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MD520 Series General-Purpose AC Drive

Communication Guide

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Preface

About This Guide

The MD520 series AC drive is a general-purpose high-performance current vector control AC drive. It is designed to control and regulate the speed and torque of three-phase AC asynchronous motors. The AC drive can be used to drive textile machines, paper machines, wire drawing machines, machine tools, packaging machines, food machines, fans, water pumps, and other automated production equipment.

This guide describes the communication mode, communication networking, and communication configuration of the AC drive.

More Documents

Document Name	Data No.	Description
MD520 Series General-Purpose AC Drive Quick Installation and Commissioning Guide	19011712	Describes the installation, wiring, commissioning, troubleshooting, parameters, and fault codes of the AC drive.
MD520 Series General-Purpose AC Drive Hardware Guide	19011713	Describes the composition, technical specifications, components, dimensions, options (including installation accessories, cables, and peripheral electrical components), and expansion cards of the MD520 series AC drive, as well as routine maintenance and repair, and certification and standard compliance of the AC drive.
MD520 Series General-Purpose AC Drive Installation Guide	19011714	Describes the installation dimensions, space design, specific installation steps, wiring requirements, routing requirements, and option installation requirements of the AC drive, as well as common EMC troubleshooting recommendations.
MD520 Series General-Purpose AC Drive Commissioning Guide	19011715	Describes the tools, processes, and specific steps of commissioning of the AC drive, as well as troubleshooting, fault codes, and parameters related to the AC drive.
MD520 Series General-Purpose AC Drive Communication Guide (this document)	19011716	Describes the communication method, networking, and communication settings of the AC drive.
MD520 Series General-Purpose AC Drive Function Guide	19011717	Introduces function application, fault codes, and parameters of the AC drive.

Revision History

Date	Version	Description
January 2022	A00	First release

How To Obtain

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Safety Precautions

Safety Disclaimer

1. This chapter presents essential safety instructions for proper use of the AC drive. Before using the product, please read the guide and make sure you understand the safety instructions correctly. Failure to comply with the safety instructions may result in death, serious injury, or equipment damage.
2. "CAUTION", "WARNING", and "DANGER" items in the guide are just supplementary and do not cover all safety instructions.
3. Use this product in an environment that complies with the design specifications. Malfunction or component damage caused by improper usage is not covered by warranty.
4. Inovance shall take no responsibility for any personal injuries or property loss caused by noncompliance with this guide or improper use of this product.

Safety Levels and Definitions

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

WARNING indicates that failure to comply with the notice may result in severe personal injuries or even death.

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

Safety Precautions

- The drawings in this guide sometimes show the product without covers or protective guards to display more details. When using this product, be sure to install the casing or cover according to the regulations, and operate in accordance with the guide.
- The product drawings in this guide are for reference only and may be slightly different from the product you ordered.

Unpacking and Acceptance
WARNING • Do not install the product if any damage, rust, or sign of use is found on the product and accessories. • Do not install the product in case of water seepage in the product, part missing or part damage. • Do not install the product if you find the packing list does not conform to the product you received.

CAUTION

- Before unpacking, check whether the packing is intact without damage, water seepage, damp, and deformation.
- Unpack the package in sequence. Do not hit the package with force.
- Check the surface of the equipment and accessories for any damage or rust.
- Check the equipment, accessories, and materials in the package against the packing list to ensure that no item is missing.

Storage and Transportation

WARNING

- Use professional hoisting equipment operated by qualified professionals to carry large-scale or heavy products. Failure to comply may result in personal injury or product damage.
- Before hoisting the product vertically, confirm that the front cover, terminal block, and other parts of the product have been firmly fixed with screws. Failure to comply may cause the parts to fall off and result in personal injury or product damage.
- Never stand or stay below the product that is lifted by hoisting equipment.
- Lift the product with a steel rope steadily at a constant speed to protect the product against vibration, impact, or turnover. Do not keep the product lifted for a long time. Failure to comply may result in personal injury or product damage.

CAUTION

- Handle the product with care and mind your steps. Failure to comply may result in personal injury or product damage.
- When carrying the product with bare hands, hold the product casing firmly with care to prevent parts from falling. Failure to comply may result in personal injury or product damage.
- Store and transport the product as required. Failure to comply may result in product damage.
- Avoid storage and transportation in environments subject to water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the product for more than 3 months. Long-term storage shall require stricter protection and necessary inspections.
- Pack the product strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport this product with equipment or materials that may damage or have negative impacts on this product.

Installation

DANGER

- Only professional personnel with electrical expertise can operate this product. Operations by non-professionals are strictly prohibited.

WARNING

- Read through the user guide and safety precautions before installation.
- Do not install this product in places subject to strong electric field or strong electromagnetic wave interference.
- Before installation, make sure that the installation position is mechanically strong enough to bear the weight of the equipment. Failure to comply may 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 product in a closed environment (such as a cabinet or a chassis), cool the environment with a fan or an air conditioner to prevent overheat or fire.
- Do not modify this product.
- Do not fiddle with the bolts used to fix equipment components or the bolts marked in red.
- When installing this product in a cabinet or terminal equipment, equip the cabinet or terminal equipment with protective devices such as fireproof enclosures, electrical protective enclosures, and mechanical protective enclosures with the protection level that meets requirements of relevant IEC standards and local laws and regulations.
- Before installing equipment with strong electromagnetic interference, such as a transformer, install an electromagnetic shielding device to prevent malfunctions of this product.
- Install the product on incombustible objects such as metal and keep it away from combustible materials. Failure to comply may result in a fire.

CAUTION

- Cover the top of the product with a piece of cloth or paper during installation 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 to prevent overtemperature 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 anti-vibration rubber under the motor frame or use the vibration suppression function to reduce the resonance.

Wiring

DANGER

- Do not allow non-professionals to perform equipment installation, wiring, maintenance, inspection, or parts replacement.
- Cut off all power supplies before wiring. Wait for at least the time specified on the product warning label after power-off so that residual voltage can discharge safely. Measure the DC voltage on the main circuit to ensure that it is within the safe voltage range. Failure to comply may result in an electric shock.
- Do not perform wiring, remove the product cover, or touch the circuit board with power ON. Failure to comply may result in an electric shock.
- Ensure that the product is well grounded. Failure to comply may result in an electric shock.

WARNING

- Never connect the power cable to an output terminal. Failure to comply may result in product damage or even fire.
- When connecting a drive with the motor, ensure that the phase sequences of the drive and motor are consistent to prevent motor reverse rotation.
- Ensure that the diameter and shielding of the cables used meet corresponding requirements, and that the shielding layer of the shielded cables is grounded reliably at one end.
- Tighten terminal screws with tightening torque specified in this guide. Failure to comply may result in overheat and damage to the connection parts or even fire.
- After wiring, check that each cable is connected properly, no screws or gaskets fall into the product, and no cables are exposed. Failure to comply may result in an electric shock or product damage.

CAUTION

- Follow the proper electrostatic discharge (ESD) procedures, and wear an anti-static wrist strap during wiring. Failure to comply may result in damage to the product or the circuit of the product.
- Use shielded twisted pair cables for the control circuit. Connect the shielding layer to the product grounding terminal. Failure to comply may result in product malfunction.

Power-on

DANGER

- Before power-on, ensure that the product is properly installed, all cables are securely connected, and the motor can be restarted.
- Before power-on, ensure that the power supply meets requirements. Failure to comply may result in product damage or even fire.
- Do not open the cabinet or protective cover, touch any terminal, or dismantle any device or component when the product is powered on. Failure to comply may result in an electric shock.

WARNING

- After wiring and parameter setting, perform a trial run to check whether the device can run properly. Failure to comply may result in personal injury or device damage.
- Before power-on, check that the rated voltage of the product is consistent with that of the power supply. Failure to comply may result in fire.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in personal injury or even death.

Operation

DANGER

- Do not allow non-professionals to operate the product. Failure to comply may result in personal injury or even death.
- Do not touch any wiring terminals or disassemble any unit or component of the equipment during operation. Failure to comply may result in an electric shock.

WARNING

- Never touch the product shell, fan, or resistor to check the temperature. Failure to comply may result in burn.
- Prevent metal or other objects from falling into the product during operation. Failure to comply may result in product damage or fire.

Maintenance

DANGER

- Do not allow non-professionals to perform equipment installation, wiring, maintenance, inspection, or parts replacement.
- Never perform maintenance during power-on. Failure to comply may result in an electric shock.
- Before maintenance, cut off all equipment power supplies and wait for at least the time specified on the product 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 may result in an electric shock.

WARNING

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

Repair

DANGER

- Do not allow non-professionals to perform equipment installation, wiring, maintenance, inspection, or parts replacement.
- Never perform any inspection or maintenance operations during power-on. Failure to comply may result in an electric shock.
- Before inspection or maintenance, cut off all equipment power supplies and wait for at least the time specified on the product warning label.

WARNING

- Require repair services according to the product warranty agreement.
- When the fuse is blown or the circuit breaker or earth leakage current breaker (ELCB) trips, wait for at least the time specified on the product warning label before power-on or further operations. Failure to comply may result in equipment damage, personal injury, or even death.
- When the equipment fails or is damaged, designate qualified technicians to troubleshoot and repair the equipment in accordance with the maintenance instructions and keep a maintenance record.
- Replace quick-wear parts of the equipment according to the replacement guide.
- Do not use a damaged machine. Failure to comply may result in worse damages, personal injury, or even death.
- Make sure to re-check the wiring and parameter setting after device replacement.

Disposal
WARNING • Scrap the equipment or product in accordance with relevant national 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 Signs

For safety operations, follow the safety signs on the equipment. Do not stain or remove the safety signs. The safety signs are described as follows:

Safety Signs	Description
	• Read through the safety instructions before operating the equipment. Failure to comply may result in equipment damage, personal injury, or even death. • Do not touch terminals or remove the cover during power-on or within 10 minutes after power-off. Failure to comply may result in an electric shock.

1 Parameter Communication Addresses

1.1 Parameter Data

The parameters involve 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 and H2

The following table lists the addresses for monitoring parameters, which involve the operation 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. The higher 16 bits of the communication address for a function parameter are the function parameter group ID, and the lower 16 bits are the hexadecimal format of the serial number of the parameter in the function 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 storing them.

For parameters in group F, you can change F in higher bits of the parameter address into 0 to obtain the corresponding RAM address. For example, the communication RAM address of F3-12 is 0x030C.

For parameters in group A, you can change A in higher bits of the parameter address into 4 to obtain the corresponding RAM address. For example, the communication RAM address of A0-05 0x4005.

For parameters in group B, you can change B in higher bits of the parameter address into 5 to obtain the corresponding RAM address. For example, the communication RAM address of B0-05 is 0x5005.

For parameters in group C, you can change C in higher bits of the parameter address into 6 to obtain the corresponding RAM address. For example, the communication RAM address of C0-05 0x6005.

Parameter Groups	Access Address	Parameter Address in RAM
F0 to FE	0xF000 to 0xFEFF	0x0000 to 0x0EFF
A0 to AF	0xA000 to 0xACFF	0x4000 to 0x4CFF
B0 to BF	0xB000 to 0xBFFF	0x5000 to 0x5FFF
C0 to CF	0xC000 to 0xCFFF	0x6000 to 0x6FFF
H0 to H6	0x8000 to 0x88FF	-
U0 to U3	0x7000 to 0x73FF	-
L0 to LD	0x9000 to 0x9DFF	-

Note the following:

- Parameters in group FF cannot be read or modified
- 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	Parameter Description	Parameter Address	Parameter Description
1000H	Communication reference (decimal) –10000 to +10000	1010H	PID reference
1001H	Running frequency	1011H	PID feedback

Parameter Address	Parameter Description	Parameter Address	Parameter Description
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 duration
1006H	Output torque	1016H	AI1 voltage before correction
1007H	Running speed	1017H	AI2 voltage before correction
1008H	DI input flag	1018H	AI3 voltage before correction
1009H	DO output flag	1019H	Linear speed
100AH	AI1 voltage	101AH	Current power-on duration
100BH	AI2 voltage	101BH	Current running duration
100CH	AI3 voltage	101CH	Pulse input frequency (unit: 1 Hz)
100DH	Count input	101DH	Communication reference
100EH	Length input	101EH	Actual feedback speed
100FH	Load speed	101FH	Main frequency X
-		1020H	Auxiliary frequency Y

Table 1–2 Description of Modbus-specific parameter addresses

Parameter Address		Parameter Description
Frequency reference 1 set through communication	1000H	Communication reference (decimal) –10000 to +10000 The communication reference is a relative value (percentage). 10000 corresponds to 100.00%, and –10000 corresponds to –100.00%. The communication references apply when the frequency, torque upper limit, V/f separation voltage, PID reference, and PID feedback of the MD520 AC drive are set through communication. As for frequency data, the communication reference is a percentage of the maximum frequency (F0-10). As for torque data, the communication reference is a percentage of the torque upper limit (F2-10 for motor 1 and A2-48 for motor 2).
Frequency reference 2 set through communication	7310H	The unit of the written data is Hz. The number of decimal places is consistent with that defined by F0-22. For example, if the decimal value 1000 is written, the frequency reference is 10.00 Hz when F0-22 is set to 2.
Control command input to AC drive 1 (write-only)	7311H	0: Stop according to the stop mode defined by F6-10 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: Stop according to the stop mode defined by F6-10 7: Reset upon fault
Control command input to AC drive 2 (write-only)	2000H	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

Parameter Address		Parameter Description
Read AC drive state 1	3000H	1: Running in forward direction 2: Running in reverse direction 3: Stopped 4: Auto-tuning 5: Faulty
Read AC drive state 2	7044H	Bit0: Running state Bit1: Forward/Reverse direction Bit2: Whether a fault occurs Bit3: Whether the output frequency reaches the frequency reference Bit4: Communication normal flag Bit5 to Bit7: Reserved Bit8 to Bit15: Fault code
Parameter lock password verification	1F00H	If the actual password value is returned, password verification is passed. (If password protection is disabled, that is, the password is 0, 0000H is returned.)
Parameter initialization	1F01H	1: Restore factory settings 4: Restore user parameters from backup 501: Back up current user parameters
DO control	2001H	Bit0: DO1 output control Bit1: DO2 output control Bit2: Relay 1 output control Bit3: Relay 2 output control Bit4: FMR output control Bit5: VDO1 Bit6: VDO2 Bit7: VDO3 Bit8: VDO4 Bit9: VDO5
AO1 control (write-only)	2002H	0 to 7FFF, indicating 0% to 100%
AO2 control (write-only)	2003H	0 to 7FFF, indicating 0% to 100%
Pulse output control (write-only)	2004H	0 to 7FFF, indicating 0% to 100%

Parameter Address		Parameter 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 exception 18: Current sampling exception 19: Motor auto-tuning exception 20: Encoder/PG card exception 21: EEPROM fault 22: Encoder card not activated (To be continued)
Continued	Continued	Continued 23: Output short-to-ground 26: Accumulative running duration reach 27: User-defined fault 28: User-defined alarm 29: Accumulative power-on duration reach 30: Output load loss 31: PID feedback loss during running 32: Parameter exception 40: Pulse-by-pulse current limit fault 42: Excessive speed deviation 43: Motor overspeed 45: Motor overtemperature 47: STO fault (To be continued)

Parameter Address		Parameter Description
Continued	Continued	Continued 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: Timing fault 93: Motor control exception 1 94: Motor control exception 2 159: Auto reset fault 160: Modbus timeout 161: CANopen fault 162: CANlink fault 164: Expansion card fault 174: Input exception protection

2 List of Communication Protocols

The MD520 series AC drive supports seven communication protocols in the form of external communication expansion modules. For details, see the following table.

Communication Protocol	Communication Hardware	
Modbus	External communication expansion modules	RS485 communication interface of MD520 series AC drive
CANopen/CANlink		CN1 interface of MD520 series AC drive
PROFINET		MD500-PN1 communication expansion card
PROFIBUS DP		MD38DP2 communication expansion card
EtherCAT		MD500-ECAT communication expansion card
MD-SI-DP1		MD-SI-DP communication expansion card
EtherNet/IP		MD500-EN1 communication expansion card

3 Modbus Communication

3.1 Introduction

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, which allows centralized control by using a PC or PLC. You can set the operation commands, modify or read parameters, and read the operating status and fault information of the AC drive through the communication protocol.

The AC drive supports the Modbus RTU and Modbus ASCII slave communication protocols. These protocols define the content and format of messages transmitted during serial communication. If the slave has 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 Networking and Interfaces

In a network with a single master and multiple slaves, one of the devices works as the communication master (typically a PC host controller, PLC, or HMI), and the other devices work as communication slaves. The communication master initiates communication actively to read or write to parameters of communication slaves, and the slaves respond to queries or communication operations from the master. At the same moment, either the master or the slave transmits 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 Interface

The MD38TX1 communication card required for Modbus communication is specially designed for the MD520 series AC drive to provide the RS485 communication function. It adopts the isolation scheme and its electrical parameters conform to international standards. You can use it as required to control operation and parameter setting of the AC drive through the remote serial interface. See the following figure.

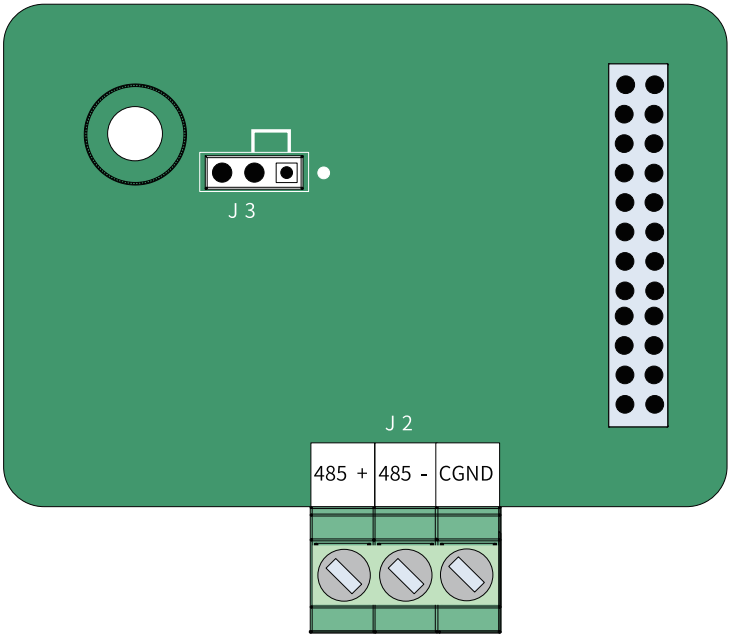


Figure 3-1 Modbus communication interface

Table 3–1 Function description of MD38TX1 terminals

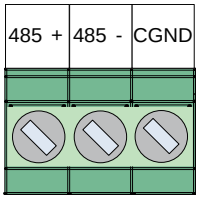
Terminal ID		Terminal Name	Function	Terminal Layout
J2	485+	RS485 communication signal (positive)	RS485 communication terminal with isolation input	
	485–	RS485 communication signal (negative)	RS485 communication terminal with isolation input	
	CGND	Reference ground of RS485 communication signal	Isolated power supply	

Table 3–2 Jumper on the MD38TX1 expansion card

Terminal ID	Terminal Name	Function	Jumper/DIP Switch Position
J3	RS485 communication terminal resistor setting jumper	Connect the terminal resistor.	
		Disconnect the terminal resistor.	

The jumper setting is based on the top view of the expansion card with the main wiring terminal as the bottom side. For the position of the jumper, see the PCB silkscreen.

Communication Networking

1. RS485 topology

   The following figure shows the RS485 bus topology. You are advised to use shielded twisted pairs for the RS485 bus and use twisted pair cables to connect RS485+ and RS485–. A 120 Ω terminal matching resistor is connected at both ends of the bus to prevent signal reflection. The reference grounds of RS485 signals on all nodes are connected together. A maximum of 128 nodes are supported and the distance between each node and the bus must be less than 3 m.

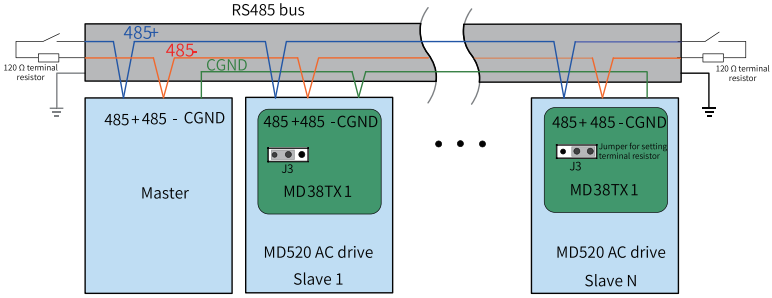


Figure 3-2 RS485 bus topology

2. Multi-node connection mode

   When the number of nodes is large, the RS485 bus must be daisy-chained. If branch connection is required, it is recommended that the length of the cable between the bus and the node do not exceed 3 m. The shorter, the better. Never use the star topology. The following figure shows the frequently used bus structure.

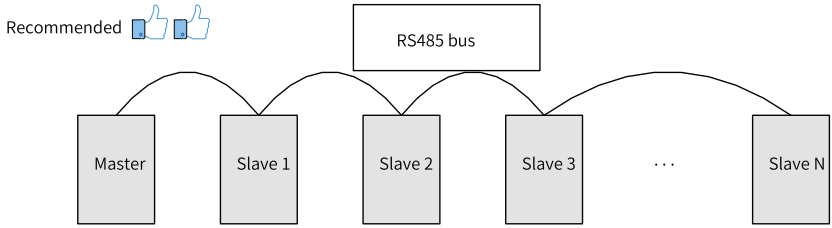


Figure 3-3 Daisy chain

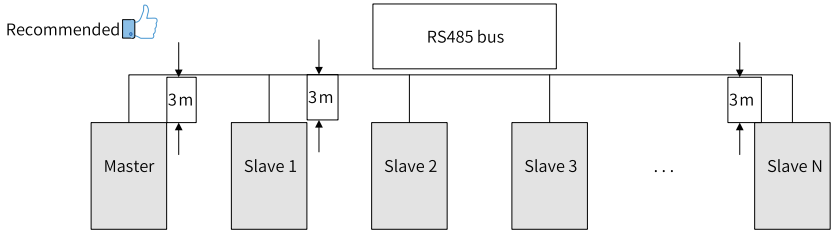


Figure 3-4 Branch connection

It is recommended that the distance between the bus and the node do not exceed 3 m.

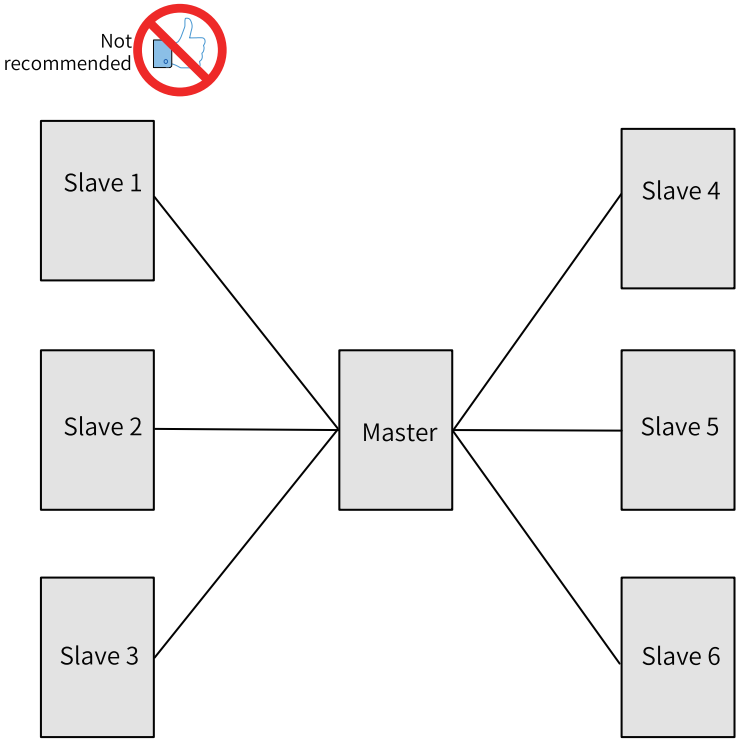
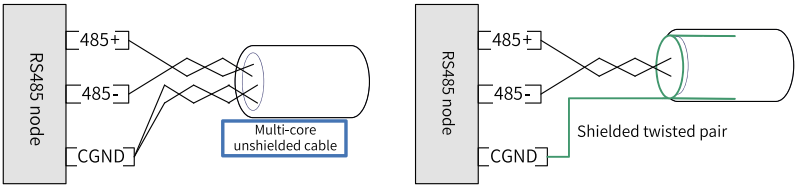


Figure 3-5 Star topology (prohibited)

3. Terminal wiring

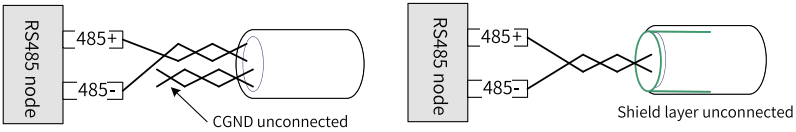
- Terminal wiring for nodes with CGND
  MD38TX1 provides three cables, which connect to terminals RS485+, RS485–, and CGND respectively. Check that the RS485 field bus has these three cables and the wiring terminals are not connected reversely or incorrectly. If a shielded cable is used, connect the shield layer to CGND. Never connect the shield layer to any terminal except CGND, including the drive housing and grounding terminal.

  Considering cable attenuation, you are advised to use AGW26 or thicker cables if the connection length is longer than 3 m. Always use twisted pair cables to connect RS485+ and RS485–.



- Recommended cable 1: Multi-core twisted pair cables. Use one twisted pair to connect RS485+ and RS485– and twist the remaining pairs into one to connect CGND.
- Recommended cable 2: Shielded twisted pair cables. Use the twisted pair cable to connect RS485+ and RS485– and use the shield layer to connect CGND.
- In occasions where shielded cables are used, connect the shield layer to CGND only. Never connect the shield layer to the ground.

- Terminal wiring for nodes without CGND
  For nodes without CGND, do not connect CGND or the shield layer 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 layer) of the bus directly to the pin.
- Method 2: Find the reference ground of the RS485 circuit on the PCB with the node and connect the drain wire to CGND or the shield layer.
- Method 3: If the reference ground of the RS485 circuit cannot be found, keep the CGND cable or the shield layer unconnected and use an extra grounding cable to connect this node to the PE terminal of other nodes.

Transmission Distance

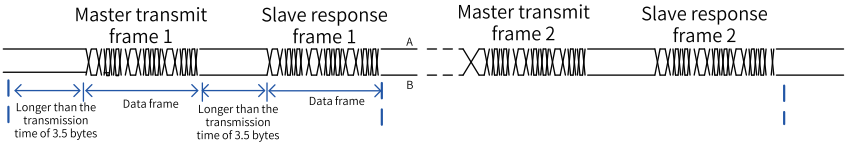
The maximum number of nodes and transmission distance of a standard RS485 circuit vary with the transmission rate, as listed in the following table.

Table 3–3 Maximum number of nodes and transmission distance

Transmission Distance (m)	Rate (kbps)	Number of Nodes	Cable Diameter
100	115.2	128	AWG26
1000	19.2	128	AWG26

3.3 Transmission Mode

The RS485 communication network adopts the asynchronous serial half-duplex transmission mode. Data is transmitted frame by frame in the form of packets agreed in the Modbus RTU protocol. An interval that is longer than the transmission time of 3.5 bytes on the communication data line marks the start of a new communication frame.

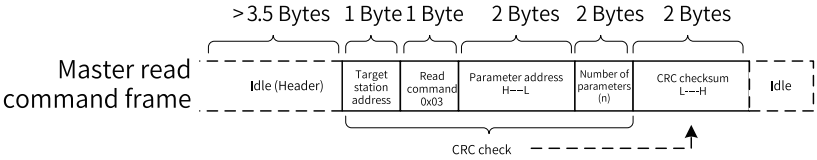


With built-in Modbus RTU slave communication protocol, the AC drive can respond to the query command from the master or act according to the query command and respond to communication data.

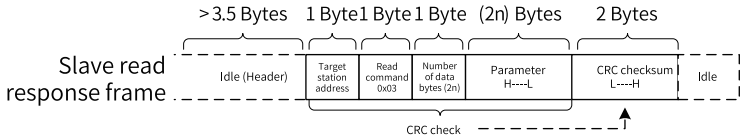
The master can be a personal computer (PC), an industrial control device, or a programmable logic controller (PLC). It can communicate with a slave separately, or send broadcast messages to all slaves. When the master sends a query command to a single slave, the slave is required to return a response frame. For a broadcast message sent by the master, no response from the slaves is required.

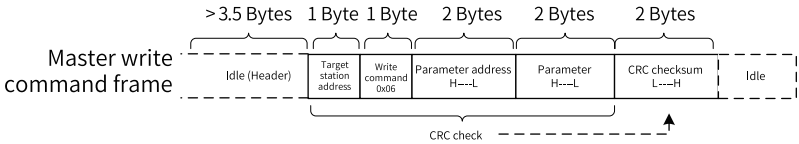
3.4 Data Frame Structure

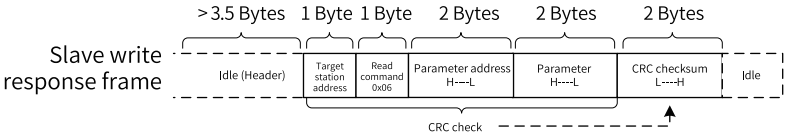
The following figure shows the communication data format of the Modbus RTU protocol. The AC drive allows read-write operations on only word-type parameters. The communication read command is 0x03, the write command is 0x06, and the multi-write command is 0x10. Read-write operations on bytes or bits are not allowed.

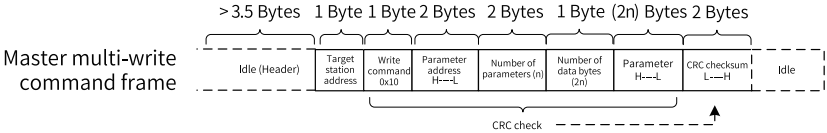


In theory, the host controller can read a maximum of 12 consecutive parameters. However, it cannot read parameters across parameter groups. Otherwise, a response error will occur.

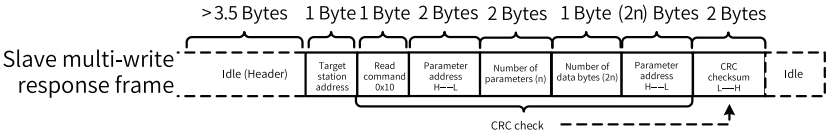








Similarly, multi-write can be performed on up to 12 consecutive parameters at a time.



If a slave detects a communication frame error or reading/writing failure caused by other reasons, it returns an error frame.

Note

No response is returned for CRC check error.

The slave read response error command is 0x83, the write response error command is 0x86, and the multi-write response error command is 0x90.

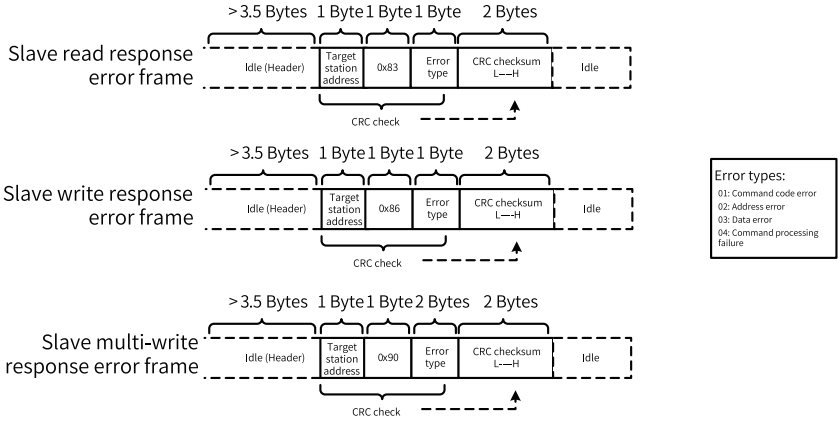


Table 3–4 Data frame fields

Frame header (START)	Idle time longer than the transmission time of 3.5 characters
Slave address (ADR)	Communication address range: 1 to 247
Command code (CMD)	03: Read slave parameters; 06: Write to slave parameters; 10: Multi-write to slave parameters
Parameter address (H)	Internal parameter address of the AC drive, in hexadecimal format; parameter type or non- parameter type (such as the running status and running command). For details, see the address definition. 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. This field is unavailable because this protocol allows only one parameter to be modified at a time.
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 lower bits	Check value: CRC16 check value. Low-order bytes follow high-order bytes during transmission. For details about the calculation method, see the description of CRC in this section.
CRC higher bits	
END	Transmission time of 3.5 characters

CRC check:

The cyclical redundancy check (CRC) adopts the RTU frame format. A Modbus message includes a CRC-based error-check field, which checks 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 TX device. The RX device recalculates a CRC value for the received message, and compares the calculated value with the CRC value in the received CRC field. If the two CRC values are inconsistent, a transmission error occurs.

The CRC is first stored to 0xFFFF. Then a process is invoked to process the consecutive 8-bit byte in the message and the value in the register. CRC is performed on only the eight bits in each character, but not the start bit, stop bit, and parity bit.

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

When CRC is added in a message, high-order bytes follow low-order bytes. The CRC simple function 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	Parameter Name	Default Value	Value Range	Description
FD-00	RS485 baud rate	5005	Ones: Modbus 0: 300 bit/s 1: 600 bit/s 2: 1200 bit/s 3: 2400 bit/s 4: 4800 bit/s 5: 9600 bit/s 6: 19200 bit/s 7: 38400 bit/s 8: 57600 bit/s 9: 11,5200 bit/s Tens: Reserved Hundreds: Reserved Thousands: CAN baud rate 0: 20 1: 50 2: 100 3: 125 4: 250 5: 500 6: 1M	This parameter defines the rate of data transmission between the host controller and the AC drive. A higher baud rate indicates faster communication. 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	RS485 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) (valid for Modbus)	Note that the data format set in the host controller must be the same as that set in the AC drive. Otherwise, communication will fail.

Parameter	Parameter Name	Default Value	Value Range	Description
FD-02	RS485 local address	1	1 to 247	The uniqueness of the local address is the prerequisite for point-to-point communication between the host controller and AC drive.
FD-03	RS485 response delay	2	0 ms to 20 ms (valid for Modbus)	This parameter defines the interval from when the AC drive finishes receiving data to when it sends data to the host controller. • If the response delay is shorter than the system processing time, the system processing time prevails. • If the response delay is longer than the system processing time, the AC drive sends data to the host controller only after the response delay elapses.
FD-04	RS485 communication timeout time	0	0.0 (invalid) 0.1s to 60.0s	When this parameter is set to a valid value, the system reports the communication error Err160 if the interval between two consecutive communications exceeds the communication timeout time. It is set to 0.0s under normal circumstances. This parameter is used to monitor communication status in a system with continuous communication.

3.6 Communication Configurations

3.6.1 Configuration of RS485 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 RS485+ and RS485– on the H5U terminal to RS485+ and RS485– on the AC drive, as shown in the following figure.

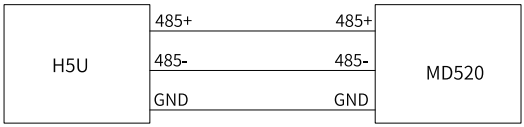


Figure 3-6 Connecting communication interfaces

Master-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 COM on the left to go to the PLC configuration interface, select the protocol and data format, and click **"OK"**.

3. Click COM , then click **"Add Modbus Config"** and **"OK"**.

   COM
   COM0 Modbus Config is displayed. Double-click COM0 Modbus Config , and click **"Add"** on the displayed interface.
   You can perform operations on a variable of the AC drive each time you click **"New"**.

4. 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. Set **Quantity** to **1**. The internal variables of the AC drive are all 16-bit data. If **Quantity** is set to **2**, the write operation will fail.

5. 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. Set **Quantity** to **1**. The internal variables of the AC drive are all 16-bit data. If **Quantity** is set to **2**, the read operation will fail.

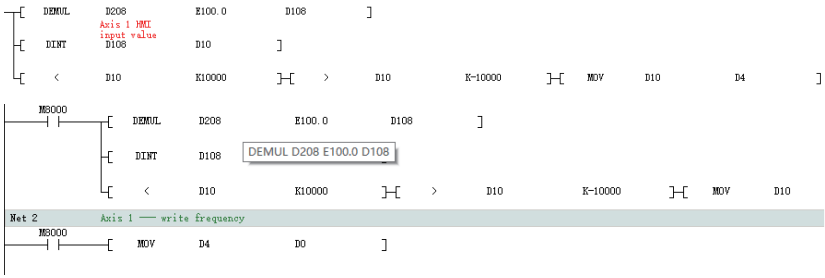
After the read and write settings, click **"OK"** to return to the programming interface.

