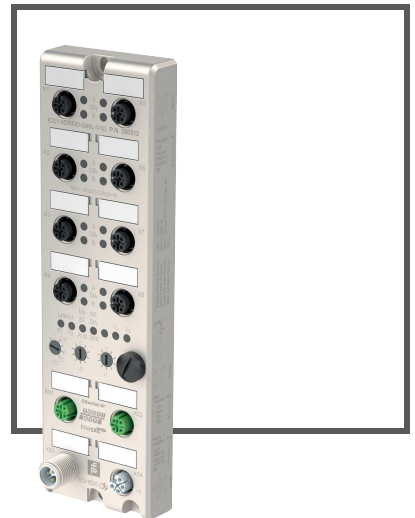# MANUAL

ICE1-8DI8DO-G60L-V1D
ICE1-8DI8DO-G60L-C1-V1D
ICE1-16DI-G60L-V1D
Fieldbus Modules with Multiprotocol Technology

EtherCAT®

PROFI NET®

EtherNet/IP™

PEPPERL+FUCHS

SENSING YOUR NEEDS

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With regard to the supply of products, the current issue of the following document is applicable: The General Terms of Delivery for Products and Services of the Electrical Industry, published by the Central Association of the Electrical Industry (Zentralverband Elektrotechnik und Elektroindustrie (ZVEI) e.V.) in its most recent version as well as the supplementary clause: "Expanded reservation of proprietorship"

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1 Safety

1.1 Introduction

1.1.1 Contents

This document contains information that you need in order to use your product throughout the applicable stages of the product life cycle. These can include the following:

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

Note!

This document does not substitute the instruction manual.

Note!

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

The documentation consists of the following parts:

- Present document
- Instruction manual
- Datasheet

Additionally, the following parts may belong to the documentation, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Additional documents

1.1.2 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.

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1.1.3 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

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

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2   Product Description

2.1   Use and Application

The ICE1-*-G60L-*- modules function as an interface in an industrial fieldbus system. They enable communication between a central controller at the control level and the decentralized sensors and actuators at the field level. The resulting potential line or ring topologies that can be achieved enable reliable data communication and a significant reduction in the amount of wiring required, which therefore makes the costs for installation and maintenance reasonable. Simple and rapid extension is also possible.

The ICE1-*-G60L-*- series modules have a robust metal housing made of die-cast zinc. Due to the fully encapsulated device housing, the module electronics are protected against environmental influences and can be used in a wide range of temperatures. Despite the robust design, the modules have compact dimensions and a low weight. They are especially suitable for use in machines and plants with a moderate I/O concentration on distributed assemblies.

Multiprotocol

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

Using rotary coding switches in the lower area of the modules, you can comfortably and easily set both the protocol and the address of the module, provided 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.

Special Product Features

- **Robust design:**

   Connectivity options for the module series include the widespread M12 connector with A encoding for I/O signals and D coding for the network. In addition, the connectors are color-coded to prevent confusion of the ports. The output circuits are galvanically isolated from the rest of the network and the sensor electronics. Controllers are therefore reliably protected against noise.

- **Integrated web server:**

   Network parameters such as IP address, subnet mask, and gateway can be adjusted via control switches (last byte of the IP address) or the integrated web server. The modules support the communication protocols BOOTP and DHCP for automated assignment of network parameters via the corresponding servers.

- **Integrated network switch:**

   The integrated two-port Ethernet switch of the modules allows you to set up a line topology for an EtherCAT® network or a ring topology for the EtherNet/IP network or PROFINET network. The additionally implemented 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 to an alternative ring segment and thus ensure interruption-free operation. The DLR class supported is "beacon-based" in accordance with the EtherNet/IP specification.

- **Fail-safe function:**

   The modules with output functionality (variant 8DI8DO) offer 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.

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■ **QuickConnect:**

QuickConnect allows the modules to quickly record the communication in an EtherNet/IP network thanks to an accelerated boot-up process. This allows you to switch tools more quickly, for example.

2.2 Indicators and Operating Elements
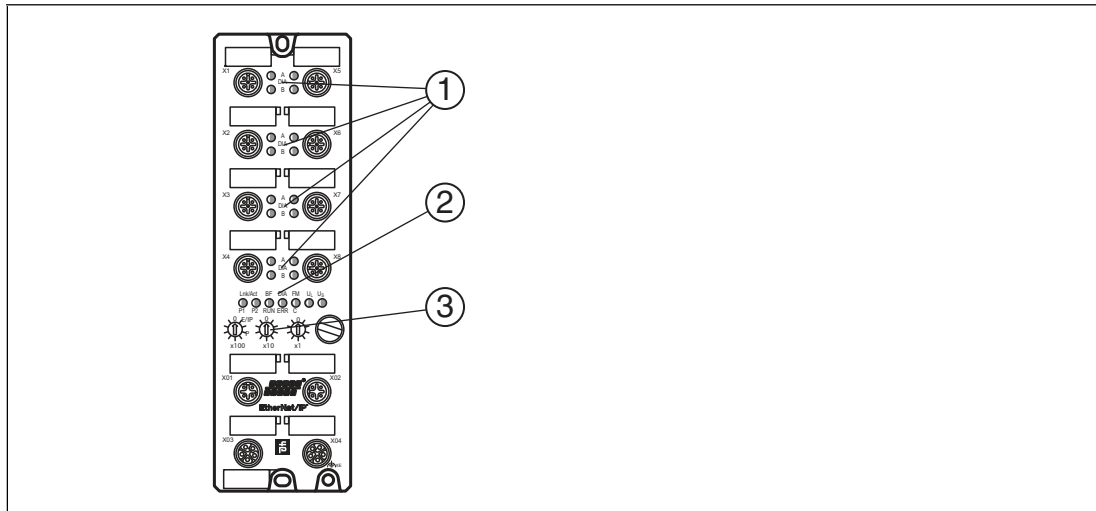
1 LED channel indicator

2 LED status indicator

3 Rotary switch

Indicators

LED	Function
LED BF	Red: no configuration, slow or no physical connection Flashing red at 2 Hz: no data exchange Off: no error message present
LED DIA B	White: channel status Red: peripheral error
LED Lnk/Act P1	Green: connection to an Ethernet node Flashing yellow: data exchange with an IO device Off: no connection
LED Lnk/Act P2	Green: connection to an Ethernet node Flashing yellow: data exchange with an IO device Off: no connection
LED DIA	Red: watchdog timeout; diagnosis exists; system error Flashing red at 2 Hz for 3 s: DCP signal service triggered via a bus Off: no error message present
LED RUN	Green: module ready for operation Flashing green: missing configuration Flashing red/green: self-test Red: non-recoverable, serious error Flashing red: minor recoverable error (e.g., incorrect configuration) Off: device switched off
	In addition/alternatively with EtherCAT: Green: OPERATIONAL status 1 x green flash: SAFE OPERATIONAL status Flashing red: PRE-OPERATIONAL status Off: INIT status Flickering: module booting up; BOOTSTRAP status

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LED	Function
LED ERROR	Green: connection to the master Flashing green: no connection to the master, IP address available Red: IP address already in use Flashing red: connection timeout or interrupted Flashing red/green: self-test Off: device is switched off, no IP address available
	In addition/alternatively with EtherCAT: Red: control error, e.g., PDI watchdog timeout Flickering: error during booting Flashing red: incorrect configuration; general configuration error 1 x red flash: local error, undesired status change 2 x red flash: watchdog error Off: no error message present
LED U_S	Green: voltage $19\ V \leq U_S \leq 30\ V$ Red: voltage $U_S < 19\ V$ or $U_S > 30\ V$
LED U_L[1]	Green: voltage $19\ V \leq U_L \leq 30\ V$ Red: voltage $U_L < 19\ V$ or $U_L > 30\ V$

1.Only 8DI8DO

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

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2.3 Interfaces and Connections

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

Fieldbus Connection

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

Figure 2.1   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 2.1   Assignment of port X01, X02

Caution!

Risk of destruction!

Never route the power supply to the data cable.

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.

Connection for the Power Supply

- Power supply with M12 power L-coded
- Color coding: gray
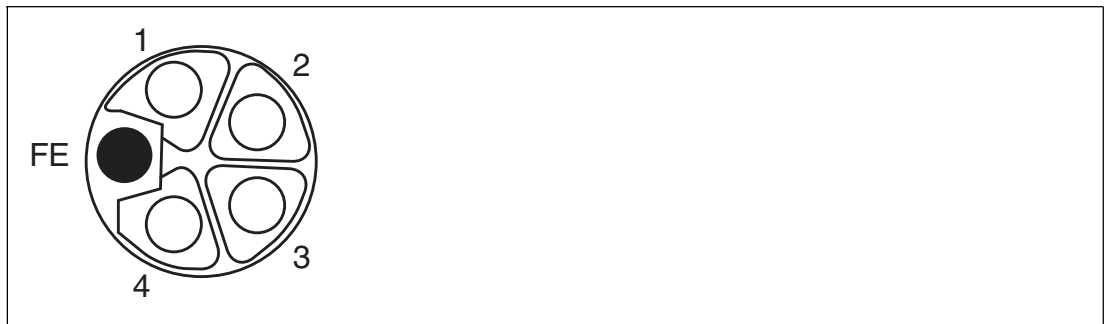
Figure 2.2   Schematic drawing of M12 L-encoding (plug); port X03 (IN)

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Figure 2.3   Schematic drawing of M12 L-encoding (socket); port X04 (OUT)

Port	Pin	Signal	Function
Power supply X03, X04	1	U_S(+24 V)	Sensor/system supply
	2	GND U_L	Ground/reference potential V_{Aux}
	3	GND U_S	Ground/reference potential V_s
	4	U_L (+24 V)	Auxiliary power supply (galv. separated)
	FE (5)	FE (FE)	Functional ground

2.4   Dimensions
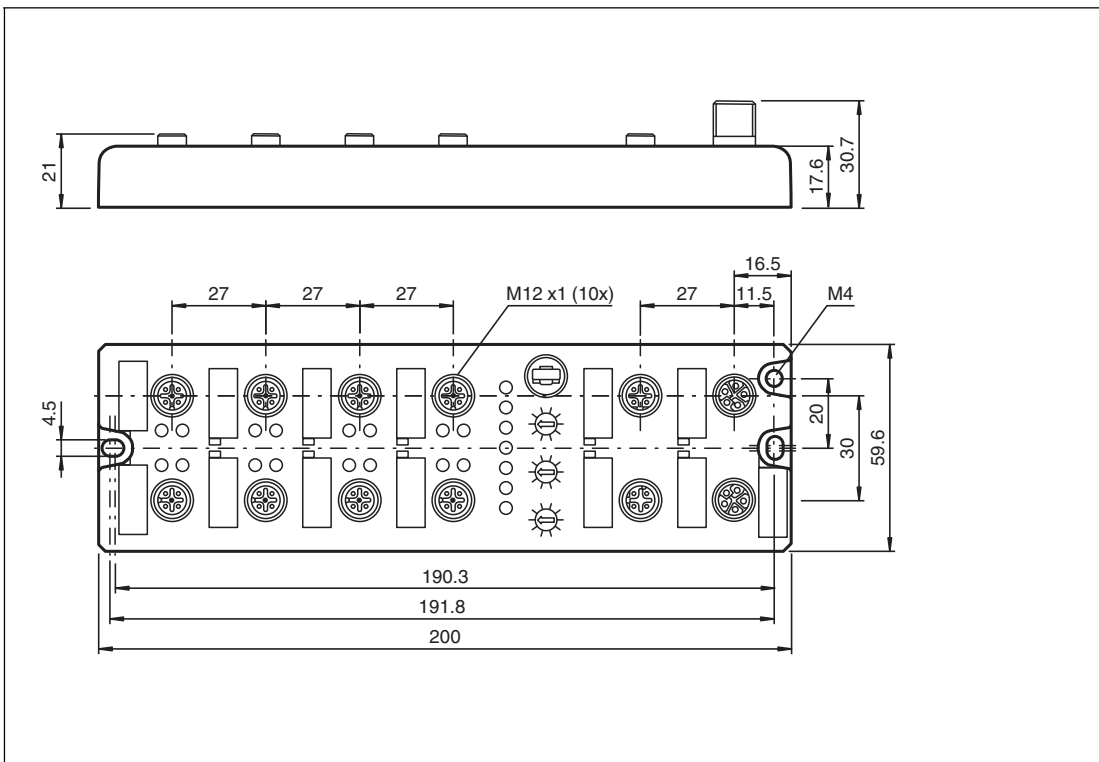
Figure 2.4   ICE1-8DI8DO-G60L-V1D
                     ICE1-8DI8DO-G60L-C1-V1D
                     ICE1-16DI-G60L-V1D

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3 Installation

3.1 General Information

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

Note!

To dissipate interference currents and the EMC resistance, the modules use a short circuit to ground 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.

Note!

Use a suitable UL-certified cable (CYJV or PVVA). To program the controller, please consult the manufacturer information and use only the appropriate accessories.

Note!

For UL application:

Approved only for indoor use. Please observe the maximum altitude of 2000 meters. Approved up to a maximum of pollution degree 2.

Warning!

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

Warning!

Use temperature-resistant cables with the following properties:

Heat-resistance up to at least 96 °C for modules ICE1-8DI8DO-G60L-C1-V1D and ICE1-8DI8DO-G60L-V1D.

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4 Commissioning

4.1 Setting Protocols

Multiprotocol

You can use the multiprotocol modules to select various protocols for communication within a fieldbus system. This allows you to integrate the multi-protocol modules into different networks without having to obtain a specific module 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 if the protocol to be used supports this. Once you have selected a protocol and started the cyclical communication, the module recognizes these settings 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. Alter the switch position for the first rotary switch X100 to set the protocol. For the other rotary switches, set the last two digits of the IP address when using EtherNet/IP.
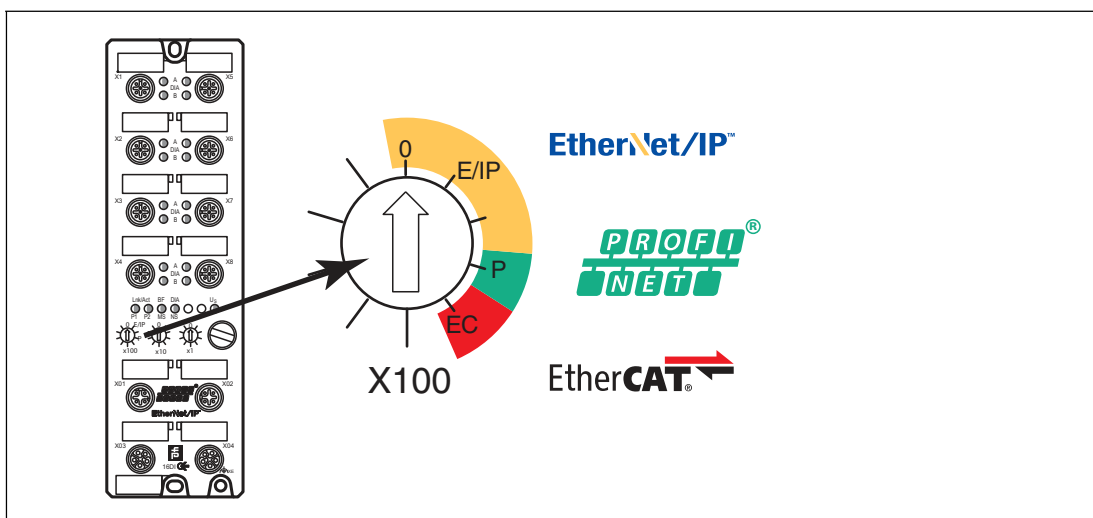
Figure 4.1   Rotary switch X100

Assigning the Protocol Using the Rotary Switches

Protocol	X100	X10	X1
EtherNet/IP	0-2	0-9	0-9
PROFINET	P	-	-
EtherCAT	EC	-	-

The default settings of the module do not contain any protocol settings. In this case, simply select the desired protocol. To use a modified rotary switch setting (protocol setting), you have to execute a power cycle or "Reset" of the web interface. Once you have set the protocol using the rotary switches, the module saves these settings as soon as it starts a cyclical communication. From this point, you can no longer change the protocol using the rotary switches. To change the protocol, perform a factory reset first.

If you set the rotary coding switches 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 selected protocol.

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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. With rotary switch X100 you can set a value of 0 to 2 for the IP address. With rotary switches X10 and X1, you can select values between 0 and 9. You can use rotary switch X10 to configure position 10 of the last octet of the IP address. With rotary switch X1 you can 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.

PROFINET

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

EtherCAT

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

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.

