INVT FE Series
I/O System

User Manual

Preface

Overview

Thank you for choosing INVT FE series I/O system.

INVT FE series I/O system is a flexible, reliable, and efficient signal transmission system with a more reliable structural design. The system is able to access to multiple standard communication networks, respond in microseconds, and equipped with rich signal modules to meet various industrial automation needs while saving cabinet space, helping you develop more competitive personalized solutions.

Target audience

Personnel with electrical professional knowledge (such as qualified electrical engineers or personnel with equivalent knowledge).

About documentation obtaining

In addition to this user guide, you can also obtain product documentation and technical support from our website:

Visit www.invt.com, choose **Support** > **Download**, enter a keyword, and click **Search**.

Change history

The manual is subject to change irregularly without prior notice due to product version upgrades or other reasons.

Version	Release date	Change description
V1.0	January 2026	First release.

Contents

1 Safety precautions

1.1 What this chapter contains

Read this manual carefully and follow all safety precautions before moving, installing, operating and servicing the product. Otherwise, equipment damage or physical injury or death may be caused.

We shall not be liable or responsible for any equipment damage or physical injury or death caused due to failure to follow the safety precautions.

1.2 Safety level definition

To ensure personal safety and avoid property damage, you must pay attention to the safety symbols and warnings in the manual.

Warning symbol	Name	Description
	Danger	Severe personal injury or even death can result if related requirements are not followed.
	Warning	Personal injury or equipment damage can result if related requirements are not followed.

1.3 Personnel requirements

Trained and qualified professionals: People operating the equipment must have received professional electrical and safety training and obtained the certificates, and must be familiar with all steps and requirements of equipment installing, commissioning, running and maintaining and capable to prevent any emergencies.

1.4 Safety guidelines

General principles
- Only trained and qualified professionals are allowed to carry out related operations.   - Do not perform wiring, inspection or component replacement when power supply is applied. Ensure that all the input power supplies are disconnected before wiring and inspection.   - The product design is applied to indoor electrical environments at overvoltage category II. Ensure that the power supply system of the product has lightning protection devices to prevent lightning overvoltage from being applied to the power input or signal I/O terminals of the product so as to avoid equipment damage.   - Do not modify the product unless authorized; otherwise fire, electric shock or other injury may result.   - Prevent metal scraps, copper wires, screws, cables, and other conductive objects from falling into the interior of the product.   - Do not contact the product with damp objects or body parts. Otherwise, electric shock may result.

Moving	
⚠️	• Select appropriate tools for product delivery, and take mechanical protective measures like wearing safety shoes and working uniforms to avoid personal injury. • Protect the product against physical shock or vibration.

Installation	
⚡	• Do not install the product on inflammables. In addition, prevent the product from contacting or adhering to inflammables. • Do not run a damaged or incomplete product.
⚠️	• Install the product in a lockable control cabinet of at least IP20, which prevents the personnel without electrical equipment related knowledge from touching by mistake, since the mistake may result in equipment damage or electric shock. Only personnel who have received related electrical knowledge and equipment operation training can operate the control cabinet. • During installation, ensure that all the modules are tightly connected and fastened. Insecure connection may cause problems such as communication failure and fall-off. • After installation, ensure that there are no obstructions on the vents of the product; otherwise, the chips of the product may be burned due to overheating and poor heat dissipation, which causes system control failure and misoperation.

Wiring	
⚠️	• Before wiring, clearly understand the necessary information including interfaces, power supply types, and specifications, and comply with relevant standards and requirements to ensure that the system wiring is correct. • To ensure personal safety and equipment use safety, reliably ground the product using cables with proper diameters and specifications. • Route the control signal and communication signal cables separately from cables with strong interference such as power cables. • Secure long or heavy cables properly.
⚡	• Cut off all power supplies connected to the product before performing wiring. • Before power-on for running, ensure that each module terminal cover is properly installed in place after the installation and wiring are completed. This prevents a live terminal from being touched. Otherwise, physical injury, equipment fault or misoperation may result. • Install proper protection components or devices when using external power supplies for the product. This prevents the product from being damaged due to external power supply faults, overvoltage, overcurrent, or other exceptions.

Commissioning and running	
⚡	• Before power-on for running, ensure that the working environment of the product meets the requirements (see section 3.1.2 Installation environment and site for details), and a protection circuit has been designed to protect the product so that the product can run safely even if an external device fault occurs. • When the output units such as relays and transistors of the product are damaged, the output cannot be controlled to be On or Off as configured. • For modules or terminals requiring external power supply, configure external safety devices such as fuses or circuit breakers to prevent damage caused due to external power supply or device faults. • In the external circuit of the product, configure an emergency braking circuit, a

Commissioning and running
protection circuit, a circuit for interlocking between forward and reverse operations, and an anti-equipment-damage switch for interlocking between the position upper limit and lower limit. • To ensure the safe running of equipment, design external protection circuits and safety mechanisms for output signals related to major accidents. • In the event of a controller system failure, the output may become uncontrolled. To ensure normal operation of the equipment, appropriate external control circuits must be designed.

	Maintenance, servicing, and component replacement
⚡	• Keep the product and its parts and components away from combustible materials and ensure they have no combustible materials adhered. • Before performing product maintenance, servicing, or component operations, disconnect all power supplies connected to the product. • During maintenance, servicing, or component replacement, prevent metal scraps, copper wires, screws, cables and other conductive parts from falling into the interior of the product. • During maintenance, servicing, or component replacement, take proper anti-static measures on the product and its internal parts.
Note	• Use proper torque to tighten screws.

	Disposal
⚠️	• The product contains heavy metals. Dispose of a scrap product as industrial waste.
🗑️	• Dispose of a scrap product separately at an appropriate collection point but not place it in the normal waste stream.

2 System overview

2.1 System introduction

The INVT FE series I/O system is a remote I/O expansion solution designed for signal acquisition and signal distribution control, applicable to a wide range of industrial automation applications. Featuring an open and modular architecture, the system supports multiple mainstream industrial fieldbus protocols and offers flexible configuration options, enabling seamless integration with various PLCs and controllers.

By importing the device description file, module configuration can be completed directly within a third-party controller or supervisory system, eliminating the need for dedicated configuration software. The system is equipped with a 6Mbps backplane bus, enabling high-speed field data interaction.

The product adopts two-sided clamp-on connection structure and gold plating process, has good corrosion resistance and contact reliability, the whole series is coated with three anti-paint, adapted to the harsh conditions. The compact module is only 12mm thick, effectively saving cabinet space; PUSH IN wiring improves wiring efficiency and enables quick tool-less installation. The module is clearly identified and the status indicator is intuitive for easy identification and maintenance.

2.2 System components

The FE series I/O system consists of communication couplers and a variety of function modules such as digital, analog, temperature acquisition, and process control modules), which can be flexibly configured according to the actual application requirements.

3 Installation

3.1 Preparing

3.1.1 Installation precautions

	Before installation
⚠️	• Make sure all the modules have been powered off before installation. • Check the planned overall size and ensure that there is enough space to accommodate all the modules. The product must be installed in a cabinet with each clearance to the surrounding greater than 50mm so that the product hardware has good heat dissipation.

	During installation
⚠️	• During installing, use the installation tools that meet the requirements, such as screws and gaskets. • Prevent metal wire heads, debris, screws, and other objects from falling into the interior of the product. Otherwise, short circuit may occur, or heat dissipation may be degraded.

	After installation
⚠️	• Ensure that all the communication cables, I/O signal cables, and wiring terminals are securely connected. • Ensure that the DIN rail that hosts the product is reliably fixed. • Ensure that the strong-electricity cables are separately routed from the weak-electricity cables, and the cables are routed neatly in the cabinet. • Remove the sticker attached to the heat dissipation hole of the product to make the heat dissipation smooth. • Check the air circulation around the product.

3.1.2 Installation environment and site

Check the installation environment and ensure that the environment meets the working conditions of all the components of the product, which include temperature, humidity, dust and corrosion protection requirements.

■Environmental requirements

Environment		Requirement
Temperature		• -20℃–55℃ • The temperature does not change rapidly. • When the product is installed in a closed space, such as control cabinet, use a cooling fan for temperature adjustment if necessary.
Humidity		• RH: 5% to 95%, no condensation

■**Site requirements**

Site		Requirement
Indoor overvoltage class II		● No strong electric field, strong magnetic field or direct sunlight
		● No dust, conductive powder such as iron powder, oil mist, salt, or organic solvent
		● No corrosive or flammable gas
		● No factors that will cause the machine to directly vibrate or suffer conductive shocks

3.1.3 Installation space

Sufficient space should be reserved between the top and bottom of each module and the housing and other components to facilitate product replacement, ventilation, and heat dissipation.

Figure 3-1 Installation space (unit: mm)
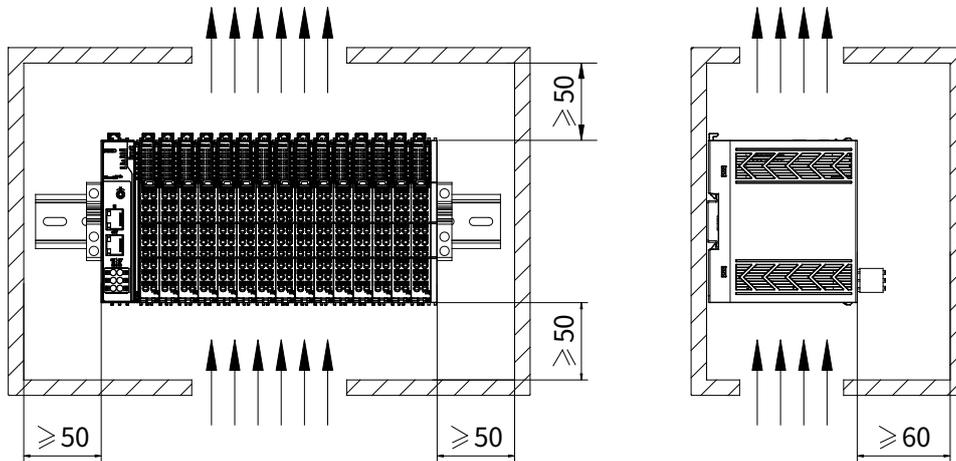
3.2 DIN rail model selection

You can refer to the following table to select the applicable DIN rail model.

Model	Length × Depth (unit: mm)	Fastening screw
TH35-7.5Fe	35×7.5	M4
TH35-7.5A1	35×7.5	M4
TH35-15Fe	35×15	M4

Figure 3-2 DIN rail installation dimensions (unit: mm)
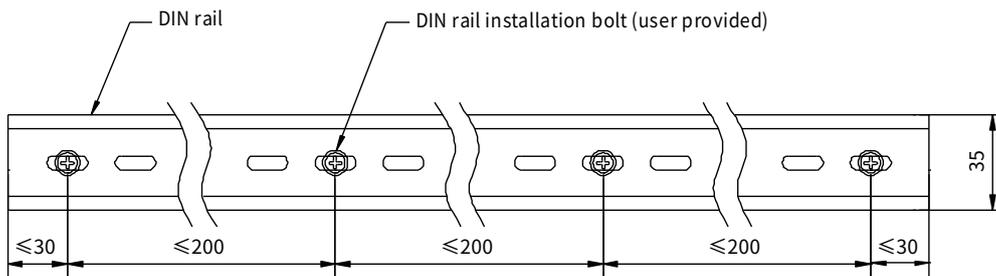
✏**Note:** To ensure the strength of the DIN rail, install the DIN rail installation bolts (user provided) at the places within 30mm from both ends of the DIN rail, (for details, see Figure 3-2), and ensure that the interval between two adjacent bolts must be within 200mm.

3.3 Installation procedure

The installation procedure is as follows:

Step 1 Slide the right end cover of the communication coupler forward and remove it.
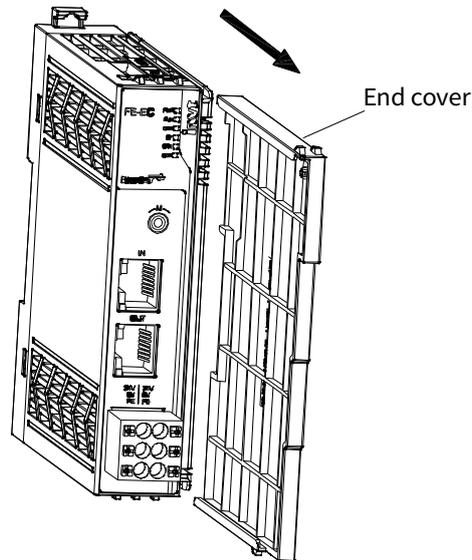
Step 2 Align the communication coupler module with the DIN rail and press inward until the module engages with the DIN rail (there is a noticeable sound of engagement when installed in place).
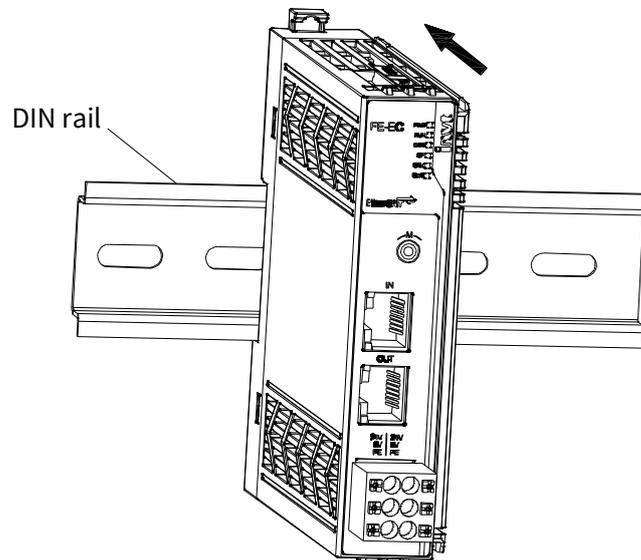
Step 3 Align the module with the connection rail with the sliding rail of the module fixed on the DIN rail, and push it inward until the module with the connection rail engages with the DIN rail (there is a noticeable sound of engagement when installed in place).
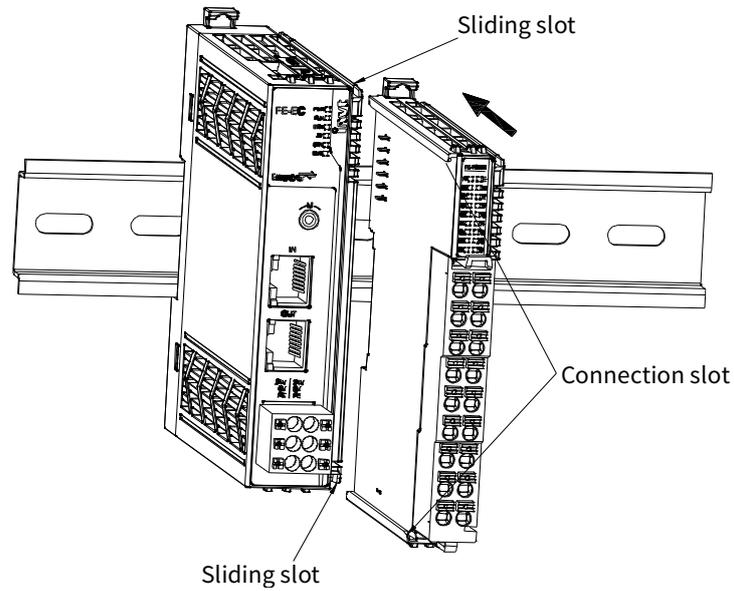
Step 4 Slide the end cover with the connection rail onto the last I/O module.
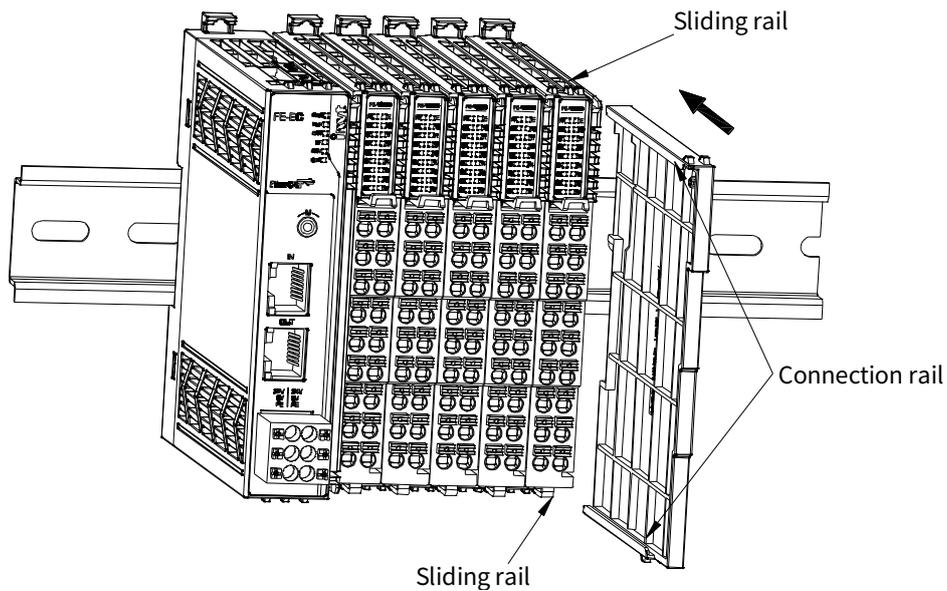
Note: The metal pins on the last I/O module must not be exposed outside.

Step 5 Install a guide rail fixing clip at the head and tail of the module assembly to prevent it from sliding leftward or rightward.

DIN rail fixing clip   End cover
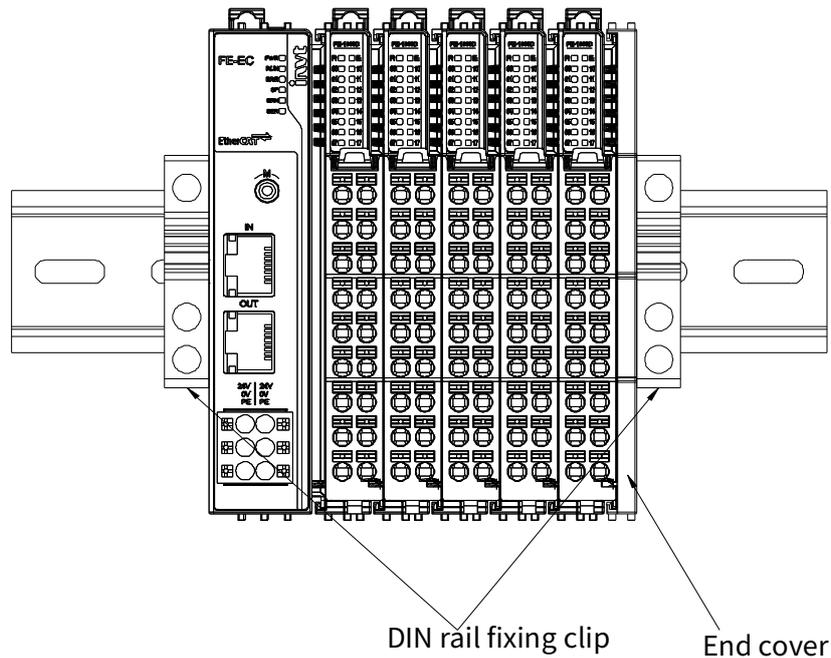
✎Note:

- Remove the end cover before installing the modules, and install the end cover on the rightmost module when the modules are installed.

- After a module is installed, the DIN rail locking latch automatically engages. If the latch does not lock automatically, press the top of the locking latch toward the DIN rail to secure the module in place.

- The DIN rail mounting clip is user supplied.

- For detailed installation dimensions, see Appendix A Product dimensions.

3.4 Disassembly procedure

The disassembly steps are as follows:

Step 1   Loosen the rail fixing clip to ensure that there is sufficient clearance to pull away the module from the DIN rail.

Step 2   Use a slotted screwdriver or other similar tool to pry the DIN rail locking latch as shown in the following figure.
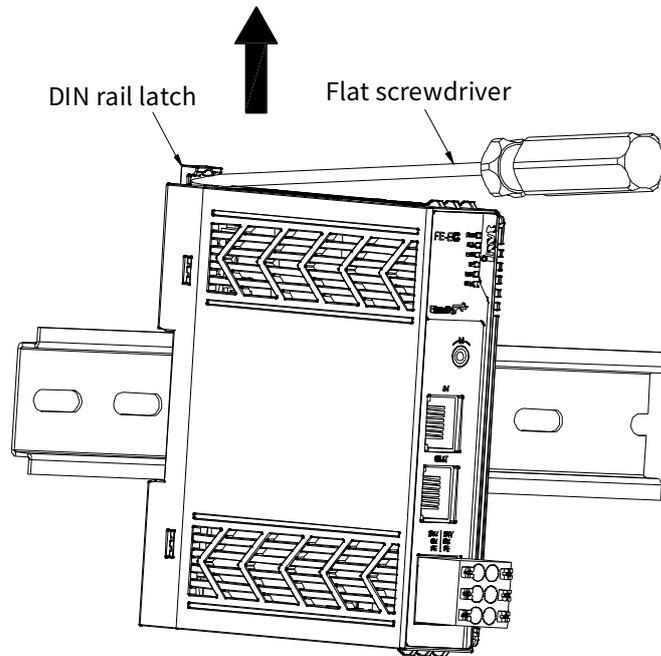
Step 3 Pull the module out in the direction perpendicular to the DIN rail.
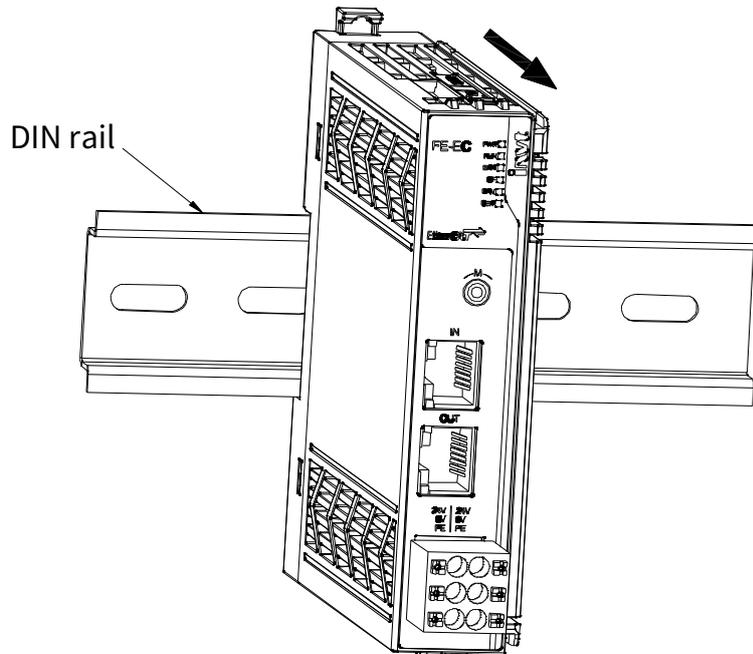
✏**Note:** Refer to section 3.3 Installation procedure to remove the end cover.

4 Wiring

4.1 Wiring requirements

- Before wiring, ensure that all external power supplies have been cut off.

- After completing the wiring, ensure the module top end cover has been installed properly before powering on or operating the module. Otherwise, electric shock or maloperation can result.

- Before wiring, check the rated voltage and terminal configuration according to product specifications to ensure safe wiring. The connection to a power supply that does not match the ratings or incorrect product wiring may cause serious accidents such as fire and product damage.

- Tighten up screws according to specified torque. If screws are loose, short circuit, fire, or maloperation may result.

  ✏**Note:** If terminal screws are too tightened, screw or module damage, falling, short circuit, or faults may result.

- Ensure that there are no foreign objects such as metal scraps or wiring residues in each module. The foreign objects may cause short circuit, fire, or maloperation.

4.2 Grounding requirements

- **Power cable grounding**

  - Use correct, independent wiring methods.

  - Connect a cable with the cross-sectional area ≥2mm^2 and length ≤30cm for grounding, and ground the power supply module terminal ⏚.

  - If the grounding point is close to the product, ensure that the grounding cable is secure.

- **Shielded cable grounding**

  - Use shielded cables for analog I/O, RS485, and EtherCAT cables and other cables that transmit sensitive signals.

  - The grounding point should be as close as possible to the module.

  - For the shield part exposed after some of the shield cable is stripped, ground the part and the conductive backplane with an area as large as possible to ensure good contact.

4.3 Cable specifications

Cable material	Cable diameter		Crimping tool
	GB size (mm^2)	**American wire gauge (AWG)**	
Tubular cable lug	0.3	22	Use a proper crimping plier.
	0.5	20	
	0.75	18	
	1.0	18	
	1.5	16	

✏**Note:**

- The cable diameters of the tubular cable lugs in the preceding table is only for reference, which can be adjusted based on actual situations.

- When using other tubular cable lugs, crimp multiple strands of cable, and the processing size requirements are as follows:
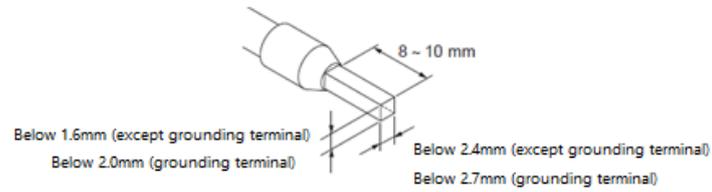
5 Product specifications

5.1 Overview

This chapter provides a detailed description of the design, functions, interfaces, hardware specifications, software specifications, and environmental requirements of the communication couplers and I/O modules in the FE series I/O system.

5.2 Basic information

Model	Ordering code	Description	Applicable to
FE-EC	11016–00042	Communication coupler, EtherCAT, 24VDC, RoHS	EtherCAT master devices
FE-PN	11016–00046	Communication coupler, PROFINET, 24VDC, RoHS	PROFINET master devices
FE-1600D	11016–00041	Digital input module, 16 channels, sourcing/sinking, 500mA@24VDC, RoHS	INVT FE series products
FE-0016N	11016–00043	Digital output module, 16 channels of NPN transistor output, 500mA@24 VDC, RoHS	INVT FE series products
FE-0016P	11016–00040	Digital output module, 16 channels of PNP transistor output, 500mA@24 VDC, RoHS	INVT FE series products
FE-4ADM	11016–00037	Analog input module, 4 channels of voltage signal + 4 channels of current signal, 16-bit resolution, room temperature accuracy ±0.15%FS, RoHS	INVT FE series products
FE-8ADV	11016–00036	Analog input module, 8 channels, voltage signal, 16-bit resolution, room temperature accuracy ±0.15%FS, RoHS	INVT FE series products
FE-8ADI	11016–00038	Analog input module, 8 channels, current signal, 16-bit resolution, room temperature accuracy ±0.15%FS, RoHS	INVT FE series products
FE-4DA	11016–00032	Analogue output module, 4 channels, 16-bit resolution, room temperature accuracy ±0.15%FS, RoHS	INVT FE series products
FE-4PT	11016–00035	RTD module, 4 channels, 24-bit resolution, room temperature accuracy 0.1℃/℉, RoHS	INVT FE series products
FE-4TC	11016–00039	Thermocouple input module, 4 channels, 24-bit resolution, sensitivity 0.1℃/℉, RoHS	INVT FE series products
FE-0808N	11016–00034	Digital I/O module, 8 channels of NPN transistor input, 8 channels of NPN transistor output, RoHS	INVT FE series products
FE-0808P	11016–00033	Digital I/O module, 8 channels of PNP transistor input, 8 channels of PNP transistor output, RoHS	INVT FE series products

5.3 Environmental requirements

Item	Specifications
Working environment temperature	-20°C–+55°C
Working environment relative humidity (RH)	RH < 95%, without condensation
Storage temperature	-40°C–70°C
Storage environment RH	RH < 90%, without condensation
Air	No corrosive gas
Altitude	Lower than 3000m
Pollution degree	Below degree 2
Immunity	2kV power cable compliant with IEC61000-4-4
Overvoltage category	Category II
EMC anti-interference level	Zone B, compliant with IEC61131-2
vibration resistance	Compliant with IEC60068-2-6
Impact resistance	Compliant with IEC60068-2-27

5.4 Communication coupler

5.4.1 EtherCAT communication coupler FE-EC

Figure 5-1 FE-EC appearance
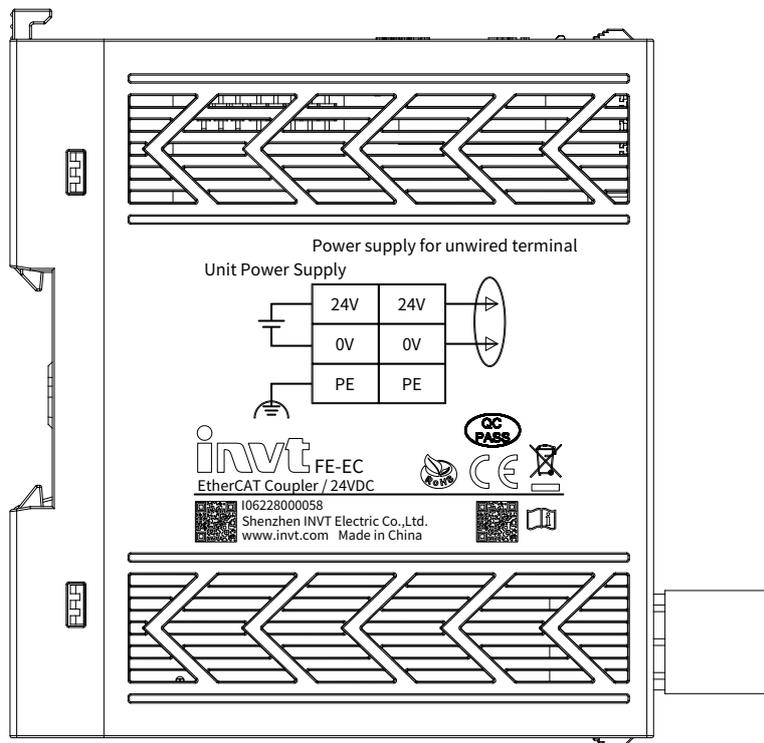
Figure 5-2 Product components
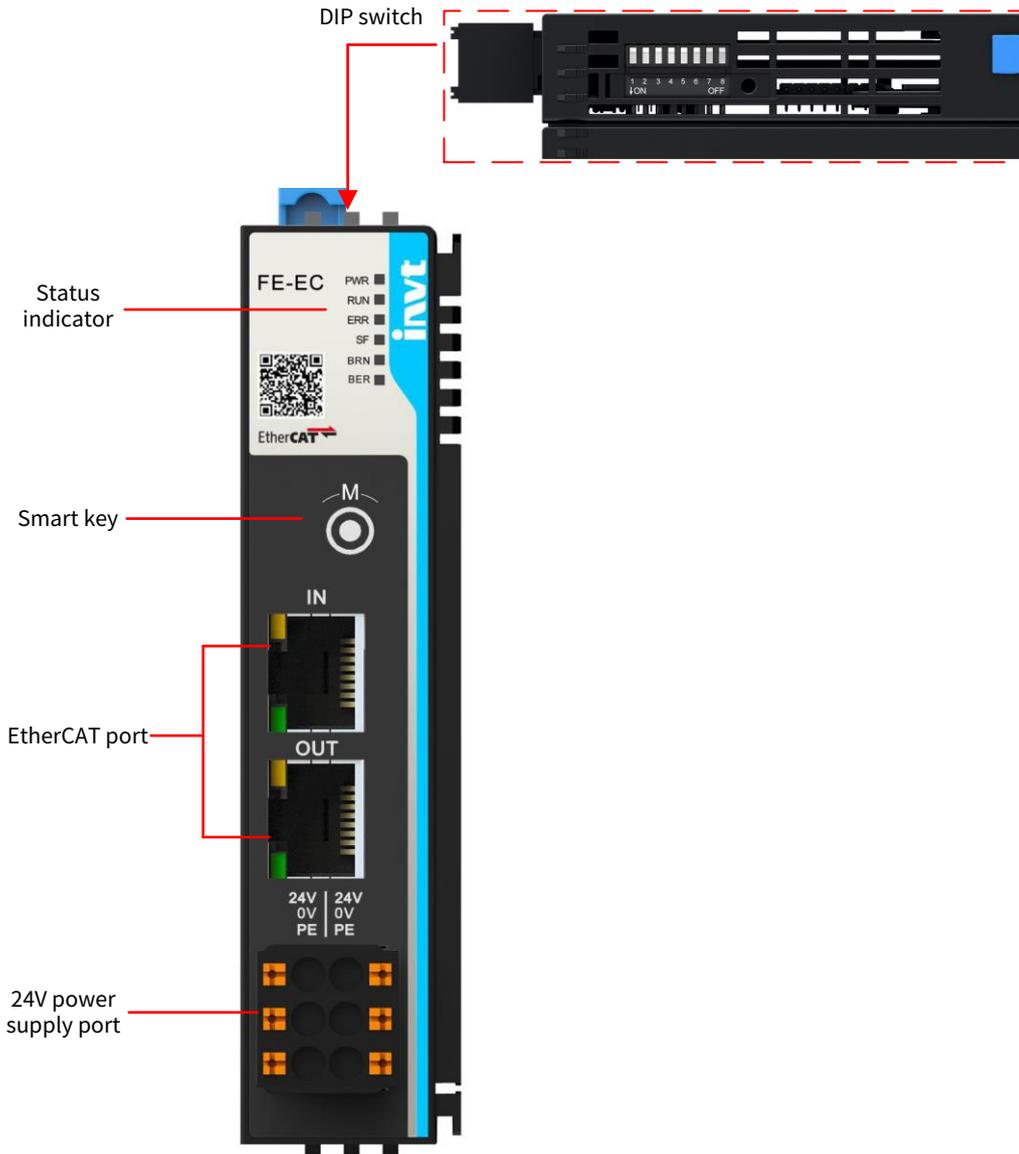
Table 5-1 Product component description

Name	Color	Silk screen	Description
Power supply indicator	Green	PWR	Off: The power connection is abnormal. On: The power connection is normal.
Run indicator	Green	RUN	Off: The communication coupler module is in INIT state. Blinking: The communication coupler module is Pre-Operational state. Single flash: The communication coupler module is in Safe-Operational state. On: The communication coupler module is in Operational state.
Fault indicator	Red	ERR	Off: The EtherCAT communication is in normal state. Blinking: An invalid EtherCAT state transition command has been received. Single flash: Network disconnection or a communication coupler module synchronization error has occurred.

Name	Color	Silk screen	Description
			Double Flash: An EtherCAT communication watchdog error has occurred.
Bus fault indicator	Red	SF	Off: The device is operating normally. Slow flash (500ms): Configuration mismatch. Fast flash (100ms): Backplane bus initialization failed. On: Hardware failure－e2prom operation failed or ESC initialization failed.
Backplane bus run indicator	Green	BRN	Off: Initialization state or no power. Slow flash (500ms): Backplane bus is initializing. Fast flash (100ms): Backplane bus initialization successful, waiting for data communication. On: Backplane bus initialization successful, interacting with data.
Backplane bus fault indicator	Red	BER	Off: The backplane bus is running normally. Slow flash (500ms): Backplane communication timeout. On: The backplane bus has been unable to transmit or receive data for an extended period.
Smart key	Used to switch to factory mode and connect to the IO-Tools host controller.		
DIP switch	Alias setting. The alias is set via an 8-bit binary hardware DIP switch, with a setting range of 1－255. The ON position of the DIP switch corresponds to logic "1".		
EtherCAT interface	IN: EtherCAT input port		
	OUT: EtherCAT output port		

- **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	24V	**24V**	**24V**	24V
	0V	**0V**	**0V**	0V
	⏚	**PE**	**PE**	⏚

- **Terminal wiring**

- **Hardware specifications**

Item	Specifications
Rated input voltage	24VDC (20.4VDC－28.8VDC)
Rated input current	0.8A (Typical value at 24VDC)
Backplane fieldbus output rated voltage	5VDC (4.75VDC－5.25VDC)
Backplane fieldbus output rated current	2.5A (Typical value at 5VDC)

Item	Specifications
Isolation	The input power is not isolated.
Power supply protection	Protection against overcurrent, reverse connection, and surges

■ **Software specifications**

Item	Specifications
Alias access	Supports EtherCAT alias access. Station alias can be set via a DIP switch, with an alias range of 1−255.
Number of input/output PDOs	Up to 1024 bytes
Input/output mailbox size	Up to 128 bytes
Max. number of expansion modules	32
Supported min. synchronization interval	1ms

■ **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	-	-	-	-
Input data	iBus	uint32_t	-	Backplane bus state machine
	ModuleStatus	uint32_t	-	Module fault status (0: No module fault; 1: Module fault present) Bit0: Fault status of module 1 Bit1: Fault status of module 2 ... Bit31: Fault status of module 32 **Note:** The module fault codes can be obtained from the object dictionary 16 #3023.
Output data	-	-	-	-

5.4.2 PROFINET communication coupler FE-PN

Figure 5-3 FE-PN appearance

Figure 5-4 Product components

Table 5-2 Product component description
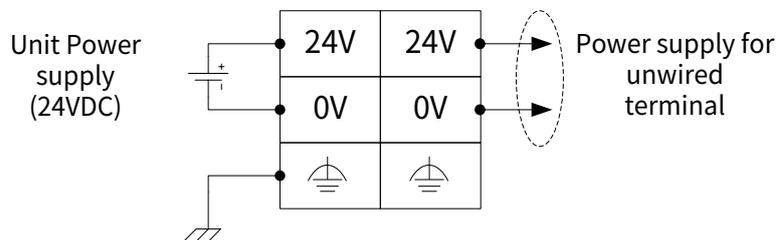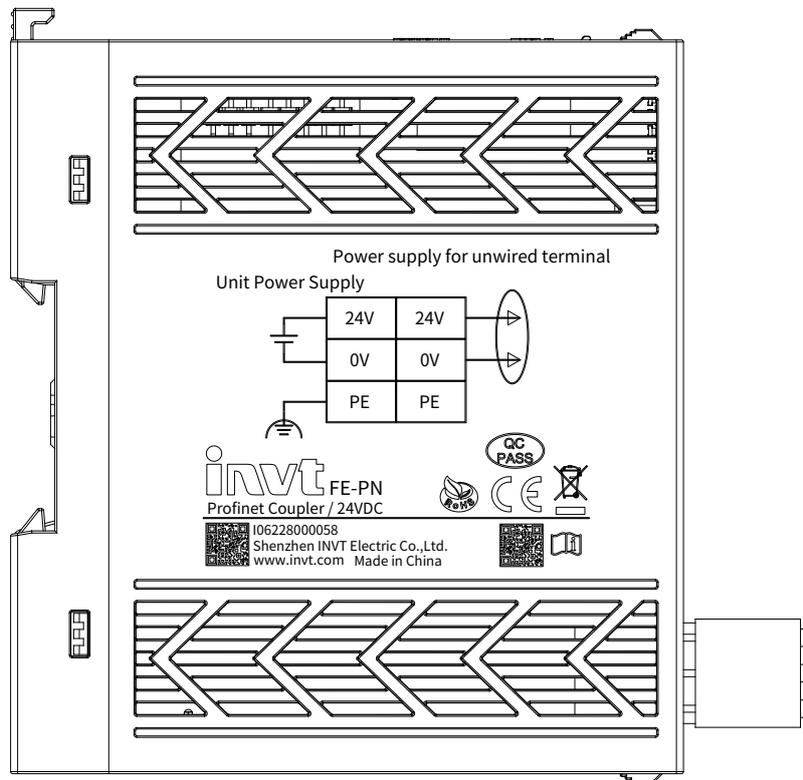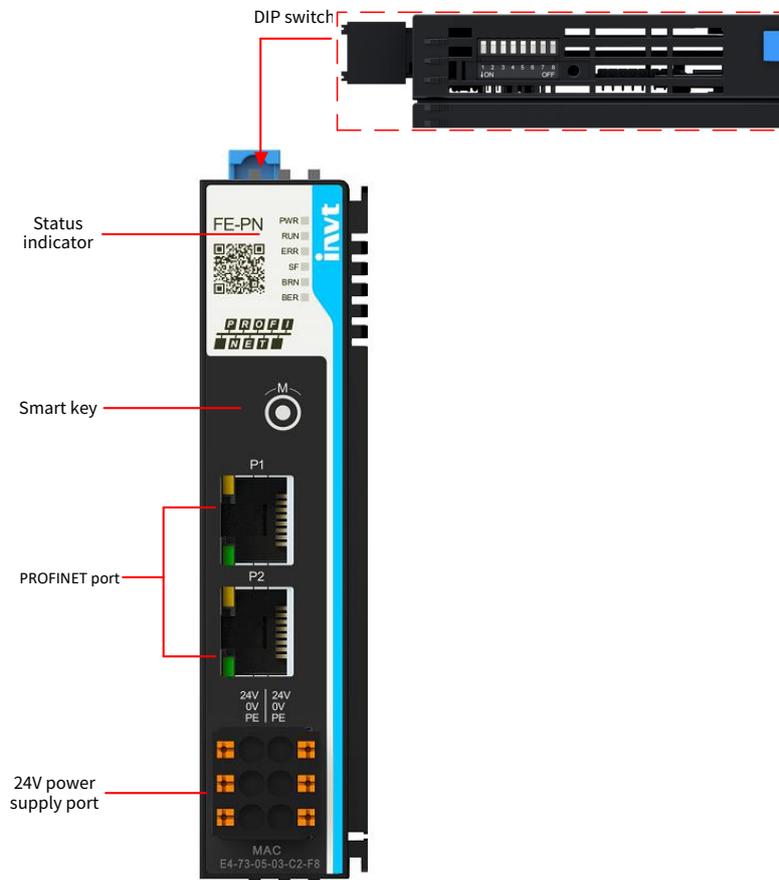
Name	Color	Silk screen	Description
Power supply indicator	Green	PWR	Off: The power connection is abnormal. On: The power connection is normal.
Run indicator	Green	RUN	Off: The communication coupler module is in Initialization state. Blinking (1000ms): Communication coupler module initialization completed, waiting for connection. Blinking (500ms): Communication coupler module connection established, waiting for configuration. Blinking (100ms): Communication coupler module configuration completed, waiting for cyclic data interaction. On: The communication coupler module is in cyclic data exchange state.
Fault indicator	Red	ERR	Off: The communication coupler module is in normal state. Blinking (500ms): Expansion module fault. Blinking (100ms): PROFINET communication timeout.
Bus fault indicator	Red	SF	Off: The device is operating normally. Slow flash (500ms): Configuration mismatch. Fast flash (100ms): Backplane bus initialization failed. On: Hardware fault.
Backplane bus run indicator	Green	BRN	Off: Initialization state or no power. Slow flash (500ms): Backplane bus is initializing. Fast flash (100ms): Backplane bus initialization successful, waiting for data communication. On: Backplane bus initialization successful, interacting with data.
Backplane bus fault indicator	Red	BER	Off: The backplane bus is running normally. Slow flash (500ms): Backplane communication timeout. On: The backplane bus has been unable to transmit or receive data for an extended period.
Smart key	Used to switch to factory mode and connect to the IO-Tools host controller.		
DIP switch	PN device name setting. The alias is set via an 8-bit binary hardware DIP switch, with a setting range of 1−255. The ON position of the DIP switch corresponds to logic "1".		
PROFINET interface	P1: Ethernet interface 1 P2: Ethernet interface 2		

- **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	24V	**24V**	**24V**	24V
	0V	**0V**	**0V**	0V
	⏚	**PE**	**PE**	⏚

■ **Terminal wiring**

■ **Hardware specifications**

Item	Specifications
Rated input voltage	24VDC (20.4VDC–28.8VDC)
Rated input current	0.8A (Typical value at 24VDC)
Backplane fieldbus output rated voltage	5VDC (4.75VDC–5.25VDC)
Backplane fieldbus output rated current	2.5A (Typical value at 5VDC)
Isolation	The input power is not isolated.
Power supply protection	Protection against overcurrent, reverse connection, and surges

■ **Software specifications**

Item	Specifications
Communication mode	RT mode
Min. communication period	1ms
I&M data	From I&M0 to I&M3
PROFINET version	V2.4
Expansion capability	Supports expansion of up to 32 modules
PROFINET interface quantity	2
PROFINET switch function	Supports networking
Open IE support	Supports TCP/IP and LLDP
I/O cyclic data exchange size	≤1440Byte
Alarm/Diagnosis/Status information	Supports local diagnostic information upload to the PLC
Physical layer	100BASE-TX
Communication rate	10 Mbit/s or 100 Mbit/s (adaptive)
Communication mode	Full-duplex (auto-negotiation)
Topology structure	Line, star, tree, ring (MRP), etc.

5.5 I/O module

5.5.1 Digital input module FE-1600D

Figure 5-5 FE-1600D appearance
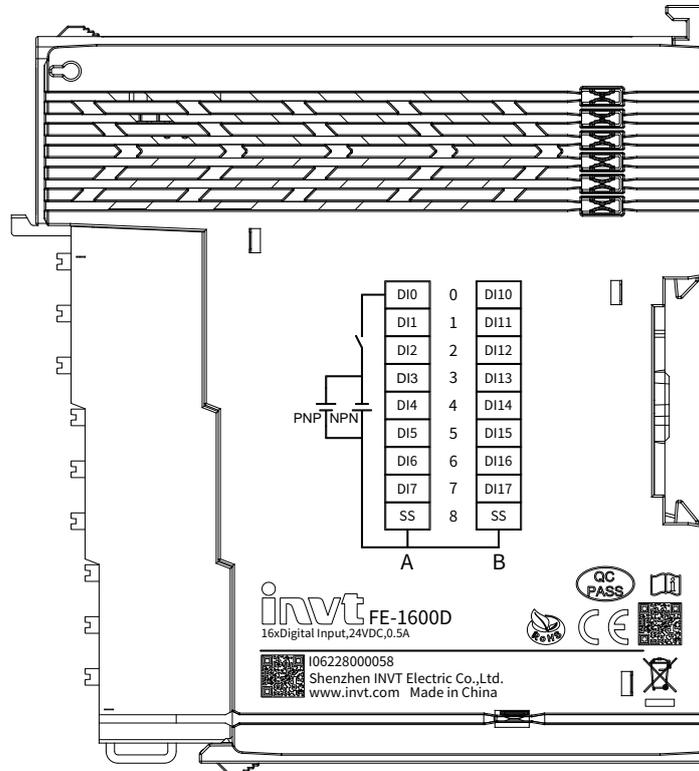
Figure 5-6 Product components
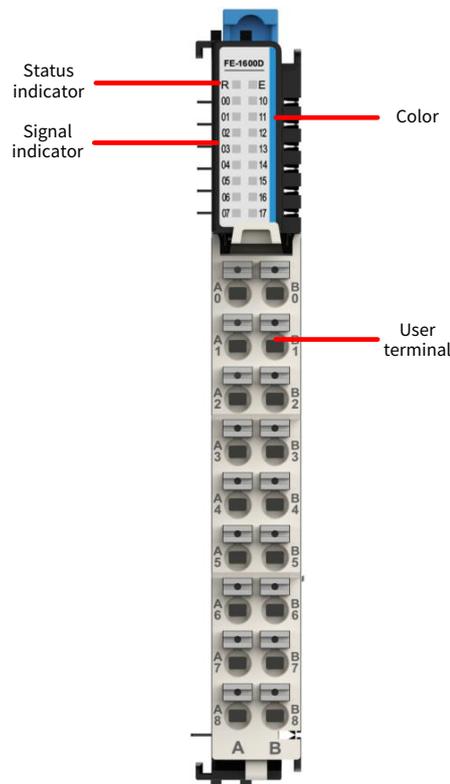
Table 5-3 Product component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Input signal indicator (For each input)	Green	00–07 10–17	On: The input is valid. Off: The input is invalid.
User terminal	External wiring I/O terminal		

- **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	DI0	**A0**	**B0**	DI10
	DI1	**A1**	**B1**	DI11
	DI2	**A2**	**B2**	DI12
	DI3	**A3**	**B3**	DI13
	DI4	**A4**	**B4**	DI14
	DI5	**A5**	**B5**	DI15
	DI6	**A6**	**B6**	DI16
	DI7	**A7**	**B7**	DI17
	SS	**A8**	**B8**	SS

■ **Terminal wiring**

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	80mA (Typical value at 5VDC)
Terminal input power rated voltage	None
Terminal input power rated current	None
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Input specifications**

Item	Specifications
Input type	Digital input
Input mode	Sourcing/sinking
Input channel	16
Input voltage class	24VDC±10% (21.6VDC–26.4VDC)

Item	Specifications
Input current (typical)	5mA (Typical value at 24VDC)
ON voltage	>15V
OFF voltage	<5V
Hardware response time ON/OFF	300μs/300μs
Software filter time	Supported
Input resistance	Reference value about 5.2kΩ
Isolated	Yes
Input action display	When the input is in driving state, the input indicator is on.
Input derating	When operating at an ambient temperature of 55°C, derate to 75% (no more than 12 inputs ON simultaneously), or reduce the ambient temperature by 10°C when all inputs are ON.

