



MD520 Series General-Purpose AC Drive Communication Guide



Industrial
Automation



Intelligent
Elevator



New Energy
Vehicle



Industrial
Robot



Rail
Transit



Data code 19011716B02

Preface

Introduction

The MD520 series is a general-purpose high-performance vector control AC drive for accurate speed and torque control in high-demand applications. It can drive asynchronous AC induction motors (IM), permanent magnet synchronous motors (PMSM), and synchronous reluctance motors (SynRM). It is also equipped with the STO, limp mode upon fault, position control, and tension control functions.

This guide describes the communication method, networking, and communication settings of the AC drive.

More Documents

Data Name	Data Code	Description
MD520 Series General-Purpose AC Drive Manual Package	PS00012134	This guide describes product selection, mechanical design, electrical design, installation, communication, commissioning, function application, faults, parameters, certifications, and standards.
MD520 Series General-Purpose AC Drive Quick Installation and Commissioning Guide	19011712	This guide describes the installation, wiring, commissioning, troubleshooting, parameters, fault codes, and others.
MD520 Series General-Purpose AC Drive Hardware Guide	19011713	This guide describes the system composition, technical specifications, components, dimensions, options (including installation accessories, cables, and peripheral electrical components), expansion cards, routine inspection and maintenance, certifications, and standards of the AC drive.
MD520 Series General-Purpose AC Drive Installation Guide	19011714	This guide describes the installation dimensions, space design, specific installation steps, wiring requirements, routing requirements, option installation requirements, and common EMC troubleshooting suggestions.
MD520 Series General-Purpose AC Drive Commissioning Guide	19011715	This guide describes the software tool, commissioning process/procedure, troubleshooting, fault codes, and parameters.
MD520 Series General-Purpose AC Drive Communication Guide (this guide)	19011716	This guide describes the communication modes, networking, and communication settings of the AC drive.
MD520 Series General-Purpose AC Drive Function Guide	19011717	This guide describes function application, communication, faults, and parameters of the AC drive.
MD520 Series General-Purpose AC Drive Safety Function Guide	19011795	This guide describes the safety information, instructions for mechanical and electrical installation, commissioning and maintenance guidance, and safety-related parameters of the AC drive.

Revision History

Date	Version	Description
September 2024	B02	Modified the following content: - Updated <i>“5.1 Protocol Description” on page 54.</i> - Made minor corrections.
August 2024	B01	Added the following content: - Added <i>“12.5 Device Level Ring Protocol” on page 233.</i> Modified the following content: - Updated <i>“1.2 Parameter Communication Addresses” on page 14.</i> - Updated <i>“3.4 Communication Data Frame Structure” on page 26.</i> - Updated <i>“6.1 Protocol Description” on page 74.</i> - Updated <i>“10.7.1 Configuring Slaves on the STEP7 (V5.4) by Using S7-300” on page 177.</i> - Updated <i>“10.8 Troubleshooting” on page 192.</i> - Updated <i>“13.2 Object Dictionary Descriptions” on page 261.</i> - Made minor corrections.
November 2023	B00	Added the following content: - Added <i>“Modbus TCP Communication (MD500-EM1)” on page 41.</i> - Added <i>“CANlink Communication (MD38CAN1)” on page 74.</i> - Added <i>“Appendix 6000H Group Object Dictionary” on page 260.</i> Modified the following content: - Updated <i>“1.2 Parameter Communication Addresses” on page 14.</i> - Updated <i>“List of Communication Protocols” on page 21.</i> - Updated the section of CANopen Communication (MD38CAN1). - Made minor corrections. The guide with the version of B00 corresponds to the following software version: F7-10=U60.07/F7-11=U61.08/F7-15=000.00/F7-16=000.00
June 2022	A01	Updated the contents. Updated the section of MRP Functions of the MD500-PN1 Card. Made minor corrections.
January 2022	A00	First release

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version by the following methods:

- Do keyword search under Service and Support at <http://www.inovance.com>.
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install the app, where you can search for and download manuals.



Warranty Disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is caused by proper operation of the user. Maintenance will be charged after the warranty expires.

Within the warranty period, maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or unusual voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see Product Warranty Card.

Table of Contents

Preface.....	1
Fundamental Safety Instructions.....	9
1 Parameter Communication Addresses.....	14
1.1 Parameter Data.....	14
1.2 Parameter Communication Addresses	14
1.3 Modbus-specific Parameter Communication Addresses.....	16
2 List of Communication Protocols	21
3 Modbus Communication (MD38TX1)	22
3.1 Overview	22
3.2 Interface and Networking	22
3.3 Communication Transmission Mode	26
3.4 Communication Data Frame Structure.....	26
3.5 Related Parameters	30
3.6 Communication Configuration.....	31
3.6.1 Configuration for RS485 Communication Between AC Drive and H5U	31
3.6.2 Configuration for RS485 Communication Between AC Drive and AM600.....	35
4 Modbus TCP Communication (MD500-EM1)	41
4.1 Overview	41
4.2 Networking and Interfaces	41
4.3 Communication Data Frame Structure.....	43
4.4 Communication Parameters	45
4.4.1 Communication Card Type Setting	45
4.4.2 IP Address Setting of MD500-EM1 Card	47
4.4.3 Parameters Related to AC Drive Communication Card	49
4.5 Communication Examples	49
5 CANopen Communication (MD38CAN1)	54
5.1 Protocol Description	54
5.2 Networking and Interfaces	57
5.3 Related Parameters	60
5.4 Application.....	61
5.4.1 Communication Data Frame Structure	61

5.4.2 Operation Example (SDO)	62
5.4.3 Operation Example (PDO)	65
5.5 Communication Configuration.....	67
5.5.1 Configuration for CANopen Communication Between AC Drive and H5U	67
5.6 Troubleshooting.....	71
5.6.1 Emergency Message and AC Drive Fault	71
5.6.2 Simple Diagnosis	72
6 CANlink Communication (MD38CAN1)	74
6.1 Protocol Description	74
6.2 Networking and Interfaces	76
6.3 Related Parameters	77
6.4 Communication Configuration.....	78
6.4.1 Configuration for CANlink Communication Between AC Drive and H5U	78
7 PROFINET Communication (MD500-PN1)	83
7.1 Introduction	83
7.2 Installation.....	83
7.3 Terminal Layout and Description	84
7.4 PROFINET Topology.....	85
7.5 Data Transmission Format	86
7.6 PZD Data	87
7.7 Related Parameters	89
7.8 Communication Configuration.....	92
7.8.1 Configuring Slaves on the S7-1200 Master.....	92
7.8.2 MRP Functions of MD500-PN1 Card	101
7.9 Troubleshooting.....	104
8 PROFINET Communication (MD500-PN2)	110
8.1 Introduction	110
8.2 Installation.....	110
8.3 Interface Description.....	111
8.4 PROFINET Topology.....	112
8.5 PROFINET Communication Protocol	113
8.6 Related parameters	116
8.6.1 Parameters Related to Communication	116

8.7 通信实例	119
8.7.1 Configuring Slaves on the S7-1200 Master	119
8.7.2 MRP Function	127
8.8 Troubleshooting	129
9 EtherCAT Communication (MD500-ECAT)	134
9.1 Introduction	134
9.2 Installation	134
9.3 Terminal Layout and Description	135
9.4 Networking Topology	136
9.5 PDO Data	137
9.6 SDO Mailbox Data	139
9.7 Related Parameters	139
9.8 Communication Configuration	146
9.8.1 Communication Instance of Controlling the MD520 with an Omron Controller	146
9.8.2 Communication Instance of Controlling MD520 with an H5U Controller	150
9.8.3 Communication Instance of Controlling MD520 with an AM600 Controller	153
9.8.4 Communication Instance of Controlling the MD520 with an Beckhoff Controller	156
9.9 Troubleshooting	162
10 PROFIBUS DP Communication (MD38DP2)	164
10.1 Introduction	164
10.2 Installation	164
10.3 Terminal Layout and Description	165
10.4 PROFIBUS Topology and Transmission Distance	167
10.5 Communication Protocol	168
10.6 Related parameters	173
10.6.1 Communication Card Type Setting	173
10.6.2 Communication Control Parameters	176
10.7 Communication Configuration	177
10.7.1 Configuring Slaves on the STEP7 (V5.4) by Using S7-300	177
10.7.2 Configuring Slaves on TIA Portal V13 by using S7-1200	182
10.7.3 Performing Cyclic Read/Write Operations on the AC Drive Slave	188
10.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave	190
10.8 Troubleshooting	192

11 PROFIBUS DP Communication (MD-SI-DP2)	197
11.1 Introduction	197
11.2 Installation	197
11.3 Interface Description	198
11.4 PROFIBUS Topology and Transmission Distance	200
11.5 Communication Protocol	201
11.6 Related parameters.....	206
11.6.1 Parameters Related to Communication	206
11.7 Communication Configuration	209
11.7.1 Communication Instance Description.....	209
11.7.2 Configuring Slaves on the STEP7 (V5.4) by Using S7-300	210
11.7.3 Configuring Slaves on TIA Portal V13 by using S7-1200.....	214
11.7.4 Performing Cyclic Read/Write Operations on the AC Drive Slave	220
11.7.5 Performing Aperiodic Read/Write Operations on the AC Drive Slave	222
11.7.6 Diagnosis.....	224
11.8 Troubleshooting	225
12 Ethernet/IP Communication (MD500-EN1)	230
12.1 Introduction	230
12.2 Installation	230
12.3 Interface Description	231
12.4 Networking Topology.....	232
12.5 Device Level Ring Protocol.....	233
12.6 Communication Protocol	234
12.6.1 I/O Messages	234
12.6.2 Data Sent by the Master.....	234
12.6.3 Data Returned by the AC drive	235
12.7 Related parameters.....	235
12.7.1 Communication Card Type Setting.....	235
12.7.2 IP Address Setting of MD500-EN1 Card	238
12.7.3 Parameters Related to AC Drive Communication Card	240
12.7.4 Communication Control Parameters	241
12.7.5 Communication Monitoring Parameters	241
12.8 Communication Configuration	244
12.8.1 Using an MD500-EN1 Expansion Card on an Allen-Bradley L16ER Master.....	244
12.8.2 Using an MD500-EN1 Expansion Card on an Inovance AM600 Master.....	254

12.9 Troubleshooting 258

13 Appendix 6000H Group Object Dictionary 260

13.1 List of Object Dictionary in Group 6000h..... 260

13.2 Object Dictionary Descriptions 261

Fundamental Safety Instructions

Safety Precautions

- This chapter presents essential safety instructions for a proper use of the equipment. Before using this product, read the user guide thoroughly and correctly understand the related safety precautions. Failure to observe the safety precautions may result in serious injuries or death of personnel or device damage.
- "Danger", "Warning", and "Caution" items in this guide do not indicate all safety precautions that need to be followed; instead, they just supplement the safety precautions.
- Use this equipment according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.

Safety Levels and Definitions


DANGER

Indicates that failure to comply with the notice will result in death or severe personal injuries.


WARNING

Indicates that failure to comply with the notice may result in death or severe personal injury.


CAUTION

Indicates that failure to comply with the notice may result in minor or moderate personal injury or equipment damage.

General Safety Instructions

- Drawings in the guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions.
- The drawings in the guide are shown for illustration only and may be different from the product you purchased.
- Operators must take mechanical precautions to protect personal safety and wear protective equipment, such as anti-smashing shoes, safety clothing, safety glasses, protective gloves, and protective sleeves.

Unpacking


WARNING

- Do not install the equipment if you find damage, rust, or signs of use on the equipment or accessories upon unpacking.
- Do not install the equipment if you find water seepage or missing or damaged components upon unpacking.
- Do not install the equipment if you find the packing list does not conform to the equipment you received.



CAUTION

- Check whether the packing is intact and whether there is damage, water seepage, dampness, and deformation before unpacking.
- Unpack the package by following the unpacking sequence. Do not strike the package violently.
- Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking.
- Check whether the package contents are consistent with the packing list before unpacking.

Storage and Transportation



WARNING

- Large-scale or heavy equipment must be transported by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries or equipment damage.
- Before hoisting the equipment, ensure the components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injury or equipment damage.
- Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply may result in personal injuries or equipment damage.



CAUTION

- Handle the equipment with care during transportation and mind your steps to prevent personal injuries or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the product for more than three months. Long-term storage requires stricter protection and necessary inspections.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport the drive with other equipment or materials that may harm or have negative impacts on the drive.

Installation



DANGER

- The equipment must be operated only by professionals with electrical knowledge.

**WARNING**

- Read through the guide and safety instructions before installation.
- Do not install this equipment in places with strong electric or magnetic fields.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply will result in mechanical hazards.
- Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock.
- When installing the equipment in a closed environment (such as a cabinet or casing), use a cooling device (such as a fan or air conditioner) to cool the environment down to the required temperature. Failure to comply may result in equipment over-temperature or a fire.
- Do not retrofit the equipment.
- Do not fiddle with the bolts used to fix equipment components or the bolts marked in red.
- When the equipment is installed in a cabinet or final assembly, a fireproof enclosure providing both electrical and mechanical protections must be provided. The IP rating must meet IEC standards and local laws and regulations.
- Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction.
- Install the product on an incombustible object such as metal and do not contact or attach the product with combustible objects. Failure to comply will cause fires.

**CAUTION**

- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the equipment and causing faults. After installation, remove the cloth or paper on top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.
- Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring

**DANGER**

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Before wiring, cut off all the power supplies of the equipment, and wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safe voltage range. Failure to comply will result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply will result in an electric shock.
- Check that the equipment is grounded properly. Failure to comply can result in an electric shock.

**WARNING**

- Do not connect the input power supply to the output end of the equipment. Failure to comply can result in equipment damage or even a fire.
- When connecting a drive to the motor, check that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Fix the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may overheat or damage the connecting part, resulting in a fire.
- After wiring is done, check that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply may result in electric shock or equipment damage.



CAUTION

- Follow the proper electrostatic discharge (ESD) procedure and wear an anti-static wrist strap to perform wiring. Failure to comply may result in damage to the equipment or to the internal circuit of the product.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply can result in equipment malfunction.

Power-on



DANGER

- Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Check that the power supply meets equipment requirements before power-on to prevent equipment damage or a fire.
- Do not open the cabinet door or protective cover of the product, contact any wiring terminal of the product, or remove any part of the product at power-on. Failure to comply will result in an electric shock.



WARNING

- Perform a trial run after wiring and parameter setting to ensure the equipment operates safely. Failure to comply may result in personal injuries or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in a fire accident.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injury.

Operation



DANGER

- The equipment must be operated only by professionals. Failure to comply can result in death or personal injury.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply can result in an electric shock.



WARNING

- Do not touch the equipment casing, fan, or resistor with bare hands to feel the temperature. Failure to comply may result in personal injuries.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance



DANGER

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply can result in an electric shock.
- Before maintenance, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
- In case of a permanent magnet motor, do not touch the motor terminals immediately after power-off because the motor terminals will generate induced voltage during rotation even after the equipment power supply is off. Failure to comply will result in an electric shock.



WARNING

- Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair	
 DANGER	• Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals. • Do not repair the equipment with power ON. Failure to comply can result in an electric shock. • Before inspection and repair, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
 WARNING	• Submit the repair request according to the warranty agreement. • When the fuse is blown or the circuit breaker or residual current device (RCD) trips, wait for at least the time designated on the equipment warning label before power-on or further operations. Failure to comply may result in death, personal injury or equipment damage. • When the equipment is faulty or damaged, the troubleshooting and repair work must be performed by professionals that follow the repair instructions, with repair records kept properly. • Replace quick-wear parts of the equipment according to the replacement instructions. • Do not operate on damaged equipment. Failure to comply may result in death, personal injury, or severe equipment damage. • After the equipment is replaced, check the wiring and set parameters again.
Disposal	
 WARNING	• Dispose of retired equipment in accordance with local regulations and standards. Failure to comply may result in property damage, personal injury, or even death. • Recycle retired equipment by observing industry waste disposal standards to avoid environmental pollution.

Safety Labels

For safe operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. See the following table for descriptions of the safety labels.

Safety Label		Description
T12 models and below	T13 models	
		• Read through the safety instructions before operating the equipment. Failure to comply may result in death, personal injuries, or equipment damage. • Do not touch the terminals or remove the cover with power ON or within 10 min (for T12 models and below) or 15 min (for T13 models) after power-off. Failure to comply will result in an electric shock.

1 Parameter Communication Addresses

1.1 Parameter Data

The parameters are classified into basic function parameters and monitoring parameters, which are stored in the corresponding parameter group. Basic function parameters are stored in groups F, A, B, C, and H, as listed in the following table.

Parameter data	Group F (read/write)	F0, F1, F2, F3, F4, F5, F6, F7, F8, F9, FA, FB, FC, FD, FE, and FF
	Group A (read/write)	A0, A1, A2, A3, A4, A5, A6, A7, A8, A9, AA, AB, AC, AD, AE, and AF
	Group B (read/write)	B0, B1, B2, B3, B4, B5, B6, B7, B8, B9, BA, BB, BC, BD, BE, and BF
	Group C (read/write)	C0, C1, C2, C3, C4, C5, C6, C7, C8, C9, CA, CB, CC, CD, CE, and CF
	Group H (read/write)	H1, H2

The following table shows the addresses used by the monitoring parameters, including running command, running status, running parameters, and alarm information.

Monitoring parameters	Status data (read-only)	U0, U2, and 3000H ^{Note 1}
	Control parameters (write-only)	U3, 1000H, and 2000H to 2004H ^{Note 1}
	Fault information (read-only)	H0, H3, H4, H5, H6, H7, and H8
	Connector information (read-only)	L0, L1, L2, L3, L4, L5, L6, L7, L8, L9, LA, LB, LC, and LD

Note 1: 1000 H, 2000H to 2004H, and 3000H are Modbus-specific communication addresses.

1.2 Parameter Communication Addresses

There are multiple function parameters in each of the parameter groups F0 to FF and A0 to AF. For example, F0-16 indicates parameter number 16 in group F0. High-order eight bits in the communication address of a parameter are the parameter group number. Low-order eight bits are the hexadecimal format of the parameter serial number in the parameter group. For example, the communication address of F0-16 is 0xF010.

Writing basic function parameters and saving them upon power failure indicate frequent operations on the EEPROM, which reduces its service life. Therefore, you can modify some basic function parameters in the RAM through communication without saving them.

- For parameters in group F, to obtain the RAM address, change the high-order bit F of the parameter address to 0. For example, the communication RAM address of F3-12 is 0x030C.
- For parameters in group A, to obtain the RAM address, change the high-order bit A of the parameter address to 4. For example, the communication RAM address of A0-05 is 0x4005.

- For parameters in group B, to obtain the RAM address, change the high-order bit B of the parameter address to 5. For example, the communication RAM address of B0-05 is 0x5005.
- For parameters in group C, to obtain the RAM address, change the high-order bit C of the parameter address to 6. For example, the communication RAM address of C0-05 is 0x6005.

Parameter Group	Conversion Rule of Object Dictionary Index		
	Write to EEPROM/RAM	Index	Sub-index
Group F0 to FF (read and write)	Write to EEPROM	High-order 16 bits: add 0x2000 (0x20F0-0x20FF) For example, the index of F4-12 is 0x20F4.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of F4-12 is 0x0D.
	Write to RAM	High-order 16 bits: convert the high-order bit F to 0 and then add 0x2000 (0x2000-0x200F) For example, the index of F4-12 is 0x2004.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of F4-12 is 0x0D.
Group A0 to AF (read and write)	Write to EEPROM	High-order 16 bits: add 0x2000 (0x20A0-0x20AF) For example, the index of A0-05 is 0x20A0.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of A0-05 is 0x06.
	Write to RAM	High-order 16 bits: convert the high-order bit A to 4 and then add 0x2000 (0x2040-0x204F) For example, the index of A0-05 is 0x2040.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of A0-05 is 0x06.
Group B0 to BF (read and write)	Write to EEPROM	High-order 16 bits: add 0x2000 (0x20B0-0x20BF) For example, the index of B4-12 is 0x20B4.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of B4-12 is 0x0D.
	Write to RAM	High-order 16 bits: convert the high-order bit B to 5 and then add 0x2000 (0x2050-0x205F) For example, the index of B4-12 is 0x2054.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of B4-12 is 0x0D.
Group C0 to CF (read and write)	Write to EEPROM	High-order 16 bits: add 0x2000 (0x20C0-0x20CF) For example, the index of C4-12 is 0x20C4.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of C4-12 is 0x0D.
	Write to RAM	High-order 16 bits: convert the high-order bit C to 6 and then add 0x2000 (0x2060-0x206F) For example, the index of C4-12 is 0x2064.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of C4-12 is 0x0D.
Group H0 to H8 (group H1 and H2 can be read and written, and the other groups can only be read)	Write to EEPROM	High-order 16 bits: convert the high-order bit H to 8 and then add 0x2000 (0x2080-0x2088) For example, the index of H1-12 is 0x2081.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of H1-12 is 0x0D.

Parameter Group	Conversion Rule of Object Dictionary Index		
	Write to EEPROM/RAM	Index	Sub-index
Group L0 to LD (display parameter group, read-only)	-	High-order 16 bits: convert the high-order bit L to 9 and then add 0x2000 (0x2090-0x209D) For example, the index of L0-12 is 0x2090.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of L0-12 is 0x0D.
Group U0 to UF (read-only)	-	High-order 16 bits: convert the high-order bit U to 7 and then add 0x2000 (0x2070-0x207F) For example, the index of U0-12 is 0x2070.	Low-order 16 bits: Convert the decimal number to a hexadecimal value and then add 1. For example, the sub-index of U0-12 is 0x0D.

- If a parameter is written to the EEPROM, the parameter value will be retained after a power failure. If a parameter is written to the RAM, the parameter value will not be retained after a power failure.
- Only EEPROM addresses can be written to parameters mapped by FE group. CANopen protocol parameters can be configured according to the object dictionary provided in the EDS file. The written EEPROM addresses will be automatically converted to RAM mappings.

Note the following:

- Group FF: The parameters can neither be read or written.
- Parameters in groups U0 and U2 are read-only; parameters in group U3 can be read and modified.
- 1000H, 2000H to 2004H, and 3000H are Modbus-specific communication addresses.

1.3 Modbus-specific Parameter Communication Addresses

Table 1–1 Modbus-specific Parameter Communication Addresses

Parameter Address	Description	Parameter Address	Description
1000H	Communication reference (decimal) -10000 to 10000	1010H	PID reference
1001H	Operating frequency	1011H	PID feedback
1002H	Bus voltage	1012H	PLC process
1003H	Output voltage	1013H	Pulse input frequency (unit: 0.01 kHz)
1004H	Output current	1014H	Feedback speed (unit: 0.1 Hz)
1005H	Output power	1015H	Remaining running time
1006H	Output torque	1016H	AI1 voltage before calibration
1007H	Running speed	1017H	AI2 voltage before calibration
1008H	DI input indication	1018H	AI3 voltage before calibration
1009H	DO output indication	1019H	Linear speed
100AH	AI1 voltage	101AH	Current power-on time
100BH	AI2 voltage	101BH	Current operating time
100CH	AI3 voltage	101CH	Pulse input frequency (unit: 1 Hz)

Parameter Address	Description	Parameter Address	Description
100DH	Counting value input	101DH	Value set through communication
100EH	Length value input	101EH	Actual feedback speed
100FH	Load speed	101FH	Display of main frequency X
-	-	1020H	Display of auxiliary frequency Y

Table 1-2 Description of Modbus-specific parameter addresses

Parameter Address		Description
Frequency 1 set through communication	1000H	Communication setpoint (decimal) -10000 to 10000 The communication setpoint is a percentage of a value. The value 10000 corresponds to 100.00%, and -10000 corresponds to -100.00%. The communication setpoint applies when the source of the frequency, torque upper limit, V/f separation voltage, PID reference, and PID feedback is set through communication. The frequency dimension data is the percentage of F0-10 (maximum frequency). The torque dimension data is the percentage of F2-10 or A2-48 (torque upper limit digital setting, corresponding to motor 1 and motor 2, respectively).
Frequency 2 set through communication	7310H	The unit of the written data is Hz. The decimal place is determined by F0-22. For example, when F0-22 is set to 2, the decimal number 1000 means that the frequency reference is 10.00 Hz.
Control command input to AC drive 1 (write-only)	7311H	0: Stop according to the stop mode set by F6-10 1: Forward run 2: Reverse run 3: Forward jog 4: Reverse jog 5: Coast to stop 6: Stop according to the stop mode specified by F6-10 7: Reset upon fault
Control command input to AC drive 2 (write-only)	2000H	1: Forward run 2: Reverse run 3: Forward jog 4: Reverse jog 5: Coast to stop 6: Stop according to the stop mode specified by F6-10 7: Reset upon fault
Read AC drive state 1	3000H	1: Forward run 2: Reverse run 3: Stop 4: Motor parameter auto-tuning 5: Fault

Parameter Communication Addresses

Parameter Address		Description	
Read AC drive state 2	7044H	Bit 0: Running state Bit 1: Running direction (forward/reverse) Bit 2: Whether a fault occurs Bit 3: Whether output frequency reaches the frequency reference Bit 4: Normal communication flag Bit 5 to bit 7: Reserved Bit 8 to bit 15: Fault code	
Password verification upon parameter lock	1F00H	If the value returned is the actual password, it indicates the password passes the verification. If password protection is not applied (FP-00 = 0), the returned value is 0000H.	
Parameter initialization	1F01H	1: Restore default setting 4: Restore user backup parameters 501: Back up current user parameters	
DO control	2001H	Bit 0: DO1 output control Bit 1: DO2 output control Bit 2: Relay 1 output control Bit 3: Relay 2 output control Bit 4: FMR output control	Bit 5: VDO1 Bit 6: VDO2 Bit 7: VDO3 Bit 8: VDO4 Bit 9: VDO5
AO1 control (write-only)	2002H	0 to 7FFF represent 0% to 100%.	
AO2 control (write-only)	2003H	0 to 7FFF represent 0% to 100%.	
Pulse output control (write-only)	2004H	0 to 7FFF represent 0% to 100%.	

Parameter Address		Description
AC drive fault description	8000H	2: Overcurrent 5: Overvoltage 8: Pre-charge power fault 9: Undervoltage 10: AC drive overload 11: Motor overload 12: Input phase loss 13: Output phase loss 14: Overheat 15: External fault 17: Pre-charge circuit error 18: Current sampling error 19: Motor parameter auto-tuning error 20: Encoder/PG card error (To be continued)

Parameter Communication Addresses

Parameter Address		Description
AC drive fault description	8000H	(Continued)
		21: EEPROM fault
		22: Encoder card not activated
		23: Output shorted to ground
		26: Cumulative running time reach
		27: User-defined fault
		28: User-defined warning
		29: Cumulative power-on time reach
		30: Output load loss
		31: PID feedback loss during operation
		32: Parameter error
		40: Pulse-by-pulse current limit fault
		42: Excessive speed deviation
		43: Motor overspeed
		45: Motor over-temperature
		47: STO fault
		51: Pole position auto-tuning error
		55: Master-slave control fault
		56: Self-check fault 1
		57: Self-check fault 2
		58: Self-check fault 3
		59: Self-check fault 4
		61: Braking overload
		62: Braking transistor fault
		63: External alarm
		82: Pre-charge contactor fault
		85: Time sequence fault
		93: Motor control error 1
		94: Motor control error 2
		159: Automatic fault reset
		160: Modbus timeout
		161: CANopen fault
		162: CANlink fault
		164: Expansion card fault
		174: Input error protection

2 List of Communication Protocols

The MD520 series AC drive supports eight communication protocols with external communication expansion modules installed. For details, see the following table.

Supported Protocol	Communication Hardware
Modbus RTU, Modbus ASCII	MD38TX1 communication expansion card
Modbus TCP	MD500-EM1 communication expansion card
CANlink	MD38CAN1 communication expansion card
CANopen	MD38CAN1 communication expansion card
PROFINET	MD500-PN1 and MD500-PN2 communication expansion cards
PROFIBUS DP	MD38DP2 and MD-SI-DP2 communication expansion cards
EtherCAT	MD500-ECAT communication expansion card
EtherNet/IP	MD500-EN1 communication expansion card

3 Modbus Communication (MD38TX1)

3.1 Overview

With the RS485 communication interface, the MD520 series AC drive connects as a communication slave to the PC/PLC control network with a single master and multiple slaves. You can carry out centralized control by using a PC or PLC. Through the RS485 communication protocol, you can also set the running commands, modify or read parameters, and read the operating status and fault information of the drive.

The drive supports the Modbus RTU and Modbus ASCII slave communication protocol. These protocols define the content and format of messages transmitted during serial communication. If the slave encounters an error upon receiving a message or fails to complete the action required by the master, it responds with a fault message to the master.

3.2 Interface and Networking

In a network with a single master and multiple slaves, one of the devices works as the communication master (typically a host controller, PLC, or HMI), and the other devices work as communication slaves. The master establishes communication with the slave to perform read or write operations on slave parameters, and the slave responds to queries or operations from the master. At the same moment, only one device can transmit data and the other can only receive data.

Each communication slave has a unique slave address, which ranges from 1 to 247. 0 indicates the broadcast address.

Communication port

The MD38TX1 communication expansion card can provide the RS485 interface for the MD520 to implement Modbus communication. The isolation scheme is adopted and the electrical parameters conform to international standards. You can use the card as required to control operation and parameter settings of the AC drive through the remote serial interface. See the following figure.

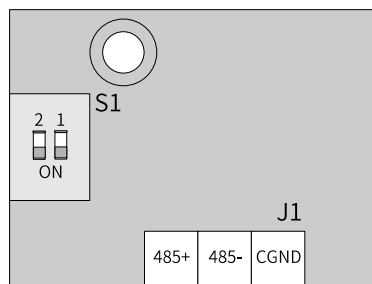


Figure 3-1 Front interface layout of the MD38TX1 card

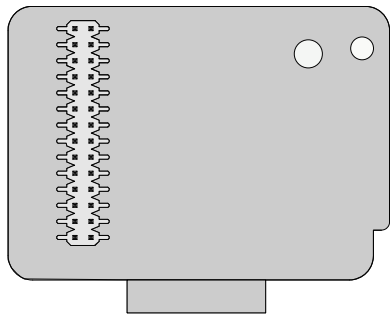


Figure 3-2 Bottom interface layout of the MD38TX1 card

Note

In “Figure 3-1 Front interface layout of the MD38TX1 card” on page 22, the gray block in the S1 terminal corresponds to the white bulging block in the product appearance diagram.

Table 3-1 Descriptions of MD38TX1 card terminals

Terminal Mark		Terminal Name	Function Description	Layout								
J1	485+	RS485 communication signal (+)	RS485 communication input terminal with the isolation function	<table><tr><td>485+</td><td>485-</td><td>CGND</td></tr><tr><td></td><td></td><td></td></tr></table>			485+	485-	CGND			
	485+	485-	CGND									
485-	RS485 communication signal (-)	RS485 communication input terminal with the isolation function										
CGND	Reference ground of RS485 communication signal	Isolated power supply										

Table 3-2 Descriptions of the MD38TX1 card jumper

Terminal Mark	Terminal Name	Function Description	Jumper/DIP Switch Position
S1	DIP switch of the RS485 communication termination resistor	The termination resistor is connected.	 ON
		The termination resistor is not connected.	 ON

Note

The MD38TX1 expansion card is connected through the DIP switch.

The DIP switch is set from the top view with main terminal block at the bottom. The DIP switch is subject to the silk-screen on the board.

Communication networking

1. RS485 bus topology

The RS485 bus topology is shown in the following figure. It is recommended to use shielded twisted pairs as the RS485 bus and use twisted pair cables to connect 485+ and 485-. Install a termination resistor with the resistance of 120 Ω at both ends of the bus to prevent signal reflection. Connect the reference grounds of RS485 signals for all nodes together. A maximum of 128 nodes is supported and the distance between the node and the RS485 bus must be shorter than 3 m.

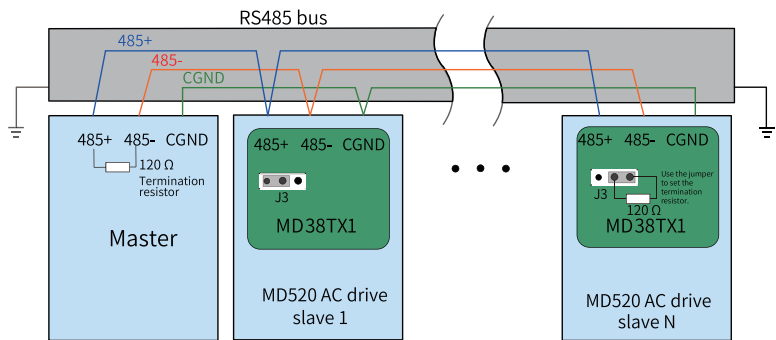


Figure 3-3 RS485 bus topology

2. Multi-node connection mode

When the number of nodes is large, the RS485 bus must be daisy-chained. If a branch line is needed, the length of the branch cable should be less than 3 m and as short as possible. Star connection is strictly prohibited. The following figures show the common bus topology.

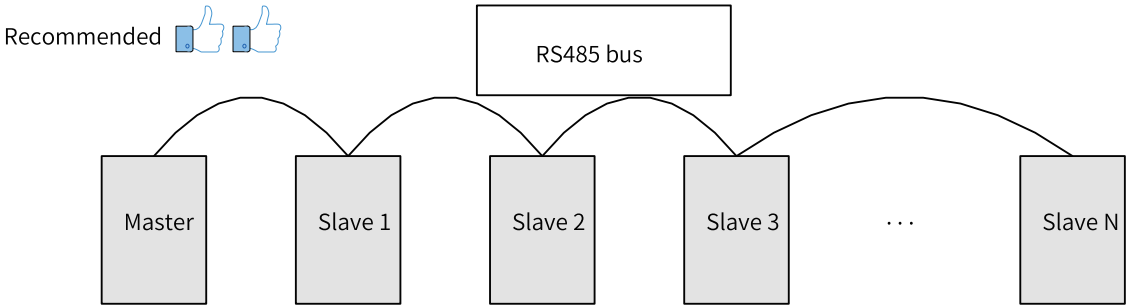


Figure 3-4 Daisy-type topology

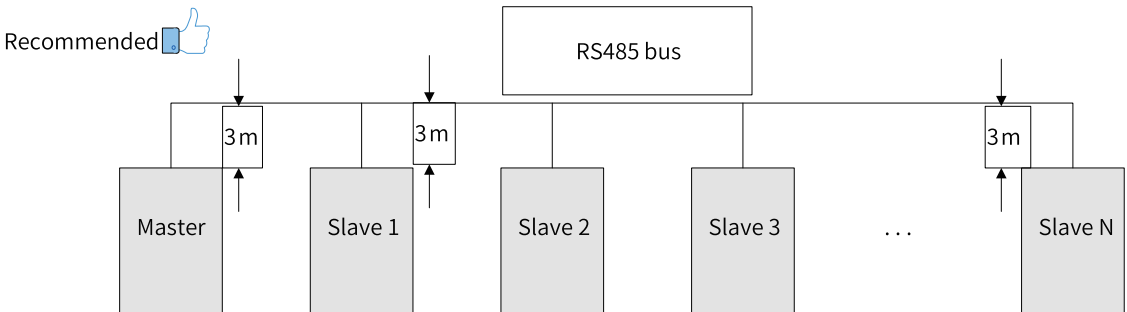


Figure 3-5 Branch topology

It is recommended that the branch not exceed 3 m.

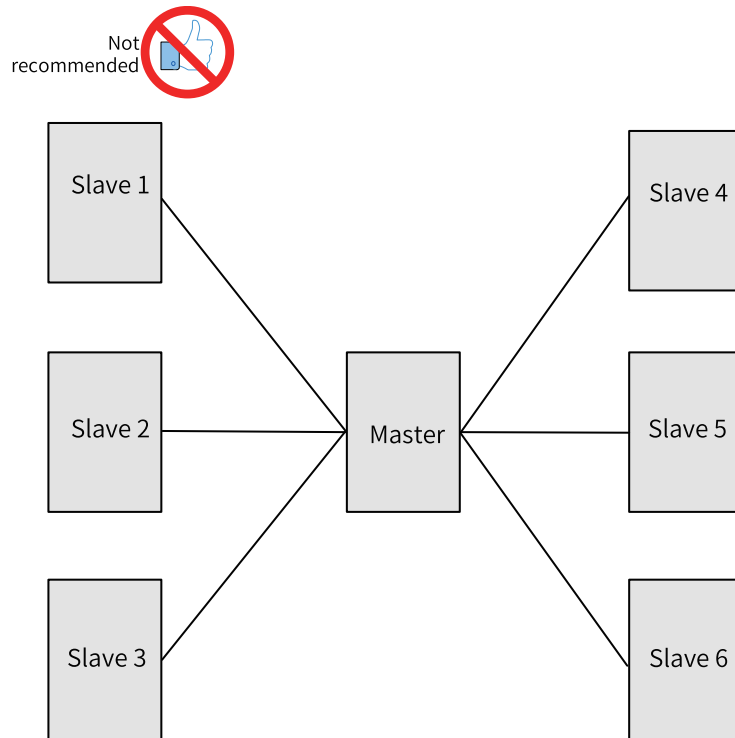


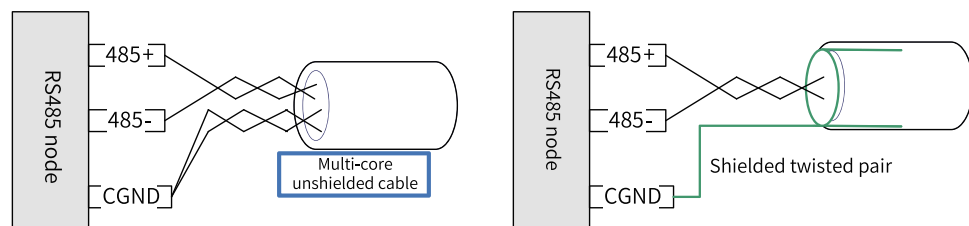
Figure 3-6 Star-type topology (prohibited)

3. Terminal wiring

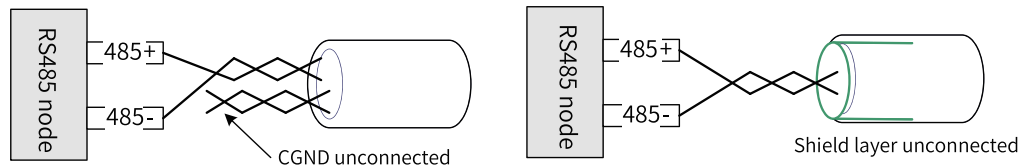
- Terminal wiring for nodes with CGND

The RS485 bus has three cables, which are used to connect to the 485+, 485-, and CGND terminals of the MD38TX1 expansion card respectively. Check that the RS485 bus on site contains three cables and the wiring terminals are connected correctly. For use of shielded cables, connect the shield to the CGND terminal. Do not connect the shield to any other part (including enclosure on site and the grounding terminal of the device) except the CGND terminal.

Due to cable attenuation, use AGW26 or thicker cables if the connection length is longer than 3 m. Twisted pair cables are always recommended for connecting 485+ and 485-.



- Recommended cable 1: Multi-conductor twisted pair cables. Connect the twisted pair cable to 485+ and 485-, and twist the remaining pairs together to connect CGND.
 - Recommended cable 2: Shielded twisted pair cables. Connect the twisted pair cable to 485+ and 485- and connect the shield to CGND.
 - In cases where the shielded cable is used as the connecting cable, connect the shield only to CGND.
 - Terminal wiring for nodes without CGND
- For nodes without CGND, do not connect CGND or the shield to the PE terminal of the node directly. Do as follows:



- Method 1: Check whether another port on this node shares a common reference ground with the RS485 circuit. If yes, connect the CGND cable (the shield) of the bus directly to the pin.
- Method 2: Find the reference ground of the RS485 circuit on the node board and connect the drain wire to CGND or the shield.
- Method 3: If the reference ground of the RS485 circuit cannot be found, keep the CGND cable or the shield unconnected and use an extra grounding cable to connect this node to the PE terminal of other nodes.

Transmission distance

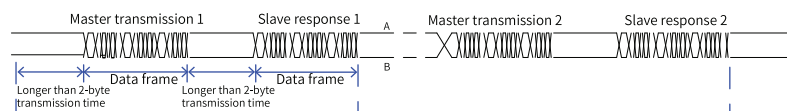
The following table lists the maximum number of nodes and transmission distance supported by the standard RS485 circuit at different transmission rates.

Table 3–3 Maximum number of nodes and transmission distance

Transmission Distance (m)	Rate (kbps)	Number of Nodes	Cable Specification
100	115.2	128	26AWG
1000	19.2	128	26AWG

3.3 Communication Transmission Mode

In an RS485 communication network, data is transmitted in the asynchronous serial and half-duplex transmission mode. Data is sent frame by frame in the message format specified by the Modbus RTU protocol. The idle time longer than 3.5-byte transmission time marks the start of a new communication frame.



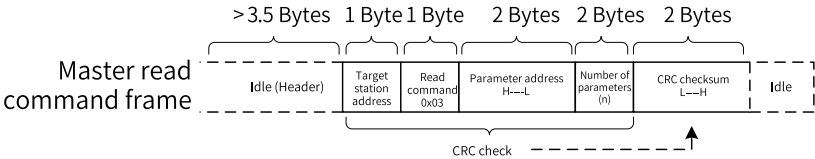
The built-in communication protocol of the AC drive is the Modbus RTU slave communication protocol, which allows the AC drive to respond to the query command from the master or execute the action according to query command from the master and respond with communication data.

A master can be a PC, an industrial control device, or a PLC, etc. The master can separately communicate with a slave or issue broadcast information to all slaves. When the master sends a query command to a single slave, the slave needs to return a response frame. For a broadcast message sent by the master, the slaves do not need to return a response to the master.

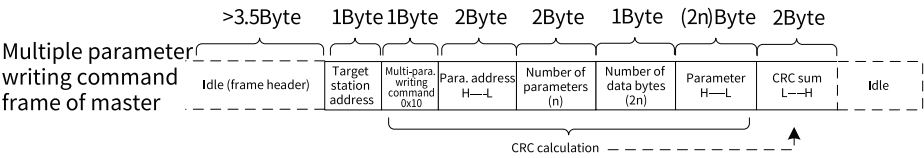
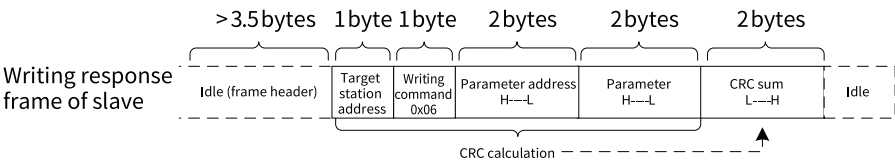
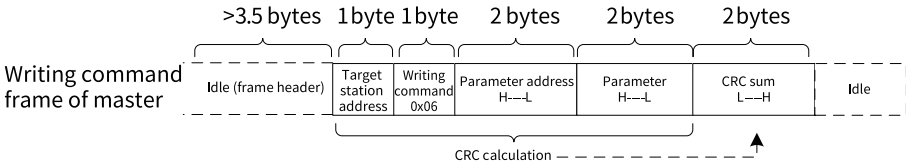
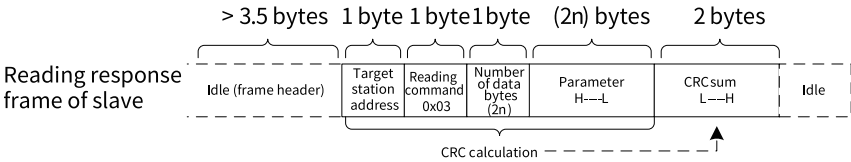
3.4 Communication Data Frame Structure

The following figure shows the communication data format of the Modbus RTU protocol. The AC drive supports reading or writing only of word type parameters, and does not support reading or writing of

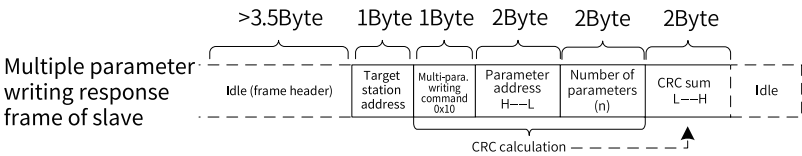
bytes or bits. The read operation command is 0x03, the write operation command is 0x06, and the multi-data write operation command is 0x10.



In theory, the host controller can read or write a maximum of 12 consecutive parameters. However, these parameters must be in the same group. Otherwise, a response error occurs.



A maximum of 12 consecutive parameters can be read or written.



If the slave detects a communication frame error or a reading/writing failure caused by other reasons, an error frame will be returned.

Note

No response is returned for CRC check error.

The command for a reading error responded by the slave is 0x83. The command for a writing error responded by the slave is 0x86. The command for a multi-data write error responded by the slave is 0x90.

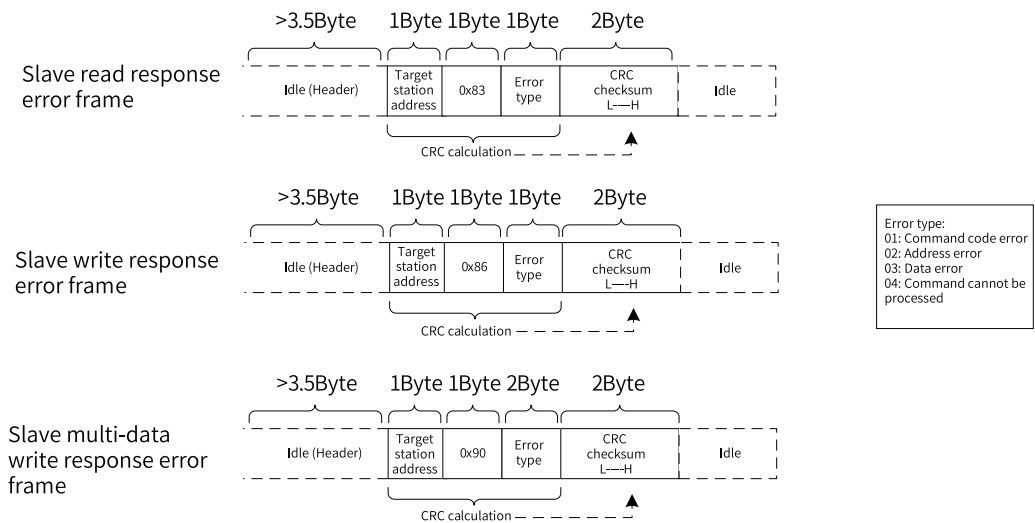


Table 3-4 Data frame fields

Frame Header (START)	Longer than the time for transmitting 3.5 bytes
Slave Address (ADR)	Communication address range: 1 to 247
Command Code (CMD)	03: Read a slave parameter; 06: Write a slave parameter; 10: Write multiple slave parameters
Parameter Address (H)	Internal parameter address of the drive are in hexadecimal format, which are divided into parameter type and non-parameter type (such as running status parameters and running commands). See the address definition for details. Low-order bytes follow high-order bytes during transmission.
Parameter Address (L)	
Number of Parameters (H)	Number of parameters read in this frame. 1 indicates that one parameter is read. Low-order bytes follow high-order bytes during transmission.
Number of Parameters (L)	
Number of Data Bytes	Data length, which is twice the number of parameters
Data (H)	Response data or data to be written. Low-order bytes follow high-order bytes during transmission.
Data (L)	
CRC Low-Order Bit	Detection value: CRC16 check value. High-order bytes follow low-order bytes during transmission. For details about the calculation method, see the description of CRC in this section.
CRC High-Order Bit	
END	Time for transmitting 3.5 bytes

CRC check:

The cyclical redundancy check (CRC) adopts the RTU frame format. A Modbus message includes a CRC-based error check field. The CRC field checks the content of the entire message. The CRC field is two bytes, containing a 16-bit binary value. It is added to the message after being calculated by the transmission device. The reception device recalculates a CRC value in the message, and compares the calculated value with the CRC value in the received CRC field. If the two CRC values are different, transmission errors occur.

The CRC is first stored to 0xFFFF. Then a procedure is invoked to process the consecutive 8-bit byte in the message and the value in the register. Only the 8-bit data in each byte is valid for the CRC. The start bit, stop bit and the parity bit do not apply to the CRC.

During generation of CRC, each 8-bit byte is in exclusive or (XOR) with the content in the register. The result is shifted to the least significant bit (LSB), and 0 is filled in the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB is 1, the register then performs XOR with a preset value. If the LSB is 0, no XOR is performed. This process is repeated eight times. After the last (eighth) time, the next 8-bit byte is in XOR with the register's current value, and the process repeats for eight more shifts as described above. The final value of the register is the CRC value after all the bytes in the message have been applied.

The CRC is added to a message from the low-order byte to the high-order byte. A simple function for the CRC is as follows:

```
unsigned int crc_chk_value(unsigned char *data_value,unsigned char length)
{
    unsigned int crc_value=0xFFFF;
    int i;
    while (length——)
    {
        crc_value^=*data_value++;
        for (i=0;i<8;i++)
        {
            if (crc_value&0x0001)
            {
                crc_value= (crc_value>>1) ^0xa001;
            }
            else
            {
                crc_value=crc_value>>1;
            }
        }
    }
    return (crc_value);
}
```

Definition of communication parameter addresses:

The parameters can be read and written (except those which cannot be changed because they are only for factory use or monitoring).

3.5 Related Parameters

Table 3-5 Parameters related to Modbus communication

Parameter Code	Parameter Name	Default	Value Range	Description
FD-00	Baud rate	5005	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	This parameter defines the speed of data transmitted between the host controller and the AC drive. The higher the baud rate, the faster the communication speed. Note that the baud rate of the host controller must be the same as that of the AC drive. Otherwise, communication will fail.
FD-01	Modbus data format	0	0: No check (8-N-2) 1: Even parity check (8-E-1) 2: Odd parity check (8-O-1) 3: No check (8-N-1) 4: No check (7-N-2) 5: Even parity check (7-E-1) 6: Odd parity check (7-O-1) 7: No check (7-N-1)	This parameter defines the format of Modbus data transmitted between the host controller and AC drive. Note that the data format of the host controller must be the same as that of the AC drive. Otherwise, communication fails.

Parameter Code	Parameter Name	Default	Value Range	Description
FD-02	Local address	1	1 to 247	The local address must be unique in the range of 1 to 247, which is the basis for point-to-point communication between the AC drive and host controller. Note: This parameter is used to set the station alias when EtherCAT communication with the communication card version other than V125 (U0-67) applies. When EtherCAT communication with the communication card version V125 applies, the parameter cannot be used to set the station alias.
FD-03	Modbus response delay	2	0 ms to 20 ms (valid for Modbus)	This parameter defines the interval from the end of data reception by the AC drive to the start of data transmission to the host controller. If the response delay is shorter than the drive processing time, the drive processing time prevails. That is, after the drive finishes data processing, it sends data to the host controller. If the response delay is longer than the system processing time, the AC drive will send data to the host controller only after the system finishes data processing and the response delay expires.
FD-04	Communication timeout time	0	0.0 (invalid) 0.1s to 60.0s	When it is set to 0.0s, the Modbus communication timeout time is invalid. Generally, set it to 0.0s. This parameter is used to monitor communication status in a system with continuous communication. When it is set to an effective value, if the time interval between the current communication and the next communication exceeds Fd-04 (Modbus communication interruption detection time), the system reports a communication fault (E160.1).

3.6 Communication Configuration

3.6.1 Configuration for RS485 Communication Between AC Drive and H5U

Software acquisition and hardware connection

1. Log in to Inovance website www.inovance.com and download the H5U programming software.
2. Connect 485+ and 485- on the H5U to 485+ and 485- on the drive, as shown in the following figure.

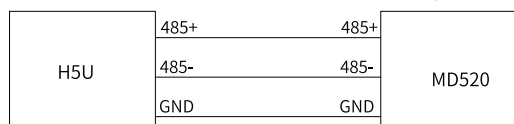
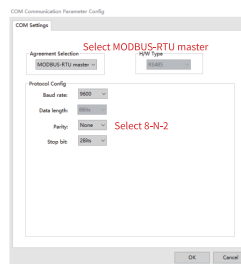


Figure 3-7 Connecting communication interfaces

Master and slave configuration

1. Open AutoShop, click **New Project**, check that **Series and models** is **H5U**, and click **OK** to enter the programming interface.

- Click  in the left pane to go to the PLC configuration interface, select the protocol and data format, and click **OK**.



- Click  , then click **Add Modbus Config** and **OK**.  **COM0 Modbus Config** is displayed. Double-click  , and click **Add** on the displayed interface.

You can perform operations on a variable of the AC drive each time you click **Add**.

- Write operation: After clicking **Add**, select the **Slave NO.** and **Trigger Mode** (typically **Cycle**).

NO.	Name	Slave NO.	Trigger Mode	Trigger Conditions	Function Code	Slave addr...	Quantity	Mapped Addr.	Repeat Num
1	slave	1	Cycle(ms)	1000	Write Register(16)	1000	1	D0	1

As shown in the preceding figure, **Slave NO.** is **1**, indicating that the operation will be performed on slave 1. Set **Trigger Mode** to **Cycle** and **Function Code** to **Write Register**; otherwise, the write operation will fail. The internal variables of the AC drive are all 16-bit data. Set **Quantity** to **1**. If **Quantity** is set to **2**, the write operation will fail.

- Read operation: After clicking **Add**, select the **Slave NO.** and **Trigger Mode** (typically **Cycle**).

NO.	Name	Slave NO.	Trigger Mode	Trigger Conditions	Function Code	Slave addr...	Quantity	Mapped Addr.	Repeat Num
1	slave	1	Cycle(ms)	.. 1000	Write Register(16)	1000	1	.. D0	1
2	slave	1	Cycle(ms)	.. 1000	Write Register(16)	2000	1	.. D2	1
3	slave	1	Cycle(ms)	.. 1000	Read Register(03)	7002	1	.. D300	1
4	slave	1	Cycle(ms)	.. 1000	Read Register(03)	7003	1	.. D302	1

As shown in the preceding figure, **Slave NO.** is **1**, indicating that the operation will be performed on slave 1. Set **Trigger Mode** to **Cycle** and **Function Code** to **Read Register**; otherwise, the read operation will fail. The internal variables of the AC drive are all 16-bit data. Set **Quantity** to **1**. If **Quantity** is set to **2**, the read operation will fail.

After the read and write operation settings, click **OK** to return to the programming interface.

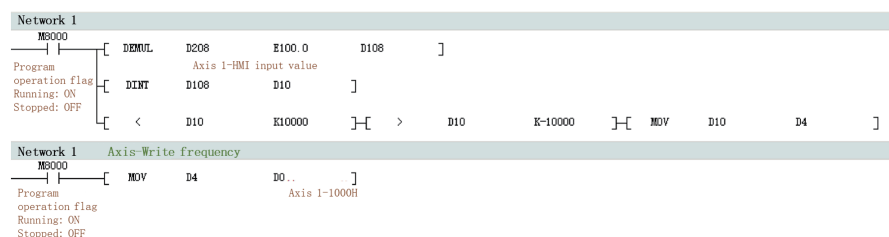
Instances

- Write the frequency (F0-03 is set to 9).

Data conversion: Multiply the required frequency (a) by 100 to obtain an integer, and then write the integer to 1000H.

The following figure shows the configuration and the program.

Function Code	Slave address (H)	Quantity	Mapped Address	Repeat Number
Write Register (16)	1000	1	D0	1



- Start or stop the AC drive (F0-02 is set to 2).

Assign a value to the D component corresponding to the station address 2000H to control forward running, reverse running, and stop of the AC drive through communication. Definitions of 2000H are as follows:

1: Run in forward direction; 2: Run in reverse direction; 3: Jog in forward direction; 4: Jog in reverse direction; 5: Coast to stop; 6: Decelerate to stop; 7: Reset upon fault

The following figure shows the configuration and the program.

Function Code	Slave addr...	Quantity	Mapped Addr.
Write Register(16)	2000	1	D2

—[	MOV	K1	D2	]
			Axis 1 control word	

The PLC soft component address corresponding to 2000H is D2. Therefore, to control the AC drive to run in forward direction through communication, write 1 to D2. Similarly, to control the AC drive to decelerate to stop, set D2 to 6.

3. Read the bus voltage.

Based on the conversion rule, convert the bus voltage U0-02 to 7002 (convert U in the high-order 2 bits to 7, and convert the low-order 2 bits to a hexadecimal equivalent). The actual bus voltage is the read bus voltage (a) divided by 10. According to the communication configuration, the D component address of the bus voltage is D300. Convert D300 to a floating-point number and then divide this value by 10.

The following figure shows the configuration and the program.

Function Code	Slave address (H)	Quantity	Mapped Address
Read Register (03)	7002	1	D300

—[	DFLT	D300	D350	]
		Axis 1-Read the value of U0-02		

—[	DEDIV	D350	E10	D500	]
				Actual bus voltage	

4. Read the output voltage.

Convert the output voltage U0-03 to 7003 based on the conversion rule. The read value is the actual output voltage. According to the communication configuration, you only need to move the value of D302 to another D component (or not).

The following figure shows the configuration and the program.

Function Code	Slave addr...	Quantity	Mapped Addr.
Read Register(03)	7003	1	D302

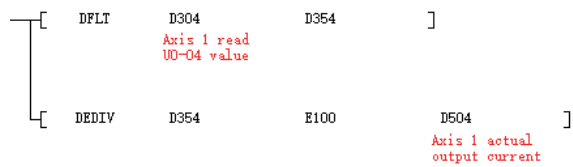
—[	MOV	D302	D502	]
		Axis 1 read U0-03 value	Axis 1 actual output voltage	

5. Read the output current.

Convert the output current address U0-04 to 7004 based on the conversion rule. The actual output current is the read output current divided by 100.

The following figure shows the configuration and the program.

Function Code	Slave addr. ...	Quantity	Mapped Addr.
Read Register (03)	7004	1	... D304



6. Read the AC drive state.

Read 3000H to directly obtain the current state of the AC drive (0001: Forward running; 0002: Reverse running; 0003: Stopped; 0004: Motor parameter auto-tuning; 0005: Fault).

The following figure shows the configuration and the program.

Function Code	Slave addr. ...	Quantity	Mapped Addr.
Read Register (03)	3000	1	... D308



7. Read the DI state.

According to the conversion rule, convert the DI state U0-07 to 7007. Convert the read value into a binary value. The LSB indicates DI1, the second bit indicates DI2, and so on.

Function Code	Slave addr. ...	Quantity	Mapped Addr.
Read Register (03)	7007	1	... D310

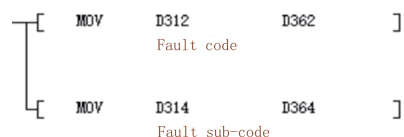


8. Read the fault code.

Convert the fault code U0-62 to 703E and convert the fault subcode U0-45 to 702D based on the conversion rule.

The following figure shows the configuration and the program.

Function Code	Slave address (H)	Quantity	Master Buffer Area Address
Read Register (03)	703E	1	D312
Read Register (03)	702D	1	D314



Common faults and solutions

The must-dos are listed as follows:

1. Check whether other pins instead of 485+ and 485- are connected.
2. Check whether the communication rate defined by FD-00 of the MD520 is consistent with that of the host controller.
3. Check whether the data format defined by FD-01 of the MD520 is consistent with that of the host controller.
4. Check whether the communication address defined by FD-02 (local address) of each device is unique to avoid conflicts caused by duplicated local addresses.

Table 3-6 Common faults and solutions

Problem	Solution
Failure to write frequency	1 Check F0-03 to confirm that the address in the configuration table is correct. When F0-03 is 0, the address is the address of F0-08; when F0-03 is 9, the address is 1000H or 7310H. 2 Check whether the termination resistor is connected. If not, switch on the termination resistor and then power on the AC drive again.
Failure to start the AC drive	1 Check that F0-02 is set to 2 (0: Operating panel; 1: Terminal; 2: Communication). 2 Check whether the termination resistor is connected. If not, switch on the termination resistor and then power on the AC drive again.
Unstable connection	1 Check that wiring on the PLC end is reliable. 2 Check that wiring on the AC drive end is reliable. 3 Check that the signal cables are far away from the power cable.
Incorrect read value	1 Check that the configuration address is correct. 2 Check whether the program performs data conversion. 3 Make sure that the D component is not occupied.

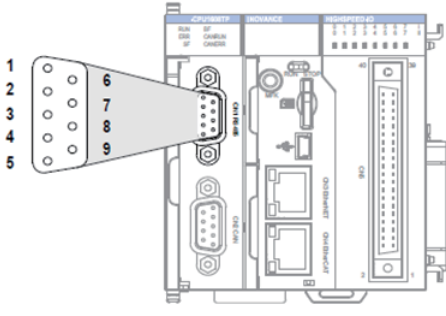
3.6.2 Configuration for RS485 Communication Between AC Drive and AM600

The following section describes how to configure the AM600 series PLC to control the AC drive to run forward or reversely.

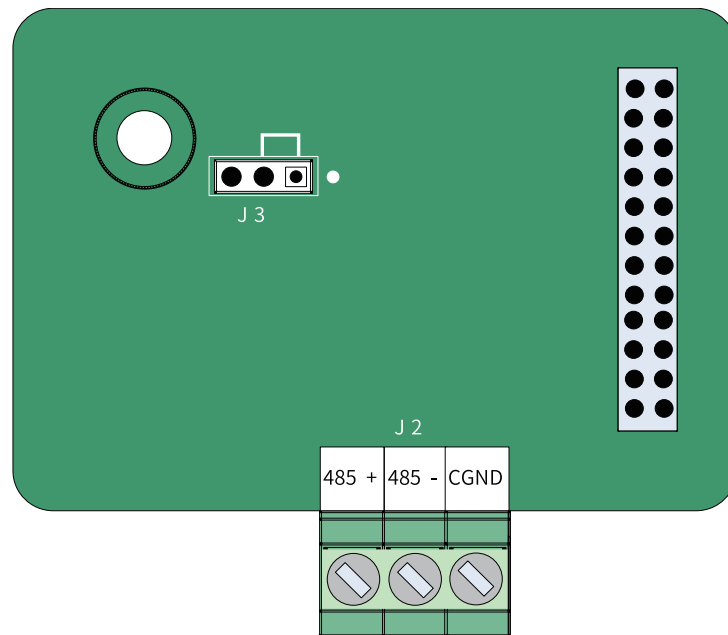
Hardware connection

Interfaces:

- The AM600 provides two RS485 ports. The two RS485 channels share the same DB9 interface. For details, see the following figure.

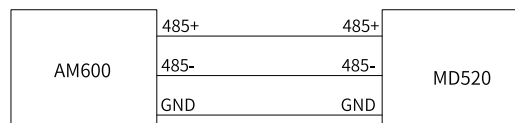
RS485 port on CPU module	Pin	Channel	Assignment	Function
	1	COM0 (RS485)	RS485-	Negative signal of the RS485 differential pair of COM0
	2		RS485+	Positive signal of the RS485 differential pair of COM0
	5		GND0	Power ground of COM0
	6	COM1 (RS485)	RS485-	Negative signal of the RS485 differential pair of COM1
	9		RS485+	Positive signal of the RS485 differential pair of COM1
	3		GND1	Power ground of COM1

- The MD520 supports one RS485 port, which is located on the MD38TX1 communication card, as shown in the following figure.



Hardware connection procedure:

1. Take COM1 as an example. Connect one end of the network cable to CN1 of the AM600 through the DB9 terminal. Strip the other end of the cable, connect the RS485+, RS485-, and GND wires to the 485+, 485-, and GND terminals of the AC drive, respectively, as shown in the following figure.



2. Insert the termination resistor jumper cap J3 on the expansion card to the right.

Configuration on the drive side

Set the following parameters on the AC drive. Set F0-02 to 2 (set the command source to communication), and set F0-03 to 9 (set the main frequency source to communication).

Ones place of FD-00 = 5

FD-01 = 0

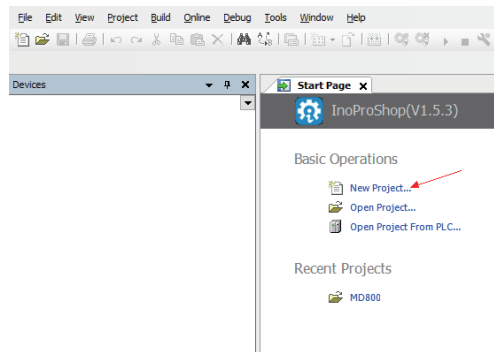
FD-03 = 2

FD-04 = 0.0

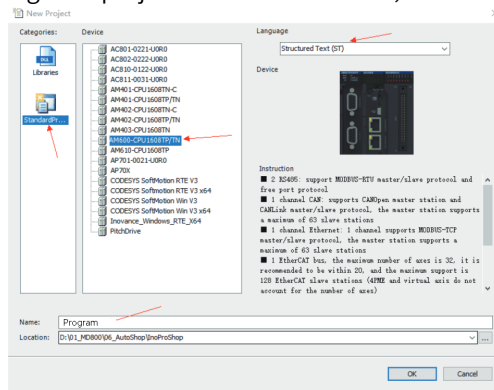
Record the address of FD-02, which is the station number of the AC drive.

Configuration on the PLC side

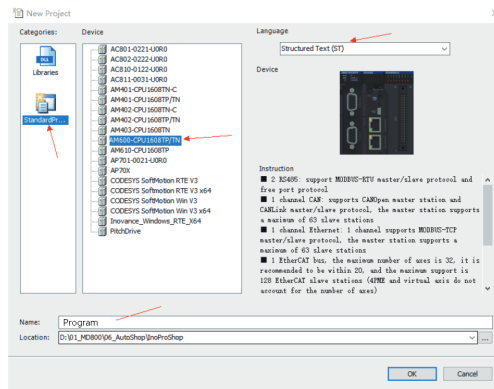
1. Connect the PC and PLC through a network cable or USB, open InoProShop, and create a new project.



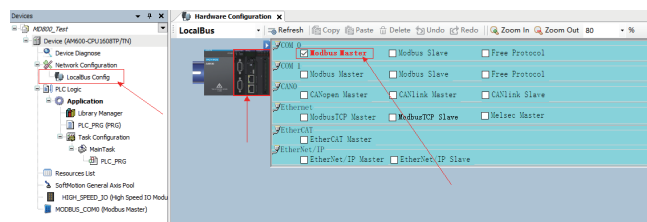
2. Click **Standard Project**, change the project name and location, and click **OK**.



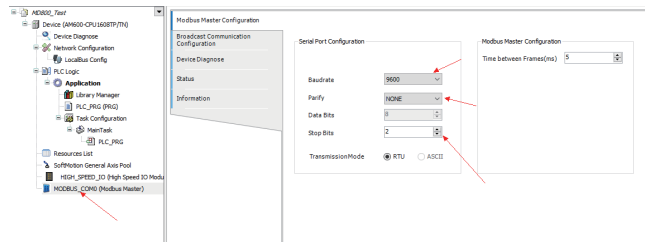
3. Select **AM600-CPU1608TP/TN**, select **Structured Text (ST)** from the **Language** drop-down list, and click **OK**.



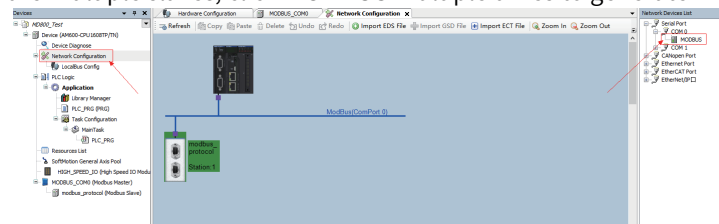
4. Click **LocalBus Config**, and click the CPU module. In hardware connection, the RS485 cable of the COM0 is connected to the RS485 terminal of the MD520. Therefore, select the Modbus master station of the serial port 0.



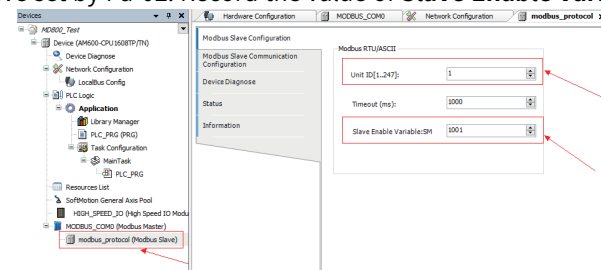
5. Click **MODBUS_COM0** in the left pane, and set the baud rate, parity, and stop bit according to the settings of FD-01.



- Double-click **Network Configuration** in the left pane. Choose **Serial Port > COM 0** in the right pane, and double-click **MODBUS**. A new slave is displayed on the Modbus bus in the center of the interface. If there are multiple slaves, click **MODBUS** multiple times to generate multiple slaves.



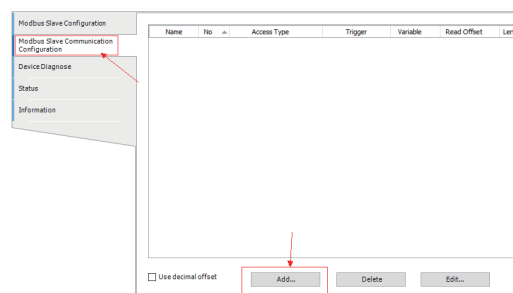
- Double-click the new Modbus slave station and set its number, which must be same as the station number of the AC drive set by Fd-02. Record the value of **Slave Enable Variable**.



- Compile the PLC program as follows: Enable the slave enable variable. Set the frequency of the AC drive to 50 Hz. Make the PLC run for 4000 scanning cycles. During the first 2000 scanning cycles, make the PLC control the AC drive to run in the forward direction. During the last 2000 scanning cycles, make the PLC control the AC drive to run in the reverse direction. Make the PLC control the AC drive to decelerate to stop. Note that the slave enable variable must be enabled.



- Add configuration information on the **Modbus Slave Communication Configuration** tab.



- Configure the register in the displayed dialog box. The control word reading address of the AC drive is 3000H, the writing address is 2000H, and the frequency address is 1000H.

Modbus Channel Set

Channel: Channel 01

Access Type: Write Single Register (Function Code 06)

Trigger: Cycle Cycle Time(ms): 100

Repeated: 1

Comment:

Read Register

Offset: 0x0000

Length(WORD): 1

Error Handling: Keep Last Value

Write Register

Offset: 0x2000

Length(WORD): 1

OK Cancel

Modbus Channel Set

Channel: Channel 02

Access Type: Read Holding Registers (Function Code 03)

Trigger: Cycle Cycle Time(ms): 100

Repeated: 1

Comment:

Read Register

Offset: 0x3000

Length(WORD): 1

Error Handling: Keep Last Value

Write Register

Offset: 0x0000

Length(WORD): 1

OK Cancel

11. On the **Internal I/O Mapping** tab, map the variable of the PLC to the address of the AC drive.

Modbus Slave Configuration

Modbus Slave Communication Configuration

Device Diagnose

Internal I/O Mapping

Status

Information

Find: Filter: show all

Variable	Mapping	Channel	Address	Type	Default Value	Unit	Description
counter		Channel 02	%I0.1	ARRAY [0..3] OF WORD			Read Holding Registers
pinlv		Channel 01	%QW1	ARRAY [0..3] OF WORD			Write Single Register

Create new variable Map to existing variable

Reset mapping Always update variables: Enabled

12. Select the variable to be mapped.

Input Assistant

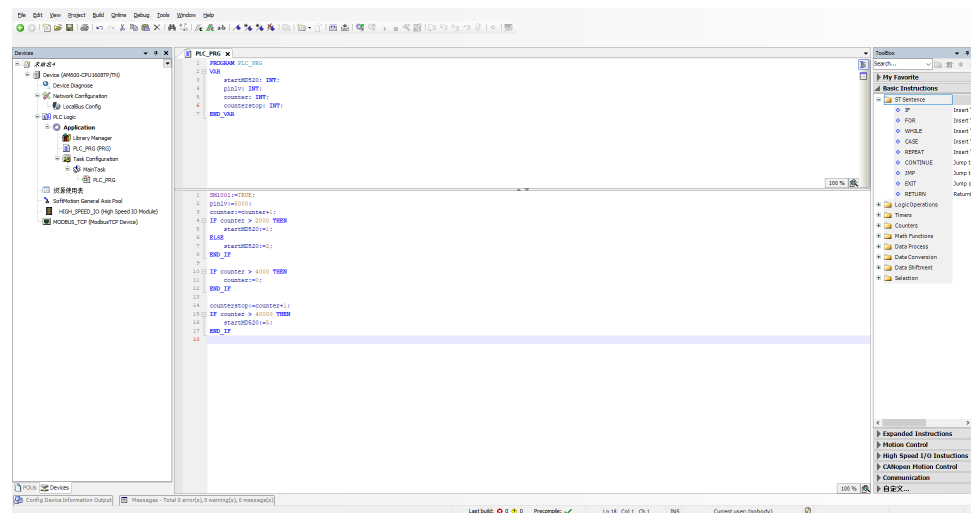
Text Search Categories

Variables

Name	Type	Address	Origin
Application	Application		
PLC_PRG	PROGRAM		
counter	INT		
pinlv	INT		
start...	INT		
IoConfig_Globals	VAR_GLOBAL		
SDElement			
SM3_Basic	Library		SM3_Basic, 4.2.0.0 (...)
SM3_Math	Library		SM3_Math, 4.2.0.0 (...)
SMEElement			

Structured view Filter: None

13. Compile the program to check whether there are errors. If no error is found, log in to the PLC, download the program, and click the **Execute** button to execute the program.



4 Modbus TCP Communication (MD500-EM1)

4.1 Overview

Through the built-in Ethernet interface, the MD500-EM1 enables the AC drive to connect to a PC- or PLC-controlled network as a slave. The network includes one master and multiple slaves. You can carry out centralized control by using a PC or PLC and set the running commands, modify or read parameters, and read the operating status and fault information of the AC drive through the communication protocol.

The MD500-EM1 expansion card supports the Modbus TCP slave communication protocol. This protocol defines the content and format of transmitted messages. If an error occurs when the slave receives a message, or the slave cannot complete the action required by the master, the slave responds with a fault message to the master.

4.2 Networking and Interfaces

Communication port

The AC drive can communicate with the master based on the Modbus TCP through the MD500-EM1 card. [“Table 4–1” on page 41](#) shows the hardware layout of the MD500-EM1 card. The pin header J7 on the back of the MD500-EM1 card is used to connect the drive. The MD500-EM1 card provides two Ethernet ports J4 and J6 to enable the card to communicate with the Modbus TCP master (or other slaves). For details about the hardware, see [“Table 4–1” on page 41](#).

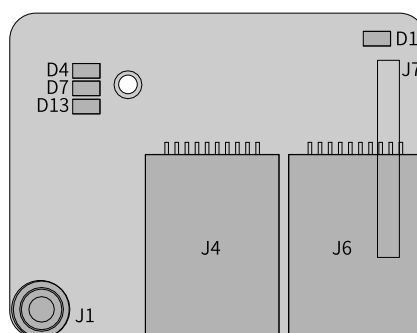


Figure 4-1 MD500-EM1 card terminal layout

Table 4–1 Descriptions of MD500-EM1 card terminals

Mark	Hardware Name	Description
J7	Pin header	It is used to connect the AC drive.
J4	Network port	The ports are standard Ethernet RJ45 ports and are direction-insensitive. The MD500-EM1 card uses the ports to communicate with the Modbus TCP master (or other slaves). The pin definition is consistent with the standard Ethernet pin definition. The crossed or straight cables are supported.
J6		
J1	EMC grounding terminal	It is used to connect the EMC grounding terminal of the AC drive.

Mark	Hardware Name	Description
D13	Power supply indicator (green)	It is used to indicate the status of the power supply. On: Normal OFF: Abnormal. Check whether the card is installed properly.
D1	Status indicator of communication with the AC drive (green)	For details, see “Table 4-2 Indicators of the MD500-EM1 card” on page 42.
D4	Modbus TCP master running indicator (green)	
D7	Modbus TCP master fault indicator (red)	



Caution

- After the MD500-EM1 card is installed, J4 is on the left and J6 is on the right when you face the RJ45 interface. J4 and J6 are direction-insensitive. You can connect either one to the PLC.
- It is recommended to use shielded Cat 5e twisted pair cables to ensure stable operation.