To select a new protocol, follow the instructions in this chapter.
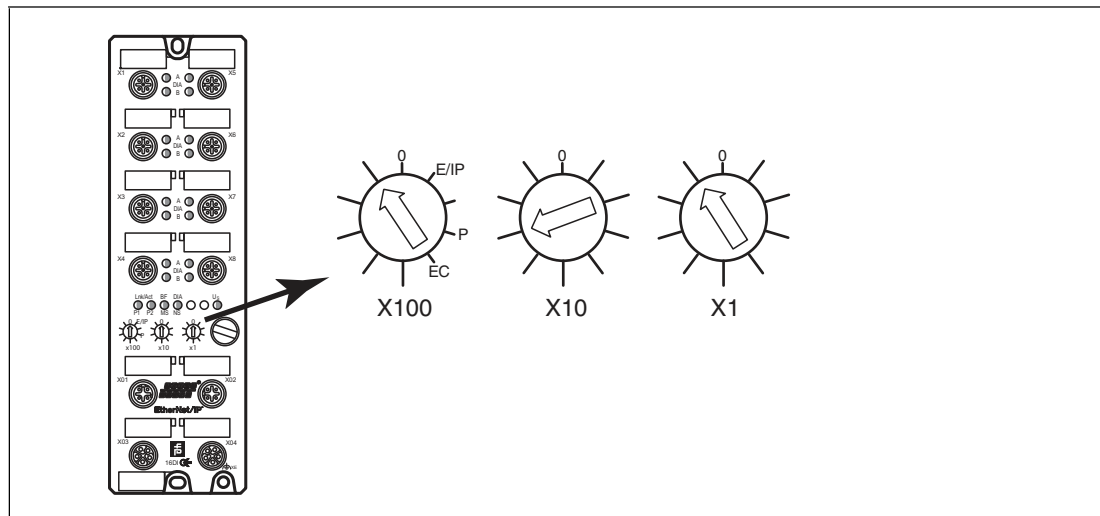
Figure 4.2   Restoring factory settings: X100 = 9, X10 = 7, X1 = 9

⚠ Caution!

Destruction of the Operating System

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

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4.2   EtherNet IP

4.2.1   Preparation

To configure a module in the controller, you need an EDS file. Each of the three module variants requires its own EDS file.

Downloading the EDS File

You can find the relevant EDS file in the **Software** 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 enter information about the device, e.g., the product designation or the item number, in the search function.

Use the hardware or network configuration tools from your controller manufacturer to install the EDS file for the module variant used. After installation, the modules can be found in the hardware catalog as "General Purpose Discrete I/O" devices.

Reading MAC IDs

Each module has a unique, vendor-assigned MAC ID that cannot be changed by the user. The assigned MAC ID is printed on the right-hand side of the module.

Setting the Network Parameters

Using the three control switches on the front of the modules, you can set the operating mode for receiving network parameters such as the IP address, subnet mask, and gateway address.

Please note that a fixed IP address is required to use QuickConnect.

Once the power supply has been restored, the modules read in the switch positions. The selected operating mode overwrites the saved settings.

The devices support the protocols DHCP and BOOTP for receiving the required network parameters such as IP address and subnet mask.

The factory settings of the static network parameters are:

- IP address: 192.168.001.001

- Subnet mask: 255.255.255.000

- Gateway address: 000.000.000.000

The following settings are possible via the rotary coding switches:

Rotary switch position	Function
000 (As delivered)	The DHCP and BOOTP functionality is activated as standard on delivery. The network parameters are initially requested using DHCP requests. If this is not successful, the request is made using BOOTP requests. The network parameters are not saved; however, it is possible to save them via the integrated web server.
000 (Network parameters already saved)	The last-saved network parameters are used (IP address, subnet mask, gateway address, DHCP on/off , BOOTP on/off).
001 to 254	The last three digits of the saved or default IP address are overwritten by the control switch setting.
255 to 998 (Exception: 888)	The network parameters are requested via DHCP and BOOTP but are not saved.
979	The device performs a reset to factory settings. The network parameters are also reset to the default values. In this operating mode, communication is not possible.

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4.2.2 Configuration

Connections and Assembly Object

The modules support exclusive owner, input only, and listen only connections.

■ **Exclusive owner**

This connection is bidirectional: the controller sends data to the module and the module sends data to the controller. This type of connection is known as exclusive owner because it connects each module **individually** to the controller.

■ **Input only**

With this type of connection, only the module sends data to the controller. The module sends a heartbeat, possibly at reduced intervals. This enables the controller to detect interruptions to the connection.

■ **Listen only**

This connection corresponds to the input only connection but can only be established if an exclusive owner or input only connection also exists between another module and the controller.

An exclusive owner connection is only available for modules with output functionality (variant 8DI8DO). By selecting the corresponding instance ID for the assembly object, you determine whether the module adds diagnostics data to the standard process data.

The modules provide the following connections and assembly instance IDs:

ICE1-16DI-G60L-V1D

Type of connection	Diagnostics	Instance ID	Length
Input only	Yes	Output: 193	0 byte
		Input: 101	4 byte
Input only	No	Output: 193	0 byte
		Input: 102	3 byte
Listen only	Yes	Output: 192	0 byte
		Input: 101	4 byte
Listen only	No	Output: 192	0 byte
		Input: 102	3 byte

ICE1-8DI8DO-G60L-V1D
ICE1-8DI8DO-G60L-C1-V1D

Type of connection	Diagnostics	Instance ID	Length
Exclusive owner	Yes	Output: 100	1 byte
		Input: 101	6 byte
		Configuration: 105	32 byte
Exclusive owner	No	Output: 100	1 byte
		Input: 102	3 byte
		Configuration: 105	32 byte
Input only	Yes	Output: 193	0 byte
		Input: 101	6 byte
Input only	No	Output: 193	0 byte
		Input: 102	3 byte

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Type of connection	Diagnostics	Instance ID	Length
Listen only	Yes	Output: 192	0 byte
		Input: 101	6 byte
Listen only	No	Output: 192	0 byte
		Input: 102	3 byte

Bit Assignment

Actual values are specified for the input data and target values are specified for output data. Please note that the number of items of provider data (input data) is variable. It is dependent on whether you have selected that the diagnostics data should be transferred. The modules provide one byte for slot diagnostics or channel diagnostics—the **module information byte**. The diagnostics data supplements the standard process input data as additional bytes.

16DI Module

INPUT	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	X4-B	X4-A	X3-B	X3-A	X2-B	X2-A	X1-B	X1-A
Byte 1	X8-B	X8-A	X7-B	X7-A	X6-B	X6-A	X5-B	X5-A
Byte 2	0	0	0	0	0	MI-SCS	0	MI-LVS
Byte 3	SCS-X8	SCS-X7	SCS-X6	SCS-X5	SCS-X4	SCS-X3	SCS-X2	SCS-X1

Table 4.1   **Bit assignment for assembly instance ID 101 (input data with diagnosis)**

INPUT	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	X4-B	X4-A	X3-B	X3-A	X2-B	X2-A	X1-B	X1-A
Byte 1	X8-B	X8-A	X7-B	X7-A	X6-B	X6-A	X5-B	X5-A
Byte 2	MI-IME	0	0	0	0	MI-SCS	0	MI-LVS

Table 4.2   **Bit assignment for assembly instance ID 102 (input data without diagnosis)**

16DI Legend

- X1-A...X8-A: Input status of channel A (contact pin 4) for slots X1 to X8

- X1-B...X8-B: Input status of channel B (contact pin 2) for slots X1 to X8

- MI-LVS: Module information byte—low system/sensor supply voltage

- MI-SCS: Module information byte—sensor short circuit on an M12 slot

- MI-IME: Module information byte—internal module error

- SCS-X1…SCS-X8: Sensor short circuit at slots X1 to X8

8DI8DO Module

INPUT	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	X4-B	X4-A	X3-B	X3-A	X2-B	X2-A	X1-B	X1-A
Byte 1	X8-B	X8-A	X7-B	X7-A	X6-B	X6-A	X5-B	X5-A
Byte 2	MI-IME	0	0	0	MI-SCA	MI-SCS	MI-LVA	MI-LVS
Byte 3	0	0	0	0	SCS-X4	SCS-X3	SCS-X2	SCS-X1
Byte 4	0	0	0	0	0	0	0	0
Byte 5	CE-X8B	CE-X8A	CE-X7B	CE-X7A	CE-X6B	CE-X6A	CE-X5B	CE-X5A

Table 4.3   **Bit assignment for assembly instance ID 101 (input data with diagnosis)**

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INPUT	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	X4-B	X4-A	X3-B	X3-A	X2-B	X2-A	X1-B	X1-A
Byte 1	X8-B	X8-A	X7-B	X7-A	X6-B	X6-A	X5-B	X5-A
Byte 2	0	0	0	0	MI-SCA	MI-SCS	MI-LVA	MI-LVS

Table 4.4   **Bit assignment for assembly instance ID 102 (input data without diagnosis)**

INPUT	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	X8-B	X8-A	X7-B	X7-A	X6-B	X6-A	X5-B	X5-A

Table 4.5   **Bit assignment for assembly instance ID 100 (output data)**

8DI8DO Legend

- ■ X1-A...X4-A: Input status of channel A (contact pin 4) for slots X1 to X4

- ■ X1-B...X4-B: Input status of channel B (contact pin 2) for slots X1 to X4

- ■ X5-A to X8-A: Output status of channel A (contact pin 4) for slots X5 to X8

- ■ X5-B to X8-B: Output status of channel B (contact pin 4) for slots X5 to X8

- ■ MI-LVS: Module information byte—low system/sensor supply voltage

- ■ MI-LVA: Module information byte—low actuator supply voltage

- ■ MI-SCS: Module information byte—sensor short circuit on an M12 slot

- ■ MI-SCA: Module information byte—actuator short circuit on an M12 slot

- ■ MI-IME: Module information byte—internal module error

- ■ SCS-X1…SCS-X4: Sensor short circuit on slots X1 to X4

- ■ CE-X5A…CE-X8A: Channel error in channel A (contact pin 4) on slots X1 to X8

- ■ CE-X5B…CE-X8B: Channel error in channel B (contact pin 2) on slots X1 to X8

Configuration Assembly Instance

The configuration assembly instance is available only for modules with output functionality (variant 8DI8DO).

This instance is used to define the monitoring time (surveillance timeout) and output status for each individual output channel in the case of a fault (fail-safe).

The instance ID for the configuration assembly instance is 105. The length of the configuration assembly instance is:

16 words (= 32 bytes) for the 8DI8DO module

Surveillance Timeout

- ■ The firmware of these modules enables you to set a delay time before the monitoring of the output currents starts, i.e., a surveillance timeout. You can set this for each output channel.

  The delay time starts after the status of the output channel changes, i.e., when the channel is activated (after a rising edge) or deactivated (after a falling edge). After this time has elapsed, the monitoring of the output begins and the diagnostics software begins reporting fault states.

  The surveillance timeout can be set between 0 to 255 ms. The default value is 80 ms. If the channel is in a static state, i.e., permanently switched on or off, the value is 100 ms.

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	MSB								LSB							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Surveillance timeout for port X5, channel A (pin 4): possible values 0...255															
Word 1	Surveillance timeout for port X5, channel B (pin 2): possible values 0...255															
...																
Word 6	Surveillance timeout for port X8, channel A (pin 4): possible values 0...255															
Word 7	Surveillance timeout for port X8, channel B (pin 2): possible values 0...255															

Fail-Safe Function

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

The following options are available:

- **Set low**—deactivate the output channel (value = 0)
- **Set high**—activate the output channel (value = 1)

■ **Hold last**—retain the last output status

|	MSB								LSB							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 8	Fail-safe for port X5, channel A (pin 4): possible values 0...2															
Word 9	Fail-safe for port X5, channel B (pin 2): possible values 0...2															
...																
Word 14	Fail-safe for port X8, channel A (pin 4): possible values 0...2															
Word 15	Fail-safe for port X8, channel B (pin 2): possible values 0...2															

Configuration Example

The configuration and commissioning procedure for modules that is described on the following pages is based on the RSLogix5000 software from Rockwell Automation. When using a control system from a different provider, please refer to the corresponding documentation.

1. Install the EDS files for the modules in RSLogix5000 using the EDS hardware installation tool in the "Tools" menu.

2. Select the controller to be used.

3. Select the "New Module" menu item. The following selection window opens:

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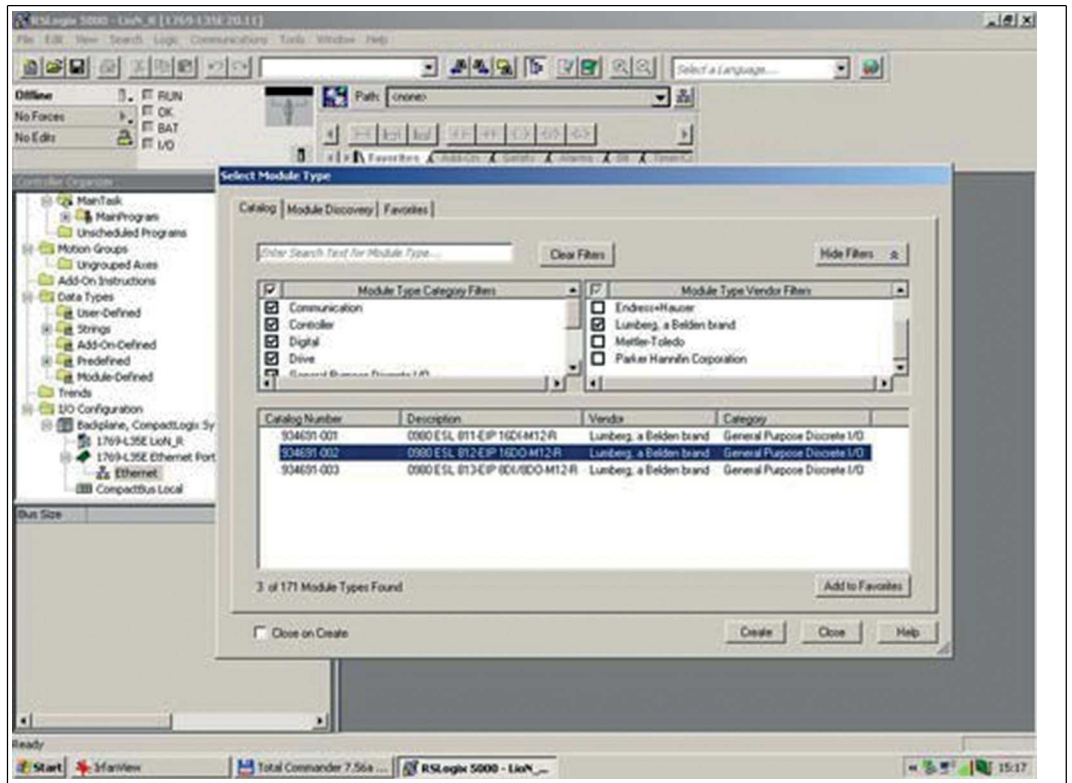
4. Select the module you want to add and click the "Create" button.
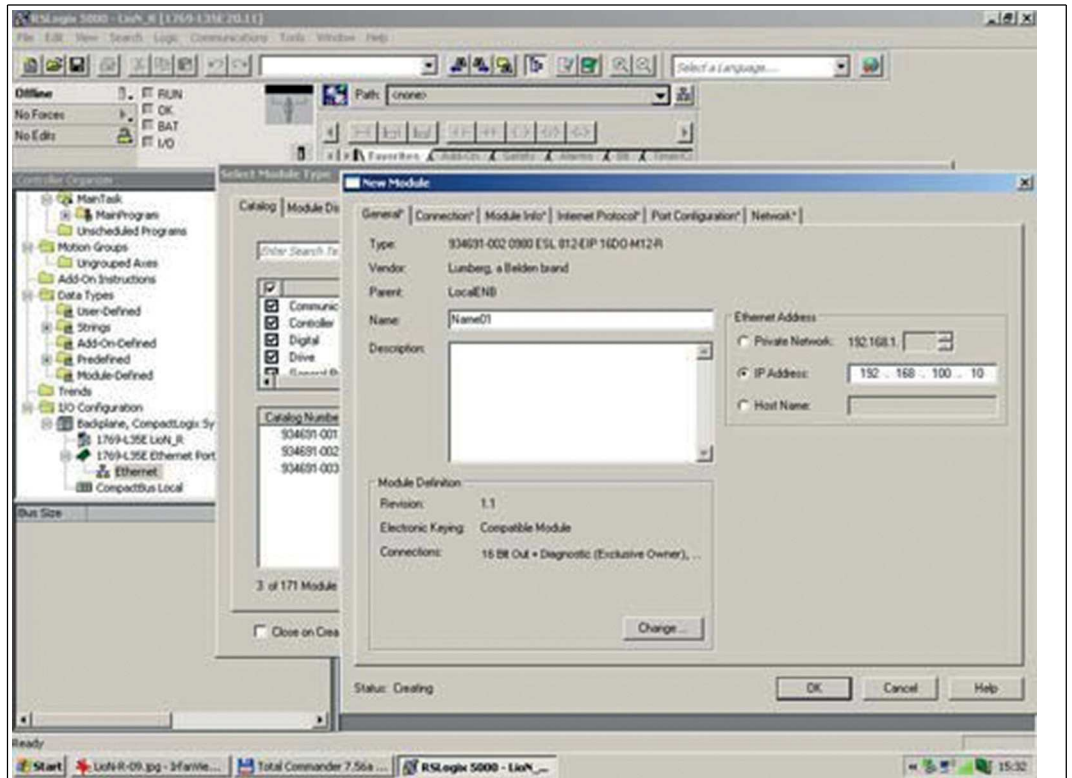
5. Enter a name for the module and the correct IP address. The name "Name01" and IP address "192.168.100.10" have been used in this example.

