凌科自动化
LATCOS
connected to smart

# User Manual
# 用 户 手 册

## RX Horizontal Multi-Function Distributed I/O

ETHERCAT protocol
Remote IO Module
Distributed IO Module

# CATALOGUE

# 1.Preface

## 1.1 Document Usage Instructions

This document describes the product's functional specifications, installation, operation and settings, as well as the content related to network protocols. This document is only applicable for trained electrical automation engineers.

**(1) Disclaimer**

The author has conducted necessary checks on the document, but as the product evolves and upgrades, the document may contain technical parameters or editing errors. We reserve the right to make adjustments and modifications without prior notice to users.

**(2) Trademark**

ETHERCAT® is a registered trademark of the ETHERCAT Association.

**(3) Patent Information**

The designer of this product has applied for patent protection for the product's appearance and technical implementation methods. Any attempt to copy, imitate or reverse engineer may violate the law.

**(4) Copyright**

Without the author's authorization, it is prohibited to copy, distribute and use this document.

## 1.2 Safety Matters

This product is a professional equipment for industrial use and can only be used by personnel with electrical operation experience. Before use, please carefully read this manual and operate in accordance with the instructions to avoid causing personal injury or product damage.

This product is designed to meet the IP20 protection level. When using, it needs to be installed in a distribution cabinet with dust-proof and moisture-proof functions.

## 1.3 Document History

| Version | Date | Explanation |
|---|---|---|
| V1.00 | 2017.05.15 | Initial release |
| V2.00 | 2017.09.01 | Added description of extended functions |
| V2.10 | 2019.11.22 | Added wiring diagrams for extended modules |
| V2.11 | 2020.11.22 | Corrected errors in analog quantity engineering values |

## 1.4 Reference document

《IEC11631-22007 Programmable controllers –Part 2:Equipment requirements and tests》;

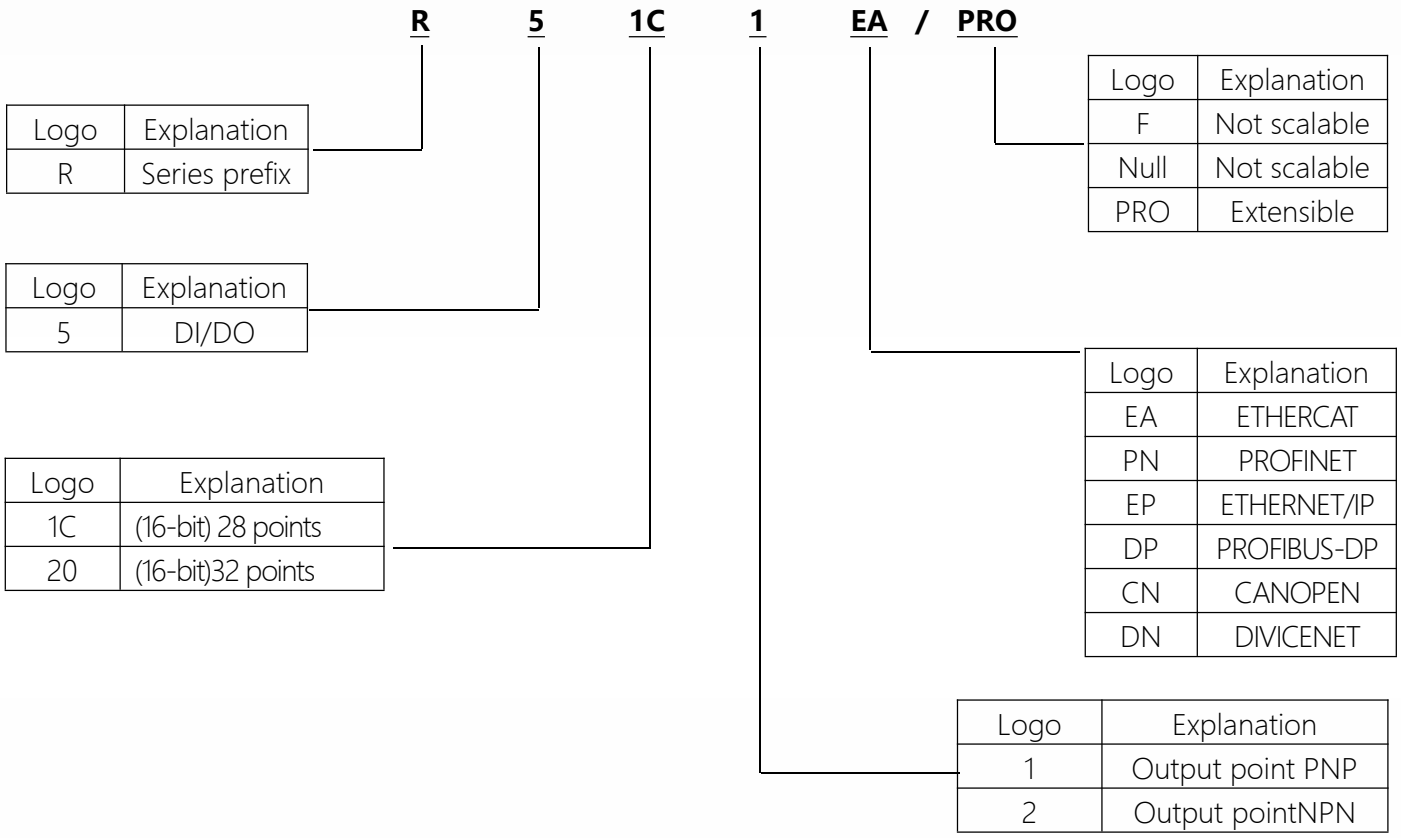
《IEC/TR 61158Industrial Communication Network - Fieldbus Specification》;

《IEC61784-1Industrial Communication Network - Industry Standards Part 1: Fieldbus Standards》;

