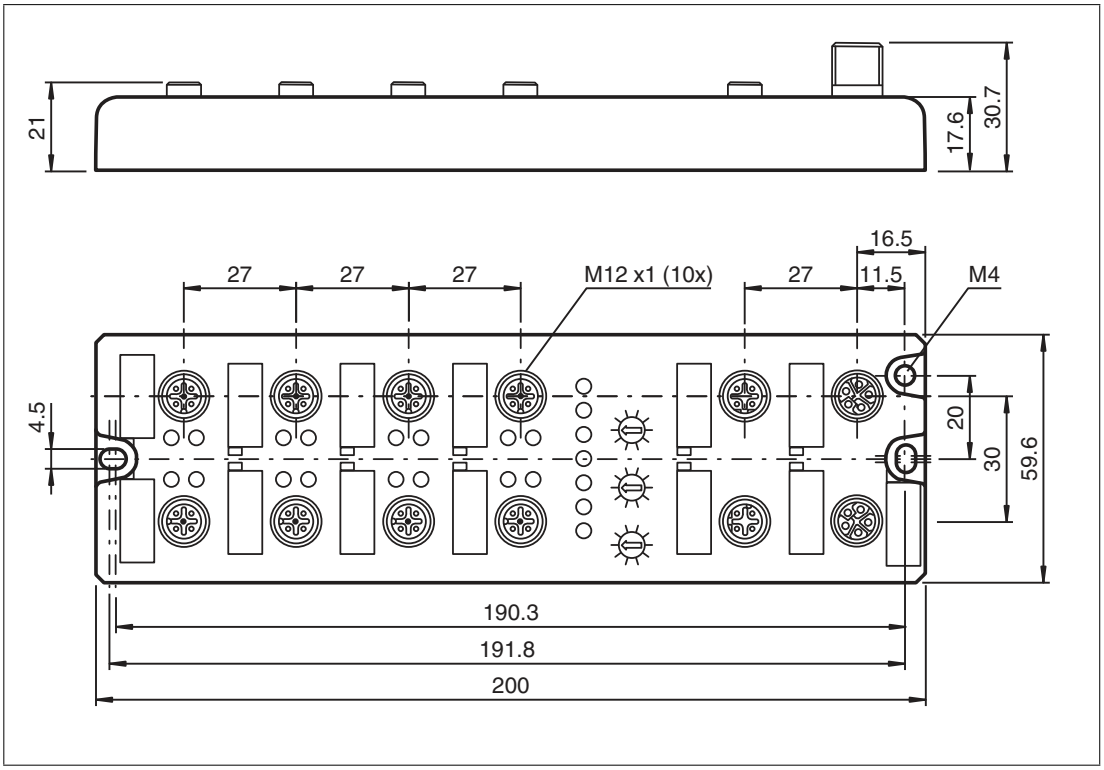


Figure 3.6

2024-04

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4 Installation

4.1 General Information

Install the module with two M6x25/30 size screws on a level surface. The required torque is 1 Nm. Use washers according to DIN 125. For the installation holes, use a spacing of 237.3 mm to 239.7 mm.

Note

Power supply connection

When connecting the power supply, ensure a separate power supply to the sensor and system via U_S and auxiliary supply via U_L for e.g., actuators. Where the plant has a separate power supply concept for system current and load current, this means the sensor and system area of the Ethernet IO module can continue working even if there is a failure of the load power supply.

Where several Ethernet IO modules are connected in series, ensure the separate power supplies are connected properly U_S .U_L.

Note

To dissipate interference currents and for EMC resistance, the modules use a ground connection with an M4 thread. This is marked with the symbol for grounding and the label "XE."

Note

Connect the module using a low-impedance connection with the reference ground. In the case of a grounded mounting surface, you can connect the module directly via the fixing screws.

Note

For non-grounded mounting surfaces, use a ground strap or a suitable FE conductor. Connect the ground strap or FE conductor to the grounding point using an M4 screw and place a washer and a serrated washer under the fixing screw if possible.

Caution!

Destruction of the device

When starting the device for the very first time, set rotary switch X100 to the desired position **before applying the operating voltage**.

Do not operate rotary switch X100 when starting the device for the very first time until the following LEDs indicate normal continuous operation:

The MS and U_S LEDs are solid green when the rotary switches are in position 0-0-0.[1]

Failure to observe this may result in the destruction of the device!

1. Factory setting, EtherNet/IP

Warning!

Risk of injury

Terminals, the housing of field-wired terminal boxes or components may exceed a temperature of 60 °C.

Warning!

Temperature resistant cables

Use temperature-resistant cables with the following properties:

Heat resistant up to at least 96 °C.

Notes on operation in UL-compliant applications

Note

For UL applications, only connect devices using a UL-certified cable with suitable CYJV or PVVA ratings. To program the control unit, refer to the manufacturer's information. Only use suitable accessories.

Approved for indoor use only. Please note the maximum height of 2000 m. Approved up to maximum pollution degree 2.

Warning!

Temperature resistant cables

For UL applications at a maximum ambient temperature of +70 °C:

Use temperature-resistant cables with a heat resistance of at least +125 °C.

Warning!

Note the following maximum currents for the sensor supply of Class A devices

Max. 4,0 A per port; for UL applications max. 5.0 A for each port pair X1/X2, X3/X4, X5/X6, X7/X8; max. 9,0 A[1] in total for the entire port group X1 ... X8.

1. with derating

Warning!

Note the following maximum currents for the sensor supply of Class A/B devices

Max. 4,0 A per port; for UL applications max. 5.0 A from the U_S power supply for each port pair X1/X2, X3/X4, X5/X6, X7/X8 and max. 5.0 A from the U_{AUX} power supply for the port group X5 ... X8; max. 9,0 A[1] in total for the entire port group X1 ... X8.

1. with derating

5 Commissioning, Protocol Setting

5.1 MAC Addresses

Each device has 3 unique, manufacturer-assigned MAC addresses that cannot be changed by the user. The first assigned MAC address is printed on the device. This MAC address has no function for EtherCAT®. For EoE (Ethernet over EtherCAT®), the device is assigned a virtual MAC address.

5.2 Assigning the Device Name to a PROFINET IO Module

Each module must have a device name so that each node in the PROFINET network can be assigned an IP address. A node search displays all PROFINET devices that have been found.

The module has three assigned MAC addresses when it is delivered. These are unique and cannot be changed by the user. The first MAC address is shown on the housing of the Ethernet IO module. (See between X2 and X3). Using this address, each device can be found in the list of available nodes and assigned a device name.

1. Connect the module to the PROFINET network.
2. In "Device View," select the module "Slot 0."
3. Open the dialog "Accessible devices" via the main menu "Online -> Accessible devices ...."

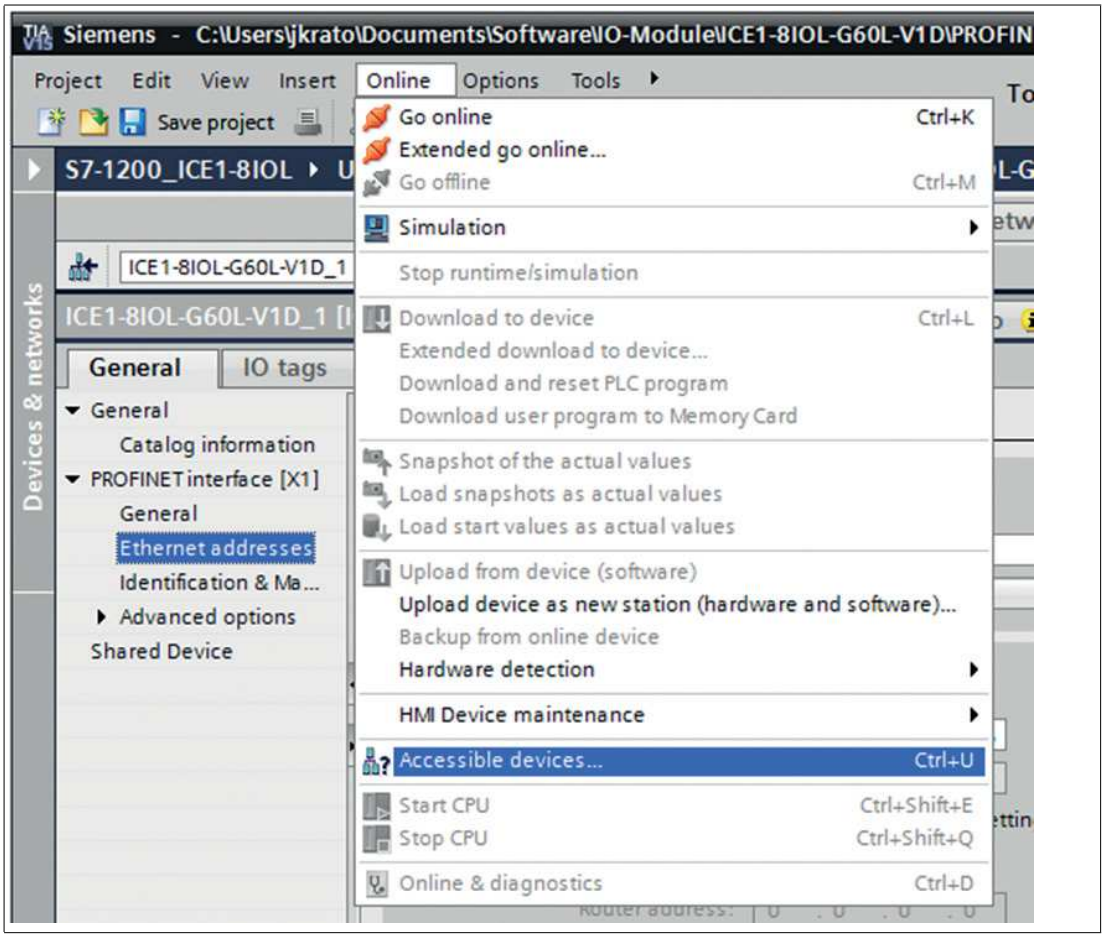

Figure 5.1

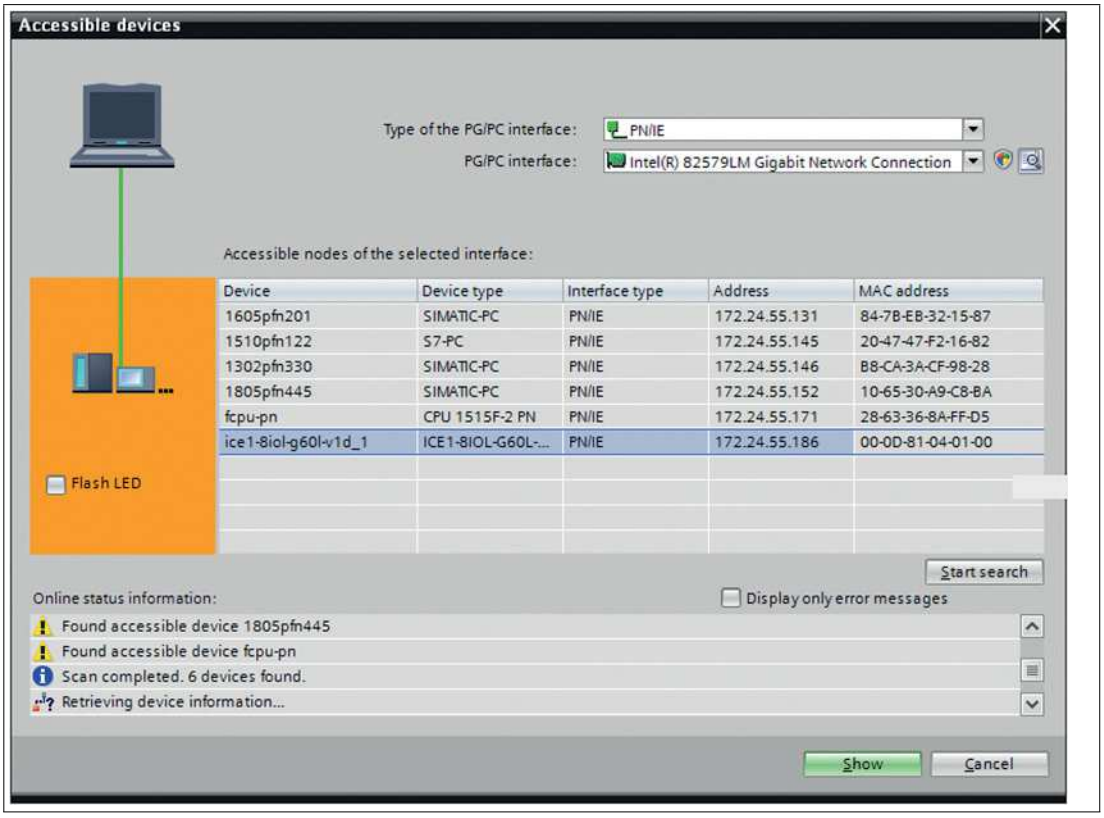

Figure 5.2

4. Select a module from those found.

   ↳ If the desired module is not displayed in the list of available nodes on the network, you can change the device filter and refresh the list. If the device still does not appear, please check your firewall settings.

5. Assign the selected PROFINET device name to the module.

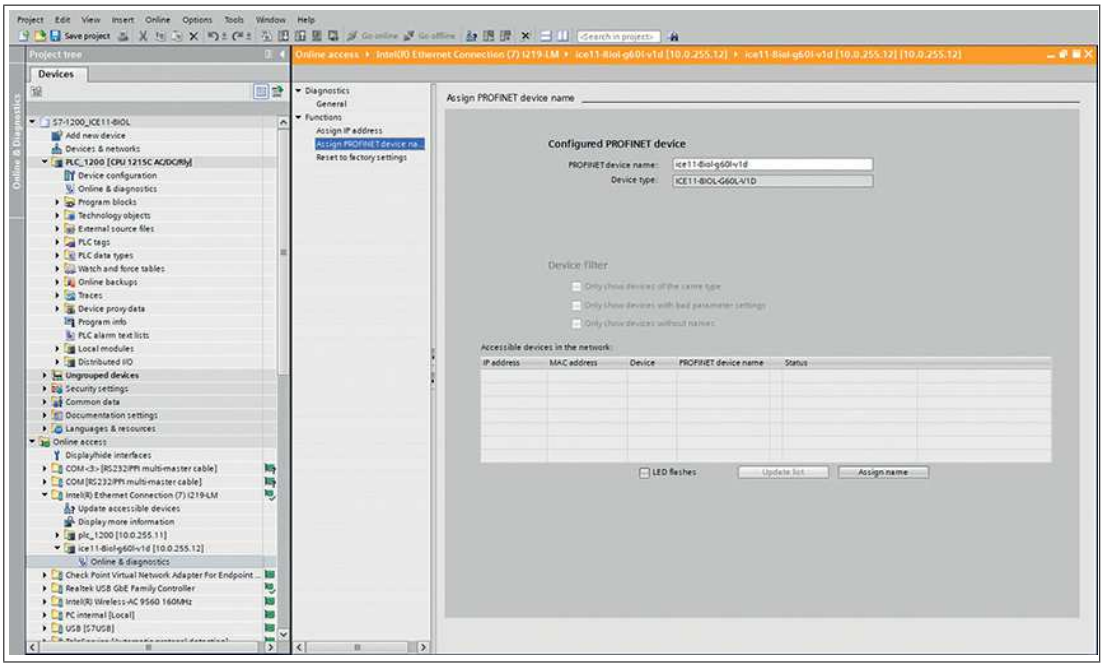

Figure 5.3

↳ If the device name was set successfully, this will be indicated by the status.

6. Complete the process by pressing the "Assign Name" button.

5.3 IODD

The IODD[a] consists of a set of files that formally describe an IO-Link device. The IODD is created by the device manufacturer and is required for each IO-Link device.

The device can use an IODD to facilitate IO-Link device configuration and make process data more readable to people. IODDs can be uploaded via the web interface and then stored sustainably on the IO-Link master. When an appropriate IO-Link device is connected, the stored IODD is used to provide a user-friendly configuration page. On the configuration page, you can view and adjust all parameters of the device. In addition, the process data is also formatted and displayed for the user in accordance with the IODD.

IO-Link Device Parameters and ISDU Requests

Each IO-Link node offers parameters that can be read and written via the special IO-Link service ISDU[b] .

Each parameter is addressed by an index. Sub-indexes are possible, but optional. Some of the parameters (mostly marked "read-only") are required for IO-Link devices and can always be found on the same indexes.

The manufacturer may use additional parameters and therefore more indexes too for their devices to provide additional configuration options. These manufacturer-specific parameters can be described in an IODD. The device's "IODD on Module" function can read and evaluate this information from an IODD and use it to provide the user with viewing and editing options for manufacturer-specific parameters without requiring additional knowledge of manufacturer-specific device properties.

Standard Definitions File

IODDs usually refer to a "Standard Definitions File". The latest "Standard Definitions File" is pre-installed in the system upon initial delivery. You can also manually update the "Standard Definitions File" by clicking on the "Upload Standard Definitions File" button.

5.4 Protocol Setting

Multiprotocol

You can use the multiprotocol modules to select various protocols for communication within a fieldbus system. This allows you to integrate the multiprotocol modules into different networks without having to obtain specific modules for each protocol. This technology also allows you to use the same module in different environments. Using the rotary switches on the front of the modules, you can easily and conveniently set the protocol and address of the module, provided that the protocol to be used supports this. Once you have selected a protocol and started the cyclical communication, the module remembers this setting and uses the selected protocol from this point on. To use another supported protocol with this module, perform a factory reset.

Setting a Protocol

Multiprotocol modules have a total of three rotary switches. Move the first rotary switch X100 to the relevant switch position to set the protocol. For the other rotary switches, set the last two digits of the IP address when using EtherNet/IP.

a. IODD = IO Device Description

b. ISDU = Indexed Service Data Unit

Caution!

Destruction of the device

When starting the device for the very first time, set rotary switch X100 to the desired position **before applying the operating voltage**.

Do not operate rotary switch X100 when starting the device for the very first time until the following LEDs indicate normal continuous operation:

The MS and U_S LEDs are solid green when the rotary switches are in position 0-0-0.[1]

Failure to observe this may result in the destruction of the device!

1. Factory setting, EtherNet/IP

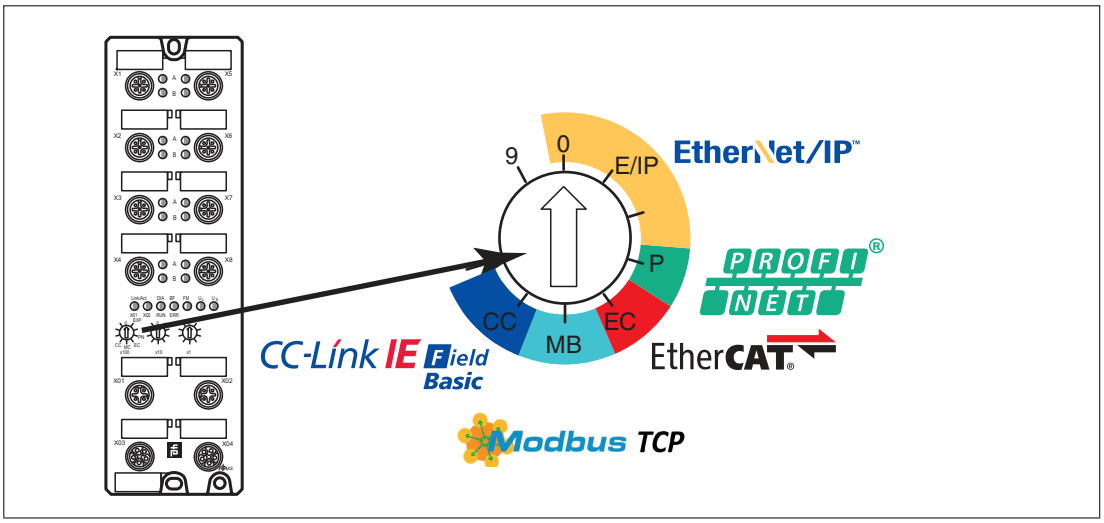

Figure 5.4 Rotary switch X100

Assignment of the Rotary Switches per Protocol

Protocol	X100	X10	X1
EtherNet/IP	0–2	0–9	0–9
PROFINET	P	-	-
EtherCAT	EC	-	-
Modbus TCP	MB	0–9	0–9
CC-Link IE Field	CC	0–9	0–9

Table 5.1

In its delivered state, the module does not contain any protocol settings. In this case, set the desired protocol.

In order to accept a changed protocol setting via the rotary switches, a restart or a "Reset" via the web interface is necessary.

Once you have set the protocol using the rotary switches, the module saves these settings as soon as it starts a cyclical communication. You can no longer change the protocol using the rotary switch from this point on. The device always starts with the saved protocol.

To change the protocol, perform a factory reset first.

If you set the rotary coding switch to an invalid position, the device signals this with a flash code: the BF/MS/ERR LED flashes red three times.

You can change the IP address depending on the protocol you choose.

EtherNet/IP

If you use EtherNet/IP as the protocol, use rotary switch X100 to set the value 100 as the last octet of the IP address for the module. You can use rotary switch X100 to set a value of 0 to 2 for the IP address. You can use rotary switches X10 and X1 to select values between 0 and 9. You can use rotary switch X10 to configure position 10 of the last octet of the IP address. You can use rotary switch X1 to configure position 1 of the last octet of the IP address.

The default setting for the first three octets of the IP address is 192.168.1.

Example: Rotary switch settings 2 (X100), 1 (X10), and 0 (X1) result in an IP address of 192.168.1.210 for EtherNet/IP.

Alternatively, the required network parameters can be obtained via DHCP or BOOTP if the rotary switch is set to zero.

PROFINET

If you are using PROFINET as the protocol, set rotary switch X100 to the value "P."

EtherCAT

If you are using EtherCAT as the protocol, set rotary switch X100 to the value "EC."

Modbus TCP

If you would like to use Modbus TCP as the protocol, set the protocol using the first rotary coding switch. The second rotary coding switch X10 can be used to configure the 10 digit of the last octet of the IP address. The third rotary coding switch X1 allows for the configuration of the 1 digit. Values between 0 and 9 can be selected for the second and third switches. The default setting for the first three octets of the IP address is 192.168.1.

Example

The rotary coding switch setting 5 - X100, 1 - X10 and 0 - X1 results in the IP address 192.168.1.10 for Modbus TCP.

Only IP addresses between 192.168.1.1 and 192.168.1.99 for Modbus TCP can be assigned via the rotary switches.

Rotary switch position	Function
500[1]	The network parameters last saved are used: IP address, subnet mask, gateway address, DHCP ON/OFF, BOOTP ON/OFF
501 to 599	The last two digits of the saved or default IP address are overwritten by the rotary switch setting.
979	The device is reset to factory settings. The network parameters are also reset to the preset values. Communication is not possible in this operating mode.

1. Network parameters already saved

CC-Link IE Field Basic

If you opt for CC-Link IE Field Basic as the protocol, set rotary switch X100 to the value CC. You can use the X10 and X1 rotary switches to specify the last 2 digits of the IP address. You can select values between 0 and 9.

The default setting for the first three octets of the IP address is 192.168.1.

Example: Rotary switch settings 2 (x100), 1 (x10), and 0 (x1) result in an IP address of 192.168.1.210 for Modbus TCP.

Alternatively, the required network parameters can be obtained via DHCP or BOOTP if the rotary switch is set to zero.

Rotary switch position	Function
600[1]	The network parameters last saved are used: IP address, subnet mask, gateway address
600 to 699	The last two digits of the saved or default IP address are overwritten by the rotary switch setting.
979	The device is reset to factory settings. The network parameters are also reset to the preset values. Communication is not possible in this operating mode.

1. Network parameters already saved

Factory Settings

A factory reset erases any changes you have made to settings, etc. and restores the factory settings. The saved protocol selection is also reset.

To perform a factory reset, set rotary switch X100 to 9, rotary switch X10 to 7, and rotary switch X1 to 9. Then switch the module off and on again. The factory settings are restored after 10 seconds.

During factory reset, the U_S LED flashes red. After resetting, the U_S LED indicates the voltage U_S again.

To select a new protocol, follow the instructions in this chapter.

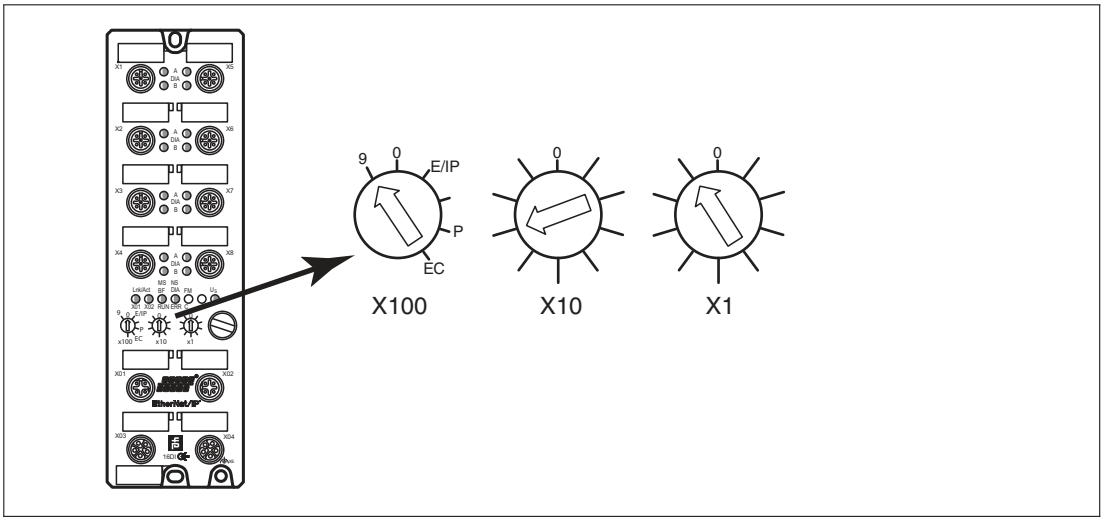

Figure 5.5 Restoring factory settings: X100 = 9, X10 = 7, X1 = 9

Caution!

Destruction of the Operating System

When restoring the factory settings, ensure that the module is connected to the voltage supply and switched on for **at least** 10 seconds. If it has been on for fewer than 10 seconds, the operating system may be destroyed. The module would then need to be sent to Pepperl+Fuchs for repair.

2024-04

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6 Commissioning with CC-Link

6.1 Preparation

CSP+ file

A CSP+ file describes the device information of a CC-Link device and is required to configure the module in an engineering tool. You can find the CSP+ file on the product detail page on our website pepperl-fuchs.com. The CSP+ file and the associated icons are combined in an archive file. To download and install this file, see chapter 6.4. Install the CSP+ file using your controller manufacturer's hardware or network configuration tool. In GxWorks®, install the files using the CSP+ Hardware Installation Tool. The module is then available in the hardware catalog as a "Communications Adapter."

MAC Addresses

The modules have three assigned MAC IDs when they are delivered. These are unique and cannot be changed by the user.

The first assigned MAC ID is printed on the module.

Factory Settings

CC-Link IE Field Basic parameters as supplied or after resetting to factory settings.

Network mode:	Static
Fixed IP address:	192.168.3.XXX (XXX = rotary switch position or last stored setting)
Subnet mask:	255.255.255.0
Gateway address:	192.168.3.100
Device names:	ICE11-8IOL-G60L-V1D
Product type:	CC-Link IE Field Basic Slave Station

Setting network parameters

Use the two right-hand rotary switches X10 and X1 on the front of the device to set the last octet of the static IP address. Each rotary switch in the CC-Link IE Field Basic area is assigned a decimal place, so that a number between 0 and 99 can be configured. During startup, the position of the rotary switches is typically read within a time cycle.

The full IP address, subnet mask, gateway address and network mode[a] can be configured via the web server or other available configuration interfaces. New configuration interfaces cannot be applied until the device is restarted. For more information, see chapter 5.4.

6.2 Configuration of CC-Link IE Field Basic

The module's parameters can be configured using SNMP, the web server, or IIoT protocols. Acyclic messages are sent via SNMP to read and overwrite the configuration. When sending, all existing parameters are overwritten by this data and the content of the SNMP messages is given the highest valence.

To prevent parameters from being overwritten by the web server or IIoT protocols during operation, some lock parameters can be enabled in the PLC configuration or configuration group.

The following information represents different setting groups with their configuration parameters. The respective default settings are highlighted.

a. DHCP or BOOTP

General Settings

Setting	Description	Default
Suppress U_{Aux} Diagnosis Mode	Supply voltage error U_L/ U_{Aux} fault report 0 = enabled 1 = disabled 2 = auto	0
Suppress Actuator Diagnosis without U_L	Actuator without U_L/ U_{Aux} voltage fault report 0 = enabled 1 = disabled	0
Suppress U_S Diagnosis	Report U_S voltage fault 0 = Diagnosis disabled 1 = Diagnosis enabled	0
Reserved	Reserved	0
Output Auto Restart	Output Auto Restart 0 = deactivated 1 = activated	0
Web Interface Lock	Web Interface Lock 0 = deactivated 1 = activated	0
Forcing Lock	Force Mode Lock 0 = deactivated 1 = activated	0
External Configuration Lock	External Configuration Lock 0 = deactivated 1 = activated	0

Force Mode Lock

The input and output process data can be forced via various interfaces.[b] Interface support depends on the software features available. If **force mode lock** is activated, no input process data or output process data can be forced via these interfaces.

Danger!

Risk of injury or death!

Forcing can lead to unexpected signals and uncontrolled machine movements.

Web Interface Lock

Access to the web interface can be set. If web interface lock is activated, the web pages are no longer accessible.

Report U_L/ U_{Aux} Supply Voltage Fault

During commissioning, it is possible that no power supply is connected to the U_L/ U_{Aux} pins. It may therefore be helpful to suppress and deactivate the U_L/ U_{Aux} supply voltage fault message.

Report Actuator Fault without U_L/ U_{Aux} Voltage

During commissioning, it is possible that no power supply is connected to the U_L/ U_{Aux} pins. It may therefore be helpful to suppress and deactivate the U_L/ U_{Aux} voltage fault message.

Report U_S voltage fault

During commissioning, it is possible that no power supply is connected to the U_S pins. It may therefore be helpful to suppress and deactivate the report U_S voltage fault message.

b. e.g., web interface, REST, OPC UA, MQTT

External Configuration Lock

Configuration parameters can be set via various alternative interfaces (e.g., web interface, REST, OPC UA, MQTT). An external configuration can only be made as long as no cyclic PLC connection is active. Each new PLC configuration overwrites the external configuration settings.

Port configuration, X1 to X8

Setting	Description	Default
Port Mode	Port mode 0: Disabled 1: IO-Link Manual 2: IO-Link Auto 3: Digital Input 4: Digital Output	3
Validation Check	Validation option 0: No device check or deletion[1] 1: Type-compatible V1.0 device[1] 2: Type-compatible V1.1 device[1] 3: Type-compatible V1.1 device with backup & restore[2] 4: Type-compatible V1.1 device with restore[3]	0
IQ Mode, Pin 2	IQ mode 0: Disabled 1: Digital Input 2: Digital Output	1
Cycle Time	Cycle time 0: As fast as possible 1: 1.6 ms 2: 3.2 ms 3: 4.8 ms 4: 8.0 ms 5: 20.8 ms 6: 40.0 ms 7: 80.0 ms 8: 120.0 ms	0
Vendor ID	Vendor ID 0 to 65535	0
Device ID	Device ID 0 to 16777215	0
IO-Link Failsafe Mode	Failsafe mode 0: Set Low 1: Set High 2: Hold Last 3: Replacement Value 4: IO-Link Master Command	0
IO-Link Failsafe Value 0 to 31	IOL Failsafe replacement values 0 to 255	0
Swap Length	Consuming Swap Length, Consuming data 0: DWORD 1: WORD	0
Offset Consuming	Swap Offset, Consuming data 0 to 30 bytes	0
Swap Count Consuming	Swap Count, Consuming data 0 to 30 bytes	0
Swap Length Producing	Swap Length, Producing data 0: DWORD 1: WORD	0

Setting	Description	Default
Offset Producing	Swap Offset, Producing data 0 to 30 bytes	0
Swap Count Producing	Swap Count, Producing data 0 to 30 bytes	0
Sensor Supply Disabled	Sensor supply disabled 0: Sensor supplied with electrical voltage 1: No electrical voltage on sensor	0
Suppress all Diagnosis	Diagnosis suppression 0: Generate diagnostics on this channel 1: Do not generate any diagnostics on this channel	0
Surv. Timeout, Pin 2	DO Surveillance Timeout for Pin 2 (IQ), valid values: 0 to 255	80
Surv. Timeout, Pin 4	DO Surveillance Timeout for Pin 4, CQ valid values: 0 to 255	80
Failsafe Mode SIO, Pin 2	DO Failsafe for Pin 2, IQ 0: Set Low 1: Set High 2: Hold Last	0
Failsafe Mode SIO, Pin 4	DO Failsafe for Pin 4, CQ 0: Set Low 1: Set High 2: Hold Last	0
DI Filter, Pin 2	DI Filter for Pin 2, IQ 0: Disabled 1: 10 ms 2: 20 ms 3: 30 ms 4: 60 ms 5: 100 ms 6: 150 ms	0
DI Filter, Pin 4	DI Filter for Pin 4, CQ 0: Disabled 1: 10 ms 2: 20 ms 3: 30 ms 4: 60 ms 5: 100 ms 6: 150 ms	0
DI Logic, Pin 2	DI Logic for Pin 2, IQ 0: Normally open 1: Normally closed	0
DI Logic, Pin 4	DI Logic for Pin 4, CQ 0: Normally open 1: Normally closed	0
DO Restart, Pin 2	DO Restart for Pin 2, IQ 0: Inactive 1: Active	0
DO Restart, Pin 4	DO Restart for Pin 4, CQ 0: Inactive 1: Active	0
Error LED Disable, Pin 2	Disable pin 2 error LED 0: Enable LED on channel B 1: Disable LED on channel B	0
Error LED Disable, Pin 4	Disable pin 4 error LED 0: Enable LED on channel A 1: Disable LED on channel A	0

2024-04

Setting	Description	Default
Level LED Disable, Pin 2	Disable pin 2 Level LED 0: Enable LED on channel B 1: Disable LED on channel B	0
Level LED Disable, Pin 4	Disable pin 4 Level LED 0: Enable LED on channel A 1: Disable LED on channel A	0
Use Push-Pull, Pin 4	Use Push-Pull for pin 4 0: Use High-Side-Switches 1: Use Push-Pull	0
Current limit, Pin 2	Pin 4 current limit; maximum current limit until pin 2 is switched off 0 to 65535	65535
Current limit, Pin 4	Pin 4 current limit; maximum current limit until pin 4 is switched off 0 to 65535	65535

Table 6.1

1. No data storage
2. Download + upload
3. Download master on device

Port mode

The port mode describes how the IO-Link master handles the presence of an IO-Link device on the port.

Disabled:	The IO-Link port is deactivated, but can be configured for later use. If the IO-Link device is not connected, no diagnostics are generated.
Manual IO-Link:	The IO-Link port is enabled and an explicit port configuration can be made for the Validation and Backup parameters (Inspection Level), Vendor ID, Device ID, and Cycle Time.
Auto IO-Link:	The IO-Link port is activated and no explicit port configuration is required. Configurations such as Validation and Backup (Inspection Level), Vendor ID, Device ID, and Cycle Time are not required.
Digital input:	In this mode, the channel operates as a digital input. The status of the channel can be seen in the Digital Input Channel Status of the cyclical process data.
Digital output:	In this mode, the channel operates as a digital output. The channel can be controlled via the Digital Output Channel Control[1] or via the IO-Link Output Data[2] of the cyclical process data. This depends on the Digital Output Control parameter in the General Settings.

1. the first two bytes of the output data
2. the first byte of the output data of each IO-Link device

Validation and Backup

This parameter enables the user to set the behavior of the IO-Link ports in relation to the type compatibility and data storage mechanism of the connected IO-Link device.

The prerequisite for using Validation and Backup is that you configure the port mode to "IO-Link Manual."

The IO-Link master has a backup memory that can be used to save device parameters and restore them to the IO-Link device. This backup memory is emptied by the following actions:

- IO-Link master factory reset, reset to factory settings
- Reconfiguration of the Channel Mode, for example from "Digital Input" to "IO-Link"

- Reconfiguration of validation and backup, for example from "No device check" to "Type compatible V1.1 device with Backup & Restore"

For more information, please refer to the "IO-Link Interface and System Specification" version 1.1.3, which can be downloaded from https://io-link.com/.

No Device Check (No Data Storage)

No verification of the connected manufacturer ID or device ID and no "backup and restore" support of the IO-Link master parameter server.

Type-Compatible V1.0 Device (No Data Storage)

Type-compatible with regard to IO-Link specification V1.0, which includes the validation of manufacturer ID and device ID. The IO-Link specification V1.0 does not support an IO-Link master parameter server. Type-compatible V1.1 device (no data storage): Type-compatible with regard to IO-Link specification V1.1, which includes the validation of manufacturer ID and device ID. Backup and Restore is deactivated.

Type-Compatible V1.1 Device with Backup + Restore (Upload + Download)

Type-compatible with regard to IO-Link specification V1.1, which includes the validation of manufacturer ID and device ID. Backup and Restore is activated.

Please note the following information on backup and restore conditions:

- Backup (device to master):
  A backup[c] is performed if an IO-Link device is connected and the master has no valid parameter data. The read parameter data is saved permanently on the IO-Link master.
  An upload is also executed if the IO-Link device has set the DS_UPLOAD_FLAG.[d] This IOL device flag can be set in two ways:
  - Parameters are written to an IOL device in block parameter mode: An IO-Link device sets the DS_UPLOAD_FLAG independently if the block parameter mode parameters have been written to the IO-Link device with the last system command ParamDownloadStore, for example, by a third-party USB IO-Link master for commissioning.
  - Parameters are written to an IOL device in single parameter mode: If single parameter data on the IOL device is changed during operation, the device parameters stored on the IOL master can be updated using the ParamDownloadStore command.[e] This command sets the DS_UPLOAD_REQ flag on the IOL device, so the IO-Link master can perform an upload process from the IO-Link device.
- Restore (master to device):
  A restore[f] is executed if an IO-Link device is connected and the IO-Link master has saved valid parameter data for the IOL device that does not correspond to the current device parameters.
  The recovery process can be blocked by the IO-Link device via the Device Access Locks parameter, provided this is supported by the IO-Link device.[g]

Type-Compatible V1.1 Device with Restore (Download Master to Device)

Type-compatible with regard to IO-Link specification V1.1, which includes the validation of vendor ID and device ID. Only "Restore" is activated.

Please note the following information on restore conditions:

- Restore (download/IOL master to IOL device):
  A restore (download from the IOL master to the IOL device) is executed if an IO-Link device is connected and the IO-Link master has saved valid parameter data for the IOL device that does not correspond to the current device parameters.
  In restore mode, no changes to the IOL device parameters are saved permanently on the

c. Upload from the IOL device to the IOL master

d. Data Storage Upload Flag

e. Index 0x0002, sub-index 0x00, value 0x05

f. Download from IOL master to IOL device

g. Index 0x000C, refer to the manufacturer-specific IO-Link device documentation

2024-04

IOL master. If the IOL device sets the DS_UPLOAD_FLAG in this mode, the device parameters are restored by the IOL master.
The recovery process can be blocked by the IO-Link device via the Device Access Locks parameter, provided that this parameter is supported by the IOLink device (index 0x000C, refer to the manufacturer-specific IO-Link device documentation).

IQ mode

The operating mode of pin 2[h] of the respective IO-Link channel can be configured using this parameter.

Digital Output

In this mode, the channel operates as a digital output. The channel can be controlled via the Digital Output Channel Control[i] or via the IO-Link Output Data[j] of the cyclical process data. This depends on the Digital Output Control parameter in the General Settings.

Digital Input

In this mode, the channel operates as a digital input. The status of the channel can be seen in the Digital Input Channel Status of the cyclical process data.

Cycle Time

The IO-Link cycle time can be configured with this parameter.

The prerequisite for using the cycle time is that you configure the port mode to "IO-Link Manual."

As fast as possible

The IO-Link port uses the max. supported IO-Link device and IO-Link master update cycle time for the cyclical I/O data update between the IO-Link master and the IO-Link device.

1.6 ms, 3.2 ms, 4.8 ms, 8.0 ms, 20.8 ms, 40.0 ms, 80.0 ms, 120.0 ms

The cycle time can be set manually to the options provided. This option can be used, for example, for IO-Link devices that are connected via inductive couplers. Inductive couplers are usually the bottleneck in the update cycle time between the IO-Link master and the IO-Link device. In this case, please refer to the datasheet of the inductive coupler.

Manufacturer ID/vendor ID

The vendor ID is required for the validation of the IO-Link device and can be configured with this parameter.

The prerequisite for using the vendor ID is that you configure the port mode to "IO-Link Manual." Validation and Backup must be set to a type-compatible V1.X device.

Device ID

The device ID is required for the validation of the IO-Link device and can be configured with this parameter.

The prerequisite for using the device ID is that you configure the port mode to "IO-Link Manual." Validation and Backup must be set to a type-compatible V1.X device.

IOL Failsafe

The module supports a failsafe function for the output data of the IO-Link channels. In the event of an internal device error, the PLC is in the STOP state and cannot supply any valid process data; the connection is interrupted or communication is lost: The output data of the IO-Link channels is controlled by the configured failsafe values.

h. Channel B

i. the first two bytes of the output data

j. the first byte of the output data of each IO-Link device

Set Low

If failsafe is active, all bits of the IO-Link output data are set to "Low".[k]

Set High

If failsafe is active, all bits of the IO-Link output data are set to "High".[l]

Hold Last

If failsafe is active, all bits of the IO-Link output data maintain the last valid process data status.[m]

Replacement Value

A substitute value can be set for each IO-Link device via the IO-Link failsafe parameter object. If failsafe is active, these substitute values are transmitted to the IO-Link device. The currently configured IO-Link output data size must be taken into account. Note that in the case of a fault, the substitute values are sent instead of the output process data, so a configured swapping mode has an influence on the byte order.

IO-Link Master Command

If failsafe is active, an IO-Link-specific mechanism for valid/invalid output process data is used and the IO-Link device determines the behavior itself.

Failsafe values

IOL Failsafe values represent 32 replacement values byte by byte. If failsafe is active, these values are transmitted to the IO-Link device.

Swapping Length

The byte order of IO-Link is Big Endian. The Swapping Mode and Swapping Offset parameters help the user to set the output data in the correct format. Up to 16 "words" or up to 8 "double words" can be selected for conversion of the output data.

Raw IO-Link Data

No "byte swap".

Data Type DWORD

Data byte order: Byte 1, Byte 2, Byte 3, Byte 4

Sequence after "Swap": Byte 4, Byte 3, Byte 2, Byte 1

Data Type WORD

Data byte order: Byte 1, byte 2

Sequence after "Swap": Byte 2, Byte 1

Swapping Offset

The Swapping Offset describes the starting point in the process data for use of the configured Swapping Length. Both parameters depend on the configured input and output data size.

Swapping Count

The Swapping Count describes the number of bytes swapped in the process data using the configured Swapping Length.

Sensor Supply Disabled

The Sensor Supply Disabled setting can be used to disable the supply of a sensor. The IO-Link master will disable the supply for the corresponding IO-Link port.

k. "0"

l. "1"

m."0" or "1"

Suppress all Diagnosis

By default, the IO-Link master generates all possible diagnostics and sends corresponding reports about cyclic and acyclic data. By setting Suppress all Diagnosis, all diagnoses can be suppressed.

DO Surveillance Timeout

The digital output channels are monitored during runtime. The error states are detected and reported as a diagnosis. To avoid error states when switching the output channels, Surveillance Timeout can be configured with a delay and deactivated monitoring.

The delay time begins with a rising edge of the output control bit. After the delay time has elapsed, the output is monitored and error states are signaled via diagnostics. If the channel is permanently switched on or off, the typical filter value is 5 ms.[n]

DO Failsafe

The module supports a failsafe function for the channels used as digital outputs. In the event of an internal device error, the PLC is in the STOP state and cannot supply any valid process data. The connection is interrupted or communication is lost. The outputs are controlled according to the configured failsafe values.

Set Low

If failsafe is active, the physical output pin of the channel is set to "Low".[o]

Set High

If failsafe is active, the physical output pin of the channel is set to "High".[p]

Hold Last

If failsafe is active, the physical output pin of the channel maintains the last valid process data status.[q]

DO Restart Mode

In the event of a short-circuit or overload on an output channel, a diagnosis is signaled and the output is switched to "off."

If DO Restart Mode is deactivated, the output channel is not automatically switched on again. It can be switched on after a logical reset of the channel's process output data.

If DO Restart Mode is activated for this channel, the output is automatically switched on again after a fixed time delay to check whether the overload or short-circuit status is still active. If it is active, the channel is switched off again.

DI Logic

The logical state of an input channel can be configured using these parameters. If a channel is set to "Normally Open," a low signal[r] is transferred to the process input data, e.g., if an undamped sensor has an open switching output.

If a channel is set to "Normally Closed," a high signal[s] is transferred to the process input data, e.g., if an undamped sensor has a closed switching output.

The channel LED indicates the physical input state of the port pin, regardless of these settings.

n. not changeable

o. "0"

p. "1"

q. "0" or "1"

r. "0"

s. "1"

DI Filter

These parameters can be used to configure a filter time for each digital input channel. If a filter is not required, it can be deactivated.

Error LED Disable

Each channel of ports X1 to X8 has an error LED. The error LED can be deactivated by enabling the Error LED Disable parameter. If this parameter is enabled, the LED status will not show "ON" in the event of a port error.

Level LED Disable

Each channel of ports X1 to X8 has a Level LED. The Level LED can be disabled by enabling the LEVEL LED Disable parameter. If this parameter is enabled, the LED status will not show "ON" in the event of input or output peaks.

Use Push Pull

If Use Push Pull is enabled, the output is actively switched to "high" or "low". In the Low state, the output can be a current sink. The digital output is supplied with a maximum current of 0.5 A by U_S.

If this option is not enabled, the "High-Side switch" option is used and the current limit is set according to the Current Limit parameter. This option is not available for the B channel of any port.

Current Limit

This parameter allows you to configure the current limitation for the digital outputs. You can choose between different current limiting options.

In the Low state, the output has a high impedance. Depending on the device version, the digital output is supplied by U_L or U_{AUX} and has an adjustable current limit. This means that the output is switched off and the error diagnosis of the actuator channel is reported as soon as this limit is exceeded. If you set the limit to 2.0 A max., the current limitation is not active and the maximum output current is available.

6.3 Process Data Assignment

The module supports process data communication in both directions. In this context, "consuming data" is defined as the process output data that controls the physical outputs and IO-Link output data. In this context, "producing data" is defined as the process input data that contains the physical inputs, diagnoses and IO-Link input data with optional extended status and event data.

The following chapters describe the data images for the data direction of consuming and producing data, which are assigned to the output and input assemblies.

Consuming Data (Output)

Port no.	Pin	Register for DO[1]	Register for IO-Link[2]	Access
X1	4	Y0	RWw00 – RWw0F	RW[3]
	2	Y1	-	RW
X2	4	Y2	RWw10 – RWw1F	RW
	2	Y3	-	RW
X3	4	Y4	RWw20 – RWw2F	RW
	2	Y5	-	RW
X4	4	Y6	RWw30 – RWw3F	RW
	2	Y7	-	RW

2024-04

Port no.	Pin	Register for DO[1]	Register for IO-Link[2]	Access
X5	4	Y8	RWw40 – RWw4F	RW
	2	Y9	-	RW
X6	4	YA	RWw50 – RWw5F	RW
	2	YB	-	RW
X7	4	YC	RWw60 – RWw6F	RW
	2	YD	-	RW
X8	4	YE	RWw70 – RWw7F	RW
	2	YF	-	RW

Table 6.2

1. = single bit

2. = WORD

3. Read/write

Producing Data (Input)

Port no.	Pin	Register for DI[1]	Register for IO-Link[2]	Access
X1	4	X0	RWr00 – RWr0F	RO[3]
	2	X1	-	RO
X2	4	X2	RWr10 – RWr1F	RO
	2	X3	-	RO
X3	4	X4	RWr20 – RWr2F	RO
	2	X5	-	RO
X4	4	X6	RWr30 – RWr3F	RO
	2	X7	-	RO
X5	4	X8	RWr40 – RWr4F	RO
	2	X9	-	RO
X6	4	XA	RWr50 – RWr5F	RO
	2	XB	-	RO
X7	4	XC	RWr60 – RWr6F	RO
	2	XD	-	RO
X8	4	XE	RWr70 – RWr7F	RO
	2	XF	-	RO

Table 6.3

1. = single bit

2. = WORD

3. Read-only

6.4 Configuration and Operation with GxWorks®

The configuration and commissioning of the module described in this chapter refers to the GxWorks® V2 Mitsubishi engineering tool. If you are using an engineering tool from another provider, please refer to the corresponding documentation.

Integration of the CSP+ file

1. Open GxWorks® and navigate to **Tool > Profile Management > Register**.

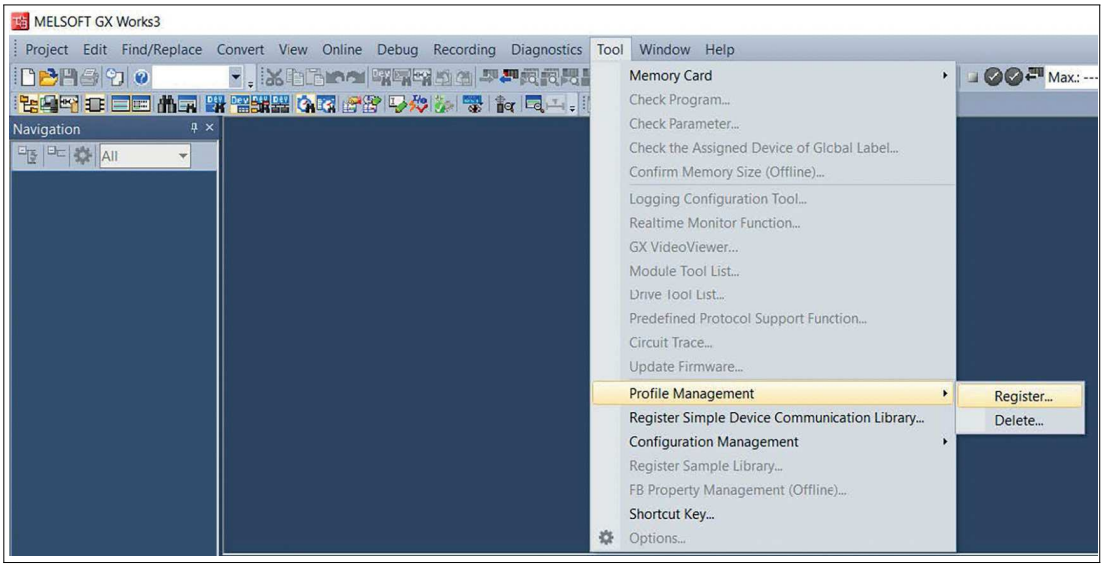


Figure 6.1

2. Select 0x1253_ICE11-8IOL-G60L-V1D_1.0_en.cspp and the CSP+ file will be registered.

Adjusting Network Parameters

1. Open GxWorks® and create a new project.
2. Select the series and type of PLC used.

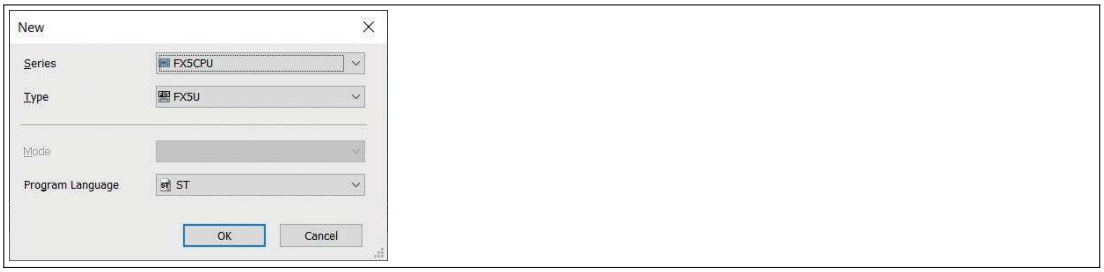


Figure 6.2

3. To open the Settings window, navigate to **Project > Parameter > "the selected CPU module" > Module Parameter**.

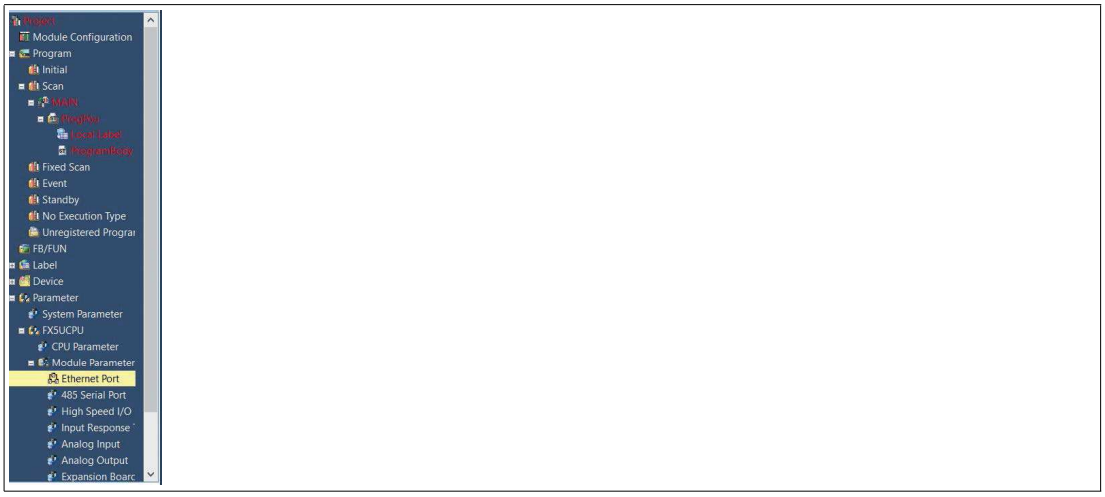


Figure 6.3

↳ The CC-Link IE Field Basic Master Station can be configured in the window that opens.

4. To configure the PLC or master station, navigate to Own Node Settings.

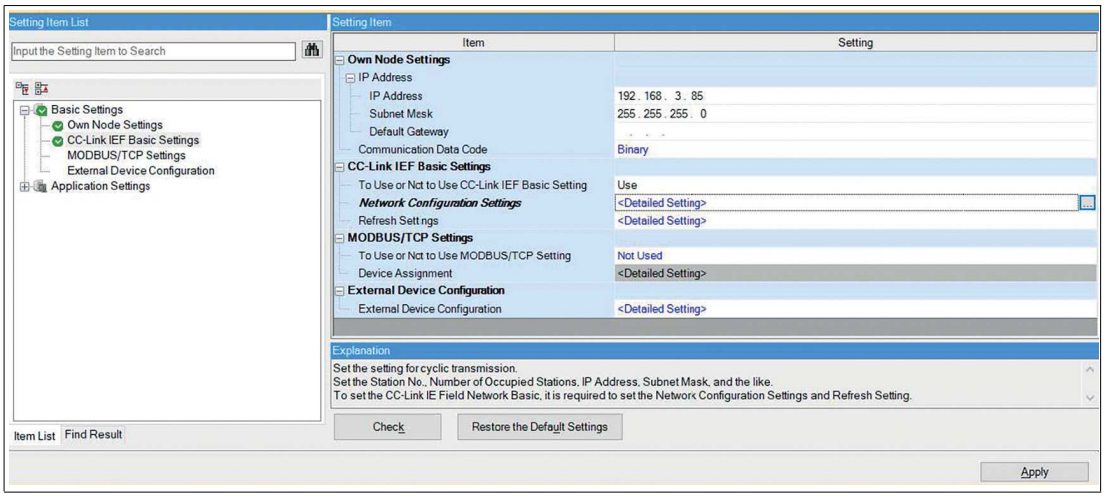


Figure 6.4

5. Under **CC-Link IEF Basic settings > To Use or Not to Use CC-Link IEF Basic Setting**, select "Use".

- The Network Configuration Settings option allows you to configure the CC-Link IE Field Basic Master, the connected stations, a network, parameters, and much more.
- Settings under Refresh Settings are required for automatic data transfer between the link page and the CPU page.

Processing parameters

1. Select the ICE11* from the Module List. Alternatively, click on the Detect Now button for automatic device recognition.

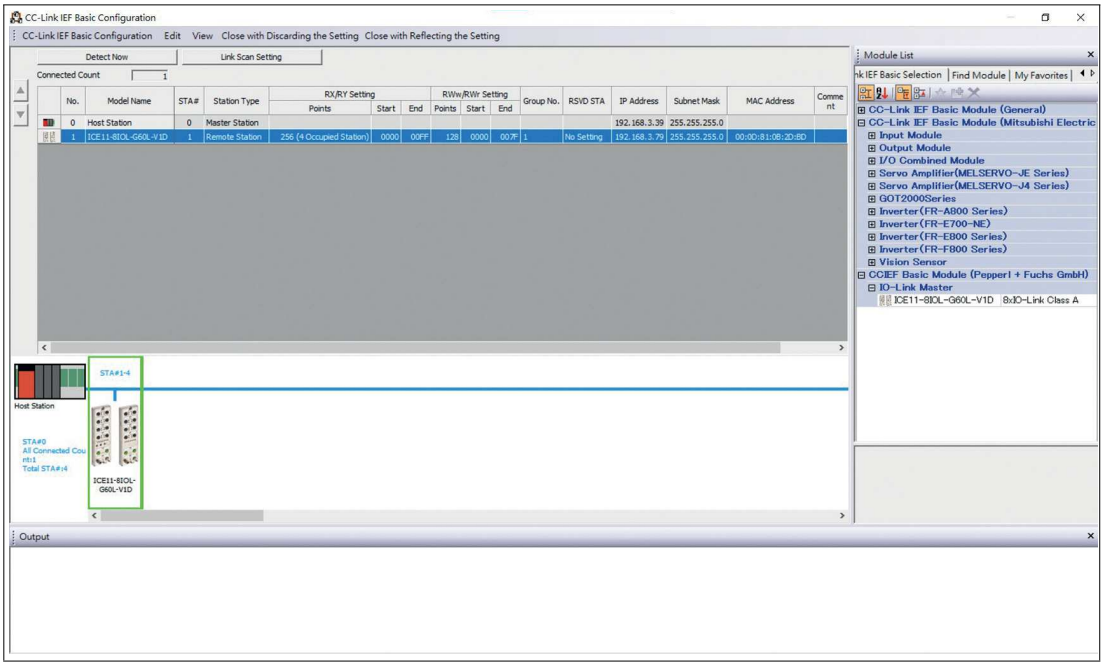


Figure 6.5

2. Right-click on "Slave Station" and select **Online > Parameter Processing of Remote Station...**.

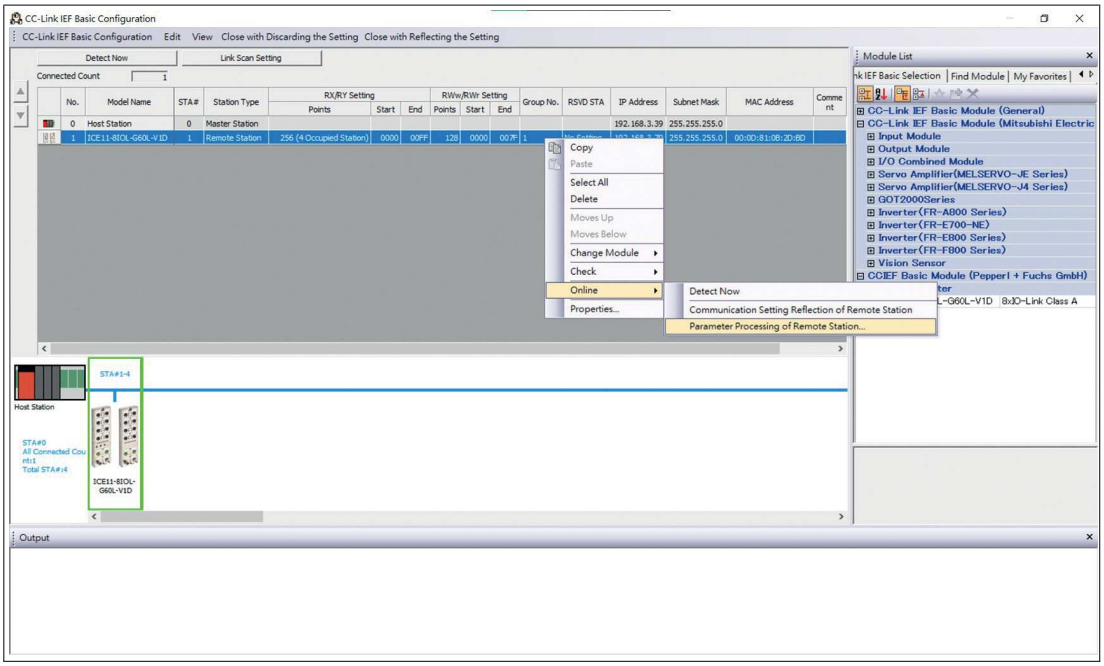


Figure 6.6

3. In the following window, under Method selection, select "Parameter read" or "Parameter write", depending on which method you would like to configure for the module. For details on the different parameters, see chapter 6.2.

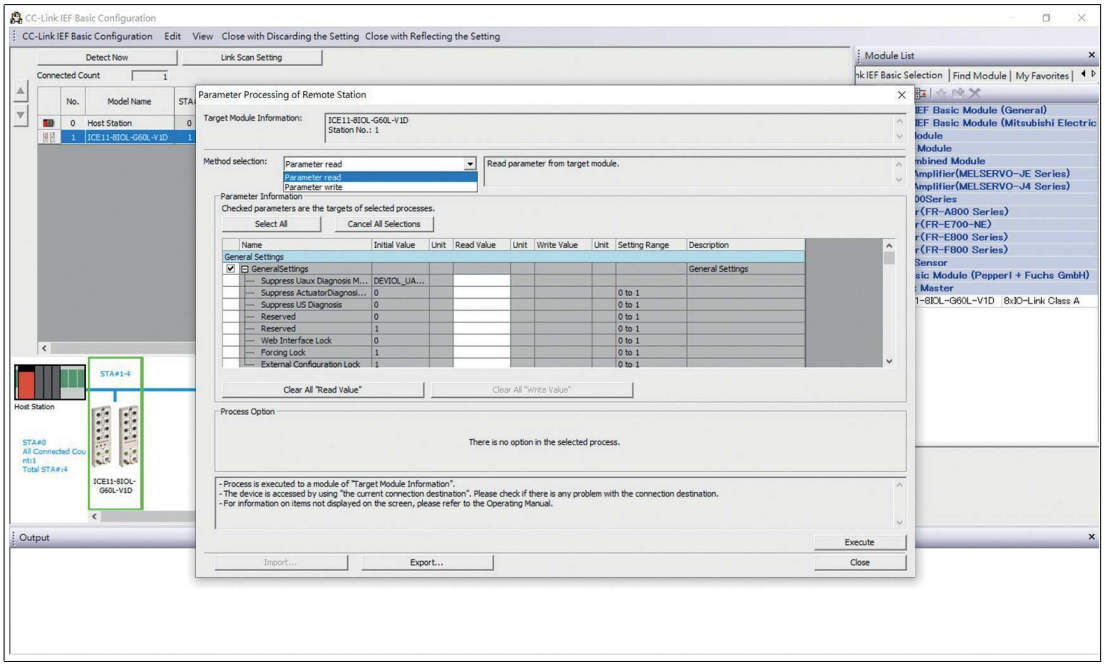


Figure 6.7

4. After you have set the parameters, click on **Communication Setting Reflection of Slave Station** to apply the changes to the appropriate module. CC- manual

7 Commissioning for EtherCAT

7.1 EtherCAT

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

7.2 Preparation

Downloading and Installing the ESI File

An ESI file (EtherCAT Slave Information file) is required to configure a module in the controller. The ESI file supports all module variants.

You can find the relevant ESI file in the **Commissioning** section of the product detail page for the device. To access the product detail page for the device, go to http://www.pepperl-fuchs.com and type information about the device, e.g. the product description or the item number, into the search function.

Use the hardware or network configuration tools from your controller manufacturer to install the ESI file for the module variant used. For TwinCat®, you usually have to copy the ESI file to the installation folder, for example: `C:\TwinCAT\3.1\Config\Io\EtherCAT`. After installation, the modules are available in the hardware catalogs.

Reading MAC IDs

Each module has a unique MAC ID that is assigned by the manufacturer. The MAC ID cannot be changed by the user. The assigned MAC ID is printed on the front side of the module.

This MAC ID has no function for EtherCAT. For EoE (Ethernet over EtherCAT), the I/O module is assigned a virtual MAC ID.

7.3 Configuration

PDO Assignments

The module supports different PDO[a] assignments for input and output data. There are assignments for bit or byte access with or without diagnostic data that are associated with the input data (TxPDO, I/O module to EtherCAT® controller).

You determine the data content by selecting the appropriate PDO.

The modules offer the following PDO assignments:

a. PDO = Process Data Object

7.3.1 Configuration

Input Data

PDO			PDO content			
Type	Index	Size [byte]	Index	Size	Type	Name
Input	0x1A00	32	0x6000:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6000:32	1	UINT32	32 byte IO-Link input data
	0x1A01	32	0x6010:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6010:32	1	UINT32	32 byte IO-Link input data
	0x1A02	32	0x6020:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6020:32	1	UINT32	32 byte IO-Link input data
	0x1A03	32	0x6030:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6030:32	1	UINT32	32 byte IO-Link input data
	0x1A04	32	0x6040:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6040:32	1	UINT32	32 byte IO-Link input data
	0x1A05	32	0x6050:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6050:32	1	UINT32	32 byte IO-Link input data
	0x1A06	32	0x6060:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6060:32	1	UINT32	32 byte IO-Link input data
	0x1A07	32	0x6070:01	1	UINT32	1 byte IO-Link input data
			etc.	etc.	etc.	etc.
			0x6070:32	1	UINT32	32 byte IO-Link input data
	0x1A08	4	0x2080:01	1	UINT32	Status of digital input ports X1– X4
			0x2080:02	1	UINT32	Status of digital input ports X5– X8
			0x2080:03	1	UINT32	Status of the IO-Link communication
			0x2080:04	1	UINT32	IO-Link process data status
	0x1A09	1	0x10F3:04	1	UINT32	"New messages available" flag from the diagnostic object 0x10F3
	0x1A0A	1	0x10F8:00	1	UINT32	Timestamp object 0x10F8

PDO			PDO content			
Type	Index	Size [byte]	Index	Size	Type	Name
Input	0x1A80	8	0xF100:01	1	UINT32	IO-Link connector status 1
			0xF100:02	1	UINT32	IO-Link connector status 2
			0xF100:03	1	UINT32	IO-Link connector status 3
			0xF100:04	1	UINT32	IO-Link connector status 4
			0xF100:05	1	UINT32	IO-Link connector status 5
			0xF100:06	1	UINT32	IO-Link connector status 6
			0xF100:07	1	UINT32	IO-Link connector status 7
			0xF100:08	1	UINT32	IO-Link connector status 8

Table 7.1

Output Data

PDO			PDO content			
Type	Index	Size [byte]	Index	Size	Type	Name
Output	0x1600	32	0x7000:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7000:32	1	UINT32	32. bytes of IO-Link output data
	0x1601	32	0x7010:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7010:32	1	UINT32	32. bytes of IO-Link output data
	0x1602	32	0x7020:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7020:32	1	UINT32	32. bytes of IO-Link output data
	0x1603	32	0x7030:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7030:32	1	UINT32	32. bytes of IO-Link output data
	0x1604	32	0x7040:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7040:32	1	UINT32	32. bytes of IO-Link output data
	0x1605	32	0x7050:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7050:32	1	UINT32	32. bytes of IO-Link output data
	0x1606	32	0x7060:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7060:32	1	UINT32	32. bytes of IO-Link output data
	0x1607	32	0x7070:01	1	UINT32	1. bytes of IO-Link output data
			etc.	etc.	etc.	etc.
			0x7070:32	1	UINT32	32. bytes of IO-Link output data

PDO			PDO content			
Type	Index	Size [byte]	Index	Size	Type	Name
Output	0x1608	4	0x2280:01	1	UINT32	Digital output mapping ports X1–X4
			0x2280:02	1	UINT32	Digital output mapping ports X5–X8
			0x2280:03	1	UINT32	Control of IO-Link COM Mode
			0x2280:04	1	UINT32	Reserved

Table 7.2

Modular Slots

The ESI file contains a modular, slot-based PDO configuration for various IO-Link configurations. The following slots are available:

Slot	Description
STD_IN_1_bit	IO-Link port as standard digital input
IOL_I_1byte	IO-Link, 1 byte as process data input
IOL_I_2byte	IO-Link, 2 bytes as process data input
IOL_I_4byte	IO-Link, 4 bytes as process data input
IOL_I_6byte	IO-Link, 6 bytes as process data input
IOL_I_8byte	IO-Link, 8 bytes as process data input
IOL_I_10byte	IO-Link, 10 bytes as process data input
IOL_I_16byte	IO-Link, 16 bytes as process data input
IOL_I_24byte	IO-Link, 24 bytes as process data input
IOL_I_32byte	IO-Link, 32 bytes as process data input
STD_OUT_1_bit	IO-Link port as standard digital output
IOL_O_1byte	IO-Link, 1 byte as process data output
IOL_O_2byte	IO-Link, 2 bytes as process data output
IOL_O_4byte	IO-Link, 4 bytes as process data output
IOL_O_6byte	IO-Link, 6 bytes as process data output
IOL_O_8byte	IO-Link, 8 bytes as process data output
IOL_O_10byte	IO-Link, 10 bytes as process data output
IOL_O_16byte	IO-Link, 16 bytes as process data output
IOL_O_24byte	IO-Link, 24 bytes as process data output
IOL_O_32byte	IO-Link, 32 bytes as process data output
IOL_I/O_1/1byte	IO-Link • 1 byte as process data input • 1 byte as process data output
IOL_I/O_2/2byte	IO-Link • 2 bytes as process data input • 2 bytes as process data output
IOL_I/O_2/4byte	IO-Link • 2 bytes as process data input • 4 bytes as process data output

Slot	Description
IOL_I/O_4/4byte	IO-Link • 4 bytes as process data input • 4 bytes as process data output
IOL_I/O_4/2byte	IO-Link • 4 bytes as process data input • 2 bytes as process data output
IOL_I/O_2/8byte	IO-Link • 2 bytes as process data input • 8 bytes as process data output
IOL_I/O_4/8byte	IO-Link • 4 bytes as process data input • 8 bytes as process data output
IOL_I/O_8/2byte	IO-Link • 8 bytes as process data input • 2 bytes as process data output
IOL_I/O_8/4byte	IO-Link • 8 bytes as process data input • 4 bytes as process data output
IOL_I/O_8/8byte	IO-Link • 8 bytes as process data input • 8 bytes as process data output
IOL_I/O_4/32byte	IO-Link • 4 bytes as process data input • 32 bytes as process data output
IOL_I/O_32/4byte	IO-Link • 32 bytes as process data input • 4 bytes as process data output
IOL_I/O_16/16byte	IO-Link • 16 bytes as process data input • 16 bytes as process data output
IOL_I/O_24/24byte	IO-Link • 24 bytes as process data input • 24 bytes as process data output
IOL_I/O_32/32byte	IO-Link • 32 bytes as process data input • 32 bytes as process data output

Table 7.3

7.3.2 Device Parameters

The modules support different parameters. The parameters are sent to the module during commissioning of the controller.