- **Software specifications**

Item	Specifications
Software input filter time	Set range: 0–255 (Default: 3) Unit: 1ms, e.g. 10 = 10ms Able to set two groups of filter parameter. Every eight channels use a group of filter parameter.
Input port exception detection and indication	None
Input channel logic level configuration	Not supported
Configuration of independent channel enabling	Not supported
Configuration of diagnosis reporting	Diagnosis information will be uploaded by default.
In stop mode	Output will not be refreshed, while input supports refreshing in Safe-operational state.
I/O mapping	Via two XML files: ●Bit-access mapping supported ●Byte-access mapping supported

- **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	IB0 Filt	uint8_t	3	[0, 255], unit: 1ms, e.g. 3 = 3ms
	IB1 Filt	uint8_t	3	[0, 255], unit: 1ms, e.g. 3 = 3ms
Input data	IB0	uint8_t	-	I00–I07 sample values
	IB1	uint8_t	-	I10–I17 sample values
Output data	-	-	-	-

5.5.2 Digital output module (sourcing) FE-0016P

Figure 5-7 FE-0016P appearance
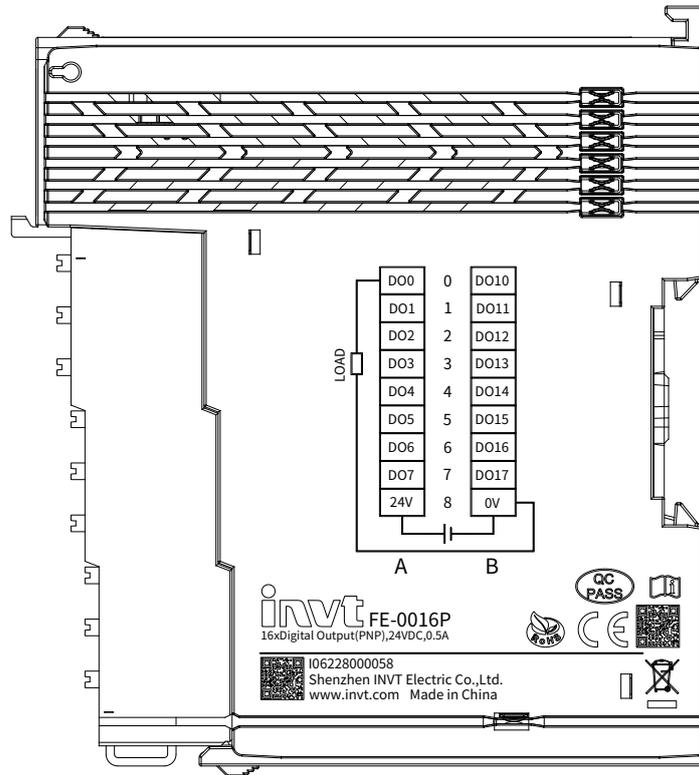
Figure 5-8 Product components
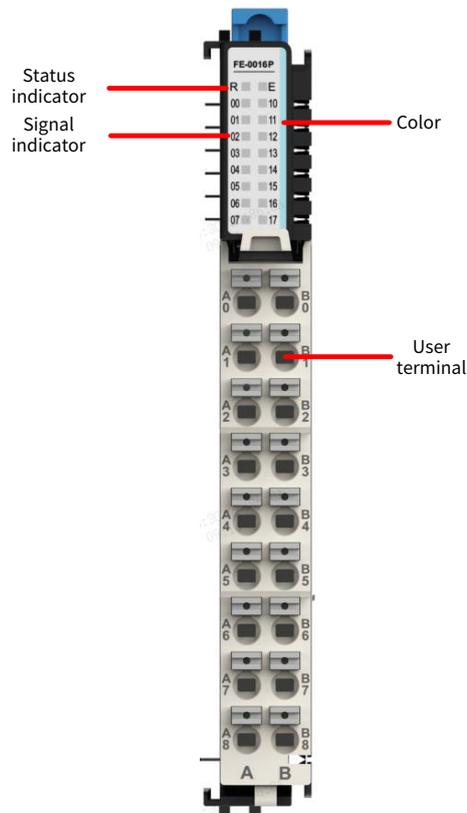
Table 5-4 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Output signal indicator (For each output)	Green	00–07 10–17	On: Output enabled. Off: Output disabled.
User terminal	External wiring I/O terminal		

- **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	DO0	A0	B0	DO10
	DO1	A1	B1	DO11
	DO2	A2	B2	DO12
	DO3	A3	B3	DO13
	DO4	A4	B4	DO14
	DO5	A5	B5	DO15
	DO6	A6	B6	DO16
	DO7	A7	B7	DO17
	24V	A8	B8	0V

■ **Terminal wiring**

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	60mA
Terminal input power rated voltage	24VDC (20.4VDC–28.8VDC)
Terminal input power rated current	2A (Typical value at 24VDC)
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Output specifications**

Item	Specifications
Output type	Digital output, high-edge output
Power-off output	The module output is turned off after the coupler or CPU is powered off.
Output mode	Source type
Output channel	16
Output voltage class	24VDC±10% (21.6VDC–26.4VDC)
Output load (Resistive load)	0.5A/point, 2A/module
Output load (Inductive load)	7.2W/point, 12W/module
Output load (Light load)	5W/point, 18W/module
Hardware response time ON/OFF	100μs/100μs
Leakage current at OFF	10μA
Switch frequency	100Hz for resistive load, 0.5Hz for inductive load, and 10Hz for lamp load
Isolated	Yes
Output action display	When the output is in driving state, the output indicator is on.

Item	Specifications
Output derating	At an ambient temperature of 55°C, the load must be derated to 50% (take resistive load for example: with all output channels ON simultaneously, the output current shall not exceed 1A). At an ambient temperature of 45°C, full load operation is permitted (take resistive load for example: with all output channels ON simultaneously, the output current shall not exceed 2A).
Protection functions	Short-circuit protection and overcurrent protection

- **Software specifications**

Item	Specifications
Stop/offline output mode	Outputs are held or set to preset values, configurable per output point.
Preset value of stop/offline output	Single-point 0 or 1
Output channel exception detection indication	Overheat/overcurrent detection on a module basis
Output channel logic level configuration	Not supported
Configuration of independent channel enabling	Not supported
Configuration of diagnosis reporting	Diagnosis information will be uploaded by default.
In stop mode	Output according to the stop/offline output mode and preset value, without refreshing any more
IO mapping	Via two XML files: ● Bit-access mapping supported ● Byte-access mapping supported

- **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	QB0 Out Mode	uint8_t	0	Q00–Q07 output mode (0: Output preset; 1: Hold output) Bit0: Q00 output mode Bit1: Q01 output mode ... Bit7: Q07 output mode
	QB0 Preset Value	uint8_t	0	Q00–Q07 output preset values
	QB1 Out Mode	uint8_t	0	Q10–Q17 output mode (0: Output preset; 1: Hold output) Bit0: Q10 output mode Bit1: Q11 output mode ... Bit7: Q17 output mode
	QB1 Preset Value	uint8_t	0	Q10–Q17 output preset values
Input data	-	-	-	-
Output data	QB0	uint8_t	-	Q00–Q07 output value

Type	Name	Type	Default	Description
	QB1	uint8_t	-	Q10–Q17 output value

The digital output module divides every eight channels into a group. Taking QB0 Out Mode as an example, the data type is uint8_t. Each bit defines the output mode of one output point, where bit0–bit7 correspond to output channels Q00–Q07, respectively.

The value of each bit corresponding to an output channel indicates the output mode:

0: Output the preset value on stop/offline.

1: Hold the output on stop/offline.

For example: If Q00–Q01 are set to hold output on stop/offline (bit0–bit1 set to 1), and Q02–Q07 are set to output preset values on stop/offline (bit2–bit7 set to 0), then the value of QB0 Out Mode is 3, that is, 0b00000011. Q02–Q07 output preset values are configured by QB0 Preset Value [Bit7–Bit2].

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0	0	0	0	0	0	1	1

5.5.3 Digital output module (sinking) FE-0016N

Figure 5-9 FE-0016N appearance
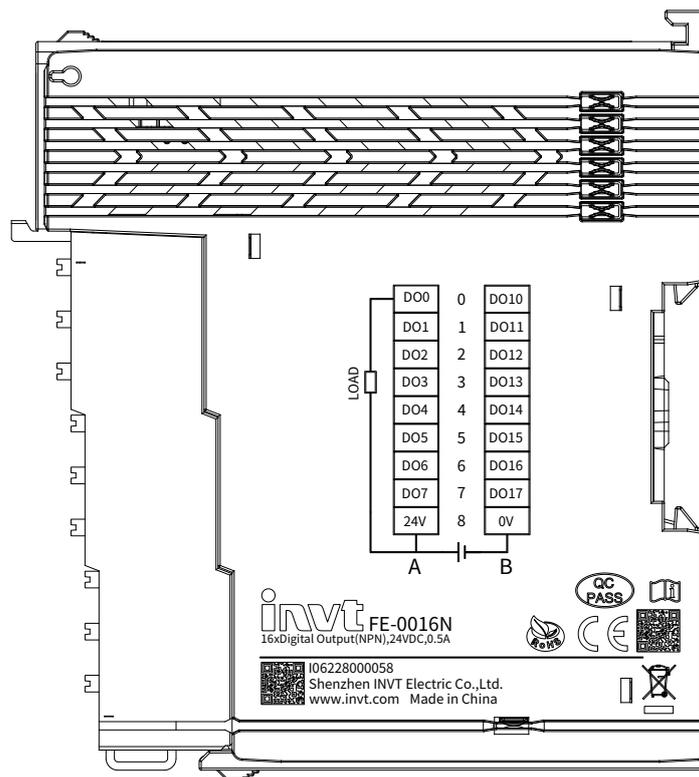
Figure 5-10 Product components

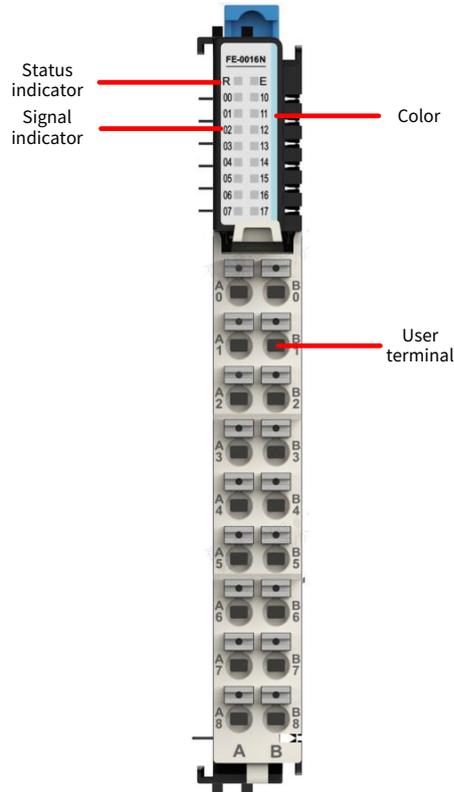Table 5-5 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Output signal indicator (For each output)	Green	00−07 10−17	On: Output enabled. Off: Output disabled.
User terminal	External wiring I/O terminal		

■ **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	DO0	**A0**	**B0**	DO10
	DO1	**A1**	**B1**	DO11
	DO2	**A2**	**B2**	DO12
	DO3	**A3**	**B3**	DO13
	DO4	**A4**	**B4**	DO14
	DO5	**A5**	**B5**	DO15
	DO6	**A6**	**B6**	DO16
	DO7	**A7**	**B7**	DO17
	24V	**A8**	**B8**	0V

■ **Terminal wiring**

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	60mA
Terminal input power rated voltage	24VDC (20.4VDC–28.8VDC)
Terminal input power rated current	100mA (Typical value at 24VDC)
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

- **Output specifications**

Item	Specifications
Output type	Digital output, low-edge output
Power-off output	The module output is turned off after the coupler or CPU is powered off.
Output mode	Sink
Output channel	16
Output voltage class	24VDC±10% (21.6VDC–26.4VDC)
Output load (Resistive load)	0.5A/point, 4A/module
Output load (Inductive load)	7.2W/point, 24W/module
Output load (Lamp load)	5W/point, 18W/module
Hardware response time ON/OFF	100µs
Leakage current at OFF	10µA
Switch frequency	100Hz for resistive load, 0.5Hz for inductive load, and 10Hz for lamp load
Isolated	Yes
Output action display	When the output is in driving state, the output indicator is on.
Output derating	At an ambient temperature of 55°C, the load must be derated to 50% (take resistive load for example: with all output channels ON simultaneously, the output current shall not exceed 2A). At an ambient temperature of 45°C, full load operation is permitted (take resistive load for example: with all output channels ON simultaneously, the output current shall not exceed 4A).
Protection functions	Short-circuit protection and overcurrent protection

- **Software specifications**

Item	Specifications
Stop/offline output mode	Outputs are held or set to preset values, configurable per output point.
Preset value of stop/offline output	Single-point 0 or 1
Output channel exception detection indication	Overheat/overcurrent detection and protection on a module basis
Output channel logic level configuration	Not supported
Configuration of independent channel enabling	Not supported
Configuration of diagnosis reporting	Diagnosis information will be uploaded by default.
In stop mode	Output according to the stop/offline output mode and preset value, without refreshing any more
IO mapping	Via two XML files: ●Bit-access mapping supported ●Byte-access mapping supported

■ **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	QB0 Out Mode	uint8_t	0	Q00–Q07 output mode (0: Output preset; 1: Hold output) Bit0: Q00 output mode Bit1: Q01 output mode … Bit7: Q07 output mode
	QB0 Preset Value	uint8_t	0	Q00–Q07 output preset values
	QB1 Out Mode	uint8_t	0	Q10–Q17 output mode (0: Output preset; 1: Hold output) Bit0: Q10 output mode Bit1: Q11 output mode … Bit7: Q17 output mode
	QB1 Preset Value	uint8_t	0	Q10–Q17 output preset values
Input data	-	-	-	-
Output data	QB0	uint8_t	-	Q00–Q07 output values
	QB1	uint8_t	-	Q10–Q17 output value

The digital output module divides every eight channels into a group. Taking QB0 Out Mode as an example, the data type is uint8_t. Each bit defines the output mode of one output point, where bit0–bit7 correspond to output channels Q00–Q07, respectively.

The value of each bit corresponding to an output channel indicates the output mode:
0: Output the preset value on stop/offline.
1: Hold the output on stop/offline.

For example: If Q00–Q01 are set to hold output on stop/offline (bit0–bit1 set to 1), and Q02–Q07 are set to output preset values on stop/offline (bit2–bit7 set to 0), then the value of QB0 Out Mode is 3, that is, 0b00000011. Q02–Q07 output preset values are configured by QB0 Preset Value [Bit7–Bit2].

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	0	0	0	0	0	1	1

5.5.4 Mixed digital module (sourcing) FE-0808P

Figure 5-11 FE-0808P appearance
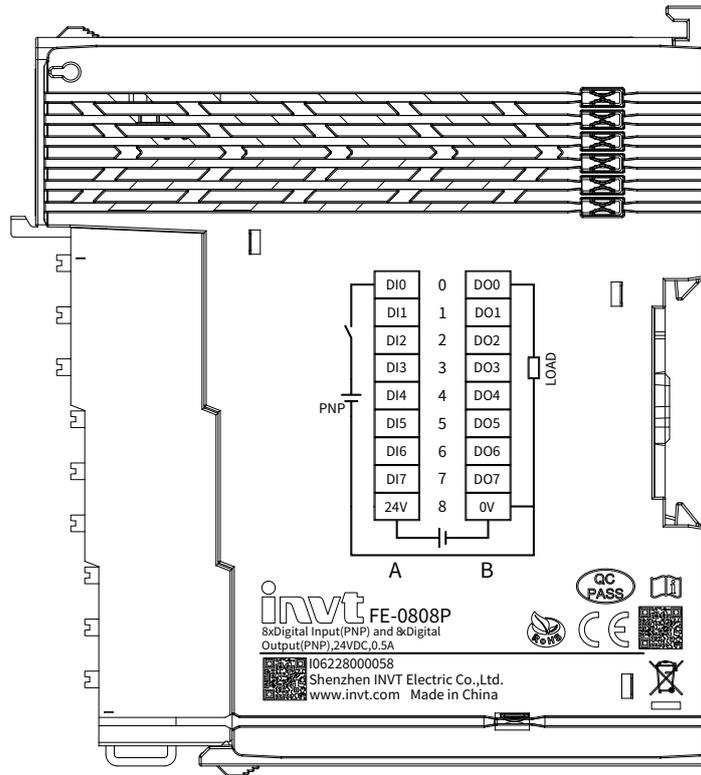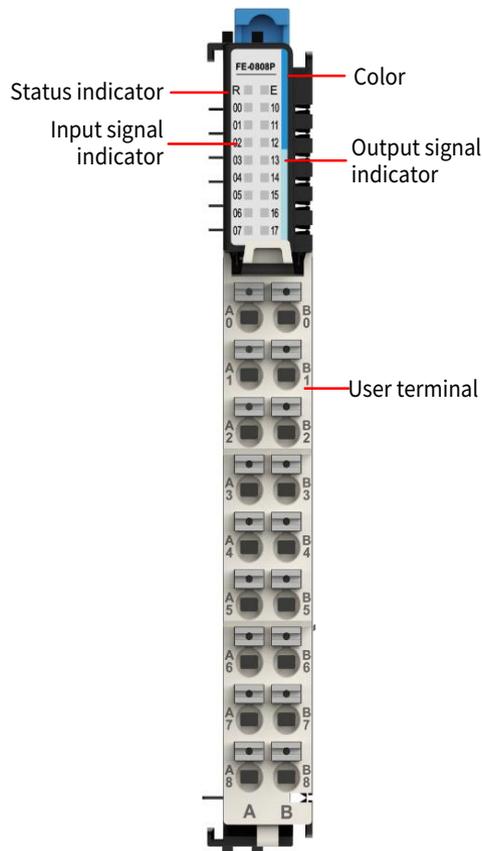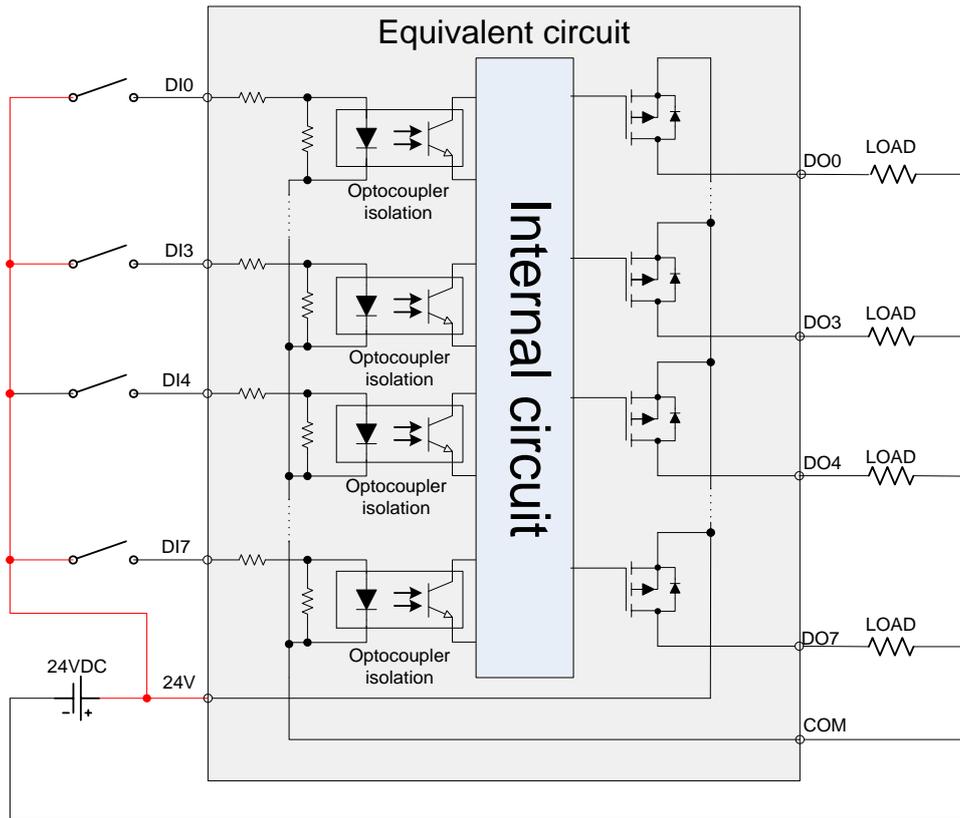

Figure 5-12 Product components

Table 5-6 Product component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Input signal indicator (For each input)	Green	00–07	On: The input is valid. Off: The input is invalid.
Output signal indicator (For each output)	Green	10–17	On: Output enabled. Off: Output disabled.
User terminal	External wiring I/O terminal		

■ **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	DI0	**A0**	**B0**	DO0
	DI1	**A1**	**B1**	DO1
	DI2	**A2**	**B2**	DO2
	DI3	**A3**	**B3**	DO3
	DI4	**A4**	**B4**	DO4
	DI5	**A5**	**B5**	DO5
	DI6	**A6**	**B6**	DO6
	DI7	**A7**	**B7**	DO7
	24V	**A8**	**B8**	0V

■ **Terminal wiring**

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	80mA (Typical value at 5VDC)
Terminal input power rated voltage	24VDC (20.4VDC–28.8VDC)
Terminal input power rated current	2A (Typical value at 24VDC)
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Input/output specifications**

Item	Specifications
Input specifications	
Input type	Digital input
Input mode	Source type
Input channel	8
Input voltage class	24VDC±10% (21.6VDC–26.4VDC)
Input current (typical)	5mA (Typical value at 24VDC)
ON voltage	>15V
OFF voltage	<5V
Hardware response time ON/OFF	300μs/300μs
Software filter time	Supported
Input resistance	Reference value about 5.2kΩ
Isolated	Yes

Item	Specifications
Input action display	When the input is in driving state, the input indicator is on.
Input derating	When each terminal is operating at 55°C, it is derated to 75% (with no more than 6 input points of ON at the same time), or the temperature drops by 10°C when all input points are ON.
Output specifications	
Output type	Digital output, high-edge output
Power-off output	The module output is turned off after the coupler or CPU is powered off.
Output mode	Source type
Output channel	8
Output voltage class	24VDC±10% (21.6VDC–26.4VDC)
Output load (Resistive load)	0.5A/point, 2A/module
Output load (Inductive load)	7.2W/point, 12W/module
Output load (Lamp load)	5W/point, 9W/module
Hardware response time ON/OFF	100μs/100μs
Leakage current at OFF	10μA
Switch frequency	100Hz for resistive load, 0.5Hz for inductive load, and 10Hz for lamp load
Isolated	Yes
Output action display	When the output is in driving state, the output indicator is on.
Output derating	At an ambient temperature of 55°C, the load must be derated to 50% (take resistive load for example: with all output channels ON simultaneously, the output current shall not exceed 1A). At an ambient temperature of 45°C, full load operation is permitted (take resistive load for example: with all output channels ON simultaneously, the output current shall not exceed 2A).
Protection functions	Short-circuit protection and overcurrent protection

- **Software specifications**

Item	Specifications
Software input filter time	Setting range: 0–255 (Default: 3) Unit: 1ms, e.g. 10 = 10ms One filter parameter is shared by a group of 8 channels.
Input port exception detection and indication	Overheat/overcurrent detection and protection on a module basis
Input channel logic level configuration	Not supported
Stop/offline output mode	Outputs are held or set to preset values, configurable per output point.
Preset value of stop/offline output	Single-point 0 or 1
Output channel exception detection indication	Overheat/overcurrent detection and protection on a module basis
Output channel logic level configuration	Not supported
Configuration of independent channel enabling	Not supported

Item	Specifications
Configuration of diagnosis reporting	Diagnosis information will be uploaded by default.
In stop mode	Output according to the stop/offline output mode and preset value, without refreshing any more
I/O mapping	Supporting the mapping method of bitwise access

■ **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	IB0 Filt	uint8_t	3	[0, 255], unit: 1ms, e.g. 3 = 3ms
	QB0 Out Mode	uint8_t	0	Q00–Q07 output mode (0: Output preset; 1: Hold output) Bit0: Q00 output mode Bit1: Q01 output mode ... Bit7: Q07 output mode
	QB0 Preset Value	uint8_t	0	Q00–Q07 output preset values
Input data	IB0	uint8_t	-	I00–I07 sample values
Output data	QB0	uint8_t	-	Q00–Q07 output values

5.5.5 Mixed digital module (sinking) FE-0808N

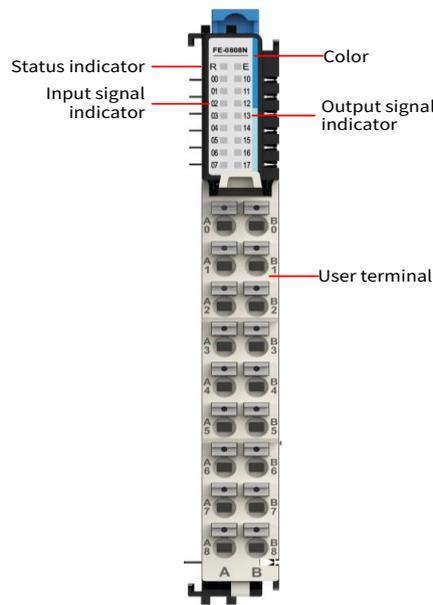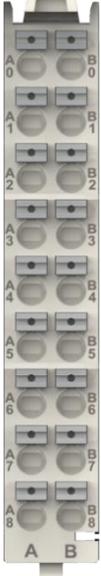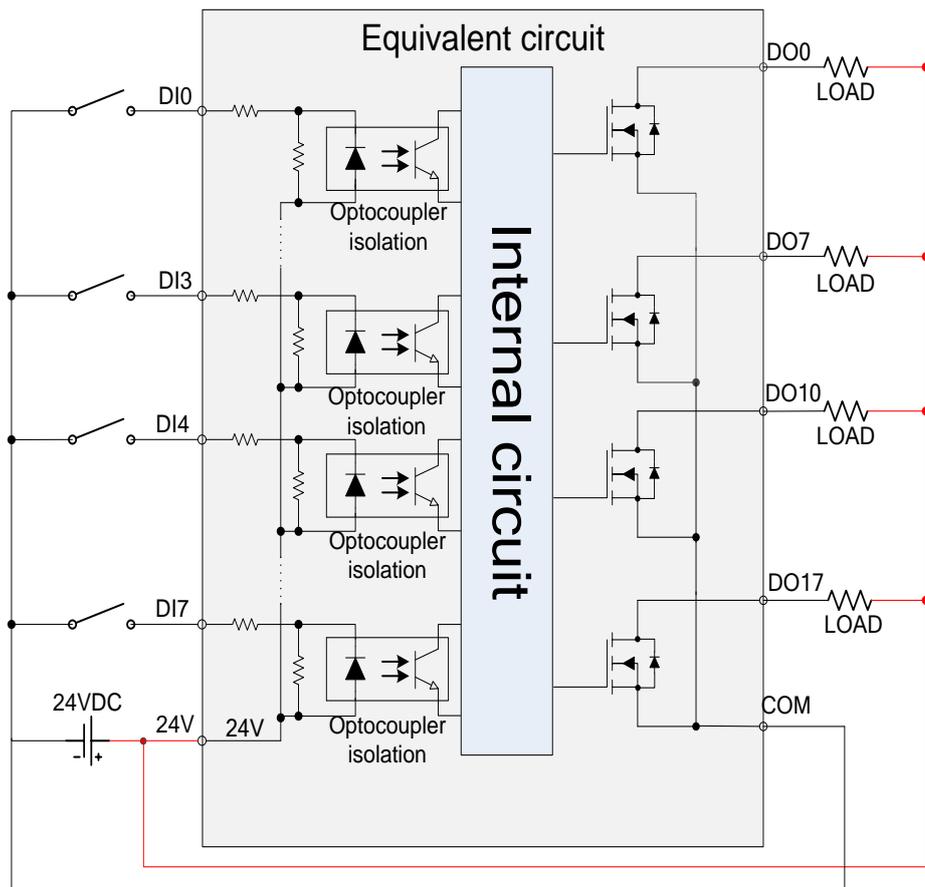Figure 5-13 FE-0808N appearance
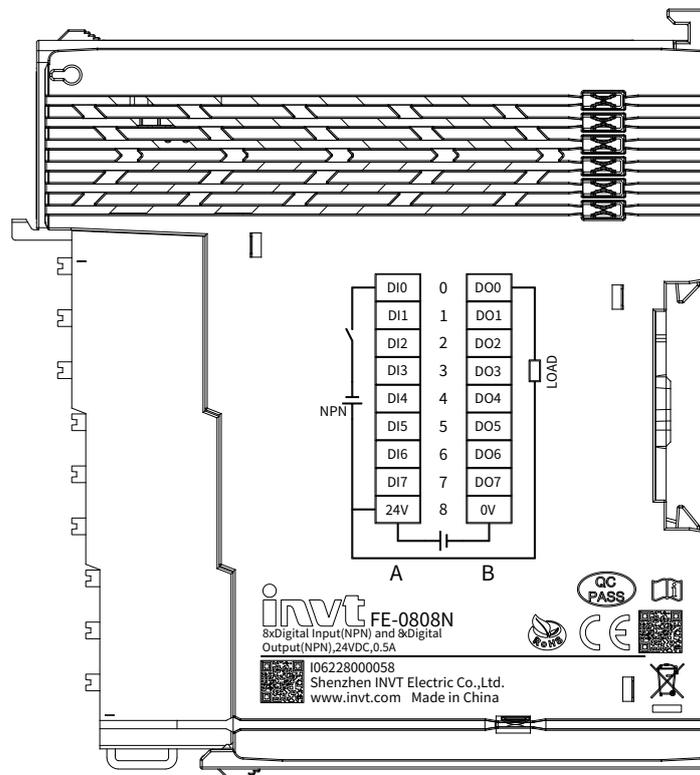
Figure 5-14 Product components

Table 5-7 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Input signal indicator (For each input)	Green	00–07	On: The input is valid. Off: The input is invalid.
Output signal indicator (For each output)	Green	10–17	On: Output enabled. Off: Output disabled.
User terminal	External wiring I/O terminal		

■ **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	DI0	**A0**	**B0**	DO0
	DI1	**A1**	**B1**	DO1
	DI2	**A2**	**B2**	DO2
	DI3	**A3**	**B3**	DO3
	DI4	**A4**	**B4**	DO4
	DI5	**A5**	**B5**	DO5
	DI6	**A6**	**B6**	DO6
	DI7	**A7**	**B7**	DO7
	24V	**A8**	**B8**	0V

■ **Terminal wiring**

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	80mA (Typical value at 5VDC)

Item	Specifications
Terminal input power rated voltage	24VDC (20.4VDC–28.8VDC)
Terminal input power rated current	100mA (Typical value at 24VDC)
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

- ■ **Input/output specifications**

Item	Specifications
Input specifications	
Input type	Digital input
Input mode	Sink
Input channel	8
Input voltage class	24VDC±10% (21.6VDC–26.4VDC)
Input current (typical)	5mA (Typical value at 24VDC)
ON voltage	>15V
OFF voltage	<5V
Hardware response time ON/OFF	300μs/300μs
Software filter time	Supported
Input resistance	Reference value about 5.2kΩ
Isolated	Yes
Input action display	When the input is in driving state, the input indicator is on.
Input derating	When operating at an ambient temperature of 55℃, derate to 75% (no more than 6 inputs ON simultaneously), or reduce the ambient temperature by 10℃ when all inputs are ON.
Output specifications	
Output type	Digital output, low-edge output
Power-off output	The module output is turned off after the coupler or CPU is powered off.
Output mode	Sink
Output channel	8
Output voltage class	24VDC±10% (21.6VDC–26.4VDC)
Output load (Resistive load)	0.5A/point, 2A/module
Output load (Inductive load)	7.2W/point, 12W/module
Output load (Lamp load)	5W/point, 9W/module
Hardware response time ON/OFF	100μs/100μs
Leakage current at OFF	10μA
Switch frequency	100Hz for resistive load, 0.5Hz for inductive load, and 10Hz for lamp load
Isolated	Yes
Output action display	When the output is in driving state, the output indicator is on.
Output derating	At an ambient temperature of 55℃, the load must be derated to 50% (take resistive load for example: with all output channels ON simultaneously, the output current shall not exceed 1A). At an ambient temperature of 45℃, full load operation is permitted (take resistive load for example: with all output channels ON simultaneously,

Item	Specifications
	the output current shall not exceed 2A).
Protection functions	Short-circuit protection and overcurrent protection

- **Software specifications**

Item	Specifications
Software input filter time	Setting range: 0–255 (Default: 3) Unit: 1ms, e.g. 10 = 10ms One filter parameter is shared by a group of 8 channels.
Input port exception detection and indication	None
Input channel logic level configuration	Not supported
Stop/offline output mode	Outputs are held or set to preset values, configurable per output point.
Preset value of stop/offline output	Single-point 0 or 1
Output channel exception detection indication	Overheat/overcurrent detection and protection on a module basis
Output channel logic level configuration	Not supported
Configuration of independent channel enabling	Not supported
Configuration of diagnosis reporting	Diagnosis information will be uploaded by default.
In stop mode	Output according to the stop/offline output mode and preset value, without refreshing any more
I/O mapping	Supporting the mapping method of bitwise access

- **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	IB0 Filt	uint8_t	3	[0, 255], unit: 1ms, e.g. 3 = 3ms
	QB0 Out Mode	uint8_t	0	Q00–Q07 output mode Bit0: Q00 output mode Bit1: Q01 output mode … Bit7: Q07 output mode 0: Output preset; 1: Hold output
	QB0 Preset Value	uint8_t	0	Q00–Q07 output preset values
Input data	IB0	uint8_t	-	I00–I07 sample values
Output data	QB0	uint8_t	-	Q00–Q07 output values

5.5.6 Analog input module FE-4ADM
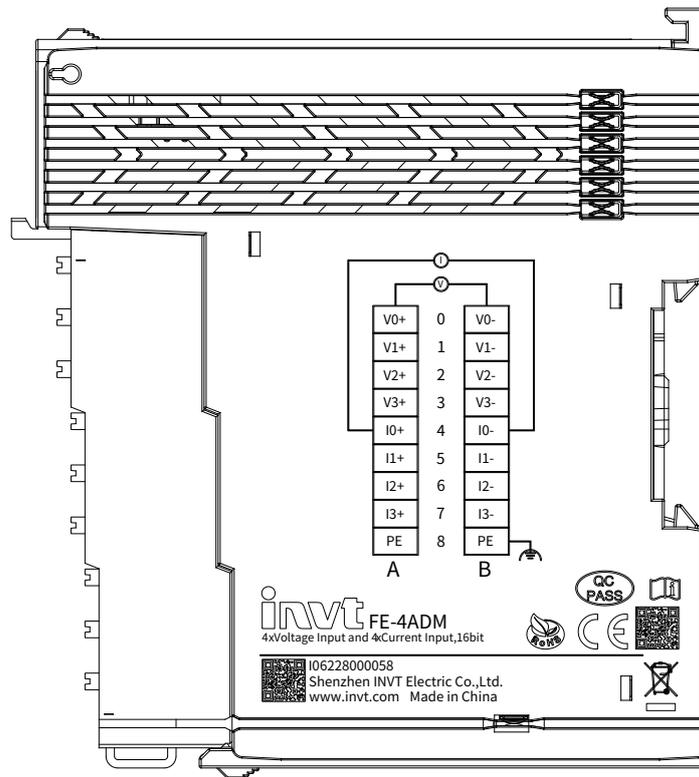
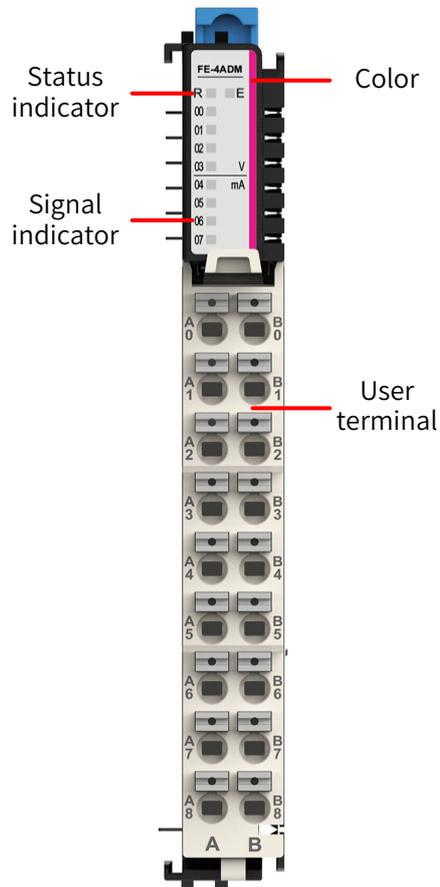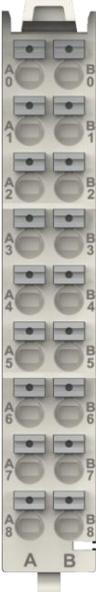Figure 5-15 FE-4ADM appearance

Figure 5-16 Product components

Table 5-8 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Channel status indicator	Green	00−07	Off: The channel is disabled. Slow flash (500ms): Input signal overrange or channel configuration parameter error. Fast flash (100ms): Hardware error − Internal chip SPI communication timeout. On: Channel enabled
User terminal	External wiring I/O terminal		

- **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	V0+	**A0**	**B0**	V0-
	V1+	**A1**	**B1**	V1-
	V2+	**A2**	**B2**	V2-
	V3+	**A3**	**B3**	V3-
	I0+	**A4**	**B4**	I0-
	I1+	**A5**	**B5**	I1-
	I2+	**A6**	**B6**	I2-
	I3+	**A7**	**B7**	I3-
	PE	**A8**	**B8**	PE

- **Terminal wiring**

Figure 5-17 Voltage input wiring
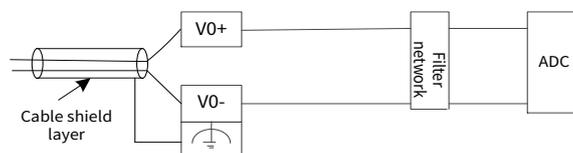
Figure 5-18 Current input wiring

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	130mA
Terminal input power rated voltage	None
Terminal input power rated current	None
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Input specifications**

Input type	Item	Specifications
Voltage input	Input type	Analog input
	Input mode	Voltage (Differential)
	Input channel	4
	Resolution	16 bits
	Conversion time	<170μs/channel
	Voltage input range	0–5V, 0–10V, -5–+5V, -10–+10V, 1–5V
	Voltage input resistance	1MΩ
	Voltage input accuracy (25℃)	±0.15%
	Voltage input accuracy (in full temperature range)	±0.3%
Current input	Input type	Analog input
	Input mode	Current (Differential)
	Input channel	4
	Resolution	16 bits
	Conversion time	<170μs/channel
	Current input range	±20mA, 0–20mA, 4–20mA
	Current input resistance	240Ω
	Current input accuracy (25℃)	±0.15%
	Current input accuracy (in full	±0.3%

Input type	Item	Specifications
	temperature range)	
	Current input limit	$\pm$ 30mA

■ **Software specifications**

Item	Specifications
Configuration of independent channel enabling	Supported
Configuration of diagnosis reporting	Supported
Configuration of enabling diagnosis detection	Over range detection
Mode switchover configuration	Voltage: 0–5V, 0–10V, $\pm$5V, $\pm$10V, 1–5V
	Current: 4–20mA, 0–20mA, $\pm$20mA
Filter parameter configuration	Software filter time can be set through the upper computer, which ranges from 0 to 255, with the sampling period as the unit.
Configuration of enabling peak holding	Not supported
Configuration of conversion digital range	-10–+10VDC	-20000–20000, -32000–32000, -27648–27648, -32768–32767
	0–10VDC	0–20000, 0–32000, 0–27648, 0–32767
	-5–+5VDC	-20000–20000, -32000–32000, -27648–27648, -32768–32767
	0–5VDC	0–20000, 0–32000, 0–27648, 0–32767
	1–5VDC	0–20000, 0–32000, 0–27648, 0–32767
	-20mA–+20mA	-20000–20000, -32000–32000, -27648–27648, -32768–32767
	0mA–20mA	0–20000, 0–32000, 0–27648, 0–32767
	4mA–20mA	0–20000, 0–32000, 0–27648, 0–32767
Sampling time	<170μs/channel
Sampling refresh	Sampling time based asynchronous refresh, but not bus period based synchronous refresh

■ **Software user interface**

Type	Name	Type	Default	Description

Configuration parameter	AI0 Cfg	uint8_t	0x61	Configuration parameter for channel 0.
				Bit0: Channel enable
				Bit1: Overrange detection enable
				Bit2: Enhanced filter enable
				bit4–bit3: Conversion range selection
				  2#00: (0–20000) or (-20000–20000)
				  2#01: (0–27648) or (-27648–27648)
				  2#10: (0–32000) or (-32000–32000)
				  2#11:(0–32767) or (-32768–32767)
				Bit7–Bit5: Conversion mode selection
				  2#000: voltage 0–5V
				  2#001: voltage 0–10V
				  2#010: voltage -5–5V
				  2#011: voltage -10–10V
				  2#100: voltage 1–5V

	AI0 Filt	uint8_t	8	Channel filter queue size
	AI1 Cfg	uint8_t	0x61	Same definition as channel 0 configuration

Type	Name	Type	Default	Description
				parameter.
	AI1 Filt	uint8_t	8	Channel filter queue size
	AI2 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI2 Filt	uint8_t	8	Channel filter queue size
	AI3 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI3 Filt	uint8_t	8	Channel filter queue size
	AI4 Cfg	uint8_t	0xA1	Configuration parameter for channel 4. Bit0: Channel enable Bit1: Overrange detection enable Bit2: Enhanced filter enable bit4−bit3: Conversion range selection 2#00: (0−20000) or (-20000−20000) 2#01: (0−27648) or (-27648−27648) 2#10: (0−32000) or (-32000−32000) 2#11:(0−32767) or (-32768−32767) Bit7−Bit5: Conversion mode selection 2#101: Current 4−20mA 2#110: Current 0−20mA 2#111: Current -20−20mA
	AI4 Filt	uint8_t	8	Channel filter queue size
	AI5 Cfg	uint8_t	0xA1	Same definition as channel 4 configuration parameter.
	AI5 Filt	uint8_t	8	Channel filter queue size
	AI6 Cfg	uint8_t	0xA1	Same definition as channel 4 configuration parameter.
	AI6 Filt	uint8_t	8	Channel filter queue size
	AI7 Cfg	uint8_t	0xA1	Same definition as channel 4 configuration parameter.
	AI7 Filt	uint8_t	8	Channel filter queue size
Input data	AI0	int16_t	-	Channel sample code value
	AI1	int16_t	-	Channel sample code value
	AI2	int16_t	-	Channel sample code value
	AI3	int16_t	-	Channel sample code value
	AI4	int16_t	-	Channel sample code value
	AI5	int16_t	-	Channel sample code value
	AI6	int16_t	-	Channel sample code value
	AI7	int16_t	-	Channel sample code value
Output data	-	-	-	-

AIx_Cfg (x = 0, 1, 2, 3, 4, 5, 6, 7) is a channel configuration parameter. The parameter type is uint8_t. For the FE-4ADM module, channels 0–3 support voltage input only, while channels 4–7 support current input only. The following takes configuring channel 0 as an example.

Channel 0 is configured with channel enabled, overrange detection enabled, enhanced filter disabled, a converted digital range of 0–20000, and a measurement range of 1–5V. The corresponding value is 131 (0b10000011). The detailed bit definition is shown in the following:

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
100			00		0	1	1
1–5V			0–20000		Disable	Enabled	Enabled

AIx_Filt (x=0, 1, 2, 3, 4, 5, 6, 7) is the channel filter parameter setting. The parameter type is uint8_t. The parameter setting range is 0 to 255. Generally, a higher value indicates better suppression of high-frequency interference, but it also leads to greater delay. It should be adjusted according to the actual situation.