Table 4-2 Indicators of the MD500-EM1 card

Indicator	Description	Solution
D1 (green): steady on	Normal	None
D1 (green): off	Abnormal communication with the AC drive	Check that FD-00 is set to 9 and FD-01 is set to 1.
D4 (green): off; D7 (red): steady on	System fault	See the following AC drive fault codes and solutions.
D4 (green): off; D7 (red): blinking	Waiting for obtaining IP addresses	The DHCP function is enabled, and the expansion card is waiting for IP address assignment by using the BOOTP or DHCP.
D4 (green): blinking; D7 (red): blinking	Network disconnection	Check that the network cable is connected properly.
D4 (green): blinking; D7 (red): off	Waiting for connecting to the master	Check that the master is running.
D4 (green): steady on; D7 (red): blinking	Communication timeout	Check that the master is running.
D4 (green): steady on; D7 (red): off	Normal	N/A

Communication networking

The Modbus TCP supports multiple types of topologies, including the bus type and star type. Multiple types of networking can be achieved through the switch.

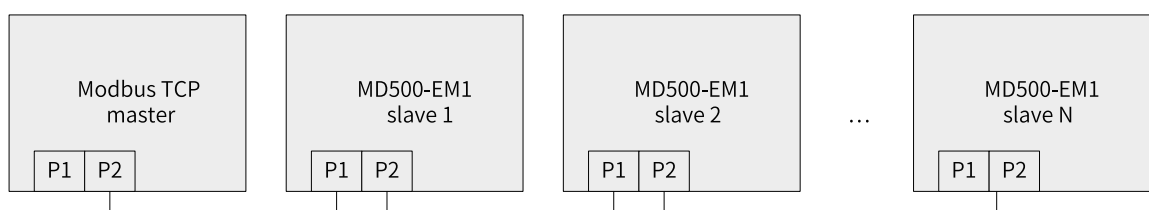


Figure 4-2 Bus-type topology

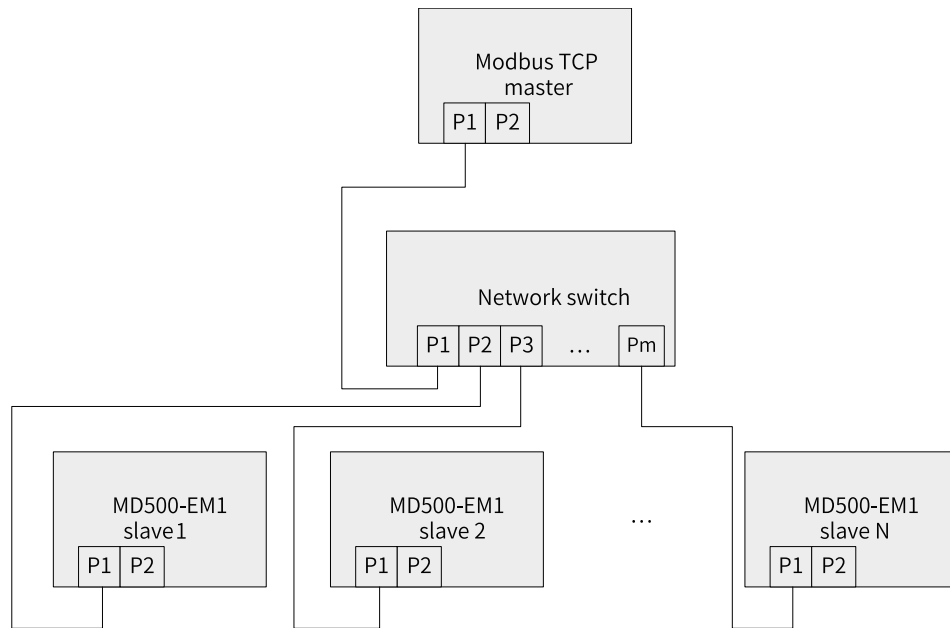


Figure 4-3 Star-type topology

4.3 Communication Data Frame Structure

The following figure shows the communication data format of the Modbus TCP protocol. The AC drive supports reading or writing only of word type parameters, and does not support reading or writing of bytes or bits. The read operation command is 0x03, the write operation command is 0x06, and the multi-data write operation command is 0x10.

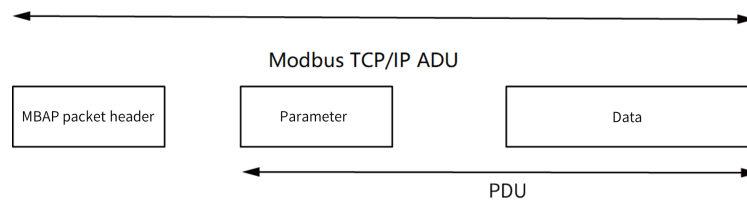
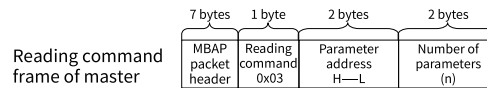


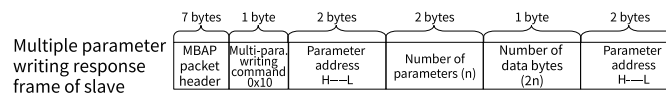
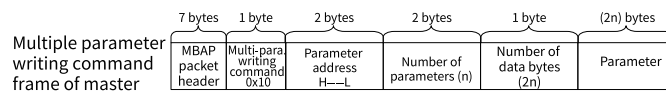
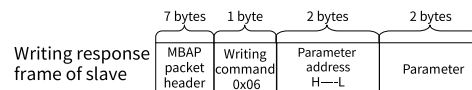
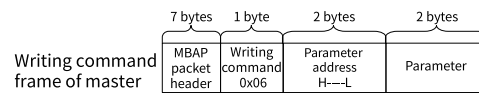
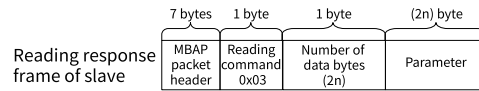
Figure 4-4 Modbus request/response over TCP/IP

The MBAP header includes the following fields.

Field	Length	Description	Client	Server
Transaction meta identifier	2 bytes	Identifier of the Modbus request/response transaction	Started by the client	Recopied by the server from the received request
Protocol identifier	2 bytes	0: Modbus protocol	Started by the client	Recopied by the server from the received request
Length	2 bytes	Number of following bytes	Started by the client (request)	Started by the server (response)
Unit identifier	1 byte	Identifier of the remote slave connected on a serial link or other bus	Started by the client	Recopied by the server from the received request



In theory, the host controller can read or write a maximum of 12 consecutive parameters. However, these parameters must be in the same group. Otherwise, a response error occurs.



The command for a reading error responded by the slave is 0x83. The command for a writing error responded by the slave is 0x86. The command for a multi-data writing error responded by the slave is 0x90.

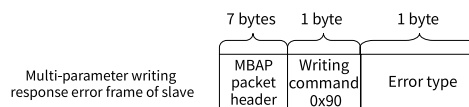
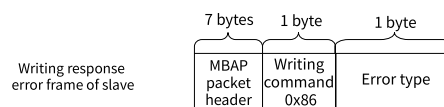
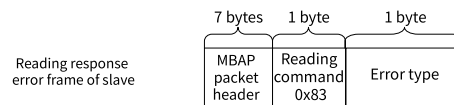


Table 4–3 Description of data frame fields

Command Code (CMD)	03: Read a parameter of the slave; 06: Write a parameter of the slave; 10: Write multiple parameters of the slave
Function Code Address	It is the internal parameter address of the AC drive, expressed in hexadecimal format. The parameters include functional parameters and non-functional parameters (running status and running command). Low-order bytes follow high-order bytes during transmission.
Number of Parameters	Number of parameters read in this frame. 1 indicates that one parameter is read. Low-order bytes follow high-order bytes during transmission. Only one parameter can be modified at a time. This field does not exist.

Number of Data Bytes	Data length, which is twice the number of parameters
Parameter	Response data or data to be written. Low-order bytes follow high-order bytes during transmission.

4.4 Communication Parameters

4.4.1 Communication Card Type Setting

After powering on the AC drive, set F0–28 to 1 to enable communication between the MD500-EM1 card and the AC drive.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-28	Communication protocol	0: Modbus protocol 1: Expansion communication protocol 2: Inobus protocol (through EtherCAT card)	1	This parameter is used to select a communication protocol. 0: Modbus protocol The Modbus protocol is used. 1: Expansion communication protocol PROFIBUS DP, PROFINET, EtherCAT, Modbus TCP, and EtherNet/IP protocols can be used. No setting is required for CANlink because it is always valid. 2: Inobus protocol (through EtherCAT card) When this parameter is set to 2, the Inobus communication protocol is used. The AC drive version must be F7-10 = U60.07/F7-11 = U61.07/F7-15 = 000.00/F7-16 = 000.00 or later.
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run and jog operation. 0: Operating panel The RUN/STOP key on the operating panel can be used to start or stop the drive. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined The command source is defined by the user as needed for expansion.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-03	Main frequency source X selection	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	9	This parameter is used to set the source of the main frequency X as below. 0: Digital setting (non-retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is restored to the value of F0-08. 1: Digital setting (retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is the same as that at the moment of the last power failure. Modifications made by using keys ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP and DOWN key remain effective. 2: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). To be continued

Parameter Code	Parameter Name	Value Range	Value	Description
Continued	Continued	Continued	Continued	7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources.

4.4.2 IP Address Setting of MD500-EM1 Card

The following table describes parameters of the AC drive communication card.

Parameter Code	Parameter Name	Value Range	Description
FD-37	DHCP selection	0: Disable 1: Enable	This parameter sets whether to enable the DHCP function of the Modbus TCP expansion card. After the DHCP function is enabled, the following IP address configuration parameters are invalid.
FD-38 to FD-41	Expansion card IP address	0-255	These parameters define the IP address of the Modbus TCP expansion card.
FD-42 to FD-45	Expansion card subnet mask	0-255	These parameters define the subnet mask of the Modbus TCP expansion card.
FD-46 to FD-49	Expansion card gateway IP address	0-255	These parameters define the gateway IP address of the Modbus TCP expansion card.

The IP address can be a static one or dynamic one assigned by DHCP function. The IP address type is selected by FD-37. The static IP address is set by FD-38 to FD-49. For example, if the static IP address is

192.168.0.6, the subnet mask is 255.255.255.0, and the gateway IP address is 192.168.0.1, set parameters as follows:

Parameter Code	Parameter Name	Value
FD-37	DHCP selection	0
FD-38	Highest order byte of the IP address	192
FD-39	Second highest order byte of the IP address	168
FD-40	Third highest order byte of the IP address	0
FD-41	Lowest order byte of the IP address	6
FD-42	Highest order byte of the subnet mask	255
FD-43	Second highest order byte of the subnet mask	255
FD-44	Third highest order byte of the subnet mask	255
FD-45	Lowest order byte of the subnet mask	0
FD-46	Highest order byte of the gateway IP address	192
FD-47	Second highest order byte of the gateway IP address	168
FD-48	Third highest order byte of the gateway IP address	0
FD-49	Lowest order byte of the gateway IP address	1

When using the DHCP or Bootstrap Protocol (BOOTP) function, you can obtain the MAC address of the expansion card by checking the label on the card, or viewing the related parameter of the AC drive. For details, see section 3.1.3.

The expansion card also supports the IP address conflict detection. When the IP address of the expansion card is the same as that of another device on the network, the D7 red indicator will be steady on. In this case, the value of parameter FD-58 is 84.

There are three IP address conflict situations, as described in the following table.

No.	Scenario	Symptom	Solution
1	Both devices support IP address conflict detection. The two devices are powered on at different time.	The device that is powered on first retains the IP address and continues to operate, while the device that is powered on later enters the IP address conflict mode.	Check the IP address conflict and modify the duplicate IP address.
2	Both devices support IP address conflict detection. The two devices are powered on almost at the same time.	Both devices can detect IP address conflict at the same time.	
3	One device supports IP address conflict detection while the other does not.	No matter which device is powered on first, the device that does not support IP address conflict detection will be assigned with the IP address, while the device that supports IP address conflict detection will detect IP address conflict.	

Note

- The expansion card implements active conflict detection upon power-on and DHCP IP address assignment, and it implements passive detection at other times. If the same dynamic (static) IP address is separately assigned to two devices, which are then connected to a network, neither of the two expansion cards will report an IP address conflict.
- IP address assignment by using the DHCP function will fail if an assignment conflict occurs during the process.

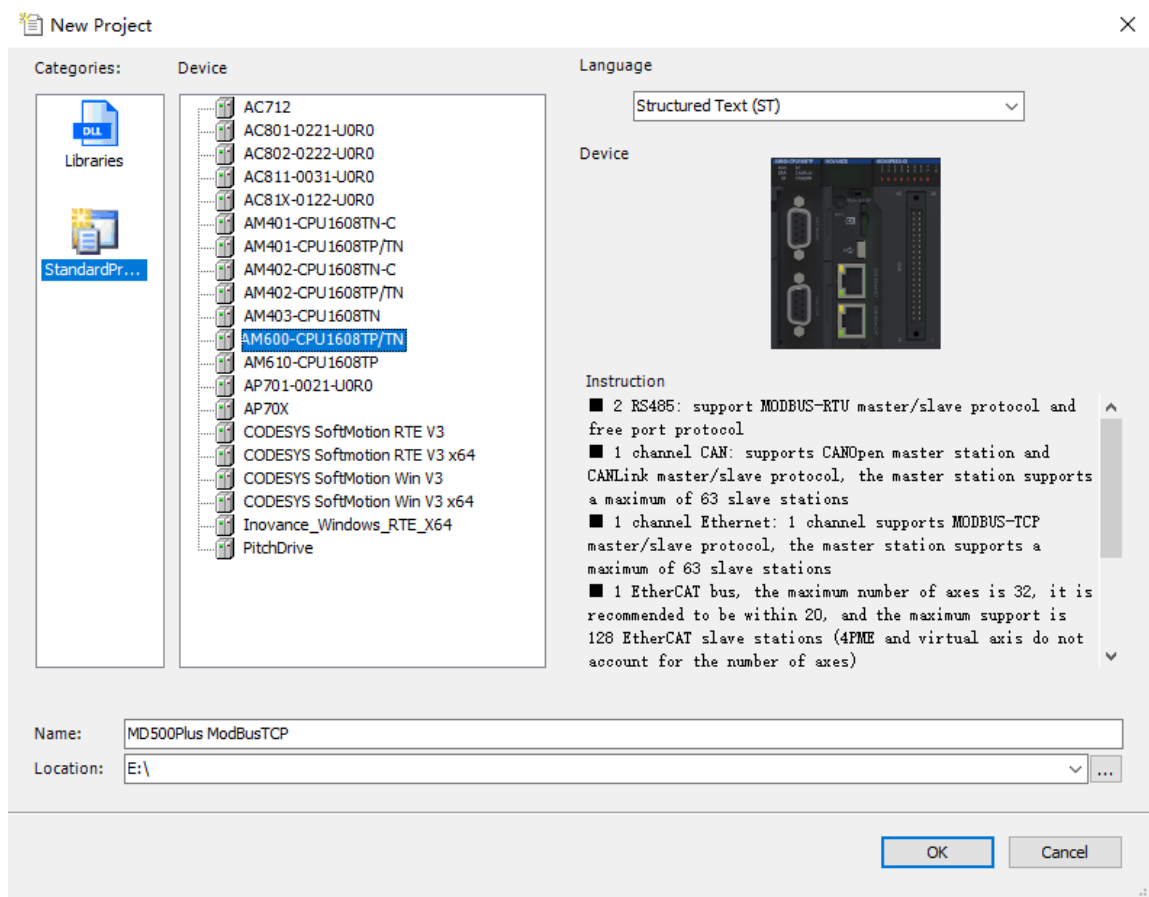
4.4.3 Parameters Related to AC Drive Communication Card

Parameter Code	Parameter Name	Unit	Description
FD-61	High-order byte of MAC address	1	Displays the high-order byte of the MAC address of the Ethernet expansion card (EtherNet/IP, Modbus TCP).
FD-62	Middle-order byte of MAC address	1	Displays the middle-order byte of the MAC address of the Ethernet expansion card (EtherNet/IP, Modbus TCP).
FD-63	Low-order byte of MAC address	1	Displays the low-order byte of the MAC address of the Ethernet expansion card (EtherNet/IP, Modbus TCP).
FD-58	Ethernet expansion card error code	1	Displays the error code of the Ethernet expansion card (EtherNet/IP, Modbus TCP).

4.5 Communication Examples

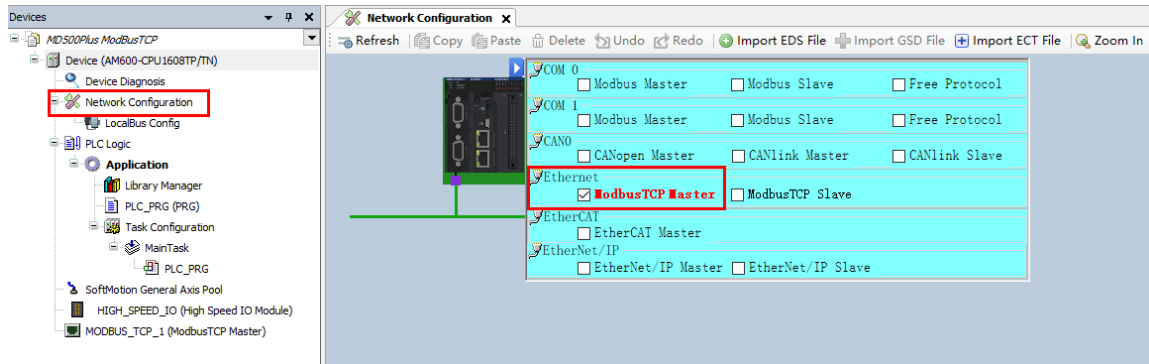
Step 1: Create a project.

Open InoProShop and create a project. Select the device model AM600-CPU1608TP/TN.



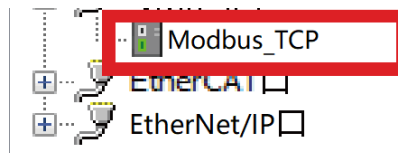
Step 2: Configure the network.

Double-click **Network Configuration** in the left pane and configure the PLC as the Modbus TCP master.



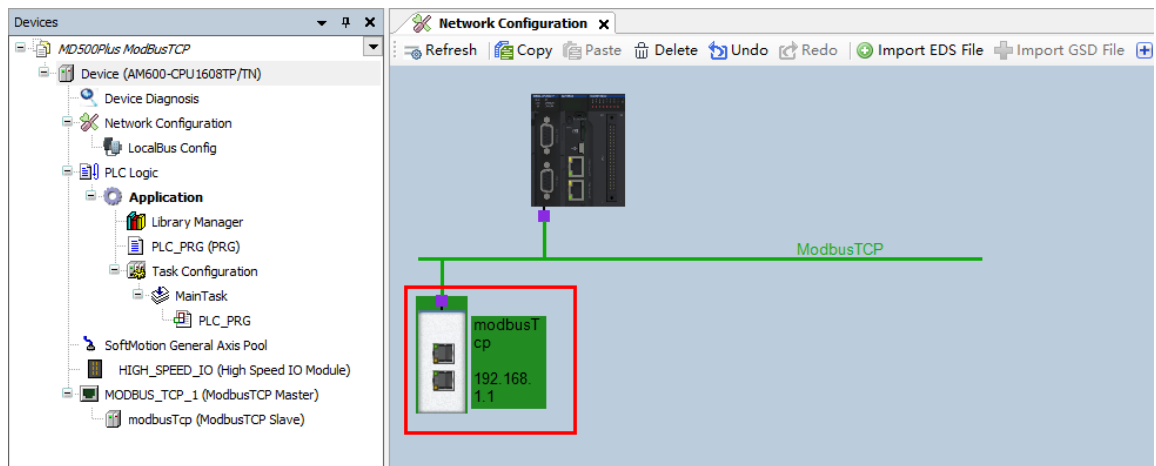
Step 3: Add a slave.

Double-click **Modbus_TCP** in the right pane.

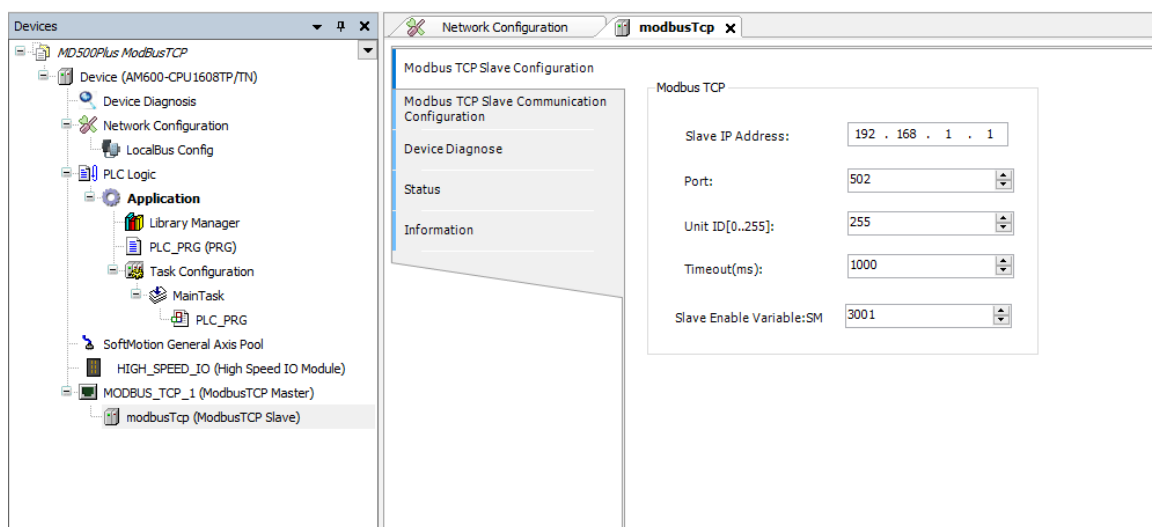


Step 4: Configure the slave.

Double-click the slave to access the configuration interface.

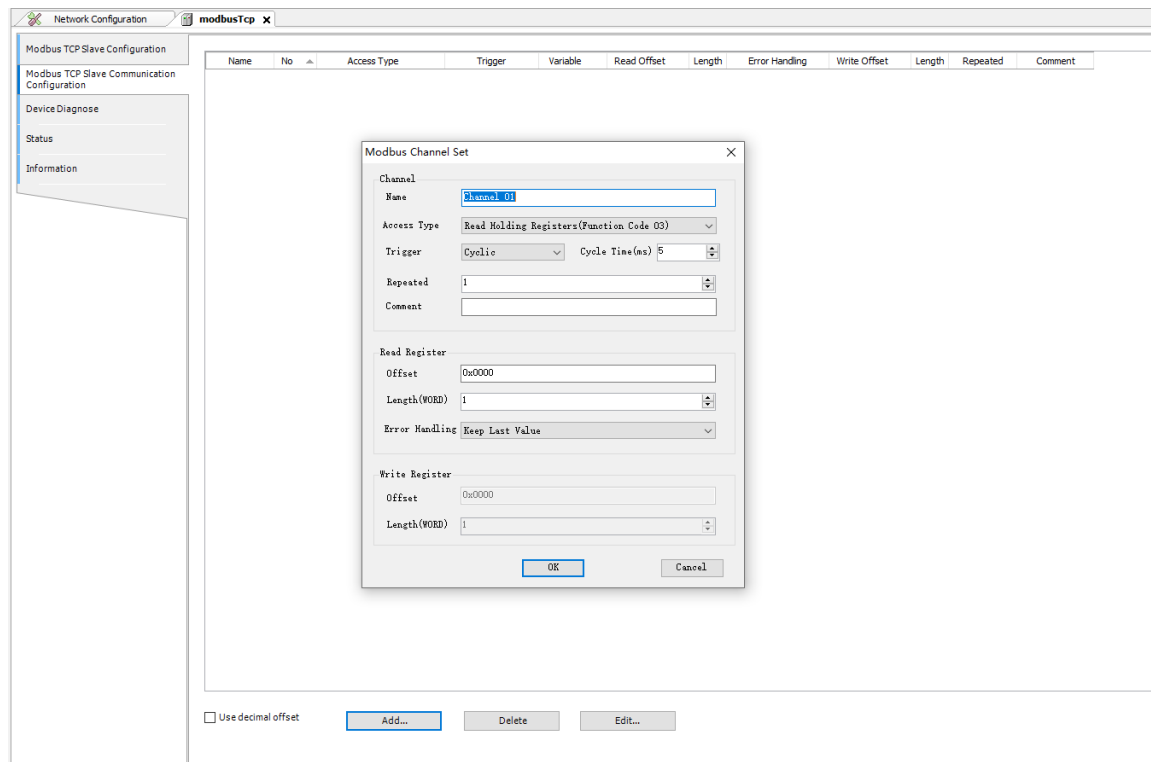


Configure the slave parameters, such as **Slave IP Address**, **Port**, and **Slave Enable Variable**.



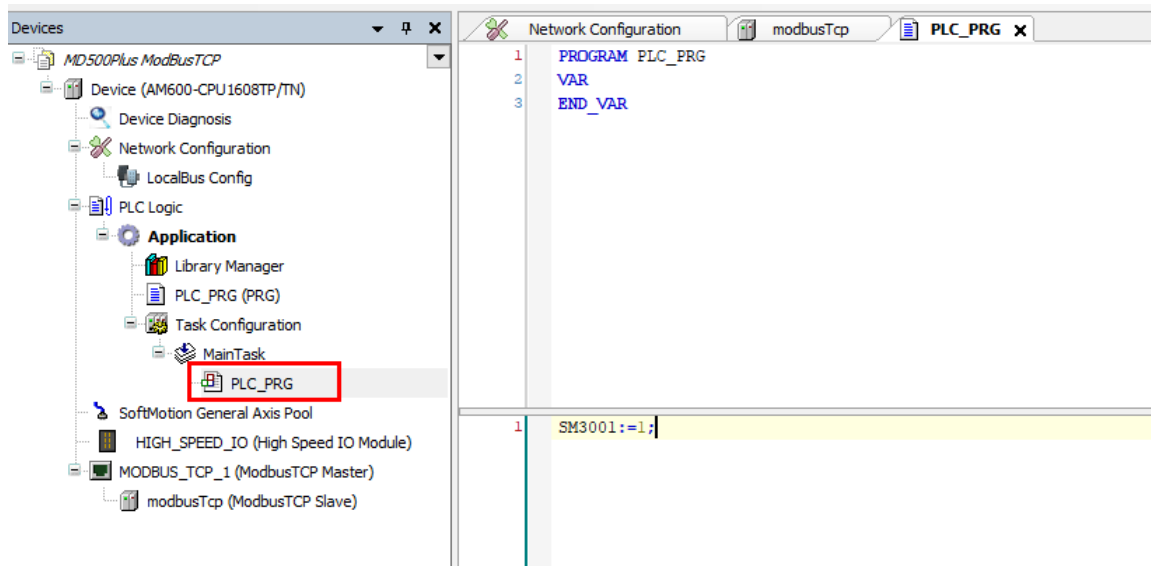
Step 5: Configure the read/write command.

Select the **Modbus TCP Slave Communication Configuration** tab, and click **Add...**



Step 6: Enable the Modbus TCP communication.

Open the PLC_PRG file and enable **Slave Enable Variable**.



Download the project to the PLC. You can observe the read/write variables in the **Internal I/O Mapping** tab.

Devices

AD500Plus ModbusTCP

Device (AM600-CPU1608TP/TN)

Device Diagnosis

Network Configuration

LocalBus Config

PLC Logic

Application

Library Manager

PLC_PRG (PRG)

Task Configuration

MainTask

PLC_PRG

SoftMotion General Axis Pool

HIGH_SPEED_IO (High Speed IO Module)

MODBUS_TCP_1 (ModbusTCP Master)

modbusTcp (ModbusTCP Slave)

Network Configuration

modbusTcp

PLC_PRG

Find

Filter

Show all

Variable	Mapping	Channel	Address	Type	Default Value	Unit	Description
		Channel 01	%IW1	ARRAY [0..0] OF WORD			Read Holding Registers
		Channel 01[0]	%IW1	WORD			READ 16#F001(-64769)
		Bit0	%DX2.0	BOOL			
		Bit1	%DX2.1	BOOL			
		Bit2	%DX2.2	BOOL			
		Bit3	%DX2.3	BOOL			
		Bit4	%DX2.4	BOOL			
		Bit5	%DX2.5	BOOL			
		Bit6	%DX2.6	BOOL			
		Bit7	%DX2.7	BOOL			
		Bit8	%DX3.0	BOOL			
		Bit9	%DX3.1	BOOL			
		Bit10	%DX3.2	BOOL			
		Bit11	%DX3.3	BOOL			
		Bit12	%DX3.4	BOOL			
		Bit13	%DX3.5	BOOL			
		Bit14	%DX3.6	BOOL			
		Bit15	%DX3.7	BOOL			

5 CANopen Communication (MD38CAN1)

5.1 Protocol Description

The CANopen communication protocol is an international standard protocol. The CANlink communication protocol is a special protocol independently developed by Inovance based on CAN bus applications. This protocol can be used to communicate with only Inovance PLCs such as H2U, H3U, H5U, Easy, AM400, and AM600.

Communication model

CANopen is an application layer protocol of the network transmission system based on the CAN serial bus. The CAN bus follows an ISO/OSI standard model. This protocol defines the data link layer and some physical layers in the OSI model. It allows the multi-master mode, in which any node in the network can send a message to other nodes. Network nodes are assigned with different priorities based on system real-time requirements, which can reduce the bus arbitration time in case of a transmission collision. The CAN network does not use the traditional address coding method. Instead, it uses the communication data block coding method. With data block coding, the number of nodes in the network is not limited theoretically, and different nodes can receive the same data at the same time. This coding mode also features short transmission byte, fast speed, good fault tolerance, and reliable data transmission, making it suitable for industrial control and distributed real-time control. The CANopen device model is shown in the following figure.

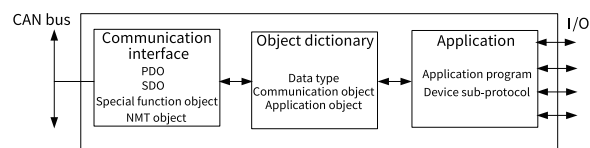


Figure 5-1 CANopen communication model

The following section introduces the object dictionary, common communication objects, and CANopen message format in the CANopen communication model.

Protocol features

CANopen supports six protocols and is described as follows:

- NodeGuard protocol, which enables the master to query device status
- Heartbeat protocol, which enables the slave to report its current state to the master regularly
- The Service Data Object (SDO) supports only the accelerated transmission mechanism. One parameter or one object dictionary is transmitted at a time.
- Four TPDOs and four RPDOs are supported.
- Emergency objects are supported
- The synchronization mode is supported.

Object dictionary

The object dictionary is an ordered set of parameters and variables that are accessed through the network in an ordered and predefined manner. It contains all parameters of device descriptions and device network status.

The CANopen protocol uses object dictionaries with 16-bit index and 8-bit sub-index. One master node or configuration tool can access all values in a slave node object dictionary. The following figure shows the structure of the object dictionary.

Index	Object
000	Not used
0001-001F	Static data type (standard data type, such as Boolean, Integer16)
0020-003F	Complicated data type (predefined structure consisting of simple types, such as PDOCommPar, SDOParmeter)
0040-005F	Complicated data type defined by the manufacturer
0060-007F	Static data type defined by the device sub-protocol
0080-009F	Complicated data type defined by the device sub-protocol
00A0-0FFF	Reserved
1000-1FFF	Communication sub-protocol area (such as device type, error register, number of supported PDOs)
2000-5FFF	Manufacturer-specified sub-protocol area
6000-9FFF	Standard device sub-protocol area (such as DSP-401 I/O module device sub-protocol: Read State 8 Input Lines)
A000-FFFF	Reserved

Figure 5-2 Structure of the object dictionary

Common communication object

CANopen provides multiple communication objects, each of which has different characteristics and applies to different applications. The predefined COB-ID is used. Specific rules are as follows:

- NMT object: 0x000
- SYNC object: 0x080
- SDO object:
 - Transmit SDO— 0x600+Node-Id
 - Receive SDO — 0x580+Node-Id
- PDO object:
 - RPDO1 — 0x200+Node-Id
 - RPDO2 — 0x300+Node-Id
 - RPDO3 — 0x400+Node-Id
 - RPDO4 — 0x500+Node-Id
 - TPDO1 — 0x180+Node-Id
 - TPDO2 — 0x280+Node-Id
 - TPDO3 — 0x380+Node-Id
 - TPDO4 — 0x480+Node-Id
- EMCY object: 0x80+Node-Id
 - Node-Id: Device ID (station address), which is defined by FD-02

Communication objects are defined as follows:

- Network management (NMT) object
 - The NMT object includes Boot-up messages, Heartbeat protocol, and NMT messages. Based on the master/slave communication mode, the NMT is used to manage and monitor all nodes in the network, implementing node state control, error control, and node startup.

- **SDO**
By using indexes and sub-indexes, SDOs enable clients to access entries in the object dictionary of devices. An SDO is achieved through a CMS object of the multi-element domain in CAL and transmitting data in any length is allowed. When the data exceeds four bytes, the data is divided into several packets. The SDO protocol produces a response for every message. The SDO request and response packets always contain eight bytes.
- **PDO**
A PDO is used to transmit real-time data from one creator to one or multiple receivers. The length of transmitted data ranges from one to eight bytes. Each CANopen device has eight default PDO channels, that is, four PDO channels for transmitting and four for receiving. The PDO supports synchronous and asynchronous transmission modes, which are determined by the communication parameter corresponding to the PDO. The content of a PDO message is pre-defined and is determined by the mapping parameter corresponding to the PDO.
- **SYNC object**
A SYNC object is a message periodically broadcast by the CANopen master to the CAN bus. It is used to provide basic network clock signals. Each device determines whether to perform synchronous communication with other network devices using the event based on its configuration.

CANopen packet format

- **NMT module control message**
Only an NMT master node can send NMTModuleControlNMT messages. For details about the message format, see [“Table 5–1 NMT message format” on page 56](#). COB-ID is fixed at 0x000. Data0 is the command word, which occupies one byte. See [“Table 5–2 NMT packet command format” on page 56](#). Data1 is a CANopen network device address occupying one byte. When it is 0, it indicates a broadcast message that is valid for all slave devices in the network.

For example, the command to set a device with device address "6" to the operable state is "0x0000x010x06".

Table 5–1 NMT message format

COB-ID	RTR	Data0	Data1
0x000	0	Command word	Node ID

Table 5–2 NMT packet command format

Command	Description
0x01	Start the remote node.
0x02	Stop the remote node.
0x80	Enter the pre-operation state.
0x81	Reset the node.
0x82	Reset communication.

- **NodeGuarding message**
By using the node protection service, the MNT master node can check the current state of every node. Especially, this service is significant when these nodes have no data to be transmitted.

The standard protocol object 0x100C is used to set GuardTime and 0x100D is used to set the multiplication factor of GuardTime. The GuardTime and its multiplication factor jointly determine the node protection time period.

[“Table 5–3 NodeGuarding packet sent by the master node” on page 57](#) describes the remote frame sent by the NMT master node.

Table 5–3 NodeGuarding packet sent by the master node

COB-ID	RTR
0x700+Node-ID	1

[“Table 5–4 NodeGuarding response packet returned from a slave node” on page 57](#) is the response message returned by the NMT slave node. [“Table 5–5 Status word returned by the NodeGuarding slave node” on page 57](#) describes the status word in the one-byte format.

Table 5–4 NodeGuarding response packet returned from a slave node

COB-ID	RTR	Data0
0x700+Node-ID	0	Status word

Table 5–5 Status word returned by the NodeGuarding slave node

Data Bit	Description
Bit 7	0 or 1 alternative
Bit 6 to bit 0	State: 4: Stopped 5: Operational 127: Pre-operational

- Heartbeat message

A node can be configured to produce periodic heartbeat messages, in which bit 7 is 0, and bit 6 to bit 0 are the same as those of the NodeGuarding message. See [“Table 5–6 Heartbeat message” on page 57](#) for details. The heartbeat time is defined by the standard protocol object 0x1017. A node can support either the NodeGuarding protocol or the Heartbeat protocol.

Table 5–6 Heartbeat message

COB-ID	RTR	Data0
0x700+Node-ID	0	Status word

5.2 Networking and Interfaces

Communication port

The MD38CAN1 card is a communication expansion card designed for CANopen/CANlink communication of the MD520 series AC drives. It enables the AC drive to access the high-speed CANopen/CANlink communication network and to be controlled by the field bus.

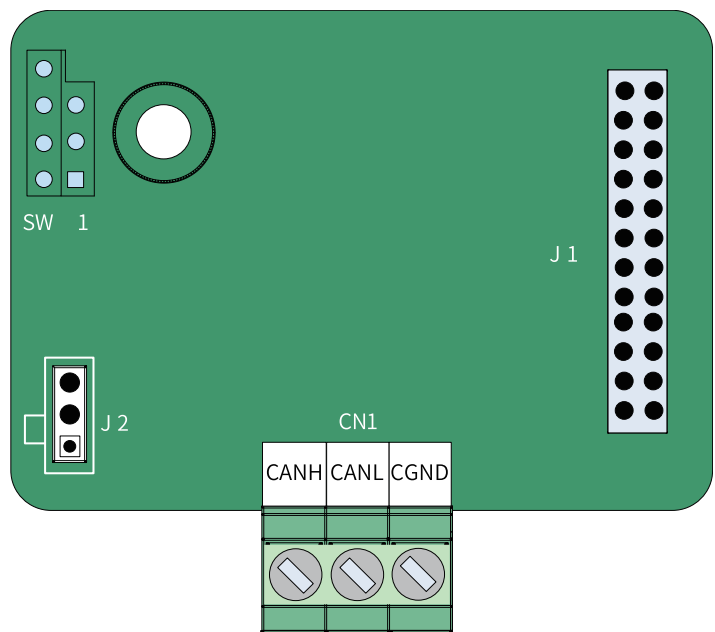


Figure 5-3 Layout of MD38CAN1 terminals

Table 5-7 Function descriptions of MD38CAN1 terminals

Mark		Terminal Name	Function Description	Layout
CN1	CANH	Positive CAN input	It is used to connect to the positive end of the CAN bus.	
	CANL	Negative CAN input	It is used to connect to the negative end of the CAN bus.	
	CGND	Power supply ground	It is used to connect to the reference ground of all CAN nodes.	

Table 5-8 Jumper on the MD38CAN1 expansion card

Mark	Terminal Name	Function Description	Jumper/DIP Switch Position
	CAN termination resistor	The termination resistor is connected.	
		The termination resistor is disconnected.	

The jumper is set when you view from the top of the expansion card with the main wiring terminal at the bottom.
For the position of the jumper, see the PCB silkscreen.

Communication networking

1. CAN bus topology

The following figure shows the CAN bus topology. It is recommended that the CAN bus use shielded twisted pair cables to connect CANH and CANL. Connect a 120 Ω termination resistor at both ends of the bus to prevent signal reflection, and connect the reference grounds of CAN signals on all nodes together. A maximum of 64 nodes are supported and the distance between each node and the bus must be less than 0.3 m.

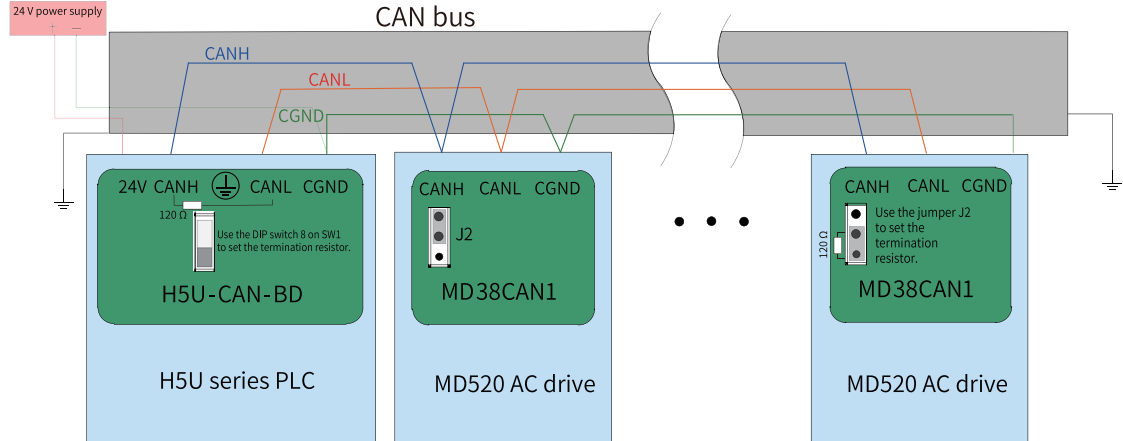
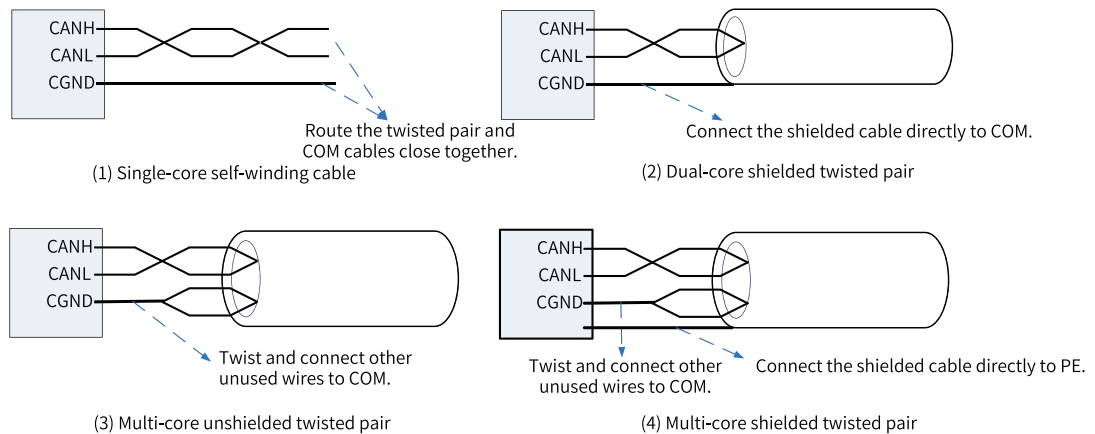


Figure 5-4 CANlink/CANopen bus topology

The following figure shows the recommended usage of different field cables.



Transmission distance

The transmission distance of the CANopen/CANlink bus is directly related to the baud rate and communication cable. The following table describes the relationship between the bus length and the baud rate.

Table 5-9 Relationship between the bus length and baud rate

Baud Rate (bps)	Length (m)
1 M	25
500 k	100
250 k	250
125 k	500
100 k	500
50 k	1000
20 k	1000

5.3 Related Parameters

Table 5–10 Related parameters

Parameter Code	Parameter Name	Default	Value Range	Description
FD-00	Baud rate	5005	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	This parameter defines the speed of data transmitted between the host controller and the AC drive. The higher the baud rate, the faster the communication speed. Note that the baud rate of the host controller must be the same as that of the AC drive. Otherwise, communication will fail.
FD-02	Local address	1	1 to 247	The local address must be unique in the range of 1 to 247, which is the basis for point-to-point communication between the AC drive and host controller. Note: This parameter is used to set the station alias when EtherCAT communication with the communication card version other than V125 (U0-67) applies. When EtherCAT communication with the communication card version V125 applies, the parameter cannot be used to set the station alias.
FD-10	Switchover between CANopen and CANlink	2	1: CANopen 2: CANlink	This parameter is used to select the CAN communication protocol for the CAN1 expansion card. The value 1 represents CANopen. The value 2 represents CANlink.

Parameter Code	Parameter Name	Default	Value Range	Description
FD-11	CiA 402	0	0: Enable 1: Enable	This parameter sets whether to enable the CiA 402 mode. When it is set to 0, the common mode is used. When it is set to 1, the CiA 402 mode is used. For details, see “13.1 List of Object Dictionary in Group 6000h” on page 260 and “13.2 Object Dictionary Descriptions” on page 261 .
FD-14	Number of frames received per unit time	0	0 to 65535	This parameter is used to monitor the bus load. It defines the number of CAN frames received by the station per second. It is valid only for the CANlink communication expansion card.
FD-15	Maximum number of error frames received by node	0	0 to 65535	This parameter is used to monitor bus errors. It defines the maximum number of error frames received by the node. It is valid only for the CANlink communication expansion card.
FD-16	Maximum number of error frame sent by node	0	0 to 65535	This parameter defines the maximum number of error frames sent by the node. It is valid only for the CANlink communication expansion card.
FD-17	Number of disconnections from bus	0	0 to 65535	This parameter is used to monitor bus errors. It defines the number that the node disconnects from the CAN bus. It is valid only for the CANlink communication expansion card.
FD-19	CAN communication disconnection coefficient	3	1 to 15	This parameter is used to set the number of timeout events allowed in CANopen communication before a warning is reported.

5.4 Application

5.4.1 Communication Data Frame Structure

The AC drive specifies the corresponding method between parameters and object dictionaries, based on which you can determine their corresponding relationship. This facilitates operations on parameters.

The corresponding method between parameters and CANopen object dictionary indexes is described as follows:

- Corresponding method

The parameter groups of the drive correspond to indexes 0x2000 to 0x20FF of the CANopen object dictionary. The corresponding method is as follows: An object dictionary index is the high-order 16

bits of a parameter address plus 0x2000; an object dictionary sub-index is the low-order 16 bits of the parameter address plus 1.

For example, the communication address of F0-03 is 0xF003. The corresponding object dictionary index and sub-index are 0x20F0 and 0x04, respectively.

- Corresponding relationship

The AC drive has the following parameter groups: F0 to FF, A0 to AF, B0 to BF, C0 to CF, H0 to HF, L0 to LF, and U0 to UF.

For parameter read/write operations, the corresponding relationship between parameter groups and object dictionary indexes is as follows.

Table 5–11 Corresponding relationship between parameter groups and object dictionary indexes

Group No.	CANopen Object Dictionary Index
F0 to FF Group	0x20F0 to 0x20FF
A0 to AF	0x20A0 to 0x20AF
B0 to BF	0x20B0 to 0x20BF
C0 to CF	0x20C0 to 0x20CF
H0 to HF	0x2080 to 0x208F
U0 to UF	0x2070 to 0x207F
L0 to LF	0x2090 to 0x209F

A sub-index is the low-order 16 bits of a parameter address plus 1. The following table describes the corresponding relationship between parameter indexes in a group and the object dictionary sub-indexes.

Table 5–12 Corresponding relationship between parameter indexes in parameter groups and object dictionary sub-indexes

Parameter Index	CANopen Object Dictionary Sub-index
0x0 to 0xFE	0x1 to 0xFF

5.4.2 Operation Example (SDO)

Take F0-17 as an example. When the value of F0-17 is read, the parameter address is 0xF011. The object dictionary index and sub-index are 0x20F0 and 0x12 respectively.

- The communication master station uses a CANopen SDO to read data from the AC drive.

Take F0-02 as an example. The index and sub-index for F0-02 are 0x20F0 and 0x03, respectively. The following table describes the format of data sent by the master.

Table 5–13 SDO object sent for the read operation

CAN Frame		CANopen Data	Description
COB-ID	11-bit ID	0x600+Node-ID	Node-ID (device address) set by the DIP switch
RTR	RTR	0	Remote frame flag "0"

CAN Frame		CANopen Data	Description
8-byte frame data	DATA0	Command code (0x40)	0x40 read command
	DATA1	Low-order byte of index	Parameter group (0xF0 for group F0)
	DATA2	High-order byte of index	0x20
	DATA3	Sub-index	Parameter No. + 1 ("0x03")
	DATA4	Data 1	0 is reserved.
	DATA5	Data 2	0 is reserved.
	DATA6	Data 3	0 is reserved.
	DATA7	Data 4	0 is reserved.

2. The following table shows the SDO responded by the slave to the read operation.

If the operation is successful, the returned value of the command code is "0x4B". The index remains unchanged. DATA4 and DATA5 return the read data, and DATA6 and DATA7 return "0".

If the operation fails, the returned value of the command code returns "0x80". The index remains unchanged. DATA4, DATA5, DATA6, and DATA7 return an SDO failure error code.

Table 5–14 SDO returned for the read operation

CAN Frame		CANopen Data	Description
COB-ID	11-bit ID	0x580+Node-ID	Node-ID (device address) set by the DIP switch
RTR	RTR	0	Remote frame flag "0"
Eight-byte frame data	DATA0	Returned value of the command code	Success: 0x4B Failure: 0x80
	DATA1	Low-order byte of index	Parameter group (0xF0 for group F0)
	DATA2	High-order byte of index	0x20
	DATA3	Sub-index	Parameter No. + 1 ("0x03")
	DATA4	Data 1	Low-order byte of data
	DATA5	Data 2	High-order byte of data
	DATA6	Data 3	Success: 0
	DATA7	Data 4	Failure: SDO operation failure error code

3. SDO for the write operation

The CANopen SDO is used to perform the write operation on the AC drive. The following table describes the data format of the SDO sent by the master.

Table 5–15 SDO sent for the write operation

CAN Frame		CANopen Data	Description
COB-ID	11-bit ID	0x600+Node-ID	Node-ID (device address) set by the DIP switch
RTR	RTR	0	Remote frame flag "0"

CAN Frame		CANopen Data	Description
Eight-byte frame data	DATA0	Command code	0x2B
	DATA1	Low-order byte of index	Parameter group (0xF0 for group F0)
	DATA2	High-order byte of index	0x20
	DATA3	Sub-index	Parameter No. + 1 ("0x03")
	DATA4	Data 1	Low-order byte of data
	DATA5	Data 2	High-order byte of data
	DATA6	Data 3	0 is reserved.
	DATA7	Data 4	0 is reserved.

4. The following table shows the SDO responded by the slave for the write operation.

If the operation is successful, the returned value of the command code is "0x60". The index remains unchanged. DATA4, DATA5, DATA6, and DATA7 return "0".

If the operation fails, the returned value of the command code returns "0x80". The index remains unchanged. DATA4, DATA5, DATA6, and DATA7 return an SDO failure error code.

Table 5–16 SDO returned for the write operation

CAN Frame		CANopen Data	Description
COB-ID	11-bit ID	0x580+Node-ID	Node-ID (device address) set by the DIP switch
RTR	RTR	0	Remote frame flag "0"
Eight-byte frame data	DATA0	Returned value of the command code	Success: 0x60; Failure: 0x80
	DATA1	Low-order byte of index	Parameter group (0xF0 for group F0)
	DATA2	High-order byte of index	0x20
	DATA3	Sub-index	Parameter No. + 1 ("0x03")
	DATA4	Data 1	Success: 0 Failure: SDO operation failure error code
	DATA5	Data 2	
	DATA6	Data 3	
	DATA7	Data 4	
			0 is reserved.

5. Perform read and write operations on the AC drive.

Take read and write operations on the F0-02 as examples. The CANopen address of the AC drive is set to "0x06".

Read the AC drive command source (F0-02).

To read the value of F0-02 (Command source selection), the master sends the following CANopen message.

Table 5–17 Message sent by the master to read F0-02

Message ID (Hex)	RTR	Data (Hex)
0x606	0	40F0200300000000

6. The AC drive returns a CANopen response message, as described in the following table.

The current value of F0-02 is "0x0002", indicating that the current command source of the AC drive is communication.

Table 5-18 Message returned by the AC drive for the read operation of F0-02

Message ID (Hex)	RTR	Data (Hex)
0x586	0	4BF0200302000000

7. Set the command source (F0-02) to the operating panel.

To set the command source to the operating panel, the master can send the following CANopen command to write 0 to F0-02.

Table 5-19 Message sent by the master for the write operation on F0-02

Message ID (Hex)	RTR	Data (Hex)
0x606	0	2BF0200300000000

8. The following table describes the CANopen message returned by the AC drive. Write 0 to F0-02 to set the current command source to the operating panel.

Table 5-20 Message returned by the AC drive for the write operation of F0-02

Message ID (Hex)	RTR	Data (Hex)
0x586	0	60F0200300000000

5.4.3 Operation Example (PDO)

The AC drive supports four RPDOs (RPDO1, RPDO2, RPDO3 and RPDO4) and four TPDOs (TPDO1, TPDO2, TPDO3 and TPDO4), which can be configured as needed.

You can configure the PDO mapping of the slave on the operating panel. It is recommended to use the CANopen master to configure mappings. You can also manually change parameters in group AF to configure PDO mappings. The following table shows the mapping relation of every PDO.

Table 5-21 PDO mapping

RPDO	Group AF Address		TPDO	Group AF Address	
RPDO1	Sub-index 1	AF-00	TPDO1	Sub-index 1	AF-32
		AF-01			AF-33
	Sub-index 2	AF-02		Sub-index 2	AF-34
		AF-03			AF-35
	Sub-index 3	AF-04		Sub-index 3	AF-36
		AF-05			AF-37
	Sub-index 4	AF-06		Sub-index 4	AF-38
		AF-07			AF-39
RPDO2	Sub-index 1	AF-08	TPDO2	Sub-index 1	AF-40
		AF-09			AF-41
	Sub-index 2	AF-10		Sub-index 2	AF-42
		AF-11			AF-43
	Sub-index 3	AF-12		Sub-index 3	AF-44
		AF-13			AF-45
	Sub-index 4	AF-14		Sub-index 4	AF-46
		AF-15			AF-47

RPDO	Group AF Address		TPDO	Group AF Address	
RPDO3	Sub-index 1	AF-16	TPDO3	Sub-index 1	AF-48
		AF-17			AF-49
	Sub-index 2	AF-18		Sub-index 2	AF-50
		AF-19			AF-51
	Sub-index 3	AF-20		Sub-index 3	AF-52
		AF-21			AF-53
	Sub-index 4	AF-22		Sub-index 4	AF-54
		AF-23			AF-55
RPDO4	Sub-index 1	AF-24	TPDO4	Sub-index 1	AF-56
		AF-25			AF-57
	Sub-index 2	AF-26		Sub-index 2	AF-58
		AF-27			AF-59
	Sub-index 3	AF-28		Sub-index 3	AF-60
		AF-29			AF-61
	Sub-index 4	AF-30		Sub-index 4	AF-62
		AF-31			AF-63

Each PDO can be configured with four mappings. To configure one mapping, you need to operate two parameters in group AF to implement 32-bit data, of which the high-order 16 bits (with a smaller parameter No.) are the object dictionary index, and the low-order 16 bits (with a larger parameter No.) are the object dictionary sub-index and object length. The object length is calculated in bits. The format of mapping objects is as follows: 311615870.

Index	Sub-index	Object Length
High-order bits of the parameter in group AF	Low-order bits of the parameter in group AF	-

According to the preceding relation between the parameter and the object dictionary, when a parameter needs to be mapped to a PDO, you only need to write the object dictionary index and sub-index and data length corresponding to the parameter into group AF according to the preceding rules.

Take configurations of two mappings to RPDO1 as examples. One mapping directs to F0-01 and the other mapping is an object dictionary 0x6060-00. The operation is as follows.

Table 5-22 Mapping example of group AF

Assumed Address	Group AF Address	Description	Remarks
F0-01	AF-00	0x20F0	Parameter address index Equal to group No. F0 + 0x2000
	AF-01	0x0210	High-order bit 02: Parameter group No. offset + 1 Low-order bit 10: 16-bit parameter length
0x6060-00	AF-02	0x6060	Object dictionary index
	AF-03	0x0008	High-order bit 00: Object dictionary sub-index Low-order bit 08: 8-bit object length

Note

- Any write operation via the software or operating panel must be finished before a CANopen remote node is started.
- PDO data will not be retained upon a power failure.

5.5 Communication Configuration

5.5.1 Configuration for CANopen Communication Between AC Drive and H5U

Software acquisition and hardware connection

- Log in to the official website of Inovance (<https://newweb.inovance.com/hc/serviceSupport/> download) to obtain the H5U programming software and the latest EDS file.
- Connect the H5U to the CN1 interface of the MD38CAN1 expansion card installed on the MD520 using twisted pair cables.

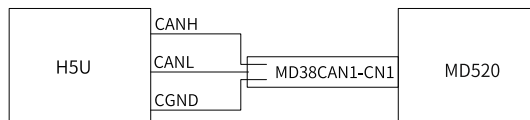


Figure 5-5 Connecting communication interfaces

Master and slave configuration

- Open AutoShop, click **New Project**, check that **Series and models** is **H5U**, and click **OK** to enter the programming interface.
- Click **CAN(CANopen)** in the left pane, set parameters as follows, and click **OK**.

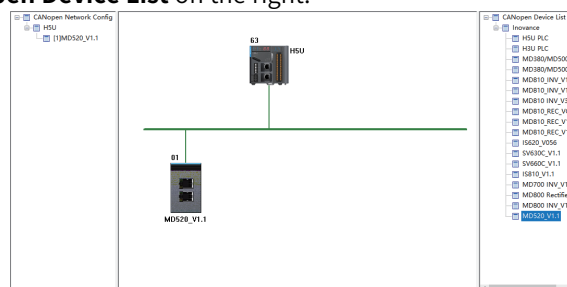
Protocol: Select **CANopen**.

Station No.: Select **Upper computer setting**. (Note that the CANopen station number of the PLC must be different from that of the AC drive.)

Baud Rate: Select **Upper computer setting**. (The communication baud rate must be consistent with the baud rate of the AC drive.)

- Configure the master and slave. Click **CAN(CANopen)**, and click **AddCAN Config**.

CAN(CANopen) is displayed. Double-click **CANopen Config**, and double-click the AC drive slave in the **CANopen Device List** on the right.



- Configure the RPDOs and TPDOs of the slave. Double-click the slave to configure.
RPDO: The PDOs for writing the running frequency and control commands are added by default.

TPDO: Click **Send PDO**, and configure the PDOs according to the following conversion rule:

Index: For groups F0 to FF, convert F in the high-order bit to 0 and then add 0x2000.

For groups A0 to AF, convert A in the high-order bit to 4 and then add 0x2000.

For groups U0 to UF, convert U in the high-order bit to 7 and then add 0x2000.

Sub-index: For the low-order 16 bits, convert the decimal serial number into a hexadecimal equivalent and then add 1.

According to the conversion rule, the index of the bus voltage U0-02 is 0x2070, and the sub-index is 03.

Slave Node	Receive PDO	Send PDO	Service Data Objects	Debug	I/O Mapping	Module Information
Num...	Name	Index	Subindex	Bit Length		
☒ 1	1st transmit PDO	16#1800				
	Running Frequency	16#2070	16#01	16		
	Bus Voltage	16#2070	16#03	16		
	Inverter State 1	16#2070	16#3E	16		
☒ 2	2nd transmit PDO	16#1801				
	Output Voltage	16#2070	16#04	16		
	Output Current	16#2070	16#05	16		
	DI State	16#2070	16#08	16		
☒ 3	3rd transmit PDO	16#1802				
	Fault Maincode	16#2070	16#2E	16		
	Fault Subcode	16#2070	16#2F	16		
☐ 4	4th transmit PDO	16#1803				



Caution

Only four PDOs can be added to each group. As the annotation of the EDS file used during configuring the PDO may be wrong, it is recommended to check the PDOs again based on parameters after all the PDOs are added.

5. Perform I/O mapping.

This step is to map data (that is, the value to be read or written) in the PDO. The D component is used as a bridge to implement data exchange between the PLC and the AC drive. The H5U high-performance small-sized PLC of Inovance automatically performs I/O mapping based on the configured PDOs. Therefore, you only need to click the I/O mapping to determine the D component to perform the read and write operations on the D component.

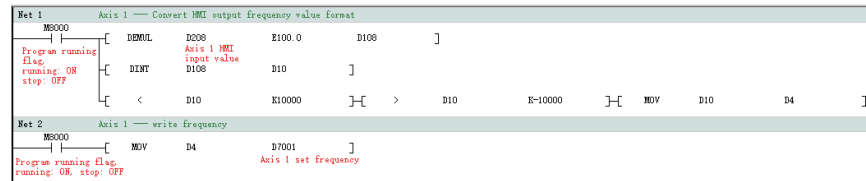
Variable	Mapping	Index: Subindex	Bit Length
-- D7000...D7001	1st receive PDO mapping	16#1600	32
D7000	Control Command	16#2073:12	16
D7001	Written Freq	16#2073:11	16
-- D7424...D7426	1st transmit PDO mapping	16#1A00	48
D7424	Running Frequency	16#2070:1	16
D7425	Bus Voltage	16#2070:3	16
D7426	Inverter State	16#2070:3E	16
-- D7408...D7410	2nd transmit PDO mapping	16#1A01	48
D7408	Output Voltage	16#2070:4	16
D7409	Output Current	16#2070:5	16
D7410	DI State	16#2070:8	16
-- D7411...D7412	3rd transmit PDO mapping	16#1A02	32
D7411	Fault Maincode	16#2070:2E	16
D7412	Fault Subcode	16#2070:2F	16

Instances

1. Write the frequency (F0-03 is set to 9).

Data conversion: Multiply the required frequency (a) by 100 to obtain an integer, and then write the integer to D7001.

The program is as follows:



2. Start or stop the AC drive (F0-02 is set to 2).

Assign a value to the D component corresponding to the control word of the desired station to control forward running, reverse running, and stop of the AC drive through communication. The control word is defined as follows:

1: Run in forward direction; 2: Run in reverse direction; 3: Jog in forward direction; 4: Jog in reverse direction; 5: Coast to stop; 6: Decelerate to stop; 7: Reset upon fault

The program is as follows:

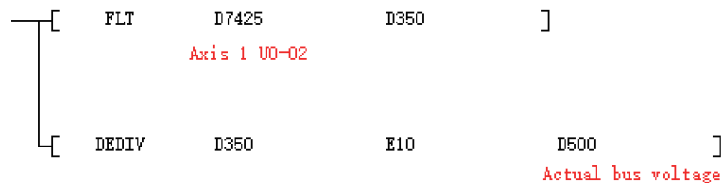


The PLC soft component address corresponding to the control word is D7000. Therefore, to control the AC drive to run in forward direction through communication, write 1 to D7000. Similarly, to control the AC drive to decelerate to stop, set D7000 to 6.

3. Read the bus voltage.

The actual bus voltage is the read bus voltage (a) divided by 10. According to the communication configuration, the D component address of the bus voltage is D7425. Convert D7425 to a floating-point number and then divide this value by 10.

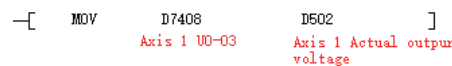
The program is as follows:



4. Read the output voltage.

According to the communication configuration, you only need to move the value of D7408 to another D component (or not).

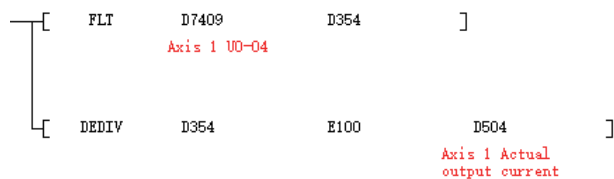
The program is as follows:



5. Read the output current.

According to the conversion rule, the actual output current is the read output current divided by 100.

The program is as follows:



6. Read the AC drive state.

Based on the I/O mapping, read D7426 to directly obtain the current state of the AC drive (1: Running in forward direction; 2: Running in reverse direction; 3: Stopped).

The program is as follows:

```

—[   MOV      D7426      D358   ]
      Axis 1
      Inverter status

```

7. Read the DI state.

According to the conversion rule, the DI state maps to D7410 based on the I/O mapping. Convert the read value into a binary value. The LSB indicates DI1, the second bit indicates DI2, and so on.

The program is as follows:

```

—[   MOV      D7410      D360   ]
      Axis 1 UD-07

```

8. Read the fault code.

According to the conversion rule and the I/O mapping, the fault code maps to 7411, and the fault subcode maps to 7412.

The program is as follows:

```

┌[   MOV      D7411      D362   ]
│      Axis 1
│      Fault master code
└[   MOV      D7412      D364   ]
      Axis 1
      Fault subcode

```

Common faults and solutions

The must-dos are listed as follows:

1. Check the wiring. Check whether other pins instead of CANH and CANL are connected to the PLC.
2. Check FD-10 for all stations. The value 1 indicates CANopen and 2 indicates CANlink.
3. Check whether the CAN communication baud rate defined by FD-00 is consistent with that of the PLC.
4. Check whether the CAN station number defined by FD-02 is unique to avoid conflicts with other drives.

Table 5–23 Common faults and solutions

Problem	Solution
Failure to write frequency	1 Check F0-03 to confirm that the D component and the address in the configuration table are correct. When F0-03 is 0, the I/O mapping is 2000sub8; when F0-03 is 9, the I/O mapping is 2073sub11. 2 Check whether the termination resistor is connected. If not, switch on the termination resistor and then power on the AC drive again.
Failure to start the AC drive	1 Check that F0-02 is set to 2 (0: Operating panel; 1: Terminal; 2: Communication). 2 Check whether the termination resistor is connected. If not, switch on the termination resistor and then power on the AC drive again.

Problem	Solution
Unstable connection	1 Touch the connection cables on the PLC end to check for poor contact. Ensure that wiring on the PLC end is reliable. 2 Check that wiring on the AC drive end is reliable, and make sure that network cables are inserted tightly. 3 Check that the signal cables are far away from the power cable.
Incorrect read value	1 Check that the configuration address is correct. 2 Check whether the program performs data conversion. 3 Make sure that the D component is not occupied. 4 Check the D component of I/O mapping.

5.6 Troubleshooting

5.6.1 Emergency Message and AC Drive Fault

Emergency message data

The following table describes the 7-byte data of the emergency message.

Table 5–24 **Emergency message data**

Emergency Error Code	Error Register	Predefined Error Code
0 to 1	2	3 to 7

Note

- Emergency error code: For details, see relevant chapters of the DS301 documentation. 0x8100 indicates the communication error, and 0xFF00 indicates predefined errors.
- Error register: For details, see the data value in 1001H of the object dictionary in relevant chapters of the DS301 documentation. Bit0 is the error flag, bit4 is the communication error flag, and bit7 is the predefined error.
- Predefined error code: See fault codes of the AC drive.

Fault code

The following table lists standard fault codes of the MD520. For details about the fault codes, see the *MD520 Series General-Purpose AC Drive Parameter Guide*.

Table 5–25 Fault code

Drive Fault Code	Drive Fault Code
2: Overcurrent	42: Excessive speed deviation
5: Overvoltage	43: Motor overspeed
8: Pre-charge power supply fault	45: Motor over-temperature
9: Undervoltage	47: STO fault
10: AC drive overload	51: Pole position auto-tuning error
11: Motor overload	55: Master-slave control fault
12: Input phase loss	56: Self-check fault 1
13: Output phase loss	57: Self-check fault 2
14: Overheat	58: Self-check fault 3
15: External fault	59: Self-check fault 4
17: Pre-charge circuit error	61: Braking overload
18: Current sampling error	62: Braking transistor fault
19: Motor parameter auto-tuning error	63: External alarm
20: Encoder/PG card error	82: Pre-charge contactor fault
21: EEPROM fault	85: Time sequence fault
22: Encoder card not activated	93: Motor control error 1
23: Output short-circuited to ground	94: Motor control error 2
26: Cumulative running time reach	159: Automatic reset fault
27: User-defined fault	160: Modbus timeout
28: User-defined warning	161: CANopen fault
29: Cumulative power-on time reach	162: CANlink fault
30: Output load loss	164: Expansion card fault
31: PID feedback loss during PID operation	174: Input error protection

5.6.2 Simple Diagnosis

Status

The AC drive parameter FD-17 provides the simple diagnosis function. This parameter shows the number of times that the CAN bus is off due to strong interference after power-on.

Diagnosis

If the value is greater than 0 but does not continue to increase, the network has suffered strong interference for a long time. If the value is greater than 0 and increases within 5 minutes, the network is suffering interference or the configuration is incorrect, which requires troubleshooting.

Solution

Check all nodes for the same baud rate or address. Check whether the DIP switch is set correctly and in place and whether the baud rate and address of the master are set correctly.

Check whether the termination resistor is connected only to both ends of the bus. Power off all devices and check whether the resistance between CANH and CANL of the bus is between 50 Ω and 60 Ω by using a multimeter.

Check whether CANH and CANL of a node are reversely connected and whether CGND of the bus is connected (typically CGND terminals of all devices are connected together and not grounded).

6 CANlink Communication (MD38CAN1)

6.1 Protocol Description

The CANlink protocol is a CAN real-time bus protocol for the application layer developed by Inovance based on the CAN2.0 bus protocol. It is mainly used for real-time control and high-speed data exchange among Inovance products, such as PLCs, AC drives, and servo drives.

The CANlink protocol defines five frame structures, including remote frames, command frames, configuration frames, monitoring frames, and data frames. The remote frame is used for the host to scan the CANlink device and obtain information about the CANlink device. The command and configuration frames are used to manage and configure the network. The monitoring frame is used to monitor the CANlink network state. The data frame is used for high-speed data exchange between devices. The CANlink protocol supports two transfer modes: request/response, and time-based or condition-based automatic transmission.

CANlink adopts only CAN2.0 extended data frame as the protocol carrier and uses 29-bit arbitration ID. It does not define other types of frame. Maximum length of a standard CANlink frame: 44 to 108 bits + 23 bits = 67 to 131 bits; maximum length of an extended frame: 64 to 128 bits + 28 bits = 92 to 156 bits

Address

The CANlink protocol supports a station address of up to 8 bits, ranging from 1 to 63. Address 0 is the broadcast address, which is not allowed for use. Addresses 246 to 255 are reserved. The high-order address can be tailored based on actual requirements, and the blank bits are filled with 0.

The address range of Inovance products is 1–63.

Note

The CANlink communication address is consistent with the communication parameter address.

Device

The CANlink devices include nodes, monitors, and configurators.

- Node: It is a CAN device that has the basic characteristics defined by CANlink.
- Monitor: It is a mandatory node that monitors the CANlink network communication status.
- Configurator: It is an optional monitor that is used to configure the CANlink network.

Transmission rate

CANlink supports the following baud rate in the unit of kbps: 20, 50, 100, 125, 250, 500 (default), 800, and 1000. The default value is recommended.

CANlink does not provide the rate error detection mechanism, and the result is unknown if the bus rates are inconsistent.

Timeout

In the CANlink network, the monitor broadcasts a heartbeat monitoring frame to the node based on the set heartbeat period, and the node returns the heartbeat message to the monitor based on the set heartbeat period. If the monitor does not receive the heartbeat frame from a node within the timeout duration, a timeout error is reported. The timeout duration is a multiple of the heartbeat period (set by a number with one decimal), and is 1.5 times of the heartbeat period by default.

The node and the monitor report the monitor timeout error and the node timeout error, respectively. If the node does not receive the heartbeat frame from the monitor within the timeout duration, a monitor timeout error is reported. If the monitor does not receive the heartbeat frame from the node within the timeout duration, a node timeout error is reported.

Network load rate

Perform CANlink configurations based on the network carrying capacity. In the CANlink protocol, it is recommended that the bus load not exceed 50%. The management configuration information device needs to calculate the bus load based on the baud rate to ensure the load ratio. The background software needs to calculate the bus load during the programming configuration. Different colors indicate different load ratio: green: < 50%; yellow: 50% to 75%; red: 75% to 90%. When the load is higher than 90%, an error is reported.

CANlink frame priority

Control frame (0111b) ← Command frame (1000b) ← Configuration frame (1010b) ← Data frame (1100b) ← Remote frame (1101b) ← Heartbeat frame (1110b)

CAN data structure

For historical reasons, the CANlink bus uses the 32-bit register's representation method with the high-order byte at the start. The following table describes the data structure. When initializing the chip, set the transmission mode with the high-order byte at the start for the chip.

Table 6–1 CANlink data structure

Chip Register	MDL				MDH			
Register value	0x data0 data1 data2 data3				0x data4 data5 data6 data7			
CAN data	data0	data1	data2	data3	data4	data5	data6	data7
Byte (8 bits)	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
CAN data	data0	data1	data2	data3	data7	data6	data5	data4
Dual bytes (16 bits)	DByte1		DByte2		DByte3		DByte4	
CAN data	0x data0data1		0x data2data3		0x data4data5		0x data6data7	
Four bytes (32 bits)	QByte1				QByte2			
CAN data	0x data0 data1 data2 data3				0x data4 data5 data6 data7			

CANlink mode

The CANlink node contains the following three running modes:

- Initial mode: The device is initialized and locked. In this mode, the remote frame and address conflict detection can be responded and configuration frames (at an interval of 8s) are broadcast.
- Based on the initial mode, the control frame, command frame, and configuration frame are responded. Heartbeat frames are sent for timeout check (if supported).
- Operation mode: Based on the configuration mode, the slave operates according to the data transmission configuration frame. The data frame is received and processed, and the configuration frame is not responded.

The following figure shows how CANlink operation modes are switched based on specific conditions.

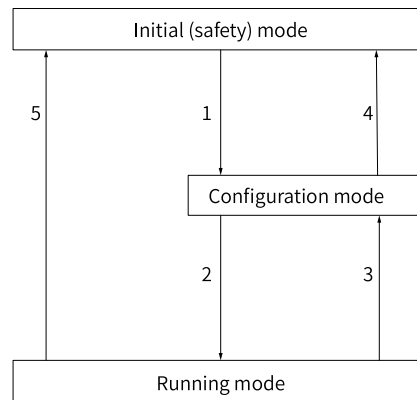


Figure 6-1 CANlink mode switch

- 1: Receive the remote frame from the monitor.
- 2: Receive the node start command.
- 3: Execute the node end command.
- 4-5: The node reports the monitor heartbeat timeout error or the message of communication parameter modification.

6.2 Networking and Interfaces

For details, see [“5.2 Networking and Interfaces” on page 57](#).

6.3 Related Parameters

Table 6-2 Related parameters

Parameter Code	Parameter Name	Default	Value Range	Description
FD-00	Baud rate	5005	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	This parameter defines the speed of data transmitted between the host controller and the AC drive. The higher the baud rate, the faster the communication speed. Note that the baud rate of the host controller must be the same as that of the AC drive. Otherwise, communication will fail.
FD-02	Local address	1	1 to 247	The local address must be unique in the range of 1 to 247, which is the basis for point-to-point communication between the AC drive and host controller. Note: This parameter is used to set the station alias when EtherCAT communication with the communication card version other than V125 (U0-67) applies. When EtherCAT communication with the communication card version V125 applies, the parameter cannot be used to set the station alias.
FD-10	Switchover between CANopen and CANlink	2	1: CANopen 2: CANlink	This parameter is used to select the CAN communication protocol for the CAN1 expansion card. The value 1 represents CANopen. The value 2 represents CANlink.

Parameter Code	Parameter Name	Default	Value Range	Description
FD-14	Number of frames received per unit time	0	0 to 65535	This parameter is used to monitor the bus load. It defines the number of CAN frames received by the station per second. It is valid only for the CANlink communication expansion card.
FD-15	Maximum number of error frames received by node	0	0 to 65535	This parameter is used to monitor bus errors. It defines the maximum number of error frames received by the node. It is valid only for the CANlink communication expansion card.
FD-16	Maximum number of error frame sent by node	0	0 to 65535	This parameter is used to monitor bus errors. It defines the maximum number of error frames sent by the node. It is valid only for the CANlink communication expansion card.
FD-17	Number of disconnections from bus	0	0 to 65535	This parameter is used to monitor bus errors. It defines the number that the node disconnects from the CAN bus. It is valid only for the CANlink communication expansion card.
FD-19	CAN communication disconnection coefficient	3	1 to 15	This parameter is used to set the number of timeout events allowed in CANopen communication before a warning is reported.

6.4 Communication Configuration

6.4.1 Configuration for CANlink Communication Between AC Drive and H5U

Software acquisition and hardware connection

1. Log in to the official website of Inovance (<https://newweb.inovance.com/hc/serviceSupport/> download) to obtain the H5U programming software.
2. Connect the H5U to the CN1 interface of the MD38CAN1 expansion card installed on the MD520 using twisted pair cables.

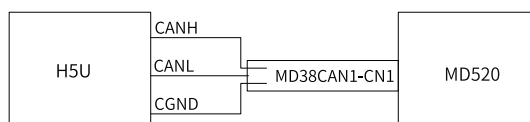


Figure 6-2 Connecting communication interfaces

Master and slave configuration

1. Open AutoShop, click **New Project**, check that **Series and models** is **H5U**, and click **OK** to enter the programming interface.

2. Click  **CAN(CANLink)** in the left pane to enter the CANlink communication setting interface, set parameters as follows, and then click **OK**.

- **Protocol:** Select **CANlink**.
- **Station No.:** Select **Upper computer setting**. Note that the CANlink station number of the PLC must be different from that of the AC drive.
- **Baud Rate:** Select **Upper computer setting**. The communication baud rate must be consistent with the baud rate of the AC drive.

3. Click  **CAN(CANLink)**, and click **AddCAN Config**.  **CAN(CANLink)** is displayed. Double-click **CANlink Config**, click **Next** on the displayed interface, and then set parameter as follows.

- Set the slave type to MD (AC drive).
- Set the slave number according to that defined by FD-02 of the AC drive.
- Set the state register and start/stop component to 7000 and 6000.
- Click **Add**, and click **Finish**.