The following parameters can be set:

Extended Parameters

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x23n0[1]	2	0x23n0:01	1	UINT8	Data storage: 0 = Data storage disabled (saved data set is retained) 1 = Data storage download only (IOLM → IOLD) 2 = Data storage upload only (IOLD → IOLM) 3 = Data storage download and upload 4 = Data storage disabled and deleted (a previously saved data set is deleted) Other = Reserved
		0x23n0:02	1	UINT8	Fail-safe mode 0 = Set low 1 = Set high 2 = Hold last 3 = Substitute value (see object 0x23n1) 4 = IO-Link master command Other = Reserved

Table 7.4

1. n = number between 0 ... 7 = port number -1

Fail-Safe Function

The firmware on the module provides a fail-safe function for the outputs for interruptions or loss of communication. When configuring modules, you can define the status of the outputs after an interruption or a loss of communication.

Substitute values

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x23n1[1]	2	0x23n1:01	1	UINT8	Failsafe substitute value byte 1
		etc.	etc.	etc.	etc.
		0x23n1:32	1	UINT8	Failsafe substitute value byte 32

Table 7.5

1. n = number between 0 ... 7 = port number -1

Digital outputs mode

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x2380	16	0x2380:01	1	UINT8	Port 1 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:02	1	UINT8	Port 1 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:03	1	UINT8	Port 2 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:04	1	UINT8	Port 2 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:05	1	UINT8	Port 3 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:06	1	UINT8	Port 3 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:07	1	UINT8	Port 4 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:08	1	UINT8	Port 4 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:09	1	UINT8	Port 5 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:10	1	UINT8	Port 5 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:11	1	UINT8	Port 6 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved

2024-04

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x2380	16	0x2380:12	1	UINT8	Port 6 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:13	1	UINT8	Port 7 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:14	1	UINT8	Port 7 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:15	1	UINT8	Port 8 Channel A 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved
		0x2380:16	1	UINT8	Port 8 Channel B 0 = Set Low 1 = Set High 2 = Hold Last Other = Reserved

Table 7.6

The following options are available:

Option	Value	Description
Set low[1]	0	Deactivation of the output channel
Set high	1	Activation of the output channel
Hold last	2	Hold the last output status

1. Standard

General device settings

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x2381	7	0x2381:01	1	BOOL	Web interface locked 0 = false 1 = true
		0x2381:02	1	BOOL	Force mode locked 0 = false 1 = true
		0x2381:03	1	BOOL	All emergency messages disabled 0 = false 1 = true
		0x2381:04	1	BOOL	UL emergency messages disabled 0 = false 1 = true
		0x2381:05	1	BOOL	Actuator emergency messages disabled 0 = false 1 = true
		0x2381:06	1	BOOL	External configuration permitted 0 = false 1 = true
		0x2381:07	1	BOOL	Automatic restart of the output after a malfunction 0 = false 1 = true

Table 7.7

Surveillance Timeout

The module firmware allows you to set a delay time before monitoring of output currents begins. The delay time is also known as “Surveillance Timeout”. You can define this for each individual output channel.

The delay time starts after the status of the output channel changes, i.e., if this is activated after a rising edge or is disabled after a falling edge. After this time has elapsed, the monitoring of the output begins and the diagnostics begin reporting error states. The value of the monitoring time limit is 0 ms to 255 ms. The default value is 80 ms. If the output channel is in a static state, i.e., permanently switched on or switched off, the value is 100 ms.

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x2382	16	0x2382:01	1	UINT8	Surveillance Timeout Port 1 Channel A
		0x2382:02	1	UINT8	Surveillance Timeout Port 1 Channel B
		0x2382:03	1	UINT8	Surveillance Timeout Port 2 Channel A
		0x2382:04	1	UINT8	Surveillance Timeout Port 2 Channel B
		0x2382:05	1	UINT8	Surveillance Timeout Port 3 Channel A
		0x2382:06	1	UINT8	Surveillance Timeout Port 3 Channel B
		0x2382:07	1	UINT8	Surveillance Timeout Port 4 Channel A
		0x2382:08	1	UINT8	Surveillance Timeout Port 4 Channel B
		0x2382:09	1	UINT8	Surveillance Timeout Port 5 Channel A
		0x2382:10	1	UINT8	Surveillance Timeout Port 5 Channel B
		0x2382:11	1	UINT8	Surveillance Timeout Port 6 Channel A
		0x2382:12	1	UINT8	Surveillance Timeout Port 6 Channel B
		0x2382:13	1	UINT8	Surveillance Timeout Port 7 Channel A
		0x2382:14	1	UINT8	Surveillance Timeout Port 7 Channel B
		0x2382:15	1	UINT8	Surveillance Timeout Port 8 Channel A
		0x2382:16	1	UINT8	Surveillance Timeout Port 8 Channel B

Table 7.8

Digital I/O Mode, Channel B

The "Digital I/O mode" parameter allows the input/output channels (I/O channels) of channel B of the module to be configured.

The following settings are possible:

1 = Input

2 = Output

Other = Reserved

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x2383	16	0x2383:01	1	UINT8	Digital I/O Mode Port 1 Channel B 1 = Input 2 = Output Other = Reserved
		0x2383:02	1	UINT8	Digital I/O Mode Port 2 Channel B 1 = Input 2 = Output Other = Reserved
		0x2383:03	1	UINT8	Digital I/O Mode Port 3 Channel B 1 = Input 2 = Output Other = Reserved
		0x2383:04	1	UINT8	Digital I/O Mode Port 4 Channel B 1 = Input 2 = Output Other = Reserved
		0x2383:05	1	UINT8	Digital I/O Mode Port 5 Channel B 1 = Input 2 = Output Other = Reserved
		0x2383:06	1	UINT8	Digital I/O Mode Port 6 Channel B 1 = Input 2 = Output Other = Reserved
		0x2383:07	1	UINT8	Digital I/O Mode Port 7 Channel B 1 = Input 2 = Output Other = Reserved
		0x2383:08	1	UINT8	Digital I/O Mode Port 8 Channel B 1 = Input 2 = Output Other = Reserved

Table 7.9

Digital Inputs Mode

The device supports the configuration of the digital input logic of channel A (pin 4) and channel B (pin 2) of the IO-Link port.

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x2384	16	0x2384:01	1	UINT8	Digital Input Logic Port 1 Channel A 0 = NO 1 = NC
		0x2384:02	1	UINT8	Digital Input Logic Port 1 Channel B 0 = NO 1 = NC
		0x2384:03	1	UINT8	Digital Input Logic Port 2 Channel A 0 = NO 1 = NC
		0x2384:04	1	UINT8	Digital Input Logic Port 2 Channel B 0 = NO 1 = NC
		0x2384:05	1	UINT8	Digital Input Logic Port 3 Channel A 0 = NO 1 = NC
		0x2384:06	1	UINT8	Digital Input Logic Port 3 Channel B 0 = NO 1 = NC
		0x2384:07	1	UINT8	Digital Input Logic Port 4 Channel A 0 = NO 1 = NC
		0x2384:08	1	UINT8	Digital Input Logic Port 4 Channel B 0 = NO 1 = NC
		0x2384:09	1	UINT8	Digital Input Logic Port 5 Channel A 0 = NO 1 = NC
		0x2384:10	1	UINT8	Digital Input Logic Port 5 Channel B 0 = NO 1 = NC
		0x2384:11	1	UINT8	Digital Input Logic Port 6 Channel A 0 = NO 1 = NC
		0x2384:12	1	UINT8	Digital Input Logic Port 6 Channel B 0 = NO 1 = NC
		0x2384:13	1	UINT8	Digital Input Logic Port 7 Channel A 0 = NO 1 = NC
		0x2384:14	1	UINT8	Digital Input Logic Port 7 Channel B 0 = NO 1 = NC
		0x2384:15	1	UINT8	Digital Input Logic Port 8 Channel A 0 = NO 1 = NC
		0x2384:16	1	UINT8	Digital Input Logic Port 8 Channel B 0 = NO 1 = NC

Table 7.10

Digital Input Filters

The device supports the configuration of a digital input filter for channel A (pin 4) and channel B (pin 2) of the IO-Link port.

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x2385	16	0x2385:01	1	UINT8	Digital Input Filter Port 1 Channel A
		0x2385:02	1	UINT8	Digital Input Filter Port 1 Channel B
		0x2385:03	1	UINT8	Digital Input Filter Port 2 Channel A
		0x2385:04	1	UINT8	Digital Input Filter Port 2 Channel B
		0x2385:05	1	UINT8	Digital Input Filter Port 3 Channel A
		0x2385:06	1	UINT8	Digital Input Filter Port 3 Channel B
		0x2385:07	1	UINT8	Digital Input Filter Port 4 Channel A
		0x2385:08	1	UINT8	Digital Input Filter Port 4 Channel B
		0x2385:09	1	UINT8	Digital Input Filter Port 5 Channel A
		0x2385:10	1	UINT8	Digital Input Filter Port 5 Channel B
		0x2385:11	1	UINT8	Digital Input Filter Port 6 Channel A
		0x2385:12	1	UINT8	Digital Input Filter Port 6 Channel B
		0x2385:13	1	UINT8	Digital Input Filter Port 7 Channel A
		0x2385:14	1	UINT8	Digital Input Filter Port 7 Channel B
		0x2385:15	1	UINT8	Digital Input Filter Port 8 Channel A
		0x2385:16	1	UINT8	Digital Input Filter Port 8 Channel B

Table 7.11

Timeout Before Restart

The device supports the configuration of a pre-reboot digital output timeout for channel A (pin 4) and channel B (pin 2) of the IO-Link port.

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x2386	16	0x2386:01	1	BOOL	Digital output timeout before restart [ms] Port 1 Channel A
		0x2386:02	1	BOOL	Digital output timeout before restart [ms] Port 1 Channel B
		0x2386:03	1	BOOL	Digital output timeout before restart [ms] Port 2 Channel A
		0x2386:04	1	BOOL	Digital output timeout before restart [ms] Port 2 Channel B
		0x2386:05	1	BOOL	Digital output timeout before restart [ms] Port 3 Channel A
		0x2386:06	1	BOOL	Digital output timeout before restart [ms] Port 3 Channel B
		0x2386:07	1	BOOL	Digital output timeout before restart [ms] Port 4 Channel A
		0x2386:08	1	BOOL	Digital output timeout before restart [ms] Port 4 Channel B
		0x2386:09	1	BOOL	Digital output timeout before restart [ms] Port 5 Channel A
		0x2386:10	1	BOOL	Digital output timeout before restart [ms] Port 5 Channel B
		0x2386:11	1	BOOL	Digital output timeout before restart [ms] Port 6 Channel A
		0x2386:12	1	BOOL	Digital output timeout before restart [ms] Port 6 Channel B
		0x2386:13	1	BOOL	Digital output timeout before restart [ms] Port 7 Channel A
		0x2386:14	1	BOOL	Digital output timeout before restart [ms] Port 7 Channel B
		0x2386:15	1	BOOL	Digital output timeout before restart [ms] Port 8 Channel A
		0x2386:16	1	BOOL	Digital output timeout before restart [ms] Port 8 Channel B

Table 7.12

Additional IO-Link Port Settings

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x30n0[1]	9	0x30n0:01	1	UINT8	Swap mode
		0x30n0:02	1	UINT8	Swap length
		0x30n0:03	1	UINT8	Swap offset
		0x30n0:04	1	BOOL	Sensor supply activated 0 = false 1 = true
		0x30n0:05	1	BOOL	Pin 2 LED activated 0 = false 1 = true
		0x30n0:06	1	BOOL	Suppress all diagnostics 0 = false 1 = true
		0x30n0:07	1	BOOL	Pin 4 DO use of push-pull 0 = Use high-side switches 1 = Use push-pull
		0x30n0:08	1	UINT16	Pin 4 current limit in mA (maximum current limit until pin 4 is switched off) Default value: 2000
		0x30n0:09	1	UINT16	Pin 2 DO use of push-pull in mA (maximum current limit until pin 2 is switched off) Default value: 2000

Table 7.13

1. n = number between 0 ... 7 = port number -1

Description

Swap mode

Byte sequence swapping is performed for the selected number of data types or for the entire length of I/O data with the selected data type (Word = 2 bytes or DWord = 4 bytes).

Swap length

Swapping can be set to Word (2 bytes) or DWord (4 bytes).

- Word swapping = byte 1 – byte 2 => byte 2 – byte 1
- DWord swapping = byte 1 – byte 4 => byte 4 – byte 1

Swap offset

A swapping offset of the bytes can be set depending on the configured I/O data length. If the setting is "2", the swapping is carried out by the 3rd byte.

IO-Link Parameterization

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x40n0[1]	7	0x40n0:01	1	UINT8	Control panel 0x00 = no action 0x02 = read 0x03 = write
		0x40n0:02	1	UINT8	Status 0x00 = no activity 0x01 = active/occupied 0x02 = access 0x04 = error 0xFF = failure
		0x40n0:03	1	UINT8	Index
		0x40n0:04	2	UINT16	Subindex
		0x40n0:05	1	UINT8	Length
		0x40n0:06	232	UINT232	Data
		0x40n0:07	2	UINT16	Error code

Table 7.14

1. n = number between 0 ... 7 = port number -1

IO-Link Configuration Data

SDO		SDO content			
Index	**Size [byte]**	**Index**	**Size**	**Type**	**Name/description**
0x80n0[1]	11	0x80n0:01	4	UINT32	Device ID
		0x80n0:05	4	UINT32	Vendor ID
		0x80n0:32	1	UINT8	IO-Link version Version of the IO-Link specification of the connected IO-Link device acc. to version 1.0 of the IO-Link specification. Bit 0 ... 3 = sub-version Bit 4 ... 7 = main version
		0x80n0:33	1	UINT8	Frame functions
		0x80n0:34	1	UINT8	Cycle time
		0x80n0:35	1	UINT8	Offset
		0x80n0:36	1	UINT8	Number and structure of the process input data "ProcessDataIn" = value in IO-Link format acc. to version 1.0 of the IO-Link specification Bit 0 ... 4 = length Bit 5 = reserved Bit 6 = SIO indicator. Indicates whether the device supports standard I/O mode. Bit 7 = byte indicator. Indicates whether the value of the length is interpreted as bit length or as byte length +1.

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x80n0	11	0x80n0:37	1	UINT8	Number and structure of the process output data "ProcessDataOut" = value in IO-Link format acc. to version 1.0 of the IO-Link specification Bit 0 ... 4 = length Bit 5 = reserved Bit 6 = SIO indicator. Indicates whether the device supports standard I/O mode. Bit 7 = byte indicator. Indicates whether the value of the length is interpreted as bit length or as byte length +1.
		0x80n0:38	2	UINT16	Compatible ID
		0x80n0:39	2	UINT16	Reserved
		0x80n0:40	2	UINT16	Master control Control of the IO-Link master port. Defines the different operating modes of the IO-Link master. Bits 0 ... 3: 0 = Inactive 1 = Digital input port 2 = Digital output port 3 = Communication via IO-Link protocol 4 = Digital input with support for acyclic IO-Link

Table 7.15

1. n = number between 0 ... 7 = port number -1

IO-Link Serial Number

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x80n1[1]	20	0x80n1:01	1	VISIBLE_STRING	Serial number

Table 7.16

1. n = number between 0 ... 7 = port number -1

IO-Link Information Data

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x90n0[1]	11	0x90n0:01	4	UINT32	Device ID
		0x90n0:05	4	UINT32	Vendor ID
		0x90n0:32	1	UINT8	IO-Link version Version of the IO-Link specification of the connected IO-Link device acc. to version 1.0 of the IO-Link specification. Bit 0 ... 3 = sub-version Bit 4 ... 7 = main version
		0x90n0:33	1	UINT8	Frame functions
		0x90n0:34	1	UINT8	Cycle time
		0x90n0:35	1	UINT8	Offset

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x90n0	11	0x90n0:36	1	UINT8	Number and structure of the process input data "ProcessDataIn" = value in IO-Link format acc. to version 1.0 of the IO-Link specification Bit 0 ... 4 = length Bit 5 = reserved Bit 6 = SIO indicator. Indicates whether the device supports standard I/O mode. Bit 7 = byte indicator. Indicates whether the value of the length is interpreted as bit length or as byte length +1.
		0x90n0:37	1	UINT8	Number and structure of the process output data "ProcessDataOut" = value in IO-Link format acc. to version 1.0 of the IO-Link specification Bit 0 ... 4 = length Bit 5 = reserved Bit 6 = SIO indicator. Indicates whether the device supports standard I/O mode. Bit 7 = byte indicator. Indicates whether the value of the length is interpreted as bit length or as byte length +1.
		0x90n0:38	2	UINT16	Compatible ID
		0x90n0:39	2	UINT16	Reserved
		0x90n0:40	2	UINT16	Master control Control of the IO-Link master port. Defines the different operating modes of the IO-Link master. Bits 0 ... 3: 0 = Inactive 1 = Digital input port 2 = Digital output port 3 = Communication via IO-Link protocol 4 = Digital input with support for acyclic IO-Link

Table 7.17

1. n = number between 0 ... 7 = port number -1

IO-Link Serial Number of Connected Devices

SDO		SDO content			
Index	Size [byte]	Index	Size	Type	Name/description
0x90n1[1]	20	0x90n1:01	1	VISIBLE_STRING	Serial number

Table 7.18

1. n = number between 0 ... 7 = port number -1

7.3.3 Configuration Example with TwinCAT® 3

The configuration and commissioning of the modules described below refers to the TwinCAT® 3 software from Beckhoff Automation GmbH & Co. KG.

The configuration is based on the example of an ICE1-16DIO-G60L-V1D module. For other module versions, configuration is carried out with a few minor changes.

If you have a control system from a different provider, please refer to the corresponding documentation from the provider.

Caution!

Personal injury and property damage

Before you adjust the inputs or outputs of the module, make sure that no personal injury or property damage can occur.

Integrating the Ethernet IO Module

1. Install the ESI file of the module family in TwinCat®. In TwinCAT® 3, the ESI file is normally inserted in the installation folder `C:\TwinCAT\3.1\Config\Io\EtherCAT`. Alternatively, use the menu commands in TwinCAT® to reload the program: **TWINCAT > EtherCAT Devices > Reload Device Descriptions**.

   ↳ After you restart TwinCAT®, the modules will be available in the hardware catalog.

2. Start TwinCat and open a new project.

3. Navigate to **Solution Explorer > I/O > Devices** in the left-hand window. Right-click on "Devices" and select the **Add New Item** … > EtherCAT Master option.

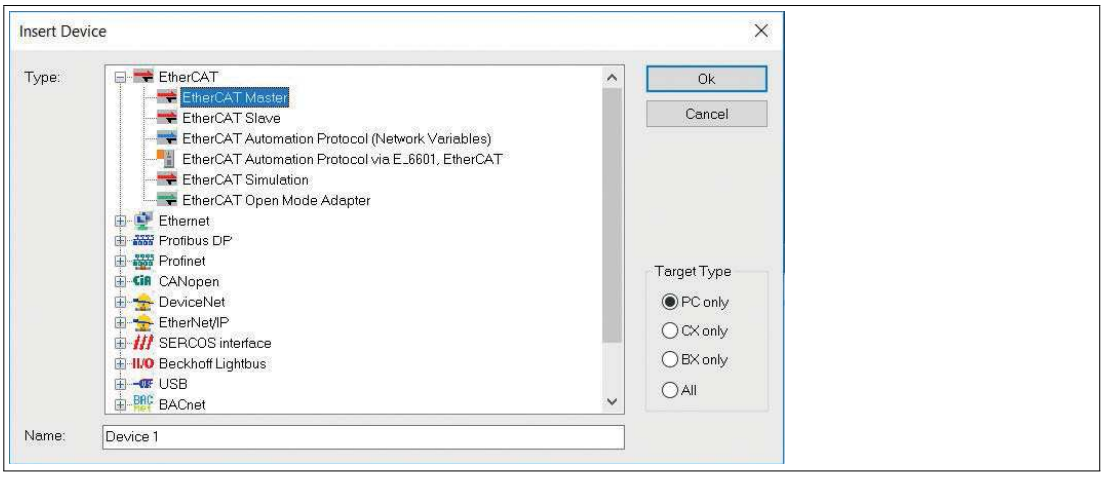


Figure 7.1

4. If you have not already done so, select a network adapter and install the driver for EtherCAT® real-time communication. Navigate to **Adapters** in the right-hand window and click on **Compatible Devices...** to select the driver and start the installation.

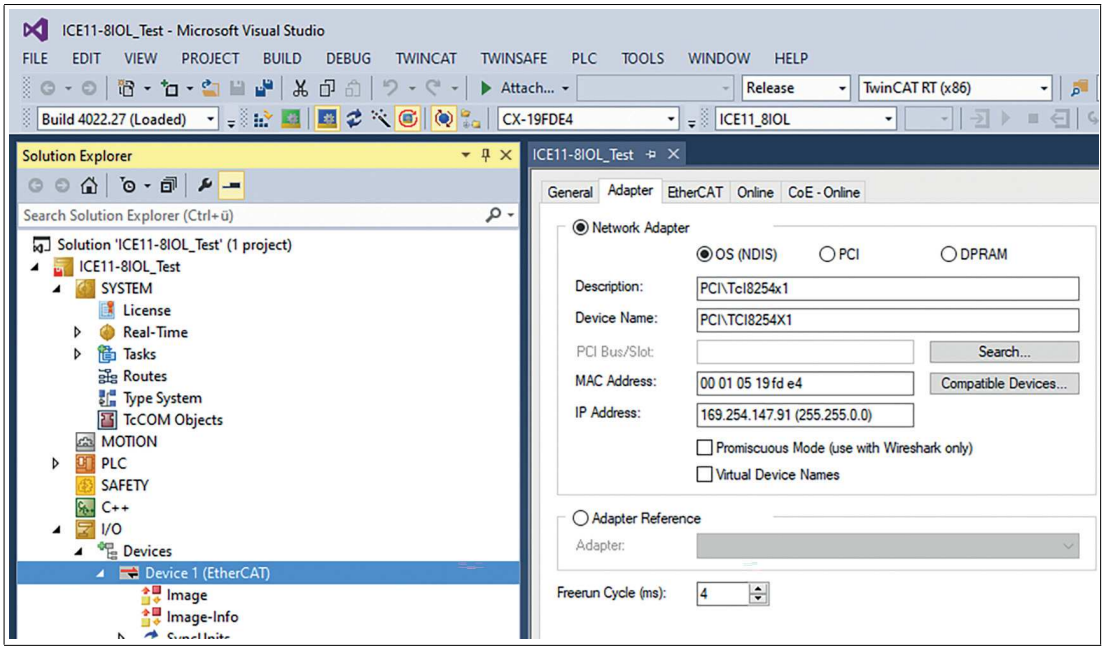


Figure 7.2

Configuration

1. Navigate to **Solution Explorer > I/O > Devices** in the left-hand window. Right-click on **Device 1 (EtherCAT)** and select the **Add New Item...** option. Select the device and click on **OK**.

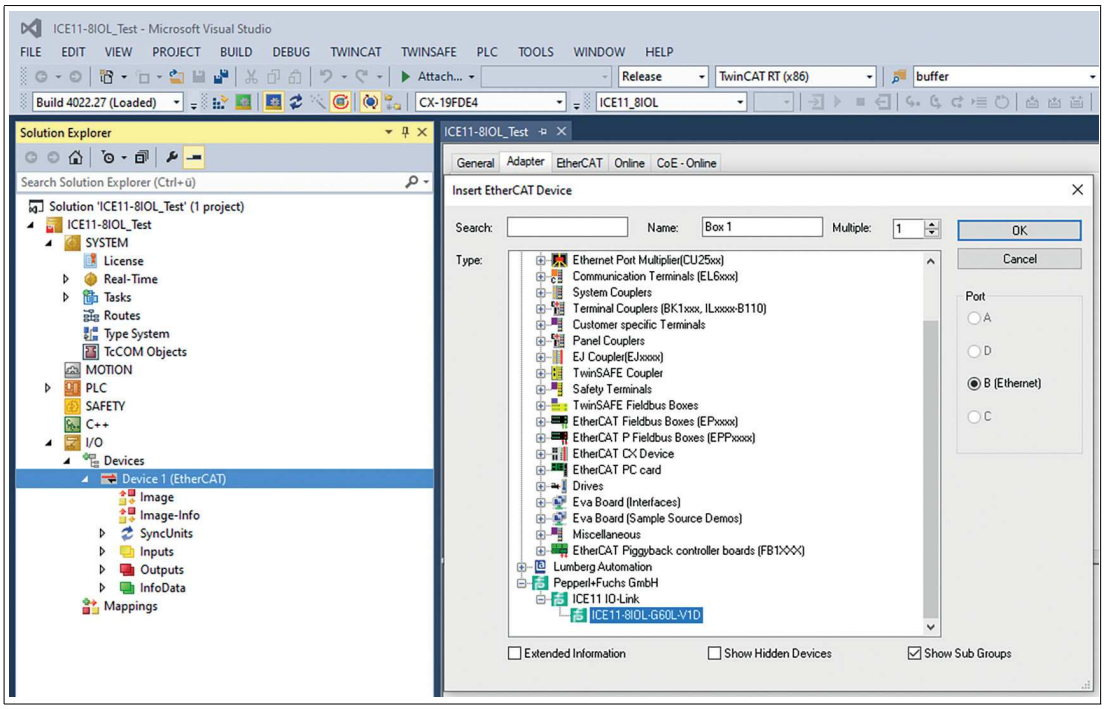


Figure 7.3

2. Navigate to **Slots** in the right-hand window and configure the IO-Link channels. For example, you can change the input/output length, channel mode or I/O mode of channel B (pin 2). You can also set additional PDOs such as "TXPDO" for DI/IOL status, "TxPDO" for a new diagnostic message flag, "TxPDO" for a time marker and "RxPDO" for DO/IOL control.

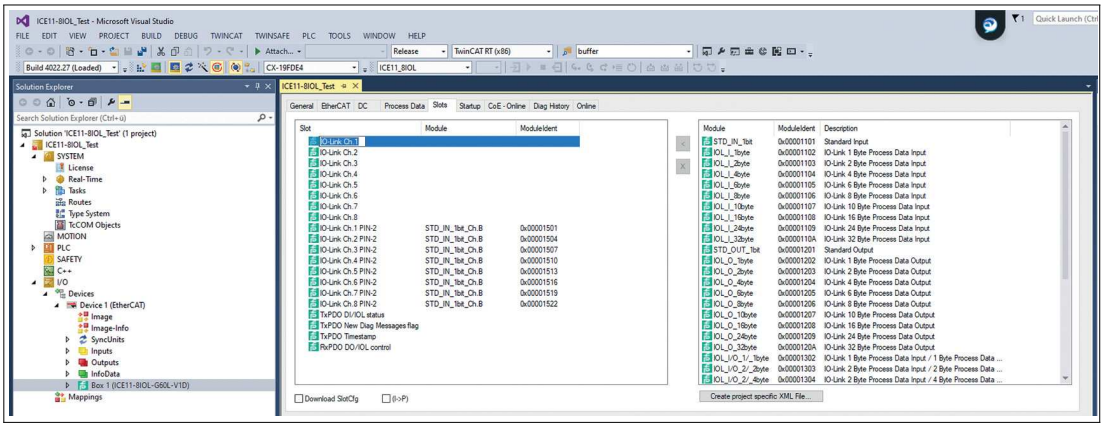


Figure 7.4

3. Navigate to **Process Data** in the right-hand window and select the PDOs for the inputs and outputs.

EoE IP address

Note

An IP address must be set if the web server will be used for the module in the future. If web server services are not to be facilitated, you can also disable this option. The following steps describe how to do this.

1. An IP address must be set to be able to use the device's web interface. Click on **EtherCAT > Advanced Settings...** In the right-hand window and navigate to **Mailbox > EoE**.

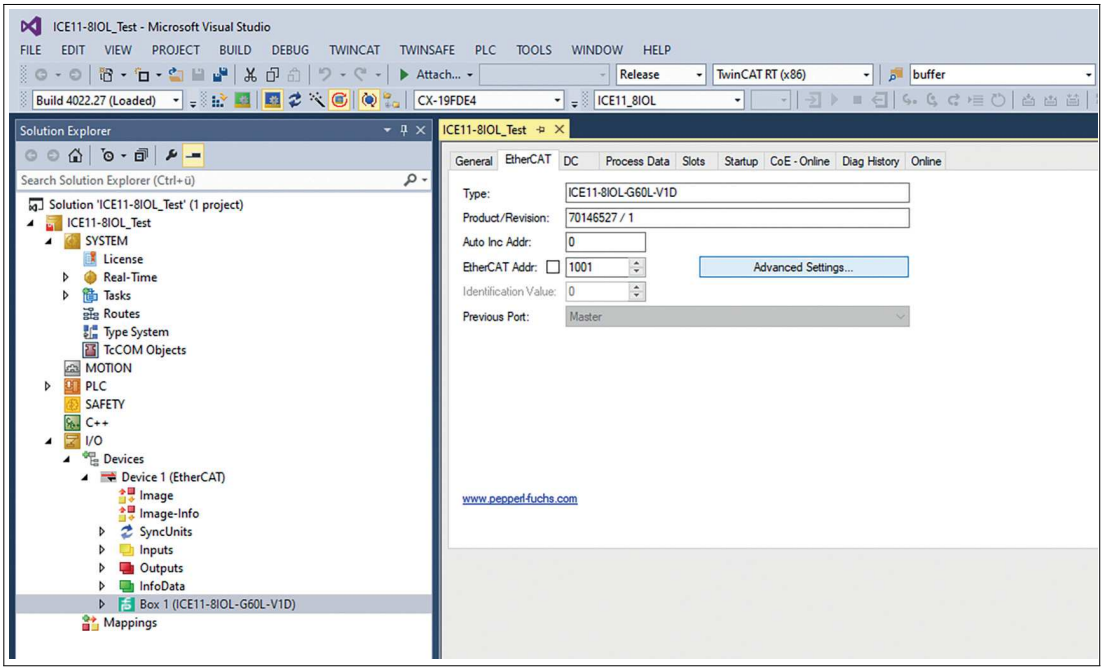


Figure 7.5

2. Disable the **Virtual Ethernet Port** option if you are not using web services.

2024-04

PEPPERL+FUCHS

3. Enable **IP Port** and **IP Address** if you are using web services. Depending on your local network adapter settings, enter your IP settings.

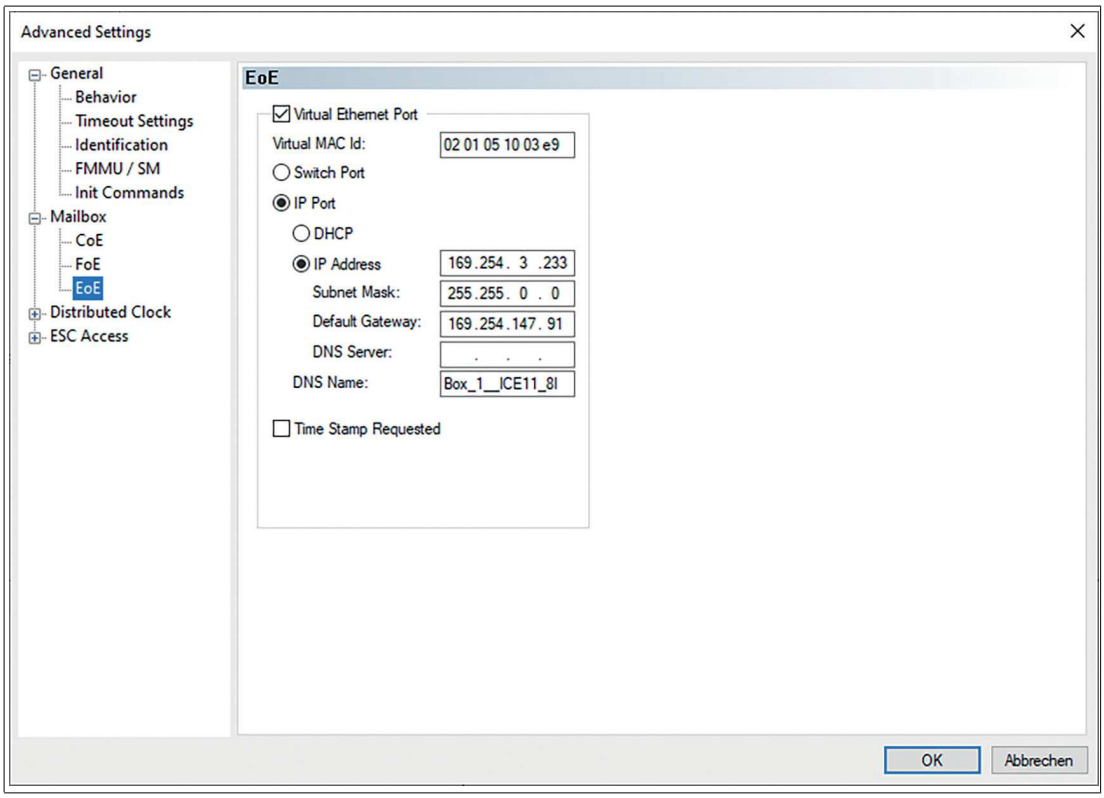


Figure 7.6

Activating Configuration

Danger!

Risk of personal injury or material damage.

Keep clear of moving machine parts while adjusting the settings on the inputs and outputs of the device.

1. If the module is connected to the EtherCAT network, select **TWINCAT** in the menu bar and then **Activate Configuration**.
2. Select **TWINCAT** in the menu bar again and then **Restart TwinCAT (Config Mode)**. Confirm the following dialog boxes by clicking on **Yes**. The device is now in the "OP" state and is transmitting I/O data.

3. Click on "Write..." to set an output of the device.

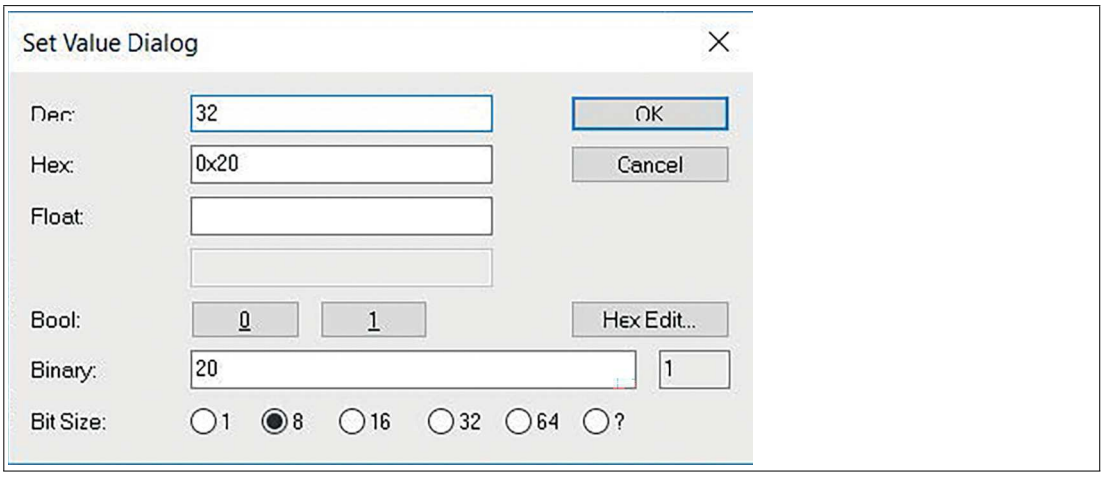


Figure 7.7

Note

Configuration of the PLC and module is now complete. You may now create your user program.

7.4 Firmware Update

A firmware update of the device is possible via the integrated web server using the EoE protocol[b], or the FoE protocol[c].

Danger!

Risk of data loss, damage to the device and injury due to uncontrolled machine movements.

Do NOT disconnect the power supply of the device during the update.

Firmware update via FoE

The FoE service must be supported by both the IOL master and the IOL device. The FoE service is supported by default. If the FoE service is activated and the device is in the "Pre-Op" state, an update can be performed via FoE in TwinCAT® as in the following example:

b. EoE = Ethernet over EtherCAT®

c. FoE = File over EtherCAT®

Update via FoE

1. Rename the file name of the firmware update file provided by Belden to "firmware".
2. In TwinCAT®, select the device for the update:

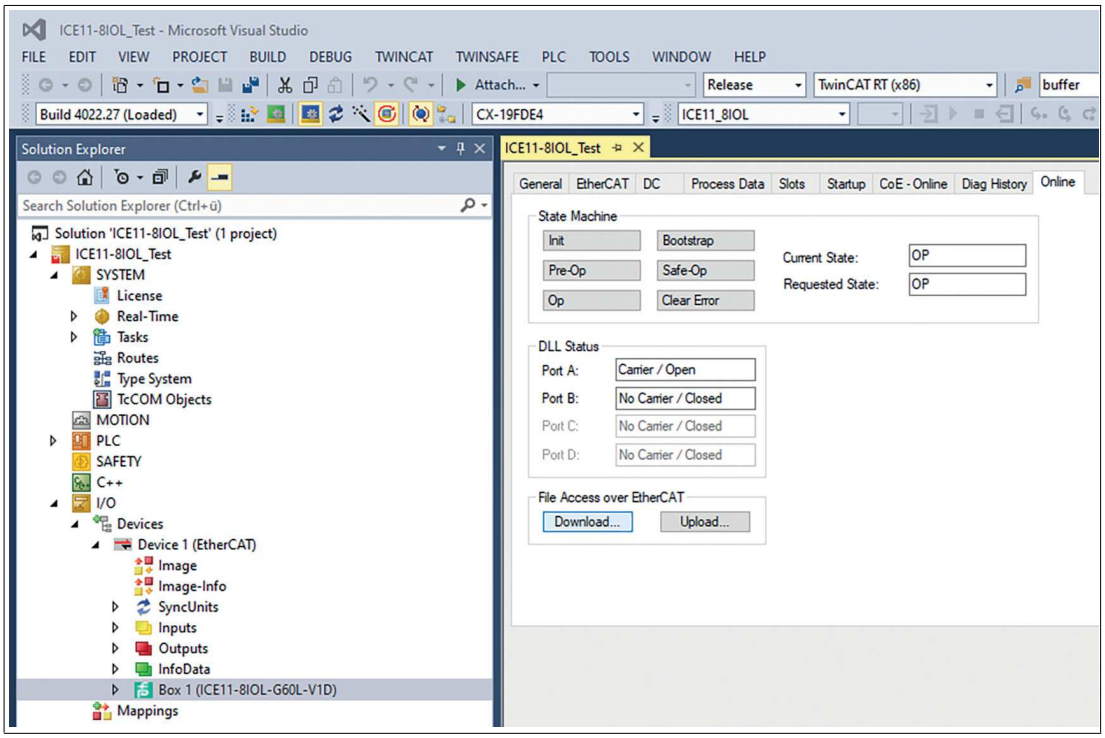


Figure 7.8

3. In the device window on the right, go to the **File Access over EtherCAT** box and click on **Download**.
4. In the following window, select the update file provided by Belden:

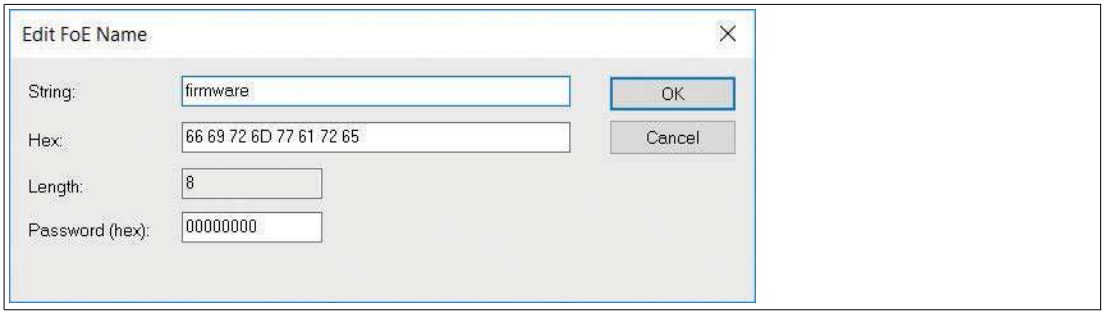


Figure 7.9

5. In the "String:" Field, add the file extension ".fwu", if not already visible:

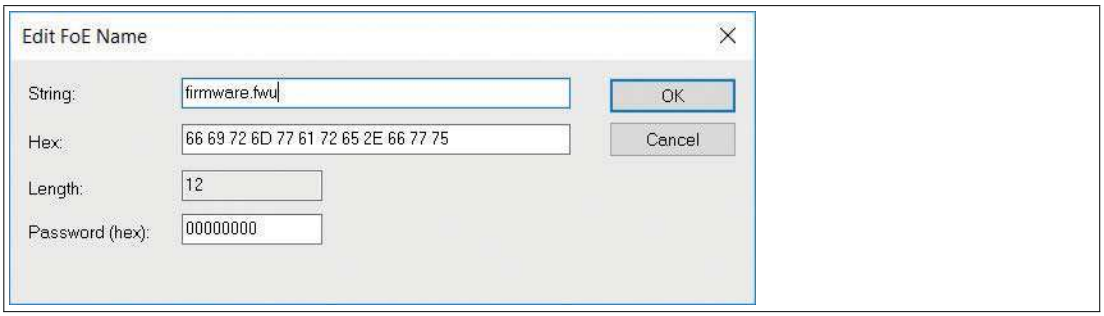


Figure 7.10

6. Click on **OK** and wait for the file to be transferred to the device.

Note

After the file has been transferred, the device resets automatically. During the restart, older firmware update files are replaced by the files in the update package.

8 Commissioning for EtherNet/IP

8.1 Configuration

The module supports implicit messaging and explicit messaging for EtherNet/IP communication. I/O process data is transmitted cyclically; assembly object connections are transmitted via implicit messaging.

Non-critical data with low priority, configuration settings and diagnostic data can be exchanged via acyclic messages using explicit messaging. The exchange takes place via EtherNet/IP and manufacturer-specific object classes. For more information on object classes, see chapter 8.5.

Assembly Types

The module supports three different assembly types.

Assembly ID	Assembly Name	Size	Payload
130	Output Connection Point Assembly	0 ... 260 bytes	Consuming Data Image
131	Input Connection Point Assembly	0 ... 446 bytes	Producing Data Image
145	Configuration Assembly	0 or 400 bytes	Module Configuration Data

Table 8.1 Assembly Types

The "Consuming Data Image" and the "Producing Data Image" have dynamic sizes that depend on the complete input data size and output data size of all connected IO-Link devices and the other input status information. The general input process data sizes and output process data sizes of each connection can be configured in the engineering tool. All IO-Link device process data sizes can be configured via "Module Configuration Data."

For the components of the "Consuming Data Image" and the "Producing Data Image," see chapter 8.3.

For the components of the "Module Configuration Data," see chapter 8.2.

Connections

The module supports two different connection types.

Connection Name	Connection Type	Output Connection Point Assembly	Output Data Size	Input Connection Point Assembly	Input Data Size	Configuration Assembly	Configuration Data Size
IO-Link (Exclusive Owner)	Exclusive owner	130	0 ... 260 bytes	131	0 ... 446 bytes	145	0 or 480 bytes
IO-Link (Listen Only)	Listen Only	192	0	131	0 ... 446 bytes	N/A	0 byte

Table 8.2 Definition of Connection Types

The dynamic data sizes depend on the complete input data size and output data size of all connected IO-Link devices and other input status information. The general input process data sizes and output process data sizes of each connection can be configured in the engineering tool. Each IO-Link device process data size can be configured using the "Configuration Data" modules. Some engineering tools require the immediate configuration of the connection parameters. Use the parameters listed below for the configuration.

IO-Link Parameters, Exclusive Owner

Connection Properties

Parameter	Content
Connection name	IO-Link (Exclusive Owner)
Application type	Exclusive owner
Trigger mode	Cyclic
RPI	min. 1 ms

Table 8.3

Connection Parameters, O -> T

Parameter	Content
Real time transfer format	32 Bit Run/Idle Header
Connection type	POINT2POINT
Assembly ID	130
Data size	0 ... 260 bytes
Data type	INT (2 bytes)

Table 8.4

Connection Parameters, T -> O

Parameter	Content
Real time transfer format	Pure data and modeless
Connection type	MULTICAST, POINT2POINT
Assembly ID	131
Data size	0 ... 446 bytes
Data type	INT (2 bytes)

Table 8.5

IO-Link Parameters, Listen Only

Connection Properties

Parameter	Content
Connection name	IO-Link (Listen Only)
Application type	Listen Only
Trigger mode	Cyclic
RPI	min. 1 ms

Table 8.6

Connection Parameters, O -> T

Parameter	Content
Real time transfer format	Heartbeat
Connection type	POINT2POINT
Assembly ID	192
Data size	0 byte
Data type	INT (2 bytes)

Table 8.7

2024-04

Connection Parameters, T -> O

Parameter	Content
Real time transfer format	Pure data and modeless
Connection type	MULTICAST
Assembly ID	131
Data size	0 ... 446 bytes
Data type	INT (2 bytes)

Table 8.8

8.2 Configuration Parameters

The module's parameters can be configured using the assembly configuration, CIP object classes, web server or IIoT protocols. An assembly configuration is sent when an exclusive owner connection has been established. They are optional in this assembly. When sending, all existing parameters are overwritten by this data. The content of the assembly configuration therefore has the highest priority.

To prevent the parameters from being overwritten by CIP object classes, web server or IIoT protocols during operation, some blocking parameters can be activated in the PLC configuration or the configuration assembly.

The following details represent various setting groups with their configuration parameters. They are part of the assembly configuration and can be set via the "Explicit Messaging" of the specified CIP object classes. The default values are highlighted in **bold**.

General Settings

Configuration Parameter	Byte Offset Config Assembly	Data Type	Valid Values	CIP Object Class 0xA0, Instance 1
Force Mode Lock	1	SINT	**0: Disable** 1: Enable	Attribute 2
Web Interface Lock	2	SINT	**0: Disable** 1: Enable	Attribute 3
Digital Output Control	3	SINT	**0: DO Channel Control** 1: IO-Link Control	Attribute 4
Report U_L/U_{AUX} Supply Voltage Fault	4	SINT	0: Disable **1: Enable**	Attribute 5
Report DO Fault without U_L/U_{AUX}	5	SINT	0: Disable **1: Enable**	Attribute 6
CIP object configuration lock	24	SINT	**0: Disable** 1: Enable	Attribute 25
External configuration lock	25	SINT	0: Disable **1: Enable**	Attribute 26
IO Mapping Mode	31	SINT	**0: Default Assignment** 1: Byte Swap 2: LSB Ch.A - MSB Ch.B 3: LSB Ch.B - MSB Ch.A 4: Free I/O Mapping	Attribute 32

Table 8.9

Force Mode Lock

The input process data and the output process data can be forced via various interfaces, e.g., web interface, REST, OPC UA, MQTT. Interface support depends on the software features available. If "Force mode lock" is activated, no input process data or output process data can be forced via these interfaces.

Danger!

Personal injury or death!

Unsupervised forcing can lead to unexpected signals and uncontrolled machine movements.

Web Interface Lock

Access to the web interface can be set. If Web interface lock is activated, the web pages are no longer accessible.

Digital Output Control

A digital output can have only one control source. You can use the parameter Digital Output Control to configure the DO channel control[a] or the IO-Link output data[b] as the control source.

Report U_L/U_{AUX} Supply Voltage Fault

During commissioning, it is possible that no electric power supply is connected to the U_L/U_{AUX} pins. It may therefore be helpful to suppress and deactivate the "U_L/U_{AUX} supply voltage fault" message.

Report DO Fault without U_L/U_{AUX}

Use this parameter to suppress the actuator diagnostic message that is sent if no U_L/U_{AUX} supply is connected while the output data of a digital channel is being controlled.

CIP Object Configuration Lock

If no Exclusive Owner connection is set up, all configuration parameters can be set by manufacturer-specific CIP object classes. To prevent parameter changes, the setting function of these objects can be blocked.

If the CIP object configuration block is activated, the manufacturer-specific parameters cannot be set via CIP services. This also applies to the CIP object configuration lock itself. This parameter can be reset via a configuration group if an Exclusive Owner connection has been set up.

External Configuration Lock

Configuration parameters can be set via various alternative interfaces, e.g., web interface, REST, OPC UA, MQTT. An external configuration can only be carried out if no cyclical PLC connection is active. Each new PLC configuration overwrites the external configuration settings.

IO Mapping Mode

The module supports five different I/O mapping modes for Digital Output Channel Control and the Input Channel Status. Modes 0 to 3 are predefined bit mappings. Mode 4 is a free user-defined mapping that can be used in conjunction with the I/O mapping of channel 1 ... 16 in the channel settings.

Default Assignment, Mode 0

DO Ch. Control / DI Ch. Status	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0, LSB	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A
Byte 1, MSB	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

Table 8.10

a. the first two bytes of the output data

b. the first byte of the output data of each IO-Link device

2024-04

Byte Swap, Mode 1

DO Ch. Control / DI Ch. Status	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0, LSB	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A
Byte 1, MSB	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A

Table 8.11

LSB Ch.A - MSB Ch.B, Mode 2

DO Ch. Control / DI Ch. Status	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0, LSB	X8A	X7A	X6A	X5A	X4A	X3A	X2A	X1A
Byte 1, MSB	X8B	X7B	X6B	X5B	X4B	X3B	X2B	X1B

Table 8.12

LSB Ch.B - MSB Ch.A, Mode 3

DO Ch. Control / DI Ch. Status	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0, LSB	X8B	X7B	X6B	X5B	X4B	X3B	X2B	X1B
Byte 1, MSB	X8A	X7A	X6A	X5A	X4A	X3A	X2A	X1A

Table 8.13

Free I/O Mapping, Mode 4

I/O mapping of channel 1 ... 16 is used; see "Channel settings."

Channel Settings

Configuration Parameter	Byte Offset Config Assembly	Data Type	Valid Values	CIP Object Class 0xA0, Instance 1 ... 16
IO Mapping (Ch1 ... 16)	32	SINT[16]	**0 ... 15**: Bit number of 16 channel process data 16: Inactive	Attribute 1
DO Surveillance Time-out (Ch1 ... 16)	48	INT[16]	0 ... 255; **80**	Attribute 2
DO Failsafe (Ch1 ... 16)	80	SINT[16]	**0: Set Low** 1: Set High 2: Hold Last	Attribute 3
DO Restart Mode (Ch1 ... 16)	96	SINT[16]	0: Disable **1: Enable**	Attribute 4
DO Switch Mode	112	SINT[16]	0: Push-Pull, U_S, 0.5 A 1: High-Side U_L, 0.5 A 2: High-Side U_L, 1.0 A 3: High-Side U_L, 1.5 A 4: High-Side U_L, 2.0 A **5: High-Side U_L, 2.0 A max**	Attribute 5
DI Logic (Ch1 ... 16)	128	SINT[16]	**0: Normally Open** 1: Normally Close	Attribute 6

Configuration Parameter	Byte Offset Config Assembly	Data Type	Valid Values	CIP Object Class 0xA0, Instance 1 ... 16
DI Filter (Ch1 ... 16)	144	SINT[16]	0: Disabled 1: 1 ms 2: 2 ms **3: 3 ms** 4: 6 ms 5: 10 ms 6: 15 ms	Attribute 7
Channel Mode (Ch1 ... 16)	192	SINT[16]	0: Inactive 1: Digital Output 2: Digital Input **3: IO-Link** 4: Auxiliary Power	Attribute 10

Table 8.14

Channel Assignment

Channel 1	Port X1.ChA	CIP object instance 1
Channel 2	Port X1.ChB	CIP object instance 2
[...]	[...]	[...]
Channel 15	Port X8.ChA	CIP object instance 15
Channel 16	Port X8.ChB	CIP object instance 16

Table 8.15

IO Mapping (Ch1 ... 16)

These configuration parameters can be used to define customized IO mapping. It is valid for the input data direction and the output data direction. Double mapping is not permitted. In the event of inconsistent mapping, the entire assembly configuration is rejected with an error code.

To use these parameters, it is necessary to configure the IO mapping mode of the general settings to Free IO Mapping (Mode 4). The default value for each parameter is its own channel number.

DO Surveillance Timeout (Ch1 ... 16)

The digital output channels are monitored during runtime. The error states are detected and reported as diagnostics. To avoid error states when switching the output channels, Surveillance Timeout can be configured with a delay and deactivated monitoring.

The delay time begins with a rising edge of the output control bit. After the delay time has elapsed, the output is monitored and error states are signaled via diagnostics. If the channel is permanently switched on or off, the typical filter value is[c] 5 ms.

DO Failsafe (Ch1 ... 16)

The module supports a failsafe function for the channels used as digital outputs. In the event of an internal device error, the PLC is in the STOP state and cannot supply any valid process data. The connection is interrupted or communication is lost. The outputs are controlled according to the configured failsafe values.

Set Low If failsafe is active, the physical output pin of the channel is set to "Low"; "0".

Set High If failsafe is active, the physical output pin of the channel is set to "High"; "1".

Hold Last If failsafe is active, the physical output pin of the channel maintains the last valid process data status; "0" or "1".

2024-04

c. not changeable

DO Restart Mode (Ch1 ... 16)

In the event of a short circuit or overload on an output channel, a diagnosis is signaled and the output is switched to "off."

If DO Restart Mode is activated for this channel, the output is automatically switched on again after a fixed time delay to check whether the overload or short-circuit status is still active. If it is active, the channel is switched off again.

If DO Restart Mode is deactivated, the output channel is not automatically switched on again. It can be switched on after a logical reset of the channel's process output data.

DO Switch Mode (Ch1 ... 16)

You can use this parameter to configure the current limit for the digital outputs by selecting a DO switch mode. You can choose between two different output switch modes:

Push-Pull, U_S, 0.5 A	If a channel is set to "Push-Pull", the output is set to active for "High" or "Low". In the "Low" state, the output can represent a current sink. The digital output is supplied with a maximum current of 0.5 A via U_S. This option is not available for the B channel of a port.
High-Side, U_L, 0.5 A ... 2.0 A max	If a channel is set to "High-Side", the output is set to active for "High", but not for "Low". In the "Low" state, the output has a high impedance. The digital output is supplied via U_L or U_{AUX} and has an adjustable current limit. This means that an actuator channel fault diagnosis is signaled if the limit is exceeded. If you set 2.0 A max., the current limit is not active and the maximum output current is available.

DI Logic (Ch1 ... 16)

The logical state of an input channel can be configured using these parameters. If a channel is set to "Normally Open", a low signal "0" is transmitted to the process input data, e.g., if an undamped sensor has an open switching output.

If a channel is set to "Normally Close", a high signal "0" is transmitted to the process input data, e.g., if an undamped sensor has a closed switching output. The channel LED indicates the physical input state of the port pin, regardless of these settings.

DI Filter (Ch1 ... 16)

These parameters can be used to configure a filter time for each digital input channel. If a filter is not required, it can be deactivated.

Channel Mode (Ch1 ... 16)

The operating mode of each channel can be configured using these parameters.

Inactive	This mode should be selected when the channel is not in use.

Note

Attention: If a port's channel A is set to inactive, the associated channel B is also set to inactive, regardless of its configuration. In this case, the entire port is deactivated.

Digital Output	In this mode, the channel operates as a digital output. The channel can be controlled using Digital Output Channel Control[1] or by IO-Link Output Data[2] of the cyclical process data. This depends on the Digital Output Control parameter in the General Settings.

Digital Input In this mode, the channel operates as a digital input. The status of the channel can be seen in the Digital Input Channel status of the cyclical process data.

IO-Link In this mode, the channel attempts to establish communication with an IO-Link device. IO-Link process data can be exchanged via a communication link between the IO-Link master and the IO-Link device. The size of the IO-Link input and output data and the port mode depend on the IO-Link port settings.

1. The first two bytes of the output data.

2. The first byte of the output data of each IO-Link device.

Note

Attention: Not all channels support this configuration.

Auxiliary Power IO-Link master versions with Class B ports offer an auxiliary power output on channel B. If Auxiliary Power has been configured, the output voltage for the affected channel is powered by the U_{AUX} supply input and cannot be controlled individually. IO-Link Class A ports do not support this configuration.

Note

Attention: Not all channels support this configuration.

IO-Link Diagnostic Settings

Configuration Parameter	Byte Offset Config Assembly	Data Type	Valid Values	CIP Object Class 0xA2, Instance 1
IO-Link master Diagnostics	208	SINT	0: Disable **1: Enable**	Attribute 1
IO-Link-Device Error	209	SINT	0: Disable **1: Enable**	Attribute 2
IO-Link-Device Warning	210	SINT	0: Disable **1: Enable**	Attribute 3
IO-Link-Device Notification	211	SINT	0: Disable **1: Enable**	Attribute 4
IO-Link-Device Diagnosis Port 1 ... 8	212 ... 219	SINT[8]	0: Disable **1: Enable**	Attribute 5 ... 12

Table 8.16

IO-Link-Master Diagnosis

If this parameter is activated, the IO-Link master diagnostics is transmitted to the IO-Link diagnostics of the input process data. If configured, additional diagnostics and information are transmitted in the IO-Link extended status and in the IO-Link events.

If this parameter is deactivated, no IO-Link master diagnosis is reported.

2024-04

IO-Link-Device Error

If this parameter is activated, the IO-Link device errors are transmitted in the IO-Link diagnostics of the input process data. If configured, additional diagnostics and information are transmitted in the IO-Link extended status and the IO-Link events.

If this parameter is deactivated, no IO-Link device error is reported.

IO-Link Device Warning If this parameter is activated, the IO-Link device warnings are transmitted in the IO-Link diagnostics of the input process data. If configured, additional diagnostics and information are transmitted in the IO-Link extended status and the IO-Link events.

If this parameter is deactivated, no IO-Link device warning is reported.

IO-Link-Device Notification

If this parameter is activated, the IO-Link device notifications are transmitted in the IO-Link diagnostics of the input process data. If configured, additional diagnostics and information are transmitted in the IO-Link extended status and the IO-Link events.

If this parameter is deactivated, no IO-Link device notification is reported.

IO-Link-Device Diagnosis Port 1 ... 8

If this parameter is activated for an IO-Link port, the corresponding diagnostics are transmitted in the IO-Link diagnostics of the input process data. If configured, additional diagnostics and information are transmitted in the IO-Link extended status and the IO-Link events.

If this parameter is deactivated for an IO-Link port, no corresponding diagnostics are reported.

Settings IO-Link Port 1 ... 8

Configuration Parameter	Byte Offset Config Assembly	Data Type	Valid Values	CIP Object Class 0xA3, Instance 1 ... 8
Output Data Size	224, 246, 268, 290, 312, 334, 356, 378	SINT	0: No data 1: 2 bytes 2: 4 bytes 3: 8 bytes 4: 16 byte **5: 32 bytes**	Attribute 1
Input Data Size	225, 247, 269, 291, 313, 335, 357, 379	SINT	0: No data 1: 2 bytes 2: 4 bytes 3: 8 bytes 4: 16 byte **5: 32 bytes**	Attribute 2
Input Data Extension	226, 248, 270, 292, 314, 336, 358, 380	SINT	0: No Data 1: Extended Status 2: Events **3: Extended Status + Events**	Attribute 3
Output Data Swapping Mode	227, 249, 271, 293, 315, 337, 359, 381	SINT	**0: Raw IO-Link Data** 1 ... 16: 1 ... 16 WORD 17 ... 24: 1 ... 8 DWORD	Attribute 4
Output Data Swapping Offset	228, 250, 272, 294, 316, 338, 360, 382	SINT	0 ... 30 bytes, **"0"**	Attribute 5
Input Data Swapping Mode	229, 251, 273, 295, 317, 339, 361, 383	SINT	**0: Raw IO-Link Data** 1 ... 16: 1 ... 16 WORD 17 ... 24: 1 ... 8 DWORD	Attribute 6

Configuration Parameter	Byte Offset Config Assembly	Data Type	Valid Values	CIP Object Class 0xA3, Instance 1 ... 8
Input Data Swapping Offset	230, 252, 274, 296, 318, 340, 362, 384	SINT	0 ... 30 bytes, **"0"**	Attribute 7
IOL Failsafe	231, 253, 275, 297, 319, 341, 363, 385	SINT	**0: Set Low** 1: Set High 2: Hold Last 3: Replacement Value[1] 4: IO-Link Master Command	Attribute 8
Port Mode	232, 254, 276, 298, 320, 342, 364, 386	SINT	0: Deactivated 1: Manual, with validation and backup config **2: Autostart, no validation and backup config**	Attribute 9
Validation and Backup	233, 255, 277, 299, 321, 343, 365, 387	SINT	**0: No device check and clear, no data storage** 1: Type compatible, V1.0 device, no data storage 2: Type compatible, V1.1 device, no data storage 3: Type compatible, V1.1 device with Backup + Restore, download + upload 4: Type compatible, V1.1 device with Restore, download master to device	Attribute 10
Vendor ID	234, 256, 278, 300, 322, 344, 366, 388	DINT	0 ... 65535, **"0"**	Attribute 11
Device ID	238, 260, 282, 304, 326, 348, 370, 392	DINT	0 ... 16777215, **"0"**	Attribute 12
Cycle Time	242, 264, 286, 308, 330, 352, 374, 396	SINT	**0: As fast as possible** 1: 1.6 ms 2: 3.2 ms 3: 4.8 ms 4: 8.0 ms 5: 20.8 ms 6: 40.0 ms 7: 80.0 ms 8: 120.0 ms	Attribute 13

Table 8.17

1. transferred via IO-Link Failsafe Parameter Object

2024-04

Assignment of the IO-Link Ports

IO-Link port 1	Port X1.ChA	CIP object instance 1
[...]	[...]	[...]
IO-Link port 8	Port X8.ChA	CIP object instance 8

Table 8.18

The number of IO-Link ports depends on the IO-Link master version. IO-Link masters with fewer than 8 IO-Link ports only support configuration parameters for their own counter. Unused configuration data bytes are sent as "zero bytes" within the configuration assembly.

Configuration parameters of an IO-Link port are only taken into account by the application if the corresponding channel mode is set to IO-Link in the channel settings.

Output Data Size

The output data size of the respective IO-Link device can be configured with this parameter. There can be up to 32 bytes of IO-Link output data per port.

The output data size of each IO-Link device has an influence on the total output data size of the connection. It must be ensured that all IO-Link output data fits into the total size.

This parameter can only be set if no connection is active.

Input Data Size

The input data size of the respective IO-Link device can be configured with this parameter. There can be up to 32 bytes of IO-Link input data.

The input data size of each IO-Link device has an influence on the total input data size of the connection. It must be ensured that all IO-Link input data fits into the total size.

This parameter can only be set if no connection is active.

Input Data Extension

The input data extension can be selected to extend the individual IO-Link input data with extended status information and/or IO-Link events.

The input data extension of each IO-Link device has an influence on the total input data size of the connection. It must be ensured that all IO-Link output data, including the extension, fits into the total size.

This parameter can only be set if no connection is active.

Output Data Swapping Mode

The byte order of IO-Link is Big Endian, which is not compatible with the Little Endian format of EtherNet/IP. The Output Data Swapping Mode and Output Data Swapping Offset parameters help the user to set the output data in the correct format. Up to 16 "WORD" or up to 8 "DWORD" can be selected for conversion of the output data.

Raw IO-Link Data	No "byte swap"
Data Type WORD	Data byte order: Byte 0, Byte 1 Sequence by "Swap": Byte 1, Byte 0
Data Type DWORD	Data byte order: Byte 0, Byte 1, Byte 2, Byte 3 Sequence by "Swap": Byte 3, Byte 2, Byte 1, Byte 0

Output Data Swapping Offset

The Output Data Swapping Offset describes the starting point in the process data for use of the configured Output Data Swapping Mode. Both parameters depend on the configured output data size.

Input Data Swapping Mode

The byte order of IO-Link is Big Endian, which is not compatible with the Little Endian format of EtherNet/IP. To obtain input data in the correct format, the Input Data Swapping Mode and Input Data Swapping Offset parameters support the user. Up to 16 "WORD" or up to 8 "DWORD" can be selected for conversion of the input data.

Raw IO-Link Data	No "byte swap"
Data Type WORD	Data byte order: Byte 0, Byte 1 Sequence by "Swap": Byte 1, Byte 0
Data Type DWORD	Data byte order: Byte 0, Byte 1, Byte 2, Byte 3 Sequence by "Swap": Byte 3, Byte 2, Byte 1, Byte 0

Input Data Swapping Offset

The Input Data Swapping Offset describes the starting point in the process data for use of the configured Input Data Swapping Mode. Both parameters depend on the configured input data size and the optional input data extension.

IOL Failsafe The module supports a failsafe function for the output data of the IO-Link channels. In the event of an internal device error, the PLC is in the STOP state and cannot supply any valid process data; the connection is interrupted or communication is lost: The output data of the IO-Link channels is controlled by the configured failsafe values.

Set Low	If failsafe is active, all bits of the IO-Link output data are set to "Low", "0".
Set High	If failsafe is active, all bits of the IO-Link output data are set to "High", "1".
Hold Last	If failsafe is active, all bits of the IO-Link output data maintain the last valid process data status "0" or "1".
Replacement Value[1]	A substitute value can be set for each IO-Link device via the IO-Link failsafe parameter object. If failsafe is active, these substitute values are transmitted to the IO-Link device. The currently configured IO-Link output data size must be taken into account. Note that in the case of a fault, the substitute values are sent instead of the output process data, so a configured swapping mode has an influence on the byte order.
IO-Link Master Command	If failsafe is active, an IO-Link-specific mechanism for valid/invalid output process data is used and the IO-Link device determines the behavior itself.

1. Replacement Value

Port Mode

The port mode describes how the IO-Link master handles the presence of an IO-Link device on the port.

Deactivated	The IO-Link port is deactivated, but can be configured for later use. If the IO-Link device is not connected, no diagnostics are generated.
IO-Link Autostart	The IO-Link port is activated and no explicit port configuration is required. Configurations such as Validation and Backup[1], Vendor ID, Device ID, and Cycle Time are not required.
IO-Link Manual	The IO-Link port is activated and an explicit port configuration can be made for the parameters Validation and Backup[1] , Vendor ID, Device ID, and Cycle Time.

1. Inspection Level

2024-04

Validation and Backup

This parameter enables the user to set the behavior of the IO-Link ports in relation to the type compatibility and data storage mechanism of the connected IO-Link device.

The prerequisite for using Validation and Backup is that you configure the port mode to "IO-Link Manual."