5.5.7 Analog input module FE-8ADV

Figure 5-19 FE-8ADV appearance
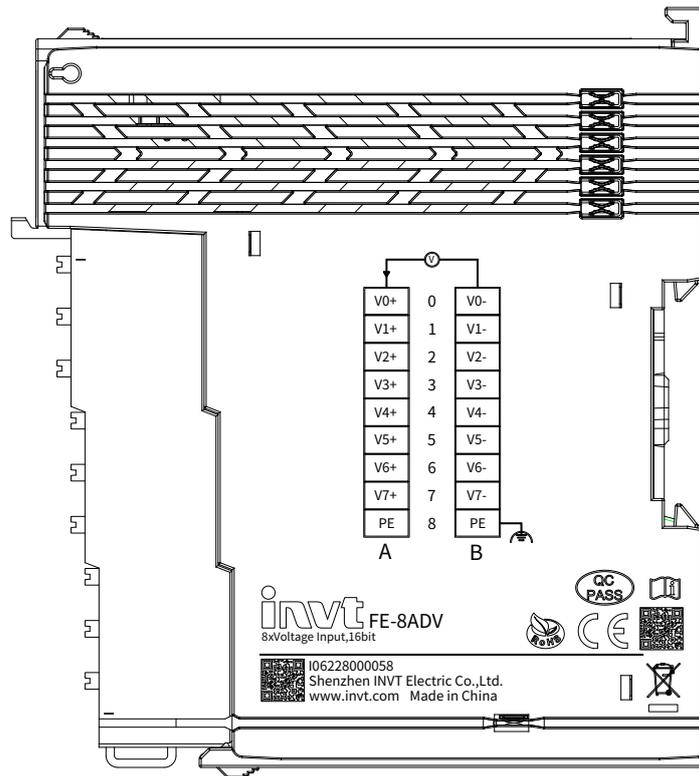
Figure 5-20 Product components
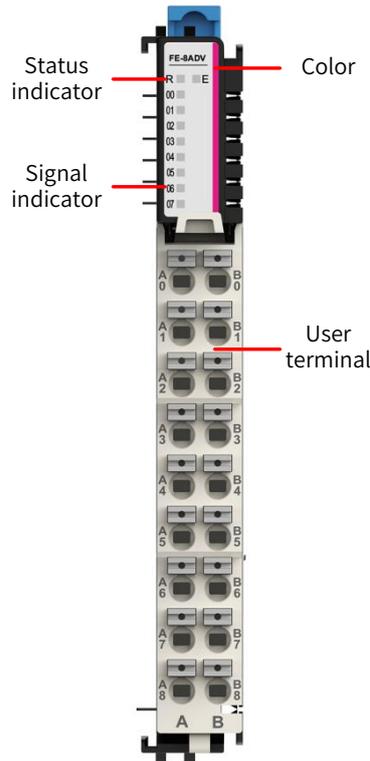
Table 5-9 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Channel status indicator	Green	00–07	Off: The channel is disabled. Slow flash (500ms): Input signal overrange or channel configuration parameter error. Fast flash (100ms): Hardware error – Internal chip SPI communication timeout. On: Channel enabled
User terminal	External wiring I/O terminal		

■ **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	V0+	A0	B0	V0-
	V1+	A1	B1	V1-
	V2+	A2	B2	V2-
	V3+	A3	B3	V3-
	V4+	A4	B4	V4-
	V5+	A5	B5	V5-
	V6+	A6	B6	V6-
	V7+	A7	B7	V7-
	PE	A8	B8	PE

■ **Terminal wiring**

Figure 5-21 Voltage input wiring

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC−5.25VDC)
Fieldbus input power rated current	130mA
Terminal input power rated voltage	None
Terminal input power rated current	None
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Input specifications**

Item	Specifications
Input type	Analog input
Input mode	Voltage (Differential)
Input channel	8
Resolution	16 bits
Conversion time	<170μs per channel
Voltage input range	0−5V, 1−5V, 0−10V, -5−+5V, -10−+10V
Voltage input resistance	1MΩ
Voltage input accuracy (25℃)	±0.15%
Voltage input accuracy (in	±0.3%

Item	Specifications
full temperature range)	
Isolated	No isolation between interface channels; voltage isolated from interface; interface isolated from bus

■ **Software specifications**

Item	Specifications
Configuration of independent channel enabling	Supported
Configuration of diagnosis reporting	Supported
Configuration of enabling diagnosis detection	Over range detection
Mode switchover configuration	0–5V, 0–10V, ±5V, ±10V, 1–5V
Filter parameter configuration	Software filter time can be set through the upper computer, which ranges from 0 to 255, with the sampling period as the unit.
Overrange detection enable configuration	Supported
Configuration of enabling peak holding	Not supported
Configuration of conversion digital range	-10–+10VDC: -20000–20000, -32000–32000, -27648–27648, -32768–32767
	0–10VDC: 0–20000, 0–32000, 0–27648, 0–32767
	-5–+5VDC: -20000–20000, -32000–32000, -27648–27648, -32768–32767
	0–5VDC: 0–20000, 0–32000, 0–27648, 0–32767
	1–5VDC: 0–20000, 0–32000, 0–27648, 0–32767
Sampling time	<170µs/channel
Sampling refresh	Sampling time based asynchronous refresh, but not bus period based synchronous refresh

■ **Software user interface**

Type	Name	Type	Default	Description

Configuration parameter	AI0 Cfg	uint8_t	0x61	Configuration parameter for channel 0.
				Bit0: Channel enable
				Bit1: Overrange detection enable
				Bit2: Enhanced filter enable
				bit4–bit3: Conversion range selection
				    2#00: (0–20000) or (-20000–20000)
				    2#01: (0–27648) or (-27648–27648)
				    2#10: (0–32000) or (-32000–32000)
				    2#11:(0–32767) or (-32768–32767)
				Bit7–Bit5: Conversion mode selection
				    2#000: voltage 0–5V
				    2#001: voltage 0–10V
				    2#010: voltage -5–5V
				    2#011: voltage -10–10V
				    2#100: voltage 1–5V
				    2#101: reserved
				    2#110: reserved
				    2#111: reserved

	AI0 Filt	uint8_t	8	Channel filter queue size

Type	Name	Type	Default	Description
	AI1 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI1 Filt	uint8_t	8	Channel filter queue size
	AI2 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI2 Filt	uint8_t	8	Channel filter queue size
	AI3 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI3 Filt	uint8_t	8	Channel filter queue size
	AI4 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI4 Filt	uint8_t	8	Channel filter queue size
	AI5 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI5 Filt	uint8_t	8	Channel filter queue size
	AI6 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI6 Filt	uint8_t	8	Channel filter queue size
	AI7 Cfg	uint8_t	0x61	Same definition as channel 0 configuration parameter.
	AI7 Filt	uint8_t	8	Channel filter queue size
Input data	AI0	int16_t	-	Channel sample code value
	AI1	int16_t	-	Channel sample code value
	AI2	int16_t	-	Channel sample code value
	AI3	int16_t	-	Channel sample code value
	AI4	int16_t	-	Channel sample code value
	AI5	int16_t	-	Channel sample code value
	AI6	int16_t	-	Channel sample code value
	AI7	int16_t	-	Channel sample code value
Output data	-	-	-	-

5.5.8 Analog input module FE-8ADI

Figure 5-22 FE-8ADI appearance
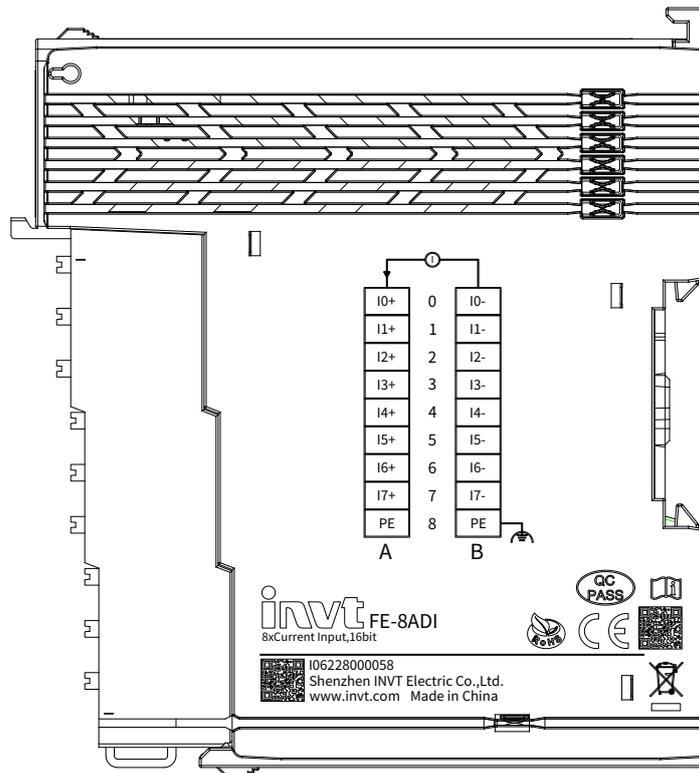
Figure 5-23 Component description
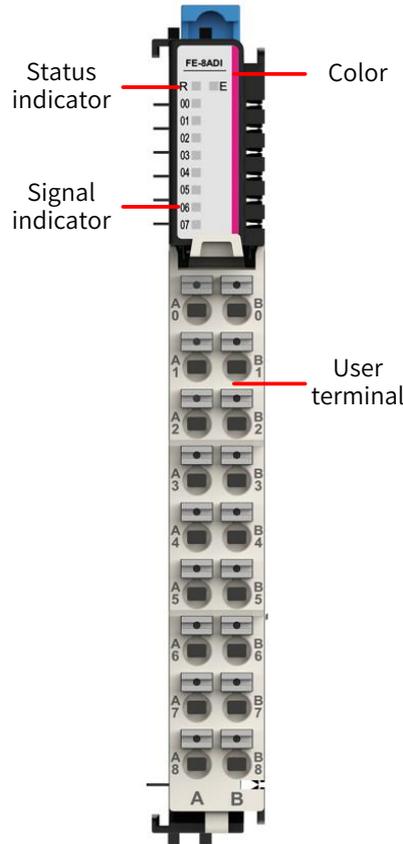
Table 5-10 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Channel status indicator	Green	00–07	Off: The channel is disabled. Slow flash (500ms): Input signal overrange or channel configuration parameter error. Fast flash (100ms): Hardware error – Internal chip SPI communication timeout. On: Channel enabled
User terminal	External wiring I/O terminal		

■ **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	I0+	**A0**	**B0**	I0-
	I1+	**A1**	**B1**	I1-
	I2+	**A2**	**B2**	I2-
	I3+	**A3**	**B3**	I3-
	I4+	**A4**	**B4**	I4-
	I5+	**A5**	**B5**	I5-
	I6+	**A6**	**B6**	I6-
	I7+	**A7**	**B7**	I7-
	PE	**A8**	**B8**	PE

■ **Terminal wiring**

Figure 5-24 Current input wiring

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	130mA
Terminal input power rated voltage	None
Terminal input power rated current	None
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Input specifications**

Item	Specifications
Input type	Analog input
Input mode	Current (Differential)
Input channel	8
Resolution	16 bits
Conversion time	<170μs/channel
Current input range	±20mA, 0–20mA, 4–20mA
Current input resistance	240Ω
Current input accuracy (25°C)	±0.15%
Current input accuracy (in full temperature range)	±0.3%
Current input limit	± 30mA
Isolated	No isolation between interface channels; voltage isolated from interface; interface isolated from bus

■ **Software specifications**

Item		Specifications
Configuration of independent channel enabling		Supported
Configuration of diagnosis reporting		Supported
Configuration of enabling diagnosis detection		Over range detection
Mode switchover configuration		4–20mA, 0–20mA, ±20mA
Filter parameter configuration		Software filter time can be set through the upper computer, which ranges from 1 to 255, with the sampling period as the unit.
Configuration of enabling over-limit detection		Supported
Configuration of enabling peak holding		Not supported
Configuration of conversion digital range	-20mA–20mA	-20000–20000, -32000–32000, -27648–27648, -32768–32767
	0mA–20mA	0–20000, 0–32000, 0–27648, 0–32767
	4mA–20mA	0–20000, 0–32000, 0–27648, 0–32767
Sampling time		<170μs/channel
Sampling refresh		Sampling time based asynchronous refresh, but not bus period based synchronous refresh

■ **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	AI0 Cfg	uint8_t	0xA1	Configuration parameter for channel 0. Bit0: Channel enable Bit1: Overrange detection enable Bit2: Enhanced filter enable bit4–bit3: Conversion range selection 2#00: (0–20000) or (-20000–20000)

Type	Name	Type	Default	Description
				2#01: (0–27648) or (-27648–27648)
				2#10: (0–32000) or (-32000–32000)
				2#11:(0–32767) or (-32768–32767)
				Bit7–Bit5: Conversion mode selection
				2#000: reserved
				2#001: reserved
				2#010: reserved
				2#011: reserved
				2#100: reserved
				2#101: Current 4–20mA
				2#110: Current 0–20mA
				2#111: Current -20–20mA
	AI0 Filt	uint8_t	8	Channel filter queue size
	AI1 Cfg	uint8_t	0xA1	Same definition as channel 0 configuration parameter.
	AI1 Filt	uint8_t	8	Channel filter queue size
	AI2 Cfg	uint8_t	0xA1	Same definition as channel 0 configuration parameter.
	AI2 Filt	uint8_t	8	Channel filter queue size
	AI3 Cfg	uint8_t	0xA1	Same definition as channel 0 configuration parameter.
	AI3 Filt	uint8_t	8	Channel filter queue size
	AI4 Cfg	uint8_t	0xA1	Same definition as channel 0 configuration parameter.
	AI4 Filt	uint8_t	8	Channel filter queue size
	AI5 Cfg	uint8_t	0xA1	Same definition as channel 0 configuration parameter.
	AI5 Filt	uint8_t	8	Channel filter queue size
	AI6 Cfg	uint8_t	0xA1	Same definition as channel 0 configuration parameter.
	AI6 Filt	uint8_t	8	Channel filter queue size
	AI7 Cfg	uint8_t	0xA1	Same definition as channel 0 configuration parameter.
	AI7 Filt	uint8_t	8	Channel filter queue size
Input data	AI0	int16_t	-	Channel sample code value
	AI1	int16_t	-	Channel sample code value
	AI2	int16_t	-	Channel sample code value
	AI3	int16_t	-	Channel sample code value
	AI4	int16_t	-	Channel sample code value
	AI5	int16_t	-	Channel sample code value
	AI6	int16_t	-	Channel sample code value
	AI7	int16_t	-	Channel sample code value
Output data	-	-	-	-

5.5.9 Analog output module FE-4DA

Figure 5-25 FE-4DA appearance
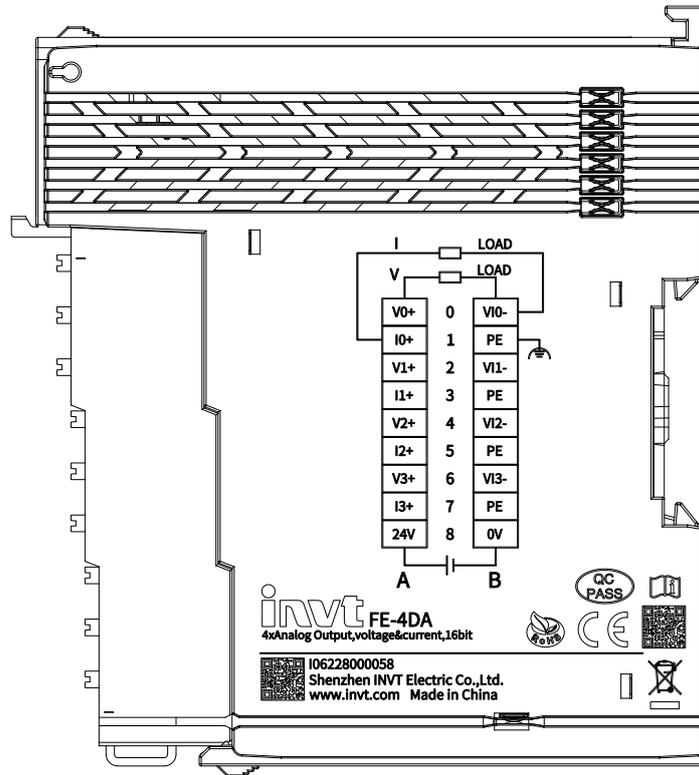
Figure 5-26 Product components
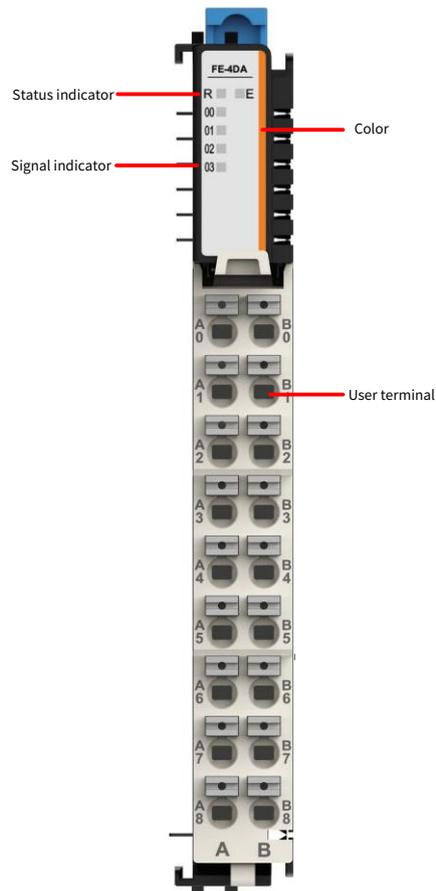
Table 5-11 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Channel status indicator	Green	00–03	Off: The channel is disabled. Slow flash (500ms): Current disconnection, voltage short circuit, or channel configuration parameter error. Fast flash (100ms): Hardware error – Internal chip SPI communication timeout, or no 24V supply. On: Channel enabled
User terminal	External wiring I/O terminal		

■ **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	V0+	A0	B0	VI0-
	I0+	A1	B1	PE
	V1+	A2	B2	VI1-
	I1+	A3	B3	PE
	V2+	A4	B4	VI2-
	I2+	A5	B5	PE
	V3+	A6	B6	VI3-
	I3+	A7	B7	PE
	24V	A8	B8	COM

■ **Terminal wiring**
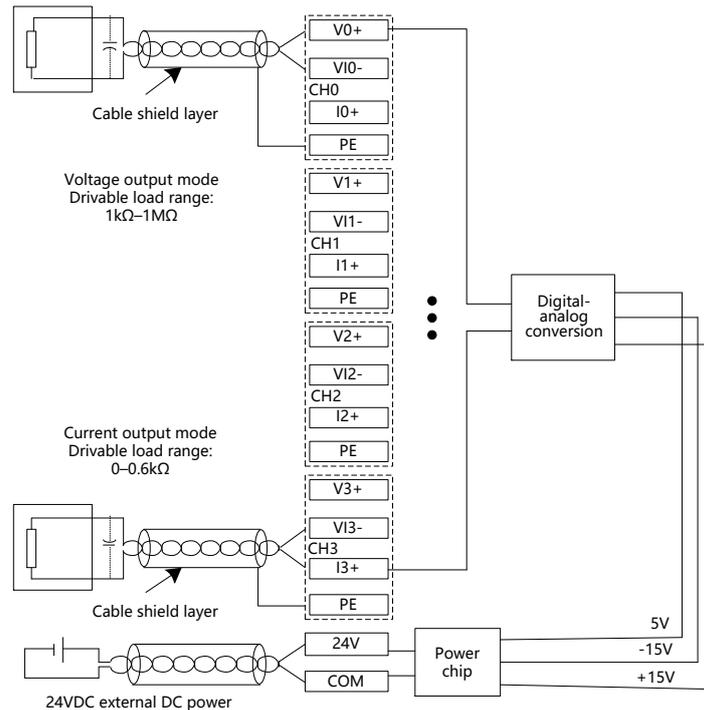
■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	100mA
Terminal input power rated voltage	24VDC (20.4VDC–28.8VDC)
Terminal input power rated current	100mA (Typical value at 24VDC)
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Output specifications**

Item	Specifications
Output type	Analog output
Output mode	Voltage/current
Output channel	4
Resolution	16 bits
Conversion time	40μs/channel
Voltage output range	0–5V, 0–10V, -5–+5V, -10–+10V
Voltage output load	1kΩ
Voltage output accuracy (25℃)	±0.3%
Voltage output accuracy (in full temperature range)	±0.5%
Voltage output diagnosis	Supports short circuit detection
Current output range	0–20mA, 4–20mA
Current output load	<600Ω
Current output accuracy (25℃)	±0.3%

Item	Specifications
Current output accuracy (in full temperature range)	±0.5%
Current output diagnosis	Supports open circuit detection.
Isolated	No isolation between interface channels; interface isolated from bus.
Output action display	None
Output derating	None

- **Software specifications**

Item	Specifications
Configuration of independent channel enabling	Supported
Configuration of diagnosis reporting	Supported
Configuration of enabling diagnosis detection	Detects voltage output short circuit and current output open circuit.
Mode switchover configuration	0–5V, 0–10V, ±5V, ±10V, 4–20mA, 0–20mA
Output status configuration after stop	The current output is hold or the preset value is output.
Preset value output after stop	Supported
Configuration of conversion digital range	0–5V	0–20000, 0–27648, 0–32000, 0–32767
	0–10V	0–20000, 0–27648, 0–32000, 0–32767
	± 5V	-20000–20000, -27648–27648, -32000–32000, -32768–32767
	± 10V	-20000–20000, -27648–27648, -32000–32000, -32768–32767
	0–20mA	0–20000, 0–27648, 0–32000, 0–32767
	4–20mA	0–20000, 0–27648, 0–32000, 0–32767
Sampling time	160µs for 4 channels
Sampling refresh	Sampling time based asynchronous refresh, but not bus period based synchronous refresh
Stop mode	Output according to the fault-caused stop mode or the preset value, without refreshing any more

- **Software user interface**

Type	Name	Type	Default	Description

Configuration parameter	AO0 Cfg	uint16_t	0x60	Configuration parameter for channel 0.
				Bit0: Channel enable
				Bit1: Output fault detection enable
				Bit2: Output mode
				    2#0: Output preset
				    2#1: Hold output
				bit4–bit3: Conversion range selection
				    2#00: (0–20000) or (-20000–20000)
				    2#01: (0–27648) or (-27648–27648)
				    2#10: (0–32000) or (-32000–32000)
				    2#11:(0–32767) or (-32768–32767)
				Bit7–Bit5: Conversion mode selection

Type	Name	Type	Default	Description
				2#000: voltage 0–5V
				2#001: voltage 0–10V
				2#010: voltage -5–5V
				2#011: voltage -10–10V
				2#100: reserved
				2#101: Current 4–20mA
				2#110: Current 0–20mA
				2#111: reserved
				bit15–bit8: Reserved
	AO0 Preset Value	int16_t	0	Channel safety output preset value
	AO1 Cfg	uint16_t	0x60	Same definition as channel 0 configuration parameter.
	AO1 Preset Value	int16_t	0	Channel safety output preset value
	AO2 Cfg	uint16_t	0x60	Same definition as channel 0 configuration parameter.
	AO2 Preset Value	int16_t	0	Channel safety output preset value
	AO3 Cfg	uint16_t	0x60	Same definition as channel 0 configuration parameter.
	AO3 Preset Value	int16_t	0	Channel safety output preset value
Input data	-	-	-	-
Output data	AO0	int16_t	-	Channel output code value
	AO1	int16_t	-	Channel output code value
	AO2	int16_t	-	Channel output code value
	AO3	int16_t	-	Channel output code value

AOx Cfg (x=0, 1, 2, 3) is a channel configuration parameter. The parameter type is uint16_t.

The following takes configuring channel 0 as an example.

Channel 0 is configured as channel enabled, output fault detection enabled, preset value output on offline, conversion range 0–20000, and channel conversion mode is set to 4–20mA. The value should be 163, that is, 0b10100011. Details are as follows:

Bit15–Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved	0b101			0b00		0	1	1
Reserved	4–20mA			0–20000		Output preset on offline	Enabled	Enabled

5.5.10 Temperature detection module (RTD) FE-4PT

Figure 5-27 FE-4PT appearance
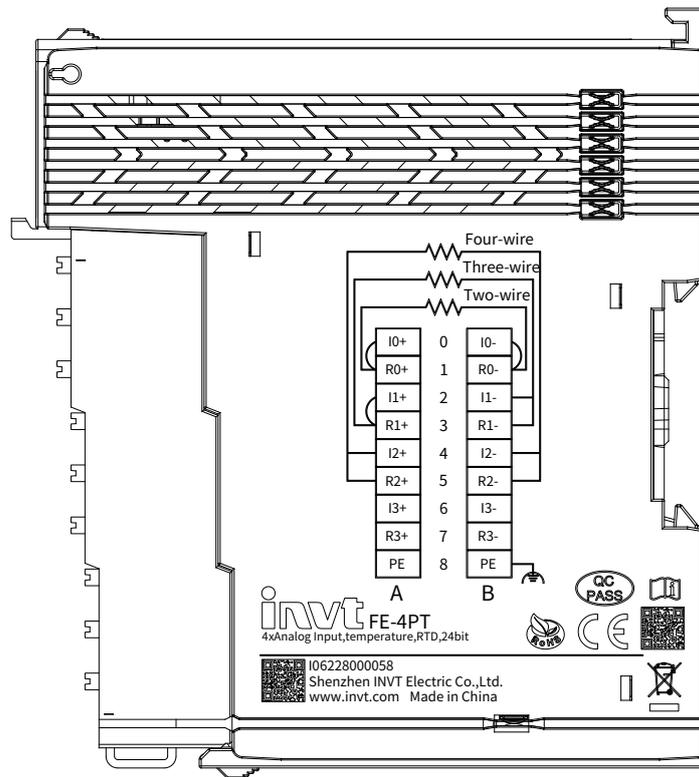
Figure 5-28 Product components
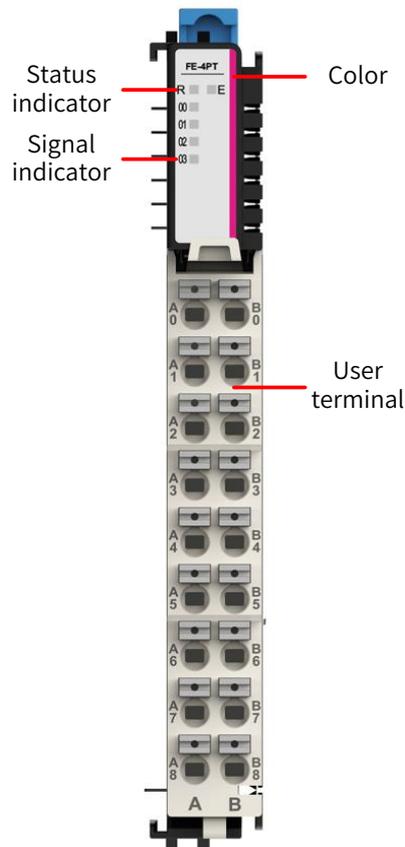
Table 5-12 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Channel status indicator	Green	00–03	Off: The channel is disabled. Slow flash (500ms): Input signal overrange/disconnected Fast flash (100ms): Hardware exception On: Channel enabled
User terminal	External wiring I/O terminal		

- **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	I0+	A0	B0	I0-
	R0+	A1	B1	R0-
	I1+	A2	B2	I1-
	R1+	A3	B3	R1-
	I2+	A4	B4	I2-
	R2+	A5	B5	R2-
	I3+	A6	B6	I3-
	R3+	A7	B7	R3-
	PE	A8	B8	PE

■ **Terminal wiring**

■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC−5.25VDC)
Fieldbus input power rated current	130mA
Terminal input power rated voltage	None
Terminal input power rated current	None
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Input specifications**

Item	Specifications
Input channel	4
Resolution	24 bits
Input terminals	Four RTD inputs
Sensor type	PT100, PT500, PT1000, Cu100
Wiring method	Two-wire/Three-wire/Four-wire
Accuracy (room temperature 25 ℃)	Full scale * ± 0.3%
Accuracy (room temperature -20℃− +55℃)	Full scale * ± 0.5%
Sampling period	Channel 1 and channel 2 form a group, while channel 3 and channel 4 form a group. When both channels within a group are enabled and one channel is configured as a three-wire system, the sampling period is 720ms per channel, and in other cases, the sampling period is 240ms per channel.
Filter parameter	0−255 (Default: 8). Unit: Sampling period

Item	Specifications
Isolation method	I/O terminals insulated from the power supply; No insulation between channels

■ **Software specifications**

Item	Specifications
Configuration of diagnosis reporting	Supported
Configuration of enabling diagnosis detection	Supports overrange detection and disconnection detection.
Independent channel configuration	Supported
Sampling period	Channel 1 and channel 2 form a group, while channel 3 and channel 4 form a group. When both channels within a group are enabled and one channel is configured as a three-wire system, the sampling period is 720ms per channel, and in other cases, the sampling period is 240ms per channel.
Display mode	Celsius degree (℃), Fahrenheit degree (℉)
Sampling refresh	Sampling time based asynchronous refresh, but not bus period based synchronous refresh
Disconnection or overrange	Output of max. value plus 1℃. Disconnection detection supported.
System diagnosis	Not supported
Channel diagnosis	Disconnect alarm/Overrange alarm
Software diagnosis	Supported

■ **Software user interface**

Type	Name	Type	Default	Description

Configuration parameter	PT0 Cfg	uint8_t	0x11	Configuration parameter for channel 0.
				Bit0: Channel enable
				Bit1: Overrange detection enable
				Bit2: Disconnection detection enable
				Bit3: Temperature unit
				    2#0: ℃
				    2#1:℉
				Bit5–Bit4: RTD wire system
				    2#00: Two-wire system
				    2#01: Three-wire system
				    2#10: Four-wire system
				Bit7–Bit6: Sensor type selection
				    2#00: Pt100
				    2#01: Pt500
				    2#10: Pt1000
				    2#11: Cu100

	PT0 Filt	uint8_t	8	Channel filter queue size
	PT1 Cfg	uint8_t	0x11	Same definition as channel 0 configuration parameter.
	PT1 Filt	uint8_t	8	Channel filter queue size
	PT2 Cfg	uint8_t	0x11	Same definition as channel 0 configuration parameter.

Type	Name	Type	Default	Description
	PT2 Filt	uint8_t	8	Channel filter queue size
	PT3 Cfg	uint8_t	0x11	Same definition as channel 0 configuration parameter.
	PT3 Filt	uint8_t	8	Channel filter queue size
Input data	PT0	real32_t	-	Temperature sampling value
	PT1	real32_t	-	Temperature sampling value
	PT2	real32_t	-	Temperature sampling value
	PT3	real32_t	-	Temperature sampling value
Output data	-	-	-	-

PTx Cfg (x=0, 1, 2, 3) is a channel configuration parameter. The parameter type is USINT.

The following takes configuring channel 0 as an example.

Channel 0 is configured as follows: channel enabled, overrange detection enabled, disconnection detection enabled, temperature unit °C selected, RTD three-wire system selected, and PT1000 selected as sensor type. The PT0 Cfg value should be 97, that is, 0b10010111. Details are as follows:

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
10		01		0	1	1	1
PT1000		Three-wire system		°C	Enabled	Enabled	Enabled

PTx Filt (x=0, 1, 2, 3) is a channel filter parameter. The parameter type is USINT and the parameter setting range is 1–255. Generally, a higher value indicates better suppression of high-frequency interference, but it also leads to greater delay. It should be adjusted according to the actual situation.

5.5.11 Temperature detection module (thermocouple) FE-4TC

Figure 5-29 FE-4TC appearance
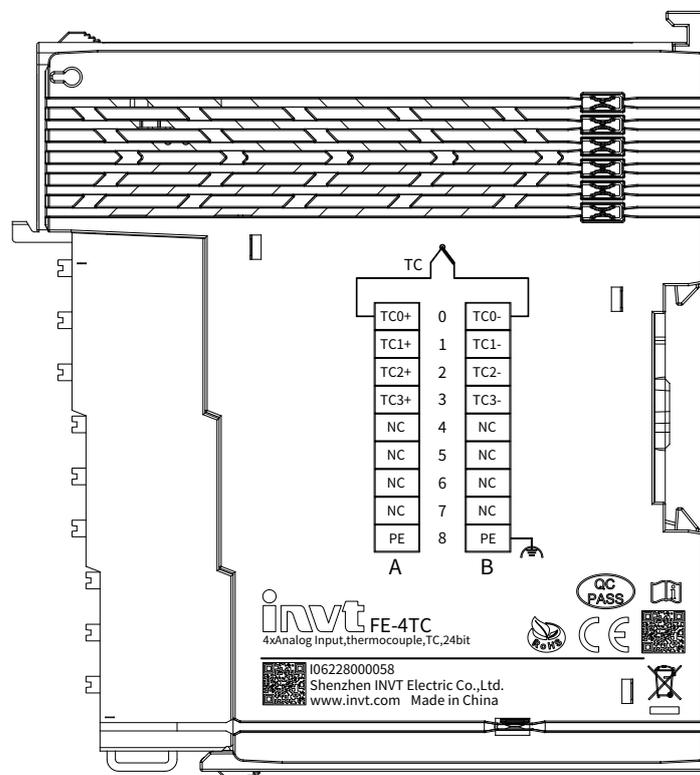
Figure 5-30 Product components
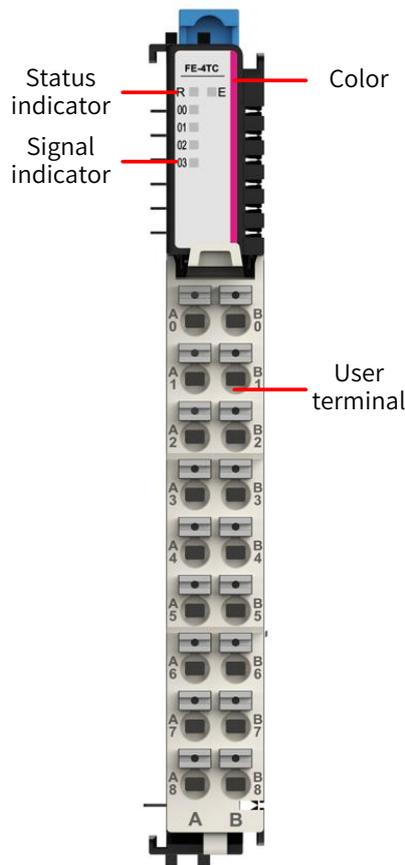
Table 5-13 Component description

Name	Color	Silk screen	Description
Power-on/Run status indicator	Yellowish green	R	Off: The module is not powered on or it is abnormal. Slow flash (1000ms): The module is waiting for communication to be established. Slow flash (500ms): The module is establishing communication. Fast flash (100ms): Module communication established, waiting for data interaction. On: The module is in data interaction.
Module fault indicator	Red	E	Off: The module works normally. Slow flash (500ms): Backplane communication timeout. Fast flash (100ms): Backplane voltage too low. On: A module fault has occurred.
Channel status indicator	Green	00–03	Off: The channel is disabled. Slow flash (500ms): Input signal overrange/disconnected Fast flash (100ms): Hardware exception On: Channel enabled
User terminal	External wiring I/O terminal		

■ **Terminal definition**

Diagram	Left signal	Left terminal	Right terminal	Right signal
	TC0+	A0	B0	TC0-
	TC1+	A1	B1	TC1-
	TC2+	A2	B2	TC2-
	TC3+	A3	B3	TC3-
	-	A4	B4	-
	-	A5	B5	-
	-	A6	B6	-
	-	A7	B7	-
	-	A8	B8	-

■ **Terminal wiring**
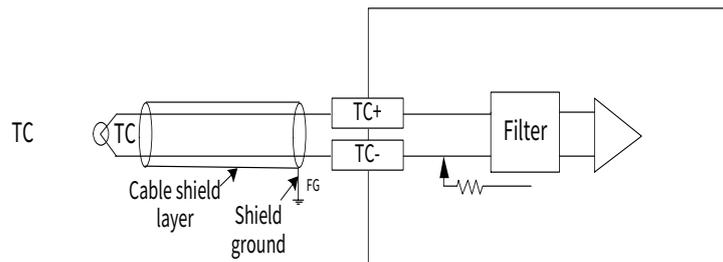
■ **Power supply specifications**

Item	Specifications
Fieldbus input power rated voltage	5VDC (4.75VDC–5.25VDC)
Fieldbus input power rated current	120mA
Terminal input power rated voltage	None
Terminal input power rated current	None
Terminal output power rated voltage	None
Terminal output power rated current	None
Hot swapping of module	Not supported

■ **Input specifications**

Item	Specifications
Input channel	4
Resolution	24 bits
Input terminals	4 thermocouple inputs
Thermocouple type	E, J, K, T
Compensation method	Internal cold junction compensation
Accuracy (room temperature 25°C)	Full scale * (±0.1%) + Cold junction compensation error

Item	Specifications
Accuracy (room temperature -20℃–+55℃)	Full scale * (±0.3%) + Cold junction compensation error
Isolated	I/O terminals insulated from the power supply; No insulation between channels
Input action display	None
Input derating	None
Over-limit and disconnection detection	Supports overrange detection and disconnection detection.

■ **Cold junction compensation**

Installation direction	Cold junction compensation error (-20℃–+55℃)
Horizontal and upright installation	±3℃
Non-horizontal but upright installation	±6℃

■ **Software specifications**

Item	Specifications
Configuration of diagnosis reporting	Supported
Configuration of enabling diagnosis detection	Supports overrange detection and disconnection detection.
Sensor type configuration	Thermocouple types supported: E, J, K, T
Filter parameter	0–255 (Default: 8)
Independent channel configuration	Supported
Sampling period	360ms per channel
Display mode	Celsius degree (℃), Fahrenheit degree (℉)
Sampling refresh	Sampling time based asynchronous refresh, but not bus period based synchronous refresh
Disconnection or over-limit	Output of max. value plus 1℃
System diagnosis	Not supported
Channel diagnosis	Disconnect alarm/Overrange alarm
Software diagnosis	Supported

■ **Software user interface**

Type	Name	Type	Default	Description
Configuration parameter	TC0 Cfg	uint8_t	0x01	Configuration parameter for channel 0. 　Bit0: Channel enable 　Bit1: Overrange detection enable 　Bit2: Disconnection detection enable 　Bit3: Temperature unit 　　2#0: ℃ 　　2#1: ℉ 　Bit5–Bit4: Reserved 　Bit7–Bit6: Sensor type selection 　　2#00: Type K thermocouple (Type N thermocouple) 　　2#01: Type J thermocouple (Type R thermocouple) 　　2#10: Type T thermocouple (Type S thermocouple) 　　2#11: Type E thermocouple (Type B thermocouple)

Type	Name	Type	Default	Description
	TC0 Filt	uint8_t	8	Channel filter queue size
	TC1 Cfg	uint8_t	0x01	Same definition as channel 0 configuration parameter.
	TC1 Filt	uint8_t	8	Channel filter queue size
	TC2 Cfg	uint8_t	0x01	Same definition as channel 0 configuration parameter.
	TC2 Filt	uint8_t	8	Channel filter queue size
	TC3 Cfg	uint8_t	0x01	Same definition as channel 0 configuration parameter.
	TC3 Filt	uint8_t	8	Channel filter queue size
Input data	TC0	real32_t	-	Temperature sampling value
	TC1	real32_t	-	Temperature sampling value
	TC2	real32_t	-	Temperature sampling value
	TC3	real32_t	-	Temperature sampling value
Output data	-	-	-	-

TCx Cfg (x=0, 1, 2, 3) is a channel configuration parameter. The parameter type is USINT.

The following takes configuring channel 0 as an example.

Channel 0 is configured as follows: channel enabled, overrange detection enabled, disconnection detection enabled, temperature unit °C selected, and type J thermocouple selected as sensor type. The TC0 Cfg value should be 47, that is, 0b01000111. Details are as follows:

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
01		00		0	1	1	1
Type J thermocouple		-		°C	Enabled	Enabled	Enabled

TCx Filt (x=0, 1, 2, 3) is a channel filter parameter. The parameter type is USINT and the parameter setting range is 1–255. Generally, a higher value indicates better suppression of high-frequency interference, but it also leads to greater delay. It should be adjusted according to the actual situation.

6 Coupler use instructions

6.1 EtherCAT communication coupler

Table 6-1 Software interface description

Type	Name	Type	Default	Description
Configuration parameter	-	-	-	-
Input data	iBus	uint32_t	-	Backplane bus state machine
	ModuleStatus	uint32_t	-	Module fault status (0: No module fault; 1: Module fault present) Bit0: Fault status of module 1 Bit1: Fault status of module 2 ... Bit31: Fault status of module 32 **Note:** The module fault codes can be obtained from the object dictionary 16 #3023.
Output data	-	-	-	-

Table 6-2 Object dictionary description

16#3010	Station address	
	uint16_t	sub index 1 Configured station address
	uint16_t	sub index 2 Configured station alias
	uint16_t	sub index 3 Coded station alias
16#3011	IN port error counters	
	uint8_t	sub index 1 Invalid frame counter
	uint8_t	sub index 2 Physical layer receive error counter
	uint8_t	sub index 3 Forwarding error counter
	uint8_t	sub index 4 Link-loss counter
16#3012	OUT port error counters	
	uint8_t	sub index 1 Invalid frame counter
	uint8_t	sub index 2 Physical layer receive error counter
	uint8_t	sub index 3 Forwarding error counter
	uint8_t	sub index 4 Link-loss counter
16#3013	ESC error counters	
	uint8_t	sub index 1 Data frame processing error counter
	uint8_t	sub index 2 PDI error
	uint8_t	sub index 3 Process data watchdog timeout
	uint8_t	sub index 4 PDI watchdog timeout
16#3020	Coupler basic information	
	uint16_t	sub index 1 Hardware version
	uint16_t	sub index 2 Software version
	uint8_t	sub index 3 Configured module count
	uint8_t	sub index 4 Actual module count
	uint32_t	sub index 5 Coupler fault code

	Module hardware type information	
16#3021	uint8_t	sub index 1 Module 1 hardware type
	uint8_t	sub index 2 Module 2 hardware type
	...	...
	uint8_t	sub index 32 Module 32 hardware type
	Module software version information	
16#3022	uint8_t	sub index 1 Module 1 software version
	uint8_t	sub index 2 Module 2 software version
	...	...
	uint8_t	sub index 32 Module 32 software version
	Module fault code information	
16#3023	uint16_t	sub index 1 Module 1 fault code
	uint16_t	sub index 2 Module 2 fault code
	...	...
	uint16_t	sub index 32 Module 32 fault code
	Backplane end station related information	
16#3030	uint32_t	sub index 1 Backplane transmit frame counter
	uint32_t	sub index 2 Backplane receive valid frame counter
	uint32_t	sub index 3 Backplane receive error frame counter
	uint32_t	sub index 4 Backplane receive consecutive error frame counter

6.1.1 CODESYS configuration description

6.1.1.1 Installing the device description file

From the menu bar, choose **Tools** > **Device Repository**. In the **Device Repository** window, click **Install**, locate the device description file, and then click **Open**.

Note: If the installation of the device description file fails, try changing the CODESYS language setting to Chinese and then perform the installation again.
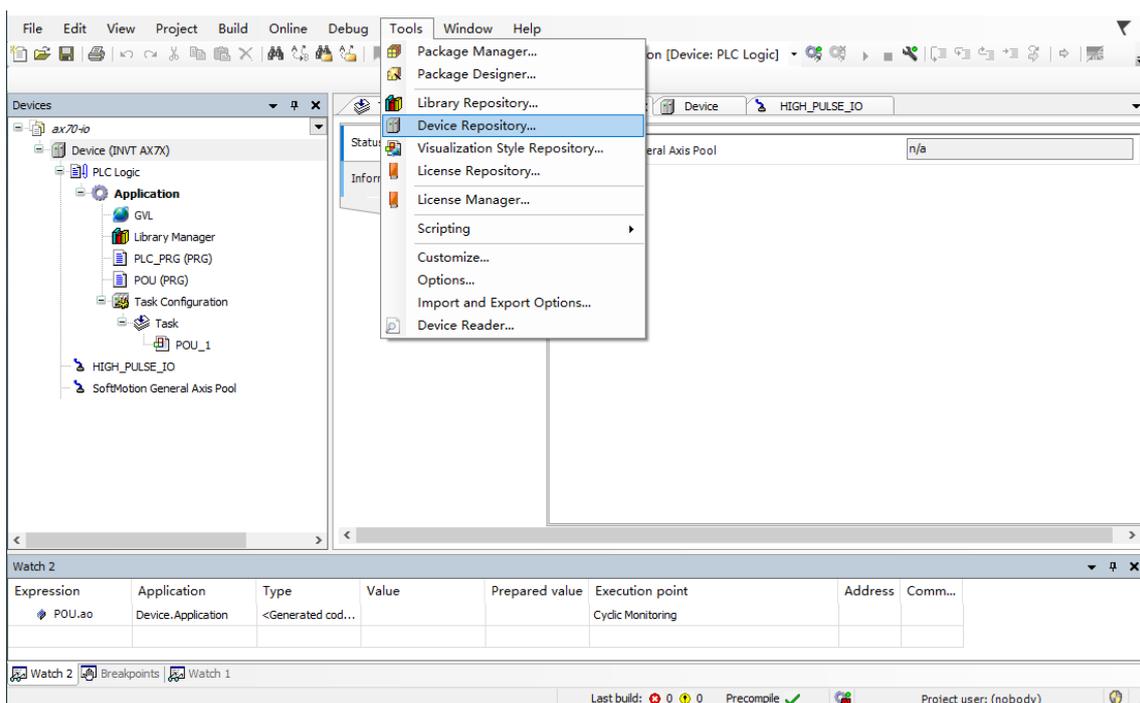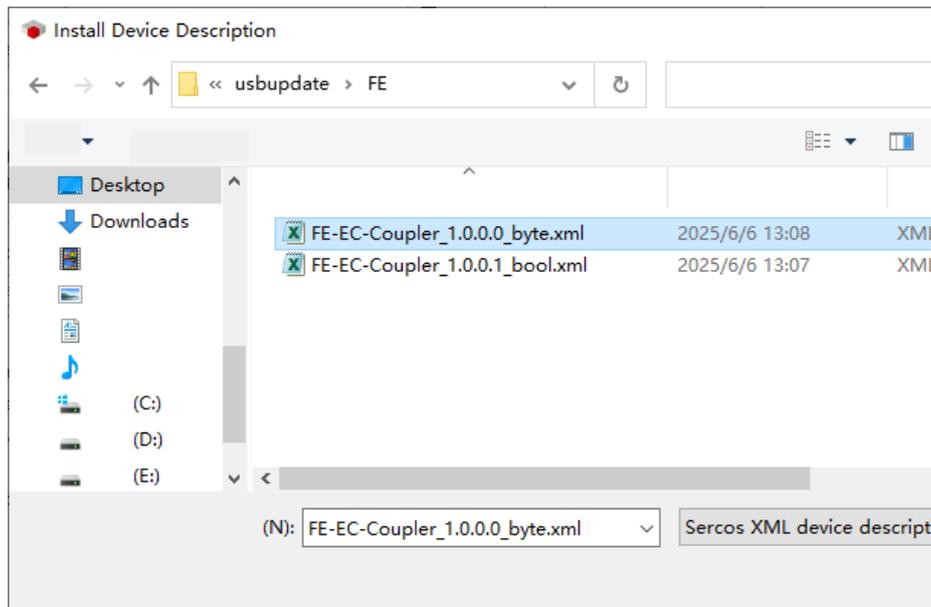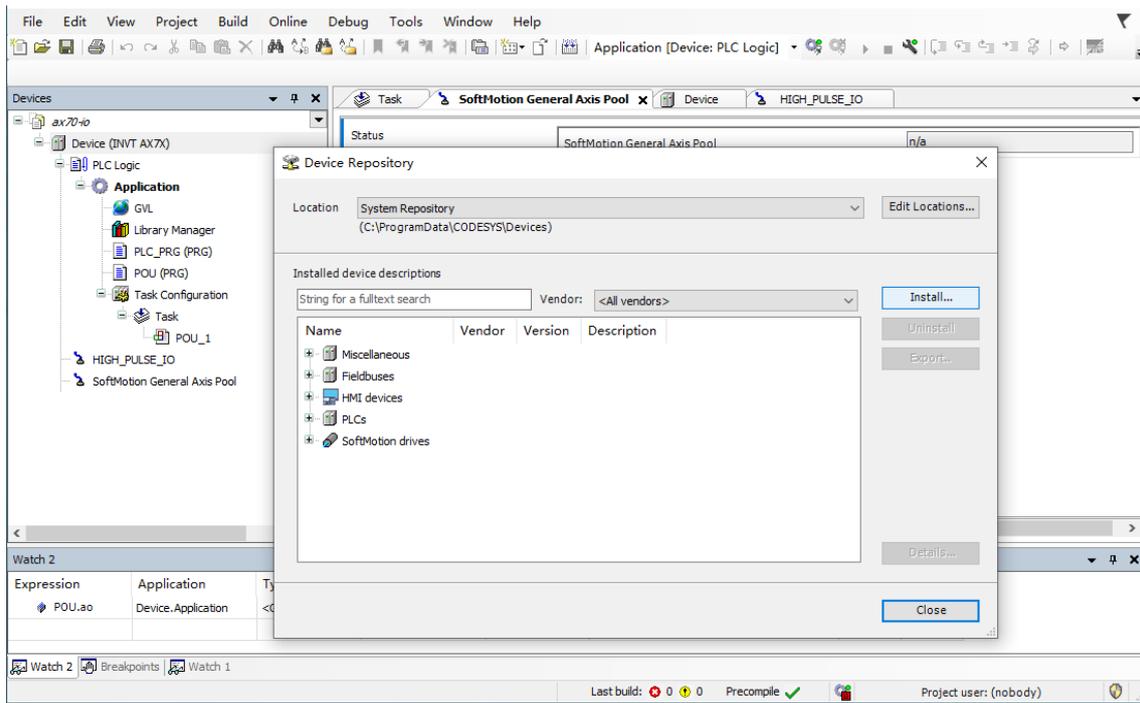
6.1.1.2 Performing network configuration

Step 1 Add **EtherCAT_Master_SoftMotion**.

Right-click **Device**, and choose **Add Device**. In the **Add Device** window, choose **Fieldbuses** > **EtherCAT** > **EtherCAT_Master_SoftMotion**, and then click **Add Device**.

✏**Note:** After adding the EtherCAT master, configure the master source MAC address.
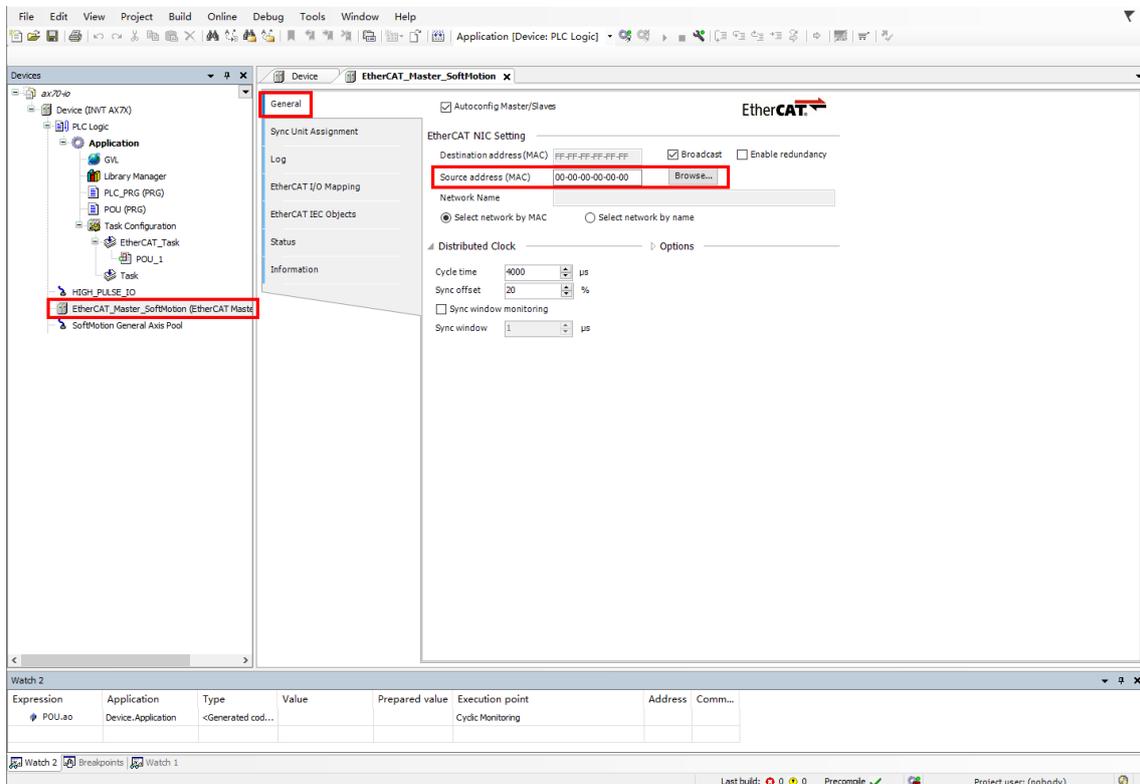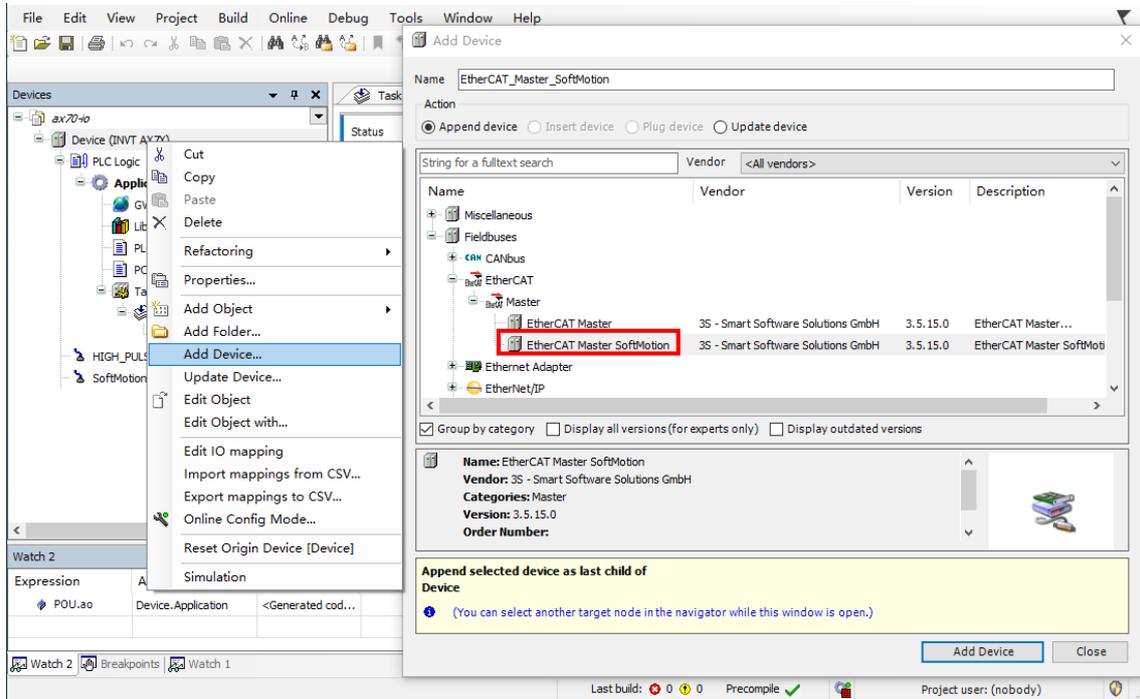
Step 2 Add **EtherCAT Slave**.