In this way, a slave is added. If there are multiple shafts, repeat the preceding steps after clicking **Add**.

4. Write operation: After a slave is added, select the PLC to set the configuration to be written to the D element of the AC drive.

Station number	Device type
63	Host(HSU Series)
1	MD (Frequency Converter)
2	MD (Frequency Converter)

Host (63) Config

Send Config								
Receive Config			Synchronous Write					
NO.	Trigger Mode	Trigger	Send Station	Send Register	Receiver Station	Receive Register	Length	
1	Time(ms)	10	63 HOST (HSU)	0 Dec	1 MD (Frequency)	1000 Hex	1	
2	Time(ms)	10	63 HOST (HSU)	2 Dec	1 MD (Frequency)	2000 Hex	1	
3	Time(ms)	10	63 HOST (HSU)	100 Dec	2 MD (Frequency)	1000 Hex	1	
4	Time(ms)	10	63 HOST (HSU)	102 Dec	2 MD (Frequency)	2000 Hex	1	

As shown in the preceding figure, assign the value of D2 to the control word address of the AC drive with the station number 1, and assign the value of D102 to the control word address of the AC drive with the station number 2. Write the corresponding register address as required, and make sure that the receiving register address is correct and writable; otherwise, the write operation will fail.

5. Read operation: Select the station (AC drive) to be read and enter the configuration interface for reading the D component of the AC drive.

To read station 1, click number 1 to start configuration. To read station 2, click number 2 to start configuration. You cannot read the required value correctly if the station number is incorrect.

Slave station (1) configuration

Send Config								
Receive Config								
NO.	Trigger Mode	Trigger	Send Station	Send Register	Receiver Station	Receive Register	Length	
1	Time(ms)	10	1 MD (Frequency)	7002 Hex	63 HOST (HSU)	300 Dec	1	
2	Time(ms)	10	1 MD (Frequency)	7003 Hex	63 HOST (HSU)	302 Dec	1	
3	Time(ms)	10	1 MD (Frequency)	7004 Hex	63 HOST (HSU)	304 Dec	1	

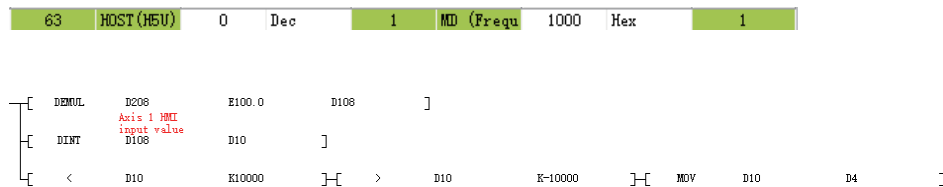
As shown in the preceding figure, the bus voltage, output voltage, and output frequency of the AC drive are sent to D300, D302, and D304 of the PLC. Configure the transmission register address and D component correctly as needed. After the read and write operation settings, keep clicking **OK** until you return to the programming interface.

Instances

- Write the frequency (F003 is set to 9).

Data conversion: Multiply the required frequency (a) by 100 to obtain an integer, and then write the integer to 1000H.

The following figure shows the configuration and the program.

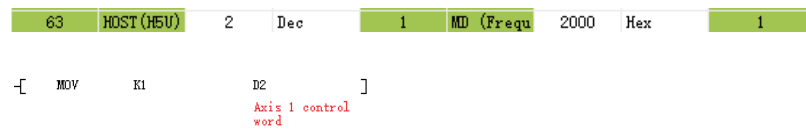


2. Start or stop the AC drive (F0-02 is set to 2).

Assign a value to the D component corresponding to the station address 2000H to control forward running, reverse running, and stop of the AC drive through communication. Definitions of 2000H are as follows:

1: Run in forward direction; 2: Run in reverse direction; 3: Jog in forward direction; 4: Jog in reverse direction; 5: Coast to stop; 6: Decelerate to stop; 7: Reset upon fault

The following figure shows the configuration and the program.

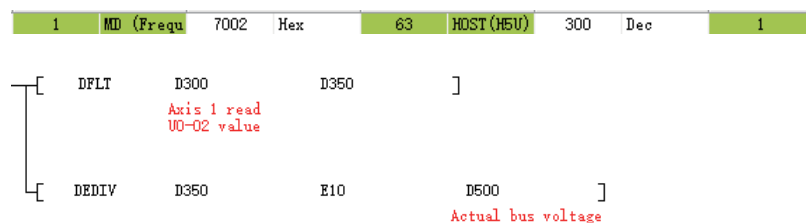


The PLC soft component address corresponding to 2000H is D2. Therefore, to control the AC drive to run in the forward direction through communication, write 1 to D2. Similarly, to control the AC drive to decelerate to stop, set D2 to 6.

3. Read the bus voltage.

Convert the bus voltage U0-02 to 7002 based on the conversion rule (convert U in the high-order two bits to 7, and convert the low-order two bits to a hexadecimal equivalent). The actual bus voltage is the read bus voltage (a) divided by 10. According to the communication configuration, the D component address of the bus voltage is D300. Convert D300 to a floating-point number and then divide this value by 10.

The following figure shows the configuration and the program.



4. Read the output voltage.

Convert the output voltage U0-03 to 7003 based on the conversion rule. The read value is the actual output voltage. According to the communication configuration, you only need to move the value of D302 to another D component (or not).

The following figure shows the configuration and the program.

1	MD (Frequ	7003	Hex	63	HOST (H5U)	302	Dec	1
-[MOV D302 D502]								
			Axis 1 read U0-03 value		Axis 1 actual output voltage			

5. Read the output current.

Convert the output current U0-04 to 7004 based on the conversion rule. The actual output current is the read output current divided by 100.

The following figure shows the configuration and the program.

1	MD (Frequ	7004	Hex	63	HOST (H5U)	304	Dec	1
[	DFLT	D304	D354	]				
		Axis 1 read U0-04 value						
[	DEDIV	D354	E100	D504	]			
				Axis 1 actual output current				

6. Read the AC drive state.

Read 3000H to directly obtain the current state of the AC drive (1: Running in forward direction; 2: Running in reverse direction; 3: Stopped).

The following figure shows the configuration and the program.

1	MD (Frequ	3000	Hex	63	HOST (H5U)	308	Dec	1
-[MOV D308 D358]								

7. Read the DI state.

According to the conversion rule, convert the DI state U0-07 to 7007. Convert the read value into a binary value. The LSB indicates DI1, the second bit indicates DI2, and so on.

The following figure shows the configuration and the program.

1	MD (Frequ	7007	Hex	63	HOST (H5U)	310	Dec	1
-[MOV D310 D360]								
			DI status					

8. Read the fault code.

Convert the fault code U0-45 to 702D and convert the fault subcode U0-46 to 702E based on the conversion rule.

The following figure shows the configuration and the program.

1	MD (Frequ	702D	Hex	63	HOST (H5U)	312	Dec	1
1	MD (Frequ	702E	Hex	63	HOST (H5U)	314	Dec	1
[	MOV	D312	D362	]				
		Fault master code						
[	MOV	D314	D364	]				
		Fault subcode						

Common faults and solutions

The must-dos are listed as follows:

1. Check the wiring. Check whether other pins instead of CANH and CANL are connected to the PLC.
2. Check FD-10 for all stations. The value 1 indicates CANopen and 2 indicates CANlink.

3. Check whether the CAN communication baud rate defined by FD-00 is consistent with that of the PLC.
4. Check whether the CAN station number defined by FD-02 is unique to avoid conflicts with other AC drives.

Table 6–3 Common problems and solutions

Problem	Solution
Failure to write frequency	1 Check F0-03 to confirm that the address in the configuration table is correct. When F0-03 is 0, the address is the address of F0-08; when F0-03 is 9, the address is 1000H or 7310H. 2 Check whether the termination resistor is connected. If not, switch on the termination resistor and then power on the AC drive again.
Failure to start the AC drive	1 Check that F0-02 is set to 2 (0: Operating panel; 1: Terminal; 2: Communication). 2 Check whether the termination resistor is connected. If not, switch on the termination resistor and then power on the AC drive again.
Unstable connection	1 Touch the connection cables on the PLC end to check for poor contact. Ensure that wiring on the PLC end is reliable. 2 Check that wiring on the AC drive end is reliable, and make sure that network cables are inserted tightly. 3 Check that the signal cables are far away from the power cable.
Incorrect read value	1 Check that the configuration address is correct. 2 Check whether the program performs data conversion. 3 Make sure that the D component is not occupied.

7 PROFINET Communication (MD500-PN1)

7.1 Introduction

The MD500-PN1 card is a PROFINET fieldbus adapter card complying with PROFINET Ethernet standards. It is installed on an MD series AC drive to improve the communication efficiency and implement the AC drive networking function. This enables the AC drive to be a slave controlled by the fieldbus master.

This user guide is applicable to the MD500-PN1 card with the software version of 1.00 or later. You can query the version by viewing the parameter U0-67 of the AC drive after the card is installed and the drive is powered on. The corresponding GSDML file is GSDML-V2.31-inovancemd500-20180705.xml.

7.2 Installation

The MD500-PN1 card is embedded in the MD520 series AC drive. Before installation, power off the AC drive, wait at least 10 minutes until the charging indicator on the AC drive becomes off. Then, insert the MD500-PN1 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. *“Figure 7-1” on page 83* describes the installation of the card.

Note that the ground terminals of both the MD500-PN1 card and AC drive must be connected properly, as shown in *“Figure 7-2” on page 83*.

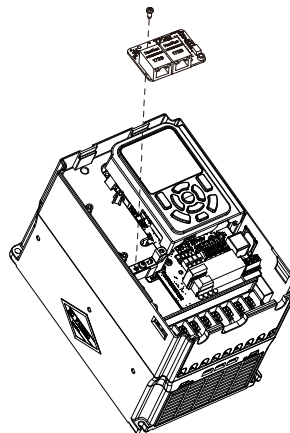


Figure 7-1 MD500-PN1 card installation

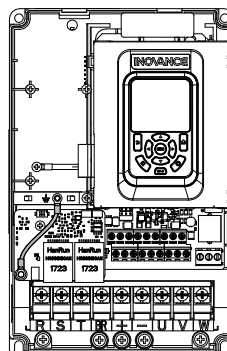


Figure 7-2 Connecting ground terminals of the MD500-PN1 card and AC drive

7.3 Terminal Layout and Description

The following figure describes terminals and indicators of the MD500-PN1 card. The pin header J1 on the back of the MD500-PN1 card is used to connect the drive. The MD500-PN1 card provides two Ethernet ports J2 and J3 to enable the card to communicate with the PN card (PLC).

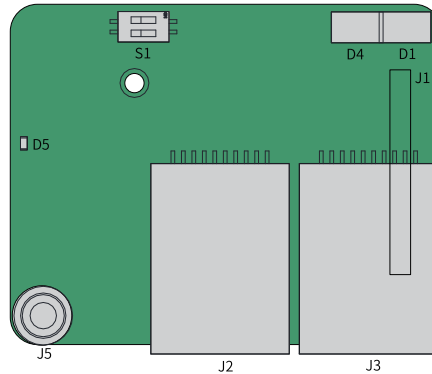


Figure 7-3 MD500-PN1 card terminal layout

Table 7-1 Indicators of the MD500-PN1 card

Mark	Hardware Name	Function Description
J1	Pin header	Check that FD-00 is set to 9 and FD-01 is set to 3.
J2	Network port	The ports are standard Ethernet RJ45 ports and are direction-insensitive. The J3 port is used by the PN card (drive) to communicate with the PN card (PLC).
J3		
D5	Power supply indicator	It is used to indicate the status of the power supply. ON: Normal; OFF: Abnormal. Check whether the card is installed properly.
D1	PLC communication status indicator (PLCLINK)	For details, see "Table 7-2" on page 85 .
D4	AC drive communication status indicator (DSPLINK)	
S1	2-bit DIP switch	Used by the manufacturer for upgrade purpose only.

Caution

- After the MD500-PN1 card is installed, J2 is on the left and J3 is on the right when facing the RJ45 interface. These two ports are direction-insensitive. You can connect either one to the near PLC end.
- The Cat5e shielded twisted pair network cable is recommended to ensure stability.

Table 7-2 Status indicators of the MD500-PN1 card

Indicator		Status	Solution
DSPLINK	Steady green	Normal	None
	Steady yellow	MAC address abnormal	Replace the PN card.
	Blinking yellow	AC drive faulty	Clear the AC drive fault.
	Steady red	Abnormal communication with the AC drive	Set F0-28 to 1 and check whether the AC drive supports the PN card.
	Flashing in red	AC drive communication timeout	Check whether the AC drive software version supports the PN card. Restore the AC drive software to default settings.
PLCLINK	Steady green	Communication normal	/
	Blinking green	The master is not found.	Check whether a device name is assigned to the slave. Check whether the corresponding PLC is connected.
	Steady yellow	Configuration error	Check whether the GSD file is correct.
	Steady red	Communication with the master interrupted	Check the wiring and check whether the shield of the network cable is connected properly.
D1 and D4	Both in red	PN card software abnormal	Power off and then power on the equipment. Replace the PN card.
		DIP switch abnormal	Check that the DIP switch S1 is OFF and re-power on the equipment.

7.4 PROFINET Topology

The PROFINET protocol supports a variety of topologies, including bus-, star-, and tree-type topologies. Diversified networking modes can be implemented by using switches.

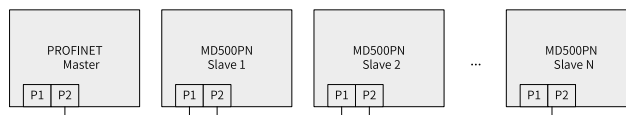


Figure 7-4 Bus-type topology

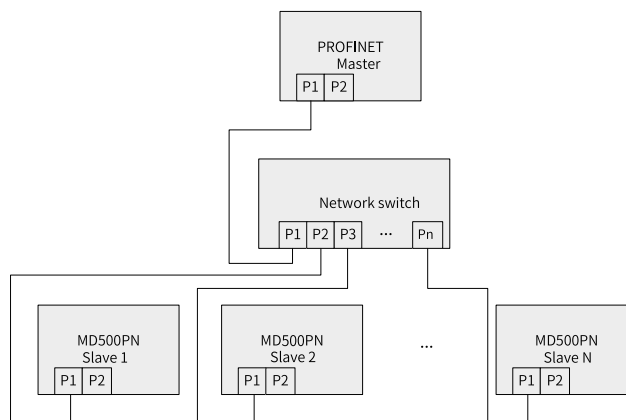


Figure 7-5 Star-type topology

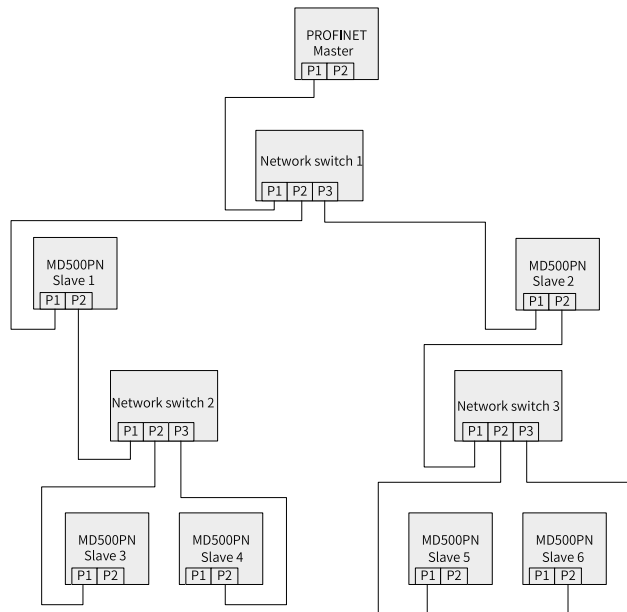


Figure 7-6 Tree-type topology

7.5 Data Transmission Format

The MD500-PN1 card transmits data using PZD formats with different lengths as required. You can set the PZD functions during configuration.

The following table lists the functions supported by each data format.

Data Type	Data Length	Supported Function
Standard telegram 1	PZD-2/2	Setting of AC drive command and frequency Reading of AC drive state and running frequency
Standard telegram 2	PZD-4/4	Setting of AC drive command and frequency Periodic writing of two function parameters Reading of AC drive state and running frequency Periodic reading of two function parameters
Standard telegram 3	PZD-6/6	Setting of AC drive command and frequency Cyclic writing of four function parameters Reading of AC drive status and running frequency Cyclic reading of four function parameters

Data Type	Data Length	Supported Function
Standard telegram 4	PZD-8/8	Setting of AC drive command and frequency Cyclic writing of six function parameters Reading of AC drive status and running frequency Cyclic reading of six function parameters
Standard telegram 5	PZD-10/10	Setting of AC drive command and frequency Periodic writing of eight function parameters Reading of AC drive state and running frequency Cyclic reading of eight function parameters
Standard telegram 6	PZD-12/12	Setting of AC drive command and frequency Cyclic writing of 10 function parameters Reading of AC drive status and running frequency Cyclic reading of 10 function parameters
Supplementary telegram	PZD-2/6	Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic reading of four function parameters

7.6 PZD Data

The master can modify and read AC drive data in real time and exchange data cyclically with the AC drive through the PZD data. Data communication addresses are directly configured by the AC drive. The specific functions are as follows:

- Real-time settings of AC drive control commands and target frequencies
- Real-time reading of AC drive current state and running frequency
- Real-time exchange of function parameters and monitoring data between the AC drive and PROFINET master station

The written PZD1 and PZD2 are mapped to U3-17 and U3-16 respectively by default. If a command or frequency fails to be written into the AC drive while PZD3 to PZD12 can be written and F0-02 and F0-03 are set to 2 and 9 respectively, check whether FE-00 and FE-01 are U3-17 and U3-16 respectively. If not, manually correct the parameter values. The read PZD1 and PZD2 are mapped to U0-68 and U0-69 respectively. If a state or running frequency fails to be read while PZD3 to PZD12 can be read, check

whether FE-20 and FE-21 are set to U0-68 and U0-69 respectively. If not, manually correct the values of FE-20 and FE-21.

The following table lists the interactive data.

Table 7-3 Interactive data

PZD Data Sent by Master			PZD Data Responded by AC Drive		
PZD1	PZD2	PZD3 to PZD12	PZD1	PZD2	PZD3 to PZD12
Control word (U3-17)	Frequency reference (U3-16)	Real-time modification of AC drive parameters	Status word (U0-68)	Running frequency (U0-69)	Real-time reading of AC drive parameters

Table 7-4 Interactive data

PZD Data Sent by Master		PZD Data Responded by AC Drive	
PZD1	AC drive command word (command source set to communication, that is, F0-02 = 2) 1: Forward run 2: Reverse run 3: Forward jog 4: Reverse jog 5: Coast to stop 6: Stop according to F6-10 (Stop mode) 7: Reset upon fault	PZD1	It indicates the AC drive state, which is described as follows: Bit 0: 0: Stopped; 1: Running Bit 1: 0: Running in forward direction; 1: Running in reverse direction Bit 2: 0: Not faulty; 1: Faulty Bit 3: 0: Running frequency not reached; 1: Running frequency reached Bit 4 to bit 7: Reserved Bit 8 to bit 15: AC drive fault code
PZD2	It indicates the AC drive target frequency (frequency source set to communication, that is, F0-03 = 9), which ranges from the reverse frequency upper limit (negative value) to forward frequency upper limit (decimal places included, for example, 2000 corresponds to 20.00 Hz on the AC drive). When the target frequency exceeds this range, the AC drive runs at the frequency upper limit.	PZD2	It indicates the AC drive running frequency (unit: 0.01 Hz). The current AC drive running frequency is returned as 16-bit signed data.
PZD3 to PZD12	Function parameters are modified in real time and are not written into the EEPROM.	PZD3 to PZD12	Function parameters are read in real time.

7.7 Related Parameters

PN card configuration of the AC drive

After the MD500-PN1 expansion card is installed in the AC drive, set F0-28 to 1 to enable the card to communicate with the AC drive.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-28	Communication protocol	0: Modbus protocol 1: Expansion communication protocol 2: Inobus protocol (through EtherCAT card)	1	This parameter is used to select a communication protocol. 0: Modbus protocol The Modbus protocol is used. 1: Expansion communication protocol PROFIBUS DP, PROFINET, EtherCAT, Modbus TCP, and EtherNet/IP protocols can be used. No setting is required for CANlink because it is always valid. 2: Inobus protocol (through EtherCAT card) When this parameter is set to 2, the Inobus communication protocol is used. The AC drive version must be F7-10 = U60.07/F7-11 = U61.07/F7-15 = 000.00/F7-16 = 000.00 or later.
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run and jog operation. 0: Operating panel The RUN/STOP key on the operating panel can be used to start or stop the drive. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined The command source is defined by the user as needed for expansion.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-03	Main frequency X selection	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	9	This parameter is used to set the source of the main frequency source X as below. 0: Digital setting (non-retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is restored to the value of F0-08. 1: Digital setting (retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is the same as that at the moment of the last power failure. Modifications made by using keys ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP and DOWN key remain effective. 2: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). To be continued

Parameter Code	Parameter Name	Value Range	Value	Description
Continued	Continued	Continued	Continued	Continued 7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources.

Parameters related to expansion cards

Parameter Code	Description
U0-66	Model of the communication expansion card • 100: CANopen • 200: PROFIBUS DP • 300: CANlink • 400: PROFINET • 500: EtherCAT • 600: EtherNet/IP
U0-67	Software version of the communication expansion card.

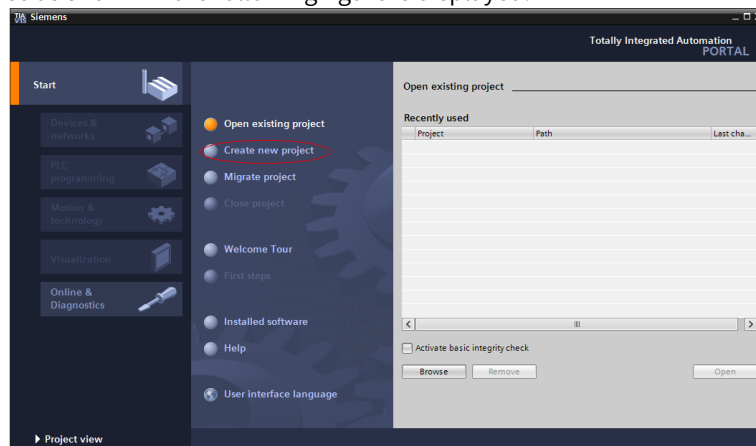
7.8 Communication Configuration

7.8.1 Configuring Slaves on the S7-1200 Master

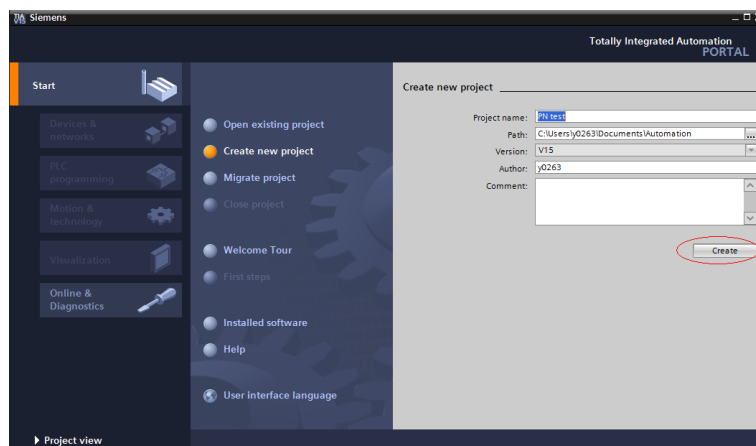
Before using the PROFINET master, you need to configure the GSDML file of the slave to add the corresponding slave stations to the master. If the file exists, skip step 2. You can obtain the GSDML file from the Inovance agent or the manufacturer.

To configure the slave, do as follows:

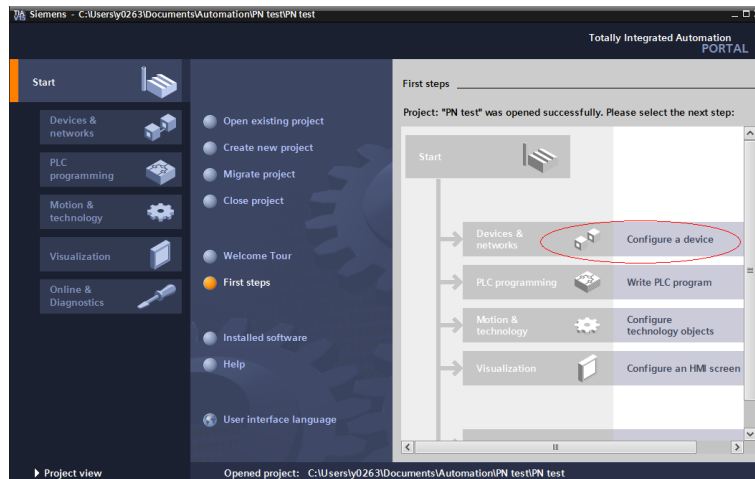
1. Create a project and add the S7-1200 master to the project in PORTAL. To be specific, open PORTAL first. The interface as shown in the following figure is displayed.



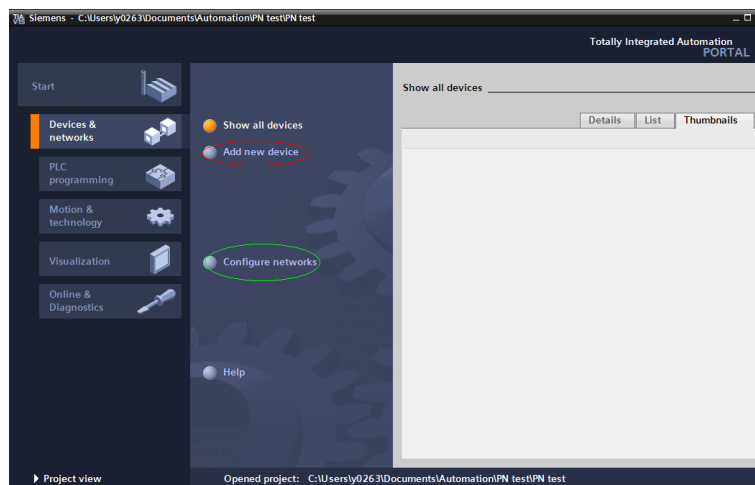
Click **Create new project**, enter a project name and storage path, and click **Create**.



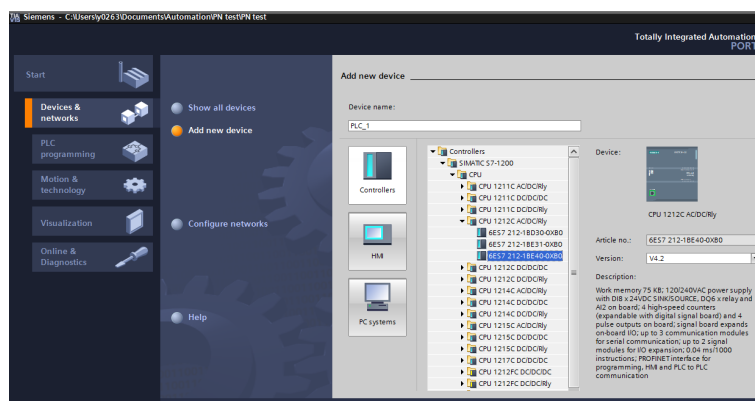
Click **Configure a device**.



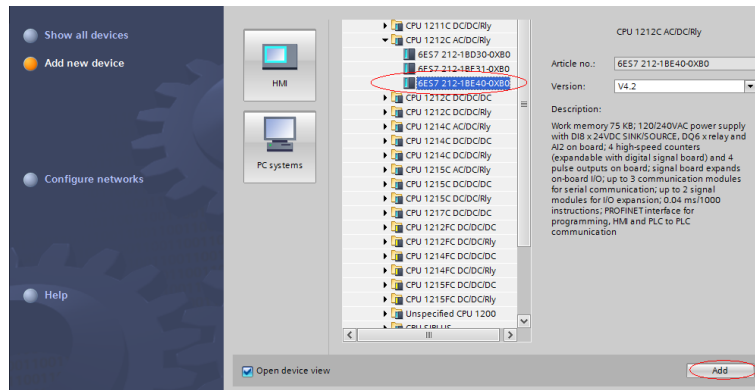
For a new project, click **Add new device** (marked with a red circle in the following figure). For an existing project, click **Configure networks** (marked with a green circle in the following figure).



Select a PLC on the displayed interface. Ensure that the article number and firmware version of the PLC are correct to avoid a download failure.

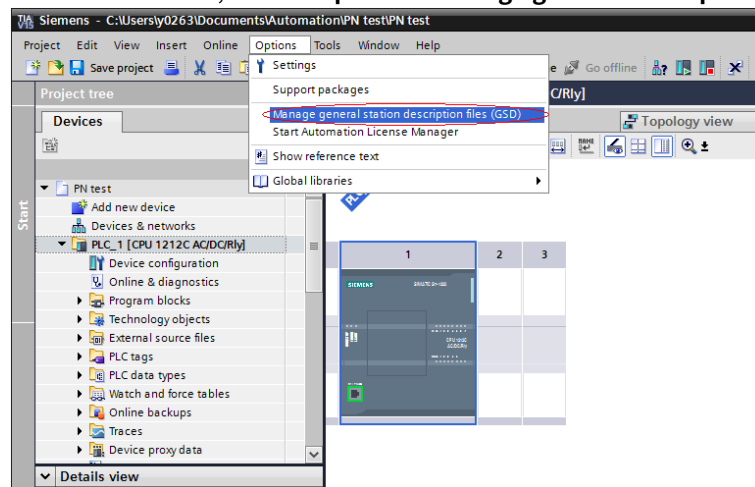


Click **Add** or double-click the selected master station.

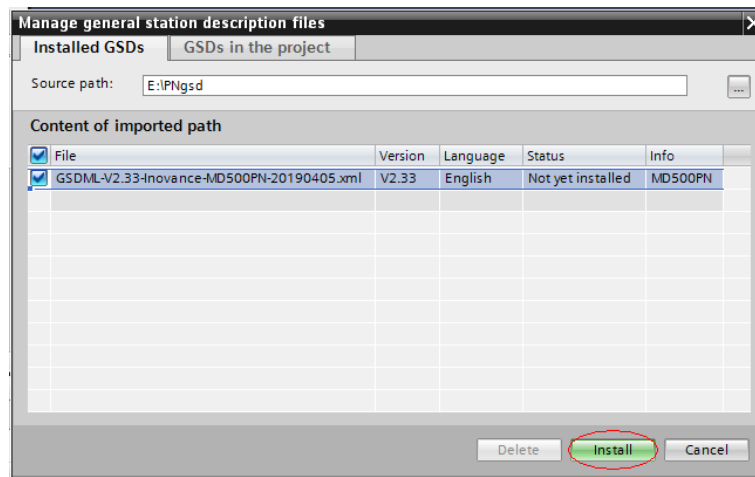


The master is added.

2. (Optional) To install the GSDML file, choose **Options > Manage general description files (GSD)**.



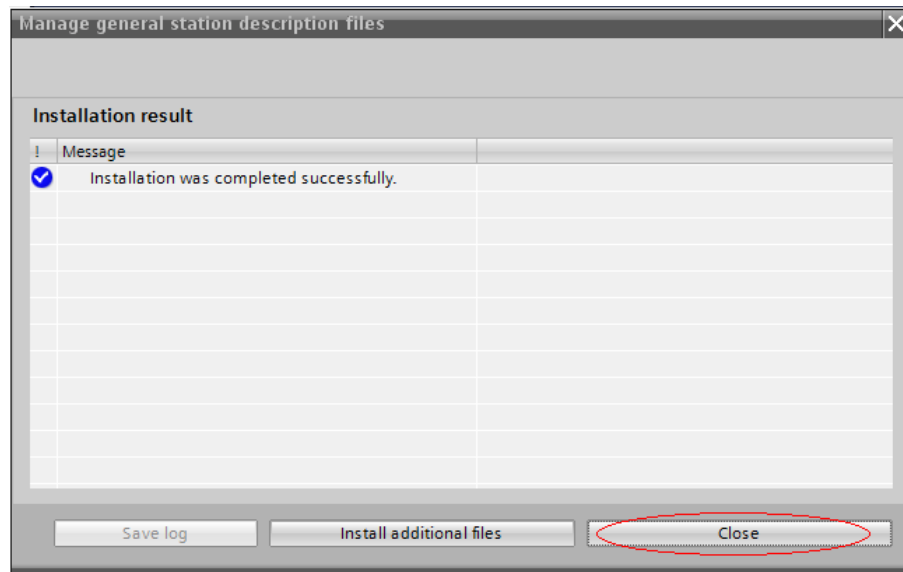
Select the storage path that does not contain any Chinese characters for the GSDML file, select the GSDML file to be installed, and click **Install**.



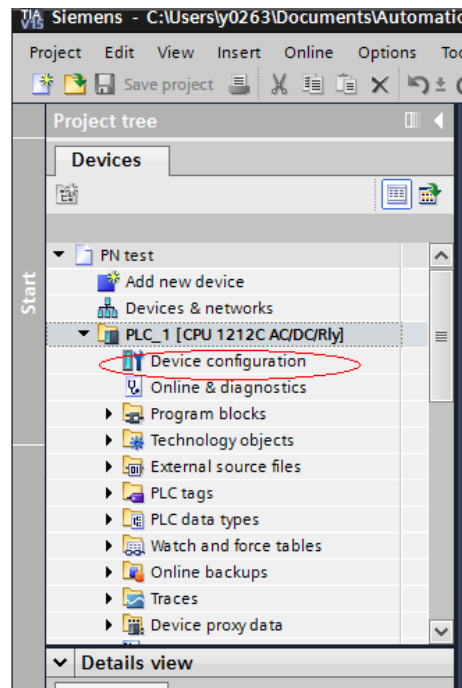
Caution

The GSDML file name varies with the AC drive series. For details, see the corresponding user guide.

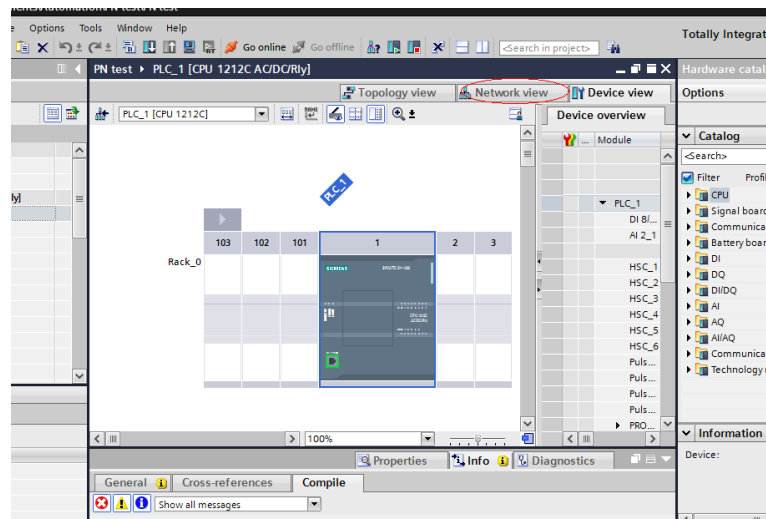
After installation is done, click **Close**.



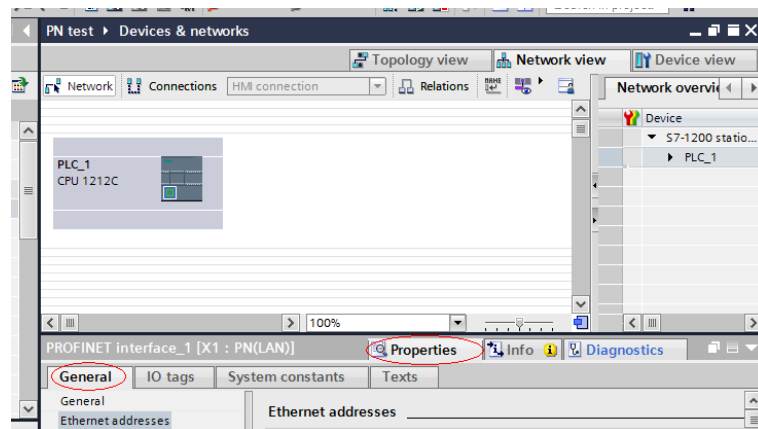
3. Configure a slave.
Click **Device configuration**.



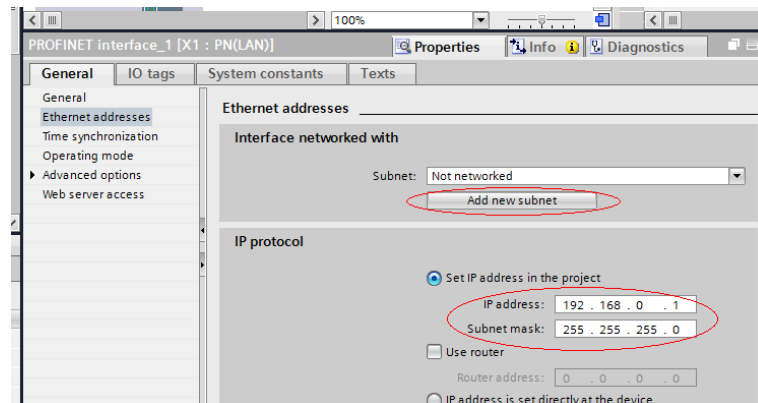
Switch to **Network View**.



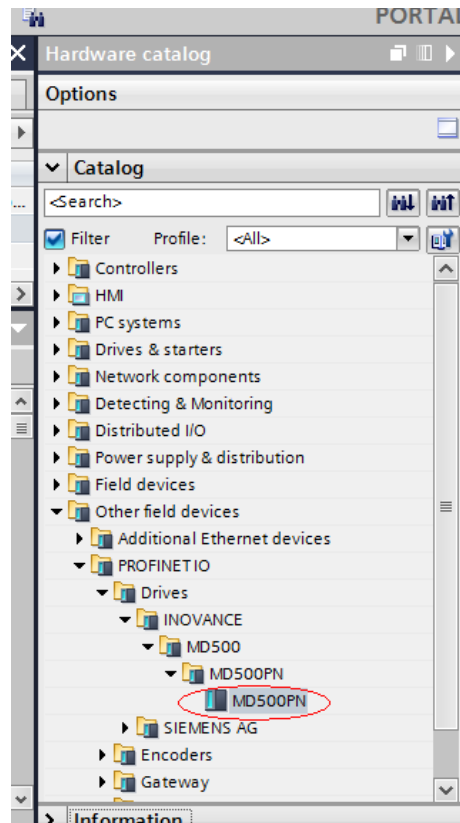
Select the Ethernet interface of the PLC, and choose **Properties > General**.



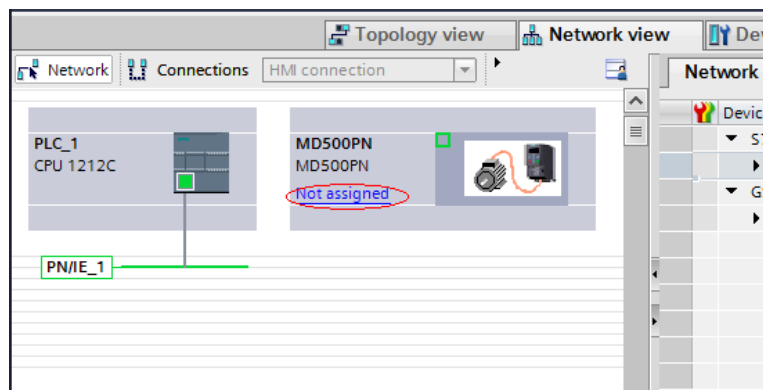
Set the IP address and subnet mask of the PLC, and click **Add new subnet**.



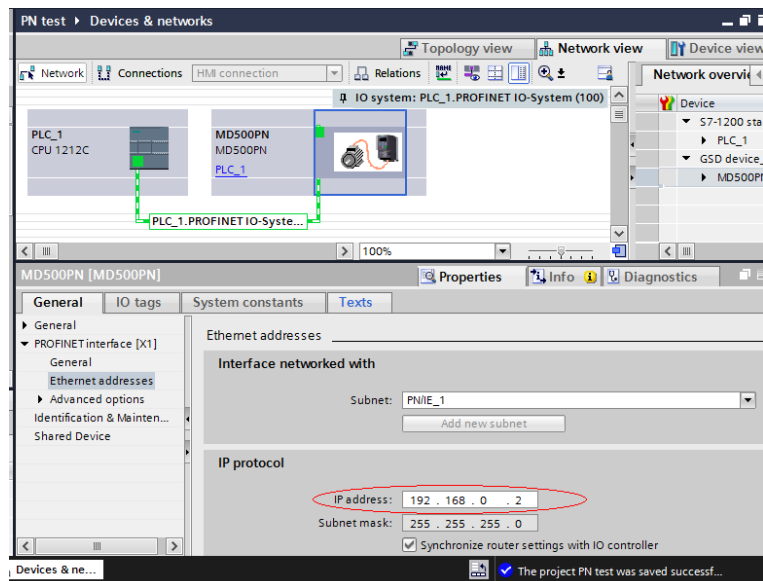
Locate MD500PN under **Hardware catalog** on the right, and double-click **MD500PN**.



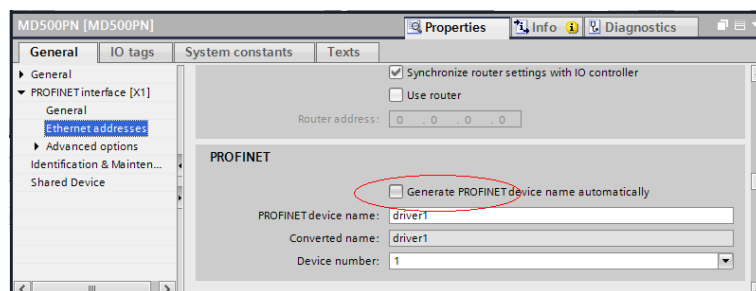
Click **Not assigned** to select the master system for the slave.



Select the slave, and choose **Properties > General > PROFINET interface [X1] > Ethernet addresses** and set the IP address.

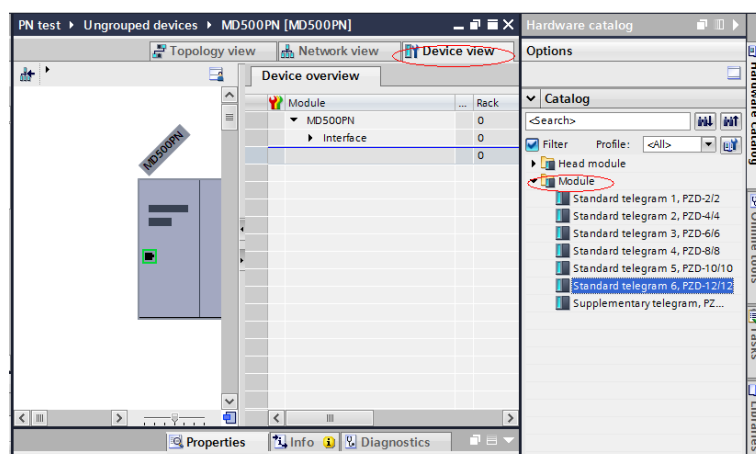


Scroll down the interface to locate the **PROFINET** area. Clear **Generate PROFINET device name automatically**, and name the slave device in the **PROFINET device name** text box. Alternatively, select **Generate PROFINET device name automatically** to enable the system to generate a device name automatically.



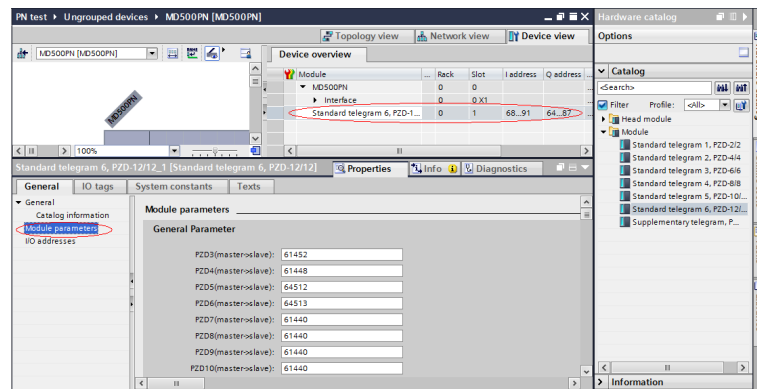
4. Configure data features of the slave.

Select the slave station and click the **Device view** tab. In the **Hardware catalog** pane, click **Module**, and double-click the data length configured to the slave station.



5. Configure the PZD.

The PZD1 and PZD2 configurations are fixed and cannot be modified by users. PZD3 to PZD12 are intended for exchange of user-defined cyclic data. They can be set in hardware configuration.



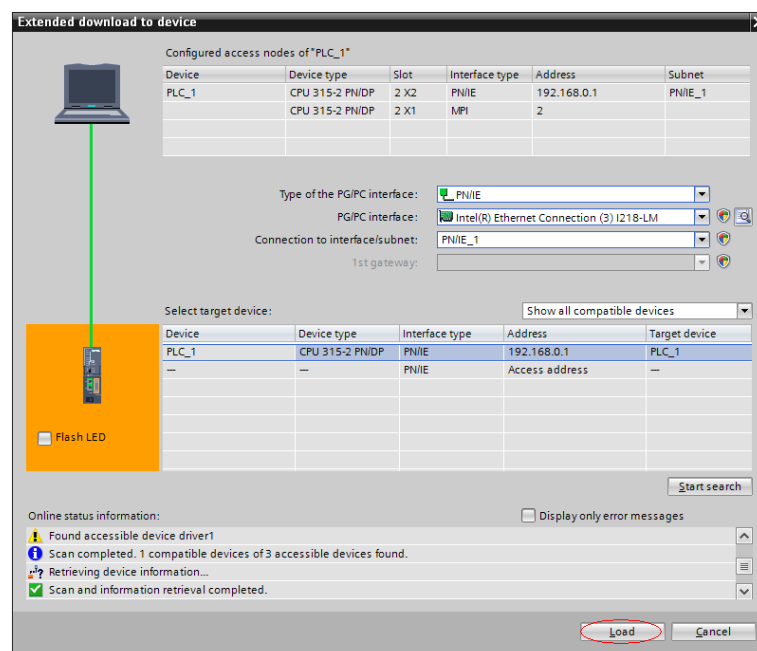
PZDx(master->slave) indicates the address of the slave used by the master to write data to the slave, and PZDx(slave->master) indicates the address of the slave used by the master to read data from the slave. PZD3 to PZD12 (determined by the selected message type) are displayed in decimal and can be modified. For example, to set PZD3(master->slave) to F0-12, enter **61452**.

By default, all PZDs of the MD520 are set to F0-00 (61440 in decimal). For unused PZDs, modification is not required and default values can be retained. PZD mapping must be set independently for each slave as required. If mapping relationships of various slaves are the same, you can select one configured slave, press Ctrl+C, select the PROFINET bus in the configuration, press Ctrl+V, and modify the device name and IP address.

Switch to **Network view**. To add more stations, repeat the preceding steps. If the configuration is the same, select and copy a configured slave and modify the IP address and device name (note that the device name must be unique).

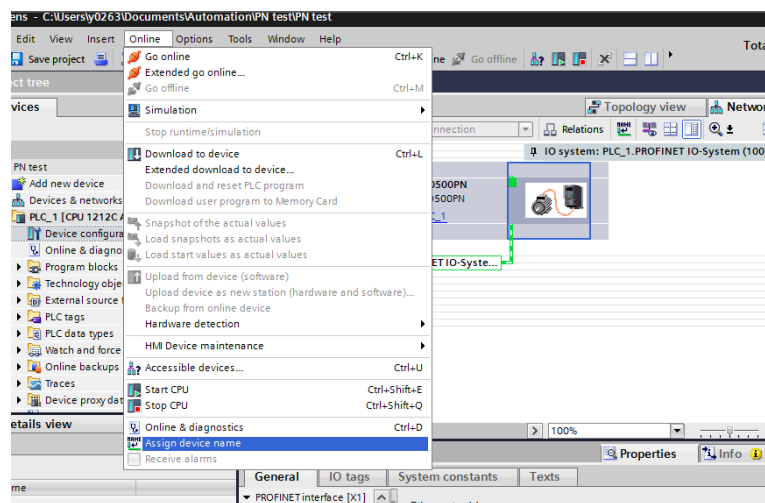
6. Download the configuration.

Save the network configuration. Set the IP address of the PC to the same network segment as that of the PLC. (Note that the IP address of the PC must be different from that of the slave station in the configuration. You can also enable the function of automatic IP address distribution for the PC.) Start compiling, click **Load**, select the interface, and click **Start search**.

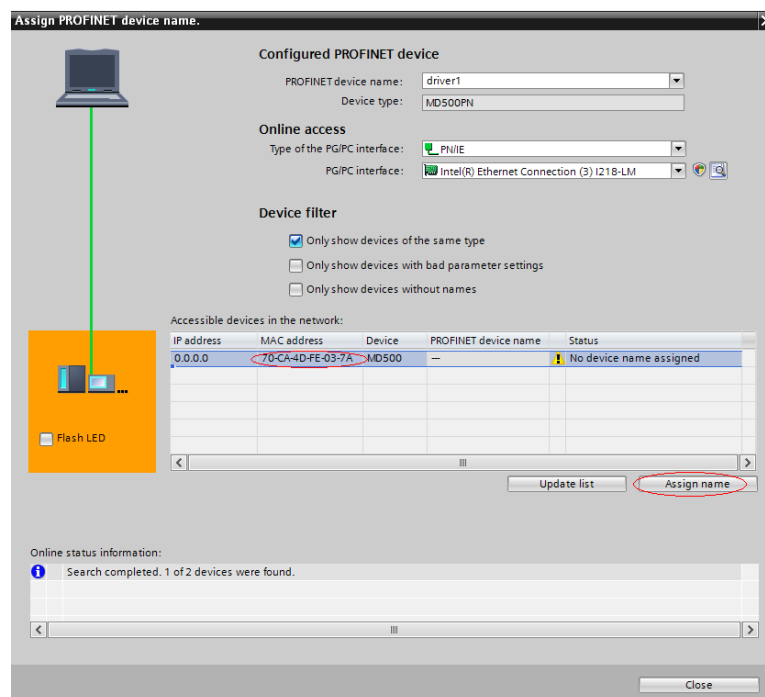


7. Assign a device name.

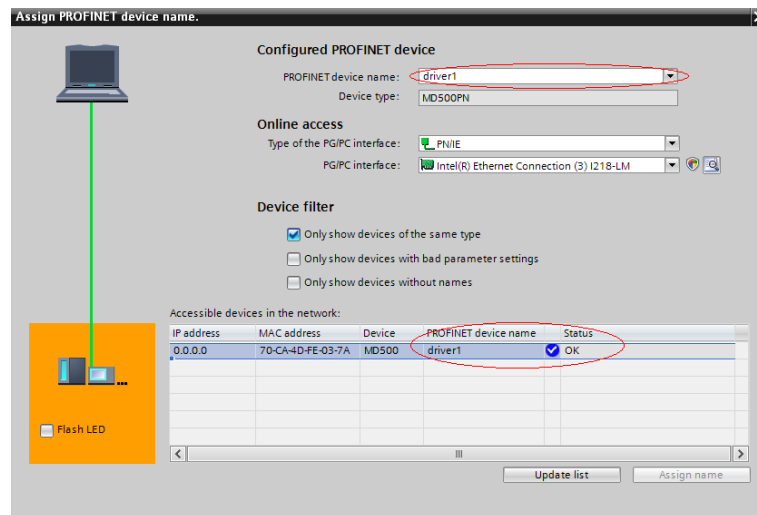
After downloading is complete, assign device names for slave stations without names. Select a slave, and choose **Online > Assign device name**, or right-click the slave and select **Assign device name**.



Devices of the same type will be displayed in the popped-out interface. Select the slave to be assigned with the device name. The MAC address for each slave is unique. When multiple devices of the same type exist in a network, differentiate such devices with their MAC addresses. The MAC address of the MD500-PN1 card is on the product enclosure. Click **Assign name**.



If information similar to the following figure is displayed, the device name is assigned successfully. The displayed **PROFINET device name** in the following figure must be consistent with that displayed in the preceding figure. After assigning the device name, close the interface or select another device from the **PROFINET device name** drop-down list to assign device names for other stations.



The slave will save the assigned name, and the master identifies each slave based on the device name. (The MAC address is not intuitive in use. The device name assigned is bound to the MAC address of a device for identification.)



Caution

- Each device name can be assigned to only one slave station on the network.
- After the device name of a station in the configuration is changed, the device must be assigned with a name again. (For any exception, see "Troubleshooting".)
- After modifying the IP address, you only need to download the modified configuration to the PLC. Name assignment is not required.

After the preceding steps, the PROFINET slave is configured. You can compile programs in the PLC to control the AC drive. Reading and writing operations on PROFINET slaves through the PLC are similar to those on PROFIBUS DP slaves through the PLC.

To ensure normal operation of the PLC, function blocks such as OB82, 83, 86, and 122 need to be added during programming. The content of the function blocks can be compiled according to actual needs or left blank.

7.8.2 MRP Functions of MD500-PN1 Card

The Media Redundancy Protocol (MRP) function is implemented by the MRP ring network in PROFINET. Only one MRP ring network is allowed in one PROFINET network.

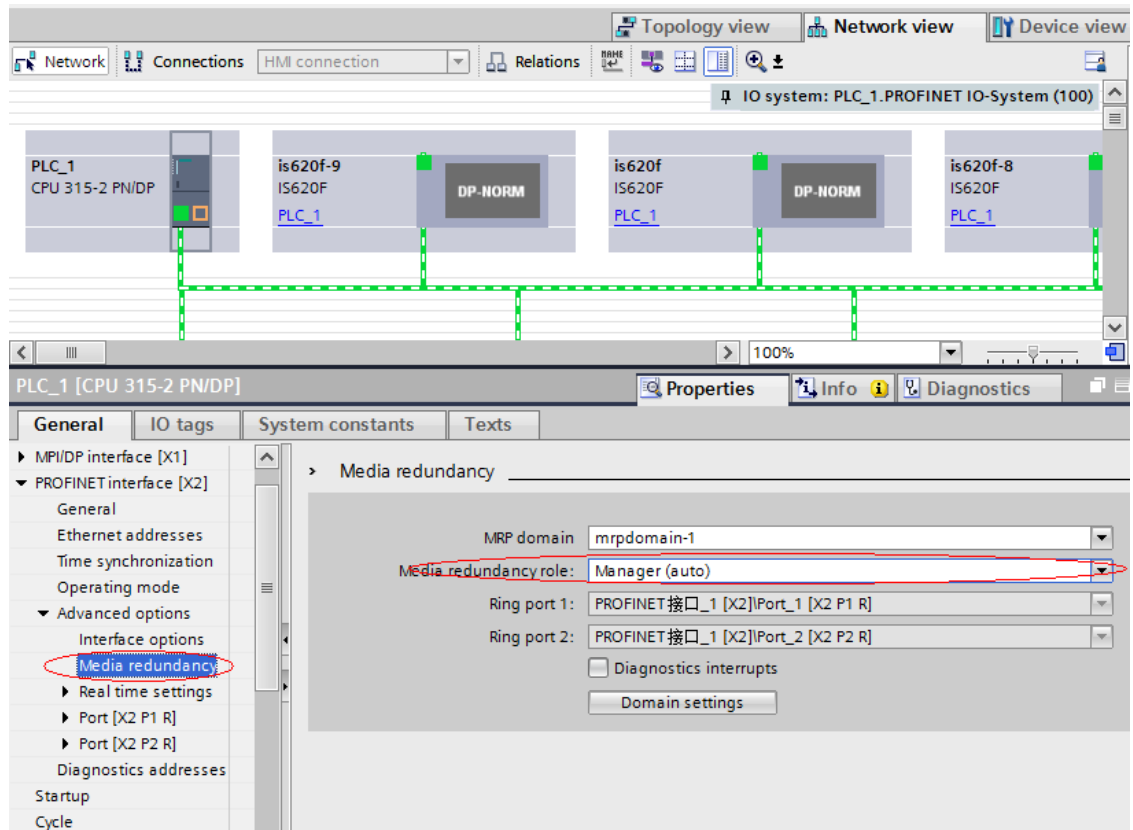
The MD500-PN1 card with the software version of 1.04 or later supports the MRP function. Check U0-67 on the AC drive to see the version. To use the MRP function, the corresponding configuration is required.

Configuring the MRP function in PORTAL

1. Configure the MRP manager.

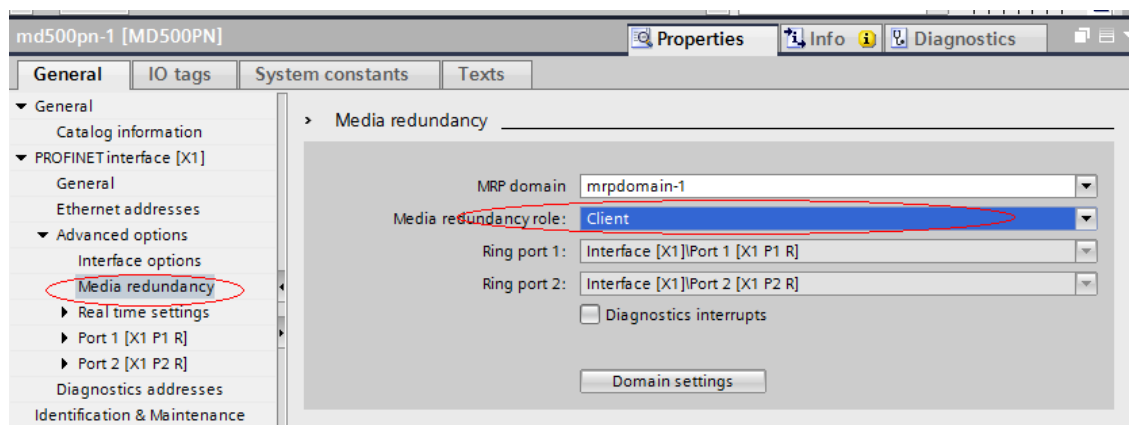
An MRP manager is required in the MRP ring network. The MD500-PN1 card cannot be used as the manager. Generally, the PLC is used as the manager. Select the station to be used as the manager,

and select **Manager (auto)** from the **Media redundancy role** drop-down list, as shown in the following figure.



2. Configure the MRP client.

Select the slave, and select **Client** from the **Media redundancy role** drop-down list, as shown in the following figure. Configure the manager before the client configuration; otherwise, an error will be reported.



3. Configure the watchdog time.

The MRP function requires that the watchdog time cannot be shorter than 200 ms. Therefore, you need to modify the watchdog time, as shown in the following figure. Click **IO cycle**. Under **Watchdog time**, modify **Watchdog time** to a value not less than 200 ms.

Note: If the watchdog time is shorter than 200 ms, and the ring network circuit is interrupted, the node in the network reports a communication interruption fault and then resumes normal connection.

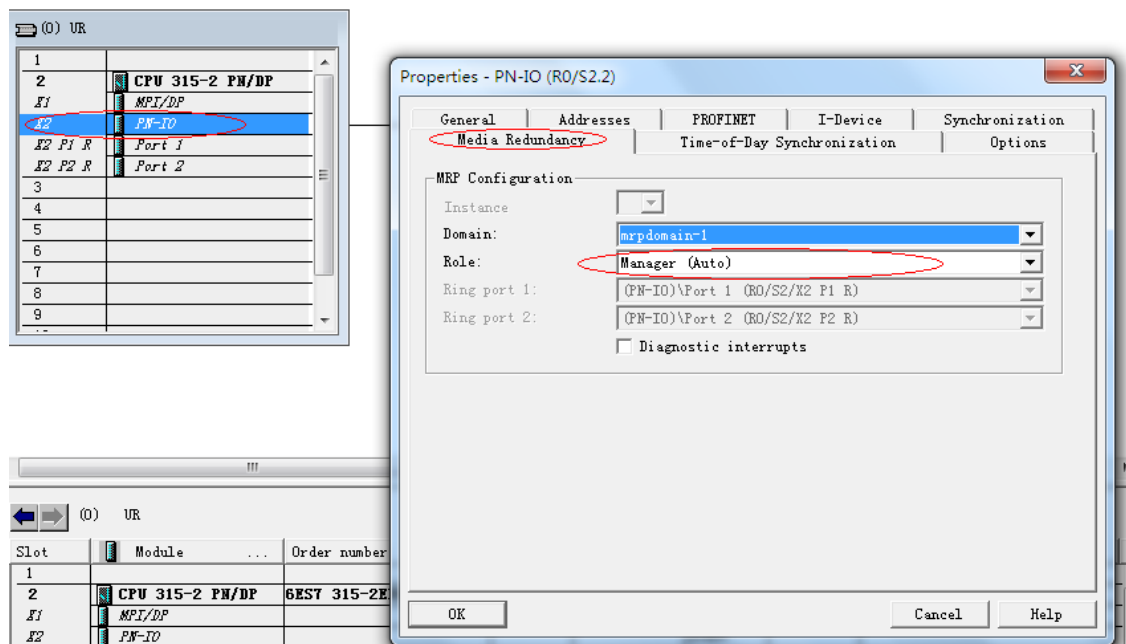
4. Download the configuration.

After configuring all devices in the MRP ring network, compile and download the configuration to the PLC.

Configuring the MRP function in STEP 7

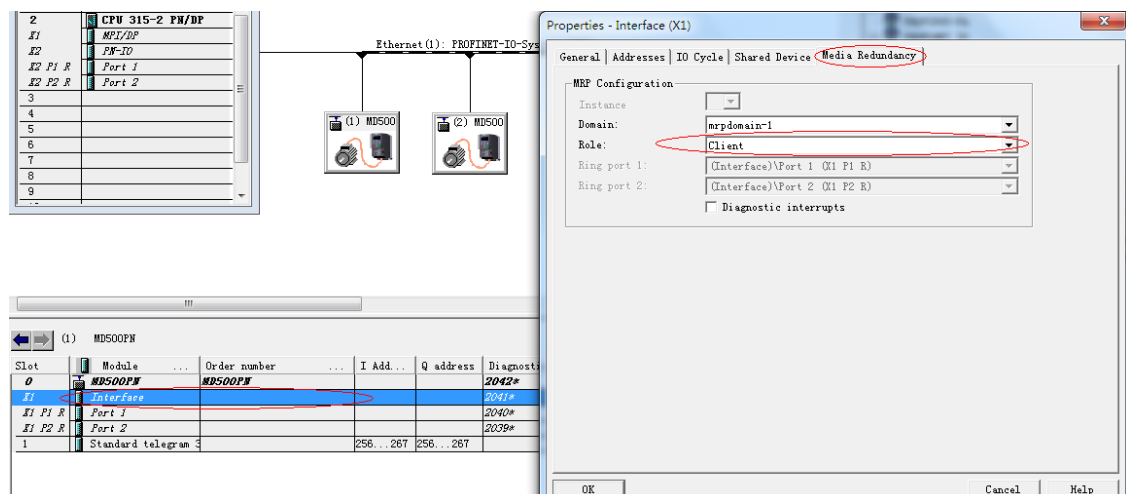
1. Configure the MRP manager.

An MRP manager is required in the MRP ring network. The MD500-PN1 card cannot be used as the manager. Generally, the PLC is used as the manager. Double-click **PN-IO** of the PLC, click the **Media Redundancy** tab, and select **Manager (auto)** from the **Role** drop-down list, as shown in the following figure.



2. Configure the MRP client.

Select the slave, double-click **Interface**, click the **Media Redundancy** tab, and select **Client** from the **Role** drop-down list, as shown in the following figure. Configure the manager before the client configuration; otherwise, an error will be reported.



3. Configure the watchdog time.

The MRP function requires that the watchdog time cannot be shorter than 200 ms. Therefore, you need to modify the watchdog time.

Click **IO cycle**. Under **Watchdog time**, modify **watchdog time** to a value not less than 200 ms.

Click **OK**.

Note: If the watchdog time is shorter than 200 ms, and the ring network circuit is interrupted, the node in the network reports a communication interruption fault and then resumes normal connection.

4. Download the configuration.

After configuring all devices in the MRP ring network, compile and download the configuration to the PLC.



Caution

- Each device in the ring network must be configured as an MRP manager or client.
- Configuration of the topological structure is not required during MRP configuration. You can configure the topological structure after the MRP configuration is complete if needed.
- Do not connect devices without the MRP function configured to the ring network. Otherwise, connection failure or frequent disconnections will occur.
- In a PROFINET network configured with MRP, when a disconnection occurs in the ring network, handshaking will be performed again. If the watchdog time is shorter than 200 ms, the AC drive slave reports ERR16, which is cleared automatically (if the automatic clearing function is supported) after the handshaking is complete. You can also manually clear the fault. The preceding action is also performed after the disconnected circuit is restored. To avoid equipment faults caused by the interruption of the ring network circuit, configure the watchdog time to not shorter than 200 ms.
- Even if the MRP is configured, when two disconnections occur in the network, all nodes between the two disconnected points cannot be connected normally. To avoid such problems, the star topology is recommended.

7.9 Troubleshooting

When the communication function is configured incorrectly, both the PLC and rectifier will report a fault. You can troubleshoot the fault based on diagnosis information on the rectifier operating panel and PLC.

The following table describes the fault code of the rectifier.

Table 7-5 Fault code of the rectifier

Fault Code	Cause	Solution
E164.1	The communication between the communication card and the master is disconnected.	Check and ensure that the connection between the communication card and PLC is normal.

The following table describes the faults that may occur during the usage of the MD500-PN1 card and AC drive.

Fault		Solution
After the AC drive is powered on, only the power supply indicator (D4) is on, indicating that the connection between the PN card and AC drive is not established.		1. Check whether F0-28 is set to 1. 2. Check the AC drive model. This user guide describes the usage of the PN card only on the MD520. For the usage of the card on other types of AC drives, contact the technical engineers to obtain the corresponding user guides. 3. Check whether the AC drive software version supports the MD500-PN1 card.
After the AC drive is powered on, the power supply indicator (D5) is on and the communication indicator (D4) is solid yellow.		A MAC address error occurs. Replace the PN card.
The connection fails after the configuration is downloaded.	After the configuration is downloaded, D5 and D4 indicators on the PN card are solid green, and D1 indicator blinks green.	1. Check that the cable is properly connected. 2. Check whether the upstream PN node operates properly. 3. Check whether a device name is assigned to this node through the PLC. 4. Check that the GSDML file used in the configuration is correct.
	After the configuration is downloaded, D5 and D4 indicators on the PN card are solid on, and D1 indicator blinks yellow.	1. Check that the GSD file used is correct. 2. Check whether the PZD mapping relations are set correctly. Device-specific parameters in STEP 7 and TIA PORTAL must be set in the decimal format. Therefore, the parameters must be converted to decimal values. For example, the decimal value of FC-11 is 64523 (0xFC0B in hexadecimal format). If a parameter in the hexadecimal format instead of the decimal format is entered, the connection fails. Note that addresses using Modbus (such as H2000 and H8000) are unavailable for PZD mapping.
After the connection is successful, all indicators on the PLC are on in green, but data cannot be written into or read from the AC drive.	No data can be written/read.	Check whether the operated address is correct. For example, if the I address and Q address of the station are both 520 to 531 (note that the I and Q addresses may start from different numbers), the PZD1 and PZD2 data written into the AC drive are stored in QW520 and QW522, respectively. (If the PLC is S7-300 or S7-400, PQW is required.) If SFC15 is used, check whether RET_VAL of SFC15 block is 0. If not, an invocation error occurs. In this case, rectify the error first and then invoke the function block.
	PZD3 or subsequent data can be written, but PZD1 or PZD2 cannot be written/read.	Check whether F0-02 and F0-03 are set to 2 and 9, respectively. Check whether the command reference is in the range of 1 to 7 (not bit) or frequency reference is in the range of -F0-10 to +F0-10. If not, the write operation fails. Check whether FE-00 and FE-01 are U3-17 and U3-16, respectively. If not, manually correct the parameter values or restore to factory settings.
	PZD1 and PZD2 can be written/read, but PZD3 or subsequent data cannot be written/read.	Check whether the message type supports this PZD. Check whether device-specific parameters are set properly (View corresponding parameters in group FE to check whether they are written to the mapping correctly.).
	-	Check the logic relations. Check whether the same PZD is assigned with values for multiple times in a certain logic relation by checking whether the value given by the PLC is correct under the logic relation in the monitoring table of the PLC.

Fault	Solution
After communication is established, the AC drive reports E164.1, which cannot be cleared. However, the D1 indicator on the PN card and the BF indicator on the PLC are normal.	Check whether the high-order 8 bits of the PZD1 data (QW data) written into the AC drive are 0 in the PLC program. If not, change them to 0. The PZD1 command in this user guide refers to values instead of bits. Note: This solution applies only to the MD520. For other AC drives, consult the technical engineers.
After the MD500-PN1 communication card is powered on, all PZD data reported by the drive is 4369 (that is, 0x1111).	1. Download the latest XML file. 2. Check the software version through U0-67. The software version must be later than 111. 3. Check whether the parameter settings are correct through F0-00 for troubleshooting. 4. Check whether the communication between the communication card and the AC drive is interfered. Check that the communication card and AC drive share common ground.



Caution

When the status word returned by the MD500-PN1 card and the drive fails to display the fault status, OB82 needs to be used for monitoring the status or writing a changed value to an address of the drive and then reading the value are used to determine the status.

When a slave reports a MD500-PN1 card fault, the card installed in the slave can be replaced directly without configurations.

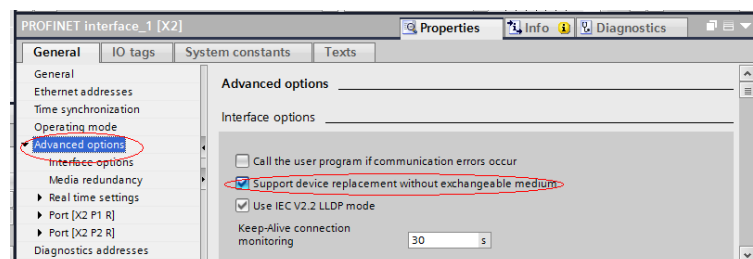
Prerequisites for directly replacing the MD500-PN1 card are as follows:

- The new card and the old card to be replaced are both MD500-PN1 cards.
- The new MD500-PN1 card has not been assigned with a device name before.
- The topology has been configured during PLC network configurations.
- The Support device replacement without exchangeable medium option is enabled during PLC configuration.

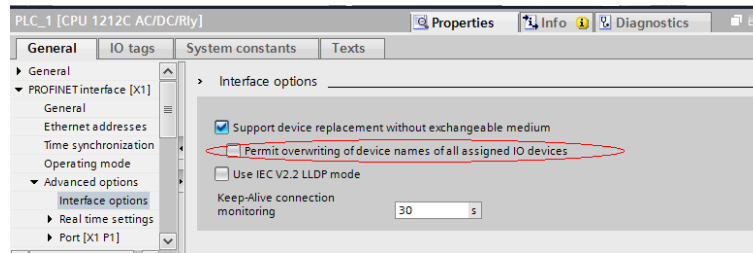
To replace the MD500-PN1 card directly, you need to perform corresponding settings during configuration. Settings in STEP 7 and PORTAL are different.

Selecting the Support device replacement without exchangeable medium option and setting the topology in PORTAL

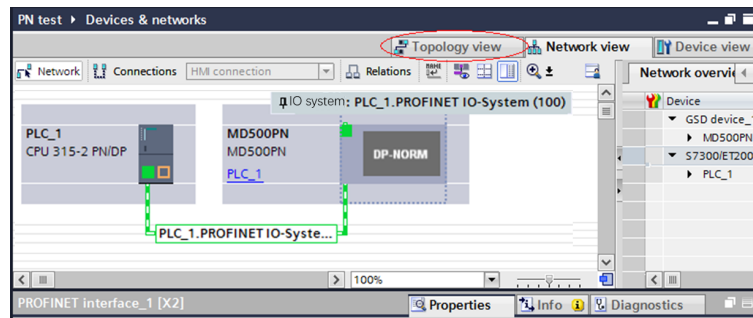
Open PORTAL, and select the PROFINET interface of the master station in the hardware configuration. Go to **Properties > General > Advanced options**, and select **Support device replacement without exchangeable medium**, as shown in the following figure.



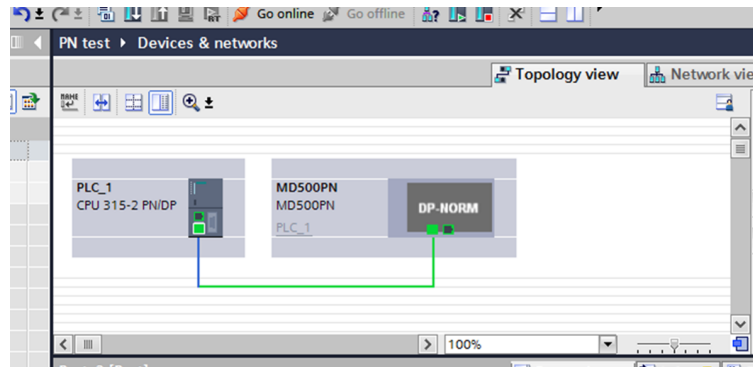
For the S7-1200 or S7-1500 PLC, the check box **Permit overwriting of device names of all assigned IO devices** is provided. If the check box is selected, the second prerequisite for directly replacing the device is not required.



Click the **Topology view** tab.



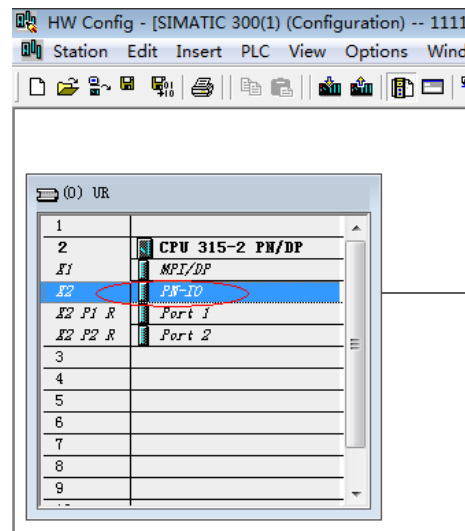
In the topology view, click and drag an interface to the interface of another device which is directly connected with the first interface, and release the mouse button. Note that the preceding connection must be consistent with the actual network connection of devices. For example, if P1 of the PLC is connected to P2 of slave station 1, and P1 of slave station 1 is connected to another slave station, the topology must be consistent with the actual connection. An incorrect topology will cause a function failure after replacement and even communication errors. After the MD500-PN1 card is installed, P1 is on the left and P2 is on the right when you face the RJ45 interface.



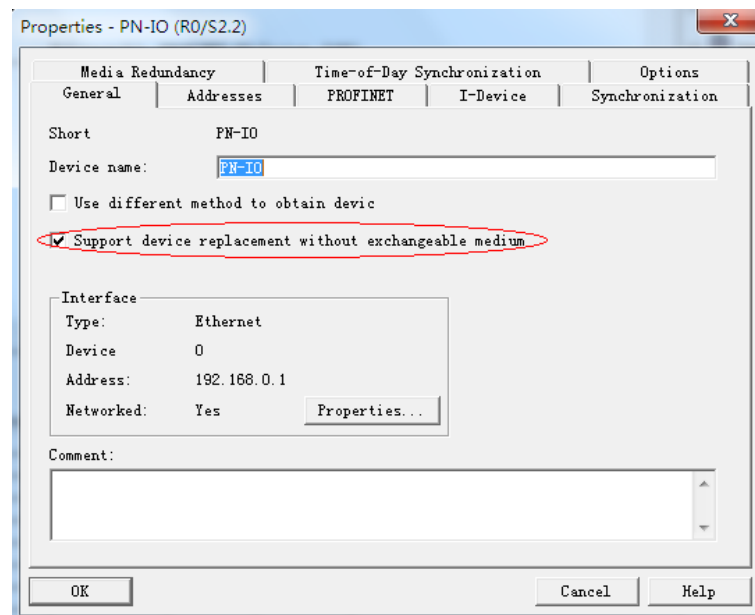
After completing the topology, start compiling and download it to the PLC.