Instances

1. Write the frequency (F0-03 is set to 9).
   Data conversion: Multiply the desired frequency value a by 100, convert it to an integer, and then write it into 1000H.

   The following figure shows the configuration and the program.

Function Code	Slave addr...	Quantity	Mapped Addr.	Repeat Num
Write Register(16)	1000	1	.. D0	1



2. Implement start/stop control on 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. 2000H is defined as follows: 1

   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

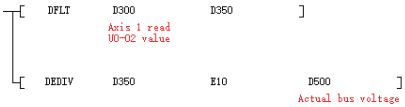
   The PLC soft component address corresponding to 2000H is D2. Therefore, to control the AC drive to run in forward direction through communication, write 1 to D2. Similarly, to control the AC drive to decelerate to stop, set D2 to 6.

3. Read the bus voltage.
   Convert the bus voltage address U002 to 7002 based on the conversion rule (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.

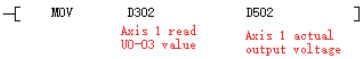
Function Code	Slave addr...	Quantity	Mapped Addr.
Read Register(03)	7002	1	D300



4. Read the output voltage.
   Convert the output voltage address U003 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.

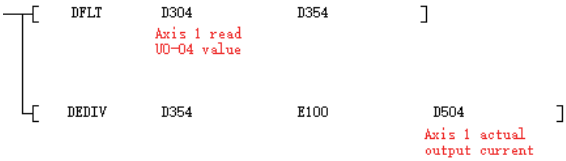
Function Code	Slave addr...	Quantity	Mapped Addr.
Read Register(03)	7003	1	D302



5. Read the output current.
   Convert the output current address U004 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 (1: Running in forward direction; 2: Running in reverse direction; 3: Stopped).

   The following figure shows the configuration and the program.

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

```
-[ MOV    D308    D358 ]
```

7. Read the DI state.
   Convert the DI state address U007 to 7007 based on the conversion rule, and 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

```
-[ MOV    D310    D360 ]
          DI status
```

8. Read the fault code.
   Convert the fault code address U045 to 702D and convert the fault subcode address U046 to 702E based on the conversion rule.

   The following figure shows the configuration and the program.

Function Code	Slave addr. (H)	Quantity	Mapped Addr.
Read Register(03)	702D	1	.. D312
Read Register(03)	702E	1	.. D314

```
-[ MOV    D312    D362 ]
          Fault master code

-[ MOV    D314    D364 ]
          Fault subcode
```

Common Problems and Solutions

The must-dos are listed as follows:

1. Check the wiring. Check whether the wrong pins are wired as RS485+ and RS485– incorrectly.
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 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 terminal resistor is ON. If not, switch on the terminal 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 terminal resistor is ON. If not, switch on the terminal 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.

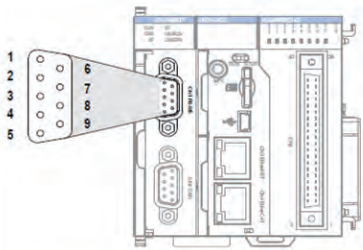
3.6.2 Configuration of RS485 Communication Between AC Drive and AM600

The following configuration instance illustrates how to control forward/reverse running of the AC drive by using the AM600 series PLC.

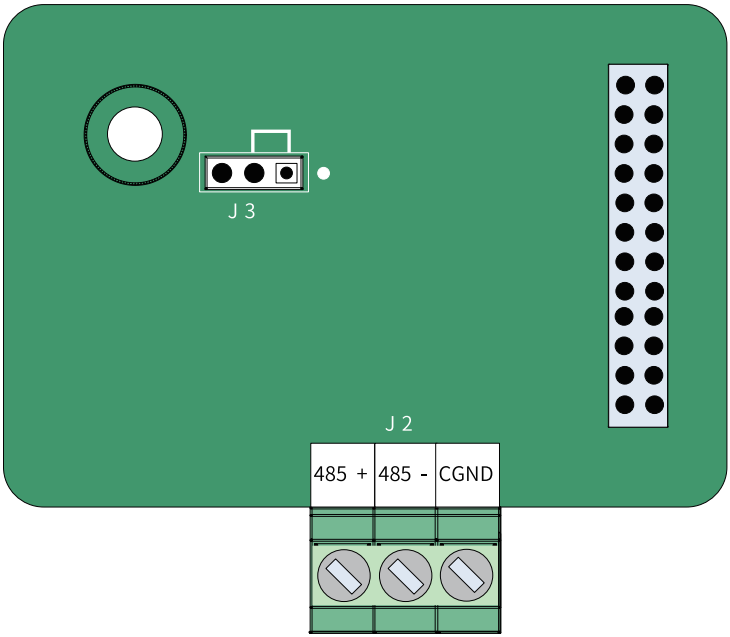
Hardware Connection

Ports:

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

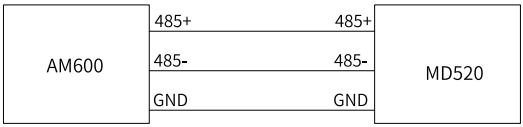
RS485 port on CPU module	Pin	Channel	Assignment	Function
	1	COM0 (RS485)	RS485-	Negative signal of the RS485 differential pair of COM0
	2		RS485+	Positive signal of the RS485 differential pair of COM0
	5		GND0	Power ground of COM0
	6	COM1 (RS485)	RS485-	Negative signal of the RS485 differential pair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

- MD520 supports one RS485 interface, 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 AM600 through the DB9 terminal, strip the other end of the cable and connect the RS485+, RS485–, and GND0 wires to RS485+, RS485–, and GND terminals of the AC drive, as shown in the following figure.



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

AC Drive Configuration

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 reference source to communication).

Set the ones place of FD-00 to 5.

Set FD-01 to 0.

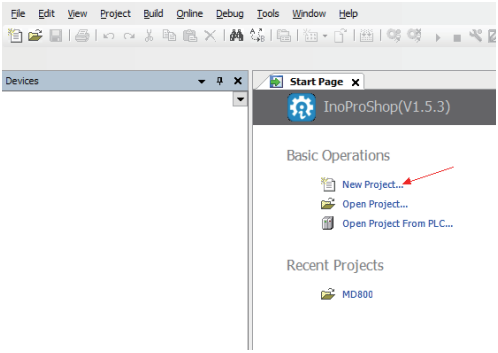
Set FD-03 to 2.

Set FD-04 to 0.0.

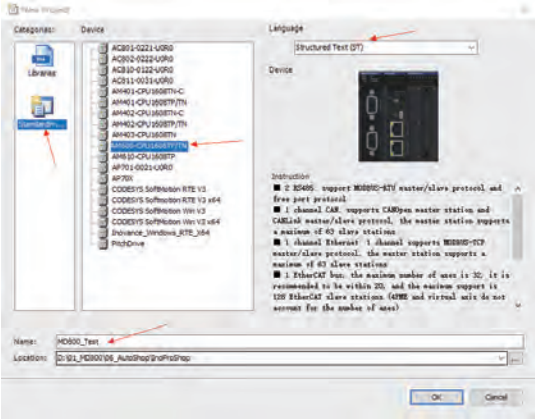
Record the address of FD-02. It is the station number of the AC drive.

PLC Configuration

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

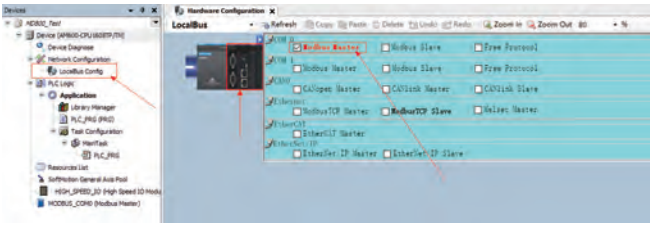


2. Click **Standard Project**, change the project name and location, and click **"OK"**.

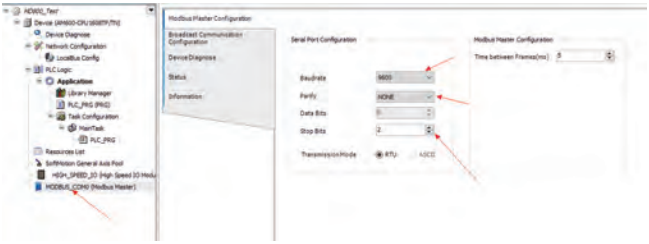


3. Select **AM600-CPU1608TP/TN**, set **Language** to **"Structured Text (ST)"**, and click **"OK"**.

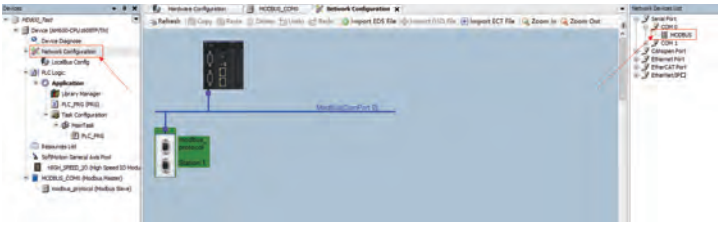
4. Click **"LocalBus Config"**, and click the CPU module. Since RS485 of COM0 is connected to the RS485 terminal of MD520 during the hardware connection step, select the Modbus master of COM0.



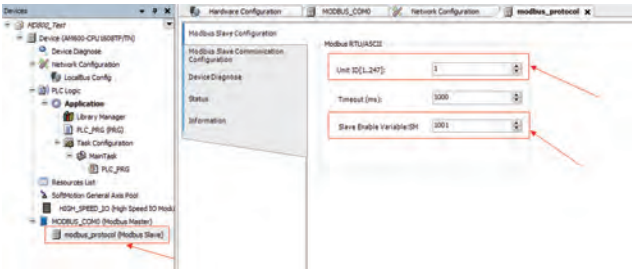
5. Click **"MODBUS_COM0"** on the left, and set the baud rate, parity, and stop bit according to the settings of FD-01.



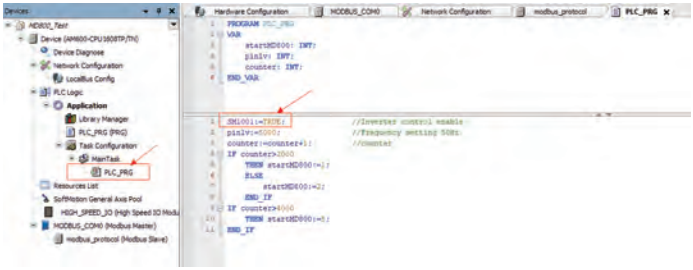
6. Double-click **"Network Configuration"** on the left, choose **Serial Port** > **COM 0** on the right, and double-click **MODBUS**. A new slave device is displayed on the Modbus bus in the center of the screen. If there are multiple slaves, click MODBUS multiple times to generate multiple slaves.



7. Double-click the new Modbus slave, set the slave station number according to the setting of FD-02 of the AC drive. Record the value of the slave enable variable.

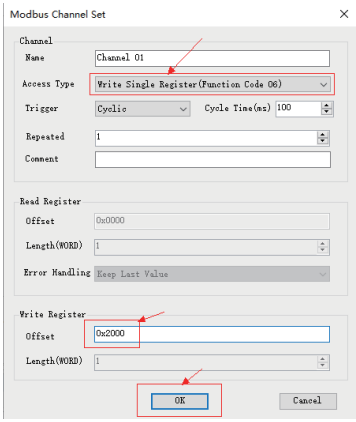


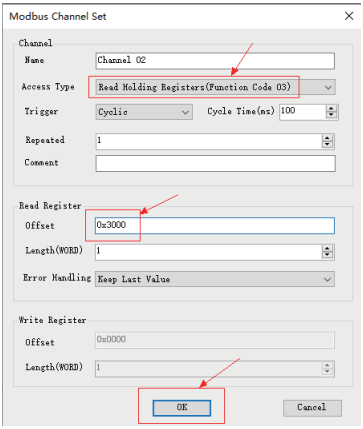
8. Write the PLC program: The slave enable variable is enabled; the frequency of the AC drive is set to 50 Hz; the PLC runs for 4000 scanning cycles; during the first 2000 scanning cycles, it controls the AC drive to run in forward direction, and during the last 2000 scanning cycles, it controls the AC drive to run in reverse direction; then it controls the AC drive to decelerate to stop. Note that the slave enable variable must be enabled.



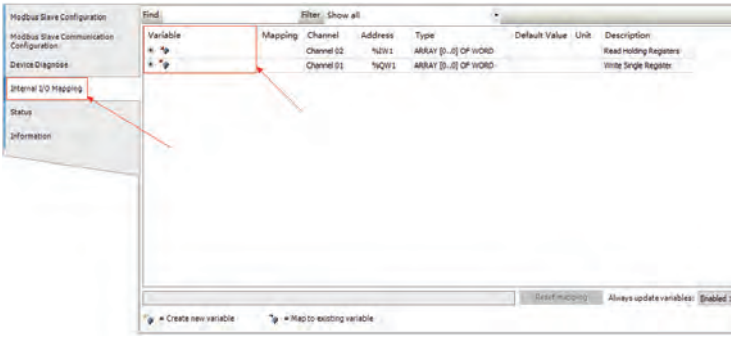
9. Add configuration information on the **Modbus Slave Communication Configuration** tab page.

10. Configure the register in the displayed window. The control word read address of the AC drive is 3000H, the write address is 2000H, and the frequency address is 1000H.

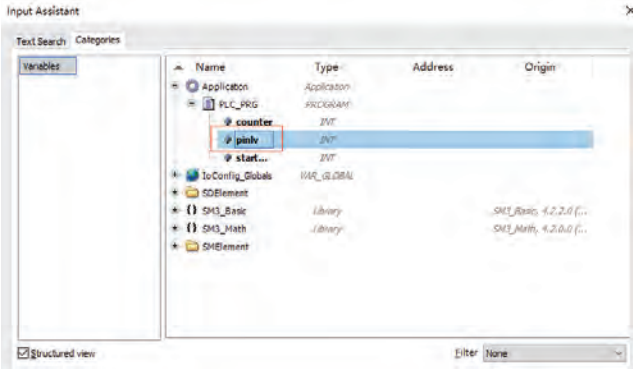




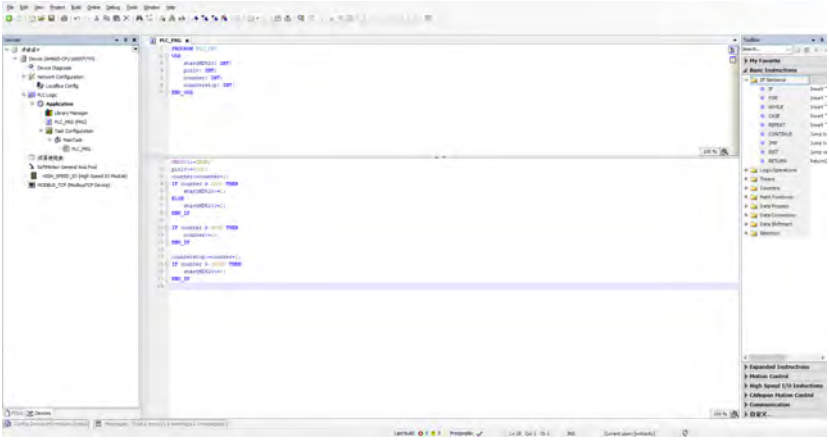
11. On the **Internal I/O Mapping** tab page, map the variable in the PLC to the address of the AC drive.



12. Select the variable to be mapped.



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 **Execute** to execute the program.



4 CANopen & CANlink Communication

4.1 Introduction

The CANopen communication protocol is an international standard protocol. The CANlink communication protocol is a dedicated protocol independently developed by Inovance based on CAN bus application. This protocol can be used for communication with only Inovance PLCs such as H2U, H3U, and AM600.

Communication Model

CANopen is an application layer protocol of 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 adopts communication data block coding instead of traditional address coding. 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, high speed, great fault tolerance, and reliable data transmission, making it suitable for industrial control and distributed real-time control. The following figure shows a CANopen equipment model.

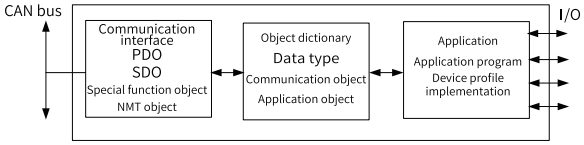


Figure 4-1 CANopen communication model

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

Protocol Features

CANopen supports six protocols:

- 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
- Accelerated transmission mechanism of Service Data Object (SDO) (one parameter or one object dictionary is transmitted at a time)
- Four TPDOs and four RPDOs
- Emergency objects

- Sync mode

Object Dictionary

The object dictionary is an ordered set of parameters and variables. It is essentially a grouping of objects accessible through the network in an ordered predefined fashion. It includes all parameters of device profile and device network state.

Each object within the object dictionary is addressed using a 16-bit index and a 8-bit sub-index. A master node or configuration tool can access all values in the object dictionary of a slave node. The following figure shows the structure of the object dictionary.

Index	Object
000	Unused
0001—001F	Static data type (standard data type such as Boolean and Integer 16)
0020—003F	Complex data type (predefined structure consisting of simple types, such as PDOCommPar and SDOParmeter)
0040—005F	Complex data type specified by the manufacturer
0060—007F	Static data type specified by the device profile
0080—009F	Complex data type specified by the device profile
00A0—0FFF	Reserved
1000—1FFF	Communication profile area (such as device type, error register, and supported PDO quantity)
2000—5FFF	Manufacturer-specific profile area
6000—9FFF	Standard device profile area (such as "DSP-401 I/O module device profile": Read State 8 Input Lines)
A000—FFFF	Reserved

Figure 4-2 Structure of object dictionary

Commonly-used Communication Objects

CANopen provides multiple communication objects, each of which has different characteristics and applies to different applications. It uses predefined communication object identifiers (COB-IDs). The 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
  NMT objects include boot-up messages, the heartbeat protocol, and NMT messages. Based on the master/slave communication mode, NMT is used to manage and monitor all nodes in the network, implementing node state control, error control, and node startup.
- Service data object (SDO)
  SDO enables a client to access object dictionary entries using an index and sub-index. SDO is implemented via the CAN-based message specification (CMS) object of multi-domain at the CAN application layer (CAL), and can transmit data of any length (segmented into several messages when the data length exceeds four bytes). The SDO protocol produces a response for every request. The SDO request and response always contain eight bytes.
- Process data object (PDO)
  PDO is used to transmit real-time data from one node to one or multiple nodes. The data length ranges from one to eight bytes. Each CANopen device has eight default PDO channels, that is, four TPDOs and four RPDOs. PDOs can be sent synchronously or asynchronously, determined by the PDO communication parameters. The content in a PDO message is predefined, determined by the PDO mapping parameters.
- Synchronization object (SYNC)
  The SYNC object is the message periodically broadcast by the CANopen master to the CAN bus to provide the basic network clock signal. Each device can determine whether to use the object to synchronize with other network devices based on its own configuration.

CANopen message format

- NMT module control message
  Only an NMT master node can send NMTModuleControlNMT messages. For details about the message format, see *"Table 4–1 NMT message format" on page 47*. COB-ID is fixed at 0x000. Data0 is the command word, which occupies one byte. See *"Table 4–2 NMT message command format" on page 47*. Data1 is the CANopen

network device address, which occupies one byte. When it is 0, the message is a broadcast message for all slave devices in the network.

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

Table 4–1 NMT message format

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

Table 4–2 NMT message command format

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

- NodeGuarding message
  With the NodeGuarding service, the NMT master can check the current state of all nodes. This service can detect whether data transmission of the nodes is available.

  The standard protocol objects 0x100C and 0x100D respectively set the guard time and the guard time multiplicative factor, which together determines the node guarding time period.

  "Table 4–3 Frame sent by the NodeGuarding master" on page 47 describes the remote frame sent by the NMT master.

Table 4–3 Frame sent by the NodeGuarding master

COB-ID	RTR
0x700+Node-ID	1

"Table 4–4 Response message returned by the NodeGuarding slave" on page 47 is the response message returned by the NMT slave. *"Table 4–5 Status word returned by the NodeGuarding slave" on page 48* describes the status word in the one-byte format.

Table 4–4 Response message returned by the NodeGuarding slave

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

Table 4–5 Status word returned by the NodeGuarding slave

Data Bit	Description
Bit7	0 or 1 alternative
Bit6 to bit0	State: 4: Stopped 5: Operational 127: Pre-operational

- Heartbeat message
  A node can be configured to produce periodic messages, called heartbeat messages, as described in *"Table 4–6 Heartbeat message" on page 48*, in which bit7 is 0, and bit6 to bit0 are the same as those of the NodeGuarding message. The heartbeat time is defined by the standard protocol object 0x1017. A node cannot support both the NodeGuarding and Heartbeat protocols.

Table 4–6 Heartbeat message

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

4.2 Networking and Interfaces

Communication Interface

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 implements control of the field bus.

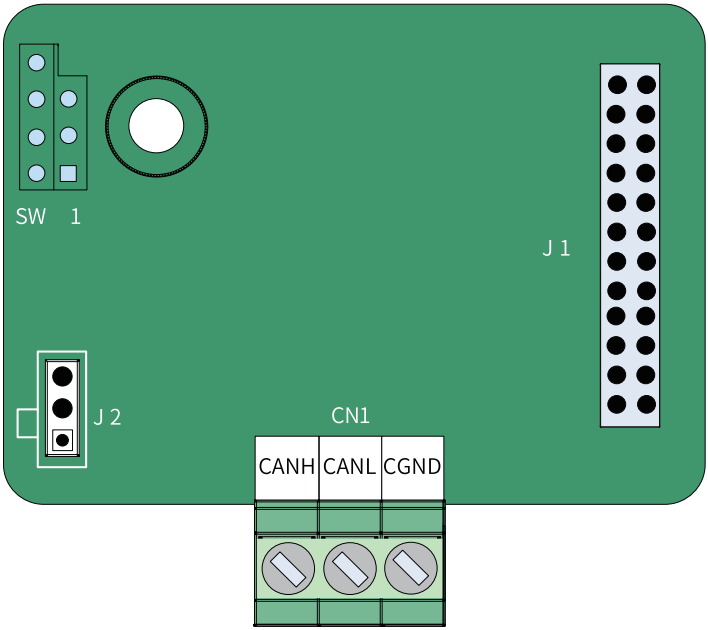


Figure 4-3 MD38CAN1 terminal layout

Table 4–7 Function description of MD38CAN1 terminals

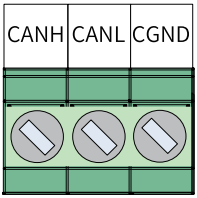
Terminal ID		Terminal Name	Function	Terminal Layout
CN1	CANH	Positive CAN input	Connect to the positive end of the CAN bus.	
	CANL	Negative CAN input	Connect to the negative end of the CAN bus.	
	CGND	Power ground	Connect to the reference ground of all CAN nodes.	

Table 4–8 Jumper on the MD38CAN1 expansion card

Terminal ID	Terminal Name	Function	Jumper/DIP Switch Position
	CAN terminal resistor	Connect the terminal resistor.	
		Disconnect the terminal resistor.	

The jumper setting is based on the top view of the expansion card with the main wiring terminal as the bottom side. For the position of the jumper, see the PCB silkscreen.

Communication Networking

1. CAN bus topology

   The following figure shows the CAN bus topology. You are advised to use shielded twisted pairs for the CAN bus and use twisted pair cables to connect CANH and CANL. A 120 Ω terminal matching resistor is connected at both ends of the bus to prevent signal reflection. The reference grounds of CAN signals on all nodes are connected together. A maximum of 64 nodes are supported and the distance between each node and the bus must be less than 0.3 m.

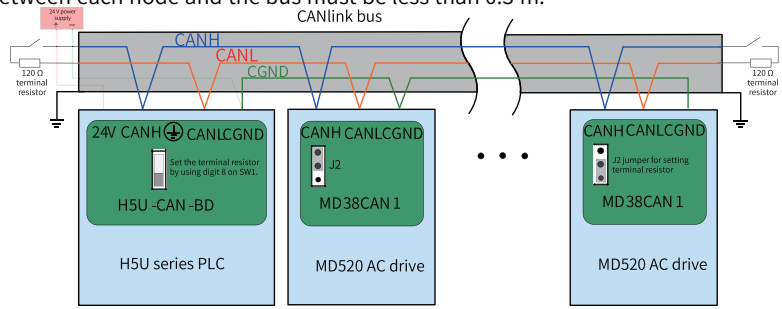
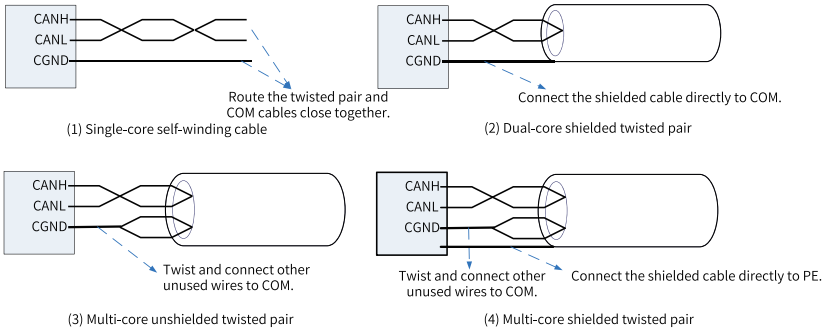


Figure 4-4 CANlink bus topology

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



Transmission Distance

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

Table 4–9 Relationship between the bus length and baud rate

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

4.3 Related Parameters

Table 4–10 Related parameters

Parameter	Parameter Name	Default Value	Value Range	Description
FD-00	Baud rate	5005	Ones: Modbus 0: 300 bit/s 1: 600 bit/s 2: 1200 bit/s 3: 2400 bit/s 4: 4800 bit/s 5: 9600 bit/s 6: 19200 bit/s 7: 38400 bit/s 8: 57600 bit/s 9: 11,5200 bit/s Tens: Reserved Hundreds: Reserved Thousands: CAN baud rate 0: 20 1: 50 2: 100 3: 125 4: 250 5: 500 6: 1M	This parameter defines the rate of data transmission between the host controller and the AC drive. A higher baud rate indicates faster communication. 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 uniqueness of the local address (except the broadcast address) is the prerequisite for point-to-point communication between the host controller and AC drive. In the same network, all station numbers must be unique. Otherwise, communication will fail.

Parameter	Parameter Name	Default Value	Value Range	Description
FD-10	Communication protocol	2	1: CANopen 2: CANlink	This parameter defines the CAN communication protocol. The value 1 indicates CANopen communication. The value 2 indicates CANlink communication.
FD-14	Number of CAN 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.
FD-15	Maximum value of node RX error counter	0	0 to 65535	This parameter is used to monitor bus errors. It defines the maximum value of the CAN RX error counter of the node.
FD-16	Maximum value of node TX error counter	0	0 to 65535	This parameter defines the maximum value of the TX error counter of the node.
FD-17	Node bus-off count	0	0 to 65535	This parameter is used to monitor bus errors. This parameter defines the CAN bus-off count of the node.
FD-19	CAN communication disconnection coefficient	3	1 to 15	This parameter defines the CAN communication disconnection coefficient.

4.4 Application

4.4.1 Data Frame Structure

The AC drive parameters specify the mapping mode between parameters and object dictionary indexes, which facilitates operations on the parameters.

Mapping between the parameters and CANopen object dictionary indexes is described as follows:

- Mapping mode
  The parameter groups of the AC drive correspond to the indexes 0x2000-0x20FF of the CANopen object dictionary. To be specific, the high-order 16 bits of a parameter address plus 0x2000 is the index of the object dictionary, and the low-order 16 bits plus 1 is the sub-index of the object dictionary.

  Take the drive parameter F0-03 as an example. Its communication address is 0xF003, and the corresponding object dictionary index is 0x20F0, and the sub-index is 0x04.

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

  The following table describes the mapping between the parameter groups and the object dictionary indexes.

Table 4–11 Mapping between parameter groups and object dictionary indexes

Parameter Groups	CANopen Object Dictionary Index
F0 to FF	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 mapping between parameter indexes in a group and the object dictionary sub-indexes.

Table 4–12 Mapping between parameter indexes in a group and object dictionary sub-indexes

Parameter Index	CANopen Object Dictionary Index
0x0 to 0xFE	0x1 to 0xFF

4.4.2 Operation Instance (SDO)

Take reading F0-17 as an example. The parameter address is 0xF011, the corresponding object dictionary index is 0x20F0, and the sub-index is 0x12.

1. The communication master uses the CANopen SDO to perform the read operation on the AC drive. The following table describes the format of data sent by the master.
   Take F0-02 as an example. The index is 0x20F0, and the sub-index is 0x03.

Table 4–13 SDO sent during 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"
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	Reserved "0"
	DATA5	Data 2	Reserved "0"
	DATA6	Data 3	Reserved "0"
	DATA7	Data 4	Reserved "0"

2. The slave returns a response message. The following table describes the data format of the SDO returned by the slave during the read operation.
   If the operation is successful, the return value of the command code is "0x4B"; the index remains unchanged; DATA4 and DATA5 are the read data; and DATA6 and DATA7 are 0.

   If the operation fails, the return value of the command code is "0x80"; the index remains unchanged; DATA4, DATA5, DATA6, and DATA7 are the SDO operation failure error code.

Table 4–14 SDO returned during 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"

CAN Frame		CANopen Data	Description
8-byte frame data	DATA0	Return 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 Failure: SDO operation failure error code
	DATA7	Data 4	

3. Perform the write operation on the AC drive by using the SDO.
   The master uses the CANopen SDO to perform the write operation on the AC drive. The following table describes the format of data sent by the master.

Table 4–15 SDO sent during 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"
8-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	Reserved "0"
	DATA7	Data 4	Reserved "0"

4. The slave returns a response message. The following table describes the data format of the SDO returned by the slave during the write operation.
   If the operation is successful, the return value of the command code is "0x60"; the index remains unchanged; DATA4, DATA5, DATA6, and DATA7 are 0.

If the operation fails, the return value of the command code is "0x80"; the index remains unchanged; DATA4, DATA5, DATA6, and DATA7 are the SDO operation failure error code.

Table 4–16 SDO returned during 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"
8-byte frame data	DATA0	Return 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 Reserved "0"
	DATA5	Data 2	
	DATA6	Data 3	
	DATA7	Data 4	

5. Perform read and write operations on the AC drive.
   The following takes the read and write operations on F0-02 as an example. The CANopen address of the AC drive is 0x06.

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

   The master reads the AC drive parameter F0-02 (command source selection). The following table describes the CANopen message sent from the master when reading the AC drive parameter F0-02 (command source).

Table 4–17 Message sent from 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 control.

Table 4–18 Message returned by the AC drive when reading 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, write 0 to F0-02. The master sends a CANopen message as described in the following table.

Table 4–19 Message sent from the master to write to F0-02

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

8. The AC drive returns a CANopen response message, as described in the following table. The value of F0-02 is changed to 0, indicating that the current command source is the operating panel.

Table 4–20 Message returned by the AC drive when writing to F0-02

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

4.4.3 Operation Instance (PDO)

The AC drive supports four RPDOs (RPOD1, RPDO2, RPDO3 and RPDO4) and four TPDOs (TPOD1, TPDO2, TPDO3 and TPDO4), which can be configured as needed.

You can configure the PDO mapping for a slave by using the operating panel. You are advised to use the CANopen master to configure a mapping. PDO mapping can be configured by manually modifying parameters in group AF. The following table describes PDO mapping.

Table 4–21 PDO mapping

RPDO	Address of Parameter in Group AF		TPDO	Address of Parameter in Group AF	
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	Address of Parameter in Group AF		TPDO	Address of Parameter in Group AF	
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 on 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 mapping object format 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	-

To map a parameter to a PDO, you need only to write the object dictionary index and sub-index corresponding to the parameter as well as the data length to the parameter in group AF based on the preceding rules.

For example, to configure two mappings for RPDO1, one points to F0-01 and the other is an object dictionary object 0x6060-00, do as follows:

Table 4–22 Example of group AF parameter mapping

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

Note

The write operation, whether through the software tool or the operating panel, must be done before CANopen remote node is started.

4.5 Communication Configurations

4.5.1 Configuration of 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.

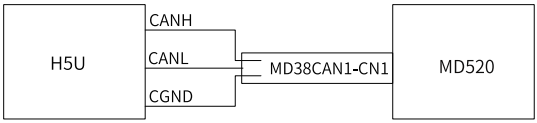


Figure 4-5 Connecting communication interfaces

Master-Slave Configuration

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

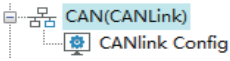
2. Click

on the left, set as follows, and click **"OK"**.
   Protocol: Select **CANlink.**

   Station No.: Select **Upper computer setting**. (Note that the CANlink station number of the PLC cannot be the same as 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

, and click **"AddCAN Config"**. 

is displayed. Double-click **"CANlink Config"**, click **"Next"** on the displayed interface, and then set as follows on the pop-up interface.

   a. Set the slave type to MD (AC drive).
   b. Set the slave number according to that defined by FD-02 of the AC drive.
   c. Set the state register and start/stop component to 7000 and 6000.
   d. 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. After adding the slave, select the PLC to configure the D component to write to the AC drive.

Station number	Device type
63	Host(H5U 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(H5U)	0	Dec	1	MD (Frequency	1000	Hex	1
2	Time(ms)	10	63	HOST(H5U)	2	Dec	1	MD (Frequency	2000	Hex	1
3	Time(ms)	10	63	HOST(H5U)	100	Dec	2	MD (Frequency	1000	Hex	1
4	Time(ms)	10	63	HOST(H5U)	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 to the corresponding register address as required, and make sure that the RX register address is correct and writable; otherwise the write operation will fail.)

5. Select the station (AC drive) to read to configure the D component to read 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

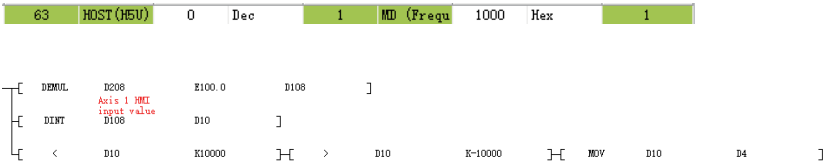
NO.	Trigger Mode	Trigger	Send Station		Send Register		Receiver Station		Receive Register		Length
1	Time(ms)	10	1	MD (Frequ	7002	Hex	63	HOST(H5U)	300	Dec	1
2	Time(ms)	10	1	MD (Frequ	7003	Hex	63	HOST(H5U)	302	Dec	1
3	Time(ms)	10	1	MD (Frequ	7004	Hex	63	HOST(H5U)	304	Dec	1

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

Instances

1. Write the frequency (F0-03 is set to 9).
   Data conversion: Multiply the desired frequency value a by 100, convert it to an integer, and then write it into 1000H.

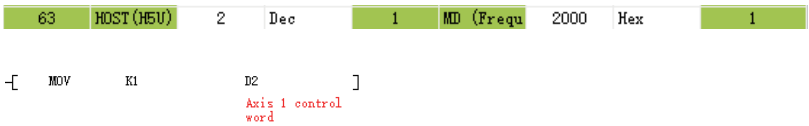
   The following figure shows the configuration and the program.



2. Implement start/stop control on 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. 2000H 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 following figure shows the configuration and the program.

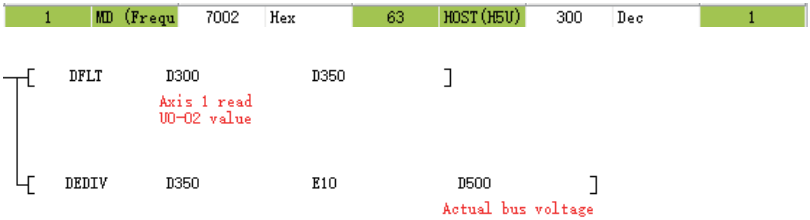


   The PLC soft component address corresponding to 2000H is D2. Therefore, to control the AC drive to run in forward direction through communication, write 1 to D2. Similarly, to control the AC drive to decelerate to stop, set D2 to 6.