# 2.Product Overview

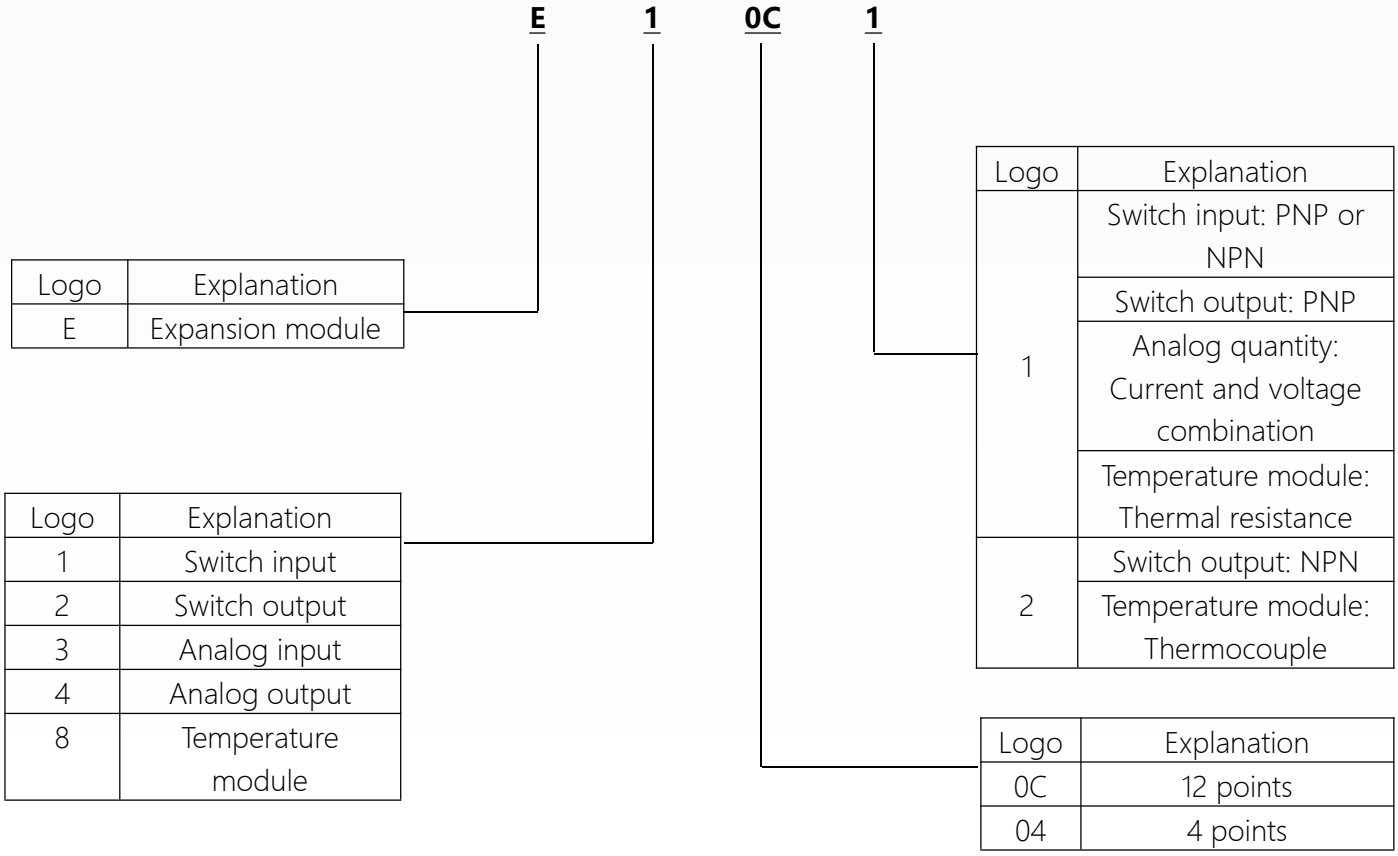
## 2.1 Model List

The R51C1-EA remote I/O module supports the high-performance EtherCAT bus communication protocol. Through the digital or analog I/O interfaces integrated in the module body, it can directly provide high-performance input and output functions without the need for other EtherCAT bus couplers. The expandable version of the module can also increase the required IO points by selecting different expansion modules.




| Number | Model number | Explanation |
|---|---|---|
| 1 | R51C1-EA/F | 16DI, 12DQ (PNP), Fixed IO points, EtherCAT Remote I/O Module |
| 2 | R51C1-EA/PRO | 16DI, 12DQ (PNP), Expandable, EtherCAT Remote I/O Module |
| 3 | R51C2-EA/F | 16DI, 12DQ (NPN), Fixed IO points, EtherCAT Remote I/O Module |
| 4 | R51C2-EA/PRO | 16DI, 12DQ (NPN), Expandable, EtherCAT Remote I/O Module |
| 5 | R5202-EA/F | 16DI, 16DQ (NPN), Fixed IO points, EtherCAT Remote I/O Module |
| 6 | R5202-EA/PRO | 16DI, 16DQ (NPN), Expandable, EtherCAT Remote I/O Module |
| | | |
| | | |

**Table 1 EtherCAT Remote I/O Module**




| Number | Model number | Explanation |
|---|---|---|
| 1 | E10C1 | 12DI, source type / drain type, digital quantity input expansion module |
| 2 | E20C1 | 12DQ (transistor source type), digital quantity output expansion module |
| 3 | E3041 | 12BIT 4-channel analog quantity input expansion module |
| 4 | E4041 | 12BIT 4-channel analog quantity output expansion module |
| 5 | E8041 | 12BIT 4-channel thermal resistance module |
| 6 | E8042 | 12BIT 4-channel thermocouple module |

**Table 2 Expansion Module***

Note: For detailed explanations and usage methods of the expansion module, please refer to the corresponding product manual.

## 2.2 R51C1-EA Specifications and Parameters

This article only provides explanations for the product specification parameters of R51C1-EA/F and R51C1-EA/Pro. For the specification parameters of other models, please contact your supplier for information.

### 2.2.1 DI specification

The specifications for digital input (DI) are shown in Table 3.

| Number | Project | Specification |
|---|---|---|
| 1 | Number of channels | 16 |
| 2 | Access type | 2 bytes |
| 3 | Ton | Type. 18uS / Max. 35uS |
| 4 | Toff | Type. 135uS / Max. 250uS |
| 5 | Input type | PNP or NPN |
| 6 | Input connector | Plug-in connector |
| 7 | Rated input voltage | 24 V DC (-15 %/+20 %), (IEC 61131-2, type 2) |
| 8 | "0" signal level | -3...+5 V (IEC 61131-2, type 2) |
| 9 | "1" signal level | 15...30 V (IEC 61131-2, type 2) |
| 10 | Input current | Typ. 10mA/Ch (IEC 61131-2, type 2) |
| 11 | Electrical isolation | Input/Control Area: 500V DC |

**Table 3 Specifications for Digital Input**

### 2.2.2 DQ Specification

The specifications and parameters of the MOSFET digital output (DQ) are shown in Table 4.

| Number | Project | Specification |
|---|---|---|
| 1 | Number of channels | 12 |
| 2 | Access type | 2 bytes |
| 3 | Ton | Type. 12uS / Max. 25uS |
| 4 | Toff | Type: 10mS / Maximum: 20mS (No load) PNP |
| 5 | Output type | Plug-in connectors |
| 6 | Output connector | Point-resistance load, inductive load, electric lamp load |
| 7 | Load type | Type: 10mS / Maximum: 20mS (No load) PNP |
| 8 | Rated output voltage | 24 V DC (-15 %/+20 %), (IEC 61131-2, type 2) |
| 9 | Maximum output current | Max. 0.5 A /Ch, independent short-circuit protection for each channel |
| 10 | Rated total output current | 6A |
| 11 | Power connector | Two sets of 2-pin spring connectors |

**Table 4 MOSFET Output Specifications**

## 2.2.3 ETHERCAT communication specification

The parameters of the EtherCAT communication specification are shown in Table 5.

| Number | Project | Specification |
|---|---|---|
| 1 | Agreement | ETHERCAT |
| 2 | Transmission rate | 10/100 Mbaud, automatically detects |
| 3 | Bus interface | RJ45 |
| 4 | Transmission cable | CAT5e shielded cable |
| 5 | ETHERCAT features | COE |
| 6 | Port protection | Transformer isolation，1500V DC（IEC61000-4-2） |

**Table 5 ETHERCAT Communication Specifications**

## 2.2.4 Expansion interface

The R51C1-EA/F is a non-expandable module. The expansion interface specification parameters of the R51C1-EA/Pro module are shown in Table 6.

| Number | Project | Specification |
|---|---|---|
| 1 | Interface power supply voltage | DC 5V |
| 2 | Maximum power supply current | 1.5A |
| 3 | Maximum number of expansion slots | 7 |

**Table 6 Specifications of Extended Interface Parameters**

## 2.2.5 Power supply specifications

The module power supply is divided into three independent parts: the control part, the digital input part, and the MOSFET digital output part, which are isolated from each other. Therefore, three independent power supplies need to be provided for each part of the circuit or they can be directly connected in parallel.

① The control voltage uses 24V DC (-15% / +20%), with a maximum current consumption of 0.5A, and has polarity reverse protection; the electrical isolation withstand voltage between it and other I/O parts is 500V DC.

② The digital input voltage uses 24V DC (-15% / +20%), with a maximum current consumption of 16*10mA; the electrical isolation withstand voltage between it and other I/O parts is 500V DC.

③ The MOSFET digital output part uses 24V DC (-15% / +20%), with a maximum current consumption of 8*0.5A, and has channel-independent overcurrent protection; the electrical isolation withstand voltage between it and other I/O parts is 500V DC.

# 3.Structure Explanation

## 3.1 Shell

The module adopts the standard enclosure design of the Rx series remote I/O module. Its dimensions are: 120.5 * 80 * 62 (W/H/D, mm). The height of the lower rail clip protrusion is h = 5.5 mm. It supports an IP20 protection level.