Selecting the Support device replacement without exchangeable medium option and setting the topology in STEP 7

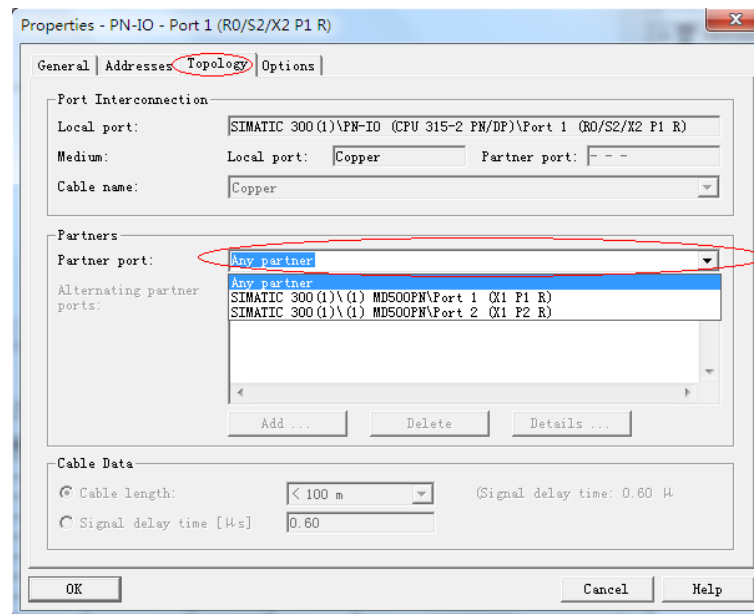
In hardware configuration, double-click **PN-IO**, as shown in the following figure.



In the **General** tab, select **Support device replacement without exchangeable medium**, and click **OK**.



According to the actual network connections, double-click **Port 1** or **Port 2** of the PLC. Click the **Topology** tab, select the port of the slave station connected to the PLC (**Any partner** by default) from the **Partner port** drop-down list box, and click **OK**.



Click the port of the slave station to set the topology. The operations are similar to the preceding steps. After setting all the connected ports, start compiling and download it to the PLC.

After completing the preceding configuration, perform the following operations when any slave station needs to be replaced: 1) Disconnect the device from the network. 2) Install a new device to which no device name is assigned before at the same position. (For S7-1200 or S7-1500, if **Permit overwriting of device names of all assigned IO devices** has been selected, devices which have been assigned names to can be used.) 3) Connect the new device to the network using the original wiring mode. (Note that the network cable connection must be consistent with the original connection and the connection in the topology.) 4) Power on the slave station to enable the PLC to assign a device name to the newly connected device automatically.

8 PROFINET Communication (MD500-PN2)

8.1 Introduction

The MD500-PN2 card is a PROFINET fieldbus adapter card complying with PROFINET Ethernet standards. It is installed on an MD series AC drive to improve the communication efficiency and implement the AC drive networking function. This enables the AC drive to be a slave controlled by the fieldbus master.



Figure 8-1 MD500-PN2 card appearance

8.2 Installation

The MD500-PN2 card is embedded in the MD520 or MD500 series AC drive. Before installation, power off the AC drive, wait at least 10 minutes until the charging indicator on the AC drive becomes off. Then, insert the MD500-PN2 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. [“Figure 8-2” on page 110](#) describes the installation of the card.

Note that the ground terminals of both the MD500-PN2 card and AC drive must be connected properly, as shown in [“Figure 8-3” on page 111](#).

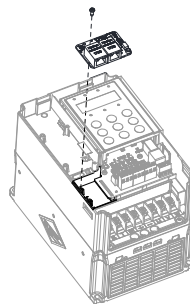


Figure 8-2 MD500-PN2 card installation

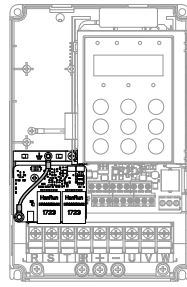


Figure 8-3 Connecting ground terminals of the MD500-PN2 card and AC drive

**Caution**

Do not install or disassemble the expansion card with power on.

8.3 Interface Description

The following figure describes terminals and indicators of the MD500-PN2 card. The pin header J1 on the back of the MD500-PN2 card is used to connect the drive. The MD500-PN2 card provides two Ethernet ports J2 and J3 to enable the card to communicate with the PN card (PLC).

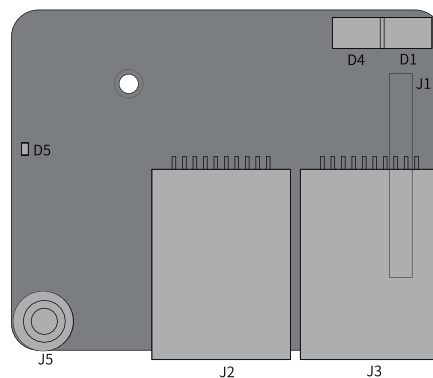


Figure 8-4 MD500-PN2 card terminal layout

Table 8-1 Indicators of the MD500-PN2 card

Mark	Hardware Name	Function Description
J1	Pin header	Check whether FD-00 is 9 and FD-01 is 3.
J2	Network port	The ports are standard Ethernet RJ45 ports and are direction-insensitive. The port is used by the MD500-PN2 card to communicate with the PN card (PLC).
J3		
D5	Power supply indicator	It is used to indicate the status of the power supply. ON: Normal; OFF: Abnormal. Check whether the card is installed properly.
D1	PLC communication status indicator (PLCLINK)	See "Table 8-2" on page 112 .
D4	AC drive communication status indicator (DSPLINK)	

Note

- After the MD500-PN2 card is installed, J2 is on the left and J3 is on the right when you face the RJ45 interface. J2 and J3 are direction-insensitive. You can connect either one to the PLC.
- It is recommended to use shielded Cat 5e twisted pair cables to ensure stable operation.

Table 8–2 Status indicators of the MD500-PN2 card

Indicator		Status	Solution
DSPLINK	Steady green	Normal	None
	Steady yellow	MAC address abnormal	Replace the PN card.
	Blinking yellow	AC drive faulty	Clear the AC drive fault.
	Steady red	Abnormal communication with the AC drive	Set F0-28 to 1 and check whether the AC drive supports the PN card.
	Blinking red	AC drive communication timeout	Check whether the AC drive software version supports the PN card. Restore the AC drive software to default settings.
PLCLINK	Steady green	Communication normal	/
	Blinking green	Master not found	Check the configuration and check whether the slave is assigned with a device name. Check whether the corresponding PLC is connected.
	Steady yellow	Configuration error	Check whether the GSD file is correct.
	Steady red	Communication with the master interrupted	Check the wiring and check whether the shield of the network cable is connected properly.
D1 and D4	Steady red	PN card software abnormal	Power off and then power on the equipment. Replace the PN card.

8.4 PROFINET Topology

The PROFINET protocol supports a variety of topologies, including bus-, star-, and tree-type topologies. Diversified networking modes can be implemented by using switches.

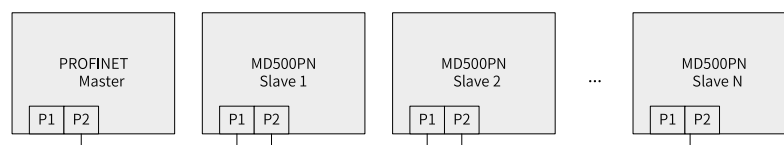


Figure 8-5 Bus-type topology

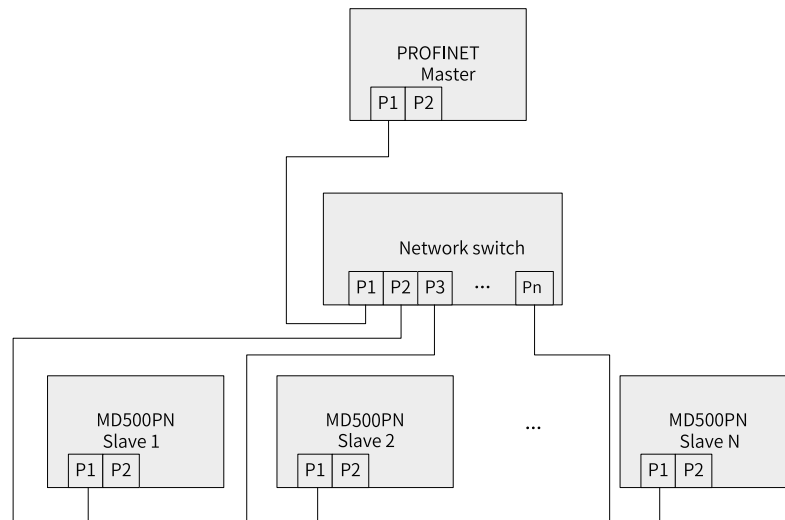


Figure 8-6 Star-type topology

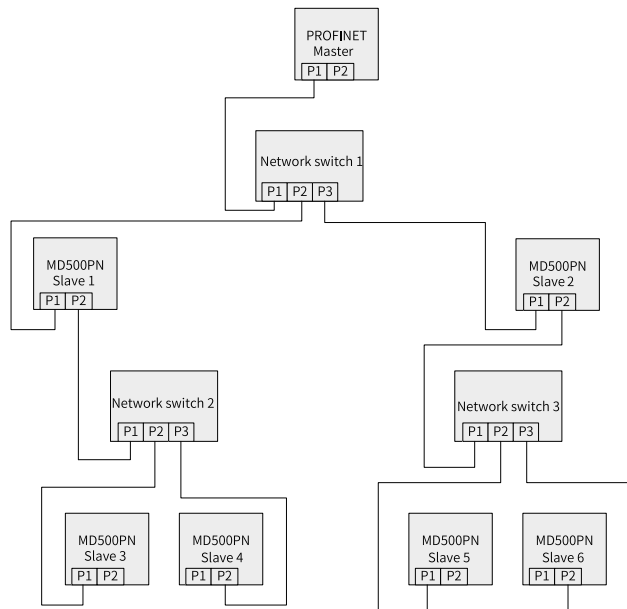


Figure 8-7 Tree-type topology

8.5 PROFINET Communication Protocol

Data transmission formats

The MD500-PN2 card transmits data using PZD formats with different lengths as required. You can set the PZD functions during configuration.

The following table lists the functions supported by each data format.

Data Type	Data Length	Supported function
Standard telegram 1	PZD-2/2	Setting of AC drive command and frequency Reading of AC drive state and running frequency
Standard telegram 2	PZD-4/4	Setting of AC drive command and frequency Periodic writing of two function parameters Reading of AC drive state and running frequency Periodic reading of two function parameters
Standard telegram 3	PZD-6/6	Setting of AC drive command and frequency Periodic writing of four function parameters Reading of AC drive status and running frequency Periodic reading of four function parameters
Standard telegram 4	PZD-8/8	Setting of AC drive command and frequency Periodic writing of six function parameters Reading of AC drive status and running frequency Periodic reading of six function parameters
Standard telegram 5	PZD-10/10	Setting of AC drive command and frequency Periodic writing of eight function parameters Reading of AC drive state and running frequency Periodic reading of eight function parameters
Standard telegram 6	PZD-12/12	Setting of AC drive command and frequency Cyclic writing of 10 function parameters Reading of AC drive status and running frequency Periodic reading of 10 function parameters
Supplementary telegram	PZD-2/6	Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic reading of four function parameters

PZD data

The master can modify and read AC drive data in real time and exchange data cyclically with the AC drive through the PZD data. Data communication addresses are directly configured by the AC drive. The specific functions are as follows:

- Real-time settings of AC drive control commands and target frequencies
- Real-time reading of AC drive current state and running frequency
- Real-time exchange of function parameters and monitoring data between the AC drive and the PROFINET master

The PZD is used for periodic data exchange between the master station and AC drive, as described in the following table.

PZD Data Sent by Master		
AC drive command	AC drive target frequency	Real-time modification of AC drive parameters
PZD1	PZD2	PZD3 to PZD12

PZD Data Responded by AC Drive		
AC drive state	AC drive running frequency	Real-time reading of AC drive parameters
PZD1	PZD2	PZD3 to PZD12

Descriptions of data sent by the master

PZD Sent by Master		
PZD1	AC drive command word (valid when the command source is set to communication)	
	01: Forward running 02: Reverse running 03: Forward jogging 04: Reverse jogging	05: Coast to stop 06: Stop according to F6-10 (Stop mode) 07: Reset upon fault
PZD2	It indicates the AC drive target frequency (frequency source set to communication) in the range of reverse frequency upper limit (negative value) to forward frequency upper limit (decimal places included, for example, 2000 corresponds to 20.00 Hz on the AC drive) When the target frequency exceeds the range, the AC drive runs at the frequency upper limit.	
PZD3 to PZD12	The data is used to change the function parameters in groups F and A in real time. The parameter values will not be written into the EEPROM. FE-02 to FE-11 correspond to PZD3 to PZD12. The mapping set manually in group FE is invalid.	

Descriptions of data responded by the AC drive

PZD Responded by the AC Drive	
PZD1	It indicates the AC drive state, which is described as follows: Bit 0: 0: Stopped; 1: Running Bit 1: 0: Running in forward direction; 1: Running in reverse direction Bit 2: 0: Not faulty; 1: Faulty Bit 3: 0: Running frequency not reached; 1: Running frequency reached Bit 4 to bit 7: Reserved Bit 8 to bit 15: AC drive fault code
PZD2	It indicates the AC drive running frequency (unit: 0.01 Hz). The current AC drive running frequency is returned as 16-bit signed data.
PZD3 to PZD12	It is used for real-time reading of function parameters in groups F and A and monitoring parameters in group U. FE-22 to FE-31 correspond to PZD3 to PZD12. The mapping set manually in group FE is invalid.

8.6 Related parameters

8.6.1 Parameters Related to Communication

AC drive communication card settings

The communication configuration varies with the drives, as described below.

- AC drive communication card settings (for MD500, MD290, MD480, MD510, and MD520 models)
After powering on the AC drive, set F0-28 to 1 to enable communication between the MD500-PN2 card and the AC drive.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-28	Communication protocol	0: Modbus protocol 1: Expansion communication protocol 2: Inobus protocol (through EtherCAT card)	1	This parameter is used to select a communication protocol. 0: Modbus protocol The Modbus protocol is used. 1: Expansion communication protocol PROFIBUS DP, PROFINET, EtherCAT, Modbus TCP, and EtherNet/IP protocols can be used. No setting is required for CANlink because it is always valid. 2: Inobus protocol (through EtherCAT card) When this parameter is set to 2, the Inobus communication protocol is used. The AC drive version must be F7-10 = U60.07/F7-11 = U61.07/F7-15 = 000.00/F7-16 = 000.00 or later.

- AC drive communication card settings (for MD500-PLUS and MD480-PLUS models)
After powering on the AC drive, set FD-00 (baud rate) to 9 (115200 bps) and FD-01 (Modbus data format) to 3 (No check 8-N-1) to enable communication between the MD500-PN2 card and the AC drive.

Communication control parameters

Parameter Code	Parameter Name	Value Range		Decimal Address
U3-16	Frequency set through communication	-320.00 Hz to 320.00 Hz		29456
U3-17	Communication setting control word	0001: Forward run 0002: Reverse run 0003: Forward jog 0004: Reverse jog	0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	29457

Parameter Code	Parameter Name	Value Range		Decimal Address
U3-18	DO state (terminal function defined by parameters in group F5: communication control)	Bit 0: DO1 output control Bit 1: DO2 output control Bit 2: Relay 1 output control Bit 3: Relay 2 output control Bit 4: FMR output control	Bit 5: VDO1 Bit 6: VDO2 Bit 7: VDO3 Bit 8: VDO4 Bit 9: VDO5	29458
U3-19	AO1 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29459
U3-20	AO2 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29460
U3-21	HDO output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29461
U3-22	Communication card error state	0 to 65535		29462
U3-23	Speed set through communication	-32000 rpm to 32000 rpm		29463

When the MD500-PN2 card is used, the written PZD1 and PZD2 are mapped to U3-17 and U3-16 respectively by default. If a command or frequency fails to be written into the AC drive while PZD3 to PZD12 can be written and F0-02 and F0-03 are set to 2 and 9 respectively, check whether FE-00 and FE-01 are U3-17 and U3-16 respectively. If not, manually correct the parameter values.

Parameters related to communication monitoring

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-00	Operating frequency	0.01 Hz	28672
U0-01	Frequency reference	0.01 Hz	28673
U0-02	Bus voltage	0.1 V	28674
U0-03	Output voltage	1 V	28675
U0-04	Output current	0.01 A	28676
U0-05	Output power	0.1 kW	28677
U0-06	Output torque	0.1%	28678
U0-07	DI input state	1	28679
U0-08	DO output state	1	28680
U0-09	AI1 voltage	0.01V	28681
U0-10	AI2 voltage	0.01V	28682
U0-11	AI3 voltage	0.01V	28683

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-12	Count value	1	28684
U0-13	Length value	1	28685
U0-14	Load speed display	1	28686
U0-15	PID reference	1	28687
U0-16	PID feedback	1	28688
U0-17	PLC stage	1	28689
U0-18	Pulse input frequency	0.01 kHz	28690
U0-19	Feedback speed	0.01 Hz	28691
U0-20	Remaining running time	0.1 min	28692
U0-21	AI1 voltage before calibration	0.001 V	28693
U0-22	AI2 voltage before calibration	0.001 V	28694
U0-23	AI3 voltage before calibration	0.001 V	28695
U0-24	Motor speed	1 rpm	28696
U0-25	Current power-on time	1 min	28697
U0-26	Current operating time	0.1 min	28698
U0-27	Pulse input frequency	1 Hz	28699
U0-28	Communication setpoint	0.01%	28700
U0-29	Encoder feedback speed	0.01 Hz	28701
U0-30	Display of main frequency X	0.01 Hz	28702
U0-31	Display of auxiliary frequency Y	0.01 Hz	28703
U0-32	Memory address view	1	28704
U0-33	Synchronous motor rotor position	0.1°	28705
U0-34	AI3 temperature mode - motor temperature value	1°C	28706
U0-35	Target torque	0.1%	28707
U0-36	Resolver position	1	28708
U0-37	Power factor angle	0.1°	28709
U0-38	ABZ position	1	28710
U0-39	Target voltage upon V/f separation	1V	28711
U0-40	Output voltage upon V/f separation	1V	28712
U0-45	Fault subcode	1	28717
U0-58	Number of motor revolutions	1	28730
U0-59	Frequency reference	0.01%	28731
U0-60	Operating frequency	0.01%	28732
U0-61	AC drive state	1	28733
U0-62	Current fault code	1	28734
U0-63	Torque sent in point-to-point communication	0.01%	38375
U0-64	Number of slaves in master-slave control	1	28736

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-65	Torque upper limit	0.1%	28737
U0-66	Model of communication expansion card	100: CANopen 200: PROFIBUS DP 300: CANlink 400: PROFINET 500: EtherCAT 600: EtherNet/IP	28738
U0-67	Software version of communication expansion card	1	28739
U0-68	AC drive state read through DP card	1	28740
U0-69	Frequency read through communication expansion card	0.01 Hz	28741
U0-70	Speed read through communication expansion card	1 rpm	28742
U0-71	Current read through communication expansion card	0.1 A	28743

When the MD500-PN2 card is used, the read PZD1 and PZD2 are mapped to U0-68 and U0-69 respectively by default. If any state or running frequency fails to be read while PZD3 to PZD12 can be read, check whether FE-20 and FE-21 are U0-68 and U0-69 respectively. If not, manually correct the parameter values.

Note

For details about the PDZ definitions of other AC drives, see the corresponding AC drive user guides.

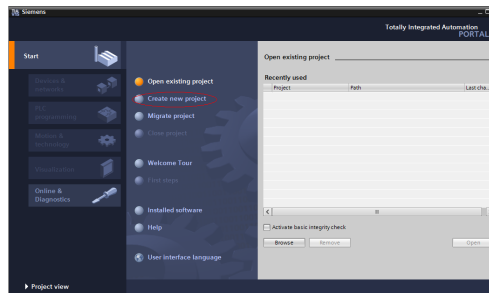
8.7 通信实例

8.7.1 Configuring Slaves on the S7-1200 Master

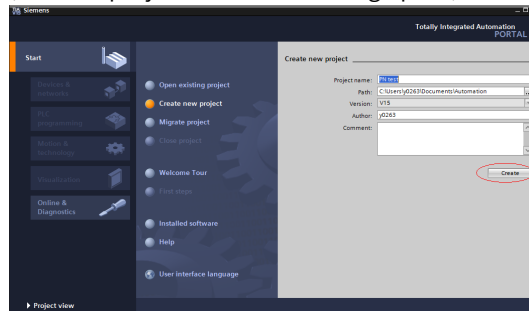
Before using the PROFINET master, you need to configure the GSDML file of the slave to add the corresponding slave stations to the master. If the file exists, skip step 2. You can obtain the GSDML file from the Inovance agent or the manufacturer.

To configure the slave, do as follows:

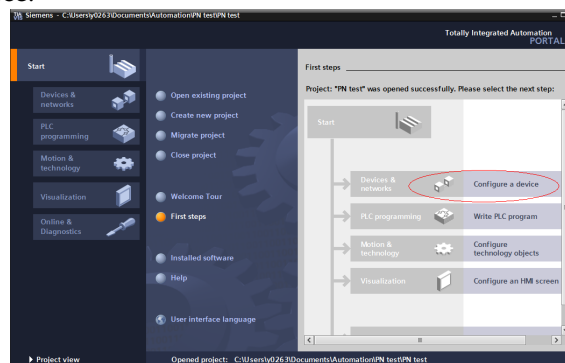
1. Create a project and add the S7-1200 master to the project in PORTAL. To be specific, open PORTAL first. The interface as shown in the following figure is displayed.



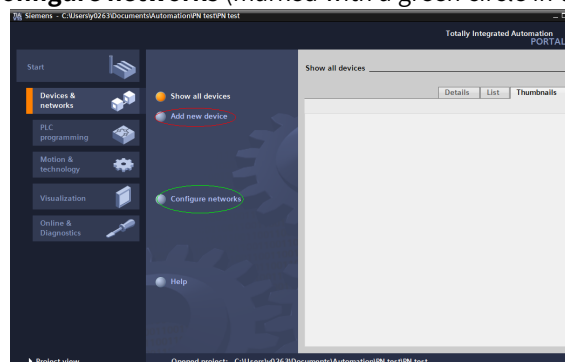
a. Click **Create new project**, enter a project name and storage path, and click **Create**.



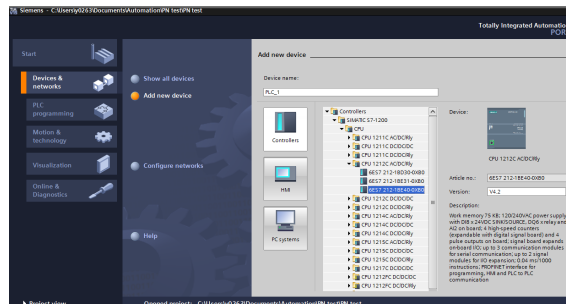
b. Click **Configure a device**.



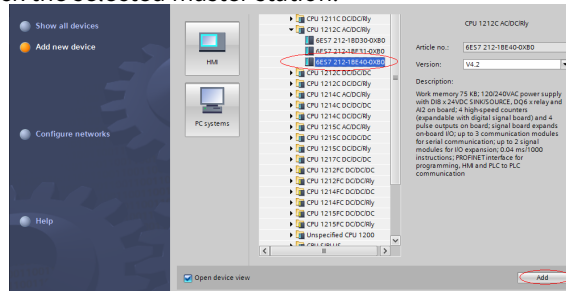
c. For a new project, click **Add new device** (marked with a red circle in the following figure). For an existing project, click **Configure networks** (marked with a green circle in the following figure).



d. Select a PLC on the displayed interface. Ensure that the article number and firmware version of the PLC are correct to avoid a download failure.

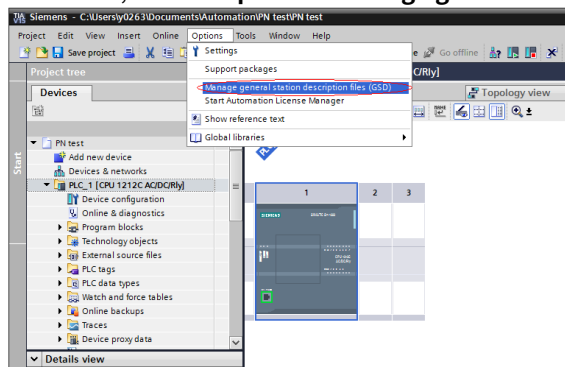


e. Click **Add** or double-click the selected master station.

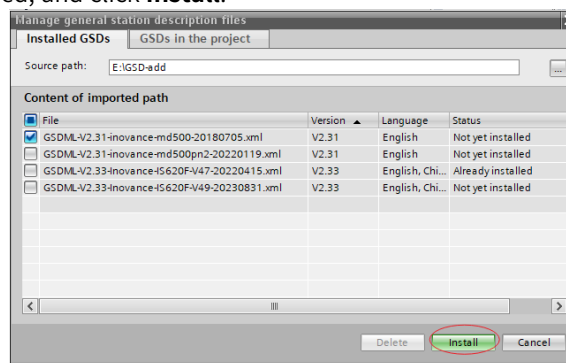


The master is added.

2. (Optional) To install the GSDML file, choose **Options > Manage general description files (GSD)**.



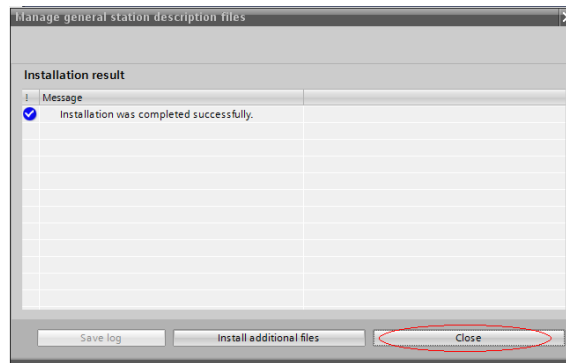
a. Select the storage path that does not contain any Chinese characters for the GSDML file, select the GSDML file to be installed, and click **Install**.



Caution

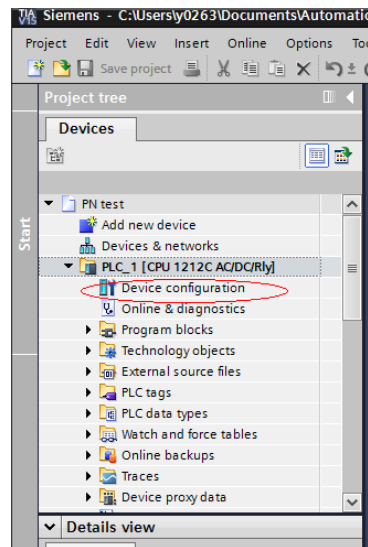
The GSDML file name varies with the AC drive series. For details, see the corresponding user guide.

b. After the installation is done, click **Close**.

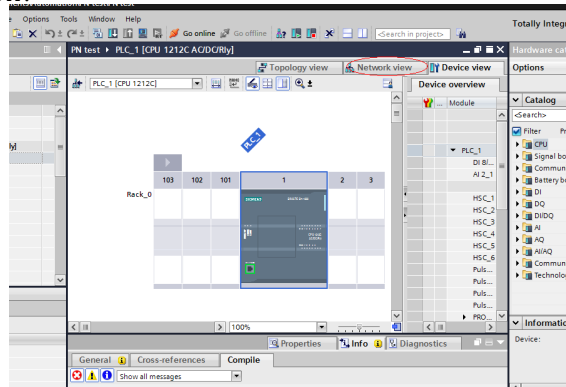


3. Configure a slave.

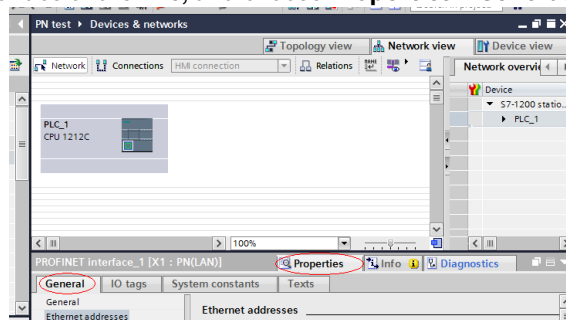
a. Click **Device configuration**.



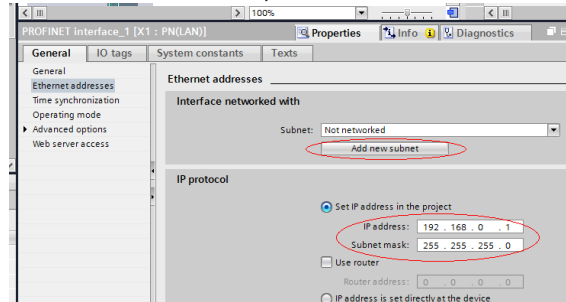
b. Switch to **Network View**.



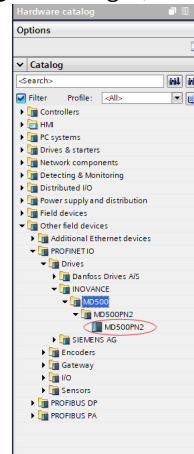
c. Select the Ethernet interface of the PLC, and choose **Properties > General**.



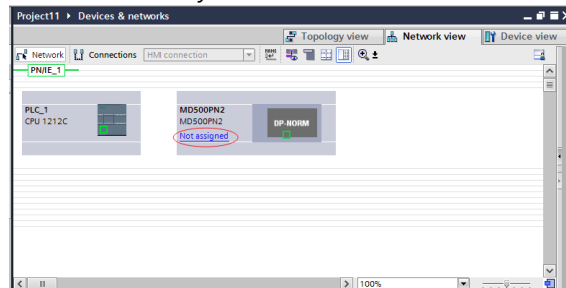
d. Set the IP address and subnet mask of the PLC, and click **Add new subnet**.



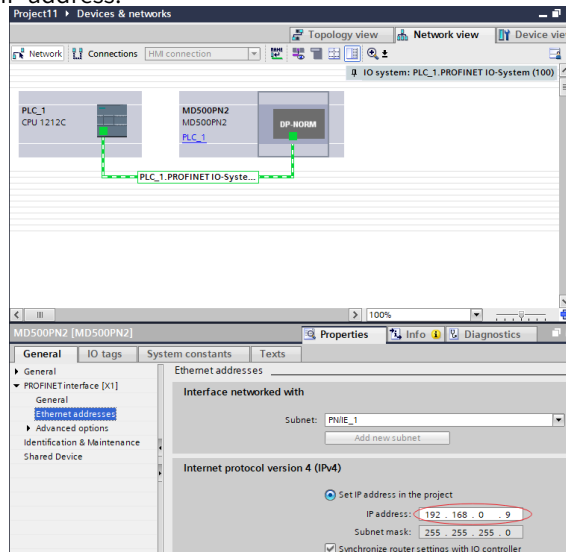
e. Locate MD500 under **Hardware catalog** on the right, and double-click **MD500PN2**.



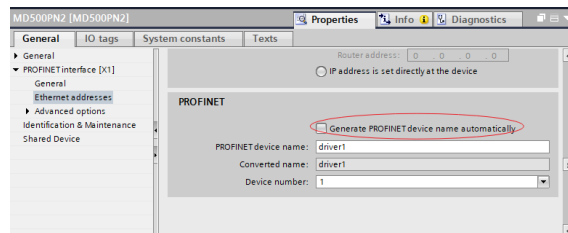
f. Click **Not assigned** to select the master system for the slave.



g. Select the slave, and choose **Properties > General > PROFINET interface [X1] > Ethernet addresses** and set the IP address.

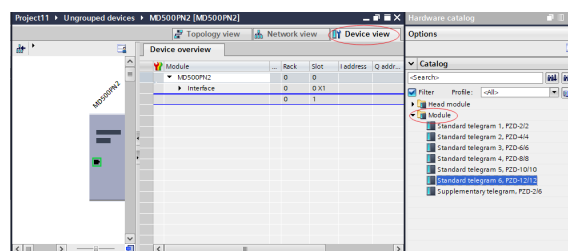


Scroll down the interface to locate the **PROFINET** area. Clear **Generate PROFINET device name automatically**, and name the slave device in the **PROFINET device name** text box. Alternatively, select **Generate PROFINET device name automatically** to enable the system to generate a device name automatically.



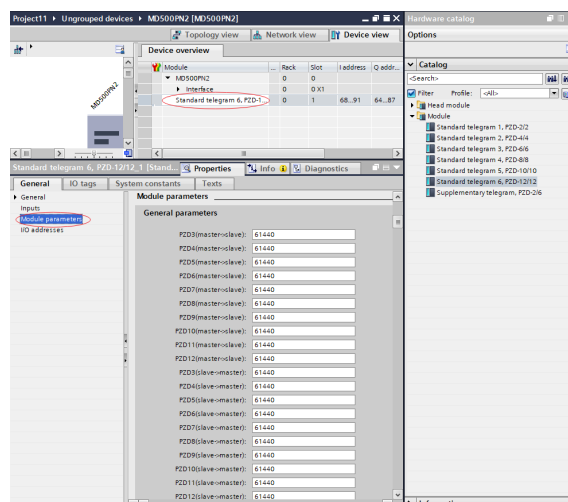
4. Configure data features of the slave.

Select the slave station and click the **Device view** tab. In the **Hardware catalog** pane, click **Module**, and double-click the data length configured to the slave station.



5. Configure the PZD.

The PZD1 and PZD2 configurations are fixed and cannot be modified by users. PZD3 to PZD12 are intended for customized periodic data exchange. They can be set in hardware configuration.



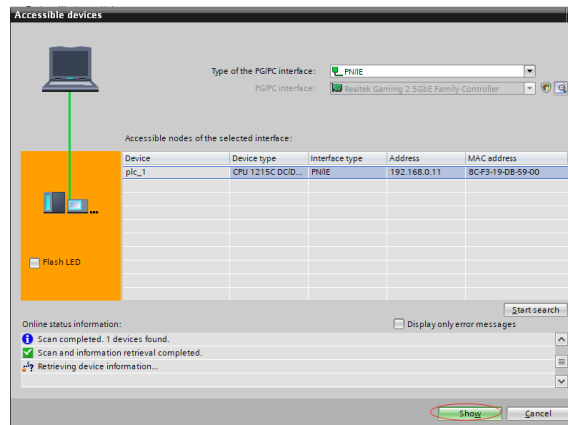
PZDx(master->slave) indicates the address of the slave used by the master to write data to the slave, and PZDx(slave->master) indicates the address of the slave used by the master to read data from the slave. PZD3 to PZD12 (determined by the selected message type) are displayed in decimal and can be modified. For example, to set PZD3(master->slave) to F0-12, enter **61452**.

By default, all PZDs of the MD520 are set to F0-00 (61440 in decimal). For unused PZDs, modification is not required and default values can be retained. PZD mapping relationship must be set independently for each slave as required (if mapping relationships of various slaves are the same, you can select one configured slave, press Ctrl+C, select the PROFINET bus in the configuration, press Ctrl+V, and modify the device name and IP address).

Switch to **Network view**. To add more stations, repeat the preceding steps. If the configuration is the same, select and copy a configured slave and modify the IP address and device name (note that the device name must be unique).

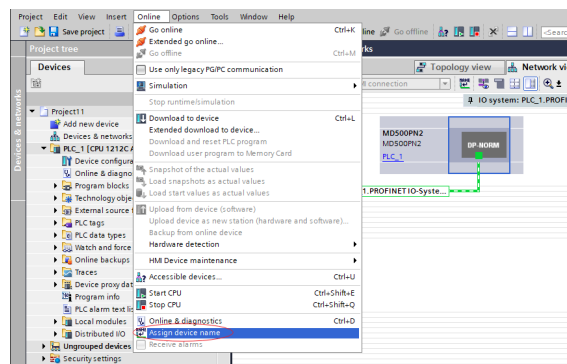
6. Download the configuration.

Save the network configuration. Set the IP address of the PC to the same network segment as that of the PLC. (Note that the IP address of the PC must be different from that of the slave station in the configuration. You can also enable the function of automatic IP address distribution for the PC.) Start compiling, click **Load**, select the interface, and click **Start search**.

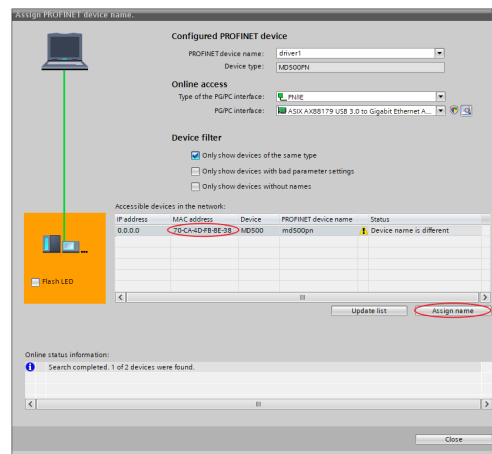


7. Assign a device name.

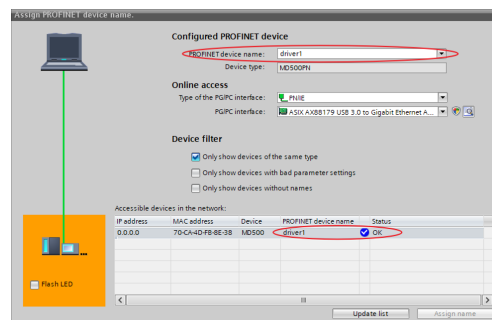
a. After downloading is complete, assign device names for slave stations without names. Select a slave, and choose **Online > Assign device name**, or right-click the slave and select **Assign device name**.



b. Devices of the same type will be displayed in the popped-out interface. Select the slave to be assigned with the device name. The MAC address for each slave is unique. When multiple devices of the same type exist in a network, differentiate such devices with their MAC address. The MAC address of the MD500-PN2 card is on the product enclosure. Click **Assign name**.



- c. If information similar to the following figure is displayed, the device name is assigned successfully. The displayed **PROFINET device name** in the following figure must be consistent with that displayed in the preceding figure. After assigning the device name, close the interface or select another device from the **PROFINET device name** drop-down list to assign device names for other stations.



The slave will save the assigned name, and the master identifies each slave based on the device name. (The MAC address is not intuitive in use. The device name assigned is bound to the MAC address of a device for identification.)



Caution

- Each device name can be assigned to only one slave station on the network.
- After the device name of a station in the configuration is changed, the device must be assigned with a name again. (For any exception, see "Troubleshooting".)
- After modifying the IP address, you only need to download the modified configuration to the PLC. Name assignment is not required.

After the preceding steps, the PROFINET slave is configured. You can compile programs in the PLC to control the AC drive. Reading and writing operations on PROFINET slaves through the PLC are similar to those on PROFIBUS DP slaves through the PLC.

To ensure normal operation of the PLC, function blocks such as OB82, 83, 86, and 122 need to be added during programming. The content of the function blocks can be compiled according to actual needs or left blank.

8.7.2 MRP Function

MRP overview

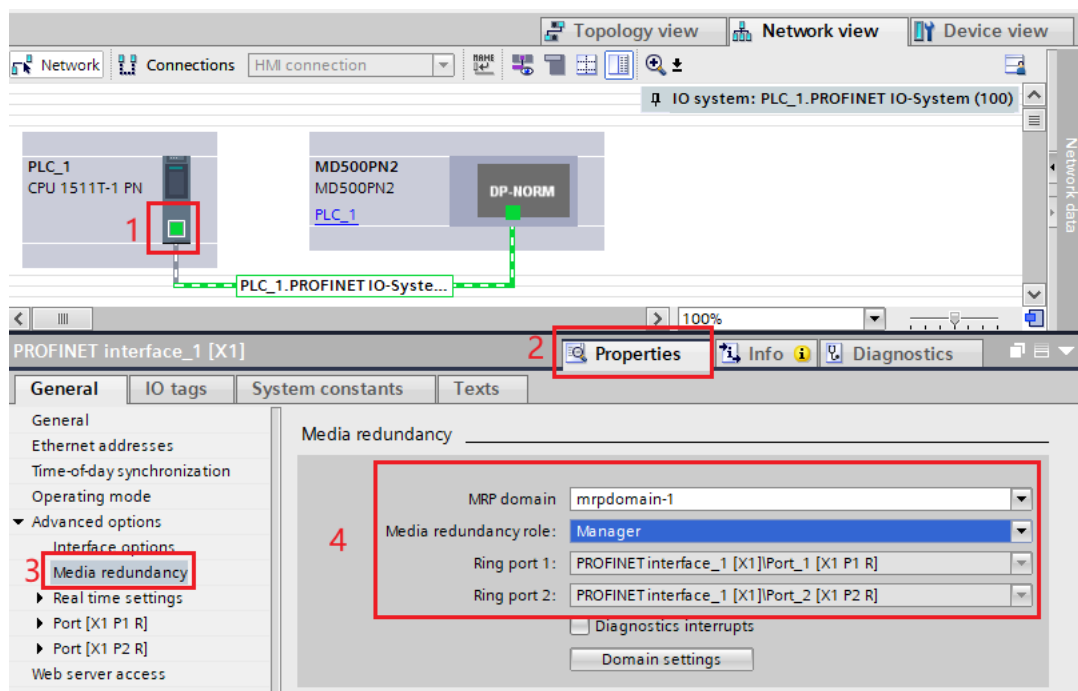
The AC drive adopts the standard Media Redundancy Protocol (MRP) which meets the IEC 62439-2 standard. The typical reconstruction time is 200 ms and each ring network supports up to 32 devices.

MRP basic rules:

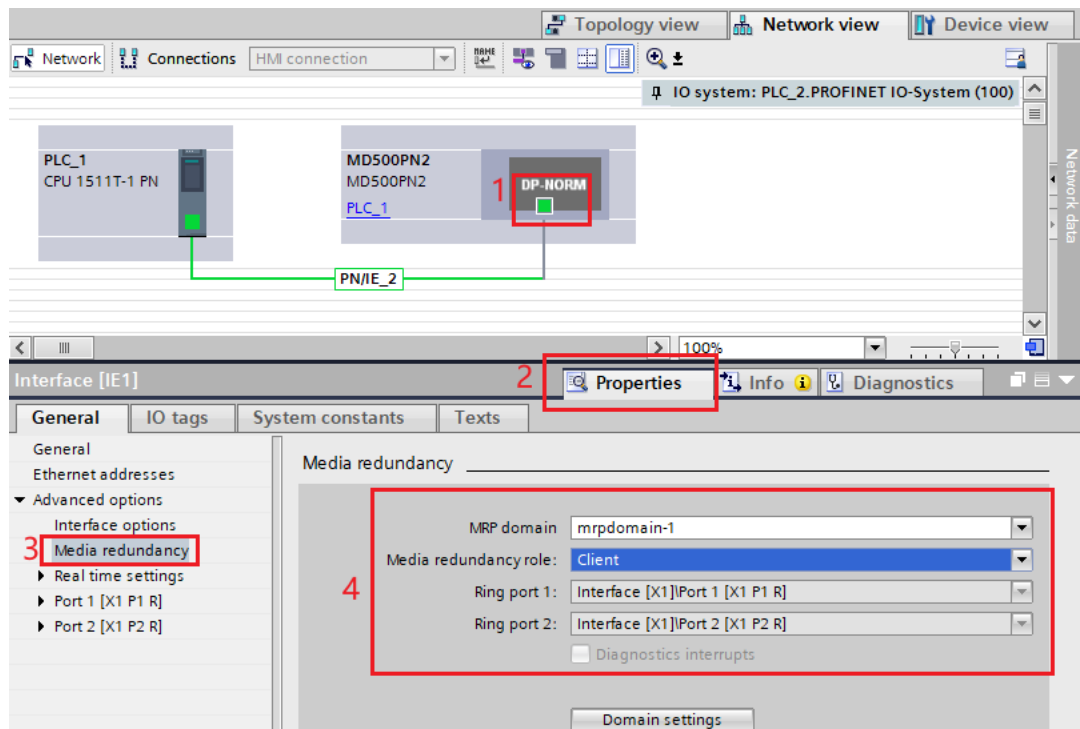
- All nodes on the ring network must support the MRP and have the MRP function enabled.
- All devices are interconnected through ports on the ring network.
- All devices on the ring network are in the same redundancy domain.
- It is recommended that the number of devices on a ring network not exceed 32. Otherwise, the network reconstruction time will be longer than 200 ms.
- Only one device on the ring network can serve as the ring network manager, and other devices are all ring network clients.

MRP settings

1. Select a PLC port. Go to **Properties > General > Advanced options > Media redundancy**. In the **Media redundancy role** drop-down list, select **Manager**. Ensure that **Ring port 1** and **Ring port 2** are configured.



2. Select a MD500–PN2 port. Go to **Properties > General > Advanced options > Media redundancy**. In the **Media redundancy role** drop-down list, select **Manager**. Ensure that **Ring port 1** and **Ring port 2** are configured.

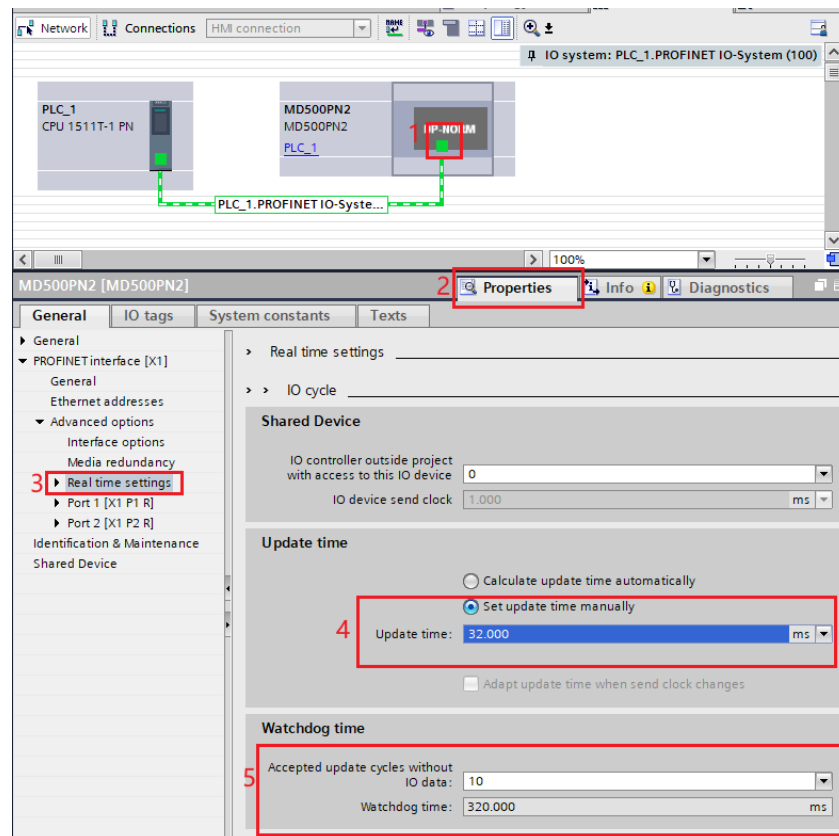


3. Reconstructing the MRP network takes time. If the default value of **Update time** and the value 3 of **Accepted update cycles without IO data** are used and the MRP function is enabled, an alarm will be reported upon network cable plugging and removing. In this case, reset **Update time** and **Accepted update cycles without IO data**, so that an alarm will not be reported upon network cable plugging and removing.

Select a MD500–PN2 port. Go to **Properties > General > Real time settings**. Set **Update time** to **32 ms** and set **Accepted update cycles without IO data** to **10**.

Note

The value 32 ms of **Update time** and the value 10 of **Accepted update cycles without IO data** are typical values for the MD500-PN2 card.



Note

To support the ring network function, the latest xml file (GSDML-V2.31-inovance-md500pn2-20230706.xml) of the MD500-PN2 card has been modified. Currently, version 308 (value of U0-67) and earlier are not supported. A component error will be reported even though the communication is normal. You can upgrade the XML file software or continue to use the XML file of the earlier version. Note that the XML file of the earlier version does not support the ring network function.

8.8 Troubleshooting

The following table describes the faults that may occur during the usage of the MD500-PN2 card and AC drive.

Fault	Solution
After the AC drive is powered on, only the power supply indicator (D4) is on, indicating that the connection between the PN card and AC drive is not established.	1. Check whether F0-28 is set to 1. 2. Check the AC drive type. 3. Check whether the AC drive software version supports the MD500-PN2 card.
After the AC drive is powered on, the power supply indicator (D5) is on and the communication indicator (D4) is solid yellow.	A MAC address error occurs. Replace the PN card.

Fault		Solution
The connection fails after the configuration is downloaded.	After the configuration is downloaded, D5 and D4 on the PN card are steady green, and D1 blinks green.	• Check that the cable is properly connected. • Check that the upstream PN node works properly. • Check whether a device name is assigned to this node through the PLC. • Check that the GSDML file used for the configuration is correct.
	After the configuration is downloaded, D5 and D4 on the PN card are steady on, and D1 blinks yellow.	• Check that the GSD file used is correct. • Check whether the PZD mapping relations are set correctly. Device-specific parameters in STEP 7 and TIA PORTAL must be set in the decimal format. Therefore, the parameters must be converted to decimal values. For example, the decimal value of FC-11 is 64523 (0xFC0B in hexadecimal format). If a parameter in the hexadecimal format instead of the decimal format is entered, the connection fails. Note that addresses using Modbus (such as H2000 and H8000) are unavailable for PZD mapping.
After the connection is successful, all indicators on the PLC are on in green, but data cannot be written into or read from the AC drive.	No data can be written/read.	Check whether the operated address is correct. For example, if the I address and Q address of the station are both 520 to 531 (note that the I and Q addresses may start from different numbers), the PZD1 and PZD2 data written into the AC drive are stored in QW520 and QW522, respectively. (If the PLC is S7-300 or S7-400, PQW is required.) If SFC15 is used, check whether RET_VAL of SFC15 block is 0. If not, an invocation error occurs. In this case, rectify the error first and then invoke the function block.
	PZD3 or subsequent data can be written, but PZD1 or PZD2 cannot be written/read.	• Check whether F0-02 and F0-03 are set to 2 and 9, respectively. • Check whether the command reference is in the range of 1 to 7 (not bit) or frequency reference is in the range of -F0-10 to +F0-10. If not, the write operation fails. • Check whether FE-00 and FE-01 are U3-17 and U3-16, respectively. If not, manually correct the parameter values or restore to factory settings.
	PZD1 and PZD2 can be written/read, while PZD3 or subsequent data cannot be written/read.	Check whether the message type supports this PZD. Check whether device-specific parameters are set properly (View corresponding parameters in group FE to check whether they are written to the mapping correctly.).
	-	Check the logic relations. Check whether the same PZD is assigned with values for multiple times in a certain logic relation (check whether the value given by the PLC is correct under the logic relation in the monitoring table of the PLC).
After communication is established, the AC drive reports E164.1, which cannot be cleared. However, the D1 indicator on the PN card and the BF indicator on the PLC are normal.		Check whether the high-order 8 bits of the PZD1 data (QW data) written into the AC drive are 0 in the PLC program. If not, change them to 0. The PZD1 command in this user guide refers to values instead of bits. Note: This solution applies only to MD500 and MD520. For other AC drives, consult the technical engineers.

When a slave reports a MD500-PN2 card fault, the card installed in the slave can be replaced directly without configurations.

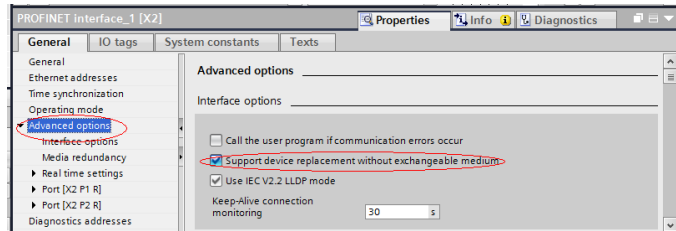
Prerequisites for directly replacing the MD500-PN2 card are as follows:

- The new card and the old card to be replaced are both MD500-PN2 cards.
- The new MD500-PN2 card has not been assigned with a device name before.
- The topology has been configured during PLC network configurations.
- The Support device replacement without exchangeable medium option is enabled during PLC configuration.

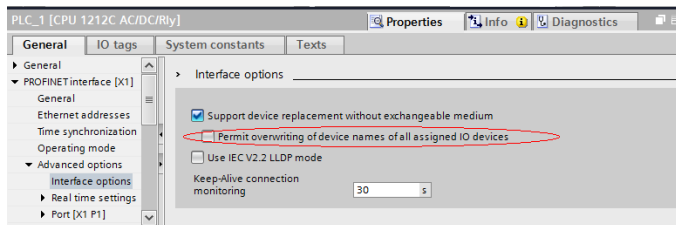
To replace the MD500-PN2 card directly, you need to perform corresponding settings during configuration. Settings in STEP 7 and PORTAL are different.

Selecting the Support device replacement without exchangeable medium option and setting the topology in PORTAL

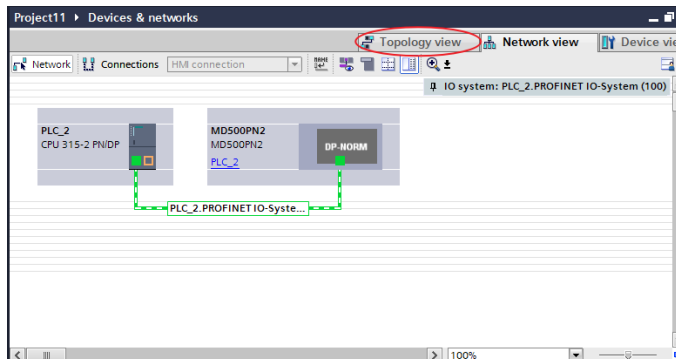
1. Open PORTAL, and select the PROFINET interface of the master station in the hardware configuration. Go to **Properties > General > Advanced options**, and select **Support device replacement without exchangeable medium**, as shown in the following figure.



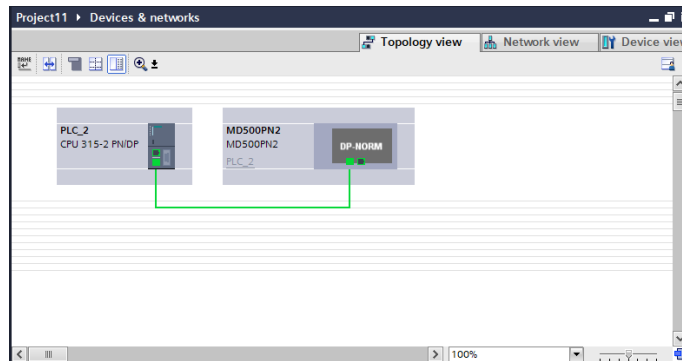
2. For the S7-1200 or S7-1500 PLC, the check box **Permit overwriting of device names of all assigned IO devices** is provided. If the check box is selected, the second prerequisite for directly replacing the device is not required.



3. Click the **Topology view** tab.



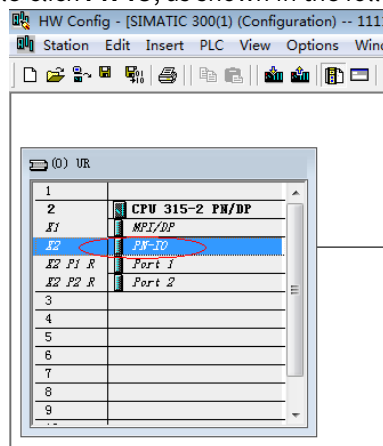
4. In the topology view, click and drag an interface to the interface of another device which is directly connected with the first interface, and release the mouse button. Note that the preceding connection must be consistent with the actual network connection of devices. For example, if P1 of the PLC is connected to P2 of slave station 1, and P1 of slave station 1 is connected to another slave station, the topology must be consistent with the actual connection. An incorrect topology will cause function failure after replacement and even communication errors. After the MD500-PN2 card is installed, P1 is on the left and P2 is on the right when you face the RJ45 interface.



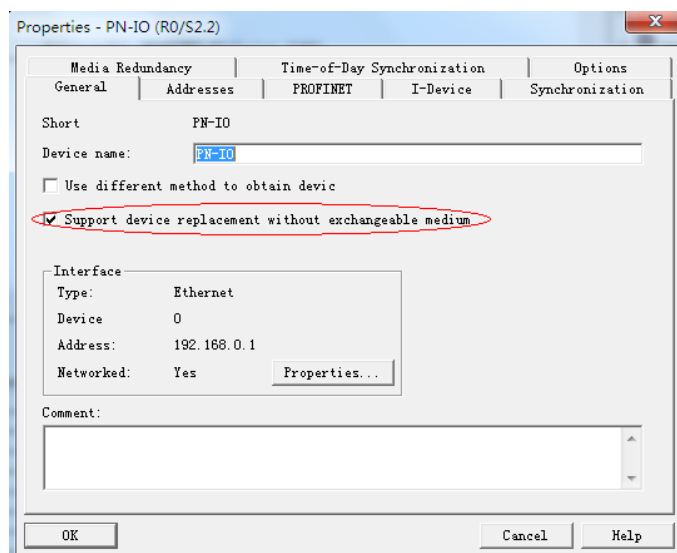
5. After completing the topology, start compiling and download it to the PLC.

Selecting the Support device replacement without exchangeable medium option and setting the topology in STEP 7

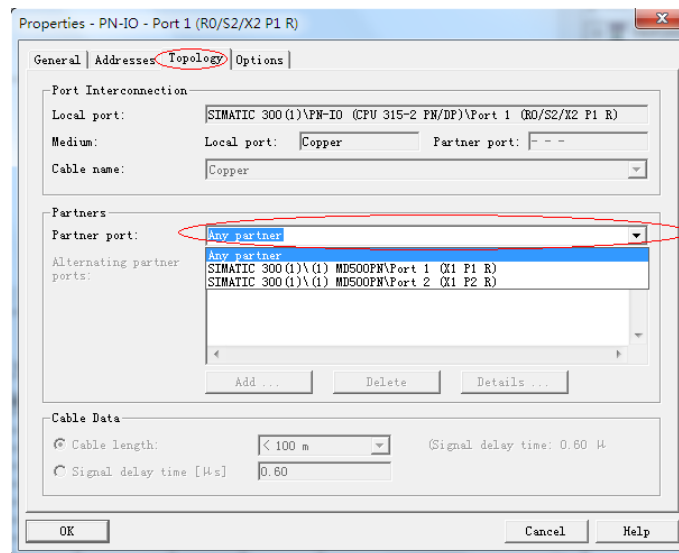
1. In hardware configuration, double-click **PN-IO**, as shown in the following figure.



2. In the **General** tab, select **Support device replacement without exchangeable medium**, and click **OK**.



3. According to the actual network connections, double-click **Port 1** or **Port 2** of the PLC. Click the **Topology** tab, select the port of the slave station connected to the PLC (**Any partner** by default) from the **Partner port** drop-down list box, and click **OK**.



4. Click the port of the slave station to set the topology. The operations are similar to the preceding steps. After setting all the connected ports, start compiling and download it to the PLC.
5. After completing the preceding configuration, perform the following operations when any slave station needs to be replaced: 1) Disconnect the device from the network. 2) Install a new device to which no device name is assigned before at the same position. (For S7-1200 or S7-1500, if **Permit overwriting of device names of all assigned IO devices** has been selected, devices which have been assigned names to can be used.) 3) Connect the new device to the network using the original wiring mode. (Note that the network cable connection must be consistent with the original connection and the connection in the topology.) 4) Power on the slave station to enable the PLC to assign a device name to the newly connected device automatically.

9 EtherCAT Communication (MD500-ECAT)

9.1 Introduction

The MD500-ECAT communication card (hereinafter referred to as the ECAT card) supports the super-high-speed I/O network for industrial field application. It features high efficiency, flexible topology, and easy operation.

It is installed on the MD520 series AC drive to improve the communication efficiency and implement AC drive networking, enabling the AC drive to be a slave controlled by the fieldbus master. The minimum synchronization cycle supported by the ECAT card is 500 μ s.

This user guide is applicable to the ECAT card with the software version of 1.00 or later. You can query the version by viewing the parameter U0-67 of the AC drive after the card is installed and the drive powered on. The corresponding device profile XML file is MD500_1Axis_V1.03.xml.

9.2 Installation

The MD500-ECAT card is embedded in the MD520 series AC drive. Before installation, cut off the power supply of the AC drive and wait at least 10 minutes until the charging indicator of the AC drive becomes off. Then, insert the MD500-ECAT card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. *“Figure 9-1” on page 134* describes the installation of the card.

Note that the ground terminals of both the MD500-ECAT card and AC drive must be connected properly, as shown in *“Figure 9-2 Connecting ground terminals of the MD500-ECAT card and AC drive” on page 135*.

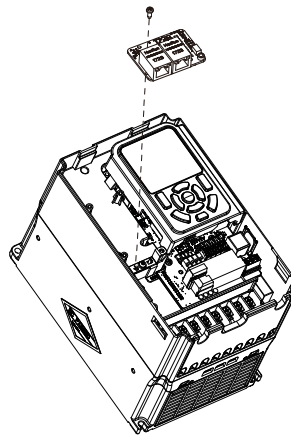


Figure 9-1 MD500-ECAT card installation

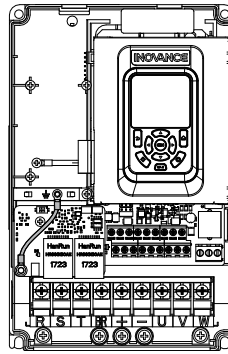


Figure 9-2 Connecting ground terminals of the MD500-ECAT card and AC drive

9.3 Terminal Layout and Description

The following figure describes terminals and indicators of the MD500-ECAT card. The pin header J7 on the back of the MD500-ECAT card is used to connect the drive. The MD500-ECAT card provides two network ports J4 and J6 for the card to communicate with the master station (or upstream slave) and the downstream slave (if any).

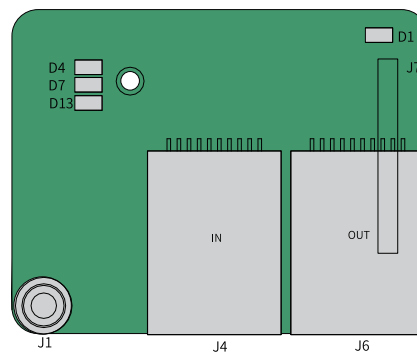


Figure 9-3 MD500-ECAT card terminal layout

Table 9-1 Interfaces and indicators of the MD500-ECAT card

Mark	Hardware Name	Function Description
J7	Pin header	It is used to connect the AC drive.
J4	Network port	The MD500-ECAT card uses the standard Ethernet RJ45 ports J4 and J6 for the card to communicate with the master (or the upstream slave) and the downstream slave (if any).
J6		
J1	EMC grounding terminal	It is used to connect the EMC grounding terminal of the AC drive.
D13	Power supply indicator (green)	It is used to indicate the status of the power supply. On: Normal Off: Abnormal. Check whether the card is installed properly.

Mark	Hardware Name	Function Description
D1	Status indicator of communication with AC drive (green)	For details, see “Table 9–2 Status indicators of the MD500-ECAT card” on page 136.
D4	EtherCAT interaction indicator (green)	
D7	ESC fault indicator (red)	

**Caution**

- J4 is the input port (ECAT IN) and J6 is the output port (ECAT OUT). Do not connect the input and output reversely.
- Use the Cat5e shielded twisted pair (STP) network cable to ensure stability.

Table 9–2 Status indicators of the MD500-ECAT card

Indicator		Status	Solution
D1	Steady green	Normal	None
	Steady off	Abnormal communication with the AC drive	Set F0-28 to 1 and check whether the AC drive supports the MD500-ECAT card. Check whether the communication expansion card is inserted firmly.
D4	Steady green	The card works in the OP state	/
	Blinking green	The card works in PREOP/SAFEOP mode.	Check the configuration. Check whether the AC drive supports the MD500-ECAT card and whether F0-28 is set to 1. Check whether the network port is connected correctly.
	Off	The master is not connected or the card works in the Initial mode.	Check whether the master and upstream network port are connected correctly.
D7	Off	Normal	None
	Steady red	An ESC internal exception occurs.	Contact Inovance for technical support.

9.4 Networking Topology

After the MD500-ECAT card can communicate with the AC drive, connect the MD500-ECAT card to the EtherCAT master correctly and complete communication configurations. This enables the MD500-ECAT card to communicate with the EtherCAT master and can implement the AC drive networking function.

The MD500-ECAT card supports various topological structures including bus-, star-, and tree-type topologies and their combinations. This enables flexible and convenient equipment connection and wiring. The following figure shows the bus topology.

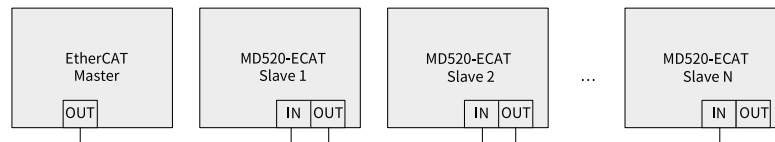


Figure 9-4 EtherCAT bus topology

9.5 PDO Data

PDO data description

The PDO data enables the master to modify and read AC drive data in real time and perform periodic data exchange with the AC drive. The data communication addresses are directly configured by the AC drive. The data mainly includes the following:

1. Real-time settings of AC drive control commands and target frequencies
2. Real-time reading of AC drive current state and running frequency
3. Real-time exchange of function parameters and monitoring parameters between the AC drive and EtherCAT master station

The PDO process data is used for periodic data exchange between the master and AC drive axes, as described in the following table.

PDO Sent from Master to AC Drive Axis 1 (1601h)			PDO Responded by AC Drive Axis 1 to Master (1A01h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Target Frequency	Real-Time Modification of AC Drive Parameters	AC Drive State	AC Drive Running Frequency	Real-Time Reading of AC Drive Parameters
RPDO1	RPDO2	RPDO3 to RPDO12	TPDO1	TPDO2	TPDO3 to TPDO12

Data sent by the master

Table 9–3 Descriptions of RPDO sent by the master

RPDO	Description
RPDO1	AC drive command word (command source set to communication, that is, F0-02 = 2) • 1: Forward run • 2: Reverse run • 3: Forward jog • 4: Reverse jog • 5: Coast to stop • 6: Stop according to F6-10 (Stop mode) • 7: Reset upon fault
RPDO2	It indicates the target frequency of the AC drive U3-16 ^{Note 1} (frequency source set to communication) in the range of the reverse frequency upper limit (negative value) to the forward frequency upper limit (decimal places included, for example, 2000 corresponds to 20.00 Hz on the AC drive). When the target frequency exceeds this range, the AC drive runs at the frequency upper limit. For example, if the frequency upper limit is set to 50.00 Hz and the value set by communication is 6000, the AC drive will run at 50.00 Hz in the forward direction. If the frequency upper limit is set to 50.00 Hz and the value set by communication is -6000, the AC drive will run at 50.00 Hz in the reverse direction.
RPDO3 to RPDO12	The RPDOs indicate that parameter values are modified in real time, but are not written into EEPROM. RPDO3 to RPDO12 correspond to FE-02 to FE-09. For details about the configuration, see the PDO data configuration.

Note

The data type of the AC drive target frequency (U3-16) is int16, and the data range is -32768 to +32767. If the range is exceeded, an AC drive abnormal value (-65535+U3-16) will occur.

TPDO data returned by the AC Drive

TPDO	Description
TPDO1	It indicates the AC drive state. • Bit 0: 0: Stopped; 1: Running • Bit 1: 0: Running in forward direction; 1: Running in reverse direction • Bit 2: 0: Not faulty; 1: Faulty • Bit 3: 0: Running frequency not reached; 1: Running frequency reached • Bit 4 to bit 7: Reserved • Bit 8 to bit 15: AC drive fault code
TPDO2	It indicates the AC drive running frequency (unit: 0.01 Hz). The current running frequency of the AC drive is returned. The returned data is 16-bit signed data and the received data is 16-bit unsigned data. Variables must be mapped to the 16-bit signed data.
TPDO3 to TPDO12	Parameters are read in real time. TPDO3 to TPDO12 correspond to FE-22 to FE-29. For details about the configuration, see the PDO data configuration.



Caution

The first two mappings of TPDO1 and RPDO1 must be configured based on the preceding table. Otherwise, an error will occur.

The default mapping 1 of the written RPDO1 is U3-17, and the default mapping 2 of the written RPDO2 is U3-16. If the command or frequency cannot be written to the AC drive, PZD3 and PZD12 can be written to the AC drive, and F0-02 is 2 and F0-03 is 9, check whether FE-00 is U3-17 and FE-01 is U3-16 on the AC drive. If not, manually change FE-20 and FE-21 to the correct values.

The default mapping 1 of the read TPRO1 is U0-68, and the default mapping 2 of the read TPRO1 is U0-69. If the state or running frequency cannot be read from the AC drive, but PZD3 and PZD12 can be read from the AC drive, check whether FE-20 is U0-68 and FE-21 is U0-69 on the AC drive. If not, manually change FE-20 and FE-21 to the correct values.

9.6 SDO Mailbox Data

EtherCAT service data object (SDO) is used to transfer non-cyclic data, such as communication parameter configurations and drive running parameter configurations.

The CANopen over EtherCAT (CoE) service types include emergency messages, SDO requests, SDO responses, TxPDO, RxPDO, remote TxPDO transmitting requests, remote RxPDO transmitting request, and SDO information.

The MD520 supports the SDO request and SDO response.

9.7 Related Parameters

MD500-ECAT card settings

After the MD500-ECAT card is installed to the AC drive and F0-28 is set to 1, the MD500-ECAT card can communicate with the AC drive.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-28	Communication protocol	0: Modbus protocol 1: Expansion communication protocol 2: Inobus protocol (through EtherCAT card)	1	This parameter is used to select a communication protocol. 0: Modbus protocol The Modbus protocol is used. 1: Expansion communication protocol PROFIBUS DP, PROFINET, EtherCAT, Modbus TCP, and EtherNet/IP protocols can be used. No setting is required for CANlink because it is always valid. 2: Inobus protocol (through EtherCAT card) When this parameter is set to 2, the Inobus communication protocol is used. The AC drive version must be F7-10 = U60.07/F7-11 = U61.07/F7-15 = 000.00/F7-16 = 000.00 or later.
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run, and jog operation. 0: Operating panel The RUN/STOP key on the operating panel can be used to start or stop the drive. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined The command source is defined by the user as needed for expansion.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-03	Main frequency source X selection	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	9	This parameter is used to set the source of the main frequency X as below. 0: Digital setting (non-retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is restored to the value of F0-08. 1: Digital setting (retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is the same as that at the moment of the last power failure. Modifications made by using keys ▲ and ▼ on the operating panel or the multi-functional input terminal functioning as the UP and DOWN key remain effective. 2: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). To be continued

Parameter Code	Parameter Name	Value Range	Value	Description
Continued	Continued	Continued	Continued	Continued 7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources.
FD-11	CiA 402 protocol	0: Disable 1: Enable	Set it as needed.	This parameter sets whether to enable the CiA 402 mode. When it is set to 0, the common mode is used. When it is set to 1, the CiA 402 mode is used. For details, see “13.1 List of Object Dictionary in Group 6000h” on page 260 and “13.2 Object Dictionary Descriptions” on page 261.

Communication control parameters

Table 9-4 Communication control parameters

Parameter Code	Parameter Name	Value Range		Description
U3-16	Frequency set through communication	-320.00 Hz to 320.00 Hz		When the frequency source is communication control, you can write the target value through this address. The unit of the written value is defined by FD-09.
U3-17	Communication setting control word	0001: Forward run 0002: Reverse run 0003: Forward jog 0004: Reverse jog	0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	When the command source is communication control, this address can be used to control the start/stop, jog, and fault reset of the drive.
U3-18	DO state (terminal function defined by parameters in group F5: communication control)	Bit 0: DO1 output control Bit 1: DO2 output control Bit 2: Relay 1 output control Bit 3: Relay 2 output control Bit 4: FMR output control	Bit 5: VDO1 Bit 6: VDO2 Bit 7: VDO3 Bit 8: VDO4 Bit 9: VDO5	This value can be changed through communication to control DO output.
U3-19	AO1 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		This value can be changed through communication to control AO1 output.
U3-20	AO2 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		This value can be changed through communication to control AO2 output.
U3-21	HDO output (terminal function defined by parameters in group F5: communication control)	0 to 32767		This value can be changed through communication to control HDO output.

Parameter Code	Parameter Name	Value Range	Description
U3-22	Communication card error state	0 to 65535	This parameter is used to write the communication card error state.
U3-23	Speed set through communication	-32000 rpm to 32000 rpm	When the frequency source is communication control, you can write the target value through this address. The unit of the written data rpm.

The position of the object dictionary in the parameter list is specified by the "Index" and "Sub-index".

Index: This field (in hexadecimal) specifies the position of the same type of objects in the object dictionary.

Sub-index: The sub-index (in hexadecimal) specifies the offset of each object in the same index.

The mapping between AC drive parameters and object dictionary indexes is as follows:

Object dictionary index = 0x2000 + Parameter group number

Object dictionary sub-index = Hexadecimal offset within the parameter group + 1

By default, when the MD500-ECAT card is used, the written PDO1 and PDO2 are mapped to U3-17 and U3-16, respectively. Therefore, the first item of the RPDO must be U3-17; otherwise, operation will be abnormal. Besides, if the eight high-order bits of U3-17 are written with any non-zero value, the AC drive will report a communication fault (E164.1).

Communication monitoring parameters

Table 9-5 Communication monitoring parameters

Parameter Code	Parameter Name	Unit	Decimal Address
U0-00	Operating frequency	Hz	28672
U0-01	Frequency reference	Hz	28673
U0-02	Bus voltage	V	28674
U0-03	Output voltage	V	28675
U0-04	Output current	A	28676
U0-05	Output power	kW	28677
U0-06	Output torque	%	28678
U0-07	DI input state	-	28679
U0-08	DO output state	-	28680
U0-09	AI1 voltage	V	28681
U0-10	AI2 voltage	V	28682
U0-11	AI3 voltage	V	28683
U0-12	Count value	-	28684
U0-13	Length	-	28685
U0-14	Load speed display	-	28686
U0-15	PID reference	-	28687
U0-16	PID feedback	-	28688
U0-17	PLC stage	-	28689
U0-18	Pulse input frequency	kHz	28690
U0-19	Feedback speed	Hz	28691

Parameter Code	Parameter Name	Unit	Decimal Address
U0-20	Remaining running time	min	28692
U0-21	AI1 voltage before calibration	V	28693
U0-22	AI2 voltage before calibration	V	28694
U0-23	AI3 voltage before calibration	V	28695
U0-24	Motor speed	rpm	28696
U0-25	Current power-on time	min	28697
U0-26	Current operating time	min	28698
U0-27	Pulse input frequency	Hz	28699
U0-28	Communication setpoint	%	28700
U0-29	Encoder feedback speed	Hz	28701
U0-30	Display of main frequency X	Hz	28702
U0-31	Display of auxiliary frequency Y	Hz	28703
U0-32	Memory address view	-	28704
U0-33	Synchronous motor rotor position	°	28705
U0-34	AI3 temperature mode - motor temperature	°C	28706
U0-35	Target torque	%	28707
U0-36	Resolver position	-	28708
U0-37	Power factor angle	°	28709
U0-38	ABZ position	-	28710
U0-39	Target voltage upon V/f separation	V	28711
U0-40	Output voltage upon V/f separation	V	28712
U0-45	Fault subcode	-	28717
U0-58	Number of motor revolutions	-	28730
U0-59	Frequency reference	%	28731
U0-60	Operating frequency	%	28732
U0-61	AC drive state	-	28733
U0-62	Current fault code	-	28734
U0-63	Torque sent in point-to-point communication	%	28735
U0-64	Number of slaves in master-slave control	%	28736
U0-65	Torque upper limit	%	28737
U0-66	Model of communication expansion card	-	28738
U0-67	Software version of communication extension card	-	28739
U0-68	AC drive state read through DP card	-	28740

Parameter Code	Parameter Name	Unit	Decimal Address
U0-69	Frequency read through communication expansion card	Hz	28741
U0-70	Speed read through communication expansion card	rpm	28742
U0-71	Current read through communication expansion card	A	28743
U0-80	EtherCAT slave name	-	28752
U0-81	EtherCAT slave alias	-	28753
U0-83	EtherCAT XML file version	-	28755
U0-84	Number of lost EtherCAT synchronization frames	-	28756
U0-85	Maximum number of error frames and invalid frames over EtherCAT port 0 per unit time	-	28757
U0-86	Maximum number of error frames and invalid frames over EtherCAT port 1 per unit time	-	28758
U0-87	Maximum number of error frames forwarded by EtherCAT port per unit time	-	28759
U0-88	Maximum number of error frames processed by EtherCAT data frame processing unit per unit time	-	28760
U0-89	Maximum number of lost links over the EtherCAT port per unit time	-	28761

By default, when the MD500-ECAT card is used, the read PDO1 and PDO2 are mapped to U0-68 and U0-69, respectively. Therefore, the first item of the TPDO must be U0-68; otherwise, operation will be abnormal.