The IO-Link master has a backup memory that can be used to save device parameters and restore them to the IO-Link device. This backup memory is emptied by the following actions:

- IO-Link master factory reset, reset to factory settings
- Reconfiguration of the Channel Mode, for example from "Digital Input" to "IO-Link"
- Reconfiguration of validation and backup, for example from "No device check" to "Type compatible V1.1 device with Backup & Restore"

For more information, please refer to the 'IO-Link Interface and System Specification' version 1.1.3, which can be downloaded from https://io-link.com/.

No Device Check, No Data Storage

No verification of the connected manufacturer ID or device ID and no "backup and restore" support of the IO-Link master parameter server.

Type-Compatible V1.0 Device, No Data Storage

Type-compatible with regard to IO-Link specification V1.0, which includes the validation of manufacturer ID and device ID. The IO-Link specification V1.0 does not support an IO-Link master parameter server.

Type-Compatible V1.1 Device, No Data Storage

Type-compatible with regard to IO-Link specification V1.1, which includes the validation of manufacturer ID and device ID. Backup and Restore is deactivated.

Type-Compatible V1.1 Device with Backup + Restore, Upload + Download

Type-compatible with regard to IO-Link specification V1.1, which includes the validation of manufacturer ID and device ID. Backup and Restore is activated.

Please note the following information on Backup and Restore conditions:

- Backup, Device to Master

  A backup[d] is performed if an IO-Link device is connected and the master has no valid parameter data. The read parameter data is saved permanently on the IO-Link master.

  An upload is also executed if the IO-Link device has set the DS_UPLOAD_FLAG (Data Storage Upload Flag). This IOLDevice flag can be set in two ways
  - Parameters are written to an IOL device in block parameter mode: An IO-Link device sets the DS_UPLOAD_FLAG independently if the block parameter mode parameters have been written to the IO-Link device with the last system command ParamDownloadStore (for example, by a third-party USB-IOLink Master for commissioning).
  - Parameters are written to an IOL device in single parameter mode: If single parameter data on the IOL device is changed during operation, the device parameters stored on the IOL master can be updated using the ParamDownloadStore command (index 0x0002, sub-index 0x00, value 0x05). This command sets the DS_UPLOAD_REQ flag on the IOL device, so the IO-Link master can perform an upload process from the IO-Link device.
- Restore, Master to Device

  A restore (download from the IOL master to the IOL device) is executed if an IO-Link device is connected and the IO-Link master has saved valid parameter data for the IOL device that does not correspond to the current device parameters.

  The recovery process can be blocked by the IO-Link device via the Device Access Locks parameter, provided this is supported by the IO-Link device[e] .

d. Upload from the IOL device to the IOL master

e. Index 0x000C, refer to the manufacturer-specific IO-Link device documentation

Type-Compatible V1.1 Device with Restore, Download Master to Device

Type-compatible with regard to IO-Link specification V1.1, which includes the validation of vendor ID and device ID. Only "Restore" is activated.

Please note the following information on restore conditions:

- Restore, Download / IOL Master to IOL Device
  A restore (download from the IOL master to the IOL device) is executed if an IO-Link device is connected and the IO-Link master has saved valid parameter data for the IOL device that does not correspond to the current device parameters.
  In restore mode, no changes to the IOL device parameters are saved permanently on the IOL master. If the IOL device sets the DS_UPLOAD_FLAG in this mode, the device parameters are restored by the IOL master.
  The recovery process can be blocked by the IO-Link device via the Device Access Locks parameter, provided that this parameter is supported by the IOLink device (index 0x000C, refer to the manufacturer-specific IO-Link device documentation).

Manufacturer ID, Vendor ID

The vendor ID is required for the validation of the IO-Link device and can be configured with this parameter. The prerequisite for using the vendor ID is that you configure the port mode to "IO-Link Manual." Validation and Backup must be set to a type-compatible V1.X device.

Device ID

The device ID is required for the validation of the IO-Link device and can be configured with this parameter. The prerequisite for using the device ID is that you configure the port mode to "IO-Link Manual." Validation and Backup must be set to a type-compatible V1.X device.

Cycle Time

The IO-Link cycle time can be configured with this parameter.

The prerequisite for using the cycle time is that you configure the port mode to "IO-Link Manual."

As fast as possible:

The IO-Link port uses the max. supported IO-Link device and IO-Link master update cycle time for the cyclical I/O data update between the IO-Link master and the IO-Link device.

1.6 ms, 3.2 ms, 4.8 ms, 8.0 ms, 20.8 ms, 40.0 ms, 80.0 ms, 120.0 ms:

The cycle time can be set manually to the options provided. This option can be used, for example, for IO-Link devices that are connected via inductive couplers. Inductive couplers are usually the bottleneck in the update cycle time between the IO-Link master and the IO-Link device. In this case, please refer to the data sheet of the inductive coupler.

8.3 Process Data Assignment

The module supports process data communication in both directions. In this context, "consuming data" is defined as the process output data that controls the physical outputs and IO-Link output data. In this context, "producing data" is defined as the process input data that contains the physical inputs, diagnoses and IO-Link input data with optional extended status and event data.

The following chapters describe the data images for the data direction of consuming and producing data, which are assigned to the output and input assemblies.

Consuming Data Image, Output

Output Data Frame	Digital Output - Channel Control	Reserved, e.g., Feature Control	IO-Link Output Data
"Consuming data" size	2 bytes, INT	2 bytes, INT	0 … 256 bytes, INT

Table 8.19

2024-04

The complete output data frame has a variable size of up to 260 bytes. It is generally preceded by a 4-byte run/idle header, which results in a total of up to 264 bytes.

The bit assignment is described below.

Digital Output - Channel Control

Digital Output Channel Control	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Channel number, default mapping	Byte 0, LSB	8	7	6	5	4	3	2	1
	Byte 1, MSB	16	15	14	13	12	11	10	9

Table 8.20

The control values are effective if the corresponding channels are configured as outputs and Digital Output Control is set to DO Channel Control.

IO-Link Output Data

IO-Link Output Data	IO-Link Port 1 Control	IO-Link Port 2 Control	IO-Link Port 3 Control	IO-Link Port 4 Control	IO-Link Port 5 Control	IO-Link Port 6 Control	IO-Link Port 7 Control	IO-Link Port 8 Control
IO-Link port output size	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes

Table 8.21

The output size of the IO-Link port does not depend on the configured channel mode. It is always taken into account in the IO-Link output data, so the offsets do not need to be recalculated by the user in the event of a channel mode reconfiguration. Each IO-Link port can be set to its required size. The control data is transmitted to the device. However, the content depends on the IO-Link output data swapping mode and the output data swapping offset.

If no IO-Link port is configured, the consuming data image has no IO-Link output data.

Producing Data Image, Input

Input Data Frame	Digital Input - Channel Status	General Diagnosis	Sensor Diagnosis	Actuator/ U_{AUX} Diagnosis	IO-Link Diagnosis	IO-Link Input Data
"Producing data" size	2 bytes, INT	2 bytes, INT	2 bytes, INT	2 bytes, INT	0 byte 6 bytes, INT	0 … 432 bytes, INT

Table 8.22

The complete input data frame has a variable size of up to 446 bytes.

The bit assignment is described below.

Digital Input - Channel Status

Digital Input Channel Status	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Channel number, default mapping	Byte 0, LSB	8	7	6	5	4	3	2	1
	Byte 1, MSB	16	15	14	13	12	11	10	9

Table 8.23

Each status value is effective if the channel is configured as an input.

General Diagnosis

General Diagnostics	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
General Bit	Byte 0, LSB	IME	FME	DTO	DTU	SCA	SCS	LVA	LVS
	Byte 1, MSB	0	0	0	0	IDN	IDW	IDE	IVE

Table 8.24

LVS Low Voltage System/Sensor Supply
LVA Low Voltage Actuator Supply
SCS Short Circuit Sensor
SCA Short Circuit Actuator/UL/U_{AUX}
DTU Device Temperature Underrun
DTO Device Temperature Overrun
FME Force Mode Enabled
IME Internal Module Error
IVE IO-Link Validation Error, collective error
IDE IO-Link Device Error, collective error
IDW IO-Link Device Warning, collective error#
IDN IO-Link Device Notification, collective error
0 Reserved

Sensor Diagnosis

Sensor Diagnostics	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port number	Byte 0, LSB	X8	X7	X6	X5	X4	X3	X2	X1
	Byte 1, MSB	0	0	0	0	0	0	0	0

Table 8.25

X1 ... X8 Sensor short circuit at port X1 ... X8
0 Reserved

2024-04

Actuator/U_L/U_{AUX} Diagnosis

Actuator/U_L/U_{AUX} Diagnostics	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Channel number, fix	Byte 0, LSB	8	7	6	5	4	3	2	1
	Byte 1, MSB	16	15	14	13	12	11	10	9

Table 8.26

1 ... 16 Actuator/U_L/U_{AUX} channel error on channel 1 ... 16

SIO-Link Diagnosis

IO-Link Diagnostics	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
General Bit	Byte 0, LSB	ICE8	ICE7	ICE6	ICE5	ICE4	ICE3	ICE2	ICE1
	Byte 1, MSB	0	0	0	0	0	0	0	0
	Byte 0, LSB	IVE8	IVE7	IVE6	IVE5	IVE4	IVE3	IVE2	IVE1
	Byte 1, MSB	IDE8	IDE7	IDE6	IDE5	IDE4	IDE3	IDE2	IDE1
	Byte 0, LSB	IDW8	IDW7	IDW6	IDW5	IDW4	IDW3	IDW2	IDW1
	Byte 1, MSB	IDN8	IDN7	IDN6	IDN5	IDN4	IDN3	IDN2	IDN1

Table 8.27

ICE1 ... 8 IO-Link Port COM Error, no device, damaged line, short circuit
IVE1 ... 8 IO-Link Port Validation Error
IDE1 ... 8 IO-Link Port Device Error
IDW1 ... 8 IO-Link Port Device Warning
IDN1 ... 8 IO-Link Port Device Notification
0 Reserved

If no IO-Link port is configured, the input_data image does not display IO-Link diagnosis.

IO-Link Input Data

IO-Link Input Data	IO-Link Port 1				[...]	IO-Link Port 8			
	Status	PQI	Extended Status	Events	[...]	Status	PQI	Extended Status	Events
IO-Link port input size	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	2 bytes	0 byte 8 bytes	0 byte 12 bytes	[...]	0 byte 2 bytes 4 bytes 8 bytes 16 byte 32 bytes	2 bytes	0 byte 8 bytes	0 byte 12 bytes

Table 8.28

The input size of the IO-Link port does not depend on the configured channel mode. It is always taken into account in the IO-Link input data. The offsets for a channel mode reconfiguration do not need to be recalculated by the user. Each IO-Link port can be set to its required size. The input data of the device is mapped to the "Status" field and the content depends on the Input Data Swapping Mode and the Input Data Swapping Offset.

An IO-Link port can be configured using the Channel mode. The PQI provides some IO-Link information, is permanently available, and is not dependent on the status size. The extended status and the events can be activated via the IO-Link port configuration.

Port Qualifier Information PQI

PQI	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
General Bit	Byte 0, LSB	PQ	DevErr	DevCom	PortActive	SubstDev	NewPar	0	0
	Byte 1, MSB	0	0	0	0	0	0	0	0

Table 8.29

NewPar	Device parameter update detected
SubstDev	Substitute device, replacement device detected, different serial number
PortActive	Port activated
DevCom	Device detected and in the PREOPERATE or OPERATE state
DevErr	Device or port error/warning occurred
PQ	Valid I/O process data from the device
0	Reserved

Extended Status

IO-Link Extended Status	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Extended Diagnostics	Byte 0, LSB	0	0	0	ICT	BUI	SPE	ILE	OLE
	Byte 1, MSB	0							
Vendor ID	Byte 2	Vendor ID, LSB							
	Byte 3	Vendor ID, MSB							
Device ID	Byte 4	Device ID, LSB							
	Byte 5	Device ID							
	Byte 6	Device ID, MSB							
	Byte 7	0							

Table 8.30

OLE	Length error of the output process data, device mismatch
ILE	Length error of the input process data, device mismatch
SPE	Startup Parameterization Error = direct parameter error
BUI	Backup Inconsistency = parameter memory error
ICT	Invalid cycle time
0	Reserved

Events

2024-04

IO-Link Events	Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Event Qualifier 1	Byte 0, LSB	Mode		Type		0	0	Instance	
	Byte 1, MSB	0	0	0	0	0	0	0	0
Event Code 1	Byte 2	Event Code							
	Byte 3								
Event Qualifier 2	Byte 4	Mode		Type		0	0	Instance	
	Byte 5	0	0	0	0	0	0	0	0
Event Code 2	Byte 6	Event Code							
	Byte 7								
Event Qualifier 3	Byte 8	Mode		Type		0	0	Instance	
	Byte 9	0	0	0	0	0	0	0	0
Event Code 3	Byte 10	Event Code							
	Byte 11								

Table 8.31

Instance	Unknown; "0", Reserved; Physical Layer PL; "1", Data Link Layer DL; "2", Application Layer AL; "3", Application; "4"
Type	Notification; "1", Warning; "2", Error; "3"
Mode	Event single shot; "1", Event disappeared; "2", Event appeared; "3"
Event Code	Diagnostic code reported by the IO-Link device
0	Reserved

Sample Applications

The connection parameters and configuration parameters of the module with its variable data sizes offer you an individual approach to implementing your application. The size of the individual IO-Link ports can be determined, which has an impact on the process data offsets.

The following application examples describe the process data assignment for the input data and output data, including the byte offsets. If there is no need to configure the data sizes, use the first example to obtain the default byte offsets for your application. If you want to reduce the data sizes, for example to set them to the required IO-Link data lengths, or if you do not need the extended status, see the second example to understand how the data mapping works.

For Rockwell Automation/Allen Bradley PLC customers, the use of an add-on instruction in Studio 5000® as an interface to the process data is recommended.see "Add-On Instruction AOI" on page 95

Example

Process Data Images - Default Configuration

The input data sizes and output data sizes of the IO-Link ports are preset to the maximum size in the EDS files by default. This means that you receive all the data from each IO-Link port. The following tables provide an overview of the data structures and the byte offsets for input data and output data:

Connection parameters

Data size output 260

Data size input 446

Default Output Process Data

Byte-Offset	Output Data
0	Digital output channel control, 2 bytes
2	Reserved, 2 bytes
4	IO-Link port 1 data, control, 32 bytes
36	IO-Link port 2 data, control, 32 bytes
68	IO-Link port 3 data, control, 32 bytes
100	IO-Link port 4 data, control, 32 bytes
132	IO-Link port 5 data, control, 32 bytes
164	IO-Link port 6 data, control, 32 bytes
196	IO-Link port 7 data, control, 32 bytes
228	IO-Link port 8 data, control, 32 bytes

Table 8.32

Default Input Process Data

Byte-Offset	Input Data
0	Digital input channel status, 2 bytes
2	General diagnostics, 2 bytes
4	Sensor diagnostics, 2 bytes
6	Actuator diagnostics, 2 bytes
8	IO-Link diagnostics, 6 bytes
14	IO-Link port 1 data, status, 32 bytes
46	IO-Link port 1 PQI, 2 bytes
48	IO-Link port 1 extended status, 8 bytes
56	IO-Link port 1 events, 12 bytes
68	IO-Link port 2 data, status, 32 bytes
100	IO-Link port 2 PQI, 2 bytes
102	IO-Link port 2 extended status, 8 bytes
110	IO-Link port 2 events, 12 bytes
122	IO-Link port 3 data, status, 32 bytes
154	IO-Link port 3 PQI, 2 bytes
156	IO-Link port 3 extended status, 8 bytes
164	IO-Link port 3 events, 12 bytes
176	IO-Link port 4 data, status, 32 bytes
208	IO-Link port 4 PQI, 2 bytes
210	IO-Link port 4 extended status, 8 bytes
218	IO-Link port 4 events, 12 bytes
230	IO-Link port 5 data, status, 32 bytes
262	IO-Link port 5 PQI, 2 bytes

2024-04

Byte-Offset	Input Data
264	IO-Link port 5 extended status, 8 bytes
272	IO-Link port 5 events, 12 bytes
284	IO-Link port 6 data, status, 32 bytes
316	IO-Link port 6 PQI, 2 bytes
318	IO-Link port 6 extended status, 8 bytes
326	IO-Link port 6 events, 12 bytes
338	IO-Link port 7 data, status, 32 bytes
370	IO-Link port 7 PQI, 2 bytes
372	IO-Link port 7 extended status, 8 bytes
380	IO-Link port 7 events, 12 bytes
392	IO-Link port 8 data, status, 32 bytes
424	IO-Link port 8 PQI, 2 bytes
426	IO-Link port 8 extended status, 8 bytes
434	IO-Link port 8 events, 12 bytes

Table 8.33

Example

Process data images with modified data sizes

The input data sizes and the output data sizes of the IO-Link ports and the presence of the extended status can be modified by the configuration group. You can decide which data is mapped to the process data. The following configuration tables provide an example and an overview of possible data structures and byte offsets for input data and output data:

Connection parameters

Data size output 62
Data size input 66

IO-Link Port 1

Data size output 2 bytes
Data size input 2 bytes
Data extension input No data

IO-Link Port 2

Data size output 32 bytes
Data size input 0 byte
Data extension input Extended Status

IO-Link Port 3

Data size output 16 byte
Data size input 4 bytes
Data extension input Extended Status + Events

IO-Link Port 4

Data size output	8 bytes
Data size input	2 bytes
Data extension input	No data

IO-Link Port 5 ... 8

Data size output	0 byte
Data size input	0 byte
Data extension input	No data

Modified process data

Byte-Offset	Output Data	Input Data
0	Digital output channel control, 2 bytes	Digital input channel control, 2 bytes
2	Reserved, 2 bytes	General diagnostics, 2 bytes
4	IO-Link port 1 data, control, 2 bytes	Sensor diagnostics, 2 bytes
6	IO-Link port 2 data, control, 32 bytes	Actuator diagnostics, 2 bytes
8		IO-Link diagnostics, 6 bytes
10		
12		
14		IO-Link port 1 data, status, 2 bytes
16		IO-Link port 1 PQI, 2 bytes
18		IO-Link port 2 PQI, 2 bytes
20		IO-Link port 2 extended status, 8 bytes
22		
24		
26		
28		IO-Link port 3 data, status, 4 bytes
30		
32		IO-Link port 3 PQI, 2 bytes
34		IO-Link port 3 extended status, 8 bytes
36		
38	IO-Link port 3 data, control, 16 bytes	
40		
42		IO-Link port 3 events, 12 bytes
44		
46		
48		
50		
52		

2024-04

Byte-Offset	Output Data	Input Data
54	IO-Link port 4 data, control, 8 bytes	IO-Link port 4 data, status, 2 bytes
56		IO-Link port 4 PQI, 2 bytes
58		IO-Link port 5 PQI, 2 bytes
60		IO-Link port 6 PQI, 2 bytes
62		IO-Link port 7 PQI, 2 bytes
64		IO-Link port 8 PQI, 2 bytes
66		

Table 8.34

8.4 Configuration and Operation with Rockwell Automation Studio 5000®

The configuration and commissioning of the module described on the following pages refers to Rockwell Automation Studio 5000®, V30. If you are using an engineering tool from another provider, please refer to the associated documentation.

Basic Commissioning

1. Create a new project in Studio 5000®.
2. Select the appropriate controller.
3. If no integrated EtherNet/IP interface is available, add the correct communication interface to your backplane under **Controller Organizer > I/O-Configuration**.
4. Define a communication path to enable the project to be downloaded.
5. Install the module's EDS_files in Studio 5000® using the EDS hardware installation tool.
6. Go to **Controller Organizer > I/O-Configuration** and right-click on Ethernet.
7. Select New Module from the menu. The following selection window opens:

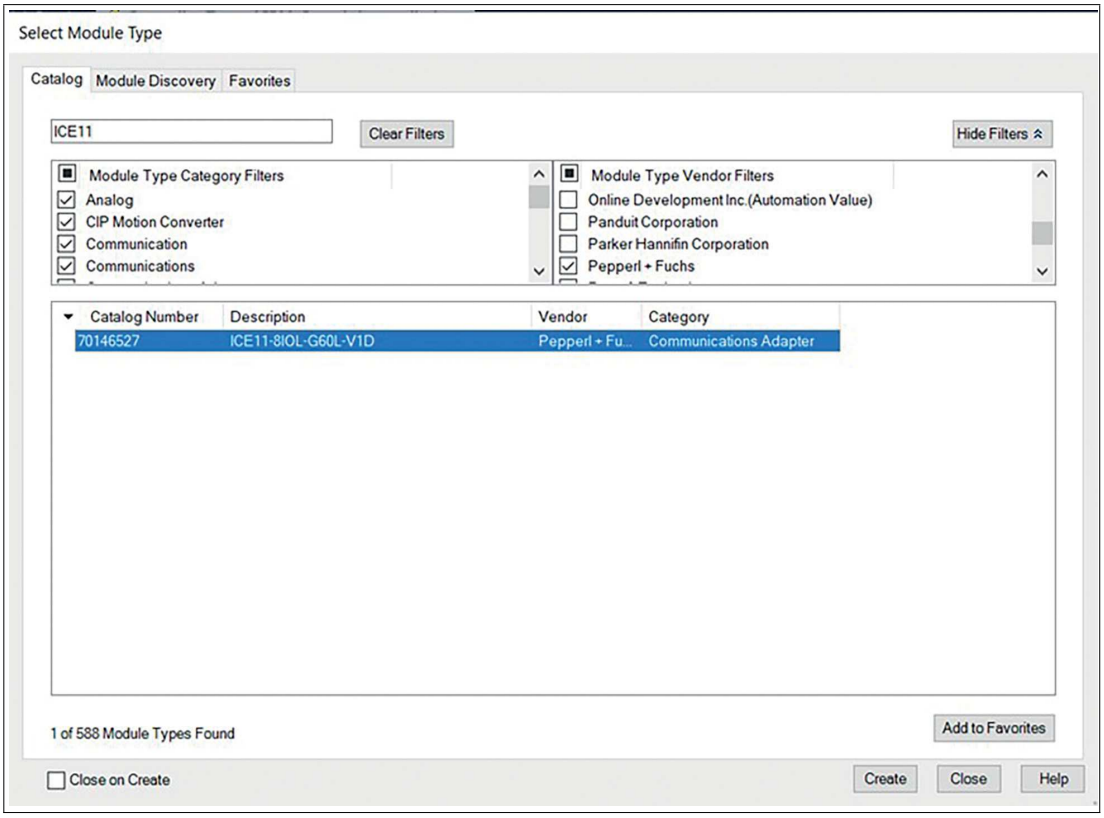


Figure 8.1

8. Use the **Module Type Vendor Filter** on the right-hand side to display all installed Pepperl+Fuchs devices.
9. Select the device that you want to add and click on "Create."

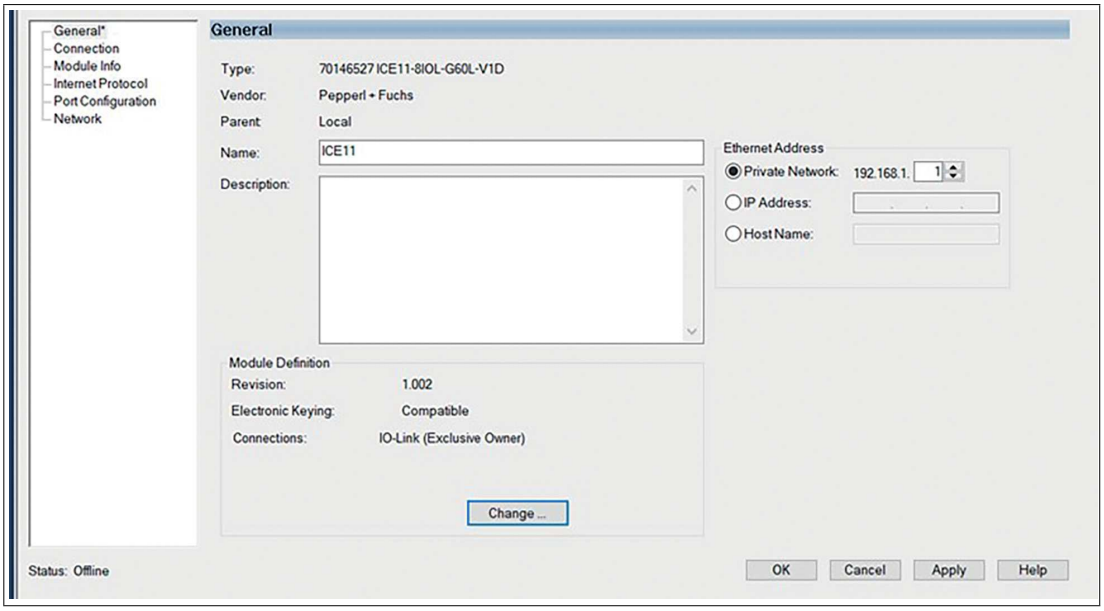


Figure 8.2

10. Enter a name for the device and select the previously selected IP address. In this example, the name is ICE11 and the IP address is 192.168.1.1.
11. Click on Change to change the settings for the device revision, the electronic coding and the connection type.

2024-04

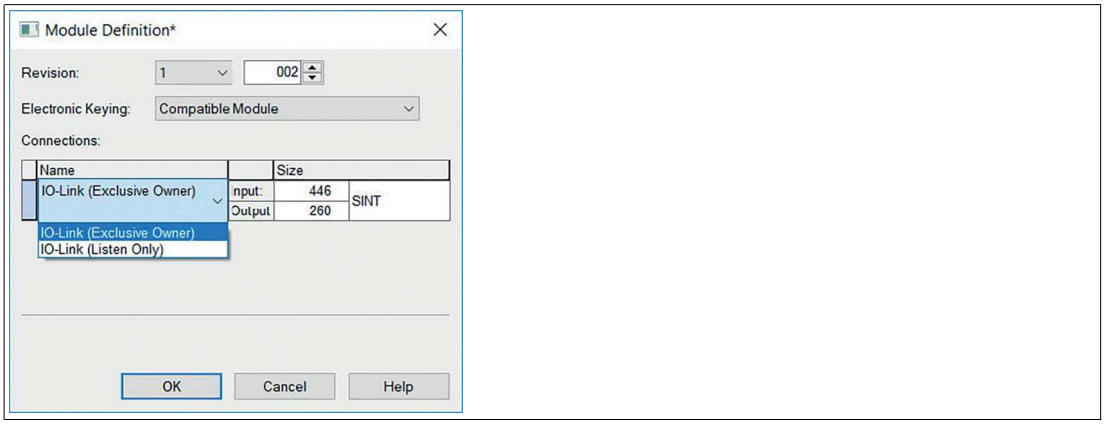


Figure 8.3

12. Select the connection type and configure the total sizes of the input and output process data. The sizes depend on the number of connected IO-Link devices and their data lengths in both directions. Each input data size and output data size of the devices must also be defined later in the IO-Link port configuration. The selection of the data type refers to the type in which Studio 5000® maps the input data and the output data. The default data type is SINT. The INT type can be selected if each size corresponds to a multiple of 2. The DINT type can be selected if each size corresponds to a multiple of 4. Click OK.

13. You can see the selected connection in the Connection folder under Module Properties. In this folder, you can also define the Requested Packet Interval (RPI) and the EtherNet/IP connection type. A value of 1 ms is the minimum for the RPI parameter and the connection types Unicast or Multicast can be selected. Apply the settings.

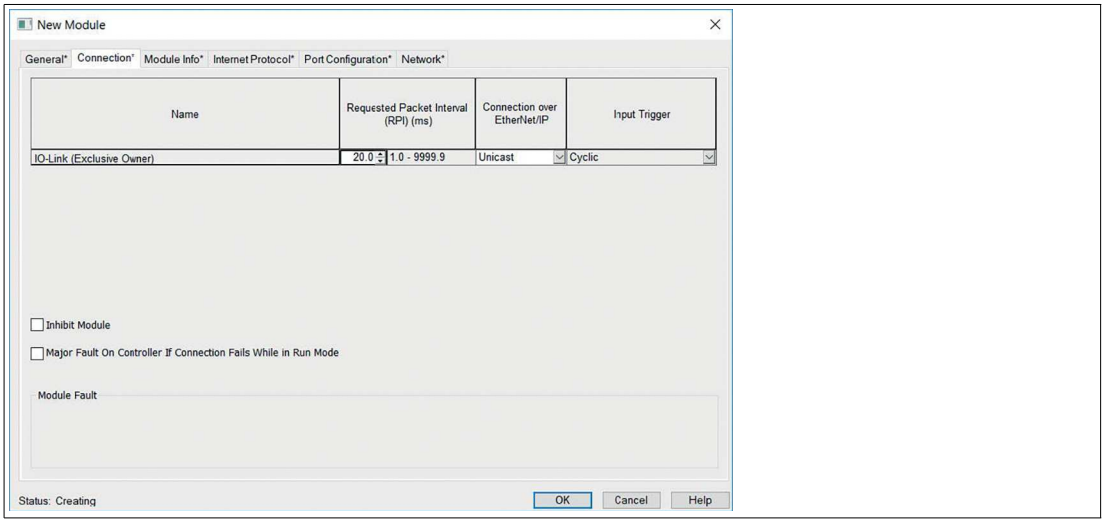


Figure 8.4

14. Go to Controller-Tags in Controller Organizer. The controller tags for the configuration parameters contain the device name followed by a ":C." The configuration parameters can be set under Value. See chapter 8.2.

	ICE11:C	{...}		_0039:70146527_B...
	ICE11:C.Force_Mode_Lock	0	Decimal	BOOL
	ICE11:C.Web_Interface_Lock	0	Decimal	BOOL
	ICE11:C.Digital_Output_Control	0	Decimal	BOOL
	ICE11:C.Report_UL_UAux_Supply_Voltage_Fault	1	Decimal	BOOL
	ICE11:C.Report_DO_Fault_without_UL_UAux	1	Decimal	BOOL
	ICE11:C.CIP_object_configuration_lock	0	Decimal	BOOL
	ICE11:C.External_configuration_lock	0	Decimal	BOOL
	ICE11:C.IO_Mapping_Mode	0	Decimal	SINT
	ICE11:C.IO_Mapping_Port1_Ch_A	0	Decimal	SINT
	ICE11:C.IO_Mapping_Port1_Ch_B	1	Decimal	SINT
	ICE11:C.IO_Mapping_Port2_Ch_A	2	Decimal	SINT
	ICE11:C.IO_Mapping_Port2_Ch_B	3	Decimal	SINT
	ICE11:C.IO_Mapping_Port3_Ch_A	4	Decimal	SINT
	ICE11:C.IO_Mapping_Port3_Ch_B	5	Decimal	SINT
	ICE11:C.IO_Mapping_Port4_Ch_A	6	Decimal	SINT
	ICE11:C.IO_Mapping_Port4_Ch_B	7	Decimal	SINT
	ICE11:C.IO_Mapping_Port5_Ch_A	8	Decimal	SINT
	ICE11:C.IO_Mapping_Port5_Ch_B	9	Decimal	SINT
	ICE11:C.IO_Mapping_Port6_Ch_A	10	Decimal	SINT
	ICE11:C.IO_Mapping_Port6_Ch_B	11	Decimal	SINT

Figure 8.5

15. The tag of the process data entered contains the device name followed by ":I.Data". The output process data has the same name followed by ":O.Data". Both arrays show the configured data sizes. See chapter 8.3.

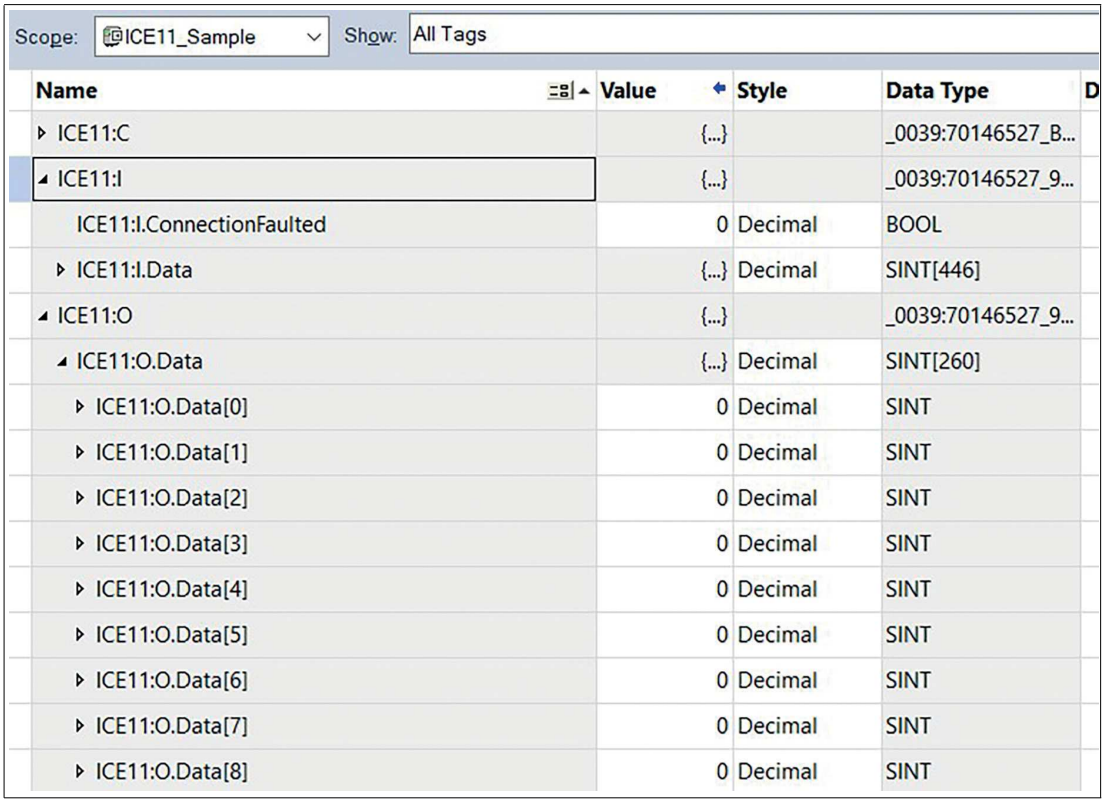


Figure 8.6

↳ When the configuration is complete, the parameters can be downloaded to the EtherNet/IP controller.

Add-On Instruction AOI

Rockwell Automation Studio 5000® provides the user with a mechanism for optimizing and encapsulating data and logic via an add-on instruction. This AOI can be added to a current path "rung" like any other predefined instruction in the controller and is useful for pre-processing a device's input data and output data. With the help of user-defined data types UDT, the user receives a comprehensible interface with a clear designation and description for each field of the process data. The advantage is that there is no need to calculate byte offsets for the input data and the output data. Each process data field can be addressed directly via a unique name. You can find AOIs for the module on the product detail page under the Software tab.

Using an AOI

1. Navigate to Controller Organizer in your Studio 5000® project. Right-click on Add-On Instructions. Click on Import Add-On Instruction...:

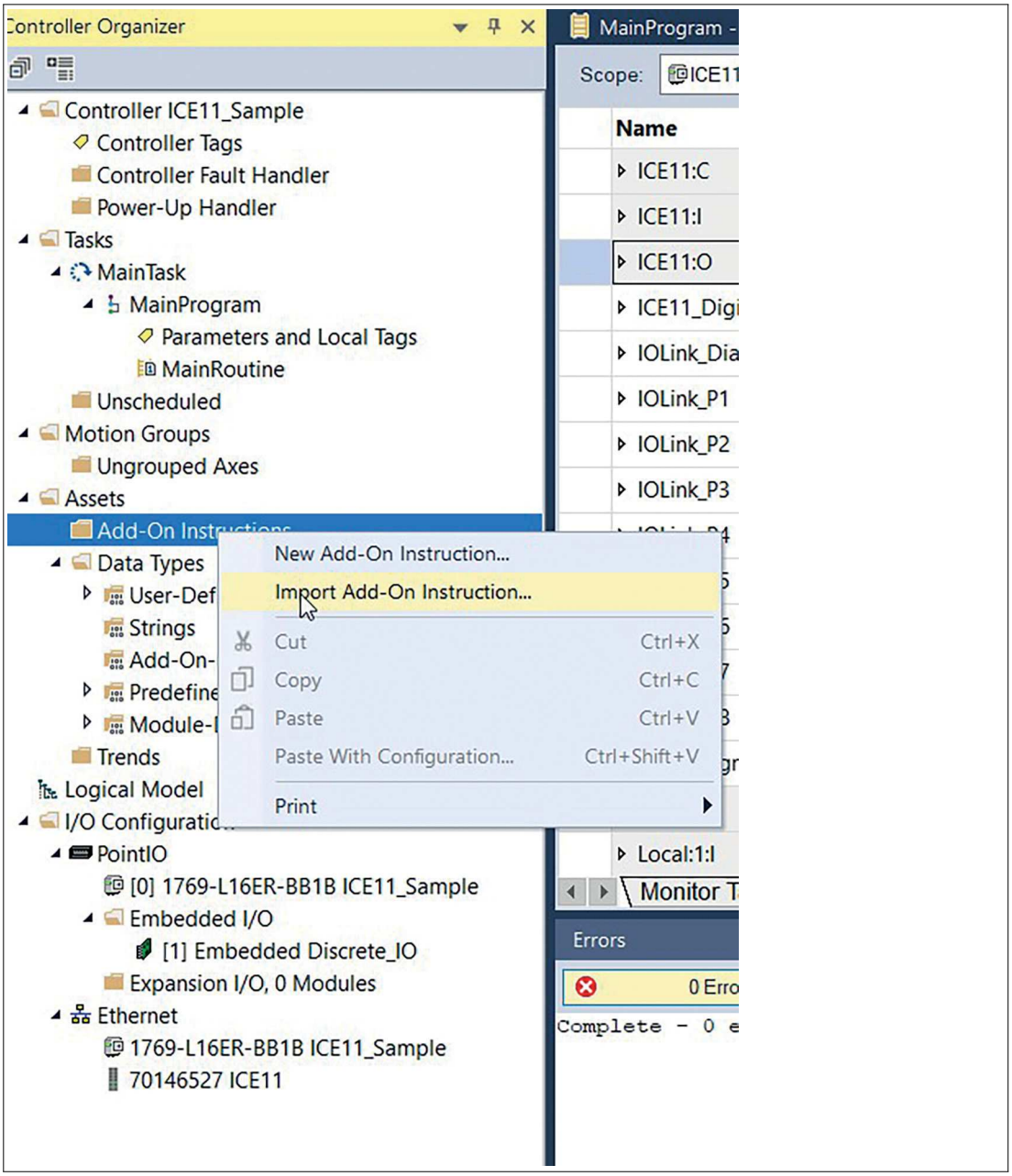


Figure 8.7

2024-04

2. Open the *.L5X file:

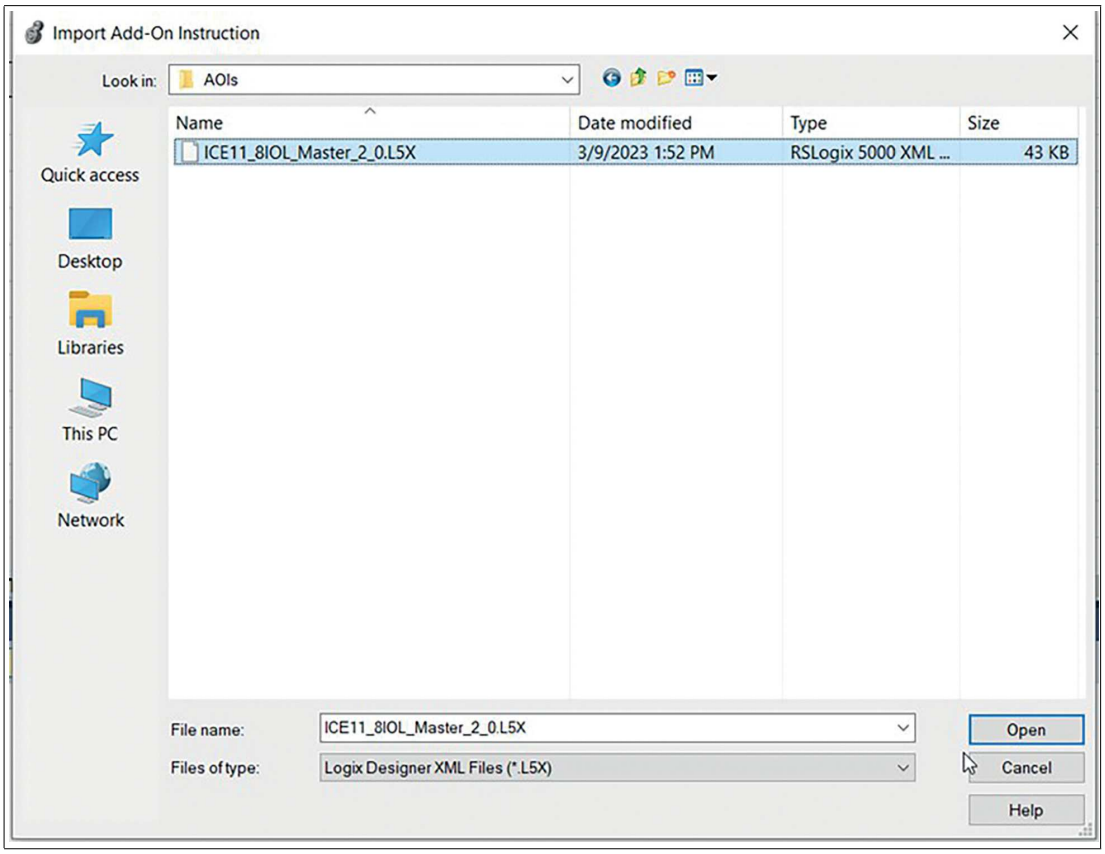


Figure 8.8

3. Click on OK to create the AOI with all the necessary User-Defined Data Types UDT:

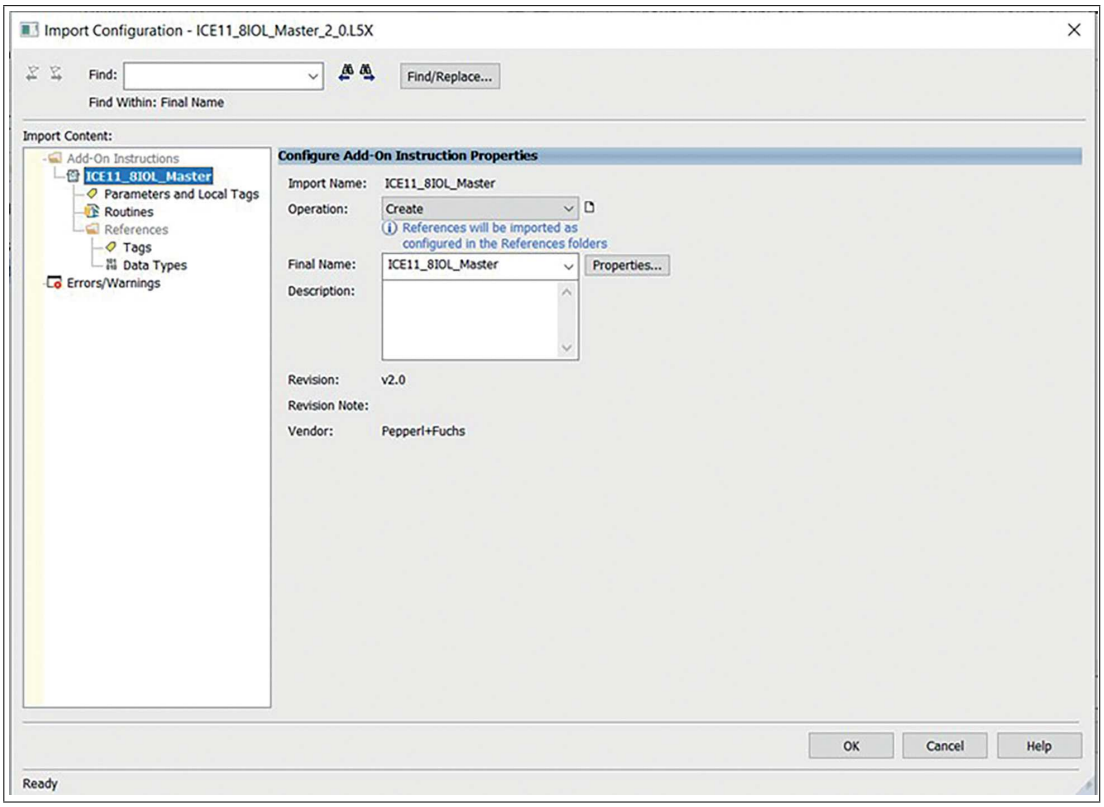


Figure 8.9

↳ The imported components are displayed in the Controller Organizer:

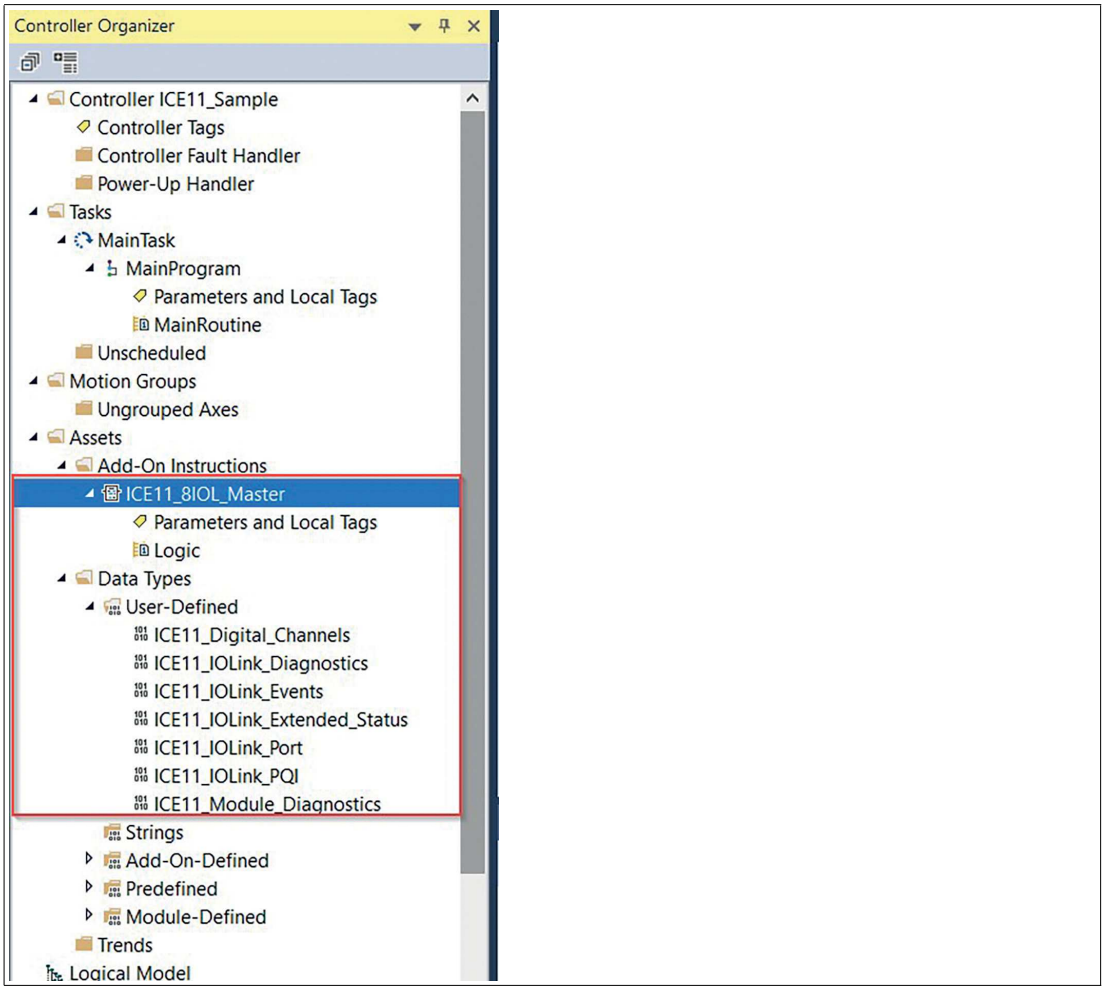


Figure 8.10

4. Check whether an error appears in the AOI tags as a red circle with a white cross. This can occur for the configuration data when you import an AOI into your system for the first time:

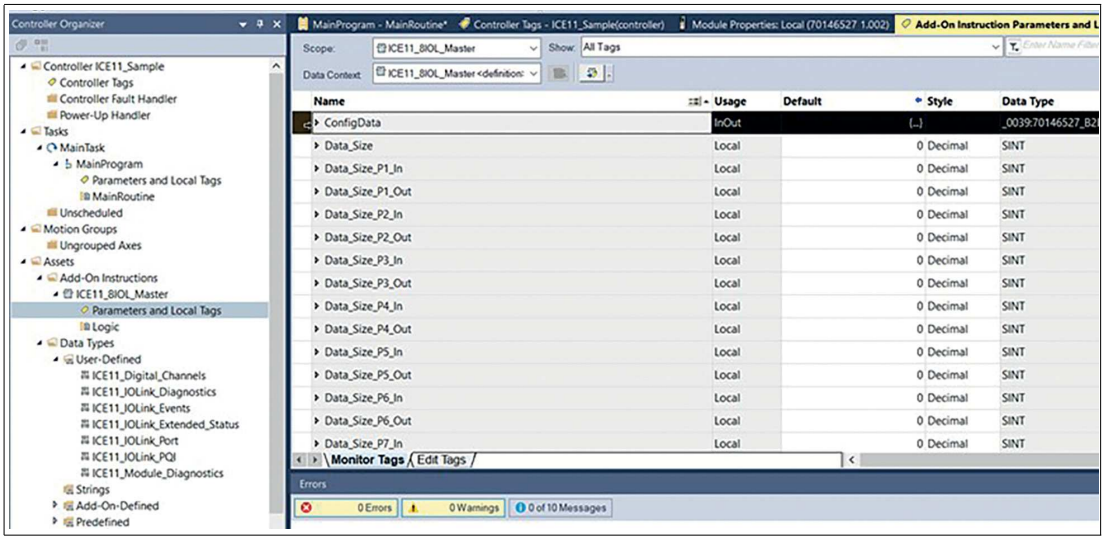


Figure 8.11

↳ If no error has occurred, go to step 9.

5. Go to Edit Tags and adjust the data type to the module-defined type on your system:

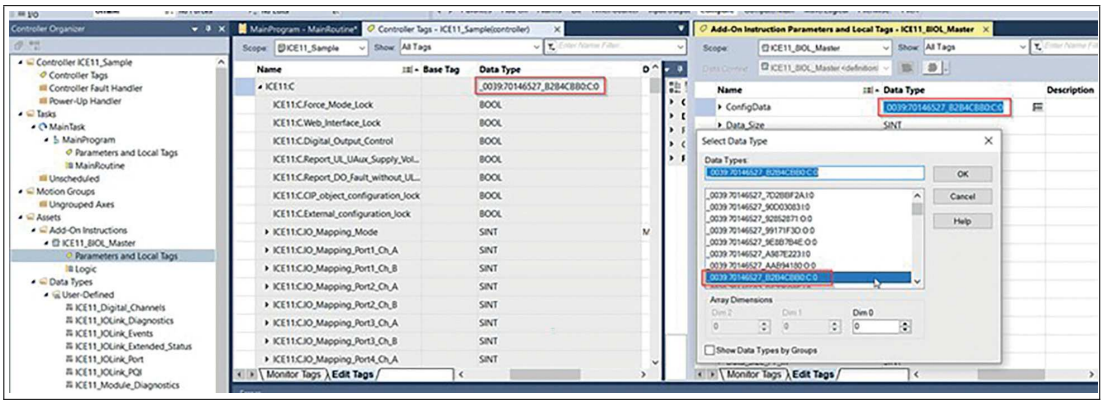


Figure 8.12

6. The Config data type must exactly match the data type associated with ConfigData. Because this data type is system-dependent, you may need to select it manually. In rare cases, you may have to delete the entire line and add the parameter manually as follows:
ConfigData InOut *****Config Data Type*****

7. If you have changed a data type in the AOI, perform an export. This saves this version for further use in other projects on your system. Right-click on the AOI and click on Export Add-On Instruction…:

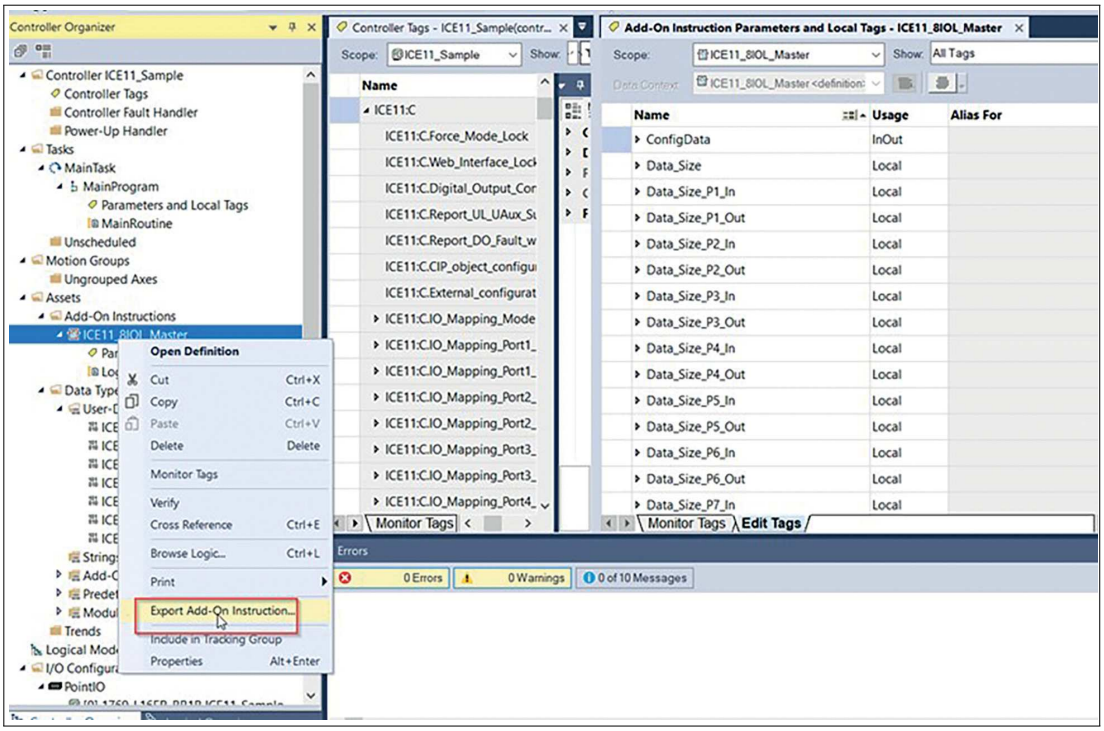


Figure 8.13

8. Edit the file name and save the AOI:

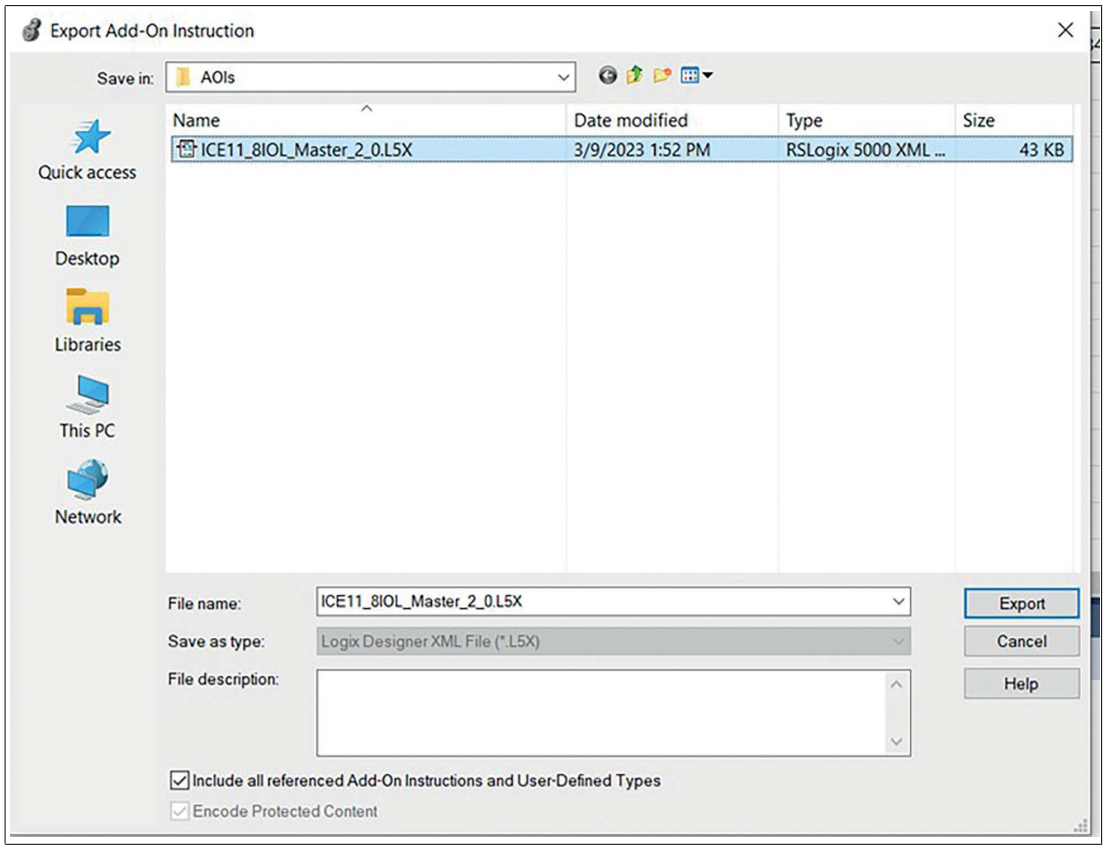


Figure 8.14

9. To use the AOI, go to a logic, e.g., the MainRoutine. Add the IO-Link Master AOI to the current path "rung" via drag-and-drop:

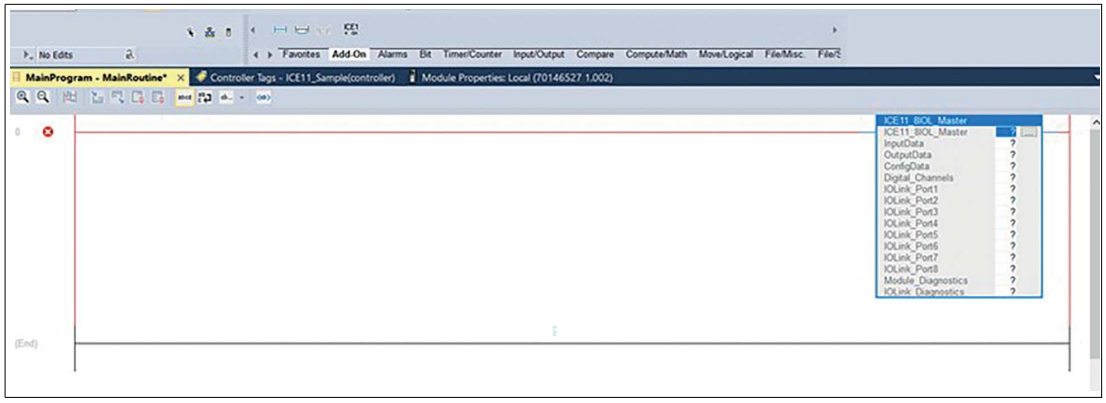


Figure 8.15

10. Right-click on the first element of the AOI and click on New Tag...:

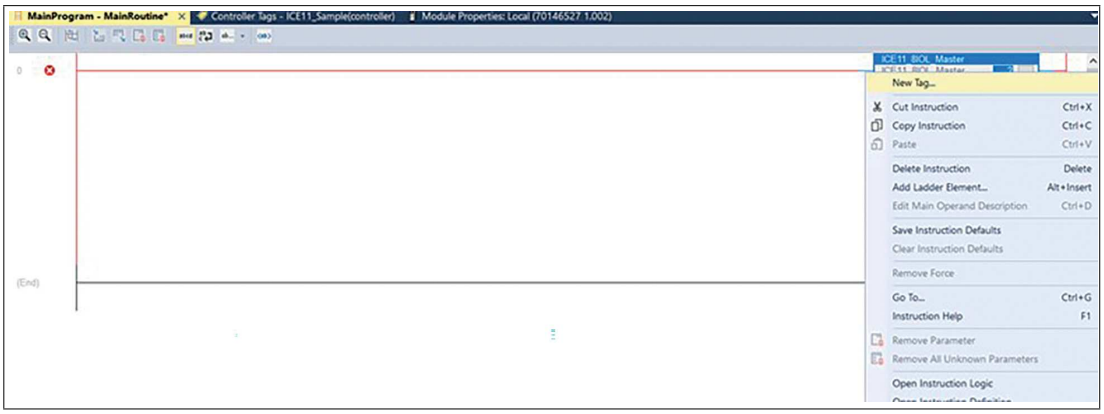


Figure 8.16

11. Enter a name and click on Create to create an AOI:

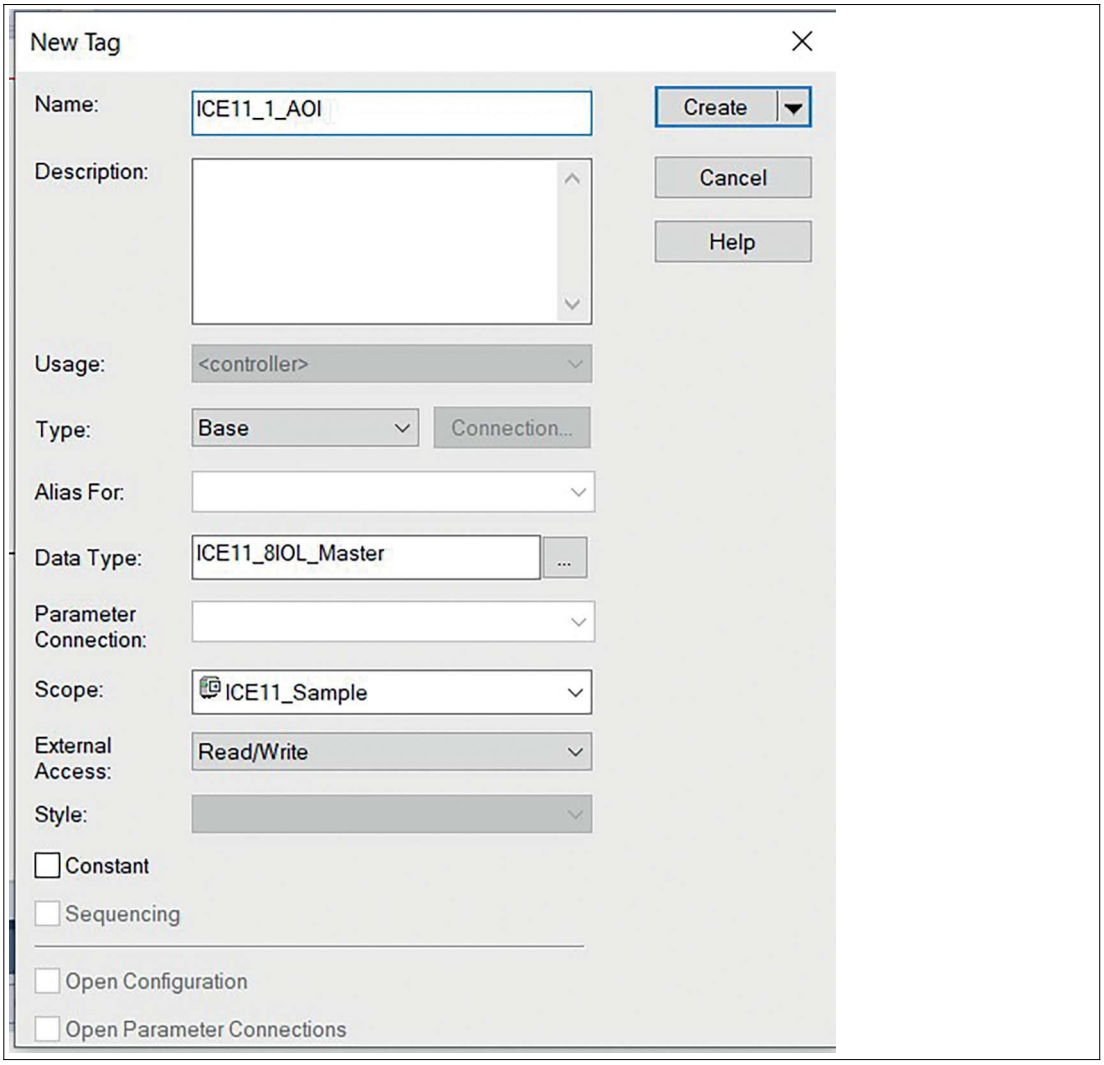


Figure 8.17

12. Assign the module's input, output and configuration data:

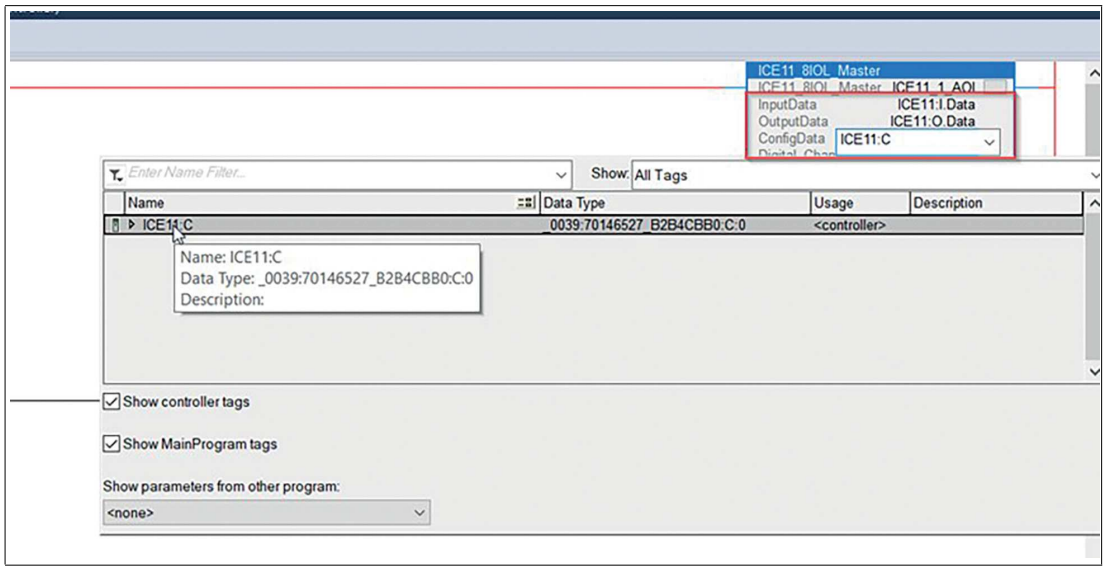


Figure 8.18

13. To create the tags for the remaining elements, repeat steps 10 and 11:

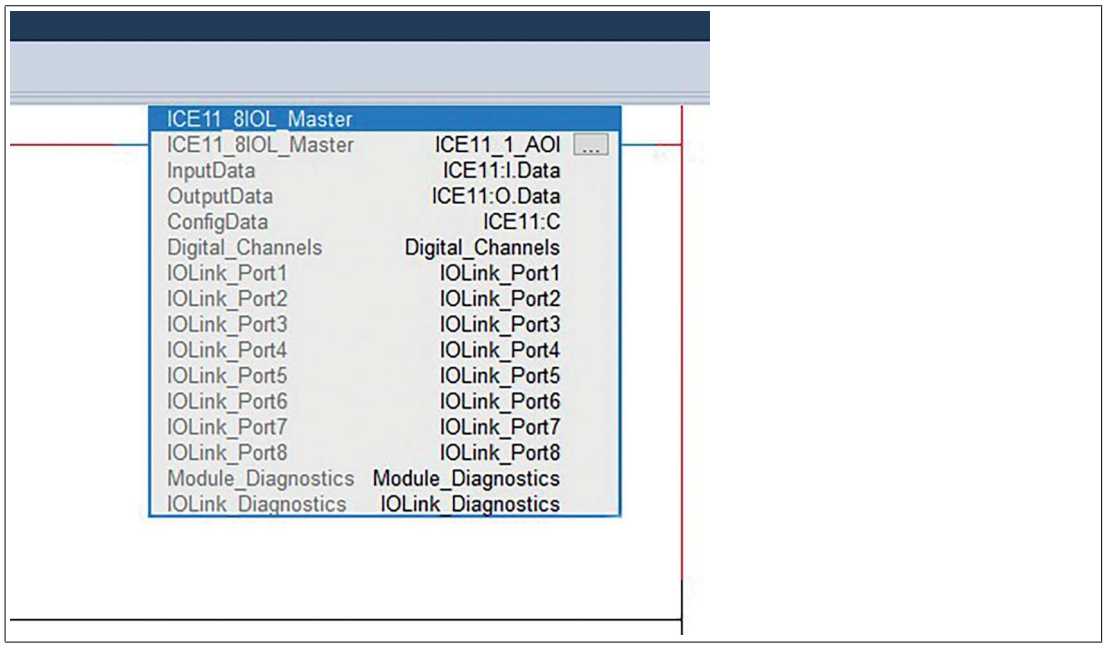


Figure 8.19

↳ Your logic no longer creates a copy of the input data and the output data simultaneously. It uses the new data tags as an interface for data exchange with the module:

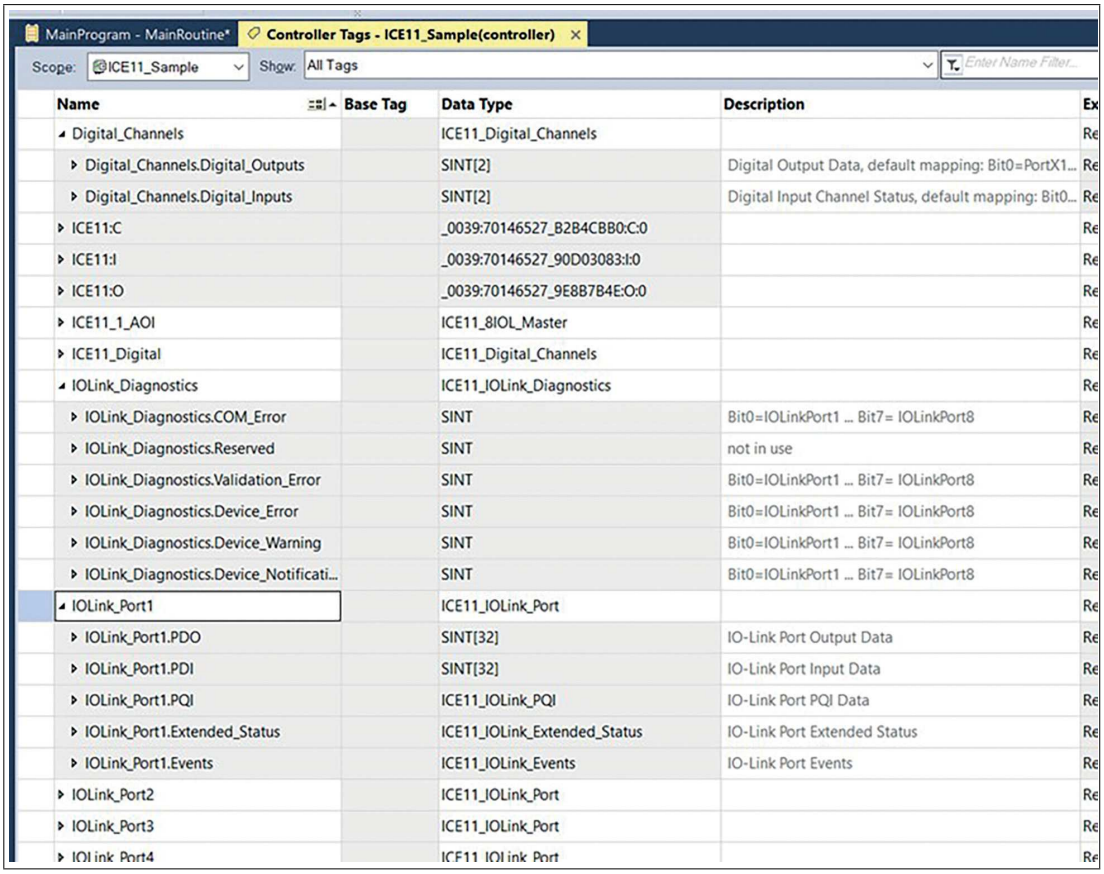


Figure 8.20

8.5 CIP Object Classes

8.5.1 EtherNet/IP Object Classes

According to the CIP specification, the module supports the following standard EtherNet/IP object classes:

Object Class	Object ID	Instances
Identity Object	0x01	0, 1
Message Router Object	0x02	0, only on class level
Assembly Object	0x04	0, 130, 131, 145
Connection Manager Object	0x06	0, only on class level
Discrete Input Point Object	0x08	0, 1 ... 16
DLR Object	0x47	0, 1
QoS Object	0x48	0, 1
TCP/IP Interface Object	0xF5	0, 1
Ethernet Link Object	0xF6	0, 1 ... 2
LLDP Management Object	0x109	0, 1

Table 8.35

All objects with instance attributes are described below.