Right-click **EtherCAT_Master_SoftMotion**, and choose **Add Device**. In the **Add Device** window, choose the coupler slave you want to add, and click **Add Device**.
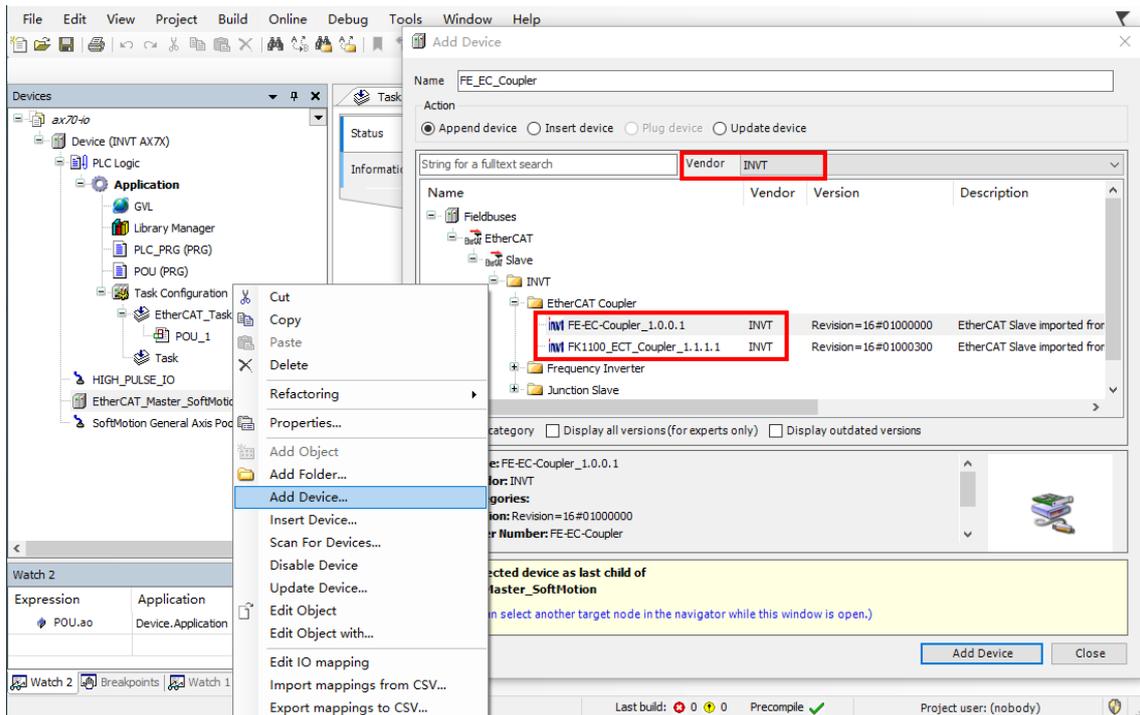
Step 3 Add the expansion module.

Right-click the added coupler slave, and choose **Add Device**. In the **Add Device** window, choose the module you want to add, and click **Add Device**.
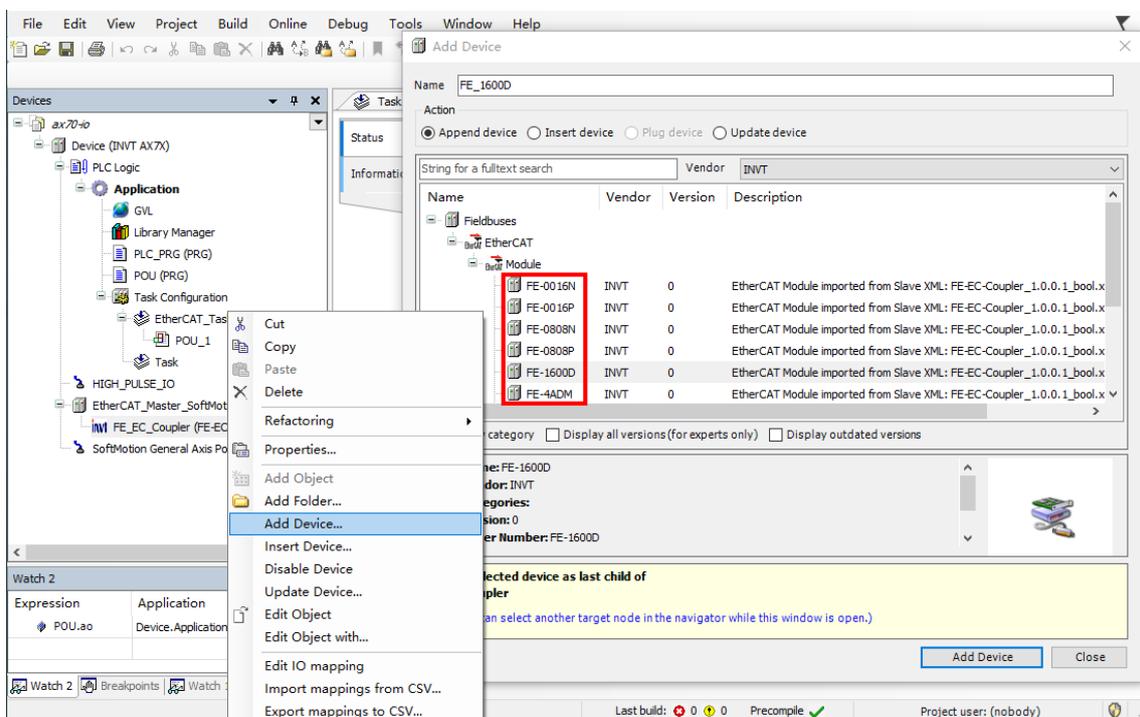
✏️**Note:** The physical configuration must be consistent with the network configuration. If the configuration is inconsistent, EtherCAT communication cannot enter the OP state.

6.1.1.3 EtherCAT communication parameter configuration

Step 1 Set the synchronization mode: Double-click the added coupler slave, and click the **General** tab. Set **Select DC** under **Distributed Clock**.
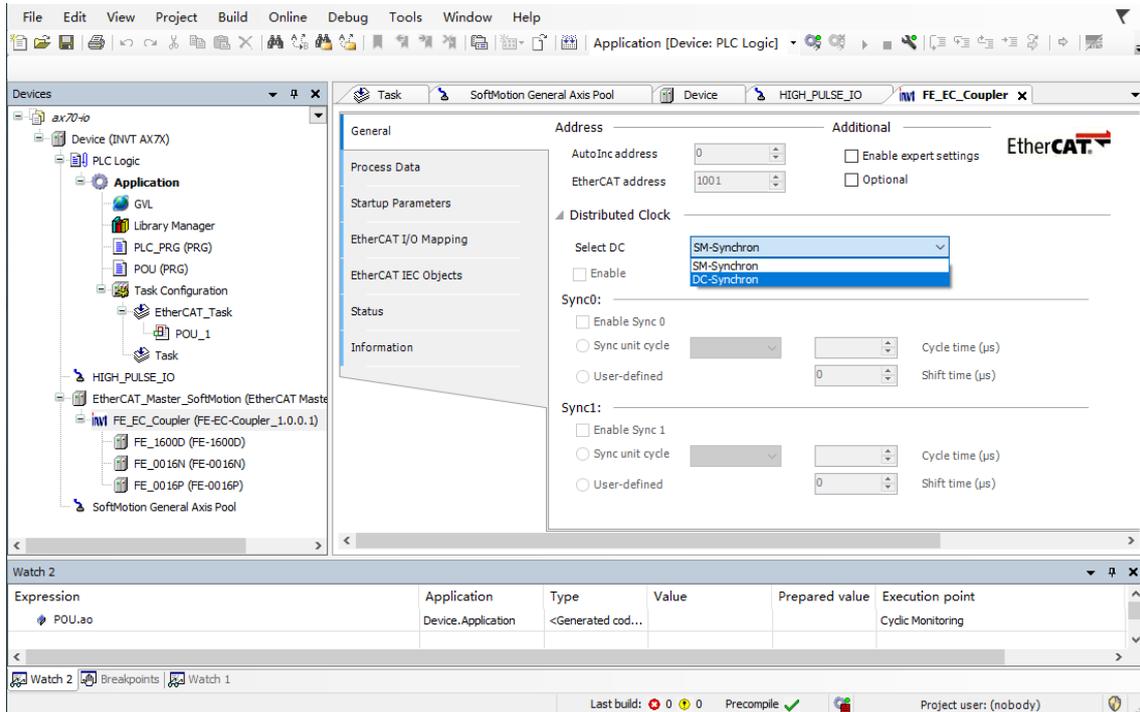
Step 2 Set the synchronization cycle: Double-click **EtherCAT_Master_SoftMotion**, and click the **General** tab. Set **Cycle time** under **Distributed Clock**.
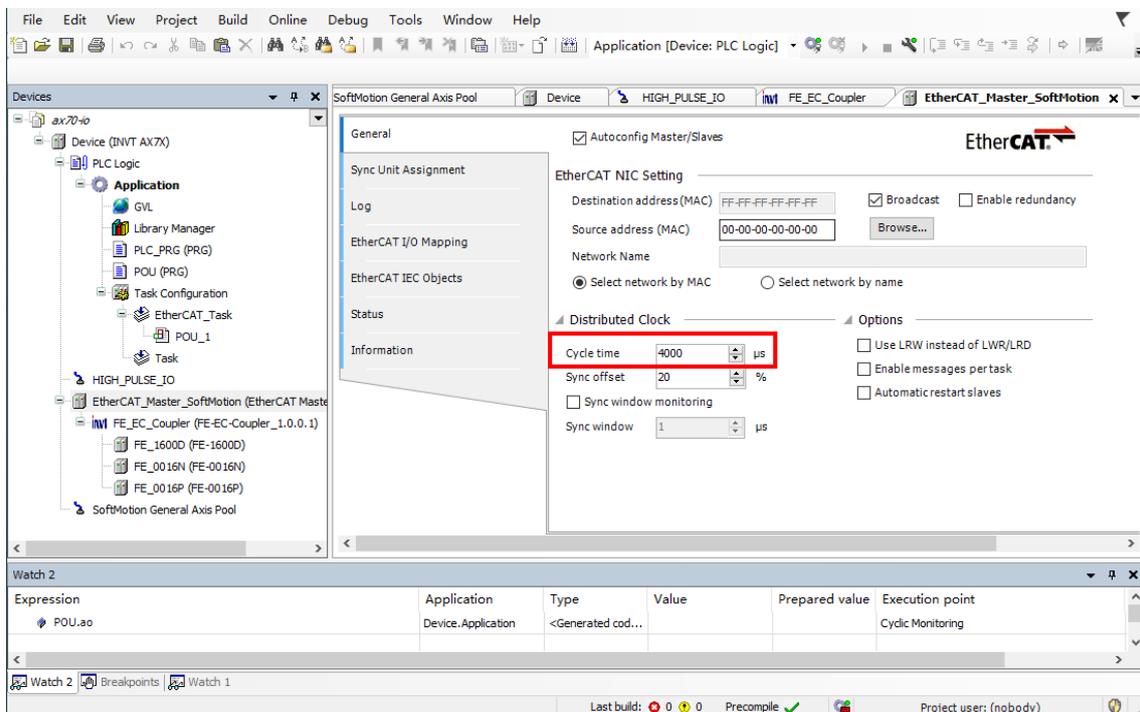
6.1.1.4 Module configuration parameter

Double-click the added expansion module, and click the **Startup Parameters** tab. Startup parameters are SDO data, which are the initialization configuration parameters for each module. Double-click to modify the initial value. These parameters are transmitted to the slave during the EtherCAT communication transition

from Pre-OP to Safe-OP. For detailed parameter descriptions, see the "Software user interface" table of the respective module in section 5.5 I/O module.
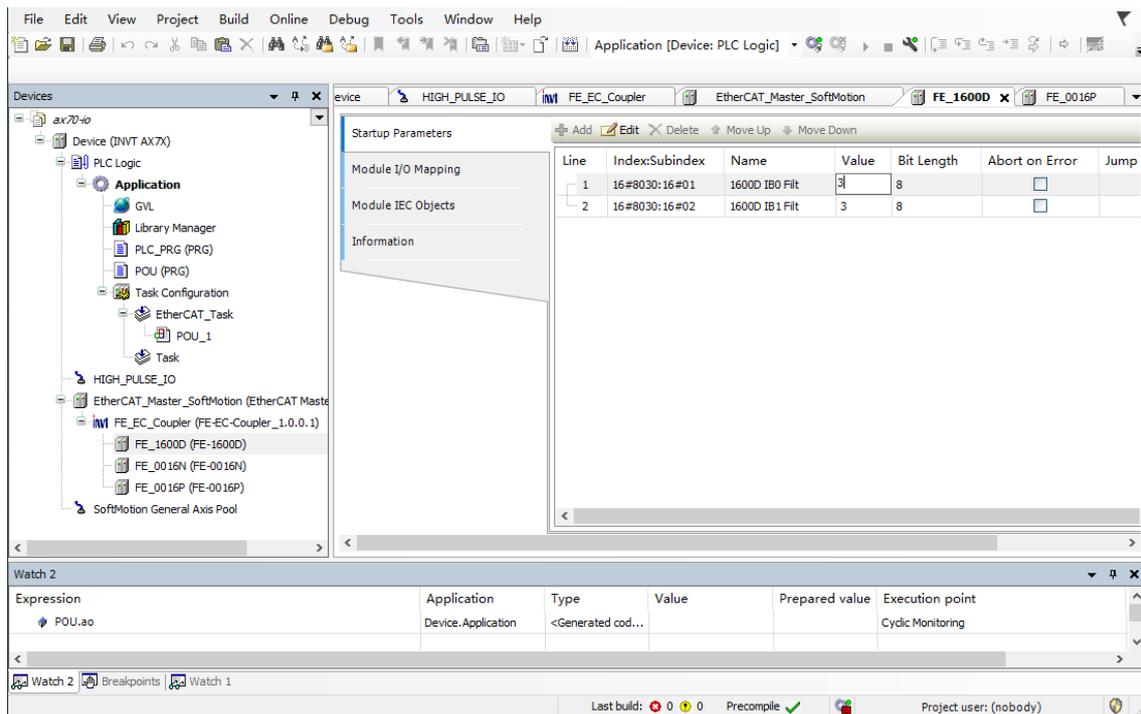
6.1.1.5 Module process data

Double-click the added expansion module, and click the **Module I/O Mapping** tab. Double-click a link variable under **Variable** to obtain the sample value or control the output in the program. For detailed I/O data descriptions, see the "Software user interface" table of the respective module in section 5.5 I/O module.

6.1.1.6 Retrieving module fault status

The coupler I/O mapping parameter **ModuleStatus** indicates the module fault status, as specified in the following table.

Name	Type	Meaning
ModuleStatus	uint32_t (Unsigned 32-bit data)	Module fault status (0: No fault; 1: Fault) Bit0: Fault status of module 1 Bit1: Fault status of module 2 ... Bit31: Fault status of module 32

A specific module fault code can be obtained by using the **ETC_CO_SdoRead** function block to read the corresponding sub index of Object Dictionary 16#3023. The definition of Object Dictionary 16#3023 is as follows.

	Module fault code information	
	uint16_t	sub index 1 Module 1 fault code
16#3023	uint16_t	sub index 2 Module 2 fault code
	...	...
	uint16_t	sub index 32 Module 32 fault code

For detailed **ETC_CO_SdoRead** function block input/output descriptions, see the Codesys Help.
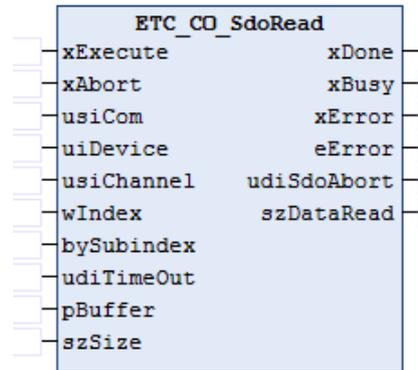
```
                    ETC_CO_SdoRead
    ─┤xExecute                    xDone├─
    ─┤xAbort                      xBusy├─
    ─┤usiCom                     xError├─
    ─┤uiDevice                   eError├─
    ─┤usiChannel            udiSdoAbort├─
    ─┤wIndex                 szDataRead├─
    ─┤bySubindex
    ─┤udiTimeOut
    ─┤pBuffer
    ─┤szSize
```

Procedure for retrieving module fault codes:

1. Read the **ModuleStatus** data and check whether ModuleStatus.bit0 is equal to 1. If bit0 = 1, a fault is present. In this case, enable the **SdoRead** function block
(Index = 16#3023, sub index = 1). After the function block execution is completed without errors, Module 1 fault code of can be obtained. Read the **ModuleStatus** data and check whether ModuleStatus.bit1 is equal to 1. If bit1 = 1, a fault is present. In this case, enable the **SdoRead** function block
(Index = 16#3023, sub index = 2). After the function block execution is completed without errors, Module 2 fault code of can be obtained.

2. Read the **ModuleStatus** data and check whether ModuleStatus.bit2 is equal to 1. If bit2 = 1, a fault is present. In this case, enable the **SdoRead** function block
(Index = 16#3023, sub index = 3). After the function block execution is completed without errors, Module 3 fault code of can be obtained.

   ...

32. Read the **ModuleStatus** data and check whether ModuleStatus.bit31 is equal to 1. If bit31 = 1, a fault is present. In this case, enable the **SdoRead** function block
(Index = 16#3023, sub index = 32). After the function block execution is completed without errors, Module 32 fault code of can be obtained.

🖉**Note:** Enabling the **SdoRead** function block affects the real-time performance of EtherCAT communication. Therefore, do not continuously read module fault codes. First determine whether a module has a fault by checking **ModuleStatus**. The **SdoRead** function block should be enabled only when a fault is detected. Within a single task cycle, try to check only one module for faults, and do not retrieve fault codes for multiple modules within the same task cycle.

6.1.2 Sysmac Studio configuration description

6.1.2.1 Installing the device description file

Double-click **EtherCAT**, right-click **Master device** in the pop-up window, and choose **Display ESI library**. Click **Install (File)** in the pop-up **ESI Library** window, and locate the device description file for installation.
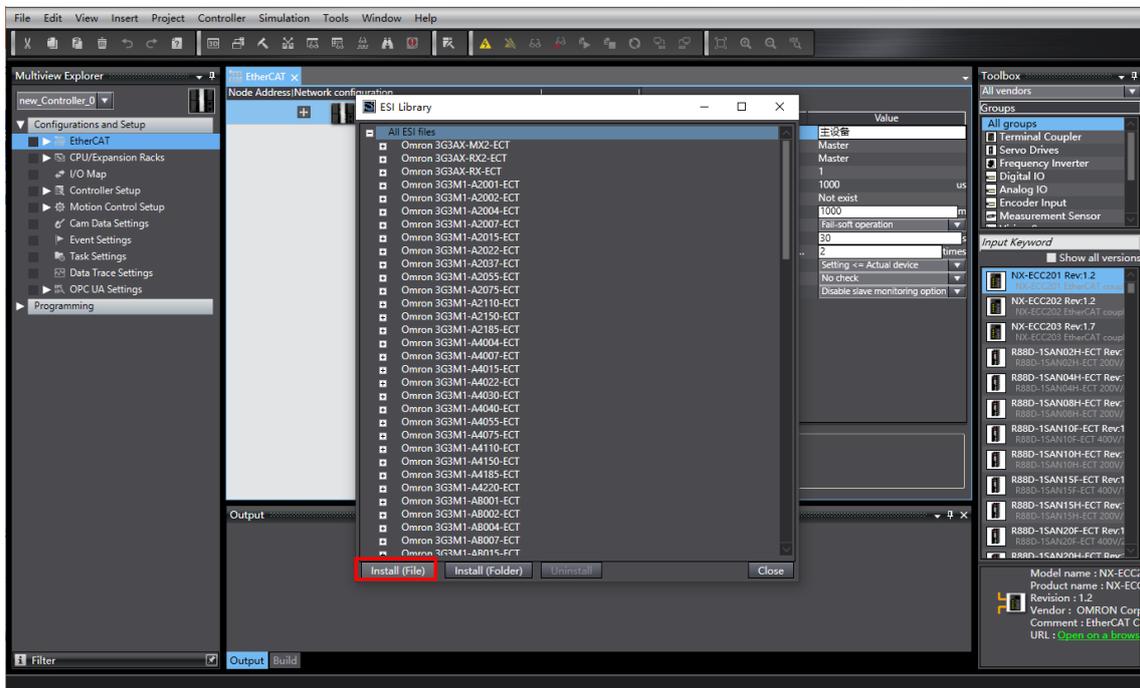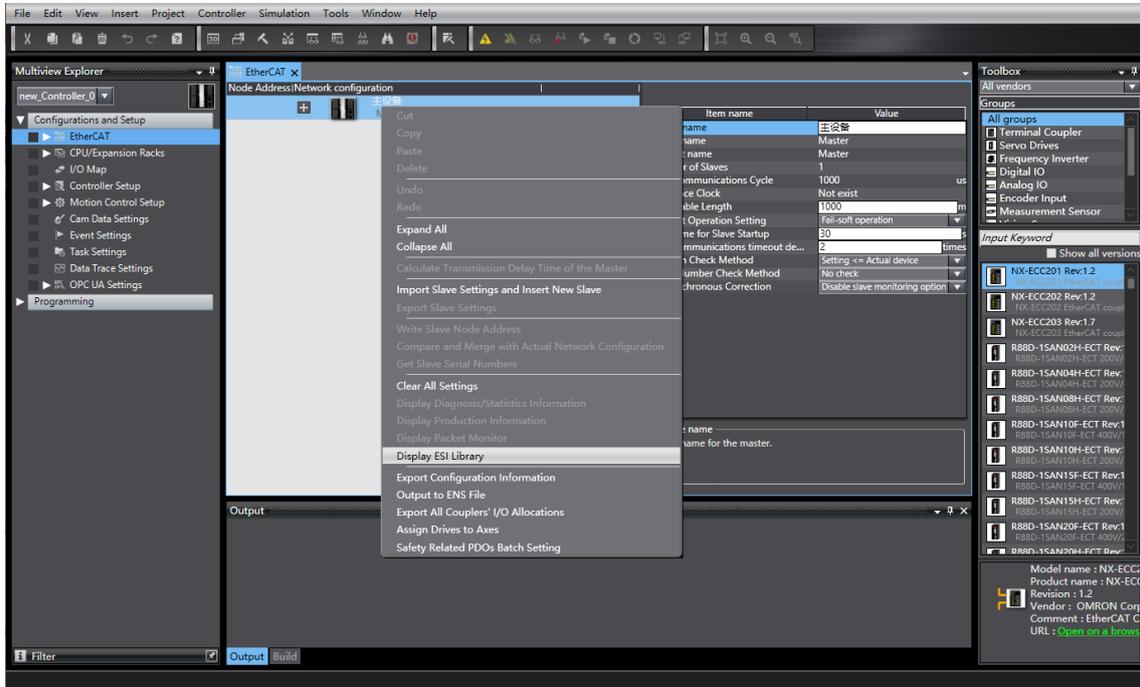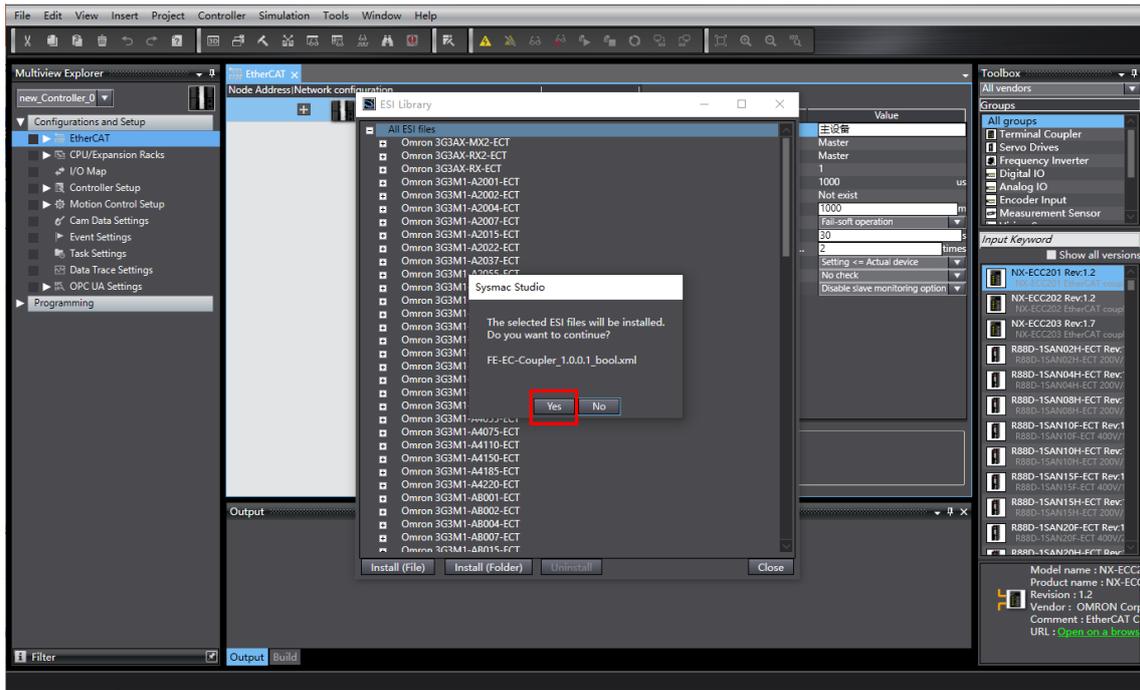
6.1.2.2 Setting the slave address

When the coupler device is used for the first time, the slave node address must be configured. It is recommended to set the node address using the DIP switch on the coupler. When the coupler DIP switch is set to a non-zero value, the coupler node address is determined by the DIP switch setting. When the coupler DIP switch is set to 0, the coupler node address is configured by the PLC. The following briefly describes the method for configuring the node address via the PLC.

Step 1 Once the device is connected, Click **Online**. Right-click **Master device**, and choose **Write Slave Node Address**.
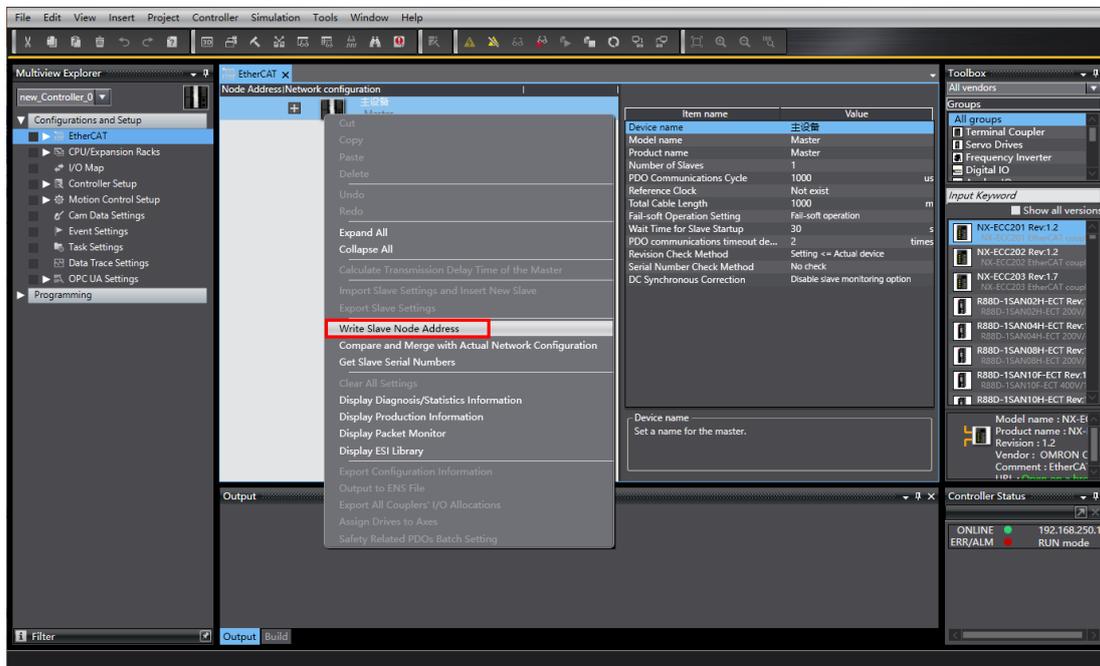
Step 2 In the pop-up **Slave Node Address Writing** window, modify the setting (setting range: 1–192, unique), and click **Write**.
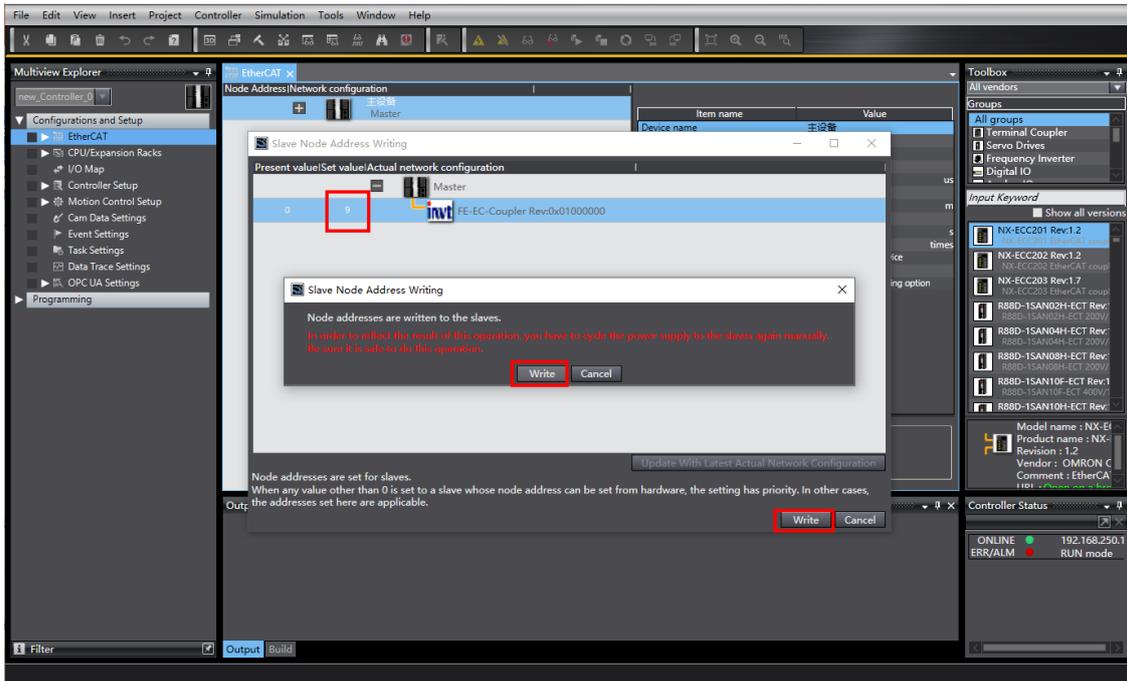
Step 3 After the coupler is powered off and on again, verify that the coupling node address has been set successfully. If not, check whether the DIP switch is set to 0.
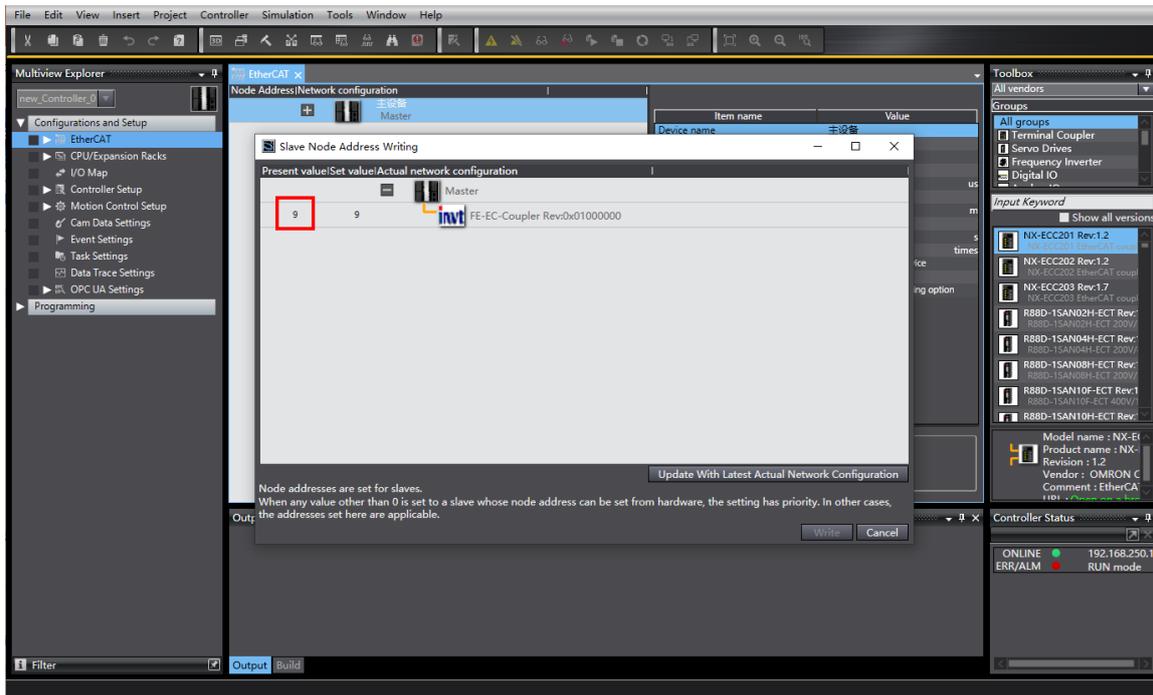
6.1.2.3 Performing network configuration

■ **Manual configuration**

Step 1 Add **EtherCAT Slave**.

In offline state, double-click **EtherCAT** and then **Master Device**, find the EtherCAT coupler with the **invt** label in the toolbar on the right, double-click the slave device to be added, and then modify the slave address.
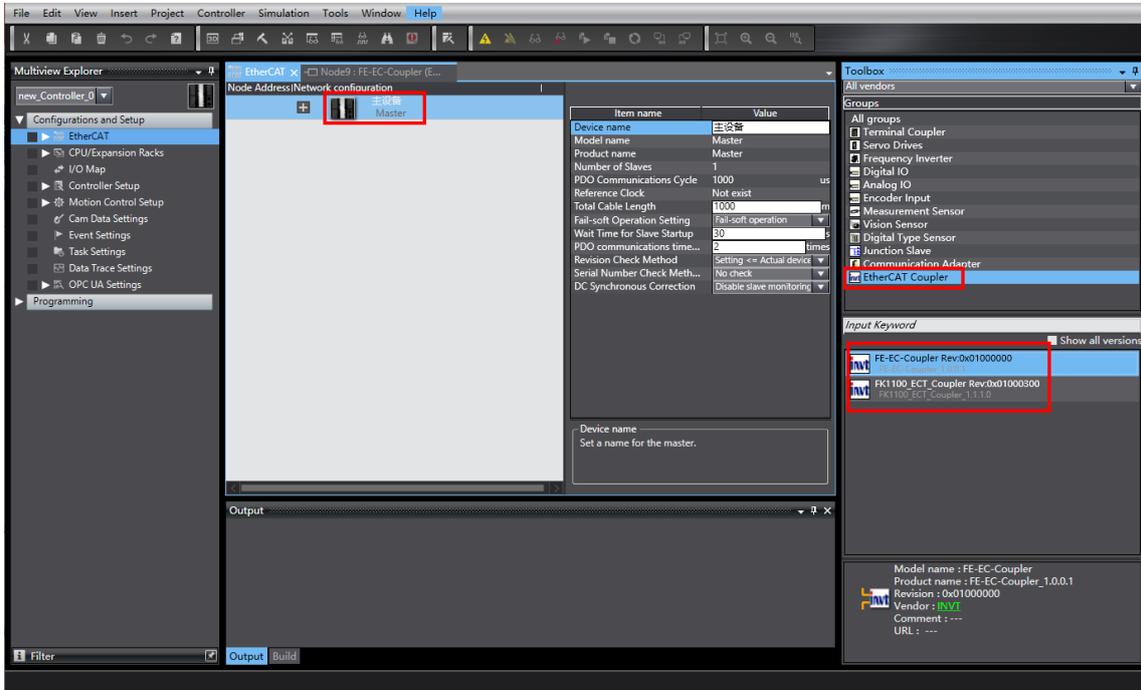
Note: The address of this slave address must be consistent with the one configured in section 6.1.2.2 Setting the slave address.
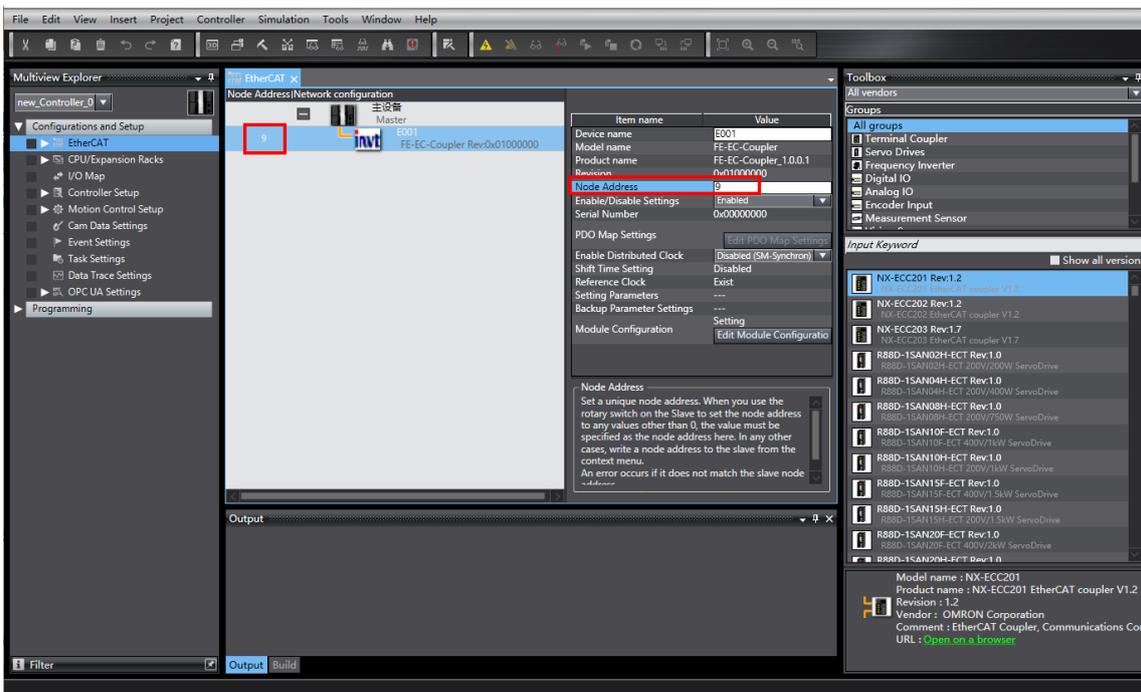
Step 2 Add the expansion module.

Click the coupler slave device that has been added, then click **Edit Module Configuration** in the configuration box on the right. Based on the actual physical connection of the modules, add the modules from the toolbar to the slots.
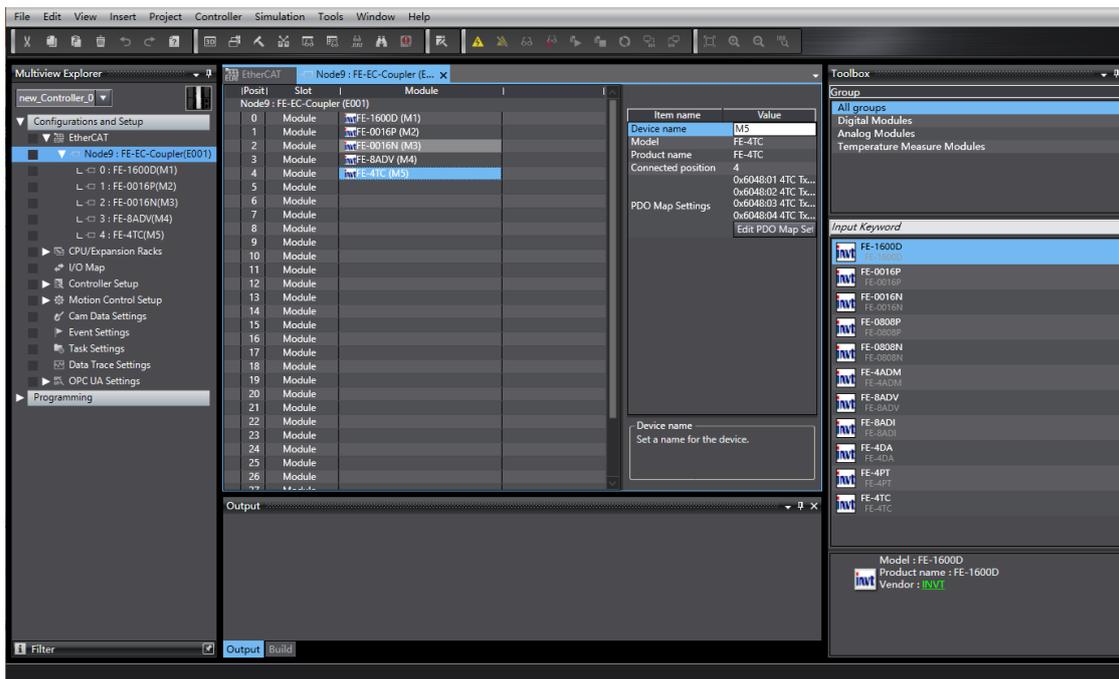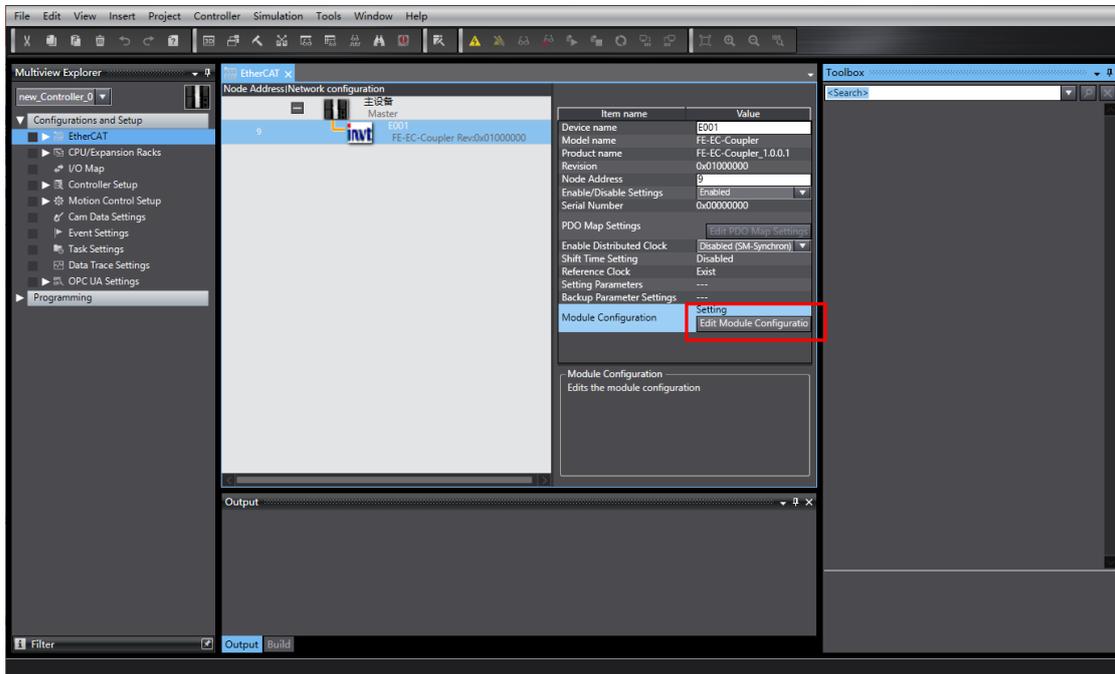
✏️**Note**: In this interface (node configuration interface), click **Node9: FE-EC-Coupler(E001)** (for example), and change **Module Configuration Send Method** to **Send** on the right configuration interface. If the network configuration is not modified, it will not be sent to the slave, and thus the slave cannot receive the network configuration, resulting in a configuration mismatch error. In addition, EtherCAT communication will also fail to enter the OP state.
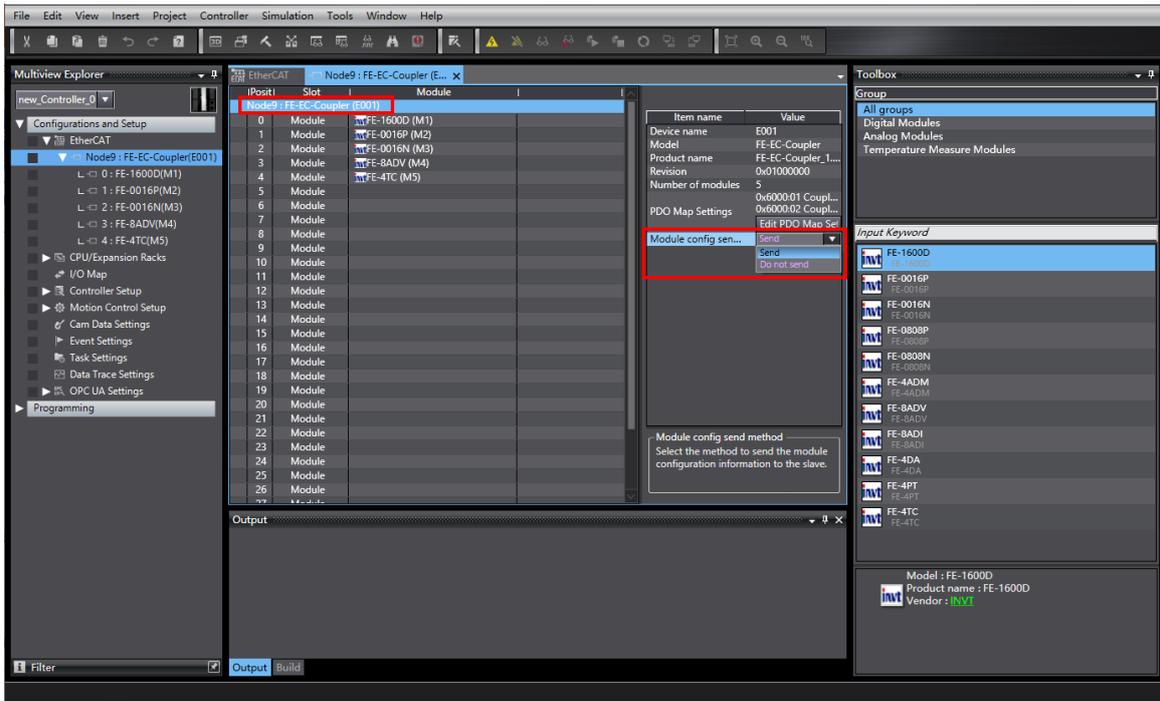
Note: The physical configuration must be consistent with the network configuration. If the configuration is inconsistent, EtherCAT communication cannot enter the OP state.