6. Click the "Change" button and change the module revision and the electronic keying settings, as well as the type of connection.

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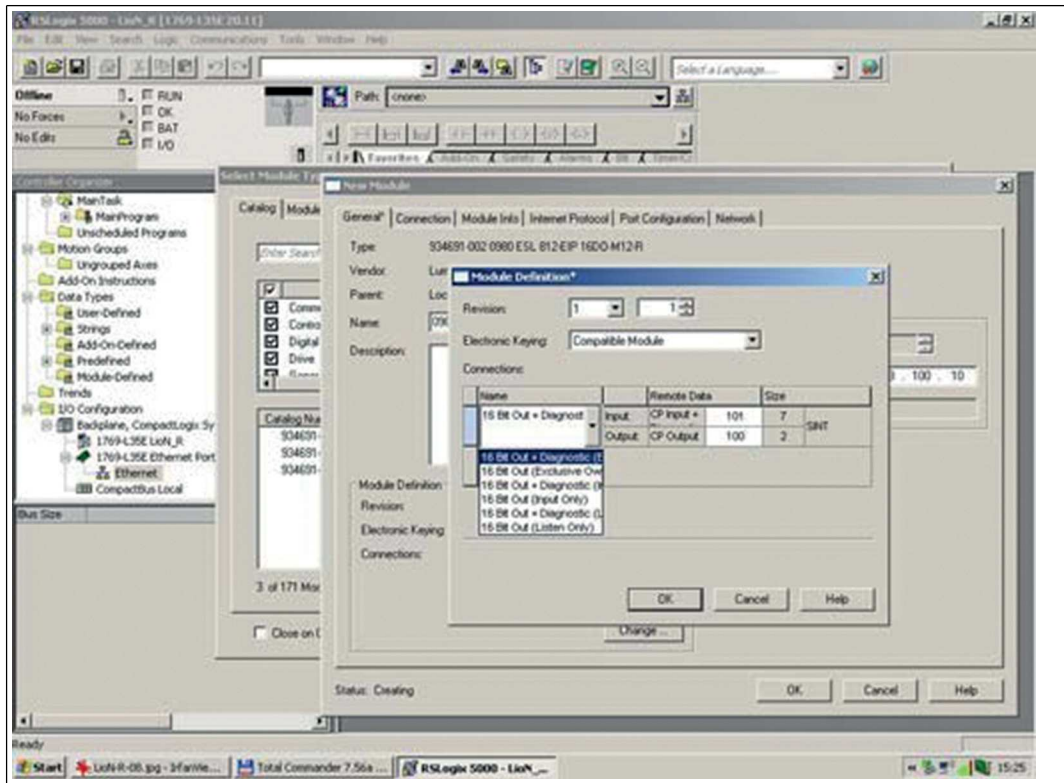
7. Select the type of connection. This determines which process and diagnostics data the module makes available.

8. You can see the selected connection type on the "Connections" tab in "Module Properties." You can also set the "Requested Packet Interval (RPI)" and "Input Type" on this tab. The minimum value for the RPI parameter is 5 ms.

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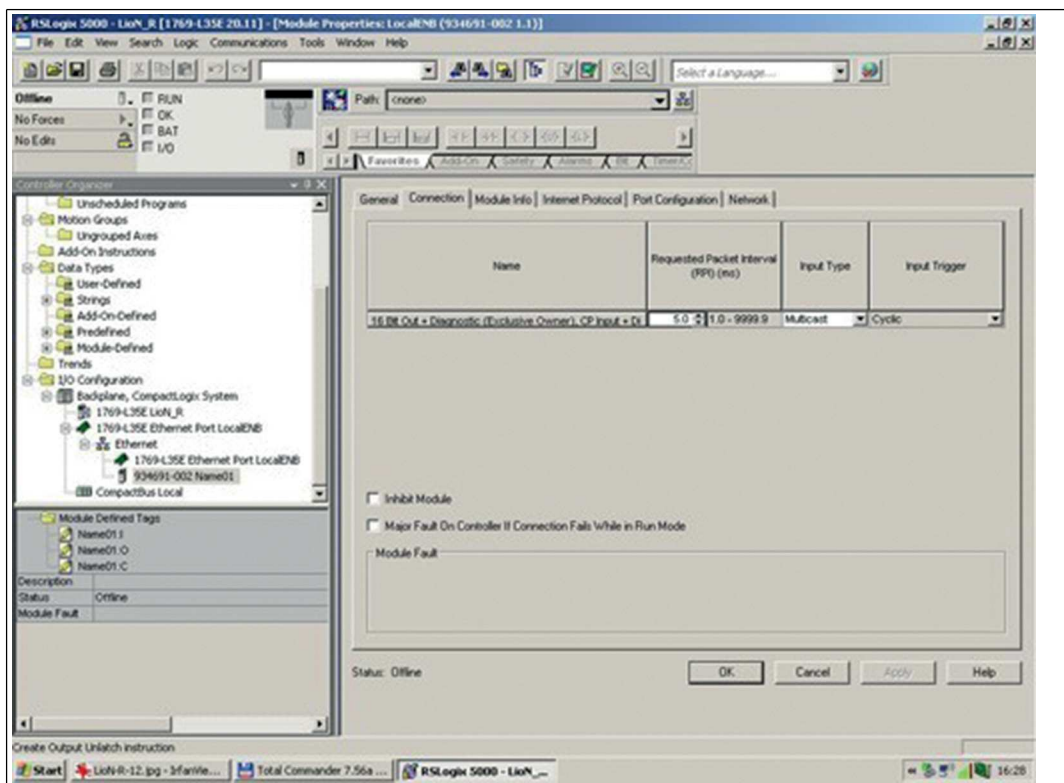
9. Go to the "Controller Tags" section in "Controller Organizer." The controller tags for the configuration parameters have the same name as the module, followed by : C. You can define the parameters for surveillance timeout and fail-safe individually for each output channel, as shown in the following image:
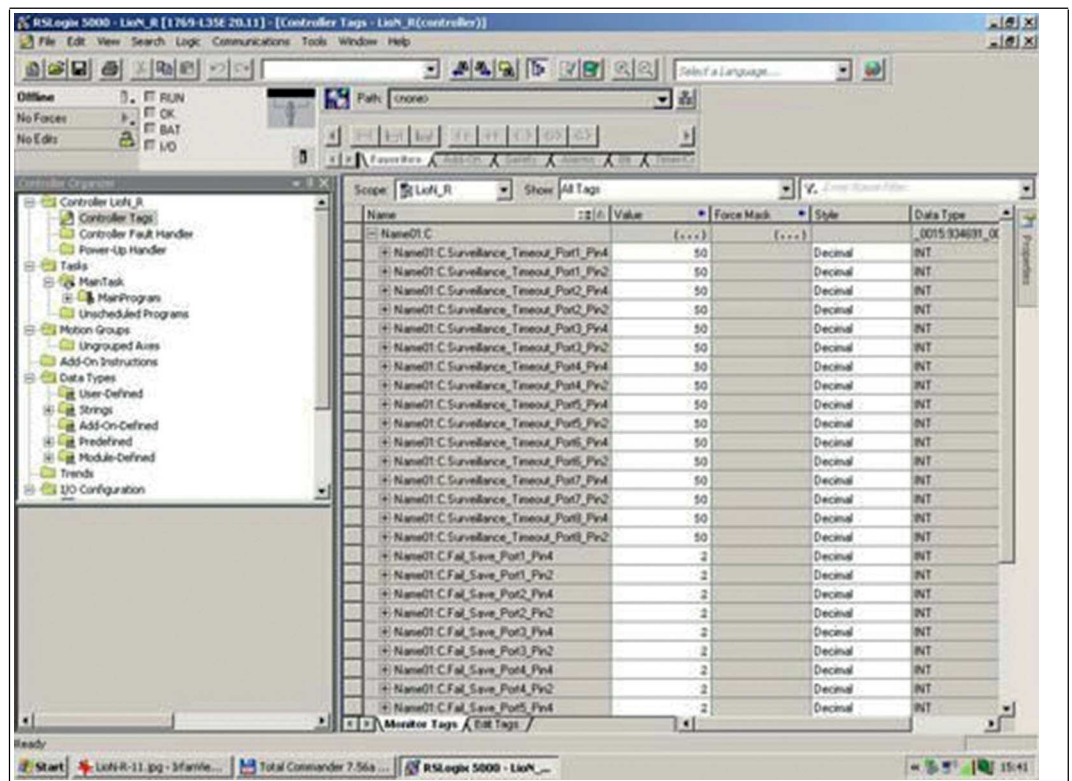
Initial Settings for Connection Parameters

Configuration tools from other control system manufacturers may require additional parameters to be entered to establish a communication connection between your EtherNet/IP I/O scanner and the modules. In such cases, the table below provides a list of useful parameters:

ICE1-16DI-G60L-V1D

Transport type	Input only
Trigger mode	Cyclic
Requested packet interval (RPI)	Min. 2 ms
Sender to target device (O>T) connection parameters	
Real-time transfer format	Heartbeat
Connection type	POINT2POINT
Assembly instance ID	193
Data type	USINT
Data size	1 byte
Data length	0 byte
Target device to sender (T>O) connection parameters	
Real-time transfer format	Pure, non-modal data connection
Connection type	MULTICAST
Assembly instance ID	101
Data type	USINT

Data size	1 byte
Data length	4 byte

ICE1-8DI8DO-G60L-V1D
ICE1-8DI8DO-G60L-C1-V1D

Transport type	Exclusive owner
Trigger mode	Cyclic
Requested packet interval (RPI)	Min. 2 ms
Sender to target device (O>T) connection parameters	
Real-time transfer format	32 bit Run/Idle header
Connection type	POINT2POINT
Assembly instance ID	100
Data type	USINT
Data size	1 byte
Data length	1 byte
Target device to sender (T>O) connection parameters	
Real-time transfer format	Pure, non-modal data connection
Connection type	MULTICAST
Assembly instance ID	101
Data type	USINT
Data size	1 byte
Data length	6 byte

4.2.3 QuickConnect

QuickConnect (QC) accelerates the startup process of the module. This enables the network communication to be recorded exceptionally quickly.

If you activate QuickConnect, it takes no longer than 350 ms for the module to accept a TCP connection after it is switched on. The controller subsequently establishes the connection. This allows the module to achieve a startup time of approximately 400 to 500 ms.

To use QC, the network must be arranged in a star or linear topology and the module must have a static IP address. Ring topologies and DHCP/BOOTP are not supported. Please note that there is no automatic check for duplicate IP addresses within the same network.

If QuickConnect is activated, the following parameters are set for the Ethernet interface of the module:

■ 100 Mbit/s transfer rate

■ Full duplex connection

■ Auto-negotiation and Auto-MDIX disabled

Ensure that your control software is configured according to these parameters.

Activation

You can activate QuickConnect using any EtherNet/IP master, for example via your machine control. The following instructions apply when using RSLogix5000 software from Rockwell Automation.

You can activate QC using configuration assembly instance 105 or via an EtherNet/IP object (TCP/IP object). Please note the changes are only implemented in the modules once a new power cycle has begun.

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Configuration Assembly Instance 105

In the "Controller Organizer", select the "Controller Tags" section and set the bit "QuickConnectEn" to 1.

EtherNet/IP Object (TCP/IP Object)

Insert a message command from the command list and open the corresponding configuration window. Enter the values F5 for "Class" and 12 for "Attributes" and under "Source Element" set the corresponding variable to 1.

4.3 PROFINET

4.3.1 Project Planning and Commissioning

The configuration and commissioning process for the modules described over the following pages was performed using STEP 7 software from Siemens AG, version 5.x. 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, https://www.pepperl-fuchs.com.

The file for the PROFINET modules is named GSDML-V2.3*-Pepperl+Fuchs-ICE1-yyyymmdd.xml. In this case, **yyyymmdd** is the issue date of the file.

Create a new project in STEP 7 and open the "Hardware Config." hardware manager. Use the menu command "Extras > Install GSD Files..." and the following dialog to install the GSD file. The modules with a PROFINET interface are subsequently available in the hardware catalog.

MAC IDs

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

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.

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Configuring PROFINET IO Modules in STEP 7

After the GSDML file for the PROFINET modules has been installed, the modules are available in the hardware catalog under PROFINET IO > Additional Field Devices > I/O > Pepperl+Fuchs.

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

Click the item number for the module in the hardware catalog and move the desired module to the PROFINET segment of the controller. The appropriate element for the I/O function is automatically inserted in slot 1 of the rack. You can change the input and output addresses specified using the hardware manager.

Figure 4.3

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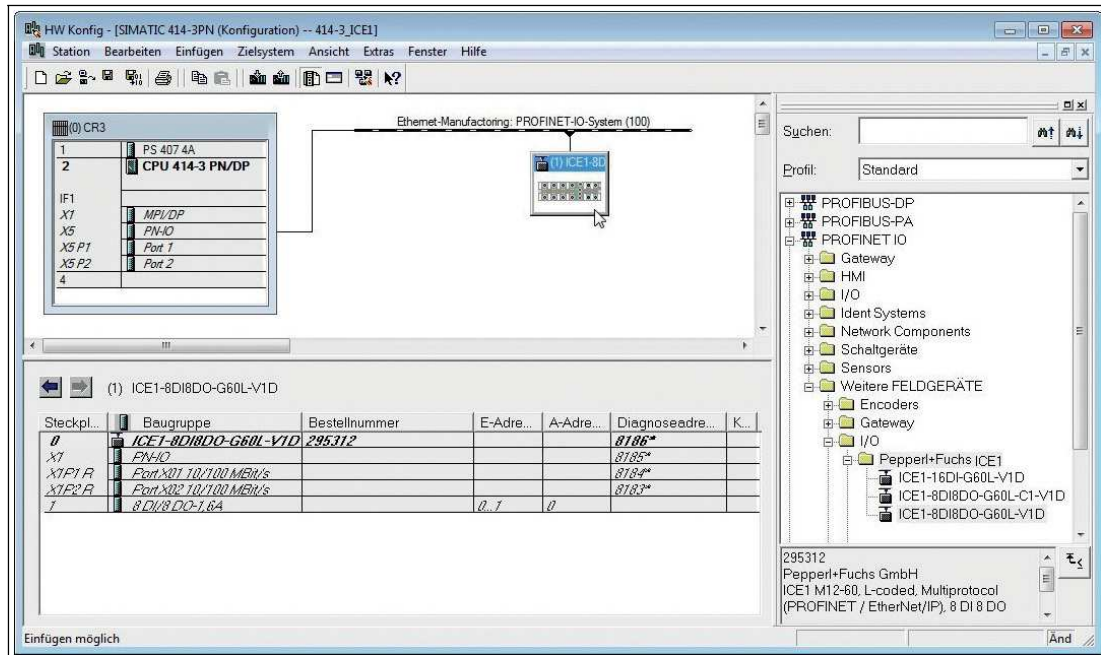
Assigning a Unique Device Name

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

Select the module in "Hardware Config." and open the menu item "Edit > Object Properties." You can change the device name in the dialog box that opens. Check that the IP address displayed is correct and that the controller and the module are in the same Ethernet subsystem.

Confirm the settings with "OK".