Identity Object 0x01

Supported services:

- Get Attributes All 0x01
- Reset 0x05:
  - 0 = Reset Module, Warmstart
  - 1 = Reset to Factory Default
- Get Attribute Single 0x0E

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device
6	Maximum ID Number Class Attributes	Get	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device
7	Maximum ID Number Instance Attributes	Get	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.

Table 8.36

Instance Attribute, Instance <AssemblyID>

Attribute	Name	Access	Data Type	Description
1	Vendor ID	Get	UINT	Vendor Identification
2	Device Type	Get	UINT	Indication of general type of product
3	Product Code	Get	UINT	Identification of a particular product of an individual vendor
4	Revision	Get	USINT, USINT	Structure with major and minor revision
5	Status	Get	WORD	Summary status of device: b0: Owned b1: Reserved "0" b2: Configured b3: Reserved "0" b4 ... 7: Extended Device Status 0 = Self-Testing or Unknown 1 = Firmware Update in Progress 2 = At least one faulted I/O connection 3 = No I/O connections established 4 = Non-Volatile Configuration bad 5 = Major Fault 6 = At least one I/O connection in RUN mode 7 = At least one I/O connection established, all in IDLE mode 8 = Unused, valid only for instances grater than "1" 9 = Reserved 10 ... 15 = Vendor-specific b8: Minor Recoverable Fault b9: Minor Unrecoverable Fault b10: Major Recoverable Fault b11: Major Unrecoverable Fault b12 ... 15: Reserved, "0"
6	Serial Number	Get	UDINT	Serial number of device

Attribute	Name	Access	Data Type	Description
7	Product Name	Get	STRING	Human readable identification
8	State	Get	USINT	Present state of the device: 0 = Nonexistent 1 = Device Self Testing 2 = Standby 3 = Operational 4 = Major Recoverable Fault 5 = Major Unrecoverable Fault 6 ... 254 = Reserved 255 = Default Value
9	Configuration Consistency Value	Get	UINT	Can be a CRC, incrementing count or any other mechanism (vendor-specific behavior) to reflect a non-volatile configuration change
19	Protection Mode	Get	WORD	Current protection mode of the device: b0: Implicit Protection enabled b1 ... 2: Reserved b3: Explicit Protection enabled b4 ... 15: Reserved

Table 8.37

Assembly Object 0x04

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device
3	Number of Instances	Get	UINT	Number of instances currently created in this class level of the device
6	Maximum ID Number Class Attributes	Get	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device
7	Maximum ID Number Instance Attributes	Get	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.

Table 8.38

Instance Attribute, Instance 1

Attribute	Name	Access	Data Type	Description
3	Data	Get, Set	ARRAY	Assembly Data, Set service only available for consuming assemblies that are not part of an active implicit connection
4	Size	Get	UINT	Number of bytes in Attribute 3

Table 8.39

2024-04

Discrete Input Point Object 0x08

Supported services:

- Get Attribute Single 0x0E

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object

Table 8.40

Instance Attribute, Instance 1 ... 16

Attribute	Name	Access	Data Type	Description
3	Value	Get	BOOL	Input Point Value; 0 = OFF, 1 = ON
4	Status	Get	BOOL	Input Point Status; 0 = OK, 1 = Alarm

Table 8.41

DLR Object 0x47

Supported services:

- Get Attributes All 0x01
- Get Attribute Single 0x0E

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device
6	Maximum ID Number Class Attributes	Get	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device
7	Maximum ID Number Instance Attributes	Get	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.

Table 8.42

Instance Attribute, Instance 1

Attribute	Name	Access	Data Type	Description
1	Network Topology	Get	BOOL	0 = Linear 1 = Ring
2	Network Status	Get	BOOL	0 = Normal operation 1 = Ring Fault 2 = Unexpected Loop Detected 3 = Partial Network Fault 4 = Rapid Fault/Restore Cycle
10	Active Supervisor Address	Get	ARRAY	Supervisor IP Address, Supervisor MAC Address, 0 = not configured

Attribute	Name	Access	Data Type	Description
12	Capability Flags	Get	DWORD	Flag description: b0: Announce-based Ring Node, "0" b1: Beacon-based Ring Node, "1" b2 ... 4: Reserved, "0" b5: Supervisor Capable, "0" b6: Redundant Gateway Capable, "0" b7: Flush_Table frame Capable, "1" b8 ... 15: Reserved, "0"

Table 8.43

QoS Object 0x48

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device
6	Maximum ID Number Class Attributes	Get	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device
7	Maximum ID Number Instance Attributes	Get	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.

Table 8.44

Instance Attribute, Instance 1

Attribute	Name	Access	Data Type	Description
1	802.1Q Tag Enable	Get, Set	USINT	Enables "1" or disables "0" sending 802.1Q frames on CIP and IEEE 1588 messages, default value "0"
2	DSCP PTP Event	Get, Set	USINT	DSCP value for PTP Event frames, default value "59"
3	DSCP PTP General	Get, Set	USINT	DSCP value for PTP General frames, default value "47"
4	DSCP Urgent	Get, Set	USINT	CIP transport class 0/1 messages with Urgent priority, default value "55"
5	DSCP Scheduled	Get, Set	USINT	CIP transport class 0/1 messages with Scheduled priority, default value "47"
6	DSCP High	Get, Set	USINT	CIP transport class 0/1 messages with High priority, default value "43"
7	DSCP Low	Get, Set	USINT	CIP transport class 0/1 messages with Low priority, default value "31"
8	DSCP Explicit	Get, Set	USINT	CIP UCMM, CIP transport class 2/3, All other EtherNet/IP encapsulation messages, default value "27"

Table 8.45

2024-04

TCP/IP Object 0xF5

Supported services:

- Get Attributes All 0x01
- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Table 8.46

Instance Attribute, Instance 1

Attribute	Name	Access	Data Type	Description
1	Status	Get	DWORD	Interface Status description: b0 ... 3: Interface Configuration Status 0 = Not configured 1 = Configuration obtained by BOOTP, DHCP or stored value 2 = Configuration obtained by hardware settings, e.g., rotary switches 3 ... 15 = Reserved b4: Mcast Pending b5: Interface Configuration Pending b6: Acd Status b7: Acd Fault b8 ... 31: Reserved "0"
2	Configuration Capability	Get	DWORD	Interface Capability Flags: b0: BOOTP Client "1" b1: DNS Client "0" b2: DHCP Client "1" b3: DHCP-DNS Update "0" b4: Configuration Settable "1" b5: Hardware Configurable, 0 = no rotary switches; 1 = rotary switches available b6: Interface Configuration Change Requires Reset "0" b7: Acd Capable "1" b8 ... 31: Reserved "0"
3	Configuration Control	Get, Set	DWORD	Interface Control Flags: b0 ... 3: Configuration Method: 0 = Stored Value 1 = BOOTP 2 = DHCP 3 ... 15 = Reserved b4: DNS Enable "0" b5 ... 31: Reserved "0"
4	Physical Link Object	Get	STRUCT	Path to physical link object
5	Interface Configuration	Get, Set	STRUCT	TCP/IP network interface configuration
6	Host Name	Get, Set	STRING	Host name of the device, length of 0 = not configured
10	Select Acd	Get, Set	BOOL	Enables "1" or disables "0" the use of ACD, default value "1"

Attribute	Name	Access	Data Type	Description
11	Last Conflict Detected	Get, Set	STRUCT	Structure containing information related to the last conflict detected
13	Encapsulation Inactivity Timeout	Get, Set	UINT	Number of seconds of inactivity before TCP connection is closed: 0 = disable 1 ... 3600 = timeout in seconds 120 = default value

Table 8.47

Ethernet Link Object 0xF6

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10
- Get and Clear 0x4C

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device
3	Number of Instances	Get	UINT	Number of object instances currently created at this class level of the device[1]

Table 8.48

1. In this case number of Ethernet ports

Instance Attribute, Instance 1 ... 2

Attribute	Name	Access	Data Type	Description
1	Interface Speed	Get	UDINT	Current interface speed in Mbps
2	Interface Flags	Get	DWORD	Interface Flags: b0: Link Status b1: Half "0" or Full "1" Duplex b2 ... 4: Negotiation Status: 0 = Auto-negotiation in progress 1 = Auto-negotiation and speed detection failed (using default 10Mbps and half duplex) 2 = Auto negotiation failed but detected speed (using default half duplex) 3 = Successfully negotiated speed and duplex 4 = Auto-negotiation not attempted (forced speed and duplex) b5: Manual Setting Requires Reset b6: Local Hardware Fault b7 ... 31: Reserved "0"
3	Physical Address	Get	ARRAY	MAC address
4	Interface Counters	Get	STRUCT	Interface Counters
5	Media Counters	Get	STRUCT	Media-specific counters

2024-04

Attribute	Name	Access	Data Type	Description
6	Interface Control	Get, Set	STRUCT	Configuration for physical interface Control Bits, WORD: b0: Auto-negotiate b1: Forced Duplex Mode, 0 = Half Duplex; 1 = Full Duplex, only valid when Auto-negotiate = 0 b2 ... 15: Reserved "0" Forced Interface Speed in Mbps (UINT)
7	Interface Type	Get	USINT	Type of interface: 0 = Unknown interface type 1 = Internal interface 2 = Twisted-pair 3 = Optical fiber 4 ... 255 = Reserved
8	Interface State	Get	USINT	State of interface: 0 = Unknown 1 = Enabled and ready to send and receive data 2 = Disabled 3 = Testing 4 ... 255 = Reserved
9	Admin State	Get, Set	USINT	Administrative state: 0 = Reserved 1 = Enable interface 2 = Disable interface 3 ... 255 = Reserved
10	Interface Label	Get	STRING	Human readable identification, size max. 64
11	Interface Capability	Get	STRUCT	Interface Capability Flags DWORD: b0: Manual Setting Requires Reset "0" b1: Auto-negotiate "1" b2: Auto-MDIX "1" b3: Manual Speed/Duplex "1" b4 ... 31: Reserved "0" Speed/Duplex Array Count of following struct (USINT, 4) Interface Speed in Mbps (UINT, 10/100) Interface Duplex Mode (USINT, 0/1): 0 = Half Duplex 1 = Full Duplex 2 ... 255 = Reserved

Table 8.49

LLDP Management Object 0x109

Supported services:

- Get Attributes All 0x01
- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Attribute	Name	Access	Data Type	Description
3	Number of Instances	Get	UINT	Number of instances currently created in this class level of the device[1]
6	Maximum ID Number Class Attributes	Get	UINT	Attribute ID number of the last class attribute
7	Maximum ID Number Instance Attributes	Get	UINT	Attribute ID number of the last instance attribute

Table 8.50

1. In this case number of Ethernet ports

Instance Attribute, Instance 1

Attribute	Name	Access	Data Type	Description
1	LLDP Enable	Get/Set	STRUCT	LLDP Enable Array Length (UINT): 1 + Class attribute 2 from the Ethernet Link Object (0xF6) = 3 LLDP Enable Array (BYTE): b0: Global Enable, LLDP Tx & Rx Enabled (1) b1: LLDP Tx Enabled (Instance 1 of Ethernet Link Object) (1) b2: LLDP Tx Enabled (Instance 2 of Ethernet Link Object) (1)
2	msgTxInterval	Get/Set	UINT	From 802.1AB-2016: Interval in seconds for transmitting LLDP frames from this device 0 ... 4 = Reserved 5 ... 32768 = Message Transmission Interval for LLDP frames (30) 32769 ... 65535 = Reserved
3	msgTxHold	Get/Set	USINT	From 802.1AB-2016: Multiplier of msgTxInterval to determine the value of the TTL TLV sent to neighboring devices 0 = Reserved 1 ... 100 = Message Transmission Multiplier for LLDP Frames (4) 101 ... 255 = Reserved
4	LLDP Datastore	Get	WORD	Indication of the retrieval methods for the LLDP database: b0: LLDP Data Table Object (0) b1: SNMP (1) b2: NETCONF YANG (0) b3: RESTCONF YANG (0) b4 ... b15: Reserved (0)
5	Last Change	Get	UDINT	Counter in seconds from the last time any entry in the local LLDP database changed or power up

Table 8.51

8.5.2 Manufacturer-Specific Object Classes

The module supports the following manufacturer-specific object classes:

Object Class	Object ID	Instances
General Settings Object	0xA0	0, 1
Channel Settings Object	0xA1	0, 1 ... 16
IO-Link Diagnosis Settings Object	0xA2	0, 1
IO-Link Port Settings Object	0xA3	0, 1 ... 8
IO-Link Failsafe Parameter Object	0xA4	0, 1 ... 8
IO-Link Device Parameter Object	0xA5	0, 1 ... 8

Table 8.52

All objects with instance attributes are described below.

General Settings Object 0xA0

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Table 8.53

Instance Attribute, Instance 1

Attribute	Name	Access	Data Type	Description
2	Force Mode Lock	Get, Set	BOOL	0: Disable 1: Enable
3	Web Interface Lock	Get, Set	BOOL	0: Disable 1: Enable
4	Digital Output Control	Get, Set	BOOL	0: DO Channel Control 1: IO-Link Control
5	Report U_L/U_{AUX} Supply Voltage Fault	Get, Set	BOOL	0: Disable 1: Enable
6	Report DO Fault without U_L/U_{AUX}	Get, Set	BOOL	0: Disable 1: Enable
7 ... 24	Reserved			
25	CIP object configuration lock	Get, Set	BOOL	0: Disable 1: Enable
26	External configuration lock	Get, Set	BOOL	0: Disable 1: Enable
27 ... 31	Reserved			

Attribute	Name	Access	Data Type	Description
32	IO Mapping Mode	Get, Set	SINT	0: Default Assignment 1: Byte Swap 2: LSB Ch.A - MSB Ch.B 3: LSB Ch.B - MSB Ch.A 4: Free IO Mapping

Table 8.54

Channel Settings Object 0xA1

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Table 8.55

Instance Attribute, Instance 1 ... 16

Attribute	Name	Access	Data Type	Description
1	IO Mapping	Get, Set	SINT	0 ... 15: Bit number of 16 channel process data 16: Inactive
2	DO Surveillance Timeout	Get, Set	INT	0 ... 255
3	DO Failsafe	Get, Set	SINT	0: Set Low 1: Set High 2: Hold Last
4	DO Restart Mode	Get, Set	SINT	0: Disable 1: Enable
5	DO Switch Mode	Get, Set	SINT	0: Push-Pull U_S, 0.5 A 1: High-Side U_L, 0.5 A 2: High-Side U_L, 1.0 A 3: High-Side U_L, 1.5 A 4: High-Side U_L, 2.0 A 5: High-Side U_L, 2.0 A max
6	DI Logic	Get, Set	SINT	0: Normally Open 1: Normally Close
7	DI Filter	Get, Set	SINT	0: Disabled 1: 1 ms 2: 2 ms 3: 3 ms 4: 6 ms 5: 10 ms 6: 15 ms
8 ... 9	Reserved			

Attribute	Name	Access	Data Type	Description
10	Channel Mode	Get, Set	SINT	0: Inactive 1: Digital Output 2: Digital Input 3: IO-Link 4: Auxiliary Power

Table 8.56

IO-Link Diagnosis Settings Object 0xA2

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Table 8.57

Instance Attribute, Instance 1 ... 16

Attribute	Name	Access	Data Type	Description
1	IO-Link Master Diagnosis	Get, Set	BOOL	0: Disable 1: Enable
2	IO-Link Device Error	Get, Set	BOOL	0: Disable 1: Enable
3	IO-Link Device Warning	Get, Set	BOOL	0: Disable 1: Enable
4	IO-Link Device Notification	Get, Set	BOOL	0: Disable 1: Enable
5 ... 12	IO-Link Device Diagnosis Port 1 ... 8	Get, Set	BOOL	0: Disable 1: Enable

Table 8.58

IO-Link Port Settings Object 0xA3

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Table 8.59

Instance Attribute, Instance 1 ... 8

Attribute	Name	Access	Data Type	Description
1	Output Data Size[1]	Get, Set	SINT	0: No data 1: 2 bytes 2: 4 bytes 3: 8 bytes 4: 16 byte 5: 32 bytes
2	Input Data Size[1]	Get, Set	SINT	0: No data 1: 2 bytes 2: 4 bytes 3: 8 bytes 4: 16 byte 5: 32 bytes
3	Input Data Extension[1]	Get, Set	SINT	0: No Data 1: Extended Status 2: Events 3: Extended Status + Events
4	Output Data Swapping Mode[1]	Get, Set	SINT	0: Raw IO-Link Data 1 ... 16: 1 ... 16 WORD 17 ... 24: 1 ... 8 DWORD
5	Output Data Swapping Offset[1]	Get, Set	SINT	0 ... 30 bytes
6	Input Data Swapping Mode[1]	Get, Set	SINT	0: Raw IO-Link Data 1 ... 16: 1 ... 16 WORD 17 ... 24: 1 ... 8 DWORD
7	Input Data Swapping Offset[1]	Get, Set	SINT	0 ... 30 bytes
8	IOL Failsafe	Get, Set	SINT	0: Set Low 1: Set High 2: Hold Last 3: Replacement Value, transferred via IO-Link Failsafe Parameter Object 4: IO-Link Master Command
9	Port Mode	Get, Set	SINT	0: Deactivated 1: Manual, with validation and backup config 2: Autostart, no validation and backup config
10	Validation and Backup	Get, Set	SINT	0: No device check and clear, no data storage 1: Type compatible V1.0 device, no data storage 2: Type compatible V1.1 device, no data storage 3: Type compatible V1.1 device with Backup + Restore, Download + Upload 4 Type compatible V1.1 device with Restore, Download Master to Device
11	Vendor ID	Get, Set	DINT	0 ... 65535
12	Device ID	Get, Set	DINT	0 ... 16777215

2024-04

Attribute	Name	Access	Data Type	Description
13	Cycle Time	Get, Set	SINT	0: As fast as possible 1: 1.6 ms 2: 3.2 ms 3: 4.8 ms 4: 8.0 ms 5: 20.8 ms 6: 40.0 ms 7: 80.0 ms 8: 120.0 ms

Table 8.60

1. Can only be set if no connection is established.

IO-Link Failsafe Parameter Object 0xA4

Supported services:

- Get Attribute Single 0x0E
- Set Attribute Single 0x10

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Table 8.61

Instance Attribute, Instance 1 ... 8

Attribute	Name	Access	Data Type	Description
1	Failsafe value of IO-Link port	Get, Set	Array of bytes	Depends on configured process data lengths, content must consider possible swapping configuration, failsafe value format must match output data format

Table 8.62

IO-Link Device Parameter Object 0xA5

Supported services:

Instance 0

- Get Attribute Single 0x0E

Instance 1 ... 8

- Get ISDU data 0x4B
- Set ISDU data 0x4C

Class Attribute, Instance 0

Attribute	Name	Access	Data Type	Description
1	Revision	Get	UINT	Revision of this object
2	Max. Instance	Get	UINT	Maximum instance number of an object currently created in this class level of the device

Table 8.63

Instance Attribute, Instance 1 ... 8

Attribute	Name	Access	Data Type	Description
1	ISDU data of IO-Link port	Get, Set	Array of bytes	ISDU data of an IO-Link device can be read with the "Get ISDU Data" service and written with the "Set ISDU Data" service; see description of these services below

Table 8.64

Get ISDU Data

The index and the subindex must be set in the source data. The different protocol data formats between EtherNet/IP (Little-Endian) and IO-Link (Big-Endian) must be taken into account. The data length of the response depends on the data type of the IO-Link device.

Source

Protocol	EtherNet/IP		
Byte	0	1	2
Data type	UINT		USINT
Endianness	LSB	MSB	-
Content	Index		Subindex

Table 8.65

Objective

Protocol	IO-Link		
Byte	0	...	n
Data type	Dependent on the device data type		
Endianness	MSB	...	LSB
Content	Data occurrence or error occurrence, max. 232 bytes		

Table 8.66

Set ISDU Data

The index, subindex and IO-Link data must be set in the source data. The data length of the request depends on the data type of the IO-Link device. The different protocol data formats between EtherNet/IP (Little-Endian) and IO-Link (Big-Endian) must be noted. Data is only present in the response from the IO-Link device if an error has occurred.

Source

Protocol	EtherNet/IP			IO-Link		
Byte	0	1	2	3	...	n
Data type	UINT		USINT	Dependent on the device data type		
Endianness	LSB	MSB	-	MSB	...	LSB
Content	Index		Subindex	Data, max. 232 bytes		

Table 8.67

Objective

Protocol	IO-Link		
Byte	0	...	n
Data type	Dependent on the device data type		
Endianness	MSB	...	LSB
Content	Error on occurrence, max. 232 bytes		

Table 8.68

If "Read Request" or "Write Request" are not successful[f] the following response format of 4 bytes is available:

Name	Data Type	Error Code Description	Error Code
IO-Link Master Error	UINT	Service not available	1
		Port blocked	2
		Timeout	3
		Invalid index	4
		Invalid sub-index	5
		Wrong port	6
		Wrong port function	7
		Invalid length	8
		ISDU not supported	9
IO-Link Device Error	USINT	Refer to IO-Link specification	-
IO-Link Device Additional Error	USINT	Refer to IO-Link specification	-

Table 8.69

8.5.3 "Message" Configuration in Rockwell Automation Studio 5000®

Attributes of CIP object classes can be edited in Rockwell Automation Studio 5000® using the Message instruction. This requires the selection of the correct message and service type with the corresponding service code.

The channels, as in the Channel Settings Object, are each assigned to an instance ID in ascending order.

Channel Assignment

Channel 1	Port X1.ChA	CIP object instance 1
Channel 2	Port X1.ChB	CIP object instance 2
[...]	[...]	[...]
Channel 15	Port X8.ChA	CIP object instance 15
Channel 16	Port X8.ChB	CIP object instance 16

Table 8.70

The IO-Link ports, as in the IO-Link Port Settings Object, IO-Link Failsafe Parameter Object and IO-Link Device Parameter Object, are each assigned to an instance ID in ascending order.

f. CIP response status is not equal to "0"

Assignment of the IO-Link Ports

IO-Link port 1	Port X1.ChA	CIP object instance 1
[...]	[...]	[...]
IO-Link port 8	Port X8.ChA	CIP object instance 8

Table 8.71

Get/Set Attribute Single

With the exception of the IO-Link device parameter object instance 1 ... n, each attribute can be accessed using the Get/Set attribute single service of the CIP object class ID, the instance ID and the attribute ID.

The following figure shows an example setting for the Force Mode Lock, Attribute 2 of the general settings object 0xA0 with Message instruction:

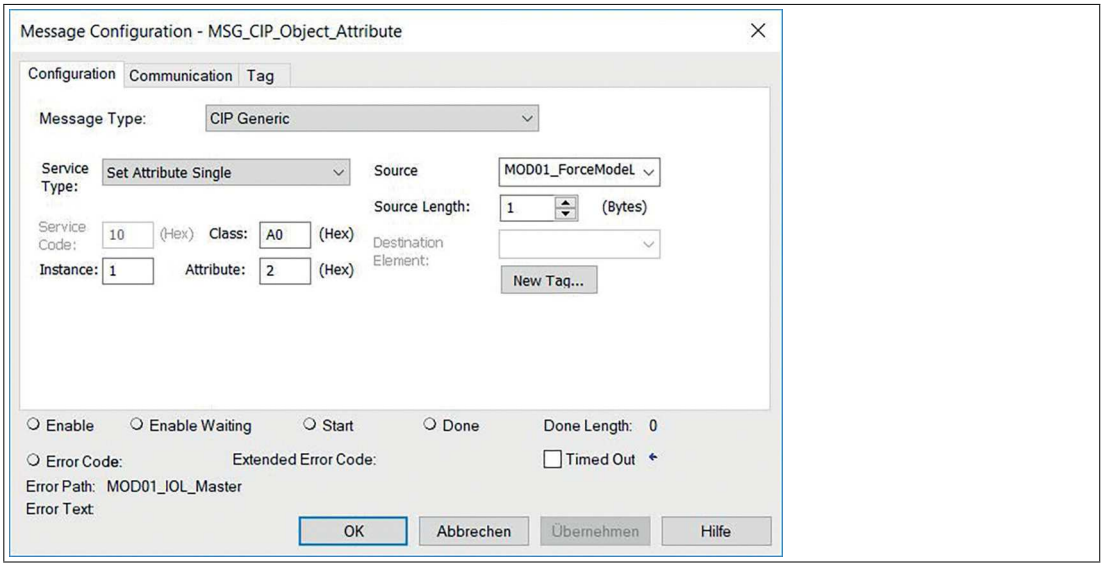


Figure 8.21

Get/Set ISDU Data

The IO-Link device parameter object instance 1 ... n can be accessed with the manufacturer-specific Get/Set ISDU data service via the CIP object class ID, the instance ID and the attribute ID. The index and the subindex must be set in the source data. The IO-Link data must be appended for the Set ISDU data service. The different protocol data formats between EtherNet/IP (Little-Endian) and IO-Link (Big-Endian) must be noted in this respect. The corresponding data is described in the previous chapters.

The following figure shows an example of querying an IO-Link device parameter using the Get ISDU data 0x4B service of the IO-Link device parameter object 0xA5 with Message instruction:

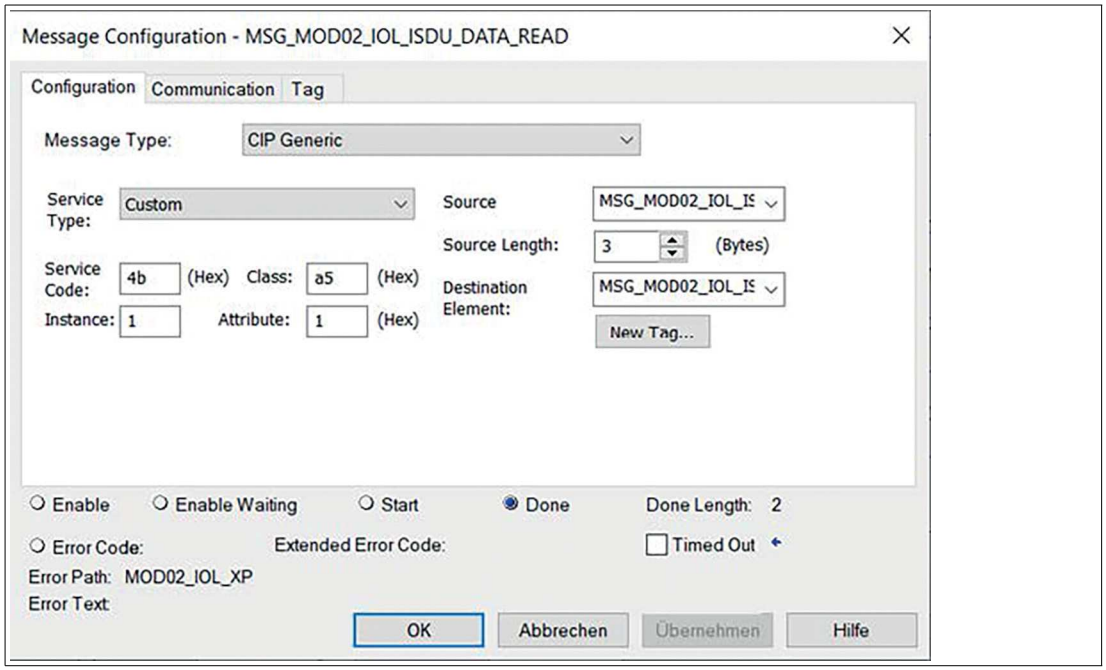


Figure 8.22

The index 0x003C and subindex 0x01 of the IO-Link device parameter are set in the Little-Endian format of EtherNet/IP in the source data:

− MSG_MOD02_IOL_ISDU_SRC_READ	{...}	{...}	Hex	SINT[8]
+ MSG_MOD02_IOL_ISDU_SRC_READ[0]	16#3c		Hex	SINT
+ MSG_MOD02_IOL_ISDU_SRC_READ[1]	16#00		Hex	SINT
+ MSG_MOD02_IOL_ISDU_SRC_READ[2]	16#01		Hex	SINT

Figure 8.23

The response data of the IO-Link device can be found in the target element. In the following example, the received value is of type UINT in the Big-Endian format of IO-Link, 0x0546 = 1350:

− MSG_MOD02_IOL_ISDU_DST_READ	{...}	{...}	Hex	SINT[8]
+ MSG_MOD02_IOL_ISDU_DST_READ[0]	16#05		Hex	SINT
+ MSG_MOD02_IOL_ISDU_DST_READ[1]	16#46		Hex	SINT

Figure 8.24

9 Commissioning with Modbus

9.1 Preparation

Device identification

With each MODBUS client, the server can be reached to obtain identification data such as manufacturer name, product code, and revision.

Register	Length	Description	Default	Access
401025	1	"Version major" device firmware	–	RO[1]
401026	1	"Version minor" device firmware	–	RO
401027	32	Name of the IO-Link device	–	RO
401043	1	Source of the IP address: 0: DHCP 1: Static	–	RO
401044	2	IP address of the device	–	RO
401046	3	MAC address	–	RO
401047	1	Active TCP connections	–	RO

Table 9.1

1. Read-only

MAC Addresses

The modules have three assigned MAC IDs when they are delivered. These are unique and cannot be changed by the user.

The first assigned MAC ID is printed on the module.

Modbus function codes

The device supports the following Modbus function codes:

- Function code 03 (0x03) - Read Multiple Holding Registers
- Function code 06 (0x06) - Write Single Holding Registers
- Function code 16 (0x10) - Write Multiple Holding Registers

Write access to holding registers depends on the device properties and the configuration of the holding register.

Factory Settings

Modbus TCP parameters as supplied or after resetting to factory settings.

Network mode:	DHCP
Fixed IP address:	192.168.1.XXX (XXX = rotary switch position or last stored setting)
Subnet mask:	255.255.255.0
Gateway address:	0.0.0.0
Device names:	ICE11-8IOL-G60L-V1D
Product type:	Modbus TCP server

2024-04

Setting network parameters

Use the two right-hand rotary switches X10 and X1 on the front of the device to set the last octet of the static IP address. Each rotary switch in the Modbus TCP area is assigned a decimal place, so that a number between 0 and 99 can be configured. During startup, the position of the rotary switches is typically read within a time cycle.

The full IP address, subnet mask, gateway address and network mode[a] can be configured via the web server or other available configuration interfaces. New configuration interfaces cannot be applied until the device is restarted. For more information, see chapter 5.4.

9.2 Configuration

The module supports Modbus via a standard TCP network. It is possible to establish 4 to 8 socket connections with devices.

Configuration Parameters

The parameters of the device can be configured using function codes 06 and 16, depending on the features and the intended functionality of the holding register. To prevent malfunctions of the device, a register acts as an interlock switch.

Register	Length	Description	Default	Access
400512	1	The configuration registers described below can only be created if 1 is written. If 0 is written, the updated configuration is applied by the device. The change must be recorded: 0 to 1: Registers described below are set to "RW" 1 to 0: Apply configuration	0	RW[1]
400593	1	Report U_L/U_{AUX} Supply Voltage Fault 0 = U_L/U_{AUX} supply voltage fault report enabled 1 = U_L/U_{AUX} supply voltage fault report disabled 2 = Auto	0	RW
400594	1	Report actuator fault without U_L/U_{AUX} voltage 0 = Fault report for actuator without U_L/U_{AUX} voltage enabled 1 = Fault report for actuator without U_L/U_{AUX} voltage disabled	0	RW
400595	1	Report U_S voltage fault 0 = U_S voltage fault report enabled 1 = U_S voltage fault report disabled	0	RW
400596	1	Reserved	0	
400597	1	Output auto restart 0 = Auto restart of outputs disabled 1 = Auto restart of outputs enabled	0	RW
400598	1	Web interface lock 0 = Web interface lock disabled 1 = Web interface lock enabled	0	RW
400599	1	Force mode lock 0 = Force lock disabled 1 = Force lock enabled	0	RW

a. DHCP or BOOTP

Register	Length	Description	Default	Access
400600	1	External configuration lock 0 = External configuration lock disabled 1 = External configuration lock enabled	0	RW

Table 9.2

1. Read/write

Force Mode Lock

The input and output process data can be forced via various interfaces.[b] Interface support depends on the software features available. If force mode lock is activated, no input process data or output process data can be forced via these interfaces.

Danger!

Risk of injury or death!

Unsupervised forcing can lead to unexpected signals and uncontrolled machine movements.

Web Interface Lock

Access to the web interface can be set. If web interface lock is activated, the web pages are no longer accessible.

Report U_L/U_{AUX} Supply Voltage Fault

During commissioning, it is possible that no electric power supply is connected to the U_L/U_{AUX} pins. It may therefore be helpful to suppress and deactivate the U_L/U_{AUX} supply voltage fault message.

Report Actuator Fault Without U_L/U_{AUX} Voltage

During commissioning, it is possible that no electric power supply is connected to the U_L/U_{AUX} pins. It may therefore be helpful to suppress and deactivate the report actuator fault without U_L/U_{AUX} voltage message.

Report U_S Voltage Fault

During commissioning, it is possible that no power supply is connected to the U_S pins. It may therefore be helpful to suppress and deactivate the report U_S voltage fault message.

External Configuration Lock

Configuration parameters can be set via various alternative interfaces. An external configuration can only be made as long as no cyclic PLC connection is active. Each new PLC configuration overwrites the external configuration settings.

Channel Settings

Register	Length	Description	Default	Access
400513 to 400528	1	DO Surveillance Timeout Port X1 Ch A to Port X8 Ch B Valid values: 0 to 255	0	RW[1]
400529 to 400544	1	DO Failsafe Port X1 Ch A to Port X8 Ch B 0: Set Low 1: Set High 2: Hold Last	0	RW

b. e.g., web interface, REST, OPC UA, MQTT

2024-04

Register	Length	Description	Default	Access
400545 to 400560	1	DI Filter Port X1 Ch A to Port X8 Ch B 0: Disabled 1: 1 ms 2: 2 ms 3: 3 ms 4: 6 ms 5: 10 ms 6: 15 ms	0	RW
400561 to 400576	1	DI Logic Port X1 Ch A to Port X8 Ch B 0: Normally open 1: Normally closed	0	RW
400577 to 400592	1	DO Restart Port X1 Ch A to Port X8 Ch B 0: Inactive 1: Active	1	RW

Table 9.3

1. Read/write

DO Surveillance Timeout

The digital output channels are monitored during runtime. The error states are detected and reported as a diagnosis. To avoid error states when switching the output channels, Surveillance Timeout can be configured with a delay and deactivated monitoring.

The delay time begins with a rising edge of the output control bit. After the delay time has elapsed, the output is monitored and error states are signaled via diagnostics. If the channel is permanently switched on or off, the typical filter value is 5 ms.[c]

DO Failsafe

The module supports a failsafe function for the channels used as digital outputs. In the event of an internal device error, the PLC is in the STOP state and cannot supply any valid process data. The connection is interrupted or communication is lost. The outputs are controlled according to the configured failsafe values.

Set Low:

If failsafe is active, the physical output pin of the channel is set to "Low".[d]

Set High:

If failsafe is active, the physical output pin of the channel is set to "High".[e]

Hold Last: If failsafe is active, the physical output pin of the channel maintains the last valid process data status.[f]

DO Restart Mode

In the event of a short-circuit or overload on an output channel, a diagnosis is signaled and the output is switched to "off."

If DO Restart Mode is deactivated, the output channel is not automatically switched on again. It can be switched on after a logical reset of the channel's process output data.

c. not changeable

d. "0"

e. "1"

f. "0" or "1"

If DO Restart Mode is activated for this channel, the output is automatically switched on again after a fixed time delay to check whether the overload or short-circuit status is still active. If it is active, the channel is switched off again.

DI Logic

The logical state of an input channel can be configured using these parameters. If a channel is set to "Normally Open," a low signal is transferred to the process input data, e.g., if an undamped sensor has an open switching output.

If a channel is set to "Normally Closed", a high signal is transferred to the process input data, e.g., if an undamped sensor has a closed switching output.

The channel LED indicates the physical input state of the port pin, regardless of these settings.

DI Filter

These parameters can be used to configure a filter time for each digital input channel. If a filter is not required, it can be deactivated.

IO-Link Port 1 to 8 – settings

Register	Length	Description	Default	Access
401513	64	IO-Link Ch. 1 Settings	-	RW[1]
401577	64	IO-Link Ch. 2 Settings	-	RW
401641	64	IO-Link Ch. 3 Settings	-	RW
401705	64	IO-Link Ch. 4 Settings	-	RW
401769	64	IO-Link Ch. 5 Settings	-	RW
401833	64	IO-Link Ch. 6 Settings	-	RW
401897	64	IO-Link Ch. 7 Settings	-	RW
401961	64	IO-Link Ch. 8 Settings	-	RW

Table 9.4

1. Read/write

Register	Length	Description	Default	Access
402025	16	IO-Link Ch. 1 Serial no.	0	RO[1]
402041	16	IO-Link Ch. 2 Serial no.	0	RO
402057	16	IO-Link Ch. 3 Serial no.	0	RO
402073	16	IO-Link Ch. 4 Serial no.	0	RO
402089	16	IO-Link Ch. 5 Serial no.	0	RO
402105	16	IO-Link Ch. 6 Serial no.	0	RO
402121	16	IO-Link Ch. 7 Serial no.	0	RO
402137	16	IO-Link Ch. 8 Serial no.	0	RO

Table 9.5

1. Read-only

Detailed channel settings:

The following example for channel 1 shows all possible port settings for IO-Link. The values are identical for all 8 ports.

Register	Length	Description	Default	Access
401513	1	Port mode 0 = Disabled 1 = Manual IO-Link 2 = Auto IO-Link 3 = Digital input 4 = Digital output	3	RW[1]
401514	1	Validation and Backup 0: No device check, no data storage 1: Type-Compatible V1.0 Device, No Data Storage 2: Type-Compatible V1.1 Device, No Data Storage 3: Type-compatible V1.1 device with backup + restore, download + upload 4: Type-compatible V1.1 device with restore, download master to device	0	RW
401515	1	IQ mode 0 = Disabled 1 = Digital input 2 = Digital output	1	RW
401516	1	Cycle Time 0: As fast as possible 1: 1.6 ms 2: 3.2 ms 3: 4.8 ms 4: 8.0 ms 5: 20.8 ms 6: 40.0 ms 7: 80.0 ms 8: 120.0 ms	0	RW
401517	1	Manufacturer ID/vendor ID 0 to 65535	0	RW
401518	2	Device ID 0 to 16777215	0	RW
401520	1	Swapping mode, producing: 0: Raw IO-Link data 1 to 16: 1 to 16 WORD 17 to 24: 1 to 8 DWORD 0 to 30 bytes	0	RW
401521	1	Swapping mode, consuming: 0: Raw IO-Link data 1 to 16: 1 to 16 WORD 17 to 24: 1 to 8 DWORD 0 to 30 bytes	0	RW
401522	1	Swapping offset, producing 0 to 30 bytes	0	RW
401523	1	Swapping offset, consuming 0 to 30 bytes	0	RW
401524	1	Pin2 LED activated 0: Inactive LED on channel B 1: Active LED on channel B	1	RW
401525	1	Suppress all diagnoses 0: Create diagnoses on this channel 1: Do not create any diagnoses on this channel	0	RW

Register	Length	Description	Default	Access
401526	1	Failsafe mode 0: Set Low 1: Set High 2: Hold Last 3: Replacement Value[2]	2	RW
401527	32	IOL Failsafe replacement values	0	RW
401559	1	Use Push-Pull for pin 4 0: Use High-Side-Switches 1: Use Push-Pull	0	RW
401560	1	Reserved	0	
401561	1	Pin 4 current limit 0: U_L, 0.5 A 1: U_L, 1.0 A 2: U_L, 1.5 A 3: U_L, 2.0 A 4: U_L, max. 4 A	4	RW
401562	1	Pin 2 current limit 0: U_L, 0.5 A 1: U_L, 1.0 A 2: U_L, 1.5 A 3: U_L, 2.0 A 4: U_L, max. 4 A	4	RW
401563 to 401576	14	Reserved	0	

Table 9.6

1. Read/write

2. Transmitted via offset 14–46

Port mode

The port mode describes how the IO-Link master handles the presence of an IO-Link device on the port.

Disabled:

The IO-Link port is deactivated, but can be configured for later use. If the IO-Link device is not connected, no diagnostics are generated.

Manual IO-Link:

The IO-Link port is activated and an explicit port configuration can be made for the parameters Validation and Backup[g], Vendor ID, Device ID, and Cycle Time.

Auto IO-Link:

The IO-Link port is activated and no explicit port configuration is required. Configurations such as Validation and Backup, Vendor ID, Device ID, and Cycle Time are not required.

Digital input:

In this mode, the channel operates as a digital input. The status of the channel can be seen in the Digital Input Channel Status of the cyclical process data.

Digital output:

In this mode, the channel operates as a digital output. The channel can be controlled via the Digital Output Channel Control[h] or via the IO-Link Output Data[i] of the cyclical process data. This depends on the Digital Output Control parameter in the General Settings.

g. Inspection Level

Validation and Backup

This parameter enables the user to set the behavior of the IO-Link ports in relation to the type compatibility and data storage mechanism of the connected IO-Link device.

The prerequisite for using Validation and Backup is that you configure the port mode to "IO-Link Manual."

The IO-Link master has a backup memory that can be used to save device parameters and restore them to the IO-Link device. This backup memory is emptied by the following actions:

- IO-Link master factory reset (reset to factory settings)
- Reconfiguration of the Channel Mode, for example from "Digital Input" to "IO-Link"
- Reconfiguration of validation and backup, for example from "No device check" to "Type compatible V1.1 device with Backup & Restore"

For more information, please refer to the "IO-Link Interface and System Specification" version 1.1.3, which can be downloaded from https://io-link.com/.

No Device Check (No Data Storage)

No verification of the connected manufacturer ID or device ID and no "backup and restore" support of the IO-Link master parameter server.

Type-Compatible V1.0 device (No Data Storage)

Type-compatible with regard to IO-Link specification V1.0, which includes the validation of manufacturer ID and device ID. The IO-Link specification V1.0 does not support an IO-Link master parameter server. Type-compatible V1.1 device (no data storage): Type-compatible with regard to IO-Link specification V1.1, which includes the validation of manufacturer ID and device ID. Backup and Restore is deactivated.

Type-Compatible V1.1 Device with Backup + Restore (Upload + Download)

Type-compatible with regard to IO-Link specification V1.1, which includes the validation of manufacturer ID and device ID. Backup and Restore is activated.

Please note the following information on backup and restore conditions:

- Backup (device to master):
  A backup[j] is performed if an IO-Link device is connected and the master has no valid parameter data. The read parameter data is saved permanently on the IO-Link master.
  An upload is also executed if the IO-Link device has set the DS_UPLOAD_FLAG.[k] This IOL device flag can be set in two ways:
  - Parameters are written to an IOL device in block parameter mode: An IO-Link device sets the DS_UPLOAD_FLAG independently if the block parameter mode parameters have been written to the IO-Link device with the last system command ParamDownloadStore, for example, by a third-party USB IO-Link master for commissioning.
  - Parameters are written to an IOL device in single parameter mode: If single parameter data on the IOL device is changed during operation, the device parameters stored on the IOL master can be updated using the ParamDownloadStore command.[l] This command sets the DS_UPLOAD_REQ flag on the IOL device, so the IO-Link master can perform an upload process from the IO-Link device.
- Restore (master to device):
  A restore[m] is executed if an IO-Link device is connected and the IO-Link master has saved valid parameter data for the IOL device that does not correspond to the current device parameters.
  The recovery process can be blocked by the IO-Link device via the Device Access Locks parameter, provided this is supported by the IO-Link device.[n]

h. the first two bytes of the output data

i. the first byte of the output data of each IO-Link device

j. Upload from the IOL device to the IOL master

k. Data Storage Upload Flag

l. Index 0x0002, sub-index 0x00, value 0x05

Type-Compatible V1.1 device with Restore (Download Master to Device)

Type-compatible with regard to IO-Link specification V1.1, which includes the validation of vendor ID and device ID. Only "Restore" is activated.

Please note the following information on restore conditions:

- Restore (download/IOL master to IOL device):
  A restore (download from the IOL master to the IOL device) is executed if an IO-Link device is connected and the IO-Link master has saved valid parameter data for the IOL device that does not correspond to the current device parameters.
  In restore mode, no changes to the IOL device parameters are saved permanently on the IOL master. If the IOL device sets the DS_UPLOAD_FLAG in this mode, the device parameters are restored by the IOL master.
  The recovery process can be blocked by the IO-Link device via the Device Access Locks parameter, provided that this parameter is supported by the IOLink device (index 0x000C, refer to the manufacturer-specific IO-Link device documentation).

IQ mode

The operating mode of pin 2[o] of the respective IO-Link channel can be configured using this parameter.

Digital Output

In this mode, the channel operates as a digital output. The channel can be controlled via the Digital Output Channel Control[p] or via the IO-Link Output Data[q] of the cyclical process data. This depends on the Digital Output Control parameter in the General Settings.

Digital Input

In this mode, the channel operates as a digital input. The status of the channel can be seen in the Digital Input Channel Status of the cyclical process data.

Cycle Time

The IO-Link cycle time can be configured with this parameter.

The prerequisite for using the cycle time is that you configure the port mode to "IO-Link Manual."

As Fast as Possible

The IO-Link port uses the max. supported IO-Link device and IO-Link master update cycle time for the cyclical I/O data update between the IO-Link master and the IO-Link device.

1.6 ms, 3.2 ms, 4.8 ms, 8.0 ms, 20.8 ms, 40.0 ms, 80.0 ms, 120.0 ms

The cycle time can be set manually to the options provided. This option can be used, for example, for IO-Link devices that are connected via inductive couplers. Inductive couplers are usually the bottleneck in the update cycle time between the IO-Link master and the IO-Link device. In this case, please refer to the datasheet of the inductive coupler.

Manufacturer ID/vendor ID

The vendor ID is required for the validation of the IO-Link device and can be configured with this parameter.

The prerequisite for using the vendor ID is that you configure the port mode to "IO-Link Manual." Validation and Backup must be set to a type-compatible V1.X device.

m. Download from IOL master to IOL device

n. Index 0x000C, refer to the manufacturer-specific IO-Link device documentation

o. Channel B

p. the first two bytes of the output data

q. the first byte of the output data of each IO-Link device

Device ID

The device ID is required for the validation of the IO-Link device and can be configured with this parameter.

The prerequisite for using the device ID is that you configure the port mode to "IO-Link Manual." Validation and Backup must be set to a type-compatible V1.X device.

Swapping mode

The byte order of IO-Link is Big Endian. The Swapping Mode and Swapping Offset parameters help the user to set the output data in the correct format. Up to 16 "words" or up to 8 "double words" can be selected for conversion of the output data.

Raw IO-Link Data

No "byte swap".

Data Type DWORD

Data byte order: Byte 1, Byte 2, Byte 3, Byte 4

Sequence after "Swap": Byte 4, Byte 3, Byte 2, Byte 1

Data Type WORD

Data byte order: Byte 1, byte 2

Sequence after "Swap": Byte 2, Byte 1

Swapping Offset

The Swapping Offset describes the starting point in the process data for use of the configured Swapping Length. Both parameters depend on the configured input and output data size.

IOL Failsafe

The module supports a failsafe function for the output data of the IO-Link channels. In the event of an internal device error, the PLC is in the STOP state and cannot supply any valid process data; the connection is interrupted or communication is lost: The output data of the IO-Link channels is controlled by the configured failsafe values.

Set Low

If failsafe is active, all bits of the IO-Link output data are set to "Low".[r]

Set High

If failsafe is active, all bits of the IO-Link output data are set to "High".[s]

Hold Last

If failsafe is active, all bits of the IO-Link output data maintain the last valid process data status.[t]

Replacement Value

A substitute value can be set for each IO-Link device via the IO-Link failsafe parameter object. If failsafe is active, these substitute values are transmitted to the IO-Link device. The currently configured IO-Link output data size must be taken into account. Note that in the case of a fault, the substitute values are sent instead of the output process data, so a configured swapping mode has an influence on the byte order.

IO-Link Master Command

If failsafe is active, an IO-Link-specific mechanism for valid/invalid output process data is used and the IO-Link device determines the behavior itself.

r. "0"

s. "1"

t. "0" or "1"

IOL Failsafe replacement values

32 inventory registers set 32 replacement values byte by byte. If failsafe is active, these values are transmitted to the IO-Link device.

Serial number

Starting with 402025, the desired IO-Link device serial number can be written to the holding registers. Each serial number can contain a maximum of 32 bytes. Each IO-Link channel is assigned 16 registers.

9.3 Process Data Assignment

The module supports process data communication in both directions. In this context, "consuming data" is defined as the process output data that controls the physical outputs and IO-Link output data. In this context, "producing data" is defined as the process input data that contains the physical inputs, diagnoses and IO-Link input data with optional extended status and event data.

The data images for the data direction of consuming and producing data, which are assigned to the output and input assemblies, are described below.

Consuming data, output

Register	Length	Description	Default	Access
400001	16	Output Port 1 process data	-	RW[1]
400017	16	Output Port 2 process data	-	RW
400033	16	Output Port 3 process data	-	RW
400049	16	Output Port 4 process data	-	RW
400065	16	Output Port 5 process data	-	RW
400081	16	Output Port 6 process data	-	RW
400097	16	Output Port 7 process data	-	RW
400113	16	Output Port 8 process data	-	RW

Table 9.7

1. Read/write

Each holding register contains two bytes of output data. Valid process data values depend on the port configuration.

Example for consuming data

Port	Mode	Valid output data is written
1	IO-Link 1 Byte Output	Least significant 1 Byte of 400001
2	Digital output	Least significant Bit[1] of 400017
3	IO-Link 4 Bytes Output	
4	IO-Link 16 Bytes Output	Every 2 bytes on registers 400049 to 400057
5	IO-Link 32 Bytes Output	Every 2 bytes on registers 400065 to 400080

Table 9.8

1. Bit 0

Producing data, input

Register	Length	Description	Default	Access
400257	16	Input Port 1 process data	-	RO[1]
400273	16	Input Port 2 process data	-	RO
400289	16	Input Port 3 process data	-	RO
400305	16	Input Port 4 process data	-	RO
400321	16	Input Port 5 process data	-	RO
400337	16	Input Port 6 process data	-	RO
400353	16	Input Port 7 process data	-	RO
400369	16	Input Port 8 process data	-	RO

Table 9.9

1. Read-only

Each holding register contains two bytes of input data. Valid process data values depend on the port configuration.

Example for producing data

Port	Mode	Valid output data is written
1	IO-Link 1 Byte Input	Least significant 1 Byte of 400257
2	Digital Input	Least significant Bit[1] of 400273
3	IO-Link 4 Bytes Input	Every 2 bytes on registers 400289 to 400290
4	IO-Link 16 Bytes Input	Every 2 bytes on registers 400305 to 400312
5	IO-Link 32 Bytes Input	Every 2 bytes on registers 400321 to 400336

Table 9.10

1. Bit 0

Channel B as a digital output

Register	Length	Description	Default	Access
400436	1	PIN 2, Channel B as DO[1]	-	RW[2]

Table 9.11

1. bit by bit
2. Read/write

This holding register represents the values of channel B, pin 2 of the IO-Link Class A connection bit by bit. Values written to this register only have an effect if channel B is configured as a digital output.

Ch. B digital output

400436	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X8	X7	X6	X5	X4	X3	X2	X1

Table 9.12

Channel B as a digital input

Register	Length	Description	Default	Access
4004365	1	PIN 2, Channel B as DI[1]	-	RW[2]

Table 9.13

1. bit by bit
2. Read/write

This holding register represents the values of channel B, pin 2 of the IO-Link Class A connection bit by bit. Values written to this register only have an effect if channel B is configured as a digital input.

Ch. B digital input

400435	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X8	X7	X6	X5	X4	X3	X2	X1

Table 9.14

10 Commissioning for PROFINET

10.1 Preparation

The configuration and commissioning process for the modules described over the following pages was performed using TIA Portal V15 project planning software from SIEMENS. When using a control system from a different control system provider, please refer to the corresponding documentation.

GSDML File

To configure the modules in the control system, you need a GSD file in XML format. You can download this file from our website at https://www.pepperl-fuchs.com.

The file for the PROFINET modules is named GSDML-V2.41-Pepperl+Fuchs-ICE11-yyyymmdd. In this case, **yyyymmdd** is the issue date of the file.

Integrate the GSDML file into the TIA Portal using the GSD manager via the main menu "Options > Manage general station description files (GSD)." The modules with a PROFINET interface are then available in the hardware catalog.

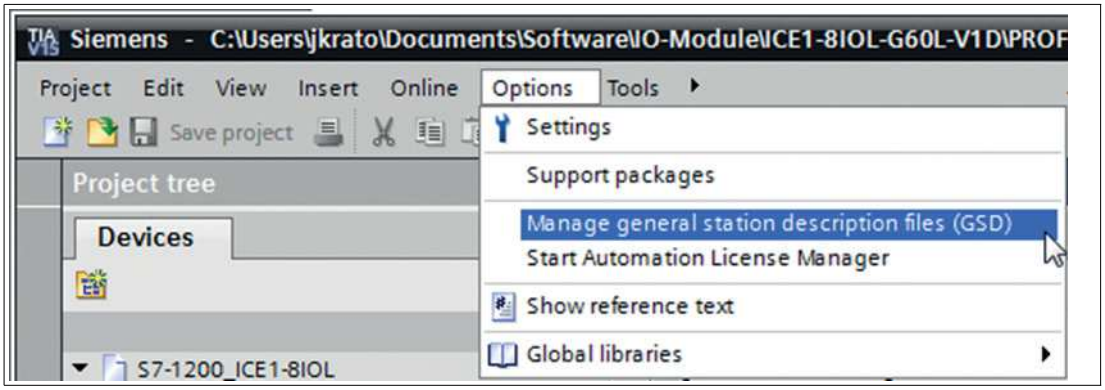


Figure 10.1

MAC Addresses

The modules have three assigned MAC IDs when they are delivered. These are unique and cannot be changed by the user.

The first assigned MAC ID is printed on the module.

SNMP

The modules support the SNMP Ethernet network protocol (Simple Network Management Protocol). The information from the network management system is displayed in accordance with MIB-II (Management Information Base), which is defined in RFC 1213.

Passwords:

Read community: `public`

Write community: `private`

10.2 Configuration Example

The configuration and commissioning process for the modules described over the following pages was performed using TIA Portal V15 project planning software from SIEMENS.

Note

To configure a module in the control system, you need a GSDML file.

10.2.1 Integration of PROFINET IO Modules in the TIA Portal

1. Install the GSDML file for the desired module in the TIA portal.

   ↳ Once the GSDML file for the PROFINET modules has been installed, the modules are available in the TIA portal hardware catalog.

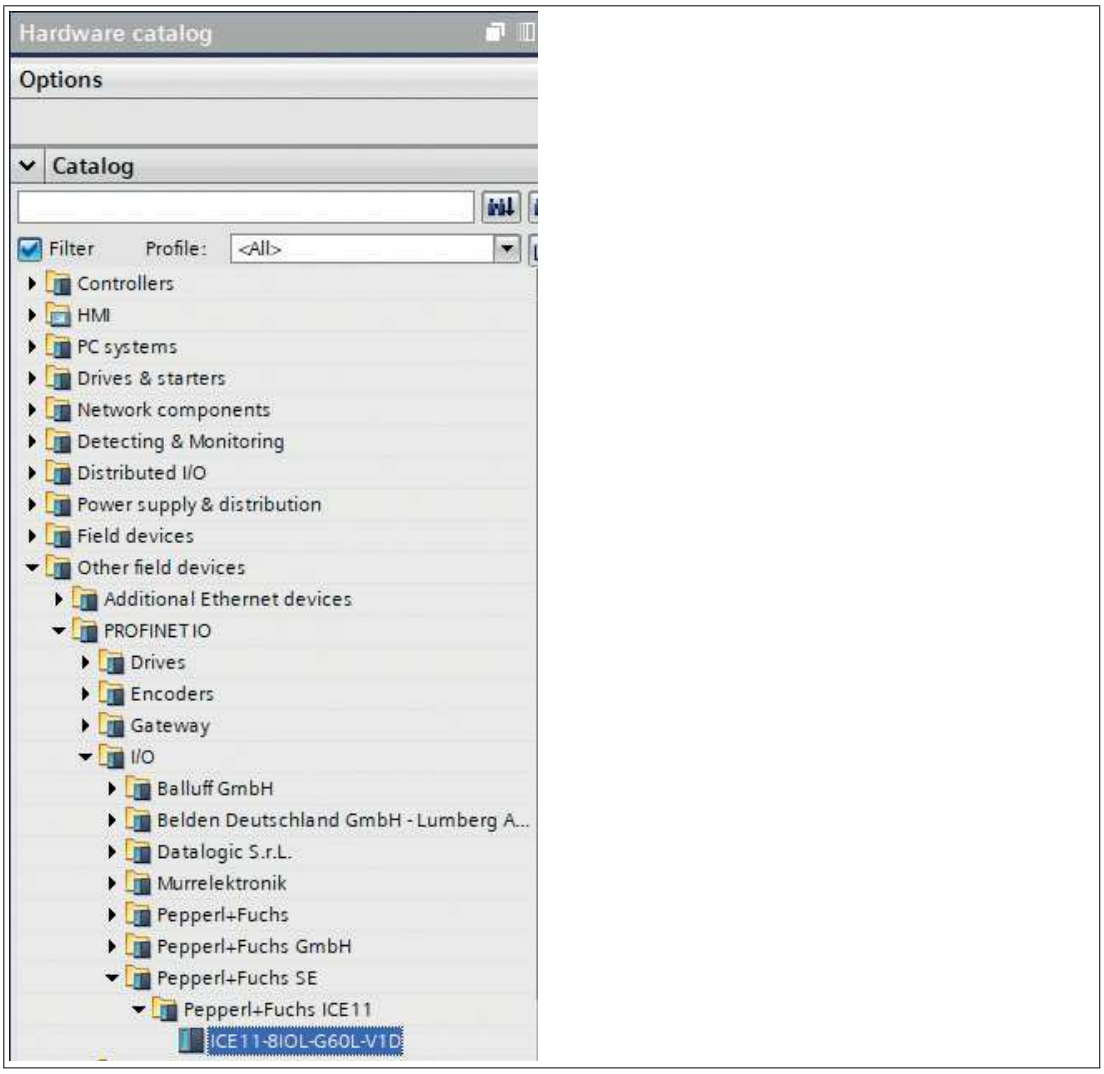


Figure 10.2

2. Click on the desired module in the hardware catalog. Drag and drop the module into the network view.

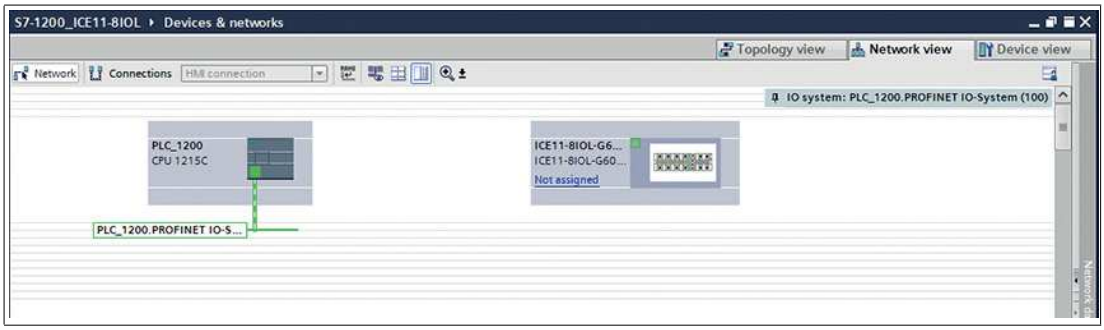


Figure 10.3

3. Assign the module to the PROFINET network.

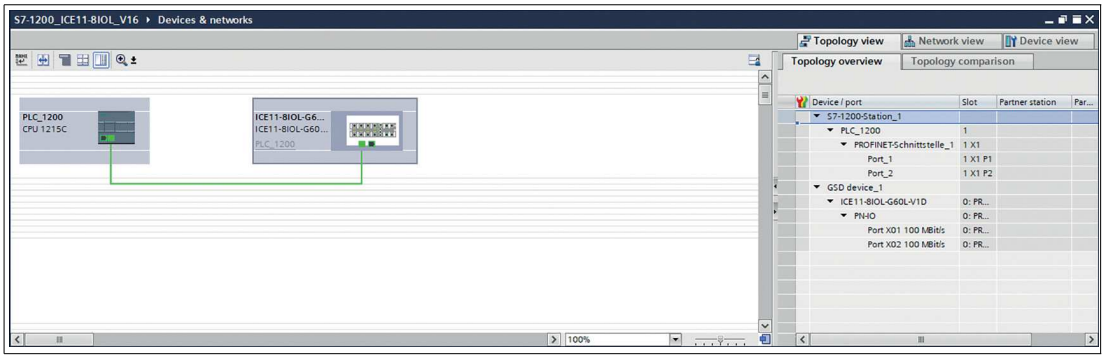


Figure 10.4

4. Switch to the device configuration.
5. Select the desired device to view the configuration options.

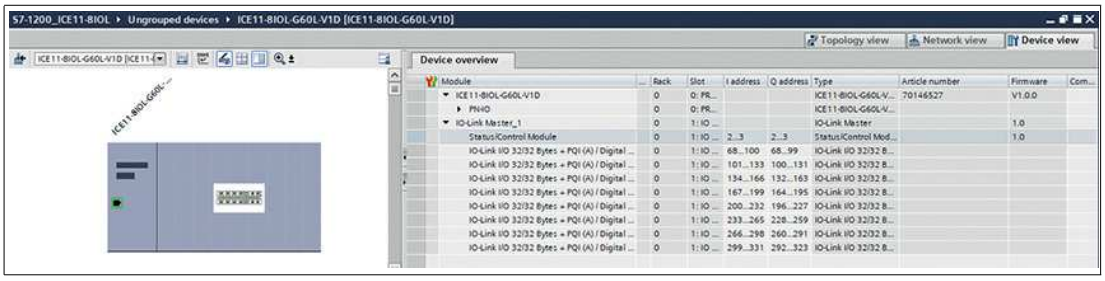


Figure 10.5

10.2.2 Assignment of a Device Name and IP Address

Assignment of a unique device name and IP address

PROFINET IO devices are addressed in the PROFINET network via a unique device name. This can be freely assigned by the user but must appear only once in the network.

1. Click on the device icon or in the first line of the device overview.

↳ The settings for PROFINET interface > Ethernet addresses opens

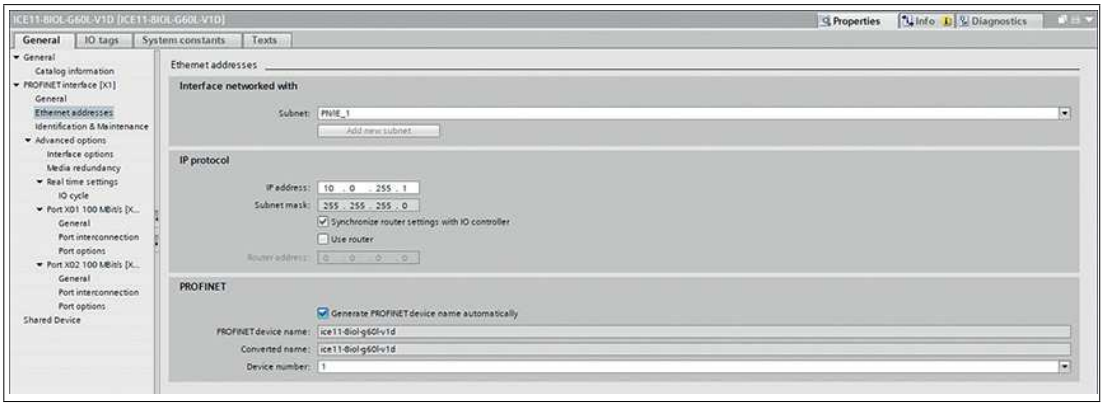


Figure 10.6

2. Verify that the controller and I/O device are on the same ETHERNET subnet.
3. Either use or modify the device name and IP address defaults.
4. For a correctly working setup, the selected device name must be programmed online in the I/O device. If the HW has been installed, you can easily switch to online mode. The new I/O device should already be accessible via PROFINET.