■ **Automatic scanning**

Click **Online**, right-click **Master Device**, choose **Compare and Merge with Physical Network Configuration**, and click **Apply actual network configuration** in the pop-up **Compare and Merge with Physical Network Configuration** window.
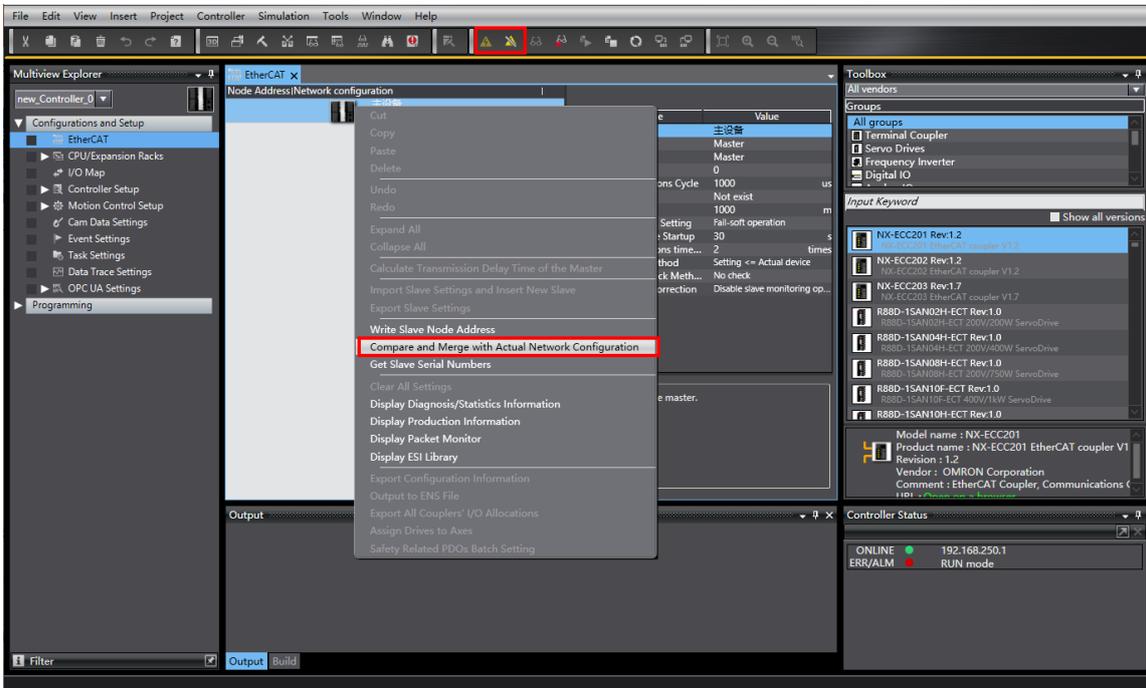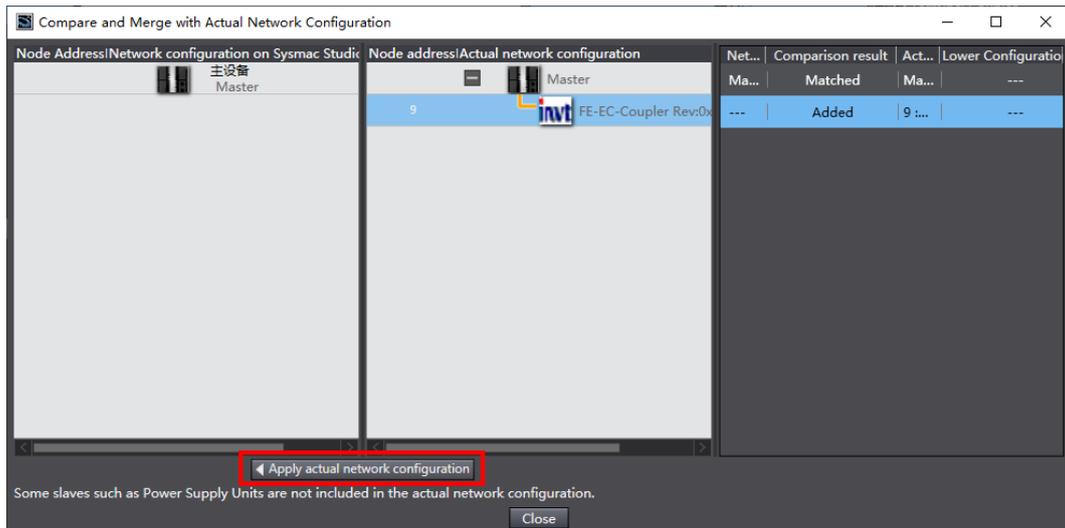
Note:

- After going offline, click **Node *n*: *Coupler device*** in the node configuration interface, and set **Module Configuration Send Method** to **Send** on the right configuration interface. If the network configuration is not modified, it will not be sent to the slave, and thus the slave cannot receive the network configuration, resulting in a configuration mismatch error. In addition, EtherCAT communication will also fail to enter the OP state.

- It is recommended to check whether the network configuration and physical configuration added in automatic scan match, and adjustments can be made manually.

6.1.2.4 EtherCAT communication parameter configuration

Step 1 Set the synchronous mode: Double-click **EtherCAT**, click the added coupler device in the pop-up interface, and set **Enable Distributed Clock** to **Enabled (DC-Synchron)** on the right side.
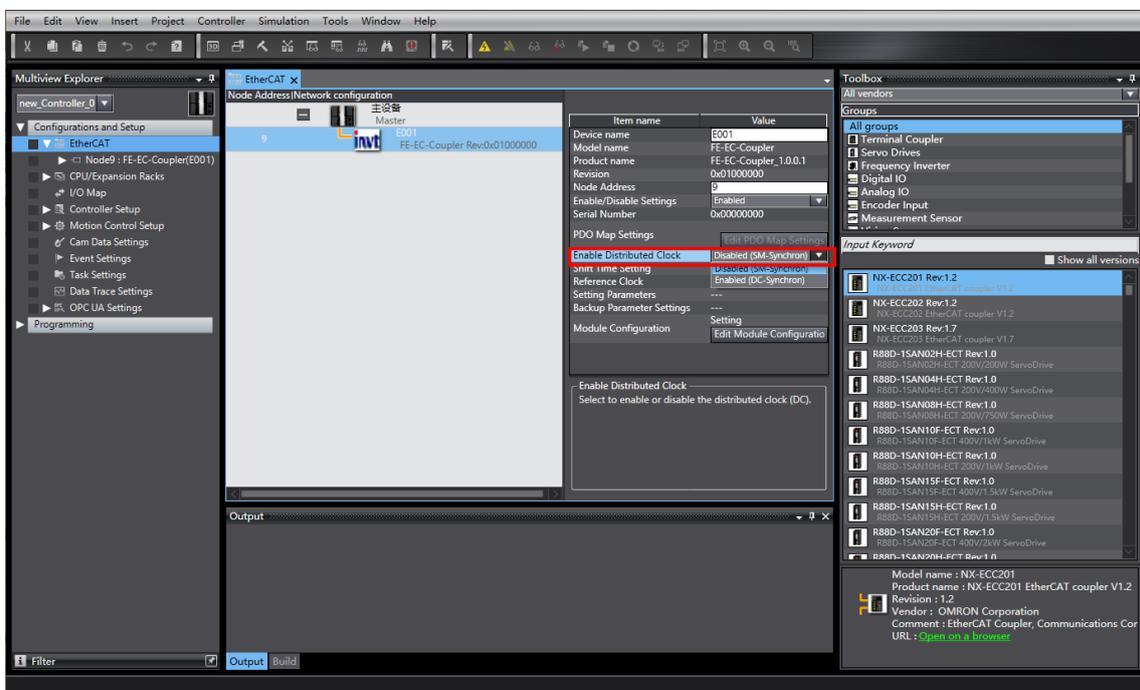
Step 2 Set the synchronization cycle: The synchronization cycle and main task cycle are consistent. You only need to adjust the main task cycle.
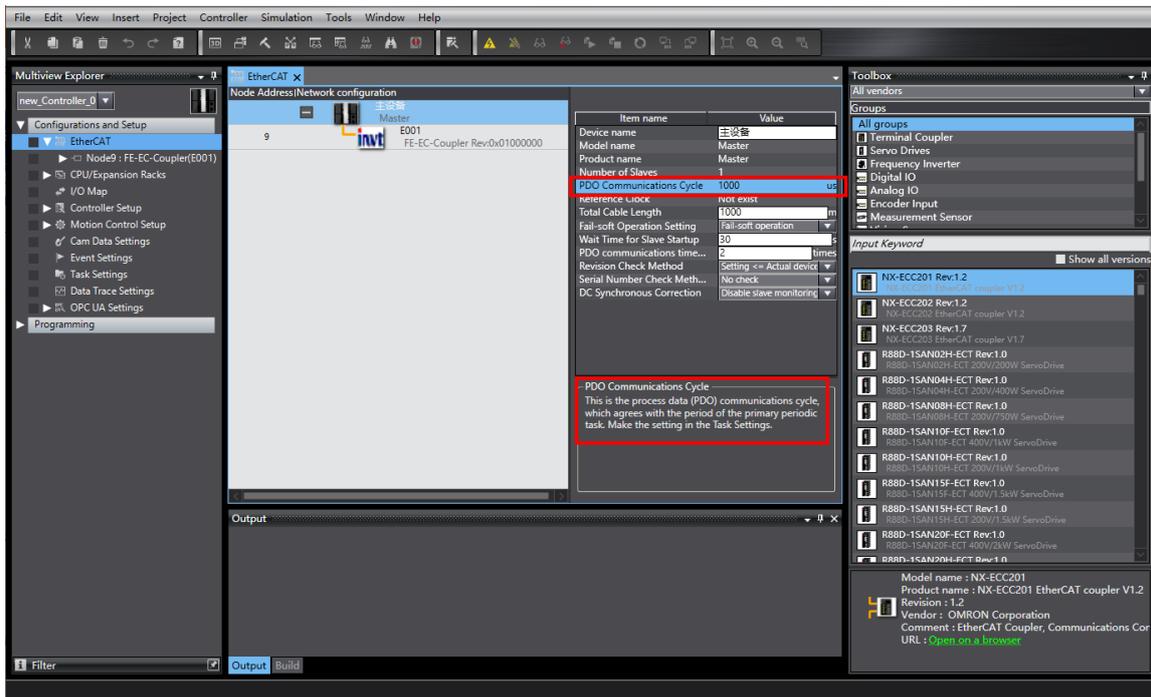
6.1.2.5 Module configuration parameter

Testing indicate that only certain Omron PLC versions support visual configuration of initialization parameters. The testing results obtained using Omron Sysmac Studio V1.52 are as follows; other versions may vary depending on specific conditions.

Omron host controller	Model	PLC version	Support visual configuration
NJ501	1300, 1400, 1500	V1.40 and later	Supported
		V1.21 and earlier	Not supported
NX701	1600, 1700	V1.21 and earlier	Not supported
NX1P2	9024DT, 1040DT, 1140DT	V1.40 and later	Supported
		V1.21 and earlier	Not supported

■ **Visual modification of initialization parameters**

Double-click the added module, Click **Edit Setting Parameters** on the right. Modify the module configuration parameters in the **Edit Setting Parameters** window. For detailed parameter descriptions, see the "Software user interface" table of the respective module in section 5.5I/O module.
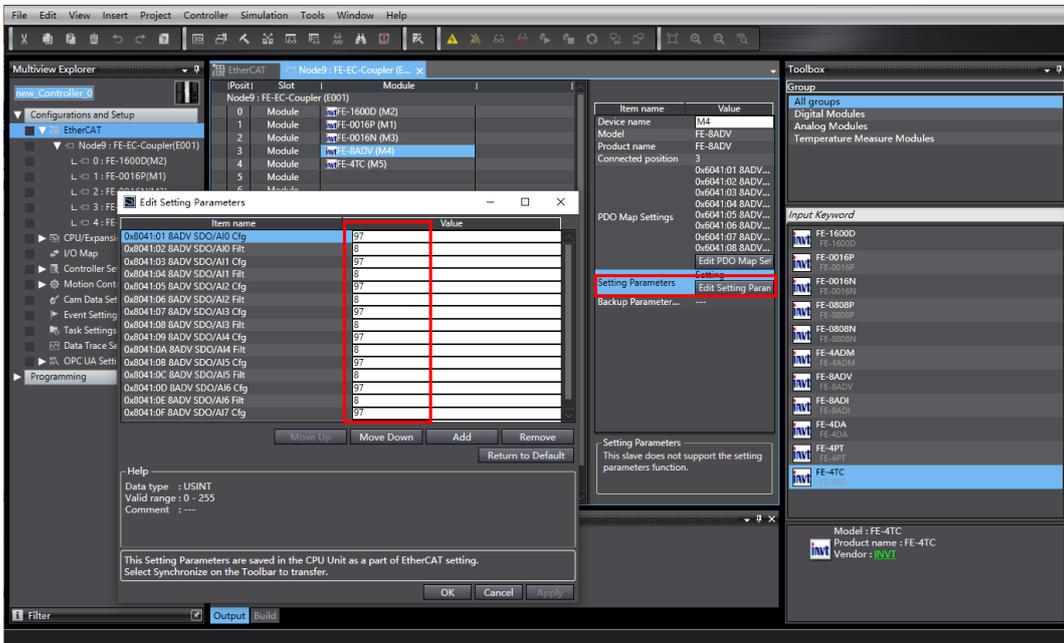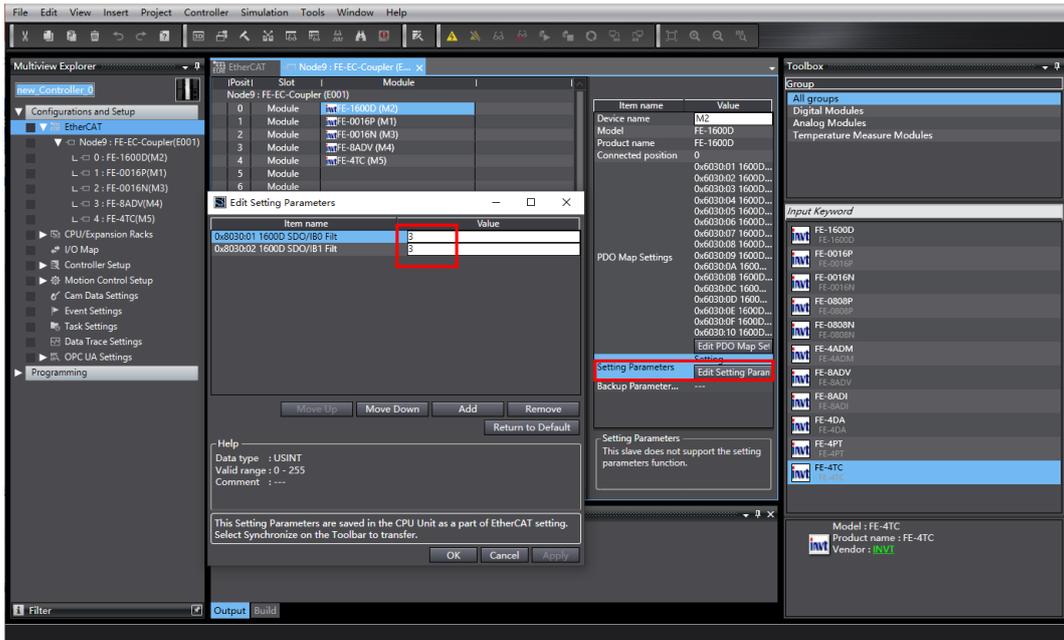
■ **Modifying initialization parameters via SDO function blocks**

If configuration parameters are all SDO parameters and the Omron PLC version does not support the visual configuration of initialization parameters, configure SDO parameters by using the **EC_CoESDOWrite** function block.
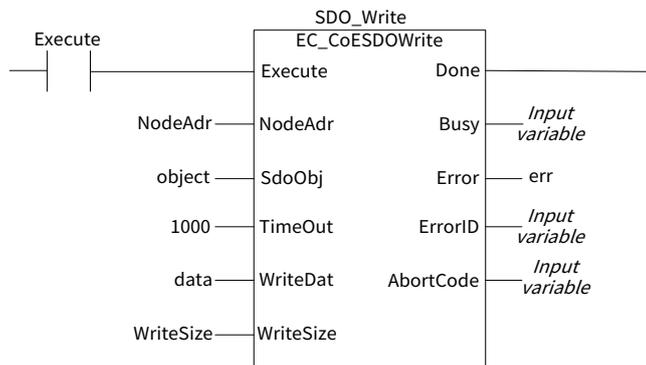
Name	Description
Execute	Rising edge active, and the rising edge enables the SDO Write function block.
NodeAdr	Node address
SdoObj	Object dictionary SDO parameter SdoObj.Index: Index SdoObj.Subindex: Subindex SdoObj.IsCompleteAccess: Indicates whether to access all indexes.
TimeOut	Timeout time
WriteDat	Data written
WriteSize	Write data size in bytes (1 byte = 8 bits)

The index of each module configuration parameter can be viewed by importing the same configuration into the Invtmatic Studio (that can be downloaded at www.invt.com). In this software, the index and sub index of each configuration parameter can be checked.
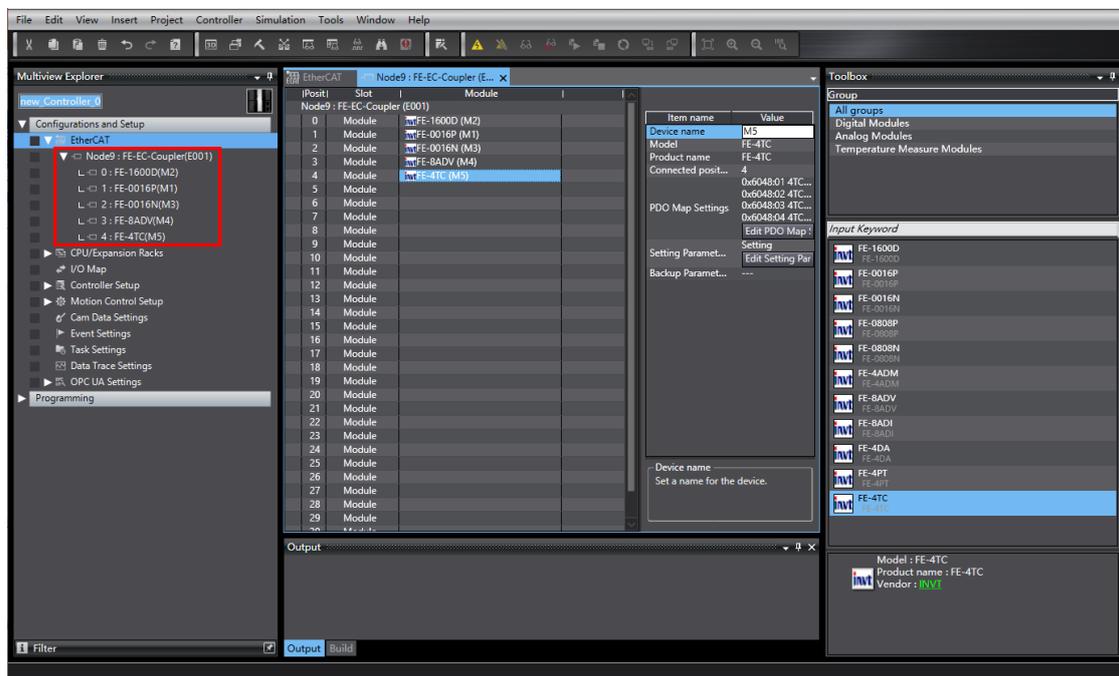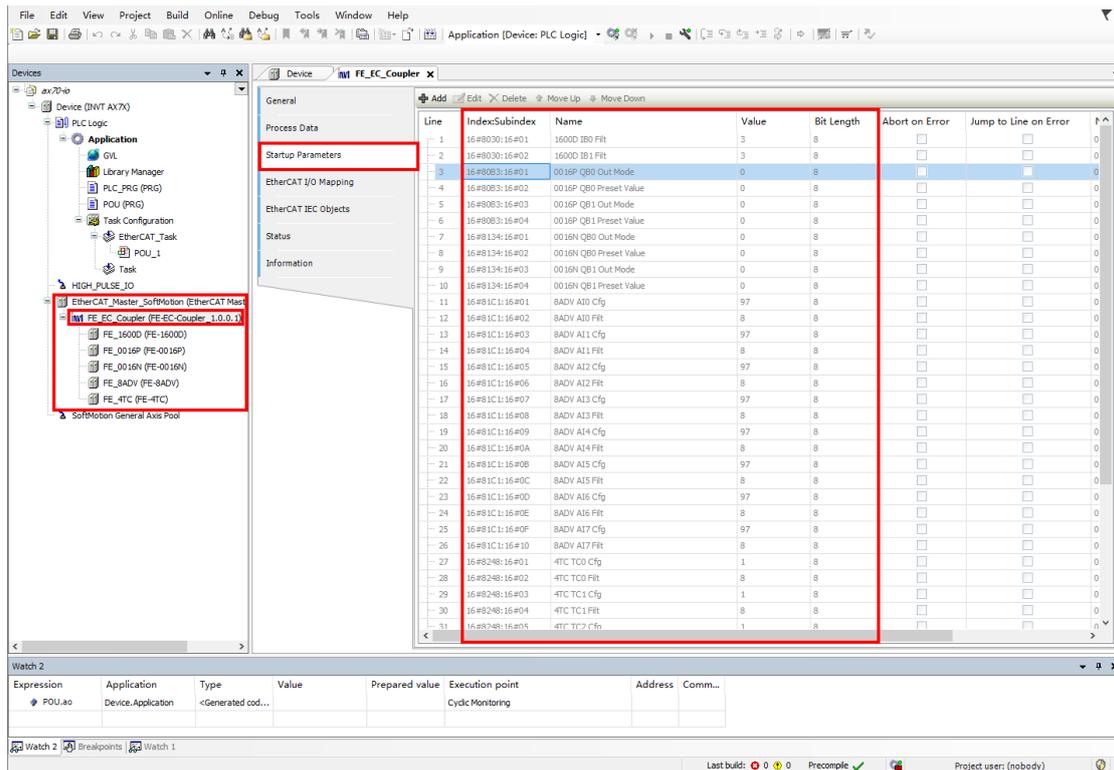
The delay before starting to write the SDO should be adjusted according to the actual situation; here, only a simple example is provided.

```
CASE myStep OF
    0://Configure the 1600D module filter parameter IB0 Filt to 10 (10ms)
        NodeAdr : = 9;
        object.Index : = 16#8030;
        object.Subindex : = 16#01;
        object.IsCompleteAccess : = 0;
        data : = 10;
        WriteSize : = 1;
        Execute : = 1;
        IF SDO_Write.Done AND NOT SDO_Write.Error THEN
            Execute : = 0;
```

```
        myStep : = 1;
    END_IF;
1://Configure the 1600DI module filter parameter IB0 Filt to 5 (5ms)
    NodeAdr : = 9;
    object.Index : = 16#8030;
    object.Subindex : = 16#02;
    object.IsCompleteAccess : = 0;
    data : = 5;
    WriteSize  : = 1;
    Execute : = 1;
    IF SDO_Write.Done AND NOT SDO_Write.Error THEN
        Execute : = 0;
        myStep : = 2;
    END_IF;
2://Configure the 8ADV module channel 0 configuration parameter AI0 Cfg
    NodeAdr : = 9;
    object.Index : = 16#81C1;
    object.Subindex : = 16#01;
    object.IsCompleteAccess : = 0;
    data := 97; //-10-10V channel enable
    WriteSize  : = 1;
    Execute : = 1;
    IF SDO_Write.Done AND NOT SDO_Write.Error THEN
        Execute : = 0;
        myStep : = 3;
    END_IF;
3://Configure the 8ADV module channel 0 configuration parameter AI0 Filt
    NodeAdr : = 9;
    object.Index : = 16#81C1;
    object.Subindex : = 16#02;
    object.IsCompleteAccess : = 0;
    Data:= 7;//Filter parameter 7 //Median of every 7 samples
    WriteSize  : = 1;
    Execute : = 1;
    IF SDO_Write.Done AND NOT SDO_Write.Error THEN
        Execute : = 0;
        myStep : = 4;
    END_IF;
4://Configure the 8ADV module channel 1 configuration parameter AI1 Cfg
    NodeAdr : = 9;
    object.Index : = 16#81C1;
    object.Subindex : = 16#03;
    object.IsCompleteAccess : = 0;
    data := 1; //0-5V channel enable
    WriteSize  : = 1;
    Execute : = 1;
    IF SDO_Write.Done AND NOT SDO_Write.Error THEN
        Execute : = 0;
        myStep : = 5;
    END_IF;
5://Configure the 8ADV module channel 1 configuration parameter AI1 Filt
```

```
            NodeAdr : = 9;
            object.Index : = 16#81C1;
            object.Subindex : = 16#04;
            object.IsCompleteAccess : = 0;
            Data:= 15;//Filter parameter 15 //Median of every 15 samples
            WriteSize  : = 1;
            Execute : = 1;
            IF SDO_Write.Done AND NOT SDO_Write.Error THEN
                Execute : = 0;
                myStep : = 6;
            END_IF;
        6://Configure the 4TC module channel 0 configuration parameter TC0 Cfg
            NodeAdr : = 9;
            object.Index : = 16#8248;
            object.Subindex : = 16#01;
            object.IsCompleteAccess : = 0;
            data := 1; //Type K thermocouple channel enable
            WriteSize  : = 1;
            Execute : = 1;
            IF SDO_Write.Done AND NOT SDO_Write.Error THEN
                Execute : = 0;
                myStep : = 7;
            END_IF;
        7://Configure the 4TC module channel 0 configuration parameter TC0 Filt
            NodeAdr : = 9;
            object.Index : = 16#8248;
            object.Subindex : = 16#02;
            object.IsCompleteAccess : = 0;
            Data:= 5;//Filter parameter 5 //Median of every 5 samples
            WriteSize  : = 1;
            Execute : = 1;
            IF SDO_Write.Done AND NOT SDO_Write.Error THEN
                Execute : = 0;
                myStep : = 8;
            END_IF;
        8://Configure the 4TC module channel 1 configuration parameter TC1 Cfg
            NodeAdr : = 9;
            object.Index : = 16#8248;
            object.Subindex : = 16#03;
            object.IsCompleteAccess : = 0;
            Data: = 65;//Type J thermocouple channel enable
            WriteSize  : = 1;
            Execute : = 1;
            IF SDO_Write.Done AND NOT SDO_Write.Error THEN
                Execute : = 0;
                myStep : = 9;
            END_IF;
        9:
            //do something
            ;
    END_CASE;
```

6.1.2.6 Module process data

After variable mapping is completed in the **I/O Map** window, the variables can be used by the program. For detailed I/O data descriptions, see the "Software user interface" table of the respective module in section 5.5 I/O module.
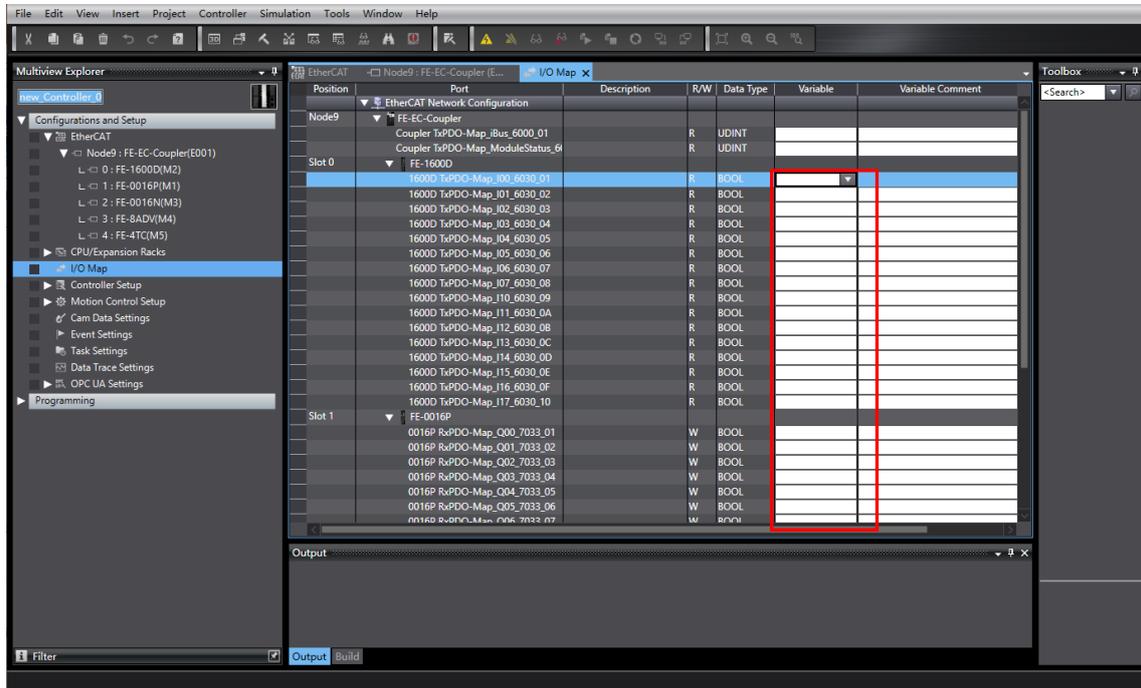
6.1.2.7 Retrieving module fault status
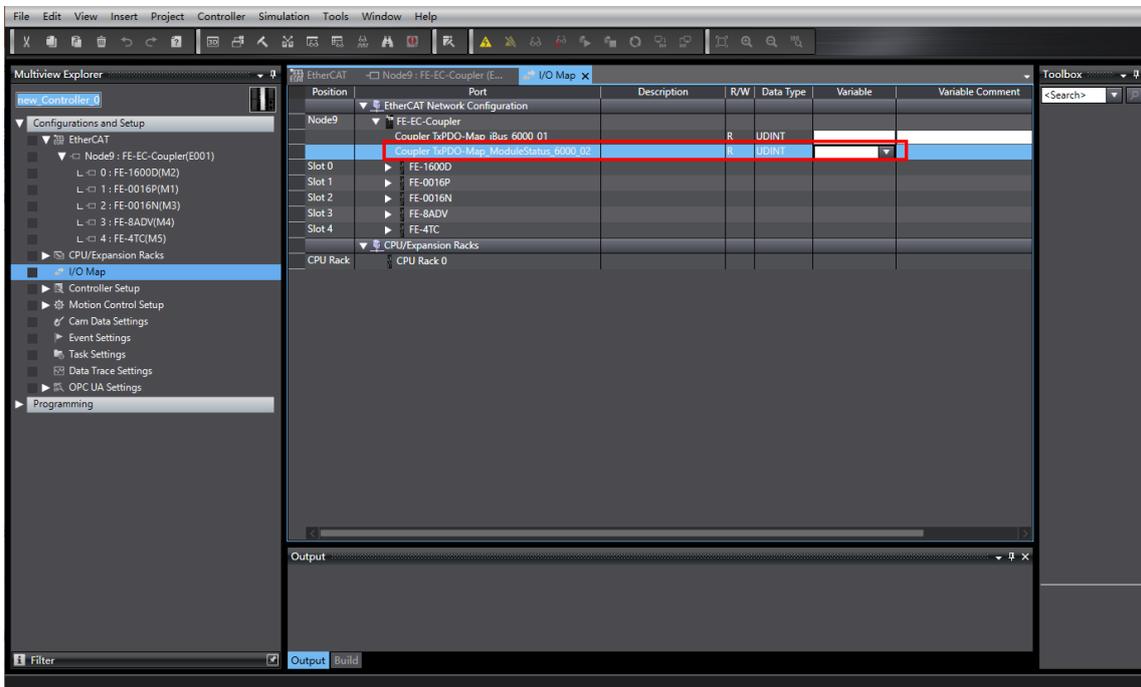
The coupler I/O mapping parameter **ModuleStatus** indicates the module fault status, as specified in the following table.

Name	Type	Meaning
ModuleStatus	uint32_t (Unsigned 32-bit data)	Module fault status (0: No fault; 1: Fault) Bit0: Fault status of module 1

Name	Type	Meaning
		Bit1: Fault status of module 2
		...
		Bit31: Fault status of module 32

A specific module fault code can be obtained by using the **EC_CoESDORead** function block to read the corresponding sub index of Object Dictionary 16#3023. The definition of Object Dictionary 16#3023 is as follows.

	Module fault code information	
	uint16_t	sub index 1 Module 1 fault code
16#3023	uint16_t	sub index 2 Module 2 fault code
	...	...
	uint16_t	sub index 32 Module 32 fault code

For detailed **EC_CoESDORead** function block input/output descriptions, see the Help.

```
         EC_CoESDORead
 ─ Execute          Done ─
 ─ NodeAdr          Busy ─
 ─ SdoObj           Error ─
 ─ TimeOut          ErrorID ─
 ─ ReadDat ──────── ReadDat ─
                    AbortCode ─
                    ReadSize ─
```

Procedure for retrieving module fault codes:

1. Read the **ModuleStatus** data and check whether ModuleStatus.bit0 is equal to 1. If bit0 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 1). After the function block execution is completed without errors, Module 1 fault code of can be obtained.

2. Read the **ModuleStatus** data and check whether ModuleStatus.bit1 is equal to 1. If bit1 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 2). After the function block execution is completed without errors, Module 2 fault code of can be obtained.

3. Read the **ModuleStatus** data and check whether ModuleStatus.bit2 is equal to 1. If bit2 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 3). After the function block execution is completed without errors, Module 3 fault code of can be obtained.

...

32. Read the **ModuleStatus** data and check whether ModuleStatus.bit31 is equal to 1. If bit31 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 32). After the function block execution is completed without errors, Module 32 fault code of can be obtained.

🖉 **Note:** Enabling the **SdoRead** function block affects the real-time performance of EtherCAT communication. Therefore, do not continuously read module fault codes. First determine whether a module has a fault by checking **ModuleStatus**. The **SdoRead** function block should be enabled only when a fault is

detected. Within a single task cycle, try to check only one module for faults, and do not retrieve fault codes for multiple modules within the same task cycle.

6.1.3 TwinCAT3 configuration description

6.1.3.1 Installing the device description file

Copy the coupler device description file (**.xml**) to the directory
C:\TwinCAT\3.1\Config\Io\EtherCAT (the storage directory for TwinCAT EtherCAT device description files) and restart the TwinCAT software.

6.1.3.2 Performing network configuration

■ **Manual configuration**

Step 1 Add the EtherCAT master.

Right-click **Device** under **I/O**, and choose **Add New Item**. In the **Insert Device** window, choose **EtherCAT Master**, and click **OK**. Select the correct network port in the **Device Found At** window.
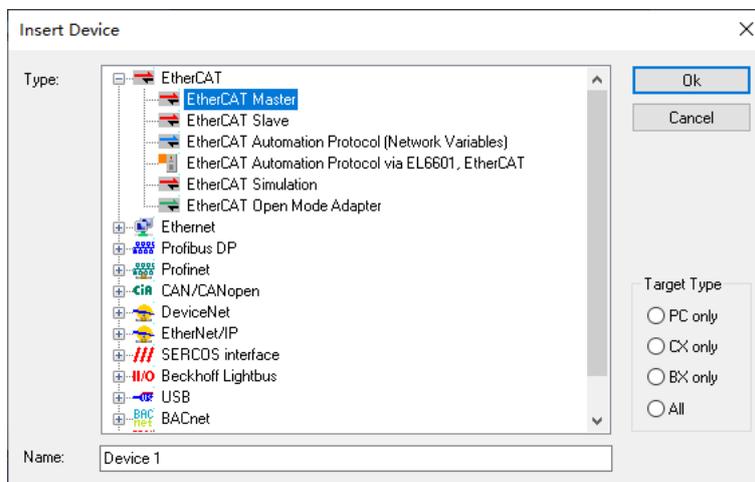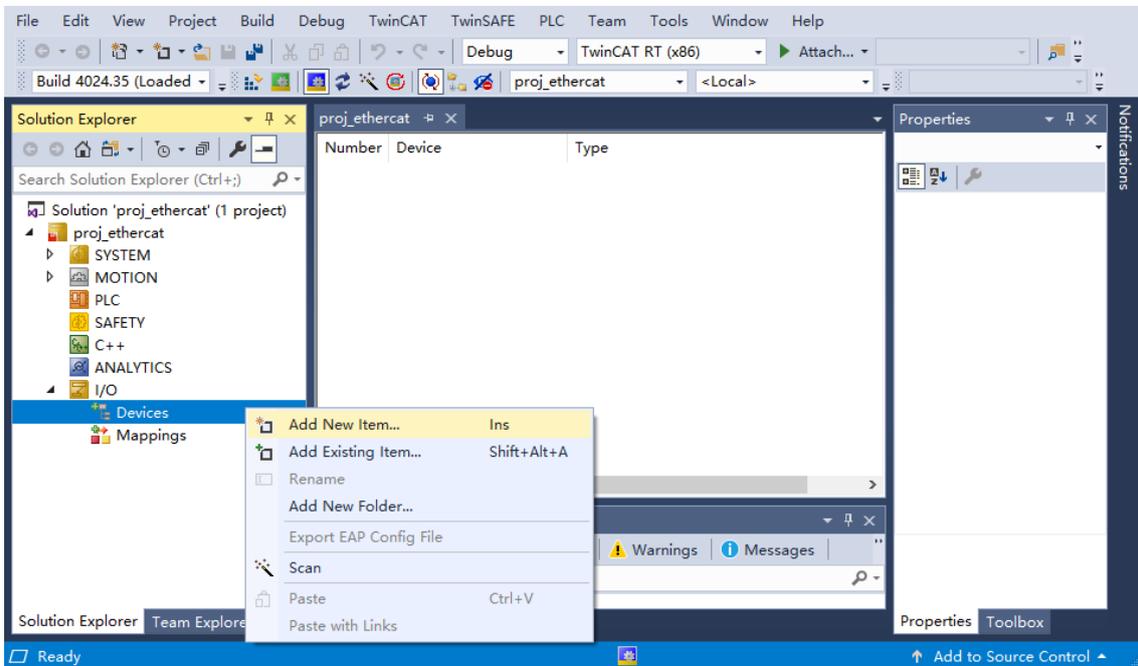
Step 2 Add the EtherCAT slave.

Right-click **EtherCAT** under **Device**, and choose **Add New Item**. In the **Insert EtherCAT Device** window, locate the slave device you want to add, and click **OK** to add the EtherCAT slave device.
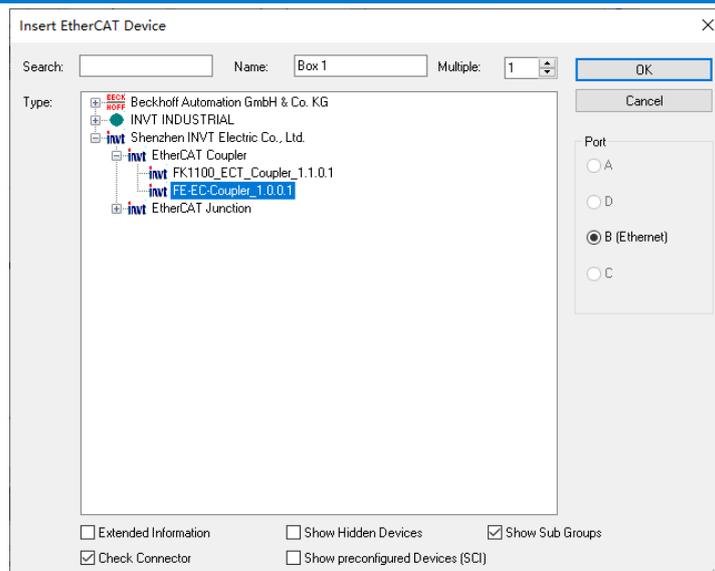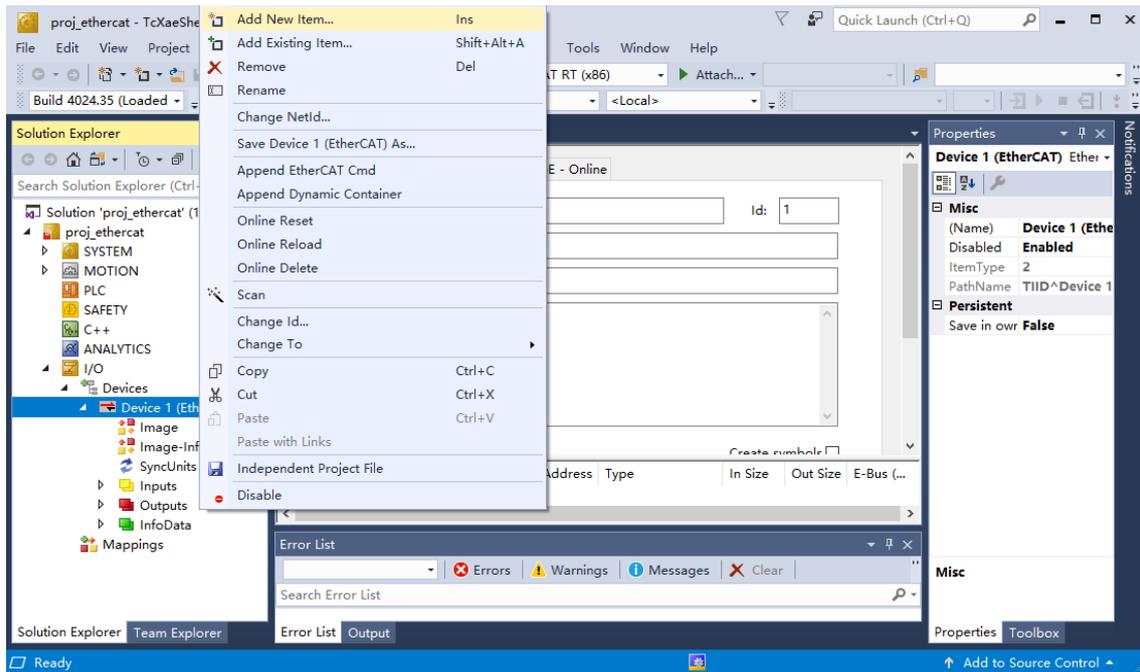
Step 3 Add slot devices.

Double-click the added coupler slave device and click the **Slots** tab. Based on the physical configuration (actual physical connection sequence), correctly add the modules on the right to the slots on the left.

✎**Note:** The physical configuration must be consistent with the network configuration. If the configuration is inconsistent, EtherCAT communication cannot enter the OP state.
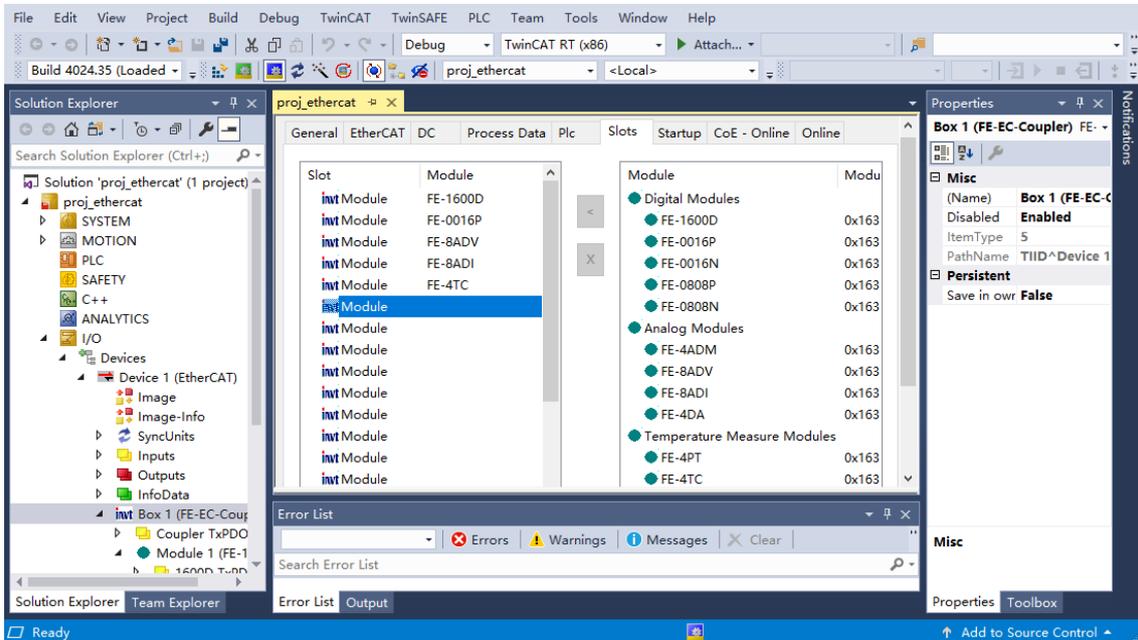
■ **Automatic scanning**

Step 1 Establish a reliable physical connection for Computer > PLC > Coupler slave, and switch the PLC to **Config Mode**.
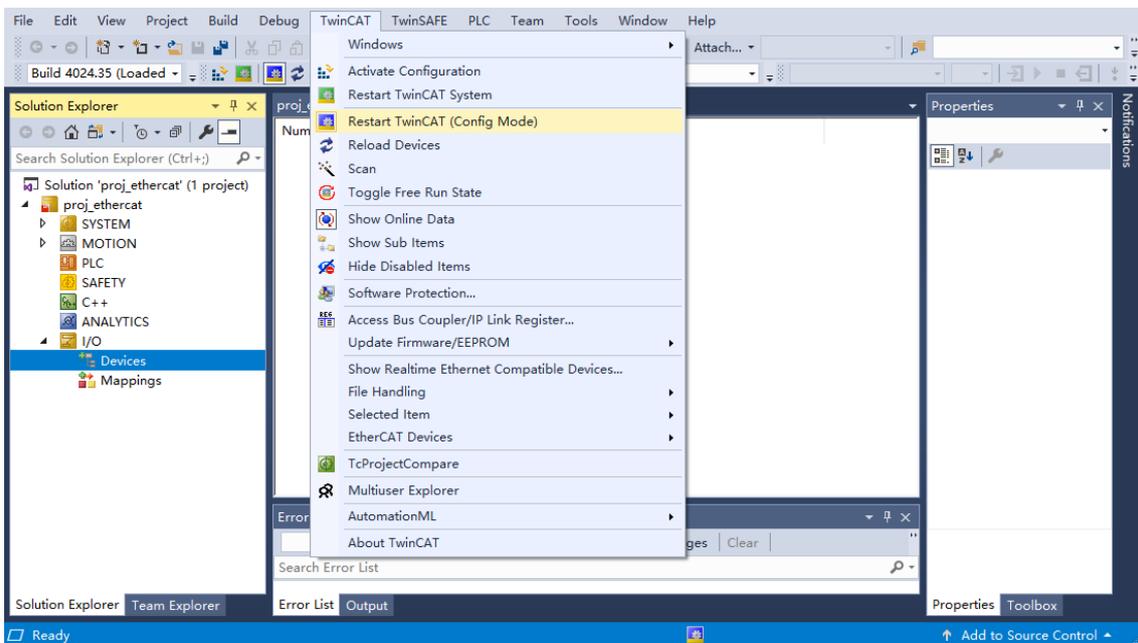
Step 2 Right-click **Devices** under **I/O**, choose **Scan**, and click **OK** in the pop-up dialog box to wait for the scan results. Select the scanned devices as needed, and click **OK**. Click **Yes** in the pop-up **Scan for boxes** dialog box to wait for the scan results.

🖋**Note:** It is recommended to check whether the network configuration and physical configuration added in automatic scan match, and adjustments can be made manually.
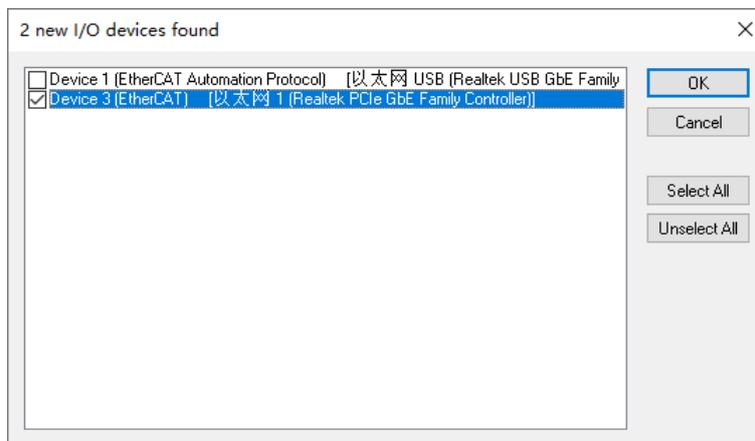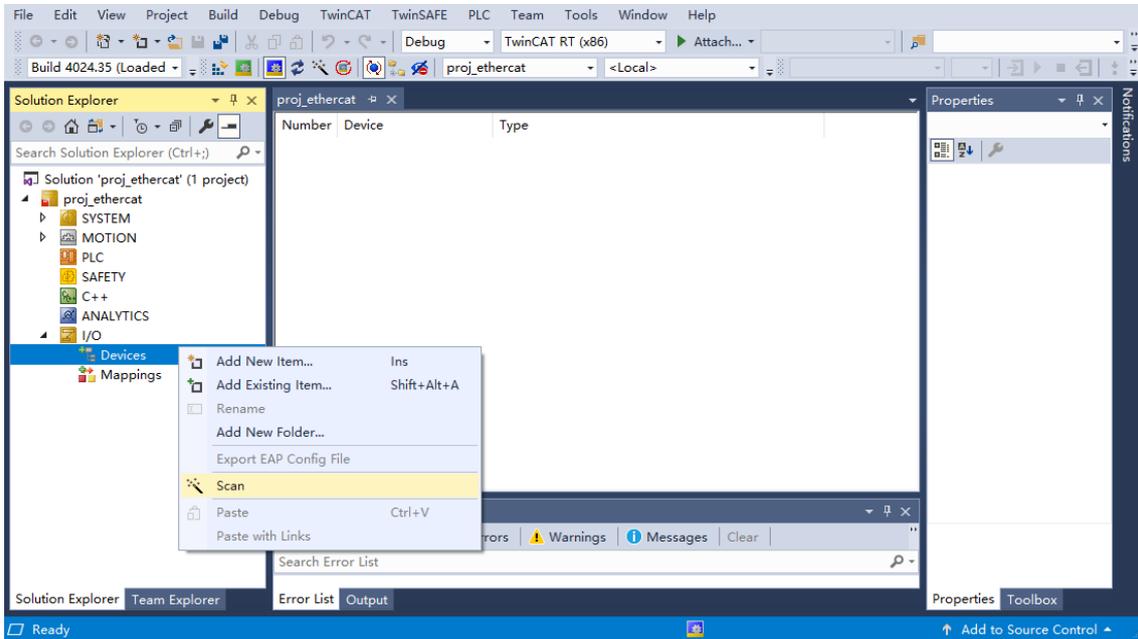
6.1.3.3 EtherCAT communication parameter configuration

Step 1 Set the synchronization mode: Double-click the added coupler, and click the **DC** tab. Set **Operation Mode**.
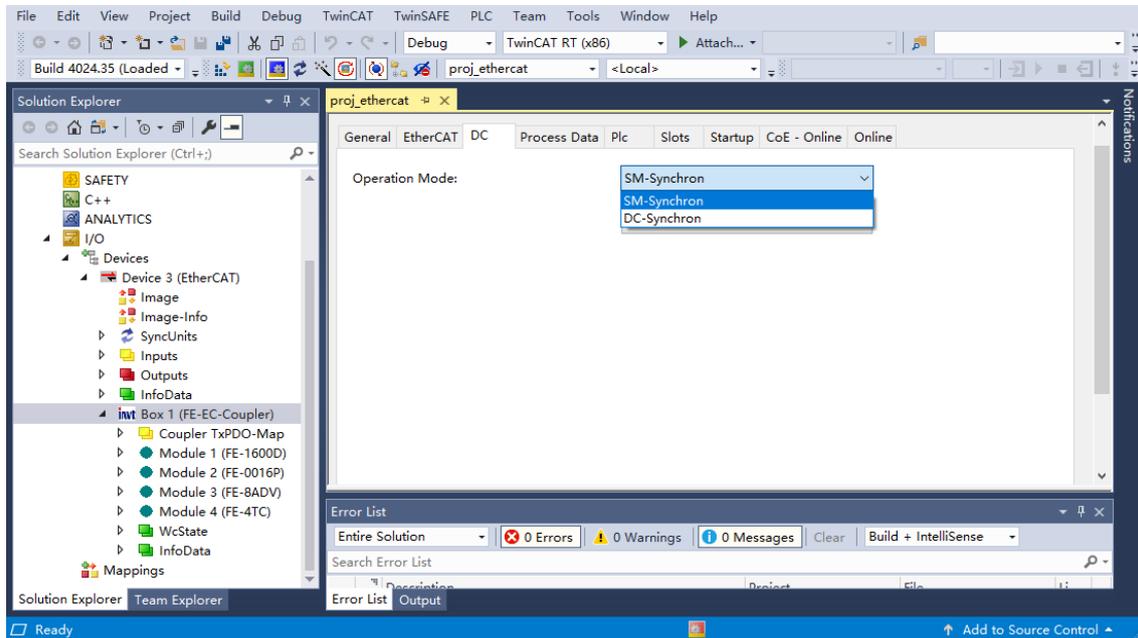
Step 2 Set the synchronization cycle.