3. Read the bus voltage.
   Convert the bus voltage address U002 to 7002 based on the conversion rule (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

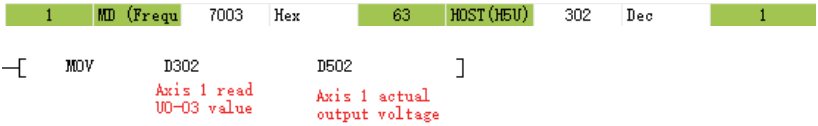
the bus voltage is D300. Convert D300 to a floating-point number and then divide this value by 10.

The following figure shows the configuration and the program.



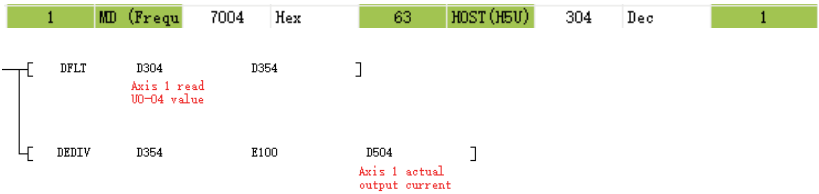
4. Read the output voltage.
   Convert the output voltage address U003 to 7003 based on the conversion rule. The read value is the actual output voltage. According to the communication configuration, you only need to move the value of D302 to another D component (or not).

   The following figure shows the configuration and the program.



5. Read the output current.
   Convert the output current address U004 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.



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.
   Convert the DI state address U007 to 7007 based on the conversion rule, and 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 address U045 to 702D and convert the fault subcode address U046 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 Problems and Solutions

The must-dos are listed as follows:

1. Check the wiring. Check whether the wrong pins are wired as CANH and CANL to the PLC.
2. Check the value of FD-10. 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 4–23 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 terminal resistor is ON. If not, switch on the terminal 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 terminal resistor is ON. If not, switch on the terminal resistor and then power on the AC drive again.
Unstable connection	1. Check that wiring on the PLC end is reliable. (Touch the connection cables on the PLC end to check for poor contact.) 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.

4.5.2 Configuration of CANopen 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 and the latest EDS file.
2. Connect the H5U to the CN1 interface of the MD38CAN1 expansion card installed on the MD520 using twisted pair cables.

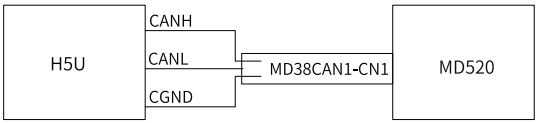


Figure 4-6 Connecting communication interfaces

Master-Slave Configuration

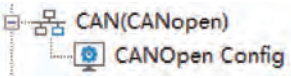
1. Open AutoShop, click **"New Project"**, check that **"Series and models"** is **H5U**, and click **"OK"** to enter the programming interface.
2. Click

on the left, set as follows, and click **"OK"**.
   Protocol: Select **CANopen.**

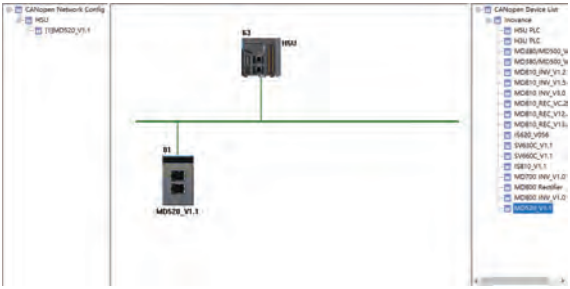
   Station No.: Select **Upper computer setting**. (Note that the CANopen station number of the PLC cannot be the same as that of the AC drive.)

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

3. Configure the master and slave. Click

, and click **"AddCAN Config"**. 

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



4. Configure the receive PDOs and transmit PDOs of the slave. Double-click the slave to configure.
   Receive PDO: The PDOs for writing the running frequency and control commands are added by default.

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

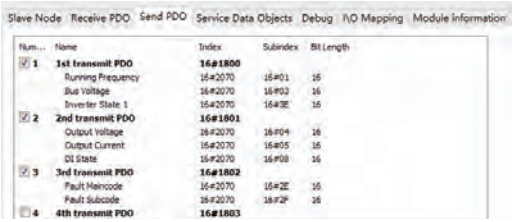
   Index: For groups F0 to FF, convert F in high-order bits to 0 and then add 0x2000.

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

   For groups U0 to UF, convert U in high-order bits 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 corresponding to the bus voltage address U002 is 0x2070, and the sub-index is 03.



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

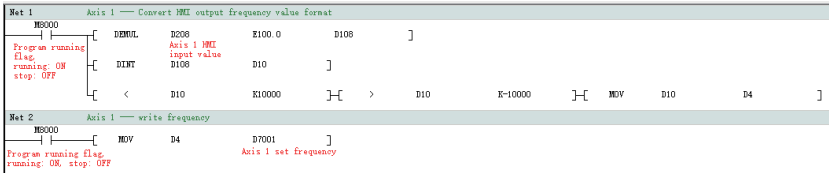
Variable	Mapping	Index: Subindex	Bit Length
D7000...D7001	1st receive PDO mapping	16#1600	32
D7000	Control Command	16#2073:12	16
D7001	Written Freq	16#2073:11	16
D7424...D7426	1st transmit PDO mapping	16#1A00	48
D7424	Running Frequency	16#2070:1	16
D7425	Bus Voltage	16#2070:3	16
D7426	Inverter State	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 desired frequency value a by 100, convert it to an integer, and then write it into D7001.

   The program is as follows:



2. Implement start/stop control on 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:

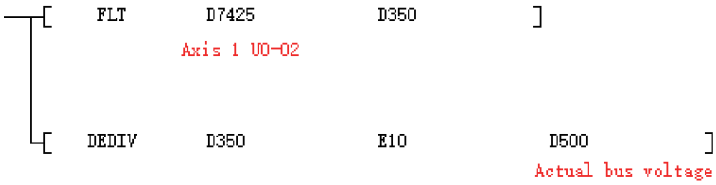
   1: Run in forward direction; 2: Run in reverse direction; 3: Jog in forward direction; 4: Jog in reverse direction; 5: Coast to stop; 6: Decelerate to stop; 7: Reset upon fault

   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:

```
─[ MOV    D7408          D502          ]
          Axis 1 U0-03   Axis 1 Actual outpur
                         voltage
```

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:

```
─┬─[ FLT    D7409          D354          ]
 │          Axis 1 U0-04
 │
 └─[ DEDIV  D354           E100          D504          ]
                                         Axis 1 Actual
                                         output current
```