Figure 10.7

5. Enter the same device name that you previously configured offline in the project.

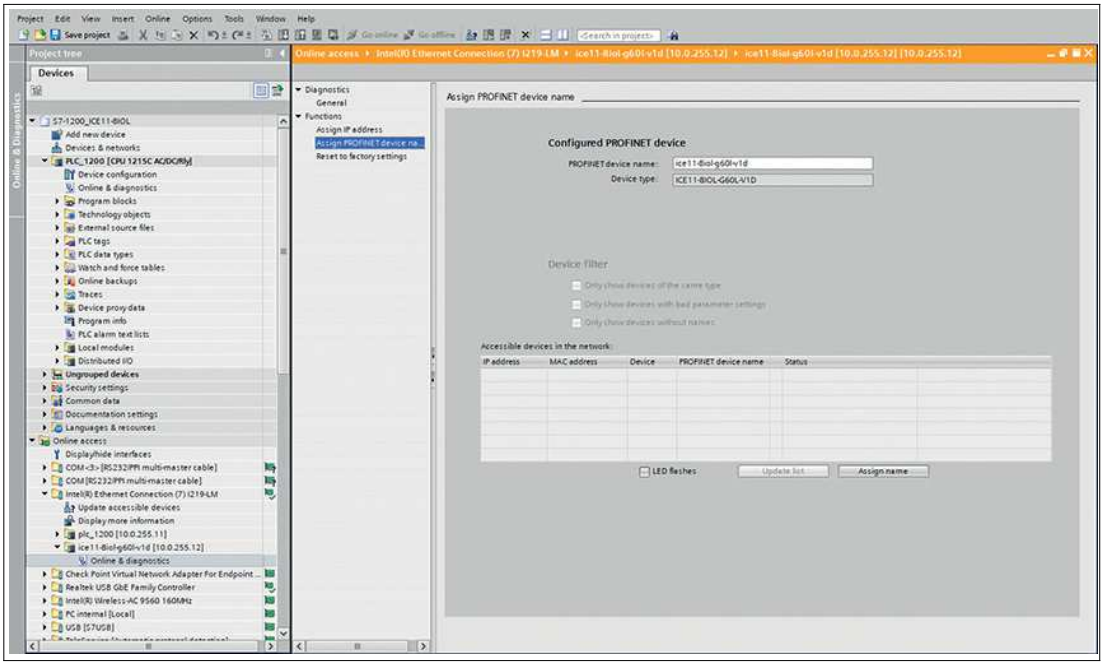


Figure 10.8

Note

Using a modified device name is not recommended for clarity reasons.

10.2.3 Configuring the IO-Link Channels

By default, all channels are preconfigured as IO-Link I/O 32/32 bytes + PQI according to IO-Link specification V1.1.3.

Presetting the Channels

Device overview

Module	Fail-safe	Rack	Slot	I address	Q address	Type	Article number
ICE11-8IOL-G60L-V1D		0	0: PROFINET Interface			ICE11-8IOL-G60L-V1D	70146527
PN-IO		0	0: PROFINET Interface X1			ICE11-8IOL-G60L-V1D	
IO-Link Master_1		0	1: IO System 1.			IO-Link Master	
Status/Control Module		0	1: IO System 1. 1	2...3	2...3	Status/Control Module	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)		0	1: IO System 1. 2: Port X1	68...100	68...99	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_1		0	1: IO System 1. 3: Port X2	101...133	100...131	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_2		0	1: IO System 1. 4: Port X3	134...166	132...163	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_3		0	1: IO System 1. 5: Port X4	167...199	164...195	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_4		0	1: IO System 1. 6: Port X5	200...232	196...227	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_5		0	1: IO System 1. 7: Port X6	233...265	228...259	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_6		0	1: IO System 1. 8: Port X7	266...298	260...291	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_7		0	1: IO System 1. 9: Port X8	299...331	292...323	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	

Figure 10.9

The IO-Link channels (C/Q or channel A/pin 4 of the I/O port) in sub-slots 2–9 (port X1 of the device corresponds to sub-slot 2, ..., port X8 of the device corresponds to sub-slot 9) can be configured flexibly.

The input and output addresses defined by the hardware manager can be changed.

Deleting an IO-Link Channel Configuration

1. To delete one or more IO-Link channels, select the desired IO-Link channel in "Device View."

Device Overview

Device overview

Module	Fail-safe	Rack	Slot	I address	Q address	Type	Article number
ICE11-8IOL-G60L-V1D		0	0: PROFINET Interface			ICE11-8IOL-G60L-V1D	70146527
PN-IO		0	0: PROFINET Interface X1			ICE11-8IOL-G60L-V1D	
IO-Link Master_1		0	1: IO System 1.			IO-Link Master	
Status/Control Module		0	1: IO System 1. 1	2...3	2...3	Status/Control Module	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)		0	1: IO System 1. 2: Port X1	68...100	68...99	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_1		0	1: IO System 1. 3: Port X2	101...133	100...131	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_2		0	1: IO System 1. 4: Port X3	134...166	132...163	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_3		0	1: IO System 1. 5: Port X4	167...199	164...195	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_4		0	1: IO System 1. 6: Port X5	200...232	196...227	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_5		0	1: IO System 1. 7: Port X6	233...265	228...259	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_6		0	1: IO System 1. 8: Port X7	266...298	260...291	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_7		0	1: IO System 1. 9: Port X8	299...331	292...323	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	

Figure 10.10

2. Right-click on this entry. From the menu that appears, select the Delete option.

Free IO-Link Channels

Device overview

Module	Fail-safe	Rack	Slot	I address	Q address	Type	Article number
ICE11-8IOL-G60L-V1D		0	0: PROFINET Interface			ICE11-8IOL-G60L-V1D	70146527
PN-IO		0	0: PROFINET Interface X1			ICE11-8IOL-G60L-V1D	
IO-Link Master_1		0	1: IO System 1.			IO-Link Master	
Status/Control Module		0	1: IO System 1. 1	2...3	2...3	Status/Control Module	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)		0	1: IO System 1. 2: Port X1	68...100	68...99	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
		0	1 3: Port X2				
		0	1 4: Port X3				
		0	1 5: Port X4				
		0	1 6: Port X5				
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_5		0	1: IO System 1. 7: Port X6	233...265	228...259	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_6		0	1: IO System 1. 8: Port X7	266...298	260...291	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_7		0	1: IO System 1. 9: Port X8	299...331	292...323	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	

Figure 10.11

Creating an IO-Link Channel Configuration

1. The I/O Module Submodules folder in the hardware catalog displays all configurable options that can be selected.

IO-Link Channel Configuration

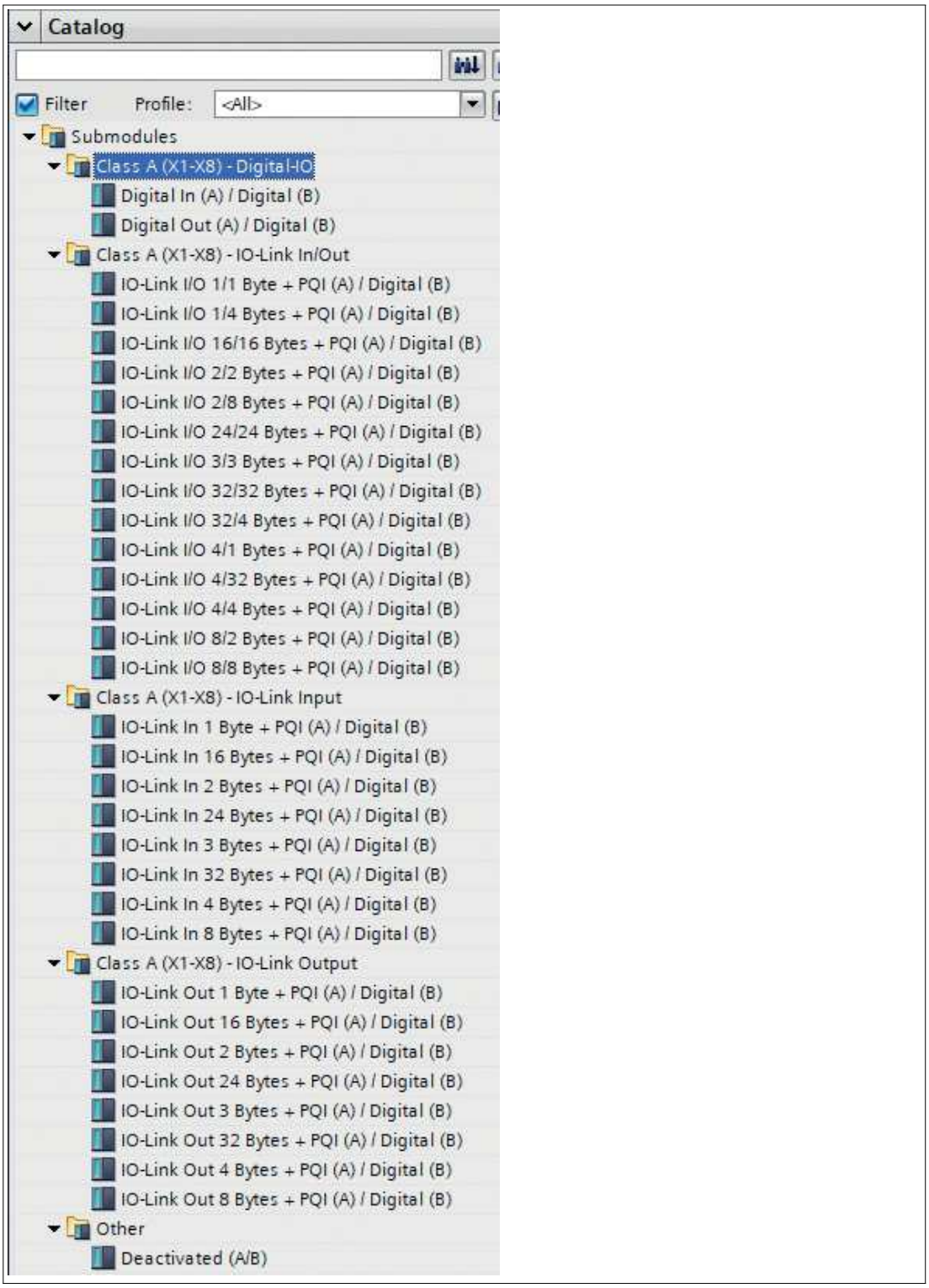


Figure 10.12

2024-04

2. Select the desired option and then click and hold the left mouse button to drag the configuration to a free IO-Link sub-slot.

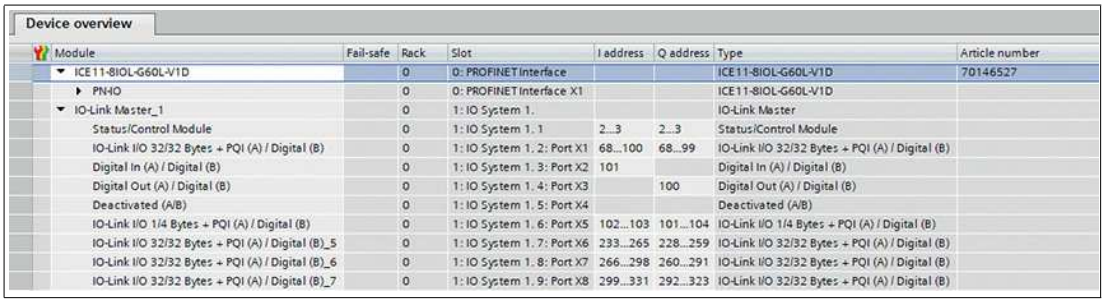


Figure 10.13

The following options are available for the IO-Link C/Q channel (channel A/pin 4):

Digital Input: In this mode the channel works as a digital input.
The IO-Link master does not attempt to independently establish communication with the connected IO-Link device.

Digital Output: In this mode the channel works as a digital output.

Deactivated: This mode should be selected when neither the A channel nor the B channel of the I/O ports (ports X1–X8) are used.
In this case, the power supply L+ to pin 1 of the connection is disabled.

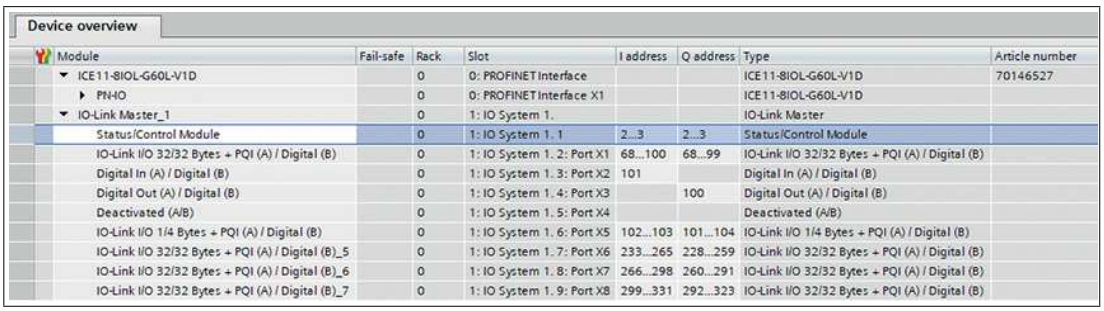
IO-Link ... : In this mode (IO-Link communication mode), process data is exchanged from or to the device via a communication connection.
The IO-Link master automatically starts communication with the connected IO-Link device, taking into account the baud rate.
In this mode, all IO-Link functions can be used without limitation (parameterization, diagnosis, etc.).

Configuration modules with data lengths of 1–32 bytes + PQI[1] are available for the physical input and 1–32 bytes for the physical output.
If the IO-Link device does not have a suitable configuration module, the next largest data length must be selected.
After the initial configuration of the device, this port configuration is permanently saved on the IO-Link master. This means that the next time you turn on the power, the I/O port is preconfigured with these settings before the controller sends a new port configuration.
The sensor power supply via I/O port pin 1 is switched on directly dependent on the last active configuration.
A configuration telegram of the PN controller is not required. The I/O data remains invalid until a new configuration is received after the IO-Link master is switched on.

1. Port Qualifier Information

10.2.4 Parameterization of the Status/Control Module

Status/Control Module



Module	Fail-safe	Rack	Slot	I address	Q address	Type	Article number
ICE11-8IOL-G60L-V1D		0	0: PROFINET Interface			ICE11-8IOL-G60L-V1D	70146527
PN-IO		0	0: PROFINET Interface X1			ICE11-8IOL-G60L-V1D	
IO-Link Master_1		0	1: IO System 1.			IO-Link Master	
Status/Control Module		0	1: IO System 1. 1	2...3	2...3	Status/Control Module	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)		0	1: IO System 1. 2: Port X1	68...100	68...99	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
Digital In (A) / Digital (B)		0	1: IO System 1. 3: Port X2	101		Digital In (A) / Digital (B)	
Digital Out (A) / Digital (B)		0	1: IO System 1. 4: Port X3		100	Digital Out (A) / Digital (B)	
Deactivated (A/B)		0	1: IO System 1. 5: Port X4			Deactivated (A/B)	
IO-Link I/O 1/4 Bytes + PQI (A) / Digital (B)		0	1: IO System 1. 6: Port X5	102...103	101...104	IO-Link I/O 1/4 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_5		0	1: IO System 1. 7: Port X6	233...265	228...259	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_6		0	1: IO System 1. 8: Port X7	266...298	260...291	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	
IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)_7		0	1: IO System 1. 9: Port X8	299...331	292...323	IO-Link I/O 32/32 Bytes + PQI (A) / Digital (B)	

Figure 10.14

Parameters in the status/control module:

Figure 10.15

The status/control module in slot 1/sub-slot 1 is permanently preconfigured for each module. It contains 2 bytes of input data and 2 bytes of output data for the digital IO data plus status and control bits of the IO-Link master.

The bit assignments are described in the main chapter "Commissioning for PROFINET" in the "Bit Assignment" chapter see chapter 10.3.

Using the status/control module, it is also possible to carry out all of the global module-specific parameterization that is not related to ports in the IO-Link COM mode.

The following is a brief description of the individual areas for parameter setting.

General Device Settings

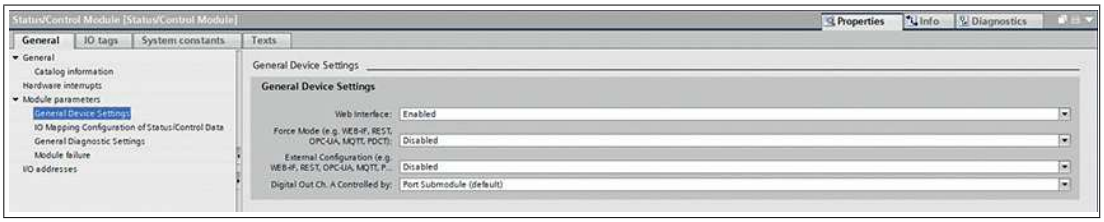


Figure 10.16 Force Mode

- **Web Interface**
  Access to the web interface can be set to "Enabled" or "Disabled" with this parameter. In the case of the "Disabled" setting, the web pages are not accessible.
  Default setting: Enabled
- **Force Mode**
  The I/O input and output data can be forced (= changed) for implementation reasons. This can be done via various interfaces, e.g., web interface, REST, OPC UA, MQTT. The support of interfaces for forcing depends on the selected software variant. This function can be used to enable or disable possible forcing of I/O data.
  Default setting: Disabled

Danger!

Unexpected signals, machine movements

Risk of injury or death! Unsupervised forcing can lead to unexpected signals and uncontrolled machine movements.

- **External Configuration**
  Configuration and parameter data can be set via various external interfaces outside the GSDML configuration, e.g., web interface, REST, OPC UA, MQTT. This option enables or disables the external configuration. An external configuration can only be made as long as no cyclic PLC connection is active. Each new PLC configuration overwrites the external configuration settings.
  Default setting: Disabled
- **Digital Out Ch. A controlled by...**
  - Port sub-module:
    The output byte 1/bit 0 for the corresponding sub-slot module must be used to control the digital A channels.
  - Status/Control Module:
    In this case, the digital A-channel outputs can be controlled by the output bits of the status/control module. The digital outputs can be controlled only from one source of data.

  Default setting: Port sub-module

I/O Mapping Configuration of Status/Control Data

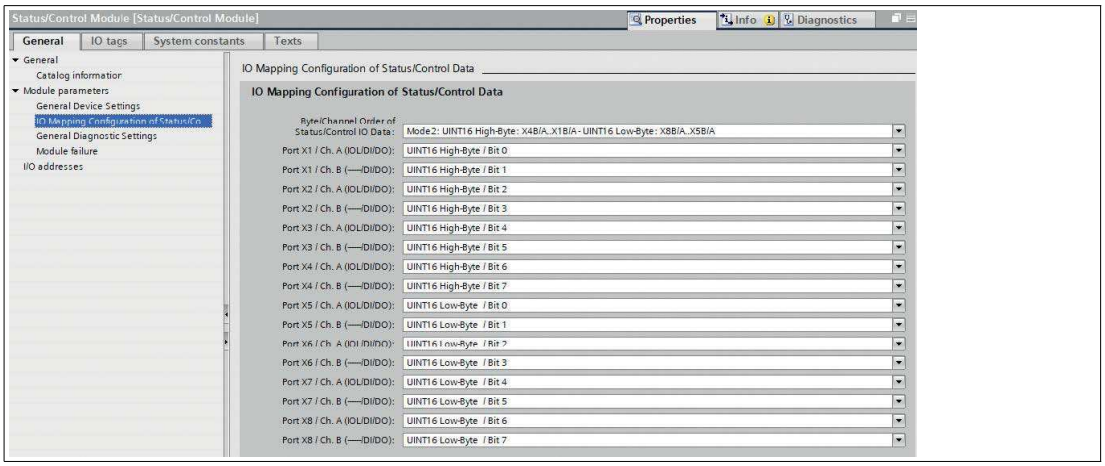


Figure 10.17

Byte/Channel order of Status/Control I/O data

This parameter can be used to select 4 (modes 1–4) predefined bit mappings for the digital I/O bits. The I/O data is mapped to the input and output bytes of the status/control module.

Mode 5 can be used for unrestricted, user-defined mapping. The parameter settings "Port X1/Channel A" – "Port X8/Channel B" must be used for this purpose. These parameters allow all I/O channels to be freely assigned to a bit in the status/control I/O data. Note that duplicate assignments are not possible at this point. If an incorrect parameterization is detected in the device, an error is registered.

If Mode 1 – Mode 4 was selected, the "Port X1/Channel A" – "Port X8 Channel B" settings in the device are ignored.

The selected mapping is used equally for both input and output data traffic.

Legend

UINT16 High-Byte	1st/"low address" byte in a Siemens PLC
UINT16 Low-Byte	2nd/"high address" byte in a Siemens PLC

Applies when the Siemens PLC uses the Big Endian format

Mode 1

Figure 10.18

Mode 2

Figure 10.19

Mode 3

Figure 10.20

Mode 4

Figure 10.21

Mode 5

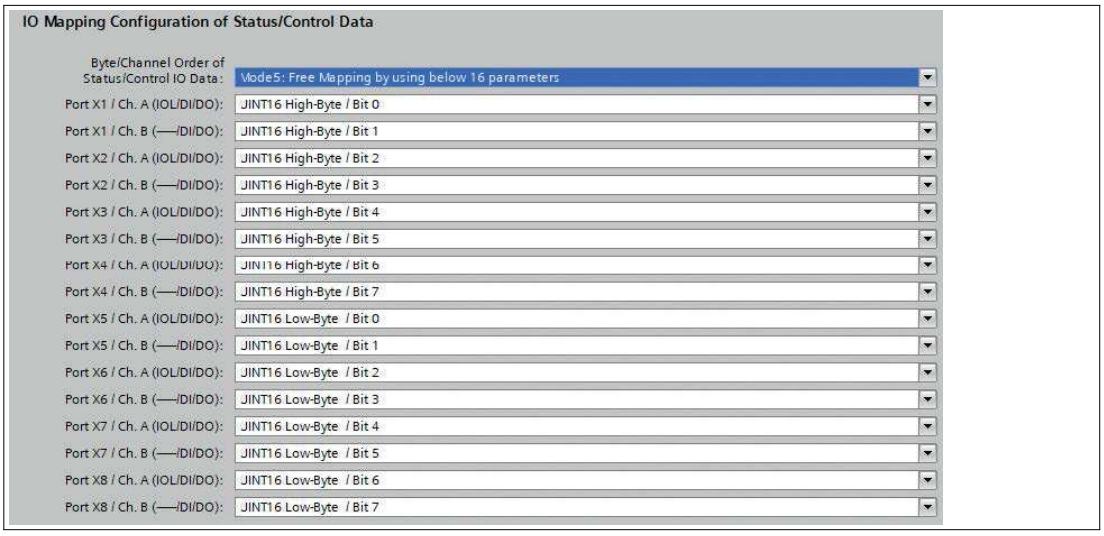


Figure 10.22

For details on I/O mapping, see chapter 10.3.

General Diagnostic Settings

Modules with IO-Link Class A Ports

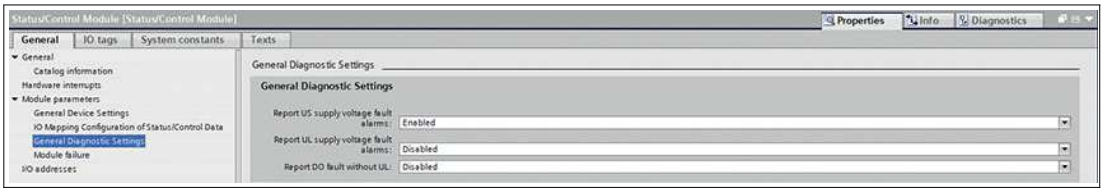


Figure 10.23

2024-04

PEPPERL+FUCHS

- **Report U_S supply voltage fault alarms**

  The U_S supply voltage fault alarm[a] can be set to "Disabled" or "Enabled" with this parameter.
  Default setting: Enabled
- **Report U_L supply voltage fault alarms**

  The U_L supply voltage fault alarm[b] can be set to "Disabled", "Enabled", or "Auto Mode" with this parameter. In the "Auto Mode" setting, the U_L diagnostics are activated with the first detection of a rising edge after power-up.
  Default setting: Disabled

Note

The Report U_L supply voltage fault option is disabled by default to avoid diagnostic messages due to subsequent activation or deactivation of the power supply.

- Report DO fault without U_L

  Diagnostics of the digital outputs can be configured depending on the U_L status. If the output is active without active U_L while this parameter is activated, a diagnostic message is generated for the output channel.
  Default setting: Enabled

Modules with IO-Link Class A/B Ports

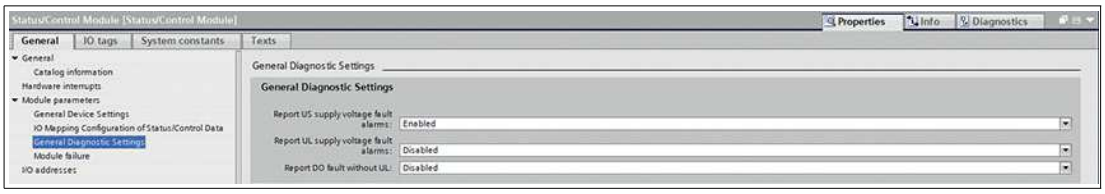


Figure 10.24

- **Report U_S supply voltage fault alarms**

  The U_S supply voltage fault alarm[c] can be set to "Disabled" or "Enabled" with this parameter.
  Default setting: Enabled
- **Report U_L supply voltage fault alarms**

  The U_{AUX} supply voltage fault alarm[d] can be set to "Disabled", "Enabled", or "Auto Mode" with this parameter. In the "Auto Mode" setting, the U_{AUX} diagnostics are activated with the first detection of a rising edge after power-up.
  Default setting: Disabled

Note

The Report U_{AUX} supply voltage fault option is disabled by default to avoid diagnostic messages due to subsequent activation or deactivation of the power supply.

- Report DO fault without U_{AUX}

  Diagnostics of the digital outputs can be configured depending on the U_{AUX} status. If the output is active without active U_{AUX} while this parameter is activated, a diagnostic message is generated for the output channel.
  Default setting: Enabled

a. Fault alarm of the U_S supply voltage

b. Fault alarm of the U_L supply voltage

c. Fault alarm of the U_S supply voltage

d. Fault alarm of the U_{AUX} supply voltage

10.2.5 Parameterization of IO-Link Channels X1 ... X8

Parameterization of the IO-Link Channels

By double-clicking the relevant IO-Link sub-slot in the hardware configuration and selecting the "Module parameters" tab, you can set the following parameters.

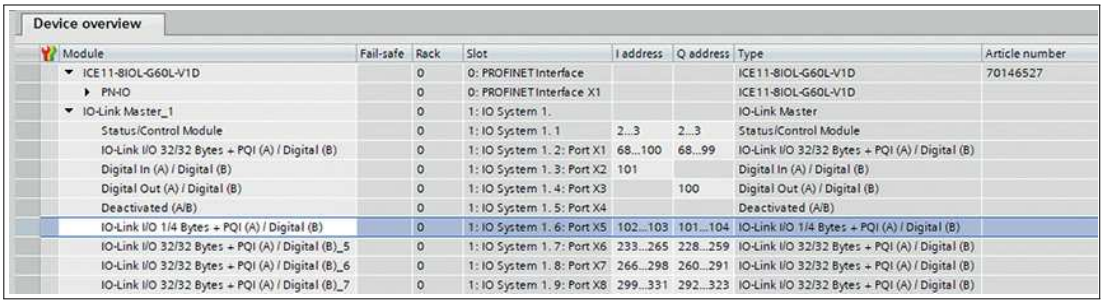


Figure 10.25

Parameters of the IO-Link Channels

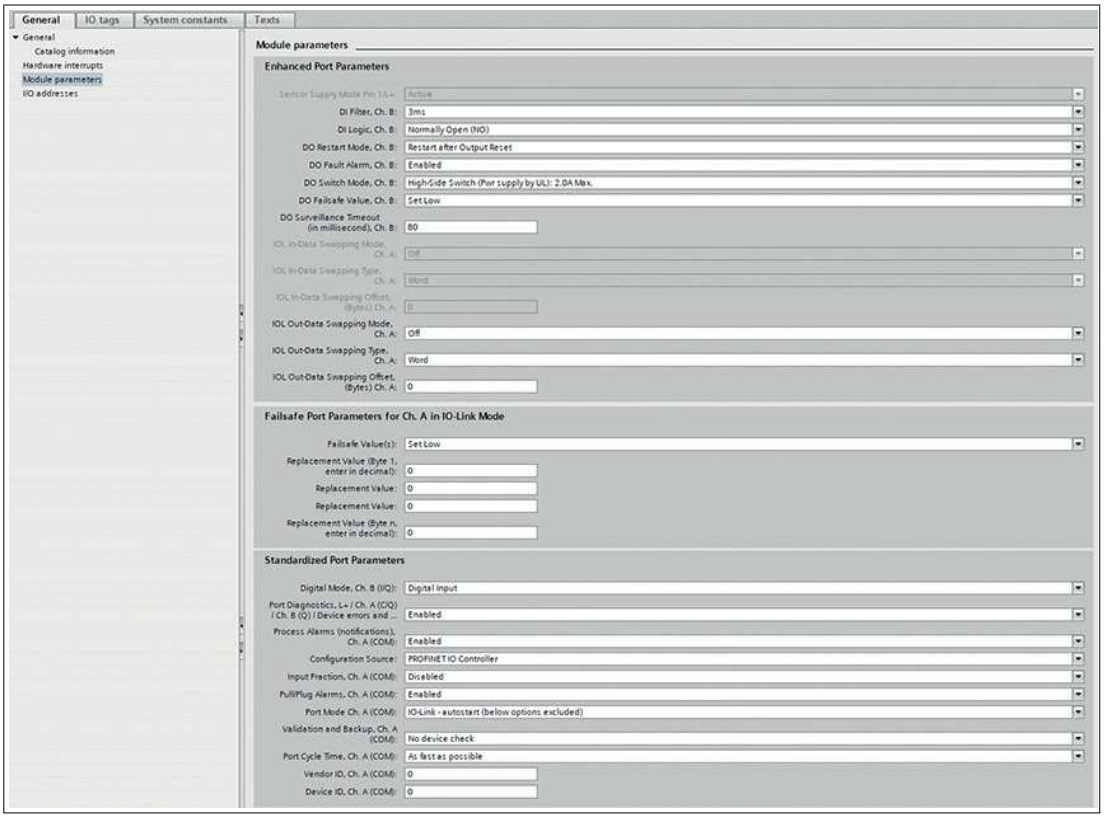


Figure 10.26

Extended Port Parameters[e]

- **Sensor Supply Mode Pin 1/L+**
  The sensor voltage at pin 1 is permanently active and cannot be deactivated.
- **DI Filter**
  This parameter can be used to define the filter time of the digital input. The following options are available:
  Off; 1 ms; 2 ms; 3 ms; 6 ms; 10 ms; 15 ms
  Default setting: 3 ms

e. Depending on the configuration of the submodule, some of the parameters described below may differ

- **DI Logic**
  These parameters can be used to set the logic of the channels used as digital inputs.
  - **NO**[f]
    In this case, an undamped sensor has an open switching output (low level). The input of the device detects a low level and supplies a "0" to the controller.
    The channel LED indicates the status of the physical input.
  - **NC**[g]
    In this case, an undamped sensor has a closed switching output (high level). The input of the device detects a high level, inverts the signal, and supplies a "0" to the controller.
    The channel LED indicates the status of the physical inputs, regardless of the setting.

  Default setting: NO for all channels
- **DO Restart Mode**
  This parameter can be used to set the restart behavior of the digital output.
  - **Automatic Restart after Failure:**
    If an output short-circuit or overload is detected, the output is switched off from the IO-Link master. However, after a time delay, the output is automatically switched on again to check whether the overload or short-circuit state is active.
  - **Restart after Output Reset:**
    If an output short-circuit or overload is detected, the output is switched off from the IO-Link master.

  Default setting: Restart after Output Reset
- **DO Switch Mode**
  This option allows you to select a mode for the digital output switch.
  - **Push Pull Switch (0.5 A):**
    In this mode, the output is set to active for "high" and "low". In the "low" state, the output can represent a current sink. In this mode, the digital output is supplied via U_S.
  - **High-Side Switch (0.5 A; 1.0 A; 1.5 A; 2.0 A; 2.0 A Max.):**
    In this mode, the output is set to active for "high", but not for "low". A "low" output means a high impedance at the digital output. In addition, a current limit can be selected for each digital output in high-side switch mode. This selection allows the level of actuator overvoltage diagnostics to be managed. 2.0 A Max. means that the current limit is not active and that the maximum output current is available for this output. In these modes, the digital output is supplied via U_L.

  Default setting: High-Side Switch (2.0 A Max.)
- **DO Failsafe Value**
  The device supports a "failsafe" function for the channels used as digital outputs. During configuration of the devices, the status of the PROFINET IO node outputs after an interruption or loss of communication in the PROFINET IO network can be defined. The following options can be selected:
  - Set Low – the output channel is disabled and/or the output bit is set to "0".
  - Set High – the output channel is enabled and/or the output bit is set to "1".
  - Hold Last – the last output status is retained.

  Default setting: Set Low
- **DO Surveillance Timeout**
  For channels that are configured as digital outputs, the firmware of the modules allows you to set a delay time in specific applications before output status monitoring is activated.
  This delay time is called a "Surveillance Timeout"[h] and can be set for each individual output channel. The delay time starts with a rising edge of the output control bit. Once this time has elapsed, the output is monitored and fault states are reported by the diagnostics.
  The "Surveillance Timeout" parameter can be set to a value between 0 and 255 ms. In the static state of an output channel, i.e., when the channel is permanently on or off, the unchangeable filter value before a diagnostic message is typically 5 ms.
  Default setting: 80 ms

f. NO = Normally Open

g. NC = Normally Closed

- **IO-Link Input/Output Data Swapping**
  The following parameters can be used to set the IO-Link byte data sequence separately for input and output data traffic.
  - **Swapping Mode:**
    The byte sequence swapping is performed for the selected number of data types or for the entire length of the I/O data with the selected data types (Word = 2 bytes or DWord = 4 bytes).
    Default setting: Off
  - **Swapping Data Type:**
    Swapping can be set to Word (2 bytes) or DWord (4 bytes):
    – Word Swapping: Byte 1 - Byte 2 => Byte 2 - Byte 1
    – DWord Swapping: Byte 1 - Byte 4 => Byte 4 - Byte 1
    The value of the data type has no effect when the "Swapping Mode" is set to "Off".
    Default setting: Word
  - **Swapping Offset:**
    Swapping offset in bytes can be set depending on the configured I/O data length.
    If "2" is set, byte 3 is swapped.
    Default setting: 0

Failsafe Port Parameters for Ch. A in IO-Link Mode

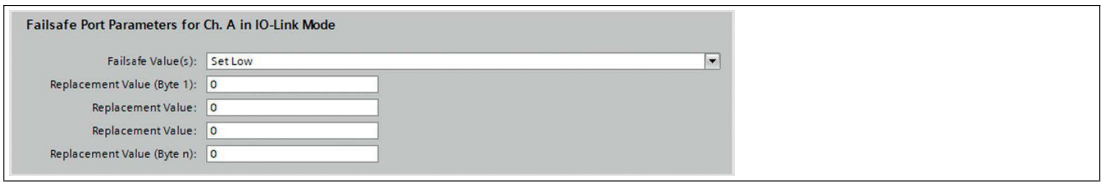


Figure 10.27 Selectable values, for output data only

To ensure proper functioning of the IO-Link failsafe values, the IO-Link node parameters should be set in the same way if possible. In the event of an interrupted network connection, the IO-Link master sends output data to the IO-Link node in accordance with its failsafe configuration. If the connection is interrupted, the IO-Link node uses the failsafe options parameterized in the device, if these are supported.

If the device supports a failsafe mechanism, select the IO-Link Master Command option.

- **Set Low**[i]
  All bits of output data with a value of "0" are transferred to the IO-Link node.
  Default Setting
- **Set High**[j]
  All bits of output data with a value of "1" are transferred to the IO-Link node.
- **Hold Last**[k]
  The last valid output value received by the controller is transferred cyclically to the IO-Link node.
  For correct Hold Last behavior, the corresponding IO-Link node parameter must also be set to Hold Last.
- **Replacement Value**[l]
  If this option is selected, the entered value of the replacement value input field described below is transferred cyclically to the IO-Link node.
- **IO-Link Master Command**[m]
  The "IO-Link master command" option enables the use of IO-Link-specific mechanisms for valid/invalid output process data. The behavior is therefore determined by the node itself.

h. Surveillance Timeout

i. Set lower-value bits

j. Set higher-value bits

k. Keep the last value

l. Replacement Value

Replacement value

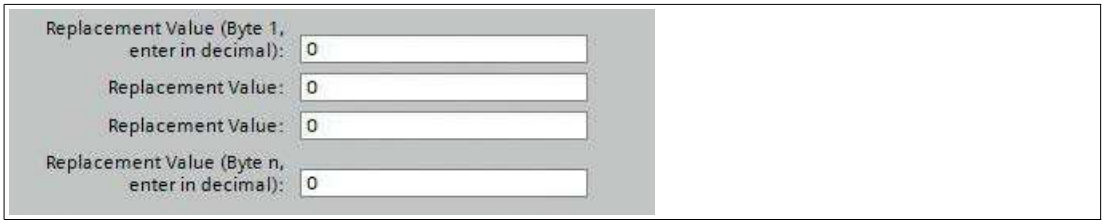


Figure 10.28 Byte data

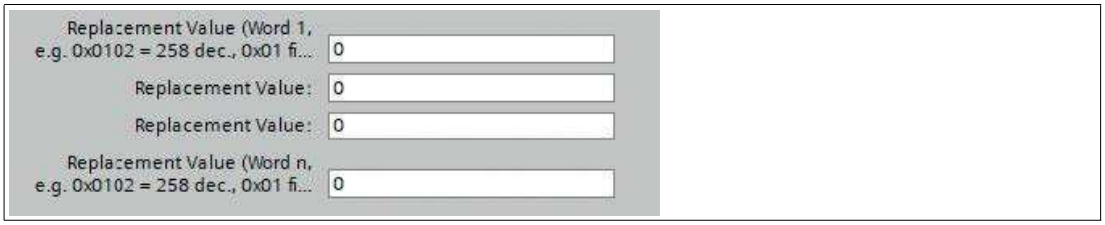


Figure 10.29 Word data

If the "Fail Safe Value(s)" option "Replacement Value" has been set, the replacement value entered in this input field(s) is used.

The value must be entered as a decimal value. Depending on the configured data length, the values must be entered as bytes (0 – 255) or word decimal values (0 – 65535) in the order of the displayed value.

- Byte 1 = highest value byte (UINT8), as decimal
- Byte n = lowest value byte (UINT8), as decimal
- Word 1 = highest value word (UINT16), as decimal
- Word n = lowest value word (UINT16), as decimal

Example

"Word" examples:

0x0102 = 258 dec.

0x01 = first byte of the IO-Link node

0x02 = second byte of the IO-Link node.

Default Port Parameters

Port Diagnostics, Ch. A

IO-Link Master Port diagnostics and IO-Link node alarms of the type "error" or "warning" can be activated or deactivated via this option.

Default setting: Enabled

Digital Mode, Ch. B

This parameter defines the mode of channel B. The following settings are available:

- Disabled
- Digital Input
- Digital Output

The activated supply voltage in the output is indicated by the white port LED.

Default setting: Digital Input

m.IO-Link master command

Process Alarm, Ch. A

IO-Link node alarm notifications can be enabled or disabled with this option. Deactivated means that all IO-Link node alarms of the "Notification" type are suppressed in the IO-Link master.

Default setting: Enabled

Configuration Source, Ch. A

- PROFINET IO controller
  The IO-Link master port configuration is assigned by the PROFINET IO controller.
- Port and device configuration tool[n]
  The IO-Link master port configuration is assigned by an external IO-Link port and device configuration tool.
  Default setting: PROFINET IO controller

Input Fraction, Ch. A

If the user configures a sub-slot module with less than the actual input data of the device, the IO-Link master sends as many IO-Link node input bytes as possible to the PLC, including the PQI byte of the sub-slot module. Consequently, only "0" up to (device input length - 1) octets of the input data of the device can be mapped to the PROFINET process input data of the IO-Link master. If this option is disabled and the input data length does not match, a data length mismatch alarm is enabled. If an incongruence[o] is detected in the output data, a diagnosis of the process data mismatches is generated regardless of the selected "Input Fraction" setting.

Default setting: Disabled

Pull/Plug, Ch. A

Enables or disables pull/plug alarms of an IO-Link node[p]. The failure or return of an IO-Link node is mapped via PROFINET pull/plug alarms. This assignment is independent of the switch-on and shutdown phases.

- **Plug Alarms:**
  – Ready to Operate, IO-Link node is ready
  – COM Fault, wrong device, or other problems. IO-Link node started but not ready for operation due to a fault.
- **Pull Alarms:**
  – COM Fault, no IO-Link node

Default setting: Enabled

Port Mode, Ch. A

- **Deactivated:**
  An IO-Link port can be configured for later use using the "Deactivated" option. If the IO-Link node is not connected, no diagnosis is generated.
- **IO-Link - Autostart:**
  No explicit port configuration is required with the "Plug&Play" option. Basic assignments such as validation and backup[q], Port Cycle Time, Vendor ID, and Device ID are not required.
- **IO-Link - Manual:**
  Explicit port configuration is possible for validation and backup[q], Port Cycle Time, Vendor ID, and Device ID. These parameters are GSD-based and can be configured via the PROFINET engineering system.
  Default setting: IO-Link Autostart

n. not yet supported

o. Mismatch

p. Add/remove submodules

q. Test level

2024-04

Overview of Port Mode Configuration Types

Function	IO-Link Autostart	IO-Link Manual (GSD)
Access on Process Data (PD)	Yes	Yes
Diagnostics of port & device	Yes	Yes
I&M data (IM0) access	Yes	Yes
Device check (consolidated/real)	No	Yes
Backup & Restore	No	Yes
Device parameterization (PDCT)	No	No
Commissioning (online)	No	No

Table 10.1

Validation and Backup, Ch. A

To use the validation and backup functionality of the IO-Link master, set the port mode to IO-Link - manual.

Depending on the Validation and Backup setting, an entry in the Vendor ID and Device ID parameters is mandatory.

- **No IO-Link-Device check**
  No verification of the connected vendor ID and device ID and no backup and restore of the IO-Link master backup memory is supported.
  Default Setting
- **Type compatible (V1.0) IO-Link-Device**
  Type-compatible according to IO-Link specification V1.0, including validation of vendor ID and device ID. The IO-Link specification V1.0 does not support IO-Link master parameters with "backup memory" and "restore" functions.
- **Type-compatible (V1.1) IO-Link-Device**
  Type-compatible according to IO-Link specification V1.1; Vendor ID and Device ID are checked by the IO-Link master.
- **Type-compatible (V1.1) IO-Link-Device with Backup & Restore**
  Type-compatible according to IO-Link specification V1.1; Vendor ID and Device ID are checked by the IO-Link master with backup[r] and Restore[s] of the IO-Link node parameters.

  Backup[r]
  During the initial connection to an IO-Link node after activating this mode, the IO-Link master loads the IO-Link node parameters into the backup memory[t] . In the example, the backup memory was empty.

  An upload is also executed if the IO-Link node has set the DS_UPLOAD_FLAG[u] . This IO-Link node flag can be set in two ways.
  1. Parameters are written to an IO-Link device in the block parameter mode: An IO-Link node sets the DS_UPLOAD_FLAG independently if the Block Parameter Mode parameters have been written to the IO-Link node with the last system command ParamDownloadStore, for example by a third-party USB IO-Link master for commissioning.
  2. Parameters are written to an IO-Link node in single-parameter mode: If the parameters are written to an IO-Link node in single-parameter mode[v], the device parameter backup memory on the IO-Link master can be updated with the system command ParamDownloadStore[w] . This command sets the backup request DS_UPLOAD_-

r. IO-Link node to IO-Link master

s. IO-Link master to IO-Link node

t. backup memory

u. Data Storage Upload Flag

v. For example, a sub-index of a parameter index

FLAG on the IO-Link node in the direction of the IO-Link master. The IO-Link master carries out a transfer from the IO-Link node to the IO-Link master backup memory.

Restore[s]

For each newly connected IO-Link node, the IO-Link master compares the saved parameters with the IO-Link node parameters and loads the saved backup parameters to the IO-Link node in the event of differences.

The recovery process can be blocked by the IO-Link node via the Device Access Locks parameter, provided that this is supported by the IO-Link node[x] .

- **Type-compatible (V1.1) IO-Link-Device with Restore:**
  Type-compatible according to IO-Link specification V1.1, Vendor ID and Device ID are checked by the IO master with Restore[s] IO-Link Device Parameter.

  Restore[s]

  During the initial connection to an IO-Link node after activating this mode, the IO-Link master loads the IO-Link node parameters into the backup memory once[y] .

  For each additional connection to an IO-Link node, the IO-Link master compares the saved parameters with the IO-Link node parameters and loads the saved backup parameters to the IO-Link node in the event of differences.

  In restore mode, no changes to the IO-Link node parameters are saved in the IO-Link master backup memory. If the IO-Link node sets the DS_UPLOAD_FLAG in this mode, the IO-Link node parameters are restored by the IO-Link master.

  The recovery process can be blocked by the IO-Link node via the Device Access Locks parameter, provided that this is supported by the IO-Link node[z] .
- **Reset conditions of the IO-Link master parameter backup memory**
  The IO-Link master backup memory is emptied by the following actions:
  - IO-Link master factory reset, reset to factory settings: Changes in the port configuration, such as from "Digital Input" to "IO-Link Mode"
  - A change in the validation and backup settings, such as from "No IO-Link-Device Check" to "Type-compatible IO-Link-Device (V1.1) with Backup & Restore"

  For more information, please refer to the 'IO-Link Interface and System Specification' version 1.1.3, which can be downloaded from https://io-link.com/.

  Default setting: No IO-Link-Device check.

Caution!

Block mode

An IO-Link node sets the "Upload Flag" independently if parameters have been written to the IO-Link node in block mode.

Port Cycle Time, Ch. A[aa]

- **As fast as possible:**
  For the cyclic IO data update between the IO-Link master and IO-Link nodes, the IO-Link master uses the maximum supported IO-Link device update cycle time, which is limited by the maximum supported IO-Link master cycle time.
- **1.6, 3.2, 4.8, 8, 20.8, 40, 80, 120 ms:**
  The cycle time can be set manually to the options provided. This option can be used for IO-Link nodes that are connected via inductive couplers, for example. Inductive couplers are usually the bottleneck in the update cycle time between IO-Link master and IO-Link node. In this case, refer to the datasheet of the inductive coupler.

Default setting: As fast as possible

w.Index 0x0002, Sub-Index 0x00, Value 0x05

x. Index 0x000C, refer to the manufacturer-specific documentation

y. backup memory

z. Index 0x000C, refer to the manufacturer-specific IO-Link device documentation

aa.Port mode IO-Link - manual required

Vendor ID, Ch. A[aa]

- The Vendor ID of the connected IO-Link device can be entered as a decimal value [0 – 65535] and is used for validating type compatibility depending on the "Validation and Backup" settings.
  Default setting: 0

Device ID, Ch. A[aa]

- The Device ID of the connected IO-Link device can be entered as a decimal value [0 – 65535] and is used for validating type compatibility depending on the "Validation and Backup" settings.
  Default setting: 0

Note

An IO-Link device sets the upload flag independently if parameters have been written to the IO-Link device in block mode.

10.2.6 IO-Link Device Parameterization

Siemens IO-Link Library

You can use the SIEMENS "IO_LINK_DEVICE" function block (FB50001) to write or read out the data of an IO-Link node connected to the IO-Link master acyclically.

"IO_LINK_DEVICE" FB in STEP 7 V15.1

Figure 10.30

IO-Link node data is uniquely addressed via the index and subindex and can be accessed via the hardware identifier of the status/control module (ID), in example 281, the client access point[ab] and the corresponding IO-Link port[ac].

Details can be found in the documentation for the "IO_LINK_DEVICE" FB from Siemens.

ab.CAP = 0xB400

ac.PORT: 1 – 8 for IO-Link ports

TIA Project: "Status/Control Module Hardware Identifier

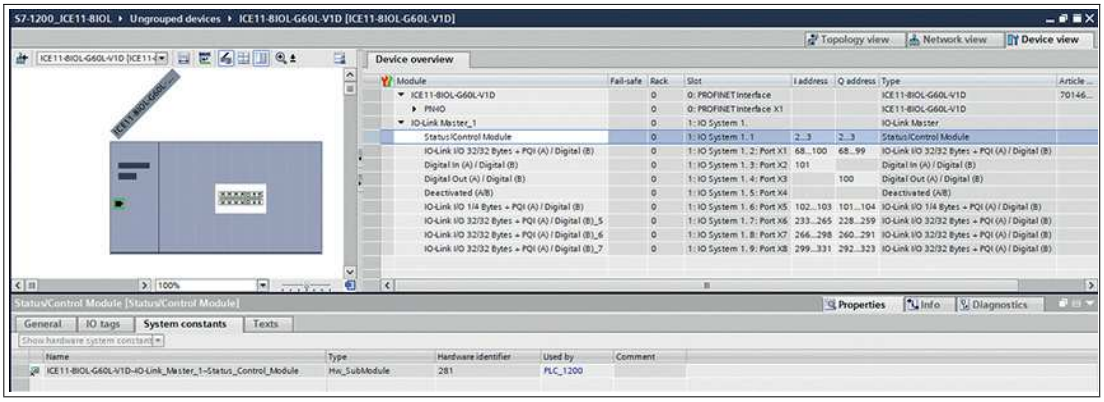


Figure 10.31

SIEMENS WRREC and RDREC

The read and write parameters from the PLC via the IO-Link master to the connected IO-Link nodes can also be called up via the SIEMENS function blocks SFB52/RDREC and SFB53/WREC.

"Write" sequence of WRREC and RDREC calls

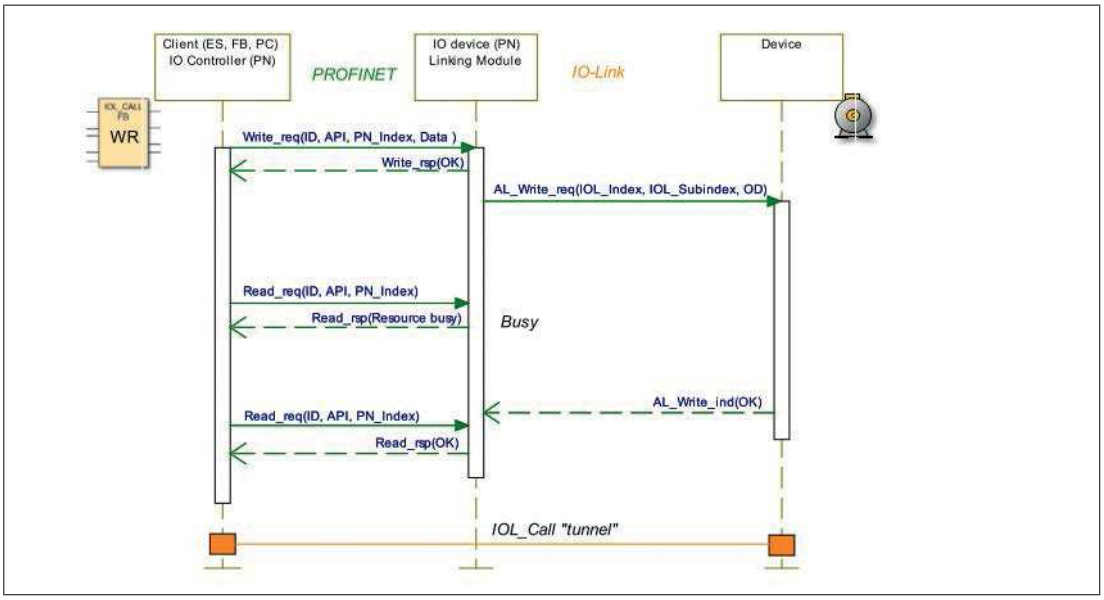


Figure 10.32

The following table shows the sequence with sample data compared to FB50001. The FB50001 also uses the WRREC and RDREC blocks internally.

WRREC ID

FB50001 Call	WRREC				RDREC	RDREC Response		
ID (address proxy)	ID (address proxy)				ID (address proxy)			
CAP	PN_Index = 0xB400				PN_Index = 0xB400			
WR	Data Header	Function (fixed)	0x08	Unsigned8		Data Header	Function (fixed)	0x08
Port		Port	1 – 8	Unsigned8			Port	1 – 8

2024-04

FB50001 Call	WRREC				RDREC	RDREC Response		
		FI_Index (Fixed)	0xFE4A	Unsigned16			FI_Index (Fixed)	0xFE4A
		Con-trol/Status (→Write)	0x02	Unsigned8			Con-trol/Status	0x00
IOL-Index		IOLIndex (0–32767; 65535)	0x...	Unsigned16			IOL-Index (0–32767; 65535)	0x...
IOLSubIndex		IOL-Sub-Index (0–255)	0x00	Unsigned8			IOL-Sub-Index (0–255)	0x00
IOL-Data		WR-Data					Data (opt. Error PDU)	

Table 10.2

Note

Unsigned16 values must be entered for PROFINET in Big Endian format.

Control parameters

Definition of Control octets	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Cancel / Release IOL_CALL	0	0	0	0	0	0	0	0
IDLE Sequence	0	0	0	0	0	0	0	1
Write On-request Data or Port function	0	0	0	0	0	0	1	0
Read On-request Data	0	0	0	0	0	0	1	1
Reserved	additional codes							

Table 10.3

Status parameters

Definition of Control octets	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Done / Transfer terminated	0	0	0	0	0	0	0	0
0IDLE Sequence	0	0	0	0	0	0	0	1
IOL_Error PDU	1	0	0	0	0	0	0	0
Reserved	additional codes							

Table 10.4

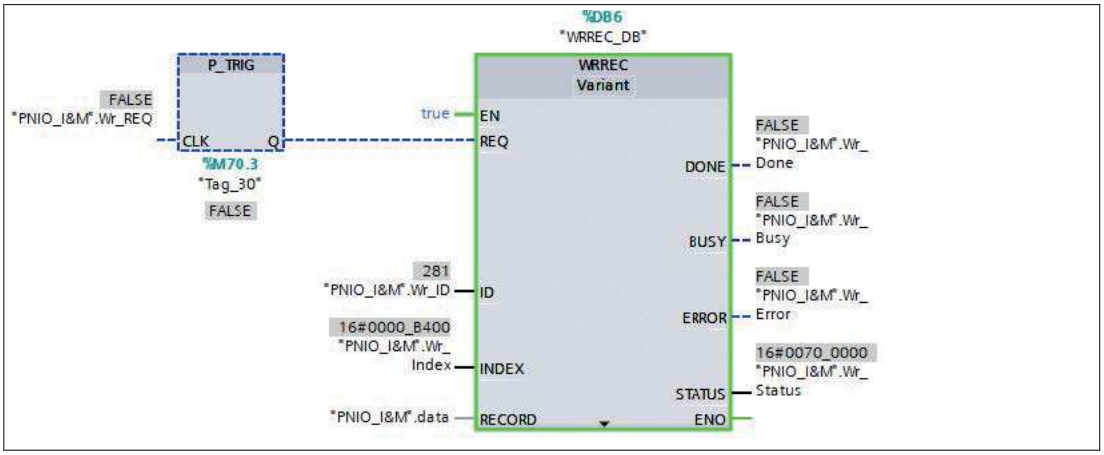


Figure 10.33

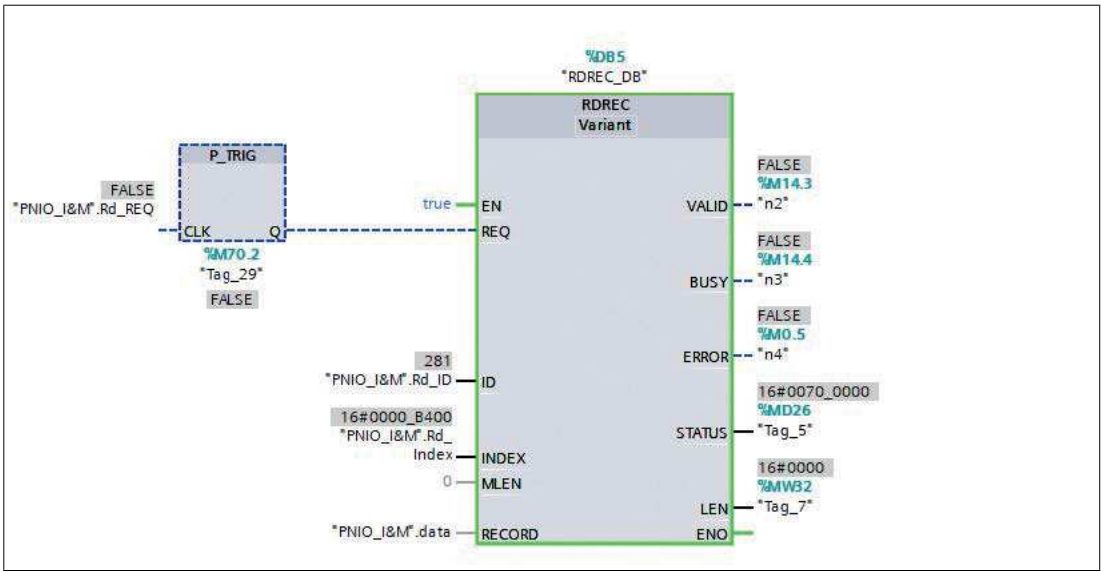


Figure 10.34

Example: Data before "Writing"

Wr_REQ	Bool	false	FALSE
Wr_Index	DWord	16#0	16#0000_B400
Wr_ID	HW_IO	0	281
Wr_Done	Bool	false	FALSE
Wr_Busy	Bool	false	FALSE
Wr_Error	Bool	false	FALSE
Wr_Status	DWord	16#0	16#0000_0000
Wr_Len	UInt	0	0
data	Array[0..39] of Byte		
data[0]	Byte	16#0	16#08
data[1]	Byte	16#0	16#05
data[2]	Byte	16#0	16#FE
data[3]	Byte	16#0	16#4A
data[4]	Byte	16#0	16#02
data[5]	Byte	16#0	16#00
data[6]	Byte	16#0	16#18
data[7]	Byte	16#0	16#00
data[8]	Byte	16#0	16#54
data[9]	Byte	16#0	16#45
data[10]	Byte	16#0	16#53
data[11]	Byte	16#0	16#54
data[12]	Byte	16#0	16#00
data[13]	Byte	16#0	16#00
data[14]	Byte	16#0	16#00
data[15]	Byte	16#0	16#00
data[16]	Byte	16#0	16#00
data[17]	Byte	16#0	16#00

Figure 10.35

Example: Data after "Writing"

Wr_REQ	Bool	false	TRUE
Wr_Index	DWord	16#0	16#0000_B400
Wr_ID	HW_IO	0	281
Wr_Done	Bool	false	FALSE
Wr_Busy	Bool	false	FALSE
Wr_Error	Bool	false	FALSE
Wr_Status	DWord	16#0	16#0000_0000
Wr_Len	UInt	0	0
data	Array[0..39] of Byte		
data[0]	Byte	16#0	16#08
data[1]	Byte	16#0	16#05
data[2]	Byte	16#0	16#FE
data[3]	Byte	16#0	16#4A
data[4]	Byte	16#0	16#02
data[5]	Byte	16#0	16#00
data[6]	Byte	16#0	16#18
data[7]	Byte	16#0	16#00
data[8]	Byte	16#0	16#54
data[9]	Byte	16#0	16#45
data[10]	Byte	16#0	16#53
data[11]	Byte	16#0	16#54
data[12]	Byte	16#0	16#00
data[13]	Byte	16#0	16#00
data[14]	Byte	16#0	16#00
data[15]	Byte	16#0	16#00
data[16]	Byte	16#0	16#00
data[17]	Byte	16#0	16#00

Figure 10.36

Example: "Read" data after "Writing"

Name	Data type	Start value	Monitor value
Static			
Rd_REQ	Bool	false	TRUE
Rd_Index	DWord	16#0	16#0000_B400
Rd_ID	HW_IO	0	281
Rd_Valid	Bool	false	FALSE
Rd_Busy	Bool	false	FALSE
Rd_Error	Bool	false	FALSE
Rd_Status	DWord	16#0	16#0000_0000
Rd_Len	UInt	0	0
data	Array[0..39] of Byte		
data[0]	Byte	16#0	16#08
data[1]	Byte	16#0	16#05
data[2]	Byte	16#0	16#FE
data[3]	Byte	16#0	16#4A
data[4]	Byte	16#0	16#00
data[5]	Byte	16#0	16#00
data[6]	Byte	16#0	16#18
data[7]	Byte	16#0	16#00
data[8]	Byte	16#0	16#54
data[9]	Byte	16#0	16#45
data[10]	Byte	16#0	16#53
data[11]	Byte	16#0	16#54
data[12]	Byte	16#0	16#00
data[13]	Byte	16#0	16#00
data[14]	Byte	16#0	16#00
data[15]	Byte	16#0	16#00
data[16]	Byte	16#0	16#00
data[17]	Byte	16#0	16#00

Figure 10.37

"Read" sequence of the WRREC and RDREC calls

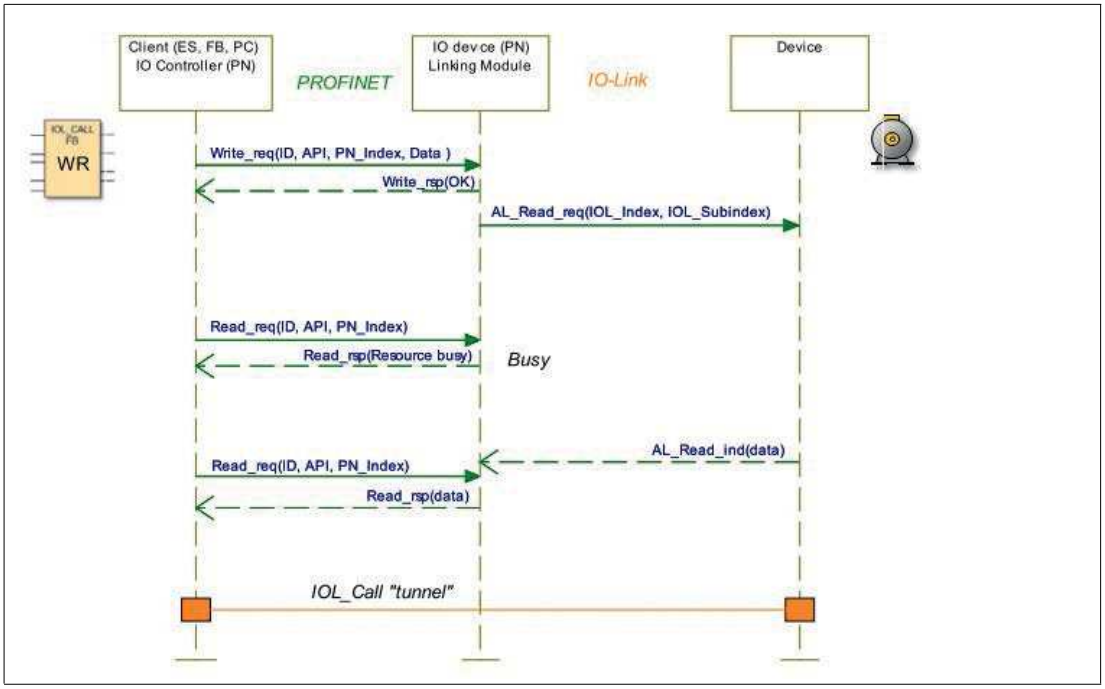


Figure 10.38

The following table shows the sequence with sample data compared to FB50001. The FB50001 also uses the WRREC and RDREC blocks internally.

RDREC ID

FB50001 Call	WRREC				RDREC	RDREC Response		
ID (address proxy)	ID (address proxy)				ID (address proxy)			
CAP	PN_Index = 0xB400				PN_Index = 0xB400			
WR	Data Header	Function (fixed)	0x08	Unsigned8		Data Header	Function (fixed)	0x08
Port		Port	1–8	Unsigned8			Port	1–8
		FI_Index (Fixed)	0xFE4A	Unsigned16			FI_Index (Fixed)	0xFE4A
		Control/Status (→Write)	0x02	Unsigned8			Control/Status	0x00
IOL-Index		IOLIndex (0–32767; 65535)	0x...	Unsigned16			IOL-Index (0–32767; 65535)	0x...
IOLSubIndex		IOL-Sub-Index (0–255)	0x00	Unsigned8			IOL-Sub-Index (0–255)	0x00
IOL-Data		WR-Data					Data (opt. Error PDU)	

Table 10.5

Note

Unsigned16 values must be entered for PROFINET in Big Endian format.