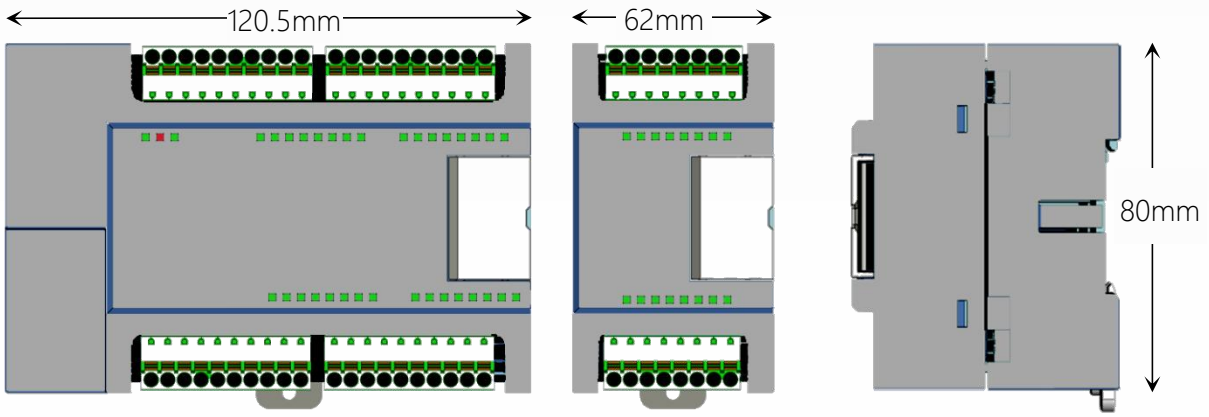



**Figure 1 Module Dimension Diagram**

## 3.2 Installation Method

① The design of the module adopts natural convection cooling method. At least 25 mm of space must be reserved above and below the device to ensure normal heat dissipation. The distance between the front panel and the back panel should also be maintained at least 75 mm.

② The module can be easily installed on a standard DIN rail or the back panel of the control cabinet. The rail specification is TS35/7.5, as shown in Figure 2.

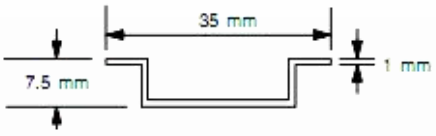
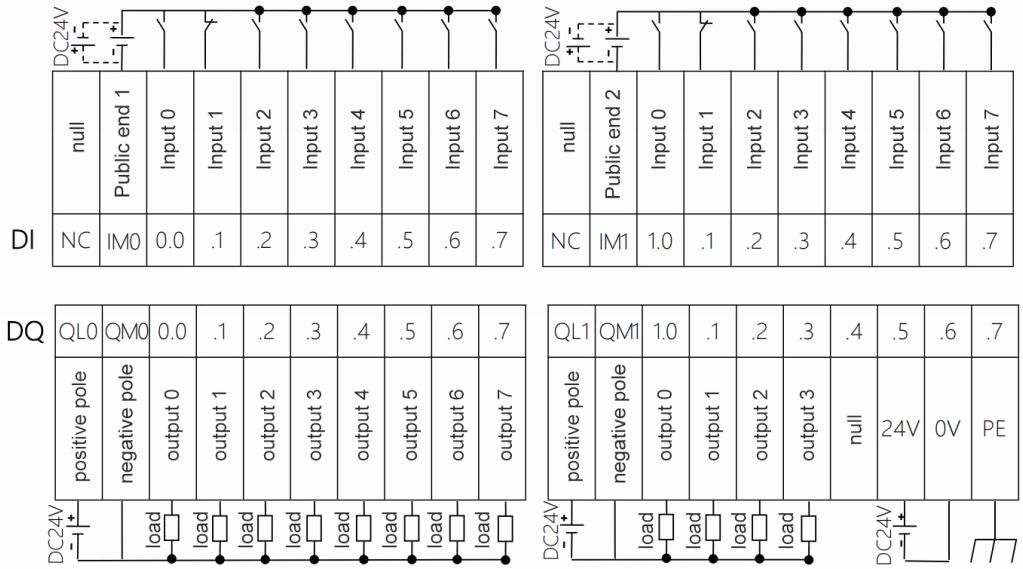