6. Read the AC drive state.
   Read D7426 to directly obtain 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. 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 U0-07
```

8. Read the fault code.
   According to the conversion rule, 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 Problems and Solutions

The must-dos are listed as follows:

1. Check the wiring. Check whether the wrong pins are wired as CANH and CANL to the PLC.
2. Check the value of FD-10. 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 4–24 Common problems 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 terminal resistor is ON. If not, switch on the terminal 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 terminal resistor is ON. If not, switch on the terminal resistor and then power on the AC drive again.

Problem	Solution
Unstable connection	1. Check that wiring on the PLC end is reliable. (Touch the connection cables on the PLC end to check for poor contact.) 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.

4.6 Communication Faults

4.6.1 Emergency Message and AC Drive Faults

Emergency Message Data

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

Table 4–25 **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 Codes

The following table lists the standard fault codes of the MD520 series AC drive. For details, see the MD520 user guide.

Table 4–26 Fault information

AC Drive Fault Information	AC Drive Fault Information
2: Overcurrent	42: Excessive speed deviation
5: Overvoltage	43: Motor overspeed
8: Pre-charge power fault	45: Motor overtemperature
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 exception	61: Braking overload
18: Current sampling exception	62: Braking transistor fault
19: Motor auto-tuning exception	63: External alarm
20: Encoder/PG card exception	82: Pre-charge contactor fault
21: EEPROM fault	85: Timing fault
22: Encoder card not activated	93: Motor control exception 1
23: Output short-to-ground	94: Motor control exception 2
26: Accumulative running duration reach	159: Auto reset fault
27: User-defined fault	160: Modbus timeout
28: User-defined alarm	161: CANopen fault
29: Accumulative power-on duration reach	162: CANlink fault
30: Output load loss	164: Expansion card fault
31: PID feedback loss during running	174: Input exception protection

4.6.2 Simple Diagnosis

Description

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, it indicates that the network has experienced strong interference for a long time. If the value is greater than 0 and increases within 5 minutes, it indicates that the network is experiencing 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 terminal resistor is only connected 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 interface is connected (typically CGND of all devices are connected together and not grounded).

5 PROFINET Communication

5.1 Introduction

The MD500-PN1 card is a PROFINET fieldbus adapter card complying with the international PROFINET standard. It is installed on an MD series AC drive to improve the communication efficiency and facilitate implementation of the AC drive networking function, enabling the AC drive to be a slave controlled by the fieldbus master.

This user guide is applicable to the MD500-PN1 card with software of version 1.00 or later (you can query the version by viewing the parameter U0-67 of the MD520 after the card is installed and powered on). The corresponding GSDML file is **GSDML-V2.31-inovancemd500-20180705.xml**.

5.2 Installation

The MD500-PN1 card is embedded in the MD520 series 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 MD500-PN1 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by the pulling force of the external signal cable. *"Figure 5–1 " on page 74* shows the installation.

After installing the MD500-PN1 card on the AC drive, connect the ground terminals of the MD500-PN1 card and the AC drive properly, as shown in *"Figure 5–2 " on page 75*.

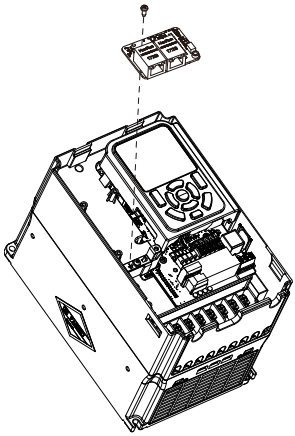


Figure 5-1 Installation of MD500-PN1

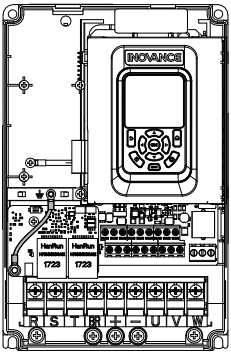


Figure 5-2 Connecting ground terminals of the MD500-PN1 card and AC drive

5.3 Interface Layout and Description

The following figure shows the interface and indicator layout of the MD500-PN1 card. The pin header J1 on the back of the MD500-PN1 card is used to connect the AC drive. The MD500-PN1 card provides two network ports (J2 and J3) for communication with the PROFINET card (PLC).

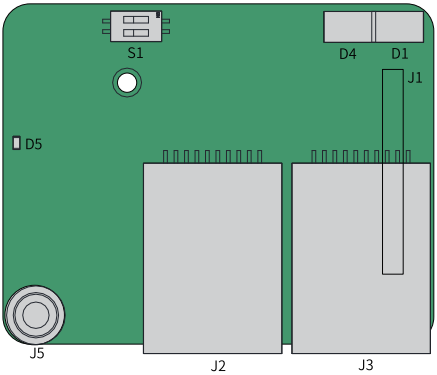


Figure 5-3 Interface layout of the MD500-PN1 card

Table 5–1 Interfaces and indicators of the MD500-PN1 card

Symbol	Hardware Name	Function
J1	Pin header	Check whether FD-00 is set to 9 and FD-01 is set to 3.
J2	Network ports	Standard Ethernet RJ45 socket, direction-insensitive. J3 is used to communicate with the PROFINET card (PLC).
J3		

Symbol	Hardware Name	Function
D5	Power indicator	It indicates the power status. ON indicates normal, and OFF indicates abnormal (check whether the installation is correct).
D1	Status indicator of communication with PLC (PLCLINK)	For details, see *"Table 5–2 " on page 77*
D4	Status indicator of communication with AC drive (DSPLINK)	
S1	2-bit DIP switch	It is used for upgrade by the manufacturer 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 5–2 Status indicators of the MD500-PN1 card

Indicator		State Description	Solution
DSPLINK	Steady green	Normal	N/A
	Steady yellow	MAC address abnormal	Replace the MD500-PN1 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 MD500-PN1 card.
	Blinking red	AC drive communication timeout	Check whether the AC drive software version supports the MD500-PN1 card. Restore the AC drive software to default settings.
PLCLINK	Steady green	Communication normal	N/A
	Blinking green	Master 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 is correct.
	Steady red	Communication with the master interrupted	Check the wiring and check whether the shield layer of the network cable is connected properly.
D1 and D4	Both in red	MD500-PN1 card software abnormal	Power off and then power on the equipment. Replace the MD500-PN1 card.
		DIP switch abnormal	Check that the DIP switch S1 is OFF and re-power on the equipment.

5.4 Topology

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

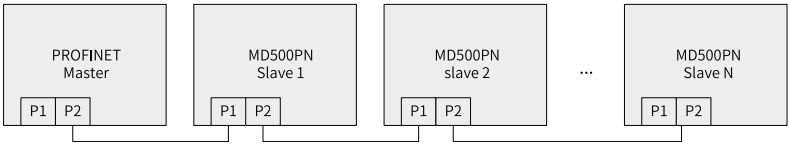


Figure 5-4 Bus topology

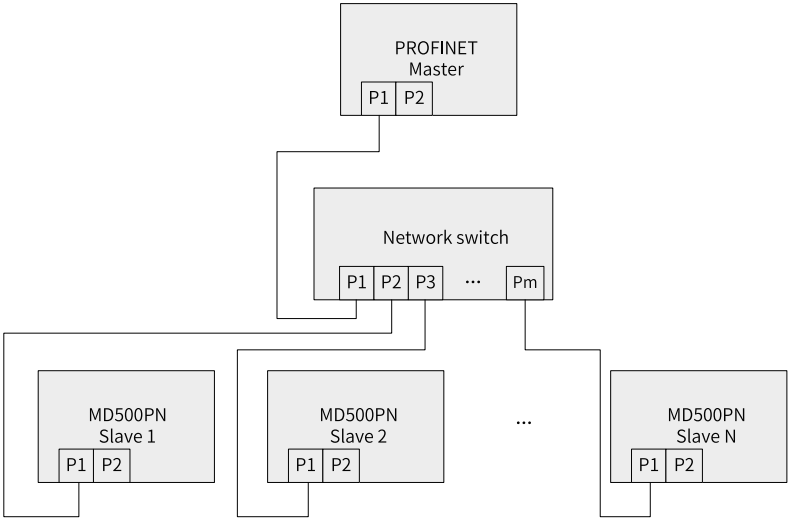


Figure 5-5 Star topology

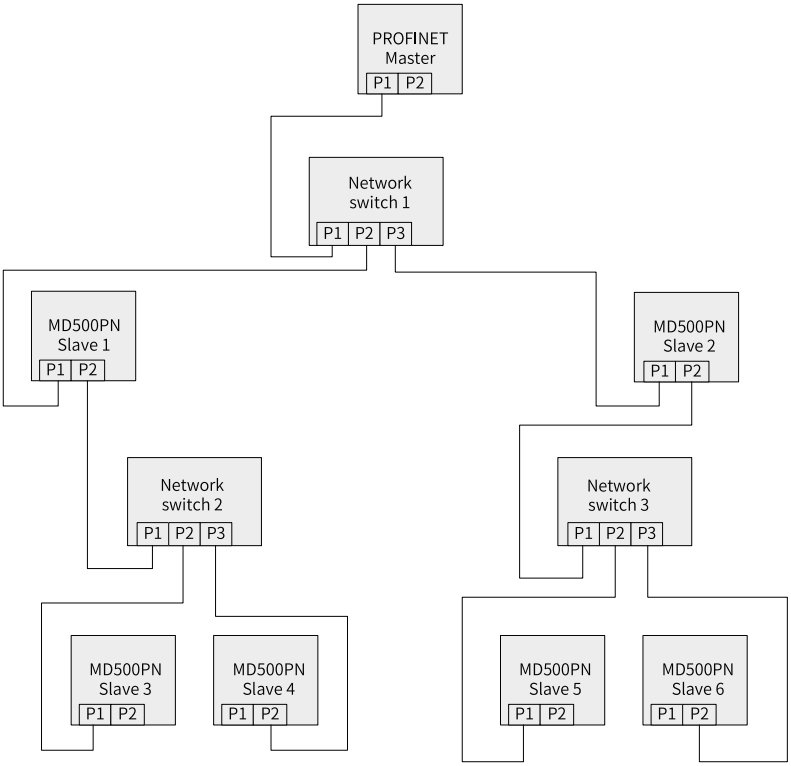


Figure 5-6 Tree topology

5.5 Data Transmission Formats

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

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

Data Format	Data Length	Supported Functions
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 state 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 state 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

Data Format	Data Length	Supported Functions
Standard telegram 6	PZD-12/12	Setting of AC drive command and frequency Periodic writing of ten function parameters Reading of AC drive state and running frequency Periodic reading of ten 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

5.6 PZD Data

The PZD data enables 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:

- Setting the AC drive control command and target frequency in real time
- Reading the current state and running frequency of the AC drive in real time
- Exchanging function parameter and monitoring parameter data between the AC drive and PROFINET master in real time

By default, the written PZD1 and PZD2 are mapped to U3-17 and U3-16, respectively. If a command or frequency fails to be written into the AC drive but 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 set to U3-17 and U3-16 respectively. If not, manually correct the values of FE-00 and FE-01. 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 5–3 Interactive data

Master Transmit Data PZD			AC Drive Response Data PZD		
PZD1	PZD2	PZD3 to PZD12	PZD1	PZD2	PZD3 to PZD12
Control word (U3-17)	Frequency reference (U3-16)	AC drive parameters modified in real time	Status word (U0-68)	Running frequency (U0-69)	AC drive parameters read in real time

Table 5–4

Master Transmit Data PZD		AC Drive Response Data PZD	
PZD1	AC drive command word (command source set to communication, that is, F0-02 = 2) 1: Run in forward direction 2: Run in reverses direction 3: Jog in forward direction 4: Jog in reverse direction 5: Coast to stop 6: Stop according to the stop mode defined by F6-10 7: Reset upon fault	PZD1	AC drive running state, which is described as follows by bit: Bit0: 0: Stopped; 1: Running Bit1: 0: Running in forward direction; 1: Running in reverse direction Bit2: 0: Not faulty; 1: Faulty Bit3: 0: Running frequency not reached; 1: Running frequency reached Bit4 to bit7: Reserved Bit8 to bit15: AC drive fault code
PZD2	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 reference target frequency exceeds this range, the AC drive runs at the frequency upper limit.	PZD2	AC drive running frequency (unit: 0.01 Hz) The current AC drive running frequency is returned as 16-bit signed data.
PZD3 to PZD12	Parameter values modified in real time, not written into EEPROM	PZD3 to PZD12	Parameter values read in real time

5.7 Related Parameters

AC Drive PN Card Configuration

After installation, the MD500-PN1 expansion card can communicate with the AC drive properly only after F0-28 is set to 1.

Parameter	Parameter Name	Value Range	Setpoint	Description
F0-28	Serial communication protocol	0: Modbus protocol 1: Communication card network bridge protocol	1	Select the special communication card network bridge protocol as the serial communication protocol.
F0-02	Command source	0: Operating panel 1: Terminal 2: Communication	2	Set the command source to communication.
F0-03	Main frequency reference source	0: Digital setting (non-retentive at power failure) 1: Digital setting (retentive at power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	9	Set the target frequency through communication.

Expansion Card Type Parameters

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

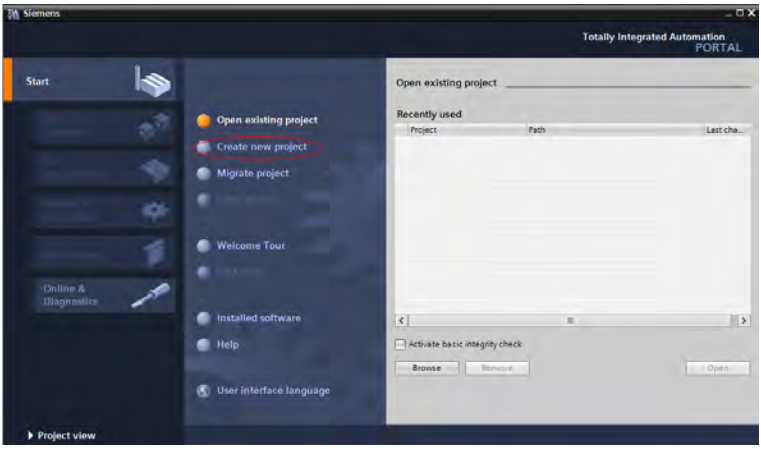
5.8 Communication Configurations

5.8.1 Configuring Slaves on the S7-1200 Master

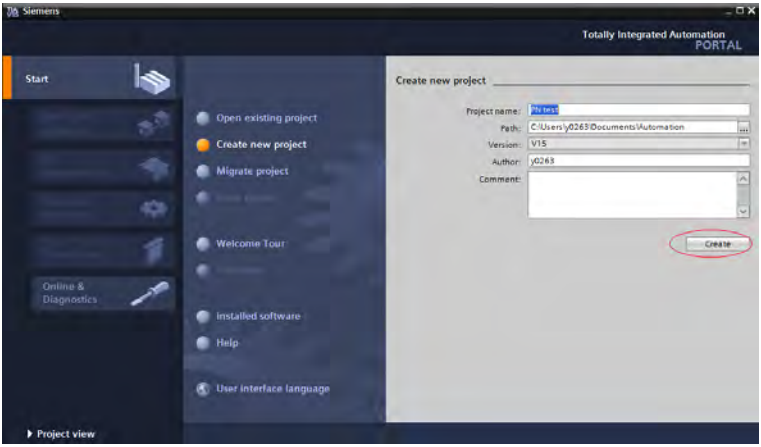
Before using the PROFINET master, you need to configure the GSDML file of the slave to add the corresponding slave device to the system of the master. If the file exists, skip step 2. You can obtain the GSDML file from Inovance or its agent.

The configuration procedure is as follows:

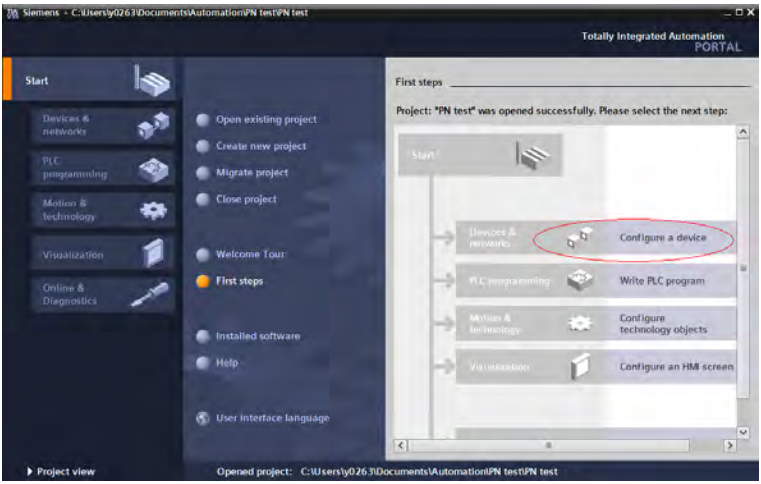
1. Create a project and add the S7-1200 master to the project in PORTAL. To be specific, open PORTAL first. The interface as shown in the following figure is displayed.



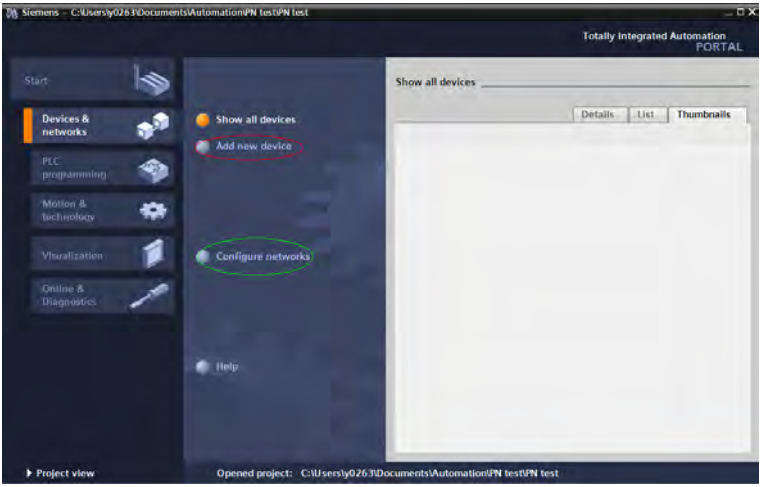
Click **Create new project**, enter a project name and storage path, and click **Create**.



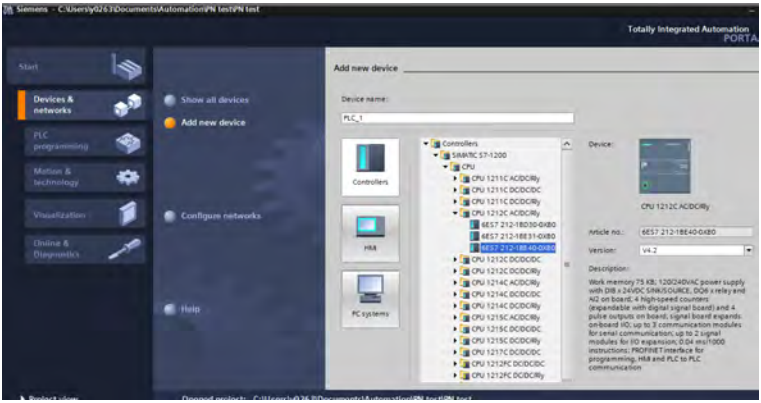
Click **Configure a device**, as shown in the following figure.



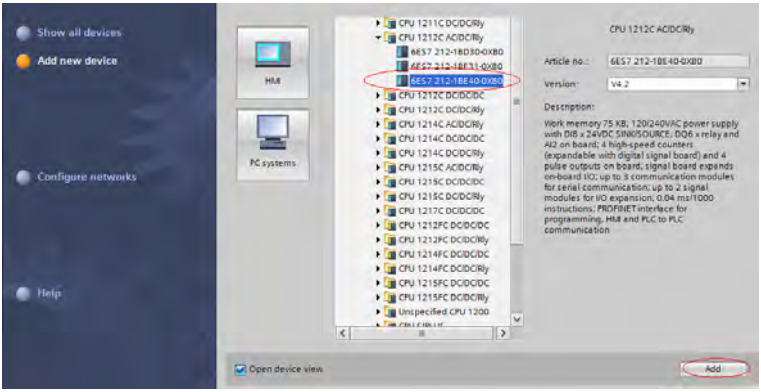
For a new project, click **Add new device** (marked with a red circle in the following figure). For an existing project, click **Configure networks** (marked with a green circle in the following figure).



Select a PLC on the displayed page. Set the article number and firmware version of the PLC correctly to avoid download failure.

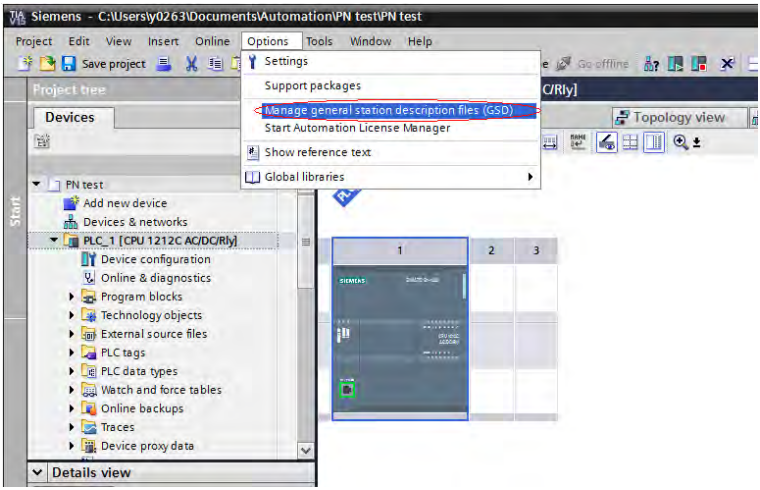


Click **Add** or double-click the selected master, as shown in the following figure.

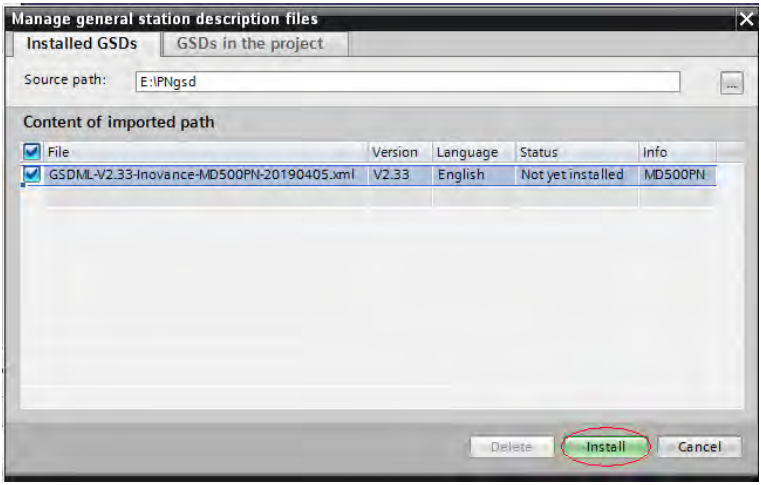


Now the master is established.

2. Install the GSDML file. (Skip this step if the GSDML file has been installed.) Choose **Options** > **Manage general station description files (GSD)**.



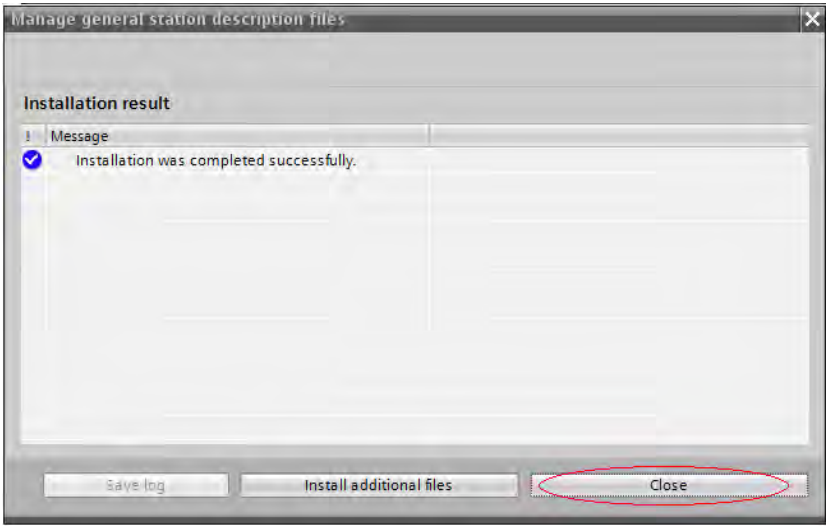
Select the path (English path required) for storing the GSDML file, select the GSDML file to be installed, and click **Install**.



Caution

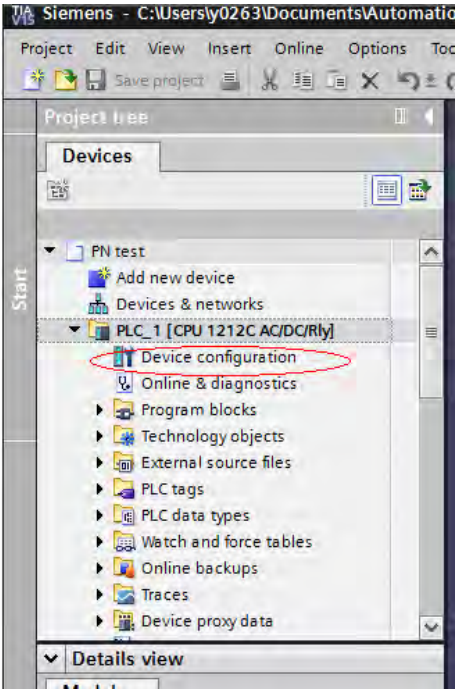
The GSDML file name varies with the AC drive series. For details, see the corresponding user guide.

After the installation is successful, click **Close**.

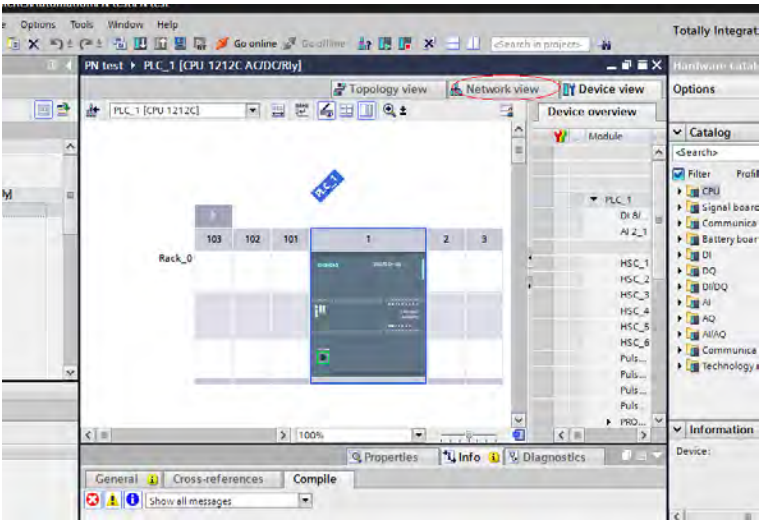


3. Configure a slave.

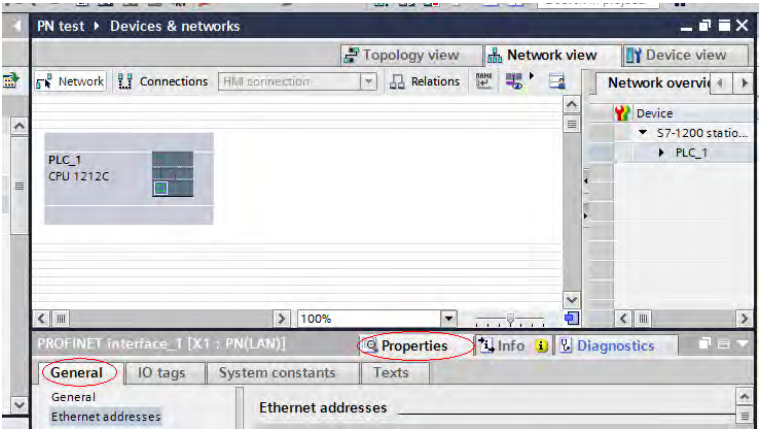
Click **Device configuration** on the interface.



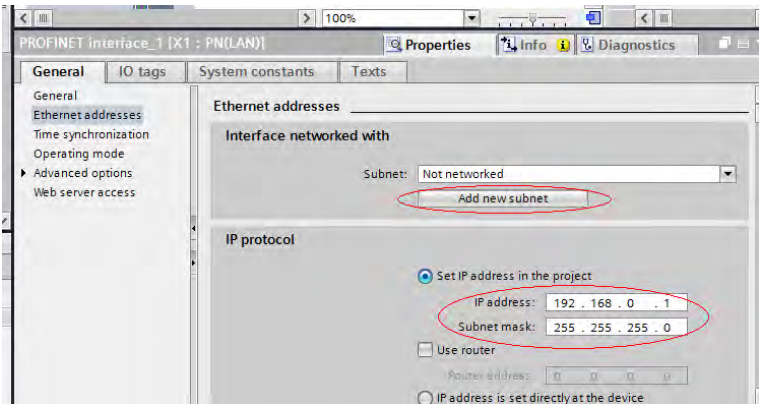
Click **Network view**.



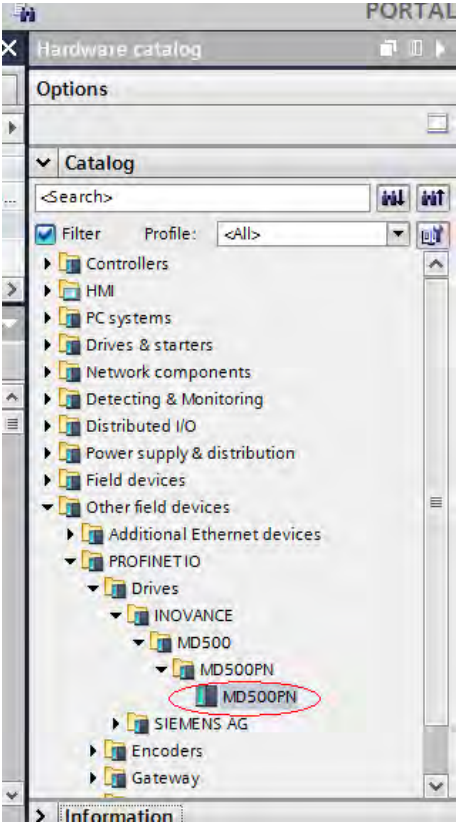
Select the Ethernet interface of the PLC, and choose **Properties** > **General**.



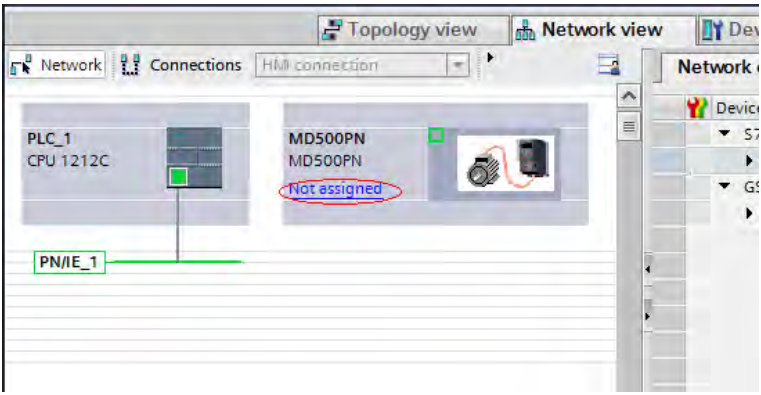
Set the IP address and subnet mask of the PLC master, and click **Add new subnet**.



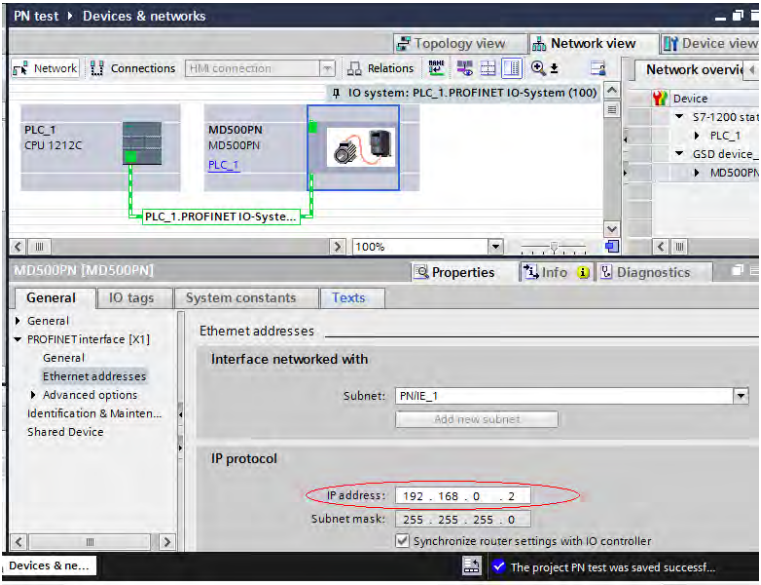
Locate MD500 under **Hardware catalog** on the right, and double-click **MD500PN**.



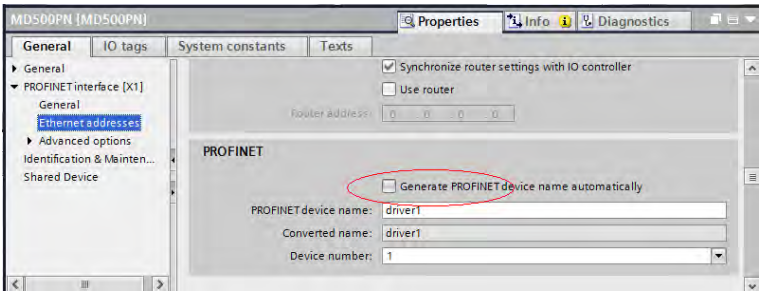
Click **Not assigned** to select the master system for the slave.



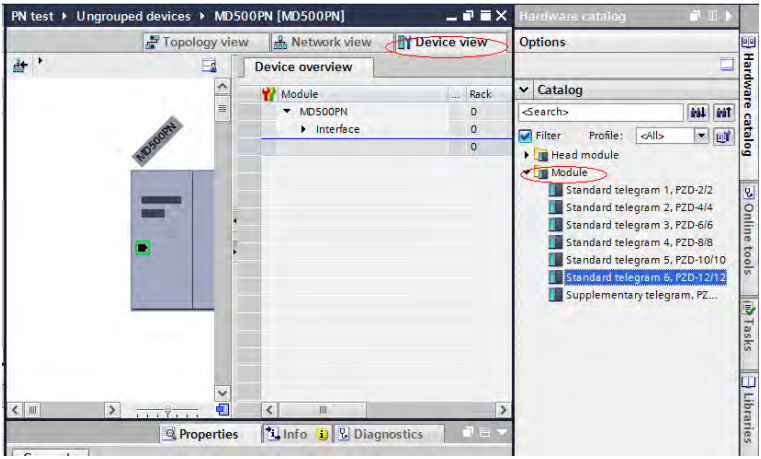
Select the slave, and choose **Properties** > **General**. Then, choose **PROFINET interface [X1]** > **Ethernet addresses** and set the IP address.



Scroll down the screen to locate **PROFINET**. Deselect **Generate PROFINET device name automatically** and enter a name in **PROFINET device name**. (Or you can keep the option selected to allow the system to generate a device name automatically.)

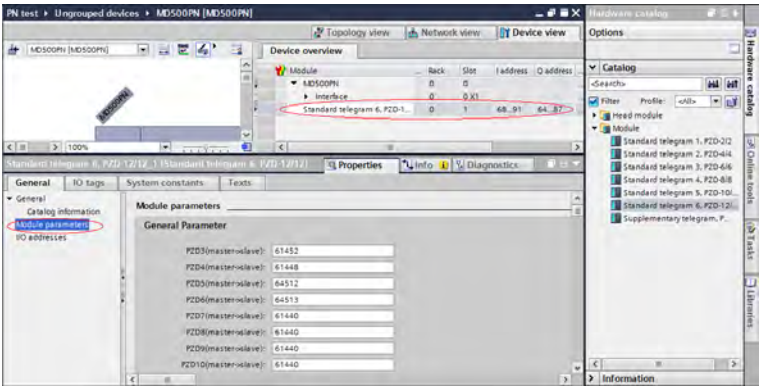


4. Configure data features of the slave.
   Select the slave and switch to the **Device view** page. Locate **Module** under **Hardware catalog**, and double-click the data length for the slave as required.



5. Configure PZDs.

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

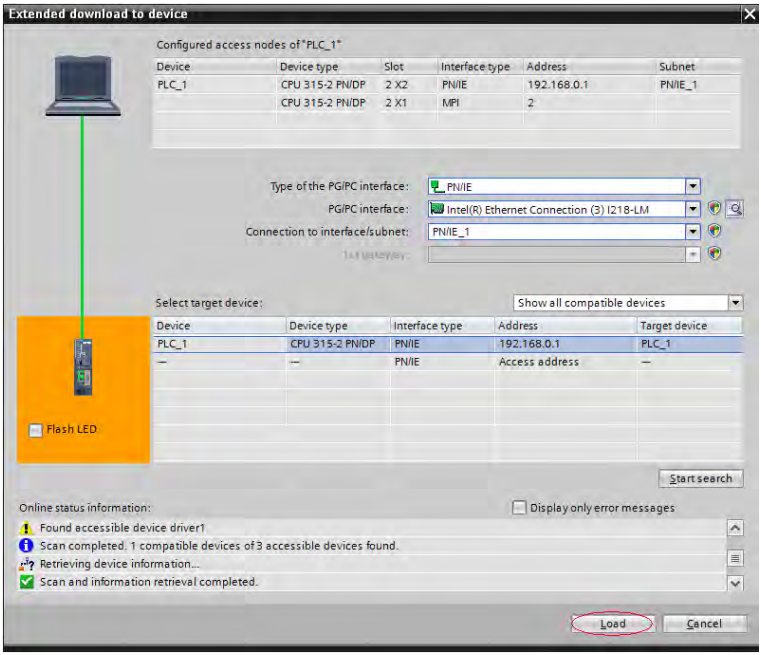


   PZDx(master->slave) indicates the address used by the master to write to the slave, and PZDx(slave->master) indicates the address used by the master to read the slave. PZD3 to PZD12 (determined by the selected message type) are displayed in decimal and can be modified. For example, to set **PZD3(master->slaver)**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

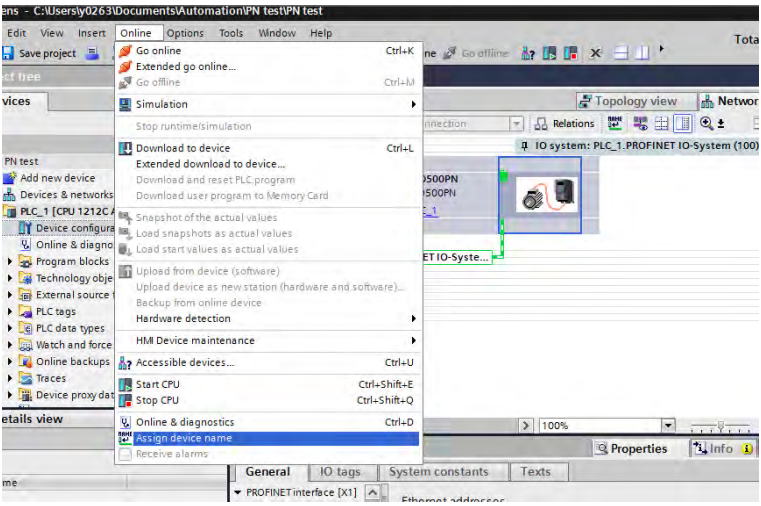
   By default, all PZDs of MD500 are set to F0-00 (61440 in decimal). For unused PZDs, modification is not required and default values can be retained. PZD mapping must be set independently for each slave as required (if the mappings of various slaves are the same, you can select a configured slave, press **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 cannot be duplicate).

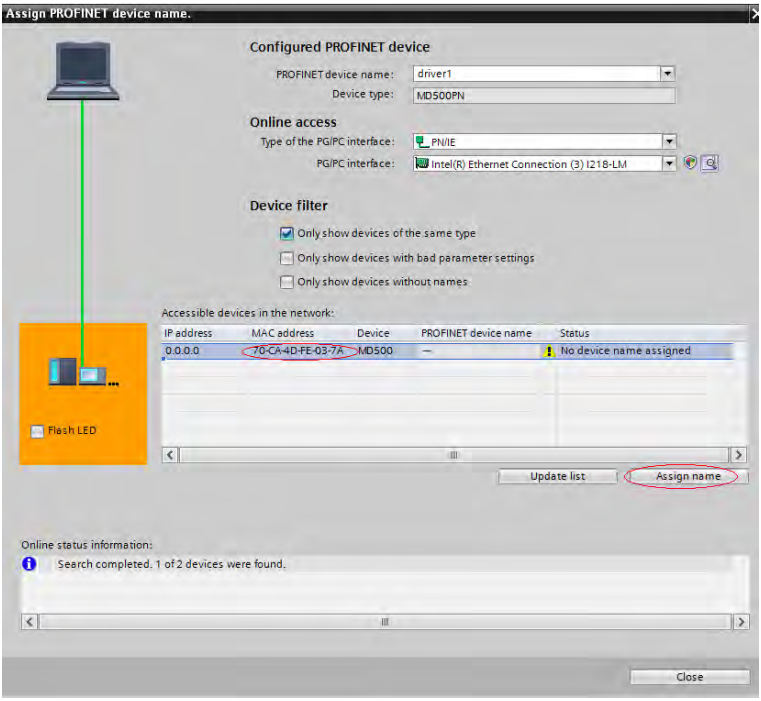
6. Download the configuration.
   Save the network configuration. Set the IP address of the PC to an address in the same network segment with the PLC. (Note that the IP address of the PC must be different from the IP addresses of the slaves in the configuration. You can also allow automatic IP address allocation for the PC.) Then, start compiling, click **Load**, select the interface, and click **Start search**.



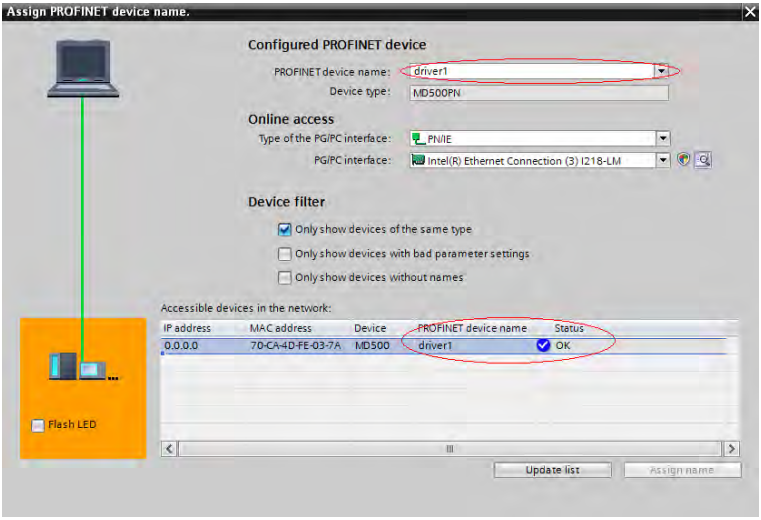
7. Assign device names.
   Assign device names for slaves without names. Select a slave, and choose **Online** > **Assign device name** (or right-click the slave and choose **Assign device name** in the shortcut menu).



On the displayed page, devices of the same type are listed. Select the slave to be assigned with a device name based on its unique MAC address. The MAC address of the MD500-PN1 card can be found on its housing. Then, click **Assign name**.



If information similar to that shown in the following figure is displayed, the device name is assigned successfully. The displayed **PROFINET device name** must be consistent with that displayed in the preceding figure. After assigning the device name, close the window 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 process of assigning the device name is actually binding the device name with the MAC address.)

Caution

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

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

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.

5.8.2 MRP Function of the 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, a 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; otherwise, an error will be reported.
3. 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, a 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; otherwise, an error will be reported.
3. 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. In this case, the AC drive slave reports ERR164, which is cleared automatically (if the automatic clearing function is supported) after the handshaking is complete. You can also manually clear the fault. After the network recovers from the disconnection, the preceding operations are repeated.
- 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.

5.9 Fault Diagnosis

5.9.1 Communication Faults

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

The following table describes the fault code of the rectifier module.

Table 5–5 Fault code of the rectifier module

Fault Code	Possible Cause	Solution
E164.1	The communication between the communication card and the master is disconnected.	Check whether the connection between the communication card and PLC is in poor contact. Make sure that they are properly connected.

5.9.2 Troubleshooting

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

Symptom		Solution
After the AC drive is powered on, only the power indicator (D4) is on, indicating that the connection between the PN card and AC drive is not established.		1. Check that F0-28 is set to 1. 2. Check the AC drive type. This user guide only describes the usage of MD520. For other AC drive models, contact the technical engineers to obtain the correct user guide. 3. Check whether the AC drive software version supports MD500-PN1.