Control parameters

Definition of Control octets	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Cancel / Release IOL_CALL	0	0	0	0	0	0	0	0
IDLE Sequence	0	0	0	0	0	0	0	1
Write On-request Data or Port function	0	0	0	0	0	0	1	0
Read On-request Data	0	0	0	0	0	0	1	1
Reserved	additional codes							

Table 10.6

Status parameters

Definition of Control octets	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Done / Transfer terminated	0	0	0	0	0	0	0	0
0IDLE Sequence	0	0	0	0	0	0	0	1
IOL_Error PDU	1	0	0	0	0	0	0	0
Reserved	additional codes							

Table 10.7

2024-04

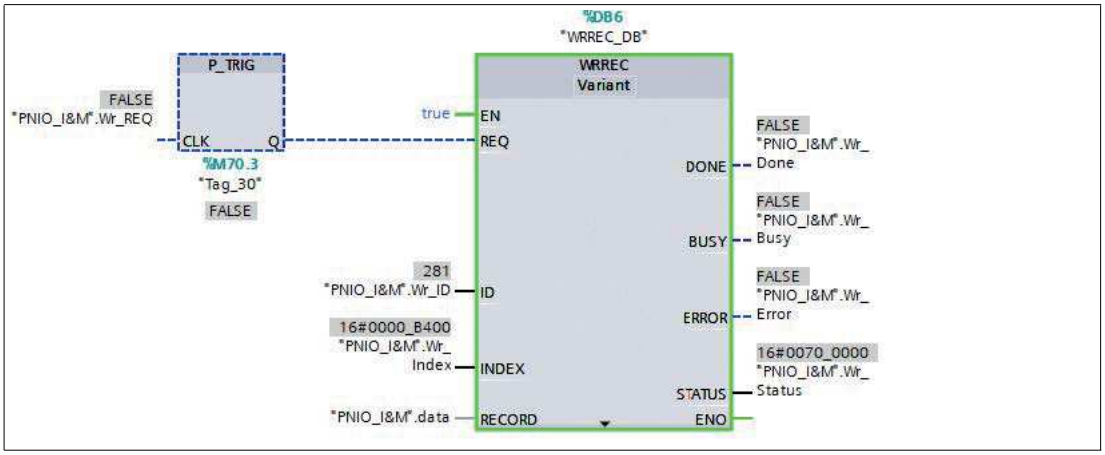


Figure 10.39

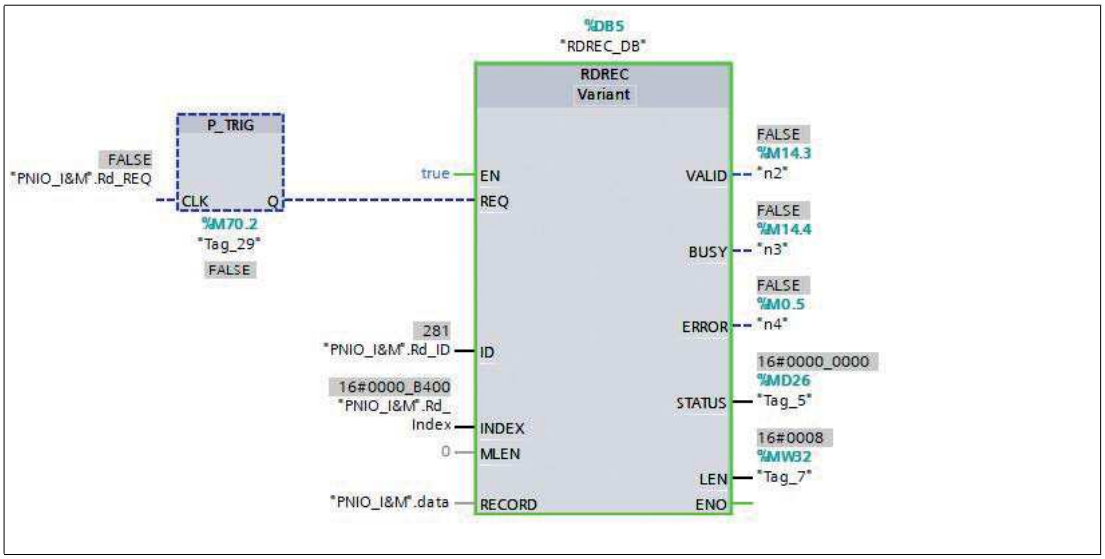


Figure 10.40

Example: Data before "Reading"

Static			
Rd_REQ	Bool	false	FALSE
Rd_Index	DWord	16#0	16#0000_B400
Rd_ID	HW_IO	0	281
Rd_Valid	Bool	false	FALSE
Rd_Busy	Bool	false	FALSE
Rd_Error	Bool	false	FALSE
Rd_Status	DWord	16#0	16#0000_0000
Rd_Len	UInt	0	0
Wr_REQ	Bool	false	FALSE
Wr_Index	DWord	16#0	16#0000_B400
Wr_ID	HW_IO	0	281
Wr_Done	Bool	false	FALSE
Wr_Busy	Bool	false	FALSE
Wr_Error	Bool	false	FALSE
Wr_Status	DWord	16#0	16#0000_0000
Wr_Len	UInt	0	0
data	Array[0..39] of Byte		
data[0]	Byte	16#0	16#08
data[1]	Byte	16#0	16#05
data[2]	Byte	16#0	16#FE
data[3]	Byte	16#0	16#4A
data[4]	Byte	16#0	16#03
data[5]	Byte	16#0	16#00
data[6]	Byte	16#0	16#18
data[7]	Byte	16#0	16#00
data[8]	Byte	16#0	16#00
data[9]	Byte	16#0	16#00
data[10]	Byte	16#0	16#00
data[11]	Byte	16#0	16#00
data[12]	Byte	16#0	16#00
data[13]	Byte	16#0	16#00
data[14]	Byte	16#0	16#00
data[15]	Byte	16#0	16#00
data[16]	Byte	16#0	16#00
data[17]	Byte	16#0	16#00

Figure 10.41

Example: Data after "Reading"

Wr_REQ	Bool	false	TRUE
Wr_Index	DWord	16#0	16#0000_B400
Wr_ID	HW_IO	0	281
Wr_Done	Bool	false	FALSE
Wr_Busy	Bool	false	FALSE
Wr_Error	Bool	false	FALSE
Wr_Status	DWord	16#0	16#0000_0000
Wr_Len	UInt	0	0
data	Array[0..39] of Byte		
data[0]	Byte	16#0	16#08
data[1]	Byte	16#0	16#05
data[2]	Byte	16#0	16#FE
data[3]	Byte	16#0	16#4A
data[4]	Byte	16#0	16#03
data[5]	Byte	16#0	16#00
data[6]	Byte	16#0	16#18
data[7]	Byte	16#0	16#00
data[8]	Byte	16#0	16#00
data[9]	Byte	16#0	16#00
data[10]	Byte	16#0	16#00
data[11]	Byte	16#0	16#00
data[12]	Byte	16#0	16#00
data[13]	Byte	16#0	16#00
data[14]	Byte	16#0	16#00
data[15]	Byte	16#0	16#00
data[16]	Byte	16#0	16#00
data[17]	Byte	16#0	16#00

Figure 10.42

Example: "Read" data after "Reading"

	Name	Data type	Start value	Monitor value
	Static			
	Rd_REQ	Bool	false	TRUE
	Rd_Index	DWord	16#0	16#0000_B400
	Rd_ID	HW_IO	0	281
	Rd_Valid	Bool	false	FALSE
	Rd_Busy	Bool	false	FALSE
	Rd_Error	Bool	false	FALSE
	Rd_Status	DWord	16#0	16#0000_0000
	Rd_Len	UInt	0	0
	data	Array[0..39] of Byte		
	data[0]	Byte	16#0	16#08
	data[1]	Byte	16#0	16#05
	data[2]	Byte	16#0	16#FE
	data[3]	Byte	16#0	16#4A
	data[4]	Byte	16#0	16#00
	data[5]	Byte	16#0	16#00
	data[6]	Byte	16#0	16#18
	data[7]	Byte	16#0	16#00
	data[8]	Byte	16#0	16#54
	data[9]	Byte	16#0	16#45
	data[10]	Byte	16#0	16#53
	data[11]	Byte	16#0	16#54
	data[12]	Byte	16#0	16#00
	data[13]	Byte	16#0	16#00
	data[14]	Byte	16#0	16#00
	data[15]	Byte	16#0	16#00
	data[16]	Byte	16#0	16#00
	data[17]	Byte	16#0	16#00

Figure 10.43

Error PDU for the "Read/Write" sequence

Offset	Parameter	Content	Data type
0	Port Error	Error Codes detected by the Linking Module or Client	Unsigned16
2	Error code	IO-Link Error codes according to AL_Read/ AL_Write services	Unsigned8
3	Additional Code	IO-Link Error codes according to AL_Read/ AL_Write services	Unsigned8

Table 10.8

Port error of the error PDU

Coding	Port error code	Definition	Source
0x0000	No error	No error detected	Server
0x0001 to 0x06FFF	Reserved	–	–
0x7000	IOL_CALL conflict	Inconsistent Header information	Server and/or Client
0x7001	Incorrect IOL_CALL	Inconsistent Header information (send-/response)	Server and/or Client
0x7002	Port blocked	Port temporarily not available	Server
0x7003 to 0x7FFF	Reserved	–	–

2024-04

Coding	Port error code	Definition	Source
0x8000	Timeout	No correct termination of IOL_CALL (Resource Busy detection)	Client
0x8001	Invalid port number	Invalid port number or port not supported	Client and/or Server
0x8002	Invalid IOL_Index	Invalid Index	Client
0x8003	Invalid IOL_Subindex	Invalid Subindex	Client
0x8004	No Device	No device	Client
0x8005 to 0x8051	Reserved	–	–
0x8052	RDREC fault	Fault during Read record invocation	Client
0x8053	WRREC fault	Fault during Write record invocation	Client
0x8054	Unexpected Error	Unspecific Error detected	Client
0x8055	Port Function error	Port function failed	Server
0x8056	Port Function not available	Port function is not available (in this state)	Server
0x8057	Port Function not supported	Port function for this port not supported	Server
0x8058 to 0xFFFF	Manu	Manufacturer-specific	Server

Table 10.9

10.2.7 Media Redundancy Protocol (MRP)

You can create redundant PROFINET communication with the modules without the need for additional switches by using a ring topology. An MRP redundancy manager closes the ring, detects individual failures and, in the case of a fault, sends the data packets via the redundant path.

The following requirements must be met in order to use MRP:

- All devices must support MRP.
- MRP must be activated on all devices.
- The devices can only be connected via the ring ports. This means an interconnected topology cannot be used.
- A maximum of 50 devices are permitted in the ring.
- All devices must be part of the same redundancy domain.
- One device must be configured as the redundancy manager.
- All other devices must be configured as redundancy clients.
- Prioritized start-up (FSU) is not permitted.
- The watchdog time for all devices must be greater than the reconfiguration time (typically 200 ms, min. 90 ms for ICE1-* modules).
- We recommend using the automatic network setting on all devices.

The following images show a potential MRP ring configuration. The PLC is used as a redundancy manager and all other devices are used as clients. We recommend activating the diagnosis alarms to detect individual failures.

Example: Setting up an MRP client in the TIA Portal®

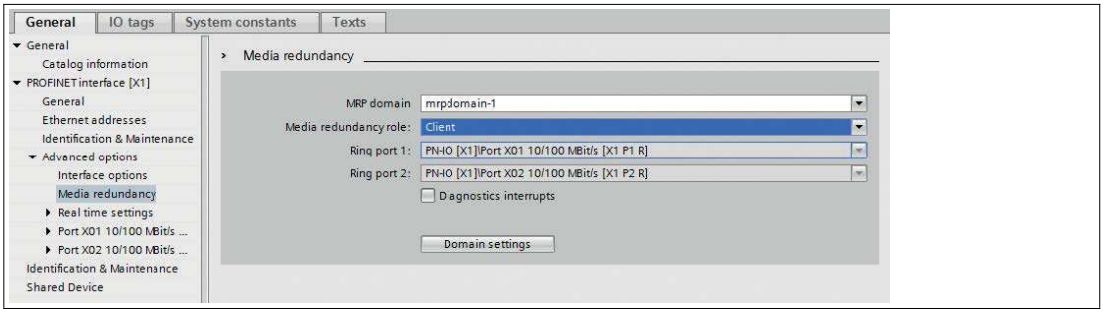


Figure 10.44

Example: Setting up Watchdog Time Monitoring in the TIA Portal® for the Use of MRP

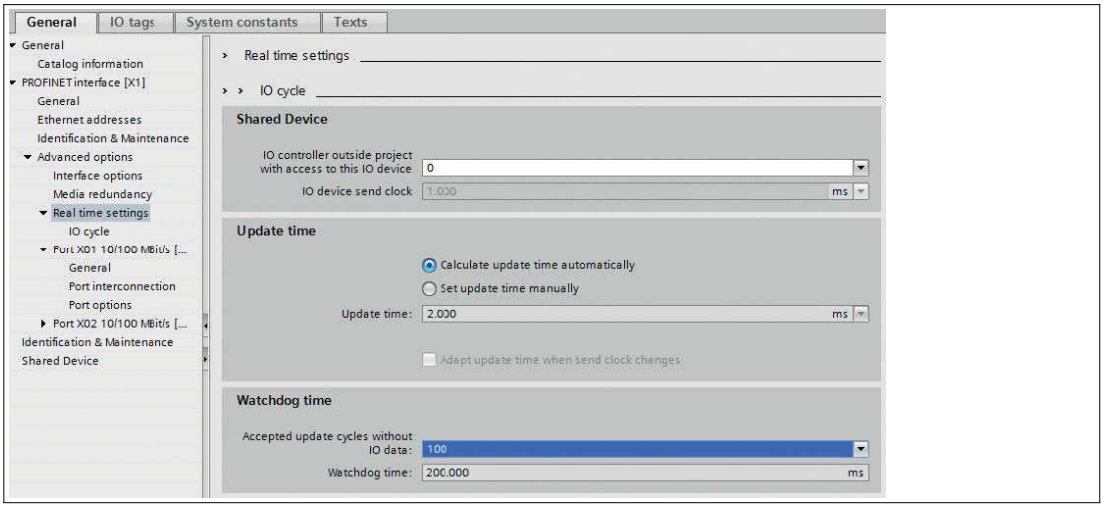


Figure 10.45

10.2.8 Replacing Devices without a Removable Medium/Programming Unit

Note

The replacement device that will be used for a replacement without a removable medium/programming unit must still have its factory settings applied. If necessary, the factory settings must be restored.

PROFINET IO devices that support the "Device replacement without removable medium or programming unit" function can be replaced by identical devices in an existing PROFINET network. In such cases, the IO controller assigns the device name. To do so, it uses the configured topology and the neighborhood relationships determined by the IO devices. The Ethernet IO modules support the device replacement function without a removable medium/programming unit.

1. Click on the PLC in slot 1 (1).
2. In the "Profinet interface_1 [Module]" area, click on "Advanced options" (2).
3. Change to the "Properties" tab (3) and click on the option to replace a device without a removable medium (4).

2024-04

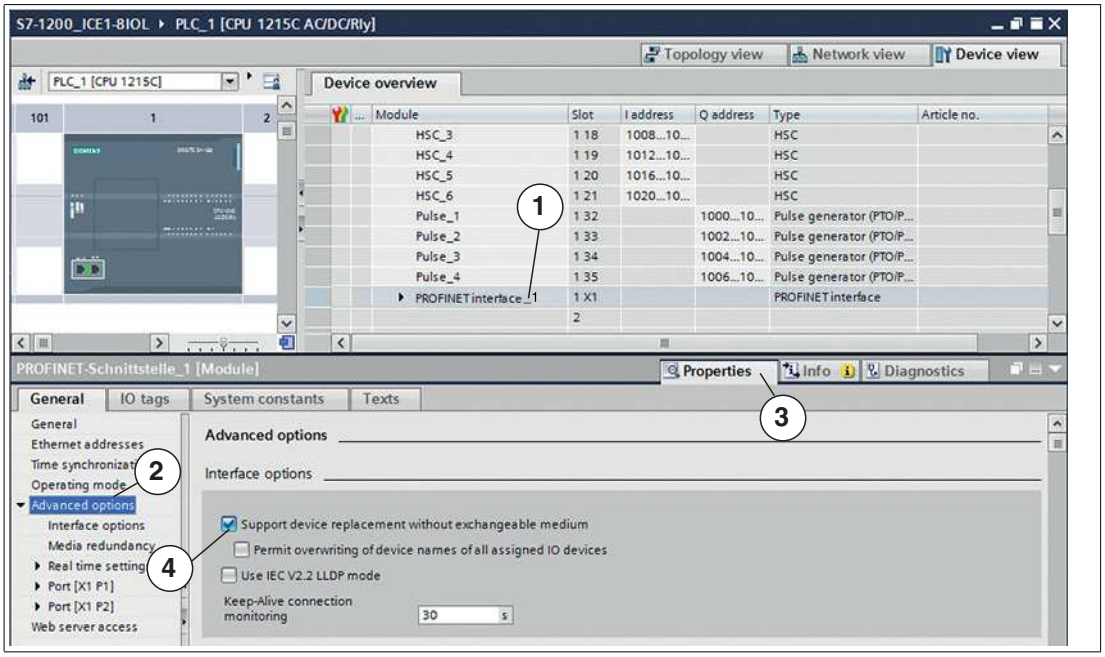


Figure 10.46

Note

A network topology is configured based on the connections between PROFINET ports on the individual devices. This can be reached via slot 0 of the PROFINET devices in use. Displaying all non-linked ports allows you to specify a suitable partner port in each case.

4. Define the network topology for the device replacement. To do so, select "Devices & networks" and "Topology view."
5. Use the mouse to drag a connection between the module and the PLC.

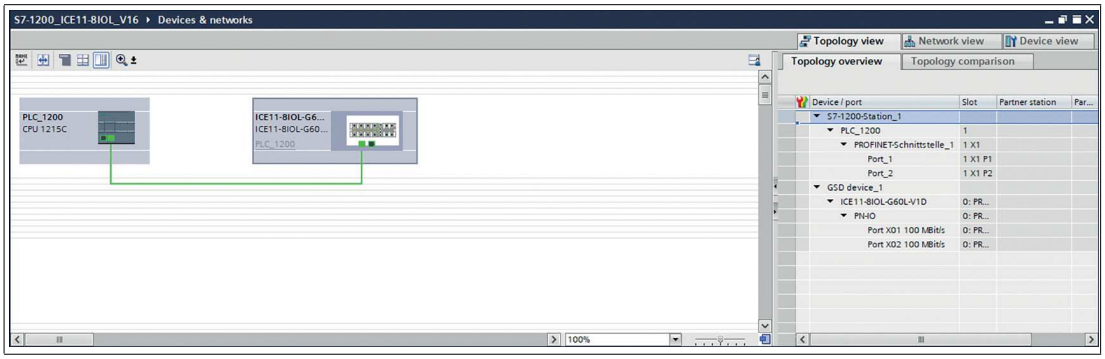


Figure 10.47

↳ The port interconnection was successful if the link is shown in the "Topology View" and on the "Partner Port."

10.2.9 Identification and Maintenance Functions (I&M)

The PROFINET IO-Link master has the ability to uniquely identify the devices installed in the system using an electronic nameplate. This device-specific data can be read acyclically at any time by the user. In addition, when the system is installed in the device, the location designation, the installation date, and further descriptions can be stored.

Supported I&M Functions

I&M Data of the PN-IO Device

To read (I&M 0–3) and write (I&M 1–3) I&M data, the corresponding hardware identifier for slot 0: PROFINET Interface X1 must be selected:

TIA Portal® hardware identifier of the PROFINET interface for I&M 0-3 RDREC/WRREC

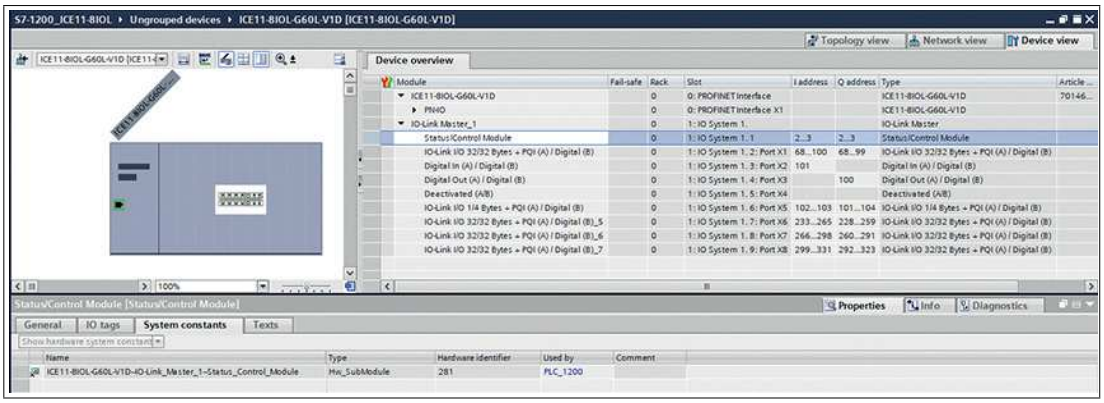


Figure 10.48

- Module-specific I&M functions
  The module-specific I&M functions can be read out (0–3) or written (1–3) via slot 0. The data records are assigned via the specified index.

I&M 0

Data object	Length [byte]	Access	Default value/description
MANUFACTURER_ID	2	Read	0x005D
ORDER_ID	20	Read	Order number of the module in ASCII
SERIAL_NUMBER	16	Read	Defined in the production process, in ASCII
HARDWARE_REVISION	2	Read	Hardware revision of the device
SOFTWARE_REVISION	4	Read	Software revision of the device
REVISION_COUNTER	2	Read	Counts each statically stored parameter change on the IO-Link master (e.g., device name or IP address)
PROFILE_ID	2	Read	0xF600 (generic device)
PROFILE_SPECIFIC_TYPE	2	Read	0x0003 (IO module)
IM_VERSION	2	Read	0x0101 (I&M version 1.1)
IM_SUPPORTED	2	Read	0x002E (I&M 1–3 & 5 are supported)

Table 10.10 I&M 0 (Slot 0: PROFINET Interface X1, Index 0xAFF0)

I&M 1

Data object	Length [byte]	Access	Default value/description
TAG_FUNCTION	32	Read/write	0x20 et seq. (empty)
TAG_LOCATION	22	Read/write	0x20 et seq. (empty)

Table 10.11 I&M 1 (Slot 0: PROFINET Interface X1, Index 0xAFF1)

I&M 2

Data object	Length [byte]	Access	Default value/description
INSTALLATION_DATE	16	Read/write	0x20 et seq. (empty) The supported data format is a visible character string with a fixed length of 16 bytes; "YYYY-MM-DD hh:mm" or "YYYY-MM-DD" filled with spaces

Table 10.12 I&M 2 (Slot 0: PROFINET Interface X1, Index 0xAFF2)

I&M 3

Data object	Length [byte]	Access	Default value/description
DESCRIPTOR	54	Read/write	0x20 et seq. (empty)

Table 10.13 I&M 3 (Slot 0: PROFINET Interface X1, Index 0xAFF3)

I&M Data of the IOL Master Proxy[ad]

To read I&M 0 data, the corresponding hardware identifier for slot 1: IO system 1.1 must be selected:

Hardware identifier of the status/control module for RDREC "IO System 1"

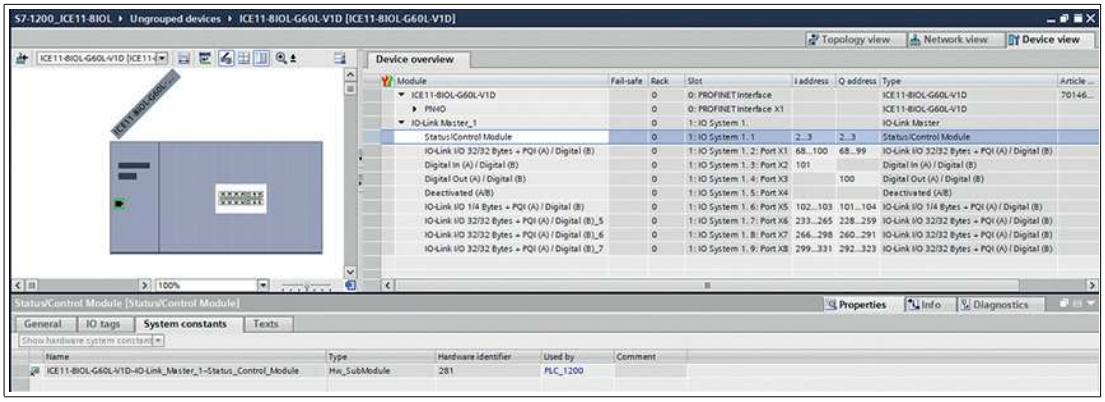


Figure 10.49

I&M 0

Data object	Length [byte]	Access	Default value/description
MANUFACTURER_ID	2	Read	0x005D
ORDER_ID	20	Read	Order number of the module in ASCII
SERIAL_NUMBER	16	Read	Defined in the production process, in ASCII
HARDWARE_REVISION	2	Read	Hardware revision of the device
SOFTWARE_REVISION	4	Read	Software revision of the device
REVISION_COUNTER	2	Read	Counts each statically stored parameter change on the IO-Link master (e.g., device name or IP address)
PROFILE_ID	2	Read	0xF600 (generic device)
PROFILE_SPECIFIC_TYPE	2	Read	0x0003 (IO module)

ad.Status/control module

Data object	Length [byte]	Access	Default value/description
IM_VERSION	2	Read	0x0101 (I&M version 1.1)
IM_SUPPORTED	2	Read	0x0000

Table 10.14 I&M 0 (slot 0, index 0xAFF0)

I&M Functions of the IO-Link Device

IO-Link device-specific I&M 0 and I&M 5 data can be read out via slot 1 and the associated sub-slot 1[ae] . The data records are assigned via the specified index. Data not equal to zero is only received if a connection to an IO-Link device could be established.

Hardware identifier of the status/control module for RDREC "IO System 1.2"

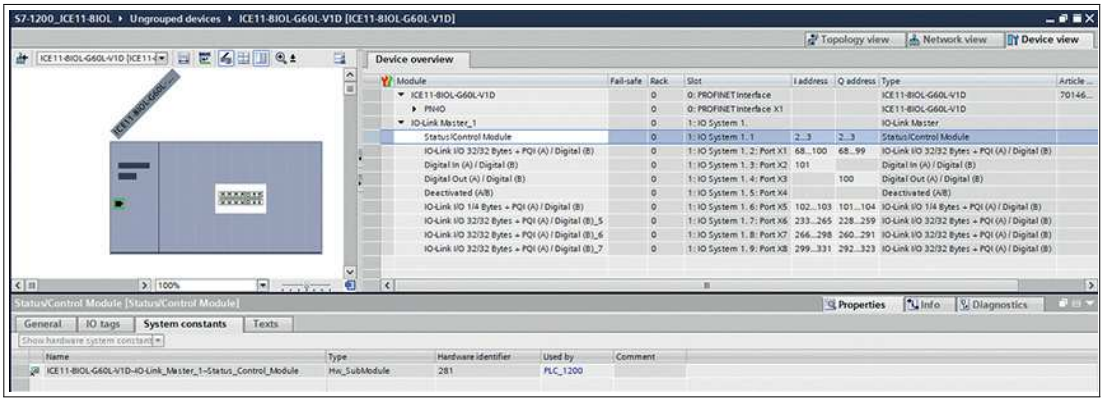


Figure 10.50

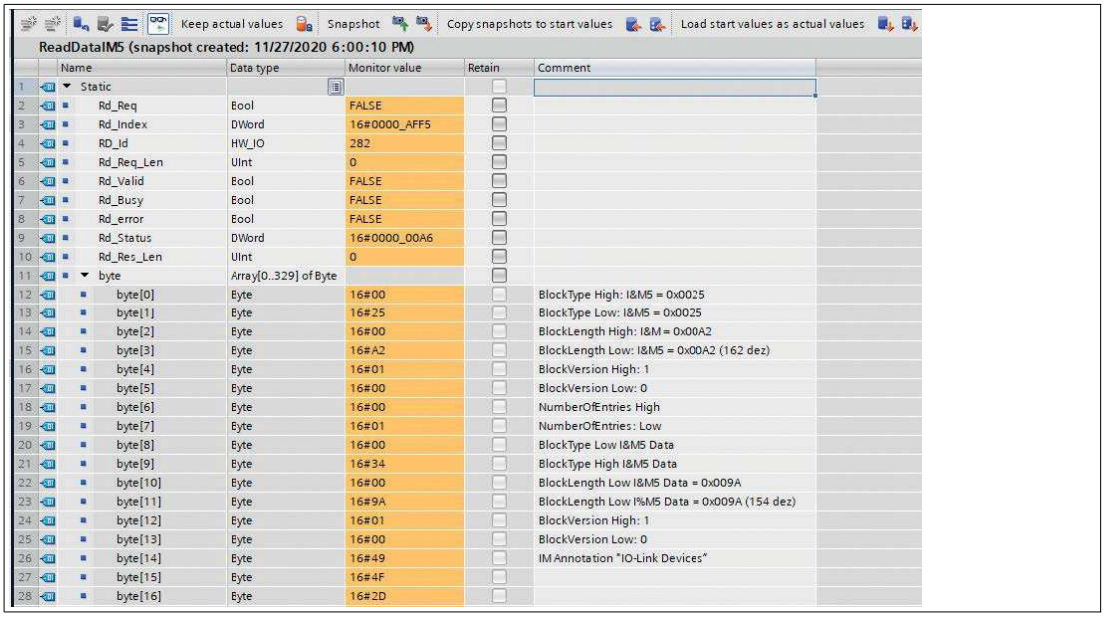
I&M 0

I&M 0 data	Octets	Data type	Mapping rule
VendorID	2	Unsigned16	IO-Link Direct parameter page 1: VendorID. Direct mapping, for example "0x136". Exceptions: 1 → 93; 26 → 257; 87 → 467.
OrderID	20	Visible String	"Product Name" or "DeviceID"
IM_Serial_Number	16	Visible String	Insert SerialNumber of Device (IO-Link Index 21). If it is not available, set to "Not accessible"
IM_Hardware_Revision	2	Unsigned8	Set to 0x0000 (default value)
IM_Software_Revision	4	Char,3 x Unsigned8	Set to V0.0.0 (official release but not detectable)
IM_RevisionCounter	2	Unsigned16	Set to "0" (0x0000)
IM_Profile_ID	2	Unsigned16	IO-Link (API = 0x4E01)
IM_Profile_Specific_Type	2	Unsigned16	Set to "0" (0x0000)
IM_Version	2	2 x Unsigned8	Octet 1 (MSB): set to 0x01 Octet 2 (LSB): set to 0x00
IM_Supported	2	Unsigned16 (Bit Array)	Profile specific I&M: 0x0000 (Bit 0 for I&M0 is always 0)

Table 10.15 I&M 0 (Slot 1: IO System 1.2–1.9, Index 0xAFF0)

ae.1.2/Port X1 – 1.9/Port X8

"Read" example I&M5 on port X1 with connected IOL device



	Name	Data type	Monitor value	Retain	Comment
1	Static				
2	Rd_Req	Bool	FALSE		
3	Rd_Index	DWord	16#0000_AFF5		
4	RD_Id	HW_IO	282		
5	Rd_Req_Len	UInt	0		
6	Rd_Valid	Bool	FALSE		
7	Rd_Busy	Bool	FALSE		
8	Rd_error	Bool	FALSE		
9	Rd_Status	DWord	16#0000_00A6		
10	Rd_Res_Len	UInt	0		
11	byte	Array[0..329] of Byte			
12	byte[0]	Byte	16#00		BlockType High: I&M5 = 0x0025
13	byte[1]	Byte	16#25		BlockType Low: I&M5 = 0x0025
14	byte[2]	Byte	16#00		BlockLength High: I&M = 0x00A2
15	byte[3]	Byte	16#A2		BlockLength Low: I&M5 = 0x00A2 (162 dez)
16	byte[4]	Byte	16#01		BlockVersion High: 1
17	byte[5]	Byte	16#00		BlockVersion Low: 0
18	byte[6]	Byte	16#00		NumberOfEntries High
19	byte[7]	Byte	16#01		NumberOfEntries: Low
20	byte[8]	Byte	16#00		BlockType Low I&M5 Data
21	byte[9]	Byte	16#34		BlockType High I&M5 Data
22	byte[10]	Byte	16#00		BlockLength Low I&M5 Data = 0x009A
23	byte[11]	Byte	16#9A		BlockLength Low I%M5 Data = 0x009A (154 dez)
24	byte[12]	Byte	16#01		BlockVersion High: 1
25	byte[13]	Byte	16#00		BlockVersion Low: 0
26	byte[14]	Byte	16#49		IM Annotation "IO-Link Devices"
27	byte[15]	Byte	16#4F		
28	byte[16]	Byte	16#2D		

Figure 10.51

I&M 5

I&M 5 data	Octets	Data type	Mapping rule
IM_Annotation	64	String (UTF8)	"IO-Link Devices"
IM_OrderID	64	Visible String	"Product Name" or "DeviceID"
IM_VendorID	2	Unsigned16	"VendorID"
IM_Serial_Number	16	Visible String	Insert SerialNumber of device (IO-Link Index 21). If it is not available, set to "Not accessible".
IM_Hardware_Revision	2	Unsigned8	Set to 0x0000 (default value)
IM_Software_Revision	4	Char,3 x Unsigned8	Set to V0.0.0 (official release but not detectable)

Table 10.16 I&M 5 (Slot 1: IO System 1.2–1.9, Index 0xAFF5)

Reading and Writing I&M Data

In its standard library, SIEMENS TIA Portal® offers system function blocks with which I&M data can be read and written. A data record contains a BlockHeader of 6 bytes and the I&M record.

The data requested when reading or the data to be written therefore begins only following the existing header. The content of the header must also be taken into account when writing.

- To read I&M 0–3, the "RDREC block" must be configured with `LEN = 6 Byte Block Header + I&M data length`.
- To read I&M 5, the "RDREC block" must be configured with `LEN = 6 Byte Block Header + 8 Byte I&M + I&M data length`.

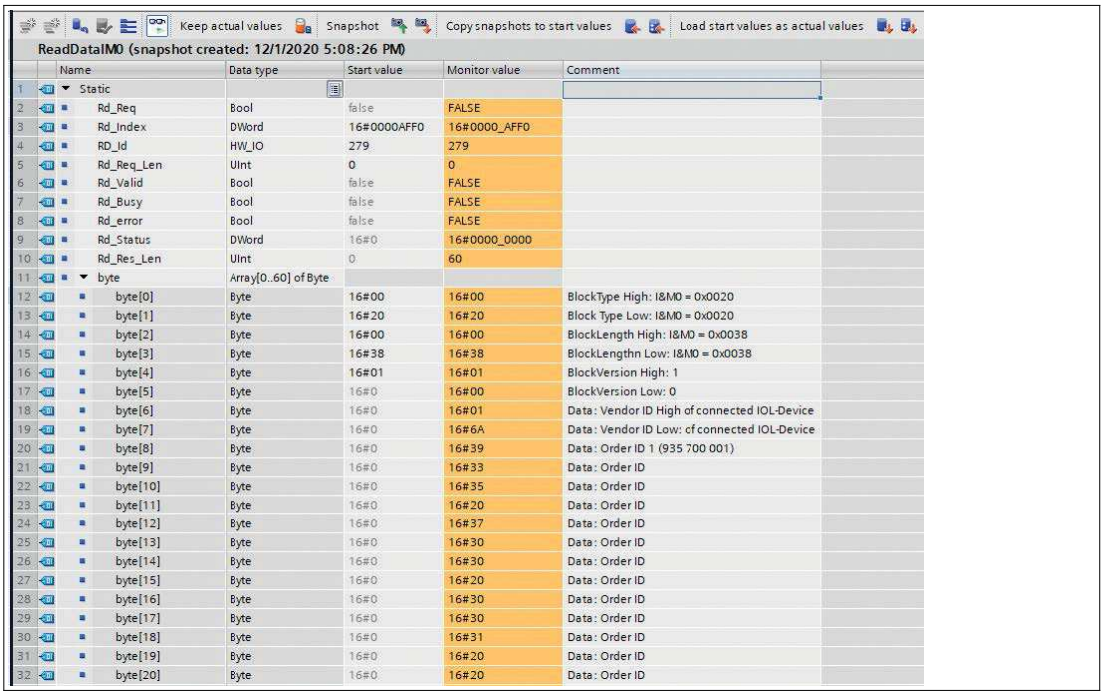
Data object	Length [byte]	Data type	Coding	Description
BlockType	2	Word	I&M 0: 0x0020 I&M 1: 0x0021 I&M 2: 0x0022 I&M 3: 0x0023 I&M 5: 0x0025	BlockHeader
BlockLength	2	Word	I&M 0: 0x0038 I&M 1: 0x0038 I&M 2: 0x0012 I&M 3: 0x0038 I&M 5: 0x0098	
BlockVersionHigh	1	Byte	0x01	
BlockVersionLow	1	Byte	0x00	
I&M data	I&M 0: 54 I&M 1: 54 I&M 2: 16 I&M 3: 54 I&M 5: 152	Byte		I&M record

Table 10.17 Data record with BlockHeader and I&M record

Reading I&M Records

I&M data can be read in the Siemens PLC using the standard RDREC function block (SFB52). The logical address of the slot/sub-slot (ID) and the I&M index (INDEX) must be used as handover parameters. Return parameters report the length of the received I&M data and a status or error message.

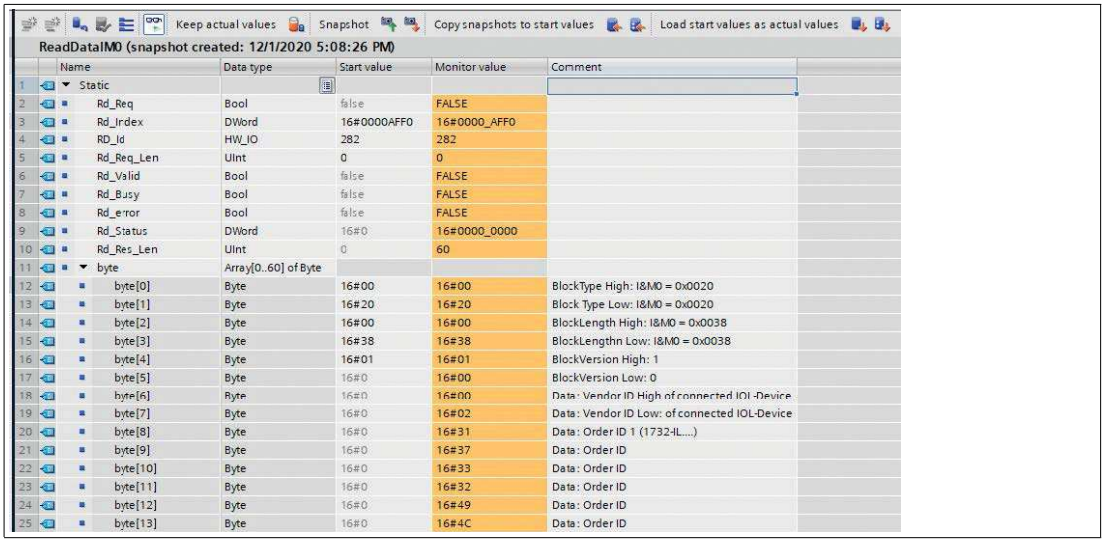
Example: "Read" I&M0 of the PROFINET IO device



	Name	Data type	Start value	Monitor value	Comment
1	Static				
2	Rd_Req	Bool	false	FALSE	
3	Rd_Index	DWord	16#0000AFF0	16#0000_AFF0	
4	RD_Id	HW_IO	279	279	
5	Rd_Req_Len	UInt	0	0	
6	Rd_Valid	Bool	false	FALSE	
7	Rd_Busy	Bool	false	FALSE	
8	Rd_error	Bool	false	FALSE	
9	Rd_Status	DWord	16#0	16#0000_0000	
10	Rd_Res_Len	UInt	0	60	
11	byte	Array[0..60] of Byte			
12	byte[0]	Byte	16#00	16#00	BlockType High: I&M0 = 0x0020
13	byte[1]	Byte	16#20	16#20	Block Type Low: I&M0 = 0x0020
14	byte[2]	Byte	16#00	16#00	BlockLength High: I&M0 = 0x0038
15	byte[3]	Byte	16#38	16#38	BlockLengthn Low: I&M0 = 0x0038
16	byte[4]	Byte	16#01	16#01	BlockVersion High: 1
17	byte[5]	Byte	16#0	16#00	BlockVersion Low: 0
18	byte[6]	Byte	16#0	16#01	Data: Vendor ID High of connected IOL-Device
19	byte[7]	Byte	16#0	16#6A	Data: Vendor ID Low: cf connected IOL-Device
20	byte[8]	Byte	16#0	16#39	Data: Order ID 1 (935 700 001)
21	byte[9]	Byte	16#0	16#33	Data: Order ID
22	byte[10]	Byte	16#0	16#35	Data: Order ID
23	byte[11]	Byte	16#0	16#20	Data: Order ID
24	byte[12]	Byte	16#0	16#37	Data: Order ID
25	byte[13]	Byte	16#0	16#30	Data: Order ID
26	byte[14]	Byte	16#0	16#30	Data: Order ID
27	byte[15]	Byte	16#0	16#20	Data: Order ID
28	byte[16]	Byte	16#0	16#30	Data: Order ID
29	byte[17]	Byte	16#0	16#30	Data: Order ID
30	byte[18]	Byte	16#0	16#31	Data: Order ID
31	byte[19]	Byte	16#0	16#20	Data: Order ID
32	byte[20]	Byte	16#0	16#20	Data: Order ID

Figure 10.52

Example: "Read" I&M0 at port X1 with connected IOL device



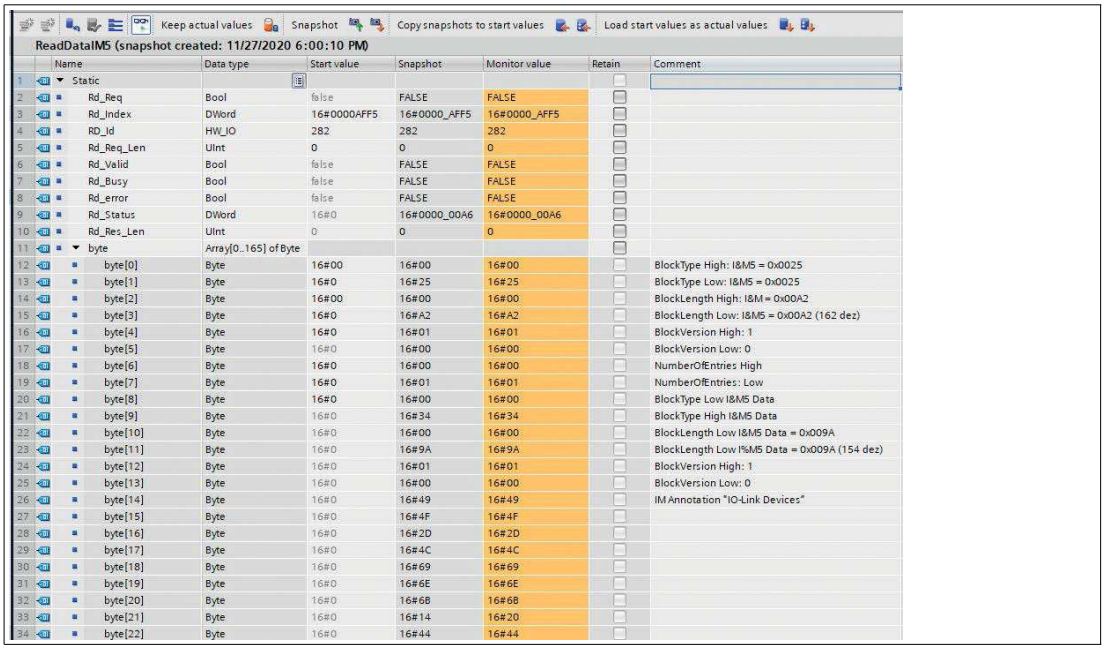
Keep actual values | Snapshot | Copy snapshots to start values | Load start values as actual values

ReadDataIM0 (snapshot created: 12/1/2020 5:08:26 PM)

	Name	Data type	Start value	Monitor value	Comment
1	Static				
2	Rd_Req	Bool	false	FALSE	
3	Rd_Irdex	DWord	16#0000AFF0	16#0000_AFF0	
4	RD_Id	HW_IO	282	282	
5	Rd_Req_Len	UInt	0	0	
6	Rd_Valid	Bool	false	FALSE	
7	Rd_Busy	Bool	false	FALSE	
8	Rd_error	Bool	false	FALSE	
9	Rd_Status	DWord	16#0	16#0000_0000	
10	Rd_Res_Len	UInt	0	60	
11	byte	Array[0..60] of Byte			
12	byte[0]	Byte	16#00	16#00	BlockType High: I&M0 = 0x0020
13	byte[1]	Byte	16#20	16#20	Block Type Low: I&M0 = 0x0020
14	byte[2]	Byte	16#00	16#00	BlockLength High: I&M0 = 0x0038
15	byte[3]	Byte	16#38	16#38	BlockLengthn Low: I&M0 = 0x0038
16	byte[4]	Byte	16#01	16#01	BlockVersion High: 1
17	byte[5]	Byte	16#0	16#00	BlockVersion Low: 0
18	byte[6]	Byte	16#0	16#00	Data: Vendor ID High of connected IOL-Device
19	byte[7]	Byte	16#0	16#02	Data: Vendor ID Low: of connected IOL-Device
20	byte[8]	Byte	16#0	16#31	Data: Order ID 1 (1732-IL....)
21	byte[9]	Byte	16#0	16#37	Data: Order ID
22	byte[10]	Byte	16#0	16#33	Data: Order ID
23	byte[11]	Byte	16#0	16#32	Data: Order ID
24	byte[12]	Byte	16#0	16#49	Data: Order ID
25	byte[13]	Byte	16#0	16#4C	Data: Order ID

Figure 10.53

Example: "Read" I&M5 at port X1 with connected IOL device



Keep actual values | Snapshot | Copy snapshots to start values | Load start values as actual values

ReadDataIM5 (snapshot created: 11/27/2020 6:00:10 PM)

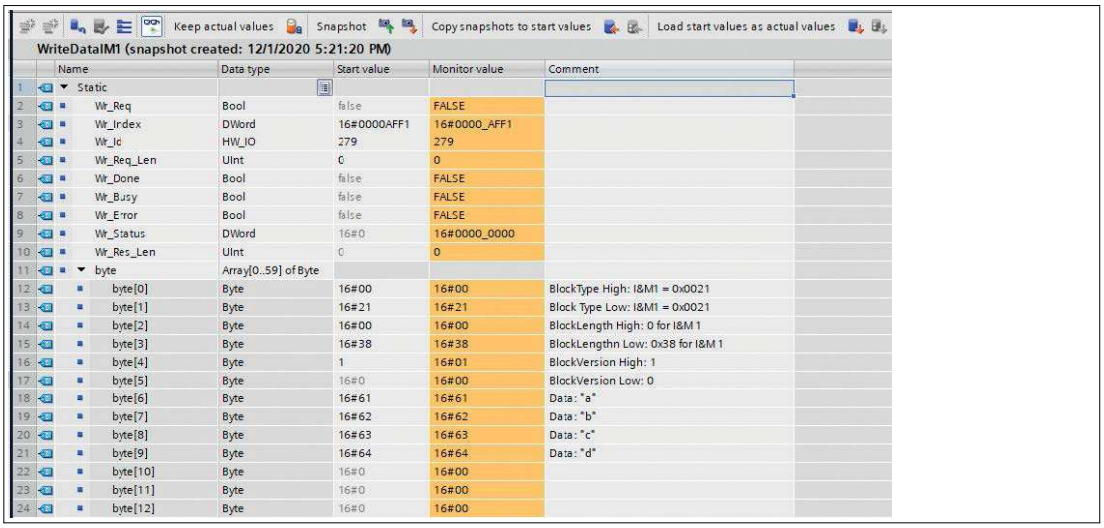
	Name	Data type	Start value	Snapshot	Monitor value	Retain	Comment
1	Static						
2	Rd_Req	Bool	false	FALSE	FALSE		
3	Rd_Index	DWord	16#0000AFF5	16#0000_AFF5	16#0000_AFF5		
4	RD_Id	HW_IO	282	282	282		
5	Rd_Req_Len	UInt	0	0	0		
6	Rd_Valid	Bool	false	FALSE	FALSE		
7	Rd_Busy	Bool	false	FALSE	FALSE		
8	Rd_error	Bool	false	FALSE	FALSE		
9	Rd_Status	DWord	16#0	16#0000_00A6	16#0000_00A6		
10	Rd_Res_Len	UInt	0	0	0		
11	byte	Array[0..165] of Byte					
12	byte[0]	Byte	16#00	16#00	16#00		BlockType High: I&M5 = 0x0025
13	byte[1]	Byte	16#0	16#25	16#25		BlockType Low: I&M5 = 0x0025
14	byte[2]	Byte	16#00	16#00	16#00		BlockLength High: I&M = 0x00A2
15	byte[3]	Byte	16#0	16#A2	16#A2		BlockLength Low: I&M5 = 0x00A2 (162 dez)
16	byte[4]	Byte	16#0	16#01	16#01		BlockVersion High: 1
17	byte[5]	Byte	16#0	16#00	16#00		BlockVersion Low: 0
18	byte[6]	Byte	16#0	16#00	16#00		NumberOfEntries High
19	byte[7]	Byte	16#0	16#01	16#01		NumberOfEntries: Low
20	byte[8]	Byte	16#0	16#00	16#00		BlockType Low I&M5 Data
21	byte[9]	Byte	16#0	16#34	16#34		BlockType High I&M5 Data
22	byte[10]	Byte	16#0	16#00	16#00		BlockLength Low I&M5 Data = 0x009A
23	byte[11]	Byte	16#0	16#9A	16#9A		BlockLength Low I%M5 Data = 0x009A (154 dez)
24	byte[12]	Byte	16#0	16#01	16#01		BlockVersion High: 1
25	byte[13]	Byte	16#0	16#00	16#00		BlockVersion Low: 0
26	byte[14]	Byte	16#0	16#49	16#49		IM Annotation "IO-Link Devices"
27	byte[15]	Byte	16#0	16#4F	16#4F		
28	byte[16]	Byte	16#0	16#2D	16#2D		
29	byte[17]	Byte	16#0	16#4C	16#4C		
30	byte[18]	Byte	16#0	16#69	16#69		
31	byte[19]	Byte	16#0	16#6E	16#6E		
32	byte[20]	Byte	16#0	16#6B	16#6B		
33	byte[21]	Byte	16#0	16#14	16#20		
34	byte[22]	Byte	16#0	16#44	16#44		

Figure 10.54

Writing I&M Records

I&M data can be written in the Siemens PLC using the standard WRREC function block (SFB53). The logical address of the slot/sub-slot (ID), the I&M index (INDEX), and the data length (LEN) must be used as handover parameters. Return parameters report a status or error message.

Example: Completed I&M1 write operation of a PROFINET IO device



	Name	Data type	Start value	Monitor value	Comment
1	Static				
2	Wr_Req	Bool	false	FALSE	
3	Wr_Index	DWord	16#0000AFF1	16#0000_AFF1	
4	Wr_Id	HW_IO	279	279	
5	Wr_Req_Len	UInt	0	0	
6	Wr_Done	Bool	false	FALSE	
7	Wr_Busy	Bool	false	FALSE	
8	Wr_Error	Bool	false	FALSE	
9	Wr_Status	DWord	16#0	16#0000_0000	
10	Wr_Res_Len	UInt	0	0	
11	byte	Array[0..59] of Byte			
12	byte[0]	Byte	16#00	16#00	BlockType High: I&M1 = 0x0021
13	byte[1]	Byte	16#21	16#21	Block Type Low: I&M1 = 0x0021
14	byte[2]	Byte	16#00	16#00	BlockLength High: 0 for I&M 1
15	byte[3]	Byte	16#38	16#38	BlockLengthn Low: 0x38 for I&M 1
16	byte[4]	Byte	1	16#01	BlockVersion High: 1
17	byte[5]	Byte	16#0	16#00	BlockVersion Low: 0
18	byte[6]	Byte	16#61	16#61	Data: "a"
19	byte[7]	Byte	16#62	16#62	Data: "b"
20	byte[8]	Byte	16#63	16#63	Data: "c"
21	byte[9]	Byte	16#64	16#64	Data: "d"
22	byte[10]	Byte	16#0	16#00	
23	byte[11]	Byte	16#0	16#00	
24	byte[12]	Byte	16#0	16#00	

Figure 10.55

10.2.10 Prioritized Start-Up/Fast Start-Up (FSU)

Devices with Fast Start-Up (FSU) function support optimized system start-up. This ensures faster restarting after the power supply is restored.

Fast Start-Up can be activated using PROFINET interface [X1] > Advanced options > Interface options (PROFINET interface [X1] > Advanced options > Interface options) via Prioritized Start-up (Prioritized Start).

1. Select "Device view" and the desired module.
2. Then, in the "General" tab, select the "Advanced Options" area.
3. Click on the "Prioritized startup" option to enable prioritized start-up.

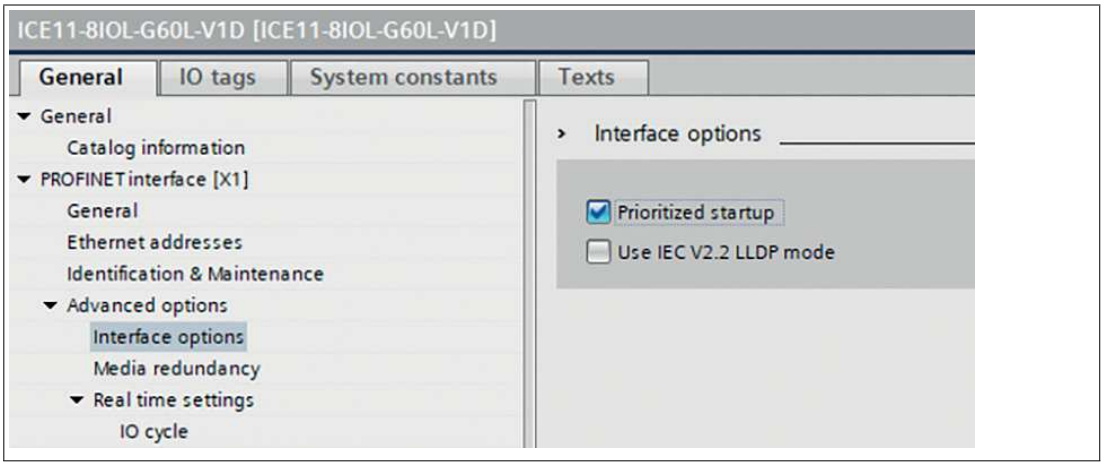


Figure 10.56

2024-04

For better FSU performance, the transfer settings of connectors X01 and X02 should be set as follows:

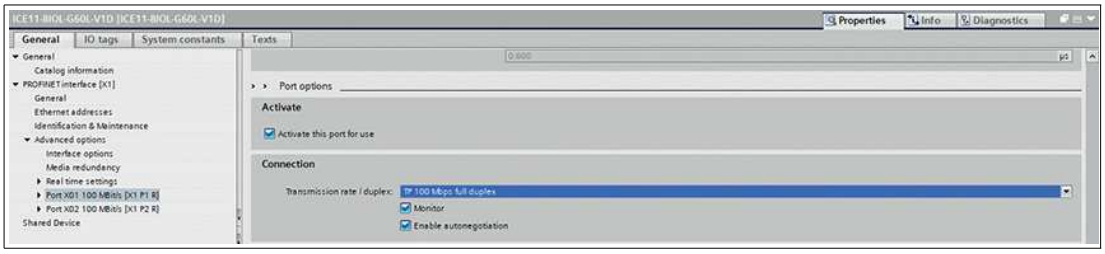


Figure 10.57

Note

The settings for the local and partner ports must be identical.

Measured booting times

PROFINET FSU time[af]: < 2200 ms

Start time with FSU enabled[ag]: ~2400 ms

Start time without FSU enabled[ag]: ~5400 ms

10.2.11 "Suspend/Resume" of the IO-Link Port Control

Use Case of the Automatic Tool Change Function

Depending on the status of a production process, a tool change is necessary within a machine, which is usually carried out by disconnecting a specific tool such as a gripper and by subsequently connecting another tool. This connecting and disconnecting includes mechanical connections and electrical connections for power supply and communication.

With the following IO-Link calls (e.g., via a Siemens FB50001),

- Suspend port operation
- Resume port operation

the IO-Link port control can be changed dynamically during cyclic data exchange.

Concept

The basic concept of the "Suspend Port operation" user function is to suppress all PROFINET error messages to the system/user, as the action is intended. Essentially, after the interruption, all pending diagnostic messages of the relevant port and device are deleted.

The current port status can always be viewed by the user via the "PortActive" flag bit in the "Port Qualifier Information - PQI". Three types of activities characterize these port operations:

- Automatic Port Operation
- Suspend Port operation
- Resume Port operation

af.Measured according to specification: Internal switch is ready to send telegrams.

ag.The PLC reads out a digital input and sets a digital output on the IO-Link master after the DUT (IO-Link master) is started up. The PLC is directly connected to DUT port X01, without any further switch between the PLC and DUT.

Automatic Port Operation

The following actions automatically set a port to the status "Port operation resumed", indicated by the flag bit "PortActive" = 1:

- Switching on the power supply of the IO-Link node or IO-Link master
- Configuration changes to the IOL master port
- The port configuration mode is set to Digital Input or Digital Output

Suspend/Resume Port Operation

Suspend/Resume Port Operation

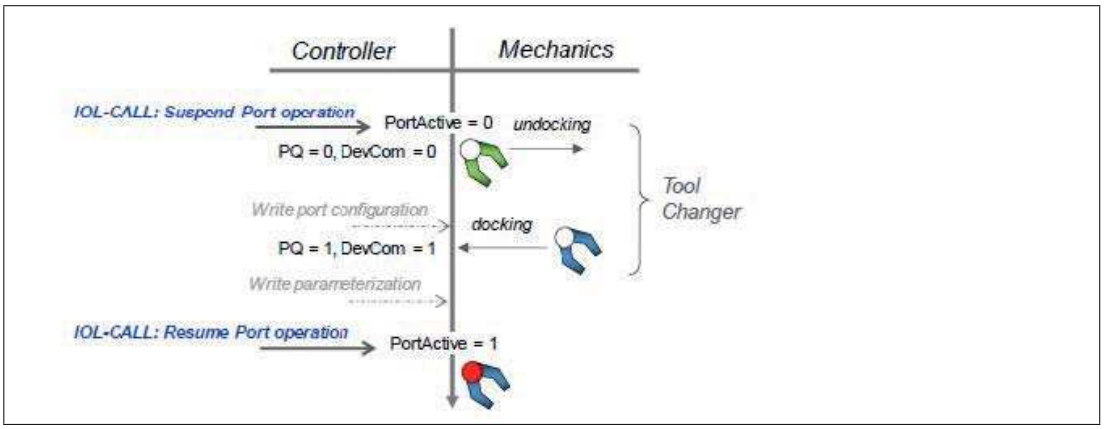


Figure 10.58

Visualization of the following actions:

- Successful "Suspended Port operation" results in the flag bit display "PortActive" = 0 and "DevErr" = 0
- Disconnecting the tool/device results in the flag bit display "PQ" = 0 and "DevCom" = 0
- Connecting a "new" tool/device leads to the flag bit display "PQ" = 1 and "DevCom" = 1
- Successful "Resumed Port operation" results in the flag bit display "PortActive" = 1

Use Cases

Use case	Inspection level (backup & restore)	Description
No. 1: A device is replaced by a device of the same type with identical parameters.	0: No device check 1: Type-compatible device (V1.0) 2: Type-compatible device (V1.1) 3: Type-compatible device (V1.1) with "Backup & Restore" 4: Type-compatible device (V1.1) with "Restore"	In use case no. 1, all inspection levels are permitted. Recommended: Type-compatible device (V1.1) with "Backup & Restore"
No. 2: A device is replaced by a device of the same type with different parameters.	0: No device check 1: Type-compatible device (V1.0) 2: Type-compatible device (V1.1)	"Backup & Restore" does not make sense in use case no. 2. Recommended: Type-compatible device (V1.0 or V1.1)
No. 3: A device is replaced by a device of a different type.	0: No device check 1: Type-compatible device (V1.0) 2: Type-compatible device (V1.1)	"Backup & Restore" does not make sense in use case no. 3. Recommended: Type-compatible device (V1.0 or V1.1) D

- The port configuration can be adjusted in the "Port operation suspended" state (use case no. 3).
- In addition, after active communication (DevCom =1), the device parametrization can be adjusted via the control program (use case no. 2).
- Especially for use cases no. 2 and no. 3, using the "Backup & Restore" feature for better visibility and startup performance is recommended

2024-04

"Suspend and Resume" Cycle

For a complete "Suspend and Resume" cycle, execute the following "Read" and "Write" requests one after the other.

After writing the "Suspend" or "Resume" commands, verify the successful execution of the command using the associated "Read" request.

Write Record Suspend – Port command

The following example shows how to suspend an IO-Link port operation using the TIA WRREC function block:

ID = 0

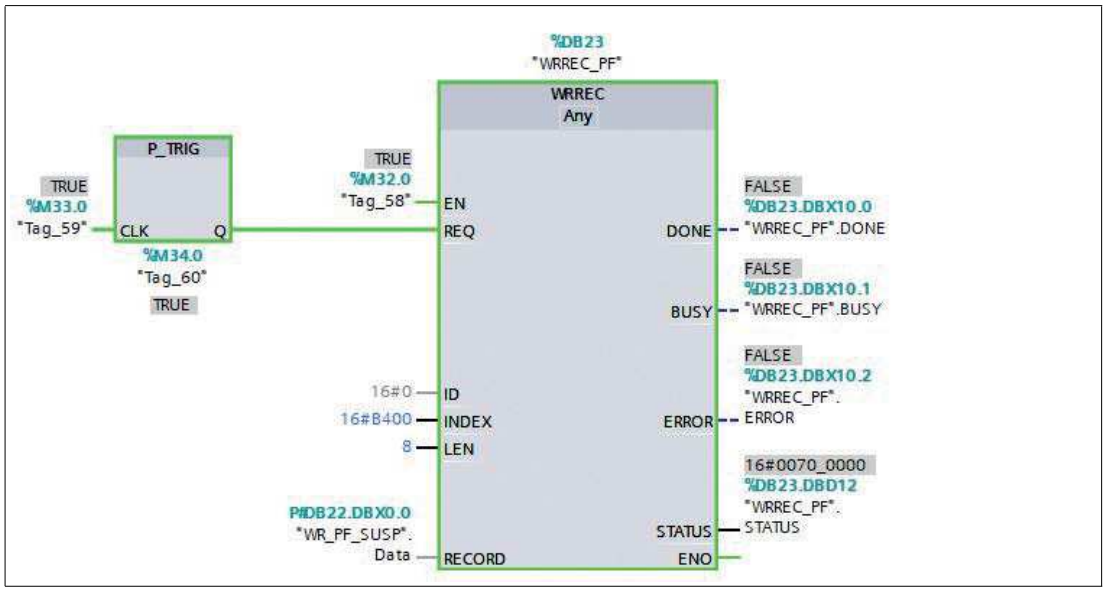


Figure 10.59 ID = 0 to address the IO-Link master proxy
INDEX = 0xB400
LEN = 8 bytes for commands

WRREC Data

		Name	Data type	Offset	Start value	Comment
1		Static				
2		Data	Array[0..59] of Byte	0.0		
3		Data[0]	Byte	0.0	16#8	Call Header
4		Data[1]	Byte	1.0	16#1	Port Number (1... 8)
5		Data[2]	Byte	2.0	16#FE	Call Fixed
6		Data[3]	Byte	3.0	16#4A	Call Fixed
7		Data[4]	Byte	4.0	16#02	Call Write
8		Data[5]	Byte	5.0	16#FF	Index Port Command
9		Data[6]	Byte	6.0	16#FF	Index Port Command
10		Data[7]	Byte	7.0	16#3	Command Suspend

Figure 10.60

Read Record Suspend – Port status

Use this request to verify that the previous writing of the "Suspend" port command was successful.

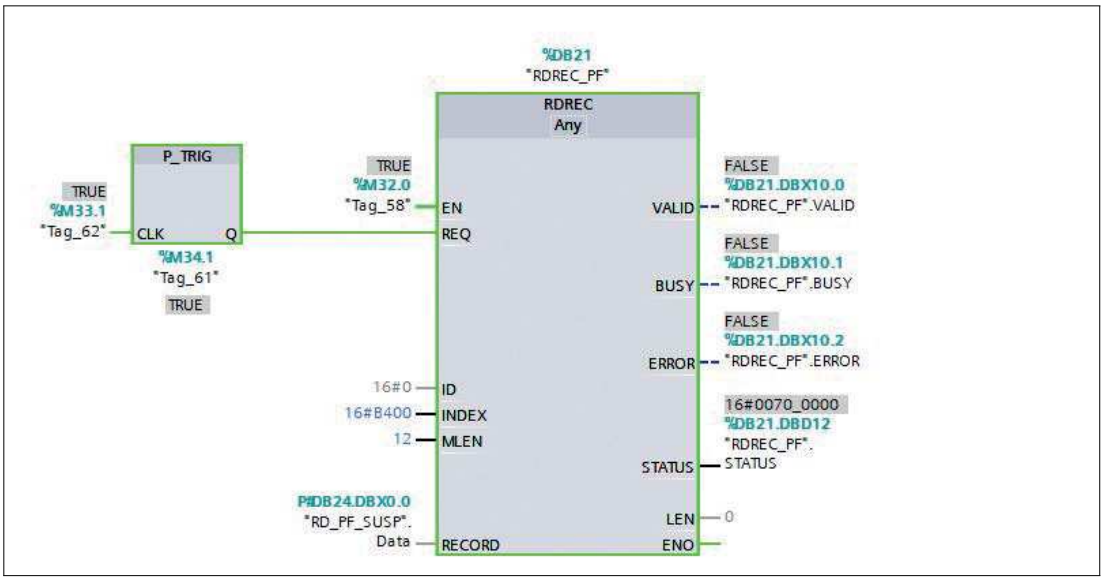


Figure 10.61

ID = 0 to address the IO-Link master proxy

INDEX = 0xB400

LEN = 12 bytes, 8 bytes for commands + 4 bytes for the error PDU

If the "Suspend" port command was successful, the read data looks as follows:

	Name	Data type	Offset	Start value	Monitor value	Comment
1	Static					
2	Data	Array[0..11] of Byte	0.0			
3	Data[0]	Byte	0.0	16#0	16#08	Call Header
4	Data[1]	Byte	1.0	16#0	16#01	Port Number (1..8)
5	Data[2]	Byte	2.0	16#0	16#FE	Call Fixed
6	Data[3]	Byte	3.0	16#0	16#4A	Call Fixed
7	Data[4]	Byte	4.0	16#0	16#00	Status 0x00 = OK, 0x80 = Error PDU
8	Data[5]	Byte	5.0	16#0	16#FF	Index Port Command
9	Data[6]	Byte	6.0	16#0	16#FF	Index Port Command
10	Data[7]	Byte	7.0	16#0	16#03	Command Suspend
11	Data[8]	Byte	8.0	16#0	16#00	Error PDU
12	Data[9]	Byte	9.0	16#0	16#00	Error PDU
13	Data[10]	Byte	10.0	16#0	16#00	SMI Job Error
14	Data[11]	Byte	11.0	16#0	16#00	SMI Job Error

Figure 10.62

The IO-Link device can now be disconnected.

If the "Suspend" process has not yet been completed before the "Read Record" has arrived at the IO-Link master, a negative PROFINET response with the code "Resource busy – 0x80C2" is sent.

Possible Error PDU Codes

NO_ERROR	0x0000
IOL_CALL_CONFLICT	0x7000
INCORRECT_IOL_CALL	0x7001
PORT_BLOCKED	0x7002
TIMEOUT	0x8000
INVALID_PORT_NUMBER	0x8001
INVALID_IOL_INDEX	0x8002
INVALID_IOL_SUBINDEX	0x8003

NO_DEVICE	0x8004
DECODE_ERROR	0x8051
RDREC_FAULT	0x8052
WREC_FAULT	0x8053
UNEXPECTED_ERROR_SEQ	0x8054
FUNCTION_ERROR	0x8055
FUNCTION_NOT_AVAILABLE	0x8056
FUNCTION_NOT_SUPPORTED	0x8057

Write Record Resume – Port command

The following example shows how an IO-Link port operation can be resumed with the TIA WRREC function block after the IO-Link node has been successfully connected:

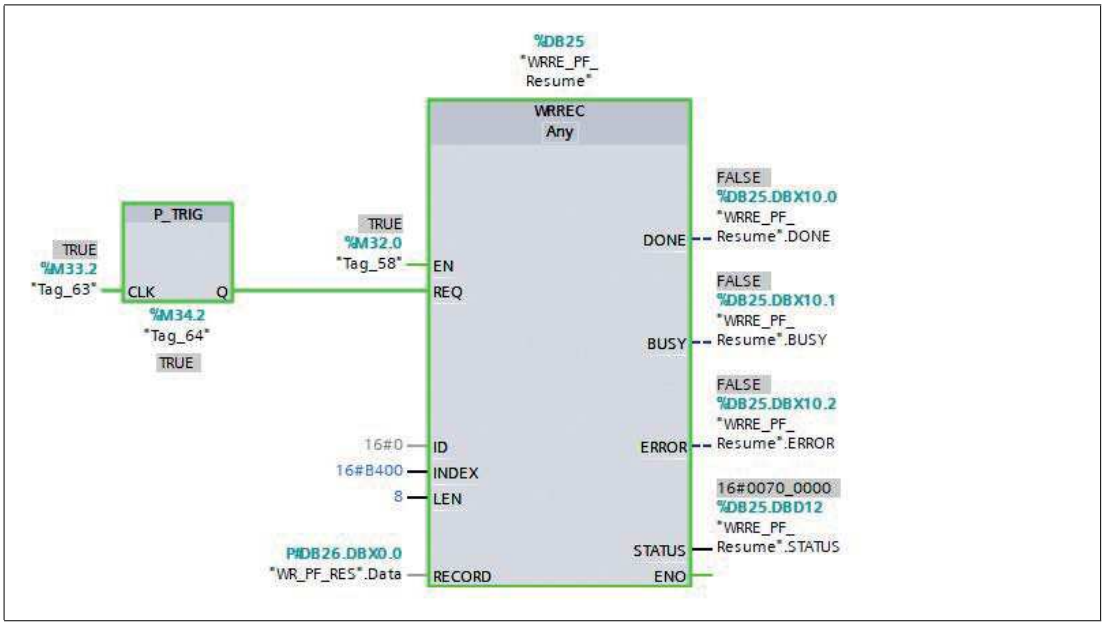


Figure 10.63

WRREC Data

		Name	Data type	Offset	Start value	Comment
1		Static				
2		Data	Array[0..31] of Byte	0.0		
3		Data[0]	Byte	0.0	16#8	Call Header
4		Data[1]	Byte	1.0	16#1	Port Number (1...8)
5		Data[2]	Byte	2.0	16#FE	Call Fixed
6		Data[3]	Byte	3.0	16#4A	Call Fixed
7		Data[4]	Byte	4.0	16#02	Call Write
8		Data[5]	Byte	5.0	16#FF	Index Port Command
9		Data[6]	Byte	6.0	16#FF	Index Port Command
10		Data[7]	Byte	7.0	16#4	Command Resume = 0x04

Figure 10.64

Read Record Resume – Port status

Use this request to verify that the previous writing of the "Resume" port command was successful.