**Figure 2 DIN rail**

# 4. Hardware Description

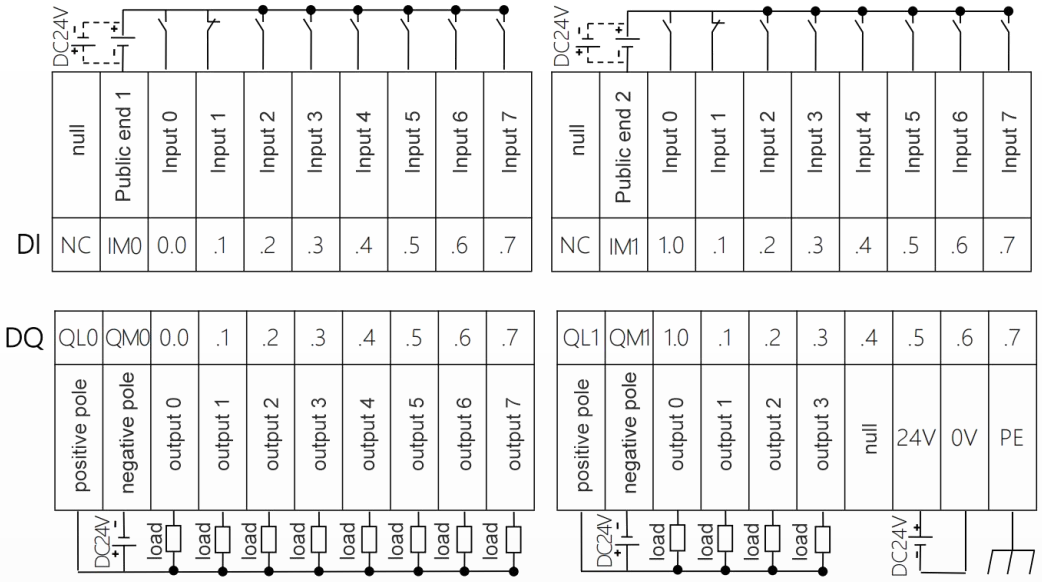
# 4.1 R51CX-EA Circuit diagram

**R51C1-EA/XX**

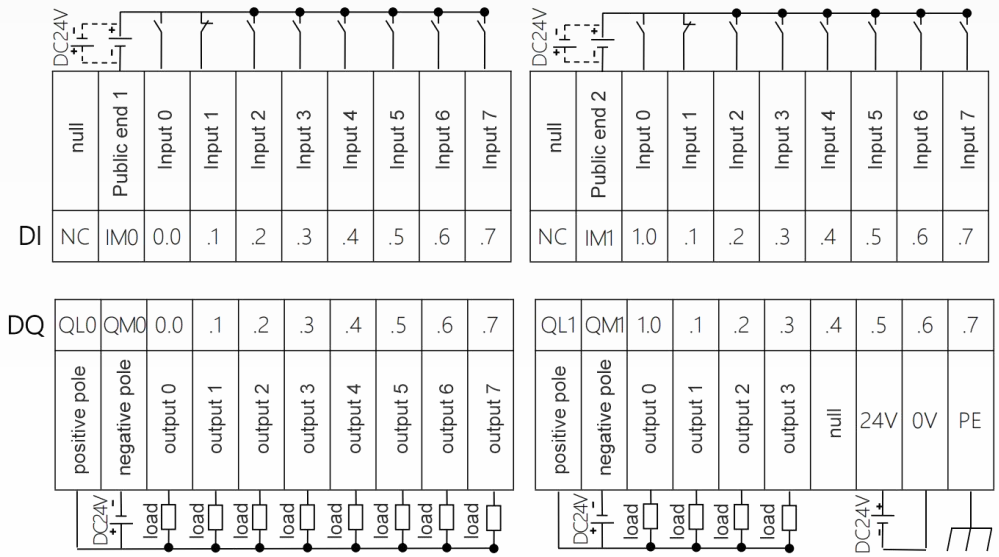



# 4.2 R520X-EA Circuit diagram

**R51C2-EA/XX**

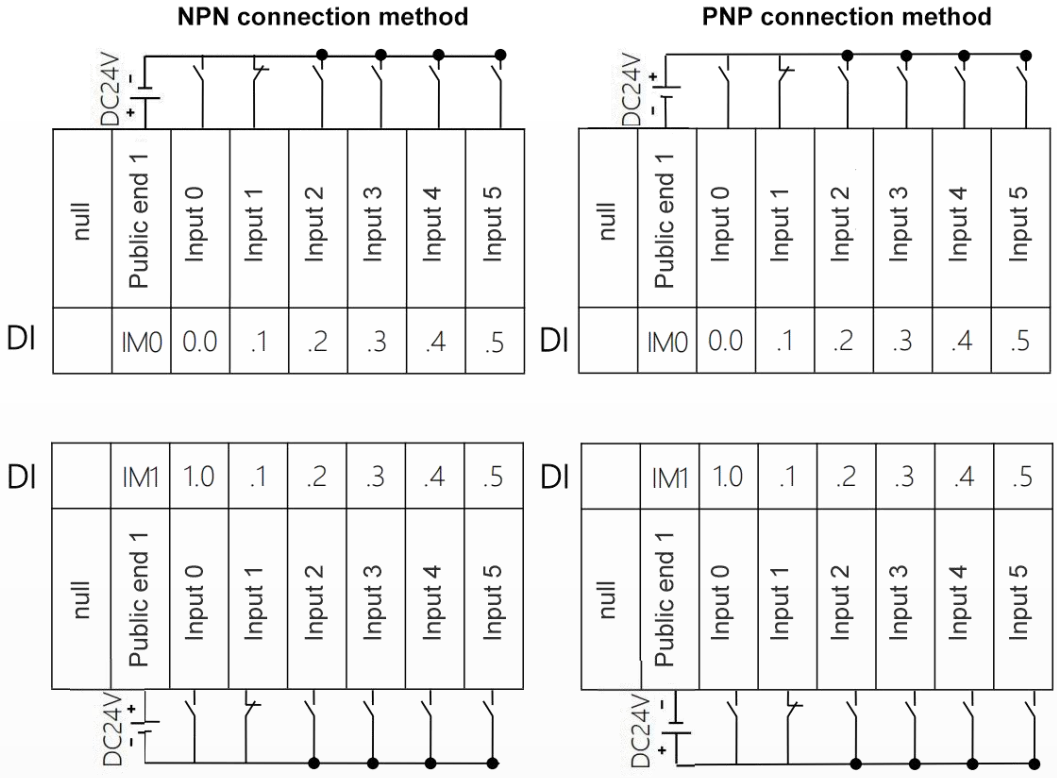


**R5202-EA/XX**

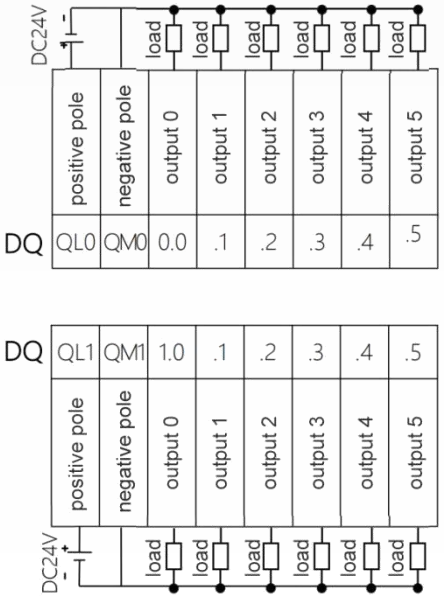



# 4.3 Expansion module wiring diagram

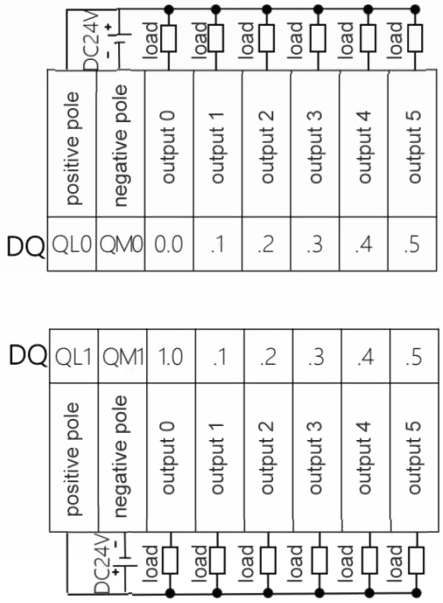
**E10C1**
**Digital 12-point input module**



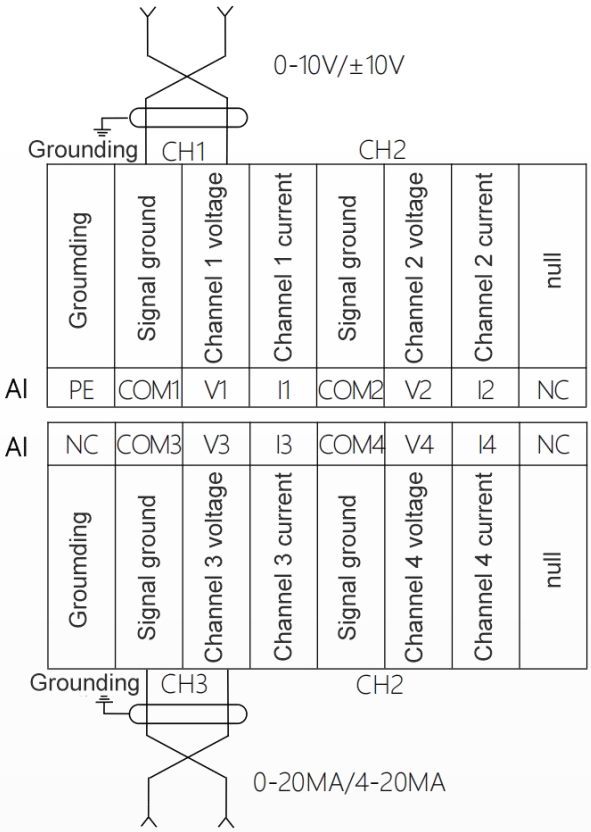
**E20C1**
**Digital 12-bit output module,**
**PNP type**