After the AC drive is powered on, the power indicator (D5) is on and the communication indicator (D4) is steady yellow.		Replace the MD500-PN1 card.
The connection fails after the configuration is downloaded.	After the configuration is downloaded, D5 and D4 on the MD500-PN1 card are steady green, and D1 blinks green.	1. Check that the cable is properly connected. 2. Check that the upstream PN node works properly. 3. Check whether the node is assigned with a device name through the PLC. 4. Check that the GSDML file used in the configuration is correct.
	After the configuration is downloaded, D5 and D4 on the MD500-PN1 card are steady on, and D1 blinks yellow.	1. Check that the GSD file used is correct. 2. Check that the PZD mapping is set correctly. Device-specific parameters in STEP 7 and PORTAL must be set in decimal format. Therefore, you need to convert the parameter numbers into decimal values when setting device-specific parameters. For example, the decimal value of FC-11 is 64523 (0xFC0B in hexadecimal format). If a parameter number that the AC drive does not support is entered, the connection fails. Note that PZD mapping does not support Modbus addresses such as H2000 and H8000.

Symptom		Solution
After the connection is successful, all indicators on the PLC are 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 the SFC15 block is **0**. If not, an invocation error exists. Eliminate this error first and invoke the block again.
	PZD3 or subsequent data can be written, but PZD1 or PZD2 cannot be written/read.	Check that F0-02 is set to 2 and F0-03 is set to 9. 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 is set to U3-17 and FE-01 is set to U3-16. 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 PZD is supported by the message type. Check whether **Device-specific parameters** are set correctly (check whether the mapping is correct by checking corresponding parameters in group FE).
	-	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 ERR164, 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 that this solution applies to MD520 only. For other AC drives, consult the technical personnel.

Caution

When the status word returned by the MD500-PN1 card and the AC drive during communication cannot show the fault state, you need to monitor the state by using OB82, or write a changed value to an address of the AC drive and read it back to check the state.

The MD500-PN1 card can be replaced directly when the slave node is faulty (only when the MD500-PN1 card is faulty) without device configuration again.

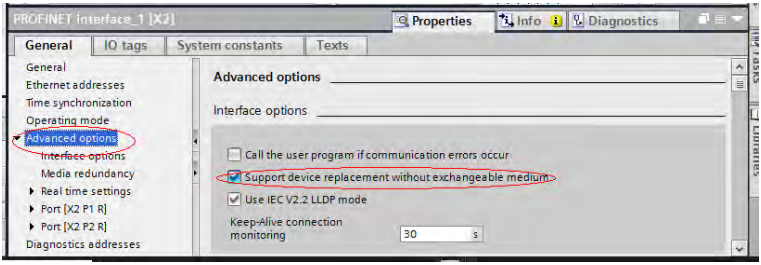
The prerequisites for directly replacing the MD500-PN1 card are as follows:

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

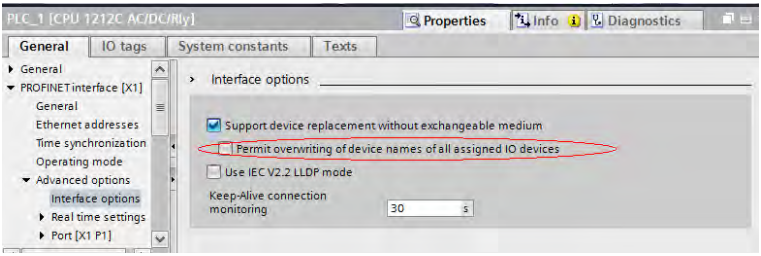
To directly replace the MD500-PN1 card, the corresponding configuration is required. The configuration varies in STEP 7 and PORTAL.

Selecting the Support device replacement without exchangeable medium Option and Setting Topology in PORTAL

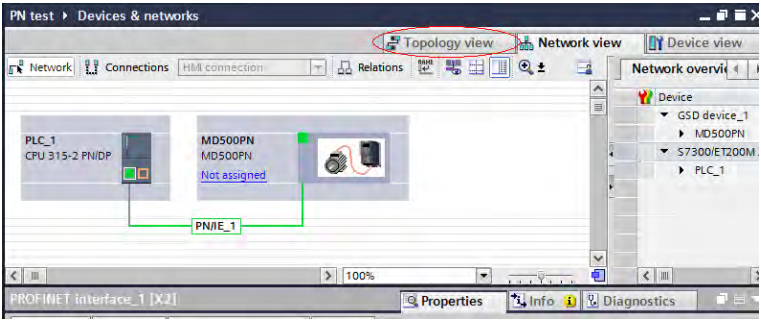
Open PORTAL, and select the PROFINET interface of the master in the hardware configuration. Choose **Properties** > **General**, choose **Advanced options** > **Interface options**, and select **Support device replacement without exchangeable medium**, as shown in the following figure.



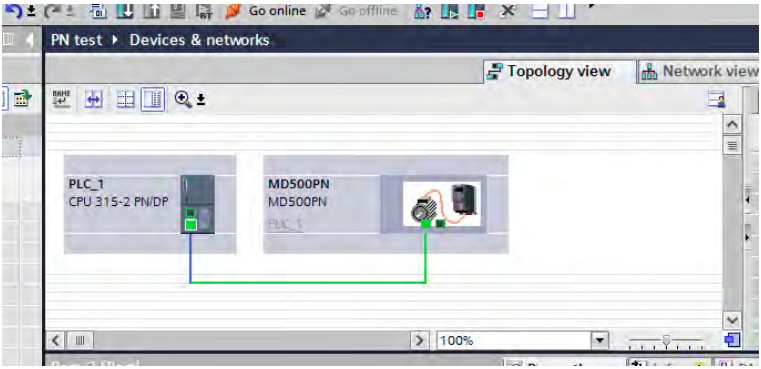
For the S7-1200 or S7-1500 PLC, the sub-option **Permit overwriting of device names of all assigned IO devices** is available. If this sub-option is selected, the second prerequisite for directly replacing the MD500-PN1 card is not required.



Then, switch to **Topology view**, as shown in the following figure.



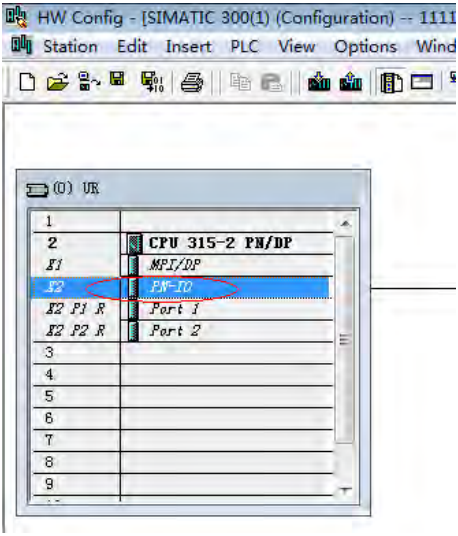
In the topology view, click and drag the interface to the interface of another device that is directly connected to this interface, and release the mouse button. Note that the preceding connection must be consistent with the actual network connection of devices. For example, if P1 of the PLC is connected to P2 of slave 1, and P1 of slave 1 is connected to another slave, the connections must be consistent in the topology. An incorrect topology will cause 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 facing the RJ45 interface.)



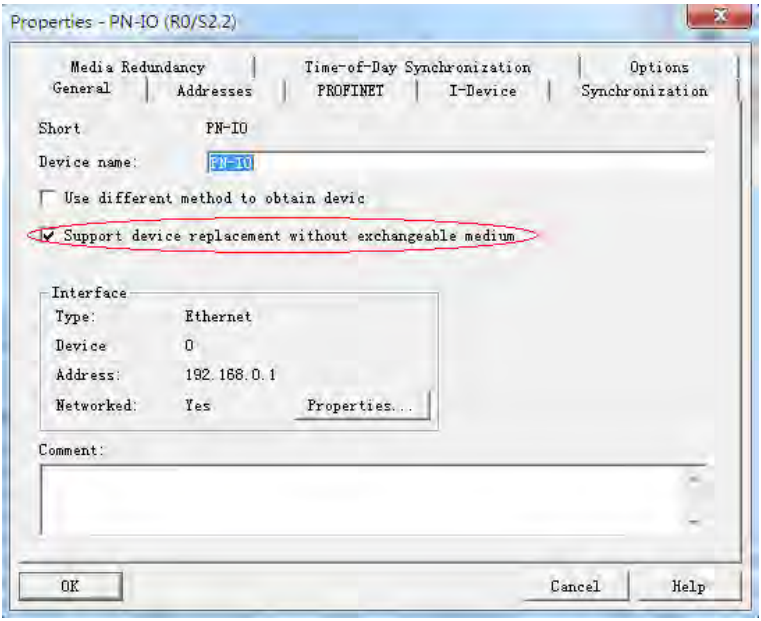
After completing the topology, start compiling and download the configuration to the PLC.

Selecting the Support device replacement without exchangeable medium Option and Setting Topology in STEP 7

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

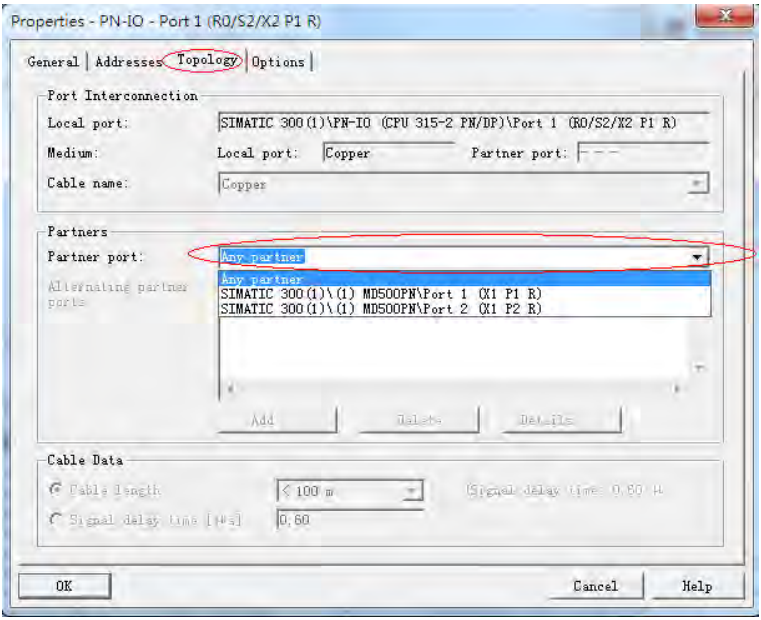


Click the **General** tab, select **Support device replacement without exchangeable medium**, and click **OK**, as shown in the following figure.



According to the actual network connections, double-click **Port 1** or **Port 2** of the PLC, and switch to the **Topology** tab. Select the port of the slave connected to the

PLC from the **Partner port** drop-down list (the default option is **Any partner**, which must be changed to the actual connected port), and click **OK**.



Then click the corresponding ports of the slave to set the topology. The operations are similar to the preceding steps. After setting all connected ports, start compiling and download the configuration to the PLC.

After completing the preceding configuration, perform the following operations when a slave device needs to be replaced: 1) Disconnect the device from the network. 2) Install a new device that is not assigned with a device name 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, a device that has been assigned with a name 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. The PLC will assign a device name to the newly connected device automatically.

6 EtherCAT Communication

6.1 Introduction

Applicable to industrial field ultra-high speed I/O network, the MD500-ECAT communication card (ECAT card for short) operates at the I/O layer and 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. It supports a minimum synchronization cycle of 500 μs.

This user guide is applicable to the ECAT card with software of version 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 powered on). The corresponding device profile XML file is **MD500_1Axis_V1.03.xml**.

6.2 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 for about 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 the pulling force of the external signal cable. *"Figure 6–1 " on page 105* shows the installation.

After installing the MD500-ECAT card on the AC drive, connect the ground terminals of the MD500-ECAT card and the AC drive properly, as shown in *"Figure 6–2 Connecting ground terminals of the MD500-ECAT card and AC drive" on page 106*.

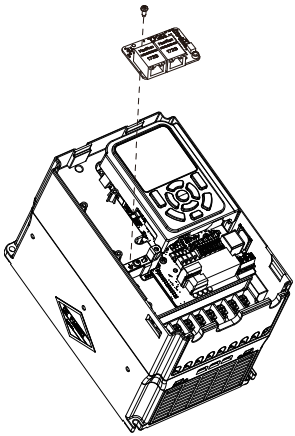


Figure 6-1 Installation of MD500-ECAT

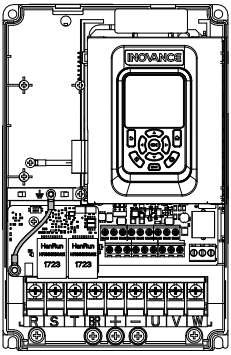


Figure 6-2 Connecting ground terminals of the MD500-ECAT card and AC drive

6.3 Interface Layout and Description

The following figure shows the interface and indicator layout of the MD500-ECAT card. The pin header J7 on the back of the MD500-ECAT card is used to connect the AC drive. The MD500-ECAT card provides two network ports (J4 and J6) for communication with the master (or the upstream slave) and the downstream slave (if any).

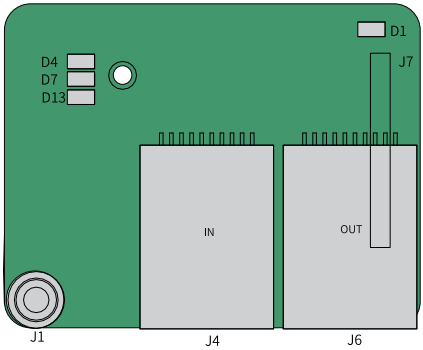


Figure 6-3 Interface layout of the MD500-ECAT card

Table 6–1 Interfaces and indicators of the MD500-ECAT card

Symbol	Hardware Name	Function
J7	Pin header	It connects to the AC drive.
J4	Network ports	They use the standard Ethernet RJ45 socket and are used for communication with the master (or the upstream slave) and the downstream slave (if any).
J6		
J1	EMC ground terminal	It connects to the EMC ground terminal of the AC drive.

Symbol	Hardware Name	Function
D13	Power indicator (green)	It indicates the power status. ON indicates normal. OFF indicates abnormal, and you need to check whether the installation is correct.
D1	Status indicator of communication with AC drive (green)	For details, see *"Table 6–2 Status indicators of the MD500-ECAT card" on page 107*
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 6–2 Status indicators of the MD500-ECAT card

Indicator		State Description	Solution
D1	Steady green	Normal	N/A
	Steady off	Abnormal communication with the AC drive	Set F0-28 to 1 and check whether the AC drive supports the MD500-ECAT card.
D4	Steady green	Working at OP state	N/A
	Blinking green	Working 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.
	Steady off	Master disconnected or working in Initial mode	Check whether the master and upstream network port are connected correctly.
D7	Steady off	Normal	N/A
	Steady red	ESC internal exception	Contact Inovance for technical support.

6.4 Topology

After enabling communication between the ECAT card and the AC drive, connecting the ECAT card to the ECAT master correctly and completing relevant communication configuration can enable the communication between the ECAT card and ECAT master and the AC drive networking function.

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

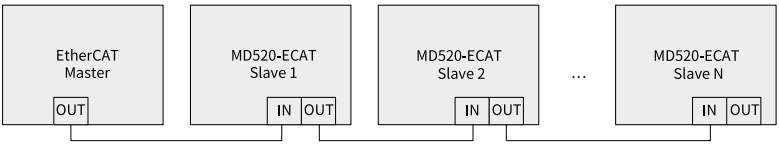


Figure 6-4 EtherCAT bus topology

6.5 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. The data communication addresses are directly configured by the AC drive. The functions of PDO data are as follows:

1. Setting the AC drive control command and target frequency in real time
2. Reading the current state and running frequency of the AC drive in real time
3. Exchanging function parameter and monitoring parameter data between the AC drive and EtherCAT master in real time

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

Transmit PDO from the Master to Axis 1 (1601h)			Response PDO of AC Drive Axis 1 (1A01h)		
Fixed RPDO		Variable RPDO			
AC Drive Command	AC Drive Target Frequency	AC Drive Parameters Modified in Real Time	AC Drive State	AC Drive Running Frequency	AC Drive Parameters Read in Real Time
RPDO1	RPDO2	RPDO3 to RPDO12	TPDO1	TPDO2	TPDO3 to TPDO12

Data Sent by the Master (RPDO)

Table 6–3 Master transmit data RPDO

RPDO	Description
RPDO1	AC drive command word (command source set to communication, that is, F0-02 = 2) • 1: Run in forward direction • 2: Run in reverses direction • 3: Jog in forward direction • 4: Jog in reverse direction • 5: Coast to stop • 6: Stop according to the stop mode defined by F6-10 • 7: Reset upon fault
RPDO2	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 reference 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 frequency reference set through 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 frequency reference set through communication is –6000, the AC drive will run at 50.00 Hz in the reverse direction.
RPDO3 to RPDO12	Parameter values modified in real time, not written into EEPROM. FE-02 to FE-09 correspond to RPDO3 to RPDO12. For details about the configuration, see the PDO Data Configuration section.

Data Returned by the AC Drive (TPDO)

Table 6–4

TPDO	Description
TPDO1	AC drive running state • Bit0: 0: Stopped; 1: Running • Bit1: 0: Running in forward direction; 1: Running in reverse direction • Bit2: 0: Not faulty; 1: Faulty • Bit3: 0: Running frequency not reached; 1: Running frequency reached • Bit4 to bit7: Reserved • Bit8 to Bit15: AC drive fault code

TPDO2	AC drive running frequency (unit: 0.01 Hz) The current AC drive running frequency 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	Parameter read in real time. FE-22 to FE-29 correspond to TPDO3 to TPDO12. For details about the configuration, see the PDO Data Configuration section.

6.6 SDO Mailbox Data

EtherCAT SDO is used to transfer non-cyclic data, such as communication parameter configuration and servo drive running parameter configuration.

The CANopen over EtherCAT (CoE) service types include: emergency message, SDO request, SDO response, TxPDO, RxPDO, remote TxPDO transmit request, remote RxPDO transmit request, and SDO information.

MD520 supports the SDO request and SDO response.

6.7 Related Parameters

AC Drive ECAT Card Configuration

After installation, the MD500-ECAT card can communicate with the AC drive properly only after F0-28 is set to 1.

Parameter	Parameter Name	Value Range	Setpoint	Description
F0-28	Serial communication protocol	0: Modbus protocol 1: Communication card network bridge protocol	1	Select the special communication card network bridge protocol as the serial communication protocol.
F0-02	Command source	0: Operating panel 1: Terminal 2: Communication	2	Set the command source to communication.
F0-03	Main frequency reference source	0: Digital setting (non-retentive at power failure) 1: Digital setting (retentive at power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	9	Set the target frequency through communication.

Communication Control Parameters

Table 6–5 Communication control parameters

Parameter	Parameter Name	Value Range		Decimal Address
U3-16	Frequency reference	–Maximum frequency to +Maximum frequency 0.01 Hz		29456
U3-17	Control command	0000: Stop according to the stop mode defined by F6-10 0001: Run in forward direction 0002: Run in reverse direction 0003: Jog in forward direction	0004: Jog in reverse direction 0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	29457
U3-18	DO control	Bit0: DO1 output control Bit1: DO2 output control Bit2: Relay 1 output control Bit3: Relay 2 output control		29458
U3-19	AO1 control	0 to 7FFF, indicating 0% to 100%		29459
U3-20	AO2 control	0 to 7FFF, indicating 0% to 100%		29460
U3-21	FMP control	0 to 7FFF, indicating 0% to 100%		29461
U3-22	Reserved	Reserved		
U3-23	Speed control	Signed data, 1 RPM		29463

Each object within the dictionary shall be addressed uniquely by using an index and sub-index.

The index (hexadecimal) specifies the position of the same type of objects in the dictionary.

The sub-index specifies the offset of each object in the same index in hexadecimal format.

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 value of offset in parameter group + 1

When the MD500-ECAT card is used, the written PDO1 and PDO2 are mapped to U3-17 and U3-16 respectively by default. Therefore, ensure that the first entry of RPDO is U3-

17; otherwise, an operation exception will occur. Besides, if any non-zero value is written to the high-order 8 bits of U3-17, the AC drive will report the communication fault Err164.

Communication Monitoring Parameters

Table 6–6 Communication monitoring parameters

Parameter	Parameter Name	Unit	Decimal Address
U0-00	Running 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
U0-06	Output torque	0.1%	28678
U0-07	DI state	1	28679
U0-08	DO/RO 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	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 duration	0.1 min	28692
U0-21	AI1 voltage before correction	0.001 V	28693
U0-22	AI2 voltage before correction	0.001 V	28694
U0-23	AI3 voltage before correction	0.001 V	28695
U0-24	Linear speed	1 m/min	28696
U0-25	Current power-on duration	1 min	28697
U0-26	Current running duration	0.1 min	28698

Parameter	Parameter Name	Unit	Decimal Address
U0-27	Pulse input frequency	1 Hz	28699
U0-28	Communication reference	0.01%	28700
U0-29	Encoder feedback speed	0.01 Hz	28701
U0-30	Main frequency X	0.01 Hz	28702
U0-31	Auxiliary frequency Y	0.01 Hz	28703
U0-32	Any memory address	1	28704
U0-33	Synchronous motor rotor position	0.1°	28705
U0-34	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	V/f separation target voltage	1 V	28711
U0-40	V/f separation output voltage	1 V	28712
U0-41	DI state display	1	28713
U0-42	DO state display	1	28714
U0-43	DI state display 1	1	28715
U0-44	DI state display 2	1	28716
U0-45	Fault information	1	28717
U0-58	Z signal counter	1	28730
U0-59	Frequency reference	0.01%	28731
U0-60	Running frequency	0.01%	28732
U0-61	AC drive state	1	28733
U0-62	Current fault code	1	28734
U0-63	Data sent by master during point-point communication	0.01%	28735
U0-64	Data sent by slave during point-point communication	0.01%	28736
U0-65	Torque upper limit	0.1%	28737

Parameter	Parameter Name	Unit	Decimal Address
U0-66	Expansion card model	100: CANopen 200: PROFIBUS DP 400: PROFINET 500: EtherCAT 600: EtherNet/IP	28738
U0-67	Expansion card version	0.01	28739
U0-68	AC drive state	1	28740
U0-69	Running frequency	0.01 Hz	28741
U0-70	Motor speed	1 RMP	28742
U0-71	Output current	0.1 A	28743
U0-80	Name of EtherCAT slave	1	28752
U0-81	Alias of EtherCAT slave	1	28753
U0-82	EtherCAT ESM transmission error code	1	28754
U0-83	EtherCAT XML file version	0.01	28755
U0-84	EtherCAT synchronization loss count	1	28756
U0-85	Maximum errors and invalid frames of EtherCAT port 0 per unit time	1	28757
U0-86	Maximum errors and invalid frames of EtherCAT port 1 per unit time	1	28758
U0-87	Maximum forwarding errors of EtherCAT port per unit time	1	28759
U0-88	Maximum error count of EtherCAT data frame processing unit per unit time	1	28760
U0-89	Maximum link loss of the EtherCAT port per unit time	1	28761

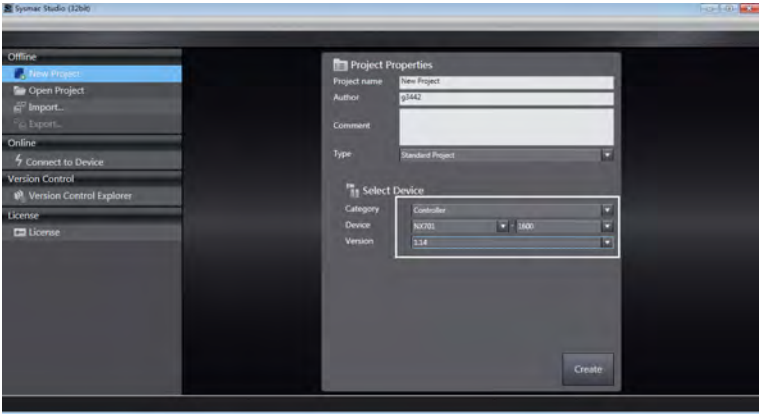
When the MD500-ECAT card is used, the read PDO1 and PDO2 are mapped to U0-68 and U0-69 respectively by default. Therefore, ensure that the first entry of TPDO is U0-68; otherwise, an operation exception will occur.

6.8 Communication Configurations

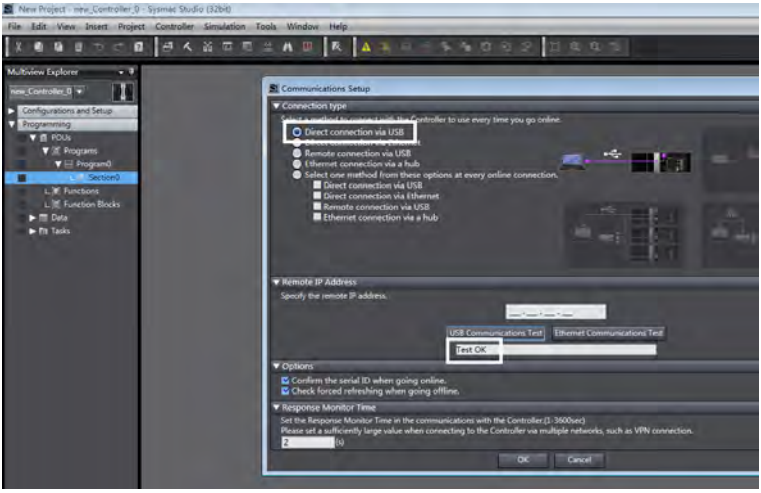
6.8.1 Communication Instance of Controlling MD520 with an Omron Controller

This section takes Omron's NX701 master as an example to describe how to configure and use the MD520 series AC drives.

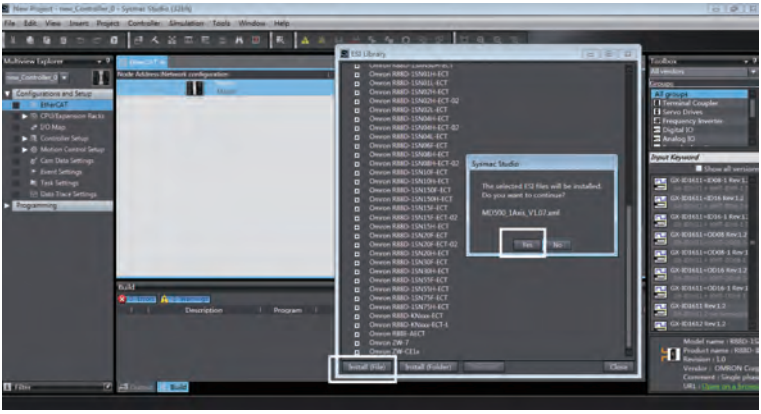