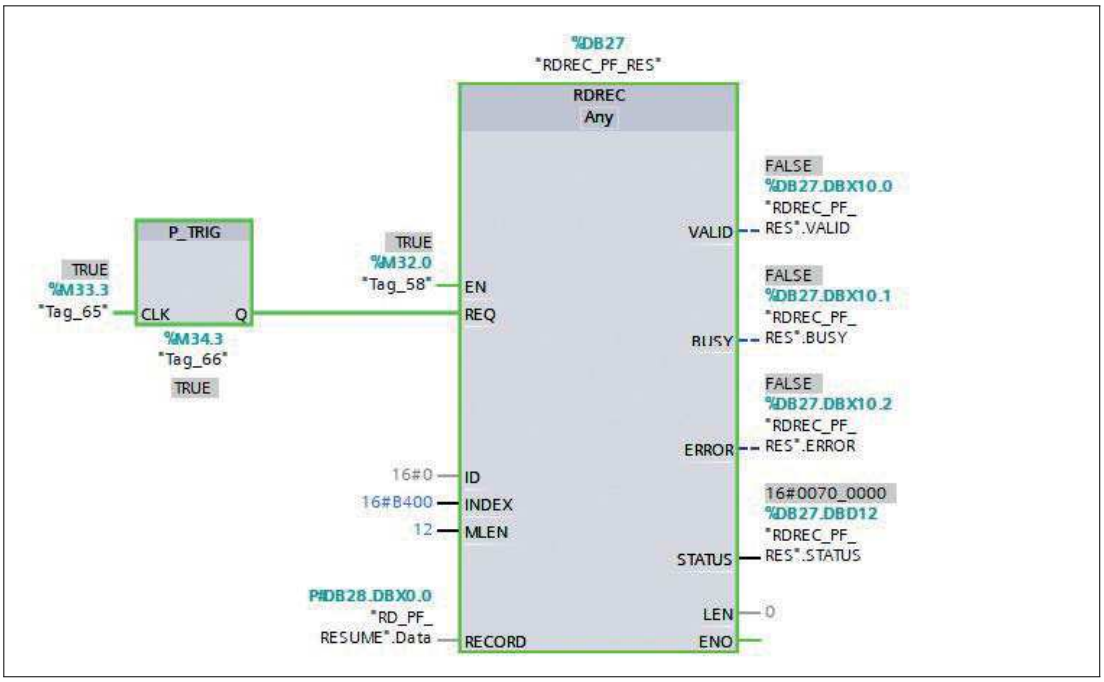


Figure 10.65

ID = 0 to address the IO-Link master proxy

INDEX = 0xB400

LEN = 12 bytes, 8 bytes for commands + 4 bytes for the error PDU

If the "Resume" port command was successful, the read data looks as follows:

	Name	Data type	Offset	Start value	Monitor value	Comment
1	Static					
2	Data	Array[0..231] of Byte	0.0			
3	Data[0]	Byte	0.0	16#0	16#08	Call Header
4	Data[1]	Byte	1.0	16#0	16#01	Port Number (1..8)
5	Data[2]	Byte	2.0	16#0	16#FE	Call Fixed
6	Data[3]	Byte	3.0	16#0	16#4A	Call Fixed
7	Data[4]	Byte	4.0	16#0	16#00	Status 0x00=OK, 0x80 = Error PDU
8	Data[5]	Byte	5.0	16#0	16#FF	Index Port Command
9	Data[6]	Byte	6.0	16#0	16#FF	Index Port Command
10	Data[7]	Byte	7.0	16#0	16#04	Command Resume
11	Data[8]	Byte	8.0	16#0	16#00	Error PDU
12	Data[9]	Byte	9.0	16#0	16#00	Error PDU
13	Data[10]	Byte	10.0	16#0	16#00	SMI Job Error
14	Data[11]	Byte	11.0	16#0	16#00	SMI Job Error

Figure 10.66

If the "Resume" process has not yet been completed before the "Read Record" has arrived at the IO-Link master, a negative PROFINET response with the code "Resource busy – 0x80C2" is sent.

Possible Error PDU Codes

NO_ERROR	0x0000
IOL_CALL_CONFLICT	0x7000
INCORRECT_IOL_CALL	0x7001
PORT_BLOCKED	0x7002
TIMEOUT	0x8000

2024-04

INVALID_PORT_NUMBER	0x8001
INVALID_IOL_INDEX	0x8002
INVALID_IOL_SUBINDEX	0x8003
NO_DEVICE	0x8004
DECODE_ERROR	0x8051
RDREC_FAULT	0x8052
WREC_FAULT	0x8053
UNEXPECTED_ERROR_SEQ	0x8054
FUNCTION_ERROR	0x8055
FUNCTION_NOT_AVAILABLE	0x8056
FUNCTION_NOT_SUPPORTED	0x8057

10.3 Bit Assignment

The IO-Link master uses a modular device model. Slot 1/sub-slot 1 contains the status/control module of the IO-Link master. This module provides 2 bytes of input data and 2 bytes of output data. When an IO-Link master is selected from the GSD file, the module is integrated automatically and cannot be changed.

The IO-Link ports use the following sub-slots 2 through 9 in slot 1. Depending on the configuration, they may have a different operating mode and data length.

Process Data Status / Control Module, Slot 1 / Sub-slot 1

The status/control module has an Unsigned16[ah] for digital input data and an Unsigned16[ah] for digital output data.

Status data (input)

The two Unsigned16 input bytes contain the status of the digital inputs. For the digital A channel inputs, the data is also available in the input byte of the corresponding sub-slot module.

Control data (output)

The two Unsigned16 output bytes contain the control bits for the digital B channel outputs.

The byte 1/bit 0 output for the corresponding sub-slot module must be used to control the digital A channels.

The General Device Settings parameter Digital Out Ch. A Controlled By: Status/Control Module can be used to switch to control bits. In this instance, the outputs cannot be controlled via the byte 1/bit 0 sub-slot output.

The digital output can be controlled only from one source of data.

Parameter Dependencies of the Digital I/O Data Mapping

For the bit mapping settings see chapter 10.2.4.

Status/Control Data with Bit Mapping

For details on bit mapping configuration see chapter 10.2.4.

Legend

X1A	Port 1, channel A
UINT16 High Byte	1st/"low address" byte in a Siemens PLC
UINT16 Low Byte	2nd/"high address" byte in a Siemens PLC

Table 10.18 Siemens PLC with Big Endian format

ah.UINT16/Word

Mode 1

I/O	Status/control	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slot 1.1	UINT16 High Byte	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A
	UINT16 Low Byte	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A

Table 10.19 Digital input/output mapping mode 1

Mode 2

I/O	Status/control	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slot 1.1	UINT16 High Byte	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A
	UINT16 Low Byte	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

Table 10.20 Digital input/output mapping mode 2

Mode 3

I/O	Status/control	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slot 1.1	UINT16 High Byte	X8B	X7B	X6B	X5B	X4B	X3B	X2B	X1B
	UINT16 Low Byte	X8A	X7A	X6A	X5A	X4A	X3A	X2A	X1A

Table 10.21 Digital input/output mapping mode 3

Mode 4

I/O	Status/control	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slot 1.1	UINT16 Low Byte	X8A	X7A	X6A	X5A	X4A	X3A	X2A	X1A
	UINT16 High Byte	X8B	X7B	X6B	X5B	X4B	X3B	X2B	X1B

Table 10.22 Digital input/output mapping mode 4

Mode 5

The mapping for mode 5 depends on the user settings.

Port	X8	X7	X6	X5	X4	X3	X2	X1
I/O pin	2/4	2/4	2/4	2/4	2/4	2/4	2/4	2/4
I/O channel	B/A	B/A	B/A	B/A	B/A	B/A	B/A	B/A
PN diag. channel	8	7	6	5	4	3	2	1

Table 10.23 PROFINET channel diagnostics mapping

IO-Link Connections Process Data, Slot 1/Sub-Slot 2–Sub-Slot 9

The process data lengths of the IO-Link connections in COM mode depend on the configurations of IO-Link connections X1–X8. Data lengths of 1–32 bytes of input data and/or 1–32 bytes of output data are configurable.

The data content can be taken from the descriptions of the IO-Link devices.

If no precise data length exists for the IO-Link device configuration, always select the next largest data length.

The IO-Link master also attaches the PQI byte[ai] to the end of the regular port input data of an IO-Link node.

ai.Port Qualifier Information

Ch. A configuration as digital input

If the port is configured as a digital input, the port data length is one byte and the status of the digital input is set to bit 0. The status of the digital input is also assigned to the status bytes of the status/control module.

The selected mapping mode for the status/control module has no effect on the process data of the IO-Link ports.

Input Data: Sub-Slots 1.2–1.9

INPUT	Input	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slot 1.1	X1 Byte 1–33	• If the IO-Link port is in "Digital-In" mode, the status is set to "DI-C/Q" (channel A, pin 4) in bit 0/byte 1. In this case, no PQI byte is available. • The last byte contains the PQI (Port Qualifier Information).							
Slot 1.3	X2 Byte 1–33								
Slot 1.4	X3 Byte 1–33								
Slot 1.5	X4 Byte 1–33								
Slot 1.6	X5 Byte 1–33								
Slot 1.7	X6 Byte 1–33								
Slot 1.8	X7 Byte 1–33								
Slot 1.9	X8 Byte 1–33								

Table 10.24

PQI Description

Bit	Acronym	Short Description	Value	Description
0	-	Reserved	0	Reserved
			-	-
1	-	Reserved	0	Reserved
			-	-
2	NewParam	New parameter	0	Not supported yet, don't evaluate this bit!
			1	Not supported yet, don't evaluate this bit!
3	SubstDev	Substitute device detection	0	Not supported yet, don't evaluate this bit!
			1	Not supported yet, don't evaluate this bit!
4	PortActive	Port operation	0	port deactivated via port function
			1	port activated (default)
5	DevCom	Device communication	0	no IOL device available
			1	IOL device detected and is in PREOPERATE or OPERATE state
6	DevErr	Port/Device error	0	no error/warning occurred indication
			1	error/warning assigned to IOL device or IOL master port occurred
7	PQ	Device process data validity	0	invalid I/O process data from IOL device
			1	valid I/O process data from device

Table 10.25

Output Data: Sub-Slots 1.2–1.9

INPUT	Input	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slot 1.1	X1 Byte 1–32	• If the IO-Link port is in "Digital-Out" mode, the state is set to "DO-C/Q" (channel A, pin 4) in bit 0/byte 1.							
Slot 1.3	X2 Byte 1–32								
Slot 1.4	X3 Byte 1–32								
Slot 1.5	X4 Byte 1–32								
Slot 1.6	X5 Byte 1–32								
Slot 1.7	X6 Byte 1–32								
Slot 1.8	X7 Byte 1–32								
Slot 1.9	X8 Byte 1–32								

Table 10.26

Ch. A configuration as digital output

If the port is configured as a digital output, the port data length is one byte for digital output control bit 0.

If the General Device parameter Digital Out Ch. A Controlled by is set to "Status/Control Module", the output cannot be controlled by bit 0 in the port output byte.

11 The Integrated Web Server

The module has an integrated web server that provides functions for configuring modules, and displaying status and diagnostic information.

The web interface provides an overview of the module configuration and status. It can also be used to adjust specific settings, perform a restart, reset to factory settings, and update firmware.

Status Page

Enter `http://` in the address bar of the web browser, followed by the IP address, e.g., `http://192.168.1.1`.

If the module home page does not open, please check your browser and firewall settings.

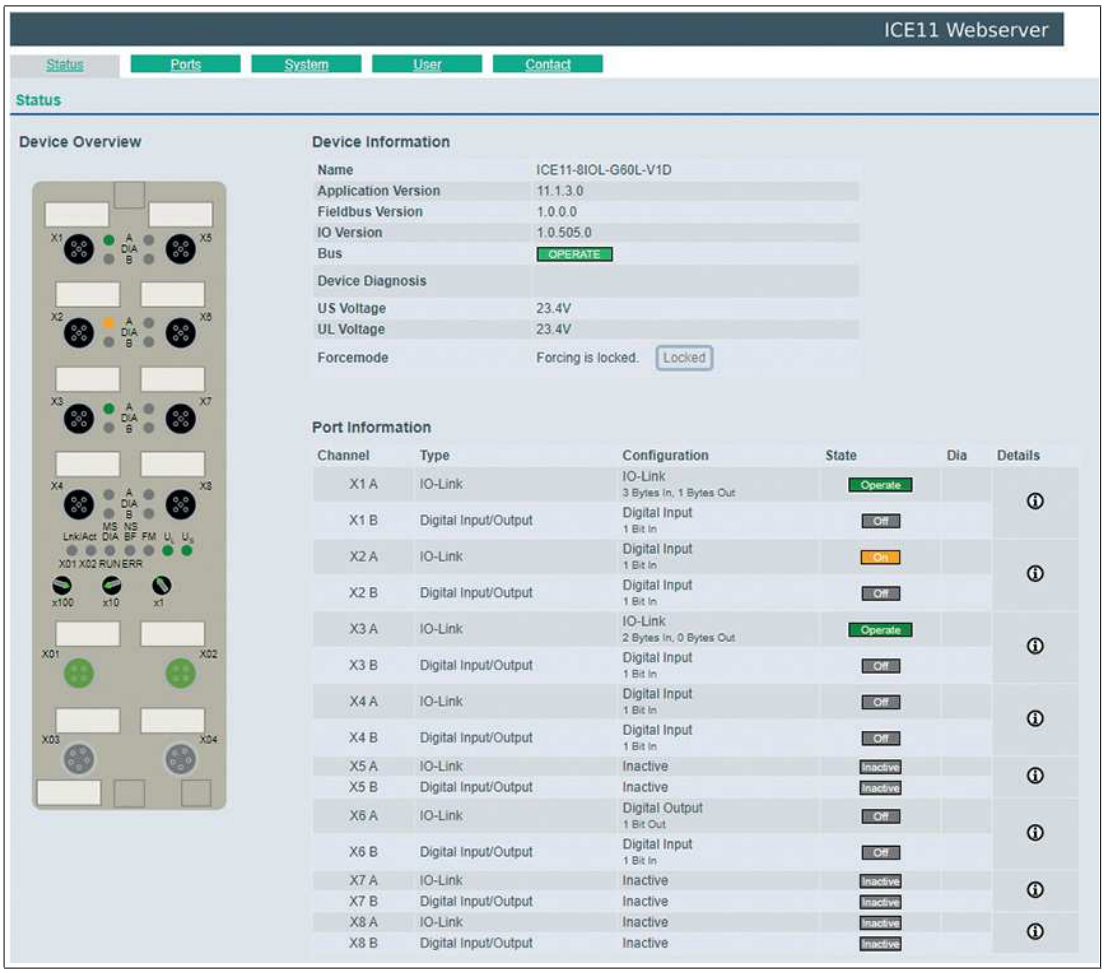


Figure 11.1

This page serves as a starting point for access to the integrated web server.

Device Overview

The left side shows a graphical representation of the module with all LEDs and the positions of the rotary coding switches

Device Information

The "Device Information" table contains some basic data on the module, e.g., the version, the state of the cyclic communication, and a diagnostic indicator. The diagnostic indicator shows whether a diagnosis is present in the module.

Port Information

The "Port Information" table indicates the configuration and status of all I/O ports of the module.

Ports (Connection Side)

Click the "Ports" tab in the menu bar of the start window. A new window opens with the details of the individual ports:

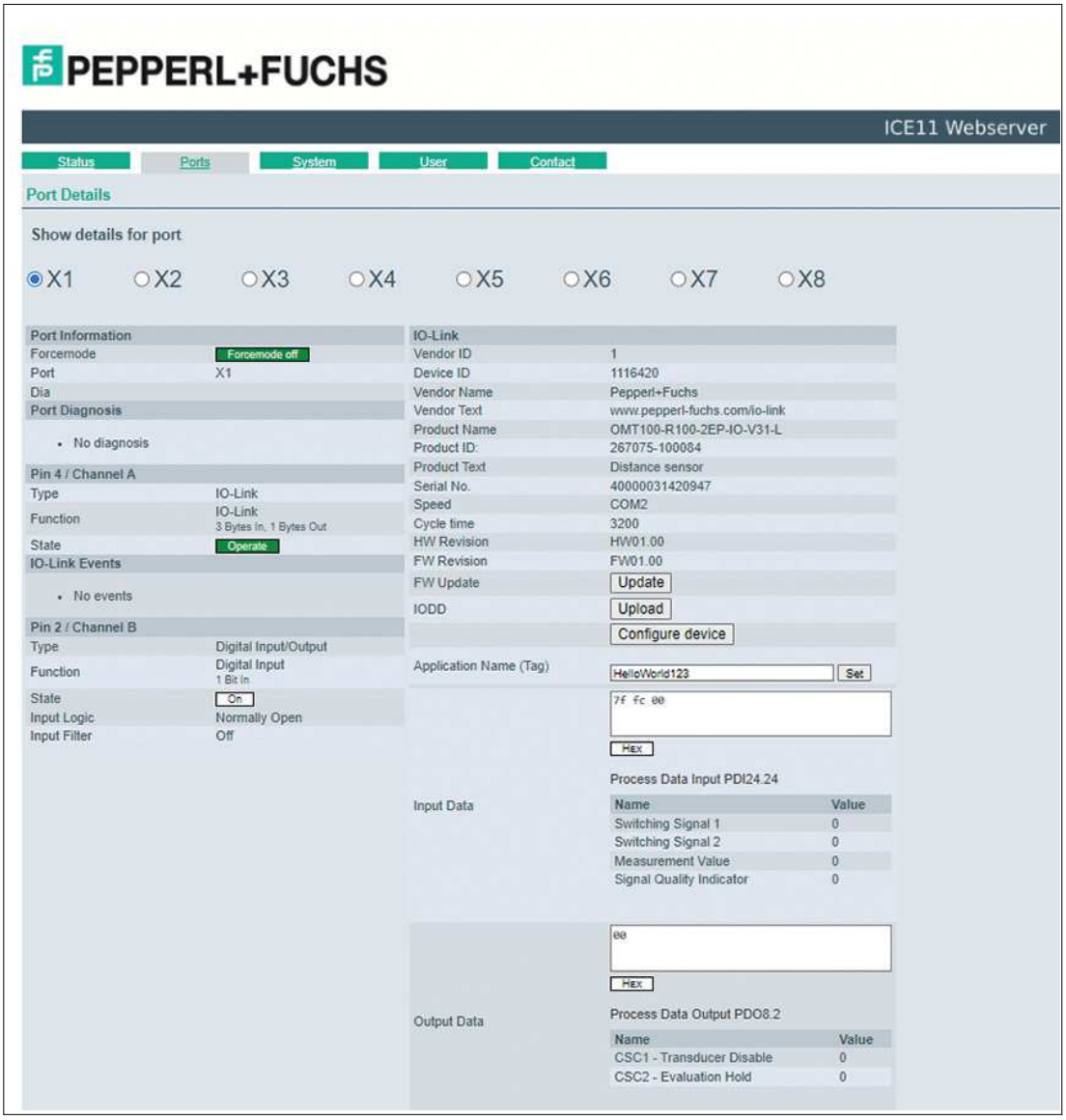


Figure 11.2

The Port Details page displays all information about the selected port. The left column displays all port and channel-specific information. If the port is configured as an IO-Link and an IO-Link node is connected, all IO-Link information for the connected device is displayed in the right column.

- Port diagnostics shows incoming and outgoing diagnoses in plain text.
- Pin 2 and pin 4 contain information about the configuration and status of the port.
- Additional information about the connected sensor and its process data is shown for IO-Link ports.

IODD Buttons

The series called IODD provides access to the "IODD on Module" functions. The UPLOAD button allows the user to upload an IODD file to the module, regardless of the original device for which the IODD was created.

The maximum number of IODDs is limited by the storage space. If there is no more space available for new IODDs, an error message is sent. In this case, navigate to the IODD Management page to delete IODDs that are no longer in use.

2024-04

If a suitable IODD for the currently connected device already exists in the system memory, the CONFIGURE button is displayed in the interface. Clicking on the button opens the Parameters page to configure the device.

Parameters Page

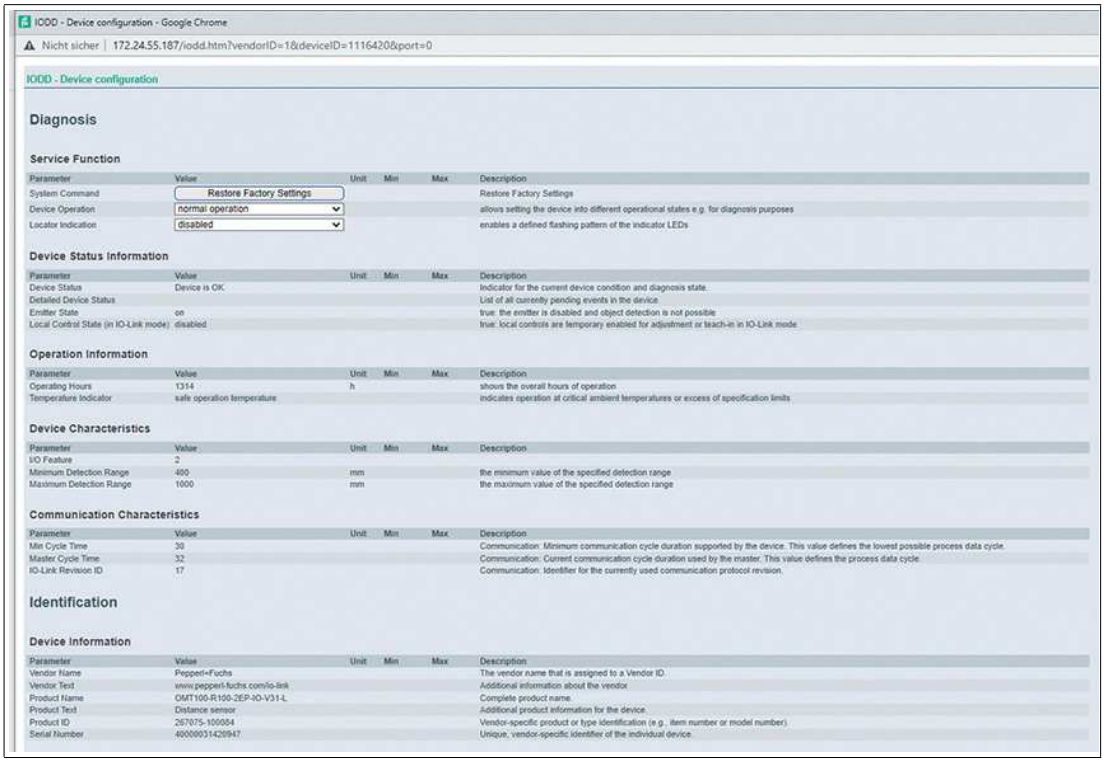


Figure 11.3

The "IODD – Device configuration" parameters page displays all parameters provided by the IODD of the device. This means that the parameter set is variable and depends on the connected IO-Link device.

The stored IODD reads the metadata of the parameters such as names, units, min/max values, descriptions, etc. The values are obtained directly from the connected device. Therefore, it may take a few seconds for the page to refresh.

If not already saved in the browser, you will be asked for your login details to continue. To edit the device parameters, valid user access with group membership in the web interface is required. After registration, you can change active values. Deactivated values cannot be changed. These can be marked as read-only in the IODD. After each change, all current values are written back directly to the device.

Limitations

- Editing parameter values changes them directly in the connected device. This does not trigger a parameter server action.
- There is a maximum IODD size that can be uploaded to the system. This depends on several values such as file size, number of parameters, nesting levels, etc.

Process Data

The process raw data of the input and output direction (byte set) is displayed for each connected IO-Link device. If a suitable IODD with information about process data is already stored in the system, this data is also displayed in a user-friendly format corresponding to the IODD.

System Page

Click the "System" tab in the menu bar of the start window. A new window opens with information on the system of the module:

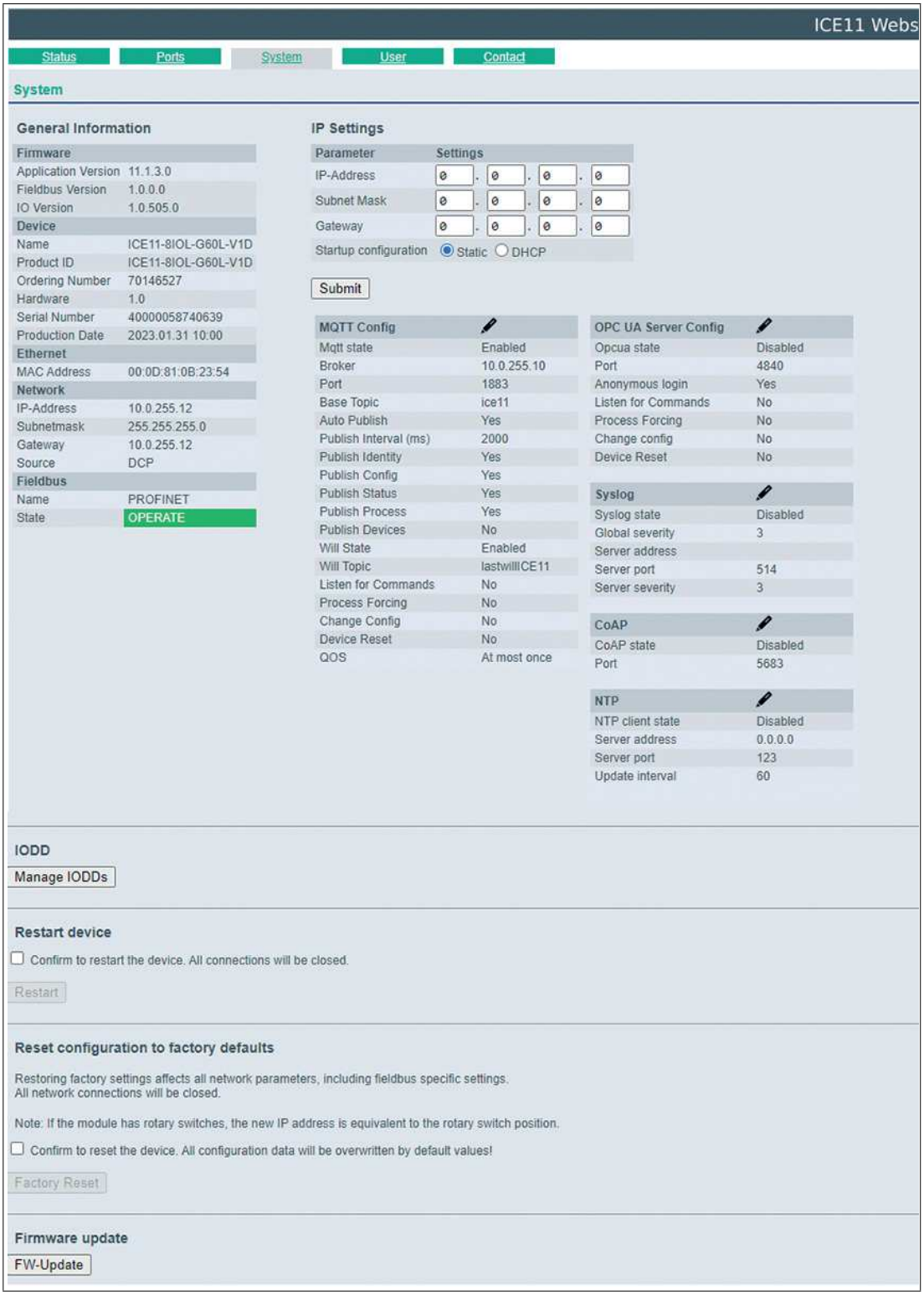


Figure 11.4

This page contains information about the following values and parameters:

- The firmware name and version are displayed under "Firmware".
- The "Device" section contains all the information about the module itself.

2024-04

- Restart device
  - The module initializes a software reset.
- Reset configuration to factory defaults
  - The module restores the default factory settings.

Note

During a factory reset, the "BF/MS/RUN" LED will light up red three times. Once reset to the factory settings, the "BF/MS/RUN" LED will light up green three times. Once the LED has lit up green three times, restart the device and wait ten seconds.

- Firmware update
  The module initializes a firmware update.
  Select the provided *.ZIP container to update firmware. For firmware updates, please contact our support team. Follow the instructions that appear on the screen.

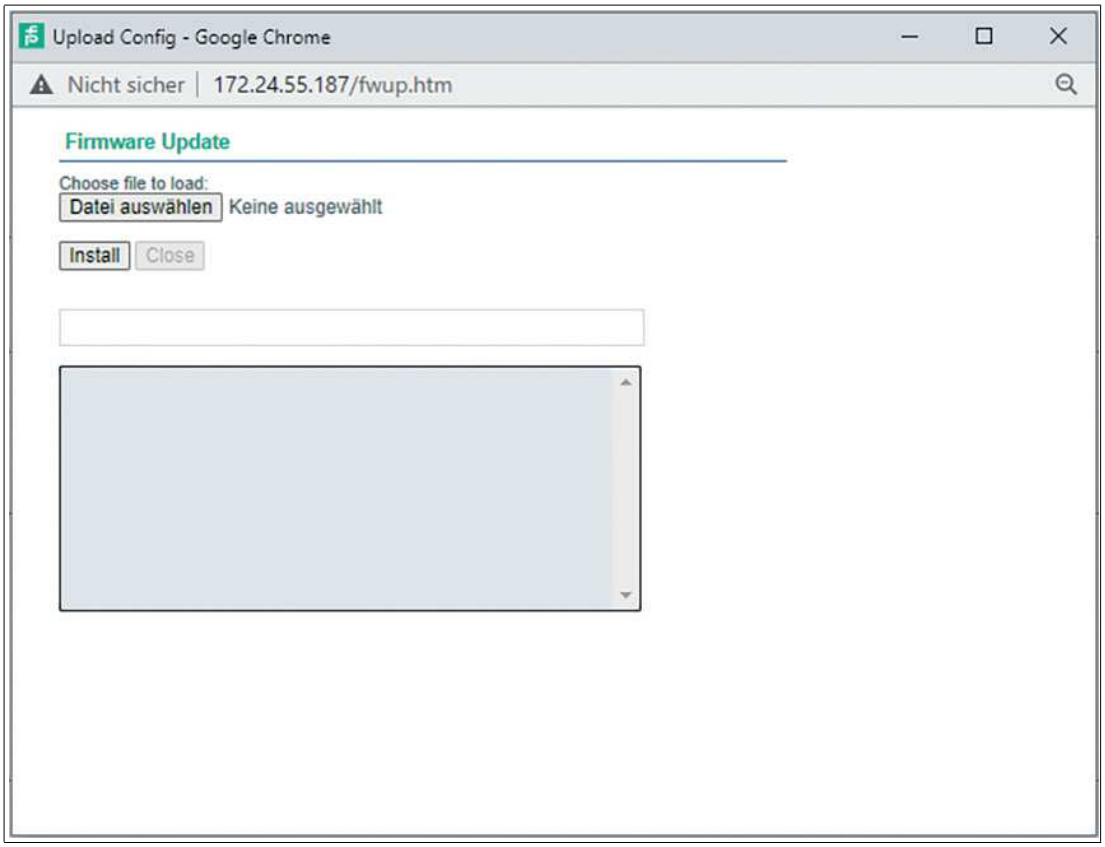


Figure 11.5

IODD Management Page

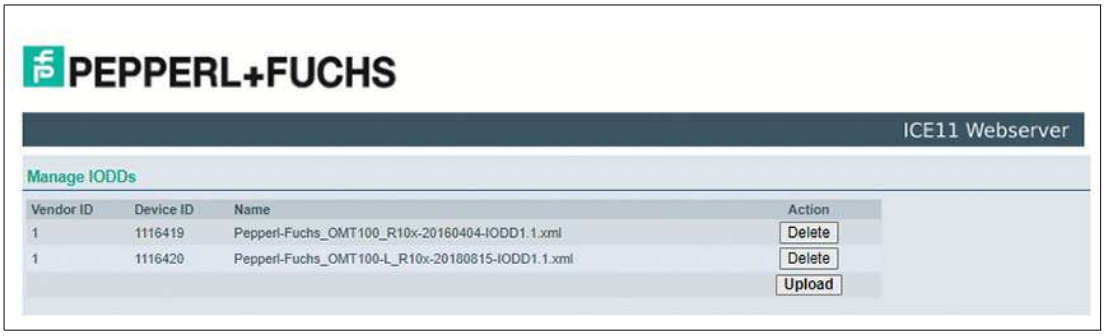


Figure 11.6

The IODD Management page can be accessed from the System page and displays all IODDs that are currently stored in the system. All IODDs that match connected devices are marked. On the IODD Management page, you can manually delete each IODD in the system.

User Administration

Click on the "User" tab in the menu bar of the start window. A new window opens with the user administration settings for the module:

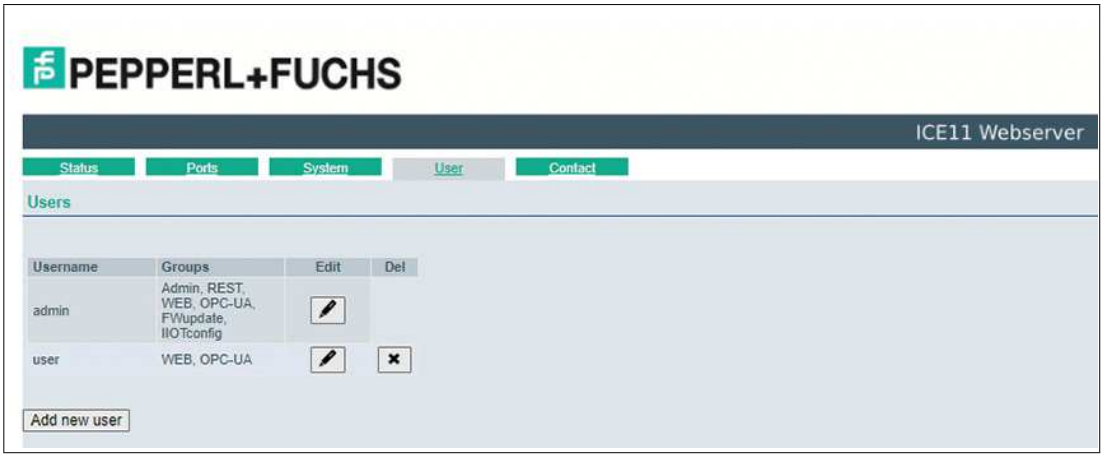


Figure 11.7

This page contains the settings relevant to managing the users of the module. New users can be added with **Admin** or **Write** access permissions.

Tip

For security reasons, change the default admin password once the device has been configured.

Default user login data:

- User: admin
- Password: private

2024-04

Contact Page

Click on the "Contact" tab in the menu bar of the start window. A new window with the contact data of Pepperl+Fuchs opens:

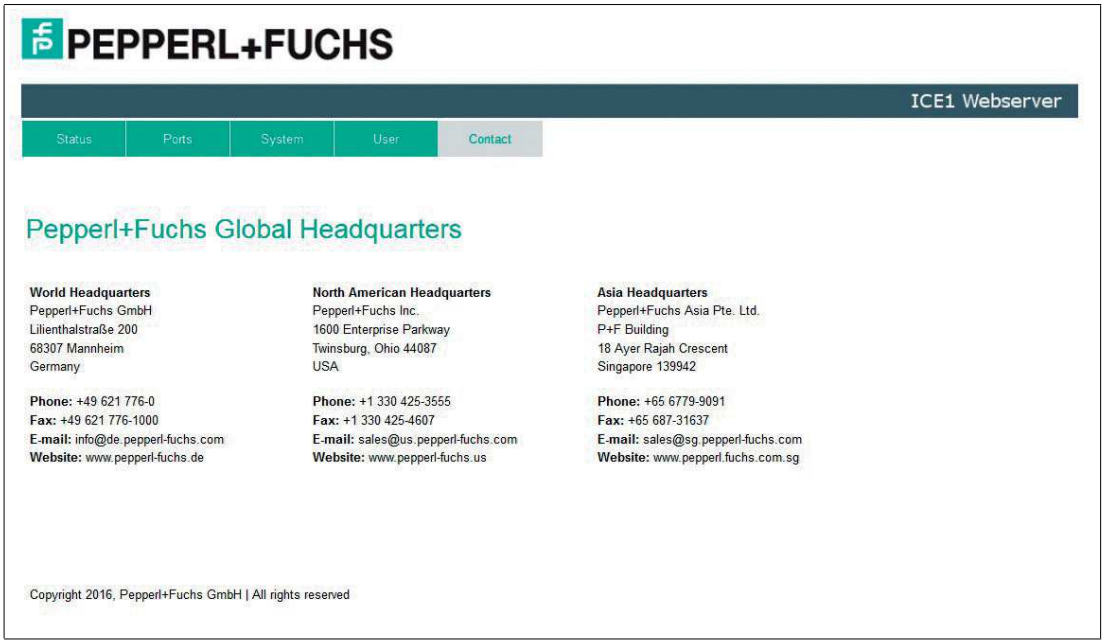


Figure 11.8

The address of the contact page is:

http://[IP address]/contact.htm

This page provides information about Pepperl+Fuchs Group contact details.

12 IIoT Functionality

The device offers interfaces and functions for optimal integration into existing or future IIoT[a] networks. The device continues to function as a fieldbus node that can communicate with a PLC[b] and be controlled by it. The device offers common IIoT interfaces that enable communication channels alongside the PLC. Communication is carried out via the IIoT-relevant protocols MQTT and OPC UA.

You can use these interfaces to

- read all the information in the device
- change the configuration of the device
- take control of the device if this is permitted

All interfaces can be extensively configured and offer read-only functionality. The device offers a user administration feature. You can control access to and use of the IIoT protocols. This allows you to manage all modification options for the device settings via personalized user authorization. All IIoT protocols can be used and configured independently of the fieldbus. You can control the device via IIoT protocols without a PLC.

Warning!

Cybersecurity

Use the IIoT functionality in a secured local network environment without direct access to the Internet. See chapter 2.

12.1 MQTT

The MQTT[c] protocol is an open network protocol for machine-to-machine communication. MQTT is used to transmit telemetric data messages between devices. The integrated MQTT client allows the device to publish a specific set of information to an MQTT broker. The messages can be published either periodically or manually triggered.

MQTT Configuration

The MQTT functions are deactivated in the factory settings. The MQTT client can be configured and read out.

1. Use the Web interface, see xxx
2. Send a JSON object as an "HTTP request", see xxx and below.
   - The configuration URL is: `http://[ip-address]/w/config/mqtt.json`.
   - The configuration can be read back as a JSON file: `http://[ip-address]/r/config/mqtt.json`

The configuration takes the form of a JSON object, with each JSONMember representing a configuration element. The object does not have to contain all elements. Only the elements provided will be changed. Any configuration changes will not take effect until after a device restart.

The following configuration elements are available:

a. IIoT = Industrial Internet of Things

b. PLC = programmable logic controller

c. MQTT = Message Queuing Telemetry Transport

MQTT Configuration

Element	Data Type	Description	Example
mqtt-enable	boolean	Master switch for the MQTT client.	true/**false**[1]
broker	string	IP address of the MQTT broker	"**192.168.1.1**"
login	string	Username for MQTT broker	"admin" Default: **null**
password	string	Password for MQTT broker	"private" Default: **null**
port	number	Broker port	**1883**
base-topic	string	Base topic	"iomodule_[mac]" Default: "**ice11**"
will-enable	boolean	If true, the device provides a last will message to the broker	true/**false**
will-topic	string	The topic for the last will message.	Default: **null**
auto-publish	boolean	If true, all enabled domains will be published automatically in the specified interval.	**true**/false
publish-interval	number	The publish interval in ms if autopublish is enabled. Minimum is 250 ms.	**2000**
publish-identity	boolean	If true, all identity domain data will be published	**true**/false
publish-config	boolean	If true, all config domain data will be published	**true**/false
publish-status	boolean	If true, all status domain data will be published	**true**/false
publish-process	boolean	If true, all process domain data will be published	**true**/false
publish-devices	boolean	If true, all IO-Link device domain data will be published	true/**false**
commands-allowed	boolean	Master switch for MQTT commands. If false, the device will not subscribe to any command topic, even if specific command topics are activated below.	true/**false**
force-allowed	boolean	If true, the device accepts force commands via MQTT.	true/**false**
reset-allowed	boolean	If true, the device accepts restart and factory reset commands via MQTT.	true/**false**
config-allowed	boolean	If true, the device accepts configuration changes via MQTT.	true/**false**
qos	number	Selects the "Quality of Service" status for all published messages.	**0 = At most once** 1 = At least once 2 = Exactly once

Table 12.1

1. bold = standard

MQTT Response

The resulting response is a JSON object with a "status" field. The status should be "0" if no error occurs and "-1" if an error occurs.

In the event of an error, the response contains an error array.

The error array contains an error object for each error that occurred. The object consists of an "Element" field, which identifies the configuration element that caused the error, and a "Message" field for the error message.

- A JSON object that is not well-formed causes an error.
- Non-existent parameters cause an error.
- Parameters with an incorrect data type cause an error.

Writing all available parameters at once is not permitted. You should write only one or a small number of parameters at a time.

Example

```
{"status": -1, "error": [{"Element": "publish-interval", "Message":
"Integer expected"}]}
{"status": 0}
{"status": -1, "error": [{"Element": "root", "Message": "Not a
JSONobject"}]
```

MQTT Topics

MQTT mainly refers to topics. All messages are attached to a topic, which adds context to the message itself. Topics can consist of any type of string and may contain slashes (/) and wildcard symbols (*, #).

Base Topic

The device has a configurable base topic, which is the prefix for all topics. The base topic can be freely selected by the user. The base topic can also contain selected variables.

Base Topic Variables

Variable	Description
mac	The MAC address of the device
Name	The name of the device
order	The ordering number of the device
serial	The serial number of the device

Table 12.2

Variables in the base topic must be written in square brackets ("[ ]").

Example

The base topic **"io_[mac]"** is translated into `"io_A3B6F3F0F2F1"`. All data is organized into domains. The domain name is the first level in the topic after the base topic. Note the following notation: **Base topic/domain/.**....

Data Domains

Domain Name	Definition	Example
identity	All fixed data that is defined by the used hardware and which cannot be changed by configuration or at runtime.	Device name, ordering number, MAC address, port types, port capabilities and more.
config	Configuration data that is commonly loaded once at startup, mostly by a PLC.	IP address, port modes, input logic, failsafe values and more.
status	All non-process data that changes quite often in normal operation.	Bus state, diagnostic information, IO-Link device status and data.
process	All process data that is produced and consumed by the device itself or by attached devices.	Digital inputs, digital outputs, cyclic IO-Link data.

2024-04

Domain Name	Definition	Example
iold	IO-Link device parameters according to the IO-Link specification.	Vendor name, product name, serial number, hardware revision, software revision and more.

Table 12.3

Often there is a topic for all gateway-related information and topics for each port. All identity topics are published only once when the device is started, as this information should be static. All other topics are either published at a fixed interval or triggered manually, depending on their configuration.

Data Model

Topic	Example	Total Publication Counter	Publication Interval
`[base-topic]/identity/gateway`	Name, ordering number, MAC, vendor, I&M etc.	1	Startup
`[base-topic]/identity/port/n`	Port name, port type	8	Startup
`[base-topic]/config/gateway`	Configuration parameters, IP address, etc.	1	Interval
`[base-topic]/config/port/n`	Port mode, data storage, mapping, direction	8	Interval
`[base-topic]/status/gateway`	Bus state, device diagnostics, master events	1	Interval
`[base-topic]/status/port/n`	Port or channel diagnostics, IO-Link state, IO-Link device events	8	Interval
`[base-topic]/process/gateway`	All Digital IN/OUT	1	Interval
`[base-topic]/process/port/n`	Digital IN/OUT per port, IOL-data, pdValid	8	Interval
`[base-topic]/iold/port/n`	IO-Link device parameter	8	Interval

Table 12.4

An MQTT client that wants to subscribe to one or more of these topics can also use wildcards.

Application Examples

Entire Topic	Description
`[base-topic]/identity/gateway`	Receive only identity objects for the gateway
`[base-topic]/identity/#`	Receive all data related to the identity domain
`[base-topic]/status/port/5`	Receive only status information for port number 5
`[base-topic]/+/port/2`	Receive information of all domains for port number 2
`[base-topic]/process/port/#`	Receive only process data for all ports
`[base-topic]/config/#`	Receive config data for the gateway and all ports.

Table 12.5

Publish-Topic

Overview of all Publish JSON data for the defined topics:

Identity/Gateway

Input	Data Type
tbd	json_string
ordering_number	json_string
device_type	json_string
serial_number	json_string
mac_address	json_string
production_date	json_string
fw_name	json_string
fw_date	json_string
fw_version	json_string
hw_version	json_string
vendor_name	json_string
vendor_address	json_string
vendor_phone	json_string
vendor_email	json_string
vendor_techn_support	json_string
vendor_url	json_string
vendor_id	json_integer
device_id	json_integer

Table 12.6

Config/Gateway

Input	Data Type	Scope	Default	Notes
fieldbus_protocol	json_string	profinet, ether-net/ip, ethercat		
network_configu-ration	json_string	PN: dcp EIP: stored_value, bootp, dhcp		
rotary_switches	json_integer	0 ... 999		
ip_address	json_string		192.168.1.1	
subnet_mask	json_string		255.255.255.0	
report_alarms	json_boolean		0.0.0.0	
report_ul_alarm	json_boolean	true / false	true	
report_do_-fault_without_ul	json_boolean	true / false	false	
force_mode_lock	json_boolean	true / false	false	
web_inter-face_lock	json_boolean	true / false	false	
do_auto_restart	json_boolean	true / false	true	
fast_startup	json_boolean	true / false	false	PROFINET and EIP only

Table 12.7

Status/Gateway

Input	Data Type	Scope	Default	Notes
protocol	json_string	wait_for_io_system wait_for_io_Connection failsafe connected error		
ethernet_port1	json_string	100_mbit/s_full 100_mbit/s 10_mbit/s_full 10_mbit/s		
ethernet_port2	json_string	100_mbit/s_full 100_mbit/s 10_mbit/s_full 10_mbit/s		
module_restarts	json_integer	0 ... 4294967295		
channel_diagnostics	json_boolean	true / false		
failsafe_active	json_boolean	true / false		
system_voltage_fault	json_boolean	true / false		
actuator_voltage_fault	json_boolean	true / false		
internal_module_error	json_boolean	true / false		
forcemode_enabled	json_boolean	true / false		

Table 12.8

Process/Gateway

Input	Data Type	Scope	Default	Notes
Input_data	json_integer[]			
output_data	json_integer[]			

Table 12.9

Identity/Port/1 ... 8

Input	Data Type	Scope	Default	Notes
port	json_integer	1 ... 8		
type	json_string	digital_universal digital_input digital_Output io_link		
max_output_power_cha	json_string	2.0_mA 0.5_mA		
max_output_power_chb	json_string	2.0_mA 0.5_mA		
channel_cha	json_string	input/output input output io_link aux		
channel_chb	json_string	input/output input output io_link aux		

Table 12.10

Config/Port/1 ... 8

Input	Data Type	Scope	Default	Notes
port	json_integer	1 ... 8		
direction_cha	json_string	input/output input output		
direction_chb	json_string	input/output input output		
failsafe_cha	json_string	set_low set_high hold_last	set_low	
failsafe_chb	json_string	set_low set_high hold_last	set_low	
surveillance_timeout_cha	json_integer	0 ... 255	80	
surveillance_timeout_chb	json_integer	0 ... 255	80	

Table 12.11

Status/Port/1 ... 8

Input	Data Type	Scope	Default	Notes
port	json_integer	1 ... 8		
physical_state_cha	json_integer	0 ... 1		
physical_state_chb	json_integer	0 ... 1		
actuator_short_circuit_cha	json_boolean	true / false		
actuator_short_circuit_chb	json_boolean	true / false		
sensor_short_circuit	json_boolean	true / false		

Table 12.12

Command-Topic, MQTT Subscribe

The main purpose of MQTT is to publish device data to a broker. This data can be obtained by any registered subscriber that is interested in it. On the other hand, the device itself may have subscribed to a topic on the broker and therefore receives data. This data can be configuration or forcing data. This allows the user to fully control a device exclusively via MQTT, without the use of other communication channels such as web or REST.

If the configuration allows commands in principle, the device subscribes to special command topics, through which it can receive commands from other MQTT clients. The command topic is based on the base topic. It always has the following form:

```
[base-topic]/command
```

After the command topic, fixed topics are for various writable objects. The data format of the MQTT payload is always JSON. It is possible to set only one subset of the possible objects and fields.

```
[...]/forcing
```

Use the [base-topic]/command/forcing command topic for force object data. The force object can have any of the following properties:

Force Object Properties

Property	Data Type	Example	Remarks
forcemode	boolean	true / false	Forcing Authority: on/off
digital	array		
iol	array		

Table 12.13

Different specification values are arrayed successively for the `digital` and `IOL` **Force object** properties:

Digital Force Object

Property	Data Type	Example	Remarks
port	integer	1, 2, 5	
channel	string	"a", "b"	
force_dir	string	"out", "in", "clear"	
force_value	integer	0, 1	

Table 12.14

IO-Link Force Object

Property	Data Type	Example	Remarks
port	integer	0, 1, 5	
output	array[integer]	[55, 88, 120]	
input	array[integer]		Input simulation

Table 12.15 Force object for IO-Link devices

`[...]/config`

Use the `[base-topic]/command/config` command topic for **Config object** data. The **Config object** can have any of the following properties:

Config Object Properties

Property	Data Type	Example	Remarks
portmode	array		
ip_address	string	"192.168.1.5"	
subnet_mask	string	"255.255.255.0"	
gateway	string	"192.168.1.100"	

Table 12.16

There are several specification values specified for the `portmode`**Config object** property:

Config Object: Portmode

Property	Data Type	Example	Remarks
port	integer	2	
channelA[1]	string	"dio", "di", "do", "iol", "off"	
channelB[2]	string	"dio", "di", "do", "iol", "off", "aux"	
inlogicA	string	"no", "nc"	
inlogicB	string	"no", "nc"	

Property	Data Type	Example	Remarks
filterA	integer	3	input filter in ms
filterB	integer	3	input filter in ms
autorestartA	boolean		
autorestartB	boolean		
iolValidation	integer	0 = NoCheck 1 = Type 1.0 2 = Type 1.1 3 = Type 1.1 BR 4 = Type 1.1 RES	
iolDeviceID	integer		for validation
iolVendorID	integer		for validation

Table 12.17

1. channelA = Pin 4
2. channelB = Pin 2

`[...]/reset`

Use the `[base-topic]/command/reset` command topic for **Reset object** data about restart and factory reset topics. The **Reset object** can have any of the following properties:

Reset Object Properties

Property	Data Type	Example	Remarks
factory_reset	boolean	true / false	
system_reset	boolean	true / false	

Table 12.18

`[...]/publish`

Use the `[base-topic]/command/publish` command topic for **Publish object** data.

The manually triggered publication of all topics can be used if "auto publish" is switched off or if "long interval" is set.

MQTT Configuration via JSON

1. Depending on your application, download and install Insomnia or a similar application: insomnia.rest/download/.
2. Configure MQTT
   POST: `[IP-address]/w/config/mqtt.json`

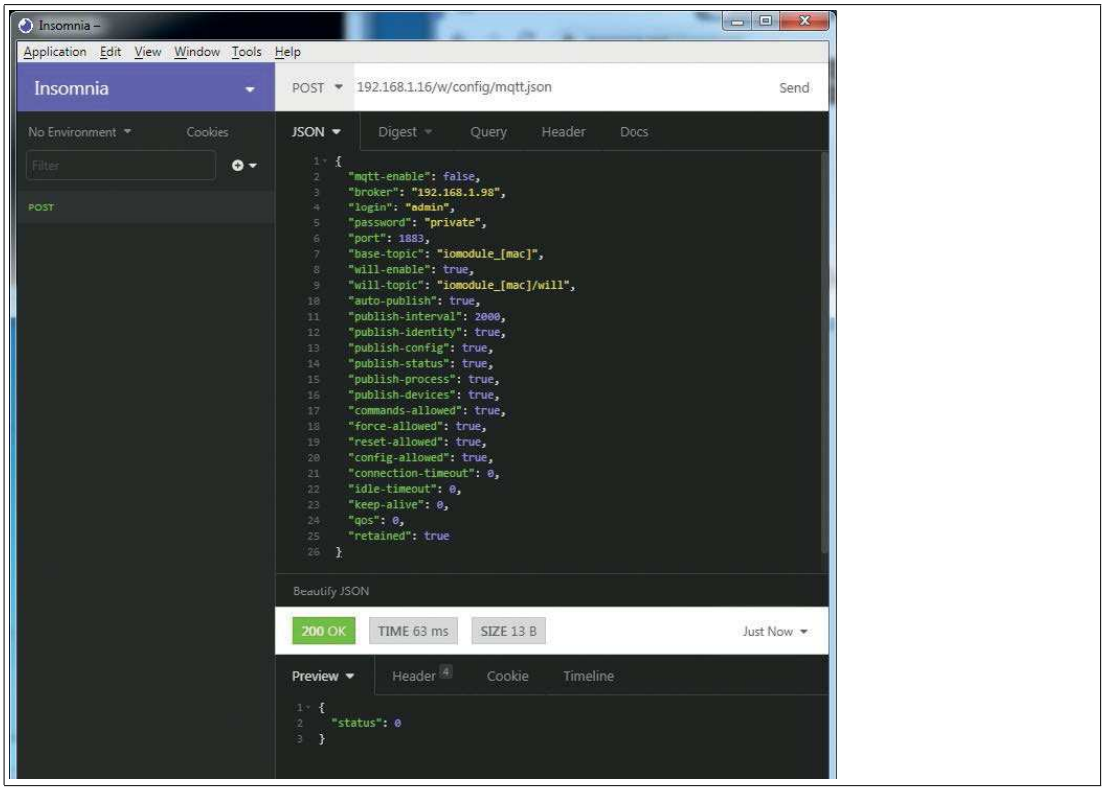


Figure 12.1

3. Read MQTT from:
GET: `[IP-address]/r/config/mqtt.json`

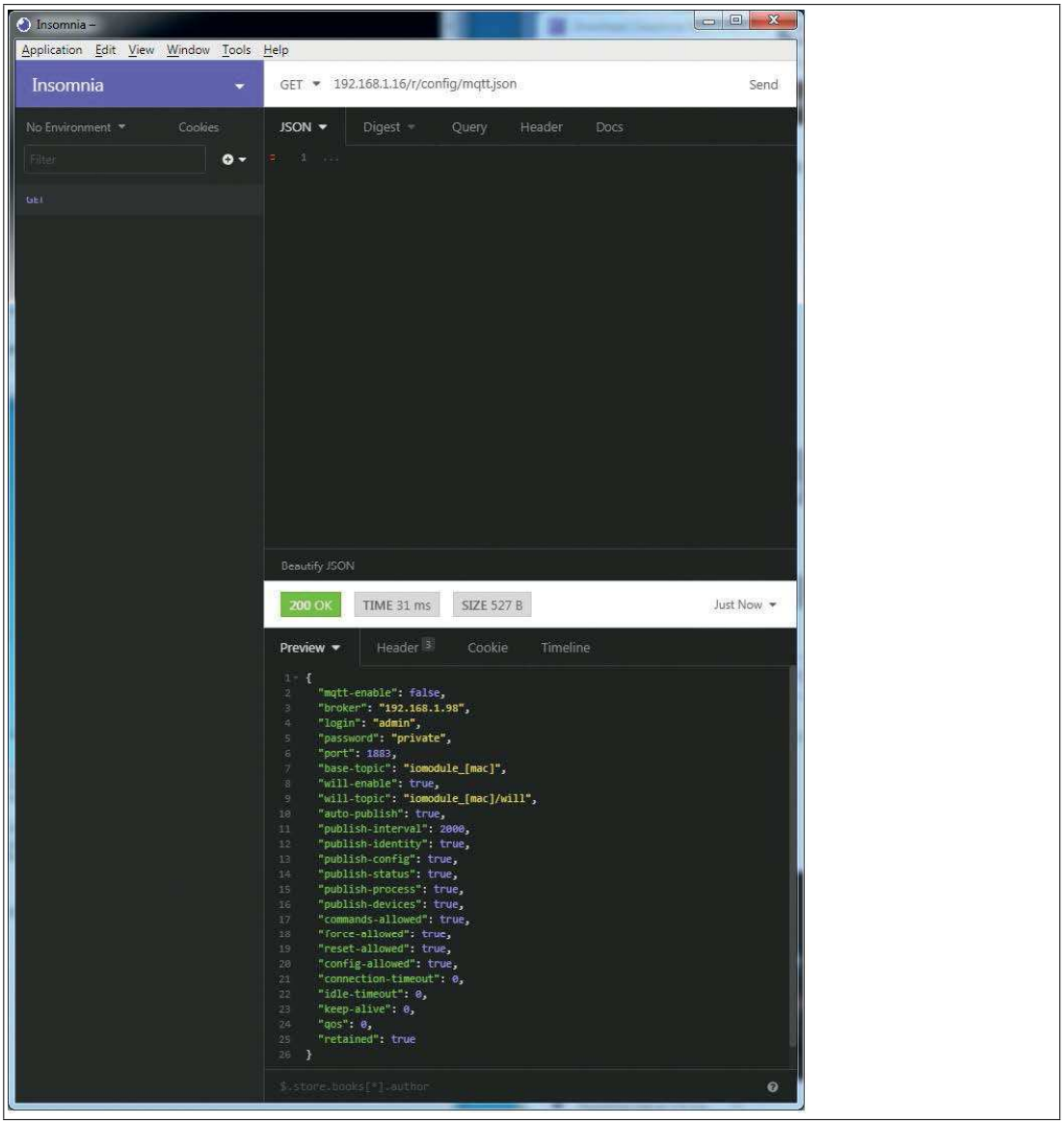


Figure 12.2

12.2 OPC UA

OPC Unified Architecture[d] is a platform-independent standard with a service-oriented architecture for communication in and with industrial automation systems.

The OPC UA standard is based on the client-server principle and allows machines and devices to communicate horizontally with each other and vertically with the ERP system or the cloud, regardless of preferred fieldbuses. The device provides an OPC UA server at the field device level to which an OPC UA client can connect for data-secure information transfer. In the case of OPC UA, we adhere to the "IO-Link Companion Specification", which you can download directly from io-link.com, with the following exceptions.

d. OPC UA = Open Platform Communications Unified Architecture

Unsupported OPC UA Features within the "IO-Link Companion Specification"

Function	Support
Managing IODDs (Section 6.1.6 in the specification)	Not supported
Mapping IODD information to OPC UA ObjectTypes (Section 6.3 in the specification)	Not supported
IOLinkIODDDeviceType (Section 7.2 ff. in the specification)	Not supported
ObjectTypes generated based on IODDs (Section 7.3 ff. in the specification)	Not supported
Creation of Instances based on ObjectTypes generated out of IODDs (Section 7.4 in the specification)	Not supported
IODDManagement Object (Section 8.2 in the specification)	Not supported
RemoveIODD Method (Section 8.3 in the specification)	Not supported

Table 12.19

OPC UA Configuration

By default, the OPC UA functions are deactivated. The OPC UA server can be configured either by using the web interface or directly through a JSON object sent in an "HTTP request." The configuration URL is: http://[ip-address]/w/config/opcua.json The configuration can also be read back as a JSON file: http://[ip-address]/r/config/opcua.json The configuration takes the form of a JSON object, whereby each JSONMember represents a configuration element. The object does not have to contain all elements. Only the elements provided will be changed. Any configuration changes will not take effect until after a device reboot.

The following configuration elements are available:

OPC UA Configuration

Element	Data Type	Description	Example
port	integer	Server port for the OPC UA server	0, **4840**[1], 0xFFFF
opcua-enable	boolean	Master switch for the OPC UA server.	true/**false**
anon-allowed	boolean	If true, anonymous login is allowed.	**true**/false
commands-allowed	boolean	Master switch for OPC UA commands. If false, there will be no writable OPC UA objects	true/**false**
force-allowed	boolean	If true, the device accepts force commands via OPC UA	true/**false**
reset-allowed	boolean	If true, the device accepts restart and factory reset commands via OPC UA	true/**false**
config-allowed	boolean	If true, the device accepts configuration changes via OPC UA	true/**false**

Table 12.20

1. bold = standard

All configuration elements are optional and not bound to any particular order. Not every element needs to be sent. This means that only configuration changes are applied.

Optional: The configuration parameters of OPC UA can be set directly via the web interface. For sharing with other devices, you can download the web interface.

Response:

The resulting response is a JSON object with a "status" field. The status should be "0" if no error occurs and "-1" if an error occurs.

In the event of an error, the response contains an error array.

The error array contains an error object for each error that occurred. The object consists of an "Element" field, which identifies the configuration element that caused the error, and a "Message" field for the error message.

Example

```
{"status": -1, "error": [{"Element": "upcua-enable", "Message": "Boolean expected"}]}
```

```
{"status": 0}
```

```
{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON object"}]}
```

OPC UA Address Space

OPC UA provides various services on the device that allow a client to navigate through the address space hierarchy and read or write variables. In addition, the client can observe up to 10 attributes of the address space regarding value changes.

A connection to an OPC UA server is reached via the endpoint URL: `opc.tcp://[ip-address]:[port]`

Various device data such as the MAC address, device settings, diagnostics or status information can be read out via Identity objects, Config objects, Status objects and Process objects. Command objects can be read and written. This makes it possible, for example, to transfer new network parameters to the device in order to use force mode or to reset the entire device to factory settings. The following graphics show the OPC UA address space of the device. The objects and information displayed depend on the device variant used.

OPC UA Configuration – Quick Start

Caution!

Third party

Pepperl+Fuchs assumes no responsibility for any content contained on the referenced websites and does not guarantee the functionality of the third-party software mentioned above.

OPC UA Configuration via JSON

1. Depending on your application, download and install Insomnia or a similar application: insomnia.rest/download/.
2. Configure OPC UA
   POST: `[IP-address]/w/config/opcua.json`

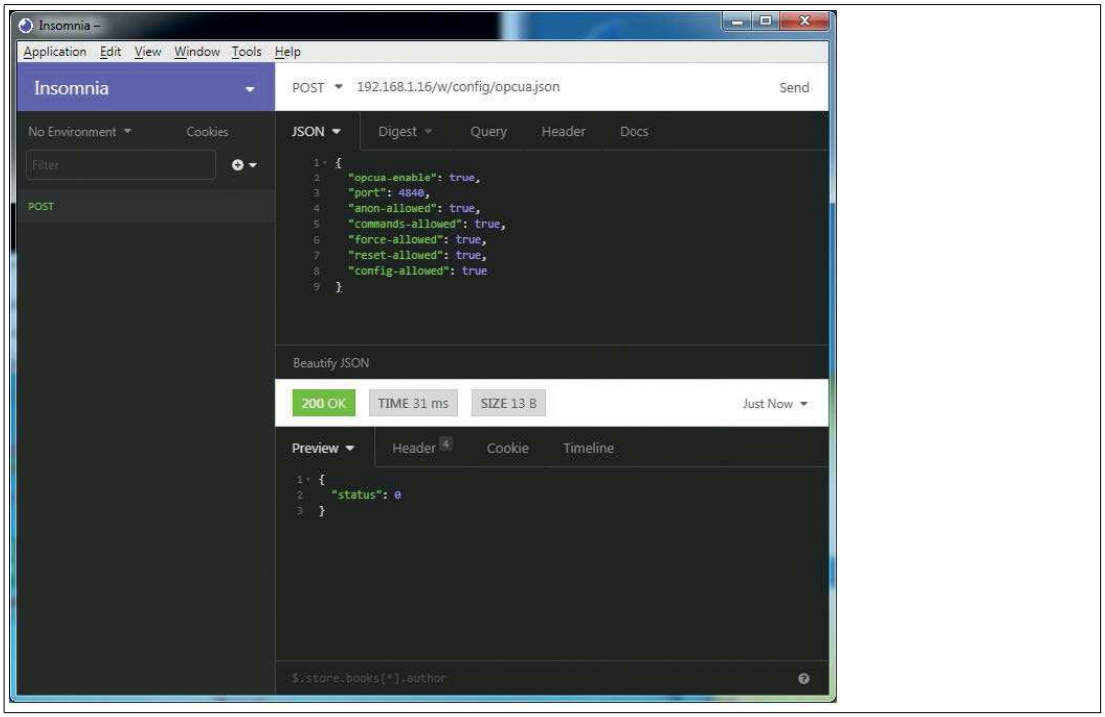


Figure 12.3

3. Read MQTT from:
GET: `[IP-address]/r/config/opcua.json`

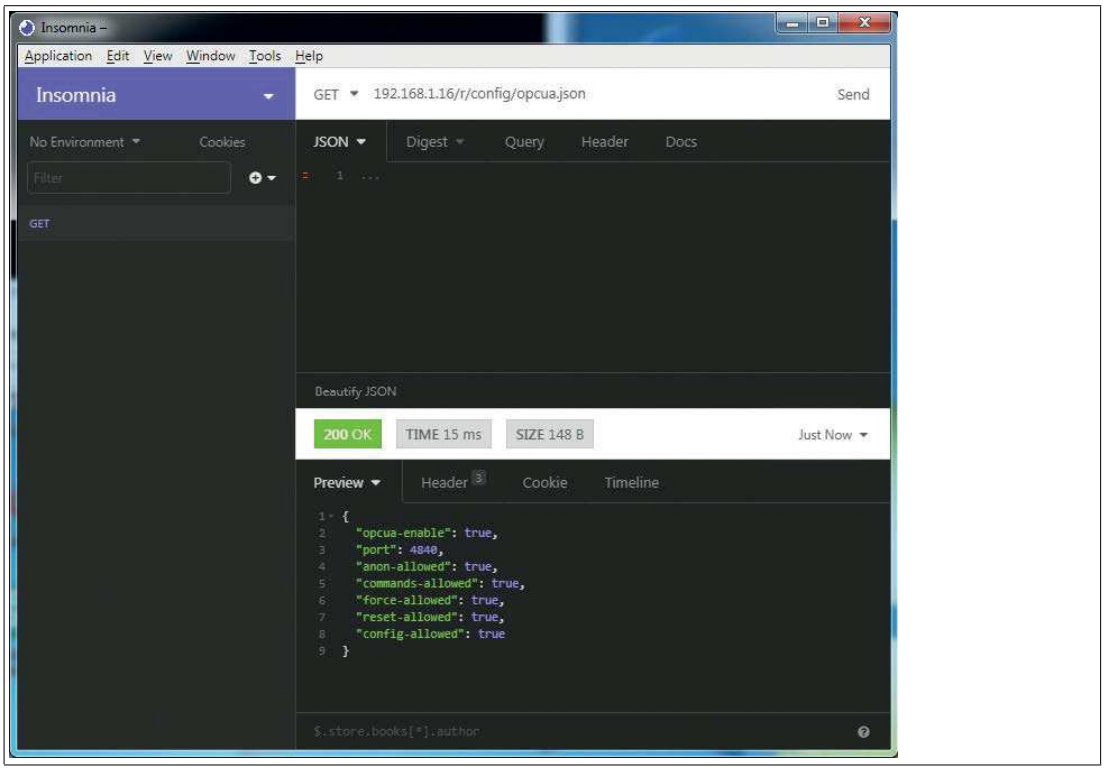


Figure 12.4

12.3 REST API

The REST API[e] is a programmable interface that uses HTTP requests for GET and POST data. This allows access to detailed device information. With the gateway, the REST API can be used to read out the device status. The REST API can also be used to write configuration and forcing data. There are two different REST API standards available for the requests:

1. A standardized REST API specified by the IO-Link community and described separately:
   `JSON_Integration_10222_V100_Mar20.pdf`
   Please download the file from io-link.com.
2. A customized REST API, which is described below.

Supported REST API Features within the IO-Link Specification

Function		Supported
Gateway	GET /identification	X
	GET /capabilities	X
	GET /configuration	X
	POST /configuration	X
	POST /reset	X
	POST /reboot	X
	GET /events	X
Master	GET /masters	X
	GET /capabilities	X
	GET /identification	X
	POST /identification	X
Port	GET /ports	X
	GET /capabilities	X
	GET /status	X
	GET /configuration	X
	POST /configuration	X
	GET /datastorage	-
	POST /datastorage	-

e. REST API = Representational State Transfer – Application Programming Interface

Function		Supported
Devices	GET /devices	X
	GET /capabilities	X
	GET /identification	X
	POST /identification	X
	GET /processdata/value	X
	GET /processdata/getdata/value	X
	GET /processdata/setdata/value	X
	POST /processdata/value	X
	GET /parameters	X
	GET /parameters/{index}/subindices	X
	GET /parameters/{parameterName}/subindices	-
	GET /parameters/{index}/value	X
	GET /parameters/{index}/subindices/{subindex}/value	X
	GET /parameters/{parameterName}/value	-
	GET /parameters/{parameterName}/subindices/ {subParameter-Name}/value	-
	POST /parameters/{index}/value	X
	POST /parameters/{parameterName}/value	-
	POST /parameters/{index}/subindices/{subindex}/value	X
	POST /parameters/{parameterName}/subindices/ {subParameter-Name}/value	-
	POST /blockparametrization	-
	GET /events	X
IODD	GET /iodds	-
	POST /iodds/file	-
	DELETE /iodds	-
	IODD GET /iodds/file	-

Table 12.21

Default device information

Request method:	http GET
Request URL:	`<ip>/info.json`
Parameter:	n.a.
Response format:	JSON

The objective of the "Standard device information" request is to obtain a complete picture of the current device status. The format is JSON. For IO-Link devices, all ports with the connected IO-Link device information are included.