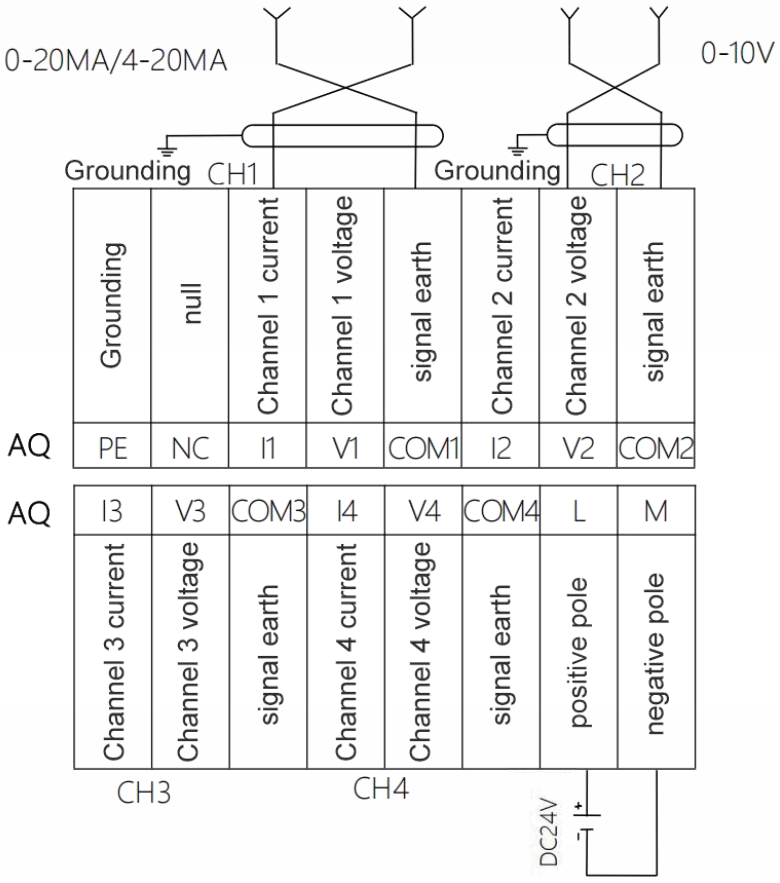

**E20C2**
**Digital 12-bit output module**
**NPN type**



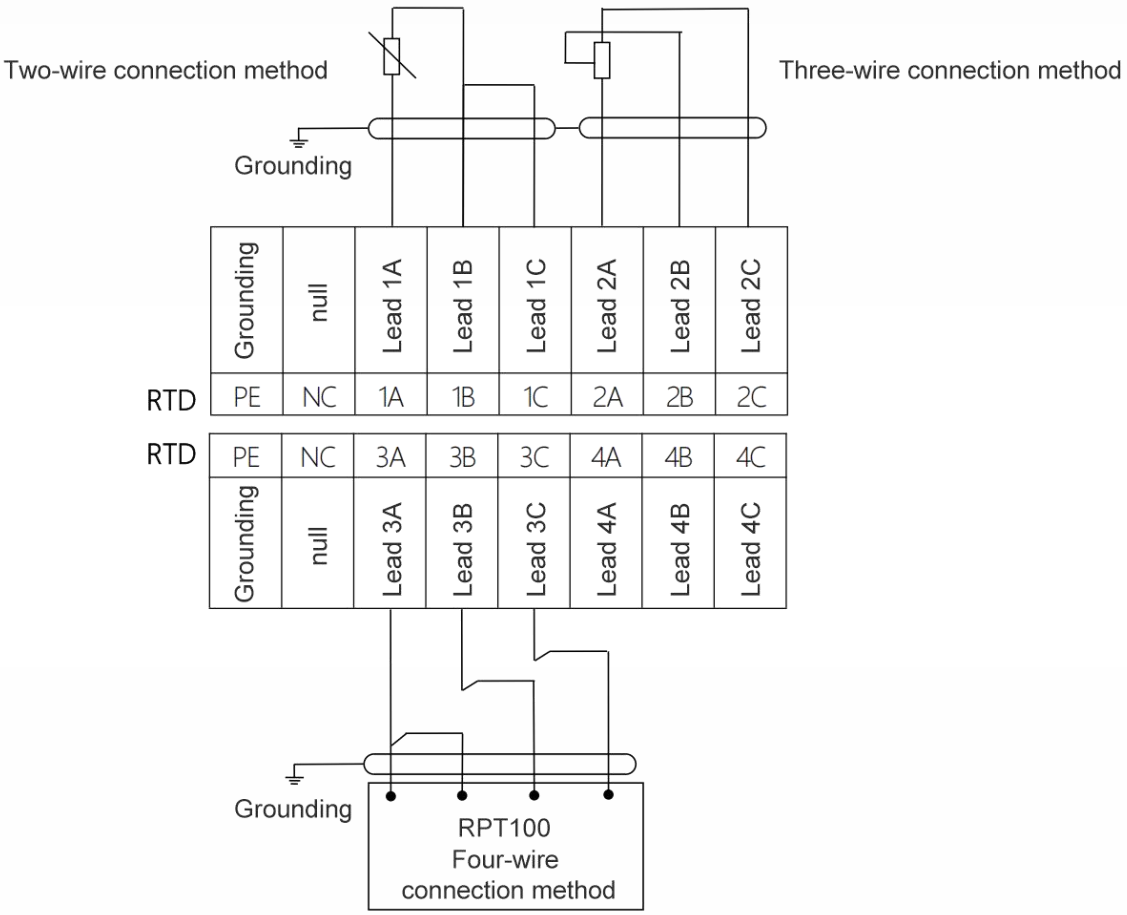

**E3041**
**4-channel analog input module**



**E4041**
**4-channel analog output module**

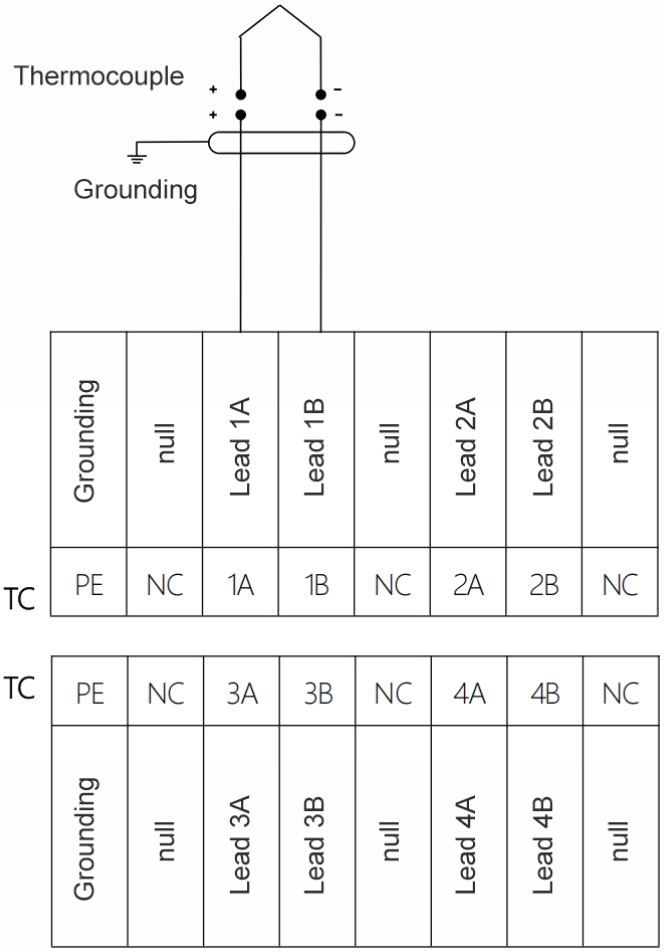


**E8041**
**4-channel thermal resistance module**



**E8042**

**4-channel thermocouple module**



## 4.4 Communication Interface

The module uses a physical interface with two RJ45 sockets for communication, which are respectively identified as IN and OUT.

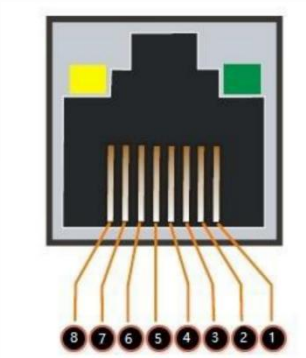



**Table 7 Ethercat Communication Interface**

| Pin | Signal | Description |
|---|---|---|
| 1 | TD+ | Data transmission positive terminal |
| 2 | TD- | Data transmission negative terminal |
| 3 | RD+ | Data reception positive terminal |
| 4 | NC | Unused |
| 5 | NC | Unused |
| 6 | RX- | Data reception negative terminal |
| 7 | NC | Unused |
| 8 | NC | Unused |

## 4.5 LED indication

The LED indicators of the module are divided into three parts: system status indicator, I/O status indicator, and RJ45 link indicator.

### 4.5.1 System status indicates the working condition of the system as shown in the table.

| ERR(red) | RUN(green) | PWR(green) | Explanation |
|---|---|---|---|
| ○ | ○ | ○ | Power supply abnormality |
| ● | ○ | ● | Communication interface failure |
| ○ | ● | ● | The module has successfully entered the operating (operate) state and successfully established a cyclic data exchange with the main station. |

**Table 8 System Status Indicators ● Indicates that the green light remains constantly on ● Indicates that the red light remains constantly on ○ Indicates that it is not lit**

### 4.5.2 I/O status indicator

The digital input/output ports use green LEDs to indicate the status of the corresponding channels. When the light is on, it indicates that the logic state of the input/output port is "1", and when the light is off, it indicates that the logic state of the input/output port is "0".