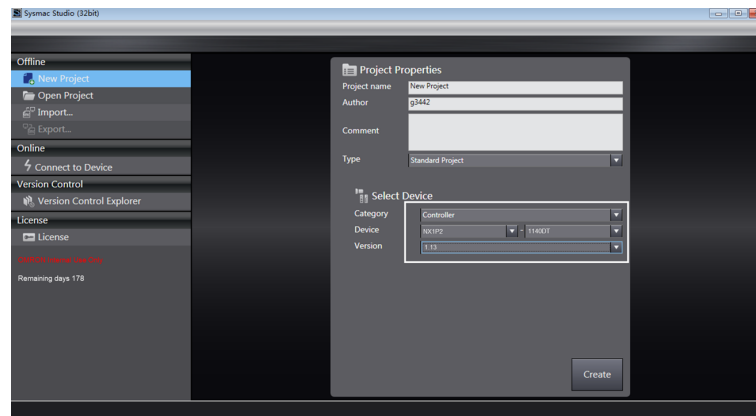
9.8 Communication Configuration

9.8.1 Communication Instance of Controlling the MD520 with an Omron Controller

This section describes how to configure the MD520 on the NX1P2 master station of Omron.

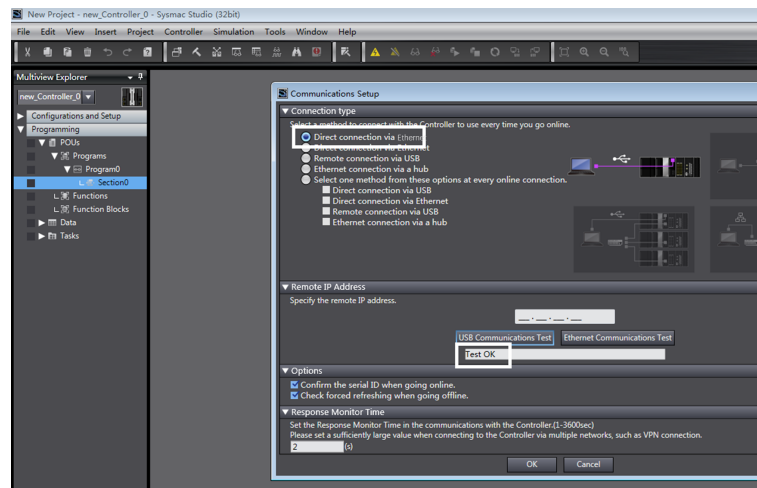
1. Create a project.

- Device: Select the actual controller model.
- Version: 1.09 or later version. NX1P2-1140DT only supports 1.13.



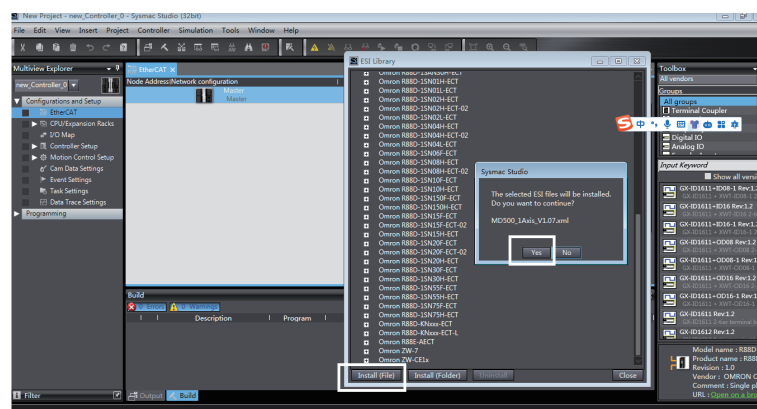
2. Configure communication.

- Enter the main interface and choose **Controller > Communications Setup** to set the connection mode for the computer and controller.
- Select **Direct connection via Ethernet**, and click **Ethernet Communications Test**. After **Test OK** is displayed, go to the next step.



3. Import the XML configuration file.

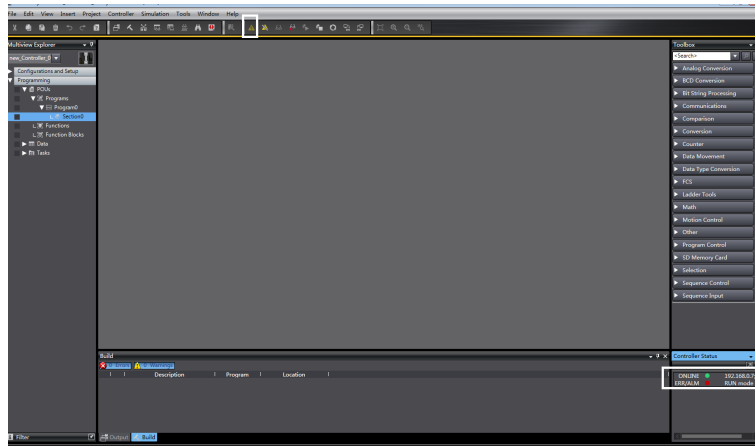
Double-click **EtherCAT** in the left pane. Right-click the master device and select **ESI Library**. Click **Install (File)**. Select the MD500-ECAT card XML configuration file and import it.



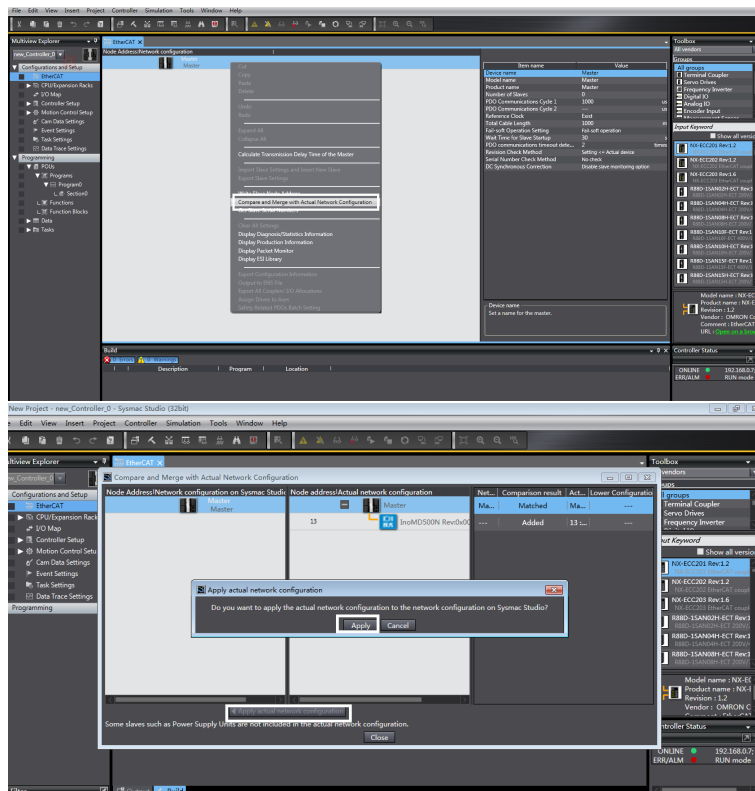
4. Scan the device.

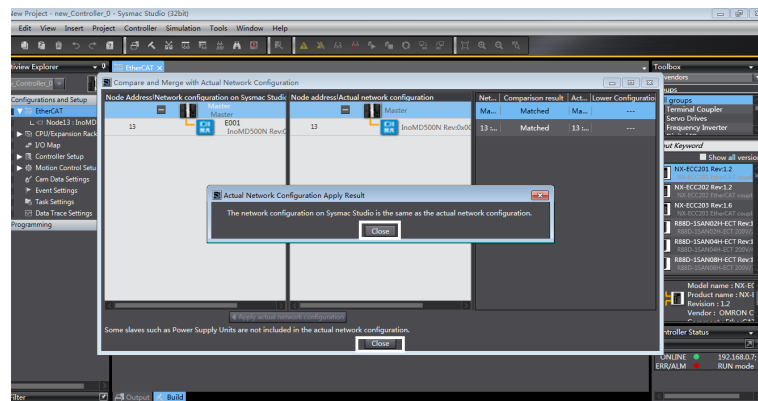
Switch the controller to the online and running mode.

Check that the controller status in the lower right corner is online and running.

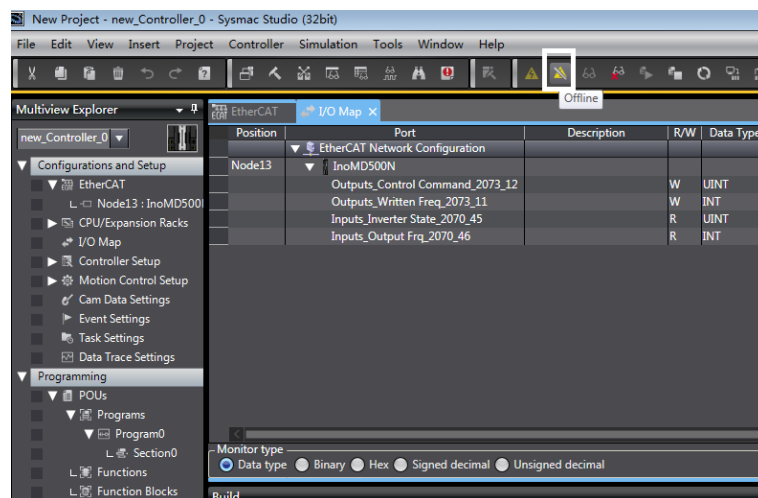


The MD500-ECAT card allows the station alias to be modified by using the parameter FD-02 or the software tool of

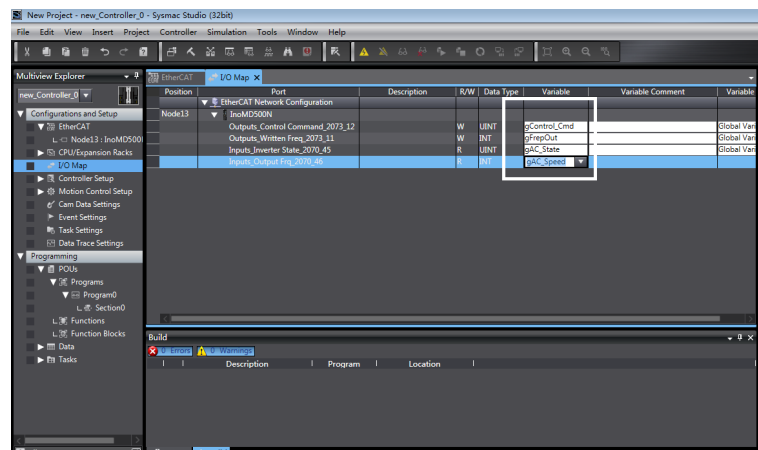




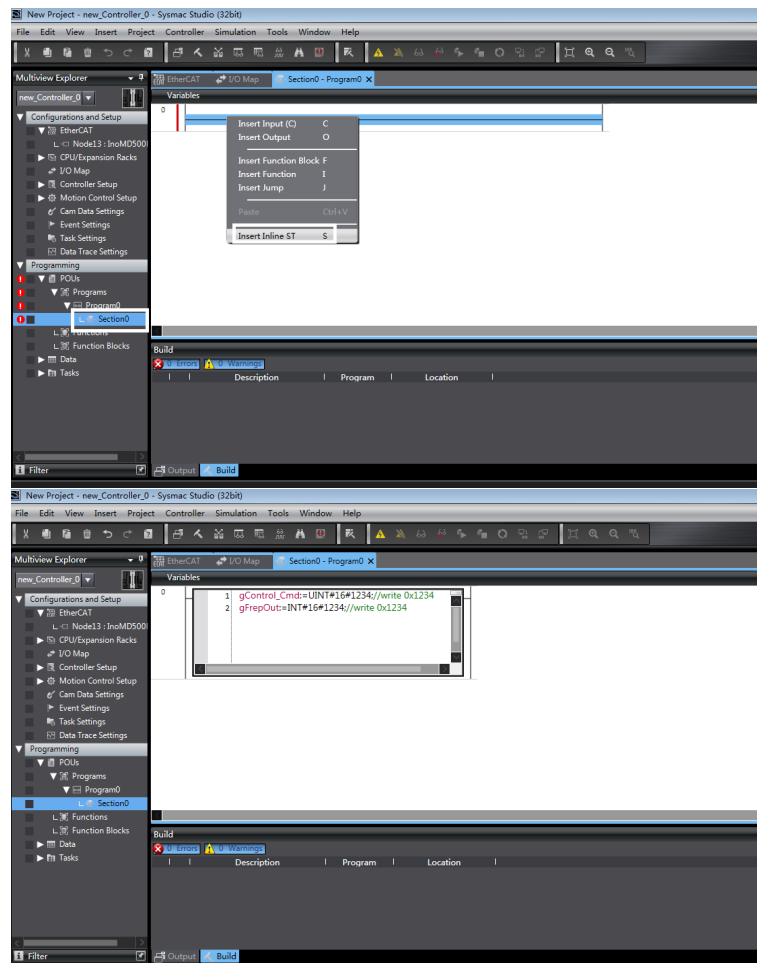
5. Configure parameters.
Switch the controller to the offline mode.



- Set the PDO mapping (I/O mapping distribution).

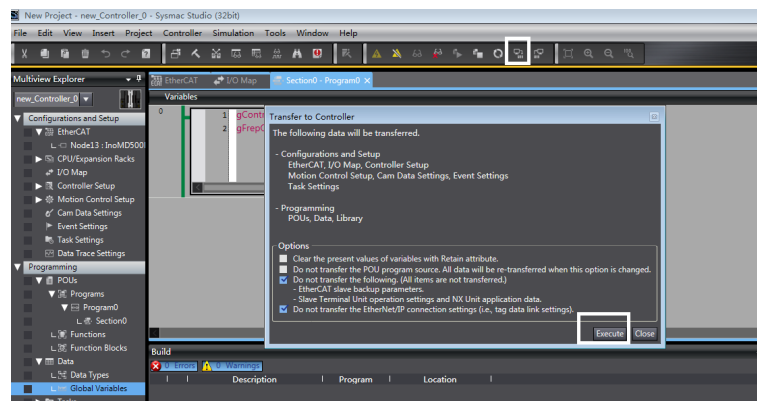


6. Edit the PLC program.



7. Download the program to the controller.

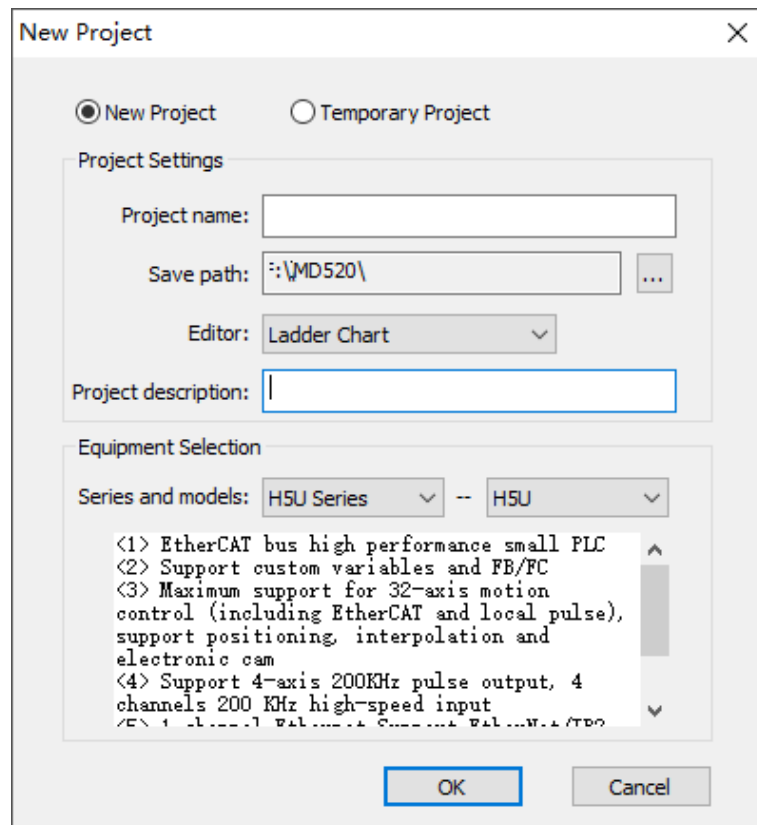
After settings and programming are complete, switch to the online state, and download the program to the controller.



9.8.2 Communication Instance of Controlling MD520 with an H5U Controller

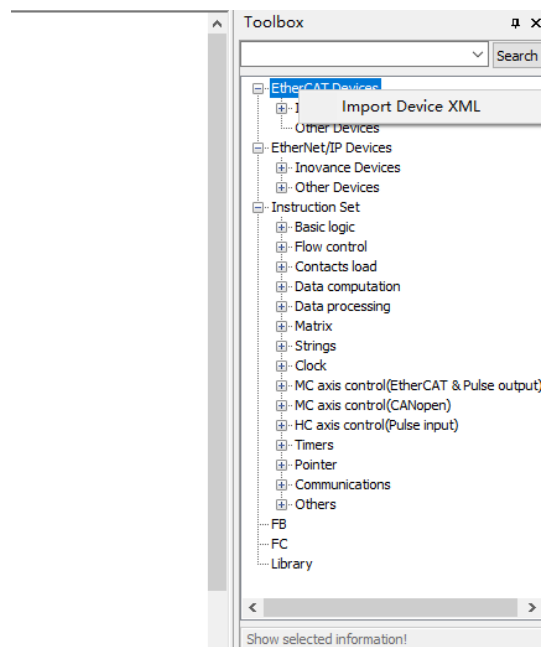
This section describes how to configure the MD520 on the H5U.

1. Open the software and create an H5U project.
Select **H5U/TN** from the **Device** drop-down list.



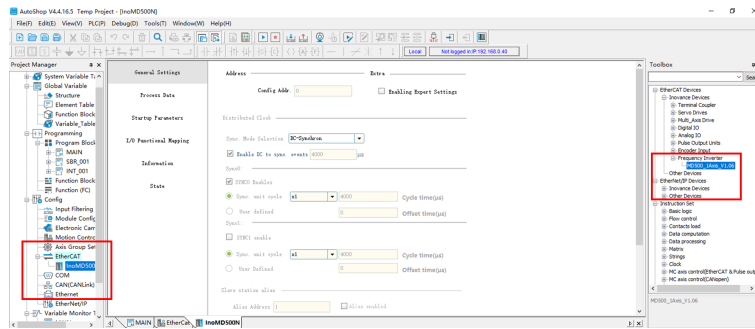
2. Import the EtherCAT configuration file of the MD520.

Right-click **EtherCATDevices** and select **Import Device XML**. If the configuration file of other versions exists, delete the existed file before importing a new one, as shown below.



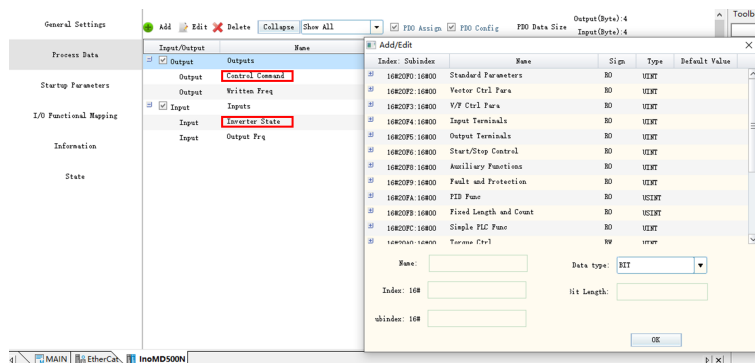
3. Add an MD520 AC drive slave.

Double-click **EtherCAT** in the left pane and drag the device in the network device list to add the AC drive slave station.



4. Configure PDO parameters.

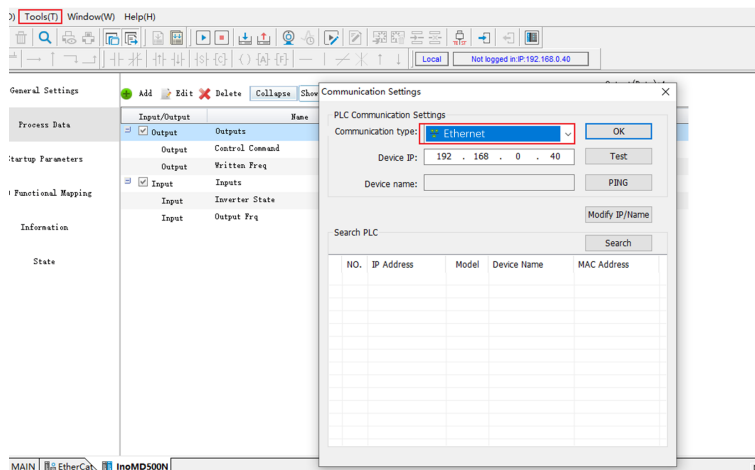
On the **Process Data** tab, add the TPDO mapping as required.



Note: Control Command of the RPDO and Inverter State of the TPDO cannot be changed and must be set as the first items. Otherwise, an exception will occur during operation.

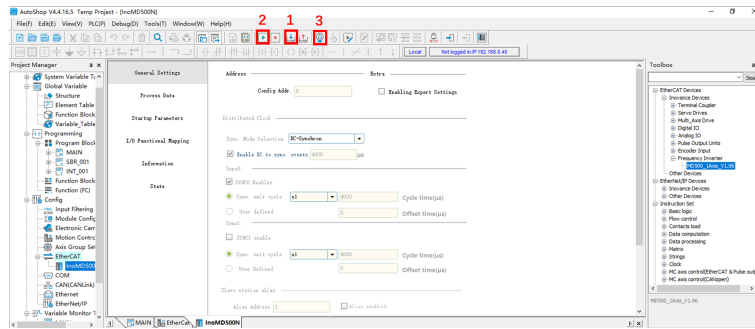
5. Scan the H5U PLC.

Click **Tools(T)**. In the **Communication Settings** dialog box, select **Ethernet** or **USB** from the **Communication type** drop-down list for communication between the PC and the PLC, and scan the PLC.

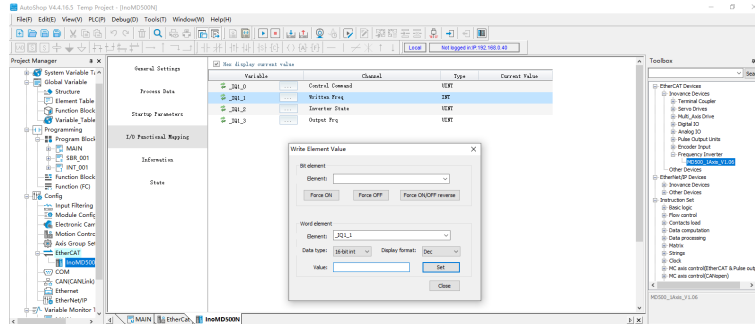


6. Download the project to the PLC and activate the PLC.

Download the compiled project file, click the running button to activate the PLC, and then click the monitoring button to view the motion data.



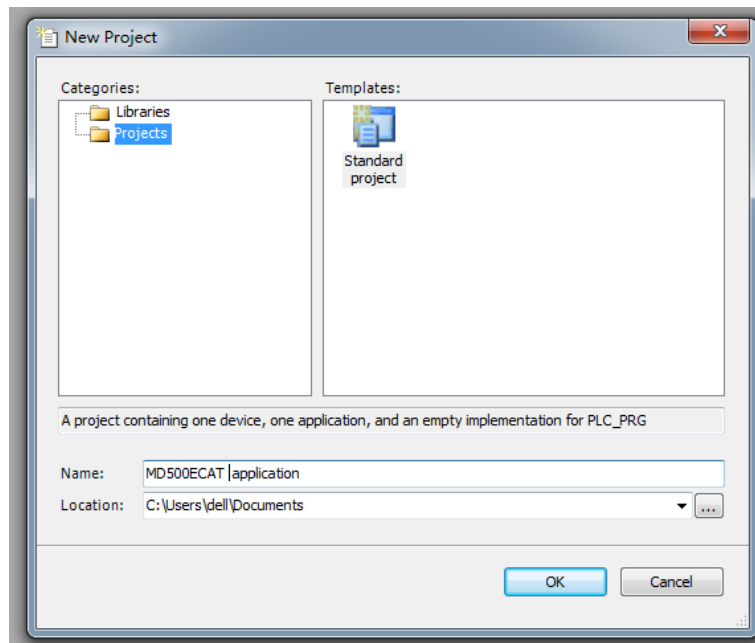
You can view TPDO data and write RPDO data in real time through EtherCAT I/O mappings.

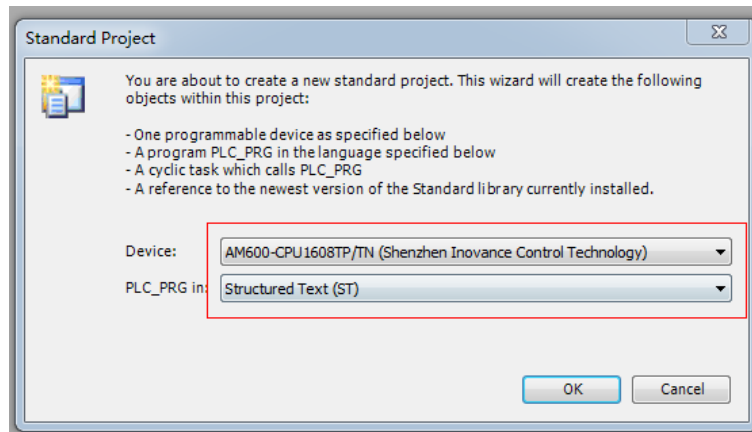


9.8.3 Communication Instance of Controlling MD520 with an AM600 Controller

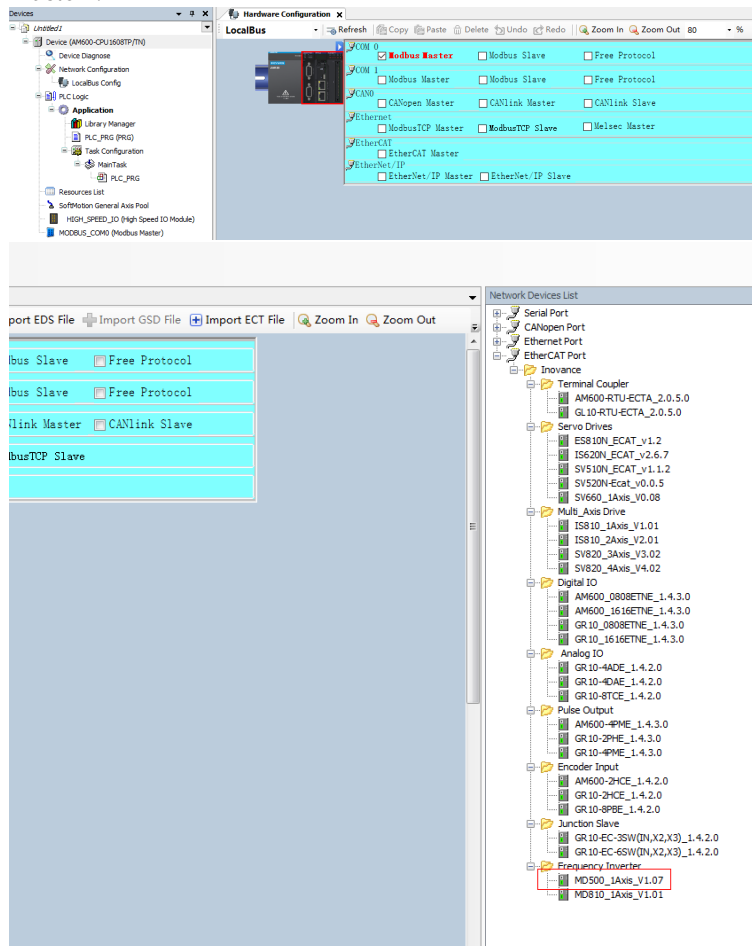
This section describes how to configure the MD520 on the AM600.

1. Open the software, and create an AM600 project.
Select **AM600-CPU1608TP/TN** from the **Device** drop-down list.

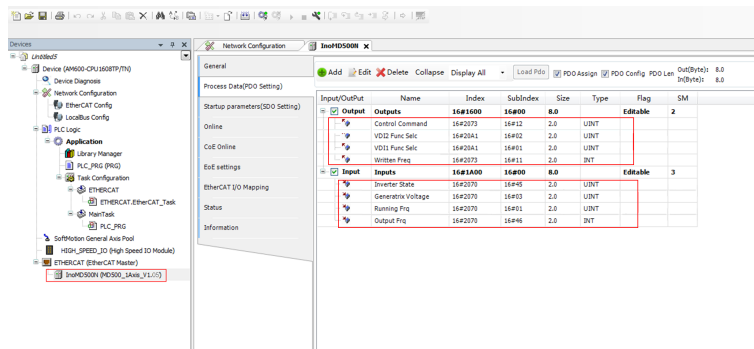




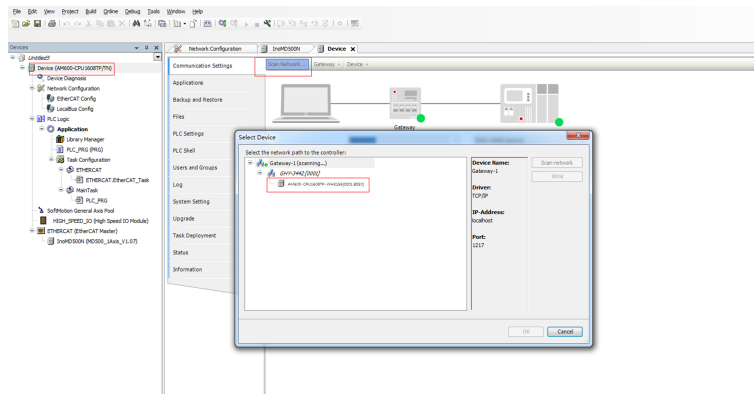
2. Add an MD520 AC drive slave. Open the network configuration, and import the EtherCAT configuration file of the MD520. If a configuration file of other versions exists, delete the existed file before importing a new one. Drag the device in the network device list to add the AC drive slave station, as shown below.



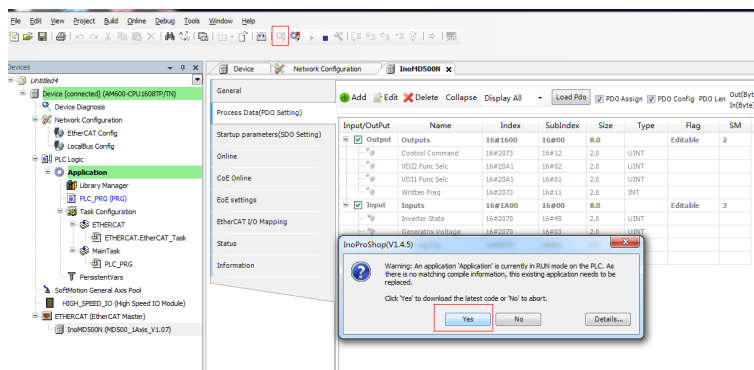
3. Configure the PDO parameters.
Add the TPDO mapping as required in the following figure. Control Command of the RPDO and Inverter State of the TPDO cannot be changed and must be set as the first items. Otherwise, an exception will occur during operation.



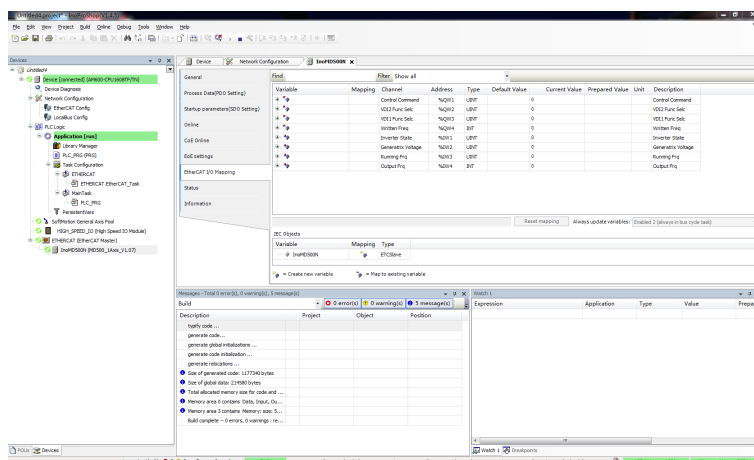
Scan the device.



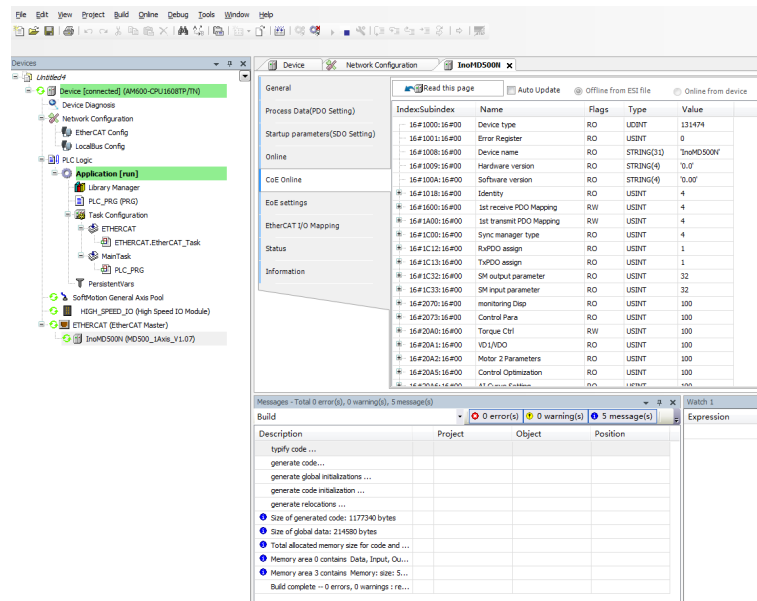
Download the project to the PLC.



You can view TPDO data and write RPDO data in real time through EtherCAT I/O mappings.



View and write parameter values through the online CoE.



9.8.4 Communication Instance of Controlling the MD520 with an Beckhoff Controller

This section describes how to configure the MD500-ECAT card on the TwinCAT master station of Beckhoff.



Caution

The Ethernet card must be 100 Mbps Ethernet card equipped with the Intel chip. If other brands are used, the EtherCAT communication may fail.

1. Install TwinCAT.

- Windows XP: tcacat_2110_2230 is recommended.
- Windows 7 (32-bit): tcacat_2110_2248 is recommended.

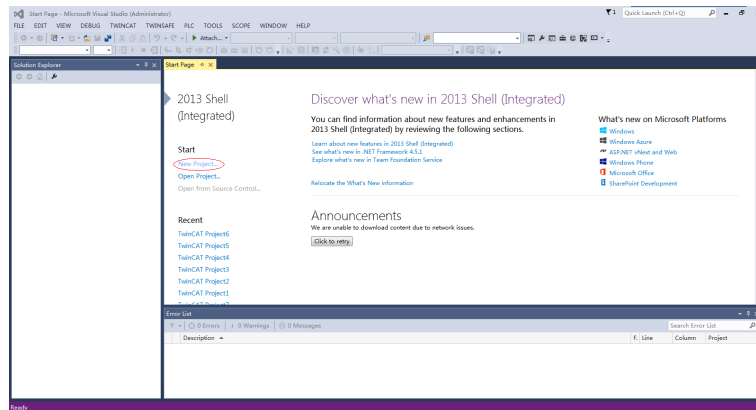
2. Copy the EtherCAT configuration file (MD500_1Axis_V1.03.xml) of the MD520 to the TwinCAT installation directory.

- TwinCAT2 directory: TwinCAT\IO\EtherCAT
- TwinCAT3 directory: TwinCAT\3.1\config\IO\EtherCAT

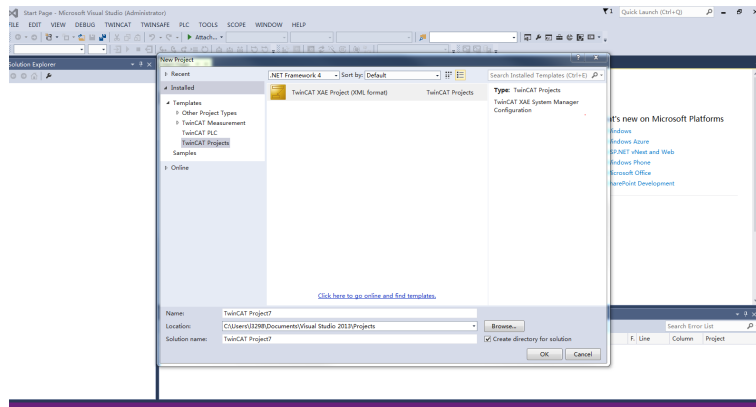
TwinCAT3 is used as an example in the following section. The operation steps for TwinCAT2 are similar to those for TwinCAT3.

3. Run TwinCAT.

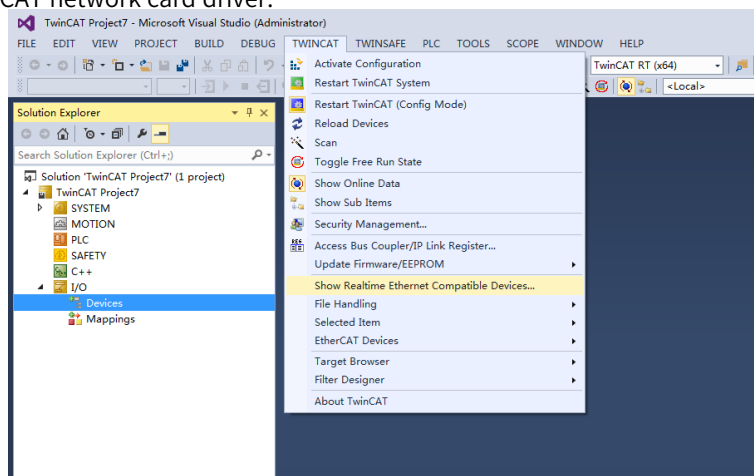
- a. Click **New Project** to create a project.



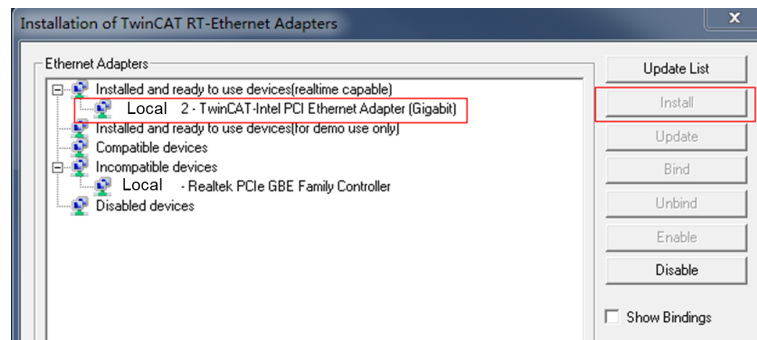
b. Click **OK**.



4. Install the TwinCAT network card driver.

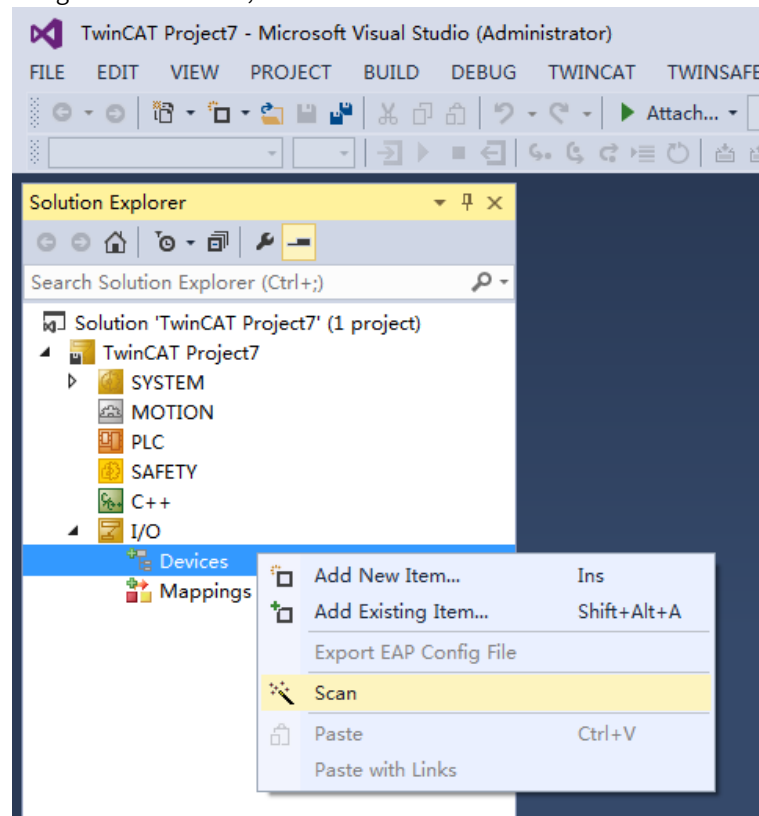


Choose **TWINCAT > Show Real Time Ethernet Compatible Devices....** In the displayed dialog box, select the local network card under **Incompatible devices**, and click **Install**. After installation is done, the network adapter installed will be displayed under **Installed and ready to use devices (realtime capable)**.

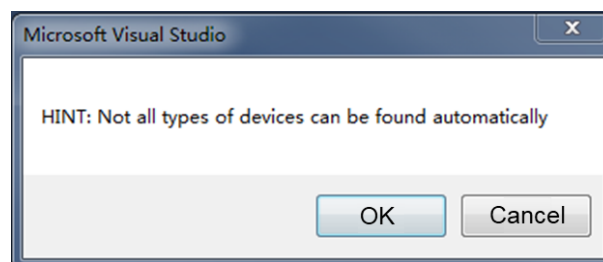


5. Search for devices.

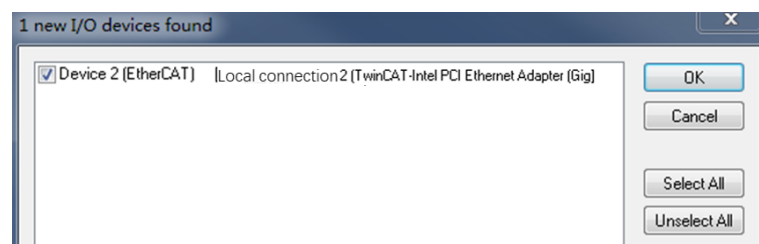
a. Create a project. Right-click **Devices**, and then select **Scan** to search for devices.



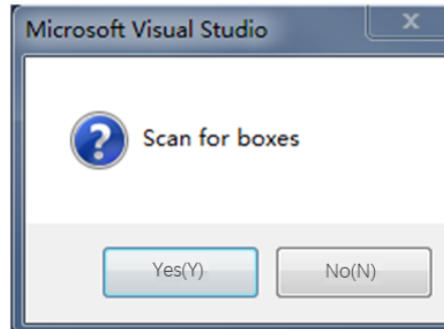
b. Click **OK**.



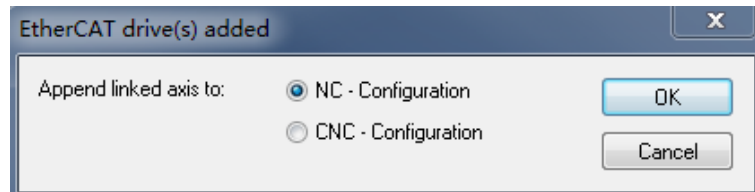
c. Click **OK**.



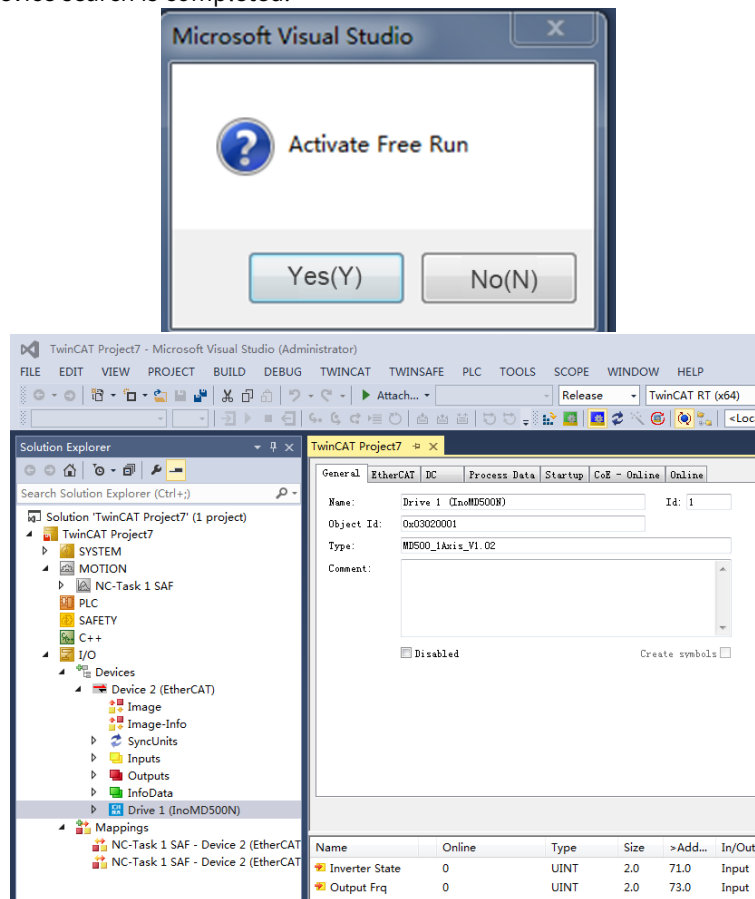
d. Click **Yes**.



e. Click **OK**.



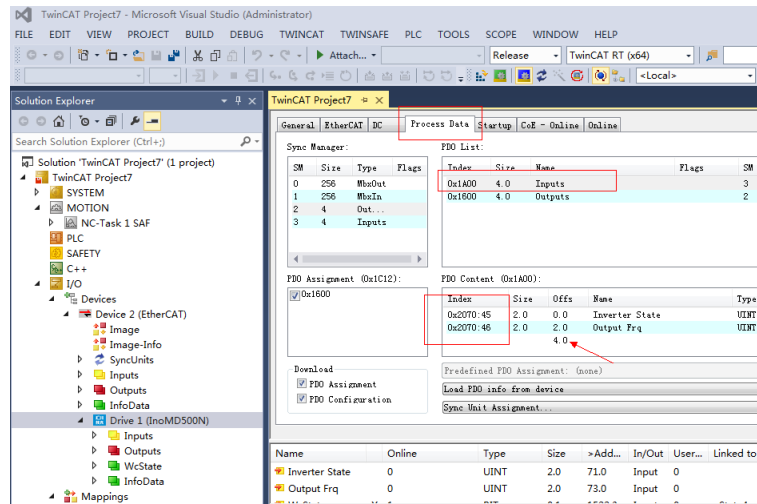
f. Click **No**. The device search is completed.



6. Configure PDO parameters.

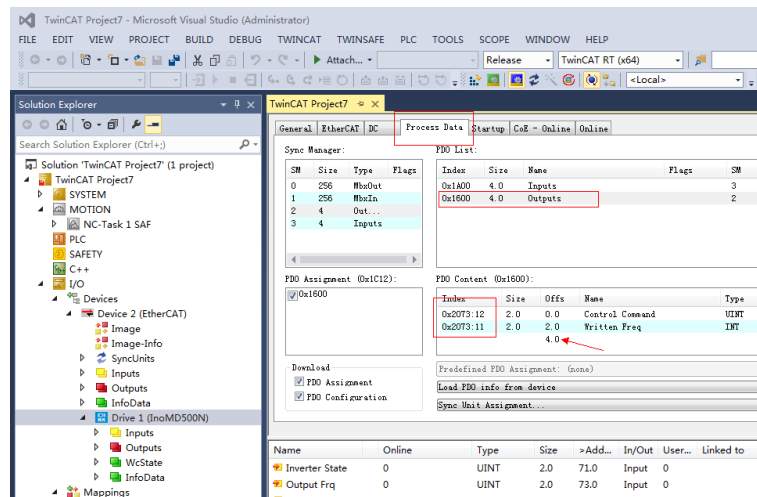
a. Configure the TPDO.

Select 0x1A00 when configuring the TPDO. The first two indexes (0x2070:45 and 0x2070:46) are the default TPDOs and cannot be changed. Right-click at the position indicated by the red arrow in the following figure to add the TPDO mapping as required.



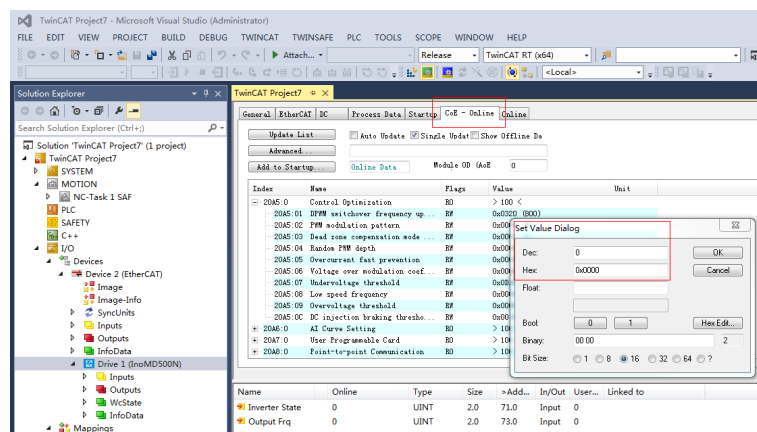
b. Configure the RPDO.

Select 0x1600 when configuring the RPDO. The first two items are the default RPDOs and cannot be changed. Right-click at the position indicated by the red arrow in the following figure to add the RPDO mapping as required.



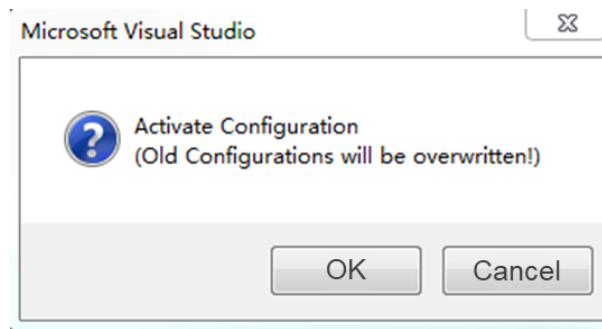
c. View the SDO data list.

After the OP state is activated, you can view real-time data in the SDO data list or double-click the object dictionary to modify the SDO data.

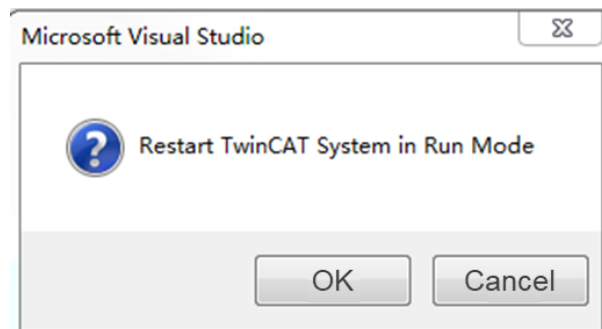


d. Activate the configuration and switch to the running mode.

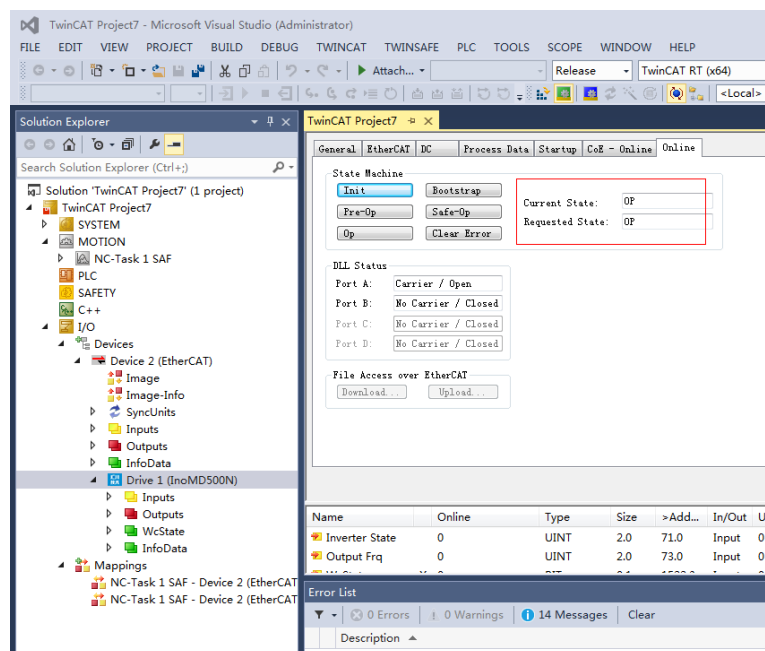
Click . The following figure appears.



Click **OK**.

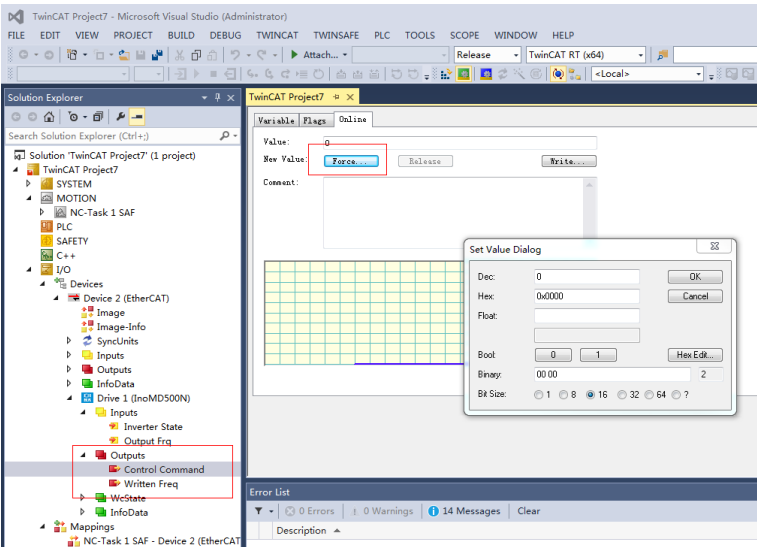


Click **OK** to enter the OP state.



e. Control the AC drive through the PDO.

Write corresponding values through the configured RPDO to control the AC drive.



9.9 Troubleshooting

The following table describes the faults that may occur during the usage of the MD500-ECAT card and AC drive.

Table 9-6 Troubleshooting

Fault		Cause	Solution
Communication between the MD500-ECAT card and AC drive fails.	The D1 indicator on the MD500-ECAT card is off.	1. The AC drive does not support the MD500-ECAT card.	1. Check whether the AC drive supports the MD500-ECAT card.
		2. The communication configuration of the MD500-ECAT card is incorrect.	2. Set F0-28 to 1.
		3. The MD500-ECAT card hardware is faulty.	3. Replace the MD500-ECAT card.
A communication error (E164.1) is reported by the AC drive during running.	The D1 indicator on the MD500-ECAT card is off.	1. The communication data is abnormal.	1. Check whether the EtherCAT master program is normal.
		2. The network cable is damaged or connected incorrectly.	2. Check whether the network cable is connected correctly. Replace the network cable if required.
		3. The AC drive suffers external interference.	3. Use the Cat 5e shielded twisted pair (STP) cable as required. Check that the MD500-ECAT card is grounded correctly. Eliminate the external interference. Contact the technical support personnel if necessary.
	The D4 indicator on the MD500-ECAT card is blinking green.	The MD500-ECAT card works in PREOP/SAFEOP mode.	Check the configuration. Check whether the AC drive supports the MD500-ECAT card and whether F0-28 is set to 1. Check whether the network port is connected correctly.
	The D4 indicator on the MD500-ECAT card is off.	The master is not connected or the MD500-ECAT card works in the Initial mode.	Check whether the master and upstream network port are connected correctly.
	The D7 indicator on the MD500-ECAT card is steady red.	An ESC internal exception occurs.	Contact Inovance for technical support.

When a slave reports a MD500-ECAT card fault, the card installed in the slave can be replaced directly without configurations.

Prerequisites for directly replacing the MD500-ECAT card are as follows:

1. Ensure that the wiring sequence of the network cable before and after replacing the MD500-ECAT card is consistent.
2. The internal XML file version of the new MD500-ECAT card is consistent with that of the old one.
3. If a station alias is configured for the MD500-ECAT card, the alias of the new card must be consistent with that of the old card.

10 PROFIBUS DP Communication (MD38DP2)

10.1 Introduction

As a PROFIBUS DP fieldbus adapter card, the MD38DP2 expansion card meets PROFIBUS fieldbus standards. It can improve the communication efficiency of the AC drive and implement the AC drive networking function, enabling the AC drive to be a slave controlled by the fieldbus master. Besides PROFIBUS DP communication, the MD38DP2 card also provides the CANlink communication interface to implement CANlink communication.

This user guide is applicable for the MD38DP2 expansion card with the software version of 1.09 or later. You can query the version by viewing the parameter U0-67 of the AC drive after the card is installed and the drive is powered on.

10.2 Installation

The MD38DP2 card is embedded in the MD520 series AC drive. Before installation, power off the AC drive, wait at least 10 minutes until the charging indicator on the AC drive becomes off. Then, insert the MD38DP2 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. *“Figure 10-1” on page 164* shows the installation.

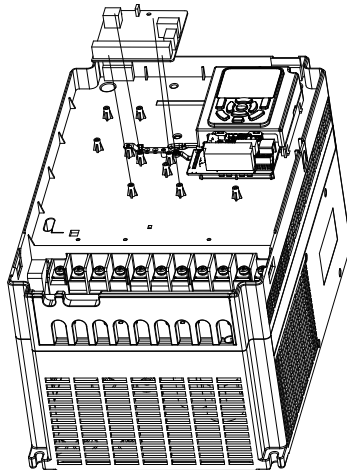


Figure 10-1 MD38DP2 card installation

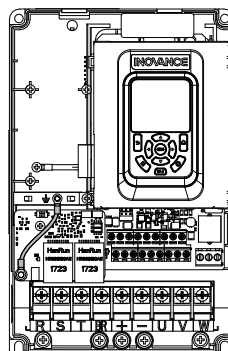


Figure 10-2 Connecting ground terminals of the MD38DP2 card and AC drive

10.3 Terminal Layout and Description

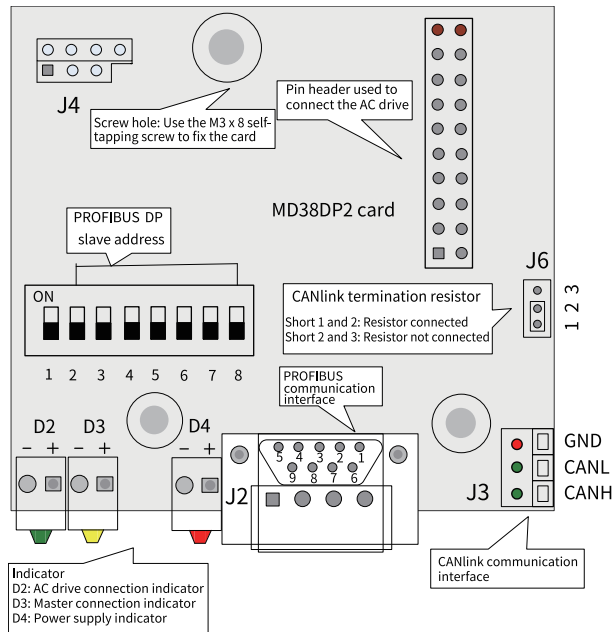
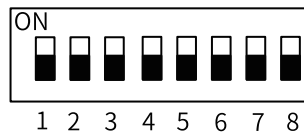


Figure 10-3 MD38DP2 card terminal layout

DIP switch



MD38DP2 DIP switch description

Position	Function	Description
1	DP card type selection	OFF: MD38DP2 (default) ON: MD38DP1
2 to 8	PROFIBUS DP communication slave address	The addresses of stations 1 to 125 can be set by the 7-digit binary DIP switch. For example: Address DIP switch setting (position 8: least significant bit) 1 000 0001 7 000 0111 20 001 0100 125 111 1101



Caution

Changes to position 1 take effect only after the next power-on. Changes to the slave address positions take effect immediately after setting.

The MD520 supports only the MD38DP2 card. Therefore, set position 1 of the DIP switch to OFF.

Description of standard 9-pin PROFIBUS interface

The MD38DP2 card is connected to the PROFIBUS master using the standard DB9 port. The pin signal definition and pin arrangement of the standard DB9 port are the same as those of Siemens' DB9 port, as shown in the following figure.

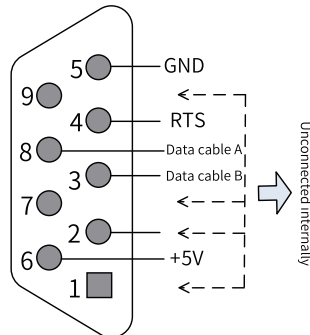


Figure 10-4 DP9 port pin

Description of control terminal functions

Table 10–1 Description of control terminal functions

Category	Terminal Mark	Terminal Name	Description
PROFIBUS communication terminal (J2)	1, 2, 7, and 9	NC	Unconnected internally
	3	Data cable B	Positive pole of the data cable
	4	RTS	Request for signal transmission
	5	GND	Isolated 5 V power supply ground
	6	+5V	Isolated 5 V power supply
	8	Data cable A	Negative pole of the data cable
CANlink communication terminal (J3, J9)	CANH	Positive CAN input	Positive pole of the data cable
	CANL	Negative CAN input	Negative pole of the data cable
	GND	Power supply ground	Isolated 5 V power supply ground
Program burning	SW1	Programming	It is the terminal for commissioning in production. Do not use it.
Jumper	J6	CANlink termination resistor configuration	• Pins 1 and 2 shorted: resistor enabled • Pins 2 and 3 shorted: resistor disabled

Category	Terminal Mark	Terminal Name	Description
Indicator ^{Note}	D4 (red)	Power supply indicator	- Steady ON: The AC drive is energized. - OFF: The AC drive is disconnected from the power supply or the PROFIBUS DP card is installed incorrectly.
	D3 (yellow)	Indicator of communication between the DP card and the master	- Solid ON: Communication between the DP card and the master is normal. - OFF: Communication between the DP card and the master is not established. Check the connection of PROFIBUS cables and the setting of the station number. - Flashing: The master does not run or a fault occurs during communication between the DP card and the PROFIBUS master.
	D2 (green)	Indicator of communication between the DP card and the AC drive	- Solid ON: Communication between the DP card and the AC drive is normal. - OFF: Communication between the DP card and the AC drive fails. F0-28 is not set to 1 or the AC drive does not support the MD38DP2 expansion card. - Flashing: Interference exists on communication between the DP card and the AC drive or the expansion card address is beyond the range of 1 to 125.

Note

Note: For some products, the indicator color and the terminal indication may not match. In this case, the terminal indication prevails. The indicators are D2, D3, and D4 from left to right. See [“Figure 10-3” on page 165](#).

10.4 PROFIBUS Topology and Transmission Distance

The following figure shows the connection between the DP card and PROFIBUS master.

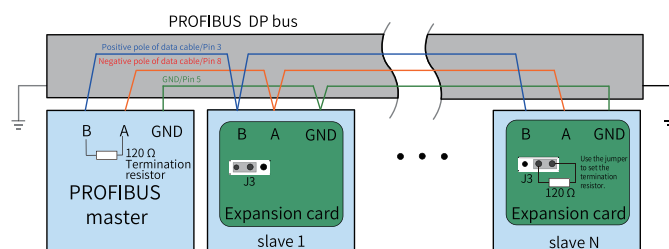
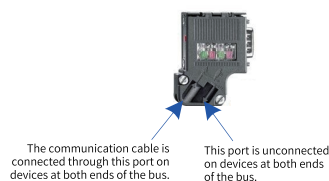


Figure 10-5 Connection between the DP card and PROFIBUS master

Connect termination resistors at both ends of the PROFIBUS bus by setting the DIP switches accordingly. If the termination resistors are connected correctly, the resistance between A1 and B1 should be about 110 Ω when power is off. For the first and last devices on the PROFIBUS bus, connect their communication cables to the ports marked with "IN" (namely, the ports corresponding to A1/B1) on the DP connectors. Otherwise, termination resistors cannot be connected to the bus. If the termination resistor is not connected or only one termination resistor is connected, the communication quality will be affected.



The length of a communication cable between the DP card and the PROFIBUS master is limited by the baud rate of the master. Restrict the length of communication data cables in strict accordance with Siemens DB9 wiring standard. The following table lists limits of communication cable length based on baud rate.

Baud Rate (kbps)	Maximum Length of Cable Type A (m)	Maximum Length of Cable Type B (m)
9.6	1200	1200
19.2	1200	1200
187.5	600	600
500	200	200
1500	100	70
3000	100	Not supported
6000	100	
12000	100	

The following table lists the technical specifications of cables.

Cable Parameter	Type A	Type B
Impedance	135 Ω to 165 Ω (f = 3 MHz to 20 MHz)	100 Ω to 130 Ω (f > 100 kHz)
Capacitor	< 30 pF/m	< 60 pF/m
Resistance	< 110 Ω /km	Not specified
Cross-sectional area of conductor	$\geq 0.34 \text{ mm}^2$	$\geq 0.22 \text{ mm}^2$

10.5 Communication Protocol

Data transmission formats

The PROFIdrive protocol defines the Parameter Process Data Object (PPO) as the format for data transmission. PPO includes five types: PPO1, PPO2, PPO3, PPO4, and PPO5. The DP card supports all the five types of the PPO.

The following table lists the functions supported by each type of the PPO.

Data Type	Supported Function
PPO1	Operation on a single function parameter Setting of AC drive commands and frequencies Reading of AC drive status and running frequency
PPO2	Operation on a single function parameter Setting of AC drive commands and frequencies Reading of AC drive status and running frequency Cyclic writing of four function parameters Cyclic reading of four function parameters
PPO3	Setting of AC drive command and frequency Reading of AC drive status and running frequency
PPO4	Setting of AC drive command and frequency Reading of AC drive status and running frequency Cyclic writing of four function parameters Cyclic reading of four function parameters
PPO5	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive status and running frequency Cyclic writing of 10 function parameters Cyclic reading of 10 function parameters

Data blocks of the PPO data format are divided into two areas, PKW area (parameter area) and PZD area (process data area). The following figure shows the data format of each PPO type supported by the DP card.

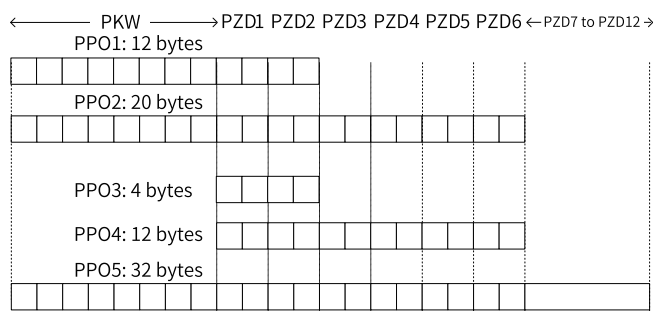


Figure 10-6 PPO data format

PKW data

The PKW data is used by the master station to read/write a single parameter of the AC drive. Communication addresses of the AC drive parameters are directly determined by the communication data. The specific functions are as follows:

- Reading function parameters of the AC drive
- Modifying function parameters of the AC drive

Data format

The PKW data consists of three parts: PKE, IND, and PWE. The PKE, IND, and PWE parts contain two bytes, two bytes, and four bytes, respectively, as shown in the following table.

PKW Data Sent by Master							
Operation command	Parameter address		Reserved			Write operation: parameter value	
						Read operation: reserved	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE
PKW Data Responded by AC Drive							
Operation command	Parameter address		Reserved			Success: parameter value	
						Failure: error information	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE

Data description

PKW Data Sent by Master		PKW Data Responded by AC Drive	
PKE	- High-order four bits: Command code 0: No request 1: Reading parameters 2: Changing parameters (The preceding command code is decimal). - Low-order four bits: Reserved - Low-order eight bits: High-order bits of the parameter address	PKE	- High-order four bits: Response code 0: No request 1: Parameter operation correct 7: Operations cannot be executed. - Low-order eight bits: High-order bits of the parameter address
IND	High-order eight bits: Low-order bits of the parameter address Low-order eight bits: Reserved	IND	High-order eight bits: Low-order bits of the parameter address Low-order eight bits: Reserved
PWE	High-order 16 bits: Reserved Low-order 16 bits: Reserved (in the case of read request) or parameter value (in the case of write request)	PWE	- Request succeeded: Parameter value - Request failed: Error code (consistent with standard Modbus) 1: Invalid command 2: Invalid address 3: Invalid data 4: Other errors

Application example

The following figure shows the PKW data sent by the master station and PKW response data sent by the AC drive when the master station reads the AC drive function parameter F0-08.

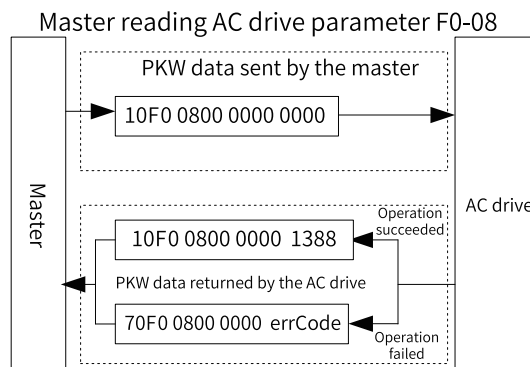


Figure 10-7 Example of PKW data transmitted when the master requests to read an AC drive parameter

The following figure shows the PKW data sent by the master station and PKW response data sent by the AC drive when the master station modifies the AC drive function parameter F0-08.

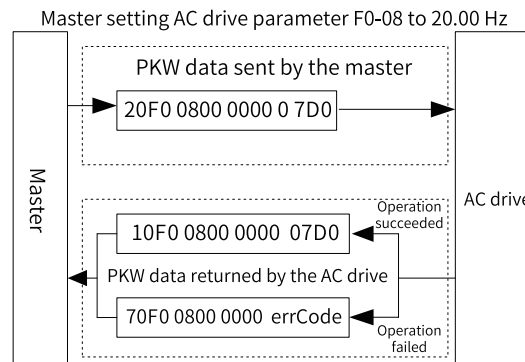


Figure 10-8 Example of PKW data transmitted when the master requests to write an AC drive parameter

PKW data exchange with the AC drive is performed cyclically. Continuous access to the EEPROM with the write command (PKE = 0x20xx) will significantly reduce the service life of the AC drive's main control chip. Therefore, to modify AC drive parameters, it is advisable to use the acyclic write command (see SFB53 described in [“10.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave” on page 190](#)) or operate the RAM addresses in PKW. The following table lists the RAM addresses of the parameters.

Parameter Group	Address
F0 to FF	0x00 to 0x0F
A0 to AF	0x40 to 0x4F

For example, the RAM address of parameter F0-10 is 0x000A.

PZD data

The PZD data is used by the master station to modify and read AC drive data in real time and perform periodic data exchange. Data communication addresses are directly configured by the AC drive. The following content is included:

- Setting AC drive control command and target frequency in real time
- Reading the current state and running frequency of the AC drive in real time
- Function parameters and monitoring parameters exchange between the AC drive and the PROFIBUS master in real time. The PZD data is used for cyclic data exchange between the master and the AC drive, as described in the following table.

PZD Data Sent by Master		
AC drive command	AC drive target frequency	AC drive parameter modification in real time
PZD1	PZD2	PZD3 to PZD12
PZD Data Responded by AC Drive		
AC drive state	AC drive running frequency	AC drive parameter reading in real time
PZD1	PZD2	PZD3 to PZD12

Data sent by the master

PZD Data Sent by Master	
PZD1	AC drive command word (valid when the command source is set to communication)
	0: No command
	01: Forward run
	02: Reverse run
	03: Forward jog
PZD2	04: Reverse jog
	05: Coast to stop
	06: Decelerate to stop
	07: Fault reset
	It specifies the AC drive target frequency. The frequency reference source must be set to communication. The value unit is determined by the AC drive and Hz is used as an example. The frequency range is 0 to F0-10. When F0-22 = 1, the range is 0.0 Hz to 3200.0 Hz. When F0-22 = 2, the range is 0.00 Hz to 320.00 Hz. When the frequency reference exceeds the value of F0-10, this frequency command will not be responded.
PZD3 to PZD12	It specifies parameters (in group F and group A) to be modified in real time. The modification is not written to the EEPROM. FE-02 to FE-11 correspond to PZD3 to PZD12. For the configuration, see PZD data configuration. After communication with the PLC is established, FE-02 to FE-11 display the parameter values written into PZD3 to PZD12. Manual settings of parameters in group FE of the AC drive are invalid.

Data responded by the AC drive

PZD Responded by the AC Drive	
PZD1	It indicates the AC drive state. AC drive running states are determined by the following bits: • Bit 0: 0: Stopped; 1: Running • Bit 1: 0: Forward running; 1: Reverse running • Bit 2: 0: No fault; 1: Fault • Bit 3: 0: Frequency reference not reached; 1: Frequency reference reached
PZD2	It indicates the AC drive running frequency. The current AC drive running frequency is returned as 16-bit signed data. When F0-22 = 1, -32000 to 32000 correspond to the actual running frequency -3200.0 Hz to 3200.0 Hz. When F0-22 = 2, -32000 to 32000 correspond to the actual running frequency -320.00 Hz to 320.00 Hz.
PZD3 to PZD12	The PZD indicates function parameter values (group F and group A) and monitoring parameter values (group U) read in real time. FE-22 to FE-31 correspond to PZD3 to PZD12. For the configuration, see PZD data configuration. After communication with the PLC is established, FE-02 to FE-11 display the parameter values written into PZD3 to PZD12. Manual settings of parameters in group FE of the AC drive are invalid.

10.6 Related parameters

10.6.1 Communication Card Type Setting

After powering on the AC drive, set F0-28 to 1 to enable communication between the MD38DP2 card and the AC drive.

Table 10-2 Related parameters

Parameter Code	Parameter Name	Value Range	Value	Description
F0-28	Communication protocol	0: Modbus protocol 1: Expansion communication protocol 2: Inobus protocol (through EtherCAT card)	1	This parameter is used to select a communication protocol. 0: Modbus protocol The Modbus protocol is used. 1: Expansion communication protocol PROFIBUS DP, PROFINET, EtherCAT, Modbus TCP, and EtherNet/IP protocols can be used. No setting is required for CANlink because it is always valid. 2: Inobus protocol (through EtherCAT card) When this parameter is set to 2, the Inobus communication protocol is used. The AC drive version must be F7-10 = U60.07/F7-11 = U61.07/F7-15 = 000.00/F7-16 = 000.00 or later.
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run and jog operation. 0: Operating panel The RUN/STOP key on the operating panel can be used to start or stop the drive. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined The command source is defined by the user as needed for expansion.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-03	Main frequency source X selection	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	9	This parameter is used to set the source of the main frequency X as below. 0: Digital setting (non-retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is restored to the value of F0-08. 1: Digital setting (retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is the same as that at the moment of the last power failure. Modifications made by using keys ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP and DOWN key remain effective. 2: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). To be continued

Parameter Code	Parameter Name	Value Range	Value	Description
Continued	Continued	Continued	Continued	7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources.

10.6.2 Communication Control Parameters

Parameter Code	Parameter Name	Value Range	Hexadecimal Address	Decimal Address
U3-16	Frequency set through communication	-320.00 Hz to 320.00 Hz	H7310	29456
U3-17	Communication setting control word	0001: Forward run 0002: Reverse run 0003: Forward jog 0004: Reverse jog 0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	H7311	29457
U3-18	DO state (terminal function defined by parameters in group F5: communication control)	Bit 0: DO1 output control Bit 1: DO2 output control Bit 2: Relay 1 output control Bit 3: Relay 2 output control Bit 4: FMR output control Bit 5: VDO1 Bit 6: VDO2 Bit 7: VDO3 Bit 8: VDO4 Bit 9: VDO5	H7312	29458
U3-19	AO1 output (terminal function defined by parameters in group F5: communication control)	0 to 32767	H7313	29459
U3-20	AO2 output reference (terminal function defined by parameters in group F5: communication control)	0 to 32767	H7314	29460

Parameter Code	Parameter Name	Value Range	Hexadecimal Address	Decimal Address
U3-21	HDO output (terminal function defined by parameters in group F5: communication control)	0 to 32767	H7315	29461
U3-23	Speed set through communication	-32000 rpm to 32000 rpm	H7317	29463

When the DP card is used, the written PZD1 and PZD2 are mapped to U3-17 and U3-16 respectively by default. If a command or frequency fails to be written into the AC drive while PZD3 to PZD12 can be written and F0-02 and F0-03 are set to 2 and 9 respectively, check whether FE-00 and FE-01 are U3-17 and U3-16 respectively. If not, manually correct the parameter values.