Structure

STANDARD Object

Name	Data type	Description	Example
Name	string	Device name	"ICE11-8IOL-G60L-V1D"
order id	string	Ordering number	"70146527"

Name	Data type	Description	Example
fw-version	string	Firmware version	"V.1.1.0.0 - 01.01.2021"
hw-version	string	Hardware version	"V.1.00"
mac	string	MAC address of the device	"3C B9 A6 F3 F6 05"
bus	number	0 = No connection 1 = Connection with PLC	1
failsafe	number	0 = Normal operation 1 = Outputs are in failsafe	0
ip	string	IP address of the device	
snMask	string	Subnet Mask	
gw	string	Default gateway	
rotarys	array of numbers (3)	Current position of the rotary switches: Array element 0 = x1 Array element 1 = x10 Array element 2 = x100	
ulPresent	boolean	True, if there is a UL voltage supply detected within valid range	
usVoltage_mv	number	US voltage supply in mV	
ulVoltage_mv	number	UL voltage supply in mV (only available for devices with UL supply)	
inputs	array of numbers (2)	Real state of digital inputs Element 0 = 1 Byte: Port X1 Channel A to Port X4 Channel B Element 0 = 1 Byte: Port X5 Channel A to Port X8 Channel B	\[128.3\]
output	array of numbers (2)	Real State of digitaloutputs Element 0 =1 Byte: Port X1 Channel A to Port X4 Channel B Element 0 = 1 Byte: Port X5 Channel A to Port X8 Channel B	\[55.8\]
consuming	array of numbers (2)	Cyclic data from PLC to device	
producing	array of numbers (2)	Cyclic data from device to PLC	
diag	array of numbers (4)	Diagnostic information: Element 0 = 1 Byte: Bit 7: Internal module error (IME) Bit 6: Forcemode active Bit 3: Actuator short Bit 2: Sensor short Bit 1: UL fault Bit 0: US fault Element 1 = 1 Byte: Sensor short circuit ports X1 ... X8 Element 2 =1 Byte: Actuator short circuit ports X1 Channel A to X4 Channel B	
fieldbus	FIELDBUS Object		

Table 12.22

2024-04

FIELDBUS Object

Name	Data type	Description	Example
fieldbus_name	string	Currently used fieldbus	
state	number	Fieldbus state	
state_text	number	Textual representation of fieldbus state: 0 = Unknown 1 = Bus disconnected 2 = Preop 3 = Connected 4 = Error 5 = Stateless	
forcing	FORCING Object	Information about the forcing state of the device	
channels	Array of CHANNEL (16)	Basic information about all input/output channels	
iol	IOL object	Contains all IO-Link-related information such as events, port states, device parameters	
iol/diagGateway	array of DIAG	Array of currently active device/ gateway-related events	
iol/diagMaster	array of DIAG	Array of currently active IOL-Master-related events	
iol/ports	array of PORT (8)	Contains one element for each IO-Link port	

Table 12.23

CHANNEL Object

Name	Data type	Description	Example
Name	string	Name of channel	
type	number	Hardware channel type as number: 0 = DIO 1 = Input 2 = Output 3 = Input/Output 4 = IO-Link 5 = IOL AUX 6 = IOL AUX with DO 7 = IOL AUX with DO. Can be deactivated. 8 = Channel not available	
type_text	string	Textual representation of the channel type	
config	number	Current configuration of the channel: 0 = DIO 1 = Input 2 = Output 3 = IO-Link 4 = Deactivated 5 = IOL AUX	
config_text	string	Textual representation of the current config	
inputState	boolean	Input data[1] bit to the PLC	
outputState	boolean	Output data bit to the physical output pin	
forced	boolean	True, if the output pin of this channel is forced	

Name	Data type	Description	Example
simulated	boolean	True, if the input value to the PLC of this channel is simulated	
actuatorDiag	boolean	True, if the output is in short circuit / overload condition	
sensorDiag	boolean	True, if the sensor supply[2] is in short circuit / overload condition	
maxOutputCurrent _mA	number	Maximum output current of the output in mA	
current_mA	number	Measured current of the output in mA[3]	
voltage_mV	number	Measured voltage of this output in mV[4]	

Table 12.24

1. producing data
2. = Pin 1
3. if current measurement is available
4. if voltage measurement is available

PORT Object

Name	Data type	Description	Example
port_type	string	Textual representation of the IO-Link port type	
iolink_mode	number	Current port mode: 0 = Inactive 1 = Digital output 2= Digital input 3 = SIO 4 = IO-Link	
iolink_text	string	Textual representation of the current port mode	"Digital Input"
aux_mode	number	Indicates the configured mode for the Pin 2: 0 = No AUX 1 = AUX output[1] 2 = Digital output[2] 3 = Digital input	
aux_text	string	Textual representation of the current aux mode	"AUX Output"
cq_mode	number	Port mode according to IOL specification	
iq_mode	number	Pin 2 mode according to IOL specification	
port_status	number	Port status according to IOL specification	
ds_fault	number	Data storage error number	
ds_fault_text	string	Textual data storage error	
device	DEVICE object	IO-Link device parameters. • Null if no IO-Link communication active	
diag	array of DIAG (n)	Array of port-related events	

Table 12.25

1. always on
2. can be controlled by cyclic data

2024-04

DIAG Object

Name	Data type	Description	Example
error	number	Error code	
source	string	Source of the current error.	"device" "master"
eventcode	number	Event code according to IO-Link specification	
eventqualifier	number	Event qualifier according to IO-Link specification	
message	string	Error message	"Supply Voltage fault"

Table 12.26

DEVICE Object[f]

Name	Data type	Description	Example
device_id	number		
vendor_id	number		
serial	string		
baudrate	string	Baudrate (COM1,2,3)	
cycle_time	number	Cycle time in microseconds	
input_len	array of numbers (n)	IOL input length in bytes	
output_len	array of numbers (n)	IOL output length in bytes	
input_data	array of numbers (n)	IOL input data	
output_data	array of numbers (n)	IOL output data	
pd_valid	number	"1", if IOL input data is valid	
pdout_valid	number	"1", if IOL output data is valid	

Table 12.27

FORCING Object[g]

Name	Data type	Description	Example
forcingActive	boolean	Force mode is currently active	
forcingPossible	boolean	True, if forcing is possible and force mode can be activated	
ownForcing	boolean	True, if forcing is performed by REST API at the moment	
forcingClient	string	Current forcing client identifier	
digitalOutForced	array of numbers (2)	The force values of all 16 digital output channels	
digitalOutMask	array of numbers (2)	The forcing mask of all 16 digital output channels	
digitalInForced	array of numbers (2)	The force values of all 16 digital input channels	
digitalInMask	array of numbers (2)	The forcing mask of all 16 digital input channels	

Table 12.28

f. Standard parameters of the IOL-Device

g. Forcing information of the device

Configuration and Forcing

Method:	POST
URL:	`<ip>/w/force.json`
Parameter:	n.a.
Format:	JSON

ROOT Object

Name	Data type	Description	Example
forcemode	boolean	Forcing authority on/off	true / false
portmode	array (Port mode object)		
digital	array (Digital object)		
iol	array (IOL object)		

Table 12.29

PORT MODE Object

Name	Data type	Description	Example
port	integer		0– 7
channel	integer		"a","b"[1]
direction	string		"dio","di","do","iol", "off", "aux"
aux	string		"dio","di","do","iol", "off", "aux"[2]
inlogica	string		"no","nc"
inlogicb	string		"no","nc"

Table 12.30

1. optional, default is "a"
2. IOL only, but optional

DIGITAL Object

Name	Data type	Description	Example
port	integer		0– 7
channel	integer		"a","b"
force_dir	string		"phys_out","plc_in","clear"[1]
force_value	integer		0.1

Table 12.31

1. optional, default is "phys_out"

IOL Object

Name	Data type	Description	Example
port	integer		0– 7
output	array[integer] or null to clear forcing	Output forcing	[55,88,120]
input	array[integer] or null to clear forcing	Input simulation to PLC	[20,0,88]

Table 12.32

Reading and Writing of ISDU Parameters

The ISDU[h]) provides an extremely flexible message format, which can include single or multiple commands.

The device supports the reading and writing of ISDU parameters of the connected IOL device. It is possible to perform this as a bulk transfer by reading and writing multiple ISDU parameters via a single request.

Read out

Method:	POST
URL:	`<ip>/r/isdu.json`
Parameter:	port (0–7)
Example:	`192.168.1.20/r/isdu.json?port=5`
Format:	JSON

Reading Out "ISDU Object"

Name	Data type	Description	Example
ix	integer	Index to be read	0-INT16
subix	integer	Subindex to be read	0-INT8

Table 12.33

Reading Out "ISDU Response Object"

Name	Data type	Description	Example
status	integer	0 = no error -1= an error occurred	0, -1
message	string	Error message if error occurred	
data	array (Read ISDU data object)	data, if no error occurred. otherwise null	

Table 12.34

Reading Out "ISDU Data Object"

Name	Data type	Description	Example
ix	integer	Index that was read	0-INT16
subix	integer	Subindex that was read	0-INT8
status	integer	0 = no error -1= an error occurred	0, -1
eventcode	integer	IOL eventcode if status is -1	
data	array[integer]	data, if no error occurred. otherwise null	

Table 12.35

Write

Method:	POST
URL:	`<ip>/w/isdu.json`
Parameter:	port (0–7)
Format:	JSON

h. ISDU = Indexed Service Data Unit

Writing "ISDU Object"

Name	Data type	Description	Example
ix	integer	Index to be read	0-INT16
subix	integer	Subindex to be read	0-INT8
data	array[integer]	Data to be written	

Table 12.36

Writing "ISDU Response Object"

Name	Data type	Description	Example
status	integer	0 = no error -1= an error occurred	0, -1
message	string	Error Message if error occurred	
data	array (Write ISDU data object)	data, if no error occurred. otherwise null	

Table 12.37

Writing "ISDU Data Object"

Name	Data type	Description	Example
ix	integer	Index that was written	0-INT16
subix	integer	Subindex that was written	0-INT8
status	integer	0 = no error -1= an error occurred	0, -1
eventcode	integer	IOL eventcode if status is -1	

Table 12.38

Example

Reading out ISDU

ISDU read request:

```
[
 {"ix":5,"subix":0},
 {"ix":18,"subix":0},
 {"ix":19,"subix":0},
 {"ix":20,"subix":0}
]
```

Response:

```
{
 "message":"OK",
 "data":
[
 {"ix":5,"subix":0,"status":-1,"eventcode":32785},

{"ix":18,"subix":0,"data":[79,68,83,49,48,76,49,46,56,47,76,65,54,44
,50, 48,48,45,77,49,50],"status":0},
 {"ix":19,"subix":0,"data":[53,48,49,50,57,53,51,53],"status":0},

{"ix":20,"subix":0,"data":[100,105,115,116,97,110,99,101,32,115,101,
110, 115,111,114],"status":0}
],
"status":0}
```

2024-04

Example

Writing IDSU

ISDU write request:

```
[
 {"ix":24,"subix":0,"data":[97,98,99,100,101,102]},
 {"ix":9,"subix":0,"data":[97,97,97,97,97,98]} ]
```

Response:

```
{
"message":"OK",
"data":
[
 {"ix":24,"subix":0,"status":0},
 {"ix":9,"subix":0,"eventcode":32785,"status":-1}
],
"status":0}
```

12.4 CoAP Server

The Constrained Application Protocol[i] is a specialized Internet application protocol for restricted networks, such as lossy or low-power networks. CoAP is especially useful in machine-to-machine communication and can be used to translate simplified HTTP requests from low-speed networks.

CoAP is based on the server-client principle and is a service layer protocol with which nodes and machines can communicate with each other. The gateway provides the CoAP server functionalities via UDP via a REST API interface.

CoAP Configuration

The CoAP functions are deactivated in the factory settings. The CoAP server can be configured either by using the web interface or directly through a JSON object sent in an "HTTP request".

The configuration URL is: `http://[ip-address]/w/config/coapd.json`

The configuration can also be read back as a JSON file: `http://[ip-address]/r/config/coapd.json`

The configuration takes the form of a JSON object, with each JSONMember representing a configuration element. The object does not have to contain all elements. Only the elements provided will be changed. Any configuration changes will not take effect until after a device restart.

The following configuration elements are available:

CoAP Configuration

Element	Data Type	Description	Example
enable	boolean	Master switch for the CoAP server	true/**false**[1]
port	integer (0 to 65535)	Port of the CoAP server	**5683**

Table 12.39

1. bold = standard

i. CoAP = Constrained Application Protocol

CoAP Response:

The resulting response is a JSON object with a "status" field. The status should be "0" if no error occurs and "-1" if an error occurs.

In the event of an error, the response contains an error array.

The error array contains an error object for each error that occurred. The object consists of an "Element" field, which identifies the configuration element that caused the error, and a "Message" field for the error message.

Example

```
{"status": -1, "error": [{"Element": "upcua-enable", "Message":
"Boolean expected"}]}
{"status": 0}
{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
object"}]}
```

REST API Access via CoAP

The connection to the CoAP server can be established via the following URL: `coap://[ip-address]:[port]/[api]`

You can access the following REST API requests in JSON format via CoAP endpoint:

REST API Access via CoAP

Type	API	Note
GET	/r/status.lr	
GET	/r/system.lr	
GET	/info.json"	
GET	/r/config/net.json	
GET	/r/config/mqtt.json	
GET	/r/config/opcua.json	
GET	/r/config/coapd.json	
GET	/r/config/syslog.json	
GET	/contact.json	
GET	/fwup_status	
GET	/iolink/v1/gateway/identification	
GET	/iolink/v1/gateway/capabilities	
GET	/iolink/v1/gateway/configuration	
GET	/iolink/v1/gateway/events	
GET	/iolink/v1/masters	
GET	/iolink/v1/masters/1/capabilities	
GET	/iolink/v1/masters/1/identification	
GET	/iolink/v1/masters/1/ports	
GET	/iolink/v1/masters/1/ports/{port_number}/capabilities	The API is available for all 8 ports. {port_number} should be selected between "1" and "8".
GET	/iolink/v1/masters/1/ports/{port_number}/status	The API is available for all 8 ports. {port_number} should be selected between "1" and "8".
GET	/iolink/v1/masters/1/ports/{port_number}/configuration	The API is available for all 8 ports. {port_number} should be selected between "1" and "8".

2024-04

Type	API	Note
GET	/iolink/v1/devices/master1port{port_number}/identification	The API is available for all 8 ports. {port_number} should be selected between "1" and "8".
GET	/iolink/v1/devices/master1port{port_number}/capabilities	The API is available for all 8 ports. {port_number} should be selected between "1" and "8".
GET	/iolink/v1/devices/master1port{port_number}/processdata/ getdata/value	The API is available for all 8 ports. {port_number} should be selected between "1" and "8".
GET	/iolink/v1/devices/master1port{port_number}/events	The API is available for all 8 ports. {port_number} should be selected between "1" and "8".

COAP Configuration - Quick Start

Caution!

Third party

Pepperl+Fuchs assumes no responsibility for any content contained on the referenced websites and does not guarantee the functionality of the third-party software mentioned above.

COAP Configuration via JSON

1. Depending on your application, download and install Insomnia or a similar application: insomnia.rest/download/.
2. Configure CoAP
   POST: `[IP-address]/w/config/coapd.json`

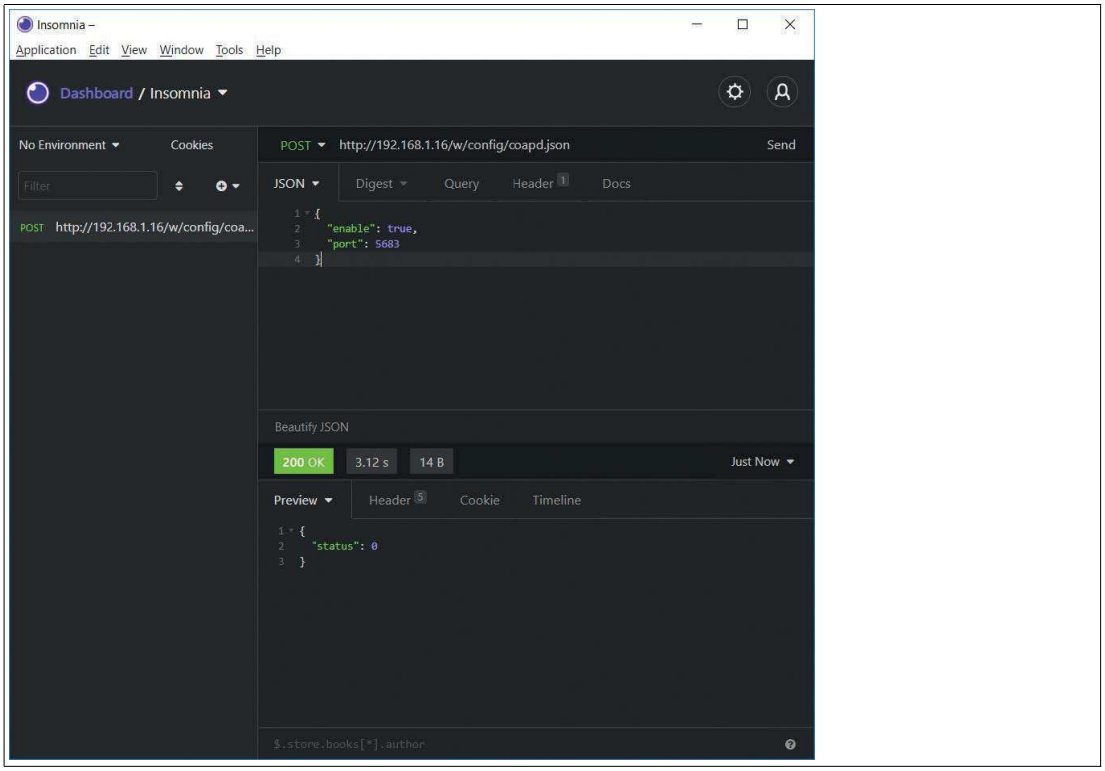


Figure 12.5

3. Read CoAP from:
GET: `[IP-address]/r/config/coapd.json`

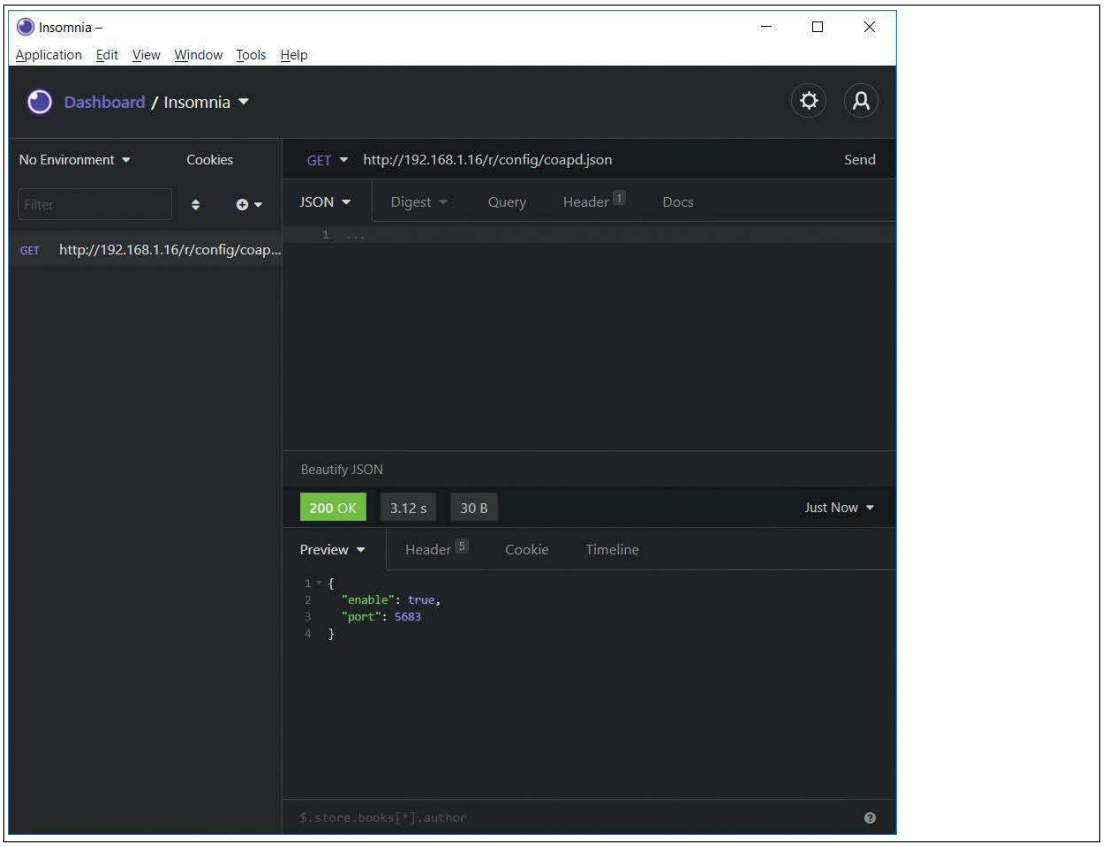


Figure 12.6

12.5 Syslog

The gateway provides a syslog client that can connect to a configured syslog server and is able to log messages.

Syslog is a platform-independent standard for logging messages. Each message contains a timestamp and information about the severity level and subsystem. The Syslog protocol RFC5424 is based on the server-client principle and allows machines and devices to send and centrally collect messages in the network. (For more details on the syslog standard used, visit datatracker.ietf.org.

The device supports the storage of 256 messages in a ring buffer, which are sent to the configured syslog server. If the ring is full with 256 messages, the oldest message is replaced by the new messages that arrive. All messages can be stored on the syslog server. The syslog client of the IO-Link master saves none of the messages permanently.

Syslog Configuration

The syslog functions are deactivated in the factory settings. The syslog client can be configured either by using the web interface or directly through a JSON object sent in an "HTTP request".

The configuration URL is: `http://[ip-address]/w/config/syslog.json`

The configuration can also be read back as a JSON file: `http://[ip-address]/r/config/syslog.json`

The configuration takes the form of a JSON object, with each JSONMember representing a configuration element. The object does not have to contain all elements. Only the elements provided will be changed. Any configuration changes will not take effect until after a device restart.

The following configuration elements are available:

Syslog Configuration

Name	Data Type	Description	Example
syslog-enable	boolean	Master switch for the syslog client	true/**false**[1]
global-severity	integer	Message level of the syslog client: 0 = Emergency 1 = Alert 2 = Critical 3 = **Error** 4 = Warning 5 = Notice 6 = Info 7 = Debug The client stores all messages of the set severity level, including all messages with a lower level.	0/1/2/**3**/4/5/6/7
server address	string (IP address)	syslog server IP address	192.168.0.51 (Default: **null**)
server-port	integer (0 to 65535)	The server port of the syslog server	**514**
server-severity	integer (0 to 7)	Message level of the syslog server: 0 = Emergency 1 = Alert 2 = Critical 3 = **Error** 4 = Warning 5 = Notice 6 = Info 7 = Debug	0/1/2/**3**/4/5/6/7

Table 12.40

1. bold = standard

Syslog Response:

The resulting response is a JSON object with a "status" field. The status should be "0" if no error occurs and "-1" if an error occurs.

In the event of an error, the response contains an error array.

The error array contains an error object for each error that occurred. The object consists of an "Element" field, which identifies the configuration element that caused the error, and a "Message" field for the error message.

Example

```
{"status": -1, "error": [{"Element": "upcua-enable", "Message":
"Boolean expected"}]}
{"status": 0}
{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
object"}]}
```

Syslog Configuration – Quick Start

Caution!
Third party

Pepperl+Fuchs assumes no responsibility for any content contained on the referenced websites and does not guarantee the functionality of the third-party software mentioned above.

Syslog Configuration via JSON

1. Depending on your application, download and install Insomnia or a similar application: insomnia.rest/download/.
2. Configure syslog
   POST: `[IP-address]/w/config/syslog.json`

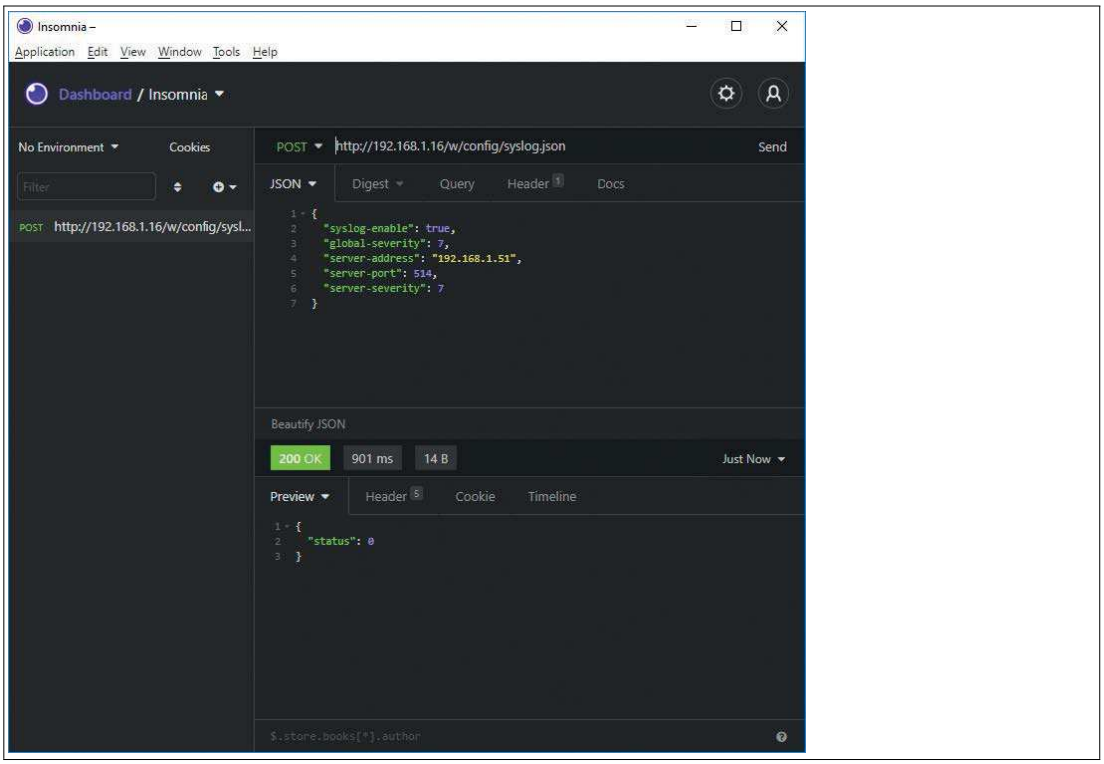


Figure 12.7

3. Read syslog from:
   GET: `[IP-address]/r/config/syslog.json`

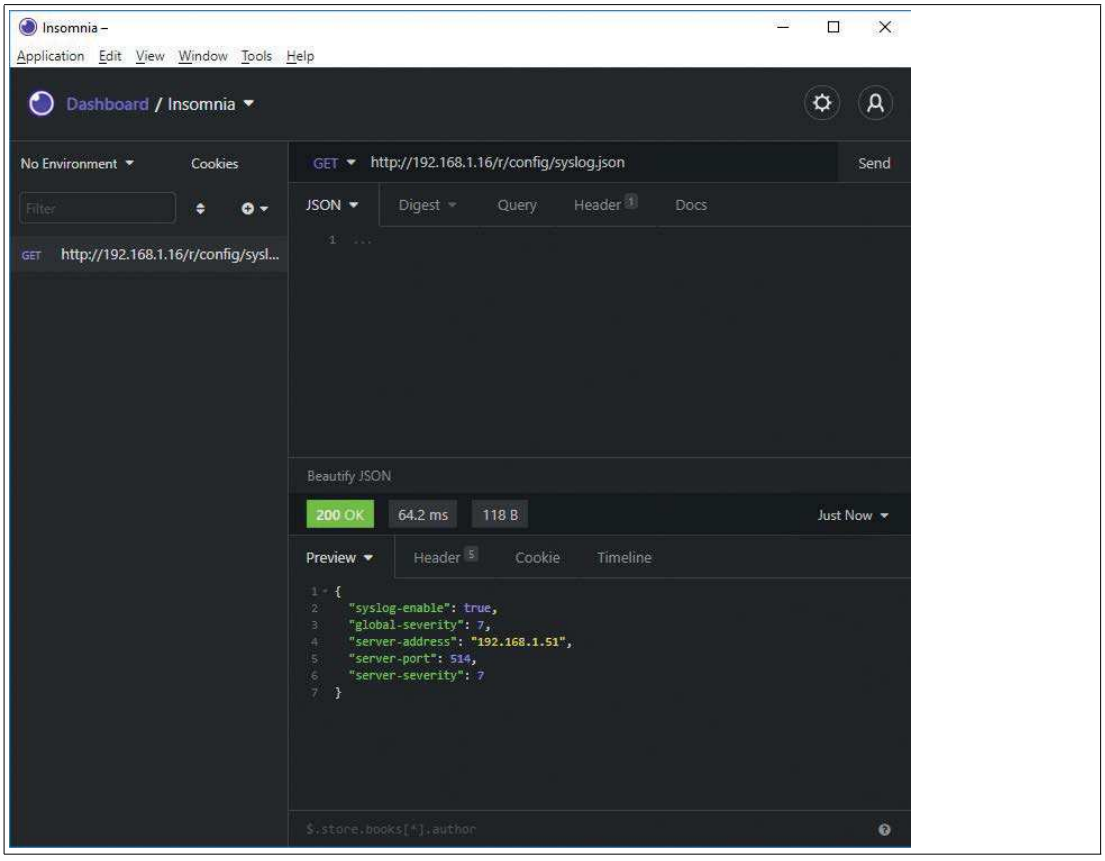


Figure 12.8

12.6 NTP

The gateway provides an NTP[j] client in version 3, which can connect to a configured NTP server. The NTP client is able to synchronize network time at a configurable interval.

NTP is a network protocol that uses UDP datagrams to send and receive timestamps to synchronize them with a local clock. The NTP protocol RFC1305 is based on the server-client principle and only supports synchronization with UTC universal time.[k] For more details on the NTP standard used, visit datatracker.ietf.org.

NTP Configuration

The NTP client is deactivated by default. The NTP client can be configured either by using the web interface or directly through a JSON object sent in an "HTTP request".

The configuration URL is: `http://[ip-address]/w/config/ntpc.json`

The configuration can also be read back as a JSON file: `http://[ip-address]/r/config/ntpc.json`

The configuration takes the form of a JSON object, with each JSONMember representing a configuration element. The object does not have to contain all elements. Only the elements provided will be changed. Any configuration changes will not take effect until after a device reboot.

j. NTP = Network Time Protocol

k. UTC = Coordinated Universal Time

The following configuration elements are available:

NTP Configuration

Name	Data Type	Description	Example
NTP client status 1/2/10/60	boolean	Master switch for the NTP client	true/**false**[1]
Server address	string	NTP server IP address	192.168.1.50
Server port	integer	Port of the NTP server	**123**
Update interval	integer	Interval at which the client connects to the configured NTP server. Note: The value is specified in seconds.	1/2/10/**60**

Table 12.41

1. bold = standard

NTP Response:

The resulting response is a JSON object with a "status" field. The status should be "0" if no error occurs and "-1" if an error occurs.

In the event of an error, the response contains an error array.

The error array contains an error object for each error that occurred. The object consists of an "Element" field, which identifies the configuration element that caused the error, and a "Message" field for the error message.

Example

```
{"status": -1, "error": [{"Element": "ntpc-enable", "Message":
"Boolean expected"}]}
{"status": 0}
{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
object"}]}
```

NTP Configuration - Quick Start

Caution!

Third party

Pepperl+Fuchs assumes no responsibility for any content contained on the referenced websites and does not guarantee the functionality of the third-party software mentioned above.

NTP Configuration via JSON

1. Depending on your application, download and install Insomnia or a similar application: insomnia.rest/download/.
2. Configure NTP
   POST: `[IP-address]/w/config/ntpc.json`

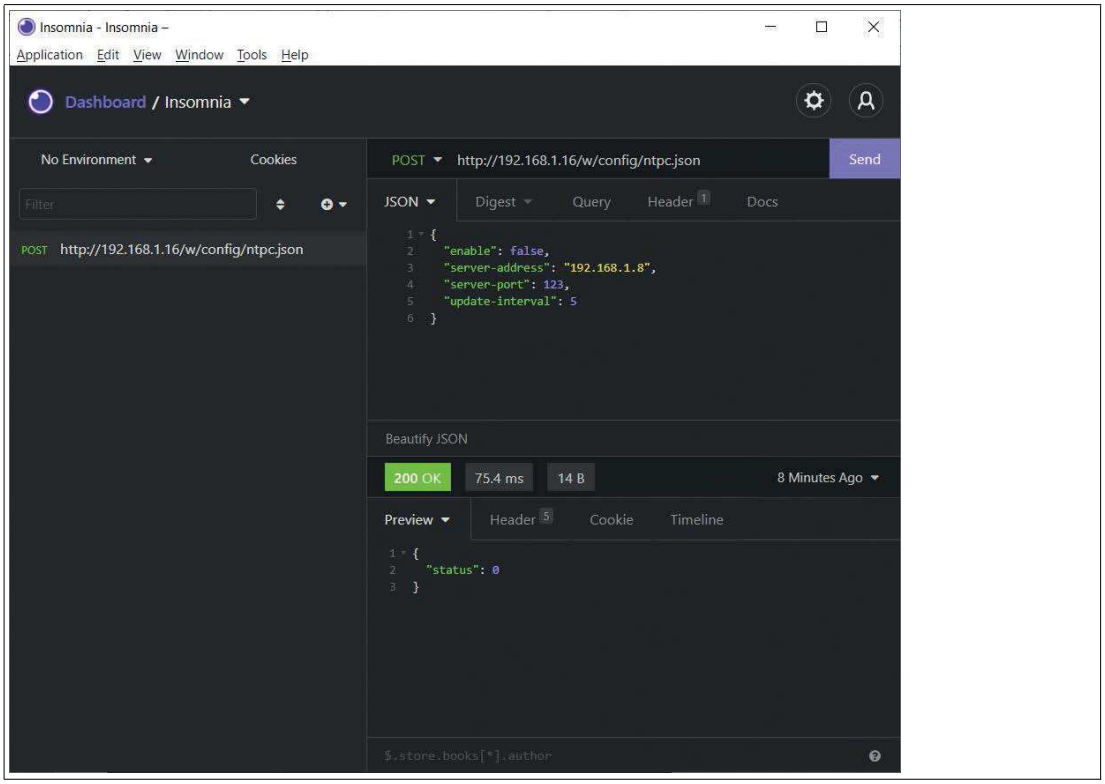


Figure 12.9

3. Read NTP from:
GET: `[IP-address]/r/config/ntpc.json`

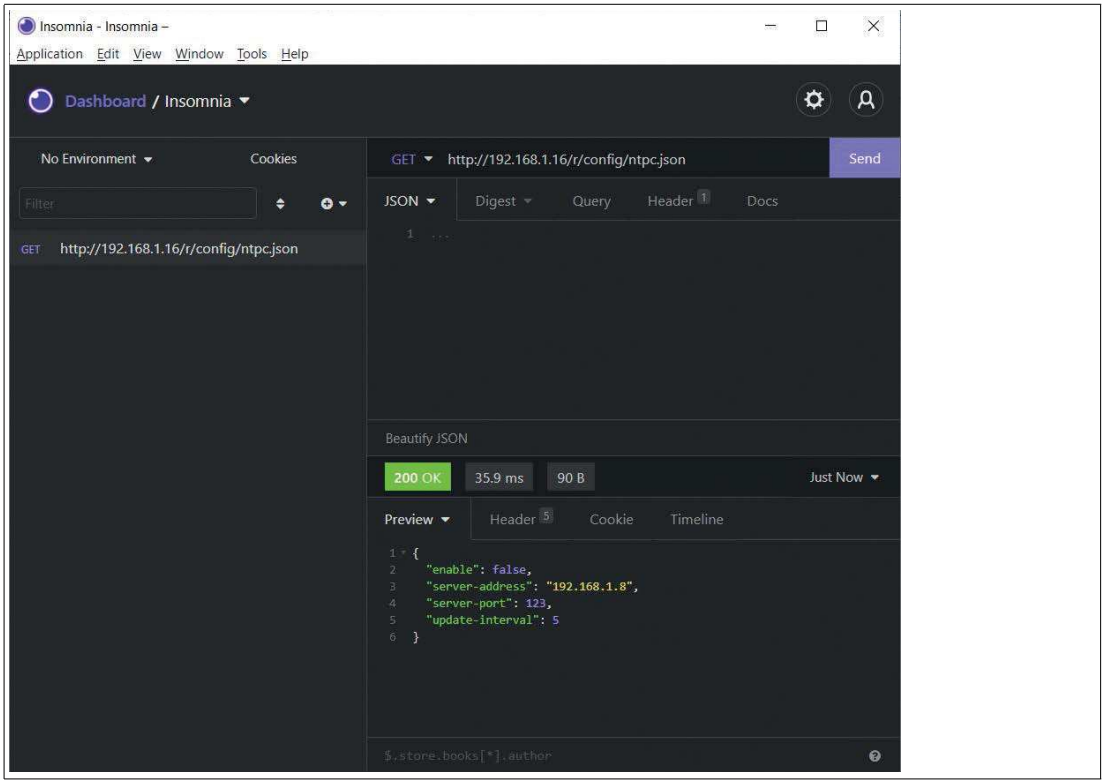


Figure 12.10

13 Troubleshooting

13.1 Diagnostics Indicator in the Integrated Web Server

The module shows the error diagnostics on the connection page of the integrated web server. For information on how to call up the connection page, .

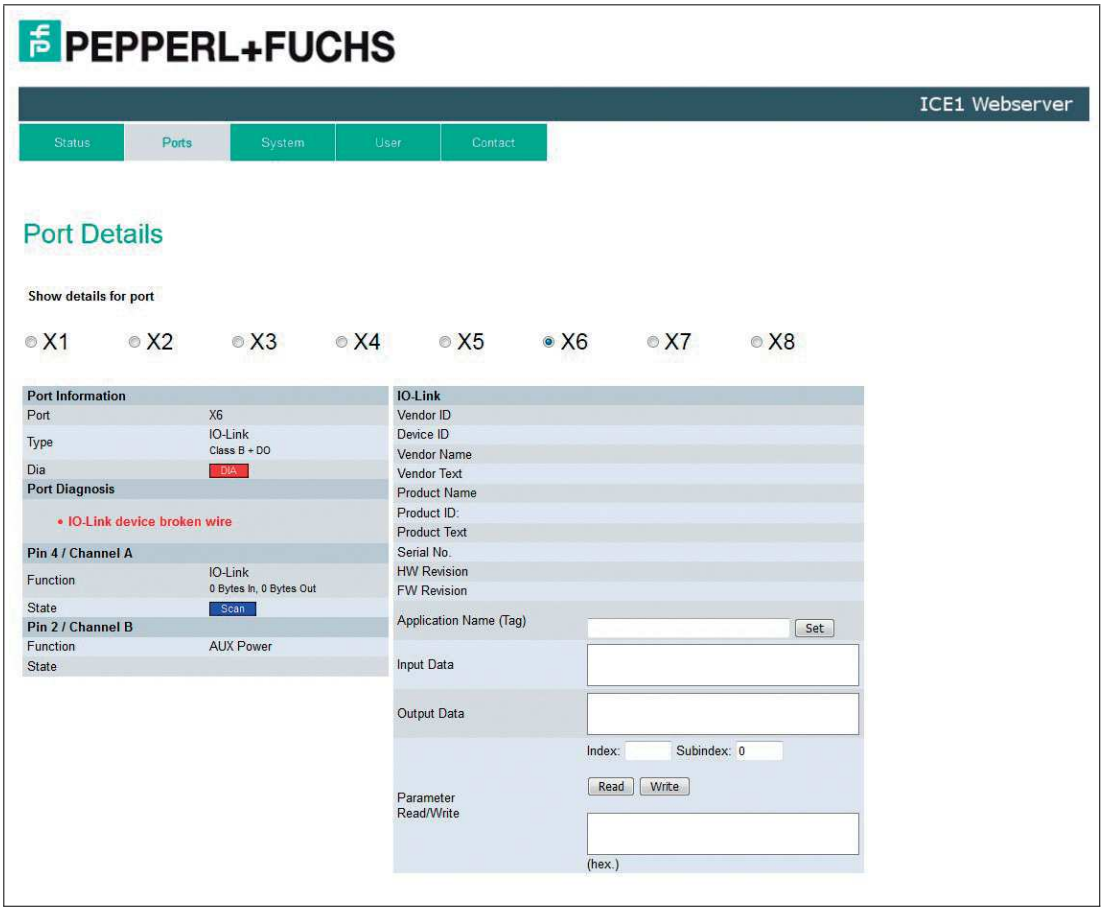


Figure 13.1

Diagnostic data is displayed in the "Port Diagnosis" area of the connection page, according to the connection.

13.2 Diagnostic Processing via CC-Link

Port no.	Register for diagnosis	Description	Access
X1	X20	X1 IO-Link data valid	RO[1]
X2	X21	X2 IO-Link data valid	RO
X3	X22	X3 IO-Link data valid	RO
X4	X23	X4 IO-Link data valid	RO
X5	X24	X5 IO-Link data valid	RO
X6	X25	X6 IO-Link data valid	RO
X7	X26	X7 IO-Link data valid	RO
X8	X27	X8 IO-Link data valid	RO

Table 13.1

1. Read-only

2024-04

Serial no.	Register for diagnosis	Description	Access
1	X38	U_S supply present	RO[1]
2	X39	U_S supply fault	RO
3	X3A	U_L supply present	RO
4	X3B	U_L supply fault	RO
5	X3C	Internal module error	RO
6	X3D	Force-mode diagnosis	RO

Table 13.2

1. Read-only

System supply/sensor supply fault

The level of the voltage value of the incoming system/sensor supply is monitored globally. If the voltage falls below approx. 18 V or the voltage exceeds approx. 30 V, an error diagnosis is generated. The IO-Link specification requires at least 20 V at the L+[a] output supply of the I/O ports. A minimum of 21 V is required at the U_S power supply for the IO-Link master to minimize the risk of internal voltage drops in the IO-Link master.

The green U_S indicator goes out.

The fault diagnosis has no effect on the outputs.

Caution!

Error message in the event of low voltage

Ensure that the supply voltage, measured at the most remote node, does not fall below 21 V DC in terms of system power supply.

Auxiliary/actuator power supply fault

The level of the voltage value of the incoming auxiliary/actuator supply is monitored globally. If Report U_L/U_{AUX} Supply Voltage Fault diagnosis is enabled, a diagnosis is generated if the voltage falls below approx. 18 V or the voltage exceeds approx. 30 V. The U_L/U_{AUX} indicator lights up red.

If output channels are set to High State and Report DO Fault without U_L/U_{AUX}, further error messages caused by the voltage fault are generated on the channels.

If Report U_L/U_{AUX} Supply Voltage Fault is disabled, U_L/U_{AUX} or channel diagnoses do not occur.

Overload/short-circuit of the digital outputs

In the event of an overload or a short-circuit of an output channel, the following channel-specific diagnoses are generated in the data image being created:

Port no.	Pin	Register for diagnosis	Description	Access
X1	4	X10	X1 channel A short-circuit	RO[1]
	2	X11	X1 channel B short-circuit	RO
X2	4	X12	X2 channel A short-circuit	RO
	2	X13	X2 channel B short-circuit	RO

a. Pin1

Port no.	Pin	Register for diagnosis	Description	Access
X3	4	X14	X3 channel A short-circuit	RO
	2	X15	X3 channel B short-circuit	RO
X4	4	X16	X4 channel A short-circuit	RO
	2	X17	X4 channel B short-circuit	RO
X5	4	X18	X5 channel A short-circuit	RO
	2	X19	X5 channel B short-circuit	RO
X6	4	X1A	X6 channel A short-circuit	RO
	2	X1B	X6 channel B short-circuit	RO
X7	4	X1C	X7 channel A short-circuit	RO
	2	X1D	X7 channel B short-circuit	RO
X8	4	X1E	X8 channel A short-circuit	RO
	2	X1F	X8 channel B short-circuit	RO

Table 13.3

1. Read-only

A channel error is determined by comparing the setpoint set by a controller with the physical value of an output channel.

Activation of an output channel[b] filters the channel errors for the time period set by the "Surveillance timeout" parameter via the configuration of the device. The value of this parameter can range from 0 to 255 ms; the default setting is 80 ms

The filter is used to prevent premature error messages when you switch on a capacitive load, switch off an inductive load or in the event of other voltage peaks during a status change.

Actuator power supply overload/short-circuit

The B-channel outputs of X5 to X8 are supplied by the U_{AUX} voltage. In the event of an overload or short-circuit of the actuator power supply of ports X5 to X8, the following channel-specific diagnoses are generated in the data image being created.

Port no.	Register for diagnosis	Description	Access
X1	X30	Reserved	RO[1]
X2	X31	Reserved	RO
X3	X32	Reserved	RO
X4	X33	Reserved	RO
X5	X34	X5 actuator supply short-circuit	RO
X6	X35	X6 actuator supply short-circuit	RO
X7	X36	X7 actuator supply short-circuit	RO
X8	X37	X8 actuator supply short-circuit	RO

Table 13.4

1. Read-only

b. rising edge of the channel status

Overload/short-circuit of the I/O port sensor supply outputs

In the event of an overload or short-circuit between pin 1 and pin 3 of ports X1 to X8, the following channel-specific diagnoses are generated in the data image being created.

Port no.	Register for diagnosis	Description	Access
X1	X28	X1 sensor short-circuit	RO[1]
X2	X29	X2 sensor short-circuit	RO
X3	X2A	X3 sensor short-circuit	RO
X4	X2B	X4 sensor short-circuit	RO
X5	X2C	X5 sensor short-circuit	RO
X6	X2D	X6 sensor short-circuit	RO
X7	X2E	X7 sensor short-circuit	RO
X8	X2F	X8 sensor short-circuit	RO

Table 13.5

1. Read-only

13.3 Alarm Signals and Error Messages from Modules via EtherCAT

If a recognized fault is detected during parameterization, the module sends error messages to the master. The coding of the first and second parts of the error messages is based on specifications CiA 301 and CiA 401. The third part of the error message is the known (manufacturer-defined) diagnosis register.

The error message is in an 8 byte format and is coded as follows:

Contents of an Error Message

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Error code		Error register CoE 0x1001	Diagnosis register				

Table 13.6

Contents of the Error Register (CoE Register 0x1001):

Error code Byte 1, byte 2	Error register (CoE 0x1001), byte 3							
	B7	B6	B5	B4	B3	B1	B0	Description of the fault (Bit 7–Bit 0)
0x0000	0	0	0	0	0	0	0	No error
0x2300	0	0	0	0	0	1	1	Output overload, MI-SCS or MI-SCA
0x3100	0	0	0	0	1	0	1	Voltage error, MI-LVS
0x3300	0	0	0	0	1	0	1	Voltage error at outputs, MI-LVA
0xF000	1	0	0	0	0	0	1	Additional "Forcing" function, MI-FC
0xFF00	1	0	0	0	0	0	1	Additional "device diagnosis" function, MI-IME

Content of the Diagnosis Register

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 4	MI-IME	MI-FC	0	0	MI-SCA	MI-SCS	MI-LVA	MI-LVS
Byte 5	SCS-X8	SCS-X7	SCS-X6	SCS-X5	SCS-X4	SCS-X3	SCS-X2	SCS-X1
Byte 6	CE-X4B	CE-X4A	CE-X2B	CE-X2A	CE-X2A	CE-X2A	CE-X1B	CE-X1A

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 7	CE-X8B	CE-X8A	CE-X7B	CE-X7A	CE-X6A	CE-X6A	CE-X5B	CE-X5A
Byte 8	0	0	0	0	0	0	0	0

Legend:

- **MI-LVS**: Module information byte—voltage for power/sensor supply low
- **MI-LVA**: Module information byte—voltage for actuator low
- **MI-SCS**: Module information byte—sensor short circuit on an M12 slot
- **MI-SCA**: Module information byte—actuator short circuit
- **MI-FC**: Module information byte—forcing active
- **MI-IME**: Module information byte—internal module error
- **CE-X1A ... CE-X8A**: Channel error, channel A (pin 4) of slots X1 to X8
- **CE-X1B ... CE-X8B**: Channel error, channel B (pin 2) of slots X1 to X8

The following example shows the error message received by a TwinCAT master regarding an actuator voltage power fault:

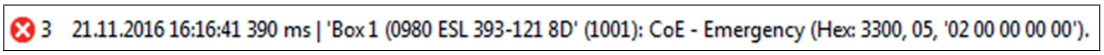


Figure 13.2

13.4 Diagnostic Processing via EtherNet/IP

Errors in the System/Sensor Power Supply

The voltage value of the power supply for the system and the sensors is monitored globally.

If the voltage falls below approx. 18 V or rises above 30 V, fault diagnosis is generated.

The green U_S LED is switched off.

The error message has no effect on the outputs.

Caution!

Power supply

It must be ensured that the supply voltage, measured at the most remote node, does not fall below 21 V_{DC}.

The following diagnosis is generated in the "producing" data image:

General Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	IME	FME	DTO	DTU	SCA	SCS	LVA	**LVS**
Byte 1	0	0	0	0	IDN	IDW	IDE	IVE

Table 13.7 General Bit

This includes:

- **IME**: Module information - internal module error
- **FME**: Module information - Force mode activated
- **DTO**: Module information - excess temperature
- **DTU**: Module information - insufficient temperature
- **SCA**: Module information - actuator short circuit channel A
- **SCS**: Module information - sensor short circuit
- **LVA**: Module information - auxiliary power supply low voltage
- **LVS**: Module information - system/sensor electric power supply low voltage
- **IDN**: IO-Link port information - device message
- **IDW**: IO-Link port information - device warning

2024-04

- **IDE**: IO-Link port information - device fault
- **IVE**: IO-Link port information - validation error

Error in the Auxiliary Voltage/Actuator Power Supply

The voltage value of the power supply for the auxiliary voltage/actuator power supply is monitored globally.

If the U_L/U_{AUX} diagnostic messaging is activated, an error message is generated as soon as the voltage falls below approx. 18 V or rises above 30 V.

The red U_L/U_{AUX} LED lights up.

If the output channels are enabled, additional error messages, which are caused by the power failure, are generated at the IO-Link connections.

The U_{AUX} diagnostic message is disabled by default and must be enabled through parameterization.

The following diagnosis is generated in the "producing" data image:

General Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	IME	FME	DTO	DTU	SCA	SCS	**LVA**	LVS
Byte 1	0	0	0	0	IDN	IDW	IDE	IVE

Table 13.8 General Bit

If output channels are set to High State and Report DO Fault without U_L/U_{AUX}, further error messages caused by the voltage error are generated on the channels.

The following diagnosis is generated in the producing data image:

Actuator/U_{AUX} Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	8	7	6	5	4	3	2	1
Byte 1	16	15	14	13	12	11	10	9

Table 13.9 Channel Number (fix)

- **1 ... 16**: Actuator/U_L/U_{AUX} channel error on channel 1 ... 16

If Report U_L/U_{AUX} Supply Voltage Fault is disabled, U_L/U_{AUX}or channel diagnoses do not occur.

Overload/Short Circuit of the Sensor Supply Outputs of the IO-Link Connections

In the event of an overload or short circuit between pin 1 and pin 3 at connections X1 ... X8, the following channel-specific diagnostic messages are generated in the producing data image:

General Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	IME	FME	DTO	DTU	SCA	**SCS**	LVA	LVS
Byte 1	0	0	0	0	IDN	IDW	IDE	IVE

Table 13.10 General Bit

Sensor Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	**X8**	**X7**	**X6**	**X5**	**X4**	**X3**	**X2**	**X1**
Byte 1	0	0	0	0	0	0	0	0

Table 13.11 Port Number

- **X1 ... X8**: Sensor short circuit at port X1 ... X8

Overload/short circuit of the digital outputs

In the event of an overload or a short circuit of an output channel, the following channel-specific diagrams are generated in the producing data image:

General Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	IME	FME	DTO	DTU	**SCA**	SCS	LVA	LVS
Byte 1	0	0	0	0	IDN	IDW	IDE	IVE

Table 13.12 General Bit

Actuator/U_{AUX} Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	8	7	6	5	4	3	2	1
Byte 1	16	15	14	13	12	11	10	9

Table 13.13 Channel Number (fix)

- **1 ... 16**: Actuator/U_L/U_{AUX} channel error on channel 1 ... 16

A channel error is determined by comparing the setpoint value set by a controller and the physical value of an output channel.

When an output channel is activated by a rising edge of the channel status, the channel errors are filtered for the duration specified via the "Surveillance Timeout" parameter when configuring the device. The value of this parameter covers a range of 0 to 255 ms; the factory setting is 80 ms.

The filter is used to prevent premature error messages when you switch on a capacitive load or switch off an inductive load, as well as other voltage peaks during a status change.

In the static state of the output channel, i.e., while it is permanently switched on, the filter time between fault detection and diagnosis is typically 5 ms.

IO-Link COM Error

If an IO-Link device is disconnected in COM mode, an incorrect IO-Link device is plugged in or an electrical fault occurs on the C/Q[c] line, for example due to a short circuit, the following diagnosis is generated in the producing data image:

IO-Link Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	**ICE8**	**ICE7**	**ICE6**	**ICE5**	**ICE4**	**ICE3**	**ICE2**	**ICE1**
Byte 1	0	0	0	0	0	0	0	0
Byte 2	IVE8	IVE7	IVE6	IVE5	IVE4	IVE3	IVE2	IVE1

c. Pin 4

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	IDE8	IDE7	IDE6	IDE5	IDE4	IDE3	IDE2	IDE1
Byte 4	IDW8	IDW7	IDW6	IDW5	IDW4	IDW3	IDW2	IDW1
Byte 5	IDN8	IDN7	IDN6	IDN5	IDN4	IDN3	IDN2	IDN1

Table 13.14 General Bit

This includes:

- **ICE1 ... 8**: IO-Link port information - COM error[d]
- **IDE1 ... 8**: IO-Link port information - device fault
- **IDN1 ... 8**: IO-Link port information - device message
- **IDW1 ... 8**: IO-Link port information - device warning
- **IVE1 ... 8**: IO-Link port information - validation error

IO-Link Validation Error

If an IO-Link device is replaced, the validation is already configured. The manufacturer and/or device ID do not correspond to the data of the device and the following diagnosis is generated in the producing data image:

IO-Link Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	ICE8	ICE7	ICE6	ICE5	ICE4	ICE3	ICE2	ICE1
Byte 1	0	0	0	0	0	0	0	0
Byte 2	**IVE8**	**IVE7**	**IVE6**	**IVE5**	**IVE4**	**IVE3**	**IVE2**	**IVE1**
Byte 3	IDE8	IDE7	IDE6	IDE5	IDE4	IDE3	IDE2	IDE1
Byte 4	IDW8	IDW7	IDW6	IDW5	IDW4	IDW3	IDW2	IDW1
Byte 5	IDN8	IDN7	IDN6	IDN5	IDN4	IDN3	IDN2	IDN1

Table 13.15 General Bit

If extended status data was activated when configuring an IO-Link port, the manufacturer ID and the device ID are also transferred to the producing data image.

IO-Link Device Diagnosis

The diagnosis of an IO-Link device is carried out in three stages: "Error", "Warning" or "Notification."

The following diagnosis is generated in the producing data image:

IO-Link Diagnostics

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	ICE8	ICE7	ICE6	ICE5	ICE4	ICE3	ICE2	ICE1
Byte 1	0	0	0	0	0	0	0	0
Byte 2	IVE8	IVE7	IVE6	IVE5	IVE4	IVE3	IVE2	IVE1
Byte 3	**IDE8**	**IDE7**	**IDE6**	**IDE5**	**IDE4**	**IDE3**	**IDE2**	**IDE1**
Byte 4	**IDW8**	**IDW7**	**IDW6**	**IDW5**	**IDW4**	**IDW3**	**IDW2**	**IDW1**
Byte 5	**IDN8**	**IDN7**	**IDN6**	**IDN5**	**IDN4**	**IDN3**	**IDN2**	**IDN1**

Table 13.16 General Bit

d. No device, damaged line, short circuit

If the IO-Link event data is activated by configuring an IO-Link port, the device also reports event codes in the producing data image. Use the documentation of your IO-Link device to decrypt the error messages.

13.5 Diagnostic Processing via Modbus

Register	Length	Description	Default	Access
400401	1	System/sensor supply voltage present 0: System/sensor supply voltage not present 1: System/sensor supply voltage present	-	RO[1]
400402	1	System/sensor supply voltage error 0: System/sensor supply voltage error does not exist 1: System/sensor supply voltage error occurred	-	RO
400403	1	Auxiliary/actuator supply voltage present 0: Auxiliary/actuator supply voltage not present 1: Auxiliary/actuator supply voltage present	-	RO
400404	1	Auxiliary/actuator supply voltage error 0: Auxiliary/actuator supply voltage error does not exist 1: Auxiliary/actuator supply voltage error occurred	-	RO
400405	1	Internal module error	-	RO
400406	1	Force-mode diagnostics	-	RO
400407	1	I/O port sensor supply output overload/short-circuit This register represents the overload/short-circuit status bit by bit	-	RO
400408	1	Overload/short-circuit of the digital outputs channel A, CQ This register shows the overload/short-circuit status of the digital outputs channel A, CQ bit by bit	-	RO
400409	1	IQ Short error Overload/short-circuit of the digital outputs channel B, IQ This register shows the overload/short-circuit status of the digital outputs channel B, IQ bit by bit.	-	RO
400410	1	Overload/short-circuit of the Class B actuator power supply This register shows the status of the Class B actuator power supply bit by bit		

Table 13.17

1. Read-only

Register	Length	Description	Default	Access
400426	1	Status of IO-Link Ch. 1	-	RO[1]
400427	1	Status of IO-Link Ch. 2	-	RO
400428	1	Status of IO-Link Ch. 3	-	RO
400429	1	Status of IO-Link Ch. 4	-	RO
400430	1	Status of IO-Link Ch. 5	-	RO
400431	1	Status of IO-Link Ch. 6	-	RO
400432	1	Status of IO-Link Ch. 7	-	RO
400433	1	Status of IO-Link Ch. 8	-	RO

Table 13.18

1. Read-only

2024-04

Register	Length	Description	Default	Access
402501	200	IO-Link Events Ch. 1	-	RO[1]
402701	200	IO-Link Events Ch. 2	-	RO
402901	200	IO-Link Events Ch. 3	-	RO
403101	200	IO-Link Events Ch. 4	-	RO
403301	200	IO-Link Events Ch. 5	-	RO
403501	200	IO-Link Events Ch. 6	-	RO
403701	200	IO-Link Events Ch. 7	-	RO
403901	200	IO-Link Events Ch. 8	-	RO

Table 13.19

1. Read-only

System supply/sensor supply fault

The level of the voltage value of the incoming system/sensor supply is monitored globally. If the voltage falls below approx. 18 V or the voltage exceeds approx. 30 V, a fault diagnosis is generated. The IO-Link specification requires at least 20 V at the L+[e] output supply of the I/O ports. A minimum of 21 V is required at the U_S power supply for the IO-Link master to minimize the risk of internal voltage drops in the IO-Link master.

The green U_S indicator goes out.

The fault diagnosis has no effect on the outputs.

Caution!

Error message in the event of low voltage

Ensure that the supply voltage, measured at the most remote node, does not fall below 21 V DC in terms of system power supply.

The diagnoses in holding register 400401 are updated.

Auxiliary/actuator power supply fault

The level of the voltage value of the incoming auxiliary/actuator supply is monitored globally. If Report U_L/U_{AUX} Supply Voltage Fault diagnosis is enabled, a diagnosis is generated if the voltage falls below approx. 18 V or the voltage exceeds approx. 30 V. The U_L/U_{AUX} indicator lights up red.

Holding register 400402 can be read to obtain the current status of the auxiliary/actuator power supply. The diagnostic data of holding register 400403 is updated.

If output channels are set to High State and Report DO Fault without U_L/U_{AUX}, further error messages caused by the voltage fault are generated on the channels.

If Report U_L/U_{AUX} Supply Voltage Fault is disabled, U_L/U_{AUX} or channel diagnoses do not occur.

e. Pin1

Overload/short-circuit of the I/O port sensor supply outputs

In the event of an overload or short-circuit between pin 1 and pin 3 of ports X1 to X8, holding register 400407 is updated with the following data:

Sensor supply short-circuit

400407	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X8	X7	X6	X5	X4	X3	X2	X1

Table 13.20

Overload/short-circuit of the digital outputs

In the event of an overload or short-circuit between pin 4 and pin 3 of ports X1 to X8, holding register 400408 is updated with the following data. This diagnosis is valid if channel A of the respective port is in Digital Output Mode.

Overload/short-circuit of channel A, CQ

400408	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X8	X7	X6	X5	X4	X3	X2	X1

Table 13.21

In the event of an overload or short-circuit between pin 2, channel B and pin 3 of ports X1 to X8, holding register 400409 is updated with the following data. This diagnosis is valid if channel A of the respective port is in Digital Output Mode.

Overload/short-circuit of channel B, IQ

400409	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X8	X7	X6	X5	X4	X3	X2	X1

Table 13.22

Overload/short-circuit of the I/O port sensor supply outputs

In the event of an overload or short-circuit between pin 1 and pin 3 of ports X1 to X8, holding register 400407 is updated with the following data:

Sensor supply short-circuit

400407	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X8	X7	X6	X5	X4	X3	X2	X1

Table 13.23

Overload/short-circuit of the Class B actuator power supply.

In the event of an overload or short-circuit of the Class B actuator power supply on ports X5 to X8, holding register 400410 is updated with the following data.

Overload/short-circuit of actuator power supply P24 (Class B)

400410	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X8	X7	X6	X5	X4	X3	X2	X1

Table 13.24

IO-Link channel status

IO-Link contains a default status value for the channels. The statuses of an individual IO-Link channel can be read in holding registers 400426 to 400433.

Status of the IO-Link channel

0 No device present
1 Disabled
2 Diagnostic mode
3 Pre-OP mode
4 OP mode
5 DI mode
6 DO mode
254 Power OFF
255 No status available

IO-Link channel events

During operation, the IO-Link master generates events for a specific channel. In holding registers 402501 to 404100, up to 32 events can be stored.

Register	Length	Description	Default	Access
402501	1	IO-Link Ch. 1 no. of events present	-	RO[1]
402502	5	IO-Link Ch. 1 Event 1	-	RO
402507	5	IO-Link Ch. 1 Event 2	-	RO
...		...		RO
402662	5	IO-Link Ch. 1 Event 32	-	RO
402667	33	Reserved	-	RO
402701	1	IO-Link Ch. 2 no. of events present	-	RO
402702	5	IO-Link Ch. 2 Event 1	-	RO
402707	5	IO-Link Ch. 2 Event 2	-	RO
...		...		RO
402762	5	IO-Link Ch. 2 Event 32	-	RO
402767	33	Reserved	-	RO
...		...		RO
403901	1	IO-Link Ch. 8 no. of events present	-	RO
403902	5	IO-Link Ch. 8 Event 1	-	RO
403907	5	IO-Link Ch. 8 Event 2	-	RO
...		...		RO
403962	5	IO-Link Ch. 8 Event 32	-	RO
403967	33	Reserved	-	RO

Table 13.25

1. Read-only

The following example shows details of a single event that applies to all 32 events on 8 channels:

Register	Length	Description	Default	Access
402502	2	Timestamp	-	RO[1]
402504	1	Event type, classification	-	RO
402505	1	Event code	-	RO
402506	1	Reserved	-	RO

Table 13.26

1. Read-only

The 32 event registers act like a ring buffer. Once the FIFO buffer is full, the earliest event is removed from the buffer and all other events are moved up one level. The latest event details are then available under Event 32.

Timestamp

Local timestamp of a device. Requires four bytes.

Event type

Classification of events. There are three different types of events. The type is classified via values 1 to 3 in the respective holding register.

1 Notification

2 Warning

3 Error

Event code

The event code represents a unique code for individual events according to the IO-Link specifications. The following event code(s) are generated in the respective holding register.

0x1000 General malfunction

0x1800 No device

0x1801 Parameterization error when powering up the device

0x1802 Incorrect manufacturer ID - Inspection level mismatch

0x1803 Incorrect device ID - Inspection level mismatch

0x1804 Short-circuit on C/Q

0x1805 PHY above temperature

0x1806 Short-circuit on L+

0x1807 Overload on L+

0x1808 Devices event overflow

0x1809 Backup inconsistency - outside the storage capacity

0x180A Backup inconsistency - identification error

0x180B Backup inconsistency - non-specific data storage error

0x180C Backup inconsistency - upload error

0x180D Parameter inconsistency—download error

0x180E P24, Class B missing or low voltage

0x180F Short-circuit on P24, Class B

0x1810 Short-circuit on I/Q

0x1811: Short-circuit on C/Q, Digital

0x1812	Overload on I/Q
0x1813	Overload on C/Q, Digital
0x6000	Invalid cycle time
0x6001	Revision fault
0x6002	ISDU batch failed
0xFF21	DL: Device inserted
0xFF22	Device communication lost
0xFF23	Data storage identification mismatch
0xFF24	Data storage buffer overflow
0xFF25	Data storage parameter access denied
0xFF26	Port status changed
0xFF27	Data storage upload complete
0xFF31	DL: Incorrect event signal

Table 13.27

13.6 Alarm Signals and Error Messages from Modules via PROFINET

Note

Alarm signals and error messages are only transmitted via PROFINET if the parameter for diagnosis is activated in the controller when the modules are configured.

If the modules detect a fault state, they trigger an alarm signal. The modules support diagnostic alarms. Diagnostic alarms are triggered by periphery faults, such as overloads, short circuits, and low voltage.

An alarm is triggered both by incoming events (e.g., sensor short circuits) and outgoing events.

The alarms are evaluated dependent on the PROFINET IO controller used.

Evaluating Alarms in the TIA portal

If a diagnostics alarm is triggered, the user program in the TIA portal is interrupted and a diagnostics block is called. The following blocks are used:

Cause	OB call
Diagnostics alarm (short circuit, overload, wire break, low voltage on an I/O module)	OB82
Failure of a station or a rack	OB86

The initial information regarding the cause and type of fault is provided by the OB called and its start information. More detailed information regarding the error event can be obtained in the error OB by calling RALRM_SFB [SFB54] (read supplementary alarm information). For this purpose, SFB 54 must called in every error OB.

If the error OB called does not exist in the CPU, the CPU switches into the STOP operating state.

The Structure of the Diagnostics Data Records

Block version 0x0101 and the format identifier (USI, User Structure Identifier) 0x8000 are used to display the diagnostics data records.

The data values "ChannelNumber" and "ChannelError" contain the following values, depending on the error that has occurred:

Type of error	Source of fault	Channel number	Error code
Undervoltage/overvoltage of sensor/system power supply	Module	0x8000 (diagnosis not channel-specific)	0x0002
Auxiliary voltage/actuator voltage too low	Auxiliary voltage	0x8000 (diagnosis not channel-specific)	0x0103
Overload/short circuit of the sensor supply	IO port (pin 1)	0x01 to 0x08	0x01
Port driver temperature excess	IO port (pin 1)	0x01 to 0x08	0x0113
Overload/short circuit of the digital 500 mA outputs	IO port (pin 4)	0x01 to 0x08	0x010A
Overload/short circuit of the digital 2 A outputs	IO port (pin 2)	0x05 - 0x08	0x0109
Overload/short circuit of auxiliary power supply (U_{Aux}) at Class B port	IO port (pin 2)	0x05 - 0x08	0x0108
IO-Link C/Q Error	IO port (pin 4)	0x01 - 0x08	0x0006
IO-Link device diagnosis	IO-Link device	0x01 - 0x08	Dependent on the IO-Link device diagnosis Extended diagnosis: 0x9000

Display of diagnosis in the TIA Portal

1. Select the faulty I/O module in the hardware manager and navigate to its device view.
2. Select the affected channel/the submodule.
3. Open the online diagnostics by right-clicking with the mouse and select the menu item "Online & diagnostics > Channel diagnostics."

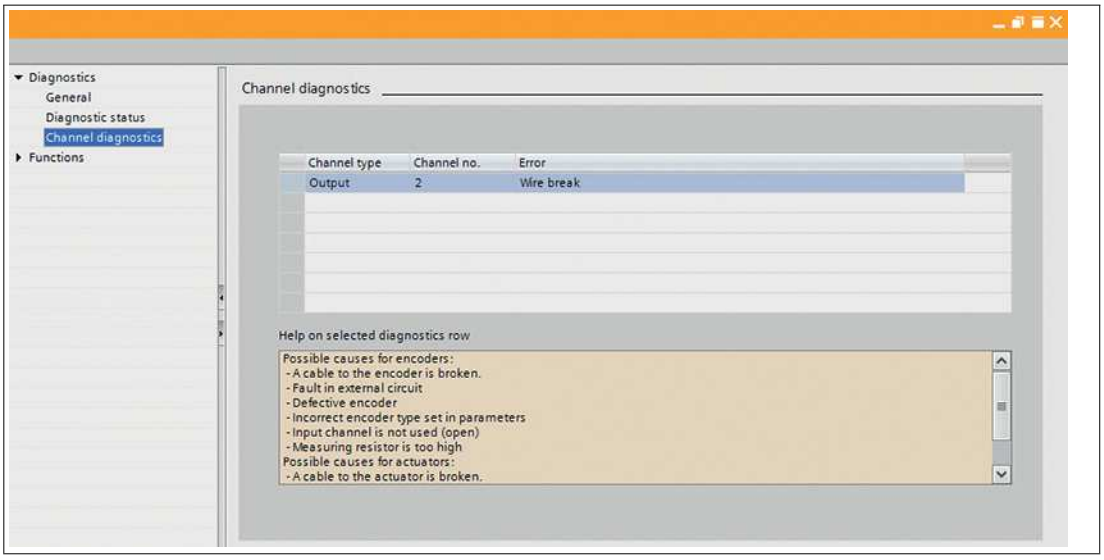


Figure 13.3

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