Double-click **I/O** > **Devices** > **EtherCAT**, click the **Adapter** tab, and set **Freerun Cycle (ms)** (recommended to adjust).

Double-click the added coupler slave device, click the **DC** interface, click **Advanced Settings** and set **SYNC 0** > **Sync Unit Cycle** (not recommended to adjust).
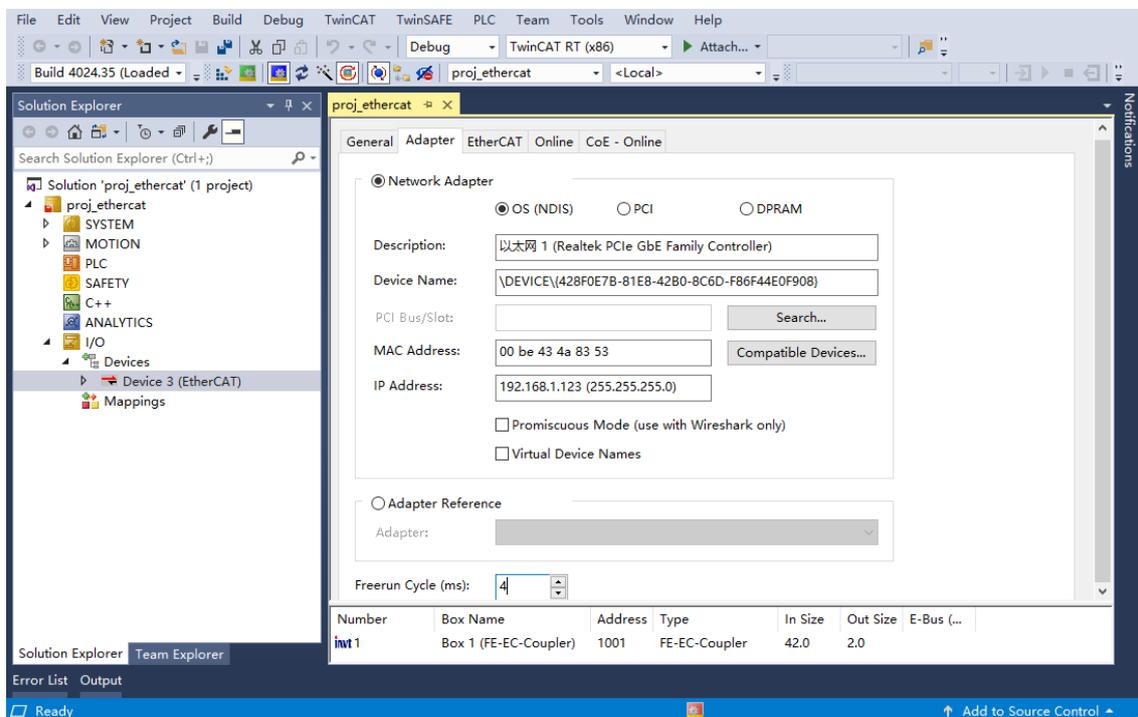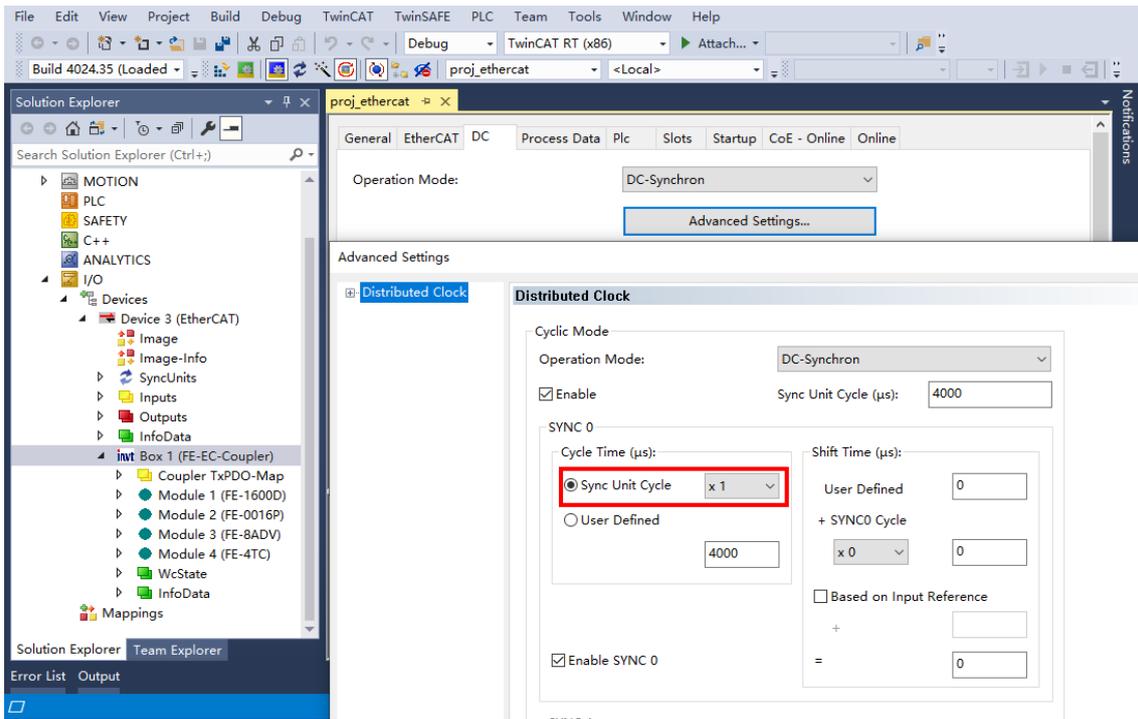
6.1.3.4 Module configuration parameters

Double-click the added coupler, and click the **Startup** tab. Startup parameters are SDO data, which are the initialization configuration parameters for each module. Double-click to modify the initial value. These parameters are transmitted to the slave during the EtherCAT communication transition from Pre-OP to Safe-OP. For detailed parameter descriptions, see the "Software user interface" table of the respective module in section 5.5 I/O module.
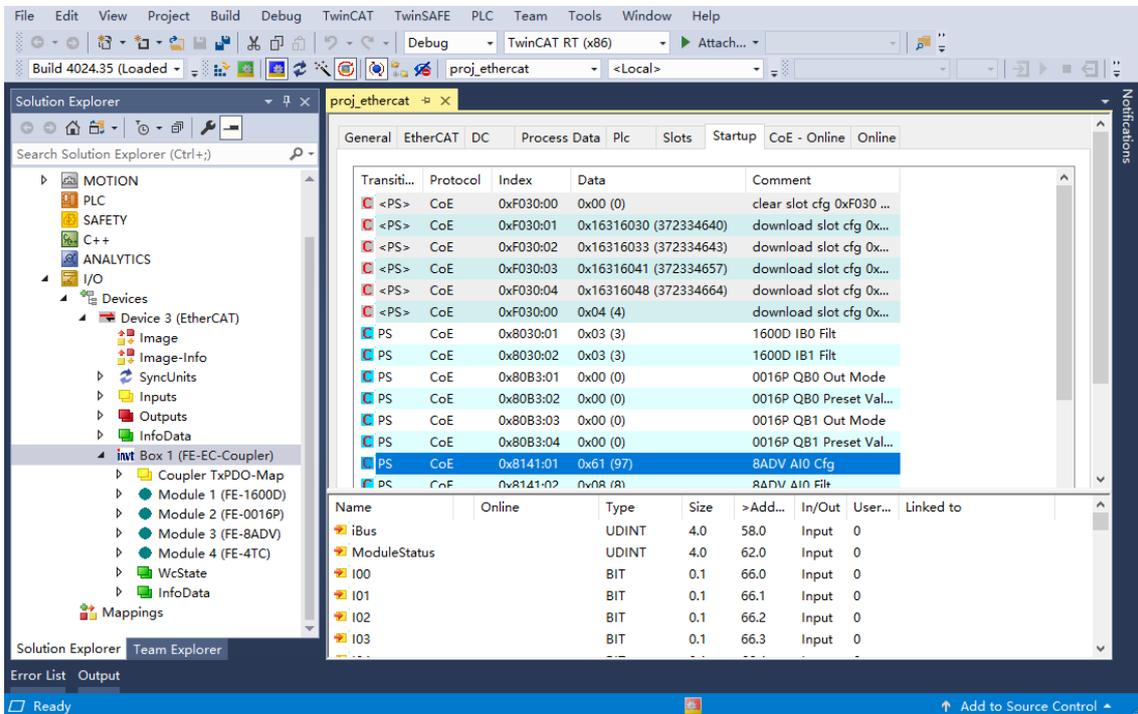
6.1.3.5 Module process data

Linked variables are used for reading input samples or controlling outputs in the program. For detailed I/O data descriptions, see the "Software user interface" table of the respective module in section 5.5 I/O module.
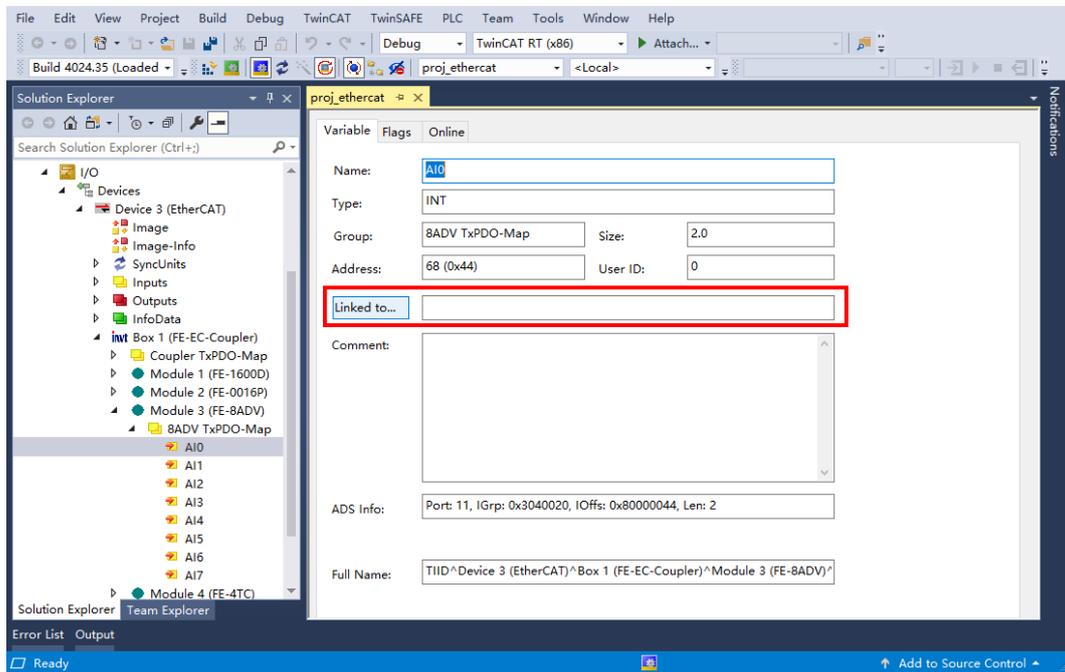
6.1.3.6 Retrieving module fault status
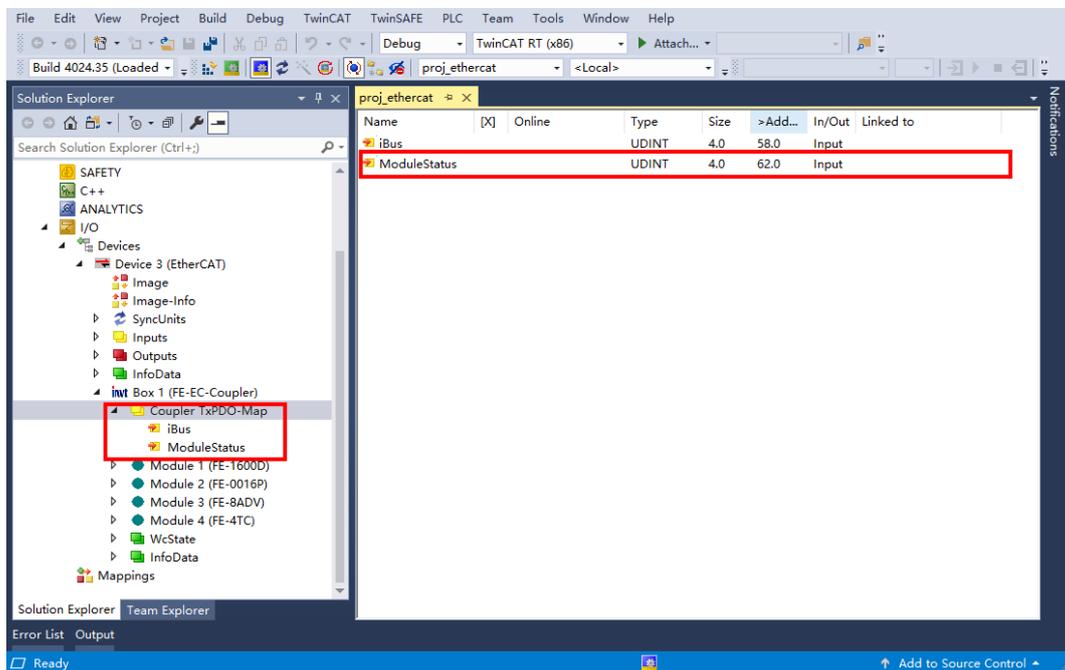
The coupler I/O mapping parameter **ModuleStatus** indicates the module fault status, as specified in the following table.

Name	Type	Meaning
ModuleStatus	uint32_t (Unsigned 32-bit data)	Module fault status (0: No fault; 1: Fault) Bit0: Fault status of module 1 Bit1: Fault status of module 2 ...

Name	Type	Meaning
		Bit31: Fault status of module 32

A specific module fault code can be obtained by using the **FB_EcCoESdoRead** function block to read the corresponding sub index of Object Dictionary 16#3023. The definition of Object Dictionary 16#3023 is as follows.

	Module fault code information	
16#3023	uint16_t	sub index 1 Module 1 fault code
	uint16_t	sub index 2 Module 2 fault code
	...	...
	uint16_t	sub index 32 Module 32 fault code

For detailed **FB_EcCoESdoRead** function block input/output descriptions, see the Help.

```
         FB_EcCoESdoRead
─┤sNetId           bBusy├─
─┤nSlaveAddr       bError├─
─┤nSubIndex        nErrId├─
─┤nIndex           cbRead├─
─┤pDstBuf
─┤cbBufLen
─┤bExecute
─┤tTimeout
```

Procedure for retrieving module fault codes:

1. Read the **ModuleStatus** data and check whether ModuleStatus.bit0 is equal to 1. If bit0 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 1). After the function block execution is completed without errors, Module 1 fault code of can be obtained.

2. Read the **ModuleStatus** data and check whether ModuleStatus.bit1 is equal to 1. If bit1 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 2). After the function block execution is completed without errors, Module 2 fault code of can be obtained.

3. Read the **ModuleStatus** data and check whether ModuleStatus.bit2 is equal to 1. If bit2 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 3). After the function block execution is completed without errors, Module 3 fault code of can be obtained.

    ...

32. Read the **ModuleStatus** data and check whether ModuleStatus.bit31 is equal to 1. If bit31 = 1, a fault is present. In this case, enable the **SdoRead** function block
    (Index = 16#3023, sub index = 32). After the function block execution is completed without errors, Module 32 fault code of can be obtained.

✎ **Note:** Enabling the **SdoRead** function block affects the real-time performance of EtherCAT communication. Therefore, do not continuously read module fault codes. First determine whether a module has a fault by checking **ModuleStatus**. The **SdoRead** function block should be enabled only when a fault is detected. Within a single task cycle, try to check only one module for faults, and do not retrieve fault codes for multiple modules within the same task cycle.

6.2 PROFINET communication coupler

6.2.1 TIA Portal configuration description

6.2.1.1 Installing the device description file

Install the device description file named in the format of GSDML-V2.43-INVT-FE-PN-xxxxxxxx.xml.
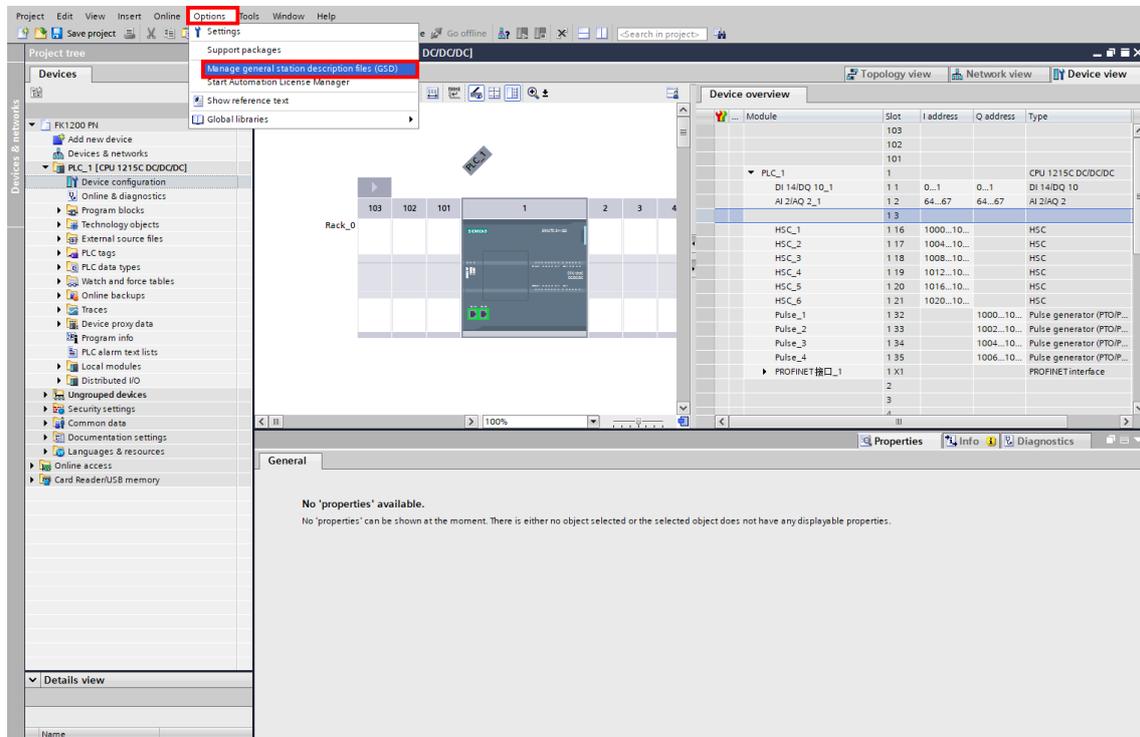
In the window that appears, set **Source path** to the GSD file saving path, select the GSD file to be installed, and then click **Install**.
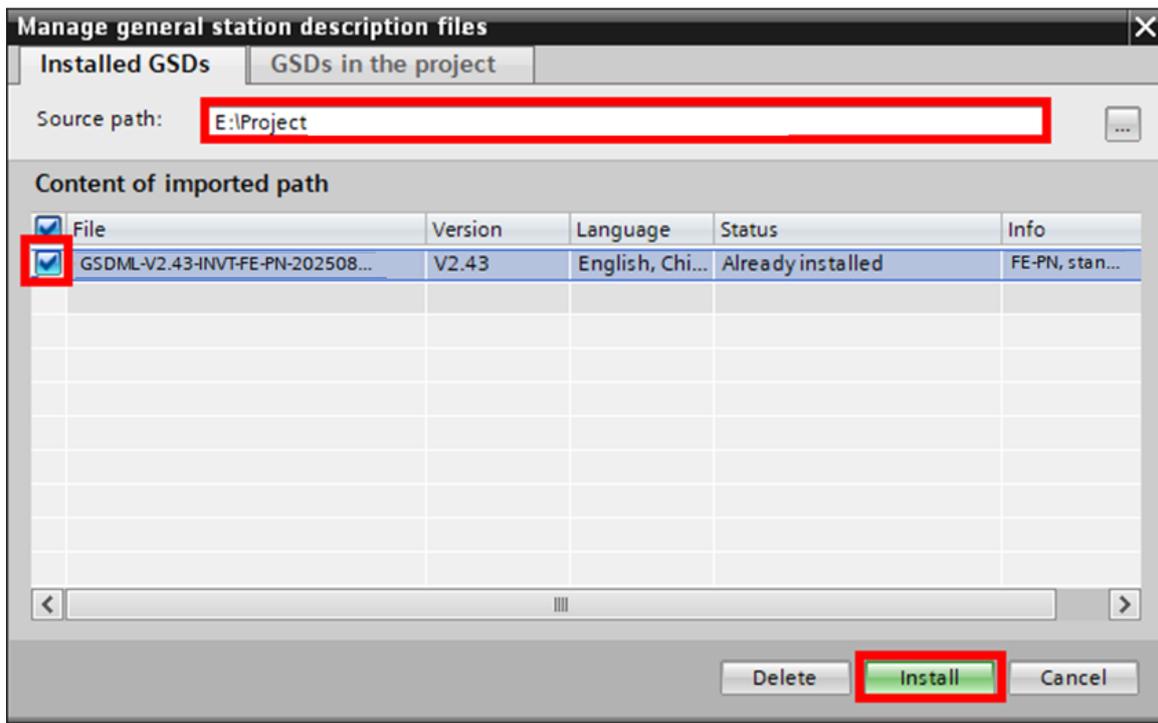
6.2.1.2 Configuring the PN device name

Complete the actual physical connection. Under **Project tree**, choose **Devices** > **Online access** > **Realtek PCle GbE Family Controller** > **Update accessible devices**.
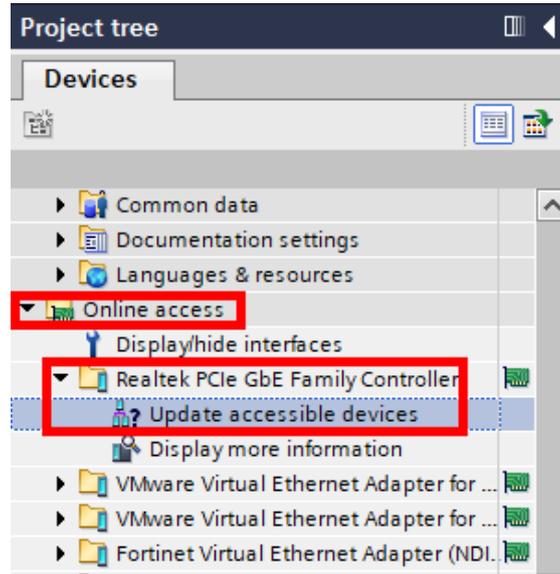
Choose the refreshed PN coupler device (you can confirm the device according to the MAC address or the LED blinking status). Choose **Online & diagnostics** under **Devices**, choose **Functions** > **Assign PROFINET device name**, set the name, and click **Assign name**.

✏️**Note:** When **Flash Lights** is selected, the corresponding coupler RUN/ERR/SF indicators flash simultaneously.
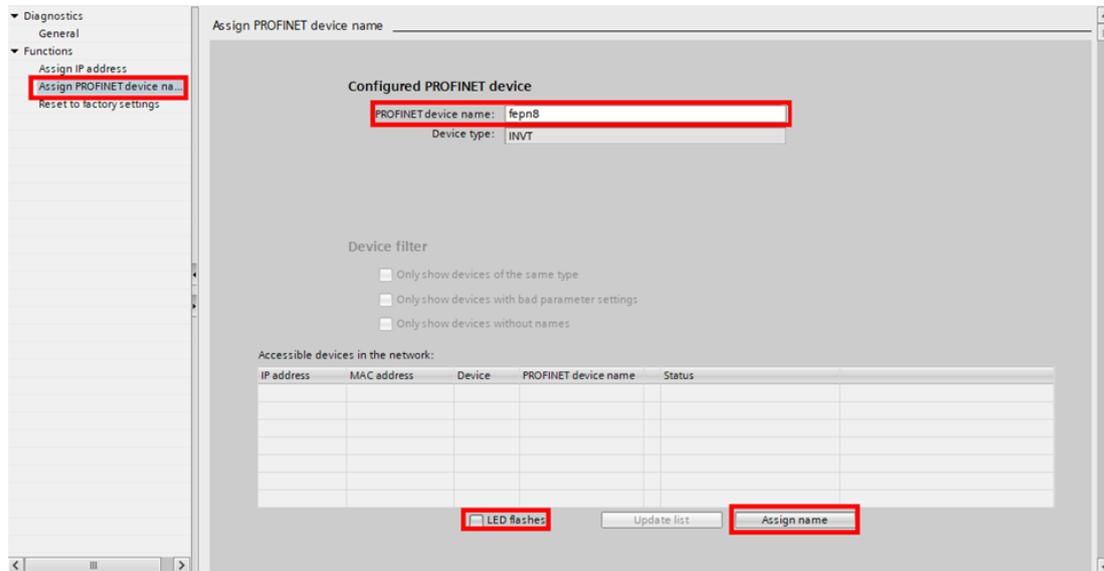
6.2.1.3 Performing network configuration

Add a coupler: Choose **PLC_1** > **Device configuration** > **Network view**, click the hardware directory on the right, and choose **Other field devices** > **PROFINET IO** > **I/O** > **INVT** > **PN IO System** > **FE Series** > **FE-PN** to add it to the project.
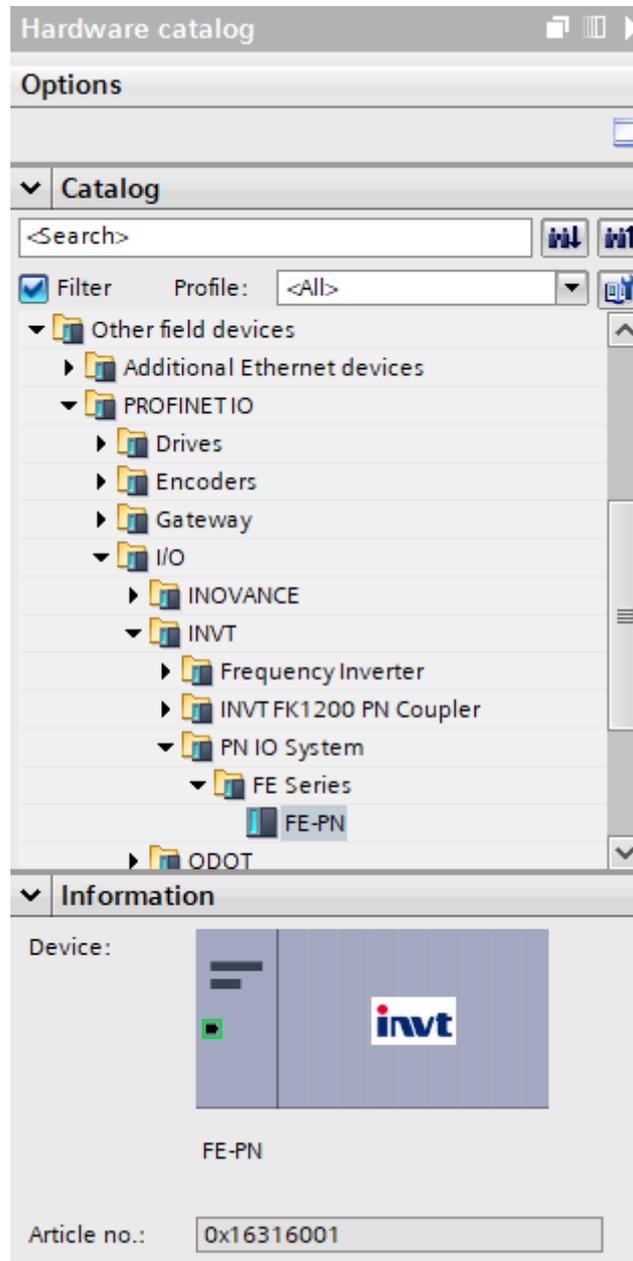
Add a module: Choose **PLC_1** > **Device configuration** > **Network view**, select the required FE-PN device in the **Device view** interface. Add the modules on the right to the slots according to the actual physical configuration.
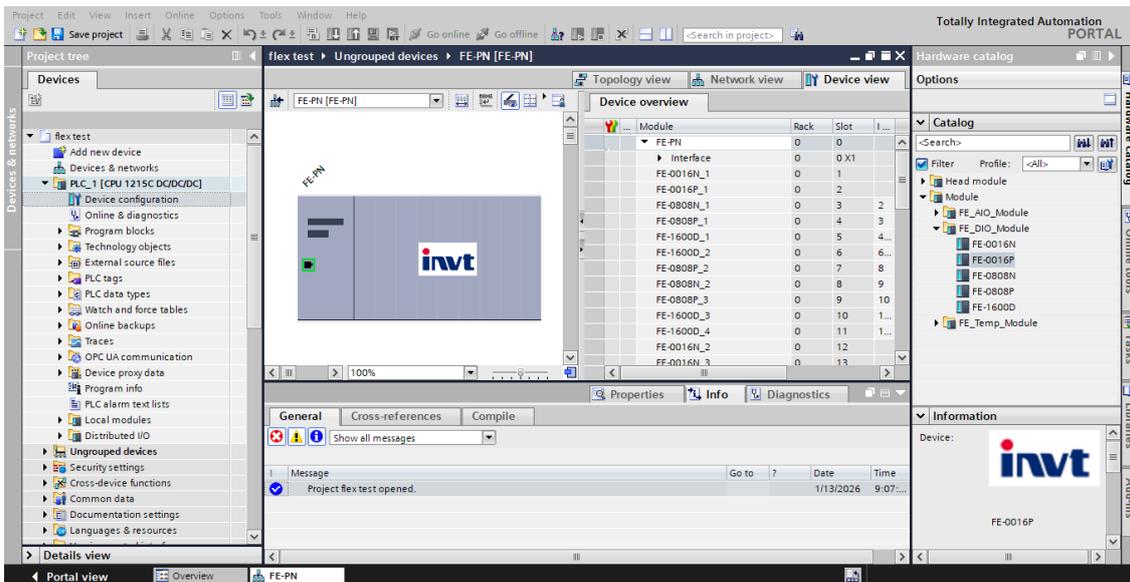
6.2.1.4 PROFINET communication parameter configuration

Set the IP address: Select the PN device to configure in the **Device view** interface, and then choose **Properties** > **General** > **Ethernet address**, and set the IP address.
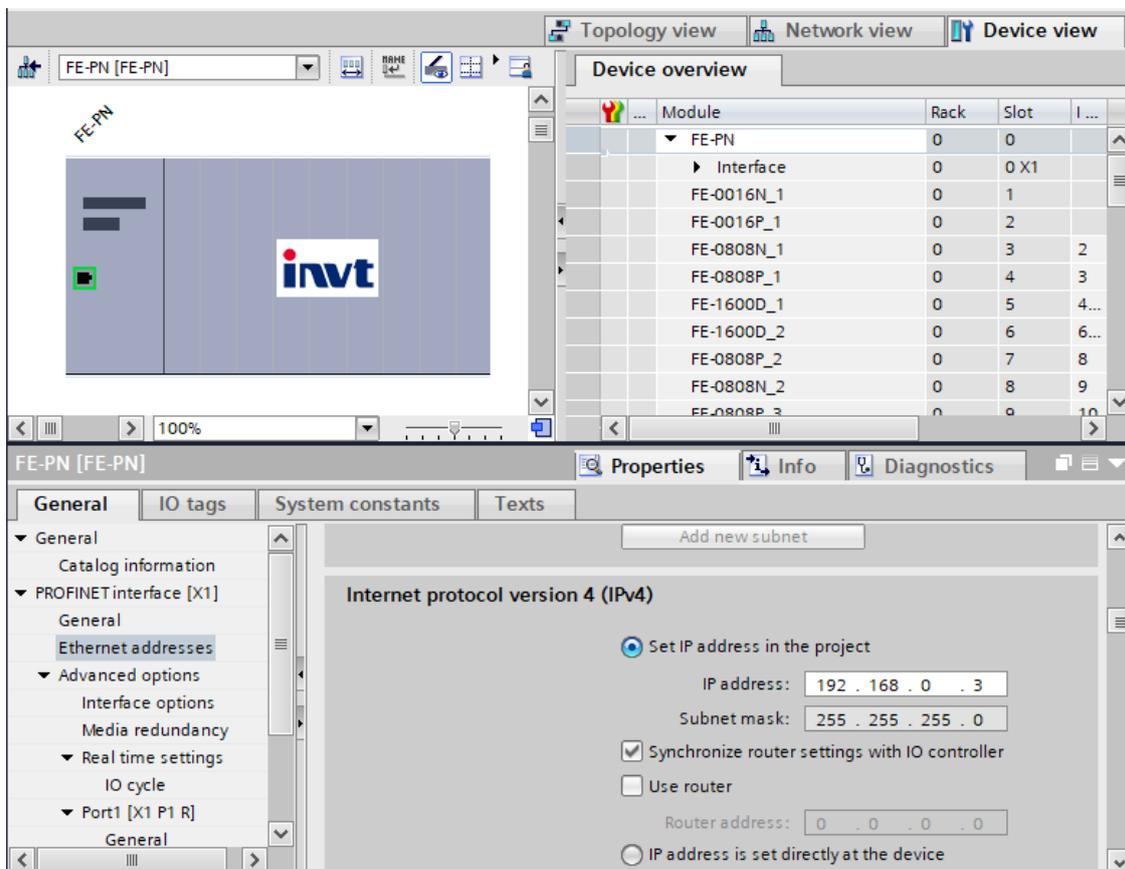
Set the PROFINET device name: There are two FE-PN device name setting methods.

Method 1   Set via a DIP switch. When the DIP switch is set to a non-zero value, the device name set via the DIP switch takes effect. For example, if the DIP switch is set to 129, the device name is fepn129.

Method 2   Set via the TIA Portal. When the DIP switch is set to 0, the device name set via the TIA Portal takes effect. Select the target PN device in the **Device view** interface, and then choose **Properties** > **General** > **Ethernet address**, and set the PROFINET device name. Clear **Generate PROFINET device name automatically** to freely set the device name.

🖊**Note:** The set PROFINET device name must be consistent with the device name as set in section 6.2.1.2 Configuring the PN device name. When PN communication is established, devices match by device name. If device names are not consistent, devices cannot be recognized.
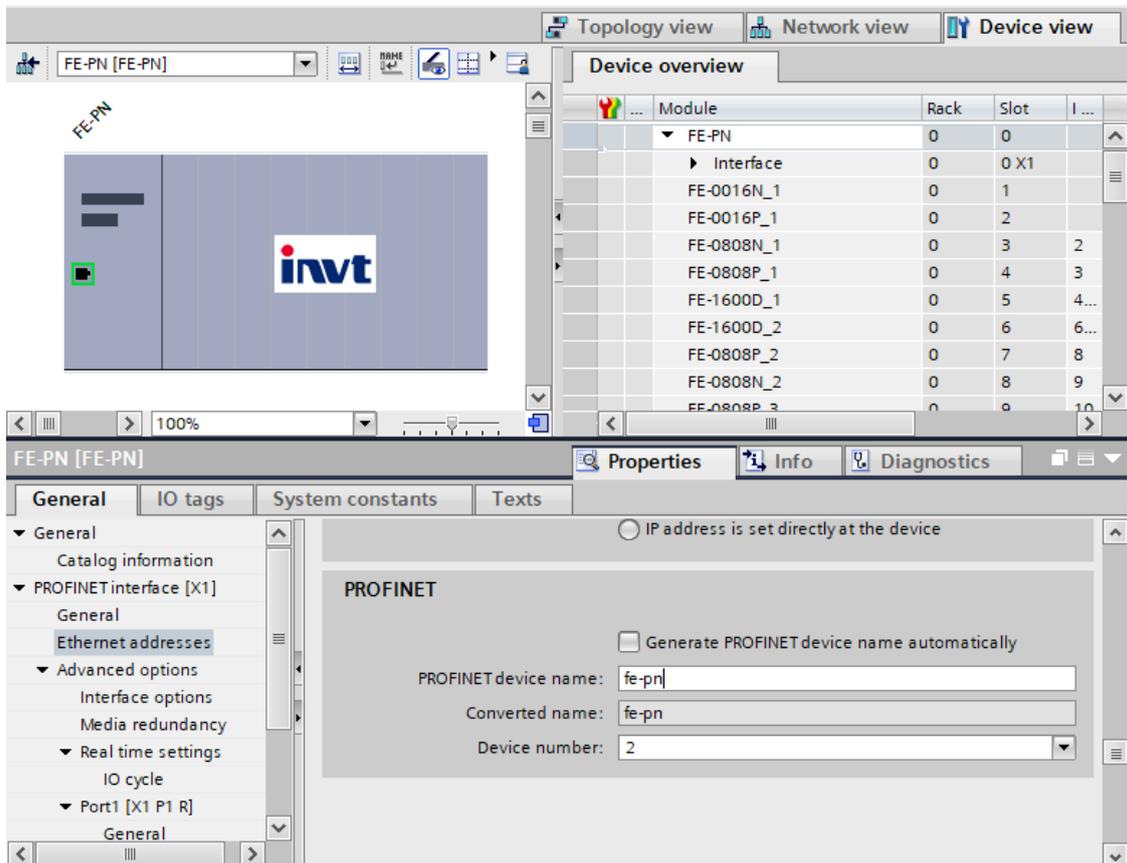
Choose **Properties** > **General** > **Advanced Options** and set other parameters such as the I/O update cycle and network port rate.

6.2.1.5 Module configuration parameters

Select the target PN device in the **Device view** interface, and then choose **Properties** > **General** > **Module parameters** > **Configure Parameters**, and set module parameters.
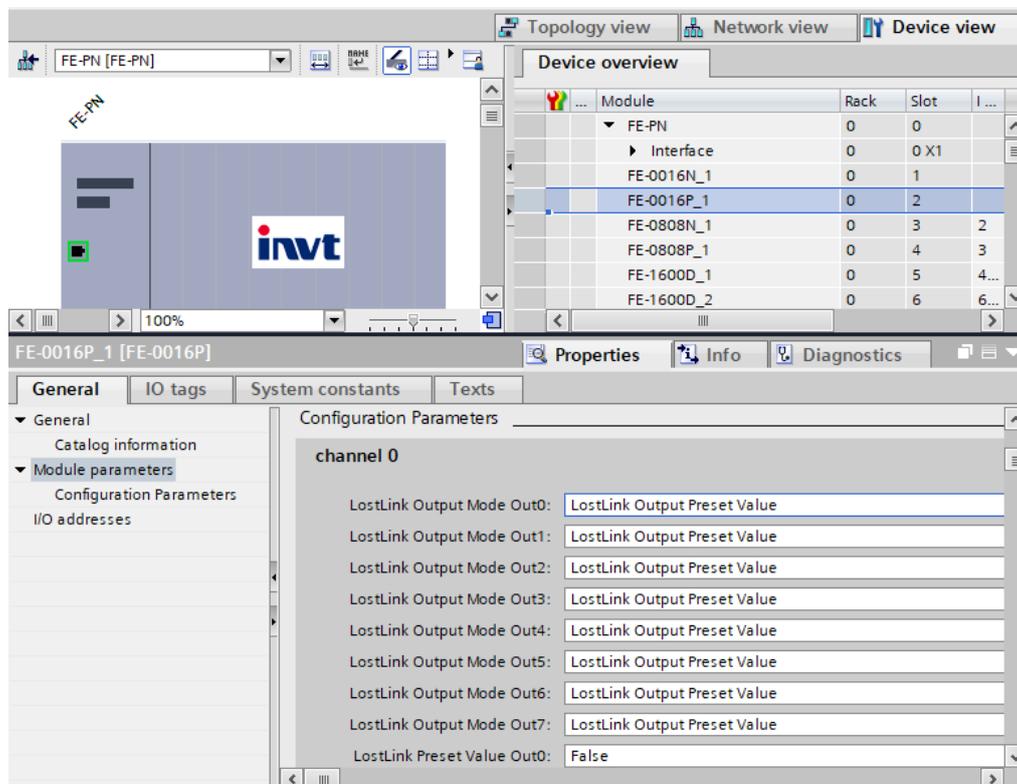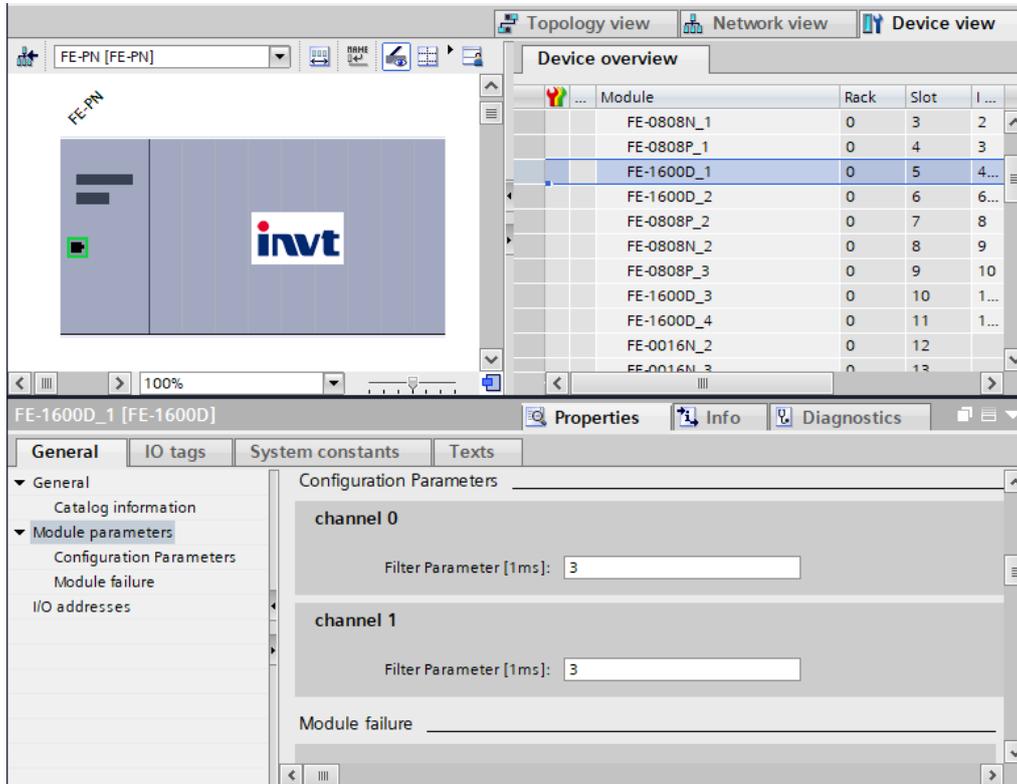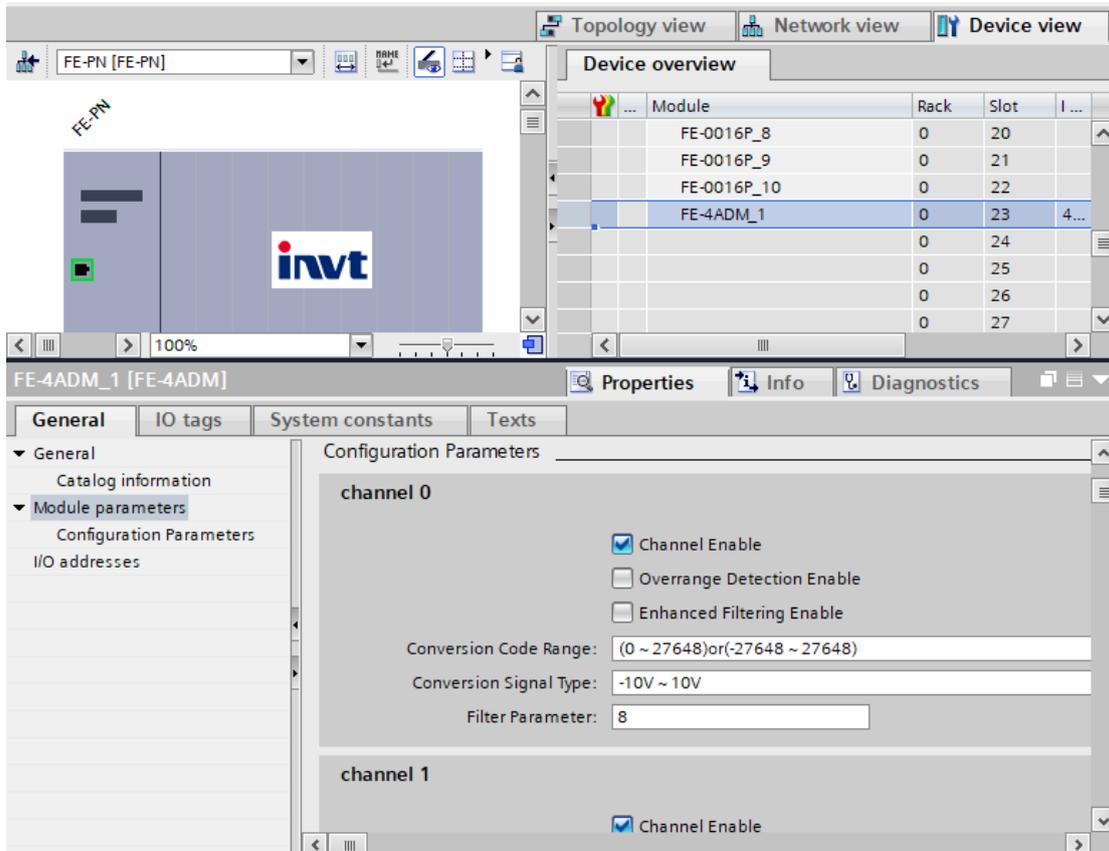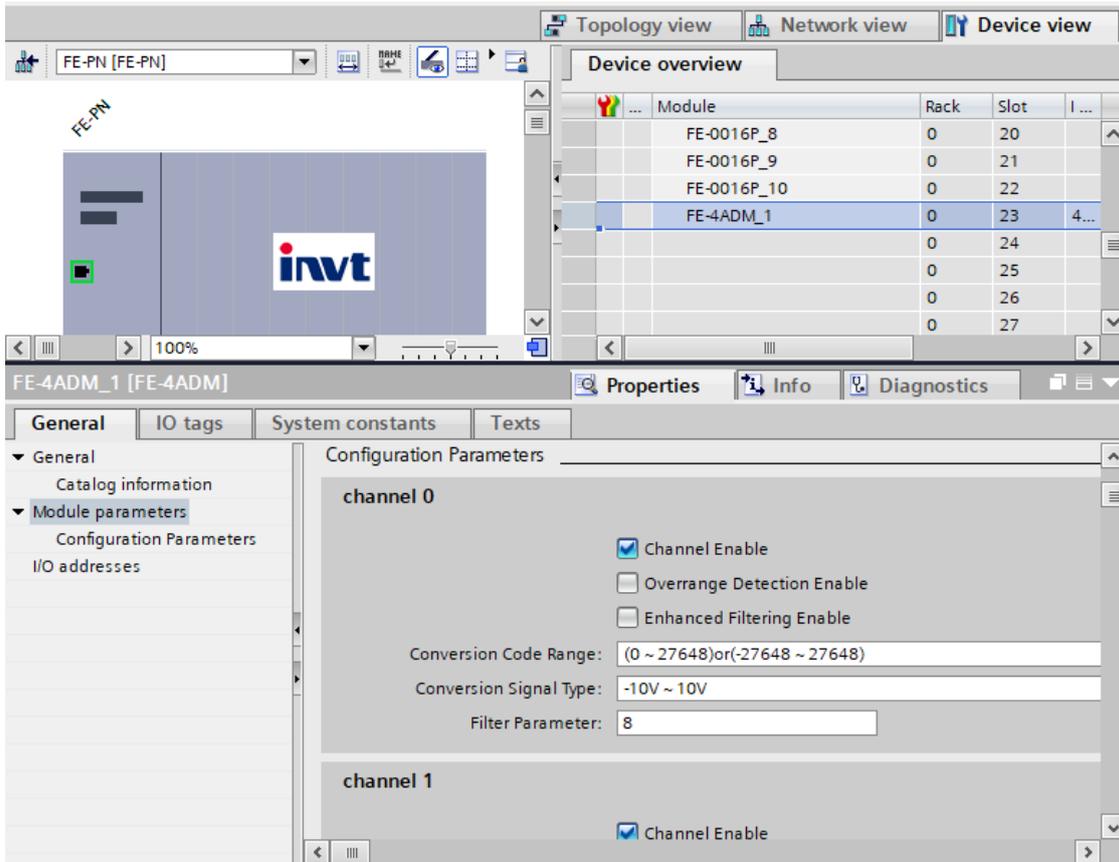
6.2.1.6 Module process data

Read and write module process data via the I and Q addresses assigned in TIA Portal. For detailed module process data descriptions, see the "Software user interface" table of the respective module in section 5.5 I/O module.