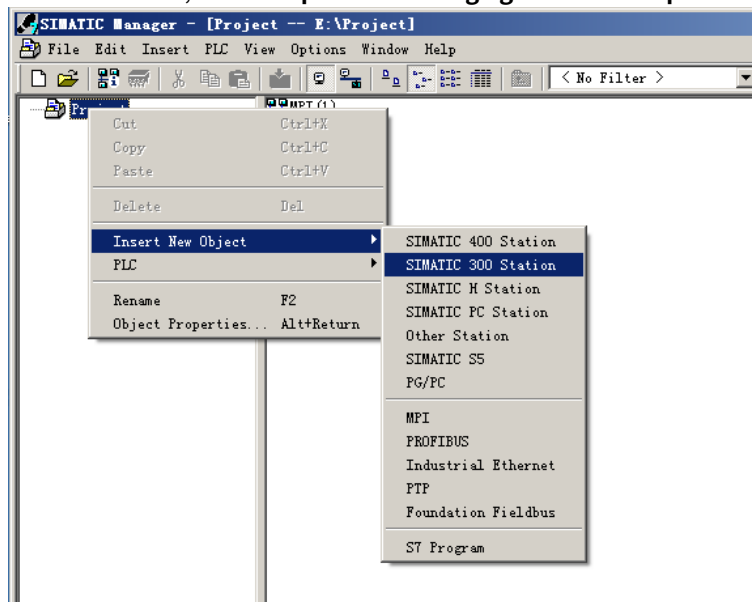
10.7 Communication Configuration

10.7.1 Configuring Slaves on the STEP7 (V5.4) by Using S7-300

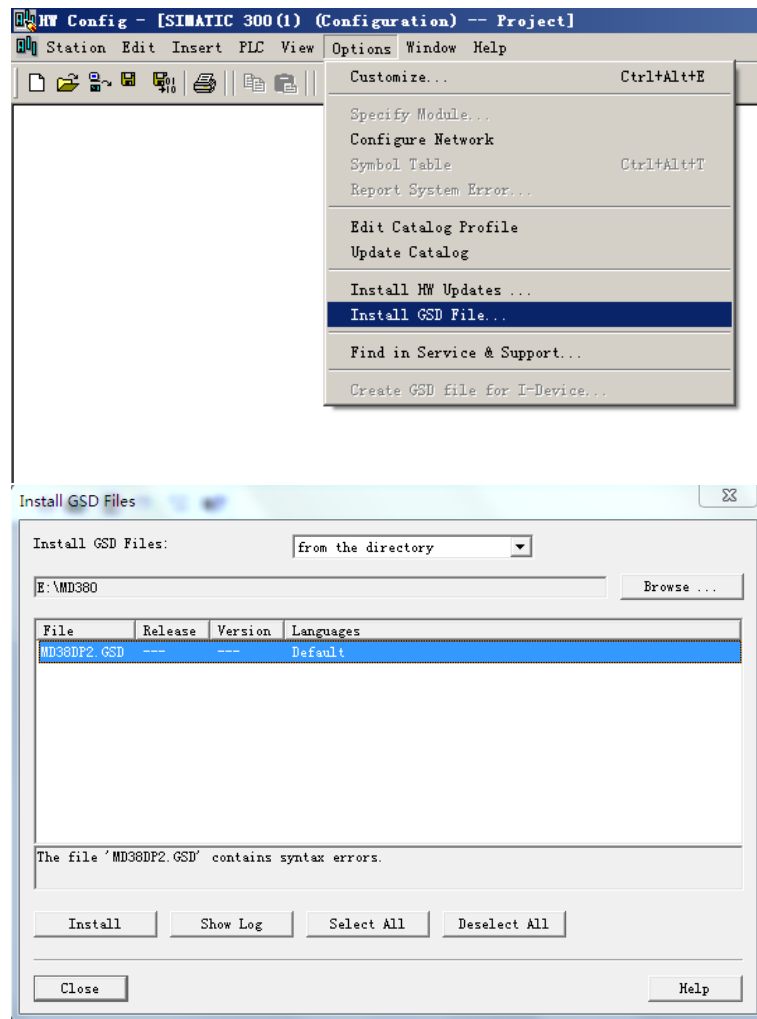
Before using the PROFIBUS master, you need to configure the GSD file of the slave to add the slave to the system of the master. If the GSD file is already configured, skip step 2. You can obtain the GSD file from Inovance or its agent.

To configure the slave, do as follows:

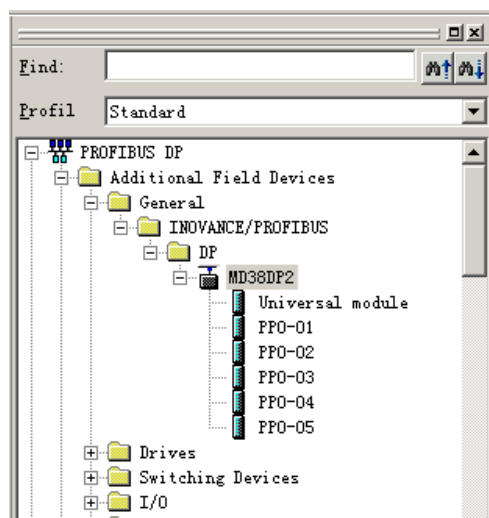
1. (Optional) To install the GSD file, choose **Options > Manage general description files (GSD)**.



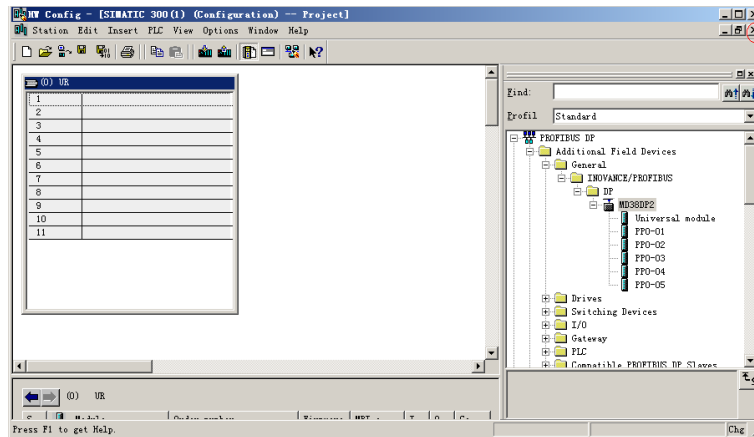
2. Double-click the hardware icon to access the **HW Config** interface, and choose **Options > Install GSD File** to add the MD38DP2.GSD file (Note that the file must be stored in an English path; otherwise, the STEP7 may fail to recognize the file).



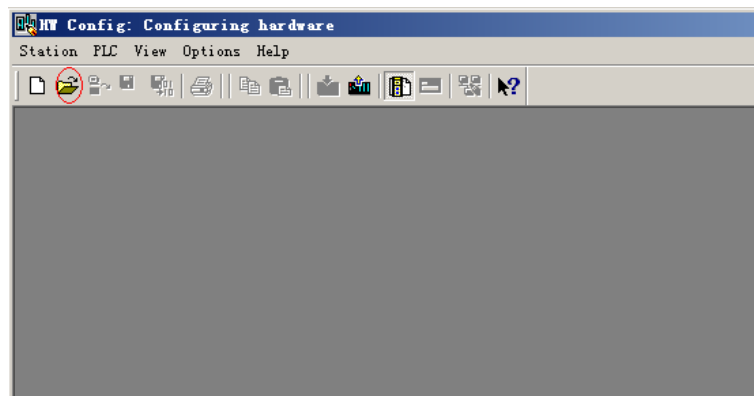
Click **Install**. After the installation is complete, the PROFIBUS DP module named MD38DP2 is displayed.



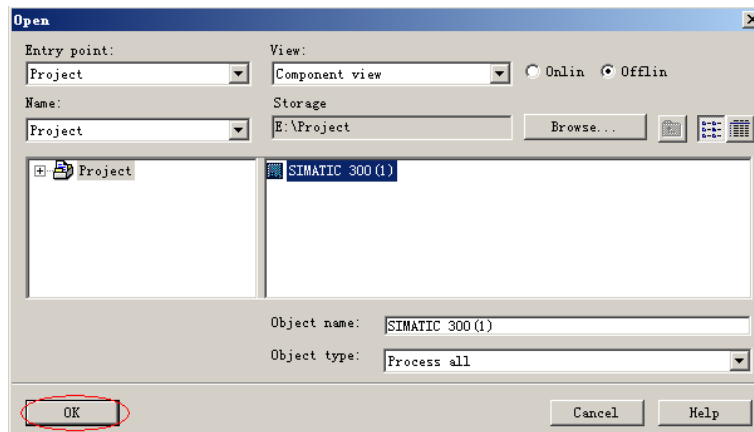
Note: If any master or slave already exists on the **HW.config** interface, close the current interface by clicking the X button (marked with a red circle in the following figure) before importing the GSD file.



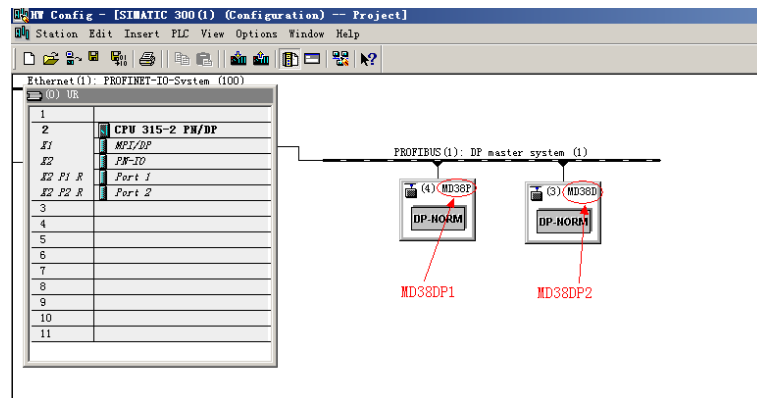
In this case, you can save the existing project. If a warning indicating that system data cannot be created is displayed, click **OK**. After closing the interface of the existing configuration project, you can install the GSD file by following the preceding steps. After the installation is completed, click the Open button, as shown in the following figure.



Select the original configuration project, and click **OK** to open it.

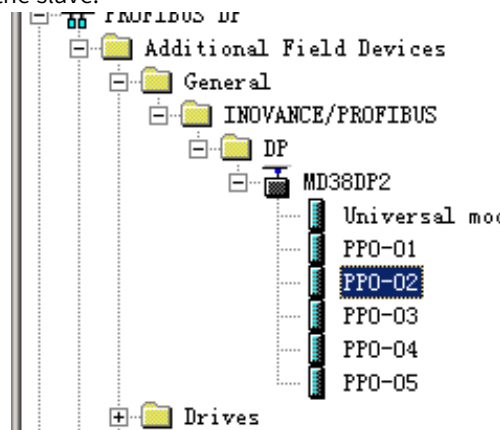


3. Configure the actual hardware system, as shown in the following figure.



In the preceding figure, station 4 is MD38DP1, which is only used for illustration. For details about its usage, see the MD380 Series PROFIBUS User Guide. MD38DP1 cards and the MD38DP2 cards can be valid on the same network.

4. Configure data features of the slave.



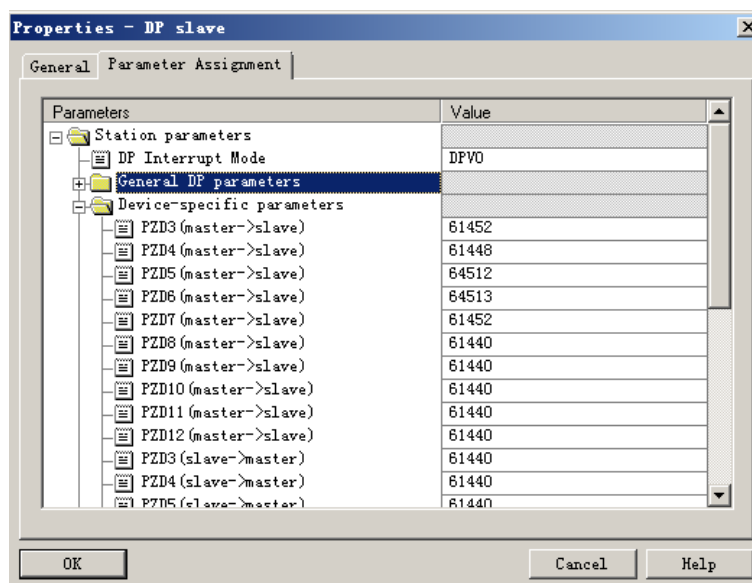
After the PPO type is added, the address assigned by the PLC to the slave is displayed. Slot 1 marked with a red circle in the following figure indicates the PKW address (8 bytes). Slot 2 indicates the PZD address (12 bytes).

If the selected PPO type does not have a PKW area, the I address and Q address of slot 1 are blank.

MD38DP2					
S...	DP ID	Order Number / Designation	I Addr...	Q Address	Comment
1	4AX	PPO-02	284...291	284...291	
2	6AX	--> PPO-02	292...303	292...303	

5. Configure the PZD.

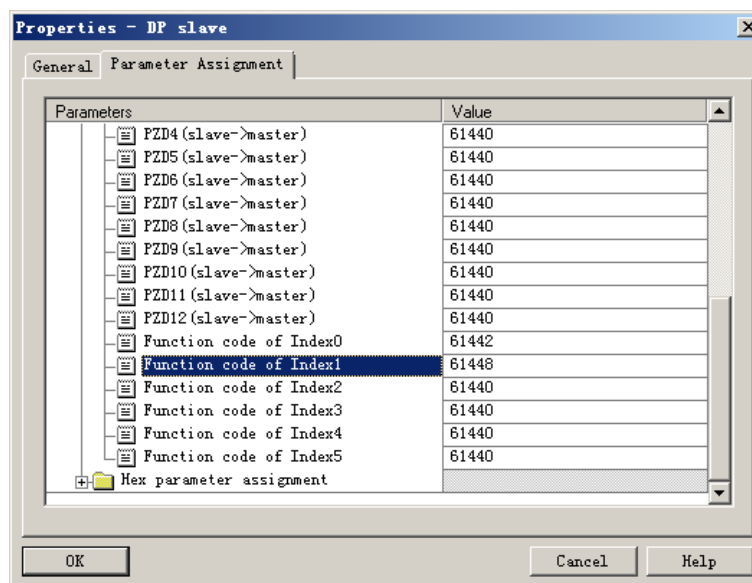
The fixed configuration of PZD1 and PZD2 cannot be modified. PZD3 to PZD12 are intended for exchange of user-defined cyclic data. They can be set in hardware configuration. On the **HW Config** interface, double-click the MD38DP icon and then click **Device-specific parameters** to configure parameter addresses as needed.



PZDx (master->slave) indicates the address used by the master to write data to the slave, whereas PZDx (slave->master) indicates the address used by the master to read data from the slave. PZD3 to PZD12 are displayed in decimal and can be set. For example, to set PZD3(master->slave) to F0-12, enter 61452.

By default, all PZDs of the MD520 are set to F0-00 (61440 in decimal). For unused PZDs, modification is not required and default values can be retained. PZD mapping relations must be set independently for each slave as required. If mapping relations of various slaves are the same, you can select one configured slave, press **Ctrl+C**, select the PROFIBUS-DP bus in the configuration, press **Ctrl+V**, and modify the station number.

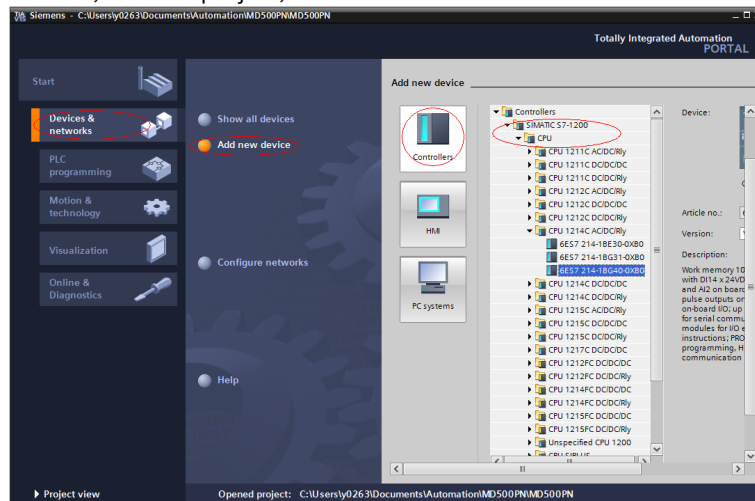
To enable the function of non-periodically reading and writing parameters of DPV1, set corresponding parameters in customized indexes at the end of **Device-specific parameters**. The AC drive provides six customized indexes numbered from 0 to 5. For example, set indexes 0 and 1 to F0-02 and F0-08, respectively.



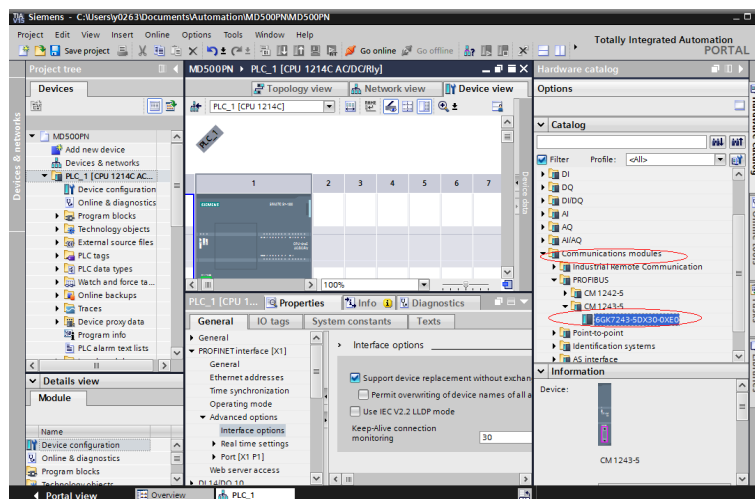
After all the preceding operations are completed, the PROFIBUS slave station is configured. Then, you can compile programs in the S7-300 to control the AC drive.

10.7.2 Configuring Slaves on TIA Portal V13 by using S7-1200

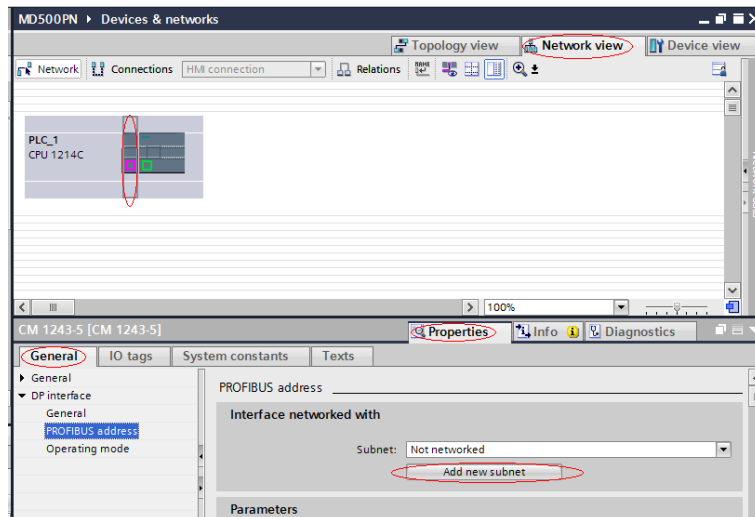
1. Open the TIA Portal V13, create a project, and add an S7-1200 master based on the actual situations.



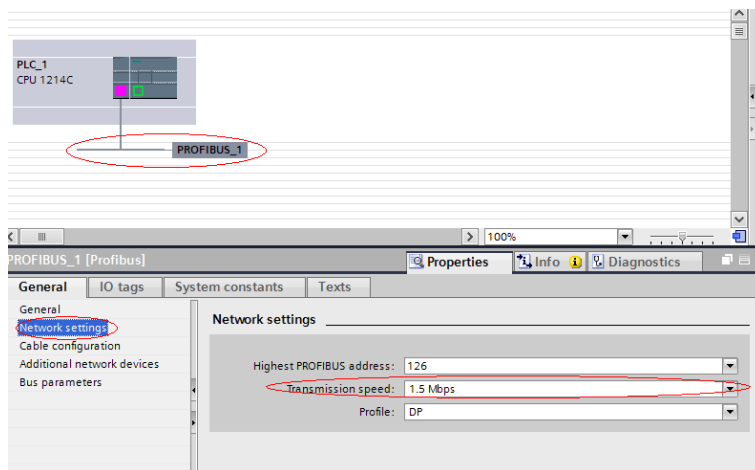
The S7-1200 CPU does not have a PROFIBUS interface, so you need to add a PROFIBUS communication module first. In this example, a CM1243-5 master module is added.



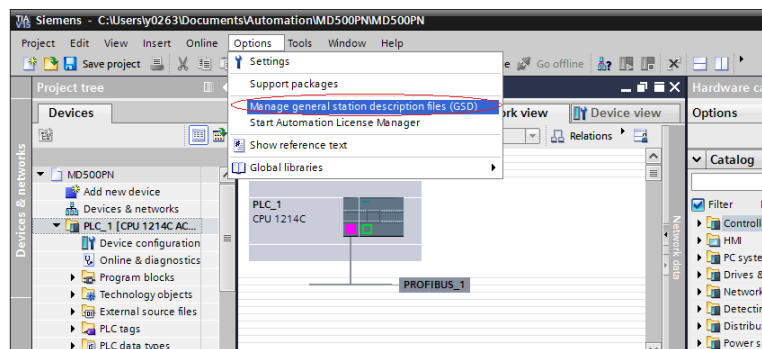
After adding the PROFIBUS master module, click the **Network view** tab. After selecting the communication module, choose **Properties > General > Add new subnet** to create a PROFIBUS network. You can also modify the master ID on this interface.

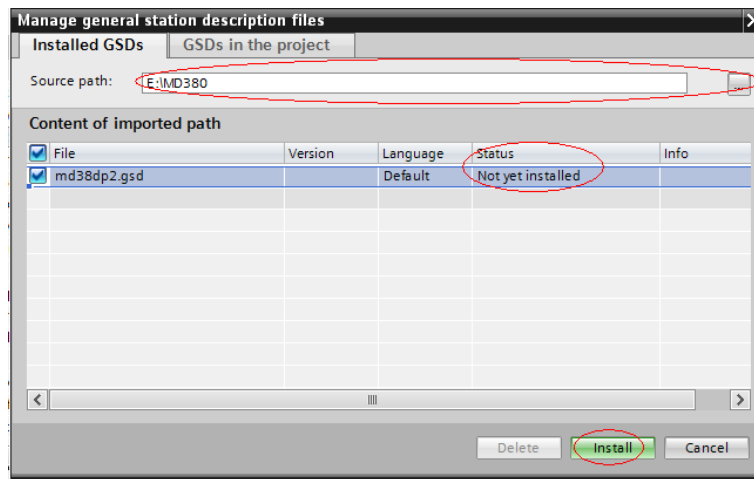


To modify the PROFIBUS baud rate, select the network, and choose **Properties > General > Network settings**. Select a baud rate from the **Transmission speed** drop-down list.

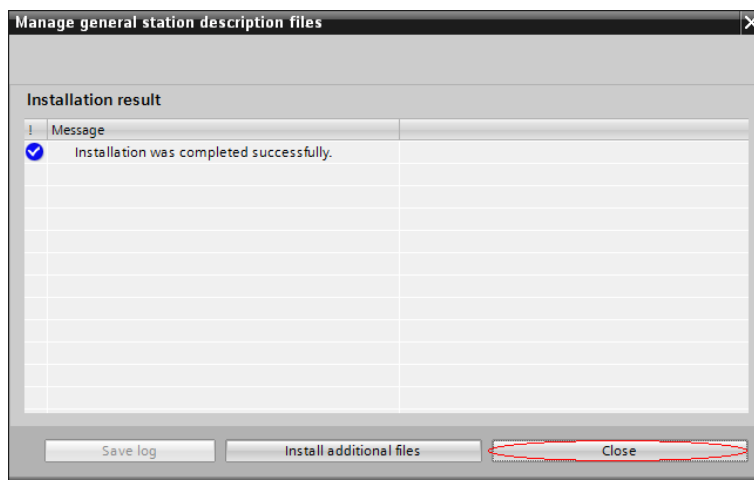


2. Install the GSD file. Skip this step if the GSD file is already installed.
If the GSD file is not installed, the message **Not yet installed** is displayed in the **Status** column. Select the GSD file and click **Install**. Note that an error will occur if the installation path contains Chinese characters.

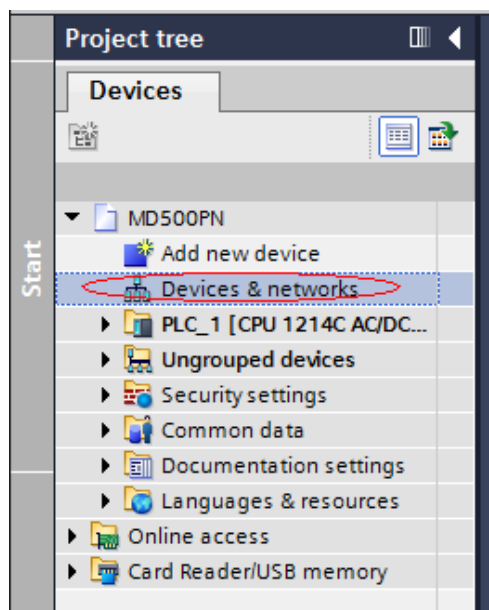




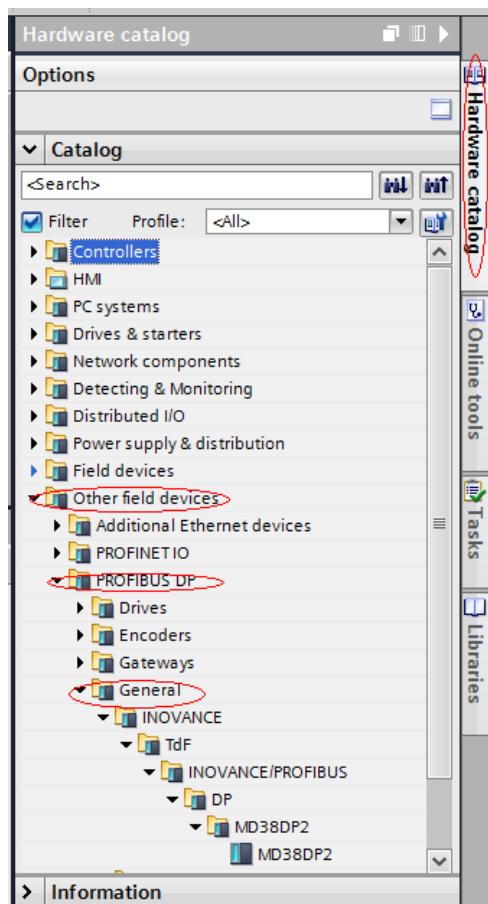
If the following figure is displayed, the installation is complete. In this case, click **Close**.



During installation of the GSD file, the PORTAL automatically closes the configuration interface. After the installation is completed, double-click **Devices & networks** in the left **Start** pane to open the previous configuration interface.

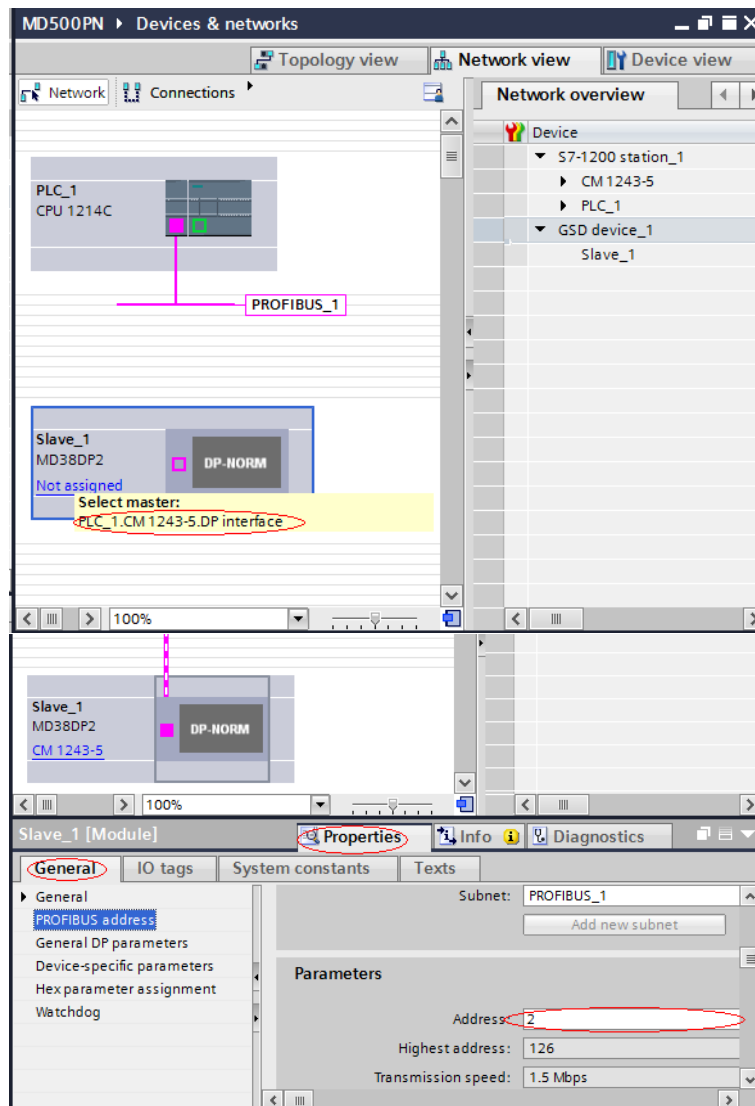


After the installation, you can choose **Hardware catalog > Other field devices > PROFIBUS DP > General** to locate the MD38DP2, which is the same for the STEP7. Expand all the sub-directories as shown in the following figure.

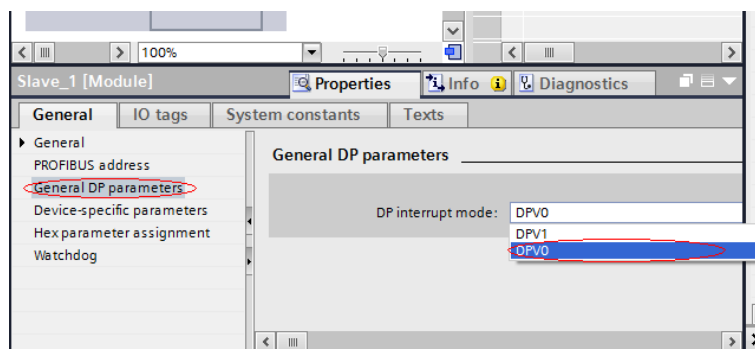


3. Start the configuration.

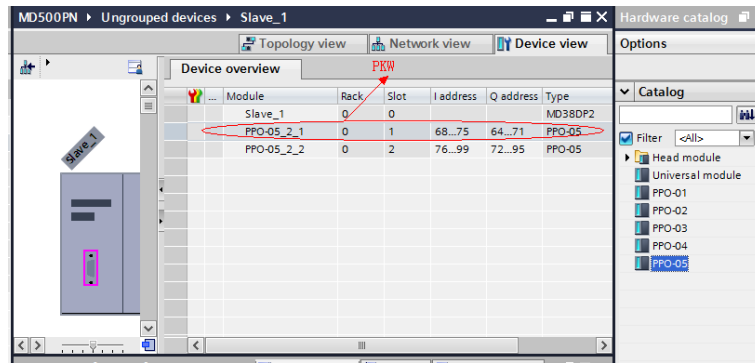
On the **Hardware catalog** tab, double-click MD38DP2 or drag it to **Network view** under **Devices & networks**. Click **Not assigned** below the slave name to select the corresponding PROFIBUS network. Select the slave, choose **Properties > General**, and set the slave ID. Note that the setting must be consistent with that set by the DIP switch on the DP expansion card.



Click **General DP parameters** and select **DPV0** from the **DP interrupt mode** drop-down list.

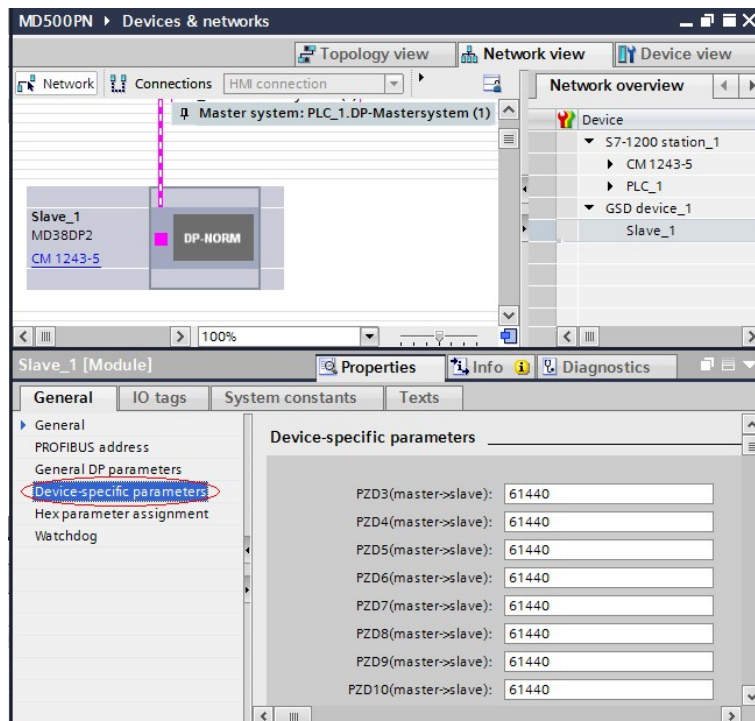


Click the **Device view** tab. Select a suitable PPO type under **Hardware catalog**. Check the addresses assigned for each segment. The row marked with a red circle in the following figure indicates the PKW address. If the selected PPO type has no PKW, the address column is blank.



4. Set PZD mappings.

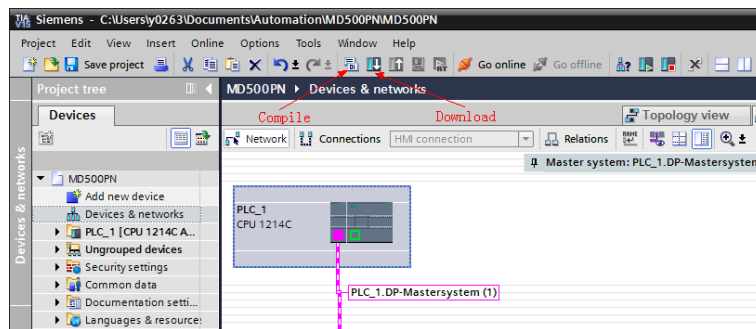
Click the **Network view** tab. Click **Device-specific parameters** to set the mapping for PZD3 to PZD12. The PZD mapping relationships for the PLC to read data from and write data to the slave must be set independently. For details, see [“10.7.1 Configuring Slaves on the STEP7 \(V5.4\) by Using S7-300” on page 177](#).



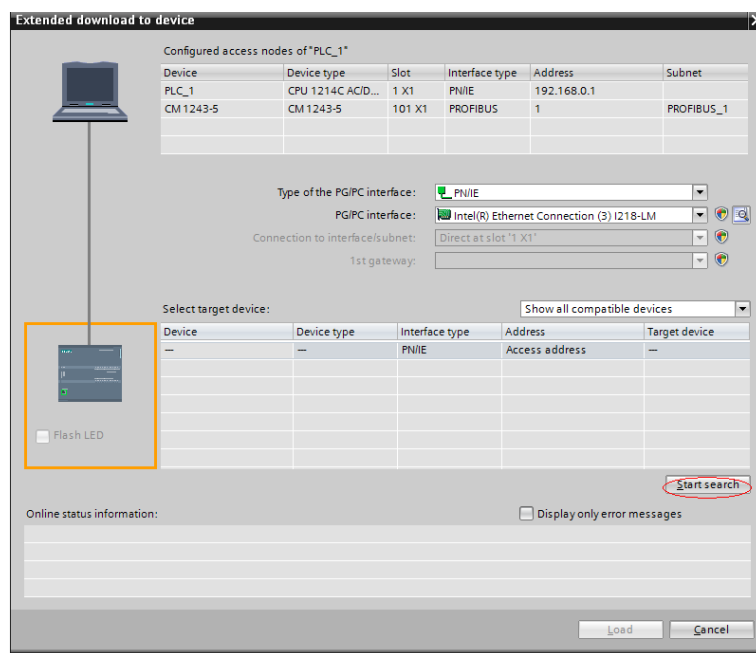
5. Compile and download the configuration.

If the settings of multiple slaves are the same, select a configured slave, press **Ctrl+C**, and then press **Ctrl+V**. Or right-click the configured slave and use the **Copy** and **Paste** function. Connect the new slave to the network, and then modify its station ID.

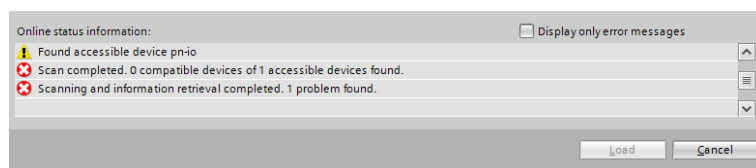
After all slaves are configured, save the configurations, and then click the **Compile** button. After the compiling is completed successfully, click the **Download** button.



On the displayed interface, set the interface for communication between the PC and PLC as required. In this example, configure the local network port and then click **Start search** to search for the PLC.



If no accessible device is found, the connection between the PC and PLC is faulty. Rectify the fault first. If the STEP7 is used for downloading through the Ethernet and then the PORTAL is used for downloading on the same PC, the problem also occurs. In this case, restart the PC or change the PG/PC interface to a non-Ethernet interface in STEP7.



If the connection is normal, the **Load** button is available. You can click **Load** to download the configuration to the PLC as instructed.

10.7.3 Performing Cyclic Read/Write Operations on the AC Drive Slave

In this example, the PLC is S7 315-2PN/DP, and the following figure shows the address assignment.

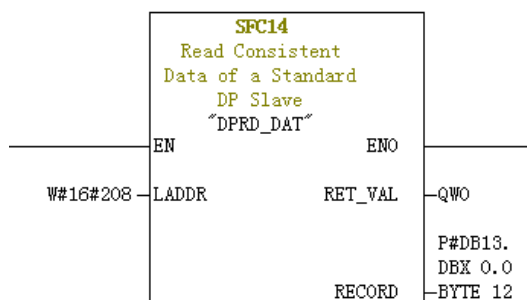
(3) MD38DP2						
S...	DP ID	Order Number / Designation	I Add...	Q Address	Comment	
1	4AX	PP0-02	512...519	512...519		
2	6AX	--> PP0-02	520...531	520...531		

1. Directly use the MOVE command to enable the AC drive to run in the forward direction at the target frequency of 30 Hz (F0-02 = 2, F0-03 = 9), as shown in the following figure.

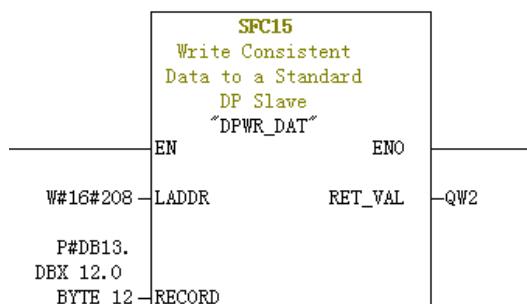


Other data is written in a similar way. The read data can also be transmitted from the PIW register to the common Q, I, L, M, or D register using the MOVE command for parsing.

2. Use SFC14 and SFC15.



- **LADDR:** Starting address configured in the I block of the module, which must be in hexadecimal format.
- **RET_VAL:** Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD:** Target area of the read user data. Its length must be consistent with the length of the module configuration selected in STEP 7. Only the byte data type is allowed.

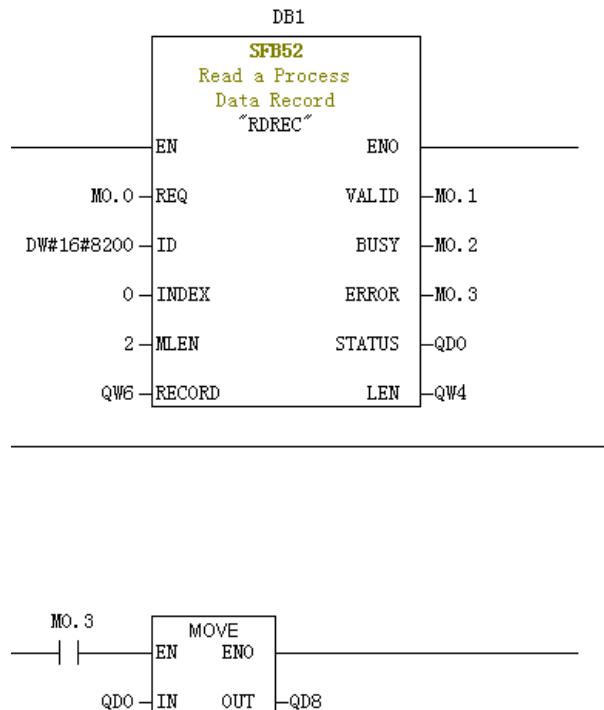


- **LADDR:** Starting address configured in the Q block of the module, which must be in hexadecimal format.
- **RET_VAL:** Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD:** Source area of the user data to be written. Its length must be consistent with the length of the module configuration selected in STEP 7. Only the byte data type is allowed.

For both SFC14 and SFC15, the addresses must be in hexadecimal format of the I and Q starting addresses (in this example, the address is 520, which is 0x208 in hexadecimal format). The length of **RECORD** must be consistent with the byte length of the PPO type PZD (in this example, PPO2 is used, which includes six PZDs, that is, a total of 12 bytes).

10.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave

To perform aperiodic read and write operations on the AC drive PROFIBUS DP slave, Siemens's system function modules SFB52 (for reading) and SFB53 (for writing) are required. Create an organization block in the program, and add relevant function blocks and programs in the organization block.



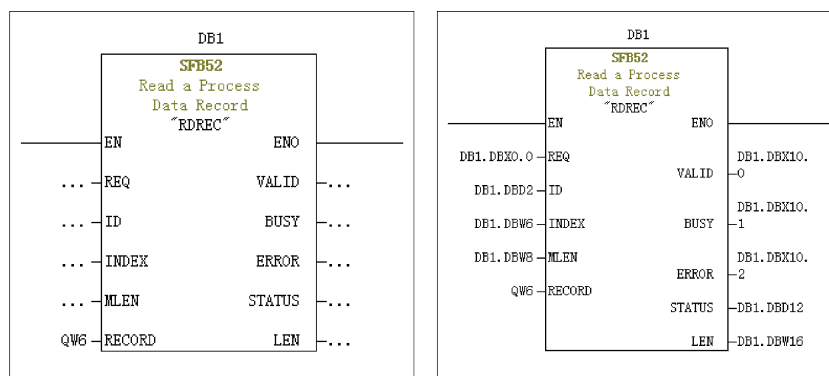
After M0.0 is set, the function block reads F0-02 (Index 0 has been set to F0-02) of the AC drive No. 3 and saves it in QW6. Field definitions are as follows:

- REQ: It is used to enable or disable the function block. When it is set to 1, the function block is enabled.
- ID: It indicates the logic address. To specify this field, convert any bit in the Q address of the AC drive slave station to a hexadecimal value, and set bit 15 of the value to 1. For example, after Q512 is converted to the hexadecimal value H8200, and bit 15 is set to 1, H8200 is obtained.

(3) MD38DP2						
S...	DP ID	...	Order Number / Designation	I Add...	Q Address	Comment
1	4AX		FP0-02	512...519	512...519	
2	6AX		--> FP0-02	520...531	520...531	

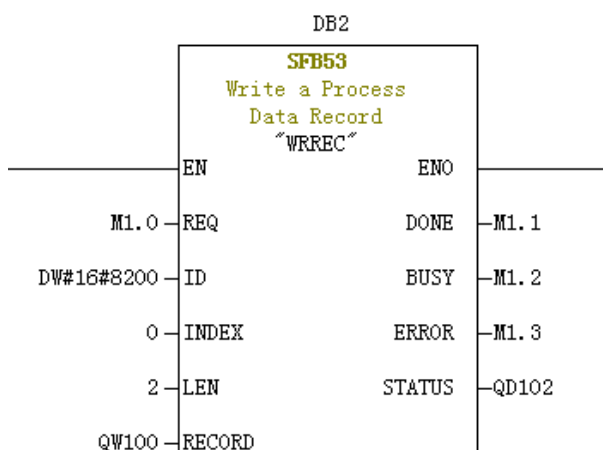
- INDEX: It is an index number ranging from 0 to 5. You can define the index mapping address of a slave as required.
- MLEN: It indicates the maximum length of the data to be obtained. For MD38DP2, this field must be set to 2.
- RECORD: It indicates the target area of an obtained data record. This field is used to store read data when the read operation is performed and sent data when the write operation is performed.
- VALID: New data record received and valid.
- BUSY: When the field value is ON, operations are not complete.
- ERROR: Error flag. When the value is **ON**, an error occurs.
- STATUS: Block status or error information
- LEN: Length of the obtained data record

During the invocation, you can use user-defined parameters or use some or all default parameters.



The left figure shows all the default parameters. If you want to customize parameters, set them according to the right figure. You can set customized or default parameters for corresponding blocks as required.

Aperiodic write operations are performed in a similar way as aperiodic read operations. The **RECORD** field stores data to be written, as shown in the following figure.



Note that before running an organization block, you need to download data blocks (above the function block, DB1 and DB2 in this example) to the PLC. Otherwise, an error indicating that the DB blocks are not loaded will be reported.

SFB53 is used to perform operations on the EEPROM. Therefore, the program is required to invoke relevant operations when required and disable relevant operations in time. As shown in the following figure, after the write operation is complete (M1.1 is set to 1), the program is invoked to reset M1.0.



When SFB52 and SFB53 are executed once, relevant blocks need to be invoked for multiple times. Therefore, do not invoke them when single execution is required.

10.8 Troubleshooting

The following table describes the faults that may occur during use of the DP expansion card and the AC drive.

Description		Solution
After the AC drive is powered on, only the power indicator (D4) is on, indicating that communication between the DP expansion card and the AC drive is not established.		1. Check whether F0-28 is set to 1. 2. Check the AC drive type. This user guide only describes the usage when the MD520 is used together with the DP expansion card. For other AC drive types, contact the technical engineers to obtain the correct user guide.
After the AC drive is powered on, the power indicator (D4) is on and the AC drive communication indicator (D2) blinks.		Set the station number correctly (within the range of 1 to 125). Note that digit 8 of the DIP switch is the least significant bit of the address.
The connection fails after the configuration is downloaded.	After the configuration is downloaded, indicators D2 and D4 on the DP expansion card are steady on whereas the yellow indicator D3 is off.	1. Check that the cable is properly connected.
		2. Check the DIP switch on the DP interface. The DIP switch on the DP interface at both ends of the network must be set to ON, and the DIP switch on other DP interfaces must be set to OFF.
		3. If the AC drive is connected at the end, check that the communication cable is connected to the DP IN interface. If the communication cable is connected to the DP OUT interface, the network cannot be connected when the DIP switch on the DP interface is set to ON.
		4. Check that the station number settings on the DP expansion card are consistent with the configuration. Digit 8 of the DIP switch is the least significant bit of the address.
		5. Check that the GSD file used in the configuration is correct.
	After the configuration is downloaded, indicators D2 and D4 on the DP expansion card are steady on while the yellow indicator D3 blinks slowly at the frequency of about 1 Hz to 2 Hz.	1. Check that the GSD file used is correct. 2. Check whether the PZD mapping relations are set correctly. Device-specific parameters in STEP 7 and TIA PORTAL must be set in the decimal format. Therefore, the parameters must be converted to decimal values. For example, the decimal value of FC-11 is 64523 (0xFC0B in hexadecimal format). If a parameter in the hexadecimal format instead of the decimal format is entered, the connection fails. Note that addresses using Modbus (such as H2000 and H8000) are unavailable for PZD mapping.
After the configuration is downloaded, the yellow indicator D3 on the DP expansion card blinks quickly.		The PLC is not in the running status. Check the PLC status and locate the fault cause (possibly because the OB block does not exist).

Description		Solution
After the connection is successful, all indicators on the PLC are on in green, but data cannot be written into or read from the AC drive.	No data can be written/read.	Check whether the operation address is correct. No matter whether the PPO type used contains the PKW zone, the read/write operation address always locates in the second row (that is, the last row). If the I address and Q address in the last row of the station are both 520 to 531 (note that the I and Q addresses may start from different numbers), the PZD1 data written into the AC drive is stored in QW520, the PZD2 data written into the AC drive is stored QW522, and so on. If the PLC is S7-300 and S7-400, PQW is used. If SFC15 is used, check whether RET_VAL of the SFC15 block is 0 . If not, an invocation error exists. Eliminate this error first and invoke the block again. For details, see section "Performing Periodic Read/Write Operations on the AC Drive Slave".
	PZD3 or subsequent data can be written, but PZD1 or PZD2 cannot be written/read.	Check whether F0-02 and F0-03 are set to 2 and 9, respectively. Check whether the command reference is in the range of 1 to 7 (not bit) or frequency reference is in the range of -F0-10 to +F0-10. If not, the write operation fails. Check whether FE-00 and FE-01 are U3-17 and U3-16, respectively. If not, manually correct the parameter values or restore to factory settings.
	PZD1 and PZD2 can be written/read, while PZD3 or subsequent data cannot be written/read.	Check whether the PPO type supports the relevant PZD. Check whether device-specific parameters are set correctly.
	-	Check the logic relations. Check whether the same PZD is assigned with values for multiple times in a certain logic relation (check whether the value given by the PLC is correct under the logic relation in the monitoring table of the PLC).
After communication is established, the AC drive reports E164.1, which cannot be cleared. However, the indicator on the DP expansion card and the BF indicator on the PLC are normal.		Check whether the high-order 8 bits of the PZD1 data (QW data) written into the AC drive are 0 in the PLC program. If not, change them to 0. The PZD1 command in this user guide refers to values instead of bits. Note: This solution applies only to MD520. For other AC drives, consult the technical engineers.
After communication is established, the communication is normal when the AC drive is not running. However, when one or more AC drives are running, they are disconnected randomly.		1. Disconnect the power supply. Use a multimeter to measure the A1/B1 resistance of the DP slave station interface at the farthest end. The correct resistance should be $100 \pm 20 \Omega$. 2. Check that the cable shields are connected together and the shields are in contact with the sheet metal in the DP interface. The shields are not required to connect with other GND terminals.
After the connection is established, the AC drive reports a fault. After the PLC configuration is changed and downloaded again or after the AC drive alone is powered on again, the faulty slave still cannot connect to the network.		The DP expansion card supports only the interruption mode DPV0. If the interruption mode is set to DPV1, when a slave is faulty, the PLC master may disable the DP connection channel of the slave or disable all the PLC communication (which usually occurs on the S7-1200). When such a symptom occurs, change the DP interruption mode (which is DPV0 by default in STEP 7 and DPV1 by default in PORTAL) of the slave to DPV0 under General DP parameters . Then, compile and download the configuration, and power on the PLC again.

Indicator status of the DP expansion card and troubleshooting

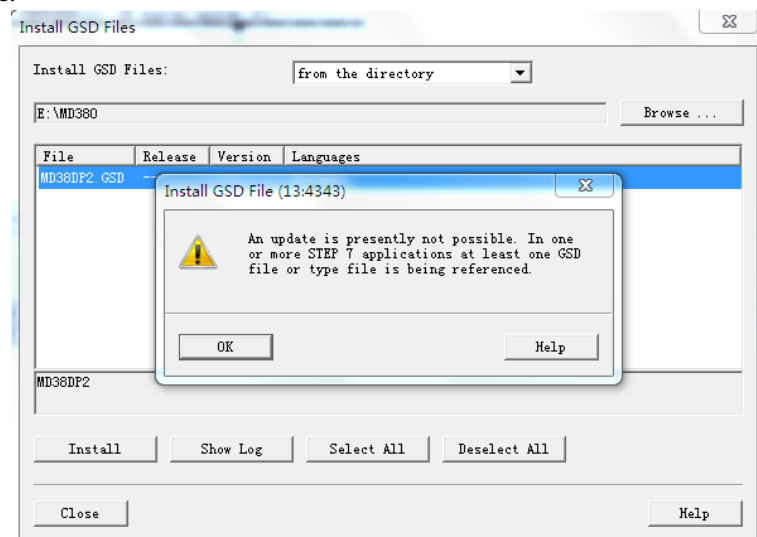
Indicator ^{Note}	Fault Status	Description	Solution
Red (D4)	Off	The DP expansion card is not powered on.	Check that the DP card is securely connected to the AC drive.
Green (D2)	Off	The connection between the DP expansion card and the AC drive fails.	Check that F0-28 is set to 1 and the DP expansion card is securely connected to the AC drive.
Green (D2)	Blinking at the frequency of 1 Hz	The station No. is set incorrectly.	Check that the PROFIBUS DP station number is set to a value from 1 to 125.
Yellow (D3)	Blinking at the frequency of 1 Hz	Configuration error	Check that the GSD file is correct.
Yellow (D3)	Blinking at the frequency of 2 Hz	Parameter error	Check that all parameter addresses in Device-specific parameters are supported by the AC drive.
Yellow (D3)	Blinking at the frequency of 5 Hz	The master is not running.	Check the master state.
Yellow (D3)	Off	The connection between the DP expansion card and the PROFIBUS master fails.	Check that the slave address is correct and the PROFIBUS cable is connected properly.

Note

Note 1: For some products, the indicator color and the terminal indication may not match. In this case, the terminal indication prevails. The indicators are D2, D3, and D4 from left to right. See [“Figure 10-3” on page 165](#).

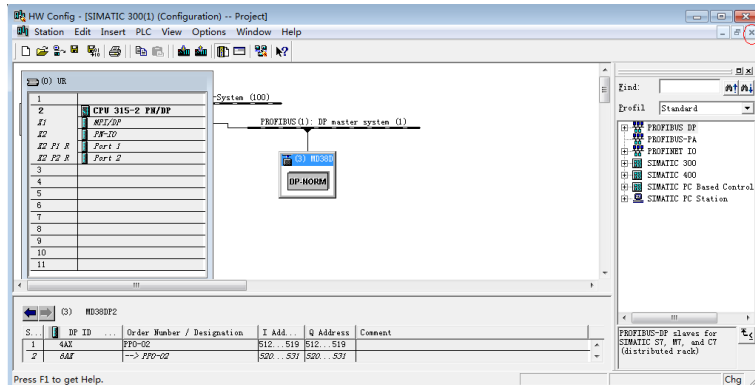
Troubleshooting for GSD installation failure

- Problem 1: The GSD file cannot be installed or updated when STEP 7 is used, as shown in the following figure.

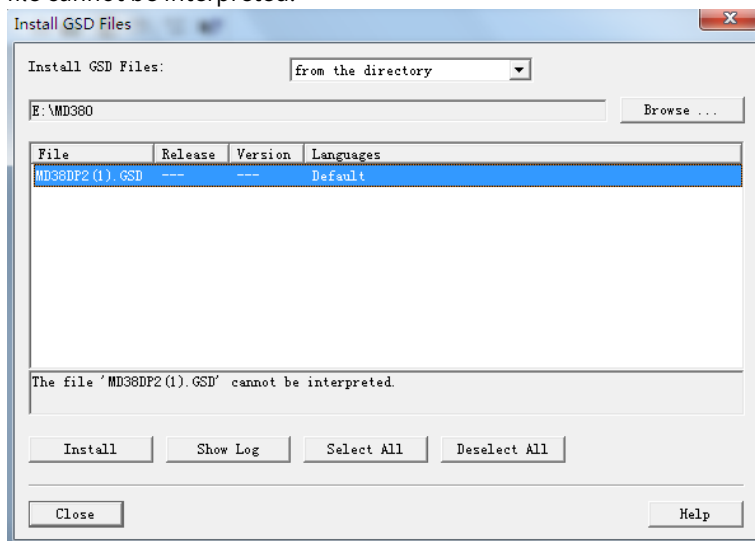


Possible cause: The current hardware configuration interface is opened and the GSD file is being used by other components.

Solution: Close the current configuration interface by clicking the Close button (marked with a red circle in the following figure). Then, install or update the GSD file and open the configuration interface again.



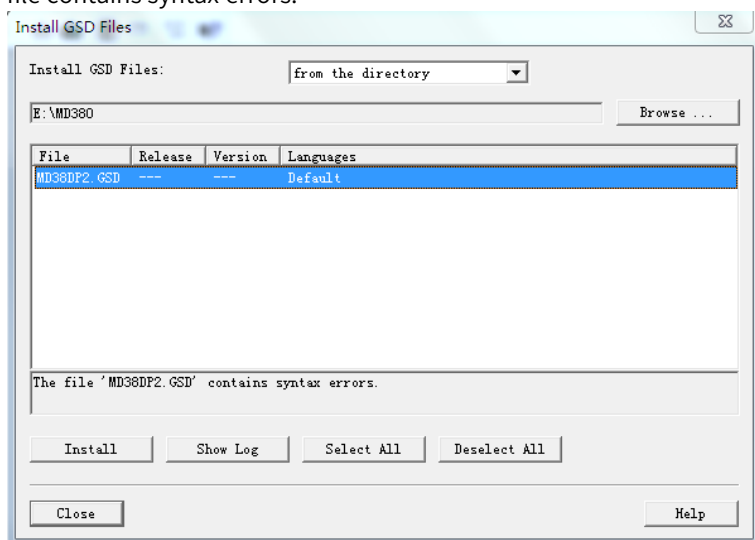
- Problem 2: The file cannot be interpreted.



Possible cause: During the GSD file transmission, the file name is changed manually or by the transmission tool. In this case, the file name fails to meet the PROFIBUS requirements.

Solution: Change the GSD file name to MD38DP2.GSD.

- Problem 3: The file contains syntax errors.



Possible cause: The GSD file is modified.

Solution: Use a correct GSD file.

- Other cases
Some versions of STEP 7 and PORTAL do not support a path that contains Chinese characters for installing the GSD file. In this case, store the GSD file in a path that does not contain Chinese characters.

11 PROFIBUS DP Communication (MD-SI-DP2)

11.1 Introduction

The MD-SI-DP2 card (hereinafter referred to as the DP card) is a PROFIBUS DP fieldbus adapter card compliant with PROFIBUS fieldbus standards. The DP card can improve the communication efficiency of the AC drive and implement the networking function, enabling the AC drive to be a slave controlled by the fieldbus master. The DP card can implement PROFIBUS DP communication.

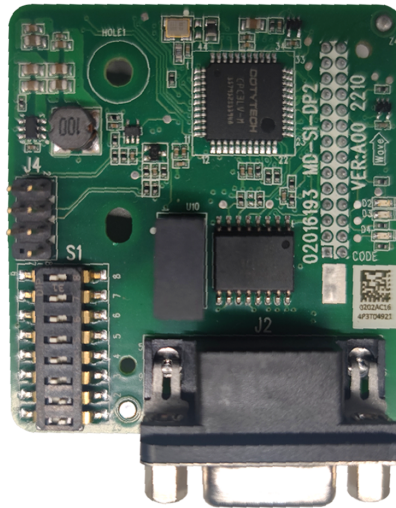


Figure 11-1 MD-SI-DP2 card appearance

11.2 Installation

The DP card is designed to be embedded in the AC drive. Before installation, cut off the power supply of the AC drive and wait for about 10 minutes until the charging indicator of the AC drive becomes off. Then, insert the DP card into the AC drive and fasten the screws to protect the signal socket between boards from being damaged by the pulling force of the external signal cable. See [“Figure 11-2” on page 197](#) for installation.

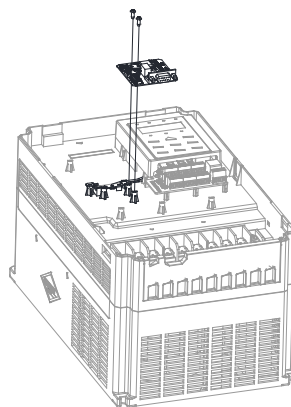


Figure 11-2 Installing the DP card



Caution

Do not install or disassemble the expansion card with power on.

11.3 Interface Description

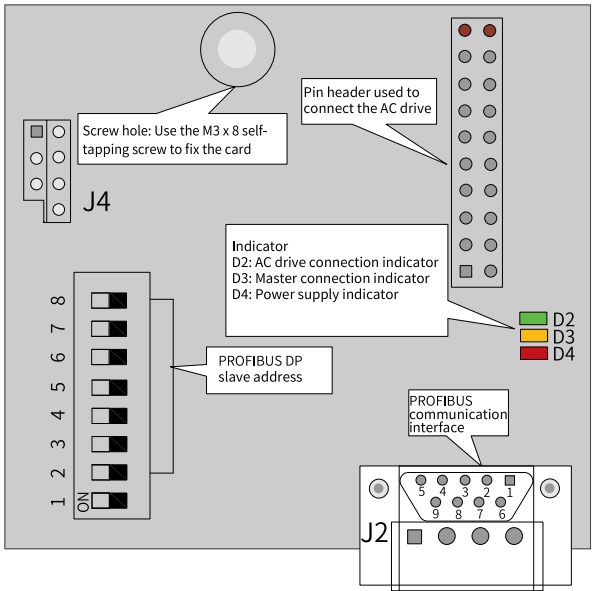
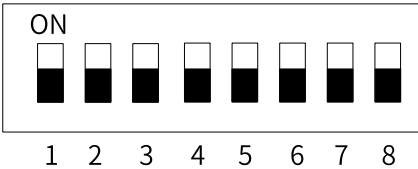


Figure 11-3 MD-SI-DP2 card terminals

DIP switch



Position	Function	Description															
1	DP card type selection	OFF: MD-SI-DP2 (default) ON: reserved															
2 to 8	Address of the PROFIBUS DP communication slave	The seven positions of the DIP switch together can set the addresses of stations 1 to 125. <table><tr><td>Example:</td><td>Address</td><td>DIP setting (position 8 as the least significant bit)</td></tr><tr><td></td><td>1</td><td>000 0001</td></tr><tr><td></td><td>7</td><td>000 0111</td></tr><tr><td></td><td>20</td><td>001 0100</td></tr><tr><td></td><td>125</td><td>111 1101</td></tr></table>	Example:	Address	DIP setting (position 8 as the least significant bit)		1	000 0001		7	000 0111		20	001 0100		125	111 1101
Example:	Address	DIP setting (position 8 as the least significant bit)															
	1	000 0001															
	7	000 0111															
	20	001 0100															
	125	111 1101															



Caution

Changes to position 1 take effect only after the next power-on. Changes to the slave address positions take effect immediately after setting.

Description of standard 9-pin PROFIBUS interface

The DP card is connected to the PROFIBUS master using the standard DB9 port. The pin signal definition and pin arrangement of the standard DB9 port are the same as those of Siemens' DB9 port, as shown in the following figure.

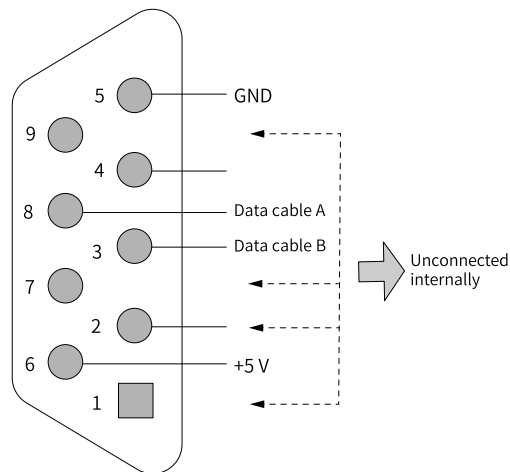


Figure 11-4 DP9 port pin

Description of control terminal functions

Table 11–1 Description of control terminal functions

Category	Terminal Mark	Terminal Name	Function Description
PROFIBUS communication terminal (J3)	1, 2, 7, and 9	NC	Unconnected internally
	3	Data cable B	Positive pole of the data cable
	5	GND	Isolated 5 V power supply ground
	6	+5V	Isolated 5 V power supply
	8	Data cable A	Negative pole of the data cable
Program burning	J4	Program burning	It is the terminal for commissioning in production. Do not use it.

Category	Terminal Mark	Terminal Name	Function Description
Indicator※	D4 (red)	Power supply indicator	- Steady ON: The AC drive is energized. - OFF: The AC drive is disconnected from the power supply or the PROFIBUS DP card is installed incorrectly.
	D3 (yellow)	Indicator of communication between the DP card and master	- Steady ON: Communication between the DP card and the PROFIBUS master is normal. - OFF: Communication between the DP card and the master is not established. Check the connection of PROFIBUS cables and the setting of the station number. - Flashing: The master does not run or a fault occurs during communication between the DP card and the master.
	D2 (green)	Indicator of communication between the DP card and AC drive	- Steady ON: Communication between the DP card and the AC drive is normal. - OFF: Communication between the DP card and the AC drive fails. Check whether F0-28 is set to 1 or the AC drive supports the MD-SI-DP2 card. - Blinking: Interference exists in communication between the DP expansion card and the AC drive or the expansion card address is beyond the range of 1 to 125.

11.4 PROFIBUS Topology and Transmission Distance

The following figure shows the connection between the DP card and PROFIBUS master.

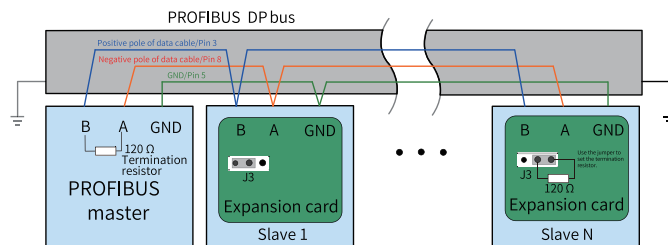
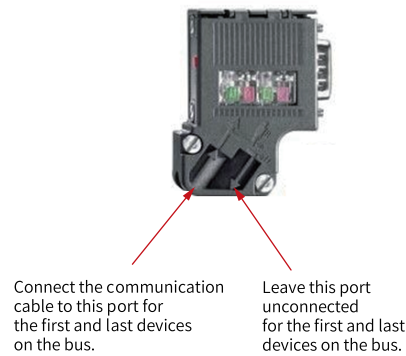


Figure 11-5 Connection between the DP card and PROFIBUS master

Connect termination resistors at both ends of the PROFIBUS bus by setting the DIP switches accordingly. If the termination resistors are connected correctly, the resistance between A1 and B1 should be about 110 Ω when power is off. For the first and last devices on the PROFIBUS bus, connect their communication cables to the ports marked with "IN" (namely, the ports corresponding to A1/B1) on the DP connectors. Otherwise, termination resistors cannot be connected to the bus. If the termination resistor is not connected or only one termination resistor is connected, the communication quality will be affected.



The length of a communication cable between the DP card and the PROFIBUS master is limited by the baud rate of the master. Restrict the length of communication data cables in strict accordance with Siemens DB9 wiring standard. The following table lists limits of communication cable length based on baud rate.

Baud Rate (kbps)	Maximum Length of Cable Type A (m)	Maximum Length of Cable Type B (m)
9.6	1200	1200
19.2	1200	1200
187.5	600	600
500	200	200
1500	100	70
3000	100	Not supported
6000	100	
12000	100	

The following table lists the technical specifications of cables.

Cable Parameter	Type A	Type B
Impedance	135 Ω to 165 Ω ($f = 3$ MHz to 20 MHz)	100 Ω to 130 Ω ($f > 100$ kHz)
Capacitor	< 30 pF/m	< 60 pF/m
Resistance	< 110 Ω /km	Not specified
Cross-sectional area of conductor	≥ 0.34 mm ²	≥ 0.22 mm ²

11.5 Communication Protocol

Data transmission formats

The PROFIdrive protocol defines the Parameter Process Data Object (PPO) as the format for data transmission. PPO includes five types: PPO1, PPO2, PPO3, PPO4, and PPO5. The DP card supports all the five types of the PPO.

The following table lists the functions supported by each type of the PPO.

Data Type	Supported Function
PPO1	Operation on a single function parameter Setting of AC drive commands and frequencies Reading of AC drive status and running frequency
PPO2	Operation on a single function parameter Setting of AC drive commands and frequencies Reading of AC drive status and running frequency Cyclic writing of four function parameters Cyclic reading of four function parameters
PPO3	Setting of AC drive command and frequency Reading of AC drive status and running frequency
PPO4	Setting of AC drive command and frequency Reading of AC drive status and running frequency Cyclic writing of four function parameters Cyclic reading of four function parameters
PPO5	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive status and running frequency Cyclic writing of 10 function parameters Cyclic reading of 10 function parameters

Data blocks of the PPO data format are divided into two areas, PKW area (parameter area) and PZD area (process data area). The following figure shows the data format of each PPO type supported by the DP card.

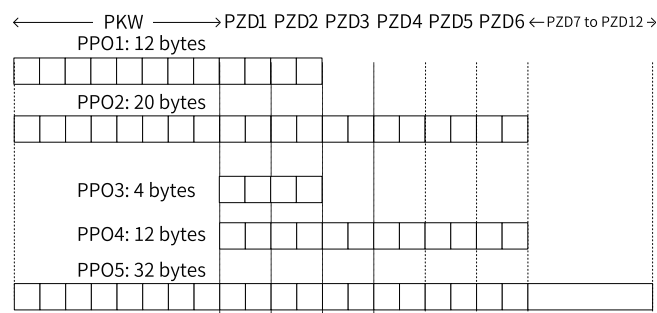


Figure 11-6 PPO data format

PKW data

The PKW data is used by the master station to read/write a single parameter of the AC drive. Communication addresses of the AC drive parameters are directly determined by the communication data. The specific functions are as follows:

- Reading function parameters of the AC drive
- Modifying function parameters of the AC drive

Data format

The PKW data consists of three parts: PKE, IND, and PWE. The PKE, IND, and PWE parts contain two bytes, two bytes, and four bytes, respectively, as shown in the following table.

PKW Data Sent by Master							
Operation command	Parameter address		Reserved			Write operation: parameter value	
						Read operation: reserved	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE
PKW Data Responded by AC Drive							
Operation command	Parameter address		Reserved			Success: parameter value	
						Failure: error information	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE

Data description

PKW Data Sent by Master		PKW Data Responded by AC Drive	
PKE	- High-order four bits: Command code 0: No request 1: Reading parameters 2: Changing parameters (The preceding command code is decimal). - Low-order four bits: Reserved - Low-order eight bits: High-order bits of the parameter address	PKE	- High-order four bits: Response code 0: No request 1: Parameter operation correct 7: Operations cannot be executed. - Low-order eight bits: High-order bits of the parameter address
IND	High-order eight bits: Low-order bits of the parameter address Low-order eight bits: Reserved	IND	High-order eight bits: Low-order bits of the parameter address Low-order eight bits: Reserved
PWE	High-order 16 bits: Reserved Low-order 16 bits: Reserved (in the case of read request) or parameter value (in the case of write request)	PWE	- Request succeeded: Parameter value - Request failed: Error code (consistent with standard Modbus) 1: Invalid command 2: Invalid address 3: Invalid data 4: Other errors

Application example

The following figure shows the PKW data sent by the master station and PKW response data sent by the AC drive when the master station reads the AC drive function parameter F0-08.

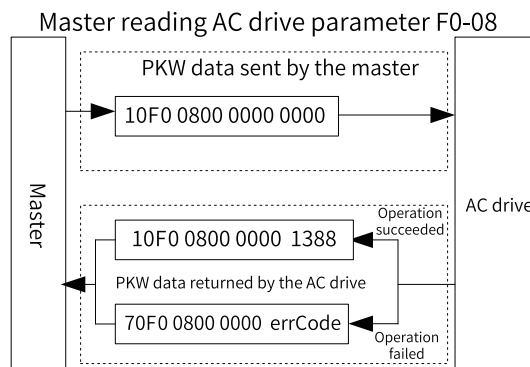


Figure 11-7 Example of PKW data transmitted when the master requests to read an AC drive parameter

The following figure shows the PKW data sent by the master station and PKW response data sent by the AC drive when the master station modifies the AC drive function parameter F0-08.

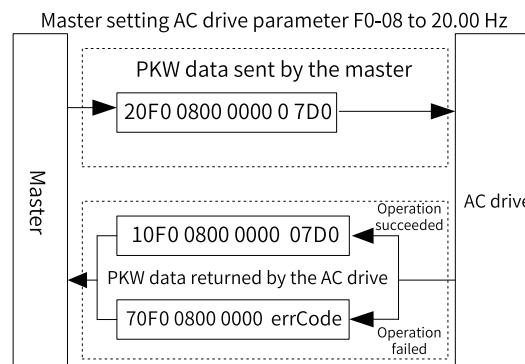


Figure 11-8 Example of PKW data transmitted when the master requests to write an AC drive parameter

PKW data exchange with the AC drive is performed cyclically. Continuous access to the EEPROM with the write command (PKE = 0x20xx) will significantly reduce the service life of the AC drive's main control chip. Therefore, to modify AC drive parameters, it is advisable to use the acyclic write command (see SFB53 described in [“10.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave” on page 190](#)) or operate the RAM addresses in PKW. The following table lists the RAM addresses of the parameters.

Parameter Group	Address
F0 to FF	0x00 to 0x0F
A0 to AF	0x40 to 0x4F

For example, the RAM address of parameter F0-10 is 0x000A.

PZD data

The PZD data is used by the master station to modify and read AC drive data in real time and perform periodic data exchange. Data communication addresses are directly configured by the AC drive. The following content is included:

- Setting AC drive control command and target frequency in real time
- Reading the current state and running frequency of the AC drive in real time
- Function parameters and monitoring parameters exchange between the AC drive and the PROFIBUS master in real time. The PZD data is used for cyclic data exchange between the master and the AC drive, as described in the following table.

PZD Data Sent by Master		
AC drive command	AC drive target frequency	AC drive parameter modification in real time
PZD1	PZD2	PZD3 to PZD12
PZD Data Responded by AC Drive		
AC drive state	AC drive running frequency	AC drive parameter reading in real time
PZD1	PZD2	PZD3 to PZD12

Data sent by the master

PZD Data Sent by Master	
PZD1	AC drive command word (valid when the command source is set to communication)
	0: No command
	01: Forward run
	02: Reverse run
	03: Forward jog
PZD2	04: Reverse jog
	05: Coast to stop
	06: Decelerate to stop
	07: Fault reset
	It specifies the AC drive target frequency. The frequency reference source must be set to communication. The value unit is determined by the AC drive and Hz is used as an example. The frequency range is 0 to F0-10. When F0-22 = 1, the range is 0.0 Hz to 3200.0 Hz. When F0-22 = 2, the range is 0.00 Hz to 320.00 Hz. When the frequency reference exceeds the value of F0-10, this frequency command will not be responded.
PZD3 to PZD12	It specifies parameters (in group F and group A) to be modified in real time. The modification is not written to the EEPROM. FE-02 to FE-11 correspond to PZD3 to PZD12. For the configuration, see PZD data configuration. After communication with the PLC is established, FE-02 to FE-11 display the parameter values written into PZD3 to PZD12. Manual settings of parameters in group FE of the AC drive are invalid.

Data responded by the AC drive

PZD Responded by the AC Drive	
PZD1	It indicates the AC drive state. AC drive running states are determined by the following bits: • Bit 0: 0: Stopped; 1: Running • Bit 1: 0: Forward running; 1: Reverse running • Bit 2: 0: No fault; 1: Fault • Bit 3: 0: Frequency reference not reached; 1: Frequency reference reached
PZD2	It indicates the AC drive running frequency. The current AC drive running frequency is returned as 16-bit signed data. When F0-22 = 1, -32000 to 32000 correspond to the actual running frequency -3200.0 Hz to 3200.0 Hz. When F0-22 = 2, -32000 to 32000 correspond to the actual running frequency -320.00 Hz to 320.00 Hz.
PZD3 to PZD12	The PZD indicates function parameter values (group F and group A) and monitoring parameter values (group U) read in real time. FE-22 to FE-31 correspond to PZD3 to PZD12. For the configuration, see PZD data configuration. After communication with the PLC is established, FE-02 to FE-11 display the parameter values written into PZD3 to PZD12. Manual settings of parameters in group FE of the AC drive are invalid.