Figure 4.4

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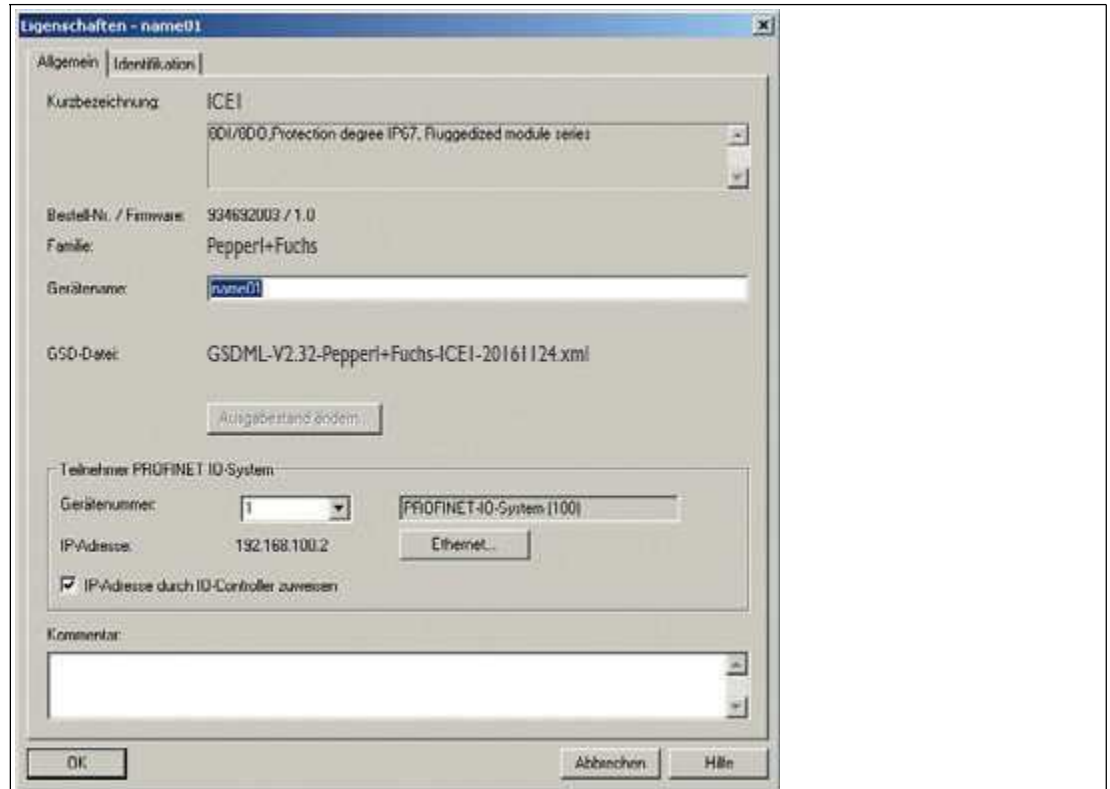
Assigning the Device Name to a Module

To assign the device name to a module, you need a PROFINET connection between the programming unit and the module.

Select the module and open the dialog "Target System > Edit Ethernet Node."

Figure 4.5

In the "Ethernet Nodes" section, select the module via the "Browse" button. Select the MAC ID of the device from the list of accessible nodes.
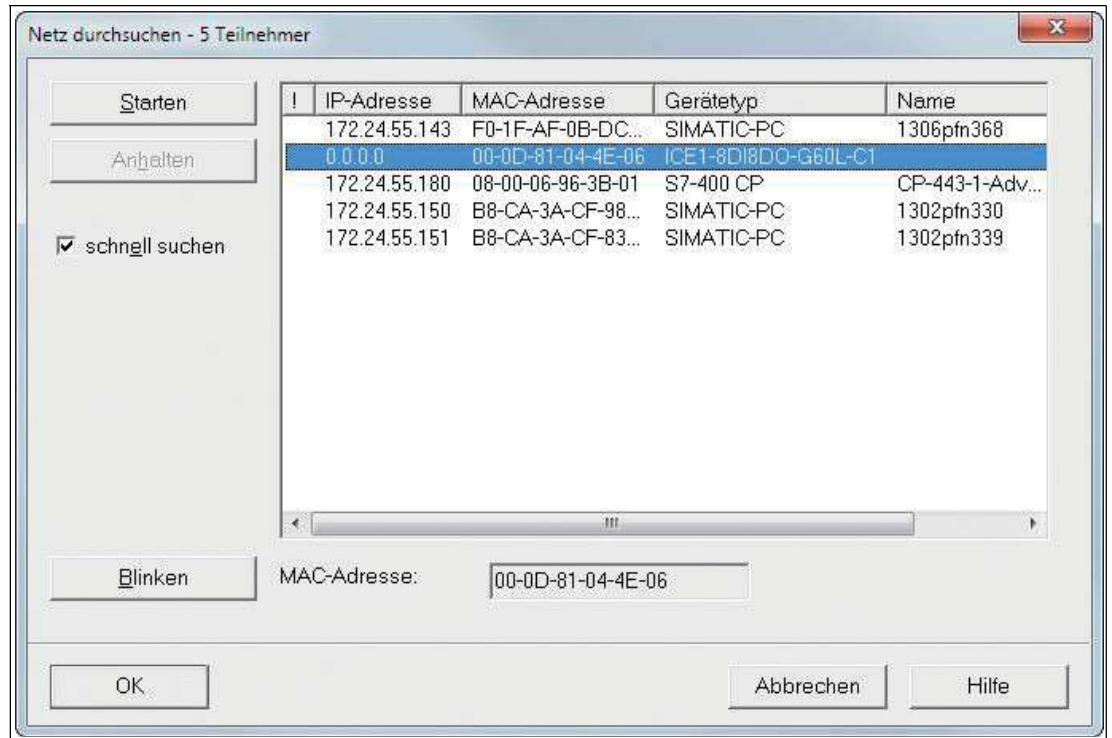
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Figure 4.6

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In the "Assign Device Name" section, enter the desired name for the module in the "Device Name" field. Use the "Assign Name" button to save the name.

Figure 4.7

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Replacing Devices Without Using Removable Media/Programming Units

PROFINET IO devices that support the device replacement function without the need for removable media or a programming unit can be replaced by identical devices in an existing PROFINET network without having to use removable media or a programming unit. In such cases, the IO controller assigns the device name. The IO controller uses the configured topology and the neighboring relationships detected by the IO devices to assign a device name.

The PROFINET modules support the device replacement function without the need for removable media/programming units.

The topology of the network must be configured in order to use this function.

The function must be selected when configuring the IO controller in "Hardware Config." Double-click the PROFINET IO port for the controller to open the "Properties" window. Activate the "Support device replacement without removable medium" function.
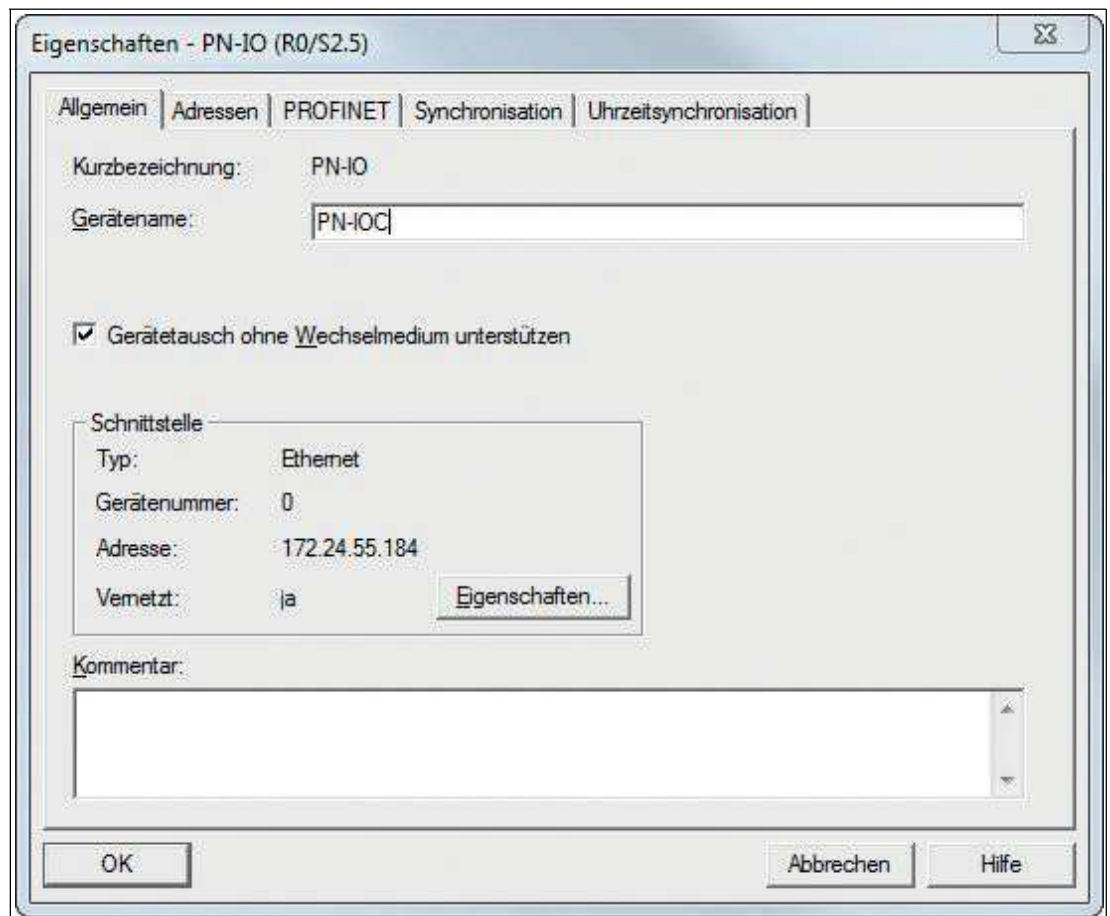

Figure 4.8

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The interconnections of the PROFINET ports of the individual devices must also be configured. Double-click the port for a device in "Hardware Config" to open the relevant "Properties" window. You define interconnections with the partner ports of other devices in the network on the "Topology" tab.
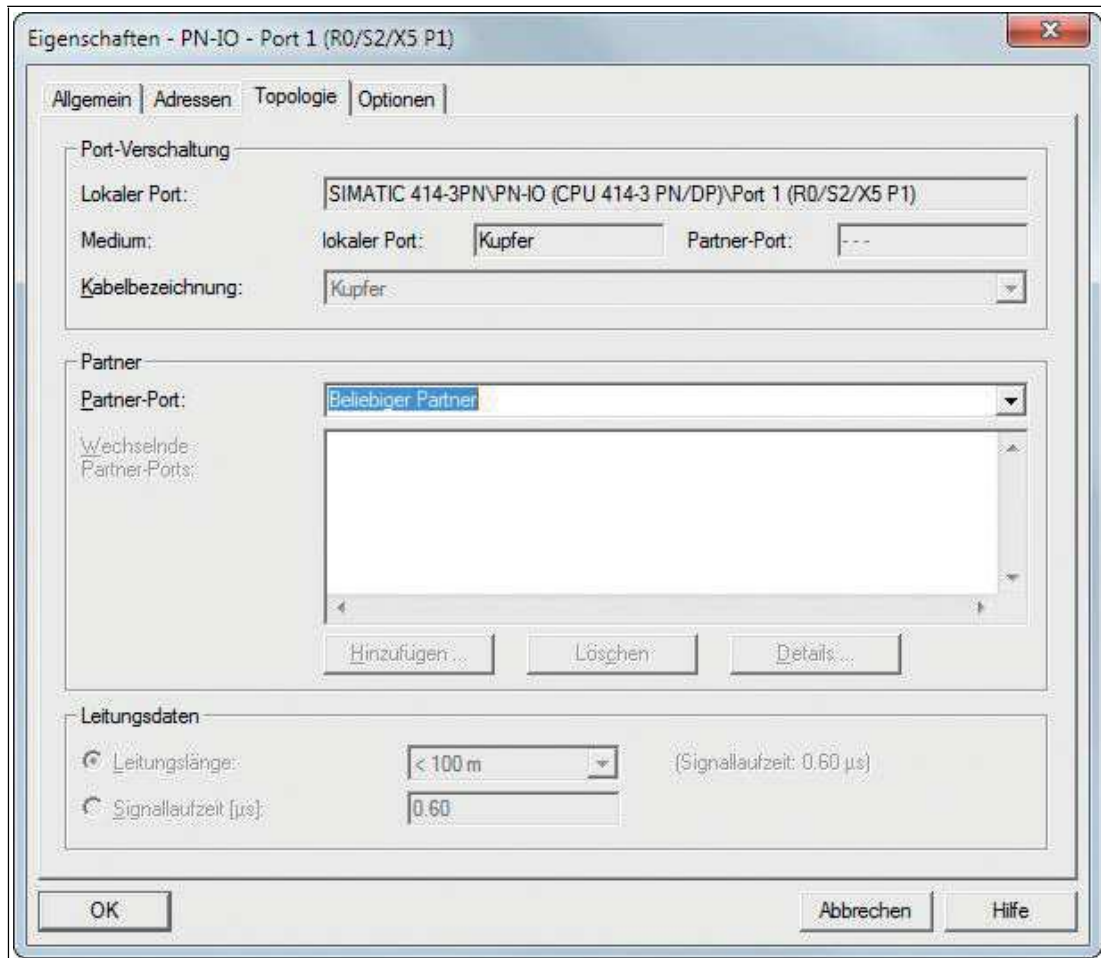
Figure 4.9

Note!

The replacement device that will be used for a replacement without removable media/programming units must still have its factory settings applied.

If necessary, the factory settings must be restored.

The Parameter Settings for the Modules

You can access the parameter settings via the "Object Properties > Parameters" menu item. Select the module in "Hardware Config." In the configuration table, right-click the line "Slot 0" and the PROFINET name for the module.

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The following figure shows the parameter settings for a module.

Figure 4.10

- The "Report Alarms" parameter

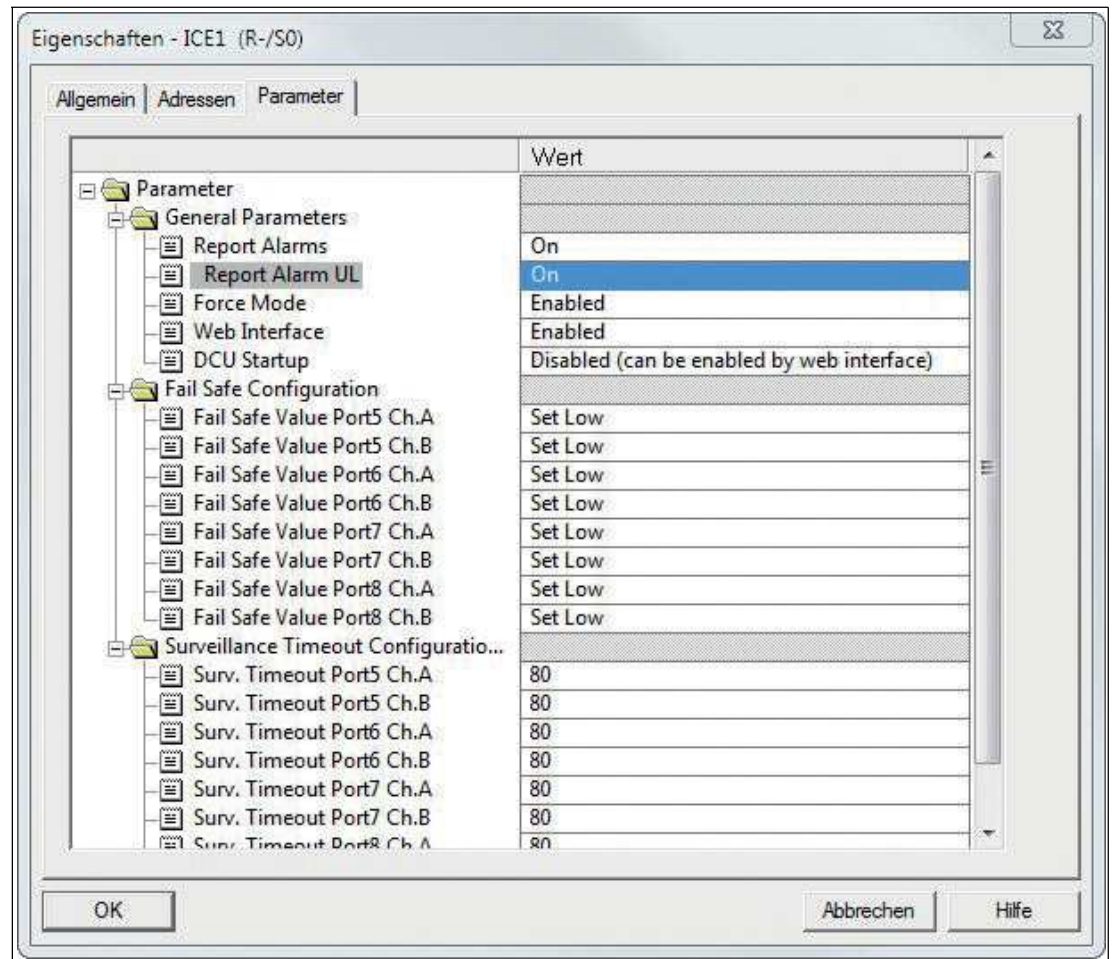   This parameter setting enables or disables the alarm signals for device-specific diagnosis via PROFINET. The setting is available for all three types of module.

- The "Fail-Safe" parameter

    This parameter is available for modules that produce digital outputs.

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

    The following options are available:

    1. **Set low**—deactivate the output channel (value = 0)
    2. **Set high**—activate the output channel (value = 1)
    3. **Hold last**—retain the last output status (value = 2)

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■ The "Surveillance Timeout" parameter

This parameter is available for modules that produce digital outputs (variant 8DI8DO).

The firmware of these modules enables you to set a delay time before the monitoring of the output currents starts, i.e., a surveillance timeout. You can set this for each output channel.

The delay time starts after the status of the output channel changes, i.e., when the channel is activated (after a rising edge) or deactivated (after a falling edge). After this time has elapsed, the monitoring of the output begins and the diagnostics software begins reporting fault states.

The surveillance timeout can be set between 0 and 255 ms. The default value is 80 ms. If the output channel is in a static state, i.e., permanently switched on or off, the value is 100 ms.