### 4.5.3 RJ45 Indicator light

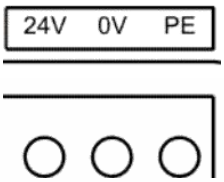
Under normal circumstances, the RJ45 port indicator lights should be the green light constantly on and the yellow light flashing. If this is not the case, it indicates that a fault has occurred. If the green light is not on, it means there is a fault in the connection of the RJ45 port to the Hub or switch; if the yellow light is not on, it might be a fault with the module itself.

As shown in Table 9: Table 9　RJ45 Indicator Light Explanation

| LINK1/LINK2 | ACT1/ACT2 | 说明 |
|---|---|---|
| ○ | Not related | The RJ45 port is not connected to a network cable or the connection is poor. |
| ● | Not related | The RJ45 port has correctly identified the Ethernet network. |
| Not related | ○ | There is no data exchange at the RJ45 port. |
| Not related | ● | There is data exchange at the RJ45 port. |

**Table 9 RJ45 Indicator Light Explanation**

## 4.6 Power supply

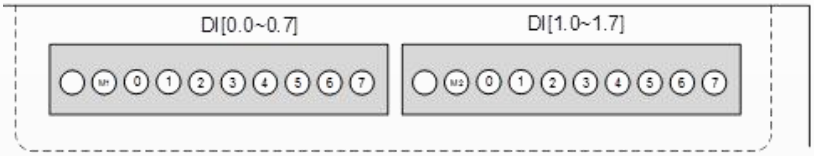



| | |
|---|---|
| 24V | 24V, positive terminal of the DC power supply |
| 0V | 0V, negative terminal of the DC power supply |
| PE | Connect to the ground |

**Table 10 Power Connection Terminal**

## 4.7 Digital input interface

The digital quantity input interface is connected using two sets of 10P plug-in connectors, with a total of 16 input signals divided into DI-0 and DI-1 groups, as shown in the following figure.



| Digital Input-0 | | Digital Input-1 | |
|---|---|---|---|
| O | null | O | null |
| M1(*) | DI Public Port 1 | M2(*) | DI Public Port 2 |
| 0 | DI-0.0 | 0 | DI-1.0 |
| 1 | DI-0.1 | 1 | DI-1.1 |
| 2 | DI-0.2 | 2 | DI-1.2 |
| 3 | DI-0.3 | 3 | DI-1.3 |
| 4 | DI-0.4 | 4 | DI-1.4 |
| 5 | DI-0.5 | 5 | DI-1.5 |
| 6 | DI-0.6 | 6 | DI-1.6 |
| 7 | DI-0.7 | 7 | DI-1.7 |

**Table 11 Digital Input Terminals**

Note*: M1 and M2 are directly connected in parallel within the module.

## 4.8 Digital output interface

The digital output interface is connected using two sets of 10P plug-in connectors. The 12 output signals occupy the left 16P section of the connectors. Each digital output port is equipped with an independent 0.5A overcurrent protection.


| Digital Output -0 | | Digital Output -1 | |
|---|---|---|---|
| L3(*) | DQ Positive terminal of the power supply | L4(*) | DQ Positive terminal of the power supply |
| M3(*) | DQPower negative terminal | M4(*) | DQPower negative terminal |
| 0 | DQ-0.0 | 0 | DQ-0.0 |
| 1 | DQ -0.1 | 1 | DQ -0.1 |
| 2 | DQ -0.2 | 2 | DQ -0.2 |
| 3 | DQ -0.3 | 3 | DQ -0.3 |
| 4 | DQ -0.4 | O | null |
| 5 | DQ -0.5 | L0 | Module power supply, referring to the description in Section 0 |
| 6 | DQ -0.6 | M0 | |
| 7 | DQ -0.7 | PE | |

**Table 12 Digital Output Terminals**

Note*: L3/M3 and L4/M4 are directly connected in parallel within the module and are insulated from the control circuit. When using, an external 24V DC power supply needs to be provided separately for the DQ circuit.

# 5.CANOPEN Bus

# 5.1 What is ETHERCAT IO?

**Definition:**

EtherCAT (Ethernet Control Automation Technology) is an open architecture fieldbus system based on Ethernet. The "CAT" in the name EtherCAT is the abbreviation of the first letters of "Control Automation Technology". It was initially developed by Beckhoff Automation GmbH, a German company. EtherCAT has set new standards for the real-time performance and topological flexibility of the system, and at the same time, it also reduces the cost of using fieldbuses and complies with them. The features of EtherCAT include high-precision device synchronization, optional cable redundancy, and functional safety protocol (SIL3). Network topology

The figure below shows the typical network layout of ETHERCAT IO.

As shown in Figure 4

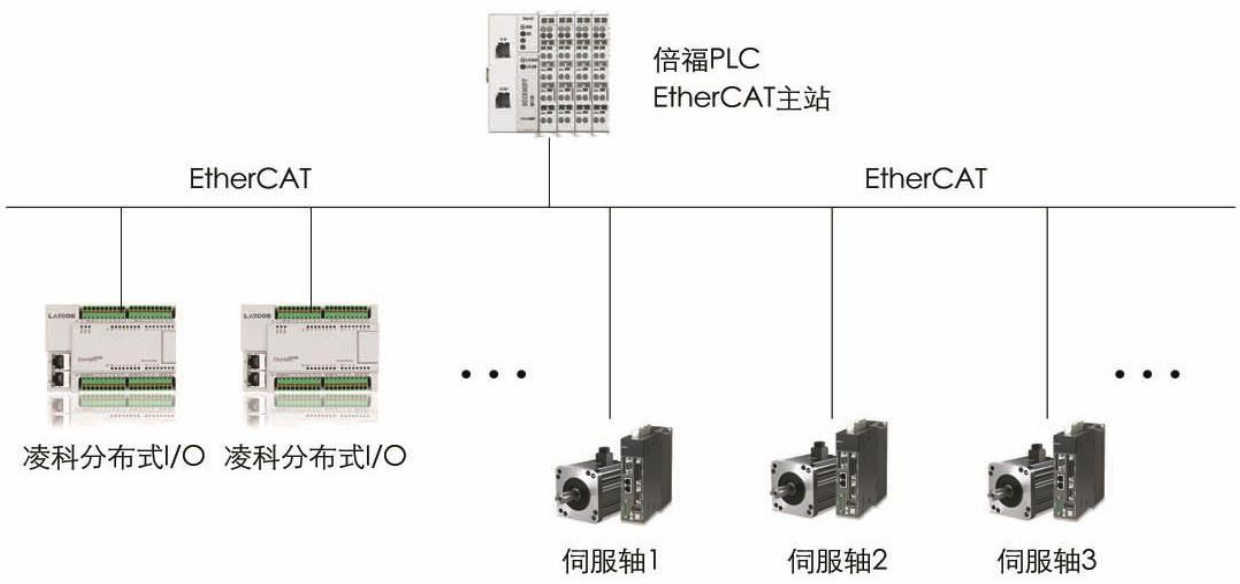



**Figure 3: Network Structure of EtherCAT IO**

# 5.2 Module configuration and address allocation

## 5.2.1 R51C1-EA/F　R51C1-EA/Pro Address mapping

R51C1-EA/F　R51C1-EA/Pro　The DI/DQ data is mapped to the main station memory space through the configuration profile, as shown in the figure.