11.6 Related parameters

11.6.1 Parameters Related to Communication

AC drive communication card settings

To select PROFIBUS DP as the serial port communication protocol of the AC drive, set F0-28 to 1. See the following table for details.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-28	Communication protocol	0: Modbus protocol 1: Expansion communication protocol 2: Inobus protocol (through EtherCAT card)	1	This parameter is used to select a communication protocol. 0: Modbus protocol The Modbus protocol is used. 1: Expansion communication protocol PROFIBUS DP, PROFINET, EtherCAT, Modbus TCP, and EtherNet/IP protocols can be used. No setting is required for CANlink because it is always valid. 2: Inobus protocol (through EtherCAT card) When this parameter is set to 2, the Inobus communication protocol is used. The AC drive version must be F7-10 = U60.07/ F7-11 = U61.07/ F7-15 = 000.00/ F7-16 = 000.00 or later.

Communication control parameters

Parameter Code	Parameter Name	Value Range	Hexadecimal Address	Decimal Address
U3-16	Frequency set through communication	-320.00 Hz to 320.00 Hz	H7310	29456
U3-17	Communication setting control word	0001: Forward run 0002: Reverse run 0003: Forward jog 0004: Reverse jog 0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	H7311	29457

Parameter Code	Parameter Name	Value Range	Hexadecimal Address	Decimal Address
U3-18	DO state (terminal function defined by parameters in group F5: communication control)	Bit 0: DO1 output control Bit 1: DO2 output control Bit 2: Relay 1 output control Bit 3: Relay 2 output control Bit 4: FMR output control Bit 5: VDO1 Bit 6: VDO2 Bit 7: VDO3 Bit 8: VDO4 Bit 9: VDO5	H7312	29458
U3-19	AO1 output (terminal function defined by parameters in group F5: communication control)	0 to 32767	H7313	29459
U3-20	AO2 output reference (terminal function defined by parameters in group F5: communication control)	0 to 32767	H7314	29460
U3-21	HDO output (terminal function defined by parameters in group F5: communication control)	0 to 32767	H7315	29461
U3-23	Speed set through communication	-32000 rpm to 32000 rpm	H7317	29463

When the DP card is used, the written PZD1 and PZD2 are mapped to U3-17 and U3-16 respectively by default. If a command or frequency fails to be written into the AC drive while PZD3 to PZD12 can be written and F0-02 and F0-03 are set to 2 and 9 respectively, check whether FE-00 and FE-01 are U3-17 and U3-16 respectively. If not, manually correct the parameter values.

Communication monitoring parameters

Parameter Code	Parameter Name	Min. unit	Hexadecimal Address	Decimal Address
U0-00	Operating frequency	0.01 Hz	H7000	28672
U0-01	Frequency reference	0.01 Hz	H7001	28673
U0-02	Bus voltage	0.1 V	H7002	28674
U0-03	Output voltage	1 V	H7003	28675
U0-04	Output current	0.01 A	H7004	28676
U0-05	Output power	0.1 kW	H7005	28677
U0-06	Output torque	0.1%	H7006	28678
U0-07	DI input state	1	H7007	28679
U0-08	DO output state	1	H7008	28680
U0-09	AI1 voltage	0.01 V	H7009	28681

Parameter Code	Parameter Name	Min. unit	Hexadecimal Address	Decimal Address
U0-10	AI2 voltage	0.01 V	H700A	28682
U0-11	AI3 voltage	0.01 V	H700B	28683
U0-12	Count value	1	H700C	28684
U0-13	Length	1	H700D	28685
U0-14	Load speed display	1	H700E	28686
U0-15	PID reference	1	H700F	28687
U0-16	PID feedback	1	H7010	28688
U0-17	PLC stage	1	H7011	28689
U0-18	Pulse input frequency	0.01 kHz	H7012	28690
U0-19	Feedback speed	0.01 Hz	H7013	28691
U0-20	Remaining running time	0.1 min	H7014	28692
U0-21	AI1 voltage before calibration	0.001 V	H7015	28693
U0-22	AI2 voltage before calibration	0.001 V	H7016	28694
U0-23	AI3 voltage before calibration	0.001 V	H7017	28695
U0-24	Motor speed	1 rpm	H7018	28696
U0-25	Current power-on time	1 min	H7019	28697
U0-26	Current operating time	0.1 min	H701A	28698
U0-27	Pulse input frequency	1 Hz	H701B	28699
U0-28	Communication setpoint	0.01%	H701C	28700
U0-29	Encoder feedback speed	0.01 Hz	H701D	28701
U0-30	Display of main frequency X	0.01 Hz	H701E	28702
U0-31	Display of auxiliary frequency Y	0.01 Hz	H701F	28703
U0-32	Memory address view	1	H7020	28704
U0-33	Synchronous motor rotor position	0.1°	H7021	28705
U0-34	AI3 temperature mode - motor temperature	1°C	H7022	28706
U0-35	Target torque	0.1%	H7023	28707
U0-36	Resolver position	1	H7024	28708
U0-37	Power factor angle	0.1°	H7025	28709
U0-38	ABZ position	1	H7026	28710
U0-39	Target voltage upon V/f separation	1 V	H7027	28711
U0-40	Output voltage upon V/f separation	1 V	H7028	28712
U0-45	Fault subcode	1	H702D	28717
U0-58	Number of motor revolutions	1	H703A	28730
U0-59	Frequency reference	0.01%	H703B	28731
U0-60	Operating frequency	0.01%	H703C	28732
U0-61	AC drive state	1	H703D	28733

Parameter Code	Parameter Name	Min. unit	Hexadecimal Address	Decimal Address
U0-62	Current fault code	1	H703E	28734
U0-63	Torque sent in point-to-point communication	0.01%	H703F	28735
U0-64	Number of slaves in master-slave control	1	H7040	28736
U0-65	Torque upper limit	0.1%	H7041	28737
U0-66	Model of communication expansion card	100: CANopen 200: PROFIBUS DP 300: CANlink 400: PROFINET 500: EtherCAT 600: EtherNet/IP	H7042	28738
U0-67	Software version of communication extension card	1	H7043	28739
U0-68	AC drive state read through DP card	1	H7044	28740
U0-69	Frequency read through communication expansion card	0.01 Hz	H7045	28741
U0-70	Speed read through communication expansion card	1 rpm	H7046	28742
U0-71	Current read through communication expansion card	0.1 A	H7047	28743

When the DP card is used, the read PZD1 and PZD2 are mapped to parameters U0-68 and U0-69, respectively, by default. If the state or running frequency cannot be read but PZD3 to PZD12 can be read, check whether parameters FE-20 and FE-21 are consistent with parameters U0-68 and U0-69, respectively. If not, manually correct the values of parameters FE-20 and FE-21.



Caution

If the AC drive is updated from an earlier version that supports MD38DP1 to a later version that supports MD38DP2, the preceding operations must be performed or the AC drive must be reset after the update is complete.

11.7 Communication Configuration

11.7.1 Communication Instance Description

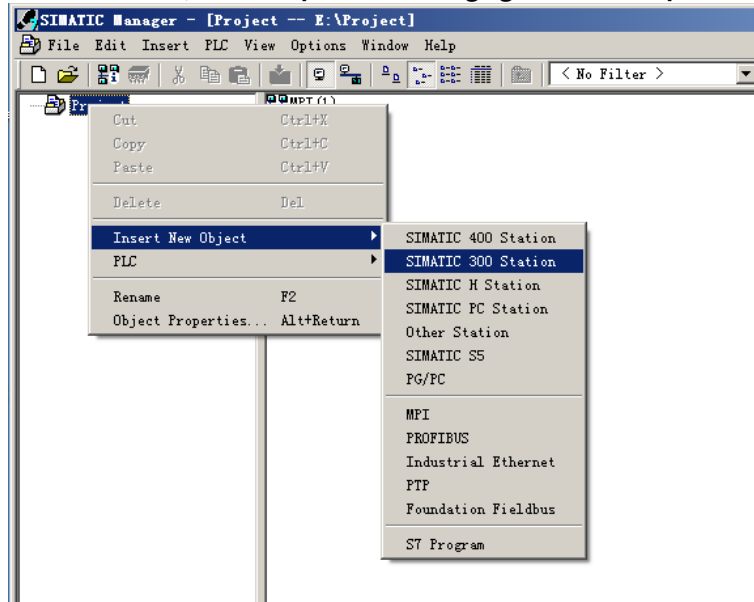
The MD-SI-DP1 expansion card uses the same GSD file as the MD38DP2 card in the same way as the MD38DP2 card. Therefore, this chapter still uses the screenshots of the communication and configuration interfaces displaying information about the MD38DP2 card. For details, see the communication examples in this section.

11.7.2 Configuring Slaves on the STEP7 (V5.4) by Using S7-300

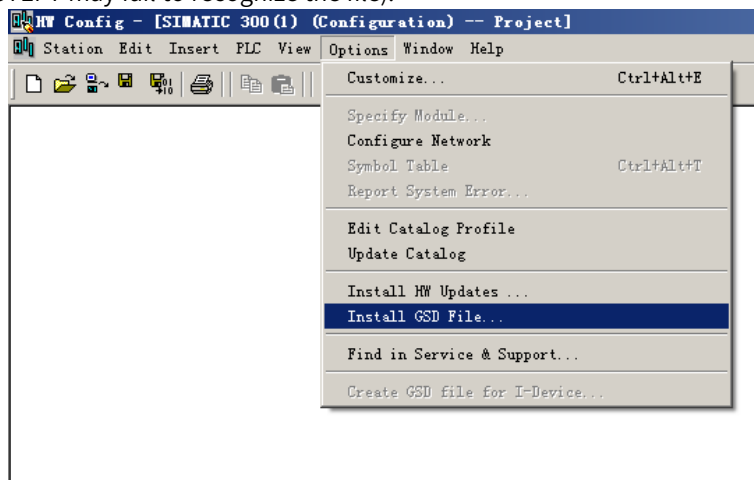
Before using the PROFIBUS master, you need to configure the GSD file of the slave to add the slave to the system of the master. If the GSD file is already configured, skip step 2. You can obtain the GSD file from Inovance or its agent.

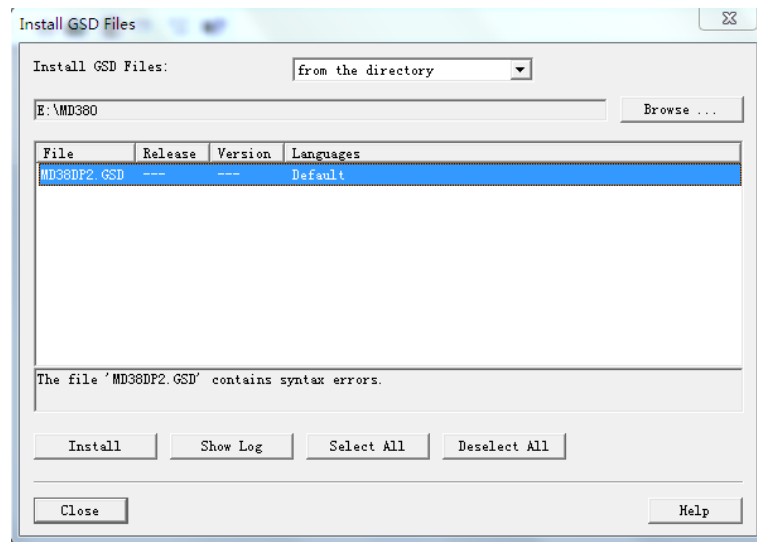
To configure the slave, do as follows:

1. (Optional) To install the GSD file, choose **Options > Manage general description files (GSD)**.

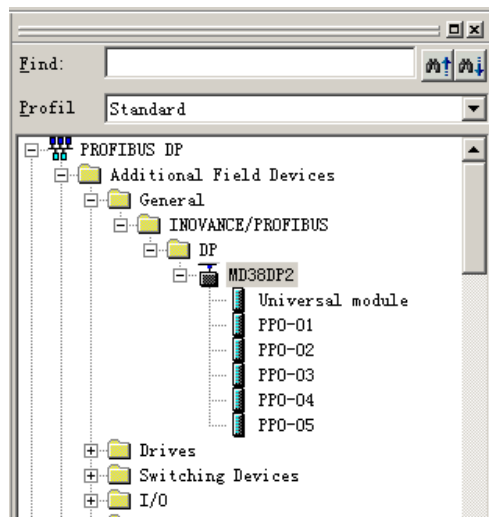


2. Double-click the hardware icon to access the **HW Config** interface, and choose **Options > Install GSD File** to add the MD38DP2.GSD file (Note that the file must be stored in an English path; otherwise, the STEP7 may fail to recognize the file).

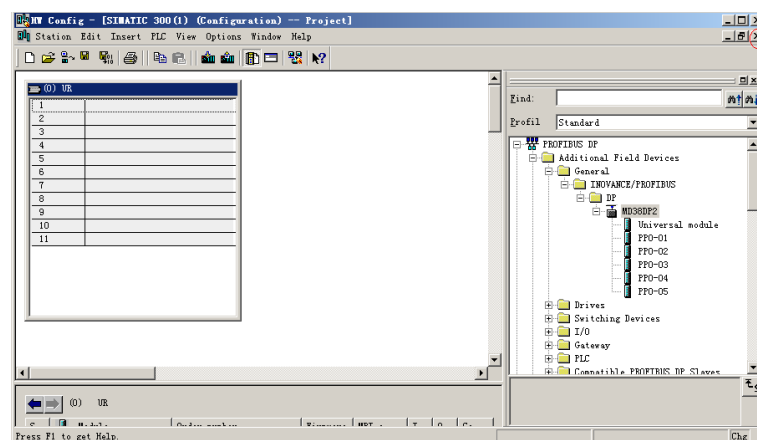




Click **Install**. After the installation is complete, the PROFIBUS DP module named MD38DP2 is displayed.



Note: If any master or slave already exists on the **HW.config** interface, close the current interface by clicking the X button (marked with a red circle in the following figure) before importing the GSD file.

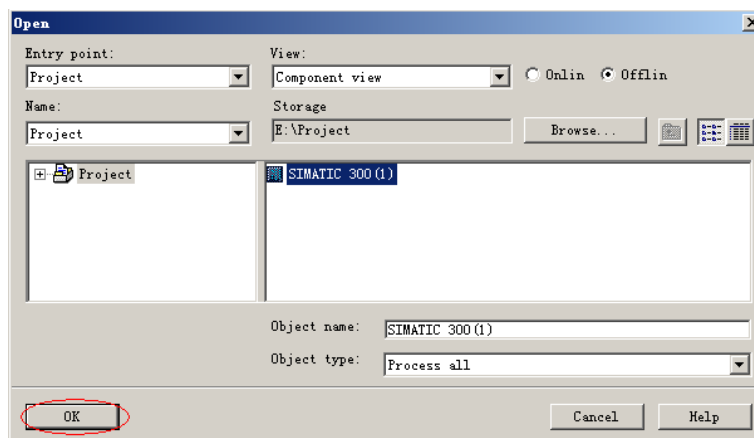


In this case, you can save the existing project. If a warning indicating that system data cannot be created is displayed, click **OK**. After closing the interface of the existing configuration project, you

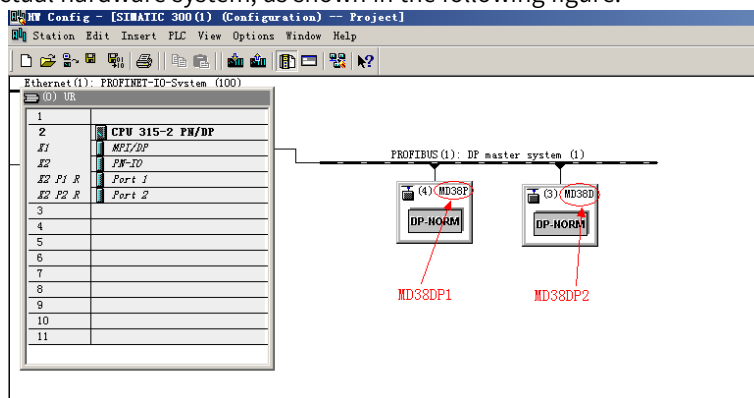
can install the GSD file by following the preceding steps. After the installation is completed, click the Open button, as shown in the following figure.



Select the original configuration project, and click **OK** to open it.

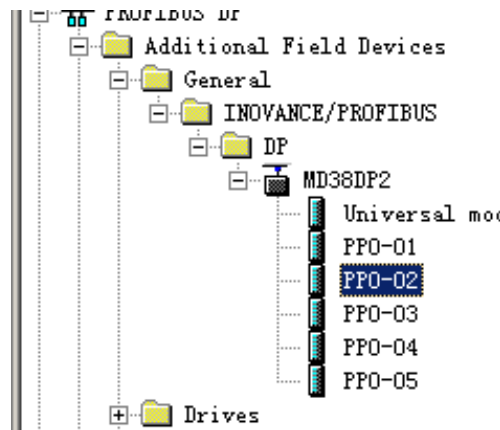


3. Configure the actual hardware system, as shown in the following figure.



In the preceding figure, station 4 is MD38DP1, which is only used for illustration. For details about its usage, see the MD380 Series PROFIBUS User Guide. MD38DP1 cards and the MD38DP2 cards can be valid on the same network.

4. Configure data features of the slave.



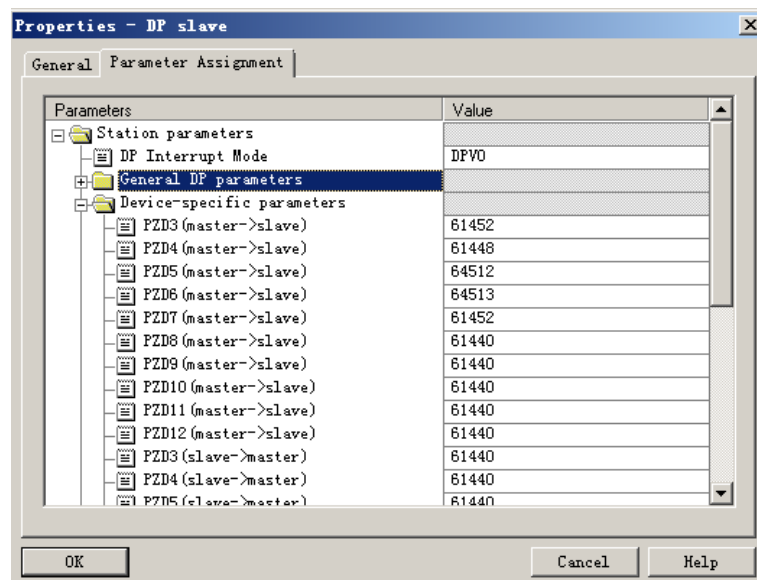
After the PPO type is added, the address assigned by the PLC to the slave is displayed. Slot 1 marked with a red circle in the following figure indicates the PKW address (8 bytes). Slot 2 indicates the PZD address (12 bytes).

If the selected PPO type does not have a PKW area, the I address and Q address of slot 1 are blank.

(3) MD38DP2					
S...	DP ID	Order Number / Designation	I Address	Q Address	Comment
1	4AX	PPO-02	284...291	284...291	
2	6AX	--> PPO-02	292...303	292...303	

5. Configure the PZD.

The fixed configuration of PZD1 and PZD2 cannot be modified. PZD3 to PZD12 are intended for exchange of user-defined cyclic data. They can be set in hardware configuration. On the **HW Config** interface, double-click the MD38DP icon and then click **Device-specific parameters** to configure parameter addresses as needed.

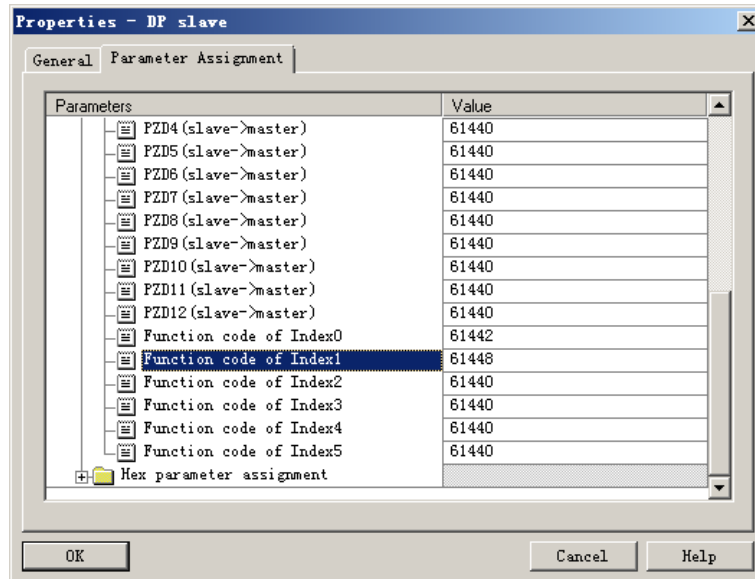


PZDx (master->slave) indicates the address used by the master to write data to the slave, whereas PZDx (slave->master) indicates the address used by the master to read data from the slave. PZD3 to PZD12 are displayed in decimal and can be set. For example, to set PZD3(master->slave) to F0-12, enter 61452.

By default, all PZDs of the MD520 are set to F0-00 (61440 in decimal). For unused PZDs, modification is not required and default values can be retained. PZD mapping relations must be set independently for each slave as required. If mapping relations of various slaves are the same, you

can select one configured slave, press **Ctrl+C**, select the PROFIBUS-DP bus in the configuration, press **Ctrl+V**, and modify the station number.

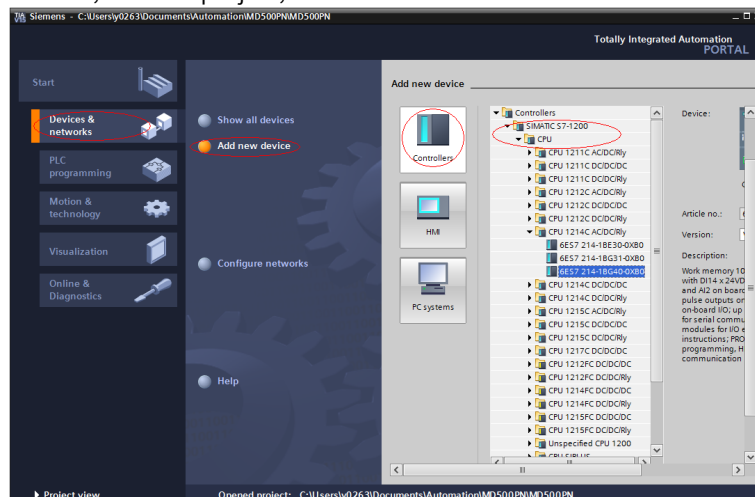
To enable the function of non-periodically reading and writing parameters of DPV1, set corresponding parameters in customized indexes at the end of **Device-specific parameters**. The AC drive provides six customized indexes numbered from 0 to 5. For example, set indexes 0 and 1 to F0-02 and F0-08, respectively.



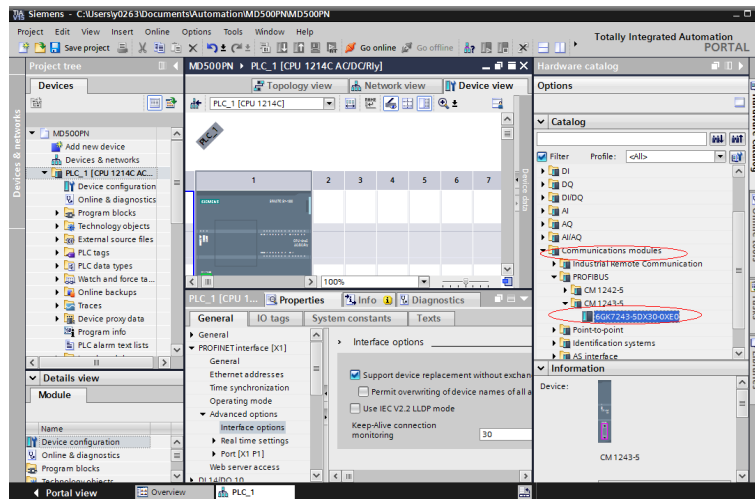
After all the preceding operations are completed, the PROFIBUS slave station is configured. Then, you can compile programs in the S7-300 to control the AC drive.

11.7.3 Configuring Slaves on TIA Portal V13 by using S7-1200

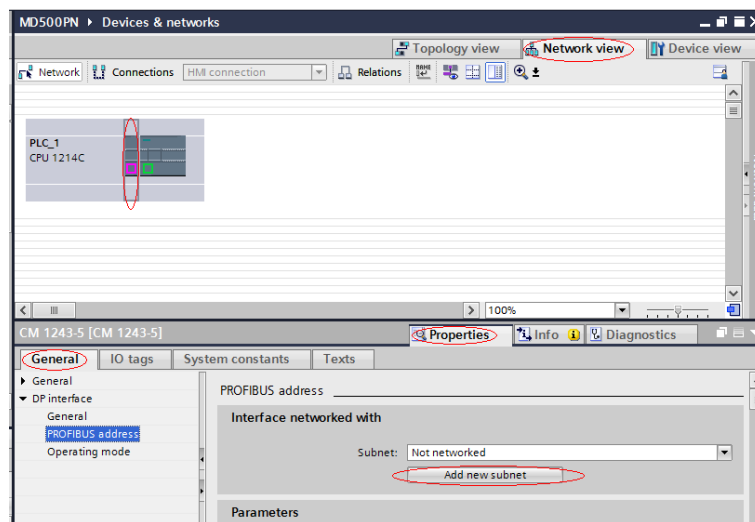
1. Open the TIA Portal V13, create a project, and add an S7-1200 master based on the actual situations.



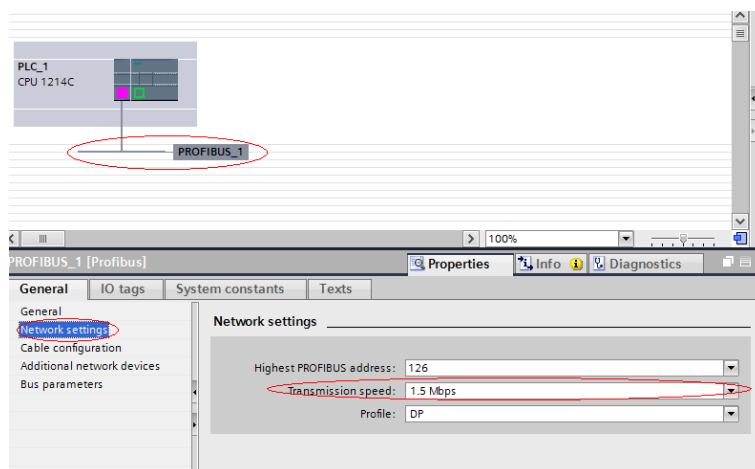
The S7-1200 CPU does not have a PROFIBUS interface, so you need to add a PROFIBUS communication module first. In this example, a CM1243-5 master module is added.



After adding the PROFIBUS master module, click the **Network view** tab. After selecting the communication module, choose **Properties > General > Add new subnet** to create a PROFIBUS network. You can also modify the master ID on this interface.

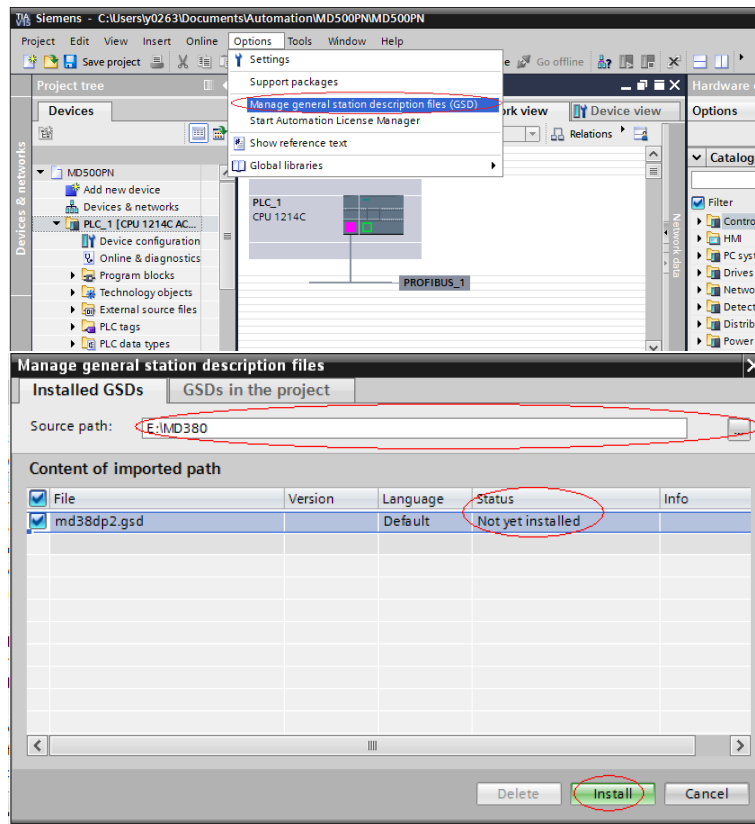


To modify the PROFIBUS baud rate, select the network, and choose **Properties > General > Network settings**. Select a baud rate from the **Transmission speed** drop-down list.

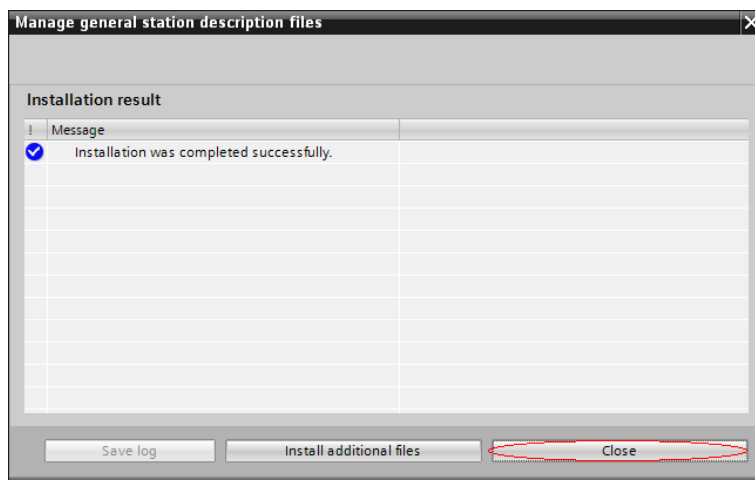


2. Install the GSD file. Skip this step if the GSD file is already installed.

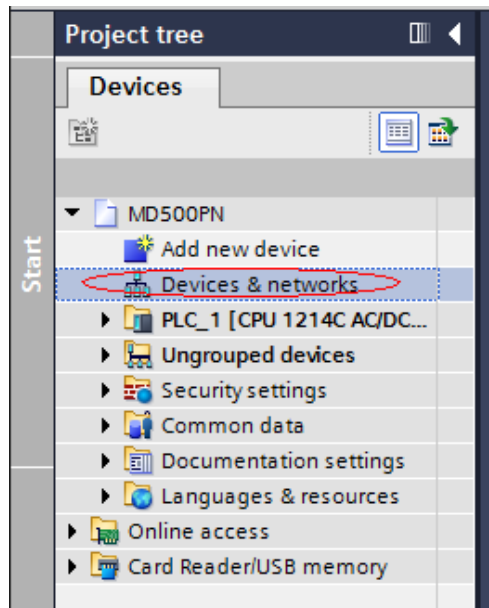
If the GSD file is not installed, the message **Not yet installed** is displayed in the **Status** column. Select the GSD file and click **Install**. Note that an error will occur if the installation path contains Chinese characters.



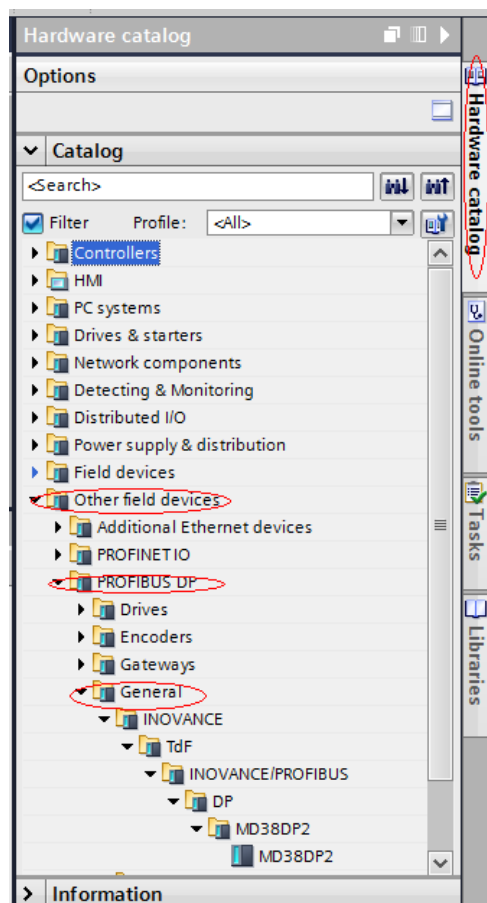
If the following figure is displayed, the installation is complete. In this case, click **Close**.



During installation of the GSD file, the PORTAL automatically closes the configuration interface. After the installation is completed, double-click **Devices & networks** in the left **Start** pane to open the previous configuration interface.



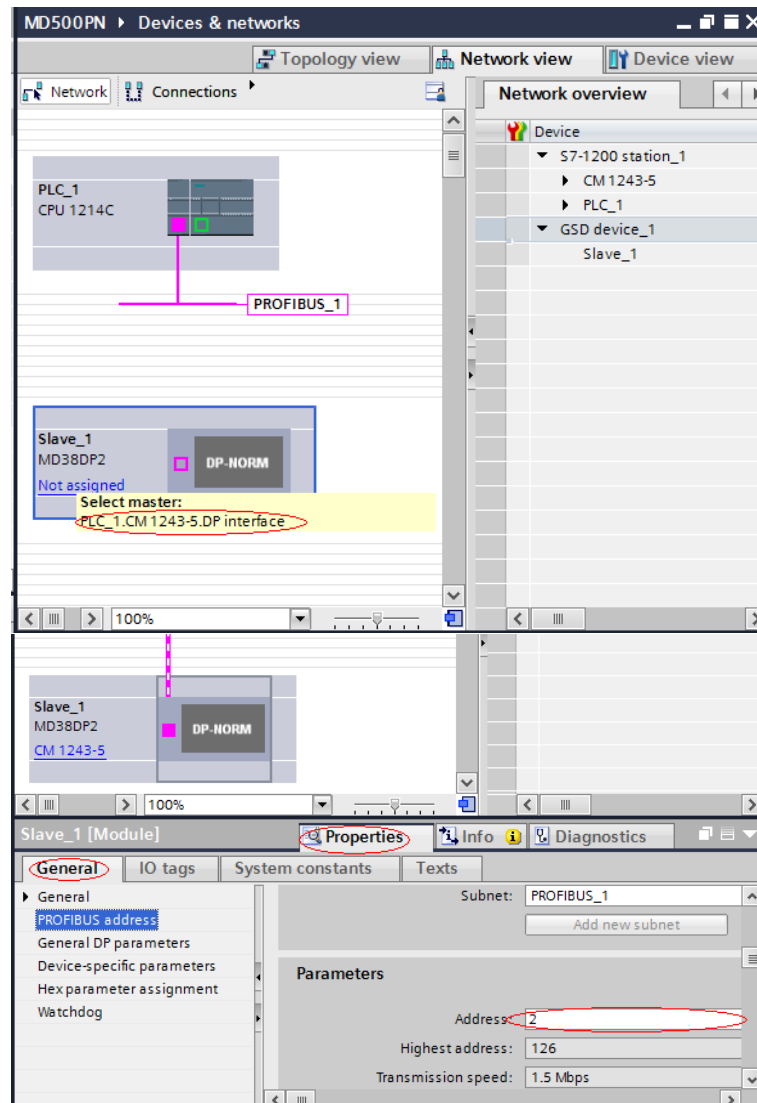
After the installation, you can choose **Hardware catalog > Other field devices > PROFIBUS DP > General** to locate the MD38DP2, which is the same for the STEP7. Expand all the sub-directories as shown in the following figure.



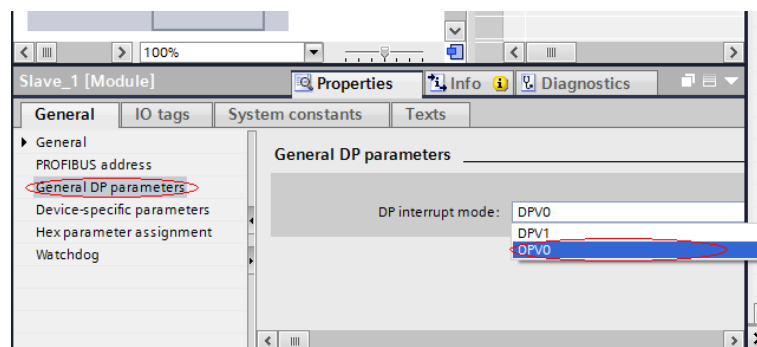
3. Start the configuration.

On the **Hardware catalog** tab, double-click MD38DP2 or drag it to **Network view** under **Devices & networks**. Click **Not assigned** below the slave name to select the corresponding PROFIBUS

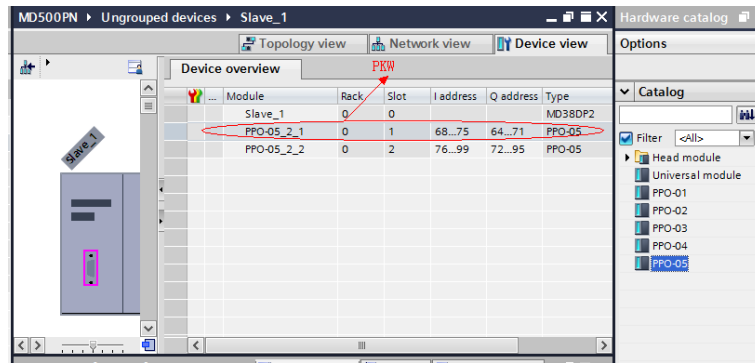
network. Select the slave, choose **Properties > General**, and set the slave ID. Note that the setting must be consistent with that set by the DIP switch on the DP expansion card.



Click **General DP parameters** and select **DPV0** from the **DP interrupt mode** drop-down list.

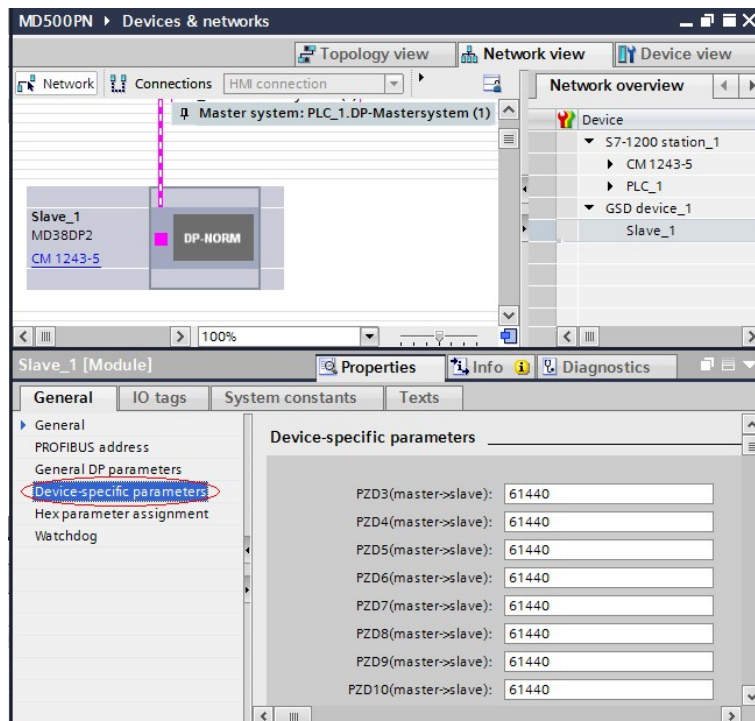


Click the **Device view** tab. Select a suitable PPO type under **Hardware catalog**. Check the addresses assigned for each segment. The row marked with a red circle in the following figure indicates the PKW address. If the selected PPO type has no PKW, the address column is blank.



4. Set PZD mappings.

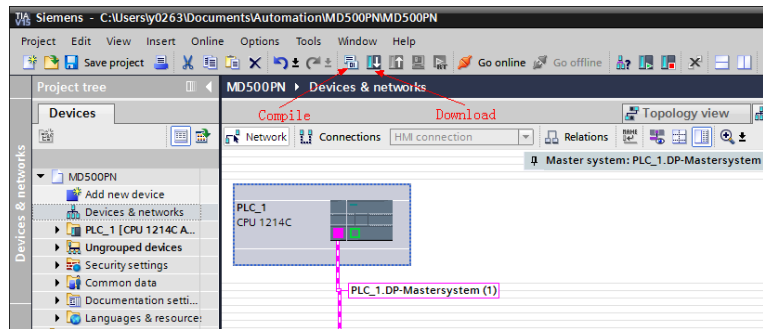
Click the **Network view** tab. Click **Device-specific parameters** to set the mapping for PZD3 to PZD12. The PZD mapping relationships for the PLC to read data from and write data to the slave must be set independently. For details, see [“11.7.2 Configuring Slaves on the STEP7 \(V5.4\) by Using S7-300” on page 210](#).



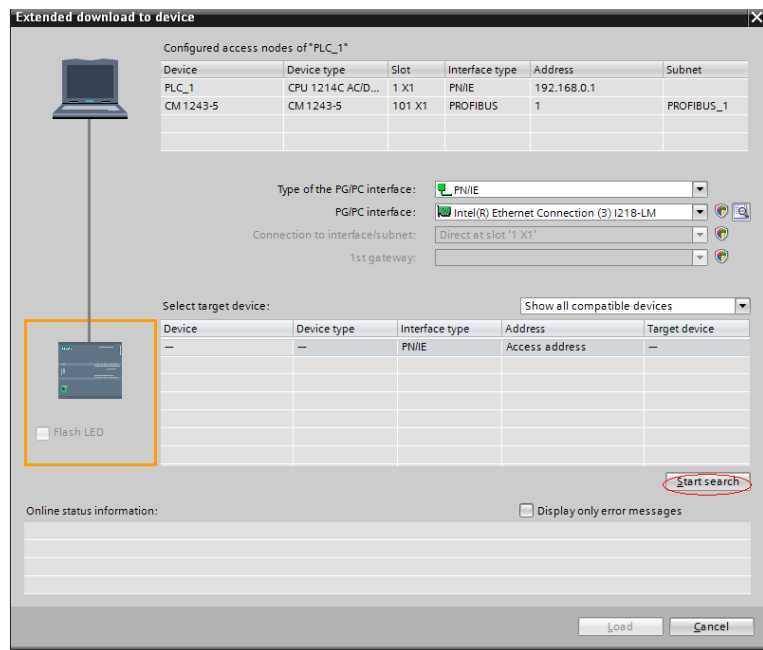
5. Compile and download the configuration.

If the settings of multiple slaves are the same, select a configured slave, press **Ctrl+C**, and then press **Ctrl+V**. Or right-click the configured slave and use the **Copy** and **Paste** function. Connect the new slave to the network, and then modify its station ID.

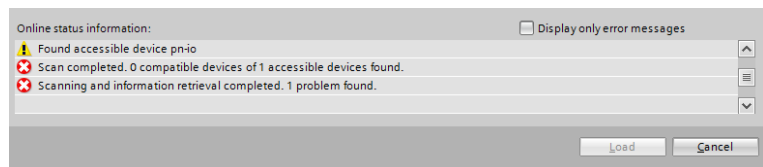
After all slaves are configured, save the configurations, and then click the **Compile** button. After the compiling is completed successfully, click the **Download** button.



On the displayed interface, set the interface for communication between the PC and PLC as required. In this example, configure the local network port and then click **Start search** to search for the PLC.



If no accessible device is found, the connection between the PC and PLC is faulty. Rectify the fault first. If the STEP7 is used for downloading through the Ethernet and then the PORTAL is used for downloading on the same PC, the problem also occurs. In this case, restart the PC or change the PG/PC interface to a non-Ethernet interface in STEP7.



If the connection is normal, the **Load** button is available. You can click **Load** to download the configuration to the PLC as instructed.

11.7.4 Performing Cyclic Read/Write Operations on the AC Drive Slave

In this example, the PLC is S7 315-2PN/DP, and the following figure shows the address assignment.

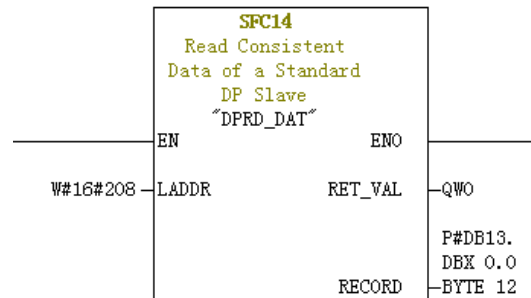
(3) MD38DP2						
S...	DP ID	Order Number / Designation	I Add...	Q Address	Comment	
1	4AX	PP0-02	512...519	512...519		
2	6AX	--> PP0-02	520...531	520...531		

1. Directly use the MOVE command to enable the AC drive to run in the forward direction at the target frequency of 30 Hz (F0-02 = 2, F0-03 = 9), as shown in the following figure.

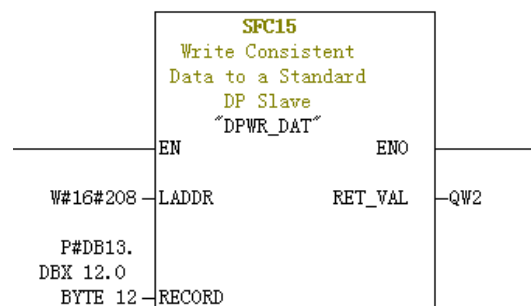


Other data is written in a similar way. The read data can also be transmitted from the PIW register to the common Q, I, L, M, or D register using the MOVE command for parsing.

2. Use SFC14 and SFC15.



- **LADDR:** Starting address configured in the I block of the module, which must be in hexadecimal format.
- **RET_VAL:** Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD:** Target area of the read user data. Its length must be consistent with the length of the module configuration selected in STEP 7. Only the byte data type is allowed.

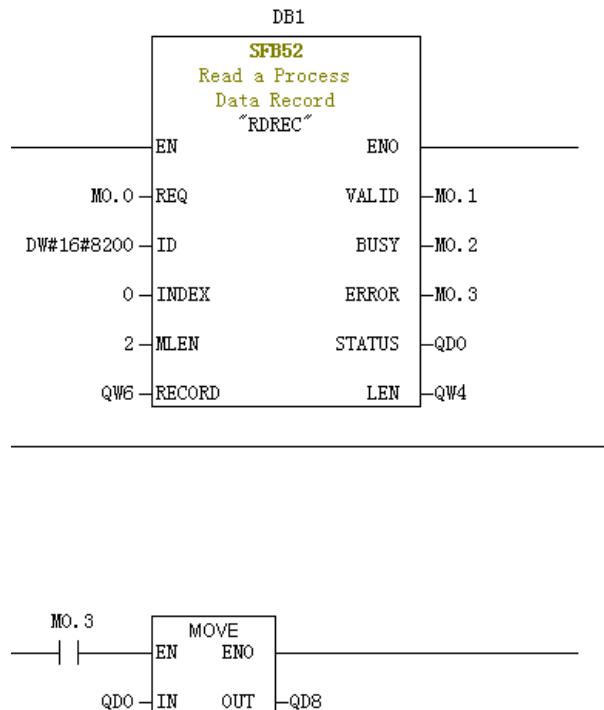


- **LADDR:** Starting address configured in the Q block of the module, which must be in hexadecimal format.
- **RET_VAL:** Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD:** Source area of the user data to be written. Its length must be consistent with the length of the module configuration selected in STEP 7. Only the byte data type is allowed.

For both SFC14 and SFC15, the addresses must be in hexadecimal format of the I and Q starting addresses (in this example, the address is 520, which is 0x208 in hexadecimal format). The length of **RECORD** must be consistent with the byte length of the PPO type PZD (in this example, PPO2 is used, which includes six PZDs, that is, a total of 12 bytes).

11.7.5 Performing Aperiodic Read/Write Operations on the AC Drive Slave

To perform aperiodic read and write operations on the AC drive PROFIBUS DP slave, Siemens's system function modules SFB52 (for reading) and SFB53 (for writing) are required. Create an organization block in the program, and add relevant function blocks and programs in the organization block.



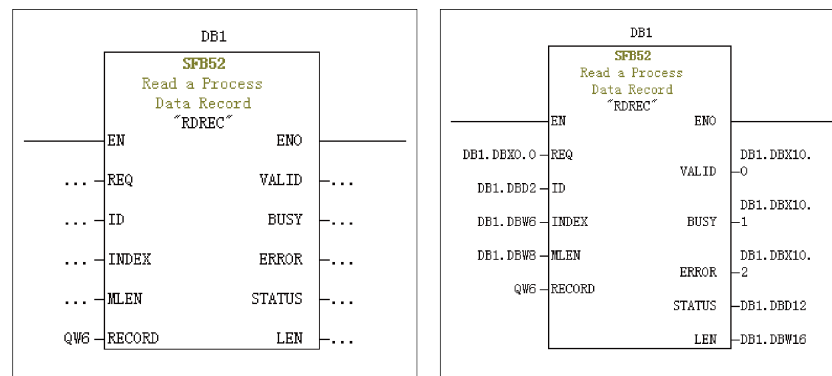
After M0.0 is set, the function block reads F0-02 (Index 0 has been set to F0-02) of the AC drive No. 3 and saves it in QW6. Field definitions are as follows:

- REQ: It is used to enable or disable the function block. When it is set to 1, the function block is enabled.
- ID: It indicates the logic address. To specify this field, convert any bit in the Q address of the AC drive slave station to a hexadecimal value, and set bit 15 of the value to 1. For example, after Q512 is converted to the hexadecimal value H8200, and bit 15 is set to 1, H8200 is obtained.

(3) MD38DP2						
S...	DP ID	...	Order Number / Designation	I Add...	Q Address	Comment
1	4AX		FP0-02	512...519	512...519	
2	6AX		--> FP0-02	520...531	520...531	

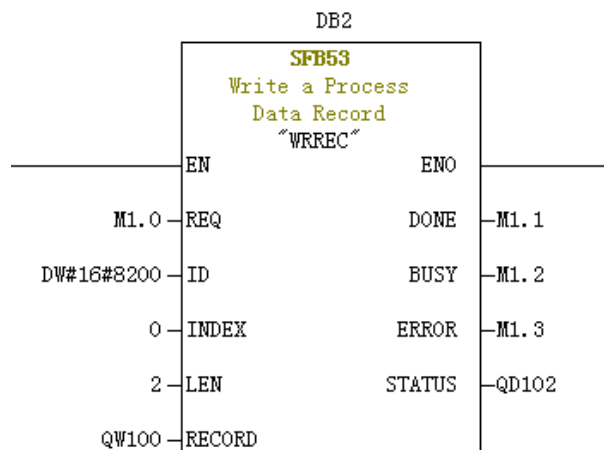
- INDEX: It is an index number ranging from 0 to 5. You can define the index mapping address of a slave as required.
- MLEN: It indicates the maximum length of the data to be obtained. For MD38DP2, this field must be set to 2.
- RECORD: It indicates the target area of an obtained data record. This field is used to store read data when the read operation is performed and sent data when the write operation is performed.
- VALID: New data record received and valid.
- BUSY: When the field value is ON, operations are not complete.
- ERROR: Error flag. When the value is **ON**, an error occurs.
- STATUS: Block status or error information
- LEN: Length of the obtained data record

During the invocation, you can use user-defined parameters or use some or all default parameters.



The left figure shows all the default parameters. If you want to customize parameters, set them according to the right figure. You can set customized or default parameters for corresponding blocks as required.

Aperiodic write operations are performed in a similar way as aperiodic read operations. The **RECORD** field stores data to be written, as shown in the following figure.



Note that before running an organization block, you need to download data blocks (above the function block, DB1 and DB2 in this example) to the PLC. Otherwise, an error indicating that the DB blocks are not loaded will be reported.

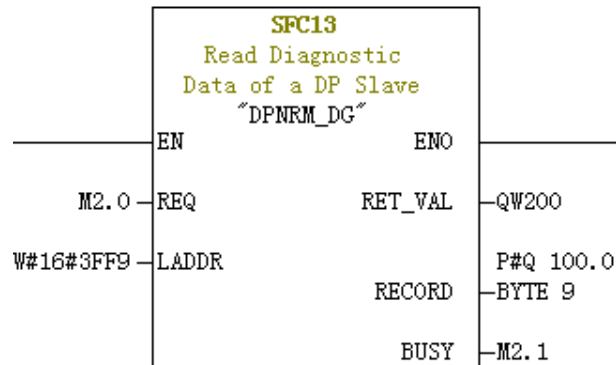
SFB53 is used to perform operations on the EEPROM. Therefore, the program is required to invoke relevant operations when required and disable relevant operations in time. As shown in the following figure, after the write operation is complete (M1.1 is set to 1), the program is invoked to reset M1.0.



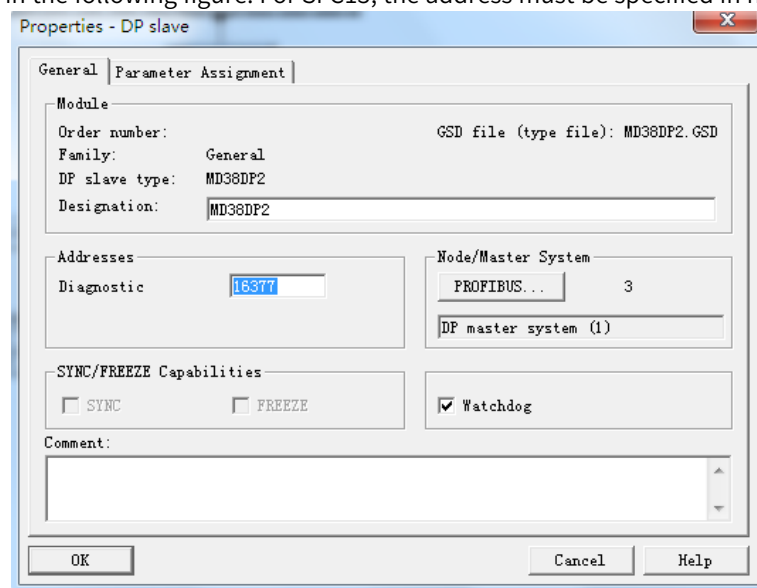
When SFB52 and SFB53 are executed once, relevant blocks need to be invoked for multiple times. Therefore, do not invoke them when single execution is required.

11.7.6 Diagnosis

You can use SFC13 in the program to obtain specific diagnosis information of each slave, as shown in the following figure.



- **REQ**: It is used to enable or disable diagnosis information reading. When this field is set to ON, diagnosis information reading is enabled.
- **LADDR**: It indicates the configured diagnosis address of the PROFIBUS DP slave station. The actual value is shown in the following figure. For SFC13, the address must be specified in hexadecimal.



- **RET_VAL**: It displays the error code (negative) when invocation errors occur or the actual transmitted data length (positive) when no error occurs.
- **RECORD**: It indicates the target area of the read diagnosis data. The value must be 9 bytes. Otherwise, an error is reported during invocation. The nine bytes are defined as follows:
 - Bytes 0 to 2: Station status
 - Byte 3: Master number
 - Byte 4: Supplier ID (high-order byte)
 - Byte 5: Supplier ID (low-order byte)
 - Byte 6: Dedicated device diagnosis length (fixed to 3)
 - Byte 7: Dedicated device diagnosis (high-order byte)

Byte 8: Dedicated device diagnosis (low-order byte)

- **BUSY:** When this field is **1**, reading is not complete.
Device-specific diagnosis provides relevant AC drive fault information, which is consistent with the value of U0-62. When the communication between the DP expansion card and AC drive is interrupted, 0x34 is returned.

11.8 Troubleshooting

The following table describes the faults that may occur during use of the DP expansion card and the AC drive.

Description		Solution
After the AC drive is powered on, only the power indicator (D4) is on, indicating that communication between the DP expansion card and the AC drive is not established.		1. Check whether F0-28 is set to 1.
		2. Check the AC drive type. This user guide only describes the usage when the MD520 is used together with the DP expansion card. For other AC drive types, contact the technical engineers to obtain the correct user guide.
		3. Check whether the AC drive software version supports the DP expansion card.
After the AC drive is powered on, the power indicator (D4) is on and the AC drive communication indicator (D2) blinks.		Set the station number correctly (within the range of 1 to 125). Note that digit 8 of the DIP switch is the least significant bit of the address.
The connection fails after the configuration is downloaded.	After the configuration is downloaded, indicators D2 and D4 on the DP expansion card are steady on whereas the yellow indicator D3 is off.	1. Check that the cable is properly connected.
		2. Check the DIP switch on the DP interface. The DIP switch on the DP interface at both ends of the network must be set to ON, and the DIP switch on other DP interfaces must be set to OFF.
		3. If the AC drive is connected at the end, check that the communication cable is connected to the DP IN interface. If the communication cable is connected to the DP OUT interface, the network cannot be connected when the DIP switch on the DP interface is set to ON.
		4. Check that the station number settings on the DP expansion card are consistent with the configuration. Digit 8 of the DIP switch is the least significant bit of the address.
		5. Check that the GSD file used in the configuration is correct.
	After the configuration is downloaded, indicators D2 and D4 on the DP expansion card are steady on while the yellow indicator D3 blinks slowly at the frequency of about 1 Hz to 2 Hz.	1. Check that the GSD file used is correct. 2. Check whether the PZD mapping relations are set correctly. Device-specific parameters in STEP 7 and TIA PORTAL must be set in the decimal format. Therefore, the parameters must be converted to decimal values. For example, the decimal value of FC-11 is 64523 (0xFC0B in hexadecimal format). If a parameter in the hexadecimal format instead of the decimal format is entered, the connection fails. Note that addresses using Modbus (such as H2000 and H8000) are unavailable for PZD mapping.
	After the configuration is downloaded, the yellow indicator D3 on the DP expansion card blinks quickly.	The PLC is not in the running status. Check the PLC status and locate the fault cause (possibly because the OB block does not exist).

Description		Solution
After the connection is successful, all indicators on the PLC are on in green, but data cannot be written into or read from the AC drive.	No data can be written/read.	Check whether the operation address is correct. No matter whether the PPO type used contains the PKW zone, the read/write operation address always locates in the second row (that is, the last row). If the I address and Q address in the last row of the station are both 520 to 531 (note that the I and Q addresses may start from different numbers), the PZD1 data written into the AC drive is stored in QW520, the PZD2 data written into the AC drive is stored QW522, and so on. If the PLC is S7-300 and S7-400, PQW is used. If SFC15 is used, check whether RET_VAL of the SFC15 block is 0 . If not, an invocation error exists. Eliminate this error first and invoke the block again. For details, see section "Performing Periodic Read/Write Operations on the AC Drive Slave".
	PZD3 or subsequent data can be written, but PZD1 or PZD2 cannot be written/read.	Check whether F0-02 and F0-03 are set to 2 and 9, respectively. Check whether the command reference is in the range of 1 to 7 (not bit) or frequency reference is in the range of -F0-10 to +F0-10. If not, the write operation fails. Check whether FE-00 and FE-01 are U3-17 and U3-16, respectively. If not, manually correct the parameter values or restore to factory settings.
	PZD1 and PZD2 can be written/read, while PZD3 or subsequent data cannot be written/read.	Check whether the PPO type supports the relevant PZD. Check whether device-specific parameters are set correctly.
	-	Check the logic relations. Check whether the same PZD is assigned with values for multiple times in a certain logic relation (check whether the value given by the PLC is correct under the logic relation in the monitoring table of the PLC).
After communication is established, the AC drive reports E164.1, which cannot be cleared. However, the indicator on the DP expansion card and the BF indicator on the PLC are normal.		Check whether the high-order 8 bits of the PZD1 data (QW data) written into the AC drive are 0 in the PLC program. If not, change them to 0. The PZD1 command in this user guide refers to values instead of bits.
After communication is established, the communication is normal when the AC drive is not running. However, when one or more AC drives are running, they are disconnected randomly.		1. Disconnect the power supply. Use a multimeter to measure the A1/B1 resistance of the DP slave station interface at the farthest end. The correct resistance should be $100 \pm 20 \Omega$.
		2. Check that the cable shields are connected together and the shields are in contact with the sheet metal in the DP interface. The shields are not required to connect with other GND terminals.
After the connection is established, the AC drive reports a fault. After the PLC configuration is changed and downloaded again or after the AC drive alone is powered on again, the faulty slave still cannot connect to the network.		The DP expansion card supports only the interruption mode DPV0. If the interruption mode is set to DPV1, when a slave is faulty, the PLC master may disable the DP connection channel of the slave or disable all the PLC communication (which usually occurs on the S7-1200). When such a symptom occurs, change the DP interruption mode (which is DPV0 by default in STEP 7 and DPV1 by default in PORTAL) of the slave to DPV0 under General DP parameters . Then, compile and download the configuration, and power on the PLC again.

Indicator status of the DP expansion card and troubleshooting

Table 11-2

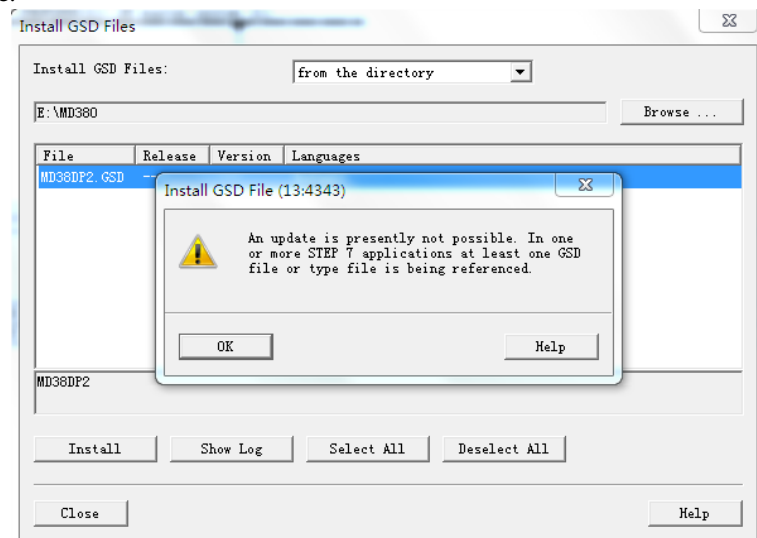
Indicator ^{Note}	Fault Status	Description	Solution
Red (D4)	Off	The DP expansion card is not powered on.	Check that the DP card is securely connected to the AC drive.
Green (D2)	Off	The connection between the DP expansion card and the AC drive fails.	Check that F0-28 is set to 1 and the DP expansion card is securely connected to the AC drive.
Green (D2)	Blinking at the frequency of 1 Hz	Station No. setting error	Check that the PROFIBUS DP station number is set to a value from 1 to 125.
Yellow (D3)	Blinking at the frequency of 1 Hz	Configuration error	Check that the GSD file is correct.
Yellow (D3)	Blinking at the frequency of 2 Hz	Parameter error	Check that all parameter addresses in Device-specific parameters are supported by the AC drive.
Yellow (D3)	Blinking at the frequency of 5 Hz	The master is not running.	Check the master state.
Yellow (D3)	Off	The connection between the DP expansion card and the PROFIBUS master fails.	Check that the slave address is correct and the PROFIBUS cable is connected properly.

Note

Note 1: For some products, the indicator color and the terminal indication may not match. In this case, the terminal indication prevails. The indicators are D2, D3, and D4 from left to right. See [“Figure 11-3” on page 198](#).

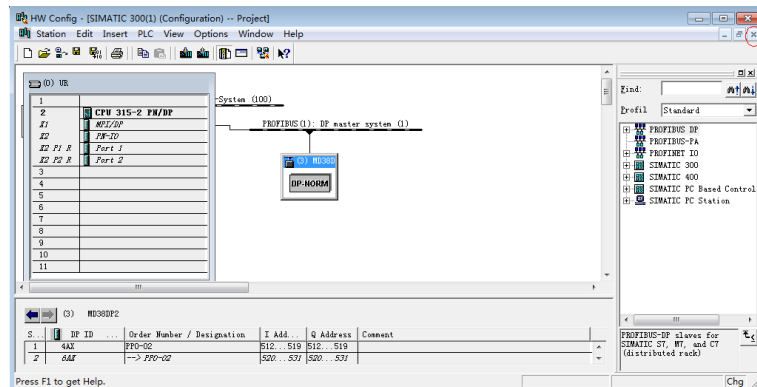
Troubleshooting for GSD installation failure

- Problem 1: The GSD file cannot be installed or updated when STEP 7 is used, as shown in the following figure.

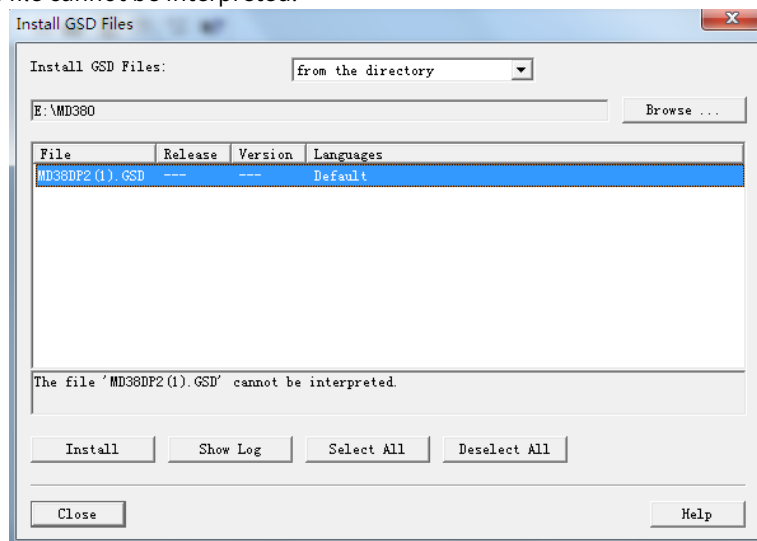


Possible cause: The current hardware configuration interface is opened and the GSD file is being used by other components.

Solution: Close the current configuration interface by clicking the Close button (marked with a red circle in the following figure). Then, install or update the GSD file and open the configuration interface again.



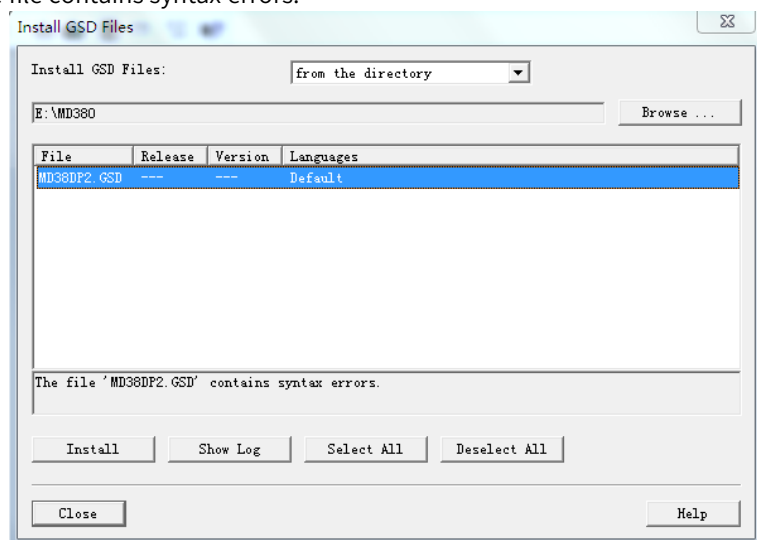
- Problem 2: The file cannot be interpreted.



Possible cause: During the GSD file transmission, the file name is changed manually or by the transmission tool. In this case, the file name fails to meet the PROFIBUS requirements.

Solution: Change the GSD file name to MD38DP2.GSD.

- Problem 3: The file contains syntax errors.



Possible cause: The GSD file is modified.

Solution: Use a correct GSD file.

- Other cases

Some versions of STEP 7 and PORTAL do not support a path that contains Chinese characters for installing the GSD file. In this case, store the GSD file in a path that does not contain Chinese characters.

12 Ethernet/IP Communication (MD500-EN1)

12.1 Introduction

As an EtherNet/IP fieldbus adapter that complies with international EtherNet/IP bus standards, the MD520 series EtherNet/IP communication expansion card (MD500-EN1 card for short) features high efficiency, flexible topology, and easy operation. It is installed in the MD series AC drive to improve the communication efficiency and implement the AC drive networking function, which enables the AC drive to be a slave controlled by the field bus master station.

This user guide is applicable to the MD500-EN1 card with the software version of 1.00 or later. You can query the version by viewing the parameter U0-67 of the AC drive after the card is installed and the drive is powered on. The corresponding EDS file is MD500P_EIP_V1.00.eds.

12.2 Installation

The MD500-EN1 card is embedded in the MD520 series AC drive. Before installation, cut off the power supply of the AC drive and wait at least 10 minutes until the charging indicator of the AC drive becomes off. Then, insert the MD500-EN1 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. The following figure describes the installation of the card.

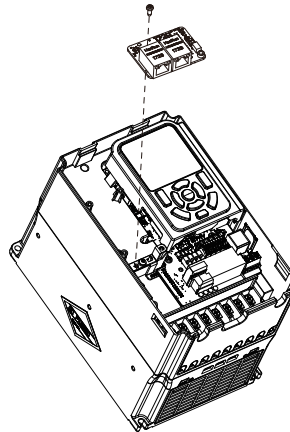


Figure 12-1 MD500-EN1 card installation

Note that the ground terminals of both the MD500-EN1 card and AC drive must be connected properly, as shown in [“Figure 12-2 Connecting ground terminals of the MD500-EN1 card and AC drive” on page 231](#).

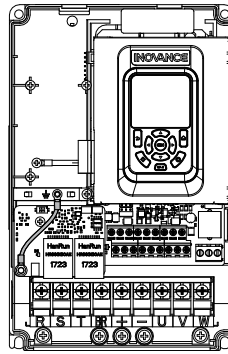


Figure 12-2 Connecting ground terminals of the MD500-EN1 card and AC drive

12.3 Interface Description

Terminal layout

“Table 12-1” on page 231 shows the hardware layout of the MD500-EN1 card. The pin header J7 on the back of the MD500-EN1 card is used to connect the drive. The MD500-EN1 card provides two Ethernet ports J4 and J6 to enable the card to communicate with the EtherNet/IP master (or other slaves). For details about the hardware, see “Table 12-1” on page 231.

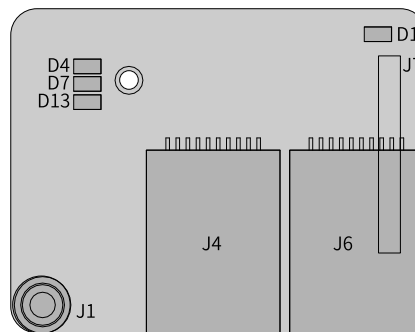


Figure 12-3 MD500-EN1 card terminal layout

Interface description

Table 12-1 Descriptions of MD500-EN1 card terminals

Terminal Mark	Terminal Name	Description
J7	Pin header	It is used to connect the AC drive.
J4	Network port	The ports are standard Ethernet RJ45 ports and are direction-insensitive. The MD500-EN1 card uses the ports to communicate with the EtherNet/IP master (or other slaves). The pin definition is consistent with the standard Ethernet pin definition. The crossed or straight cables are supported.
J6		
J1	EMC grounding terminal	It is used to connect the EMC grounding terminal of the AC drive.

Terminal Mark	Terminal Name	Description
D13	Power supply indicator (green)	It is used to indicate the status of the power supply. On: Normal OFF: Abnormal. Check whether the card is installed properly.
D1	Status indicator of communication with the AC drive (green)	For details, see “Table 12-2 Indicators of the MD500-EN1 card” on page 232.
D4	Ethernet/IP master running indicator (green)	
D7	Ethernet/IP master fault indicator (red)	

**Caution**

- After the MD500-EN1 card is installed, J2 is on the left and J3 is on the right when you face the RJ45 interface. J2 and J3 are direction-insensitive. You can connect either one to the PLC.
- It is recommended to use shielded Cat 5e twisted pair cables to ensure stable operation.

Status indicators

Table 12-2 Indicators of the MD500-EN1 card

Indicator	Status	Solution
D1 (green): steady on	Normal	None
D1 (green): off	Abnormal communication with the AC drive	Check that FD-00 is set to 9 and FD-01 is set to 3.
D4 (green): off; D7 (red): steady on	System fault	See the following AC drive fault codes and solutions.
D4 (green): off; D7 (red): blinking	Waiting for obtaining IP address	The DHCP function is enabled, and the expansion card is waiting for IP address assignment by using the BOOTP or DHCP.
D4 (green): blinking; D7 (red): blinking	Connection disconnected or timed out	Check whether the network cable is disconnected and whether the master is running.
D4 (green): blinking; D7 (red): off	Waiting for connecting to the master	Check whether the network cable is properly connected and whether the master is running.
D4 (green): steady on; D7 (red): off	Normal	None

12.4 Networking Topology

EtherNet/IP supports a variety of topologies, including bus, star, and tree topologies. Diversified networking modes can be implemented by using switches.

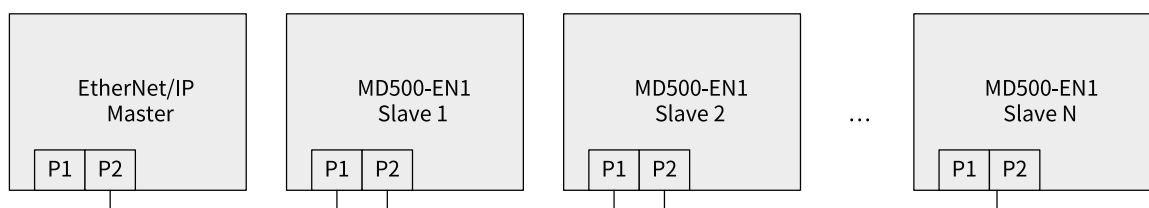


Figure 12-4 Bus topology

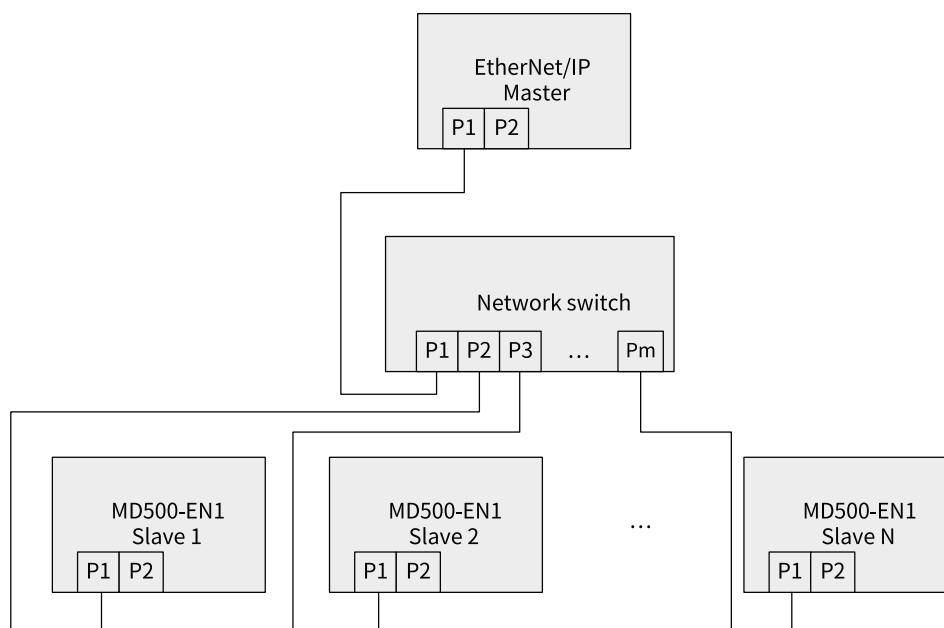


Figure 12-5 Star topology

12.5 Device Level Ring Protocol

The device level ring (DLR) protocol is the second layer protocol of the OSI. It is mainly used for EtherNet/IP devices with multiple Ethernet ports and embedded switch technologies. The DLR protocol provides quick network fault detection and re-configuration functions, and provides configuration and diagnostic interfaces (DLR Object) for EtherNet/IP devices. When the DLR protocol is used, at least one ring network manager exists in the network topology.

The MD500-EN1 card acts as the node of the DLR-based beacon frame in the ring network. When the MD500-EN1 card detects a ring network topology fault or detects that the ring network topology recovers, the switchover between the ring network and the linear network can be completed within 1 ms.

To use the DLR protocol for networking, do the following:

1. Connect the MD500-EN1 card and EtherNet/IP master to form a linear network.
2. Enable the ring network manager function of the EtherNet/IP master.
3. Connect the MD500-EN1 card and EtherNet/IP master to form a ring topology.