1. Create a project.
   - **Device**: Select the actual controller model.
   - **Version**: 1.09 or later version. NX701-1600 supports version 1.10 or later.



2. Perform communication settings.
   a. Choose **Controller** > **Communications Setup** on the main interface to set the connection mode between the PC and controller.
   b. Select **Direct connection via USB**, and click **USB Communications Test**. Proceed to the next step if the test is successful.

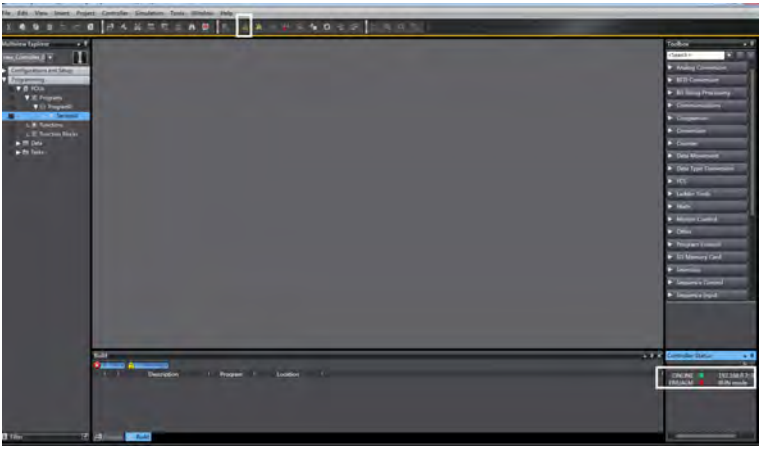


3. Import the XML configuration file.
   Double-click **EtherCAT** on the left, select and right-click the master, click **Install (File)** in the **ESI Library** window, select the MD500-ECAT card XML configuration file and import it.



4. Scan for devices.
   Switch the controller to the online running mode.

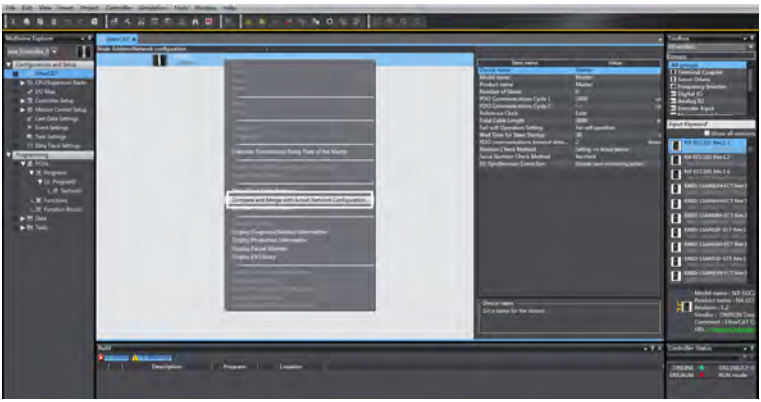
   You can observe the controller status in the lower right corner: ONLINE, RUN mode.

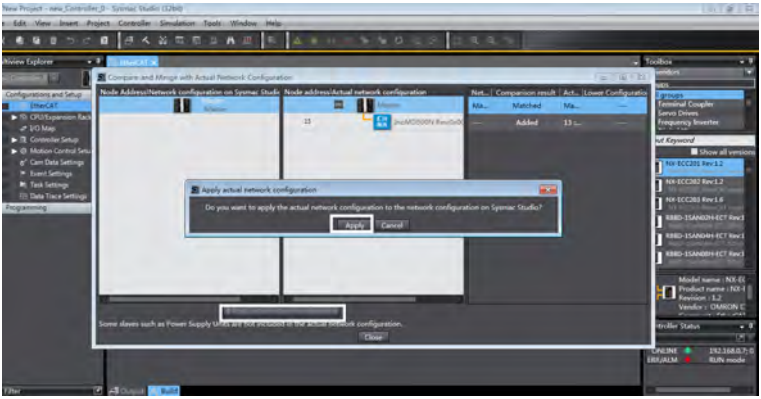


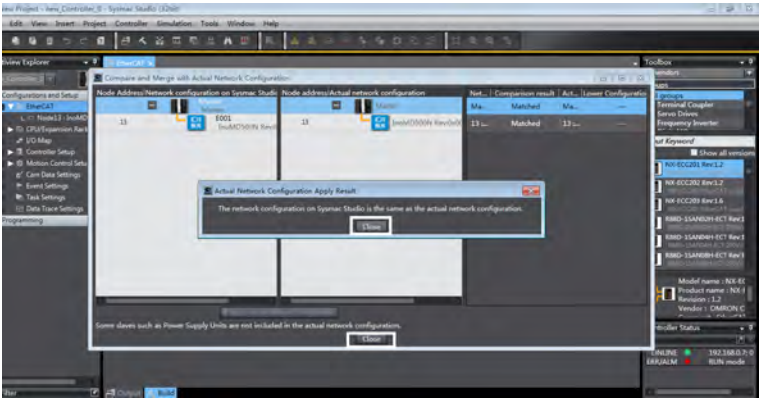
Scan for devices and add slaves. Choose **Configurations and Setup** > **EtherCAT**, right-click the master device, and choose **Compare and Merge with Actual Network Configuration**. The controller automatically scans all slaves in the network (a fault will be reported if any station number is 0). After the scanning is complete, click **Apply** in the displayed **Apply actual network configuration** dialog box. The slaves are added. You can view the added slaves on the main interface.

Note

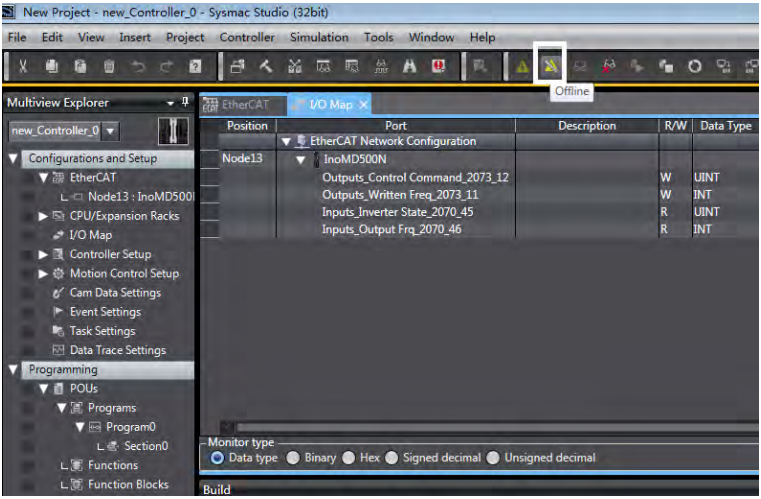
The MD500-ECAT card allows the station alias to be modified by using the parameter FD-02 or the software tool of the master station. The modified station alias takes effect upon next power-on.



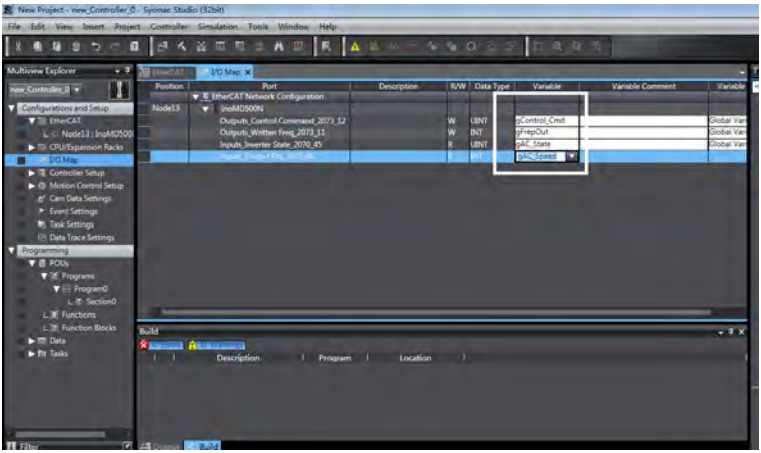




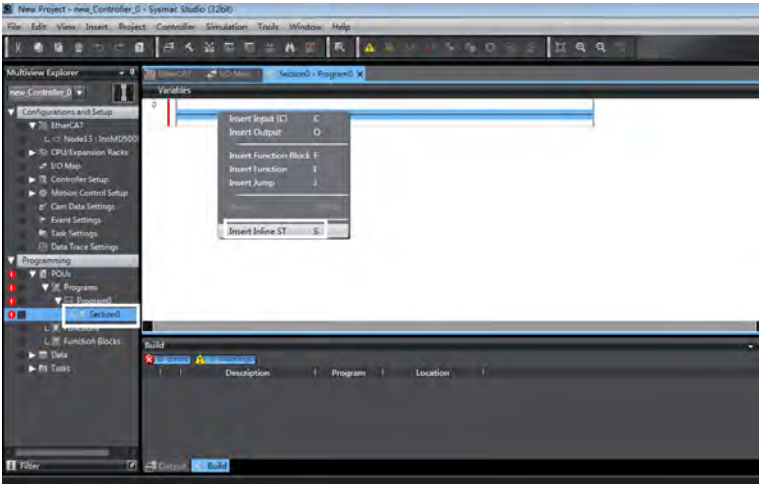
5. Set the parameters.
   Switch the controller to the offline mode.

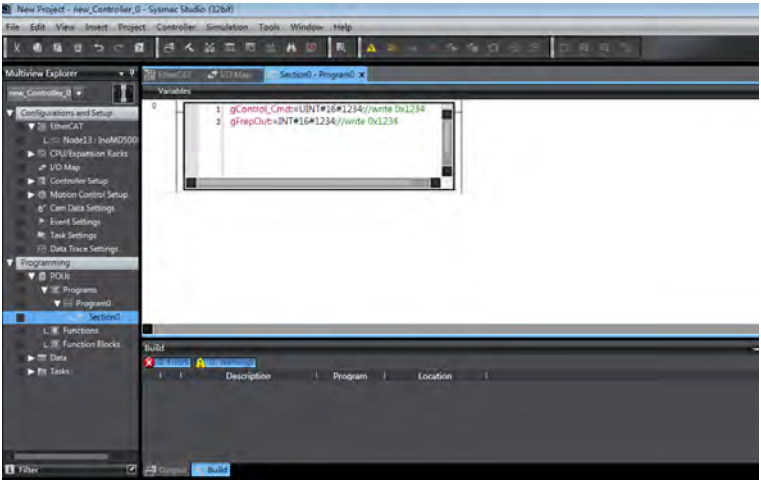


Set the PDO mapping (I/O mapping).

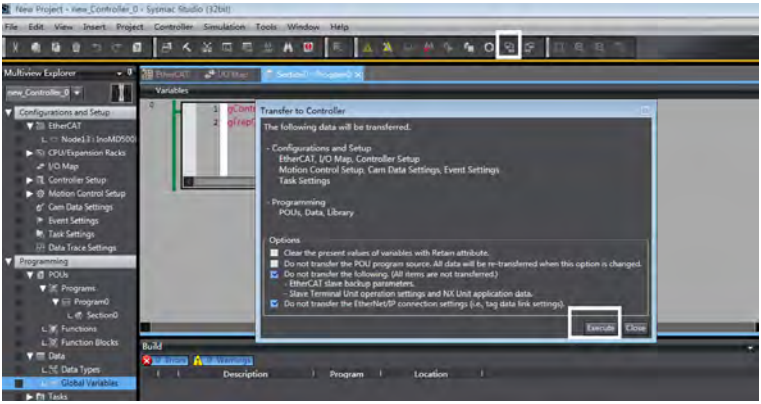


6. Edit the PLC program.





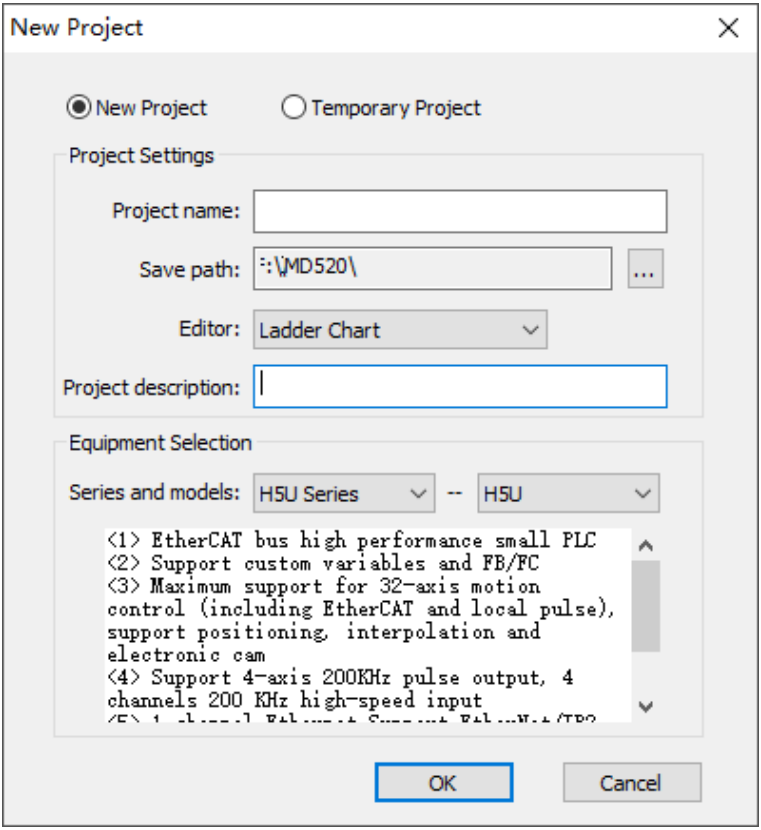
7. Download the program to the controller.
   After the configuration and programming are complete, switch the controller back to the online state, and download the program to the controller.



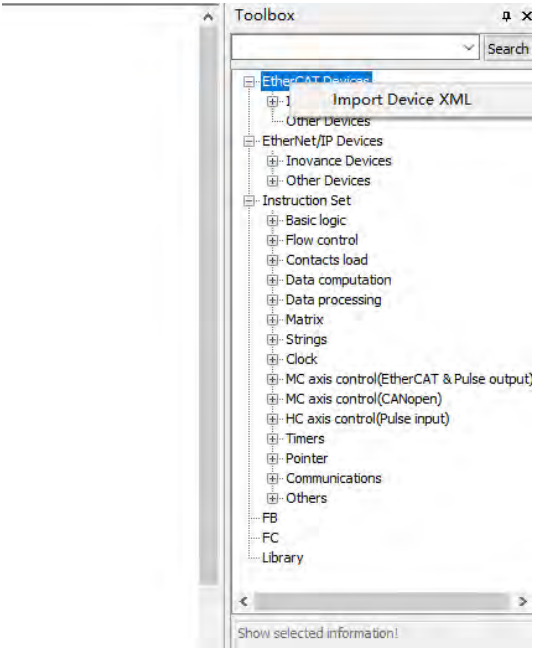
6.8.2 Communication Instance of Controlling MD520 with an H5U Controller

This section takes the H5U master as an example to describe how to configure and use the MD520 series AC drives.

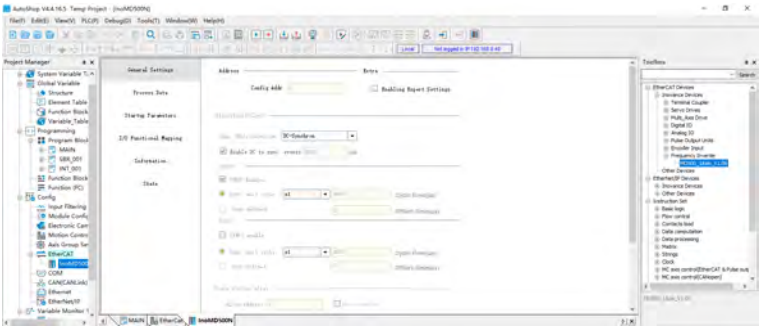
1. Open the software and create an H5U project
   Select **H5U Series** in the **Series and models** drop-down list, as shown in the following figure.



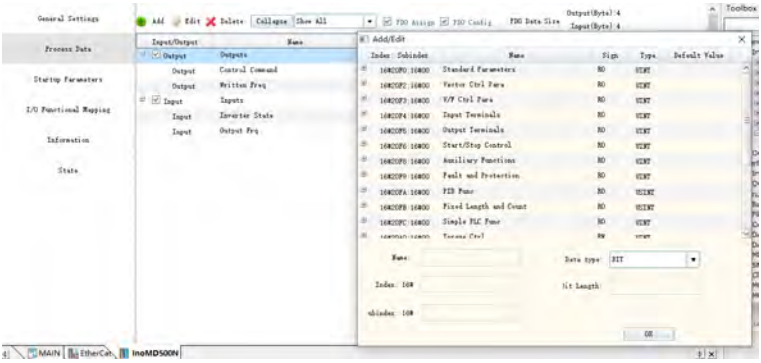
2. Import the EtherCAT configuration file of MD520.
   Right-click **EtherCAT Devices** and choose **Import Device XML**. If an MD520 EtherCAT configuration file of another version exists, delete the existing configuration file before importing a new one. See the following figure.



3. Add an MD520 AC drive slave.
   Double-click **EtherCAT** under **Config** on the left to open network configuration, and drag the device in the network device list to add the AC drive slave.

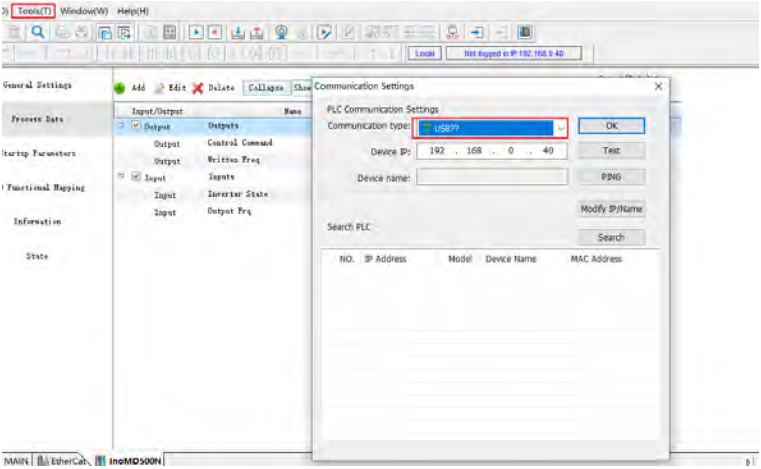


4. Set the PDO parameters.
   Click **Process Data**, and click **Add** to add the TPDO mapping as required.

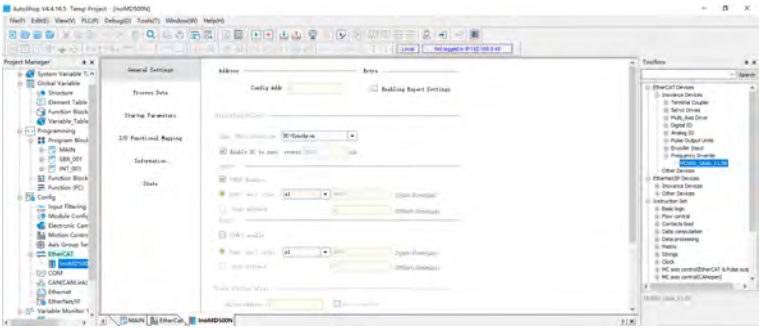


NOTE: Control Command of the RPDO and **Inverter State** of the RPDO cannot be changed and they must be set as the first entries. Otherwise, an operation exception will occur.

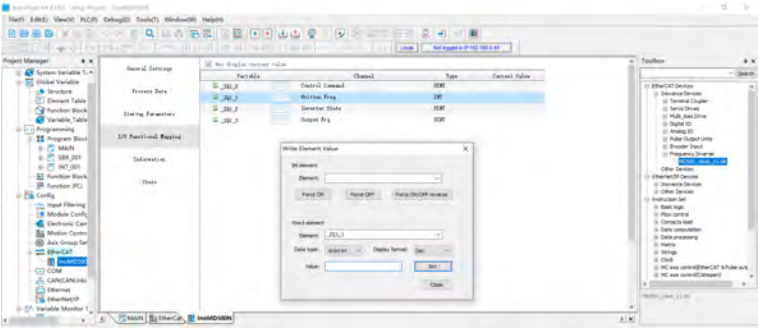
5. Scan for the H5U PLC.
   Choose **Tools** > **Communication Settings**, select a communication mode between the PC and PLC (Ethernet or USB), and scan for the PLC.



6. Download the project to the PLC and activate and run the device.
   Download the compiled project file, click the run button to activate the configuration, and click the monitor button to view the motion data.



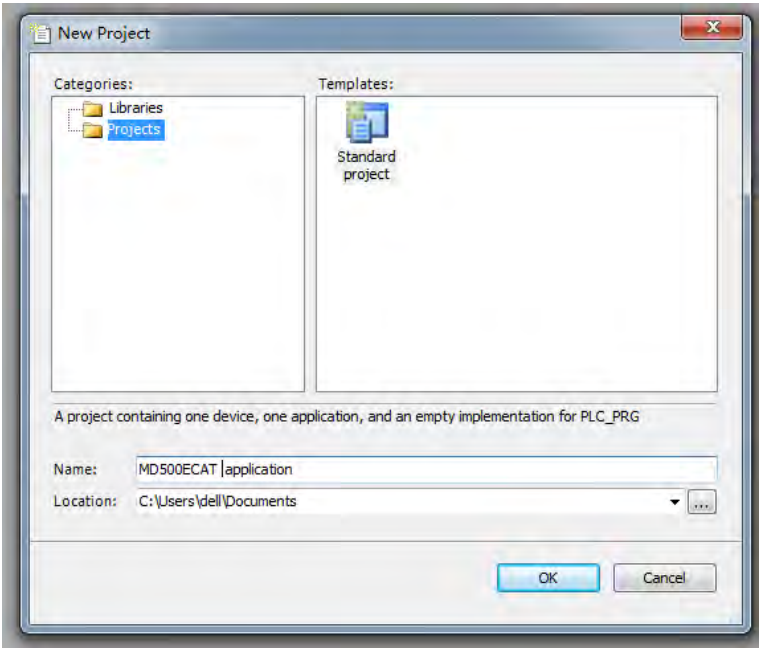
You can view TPDO data and write RPDO data in real time through EtherCAT I/O mapping.

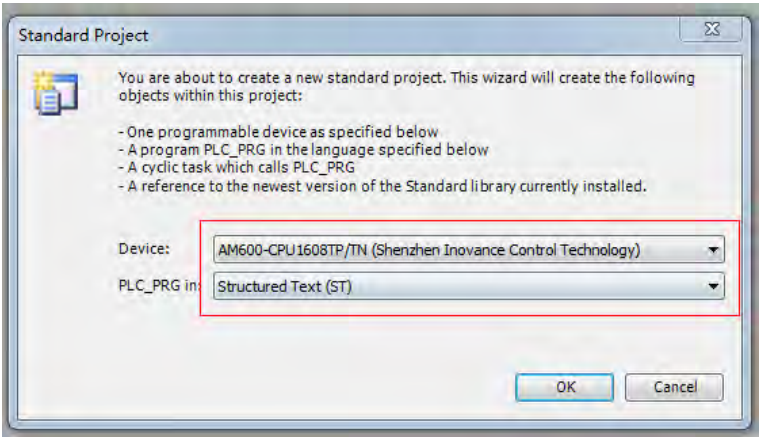


6.8.3 Communication Instance of Controlling MD520 with an AM600 Controller

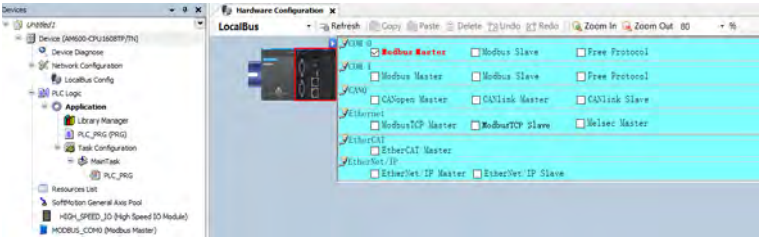
This section takes the AM600 master as an example to describe how to configure and use the MD520 series AC drives.

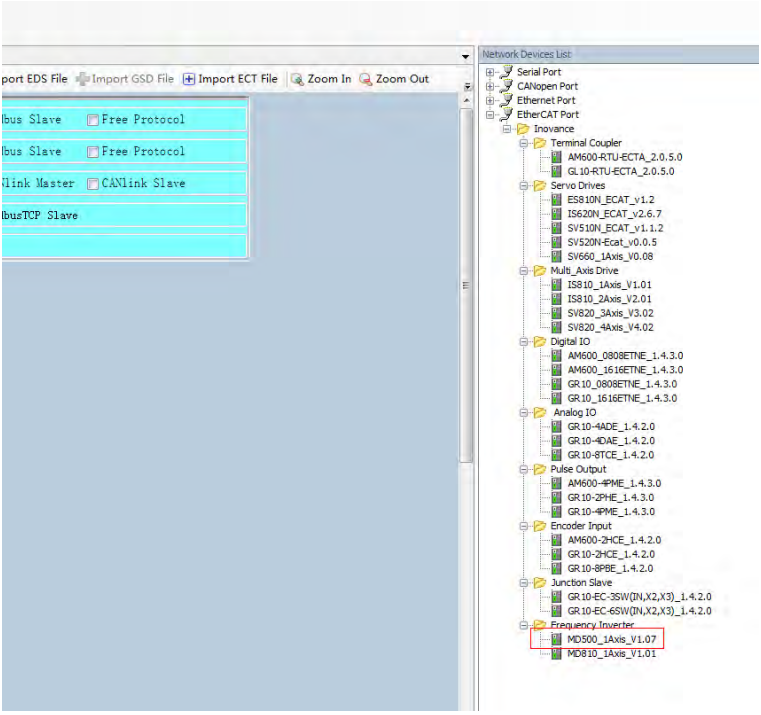
1. Open the software and create an AM600 project.
   Select **AM600-CPU1608TP/TN** in the **Device** drop-down list, as shown in the following figure.



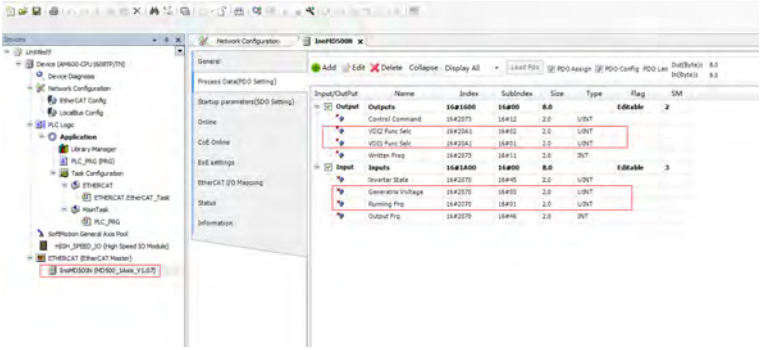


2. Add an MD520 AC drive slave. Open network configuration, and import the EtherCAT configuration file of MD520. If any configuration file of another version exists, delete the existing configuration file before importing a new one. Drag the device in the network device list to add the AC drive slave, as shown in the following figure.

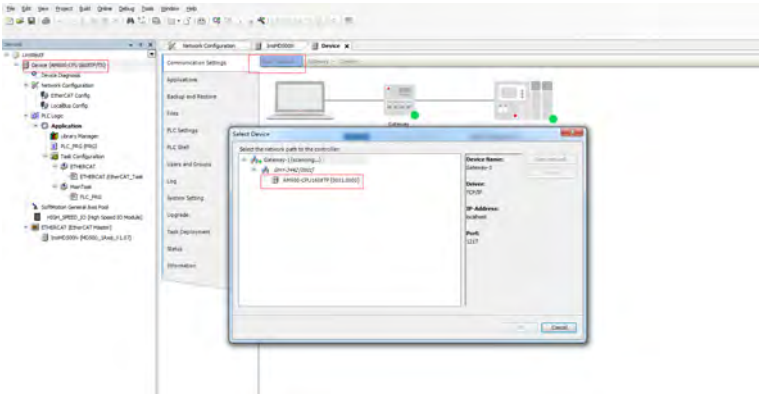




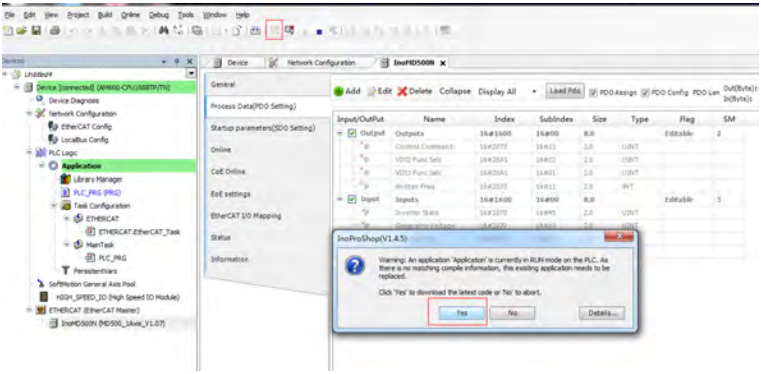
3. Set the PDO parameters.
   Right-click the position marked with a red arrow in the following figure to add the TPDO mapping as required. **Control Command** of the RPDO and **Inverter State** of the RPDO cannot be changed and they must be set as the first entries. Otherwise, an operation exception will occur.



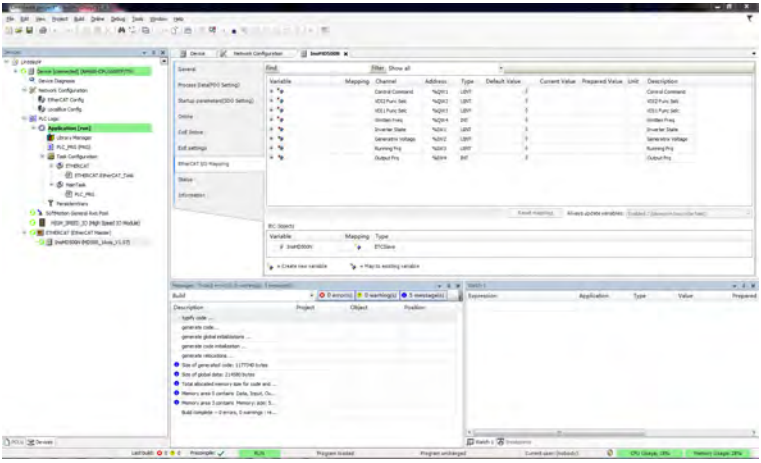
Scan for devices.



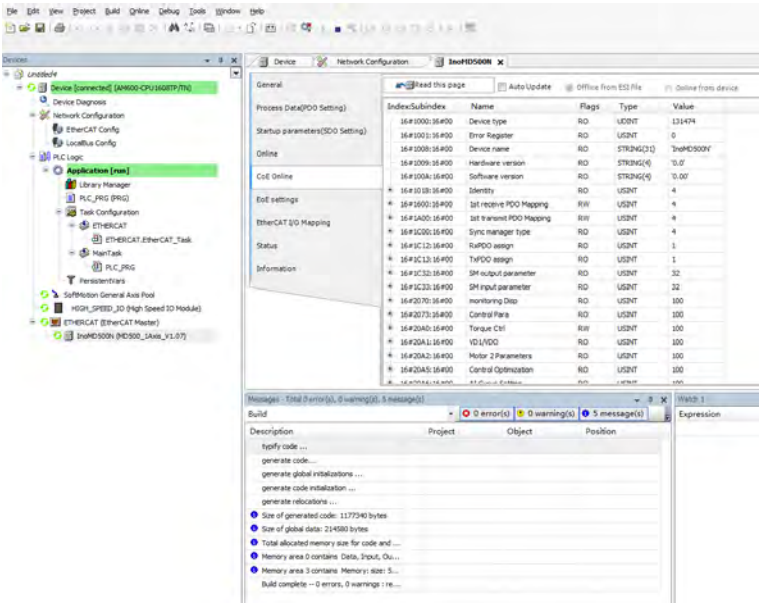
Download the project to the PLC.



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



You can view and directly write parameter values through the online CoE.



6.8.4 Communication Instance of Controlling MD520 with a Beckhoff Controller

This section takes Beckhoff's TwinCAT master as an example to describe the configuration of the MD500-ECAT card.

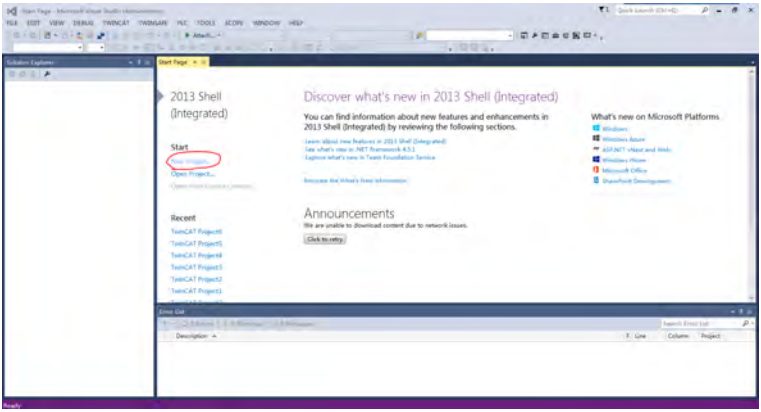
Caution

Select a 100M Ethernet network adapter with an Intel chip. Other network adapters may not support EtherCAT.

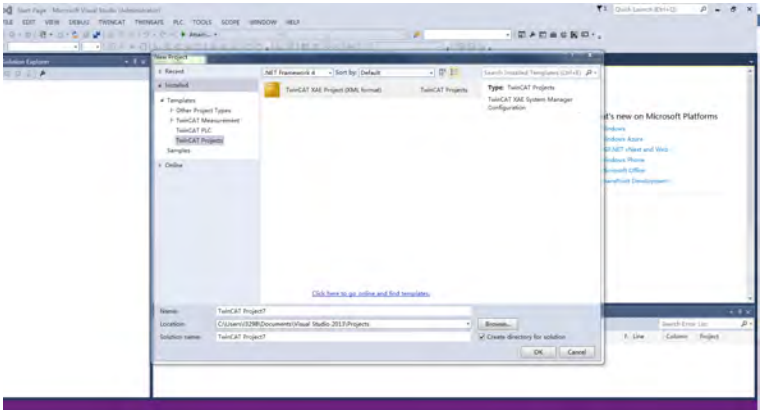
1. Install TwinCAT.
   - Windows XP: **tcat_2110_2230** is recommended.
   - Windows 7 32-bit: **tcat_2110_2248** is recommended.
2. Copy the EtherCAT configuration file (**MD500_1Axis_V1.03.xml**) of MD520 to the TwinCAT installation directory.
   - TwinCAT2 directory: **TwinCAT\IO\EtherCAT**
   - TwinCAT3 directory: **TwinCAT\3.1\config\IO\EtherCAT**

   The following takes TwinCAT3 as an example. The operation steps for TwinCAT2 are similar.
3. Open TwinCAT.

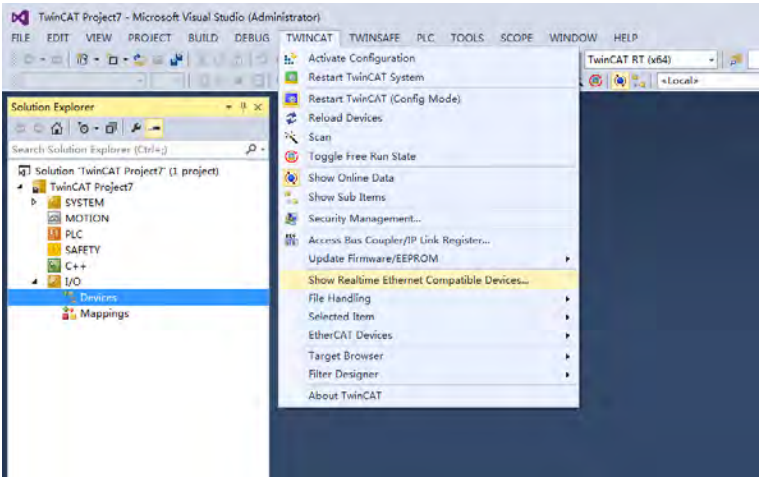
   a. Click **New Project** to create a project.



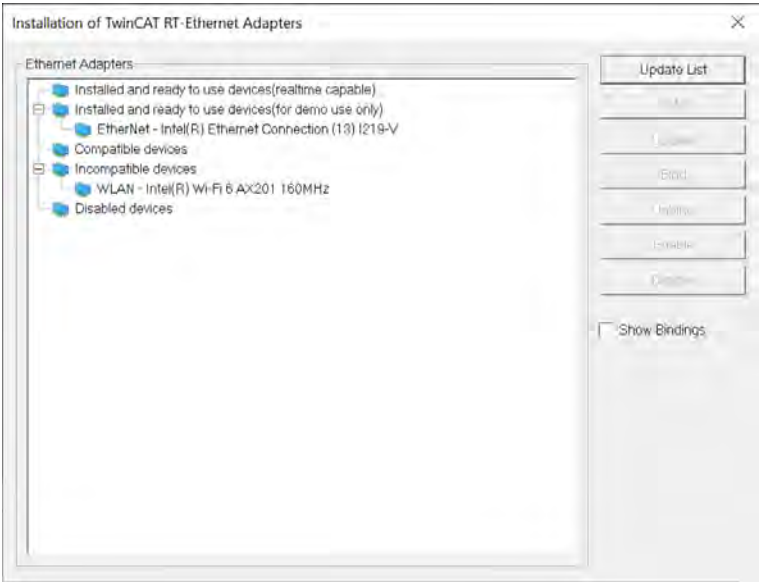
   b. Click **OK**.



4. Install the TwinCAT network adapter driver.

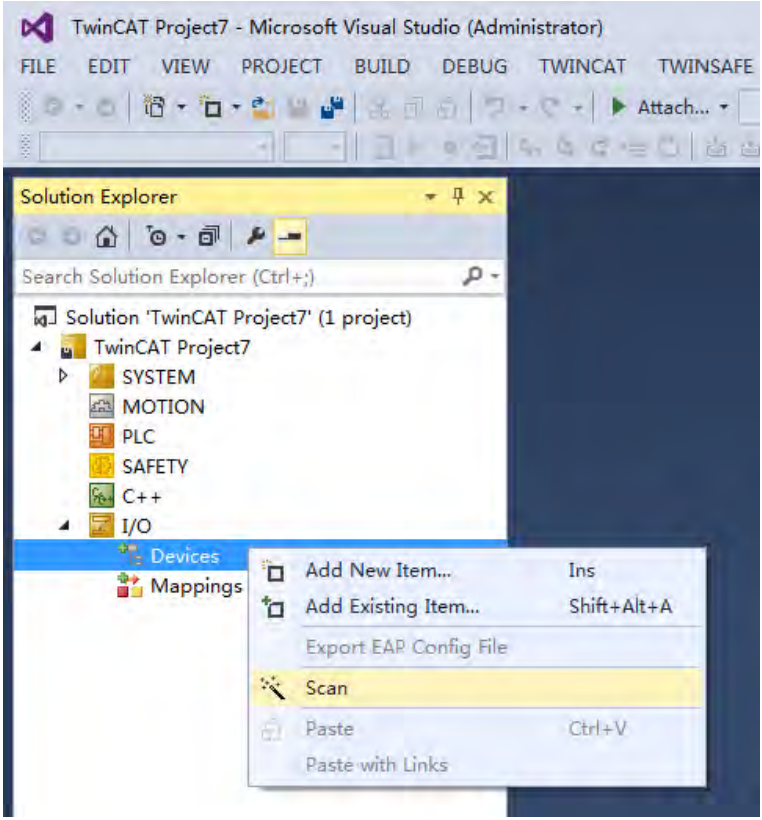


Choose **TWINCAT** > **Show Real Time Ethernet Compatible Devices...**. In the displayed dialog box, select the local network adapter under **Incompatible devices**, and click **Install**. After installation, the installed network adapter is displayed under **Installed and ready to use devices**.

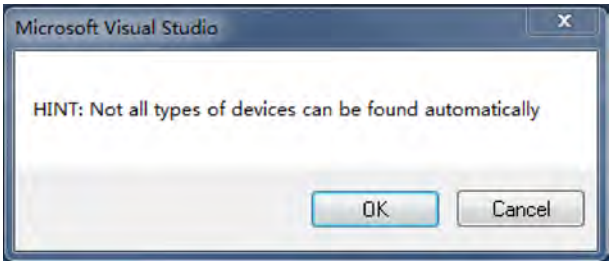


5. Search for devices.

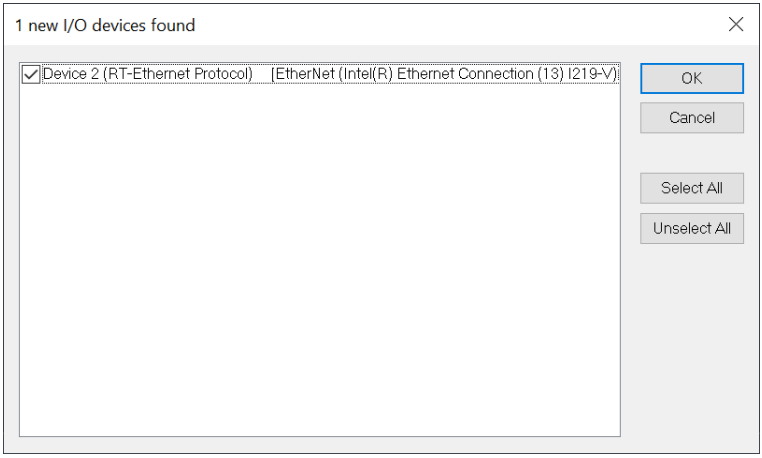
   a. Create a project, right-click **Devices**, and then click **Scan** to search for devices, as shown in the following figure.



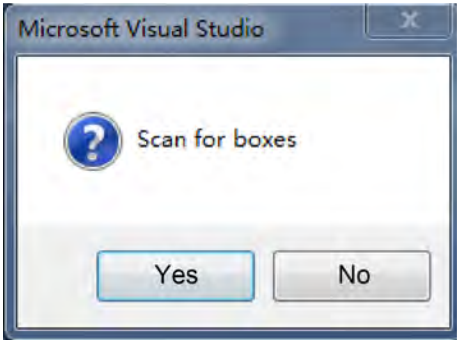
b. Click **OK**.



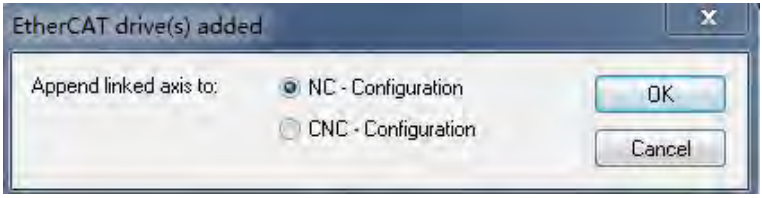
c. Click **OK.**



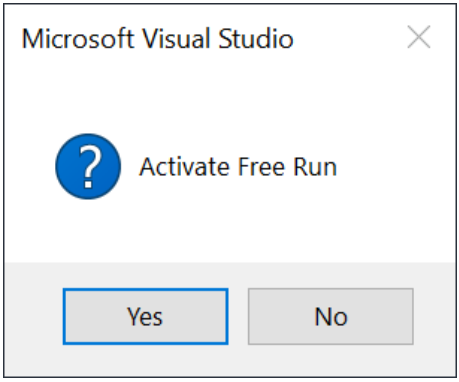
d. Click **Yes**.

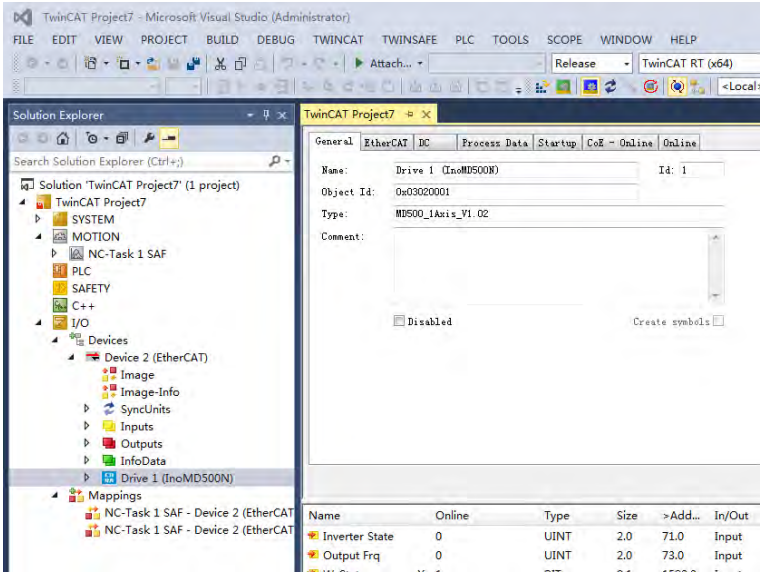


e. Click **OK.**



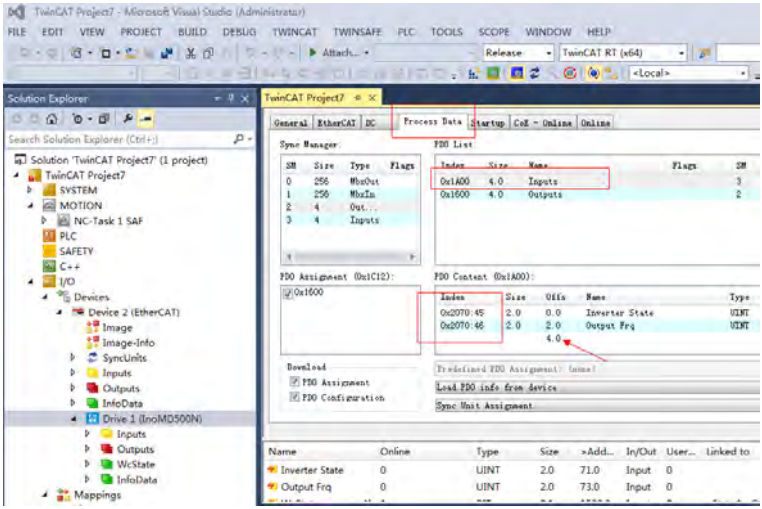
f. Click **No**. Now the device search is complete, as shown in the following figure.





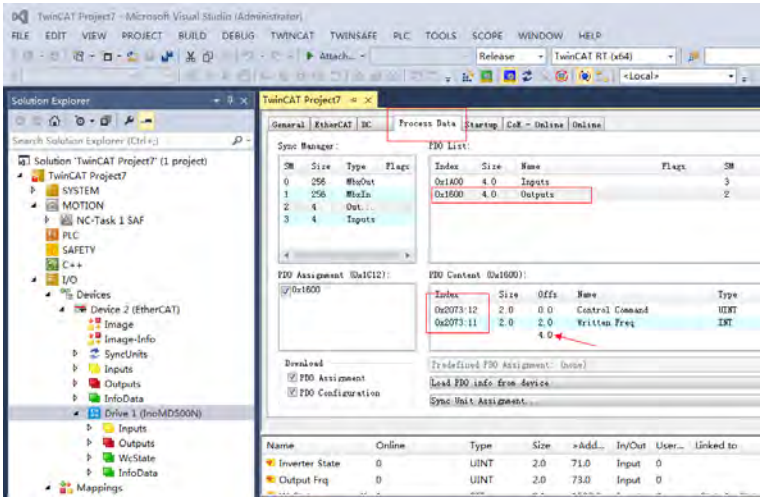
6. Set the PDO parameters.

   a. Configure TPDOs.
   Select 0x1A00. The first two entries are default TPDOs and cannot be changed. Right-click the position marked with a red arrow in the following figure to add the TPDO mapping as required.



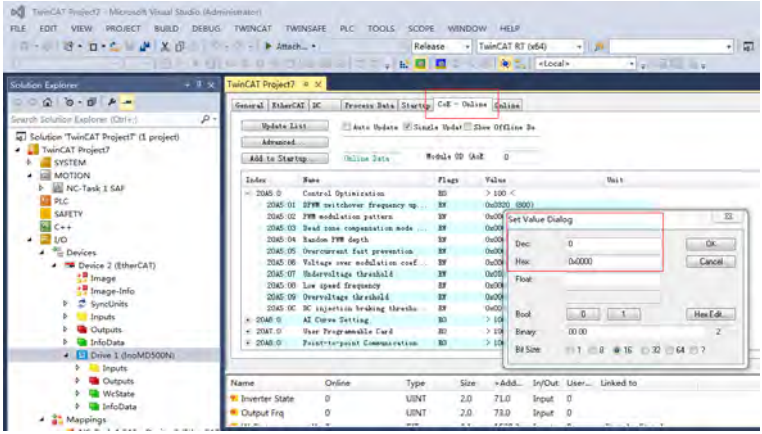
b. Configure RPDOs.

Select 0x1600. The first two entries are default RPDOs and cannot be changed. Right-click the position marked with a red arrow in the following figure to add the RPDO mapping as required.



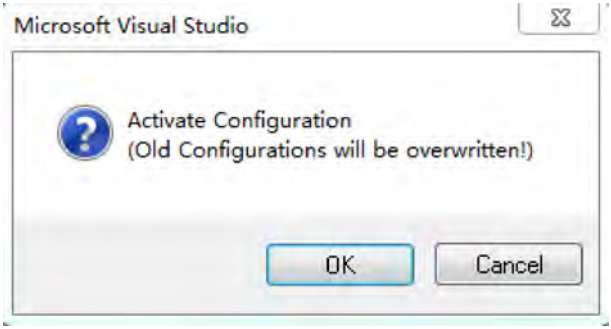
c. View the SDO data list.

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.

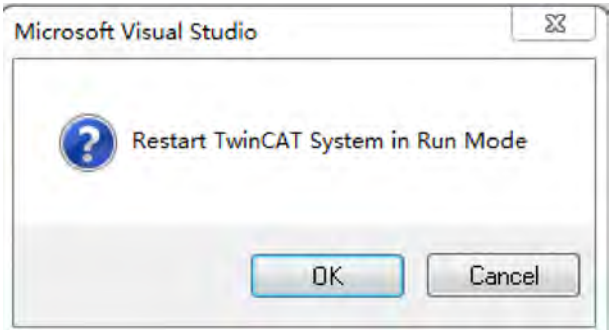


d. Activate the configuration and switch to the running mode.

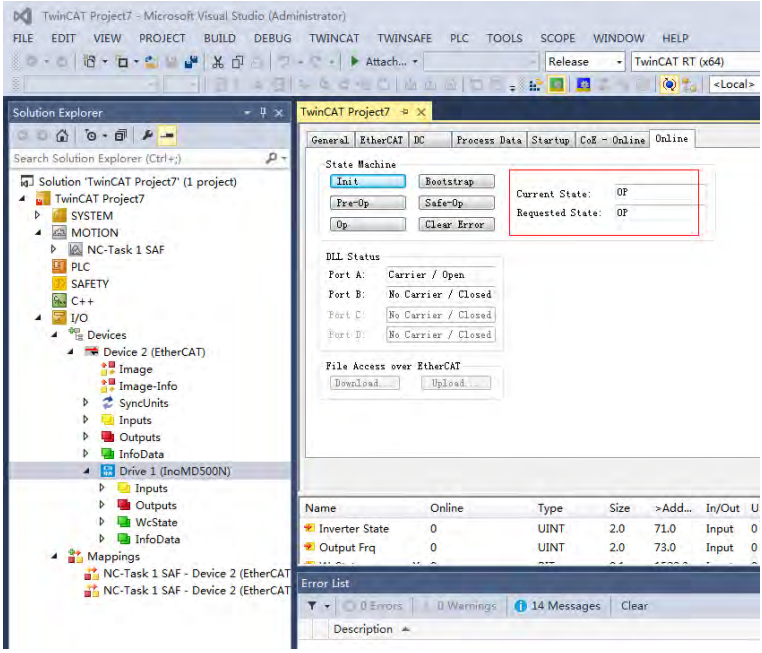
Click . The following dialog box is displayed.



Click **OK**.

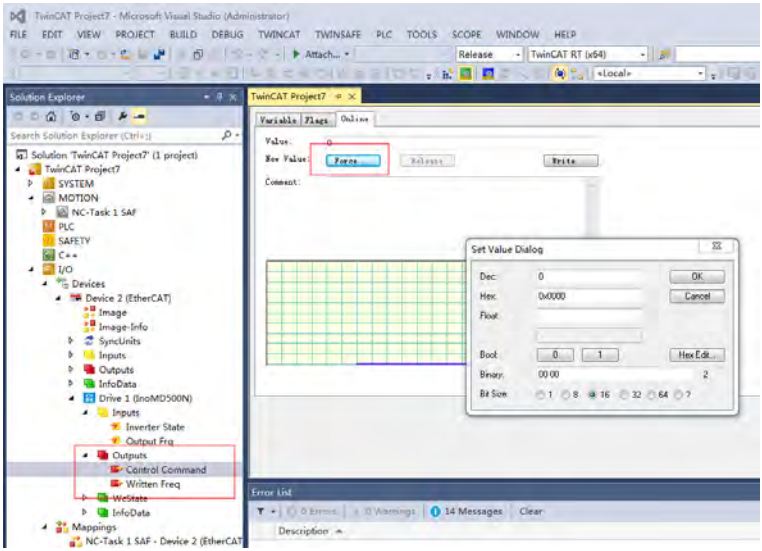


Click **OK** to enter the OP state.



e. Control the AC drive through PDO.

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



6.9 Fault Diagnosis

6.9.1 ECAT Card Communication Faults

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

Table 6–7 Troubleshooting

Symptom		Possible Cause	Solution
Communication failure between the MD500-ECAT card and AC drive	The D1 indicator on the ECAT card is steady 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.
Err164 communication error reported by the AC drive during running	The D1 indicator on the ECAT card is steady 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 Cat5e STP network 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 ECAT card is 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.
	The D4 indicator on the ECAT card is steady off.	The master is not connected or the card works in initial mode.	Check whether the master and upstream network port are connected correctly.
	The D7 indicator on the ECAT card is steady red.	An ESC internal exception occurs.	Contact Inovance for technical support.

The MD500-ECAT card can be replaced directly when the slave node is faulty (only when the MD500-ECAT card is faulty) without device configuration again.

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

1. The wiring sequence remains unchanged before and after replacing the MD500-ECAT card.
2. The XML file version of the new MD500-ECAT card is the same as that of the original card.
3. If a station alias is used for configuring the MD500-ECAT card, the alias of the new device must be consistent with that of the original device.

7 PROFIBUS DP Communication

7.1 Introduction

As a PROFIBUS DP fieldbus adapter card that meets international PROFIBUS fieldbus standards, the MD38DP2 expansion 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. Besides PROFIBUS DP communication, MD38DP2 also provides the CANlink communication interface.

This user guide is applicable to the MD38DP2 expansion card with software of version 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 powered on).

7.2 Installation

The MD38DP2 card is embedded in the MD520 series 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 MD38DP2 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by the pulling force of the external signal cable. *"Figure 7–1 " on page 143* shows the installation.

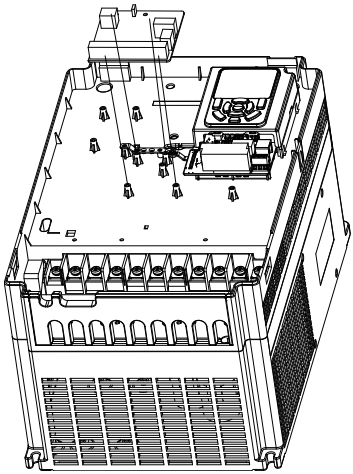


Figure 7-1 Installation of MD38DP2

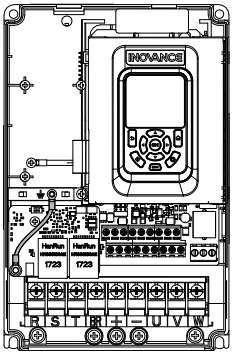


Figure 7-2 Connecting ground terminals of the MD38DP2 card and AC drive

7.3 Interface Layout and Description

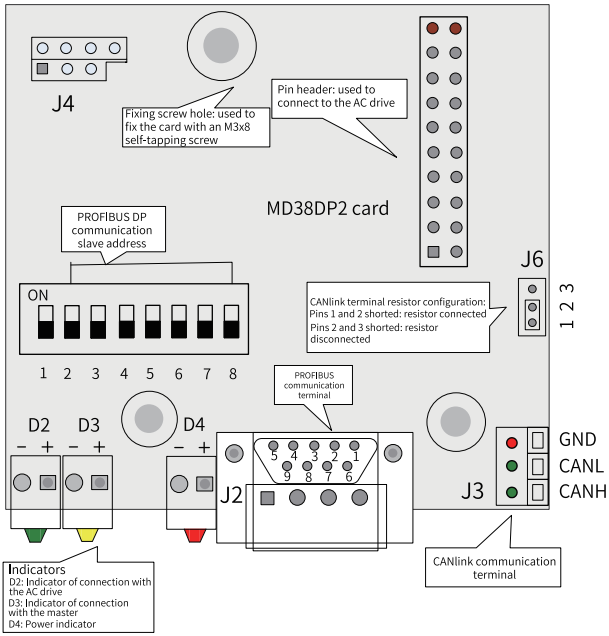
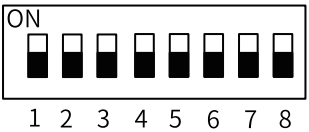


Figure 7-3 Interface layout of the MD38DP2 card

DIP Switch



MD38DP2 DIP switch description

Digit	Function	Description
1	PROFIBUS DP card type switchover	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 (digit 8: least significant bit) 1 000 0001 7 000 0111 20 001 0100 125 111 1101

Caution

The change of digit 1 is valid upon the next power-on. The change of slave addresses takes effect immediately after setting.

MD520 only supports MD38DP2. Therefore, digit 1 of the DIP switch needs to be set to OFF.

Standard 9-pin PROFIBUS Interface

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

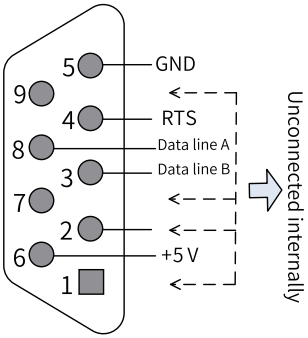


Figure 7-4 DB9 terminal pins

Control Terminals

Table 7–1 Function description of control terminals

Category	Symbol	Terminal Name	Function
PROFIBUS communication terminal (J2)	1, 2, 7, and 9	NC	Unconnected internally
	3	Data line B	Positive pole of the data line
	4	RTS	Request to send signal
	5	GND	Isolated 5 V power ground
	6	+5 V	Isolated 5 V power supply
	8	Data line A	Negative pole of the data line
CANlink communication terminal (J3, J9)	CANH	Positive CAN input	Positive pole of the data line
	CANL	Negative CAN input	Negative pole of the data line
	GND	Power ground	Isolated 5 V power ground
Programming	SW1	Programming	Interface for production and commissioning. Do not use it.
Jumper	J6	CANlink terminal resistor configuration	• Pins 1 and 2 shorted: resistor connected • Pins 2 and 3 shorted: resistor disconnected

Category	Symbol	Terminal Name	Function
Indicator[Note]	D4 (red)	Power indicator	• Steady ON: The AC drive is powered on. • 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 PROFIBUS DP card and the master	• Steady ON: Communication between the PROFIBUS DP card and the PROFIBUS master is normal. • OFF: There is no communication between the PROFIBUS DP card and the PROFIBUS master (check the connection of PROFIBUS cables and the setting of the station number). • Blinking: The master is not running or a fault occurs in communication between the PROFIBUS DP card and the master.
	D2 (green)	Indicator of communication between the PROFIBUS DP card and the AC drive	• Steady ON: Communication between the PROFIBUS DP card and the AC drive is normal. • OFF: Communication between the PROFIBUS 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.) • Blinking: Interference exists in communication between the PROFIBUS 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 symbol may not match. In this case, the terminal symbol prevails. The indicators are D2, D3, and D4 from left to right. See *"Figure 7–3 " on page 144* .

7.4 Topology and Transmission Distance

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

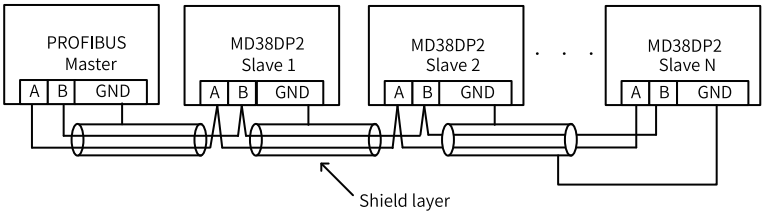
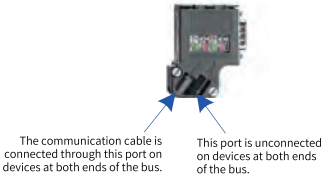


Figure 7-5 Connection between the PROFIBUS DP card and PROFIBUS master

Terminal resistors must be connected at both ends of the PROFIBUS bus and DIP switches must be set correctly according to the marks on the wiring terminals. After terminal resistors are connected correctly, the resistance between A1 and B1 should be 110 Ω upon power-off. For devices connected at both ends of the PROFIBUS network, the communication cables must be connected from their PROFIBUS DP terminals to the channels marked with "IN" (channels corresponding to A1/B1). Otherwise, terminal resistors cannot be connected. If any required terminal resistor is not connected, the communication quality will deteriorate.



The required length of the communication cable between the PROFIBUS DP expansion card and the PROFIBUS master varies with the baud rate of the master. It is strictly restricted according to the Siemens DB9 standard. The following table describes requirements on communication cable length based on the baud rate.

Baud Rate (kbit/s)	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 the cables.

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

7.5 Protocol Description

Data Transmission Formats

In the PROFIdrive protocol, the PPO is used as the data transmission format. PPOs are classified into PPO1, PPO2, PPO3, PPO4, and PPO5, all of which are supported by the MD38DP2 expansion card.

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

Data Format	Supported Functions
PPO1	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive state and running frequency
PPO2	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic writing of four function parameters Periodic reading of four function parameters
PPO3	Setting of AC drive command and frequency Reading of AC drive state and running frequency
PPO4	Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic writing of four function parameters Periodic reading of four function parameters
PPO5	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic writing of ten function parameters Periodic reading of ten function parameters

Data blocks of the PPO data are divided into two areas, PKW area (parameter value) and PZD area (process data). The following figure shows the PPO data formats supported by MD38DP2.

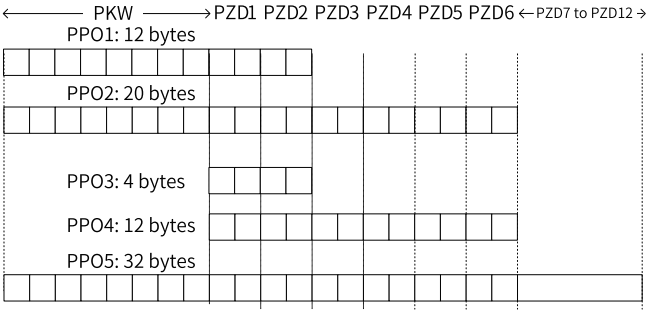


Figure 7-6 PPO data formats

PKW Data

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

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

Data format

PKW data consists of three groups of arrays, including the PKE, IND, and PWE. The lengths of PKE and IND are two bytes, and the length of PWE is four bytes. The following table describes the data format.

PKW Data Sent by the Master							
Operation Command	Parameter Address		Reserved			Write: parameter value Read: null	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE
PKW Data Returned by the AC Drive							
Operation Command	Parameter Address		Reserved			Successful: returned value Failed: error information	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE

Data description

PKW Data Sent by the Master		PKW Data Returned by the AC Drive	
PKE	• High-order 4 bits: Command code0: No request1: Read parameter data2: Modify parameter data (The preceding command code is in decimal format.) • Low-order 4 bits: Reserved • Low-order 8 bits: High-order bits of the parameter address	PKE	• High-order 4 bits: Response code0: No request1: Operation succeeded7: Operation failed • Low-order 8 bits: High-order bits of the parameter address