Prioritized Startup

Prioritized startup is not supported by the modules. Therefore, do not select the "Prioritized Startup" selection field in the "Properties - Interface (X1)" window.

Figure 4.11

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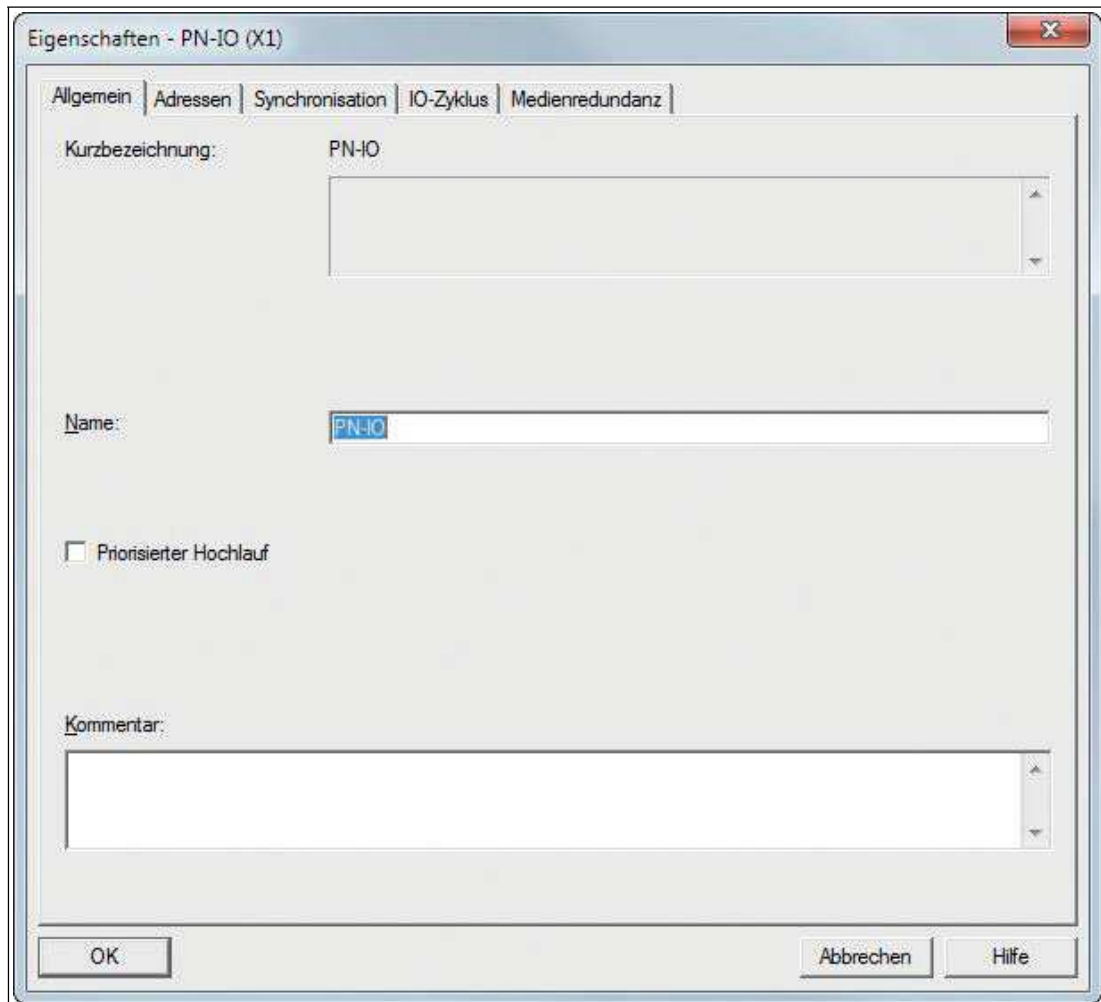
Resetting Modules to their Factory Settings

The modules can be reset to their factory settings in Step 7 via the "Target System > Edit Ethernet Node" menu item. After searching through the nodes accessible online and selecting the module that is to be reset, click the "Reset" button to reset the module to its factory settings.

Figure 4.12

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Media Redundancy Protocol (MRP)

You can create a 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 port. 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 startup (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 diagnostics alarms to detect individual failures.

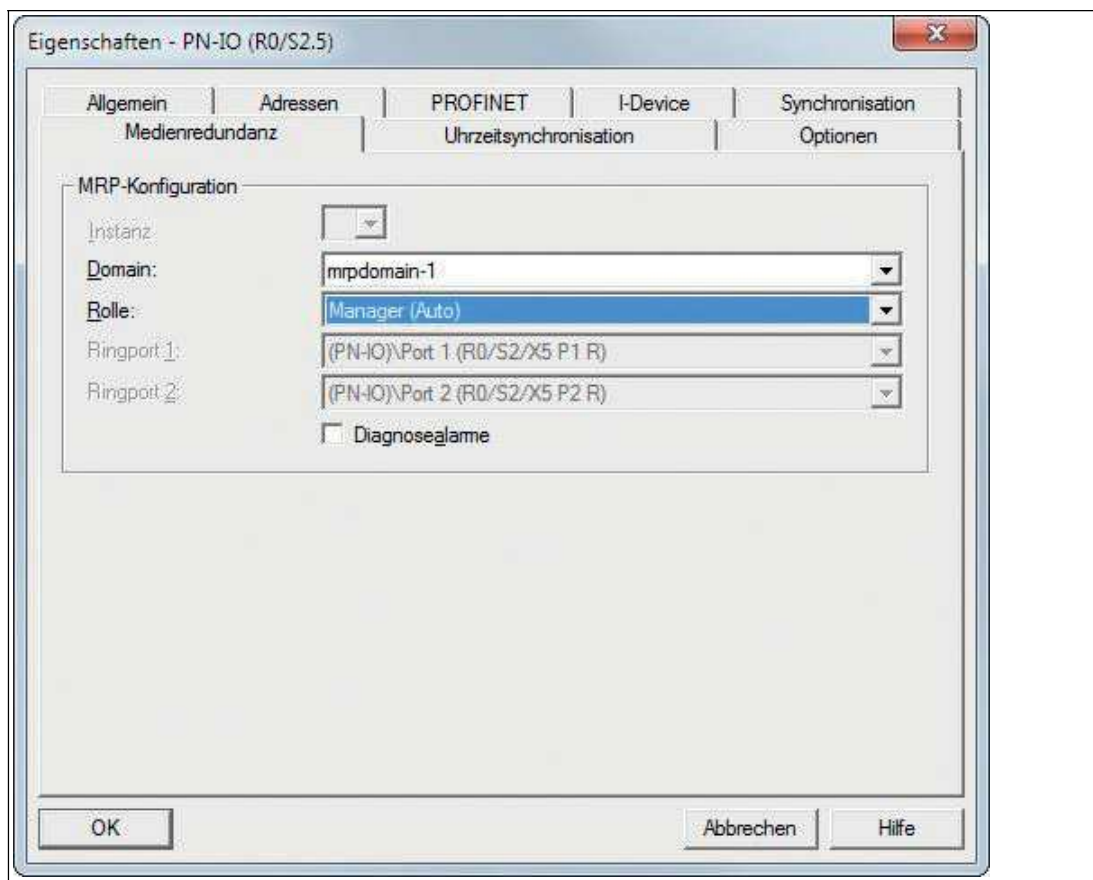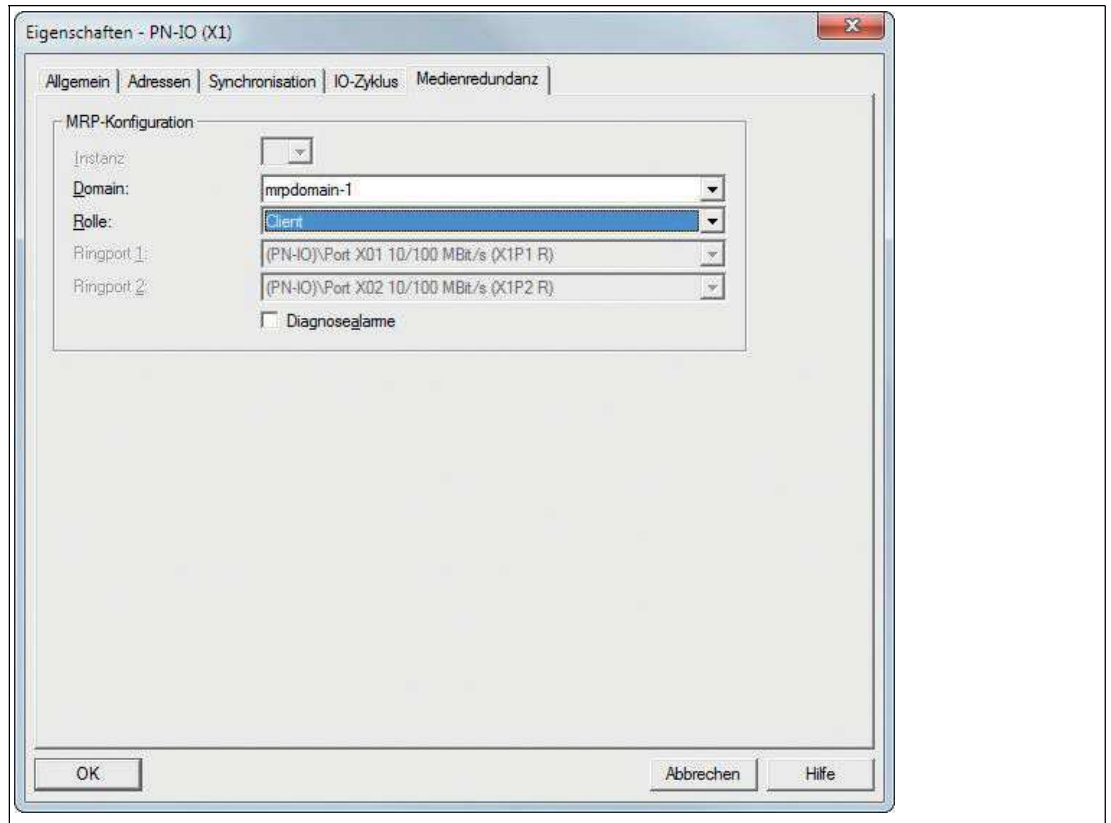Figure 4.13   An example setup of an MRP redundancy manager in STEP 7

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Figure 4.14   An example setup of an MRP client in STEP 7
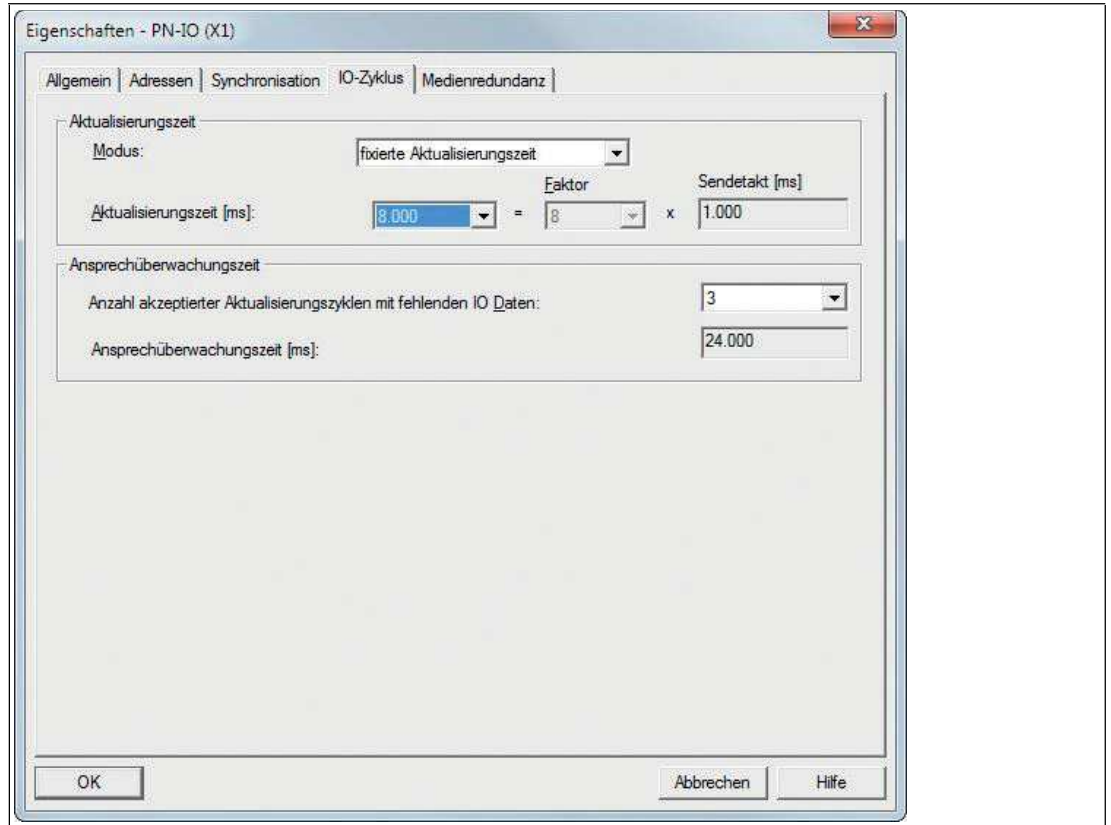

Figure 4.15   An example watchdog time setting in STEP 7

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4.3.2   Assigning Process Data

This chapter describes how process data from the controller is assigned to the I/O channels of the modules.

Input Data for the ICE1-16DI-G60L-V1D

The module provides two bytes of status information for the digital inputs. The bits are assigned as follows:

Input	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte n	4B	4A	3B	3A	2B	2A	1B	1A
Byte n+1	8B	8A	7B	7A	6B	6A	5B	5A

The values refer to the following:

■ 1A ... 8A: Actual status of input channel A (contact pin 4) for M12 connections 1 to 8.

■ 1B ... 8B: Actual status of input channel B (contact pin 2) for M12 connections 1 to 8.

Input Data for the ICE1-8DI8DO-G60L-V1D and ICE1-8DI8DO-G60L-C1-V1D

This module provides two bytes of input data that depict the current status of the input and output channels.

Input	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte n	4B	4A	3B	3A	2B	2A	1B	1A
Byte n+1	8B	8A	7B	7A	6B	6A	5B	5A

The values refer to the following:

■ 1A ... 4A: Actual status of input channel A (contact pin 4) for M12 connections 1 to 4.

■ 1B ... 4B: Actual status of input channel B (contact pin 2) for M12 connections 1 to 4.

■ 5A ... 8A: Actual status of output channel A (contact pin 4) for M12 connections 5 to 8.

■ 5B ... 8B: Actual status of output channel B (contact pin 2) for M12 connections 5 to 8.

Output Data for the ICE1-8DI8DO-G60L-V1D and ICE1-8DI8DO-G60L-C1-V1D

This module requires two bytes of status information for controlling the digital outputs.

Output	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte n	8B	8A	7B	7A	6B	6A	5B	5A

The values refer to the following:

■ 5A ... 8A: Target status of output channel A (contact pin 4) for M12 connections 5 to 8.

■ 5B ... 8B: Target status of output channel B (contact pin 2) for M12 connections 5 to 8.

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4.4 EtherCAT

4.4.1 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.

4.4.2 Configuration

PDO Assignments

The module supports different PDO assignments for input and output data. There are assignments for bit or byte access with or without diagnostic data.

You determine the data content by selecting the appropriate PDO.

The modules offer the following PDO assignments:

PDO for the ICE1-16DI-G60L-V1D

The PDOs 0x1A00 or 0x1A01 control the input data of the module.

PDO 0x1A00, Input Data in Byte Format

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A00	2	0x6000:01	1.0	USINT	Input channel X1A ... X4B
		0x6000:02	1.0	USINT	Input channel X5A ... X8B

Content of Input Channel X1A..X4B and Input Channel X5A..X8B

Index	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x6000:01	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A
0x6000:02	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

The values refer to the following:

- X1A ... X8A: Actual status of the input channel A (contact pin 4) of the inputs X1 to X8.
- X1B ... X8B: Actual status of the input channel B (contact pin 2) of the inputs X1 to X8.

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PDO 0x1A01, Input Data in Bit Format

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A01	2	0x6020:01	1.0	BIT	Input channel X1A
		0x6020:02	1.0	BIT	Input channel X1B
		0x6020:03	1.0	BIT	Input channel X2A
		0x6020:04	1.0	BIT	Input channel X2B
		0x6020:05	1.0	BIT	Input channel X3A
		0x6020:06	1.0	BIT	Input channel X3B
		0x6020:07	1.0	BIT	Input channel X4A
		0x6020:08	1.0	BIT	Input channel X4B
		0x6020:09	1.0	BIT	Input channel X5A
		0x6020:0A	1.0	BIT	Input channel X5B
		0x6020:0B	1.0	BIT	Input channel X6A
		0x6020:0C	1.0	BIT	Input channel X6B
		0x6020:0D	1.0	BIT	Input channel X7A
		0x6020:0E	1.0	BIT	Input channel X7B
		0x6020:0F	1.0	BIT	Input channel X8A
		0x6020:10	1.0	BIT	Input channel X8B

The PDOs 0x1A00 and 0x1A01 can be combined with the PDO 0x1A04 (error register) and/or the PDO 0x1A05 (diagnostics register).