- 16 digital input channels are mapped to 2-byte In addresses;
- 12 digital output channels are mapped to 2-byte Out addresses;

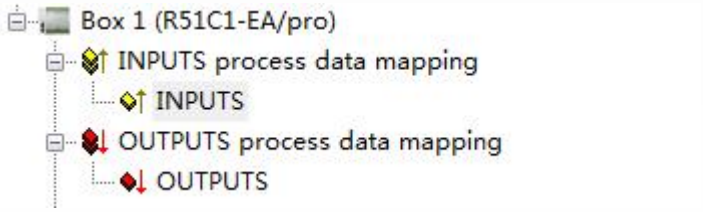



**Figure 4 Address Mapping of Module (R51C1-EA)**

## 5.2.2 Address of the expansion module

①E10C1 maps 12 digital inputs to 2-byte In addresses

②E20C1 maps 12 digital outputs to 2-byte Out addresses

③E3041 has 4 analog inputs, each using 2-byte space, and is mapped to an 8-byte In address in the controller

④E4041 has 4 analog outputs, each using 2-byte space, and is mapped to an 8-byte Out address in the controller

Note: The last page of the wiring diagram, attached file 1

# 5.3 Module parameters

Each module has specific parameters, which need to be flexibly configured according to the actual situation on the hardware configuration interface. And they will be simultaneously downloaded to the controller along with the hardware configuration. In the initial running state, the controller will send these data to the module. If the actual configuration of the module at the site is inconsistent with the hardware configuration in the program, the transmitted parameters will not be consistent with the actual situation, resulting in the failure of module parameter configuration. In this case, the controller will report an error during operation.

The following is an explanation of the configuration parameters for the modules based on the Twincat2 software of Siemens.

## 5.3.1 Digital Input (DI)

As shown in Figure 5:

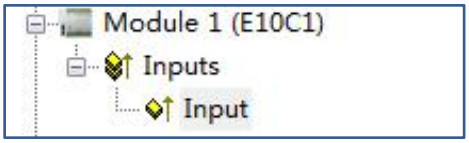



**Figure 5 Address Mapping of Module (E10C1)**

## 5.3.2 Digital output (DQ)

As shown in Figure 6:

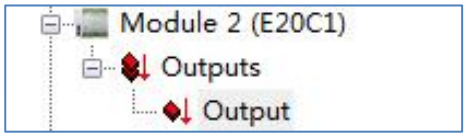



**Figure 6 Address Mapping of Module (E20C1)**

## 5.3.3 Analog Input (AI)

As shown in Figure 7:

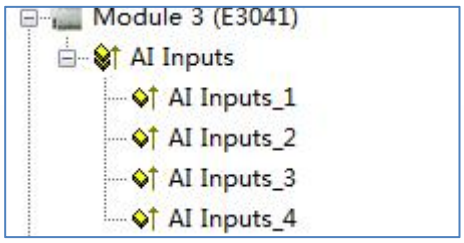



**Figure 7 Address Mapping of Module (E3041)**

As shown in Figure 8, each channel of the analog input contains 4 parameters.

| | | |
|---|---|---|
| 8010:0 | Param_list | RO |
| 8011:0 | Param_Offset | RO |
| 8012:0 | Param_Gain | RO |
| 8013:0 | Param_AverageNum | RO |

**Figure 8 Module (E3041) Parameters (The SDO parameter numbers are different for each module position, starting from 8010)**

| Param_list | Input type |
|---|---|
| Param_Offset | Data value offset |
| Param_Gain | Data value gain amplification |
| Param_AveragaNum | Sampling frequency |

▼ Input type range (default 0: Voltage +/- 10V)

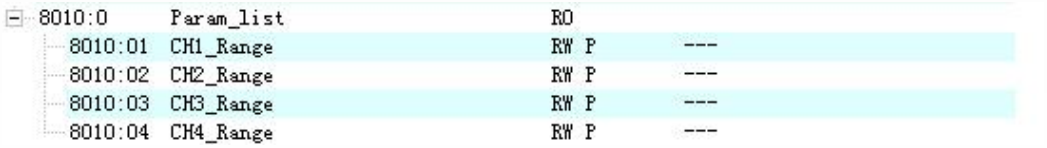



**Figure 9 Analog Input Range Parameters**

**Parameter Explanation**

| Parameters | Name | Format | Input range | Explanation |
|---|---|---|---|---|
| CHx_Measuring_Range | Measurement range | Symbol | 0- "Voltage+/-10V"<br>1- "Voltage +/- 5V"<br>2- "Voltage +/- 2.5V"<br>3- "Voltage 0 to 10V"<br>4- "Voltage 0 to 5V"<br>5- "Current +/- 20mA"<br>6- "Current 0 to 20mA"<br>7- "Current 4 to 20mA"<br>255-"Disable"<br>(Default Voltage+/-10V) | Select the corresponding range of analog input values<br>Where "Disable" indicates the closure of the sampling channel |

**Table 13 Explanation of Analog Input Parameters**

▼ Data value offset (default 0x0)

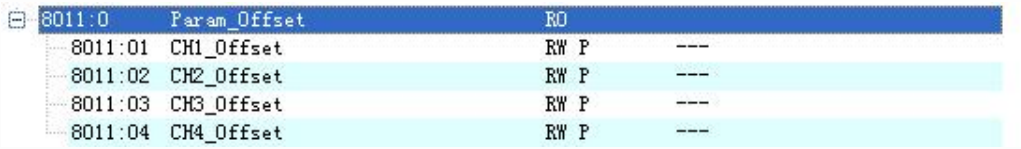



**Figure 10 Analog Quantity Offset**

▼ Data value gain amplification (amplification factor of 1000 is 1)

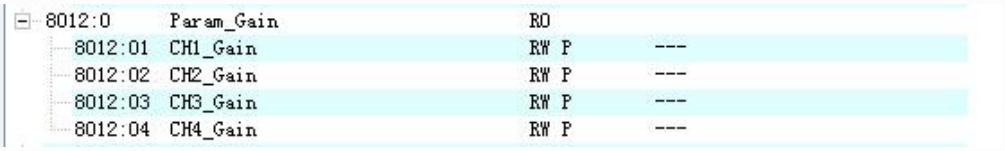



**Figure 11 Analog Value Gain Parameter**

▼ Number of samples (default 20)

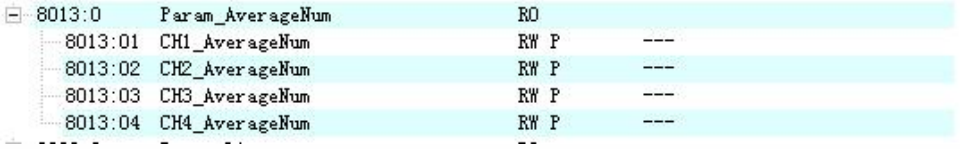



**Figure 12 Number of Analog Sampling**

## 5.4 Simulated data representation

The simulated data all use 16-bit data, with the high bits being padded. If the corresponding 16-bit data does not meet the requirements, it is invalid.

For example, (the low 4 bits of 12-bit ADC data are saved as "0" without change). During the configuration process, select the analog quantity with polarity. The high bits of the data are the sign bits as shown in the following table:

| | -/+10V | -/+5V | -/+2.5V | 0-10V | 0-5V | -/+20mA | 0-20mA | 4-20mA |
|---|---|---|---|---|---|---|---|---|
| Full-scale deflection | 32500 | 32500 | 32500 | 65000 | 65000 | 32500 | 32500 | 32500 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Negative overbalance | -32000 | -32000 | -32000 | 无 | 无 | -32000 | 无 | 无 |

**Table 14 shows the simulated data.**

**Value calculation**

E3041 12BIT Analog Input Module is configured as follows:

CH1_Output_Range: "Voltage +/- 10V"

CH1_Offset: 100 (DEC)

CH1_Gain: 2000 (DEC)

If in the analog front-end of channel 1, there is a -2.5V voltage input, the calculation is as follows:

-2.5V should be converted to decimal data - 8000 = (-32000 / -10V) * -2.5:

According to the formula, Vi = Vr * Gain / 1000 + Offset;

Then the data obtained in the program is

Decimal data: -15900 (DEC)

Hexadecimal data: C1E4 (H)

E3041 12BIT Analog Input Module is configured as follows:

CH2_Output_Range: "Current 4 to 20mA"

CH2_Offset: 100 (DEC)

CH2_Gain: 500 (DEC)