IND	High-order 8 bits: Low-order bits of the parameter address Low-order 8 bits: Reserved	IND	High-order 8 bits: Low-order bits of the parameter address Low-order 8 bits: Reserved
PWE	High-order 16 bits: Reserved Low-order 16 bits: Parameter value (write request) or not used (read request)	PWE	• Request succeeded: Parameter value • Request failed: Error code (consistent with standard Modbus)1: Invalid command2: Invalid address3: Invalid data4: Other error

Application

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

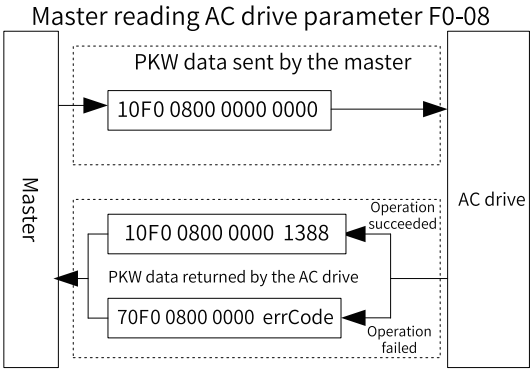


Figure 7-7 Example PKW data sent by the master when reading an AC drive parameter

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

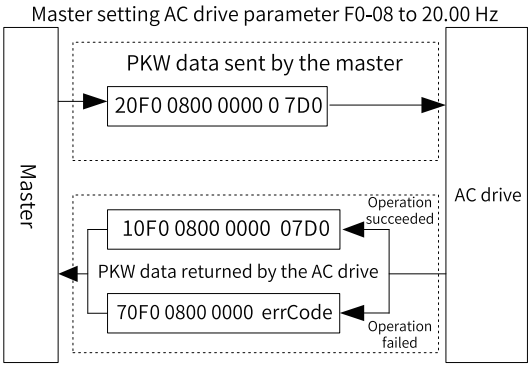


Figure 7-8 Example PKW data sent by the master when modifying an AC drive parameter

PKW data exchange with the AC drive is performed cyclically. Continuous write command (PKE = 0x20xx) on the EEPROM will significantly shorten the service life of the AC drive's main control chip. Therefore, to modify AC drive parameters, you are advised to perform aperiodic write operations (see SFB53 described in *"7.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave" on page 173 "7.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave" on page 173 " " on page*) or write to 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 F0-10 is 0x000A.

PZD Data

The PZD data enables 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 functions of PZD data are as follows:

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

Master Transmit Data PZD		
AC Drive Command	AC Drive Target Frequency	AC Drive Parameters Modified in Real Time
PZD1	PZD2	PZD3 to PZD12

Master Transmit Data PZD		
AC Drive Response Data PZD		
AC Drive Command	AC Drive Running Frequency	AC Drive Parameters Read in Real Time
PZD1	PZD2	PZD3 to PZD12

Data Sent by the Master

Master Transmit Data PZD		
PZD1	AC drive command word (command source set to communication)	
	0: No command 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: Decelerate to stop 07: Reset upon fault
PZD2	AC drive target frequency (frequency reference source set to communication; value unit determined by the AC drive while Hz is used as an example here) The frequency reference ranges from 0 to F0-10. When F0-22 is set to 1, the frequency range is 0.0 Hz to 3200.0 Hz. When F0-22 is set to 2, the frequency range is 0.00 Hz to 320.00 Hz. When the reference target frequency exceeds F0-10, the AC drive does not respond to the frequency reference.	
PZD3 to PZD12	Function parameter values (group F and group A) modified in real time, not written into 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 Returned by the AC Drive

AC Drive Response Data PZD	
PZD1	AC drive running state The AC drive running state is defined by bit as follows: • Bit0: 0: Stopped; 1: Running • Bit1: 0: Running in forward direction; 1: Running in reverse direction • Bit2: 0: Not faulty; 1: Faulty • Bit3: 0: Running frequency not reached; 1: Running frequency reached
PZD2	AC drive running frequency: The current AC drive running frequency is returned as 16-bit signed data. When F0-22 is set to 1, –32000 to +32000 correspond to the actual running frequency –3200.0 Hz to +3200.0 Hz. When F0-22 is set to 2, –32000 to +32000 correspond to the actual running frequency –320.00 Hz to +320.00 Hz.

AC Drive Response Data PZD	
PZD3 to PZD12	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.

7.6 Related Parameters

7.6.1 AC Drive Communication Card Type Setting

After powering on the AC drive, the MD38DP2 card can communicate with the AC drive properly only after F0-28 is set to 1.

Parameter	Parameter Name	Value Range	Setpoint	Description
F0-28	Serial communication protocol	0: Modbus protocol 1: Communication card network bridge protocol	1	Serial communication protocol as the serial communication protocol.
F0-02	Command source	0: Operating panel 1: Terminal 2: Communication	2	Set the command source to communication.
F0-03	Main frequency reference source	0: Digital setting (non-retentive at power failure) 1: Digital setting (retentive at power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	9	Set the target frequency through communication.

7.6.2 Communication Control Parameters

Parameter	Parameter Name	Value Range	Hexadecimal Address	Decimal Address
U3-16	Frequency reference	–Maximum frequency to +Maximum frequency Unit: 0.01 Hz	H7310	29456
U3-17	Control command	0001: Run in forward direction 0002: Run in reverse direction 0003: Jog in forward direction 0004: Jog in reverse direction 0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	H7311	29457
U3-18	DO control	Bit0: DO1 output control Bit1: DO2 output control Bit2: Relay 1 output control Bit3: Relay 2 output control Bit4: FMR output control Bit5: VDO1 Bit6: VDO2 Bit7: VDO3 Bit8: VDO4 Bit9: VDO5	H7312	29458
U3-19	AO1 control	0 to 7FFF, indicating 0% to 100%	H7313	29459
U3-20	AO2 control	0 to 7FFF, indicating 0% to 100%	H7314	29460
U3-21	FMP control	0 to 7FFF, indicating 0% to 100%	H7315	29461
U3-23	Speed control	Signed data, 1 RPM	H7317	29463

When this expansion 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 but 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 set to U3-17 and U3-16 respectively. If not, manually correct the values of FE-00 and FE-01.

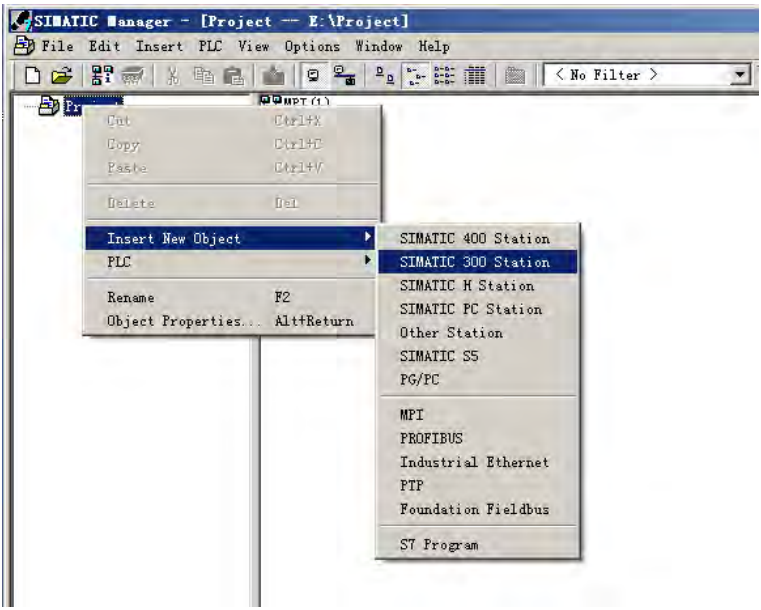
7.7 Communication Configurations

7.7.1 Configuring a Slave on the S7-300 Master in STEP 7 V5.4

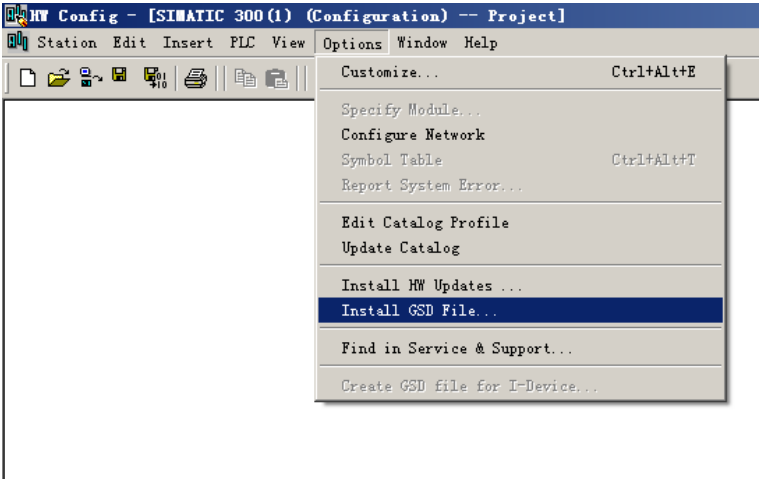
Before using the PROFIBUS master, you need to configure the GSD file of the slave to add the corresponding slave device to the system of the master. If the file exists, skip step 2. You can obtain the GSD file from Inovance or its agent.

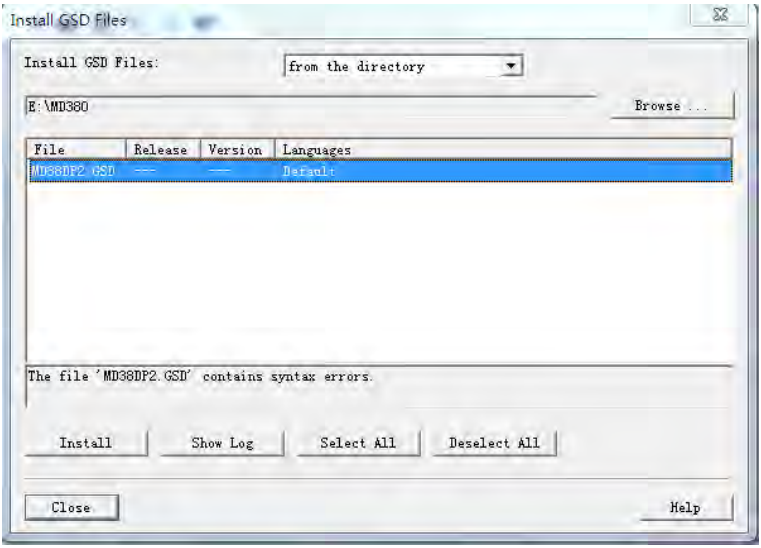
The configuration procedure is as follows:

1. Install the GSDML file. (Skip this step if the GSDML file has been installed.) Choose **Options** > **Manage general station description files (GSD)**.

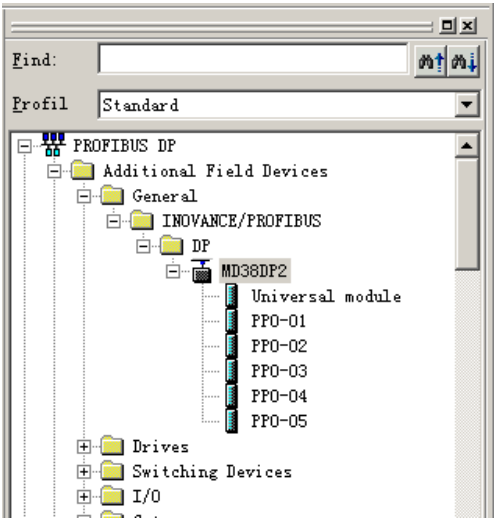


2. Double-click the hardware icon to access the **HW Config** interface, and choose **Options** > **Install GSD File** to add the **MD38DP2.GSD** file (English path required), as shown in the following figure.

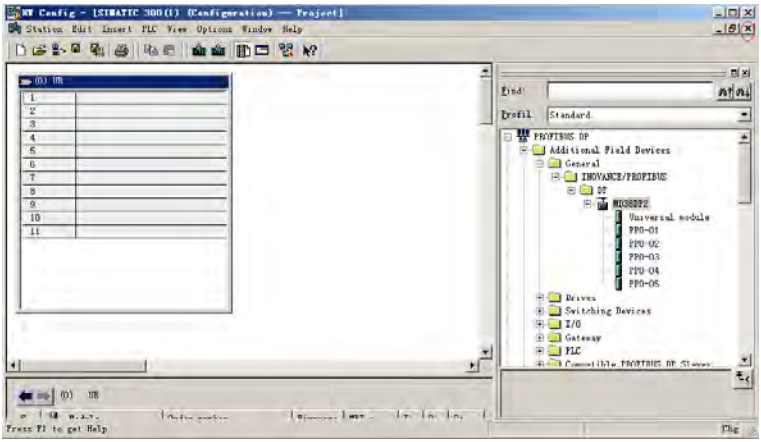




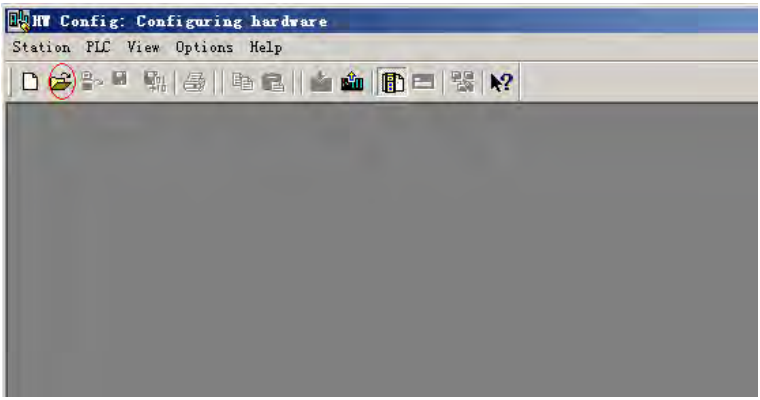
Click **Install**. After the installation is complete, the PROFIBUS DP module MD38DP2 is displayed, as shown in the following figure.



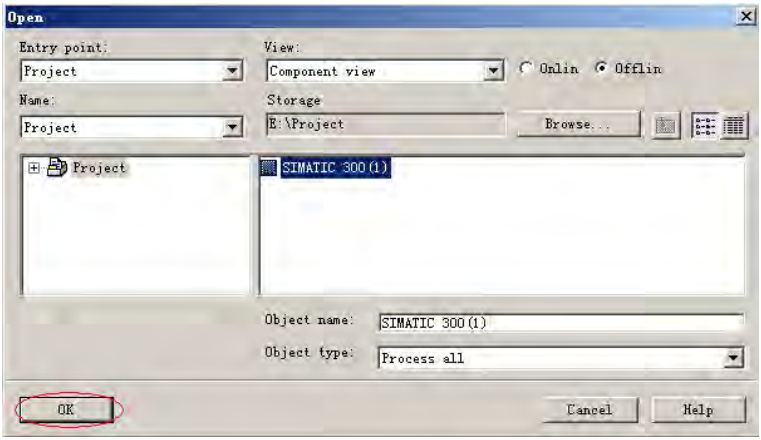
Note: If any master or slave already exists on the **HW.config** interface, close the current interface by clicking the X button (marked with a red circle as shown in the following figure) before importing the GSD file.



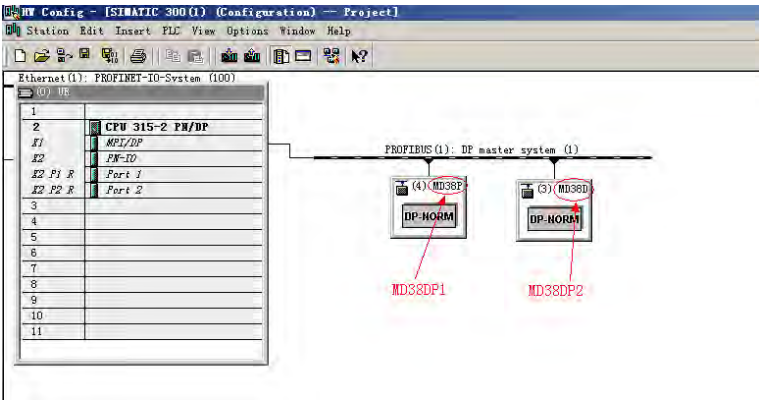
In this case, you can save the original project. If an alarm indicating that system data cannot be created is displayed, click **OK**. After closing the current configuration interface, you can install the GSD file by performing the preceding steps. After the installation is complete, click the button marked with the red circle in the following figure.



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

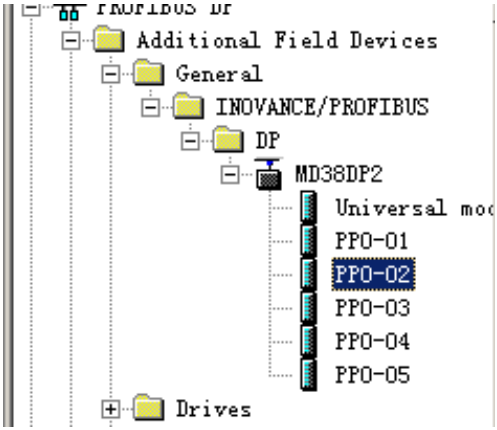


3. Configure the actual hardware system, as shown in the following figure.



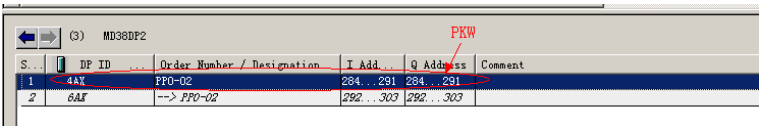
In the preceding figure, station 4 is MD38DP1, which is only used as an example. For details about its usage, see the MD380 Series PROFIBUS User Guide. MD38DP1 and MD38DP2 can coexist on the same network.

4. Configure data features of the slave.

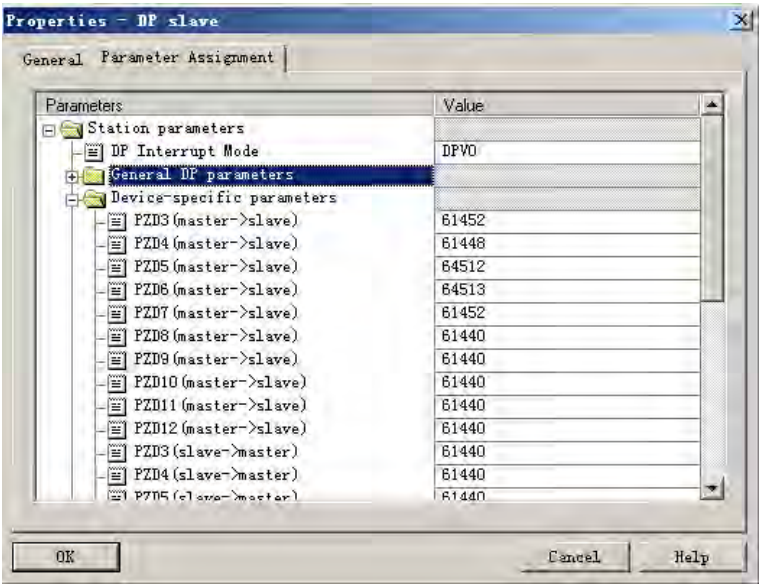


After the PPO type is added, the address assigned by the PLC to the slave is displayed, as shown in the following figure. Slot 1 marked with a red circle in the following figure indicates the PKW address (8 bytes). Slot 2 indicates the PZD address (12 bytes).

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



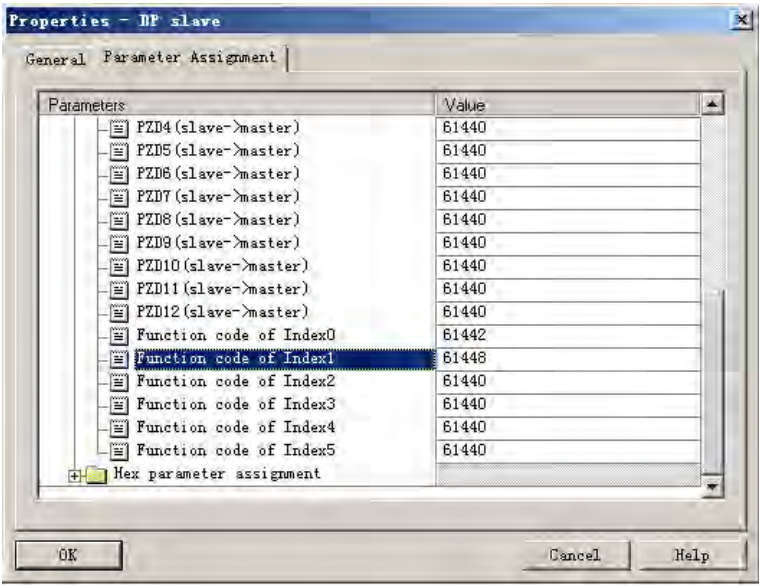
5. Configure PZDs.
The PZD1 and PZD2 configurations are fixed and cannot be modified by users. PZD3 to PZD12 are for customized periodic data exchange. They can be set in hardware configuration. Double-click the MD38DP icon in **HW Config**, click **Device-specific parameters**, and configure corresponding parameter addresses as required.



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

By default, all PZDs of MD380 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 the mappings of various slaves are the same, you can select a configured slave, press **Ctrl+C**, select the PROFINET bus in the configuration, press **Ctrl+V**, and modify the device name and IP address).

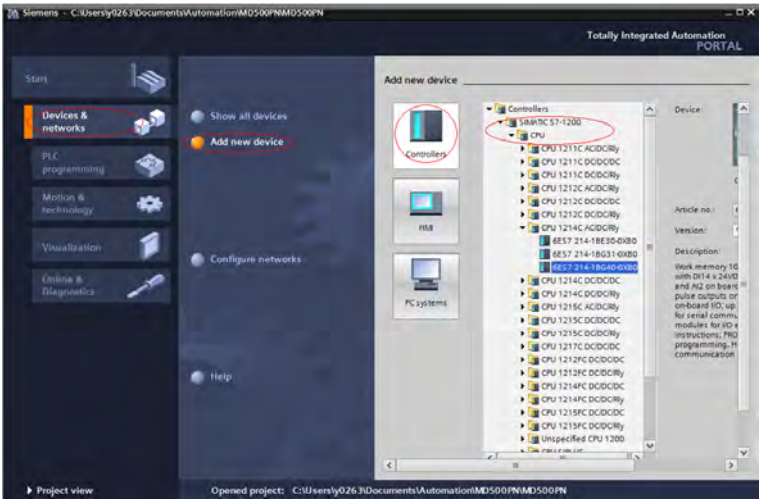
To enable the aperiodic parameter read and write function of DPV1, set corresponding parameters in customized indexes at the end of **Device-specific parameters** list. MD380 provides six customized indexes numbered from 0 to 5, as shown in the following figure. For example, you can set index 0 to F0-02 and index 1 to F0-08.



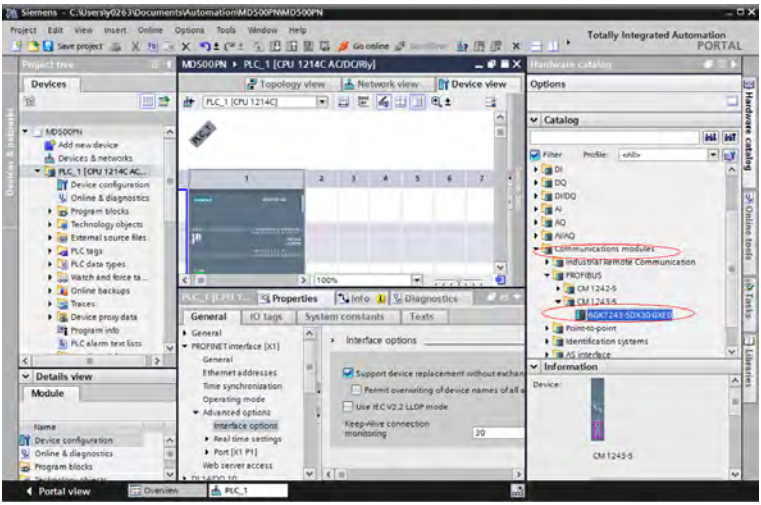
After the preceding steps, the PROFIBUS slave is configured. Now, you can compile programs in S7-300 to control the AC drive.

7.7.2 Configuring a Slave on the S7-1200 Master in TIA Portal V13

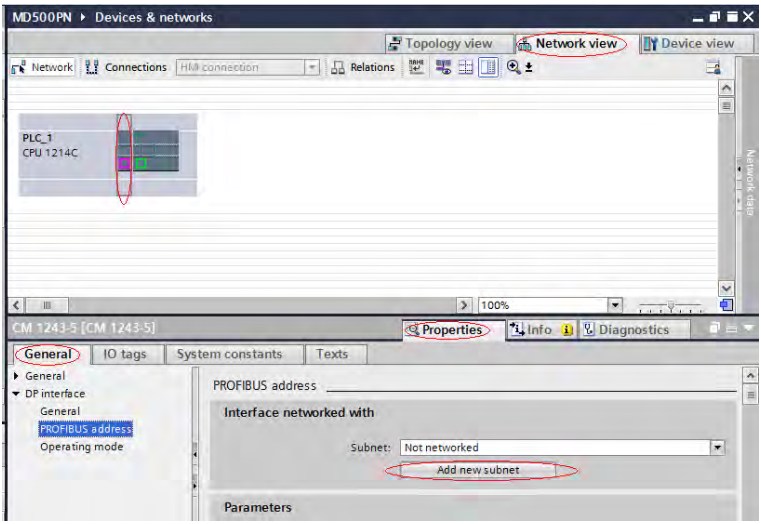
1. Open TIA Portal V13, create a project, and add an S7-1200 master according to actual situations.



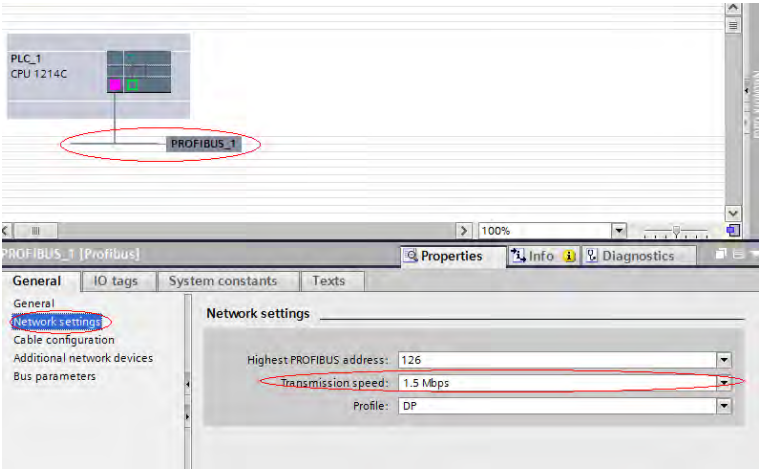
Since the S7-1200 CPU has no PROFIBUS interface, you need to add a PROFIBUS communication module. In this example, a CM1243-5 master module is added.



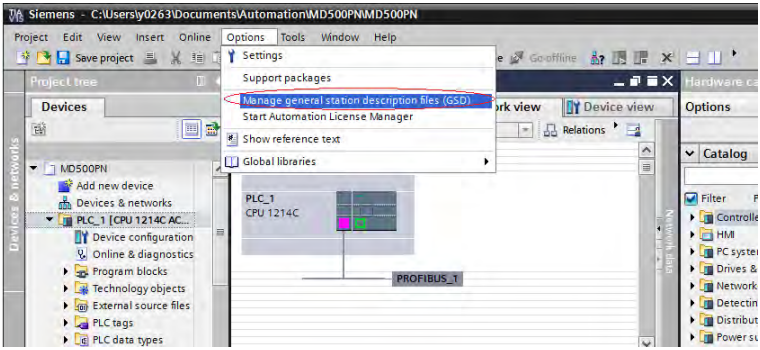
After adding the PROFIBUS master module, click **Network view**. Select the communication module, click **Properties** and then **General**, and click **Add new subnet** to create a PROFIBUS network. You can modify the master number here.

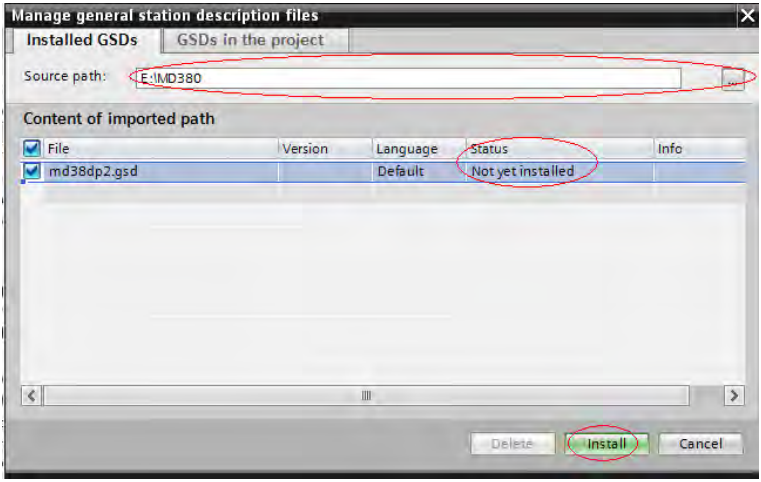


To modify the PROFIBUS baud rate, select the network in the view, and choose **General** > **Network settings** on the **Properties** tab page, and select a proper baud rate from the **Transmission speed** drop-down list.

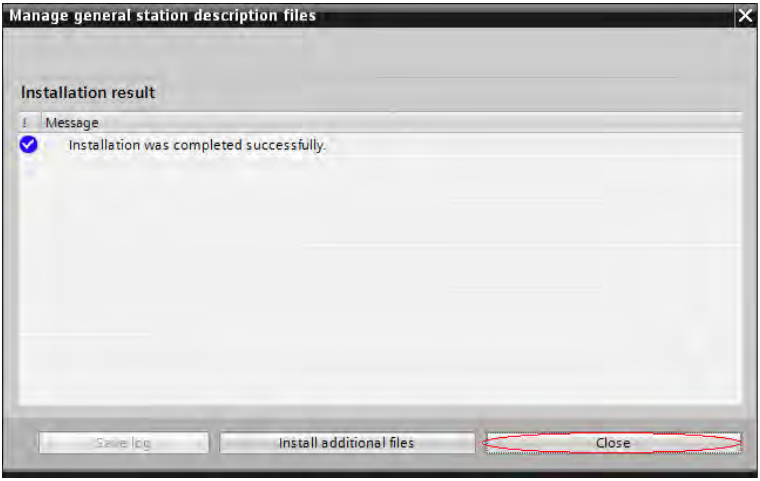


2. Install the GSD file. Skip this step if a GSD file has been installed.
   If a GSD file is not installed yet, **Not yet installed** will be displayed in the **Status** column. Select the GSD file and click **Install**. (Note that an error will occur if the installation path contains Chinese characters.)

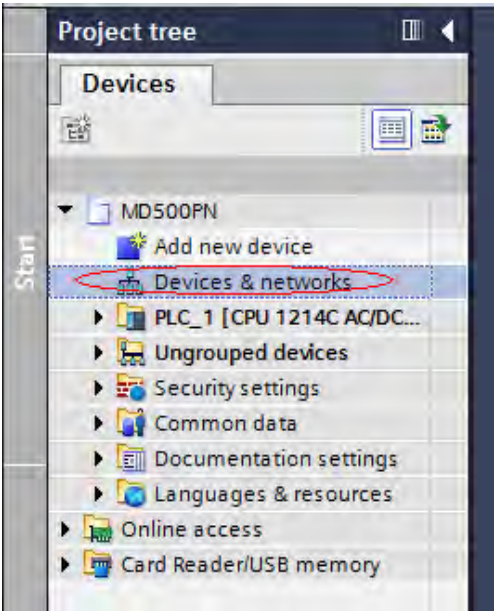




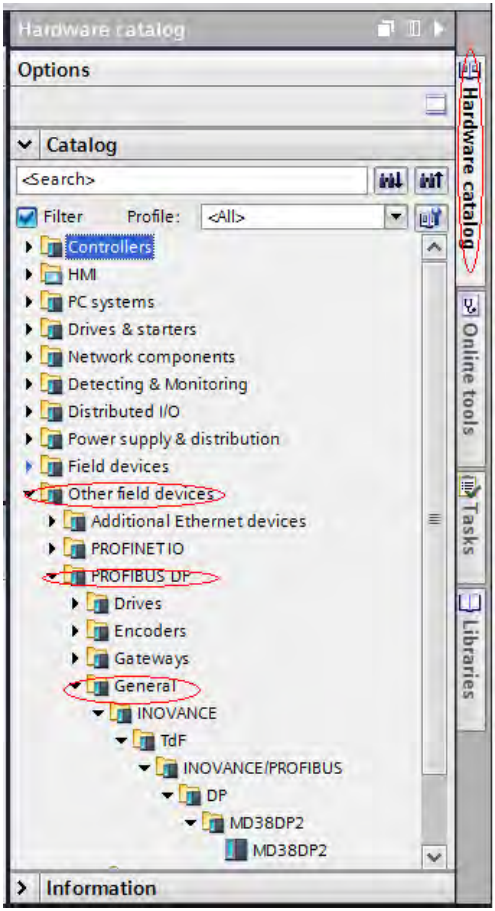
When the interface shown in the following figure is displayed, the installation is complete. Click **Close**.



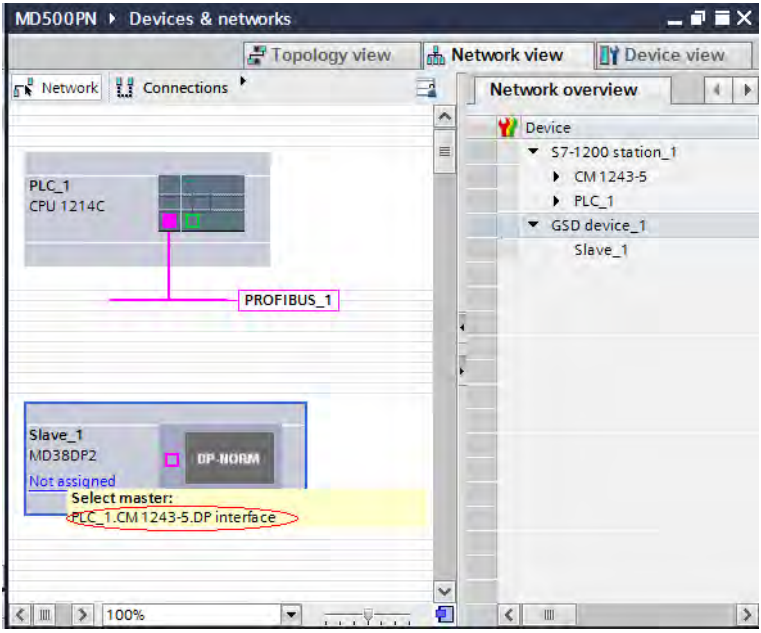
During installation of the GSD file, the PORTAL will automatically close the configuration interface. After the installation is complete, double-click **Devices & networks** on the left to open the original configuration interface.

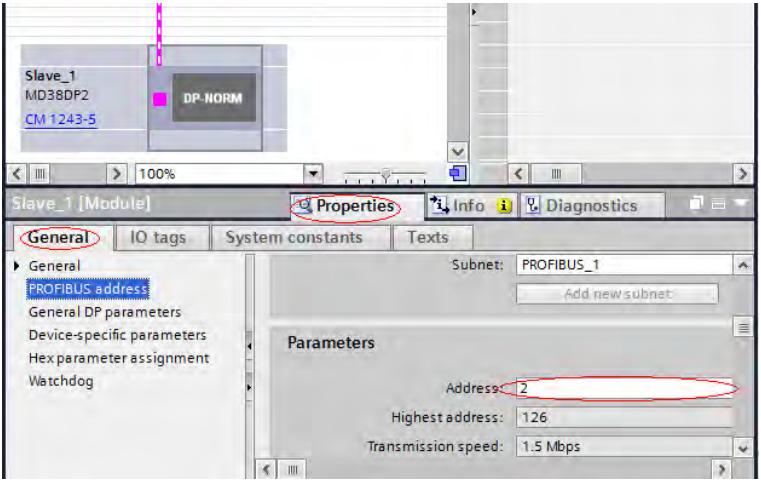


Choose **Hardware catalog** > **Other field devices** > **PROFIBUS-DP** > **General**. You can find the MD38DP2 in the list, which is the same as that in STEP 7. You need to fully expand the subordinate directories as shown in the following figure.

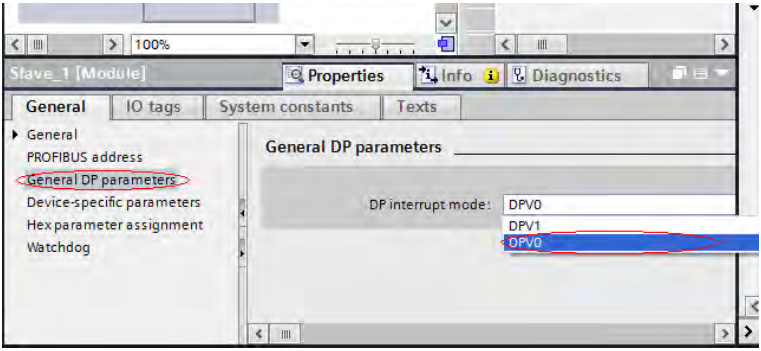


3. Start the configuration.
   On the **Hardware catalog** tab page, double-click **MD38DP2** or drag it to **Network view** under **Devices & networks**, and click **Not assigned** under the slave to select the corresponding PROFIBUS network. Select the slave, click **Properties** and then **General**, and set the slave number. Note that the setting must be consistent with that set by the DIP switch on the MD38DP2 expansion card.

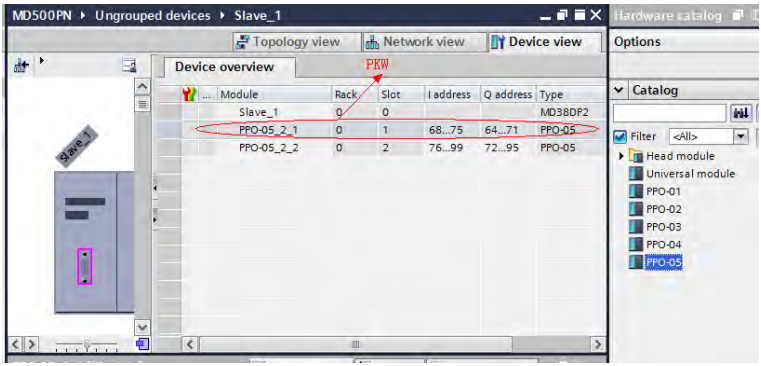




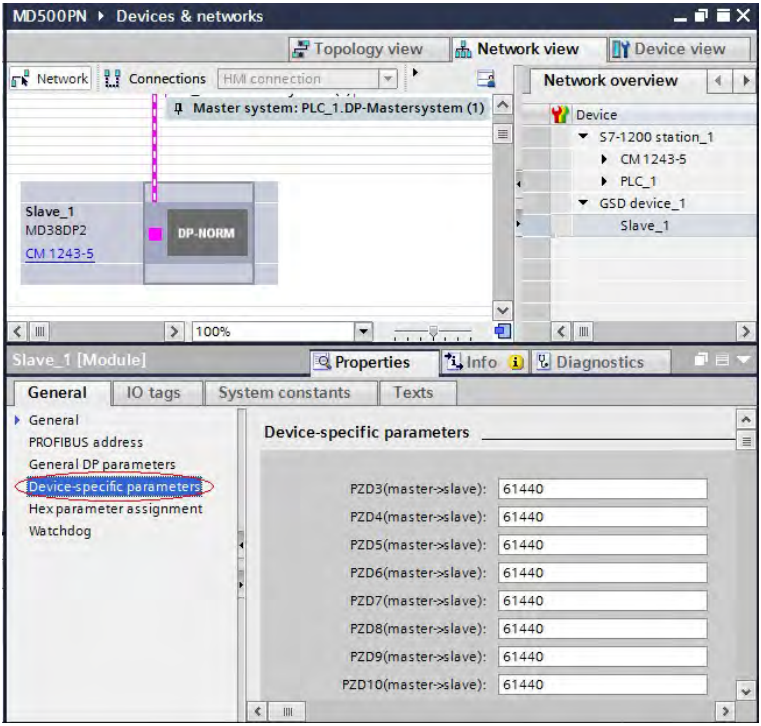
Click **General DP parameters**, and select **DPV0** from the **DP interrupt mode** drop-down list, as shown in the following figure.



Click **Device view**, and select a proper PPO type under **Hardware catalog**. The addresses assigned for each segment are displayed as follows. The PKW address is marked with a red circle in the following figure. If the selected PPO has no PKW, the column is blank.

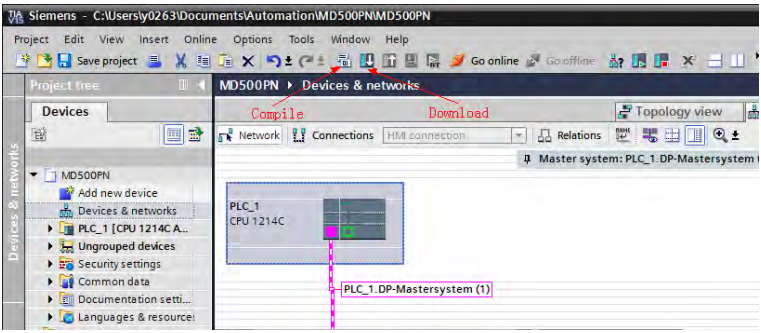


4. Set PZD mapping.
   Click **Network view** and then click **Device-specific parameters** to set the mapping for PZD3 to PZD12. Note that the PZD mappings for the PLC to read and write to the slave are set independently. For details, see *" " on page "7.7.1 Configuring a Slave on the S7-300 Master in STEP 7 V5.4" on page 156 " " on page* .

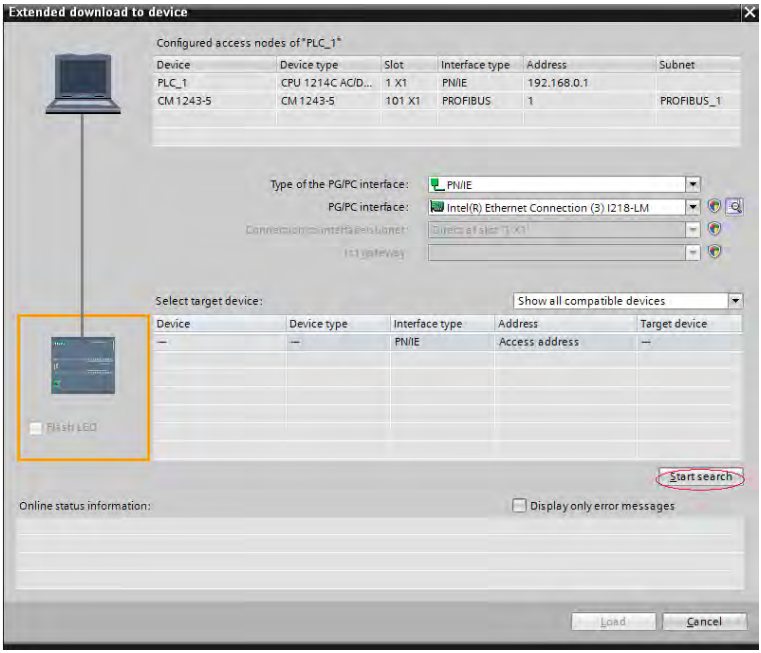


5. Compile and download the configuration.
   If the settings of multiple slaves are the same, select a configured slave, press **Ctrl** +**C** and then **Ctrl**+**V** (or right-click the configured slave and choose **Copy** and then **Paste**) to connect more slaves to the network, and then modify their station numbers.

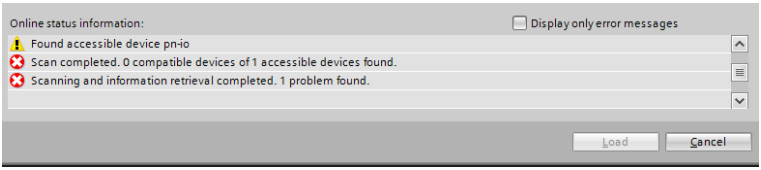
   After all slaves are configured, save the configurations, and click the compile button. After the compiling is completed successfully, click the download button.



Set the interface for the PC the communicate with the PLC as required on the displayed interface. In this example, a local network port is selected. Then click **Start search** to search for the PLC.



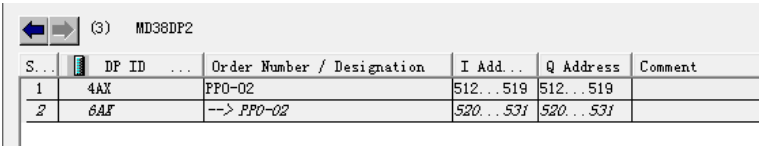
If no accessible device is found, the connection between the PC and PLC is faulty. Eliminate the fault first. (This problem also occurs when the PC was used for download through Ethernet in STEP 7 before. In this case, restart the PC or change the PG/PC interface to a non-Ethernet interface in STEP 7.)



If the connection is normal, the **Load** button is available. You can click **Load** to start download and perform subsequent operations as prompted to download the configuration to the PLC.

7.7.3 Performing Periodic 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.



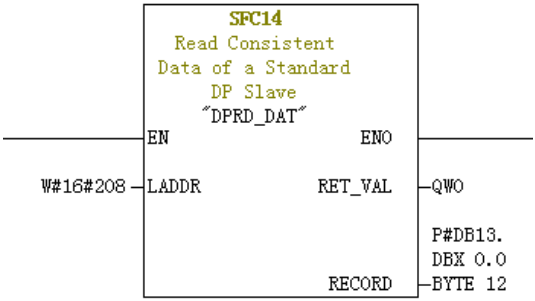
(3) MD38DP2

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

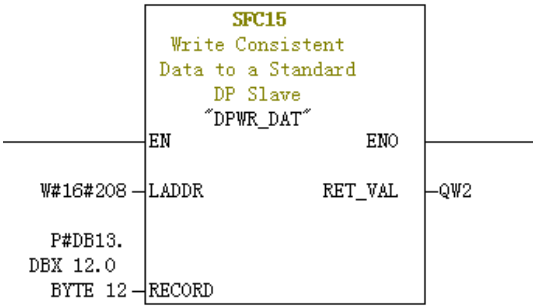
1. Directly use the MOVE command to enable the AC drive to run in forward direction at the target frequency of 30 Hz (F0-02 = 2, F0-03 = 9), as shown in the following figure.

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.

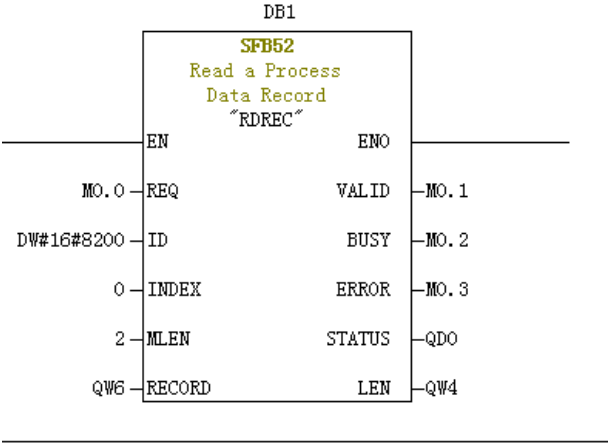


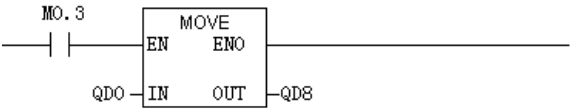
- **LADDR**: Starting address configured in the Q block of the module, which must be in hexadecimal format.
- **RET_VAL**: Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD**: Source area of the user data 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 converted from the I and Q starting addresses (in this example, the address is 520, which is H208 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).

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

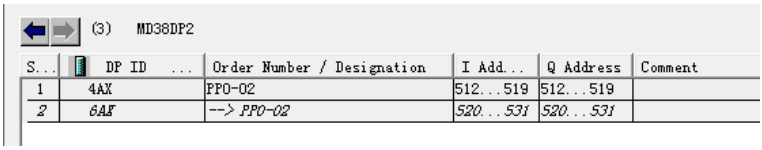
To perform aperiodic read and write operations on the AC drive PROFIBUS DP slave, Siemen's system function modules SFB52 (for reading) and SFB53 (for writing) are required. Create an organization block in the program, and add relevant function blocks and programs in the organization block.





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

- **REQ**: Command enable. When this field is set to 1, the function block is enabled.
- **ID**: Logic address. To specify this field, convert any Q address of the corresponding AC drive slave to a hexadecimal value, and set bit 15 of the value to 1. For example, for Q512, the hexadecimal value is H200. After bit 15 is set to 1, H8200 is obtained.



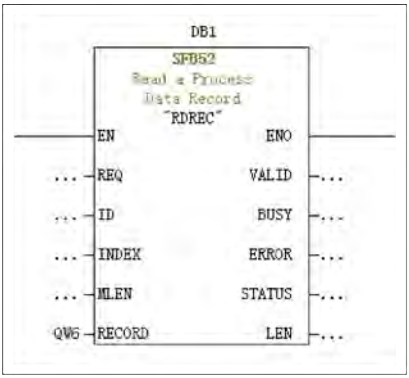
(3) MD38DP2

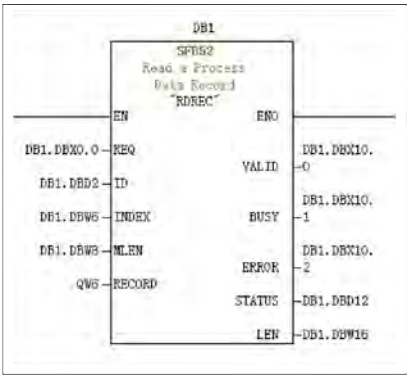
S...	DP ID ...	Order Number / Designation	I Add...	Q Address	Comment
1	4AX	PPO-02	512...519	512...519	
2	6AX	--> PPO-02	520...531	520...531	

- **INDEX**: Index number, ranging from 0 to 5. This field can be customized to an index mapping address of a slave as required.
- **MLEN**: Maximum length of the data to be obtained. For MD38DP2, this field must be set to **2**.
- **RECORD**: Target area of the 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 value is **ON**, the operation is not completed.
- **ERROR**: Error flag. When the value is **ON**, an error occurs.
- **STATUS**: Block status or error information.
- **LEN**: Length of the obtained data record.

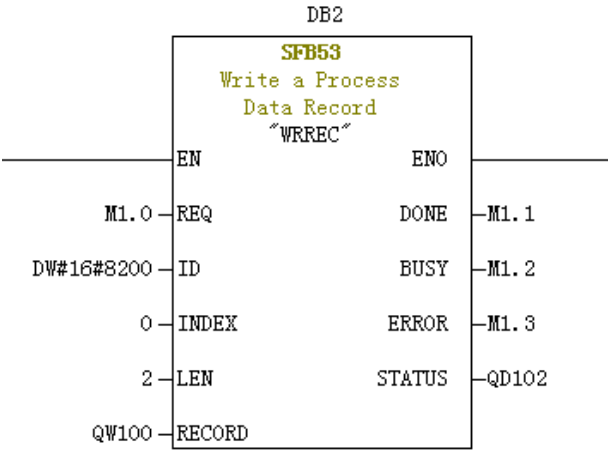
During invocation, you can customize parameters or use some or all default parameters, as shown in the following figure.





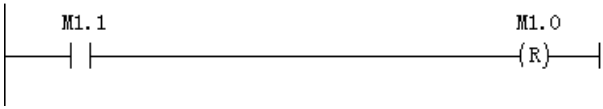
In the preceding figure, default parameters are used on the left. In this case, parameters are set according to the information shown on the right. You can set customized or default parameters for corresponding blocks as required.

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, relevant blocks need to be invoked for multiple times. Therefore, do not invoke them when single execution is required.

7.8 Fault Diagnosis

7.8.1 Troubleshooting

The following table describes the faults that may occur during use of the MD38DP2 expansion card and the AC drive.

Symptom	Solution
After the AC drive is powered on, only the power indicator (D4) is on, indicating that communication between the MD38DP2 expansion card and the AC drive is not established.	1. Check that F0-28 is set to 1.
	2. Check the AC drive type. This user guide only describes the usage of MD520. For other AC drive models, 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 indicator of communication with the AC drive (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.