PDO 0x1A04, Error Register

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A04	1	0x1001:01	1.0	USINT	Error register

Content of the Error Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	0	0	0	0	0	0	0	No error
0	0	0	0	0	0	1	1	Output overload, MI-SCS
0	0	0	0	0	1	0	1	Voltage error, MI-LVS
								Additional function override, MI-FC
1	0	0	0	0	0	0	1	Additional function device diagnostics, MI-IME

PDO 0x1A05, Diagnostics Register

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A05	1	0x2001:01	4.0	USINT	Diagnostics register

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Content of the Diagnostics Register

Input	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	MI-IME	MI-FC	0	0	0	MI-SCS	0	MI-LVS
Byte 2	SCS-X5	SCS-X4	SCS-X3	SCS-X2	SCS-X4	SCS-X3	SCS-X2	SCS-X1
Byte 3	0	0	0	0	0	0	0	0
Byte 4	0	0	0	0	0	0	1	0

Legend

MI-LVS	Module information byte—voltage for system/sensor performance low
MI-SCS	Module information byte—sensor short circuit at an M12 slot
MI-FC	Module information byte—override active
MI-IME	Module information byte—internal error
SCS-X1 ... SCS-X8	Sensor short circuit at slot X1 to X8

PDO for the ICE1-8DI8DO-G60L-V1D and ICE1-8DI8DO-G60L-C1-V1D

The PDOs 0x1A00 or 0x1A01 control the input data of the modules.

PDO 0x1A00, Input Data in Byte Format

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A00	2	0x6000:01	1.0	USINT	Input channel X1A ... X4B

Content of Input Channel X1A..X4B

Index	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x6000:01	X4B	X4A	X3B	X3A	X2B	X2A	X1B	X1A

The values refer to the following:

- X1A ... X4A: Actual status of the input channel A (contact pin 4) of the inputs X1 to X4.

- X1B ... X4B: Actual status of the input channel B (contact pin 2) of the inputs X1 to X4.

PDO 0x1A01, Input Data in Bit Format

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A01	2	0x6020:01	1.0	BIT	Input channel X1A
		0x6020:02	1.0	BIT	Input channel X1B
		0x6020:03	1.0	BIT	Input channel X2A
		0x6020:04	1.0	BIT	Input channel X2B
		0x6020:05	1.0	BIT	Input channel X3A
		0x6020:06	1.0	BIT	Input channel X3B
		0x6020:07	1.0	BIT	Input channel X4A
		0x6020:08	1.0	BIT	Input channel X4B

The following PDOs are available for the input data (TxPDO of the module).

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PDO 0x1A00, Output Status in Byte Format

If required, this object can provide real output statuses as input data to the controller (output mirror):

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A00	2	0x2200:01	1.0	USINT	Output channel X5A ... X8B

Content of the Output Channel X5A..X8B

Index	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x2200:01	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

The values refer to the following:

- X5A ... X8A: Actual status of the output channel A (contact pin 4) of the outputs X5 to X8.
- X5B ... X8B: Actual status of the output channel B (contact pin 2) of the outputs X5 to X8.

PDO 0x1A03, Output Status in Bit Format

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A03	2	0x2020:01	1.0	BIT	Output channel X5A
		0x2020:02	1.0	BIT	Output channel X5B
		0x2020:03	1.0	BIT	Output channel X6A
		0x2020:04	1.0	BIT	Output channel X6B
		0x2020:05	1.0	BIT	Output channel X7A
		0x2020:06	1.0	BIT	Output channel X7B
		0x2020:07	1.0	BIT	Output channel X8A
		0x2020:08	1.0	BIT	Output channel X8B

The PDOs 0x1A01, 0x1A02 and 0x1A03 can be combined with the PDO 0x1A04 (error register) and/or the PDO 0x1A05 (diagnostics register).

PDO 0x1A04, Error Register

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A04	1	0x1001:01	1.0	USINT	Error register

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Content of the Error Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	0	0	0	0	0	0	0	No error
0	0	0	0	0	0	1	1	Output overload, MI-SCS
0	0	0	0	0	1	0	1	Voltage error, MI-LVS
								Additional function override, MI-FC
1	0	0	0	0	0	0	1	Additional function device diagnostics, MI-IME

PDO 0x1A05, Diagnostics Register

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1A05	1	0x2001:01	4.0	USINT	Diagnostics register

Content of the Diagnostics Register

Input	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	MI-IME	MI-FC	0	0	MI-SCA	MI-SCS	MI-LVA	MI-LVS
Byte 2	SCS-X8	SCS-X7	SCS-X6	SCS-X5	SCS-X4	SCS-X3	SCS-X2	SCS-X1
Byte 3	0	0	0	0	0	0	0	0
Byte 4	CE-X8B	CE-X8A	CE-X7B	CE-X7A	CE-X6B	CE-X6A	CE-X5B	CE-X5A

Legend

MI-LVS	Module information byte—voltage for system/sensor performance low
MI-LVA	Module information byte—voltage for actuator low
MI-SCS	Module information byte—sensor short circuit at an M12 slot
MI-SCA	Module information byte—actuator short circuit
MI-FC	Module information byte—override active
MI-IME	Module information byte—internal error
SCS-X1 ... SCS-X8	Sensor short circuit at slot X1 to X8
CE-X5A ... CE-X8A	Channel error at output channel A (contact pin 4) of the outputs X5 to X8.
CE-X5B ... CE-X8B	Channel error at output channel B (contact pin 2) of the outputs X5 to X8.

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PDO 0x1600, Output Data in Byte Format

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1600	2	0x6200:01	1.0	USINT	Output channel X5A ... X8B

Content of the Output Channel X5A..X8B

Index	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x6200:01	X8B	X8A	X7B	X7A	X6B	X6A	X5B	X5A

The values refer to the following:

- X5A ... X8A: Output data channel A (contact pin 4) of the outputs X5 to X8.
- X5B ... X8B: Output data channel B (contact pin 2) of the outputs X5 to X8.

PDO 0x1601, Output Data in Bit Format

PDO		Content			
Index	Size	Index	Size	Type	Name
0x1601	2	0x6220:01	1.0	BIT	Output channel X5A
		0x6220:02	1.0	BIT	Output channel X5B
		0x6220:03	1.0	BIT	Output channel X6A
		0x6220:04	1.0	BIT	Output channel X6B
		0x6220:05	1.0	BIT	Output channel X7A
		0x6220:06	1.0	BIT	Output channel X7B
		0x6220:07	1.0	BIT	Output channel X8A
		0x6220:08	1.0	BIT	Output channel X8B

Device Parameters

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

The following parameters can be set:

General Settings

Index (bit)	Parameter
0x2300:01	Web interface locked: 0 = false, 1 = true
0x2300:02	Override locked: 0 = false, 1 = true
0x2300:03	Disable all emergency messages: 0 = false, 1 = true
0x2300:06	DCU startup: 0 = locked, 1 = disabled, 2 = run

Table 4.6   Possible parameter options for the general module settings

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Fail-Safe function

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

The following options are available:

Deactivate the output channel, value = 0

Activate the output channel, value = 1

Keep the last output status, value = 2

Index (bit)	Parameter
0x2301:01	Fail-safe function output X5, channel A (contact pin 4), value range 0 ... 2
0x2301:02	Fail-safe function output X5, channel B (contact pin 2), value range 0 ... 2
...	...
0x2301:07	Fail-safe function output X8, channel A (contact pin 4), value range 0 ... 2
0x2301:08	Fail-safe function output X8, channel B (contact pin 2), value range 0 ... 2

Table 4.7   Possible fail-safe function settings

Timeout Monitoring

The module firmware allows you to set a delay time before monitoring of output currents begins. The delay time is also called timeout. You can define this for each 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 software begins reporting error states. The value of the monitoring time limit is 0 to 255 ms. The default value is 80 ms. If the output channel is in the static state, i.e., the channel is permanently switched on or off, the value is 100 ms.

Index (bit)	Parameter
0x2302:01	Timeout monitoring output X5, channel A (contact pin 4), value range 0 ... 255
0x2302:02	Timeout monitoring output X5, channel B (contact pin 2), value range 0 ... 255
...	...
0x2302:07	Timeout monitoring output X8, channel A (contact pin 4), value range 0 ... 255
0x2302:08	Timeout monitoring output X8, channel B (contact pin 2), value range 0 ... 255

Table 4.8   Possible timeout monitoring settings

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4.4.3 Configuration Example with TwinCAT® 3

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

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.

▶ TwinCAT® 3

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`.

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

2. Start TwinCat and open a new project.

3. In the left-hand working area of the project folder explorer, switch to the option "I/O". Select the option "Add New Item ...".by right clicking on a device. Select "EtherCAT Master".
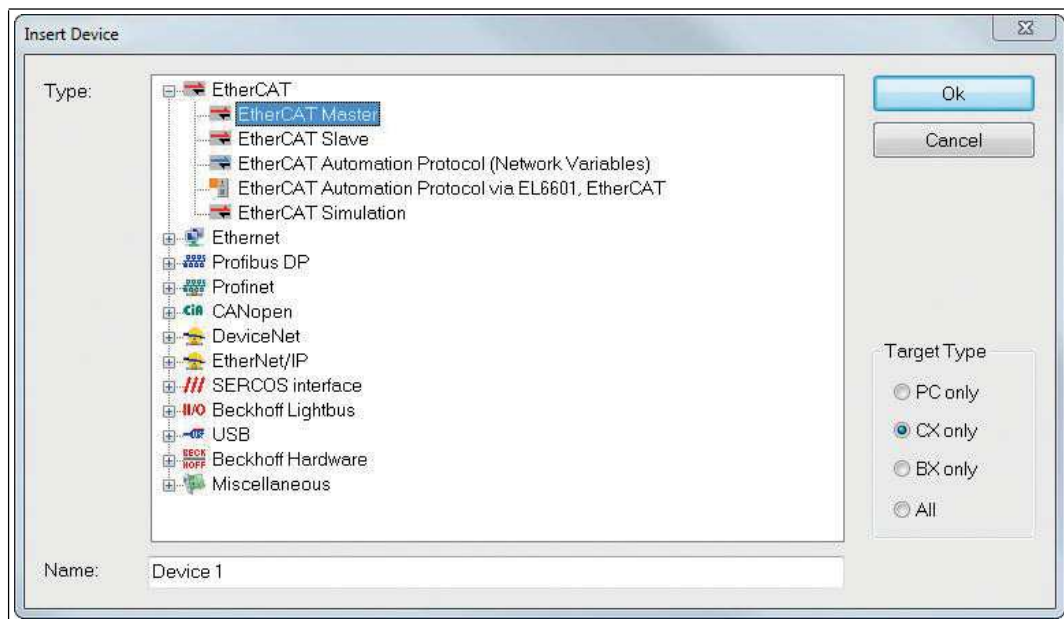
Figure 4.16

4. If you have not already done so, select the network adapter and install the driver for EtherCAT real-time communication.

5. Click on "Adapter" and then "Compatible Devices ..." to select the driver and install the EtherCAT driver.

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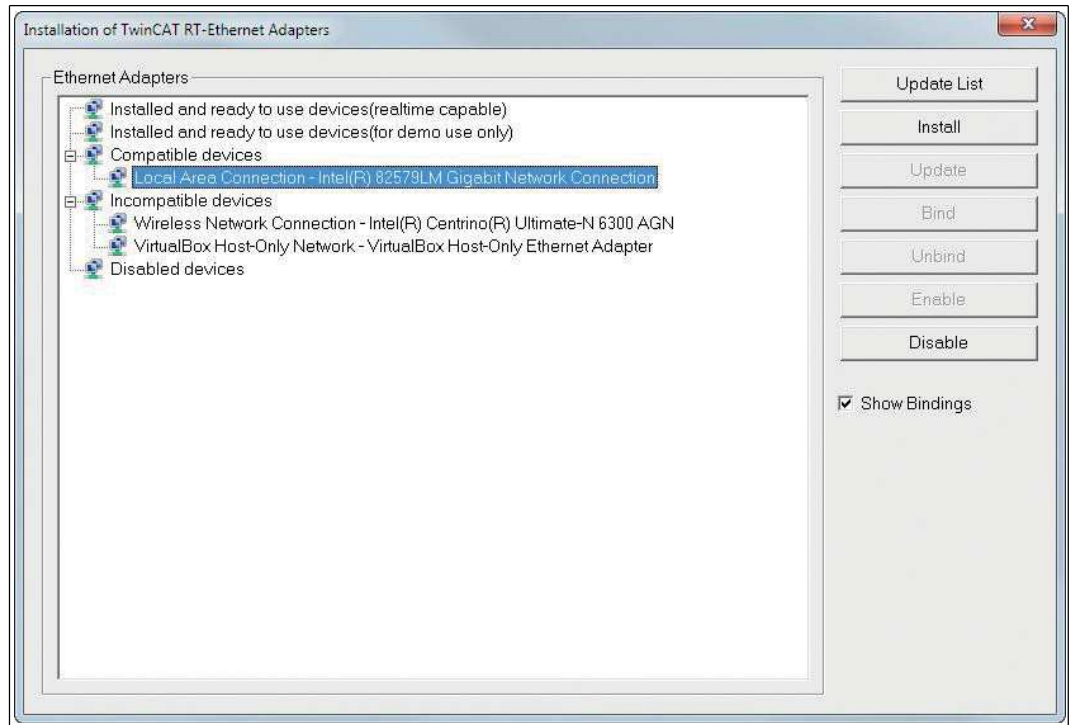
Figure 4.17

6. Select the I/O device from the hardware catalog. In the left-hand working area of the project folder explorer, switch to the option "I/O". Select the option "Add New Item ...".by right clicking on the EtherCAT master (Device 1). Select the device and click on "OK".

Figure 4.18

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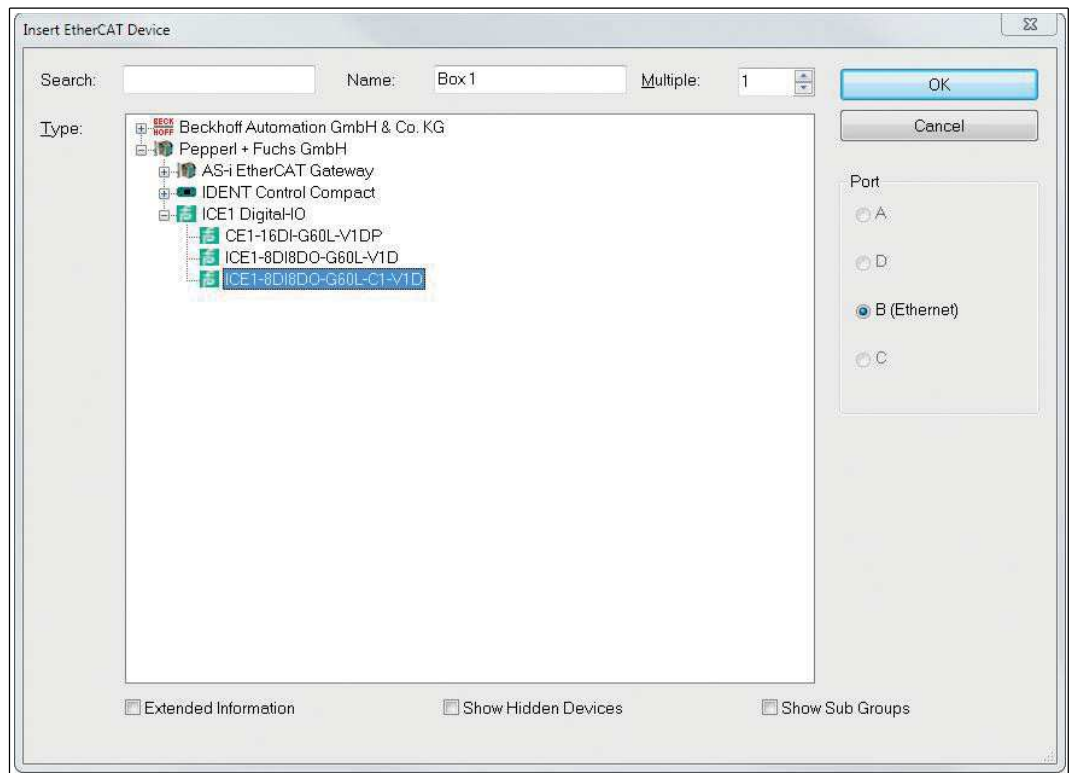
7. Set the IP address for the EoE log. The IP address must be set to use the web interface of the devices. Click on "Advanced Settings ..." on the EtherCAT tab. Navigate to "Mailbox" and then "EoE".
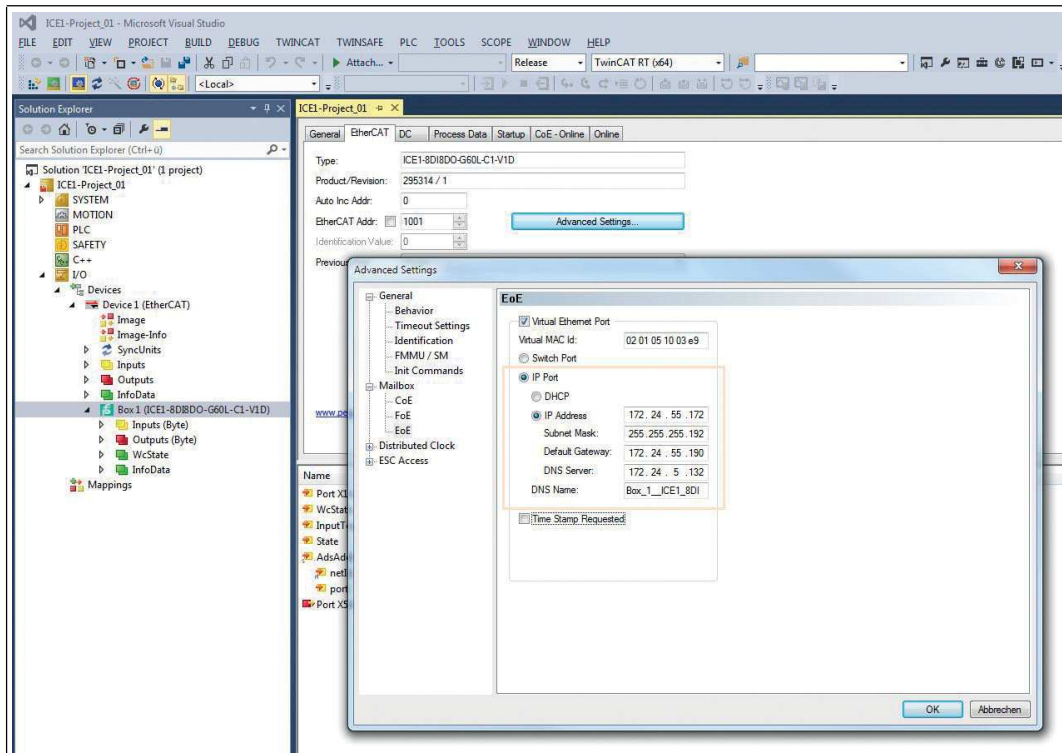
Figure 4.19