...	Module	Rack	Slot	I address	Q address	Type
▼	FE-PN	0	0			FE-PN
	▶ Interface	0	0 X1			FE-PN
	FE-1600D_1	0	1	2...3		FE-1600D
	FE-0016N_1	0	2		2...3	FE-0016N
	FE-0016P_1	0	3		4...5	FE-0016P
	FE-0808N_1	0	4	4	6	FE-0808N
	FE-0808P_1	0	5	5	7	FE-0808P
	FE-4DA_1	0	6		68...75	FE-4DA
	FE-4ADM_1	0	7	68...83		FE-4ADM
	FE-8ADV_1	0	8	84...99		FE-8ADV
	FE-8ADI_1	0	9	100...115		FE-8ADI
	FE-4PT_1	0	10	116...131		FE-4PT
	FE-4TC_1	0	11	132...147		FE-4TC
	FE-1600D_2	0	12	6...7		FE-1600D
	FE-1600D_3	0	13	8...9		FE-1600D
	FE-0016N_2	0	14		8...9	FE-0016N
	FE-0016N_3	0	15		10...11	FE-0016N
	FE-0808P_2	0	16	10	12	FE-0808P

In the preceding figure,

1. For the FE-0808N module, the I address is 4 and the Q address is 6. According to the "Software user interface" table in section 5.5.5 Mixed digital module (sinking) FE-0808N, address %IB4 corresponds to module input data IB0, and address %QB6 corresponds to module output data QB0.

Type	Name	Type	Default	Description
Configuration parameter	IB0 Filt	uint8_t	3	[0, 255], unit: 1ms, e.g. 3 = 3ms
	QB0 Out Mode	uint8_t	0	Q00–Q07 output mode Bit0: Q00 output mode Bit1: Q01 output mode ... Bit7: Q07 output mode 0: Output preset; 1: Hold output
	QB0 Preset Value	uint8_t	0	Q00–Q07 output preset values
Input data	IB0	uint8_t	-	I00–I07 sample values
Output data	QB0	uint8_t	-	Q00–Q07 output values

2. For the FE-8ADI module, the I addresses range from 100 to 115. According to the "Software user interface" table in section 5.5.8 Analog input module FE-8ADI, address %IW100 corresponds to module input data AI0, address %IW102 corresponds to module input data AI1, ..., and address %IW114 corresponds to module input data AI7.

Type	Name	Type	Default	Description
Input data	AI0	int16_t	-	Channel sample code value
	AI1	int16_t	-	Channel sample code value
	AI2	int16_t	-	Channel sample code value
	AI3	int16_t	-	Channel sample code value
	AI4	int16_t	-	Channel sample code value
	AI5	int16_t	-	Channel sample code value

Type	Name	Type	Default	Description
	AI6	int16_t	-	Channel sample code value
	AI7	int16_t	-	Channel sample code value
Output data	-	-	-	-

3. For the FE-4TC module, the I addresses range from 132 to 147. According to the "Software user interface" table in section 5.5.11 Temperature detection module (thermocouple) FE-4TC, address %ID132 corresponds to module input data TC0 (32-bit floating point), %ID136 corresponds to TC1, …, and %ID144 corresponds to TC3.

Type	Name	Type	Default	Description
Input data	TC0	real32_t	-	Temperature sampling value
	TC1	real32_t	-	Temperature sampling value
	TC2	real32_t	-	Temperature sampling value
	TC3	real32_t	-	Temperature sampling value
Output data	-	-	-	-

6.2.1.7 Retrieving module fault status

The FE-PN coupler is a standard PROFINET slave device and it is fully compatible with the full set of diagnostic functions available in the TIA Portal for PROFINET distributed I/O systems. Its diagnostic behavior is consistent with that of other PROFINET slave devices in the system.

Viewing module faults online in TIA Portal:
After going online with the PLC, select the target device in the **Device view** interface. Double-click the red wrench icon of the faulty module on the right.
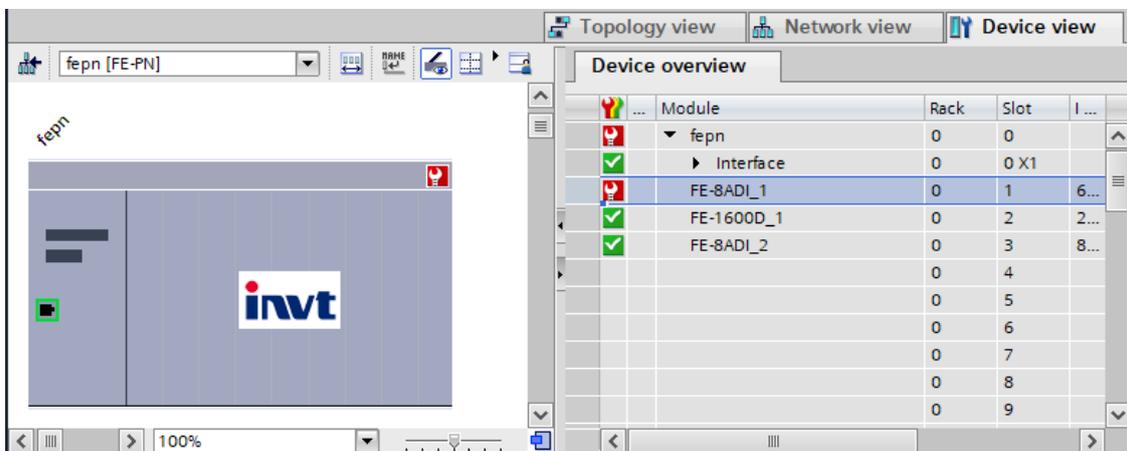
In the pop-up window, navigate to **Diagnostics** > **Diagnostic status**, where detailed fault information is displayed in the **Standard diagnostics** area.
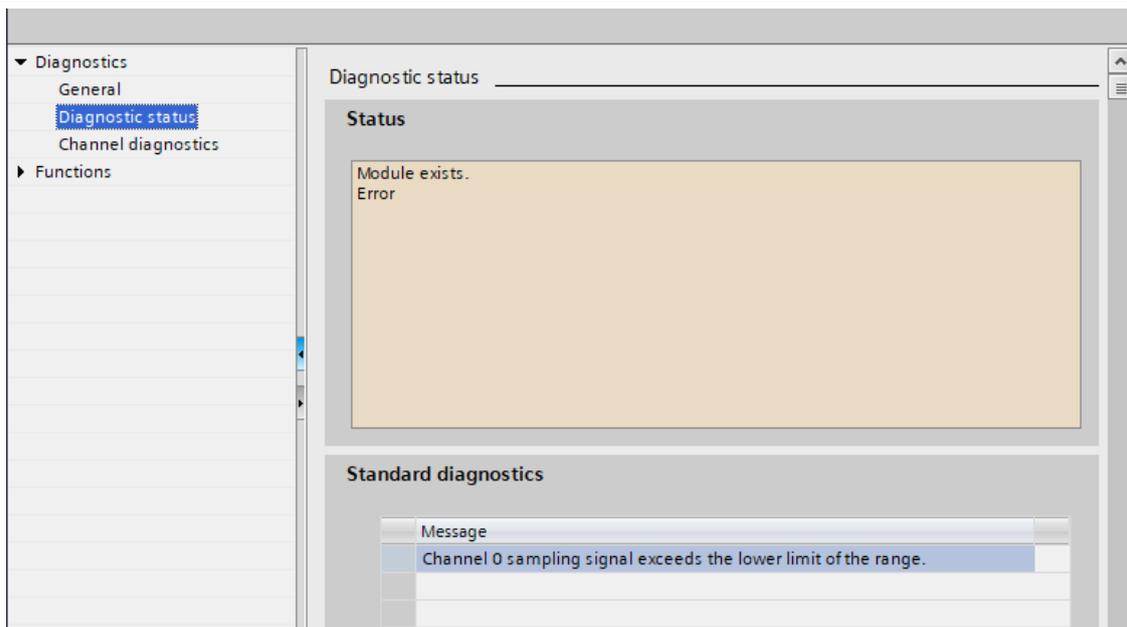
Retrieving fault status in the program:

In the TIA Portal, the **DeviceStates** instruction can be used to check whether the coupler device has a fault, and the **ModuleStates** instruction can be used to determine whether the module has a fault. The **RDREC** instruction can be used to read detailed module fault codes (RERDC[15] is the fault code described in section 8.1 Common faults and solutions).

6.2.2 STEP 7-MicroWIN SMART configuration description

6.2.2.1 Installing the device description file

Install the device description file named in the format of GSDML-V2.43-INVT-FE-PN-xxxxxxxx.xml.
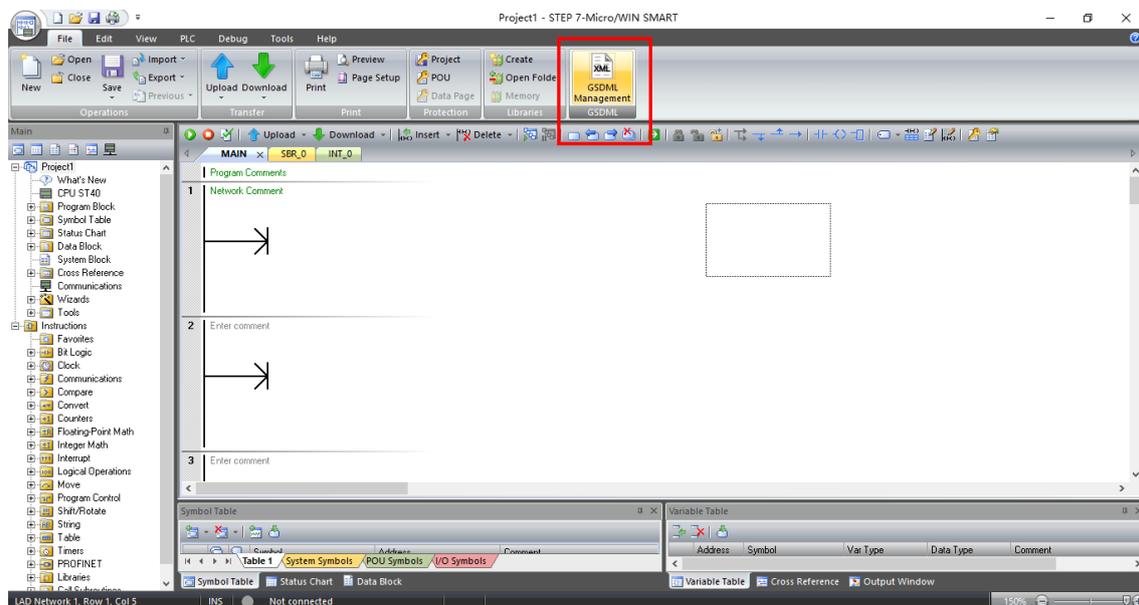
In the pop-up window, select the source path where the GSD file is located. If a verification failed dialog appears, select **Yes** to continue. After installation, the configuration file information is displayed in the project.
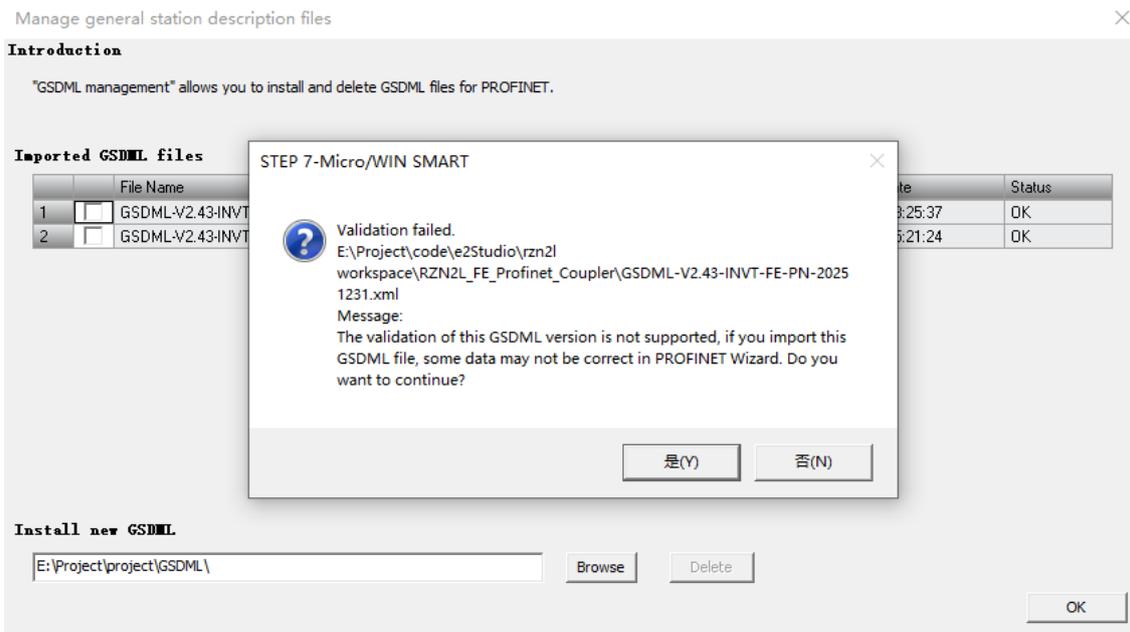
6.2.2.2 Configuring the PN device name

After completing the physical connection of the module, choose **Tools** > **Find PROFINET Devices** > **Find Devices**.
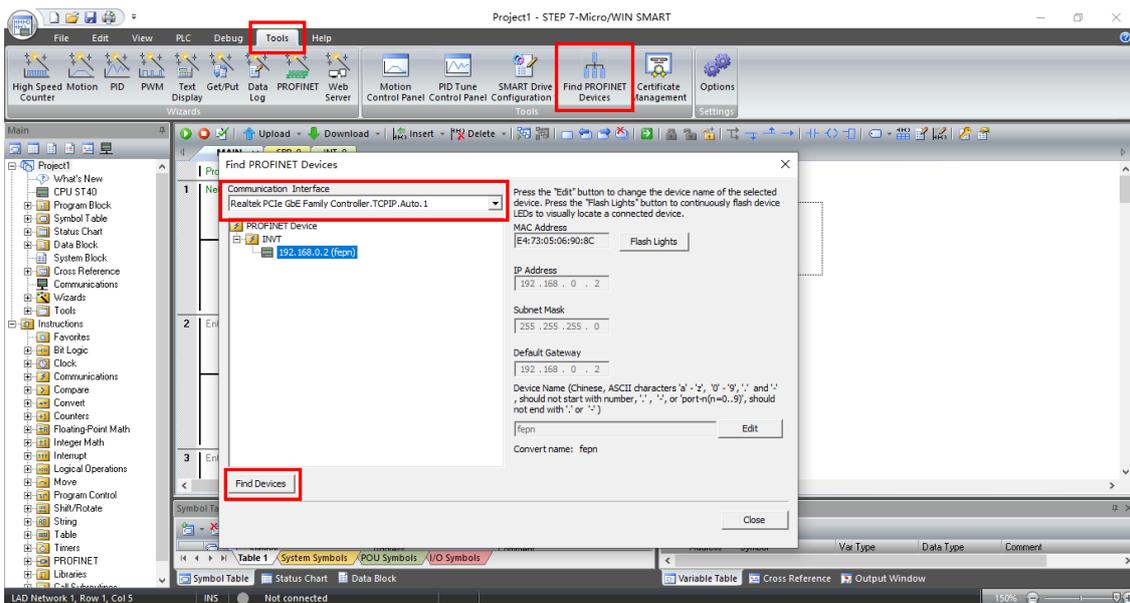
Select the refreshed PN coupler device (the device can be located by pressing the **Flash Lights** button), click **Edit**, enter the device name, and click **OK**.

✎**Note:** When **Flash Lights** is selected, the corresponding coupler RUN/ERR/SF indicators flash simultaneously.
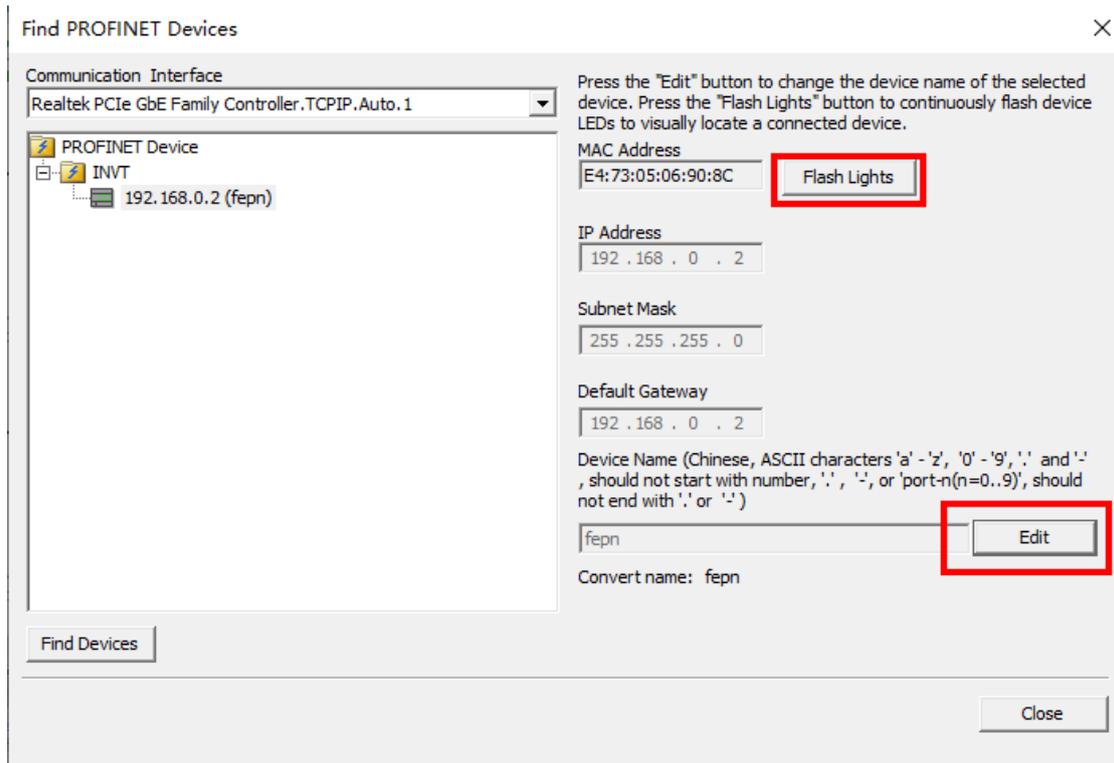
6.2.2.3 Performing network configuration

Add a coupler: Choose **Tools** > **PROFINET**, select **Controller**, enter the PLC network port information, and click **Next**.
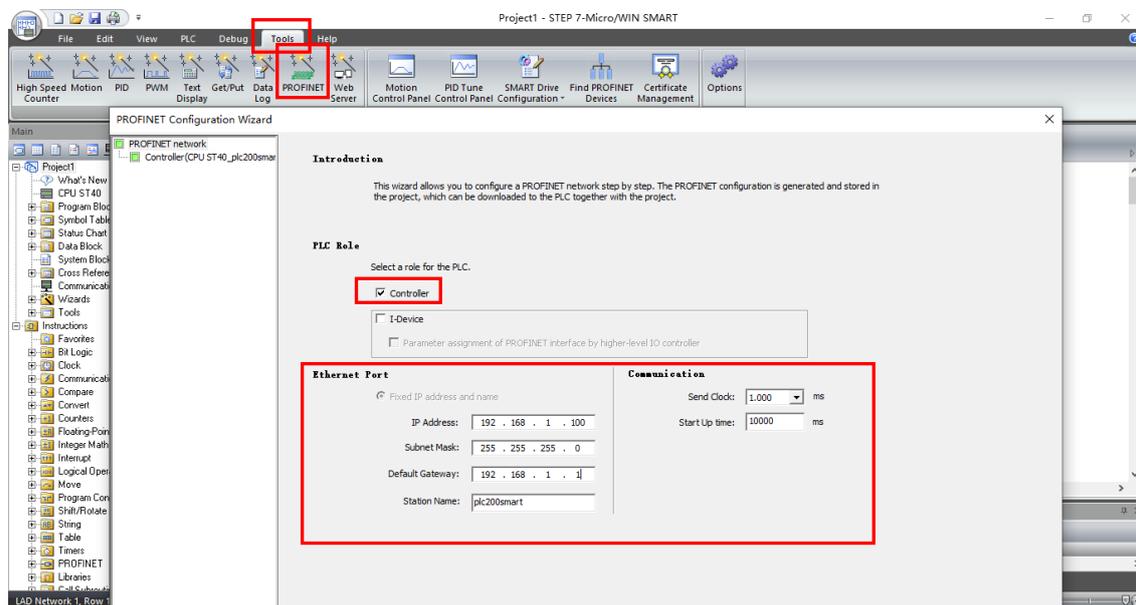
Drag the FE-PN device into the device table and configure the device name and IP address.

There are two methods to set the FE-PN device name.

- Set via a DIP switch. When the DIP switch is set to a non-zero value, the device name set via the DIP switch takes effect. For example, if the DIP switch is set to 129, the device name is fepn129.

- Set via the STEP 7-MicroWIN SMART. When the DIP switch is set to 0, the device name set via the STEP 7-MicroWIN SMART takes effect.

✏️**Note:** The set PROFINET device name must be consistent with the device name as set in section 6.2.2.2 Configuring the PN device name. When PN communication is established, devices match by device name. If device names are not consistent, devices cannot be recognized.
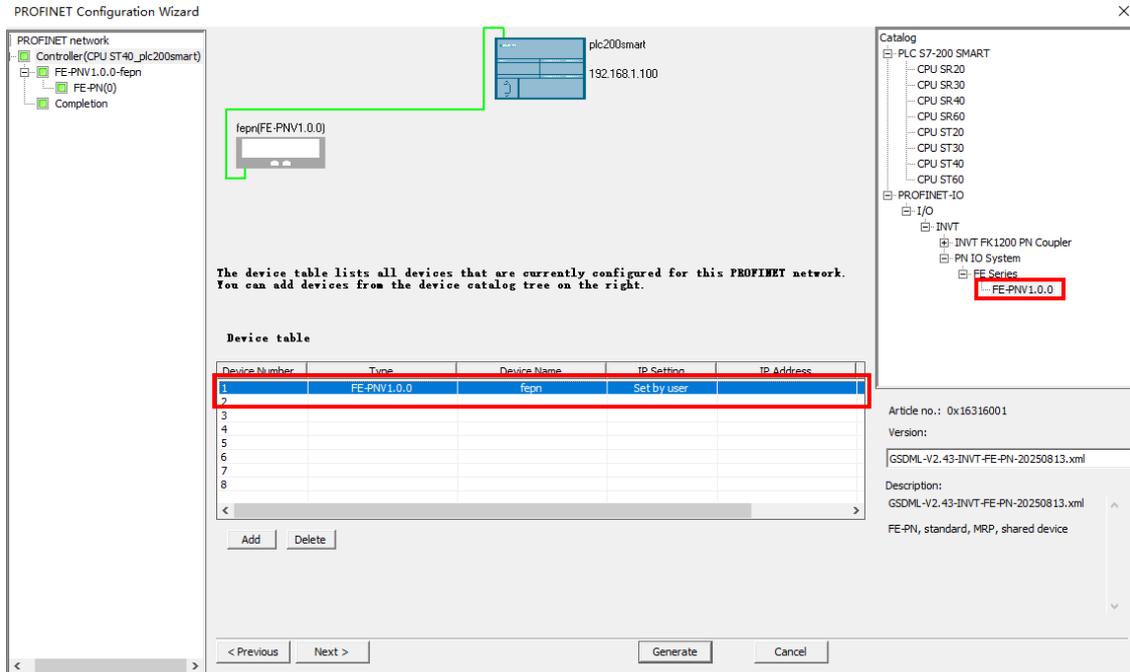
Add modules: Choose modules on the right, click **Add** or drag to add to the table. After you add the modules based on the actual configuration, click **Next** to configure the modules in order. The module configuration window can also be accessed by clicking directly on the module on the left.
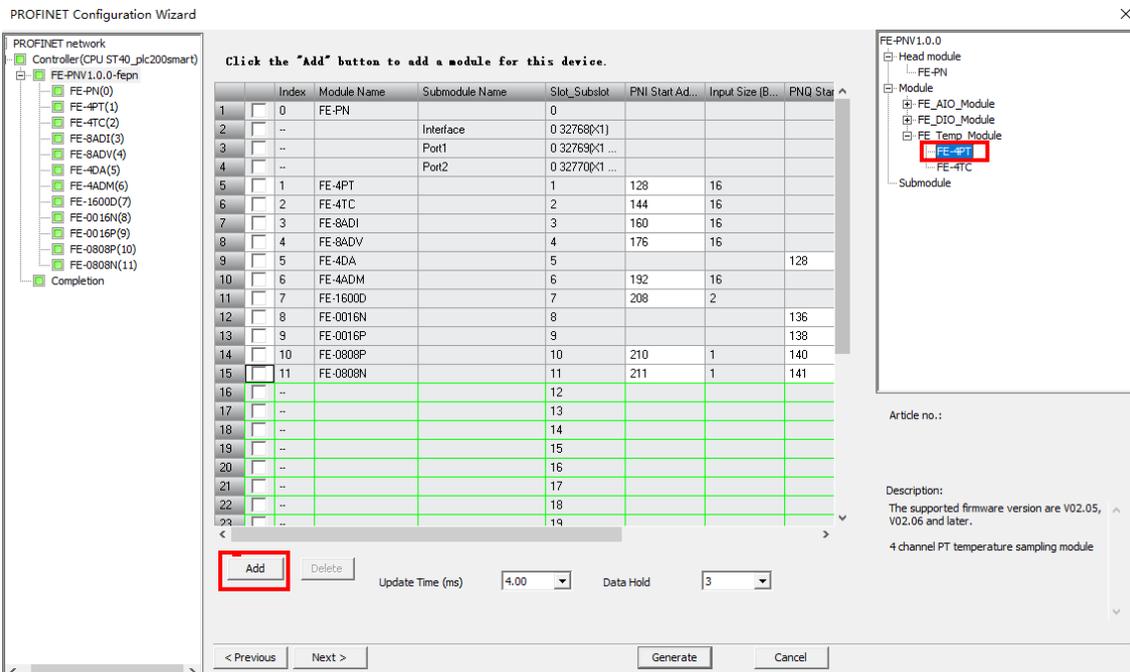
6.2.2.4 Module configuration parameter

Using FE-4ADM as an example, select the corresponding module on the left, modify the configuration parameters, and click **Generate**.
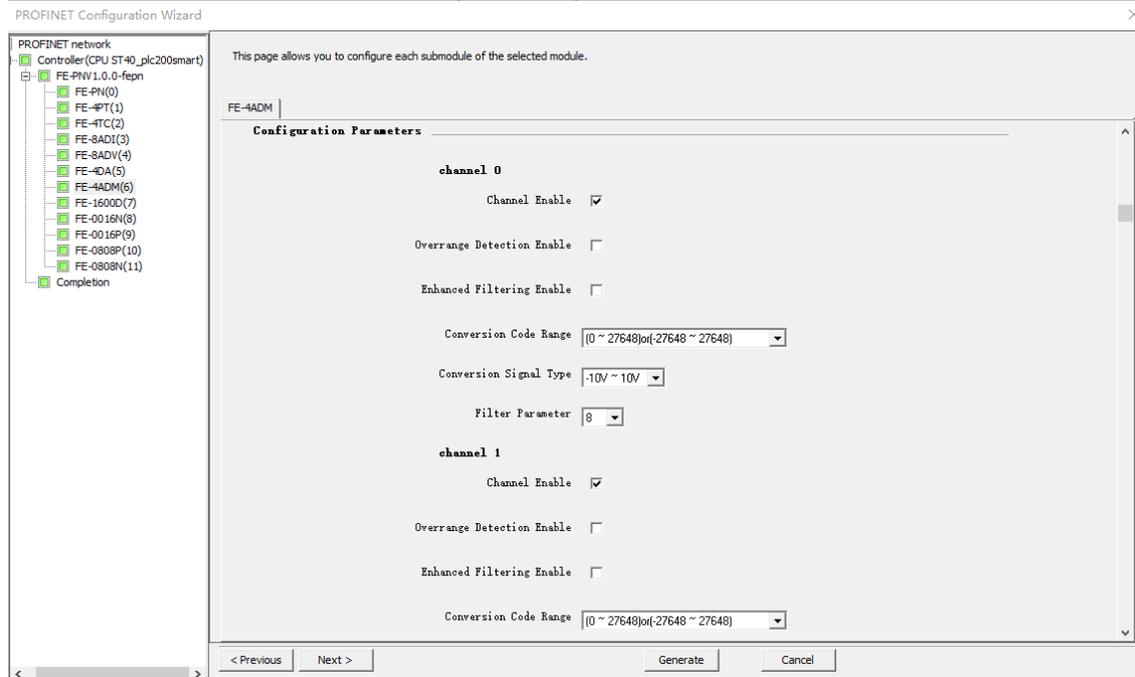
6.2.2.5 Module process data

Read and write module process data via the I and Q addresses assigned in STEP 7-MicroWIN SMART. For detailed module process data descriptions, see the "Software user interface" table of the respective module in section 5.5 I/O module.
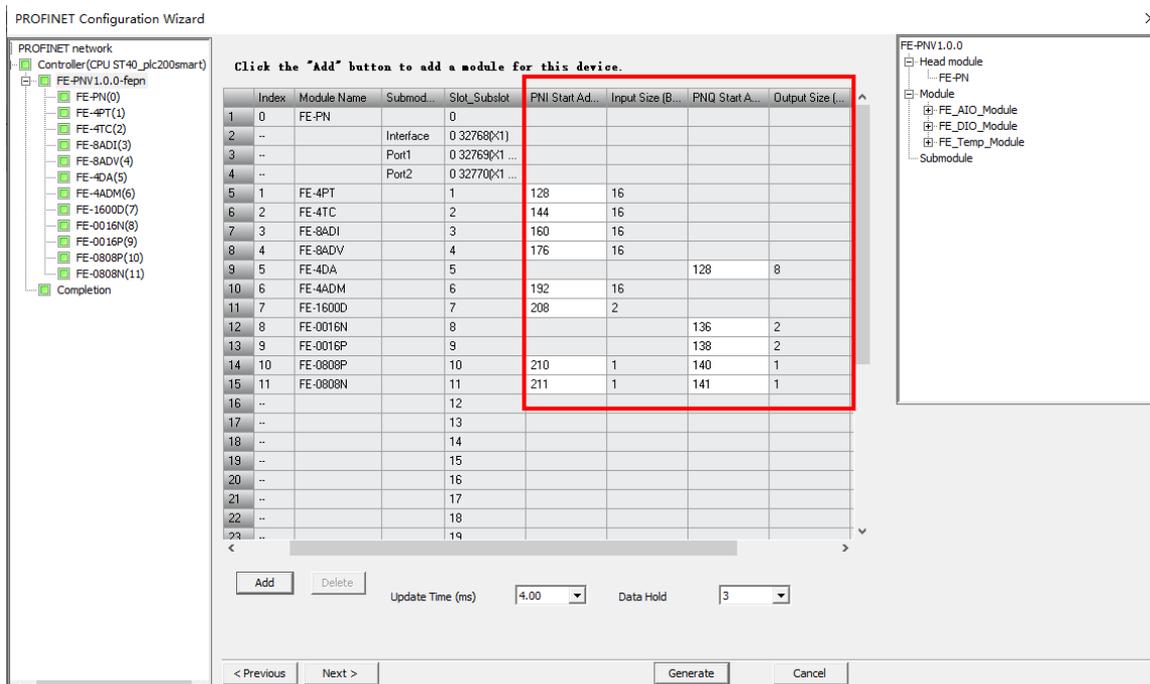
As shown in the preceding figure, for the FE-0808N module in slot 11, the I address is 211 and the Q address is 141. According to the "Software user interface" table in section 5.5 I/O module, address %IB211 corresponds to module input data IB0, and address %QB141 corresponds to module output data QB0.

Type	Name	Type	Default	Description
Configuration parameter	IB0 Filt	uint8_t	3	[0, 255], unit: 1ms, e.g. 3 = 3ms
	QB0 Out Mode	uint8_t	0	Q00–Q07 output mode Bit0: Q00 output mode

Type	Name	Type	Default	Description
				Bit1: Q01 output mode
				...
				Bit7: Q07 output mode
				0: Output preset; 1: Hold output
	QB0 Preset Value	uint8_t	0	Q00–Q07 output preset values
Input data	IB0	uint8_t	-	I00–I07 sample values
Output data	QB0	uint8_t	-	Q00–Q07 output values

6.2.2.6 Retrieving module fault status

■ **When a power supply fault occurs on 0808DN**

Click **PLC** under the PLC directory, and click the PN device name **fepn**. You can monitor the module status faults, and corresponding fault information is also available in **Event logs** and **PROFINET** alarms.

Special memory: When the 11th 0808N module has a power supply fault, SMB1800 = 16#82 and SMB1809.3 = 1.

After clearing the module fault, the errors in **fepn** and **PRIFINET alarms** are cleared; the event log remains unchanged; the error value in the special memory is set to zero.

■ **When the PN device is disconnected**

Click **PLC** under the **PLC** directory, and click the PN device name **fepn**. You can monitor the device status faults and corresponding fault information is also available in **Event logs** and **PROFINET alarms**.

7 Ttools-IO operating instructions

7.1 Overview

This chapter describes the use of the host commissioning tool to ensure stable and reliable operation of the I/O system, and to facilitate rapid identification and resolution of issues during commissioning and operation. This content is intended for commissioning engineers, system integrators, and maintenance engineers with basic knowledge of automation systems.

7.2 Coupler series selection

When starting the software, select the corresponding option for the coupler series to be connected, and click **Next** to load the interface for that series.

The switching function of the coupler **M** key is described as follows:

Procedure for entering the host configuration mode:

Method 1　　Press and hold the M key before power-on. After the power-on, release the M key when all indicators (except the Power indicator) flash simultaneously to enter the host configuration mode.

Method 2　　After the coupler is operating normally, press and hold the **M** key until all indicators (except the Power indicator) flash simultaneously, then release the key to enter host PC configuration mode.

How to enter the normal mode:

Method 1　　Power on without pressing the **M** key. The normal mode is entered.

Method 2　　There are two ways to enter the normal mode from the host configuration mode: one is to re-power on without pressing **M**; the other is to press and hold **M** until all status indicators (except the Power indicator) flash simultaneously, then release the key so that the coupler performs a software reset and enters the normal mode.

To enter the TTools-IO configuration mode from the normal mode, refer to the procedures described above

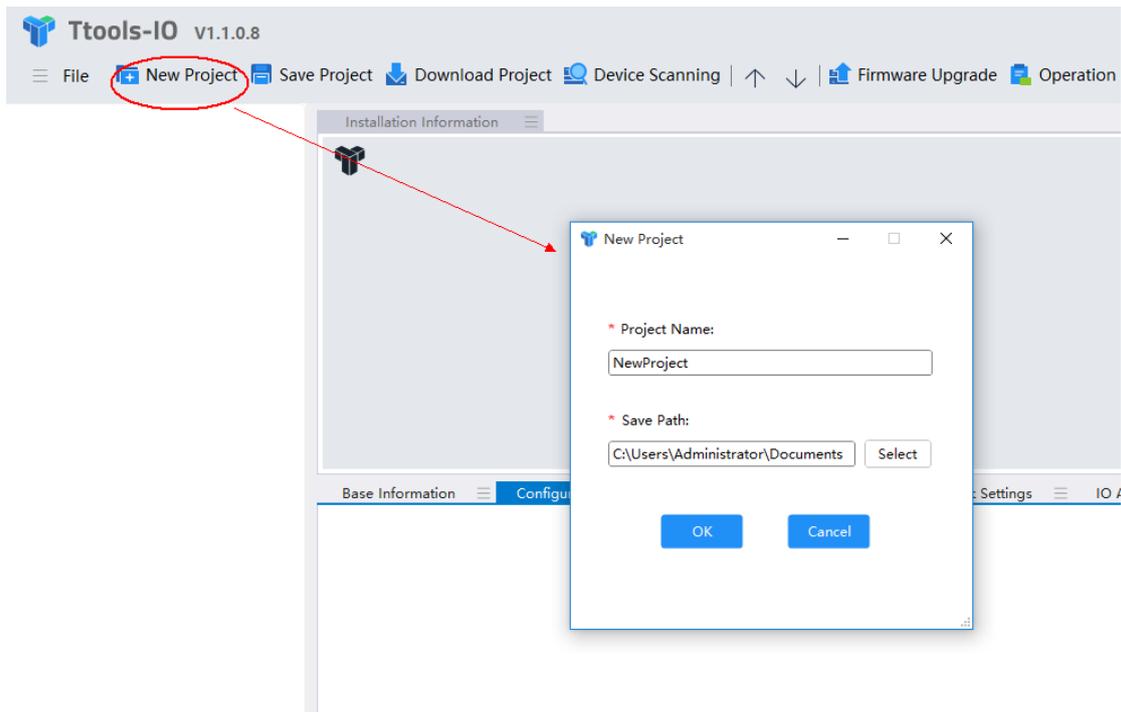for entering the host configuration mode.

7.3 Module identification and project configuration

7.3.1 Creating and opening a project
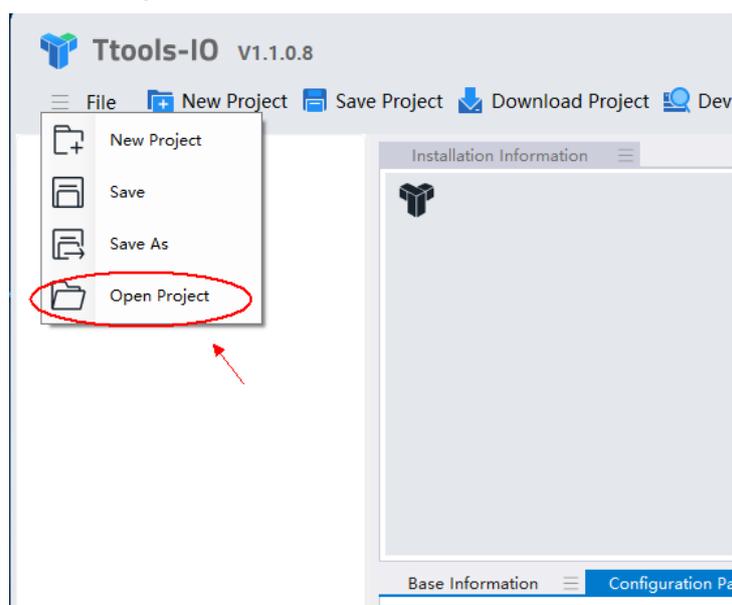
■   **Creating a project**

Step 1 Click **New Project** in the menu bar. The **New Project** window is displayed.

Step 2 Enter the project name and select the save path, and click **OK**. A project is created.
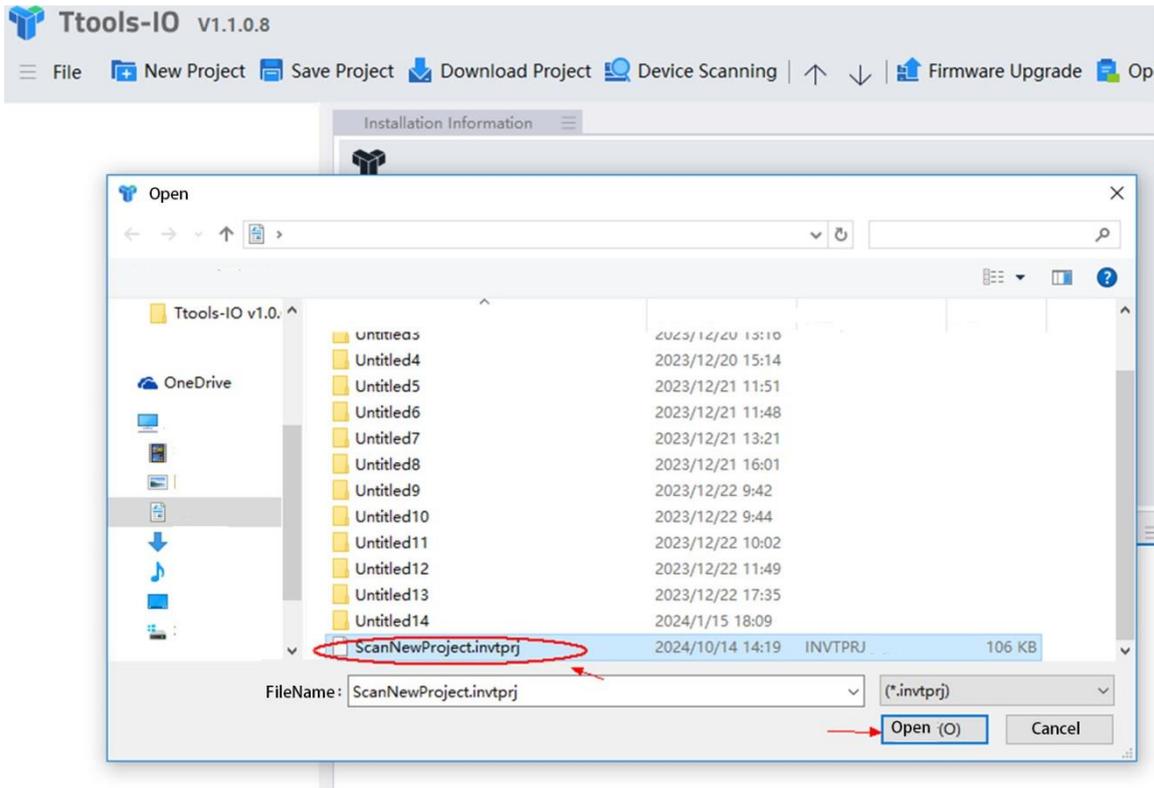

■   **Opening a project**

Step 1 Choose **File** > **Open Project**.

Step 2 In the dialog that appears, select the project to open and click **Open** to load the project.

7.3.2 Module scan and configuration verification

Click **Device Scanning**. In the **Device Scanning** window, select the network adapter connected to the coupler, then start scanning for devices. Currently, only a single-coupler configuration is supported. After the device IP address is discovered, connect to the corresponding device. If the connection is successful, the corresponding area is displayed in light green. Then click **Get Config**. The coupler and I/O module can be loaded.
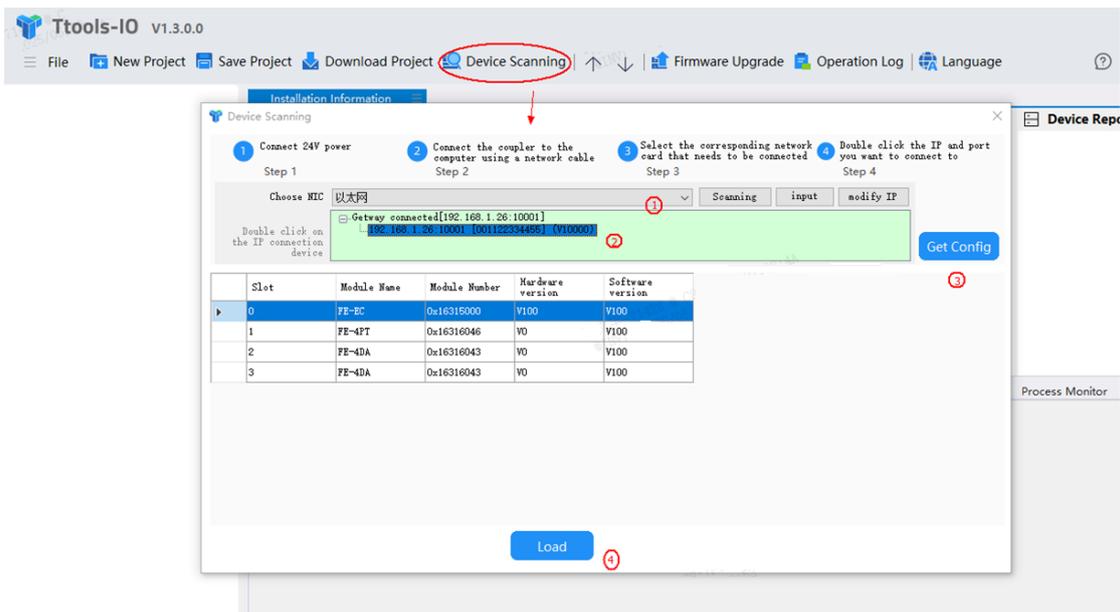
After the scan is complete, you can click the **Load** button to load it into the project, thereby creating a project that can be saved and facilitating subsequent operations such as parameter editing and download.
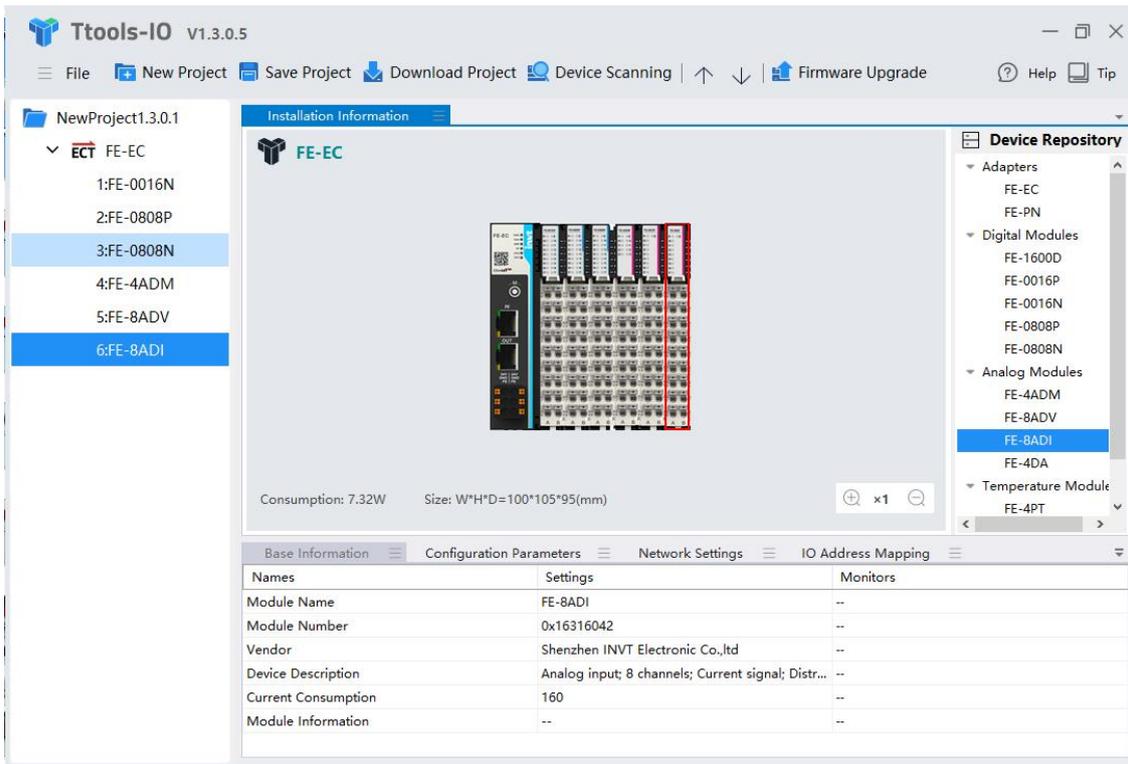
### 7.3.3 Module management

■ **Adding a module**

To add a module, double-click the corresponding module in the device library or drag the module into the software view.
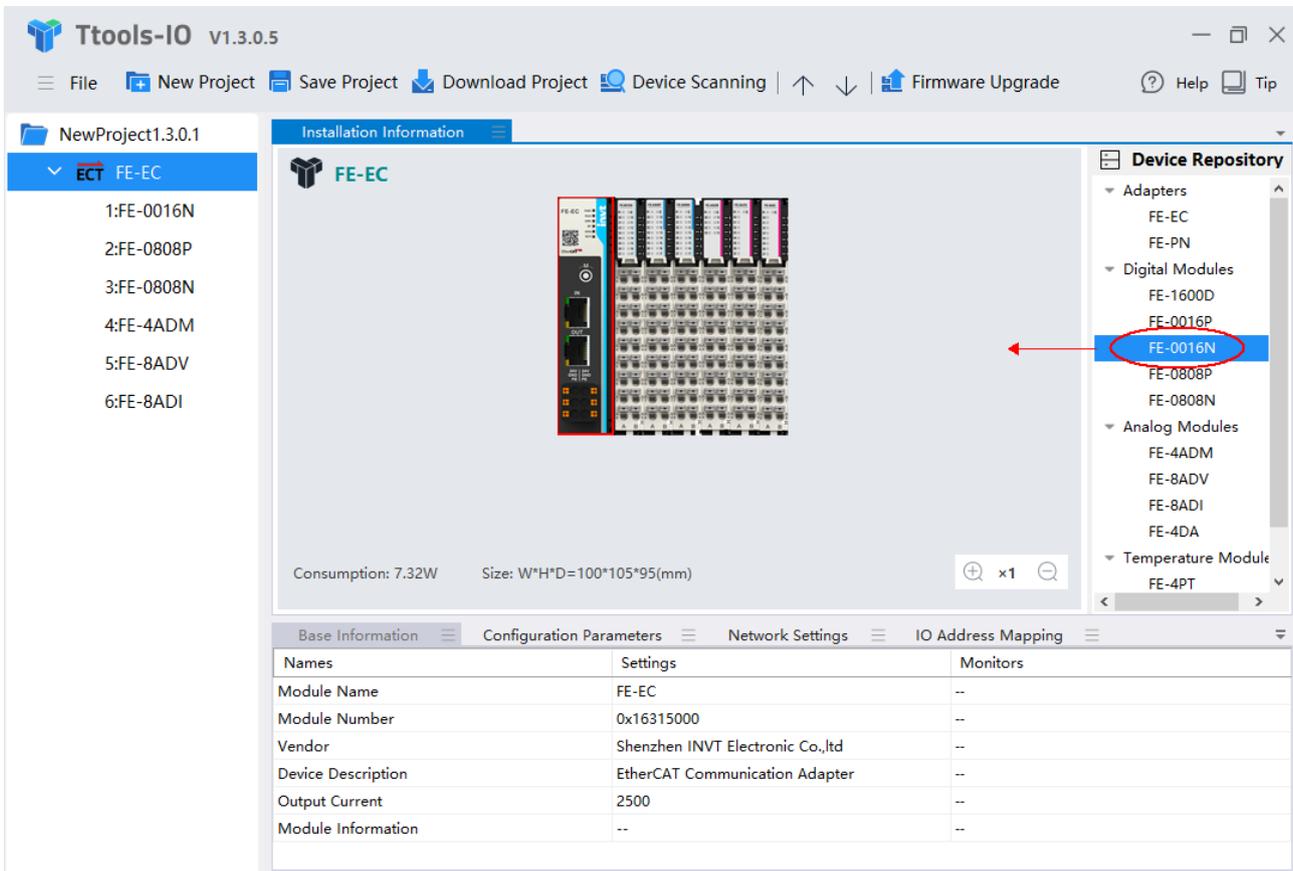
■ **Adjusting module order**

When a module is selected in the project tree, the module order can be adjusted using the Up and Down arrow keys.