Note the following:

1. The MD500-EN1 card with the version V1.12 or later supports the DLR protocol. Therefore, ensure that the software version of the MD500-EN1 card is V1.12 or later.
2. When networking by the DLR protocol, enable or keep the ring network manager function of the EtherNet/IP master station enabled before connecting to the ring network. If the ring network manager function of the EtherNet/IP master is enabled after the ring network is formed, the network link may be fully loaded and communication faults may occur.
3. When the MD500-EN1 card is used for ring networking, non-DLR devices that meet the following conditions are allowed for networking:
 - Non-DLR devices that disable unicast MAC address learning or do not use MAC address learning

- Non-DLR devices that disable the multicast MAC address filtering function of the networking port
 - Non-DLR devices that support receiving 802.1 Q Ethernet frame and retaining the VLAN field
 - Non-DLR devices that forward VLAN fields according to the priority to prevent ring network performance from being affected
4. When the switch is used for networking, the DLR switch is preferred. Using a non-DLR switch may result in the loss of unicast frames for a period of time after the loop fails or recovers until the MAC learning table of the switch is re-established. To avoid this, non-DLR switches that meet the following conditions can be used:
- The static unicast MAC address is configured.
 - Unicast MAC learning is disabled for the switch.
 - The non-DLR switch is connected to a multi-port DLR device (such as a 3-port DLR switch), and the multi-port DLR device is connected to the ring network.

12.6 Communication Protocol

12.6.1 I/O Messages

The MMD500-EN1 expansion card supports 24 I/O messages for data transmission, of which 12 messages are sent from the master to slave and 12 messages are sent from the slave to the master.

The I/O messages enable the master to modify and read AC drive data in real time and perform periodic data exchange. The data communication addresses are directly configured by the AC drive. The specific functions are as follows:

- Real-time settings of AC drive control commands and target frequencies
- Real-time reading of AC drive current state and running frequency
- Real-time exchange of function parameters and monitoring parameters between the AC drive and EtherNet/IP master

The I/O message data is used for periodic data exchange between the master and the AC drive, as described in the following table.

I/O Messages (O->T) Sent by Master		
AC drive command	AC drive target frequency	Real-time modification of AC drive function parameters
Output I/O Messages[0]	Output I/O Messages[1]	Output I/O messages 2 to 11
I/O messages (T->O) Returned by AC Drive		
AC drive state	AC drive running frequency	Real-time reading of AC drive function parameters
Input I/O Messages[0]	Input I/O Messages[1]	Input I/O messages 2 to 11

12.6.2 Data Sent by the Master

The following table describes the data sent by the master.

I/O Message Data Sent by the Master		
I/O Messages 0	AC drive command word (command source set to communication)	
	00: Stop according to the stop mode defined by F6-10; 01: Run in forward direction; 02: Run in reverse direction; 03: Jog in forward direction;	04: Jog in reverse direction; 05: Coast to stop; 06: Stop according to the stop mode defined by F6-10; 07: Reset upon fault
I/O Messages 1	It indicates the AC drive target frequency (frequency source set to communication), which ranges from the reverse frequency upper limit (negative value) to forward frequency upper limit (decimal places included, for example, 2000 corresponds to 20.00 Hz on the AC drive). When the target frequency exceeds this range, the AC drive runs at the frequency upper limit.	
I/O Messages 2 to I/O Messages 11	Function parameter values (group F and group A) are modified in real time, which are not written into the EEPROM. FE-02 to FE-11 correspond to I/O Messages 2 to I/O Messages 11. For details about the configuration, see the I/O message data configuration.	

12.6.3 Data Returned by the AC drive

The following table describes the data returned by the AC drive.

I/O Message Data Returned by the AC Drive	
I/O Messages 0	It indicates the AC drive state, which is described as follows by bit: Bit 0: 0: Stopped; 1: Running Bit 1: 0: Running in forward direction; 1: Running in reverse direction Bit 2: 0: Not faulty; 1: Faulty Bit 3: 0: Running frequency not reached; 1: Running frequency reached Bit 4 to bit 7: Reserved Bit 8 to bit 15: AC drive fault code
I/O Messages 1	It indicates the AC drive running frequency (unit: 0.01 Hz). The current AC drive running frequency is returned as 16-bit signed data.
I/O Messages 2 to I/O Messages 11	Function parameter values (group F and group A) and monitoring parameter values (group U) are read in real time. FE-22 to FE-31 correspond to I/O Messages 2 to I/O Messages 11. For details about the configuration, see the I/O message data configuration.

12.7 Related parameters

12.7.1 Communication Card Type Setting

After powering on the AC drive, set F0-28 to 1 to enable communication between the MD500-EN1 card and the AC drive.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-28	Communication protocol	0: Modbus protocol 1: Expansion communication protocol 2: Inobus protocol (through EtherCAT card)	1	This parameter is used to select a communication protocol. 0: Modbus protocol The Modbus protocol is used. 1: Expansion communication protocol PROFIBUS DP, PROFINET, EtherCAT, Modbus TCP, and EtherNet/IP protocols can be used. No setting is required for CANlink because it is always valid. 2: Inobus protocol (through EtherCAT card) When this parameter is set to 2, the Inobus communication protocol is used. The AC drive version must be F7-10 = U60.07/F7-11 = U61.07/F7-15 = 000.00/F7-16 = 000.00 or later.
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run and jog operation. 0: Operating panel The RUN/STOP key on the operating panel can be used to start or stop the drive. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined The command source is defined by the user as needed for expansion.

Parameter Code	Parameter Name	Value Range	Value	Description
F0-03	Main frequency source X selection	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	9	This parameter is used to set the source of the main frequency X as below. 0: Digital setting (non-retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is restored to the value of F0-08. 1: Digital setting (retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is the same as that at the moment of the last power failure. Modifications made by using keys ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP and DOWN key remain effective. 2: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15).

Parameter Code	Parameter Name	Value Range	Value	Description
Continued	Continued	Continued	Continued	7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources.

12.7.2 IP Address Setting of MD500-EN1 Card

The following table describes parameters of the AC drive communication card.

Parameter Code	Parameter Name	Value Range	Description
FD-37	DHCP selection	0: Disable 1: Enable	This parameter sets whether to enable the DHCP function of the EtherNet/IP expansion card. After the DHCP function is enabled, the following IP address configuration parameters are invalid.
FD-38 to FD-41	Expansion card IP address	0-255	These parameters define the IP address of the EtherNet/IP expansion card.

Parameter Code	Parameter Name	Value Range	Description
FD-42 to FD-45	Expansion card subnet mask	0-255	These parameters define the subnet mask of the EtherNet/IP expansion card.
FD-46 to FD-49	Expansion card gateway IP address	0-255	These parameters define the gateway address of the EtherNet/IP expansion card.

The IP address can be a static one or dynamic one assigned by DHCP function. The IP address type is selected by FD-37. The static IP address is set by FD-37 to FD-49. For example, if the static IP address is 192.168.0.6, the subnet mask is 255.255.255.0, and the gateway IP address is 192.168.0.1, set parameters as follows:

Parameter Code	Parameter Name	Value
FD-37	DHCP selection	0
FD-38	Highest order byte of the IP address	192
FD-39	Second highest order byte of the IP address	168
FD-40	Third highest order byte of the IP address	0
FD-41	Lowest order byte of the IP address	6
FD-42	Highest order byte of the subnet mask	255
FD-43	Second highest order byte of the subnet mask	255
FD-44	Third highest order byte of the subnet mask	255
FD-45	Lowest order byte of the subnet mask	0
FD-46	Highest order byte of the gateway IP address	192
FD-47	Second highest order byte of the gateway IP address	168
FD-48	Third highest order byte of the gateway IP address	0
FD-49	Lowest order byte of the gateway IP address	1

When using the DHCP or Bootstrap Protocol (BOOTP) function, you can obtain the MAC address of the expansion card by checking the label on the card, or viewing the related parameter of the AC drive. For details, see section 3.1.3.

The expansion card also supports the IP address conflict detection function. When the IP address of this card is the same as that of another device in the network, the red indicator D7 becomes steady on, and bit 2 of FD-58 changes to 1.

There are three IP address conflict situations, as described in the following table.

No.	Scenario	Symptom	Solution
1	Both devices support IP address conflict detection. The two devices are powered on at different time.	The device that is powered on first retains the IP address and continues to operate, while the device that is powered on later enters the IP address conflict mode.	Check the IP address conflict and modify the duplicate IP address.
2	Both devices support IP address conflict detection. The two devices are powered on almost at the same time.	Both devices can detect IP address conflict at the same time.	
3	One device supports IP address conflict detection while the other does not.	No matter which device is powered on first, the device that does not support IP address conflict detection will be assigned with the IP address, while the device that supports IP address conflict detection will detect IP address conflict.	

Note

- The expansion card implements active conflict detection upon power-on and DHCP IP address assignment, and it implements passive detection at other times. If the same dynamic (static) IP address is separately assigned to two devices, which are then connected to a network, neither of the two expansion cards will report an IP address conflict.
- IP address assignment by using the DHCP function will fail if an assignment conflict occurs during the process.

12.7.3 Parameters Related to AC Drive Communication Card

Parameter Code	Parameter Name	Unit	Description
FD-61	High-order byte of MAC address	1	Displays the high-order byte of the MAC address of the Ethernet expansion card (EtherNet/IP, Modbus TCP).
FD-62	Middle-order byte of MAC address	1	Displays the middle-order byte of the MAC address of the Ethernet expansion card (EtherNet/IP, Modbus TCP).
FD-63	Low-order byte of MAC address	1	Displays the low-order byte of the MAC address of the Ethernet expansion card (EtherNet/IP, Modbus TCP).
FD-58	Ethernet expansion card error code	1	Displays the error code of the Ethernet expansion card (EtherNet/IP, Modbus TCP).

12.7.4 Communication Control Parameters

Parameter Code	Parameter Name	Value Range		Decimal Address
U3-16	Frequency set through communication	-320.00 Hz to 320.00 Hz		29456
U3-17	Communication setting control word	0001: Forward run 0002: Reverse run 0003: Forward jog 0004: Reverse jog	0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	29457
U3-18	DO state (terminal function defined by parameters in group F5: communication control)	Bit 0: DO1 output control Bit 1: DO2 output control Bit 2: Relay 1 output control Bit 3: Relay 2 output control Bit 4: FMR output control	Bit 5: VDO1 Bit 6: VDO2 Bit 7: VDO3 Bit 8: VDO4 Bit 9: VDO5	29458
U3-19	AO1 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29459
U3-20	AO2 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29460
U3-21	HDO output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29461
U3-22	Communication card error state	0 to 65535		29462
U3-23	Speed set through communication	-32000 rpm to 32000 rpm		29463

When the MD500-EN1 card is used, the written I/O Messages0 and I/O Messages1 are mapped to U3-17 and U3-16 respectively by default. If a command or frequency fails to be written into the AC drive while I/O Messages2 to I/O Messages11 can be written and F0-02 and F0-03 are set to 2 and 9 respectively, check whether FE-00 and FE-01 are U3-17 and U3-16 respectively. If not, manually correct the parameter values.

12.7.5 Communication Monitoring Parameters

Table 12-3 Communication monitoring parameters

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-00	Operating frequency	0.01 Hz	28672
U0-01	Frequency reference	0.01 Hz	28673
U0-02	Bus voltage	0.1 V	28674
U0-03	Output voltage	1 V	28675
U0-04	Output current	0.1 A	28676
U0-05	Output power	0.1 kW	28677

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-06	Output torque	0.1%	28678
U0-07	DI input state	1	28679
U0-08	DO output state	1	28680
U0-09	AI1 voltage	0.01 V	28681
U0-10	AI2 voltage	0.01 V	28682
U0-11	AI3 voltage	0.01 V	28683
U0-12	Count value	1	28684
U0-13	Length value	1	28685
U0-14	Load speed display	1	28686
U0-15	PID reference	1	28687
U0-16	PID feedback	1	28688
U0-17	PLC stage	1	28689
U0-18	Pulse input frequency	0.01 kHz	28690
U0-19	Feedback speed	0.01 Hz	28691
U0-20	Remaining running time	0.1 min	28692
U0-21	AI1 voltage before calibration	0.001 V	28693
U0-22	AI2 voltage before calibration	0.001 V	28694
U0-23	AI3 voltage before calibration	0.001 V	28695
U0-24	Motor speed	1 rpm	28696
U0-25	Current power-on time	1 min	28697
U0-26	Current operating time	0.1 min	28698
U0-27	Pulse input frequency	1 Hz	28699
U0-28	Communication setpoint	0.01%	28700
U0-29	Encoder feedback speed	0.01 Hz	28701
U0-30	Display of main frequency X	0.01 Hz	28702
U0-31	Display of auxiliary frequency Y	0.01 Hz	28703
U0-32	Memory address view	1	28704
U0-33	Synchronous motor rotor position	0.1°	28705
U0-34	AI3 temperature mode - motor temperature	1°C	28706
U0-35	Target torque	0.1%	28707
U0-36	Resolver position	1	28708
U0-37	Power factor angle	0.1°	28709
U0-38	ABZ position	1	28710
U0-39	Target voltage upon V/f separation	1 V	28711
U0-40	Output voltage upon V/f separation	1 V	28712
U0-45	Fault subcode	1	28717
U0-58	Number of motor revolutions	1	28730
U0-59	Frequency reference	0.01%	28731

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-60	Operating frequency	0.01%	28732
U0-61	AC drive state	1	28733
U0-62	Current fault code	1	28734
U0-63	Torque sent in point-to-point communication	0.01%	28735
U0-64	Number of slaves in master-slave control	1	28736
U0-65	Torque upper limit	0.1%	28737
U0-66	Model of communication expansion card	100: CANopen 200: PROFIBUS DP 300: CANlink 400: PROFINET 500: EtherCAT 600: EtherNet/IP	28738
U0-67	Software version of communication extension card	1	28739
U0-68	AC drive state read through DP card	1	28740
U0-69	Frequency read through communication expansion card	0.01 Hz	28741
U0-70	Speed read through communication expansion card	1 rpm	28742
U0-71	Communication card-specific current	0.1 A	28743
U0-80	EtherCAT slave name	1	28752
U0-81	EtherCAT slave alias	1	28753
U0-83	EtherCAT XML file version	1	28755
U0-84	Number of lost EtherCAT synchronization frames	1	28756
U0-85	Maximum number of error frames and invalid frames over EtherCAT port 0 per unit time	1	28757
U0-86	Maximum number of error frames and invalid frames of EtherCAT port 1 per unit time	1	28758
U0-87	Maximum number of error frames forwarded by EtherCAT port per unit time	1	28759

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-88	Maximum number of error frames processed by EtherCAT data frame processing unit per unit time	1	28760
U0-89	Maximum number of lost links over the EtherCAT port per unit time	1	28761

12.8 Communication Configuration

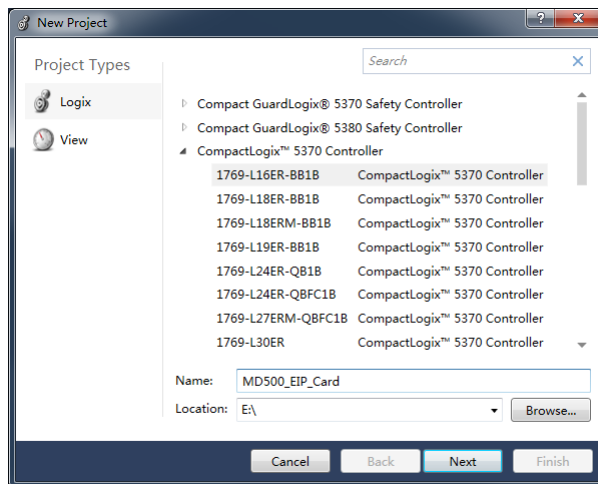
12.8.1 Using an MD500-EN1 Expansion Card on an Allen-Bradley L16ER Master

In this section, Studio 5000 version 32.00.00 is used, the master is 1769-L16ER-BB1B, and the IP address and other information have been configured in advance according to the user guide. Both network ports on the expansion card are available. To use the expansion card, set F0-02 to 2, F0-03 to 9, FD-00 to 9, and FD-01 to 3 on the AC drive.



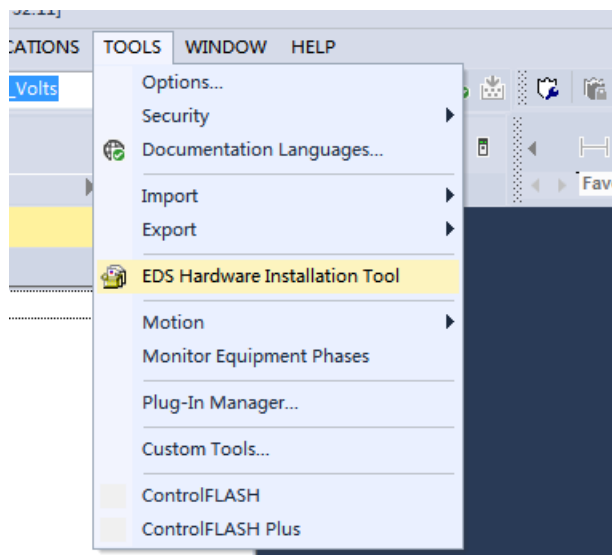
Step 1: Create a project.

Open Studio 5000 and create a project. Select **1769-L16ER-BB1B** under **CompactLogix 5370 Controller** as the controller model.

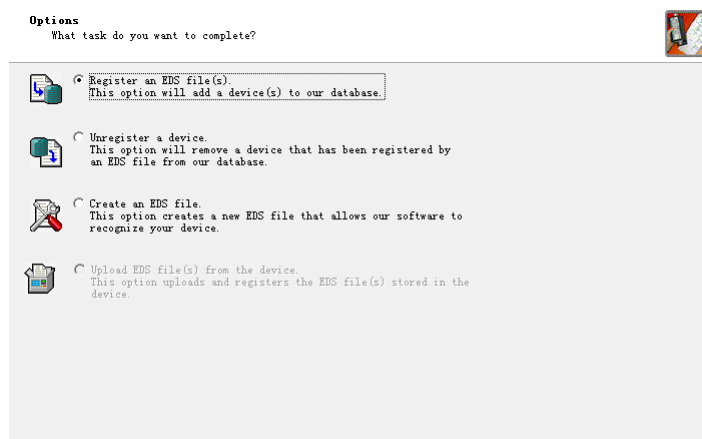


Step 2: Import the EDS file.

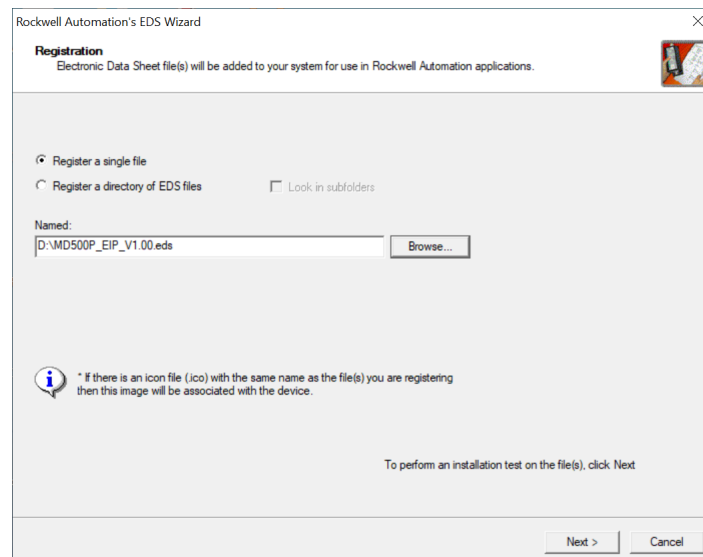
Choose **Tools > EDS Hardware Installation Tool**.



Click **Next**, and select **Register an EDS file(s)**.



Select the EDS file in your computer and click **Next**.



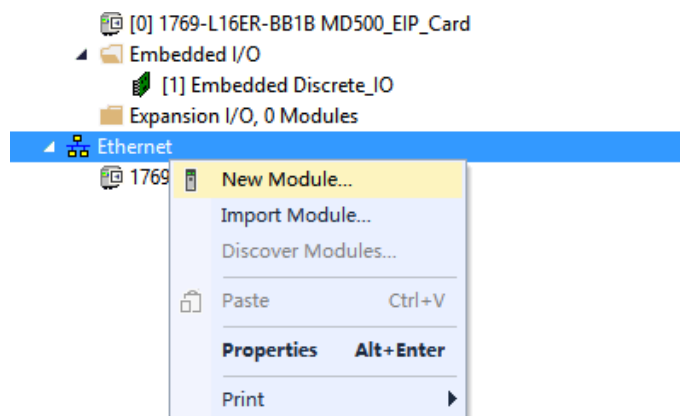
Keep clicking **Next** until the **Finish** button appears, and then click **Finish**.

Step 3: Set the IP address for the expansion card. Take a static IP address as an example.

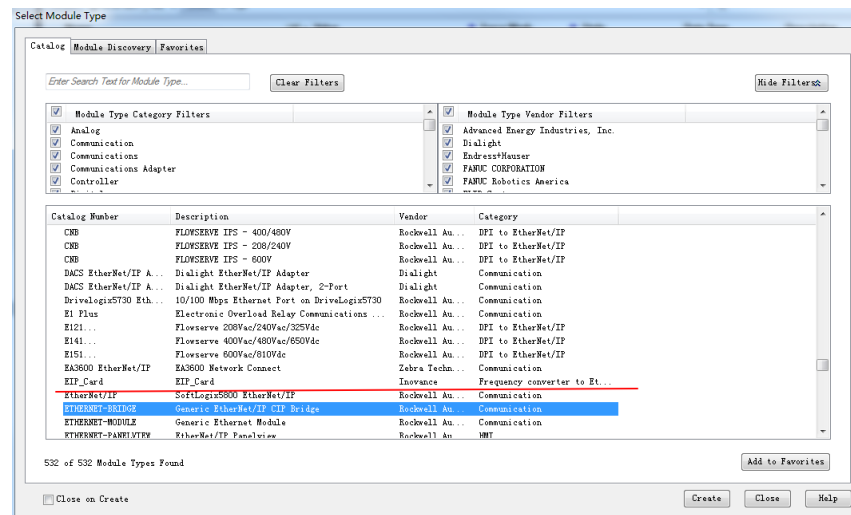
Set the AC drive parameters FD-37 to FD-49 to 0, set the IP address to 192.168.0.6, set the subnet mask to 255.255.255.0, and set the gateway address to 192.168.0.1.

Step 4: Configure the Studio 5000 project.

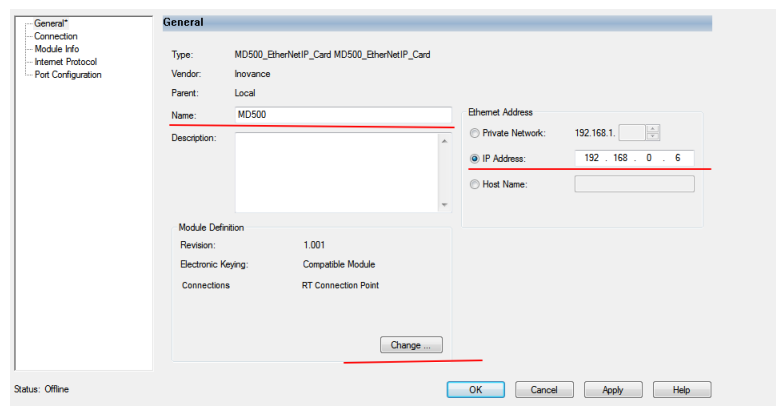
Click **Ethernet** on the left and choose **New Module**.



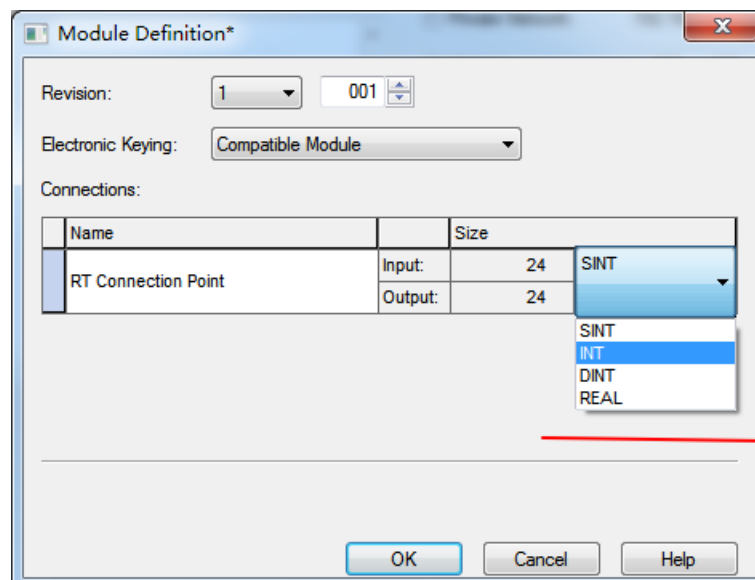
Locate **EIP_Card** and click **Create**.



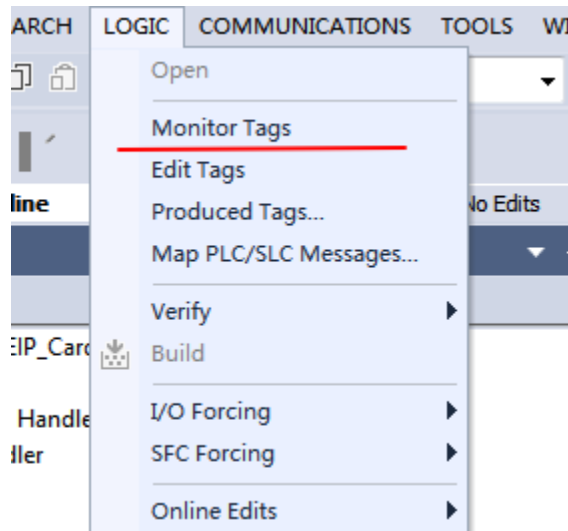
On the displayed configuration interface, enter the configured IP address and specify the name.



Click **Change**, select **INT** from the **SINT** drop-down list on the right, click **OK**, ignore the warning and click **Yes**.



Choose **LOGIC > Monitor Tags**.



Unfold **MD500:C.Data**, and select **Hex** in the **Style** column.

Name	Value	Force Mask	Style	Data Type	Description
Local:I:C		{...}	{...}	AB:Embedded_Discr...	
Local:I:I		{...}	{...}	AB:Embedded_Discr...	
Local:I:O		{...}	{...}	AB:Embedded_Discr...	
MD500:C		{...}	{...}	MD500-EtherN...	
MD500:C.Data		{...}	Hex	SINT[48]	
MD500:C.Data[0]		16#44	Hex	SINT	
MD500:C.Data[1]		16#70	Hex	SINT	
MD500:C.Data[2]		16#45	Hex	SINT	
MD500:C.Data[3]		16#70	Hex	SINT	
MD500:C.Data[4]		16#00	Hex	SINT	
MD500:C.Data[5]		16#00	Hex	SINT	
MD500:C.Data[6]		16#00	Hex	SINT	
MD500:C.Data[7]		16#00	Hex	SINT	
MD500:C.Data[8]		16#00	Hex	SINT	
MD500:C.Data[9]		16#00	Hex	SINT	
MD500:C.Data[10]		16#00	Hex	SINT	
MD500:C.Data[11]		16#00	Hex	SINT	
MD500:C.Data[12]		16#00	Hex	SINT	

The parameters under **MD500:C.Data** are related to PDO mapping. Every two parameters form a group. 0-23 are I/O Messages Mapping(T->O), and 24-27 are I/O Messages Mapping(O->T). As shown in the figure, Data[0] is 0x44, and Data[1] is 0x70, indicating that TPDO1 is mapped to U0-68.

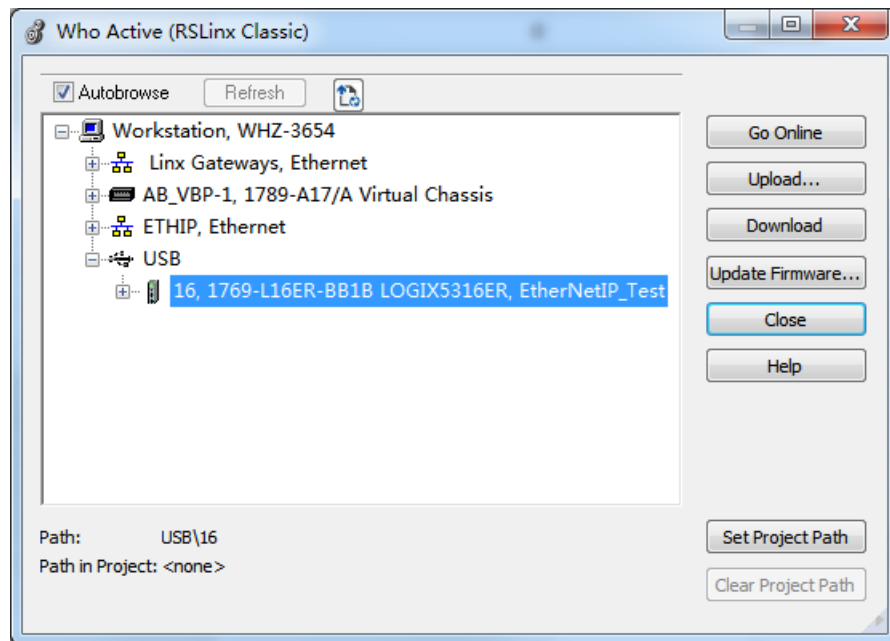
By default, I/O Messages Mapping(T->O)[0] is U0-68, I/O Messages Mapping(T->O)[1] is U0-69, I/O Messages Mapping(O->T)[0] is U3-17, and I/O Messages Mapping(O->T)[1] is U3-16. These four entries cannot be modified. Otherwise, a fault will occur. Other entries can be customized.

MD500:I.Data and MD500:O.Data are I/O data during transmission. Values written to O.Data are actually written into the corresponding parameters according to the configured mapping. The parameter configured in I/O Messages Mapping(T->O)[0] is uploaded to I.Data regularly.

After the configuration is complete, click the button marked with the red square in the figure below to search for the device.

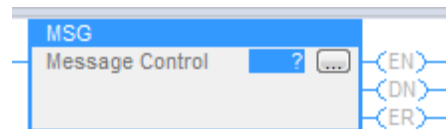


In this example, USB is used to connect the device. Select the device and click **Download** to download the code to the PLC.

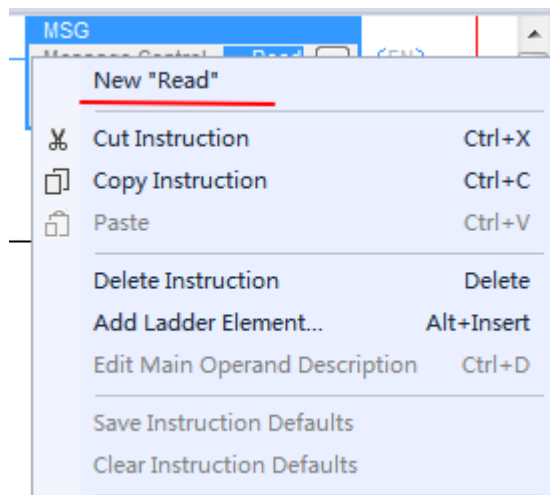


Step 5: Transmit data using explicit messages.

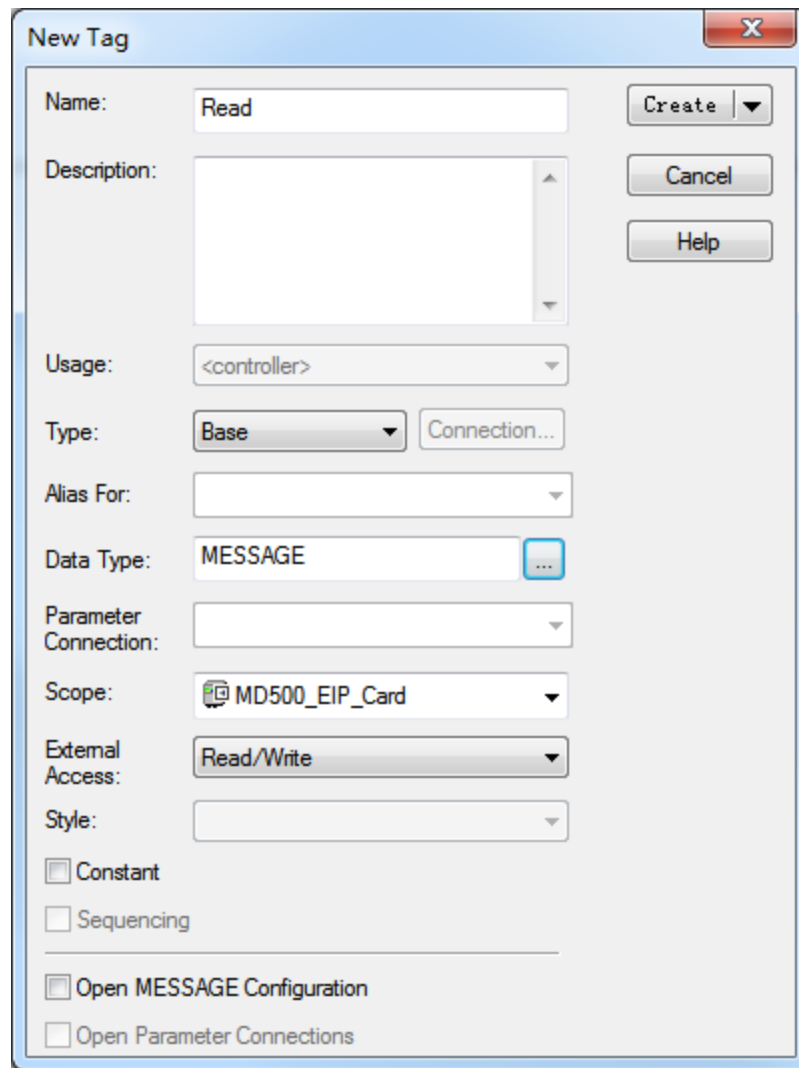
Open the program compiling part in the PLC, and click **MSG** under **Input/Output**.



Enter a name at the question mark (?), right-click the name, and choose **New "Read"**.



Click **Create**.

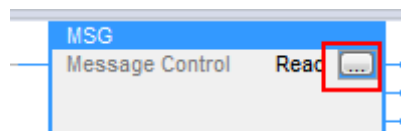


The 'New Tag' dialog box is shown with the following settings:

- Name: Read
- Description: (empty text area)
- Usage: <controller>
- Type: Base
- Alias For: (empty dropdown)
- Data Type: MESSAGE
- Parameter Connection: (empty dropdown)
- Scope: MD500_EIP_Card
- External Access: Read/Write
- Style: (empty dropdown)
- Constant: ☐
- Sequencing: ☐
- Open MESSAGE Configuration: ☐
- Open Parameter Connections: ☐

Buttons on the right: Create, Cancel, Help.

Click ... on the right under **MSG**.



Set the parameters according to the following figure.

Set **Service Type** to **Get Attribute Single** for reading parameters or **Set Attribute Single** for writing parameters. **Class** is fixed to 0x93, **Attribute** is fixed to 0x9, and **Instance** is the decimal value converted from the parameter to be read. For example, FD-13, that is, FD0D, needs to be converted to the decimal value 64781, as shown in the preceding figure.

Select a position for storing the parameter from the **Destination Element** drop-down list on the right. You can also click **New Tag** to create a variable.

Click the **Communication** tab to select the AC drive.

Message Configuration - Read

Configuration* Communication* Tag

Path: MD500 [Browse...]

Broadcast: [v]

Communication Method

☒ CIP ☐ DH+ Channel: A Destination Link: 0

☐ CIP With Source ID Source Link: 0 Destination Node: 0 (Octal)

☒ Connected ☐ Cache Connections ☐ Large Connection

☐ Enable ☐ Enable Waiting ☐ Start ☐ Done Done 0

☐ Error Extended Error ☐ Timed Out

ErrCode: Error

Click **OK**. The master will read the parameter and store the data to the selected variable. You can choose **LOGIC > Monitor Tags** to view the value of the variable.

MD500:I	{...}	{...}	_3039:MD500_EtherN...
MD500:O	{...}	{...}	_3039:MD500_EtherN...
Read	{...}	{...}	MESSAGE
EIP_Read	1	Decimal	DINT
key	0	Decimal	BOOL

To write a parameter, set the parameters according to the following figure.

Message Configuration - Read

Configuration* Communication* Tag

Message Type: CIP Generic

Service Type: Set Attribute Single Source Element: EIP_Read

Service Code: 10 (Hex) Class: 93 (Hex) Source Length: 2 (Bytes)

Instance: 64781 Attribute: 9 (Hex) Destination Element: [v]

New Tag...

☐ Enable ☐ Enable Waiting ☐ Start ☐ Done Done 0

☐ Error Extended Error ☐ Timed Out

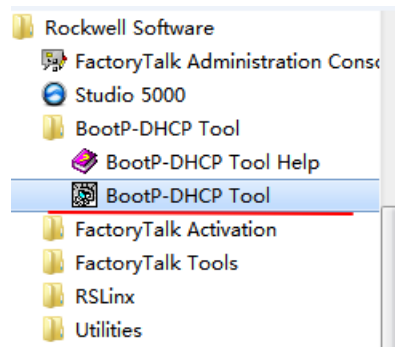
ErrCode: MD500 Error

Step 6: Set the DHCP function.

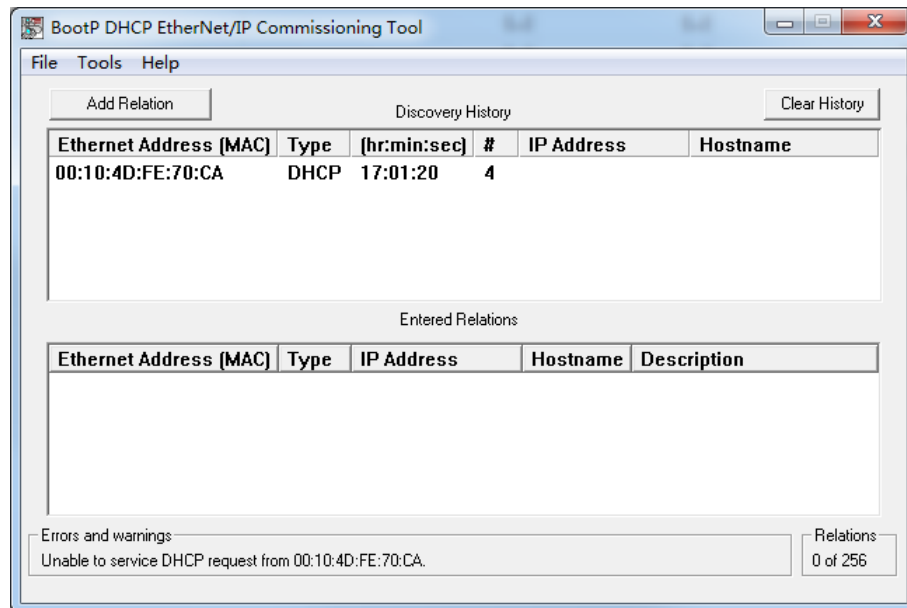
Note: IP addresses assigned by using the DHCP function are not retained upon power failure.

Set FD-37 to 1 to enable the DHCP function, power on the AC drive again, and connect the PC and AC drive to the same network.

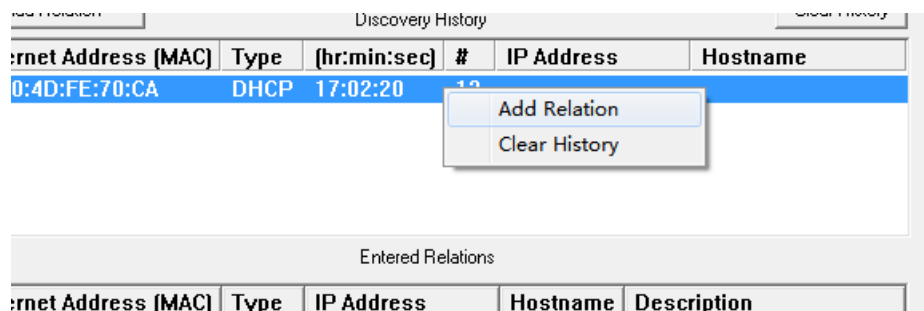
Choose **BootP-DHCP Tool** from the start menu, and select the network adapter.



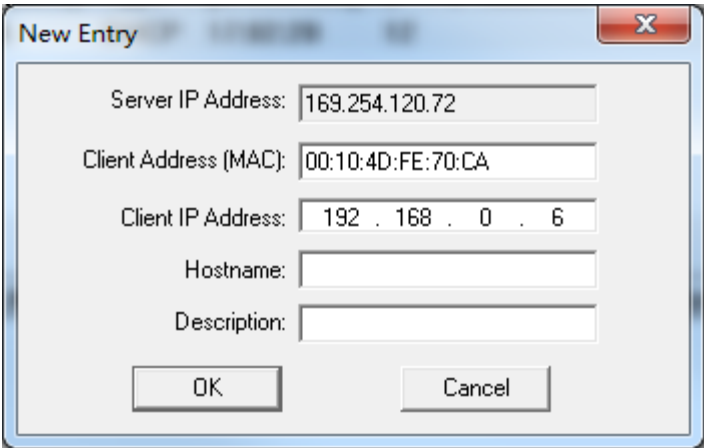
After power-on, find the device request in the BootP DHCP EtherNet/IP Commissioning Tool.



Right-click the request and select **Add Relation**.

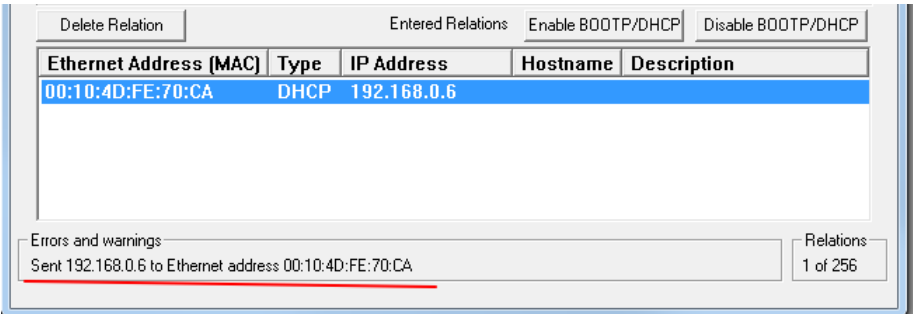


Set the IP address and click **OK**.



A dialog box titled "New Entry" with a close button (X) in the top right corner. It contains several input fields: "Server IP Address" with the value "169.254.120.72", "Client Address (MAC)" with the value "00:10:4D:FE:70:CA", "Client IP Address" with the value "192 . 168 . 0 . 6", "Hostname" (empty), and "Description" (empty). At the bottom are "OK" and "Cancel" buttons.

The IP address is written to the device.



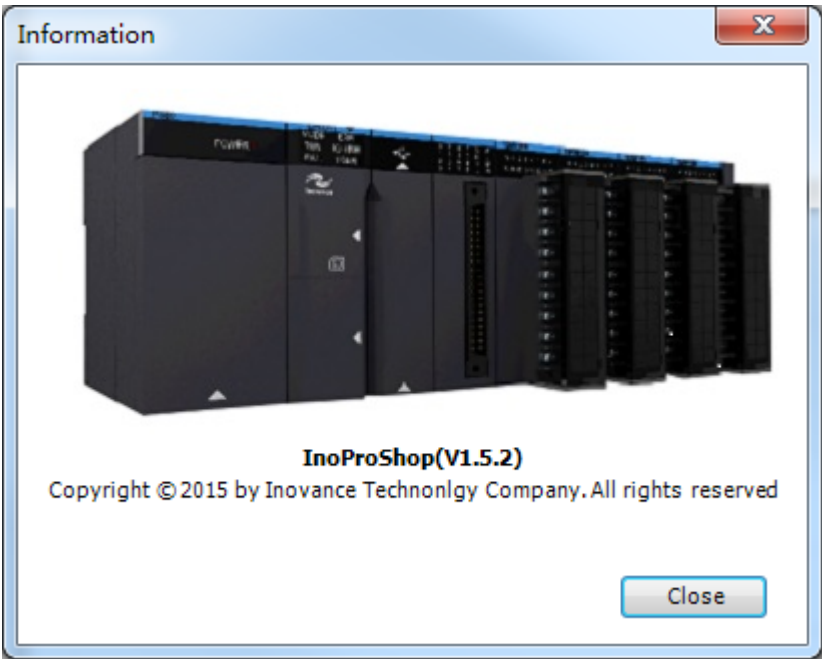
A dialog box titled "Entered Relations" with buttons for "Delete Relation", "Enable BOOTP/DHCP", and "Disable BOOTP/DHCP". It contains a table with the following data:

Ethernet Address (MAC)	Type	IP Address	Hostname	Description
00:10:4D:FE:70:CA	DHCP	192.168.0.6		

Below the table is an "Errors and warnings" section with the text "Sent 192.168.0.6 to Ethernet address 00:10:4D:FE:70:CA". A "Relations" box in the bottom right shows "1 of 256".

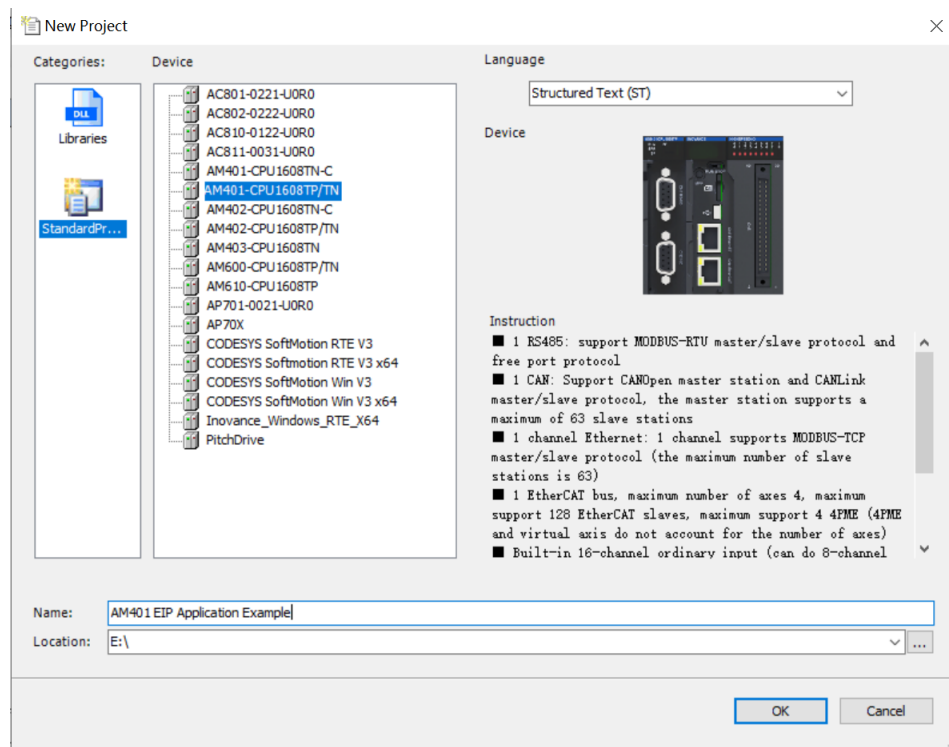
12.8.2 Using an MD500-EN1 Expansion Card on an Inovance AM600 Master

In this example, InoProShop V1.5.2 is used, the master is AM600, and the IP address and other information have been configured in advance according to the guide. You can use either the right or left network port on the expansion card. To use the expansion card, set F0-02 to 2, F0-03 to 9, FD-00 to 9, and FD-01 to 3 on the AC drive.



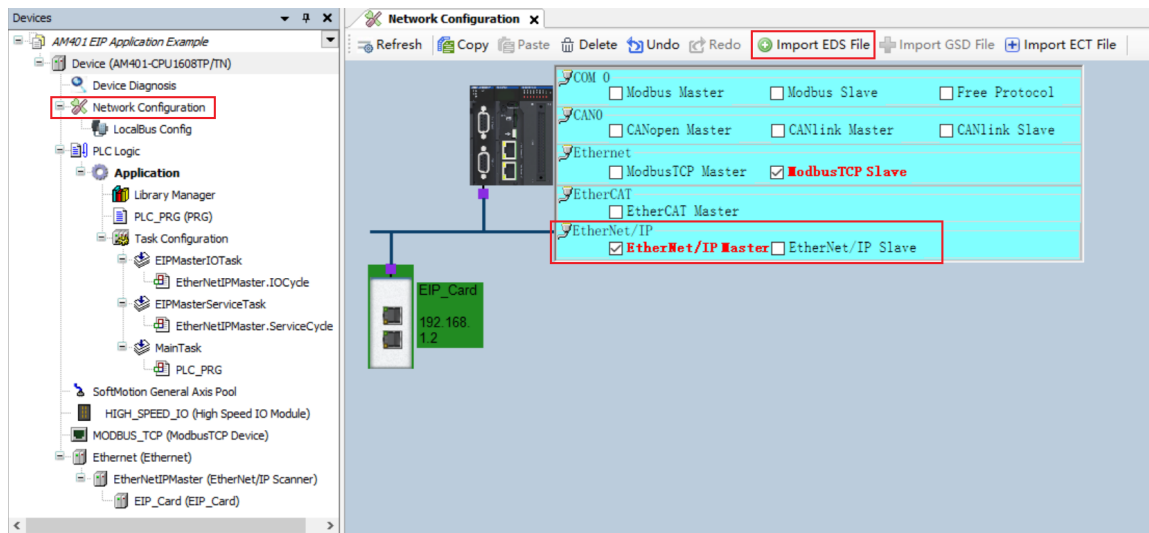
Step 1: Create a project.

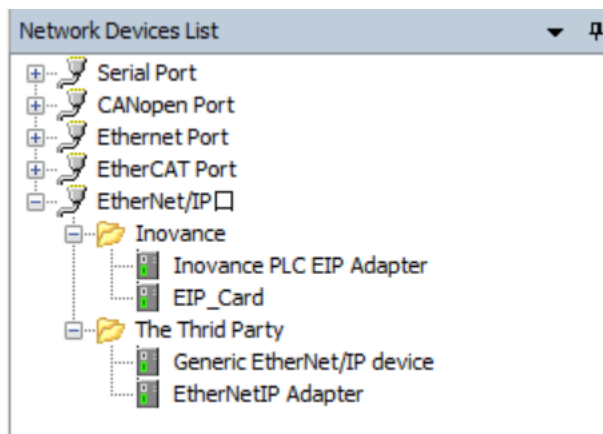
Open InoProShop and create a project. Select the device model AM600-CPU1608TP/TN.



Step 2: Import the EDS file and add a slave.

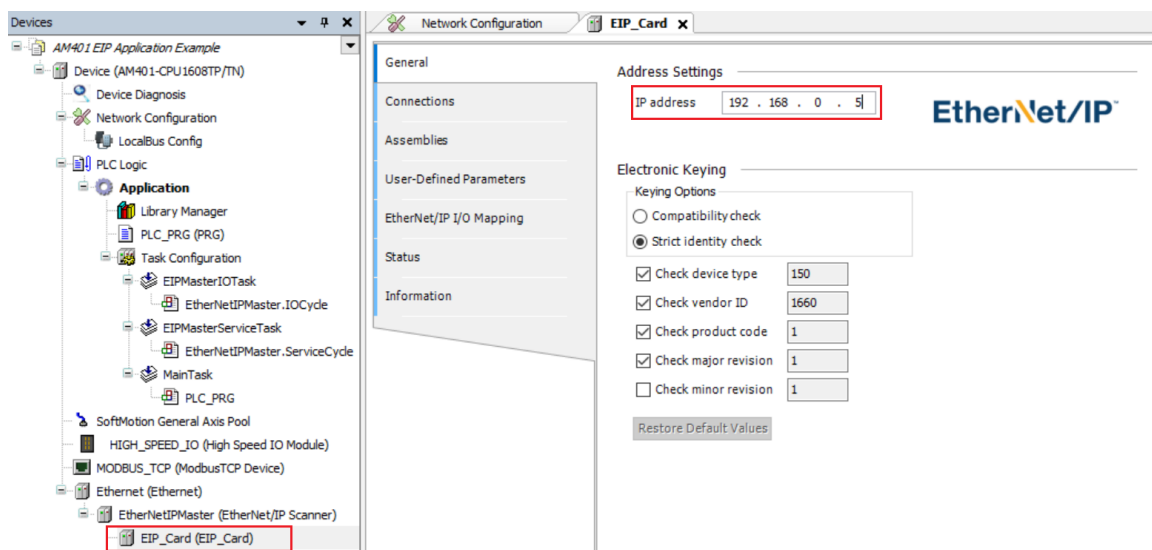
Click **Network Configuration** on the left, click the PLC, select **EtherNet/IP Master**, and click **Import EDS File** to import the EDS file for the EtherNet/IP expansion card. Import the device in the **Network Device List** on the right.





Step 3: Configure parameters for the slave.

Configure an IP address for the slave.

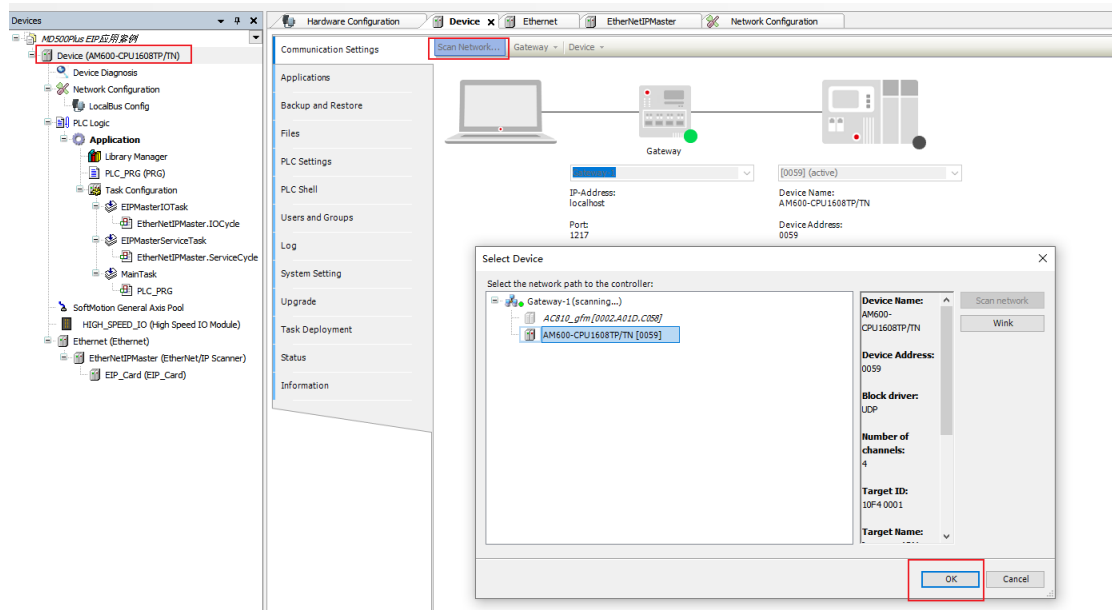


Click **Connections** on the left to configure the implicit message mapping. **Input I/O Messages Mapping(T->O)[X]** is the mapping of data sent from the slave to the master, and **Output I/O Messages Mapping(O->T)[X]** is the mapping of data sent from the master to the slave. Each entry can be configured with up to 12 mappings. By default, **Input I/O Messages Mapping(T->O)[0]** is mapped to U0-68 (28740 in decimal), **Input I/O Messages Mapping(T->O)[1]** is mapped to U0-69 (28741 in decimal); **Output I/O Messages Mapping(O->T)[0]** is mapped to U3-17 (29457 in decimal), and **Output I/O Messages Mapping(O->T)[1]** is mapped to U3-16 (29456 in decimal). Do not change these four default mappings. Other mappings are set to F0-00 (61440 in decimal) by default. You can modify the mappings as required here. Convert the parameter address into a decimal value and enter the value. For example, for F0-12, enter 61452. Retain the default values for unneeded mappings.

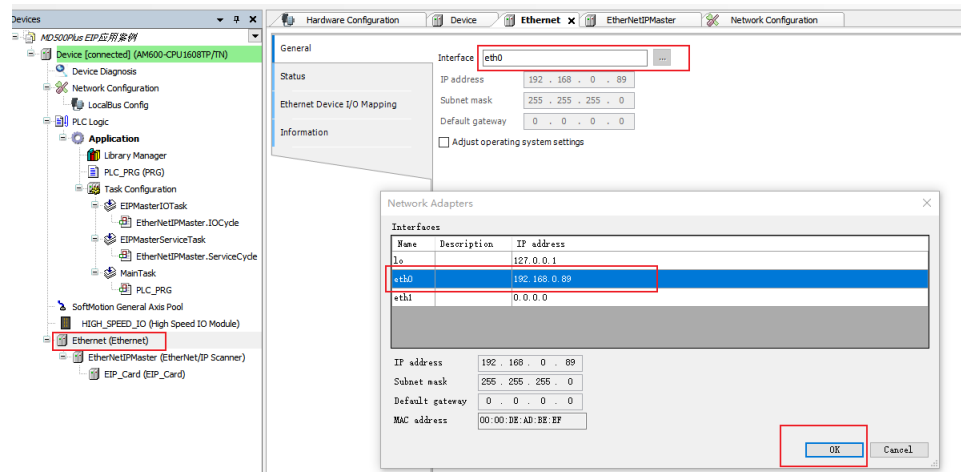
Configuration Data							
Parameters							
	Value	Unit	Data Type	Minimum	Maximum	Default	Help String
Exclusive Owner							
Target Config data							
Input I/O Messages Mapping(T->O)[0]	28740		UINT	0	65535	28740	New Help String
Input I/O Messages Mapping(T->O)[1]	28741		UINT	0	65535	28741	New Help String
Input I/O Messages Mapping(T->O)[2]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[3]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[4]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[5]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[6]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[7]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[8]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[9]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[10]	61440		UINT	0	65535	61440	New Help String
Input I/O Messages Mapping(T->O)[11]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[0]	29457		UINT	0	65535	29457	New Help String
Output I/O Messages Mapping(O->T)[1]	29456		UINT	0	65535	29456	New Help String
Output I/O Messages Mapping(O->T)[2]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[3]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[4]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[5]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[6]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[7]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[8]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[9]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[10]	61440		UINT	0	65535	61440	New Help String
Output I/O Messages Mapping(O->T)[11]	61440		UINT	0	65535	61440	New Help String

Step 4: Configure the IP address for the master.

Scan the network for the master to be configured.



Assign an IP address to the network port of the master.



Download the project to the PLC.

You can view the I/O Messages(O->T) and I/O Messages(T->O) data based on the EtherNet/IP I/O mapping.

Find	Filter	Show all							
Variable	Mapping	Channel	Address	Type	Default Value	Current Value	Prepared Value	Unit	Description
+	+	+	Inverter State	N201	UBIT	0			New Help String
+	+	+	Output Freq	N202	UBIT	0			New Help String
+	+	+	Input IO Message[0]	N203	UBIT	0			New Help String
+	+	+	Input IO Message[1]	N204	UBIT	0			New Help String
+	+	+	Input IO Message[2]	N205	UBIT	0			New Help String
+	+	+	Input IO Message[3]	N206	UBIT	0			New Help String
+	+	+	Input IO Message[4]	N207	UBIT	0			New Help String
+	+	+	Input IO Message[5]	N208	UBIT	0			New Help String
+	+	+	Input IO Message[6]	N209	UBIT	0			New Help String
+	+	+	Input IO Message[7]	N210	UBIT	0			New Help String
+	+	+	Input IO Message[8]	N211	UBIT	0			New Help String
+	+	+	Input IO Message[9]	N212	UBIT	0			New Help String
+	+	+	Control Command	N201	UBIT	0			New Help String
+	+	+	Inverter Pres	N202	UBIT	0			New Help String
+	+	+	Output IO Message[0]	N203	UBIT	0			New Help String
+	+	+	Output IO Message[1]	N204	UBIT	0			New Help String
+	+	+	Output IO Message[2]	N205	UBIT	0			New Help String
+	+	+	Output IO Message[3]	N206	UBIT	0			New Help String
+	+	+	Output IO Message[4]	N207	UBIT	0			New Help String
+	+	+	Output IO Message[5]	N208	UBIT	0			New Help String
+	+	+	Output IO Message[6]	N209	UBIT	0			New Help String
+	+	+	Output IO Message[7]	N210	UBIT	0			New Help String

12.9 Troubleshooting

The following table describes the faults that may occur during the usage of the MD500-EN1 card and AC drive.

Table 12-4 Fault analysis and solutions

Symptom	Cause	Solution
Communication between the MD500-EN1 card and AC drive fails.	1. The AC drive does not support EtherNet/IP communication. 2. The communication configuration of the MD500-EN1 card is incorrect. 3. The MD500-EN1 card hardware is faulty.	1. Check whether the AC drive supports EtherNet/IP communication. 2. Set the communication parameters of the MD500-EN1 card correctly. 3. Replace the MD500-EN1 card.
A communication error (E164.1) is reported by the AC drive during running.	1. The communication data is abnormal. 2. The network cable is damaged or connected incorrectly. 3. The AC drive suffers external interference.	1. Check whether the EtherNet/IP master program is normal. 2. Check whether the network cable is connected correctly. Replace the network cable if required. 3. Use the Cat 5e shielded twisted pair (STP) cable as required. Check that the MD500-EN1 card is grounded correctly. Eliminate the external interference. Contact the technical support personnel if necessary.

A fault code is an 8-bit binary integer, of which each bit indicates a different fault. To obtain the fault code, read the value of FD-58 of the AC drive, and convert it to an 8-bit binary number. For example, if the read value of FD-58 is 3, its binary equivalent is 0000 0011, then the fault code is bit 0 and bit 1. The following table describes the faults and solutions.

Note: A fault code may be a combination of multiple faults.

Fault Code	Description	Solution
Bit 7	N/A	N/A
Bit 6	Communication with the AC drive fails, or the AC drive version is incorrect.	Upgrade the AC drive software to the version that supports EtherNet/IP.
Bit 5	The I/O Messages mapping configuration is incorrect.	Check the PLC configurations.
Bit 4	Connection times out.	Check the connections and whether the master is running properly.
Bit 3	Link loss occurs.	Check the wiring.
Bit 2	The IP addresses conflict.	Check whether there is another device with the same IP address as this device.
Bit 1	The MAC address is lost or not programmed.	Contact Inovance for technical support.
Bit 0	An error occurs on the Ethernet hardware.	Contact Inovance for technical support.

If the fault code is 0, the green indicator D4 is steady off, and the red indicator D7 is steady on, the troubleshooting is the same as that of bit 6.

13 Appendix 6000H Group Object Dictionary

13.1 List of Object Dictionary in Group 6000h

Index	Sub-index	Name	Access	SDO	PDO	Data Type	Unit	Value Range	Default
603Fh	-	Error code	RO	YES	YES	Uint16	-	0 to 65535	-
6040h	-	Control word	RW	YES	YES	Uint16	-	0 to 65535	0
6041h	-	Status word	RO	YES	YES	Uint16	-	0 to 65535	-
6042h	-	Target speed	RW	YES	YES	Int16	Determined by FD-09	-32768 to +32767	0
6043h	-	Velocity demand (after acceleration/ deceleration)	RO	YES	YES	Int16	Same as 6042h	-32768 to +32767	-
6044h	-	Output speed	RO	YES	YES	Int16	Same as 6042h	-32768 to +32767	-
6046h	0h	Speed upper and lower limit	RO	YES	NO	Uint8	-	-	2
	1h	Speed lower limit	RW	YES	YES	Uint32	Hz	0 to 65535	0
	2h	Speed upper limit	RW	YES	YES	Uint32	Hz	0 to 65535	5000
6048h	-	Acceleration time (speed control mode)	RO	YES	NO	Uint8	-	-	2
	1h	Speed increment	RW	YES	NO	Uint32	Same as 6042h	1 to 65535	5000
	2h	Time increment	RW	YES	NO	Uint16	Determined by F0-09	0 to 65535	200
6049h	-	Deceleration time (speed control mode)	RO	YES	NO	Uint8	-	-	2
	1h	Speed increment	RW	YES	NO	Uint32	Same as 6042h	1 to 65535	5000
	2h	Time increment	RW	YES	NO	Uint16	Determined by F0-09	0 to 65535	200
605Ah	-	Quick stop mode	RW	YES	NO	Int16	-	0 to 2	1
605Bh	-	Shutdown option code	RW	YES	NO	Int16	-	0 to 1	1
605Ch	-	Disable operation option code	RW	YES	NO	Int16	-	0 to 1	1

Index	Sub-index	Name	Access	SDO	PDO	Data Type	Unit	Value Range	Default
6060h	-	Mode selection	RW	YES	YES	Int8	-	1 to 6	2
6061h	-	Mode display	RO	YES	YES	Int8	-	1 to 6	-
6063h	-	Position feedback	RO	YES	YES	Int32	Encoder unit	-2^{31} to $+(2^{31}-1)$	-
606Ch	-	Speed feedback	RO	YES	YES	Int32	rpm	-2^{31} to $+(2^{31}-1)$	-
6077h	-	Output torque	RO	YES	YES	Int16	-	-32768 to +32767	-
60FDh	-	DI state	RO	YES	YES	Uint32	-	0 to $(2^{32}-1)$	-
6502h	-	Supported mode	RO	YES	YES	Uint32	-	0 to $(2^{32}-1)$	-

13.2 Object Dictionary Descriptions

603Fh: error code

Index	Name	Error code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
603Fh										
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to 65535	Default	-

The error code indicates that the read error code is internally-defined error code and does not comply with the DS402 profile.

Example:

When the drive encounters an encoder error (E015.1), 603Fh is read and 151 is returned.

If 0 is returned, no error occurs on the drive.

6040h: control word

Index	Name	Control word			Setting Condition & Effective Time	During operation	Data Structure	VAR	Data Type	Uint16
6040h										
	Access	RW	Mapping	RPDO	Mode	ALL	Data Range	0 to 65535	Default	0

For details on control commands, see ["Table 13-1" on page 261](#).

Table 13-1 Control command descriptions

Bit	Name	Description
0	Switch on	1: Active; 0: Inactive
1	Enable voltage	1: Active; 0: Inactive
2	Quick stop	0: Active; 1: Inactive

Bit	Name	Description
3	Enable operation	1: Active; 0: Inactive
4 to 6	Operation mode specific	Related to the operation mode
7	Fault reset	The rising edge of bit 7 is used to reset a fault. If the value is always 1, the fault reset is disabled.
8	Reserved	Undefined
9	Reserved	Undefined
10	Reserved	Undefined
11 to 15	Manufacturer specific	Bits 11 to 15 are manufacturer-defined.
Bits 9 to 10 are reserved and must be set to 0.		
Bits 11 to 15 are manufacturer-defined.		

6041h: status word

Index 6041h	Name	Status word			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to 65535	Default	0
For details on the inverter state, see “Table 13–2” on page 262 .										

Table 13–2 Descriptions of the inverter state

Bit	Name	Description
0	Ready to switch on	1: Active; 0: Inactive
1	Switch on	1: Active; 0: Inactive
2	Operation enabled	1: Active; 0: Inactive
3	Fault	1: Active; 0: Inactive
4	Voltage enabled	1: Active; 0: Inactive
5	Quick stop	0: Active; 1: Inactive
6	Switch on disabled	1: Active; 0: Inactive
7	-	-
8	Manufacturer specific	-
9	Remote	1: Active; 0: Inactive
10	Target reach	1: Active; 0: Inactive
11 to 15	-	-

Table 13–3 Examples of the inverter state

Value (Binary)	Description
Xxxx xxxx x0xx 0000	Not ready to switch on
Xxxx xxxx x1xx 0000	Switch on disabled
Xxxx xxxx x01x 0001	Ready to switch on
Xxxx xxxx x01x 0011	Switched on
Xxxx xxxx x01x 0111	Operation enabled

Value (Binary)	Description
Xxxx xxxx x00x 0111	Quick stop active
Xxxx xxxx x0xx 1111	Fault reaction active
Xxxx xxxx x0xx 1000	Fault

6042h: vl target velocity

Index	Name	vl target velocity			Setting Condition & Effective Time	During operation	Data Structure	VAR	Data Type	Int16
6042h										
	Access	RO	Mapping	RPDO	Mode	vl	Data Range	-32768 to 32767	Default	0

- The unit of the target velocity is determined by FD-09. The value 0 indicates Hz and 1 indicates rpm.
- When the unit is Hz, the association needs to be set according to the frequency unit (F0-22). Assume that F0-22 is set to 2 and the frequency resolution is 0.01 Hz. To set the target frequency to 10.00 Hz, write 1000 through communication. Assume that F0-22 is set to 1 and the frequency resolution is 0.1 Hz. To set the target frequency to 10.0 Hz, write 100 through communication.
- When the unit is rpm, the supported speed ranges from -32768 to 32767. If the speed exceeds this range, use the unit of Hz to support a higher speed.
- The AC drive output frequency is converted to the motor operating frequency (Hz), which can be viewed by U0-01.

6043h: vl velocity demand

Index	Name	vl velocity demand			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
6043h										
	Access	RO	Mapping	TPDO	Mode	vl	Data Range	-32768 to 32767	Default	0

- The vl velocity demand is the instantaneous velocity provided by the ramp function.
- The unit is the same as the unit of the target velocity 6042h.
- When the unit is Hz, the decimal place is set by F0-22. When the unit is rpm, the decimal place is set by the ones place of F7-12.

6044h: vl control effort

Index	Name	vl control effort			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
6044h										
	Access	RO	Mapping	TPDO	Mode	vl	Data Range	-32768 to 32767	Default	0

- The vl control effort indicates the actual running speed of the inverter.
- The unit is the same as the unit of the target velocity 6042h.
- When the unit is Hz, the decimal place is set by the tens place of F7-12. When the unit is rpm, the decimal place is set by the ones place of F7-12.

6046h: vl velocity min max amount

Index 6046h	Name	vl velocity min max amount			Setting Condi- tion & Effective Time	-	Data Struc- ture	ARR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	OD data range	Default	OD default value
It indicates the minimum or maximum running speed (unit: Hz) at which the drive unit is allowed to run. You can define the unit as the DSP 402 protocol does not define.										

Sub- index	Name	Number of entries			Setting Condi- tion & Effective Time	-	Data Struc- ture	-	Data Type	Uint8
0h	Access	RO	Mapping	NO	Mode	vl	Data Range	-	Default	2

Sub- index 1h	Name	vl velocity min amount			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65535	Default	0
- It indicates the minimum frequency (unit: Hz) at which the drive unit is allowed to run. The value is limited by the maximum frequency (F0-10) and sub-index 2. You can view the actual value by querying F0-14 (unit: Hz). - The decimal place is set by F0-22.										

Sub- index 2h	Name	vl velocity max amount			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65535	Default	5000
- It indicates the maximum frequency (unit: Hz) at which the drive unit is allowed to run. The value is limited by the maximum frequency (F0-10). - The decimal place is set by F0-22.										

6048h: vl velocity acceleration

Index 6048h	Name	vl velocity acceleration			Setting Condi- tion & Effective Time	-	Data Struc- ture	ARR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	OD data range	Default	OD default value
It is used to set the acceleration time of the inverter.										

Sub-index 0h	Name	Number of entires			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	NO	Mode	vl	Data Range	-	Default	2

Sub-index 1h	Name	Delta speed			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	1 to 65535 (Hz)	Default	5000

- Set F0-25 to 0. If F0-25 is set to other values, the acceleration time will be inaccurate.
- The unit is the same as the unit of the target velocity 6042h.
- When the unit is Hz, the decimal place is set by F0-22. When the unit is rpm, the value is an integer.

Sub-index 2h	Name	Delta time			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65536 (s)	Default	20

Set F0-19 to 1 or 2. If F0-19 is set to 0, the acceleration/deceleration time will be inaccurate due to calculation error.

6049h: vl velocity deceleration

Index 6049h	Name	vl velocity deceleration			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	OD data range	Default	OD default value

Sub-index	Name	Number of entires			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	NO	Mode	vl	Data Range	-	Default	2

Sub-index 1 h	Name	Delta speed			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	1 to 65535	Default	5000
- Set F0-25 to 0. If F0-25 is set to other values, the deceleration time will be inaccurate. - The unit is the same as the unit of the target velocity 6042h. - When the unit is Hz, the decimal place is set by F0-22. When the unit is rpm, the value is an integer.										

Sub-index 2h	Name	Delta time			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65535	Default	20
Set F0-19 to 1 or 2. If F0-19 is set to 0, the acceleration/deceleration time will be inaccurate due to calculation error.										

605Ah: Quick stop option code

In the non-faulty state, when bit 2 (Quick stop) of the control word 6040h is set to 0, the drive implements quick stop in the mode selected by 605Ah.

This function can be set only in the stop state. After quick stop, bit 6 of the control word 6041h is set to 1 and the drive is in the stop state.

Index 605Ah	Name	Quick stop option code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	NO	Mode	ALL	Data Range	0 to 2	Default	1
The values are described as follows: 0: Coast to stop 1: Decelerate to stop. The deceleration time is set by F0-18, namely, the time set by 6049h in vl mode. 2: Emergency stop. The deceleration time is set by F8-55.										

605Bh: Shutdown option code

Index 605Bh	Name	Shutdown option code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	NO	Mode	ALL	Data Range	0 to 1	Default	1
For detailed values, see "Table 13-4" on page 267 .										

Table 13–4 Value descriptions

Value	Stop Mode
-32768 to -1	Manufacturer-defined
0	Coast to stop
1	Decelerate to stop. The deceleration time is set by F0-18, namely, the time set by 6049h in vl mode.
2 to 32767	Reserved

605Ch: Disable operation option code

Index 605Ch	Name	Disable operation option code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	NO	Mode	ALL	Data Range	0 to 1	Default	1
For detailed values, see “Table 13–5” on page 267 .										

Table 13–5 Value descriptions

Value	Stop Mode
-32768 to -1	Manufacturer-defined
0	Coast to stop
1	1: Decelerate to stop. The deceleration time is set by F0-18, namely, the time set by 6049h in vl mode.
2 to 32767	Reserved

6060H: Modes of operation

Index 6060h	Name	Modes of operation			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int8
	Access	RW	Mapping	RPDO	Mode	ALL	Data Range	0 to 9	Default	2
The values are described as follows: • 0: N/A • 1: N/A • 2: vl (speed mode) • 3: N/A • 4: N/A • 5: N/A • 6: N/A • 7: N/A • 8: N/A • 9: N/A										

6061h: Modes of operation display

Index 6061h	Name	Modes of operation display			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Int8
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to 9	Default	2
The values are described as follows: • 0: N/A • 1: N/A • 2: vl (speed mode) • 3: N/A • 4: N/A • 5: N/A • 6: N/A • 7: N/A • 8: N/A • 9: N/A										

6063h: Position actual value*

Index 6063h	Name	Position actual value*			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Int32
	Access	RO	Map- ping	TPDO	Mode	ALL	Data Range	-2 ³¹ to +(2 ³¹ - 1)	Default	-
It indicates the motor position in the encoder unit.										

606Ch: Velocity actual value

Index 606Ch	Name	Velocity actual value			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Int32
	Access	RO	Map- ping	TPDO	Mode	CSV	Data Range	-2 ³¹ to +(2 ³¹ - 1)	Default	-
• It indicates the actual running speed of the inverter. • The unit is rpm. • The decimal place is set by the ones place of F7-12. • Pv supported										

6077h: Torque actual value

Index 6077h	Name	Torque actual value			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Int16
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	Unit: 0.1%	Default	-
The unit uses the rated motor torque as the base value.										

60FDh: Digital inputs

Index 60FDh	Name	Digital inputs			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Uint32
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to (2 ³² - 1)	Default	-
It indicates the current DI logic of the drive. • 0: Invalid • 1: Valid The DI signal indicated by each bit is described as follows: • Bits 0 to 26: Reserved • Bit 27: STO1 • Bit 28: STO2 • Bit 29: EDM • Bits 30 to 31: Manufacturer-defined										

6502h: Supported drive modes

Index 6502h	Name	Supported drive modes			Setting Condi- tion & Effective Time	-	Data Struc- ture	VAR	Data Type	Uint32
	Access	RO	Mapping	RO	Mode	ALL	Data Range	0 to 2 ³²	Default	0x0000- 0002
Bits are described as below: • Bit 0: N/A • Bit 1: available only in speed mode vl • Bit 2: N/A • Bit 3: N/A • Bit 4: N/A • Bit 5: N/A • Bit 6: N/A • Bit 7: N/A • Bit 8: N/A • Bits 9 to 31: Reserved										



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