8. Disable the "Virtual Ethernet Port" option if no web services are to be used.

9. Click on "IP Port" and "IP Address" if web services are used. Enter your IP settings, depending on the settings in your local network adapter.
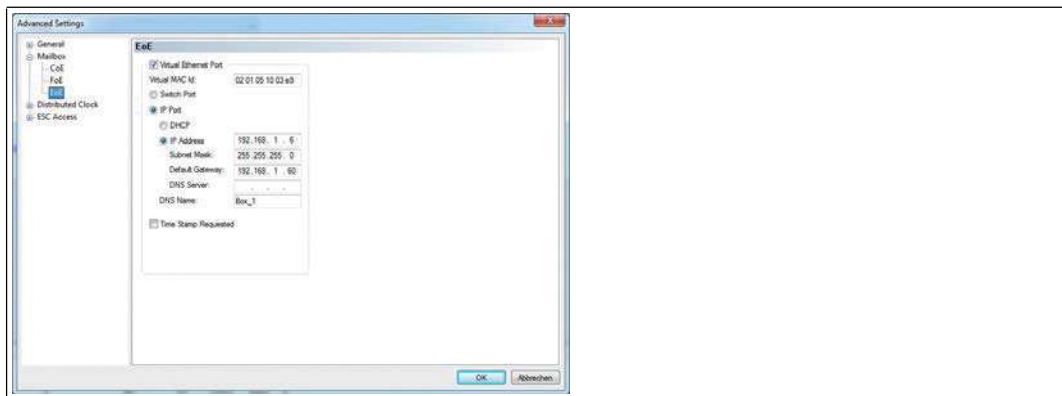
Figure 4.20

10. Switch to the "Process Data" tab and select PDOs that fit the module being used. See chapter 4.4.2.

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11. Click on "Inputs" and select your PDOs in the "PDO Assignment" field.
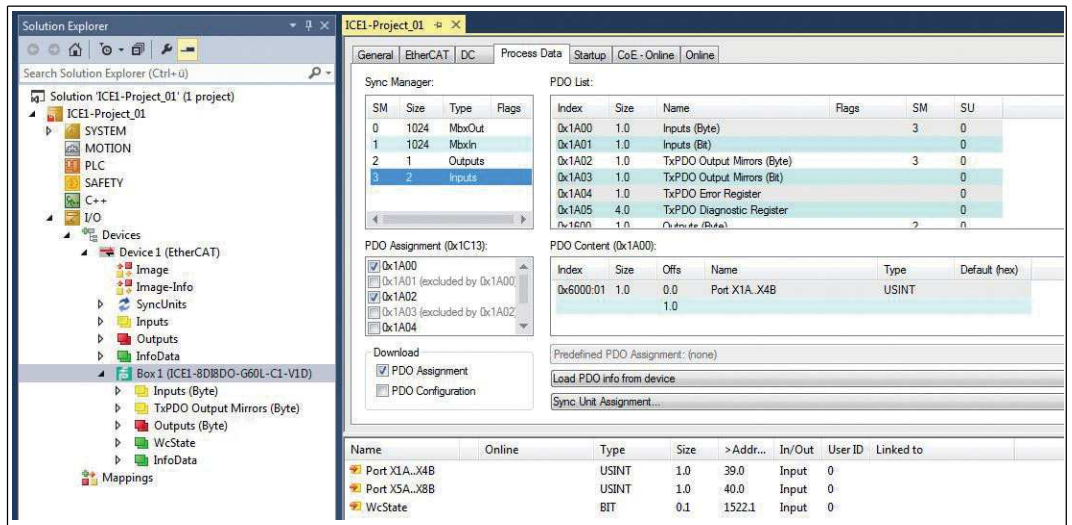
Figure 4.21

12. Click on "Outputs" and select your PDOs in the "PDO Assignment" field.

Figure 4.22

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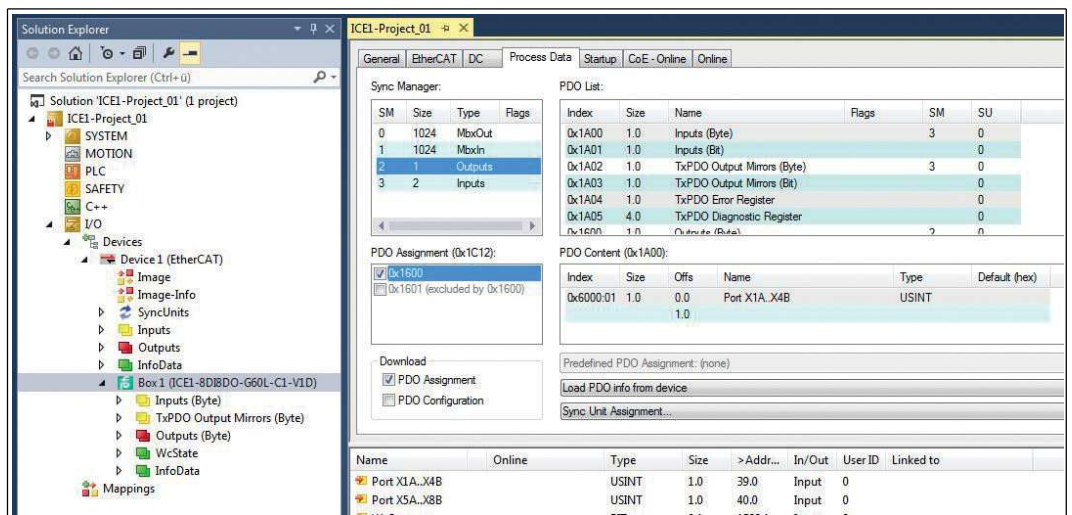
13. Switch to the "Startup" folder and check the default device parameters. Double-clicking a parameter opens the "Edit" dialog box. The new value can be entered in the "Data" dialog field:
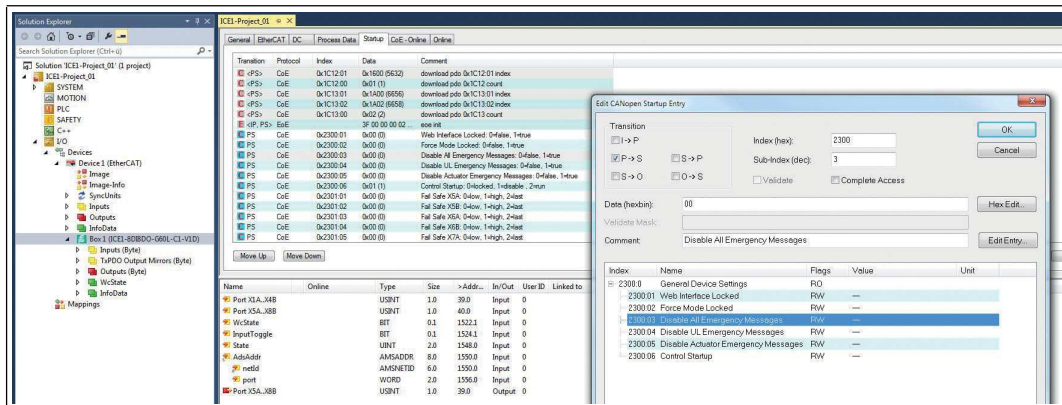
Figure 4.23

14. If the module is connected with the EtherCAT network, click on the "TWINCAT" tab and select "Activate Configuration".

15. Click on the "TWINCAT" tab again and select "Restart TwinCAT (Config Mode)". Confirm your selection with "Yes". The device now switches to the status "OP" and transfers I/O data.
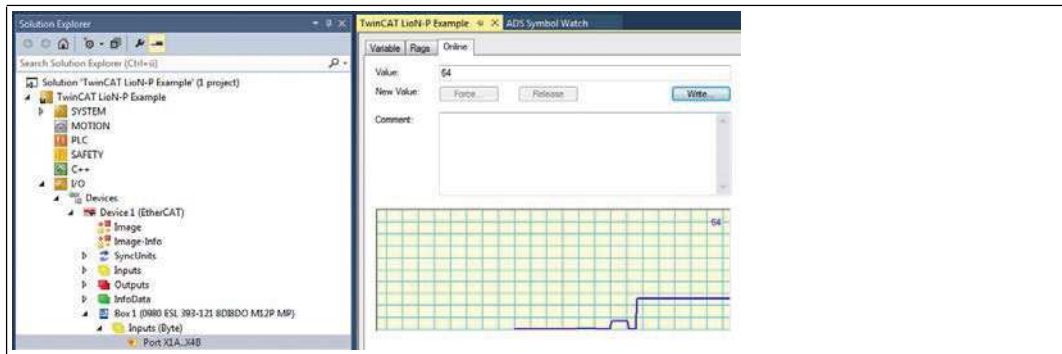
Figure 4.24

16. Click on the button "Write ..." to start an output of the module.

↳ The following dialog box appears:

Figure 4.25

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4.5 The Integrated Web Server

The modules have an integrated web server that provides functions for configuring the modules and displaying status and diagnostic information. With the help of a standard web browser, you can access the available functions via an existing TCP/IP connection. To use the web server, the modules must have their own IP addresses. In accordance with the PROFINET standard, all PROFINET IO devices are supplied with an IP address of `0.0.0.0`. You have to assign a free IP address that is different to the factory setting to the modules before using the web server.

Home Page (Home)

Enter `http://` in the address bar of your 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.
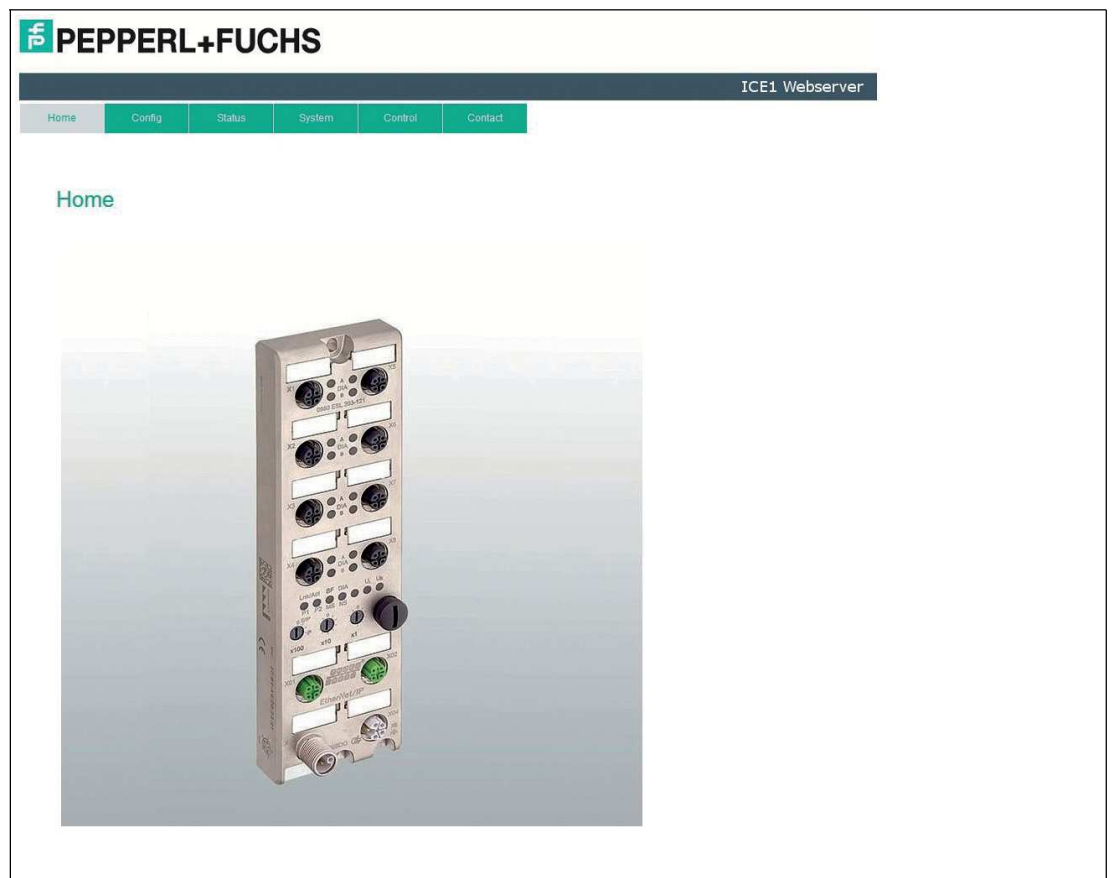
Figure 4.26

This page serves as a starting point for access to the integrated web server.

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The Configuration Page (Config)

Click on the "Config" tab in the menu bar of the start window. A new window with the configuration options opens:
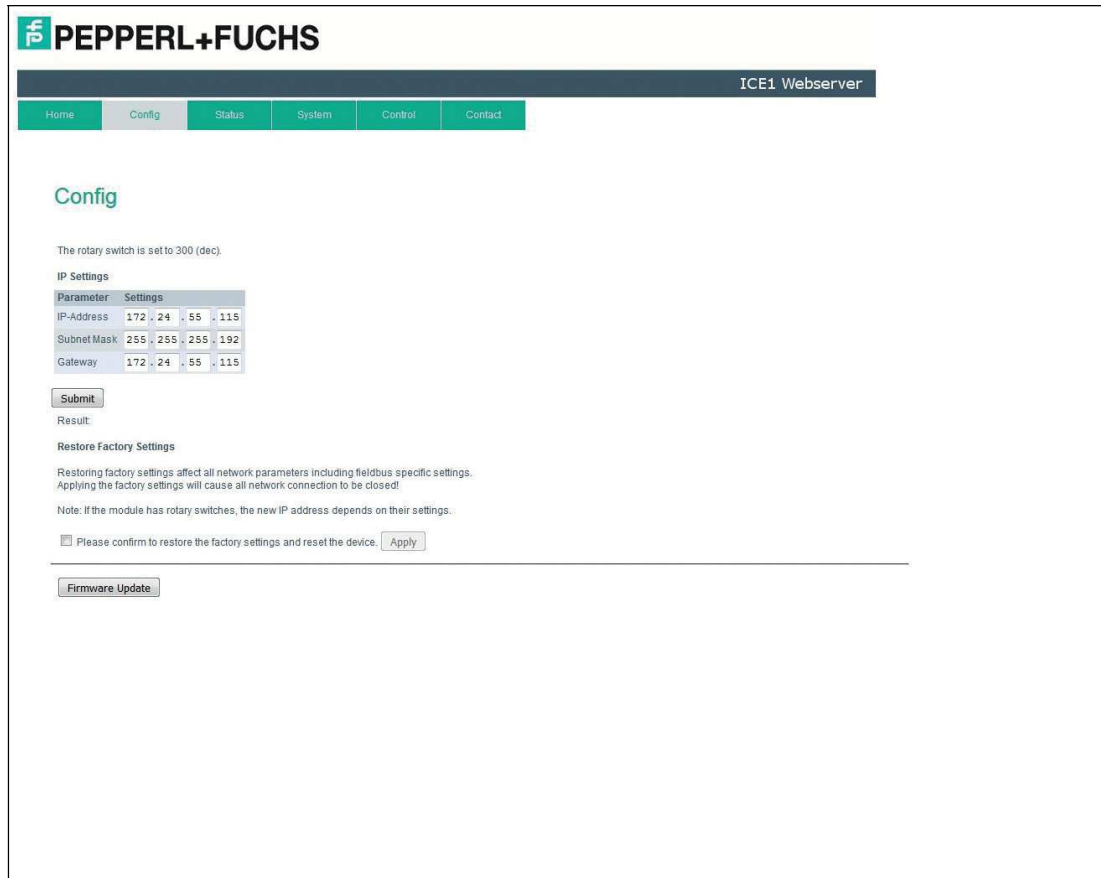

Figure 4.27

On this page, you can access the following values and parameters:

- Network parameters (IP Settings):

    - IP address, readable and writable
    - Subnet mask, readable and writable
    - Gateway address, readable and writable

  Clicking on the button "Submit" transfers the new parameters to the module. The new settings take effect on the module once the power supply has been restored.