When a module is selected in the installation information configuration window, the module order can be adjusted using the Left and Right arrow keys or using the right-click shortcut menu.
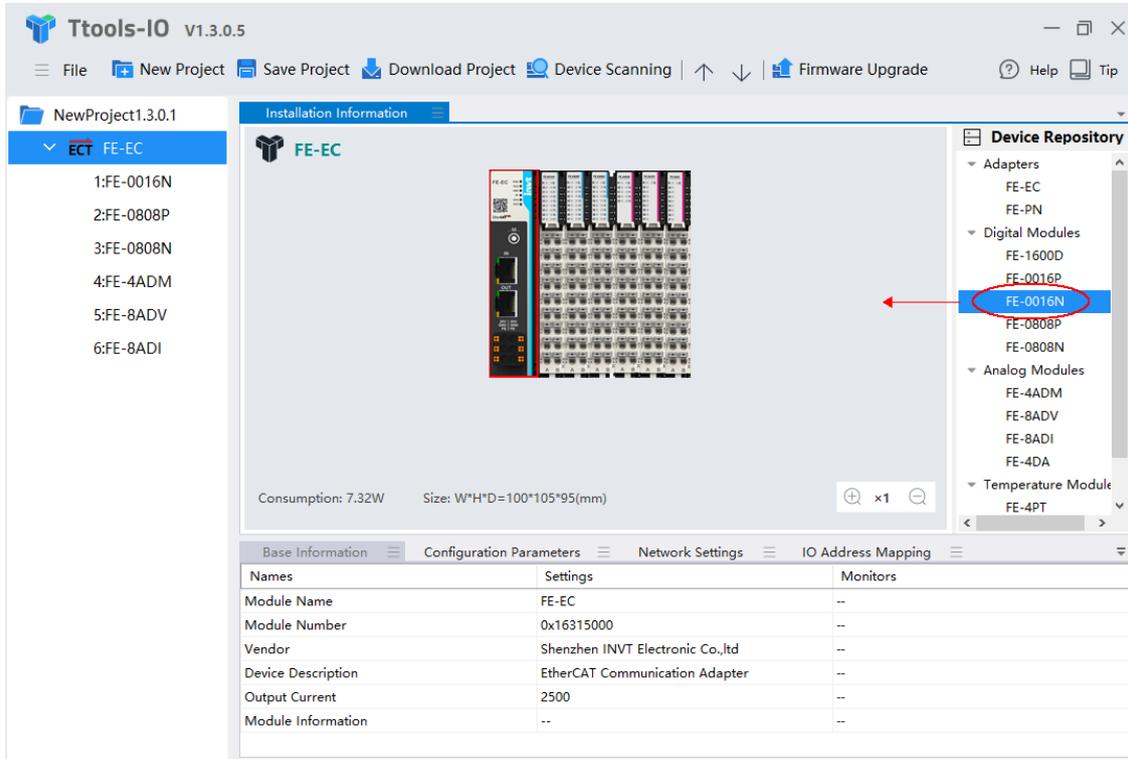
■ **Deleting a module**

When a module is selected in the project tree, the module can be deleted using the keyboard Delete key or using the right-click shortcut menu.

When a module is selected in the installation information configuration window, the module can be deleted using the right-click shortcut menu.
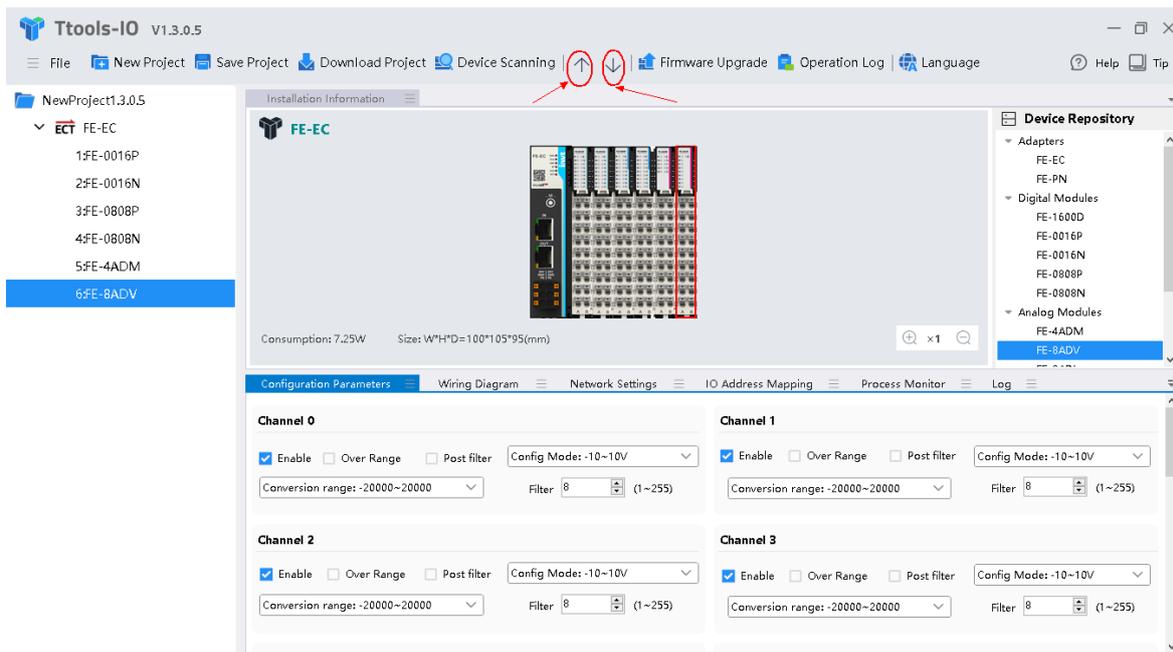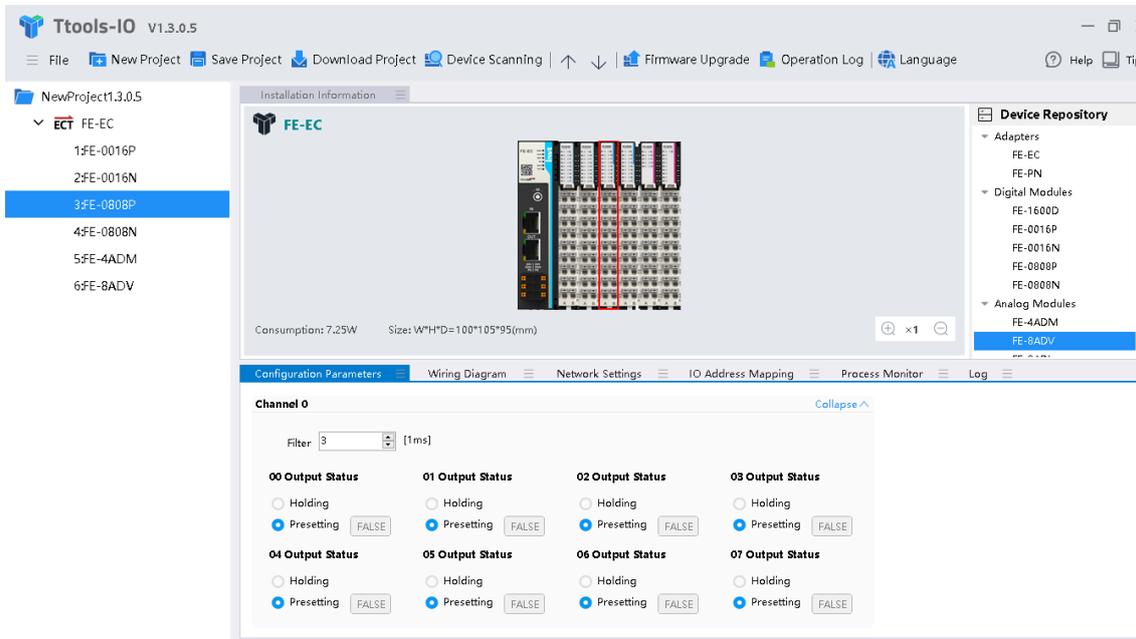
7.4 Parameter configuration and download

■ **Editing parameters**

After selecting a module or installation information in the project tree, click the **Configuration Parameters** tab to edit the module's parameters.

Save the project promptly after completing the edits to prevent data loss.

■ **Downloading project parameters**

In the project tree, select the coupler to which you want to download parameters. Click **Download Project** in the menu bar to download the parameters to the coupler. If the operation is successful, a message box is displayed.
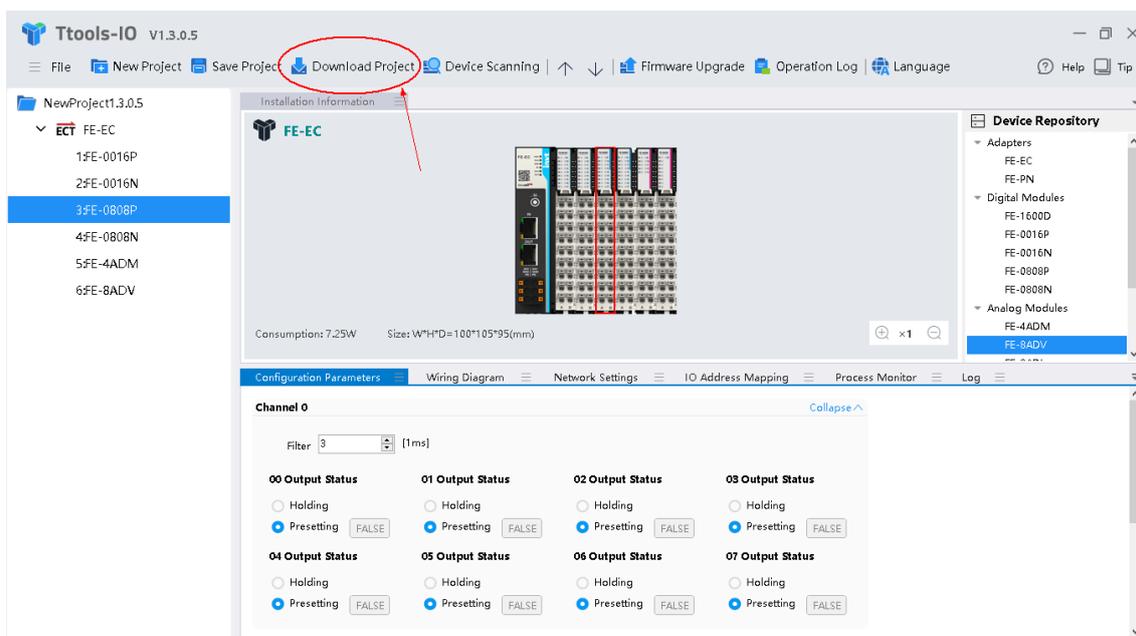

If the selected coupler is not configured with a connection method, the **Network Device Connection** window appears. After configuration, it continues with parameter download; upon successful completion, a message box is displayed.

7.5 Firmware management and log monitoring

7.5.1 Coupler and module firmware upgrade

Choose **Firmware Upgrade** from the menu bar, and select the target device in the window that appears. If the IP address does not connect automatically, check whether the device is connected correctly and the IP address is configured in the same subnet. If the device has been configured, the connected IP address is automatically loaded when the interface is displayed. If the connection is disconnected after being established, reconnect the device as illustrated in the figure.
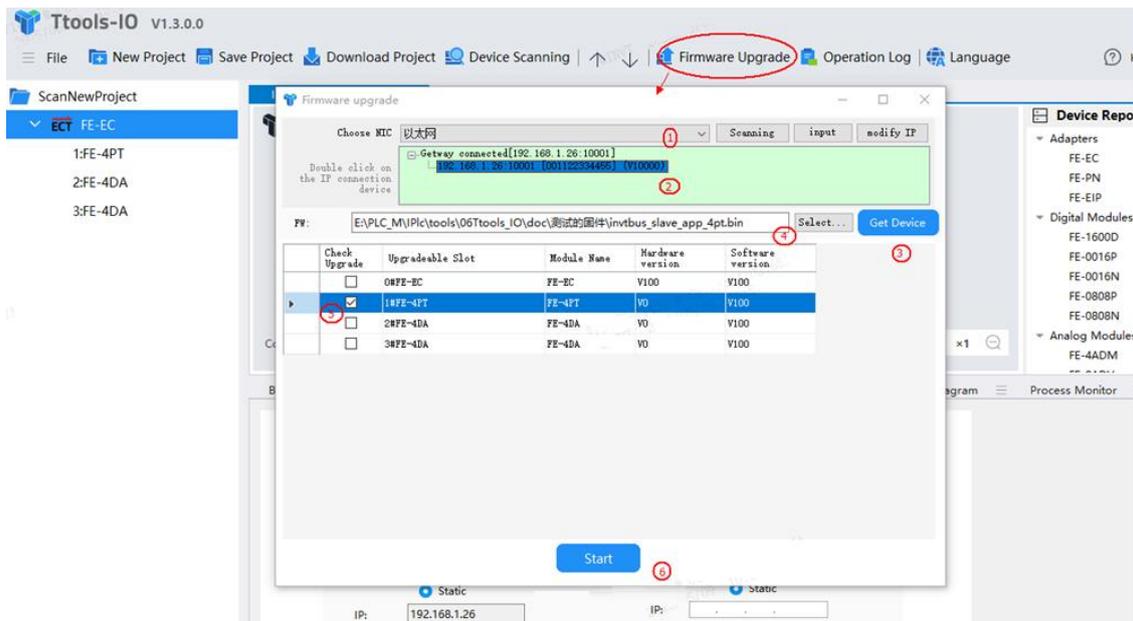

Module firmware upgrade supports batch operation only for modules of the same type. After the upgrade, a power cycle is required. Module firmware upgrade is performed on the modules connected downstream of the coupler. Choose **Firmware Upgrade** > **Module Firmware Upgrade** from the menu bar. Follow the prompts to connect the coupler, select the corresponding serial port, and retrieve the physical configuration for display in the interface.
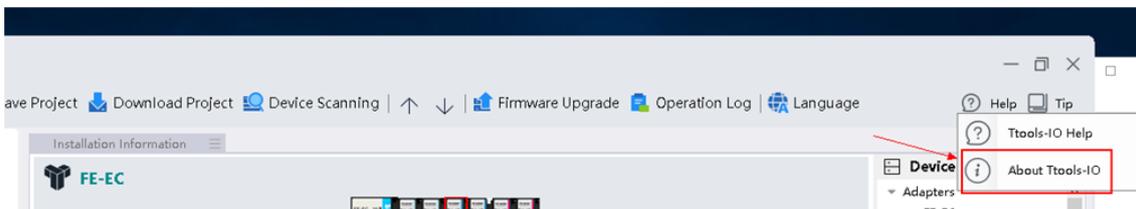
7.5.2 Log viewing and updating

■ **Viewing logs**

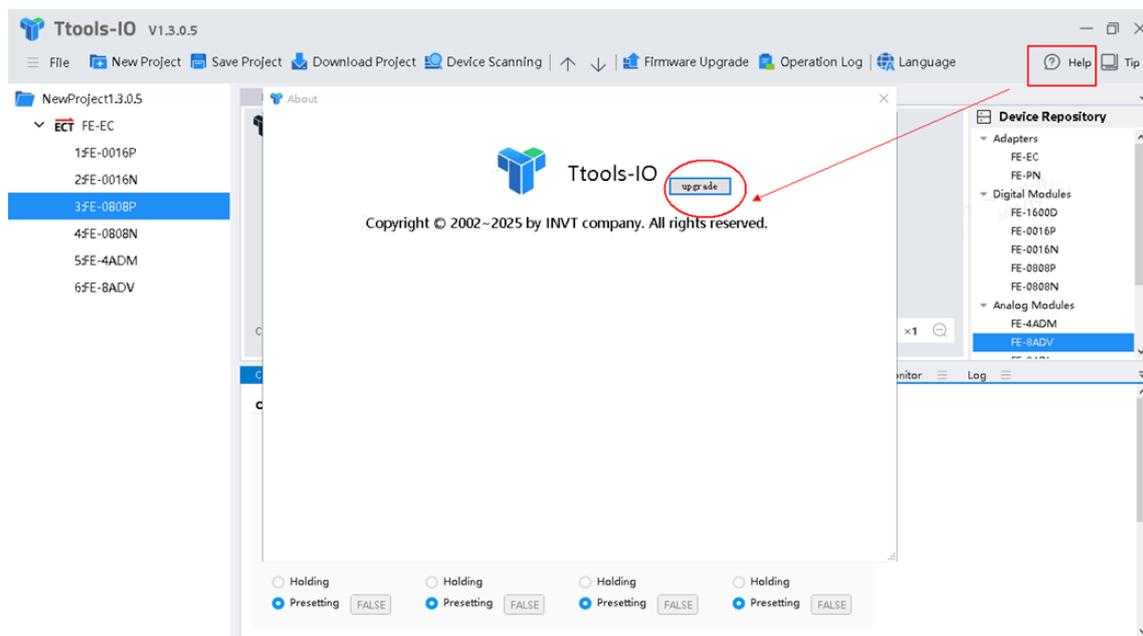Logs record operational events such as parameter changes and module connections.
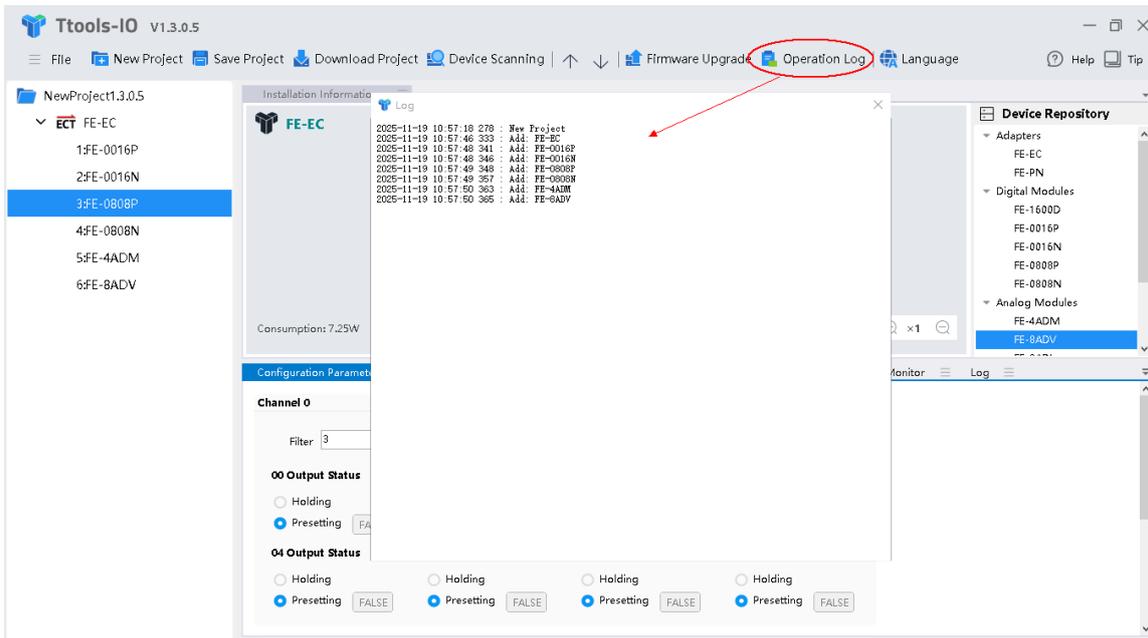
■ **Checking for updates**

You can find the latest version information online under **About Ttools-IO**.

If an update is available, you will be prompted to update. Follow the on-screen instructions to download and install.
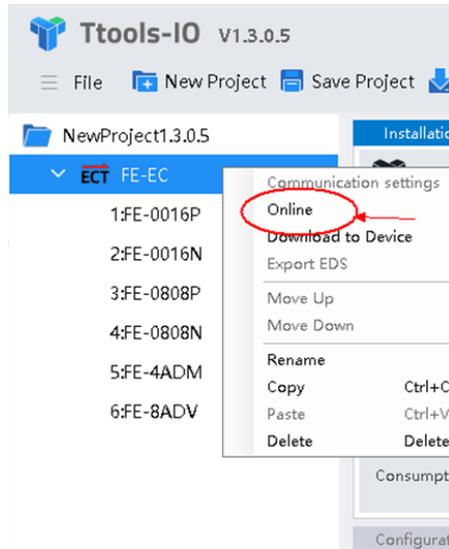
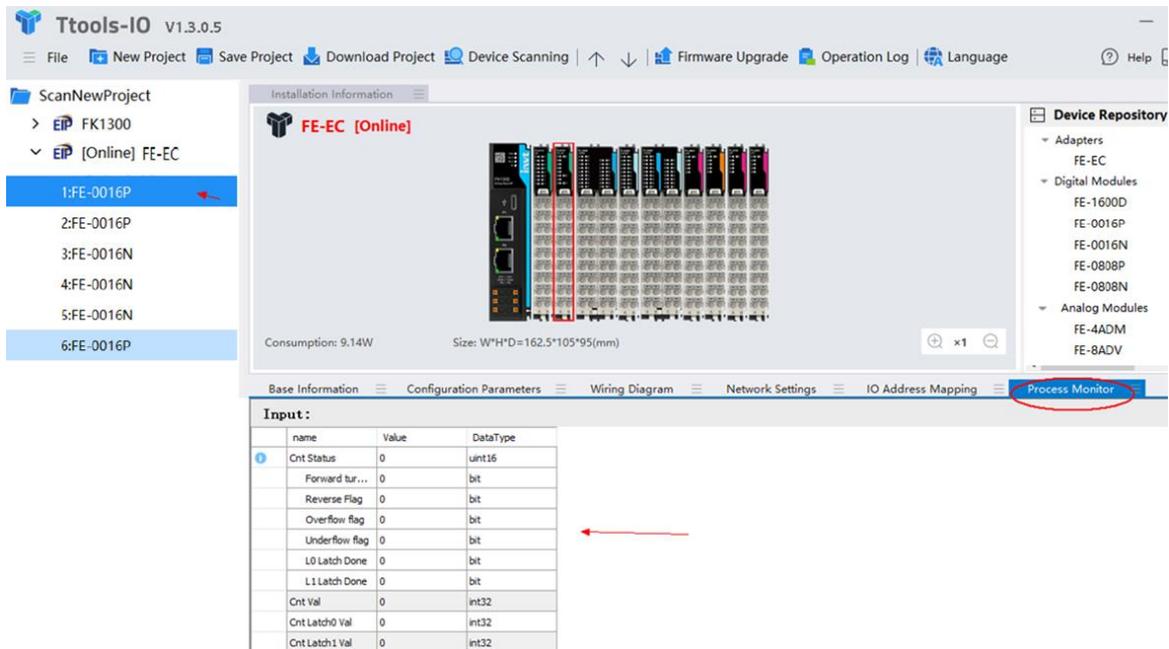# 7.6 Online monitoring and signal diagnostics

7.6.1 Starting and exiting online monitoring

■   **Starting online monitoring**

Right-click the coupler in the project tree and choose **Online** to start online monitoring.

If no communication is established for the device, a connection dialog box appears for you to set the connection type.

After selecting the module to monitor, you can view the corresponding actual values in the **Value** column.
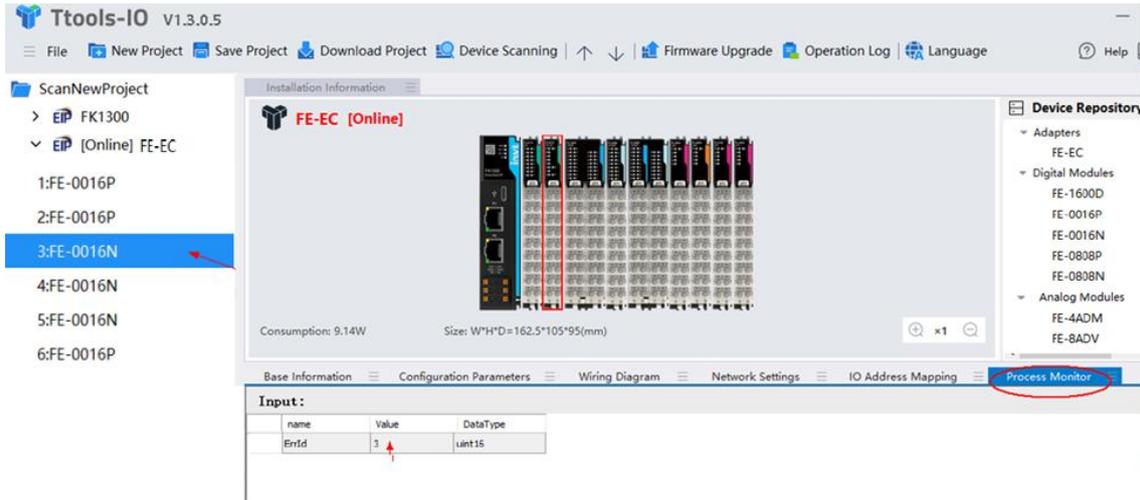
■   **Exiting online monitoring**
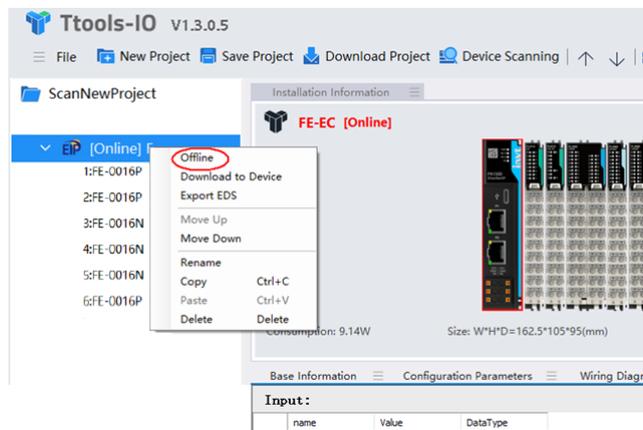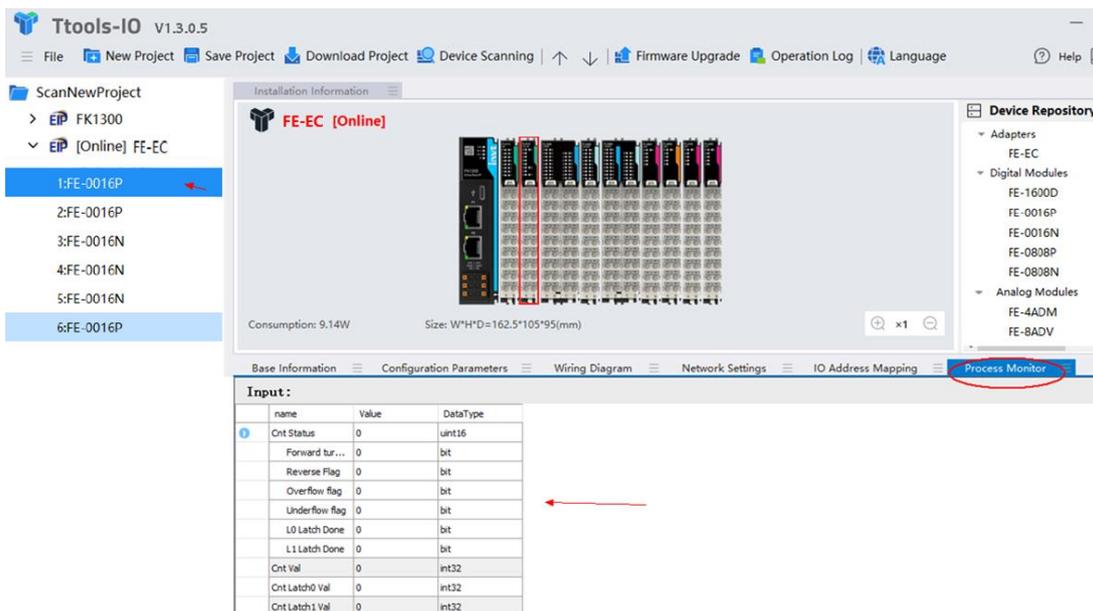
Right-click the coupler/module in the project tree and choose **Offline** to stop online monitoring.

7.6.2 Data reading and signal verification

In online mode, select the module to view the real-time status values of input and output.

7.7 Typical commissioning cases

☑Case 1: The system cannot enter the OP state after module replacement

Symptom:

After a DO module is replaced, the communication coupler RUN indicator flashes after system startup, and the system fails to enter the OP state.

Troubleshooting process:

1. Checking object dictionary 0xF050 shows that the actual identification code of slot 1 has changed.
2. The identification code is compared with the 0xF030 identification code configured on the master, and a mismatch is found.
3. Check whether the module model has been replaced.

Solution:

● Rescan the module configuration on the master.

● Verify that the identification code has been updated.

● Write the new configuration identification code to 0xF030.

● Download the configuration and perform a power cycle.

☑Case 2: Incorrect module order results in configuration validation failure

Symptom:

After the project is downloaded, the system reports an error. The communication coupler SF indicator flashes, and the module operation fails.

Troubleshooting process:

1. Check object dictionary 0xF050 and verify that the identification code order of the modules in slots 2 and 3 does not match the expected configuration.
2. Check whether the actual installation order is inconsistent with the configuration in the master project, indicating that the module positions are reversed.

Solution:

● Remove the modules and adjust their physical order to match the project configuration.

● Ensure a one-to-one correspondence between the slot positions and the configuration indices (0xF030).

● Restart the coupler, after which the system successfully enters the OP state.

☑Case 3: Module scan failure results in an empty identification code

Symptom:

The master fails to scan the modules. The log indicates that identification codes are missing for some slots, and the corresponding sub index values in object dictionary 0xF050 are 0x00000000.

Troubleshooting process:

1. Check the connection status of the downstream modules connected to the communication coupler.
2. Check the power supply output and find that the supply voltage is below 18V, preventing the modules from powering on properly.
3. Replace the power supply, after which normal operation is restored.

Solution:

● Ensure that the power supply output is ≥ 24V and remains stable.

● Power on the system again, allowing the identification codes to be automatically written to 0xF050.

Rescan the modules on the master and update the configuration.

8 Troubleshooting

For the method of retrieving module faults, refer to the respective master station fault retrieving sections in chapter 6 Coupler use instructions.

8.1 Common faults and solutions

Fault code (decimal)	Fault code (hexadecimal)	Fault type	Solution
General module fault			
1	0x0001	Module configuration fault	Check whether the network configuration corresponds to the physical configuration of the module
2	0x0002	Incorrect module parameter setting	Check whether the module parameter settings are correct; reconfigure as described in the manual.
3	0x0003	Module output port power supply fault	Measure the supply voltage at the module output port to check whether it is normal. Check whether the power supply module or the wiring is loose or disconnected.
4	0x0004	Module output fault	Check whether the load connected to the module output port exceeds the rated specifications.
Parameter configuration fault			
18	0x0012	Incorrect parameter setting for channel 0	Check whether the parameter settings for channel 0 are within the permissible range; reconfigure as described in the manual.
34	0x0022	Incorrect parameter setting for channel 1	Same as above; check the parameter configuration for channel 1.
50	0x0032	Incorrect parameter setting for channel 2	Same as above; check the parameter configuration for channel 2.
66	0x0042	Incorrect parameter setting for channel 3	Same as above; check the parameter configuration for channel 3.
82	0x0052	Incorrect parameter setting for channel 4	Same as above; check the parameter configuration for channel 4.
98	0x0062	Incorrect parameter setting for channel 5	Same as above; check the parameter configuration for channel 5.
114	0x0072	Incorrect parameter setting for channel 6	Same as above; check the parameter configuration for channel 6.
130	0x0082	Incorrect parameter setting for channel 7	Same as above; check the parameter configuration for channel 7.
Output fault			
20	0x0014	Output fault on channel 0	Measure the output terminal voltage/current of channel 0 to check whether it is normal. Check whether the load is short-circuited (resistance too low) or open-circuited

Fault code (decimal)	Fault code (hexadecimal)	Fault type	Solution
			(disconnected).
36	0x0024	Output fault on channel 1	Same as above; check the output of channel 1.
52	0x0034	Output fault on channel 2	Same as above; check the output of channel 2.
68	0x0044	Output fault on channel 3	Same as above; check the output of channel 3.
84	0x0054	Output fault on channel 4	Same as above; check the output of channel 4.
100	0x0064	Output fault on channel 5	Same as above; check the output of channel 5.
116	0x0074	Output fault on channel 6	Same as above; check the output of channel 6.
132	0x0084	Output fault on channel 7	Same as above; check the output of channel 7.
Signal source open-circuit fault			
21	0x0015	Signal source open circuit fault on channel 0	Check whether the physical connection of the signal source (such as sensors or input devices) for channel 0 is secure, and eliminate any open-circuit conditions.
37	0x0025	Signal source open circuit fault on channel 1	Same as above; check the signal source for channel 1.
53	0x0035	Signal source open circuit fault on channel 2	Same as above; check the signal source for channel 2.
69	0x0045	Signal source open circuit fault on channel 3	Same as above; check the signal source for channel 3.
85	0x0055	Signal source open circuit fault on channel 4	Same as above; check the signal source for channel 4.
101	0x0065	Signal source open circuit fault on channel 5	Same as above; check the signal source for channel 5.
117	0x0075	Signal source open circuit fault on channel 6	Same as above; check the signal source for channel 6.
133	0x0085	Signal source open circuit fault on channel 7	Same as above; check the signal source for channel 7.
Sampling signal out-of-range fault			
22	0x0016	Sampling signal limit exceeding fault on channel 0	Check whether the sampling signal of channel 0 exceeds the maximum or minimum input value permitted by the chip. Adjust the signal source or the attenuation circuit accordingly.
38	0x0026	Sampling signal limit exceeding fault on channel 1	Same as above; check the sampling signal of channel 1.
54	0x0036	Sampling signal limit exceeding fault on channel 2	Same as above; check the sampling signal of channel 2.
70	0x0046	Sampling signal limit exceeding fault on	Same as above; check the sampling signal of channel 3.

Fault code (decimal)	Fault code (hexadecimal)	Fault type	Solution
		channel 3	
86	0x0056	Sampling signal limit exceeding fault on channel 4	Same as above; check the sampling signal of channel 4.
102	0x0066	Sampling signal limit exceeding fault on channel 5	Same as above; check the sampling signal of channel 5.
118	0x0076	Sampling signal limit exceeding fault on channel 6	Same as above; check the sampling signal of channel 6.
134	0x0086	Sampling signal limit exceeding fault on channel 7	Same as above; check the sampling signal of channel 7.
Sampling signal overrange (upper limit) fault			
23	0x0017	Sampling signal measurement upper limit exceeding fault on channel 0	Check whether the sampled value of channel 0 exceeds the configured upper limit. Adjust the measurement range or the signal source output accordingly.
39	0x0027	Sampling signal measurement upper limit exceeding fault on channel 1	Same as above; check the sampling signal of channel 1.
55	0x0037	Sampling signal measurement upper limit exceeding fault on channel 2	Same as above; check the sampling signal of channel 2.
71	0x0047	Sampling signal measurement upper limit exceeding fault on channel 3	Same as above; check the sampling signal of channel 3.
87	0x0057	Sampling signal measurement upper limit exceeding fault on channel 4	Same as above; check the sampling signal of channel 4.
103	0x0067	Sampling signal measurement upper limit exceeding fault on channel 5	Same as above; check the sampling signal of channel 5.
119	0x0077	Sampling signal measurement upper limit exceeding fault on channel 6	Same as above; check the sampling signal of channel 6.
135	0x0087	Sampling signal measurement upper limit exceeding fault on channel 7	Same as above; check the sampling signal of channel 7.
Sampling signal underrange (lower limit) fault			

Fault code (decimal)	Fault code (hexadecimal)	Fault type	Solution
24	0x0018	Sampling signal measurement lower limit exceeding fault on channel 0	Check whether the sampled value of channel 0 is below the configured lower limit. Adjust the measurement range or the signal source output accordingly.
40	0x0028	Sampling signal measurement lower limit exceeding fault on channel 1	Same as above; check the sampling signal of channel 1.
56	0x0038	Sampling signal measurement lower limit exceeding fault on channel 2	Same as above; check the sampling signal of channel 2.
72	0x0048	Sampling signal measurement lower limit exceeding fault on channel 3	Same as above; check the sampling signal of channel 3.
88	0x0058	Sampling signal measurement lower limit exceeding fault on channel 4	Same as above; check the sampling signal of channel 4.
104	0x0068	Sampling signal measurement lower limit exceeding fault on channel 5	Same as above; check the sampling signal of channel 5.
120	0x0078	Sampling signal measurement lower limit exceeding fault on channel 6	Same as above; check the sampling signal of channel 6.
136	0x0088	Sampling signal measurement lower limit exceeding fault on channel 7	Same as above; check the sampling signal of channel 7.
Hardware fault			
257	0x0101	Module hardware fault - SPI timeout	Contact the manufacturer.
258	0x0102	Module hardware fault - Output Ready not asserted	Contact the manufacturer.

9 Inspection and maintenance

9.1 Daily inspection and regular maintenance

The machine internal components will become aging due to the influence of environmental temperature, humidity, dust, vibration and other factors, which causes the potential failure or shortens the service life. Therefore, to extend the machine service life and prevent safety hazards, daily inspection and regular maintenance are required.

| Check item	Content	Method
Daily inspection: Recommended on each day.		
Ambient environment	Whether the ambient temperature, humidity, vibration, dust, gas, and oil are too great, and whether there is condensation or water droplets inside and outside the machine	Visual inspection and instrument measurement
	Whether there are foreign matters, such as tools, or dangerous substances placed nearby	Visual inspection
Power voltage	Check whether supply voltage is abnormal.	Multimeter or voltage meter
Indicator	Whether display is clear	Visual inspection
	Whether some characters or fields are displayed incompletely	Visual inspection
Regular maintenance: Recommended on a quarterly basis, especially in harsh environments such as with dust, oil, or corrosive gases. Before regular maintenance, cut off the power and wait at least 15min.		
Entire machine	Check whether the DIN rail fixing clip is loose.	Visual inspection
	Check whether the machine is deformed, cracked, or damaged, or the color changes due to overheating and aging.	Visual inspection
	Check whether much dirt or dust is attached.	Visual inspection
	Check for abnormal noise, vibration, odor, or discoloration.	Auditory, olfactory, and visual inspection
Cable	Check whether there is discoloration, deformation, or damage.	Visual inspection
	Check whether the cables are loose.	Visual inspection
Connection terminals	Check for overheating or damage. Check whether the terminals are secure and not loose.	Visual inspection, instrument based inspection
Contactor and relay	Check whether there is vibration sound during running.	Auditory inspection
	Check whether the contacts are in good contact.	Visual inspection
Ventilation duct	Check whether there are foreign matters blocking or attached to the cooling fan, air inlets, or air outlets.	Visual inspection

For more details about maintenance, contact the local INVT office, or visit our website https://www.invt.com, and choose **Support** > **Services**.

Appendix A Product dimensions
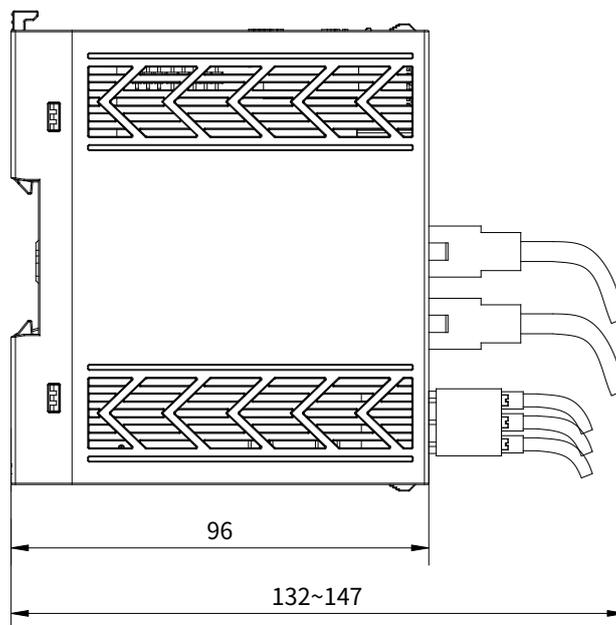
A.1 Communication coupler

A.1.1 Module installation dimensions

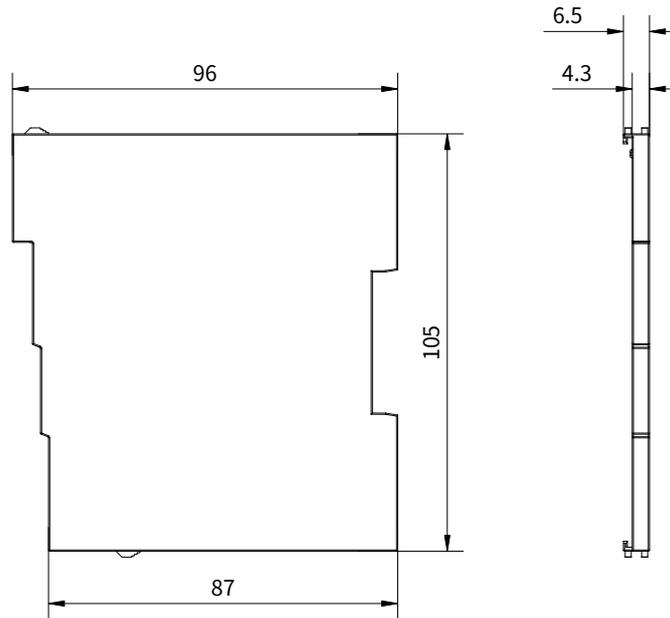Figure A-1 Module installation dimensions (unit: mm)
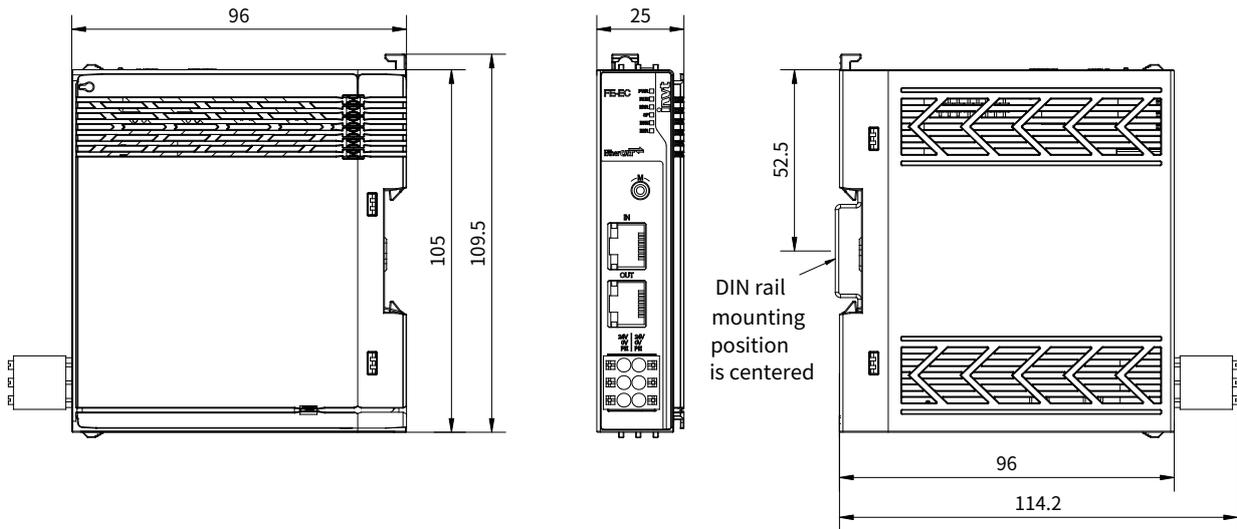
A.1.2 Connection cable dimensions

Figure A-2 Connection cable dimensions (unit: mm)
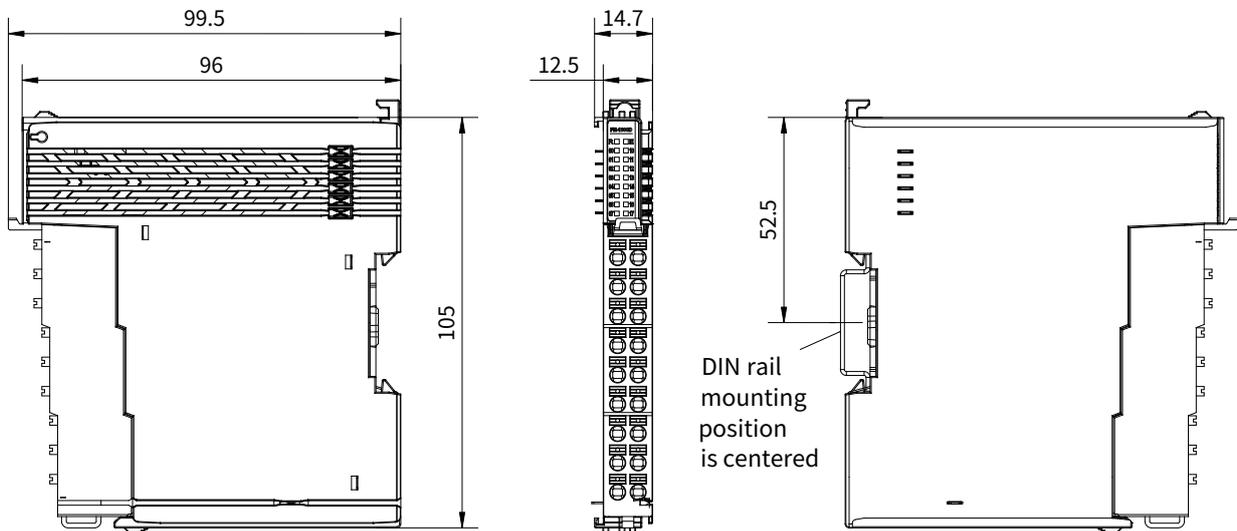
A.1.3 End cover dimensions

Figure A-3 End cover dimensions (unit: mm)
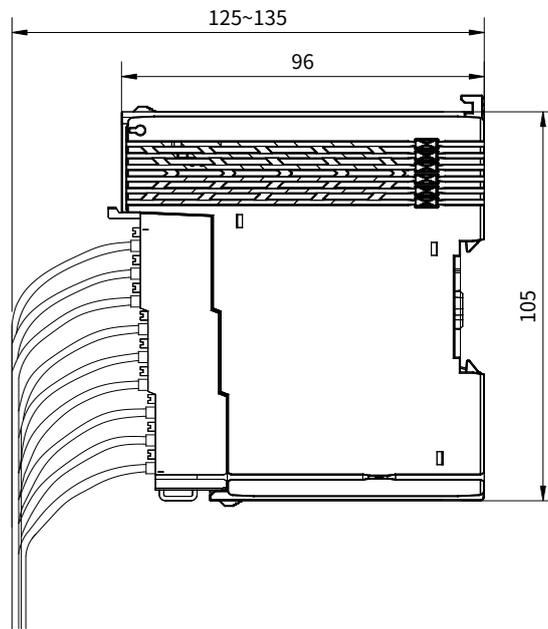
A.2 I/O module

A.2.1 Module installation dimensions

Figure A-4 Module installation dimensions (unit: mm)

DIN rail
mounting
position
is centered

A.2.2 Connection cable dimensions

The dimensions are applicable to all I/O module models.

Figure A-5 Connection cable dimensions (unit: mm)

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