If in the analog front-end of channel 2, there is a 10mA electrical current input, the calculation is as follows:

10mA should be converted to decimal data 32500 = (65000/20mA) * 10mA:

Then, according to the formula, calculate Ii = Ir * Gain/1000 + Offset;

So the data obtained in the program is

Decimal data: 16350 (DEC)

Hexadecimal data: 3FDE (H)

## 5.4.1 Analog output (A0)

As shown in Figure 13:

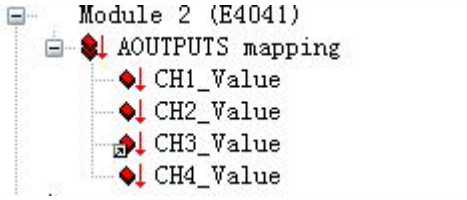



**Figure 13 Address Mapping of Module (E4041) (The SDO parameter numbers are different for each module position starting from 8010)**

As shown in Figure 14, each channel of the analog output contains 5 parameters.

| | | |
|---|---|---|
| 8020:0 | Param_list | RO |
| 8021:0 | Param_Offset | RO |
| 8022:0 | Param_Gain | RO |
| 8023:0 | Param_Error_Mode | RO |
| 8024:0 | Param_ErrorValue | RO |

**Figure 14 Module (E4041) Parameters**

| Param_list | Output type |
|---|---|
| Param_Offset | Data value offset |
| Param_Gain | Data value gain amplification |
| Param_Error_Mode | Fault mode setting: "0" does not retain, "1" outputs the set value |
| Param_ Error_Value | Set value output during fault |

▼ Output type range (default 0: Voltage +/- 10V)

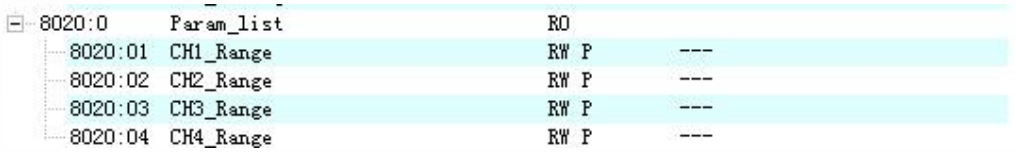



**Figure 15 Analog Output Range Parameters (The SDO parameter numbers vary depending on the module position, starting from 8010)**

| Parameter Explanation | | | | |
|---|---|---|---|---|
| **Parameters** | **Name** | **Format** | **Input range** | **Explanation** |
| CHx_Measuring_Range | Measurement range | Symbol | 0- "Voltage 0~10V"<br>1- "Current 0 to 20mA"<br>2- "Current 4 to 20mA"<br>255-"Disable"<br>(默认 Voltage 0~10V) | Select the corresponding range of analog output values<br>Where "Disable" indicates the closure of the sampling channel |

**Table 15 Explanation of Analog Input Parameters**

▼Data value offset (default 0x0)

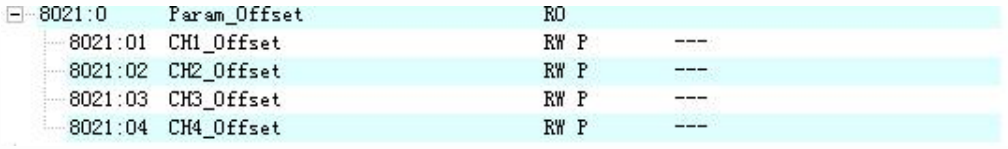



**Figure 16 Analog Quantity Offset**

▼Data value gain amplification (amplification factor of 1000 is 1)

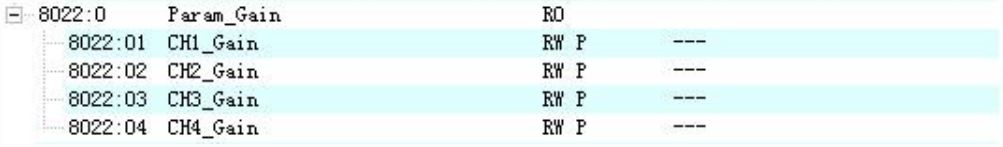



**Figure 17 Analog Value Gain Parameter**

## 5.5 Simulated data representation

The simulated data all use 16-bit data, with the high bits being padded. If the corresponding 16-bit data does not meet the requirements, it is invalid.
For example, (the low 4 bits of 12-bit ADC data are saved as "0" without change). During the configuration process, select analog quantities with polarity. The high bits of the data are the sign bits, as shown in Table 9:

| | 0~10V | 0-20mA | 4-20mA |
|---|---|---|---|
| Full-scale deflection | 32500 | 32500 | 32500 |
| 0 | 0 | 0 | 0 |
| Negative overbalance | 无 | 无 | 无 |

**Table 9: Simulated Data Illustration**

## 5.6 Equipment database file (XML)

The EtherCAT system uses the equipment database file (XML) to describe the communication characteristics of the devices. It is possible to create the EtherCAT equipment database file using a standard XML editor. File name

The R51C1-EA_Pro.xml is the supporting device database file.

- "R51C1-EA" represents the product number used for this version. This version can be used for R51C1-EA/F, R51C1-EA/Pro remote I/O.

### 5.6.1 Installation of the device database file

- The following is the installation instruction based on the Twincat2 software.

1. Shut down Twincat2

2. Copy the R51C1-EA_Pro.xml file to the C:\TwinCAT\Io\EtherCAT directory

3. Open the Twincat2 software and complete the installation.

**●The following is the installation instructions for CODESYS V3.5 SP6 Patch 1 software.**

①In the "Tools" menu, find the "Install Device Description" option and click on it. As shown in Figure 18:

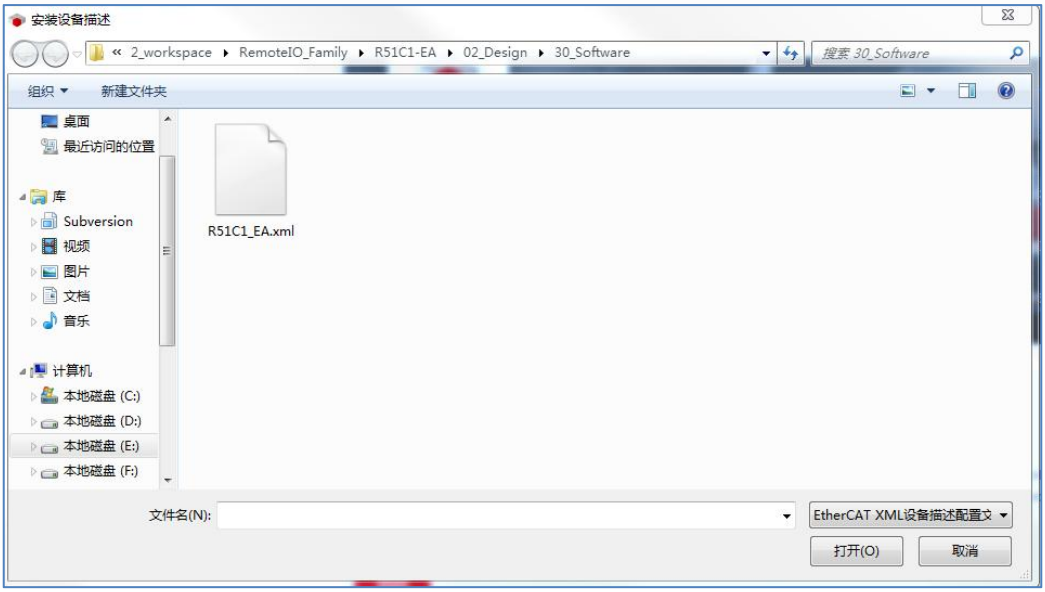



**Figure 18 CODESYS Installation Interface 1**

②Click on the file type at the bottom right corner.
As shown in Figure 19:


**Figure 19 CODESYS Installation Interface 1**

③ Select R51C1-EA_Pro*.xml

④ Installation

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