- Restore Factory Settings:

    - The module restores the default factory settings.

- Firmware Update:

  By clicking on the button "Firmware Update", you can replace the current firmware of the module with a newer version.

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Status Page

Click on the "Status" tab in the menu bar of the start window. A new window opens with the status of the module:

Figure 4.28

On this page, you can read the following values and parameters:

- Process data:
  - Output data ("Consumed")
  - Input data ("Produced") with diagnosis
- Forcing

Forcing

This function is used for test purposes. The input and output data can be set from this website and the physical input data as well as the logical output data of the controller can be overwritten.

Click on the button "Forcing On". An input window appears for password entry:
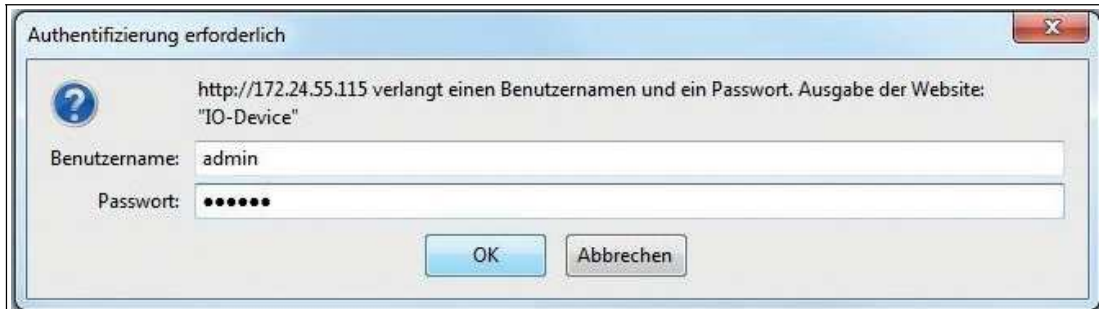

Figure 4.29

The user name is "admin". The password is "private".

After logging in, you can prepare the channels for the function with the "Forcing enabled" checkbox. Activating the checkbox "Force value" changes the state of the corresponding input/output.

⚠ Caution!

Serious injuries or property damage

Using the "Forcing" function may result in serious injuries or property damage. Be careful when you use the "Forcing" function.

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System Page

Click on the "System" tab in the menu bar of the start window. A new window with system information opens:

Figure 4.30

On this page, you can read the following values and parameters:

- Status of the LAN port:
  - Duplex mode (full, half duplex)
  - Transfer rate (10 Mbit, 100 Mbit)
- Network address:
  - MAC ID
- Size and data direction of the assembly instances
- Status of the EtherNet/IP connection:
  - Stand-by
  - Wait-for-Connection
  - Operational
- Device status:
  - System runtime
  - System information
  - Number of restarts of the I/O system
- Firmware version and date
- Device information

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- Revision:
  - Item number
  - Serial number
  - Week and year of production

There is also a user management.

Contact Page

The address of the contact page is:

http://[IP address]/contact.htm

This page provides information about Pepperl+Fuchs Gmbh contact data.

Reading Out the Process and Diagnostics Data

You can read out the process and diagnostics data of the modules using the integrated web server. The web server provides the data in the standardized JSON format. The access to the data is via the website.

The corresponding address is:

http://[IP address]/data.jsn

In higher programming languages, the process and diagnostics data is read out via HTTP requests. The following example uses the GET command in an HTTP request to obtain the data:

HTTP request:

```
GET /data.jsn HTTP/1.1
```

HTTP response:

```
HTTP/1.1 200 OK
Server: servX
Content-Length: 73
Content-Type: application/json
{"consumed": [0,0], "produced": [0,0,0,0,0,0,0]}
```

The response has the following object structure:

- Consumed: Array[a,b]—contains the output data of the module
- Produced: Array[a,b,c,d,e]—contains the input data of the module with diagnosis

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5 Troubleshooting

5.1 General Diagnostic Processing

The modules offer extended diagnostic behavior especially for the output channels, to determine errors in the transfer. The firmware of the modules distinguishes between five different types of errors.

Channel Errors

A channel error is determined by comparing the target value set by a control panel and the actual value of an output channel.

Target value	Actual value	Comment
Active	Active	OK, no diagnosis
Off	Off	OK, none
Active	Off	Short circuit Channel display is red Channel error bit is set in the diagnosis Channel is locked after error repair
Off	Active	Feeding back a voltage Red and yellow/white channel indicators are switched on Channel error bit is set in the diagnosis Channel is not locked after error repair

Note!

If both output channels of an M12 slot are activated when a channel error occurs, the controller locks both channels, even if only one channel is affected by the error. If only one channel is activated, the controller locks only this one. Locked channels are disabled and remain off if you do not reset them via the controller.

When activating (rising edge of the channel state) or deactivating (falling edge) an output channel, channel errors are filtered for the duration that you set via the parameter "Surveillance Timeout" in the module configuration. 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. If a channel is static while it is permanently on or off, the controller uses a fixed duration of 100 ms for filtering the error messages.

Voltage Error at the M12 Slots

On each M12 input socket of the module, pin 1 delivers a monitored sensor voltage US. In the event of a sensor short circuit, a voltage error is reported. Both channel indicators of the M12 input socket light up red and the corresponding error bit "sensor short circuit" is set in the diagnostic bytes. The error message is filtered by the parameter "Surveillance Timeout".

Overload of the Current Drivers

The current drivers of the modules with output functionality (variant 8DI8DO) report an error if they identify an overload. This error is reported by setting the corresponding channel error bits in the diagnostic bytes.

In the event of an overload, the status indicator of the active output channel lights up red. If both output channels of an M12 slot are active during an overload, both status indicators light up red.

The error message is filtered by the parameter "Surveillance Timeout".

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Note!

If both output channels of an M12 slot are activated when a channel error occurs, the controller locks both channels, even if only one channel is affected by the error. If only one channel is activated, the controller locks only this one. Locked channels are disabled and remain off if you do not reset them via the controller.

Reactivating a locked output channel after eliminating an error

1. Set the locked outputs to zero via the controller.

2. Activate the outputs set to zero.

   ↳ The outputs are activated again.

Actuator Supply Errors

The level of the voltage value is monitored globally and modularly at the connections for the power supply of the actuators. If the UL actuator supply leaves the voltage value range of 18 V to 30 V, an error is reported. The UL indicator lights up red and the actuator low voltage bit is set in the module information byte. If output channels are activated, the voltage error is also indicated by setting the appropriate error bits of the M12 slots.

Note!

Each output channel is locked if it is activated while a UL supply voltage error is present. This means that the controller has to reset the output channel for correct operation when the status of the UL supply voltage returns to normal. We recommend that all output channels are disabled via the controller as soon as the low voltage is detected. Otherwise, when the voltage value returns to normal, each active output channel will report a diagnosis because it is locked.

Errors in the System/Sensor Supply

The level of the voltage value of the system/sensor supply is also monitored globally. A voltage that is either below or above the voltage range of 18 V to 30 V generates an error message. The US indicator lights up red and the sensor low voltage bit is set in the module information byte. The error message has no effect on the outputs and is not filtered but instead reported immediately.

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5.2 Diagnostics Indicator in the Integrated Web Server

The modules show the error diagnostics on the status page of the integrated web server. For information on how to call up the status page, see chapter 4.5.
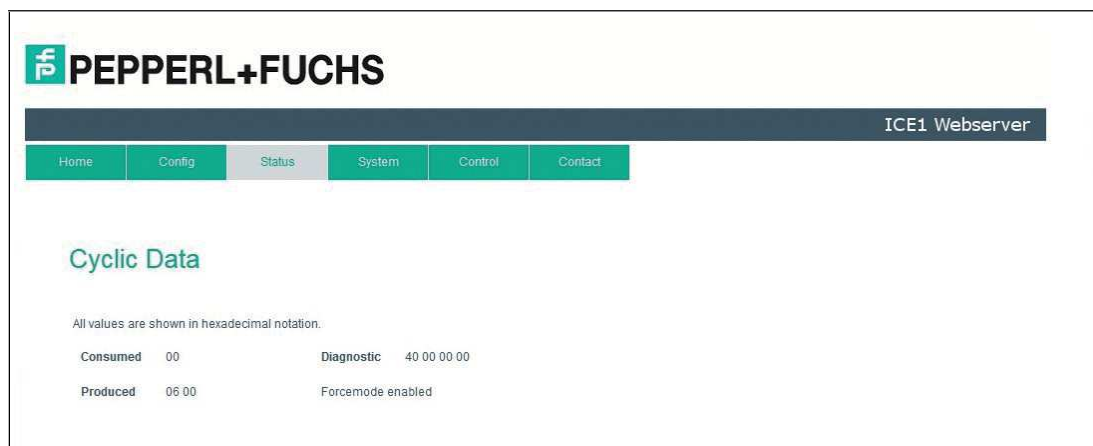

Figure 5.1

Depending on the module, up to five bytes of diagnostic data is displayed in the data area of the status page. The diagnostic bytes are structured as follows in order from left to right:

ICE1-16DI-G60L-V1D

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	0	0	0	0	0	SC	0	LV-U$_S$
Byte 2	X8	X7	X6	X5	X4	X3	X2	X1

Table 5.1   Bit assignment

ICE1-8DI8DO-G60L-V1D
ICE1-8DI8DO-G60L-C1-V1D

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	0	0	0	0	AC	SC	LV-U$_L$	LV-U$_S$
Byte 2	0	0	0	0	X4	X3	X2	X1
Byte 3	X8-B	X8-A	X7-B	X7-A	X6-B	X6-A	X5-B	X5-A

Table 5.2   Bit assignment

Legend:

- ■ LV-U$_S$: low-voltage sensor supply U$_S$

- ■ LV-U$_L$: low-voltage actuator supply U$_L$

- ■ AC: actuator short circuit

- ■ X1...X8: M12 slot with diagnosis

- ■ X1-A...X8-A: M12 slot, channel A

- ■ X1-B...X8-B: M12 slot, channel B

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5.3 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 STEP 7

If a diagnostics alarm is triggered, the user program in STEP 7 is interrupted and a diagnostics block is called. The following blocks are used:

Cause	OB call
Peripheral fault (short circuit, overload, wire break, low voltage on an I/O module)	OB B2
Complete system failure	OB B6

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 SFB 54 RALRM (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.

A diagnostics data record can also be called by via its data record number using the system function block SFB 52 "RDREC" in OB 1.

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	Reference	ChannelNumber	ChannelErrorType
Low sensor or actuator power supply voltage	Module	0x8000	0x0002
Sensor short circuit	M12 slot	0x0001 to 0x0008 M12 slot number	0x0102
Actuator short circuit	Channel A of an M12 slot	0x0001 to 0x0008 M12 slot number	0x0100
Actuator short circuit	Channel B of an M12 slot	0x0001 to 0x0008 M12 slot number	0x0101

If there is an accumulation of errors, the channel diagnosis section, including the "ChannelNumber", "ChannelProperties," and "ChannelErrorType" data values, is repeated for every error in the diagnostics data record. The following images illustrate this connection using the online diagnostics software in STEP 7.

To display the diagnosis in STEP 7, click on the faulty IO module in Hardware Manager and open the online diagnostics software using the menu item "Target System > Module Status > IO Device Diagnostics."
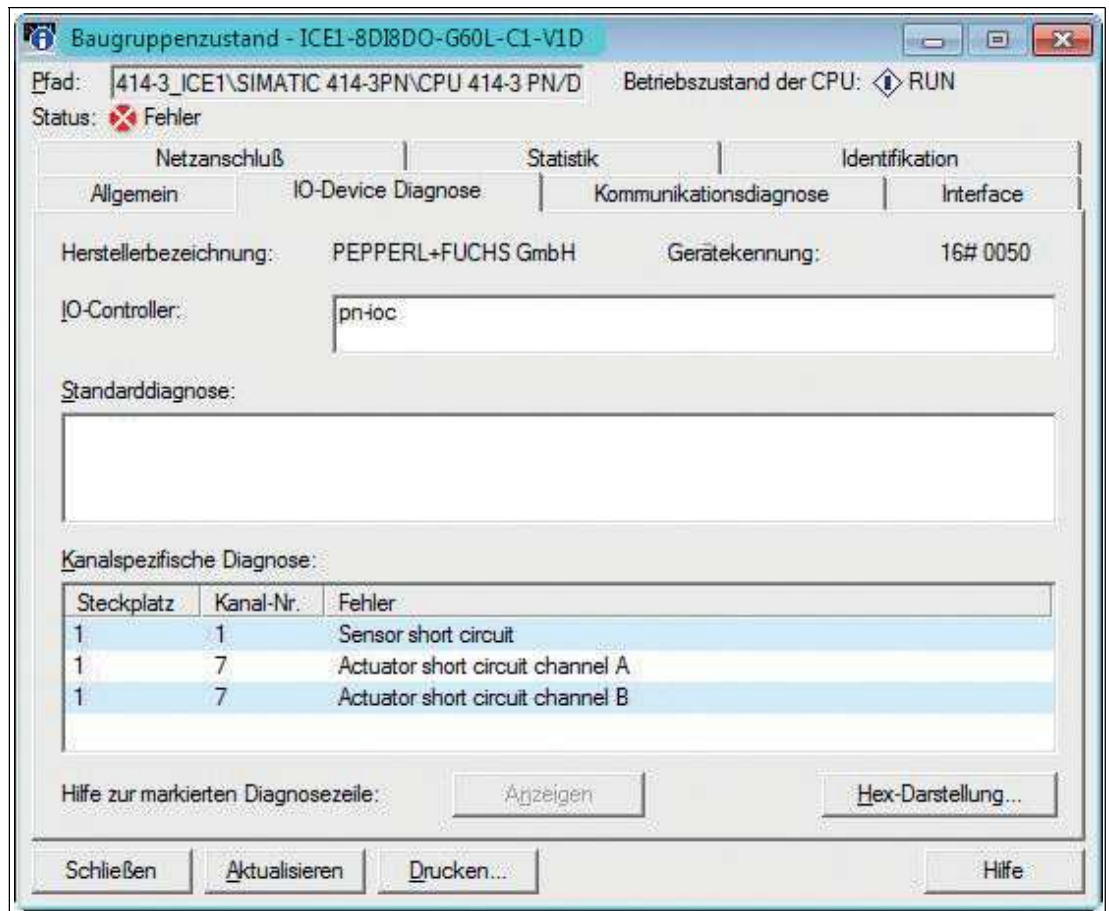
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Figure 5.2

Clicking the "Hex. Format" button in the window illustrated above displays the diagnostics data record in hexadecimal format and the structure of the data record.

5.4 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) diagnostics 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	Diagnostics register				

Table 5.3

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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 fault
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	"Force" additional function, MI-FC
0xFF00	1	0	0	0	0	0	1	"Device diagnostics" additional function, MI-IME

Content of the Diagnostics 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 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) for slots X1 to X8

- **CE-X1B ... CE-X8B**: Channel error, channel B (pin 2) for slots X1 to X8

The following example shows the error message received by a TwinCAT master regarding an actuator voltage power fault:
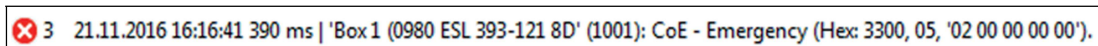
❌ 3   21.11.2016 16:16:41 390 ms | 'Box 1 (0980 ESL 393-121 8D' (1001): CoE - Emergency (Hex: 3300, 05, '02 00 00 00 00 00').

Figure 5.3

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