Symptom		Solution
The connection fails after the configuration is downloaded.	After the configuration is downloaded, indicators D2 and D4 are steady on while the yellow indicator D3 is off on the MD38DP2 expansion card.	1. Check that the cable is properly connected.
		2. Check the DIP switches on the PROFIBUS DP interfaces. The DIP switches on the PROFIBUS DP interfaces at both ends of the network must be set to ON, and the DIP switches on other PROFIBUS DP interfaces must be set to OFF.
		3. If the AC drive is connected at the end, check that the communication cable is connected through IN of the PROFIBUS DP interface. (If the communication cable is connected through OUT, it cannot be connected to the network when the PROFIBUS DP interface is set to ON.)
		4. Check that the station number settings on the MD38DP2 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 are steady on while the yellow indicator D3 blinks slowly at the frequency of about 1 Hz to 2 Hz on the MD38DP2 expansion card.	1. Check that the GSD file used is correct.
		2. Check that the PZD mapping is set correctly. Device-specific parameters in STEP 7 and PORTAL must be set in decimal format. Therefore, you need to convert the parameter numbers into decimal values when setting device-specific parameters. For example, the decimal value of FC-11 is 64523 (0xFC0B in hexadecimal format). If a parameter number that the AC drive does not support is entered, the connection fails. Note that PZD mapping does not support Modbus addresses such as H2000 and H8000.
	After the configuration is downloaded, the yellow indicator D3 on the MD38DP2 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).

Symptom		Solution
After the connection is successful, all indicators on the PLC are 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. No matter whether the PPO type used contains the PKW area, the address for the read and write operations is located in the second row (also the last row). For example, 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 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 the SFC15 block is **0**. If not, an invocation error exists. Eliminate this error first and invoke the block again. For details, see section "7.7.3 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 that F0-02 is set to 2 and F0-03 is set to 9. 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 is set to U3-17 and FE-01 is set to U3-16. 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 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 ERR164, which cannot be cleared. However, the indicators on the MD38DP2 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 that this solution applies to MD520 only. For other AC drives, consult the technical personnel.

Symptom	Solution
After communication is established, the communication is normal when the AC drive is not running. However, when one or more AC drives are running, the AC drive is disconnected randomly.	1. Disconnect the power supply, and measure the resistance between A1 and B1 of the PROFIBUS DP slave interface at the farthest end with a multimeter. The resistance should be 100±20 Ω.
	2. Check that the shield layers of cables are connected together and the shield layers are in contact with the sheet metal in the PROFIBUS DP interface. The shield layers are not required to connect with other GND.
After the connection is established, if the AC drive reports a fault, the faulty slave cannot connect to the network when the PLC configuration is changed and downloaded or when only the AC drive is powered on again.	MD38DP2 only supports the interruption mode DPV0. If the interruption mode is set to DPV1, when a slave is faulty, the PLC master may close the PROFIBUS DP connection channel of the slave or interrupt all the PLC communication (which usually occurs on S7-1200). When such a symptom occurs, change the PROFIBUS 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 and Troubleshooting

Indicator※	Status	Symptom	Solution
Red (D4)	OFF	The MD38DP2 expansion card is not powered on.	Check that connection between the MD38DP2 expansion card and the AC drive is secure.
Green (D2)	OFF	The connection between the MD38DP2 expansion card and the AC drive fails.	Check that F0-28 is set to 1 and the connection between the MD38DP2 expansion card and the AC drive is secure.
Green (D2)	Blinking at 1 Hz	The connection between the MD38DP2 expansion card and the AC drive fails.	Check that the PROFIBUS DP station number is within the range of 1 to 125.
Yellow (D3)	Blinking at 1 Hz	A configuration error occurs.	Check that the GSD file is correct.
Yellow (D3)	Blinking at 2 Hz	A parameter error occurs.	Check that all parameter addresses in **Device-specific parameters** are supported by the AC drive.

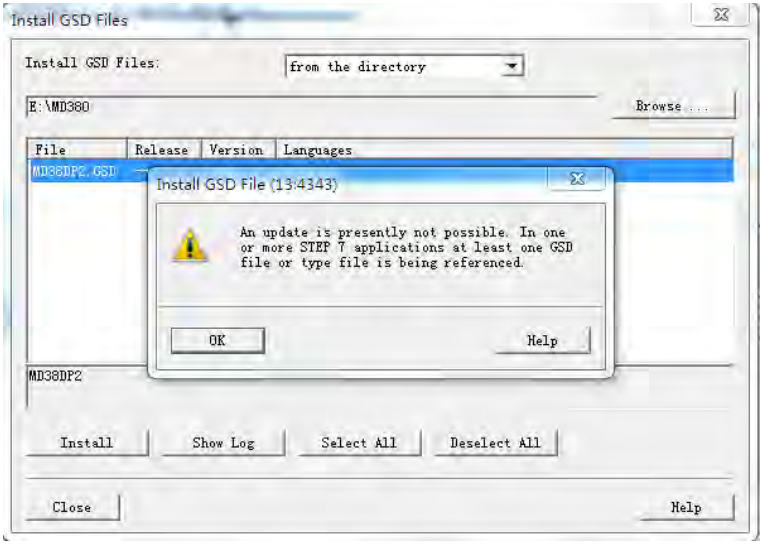
Indicator※	Status	Symptom	Solution
Yellow (D3)	Blinking at 5 Hz	The master is not running.	Check the master state.
Yellow (D3)	OFF	The connection between the MD38DP2 expansion card and the PROFIBUS master fails.	Check that the slave address is correct and the PROFIBUS cable is connected properly.

Note

Note※: For some products, the indicator color and the terminal symbol may not match. In this case, the terminal symbol prevails. The indicators are D2, D3, and D4 from left to right. See *" " on page* .

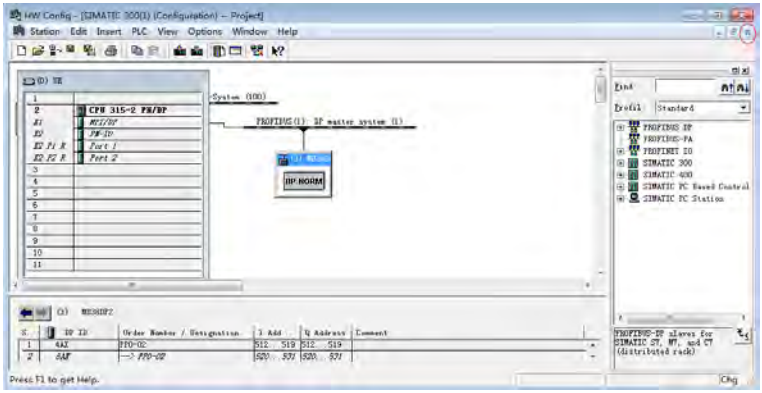
Troubleshooting for GSD Installation Failure

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

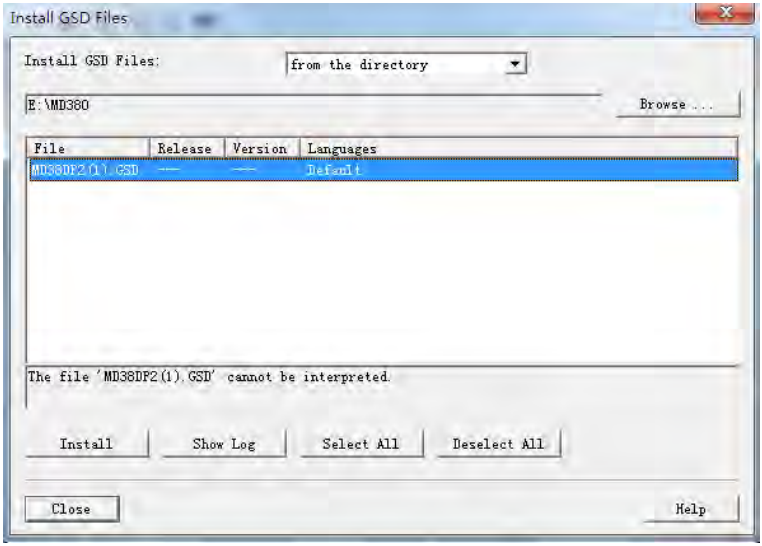


Possible cause: The current hardware configuration has been opened and the GSD file is being used by other components.

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



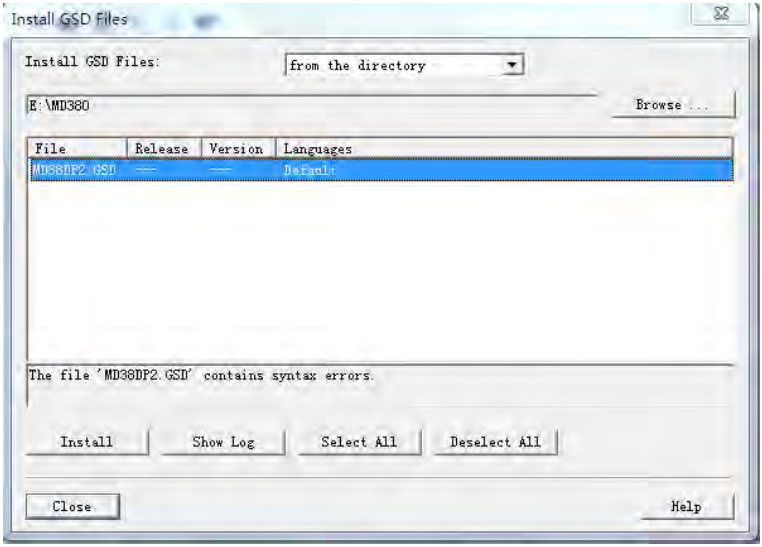
- Symptom 2: The file cannot be interpreted.



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**.

- Symptom 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 for installing the GSD file. In this case, store the GSD file in a path that does not contain Chinese characters.

8 MD-SI-DP1 Communication

8.1 Introduction

As a PROFIBUS DP fieldbus adapter card that meets international PROFIBUS fieldbus standards, the MD-SI-DP1 expansion 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. It can implement PROFIBUS DP communication.

The following table lists the differences between MD-SI-DP1 and MD38DP2.

Item	MD-SI-DP1	MD38DP2
Diagnosis	Supported	Supported
DPV1	Supported	Supported
PPO4	Supported	Supported
PPO type	Set by the Siemens software tool	Set by the Siemens software tool
PZD mapping address	Set by the Siemens software tool	Set by the Siemens software tool
Station number settings	Set by the DIP switch, ranging from 1 to 125	Set by the DIP switch, ranging from 1 to 125
Master disconnection	AC drive informed by the expansion card	AC drive informed by the expansion card
Communication rate between the expansion card and the AC drive	Constant rate	Constant rate
Slave fault	Master informed by the expansion card	Master informed by the expansion card
CAN communication	Not supported	Supported

8.2 Installation

The MD-SI-DP1 expansion card is embedded in the MD520 series 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 MD-SI-DP1 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by the pulling force of the external signal cable. *"Figure 8–1 " on page 184* shows the installation.

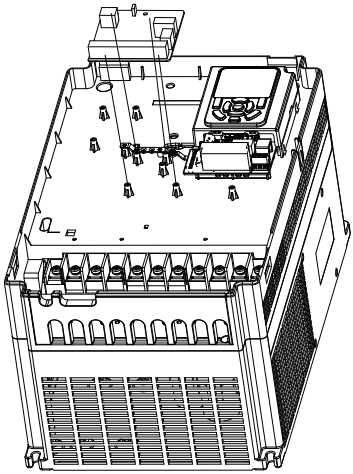


Figure 8-1 Installation of MD-SI-DP1

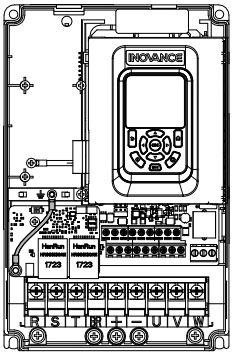


Figure 8-2 Connecting ground terminals of the MD-SI-DP1 card and AC drive

Caution

Do not install or disassemble this card with power on.

8.3 Interface Layout and Description

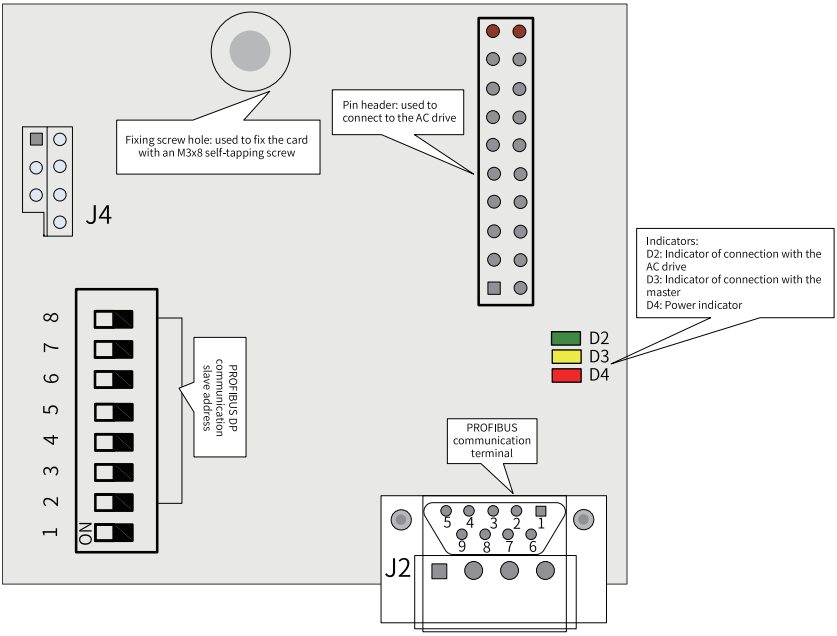


Figure 8-3 Interface layout of the MD-SI-DP1 card

DIP Switch

Digit	Function	Description
1	PROFIBUS DP card type switchover	OFF: MD-SI-DP1 (default) ON: Reserved
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. Example: Address — DIP Switch Setting (digit 8: least significant bit) 1 — 000 0001 7 — 000 0111 20 — 001 0100 125 — 111 1101

Caution

The change of digit 1 is valid upon the next power-on. The change of slave addresses takes effect immediately after setting.

Standard 9-pin PROFIBUS Interface

The MD-SI-DP1 expansion card is connected to the PROFIBUS master using the standard DB9 socket. The pin signal definition and pin arrangement of the standard DB9 socket are the same as those of Siemens' DB9 socket, as shown in the following figure.

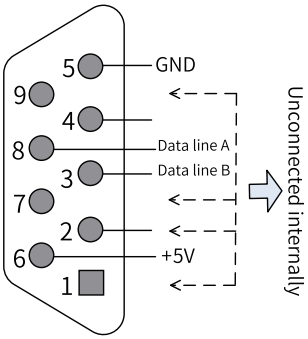


Figure 8-4 DB9 terminal pins

Control Terminals

Table 8–1 Function description of control terminals

Category	Symbol	Terminal Name	Function
PROFI BUS communi cation terminal (J3)	1, 2, 7, and 9	NC	Unconnected internally
	3	Data line B	Positive pole of the data line
	5	GND	Isolated 5 V power ground
	6	+5 V	Isolated 5 V power supply
	8	Data line A	Negative pole of the data line
Program ming	J4	Programming	Interface for production and commissioning. Do not use it.

Category	Symbol	Terminal Name	Function
Indicator※	D4 (red)	Power indicator	• Steady ON: The AC drive is powered on. • 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 MD-SI-DP1 expansion card and the master	• Steady ON: Communication between the MD-SI-DP1 card and the PROFIBUS master is normal. • OFF: There is no communication between the MD-SI-DP1 card and the PROFIBUS master (check the connection of PROFIBUS cables and the setting of the station number). • Blinking: The master is not running or a fault occurs in communication between the MD-SI-DP1 expansion card and the master.
	D2 (green)	Indicator of communication between the MD-SI-DP1 expansion card and the AC drive	• Steady ON: Communication between the MD-SI-DP1 expansion card and the AC drive is normal. • OFF: Communication between the MD-SI-DP1 card and the AC drive fails. (F0-28 is not set to 1 or the AC drive does not support the MD-SI-DP1 expansion card.) • Blinking: Interference exists in communication between the MD-SI-DP1 expansion card and the AC drive or the expansion card address is beyond the range of 1 to 125.

8.4 Topology and Transmission Distance

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

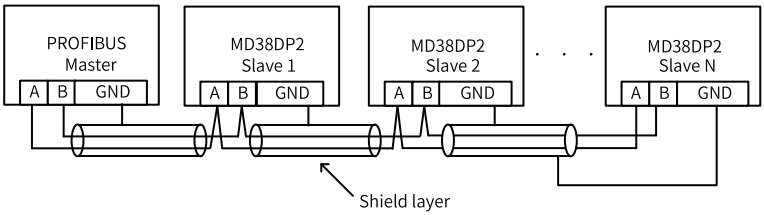
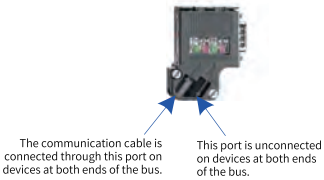


Figure 8-5 Connection between the PROFIBUS DP card and PROFIBUS master

Terminal resistors must be connected at both ends of the PROFIBUS bus and DIP switches must be set correctly according to the marks on the wiring terminals. After

terminal resistors are connected correctly, the resistance between A1 and B1 should be 110 Ω upon power-off. For devices connected at both ends of the PROFIBUS network, the communication cables must be connected from their PROFIBUS DP terminals to the channels marked with "IN" (channels corresponding to A1/B1). Otherwise, terminal resistors cannot be connected. If any required terminal resistor is not connected, the communication quality will deteriorate.



The required length of the communication cable between the PROFIBUS DP expansion card and the PROFIBUS master varies with the baud rate of the master. It is strictly restricted according to the Siemens DB9 standard. The following table describes requirements on communication cable length based on the baud rate.

Baud Rate (kbit/s)	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 the cables.

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

8.5 Protocol Description

Data Transmission Formats

In the PROFIdrive protocol, the PPO is used as the data transmission format. PPOs are classified into PPO1, PPO2, PPO3, PPO4, and PPO5, all of which are supported by the MD38DP2 expansion card.

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

Data Format	Supported Functions
PPO1	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive state and running frequency
PPO2	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic writing of four function parameters Periodic reading of four function parameters
PPO3	Setting of AC drive command and frequency Reading of AC drive state and running frequency
PPO4	Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic writing of four function parameters Periodic reading of four function parameters
PPO5	Operation on a single function parameter Setting of AC drive command and frequency Reading of AC drive state and running frequency Periodic writing of ten function parameters Periodic reading of ten function parameters

Data blocks of the PPO data are divided into two areas, PKW area (parameter value) and PZD area (process data). The following figure shows the PPO data formats supported by MD38DP2.

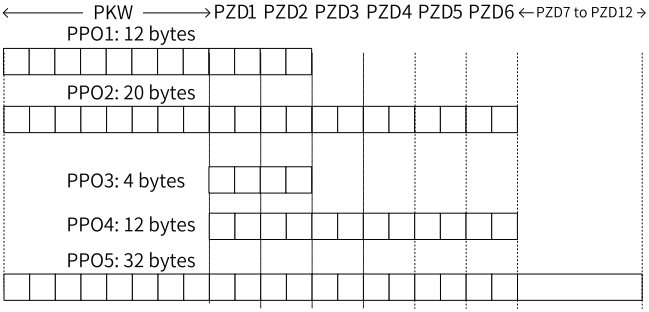


Figure 8-6 PPO data formats

PKW Data

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

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

Data format

PKW data consists of three groups of arrays, including the PKE, IND, and PWE. The lengths of PKE and IND are two bytes, and the length of PWE is four bytes. The following table describes the data format.

PKW Data Sent by the Master							
Operation Command	Parameter Address		Reserved			Write: parameter value Read: null	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE
PKW Data Returned by the AC Drive							
Operation Command	Parameter Address		Reserved			Successful: returned value Failed: error information	
PKE	PKE	IND	IND	PWE	PWE	PWE	PWE

Data description

PKW Data Sent by the Master		PKW Data Returned by the AC Drive	
PKE	• High-order 4 bits: Command code0: No request1: Read parameter data2: Modify parameter data (The preceding command code is in decimal format.) • Low-order 4 bits: Reserved • Low-order 8 bits: High-order bits of the parameter address	PKE	• High-order 4 bits: Response code0: No request1: Operation succeeded7: Operation failed • Low-order 8 bits: High-order bits of the parameter address
IND	High-order 8 bits: Low-order bits of the parameter address Low-order 8 bits: Reserved	IND	High-order 8 bits: Low-order bits of the parameter address Low-order 8 bits: Reserved
PWE	High-order 16 bits: Reserved Low-order 16 bits: Parameter value (write request) or not used (read request)	PWE	• Request succeeded: Parameter value • Request failed: Error code (consistent with standard Modbus)1: Invalid command2: Invalid address3: Invalid data4: Other error

Application

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

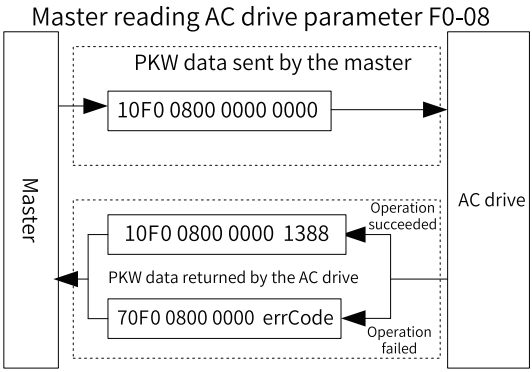


Figure 8-7 Example PKW data sent by the master when reading an AC drive parameter

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

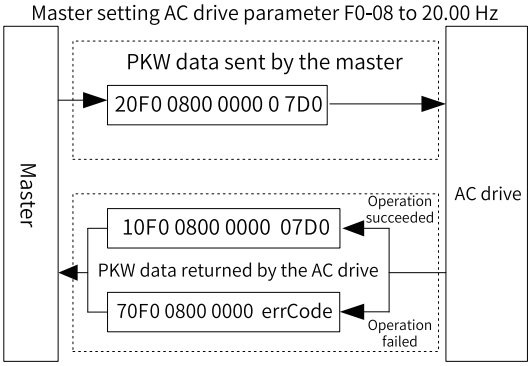


Figure 8-8 Example PKW data sent by the master when modifying an AC drive parameter

PKW data exchange with the AC drive is performed cyclically. Continuous write command (PKE = 0x20xx) on the EEPROM will significantly shorten the service life of the AC drive's main control chip. Therefore, to modify AC drive parameters, you are advised to perform aperiodic write operations (see SFB53 described in *"7.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave" on page 173 "7.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave" on page 173 " " on page*) or write to 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 F0-10 is 0x000A.

PZD Data

The PZD data enables 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 functions of PZD data are as follows:

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

Master Transmit Data PZD		
AC Drive Command	AC Drive Target Frequency	AC Drive Parameters Modified in Real Time
PZD1	PZD2	PZD3 to PZD12
AC Drive Response Data PZD		
AC Drive Command	AC Drive Running Frequency	AC Drive Parameters Read in Real Time
PZD1	PZD2	PZD3 to PZD12

Data Sent by the Master

Master Transmit Data PZD		
PZD1	AC drive command word (command source set to communication)	
	0: No command 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: Decelerate to stop 07: Reset upon fault
PZD2	AC drive target frequency (frequency reference source set to communication; value unit determined by the AC drive while Hz is used as an example here) The frequency reference ranges from 0 to F0-10. When F0-22 is set to 1, the frequency range is 0.0 Hz to 3200.0 Hz. When F0-22 is set to 2, the frequency range is 0.00 Hz to 320.00 Hz. When the reference target frequency exceeds F0-10, the AC drive does not respond to the frequency reference.	

Master Transmit Data PZD	
PZD3 to PZD12	Function parameter values (group F and group A) modified in real time, not written into 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 Returned by the AC Drive

AC Drive Response Data PZD	
PZD1	AC drive running state The AC drive running state is defined by bit as follows: • Bit0: 0: Stopped; 1: Running • Bit1: 0: Running in forward direction; 1: Running in reverse direction • Bit2: 0: Not faulty; 1: Faulty • Bit3: 0: Running frequency not reached; 1: Running frequency reached
PZD2	AC drive running frequency: The current AC drive running frequency is returned as 16-bit signed data. When F0-22 is set to 1, –32000 to +32000 correspond to the actual running frequency –3200.0 Hz to +3200.0 Hz. When F0-22 is set to 2, –32000 to +32000 correspond to the actual running frequency –320.00 Hz to +320.00 Hz.
PZD3 to PZD12	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.

8.6 Related Parameters

8.6.1 Parameters related to Communication

AC Drive Communication Card Setting

You need to set F0-28 to 1 to select PROFIBUS DP as the serial port communication protocol of the AC drive. See the following table.

Parameter	Parameter Name	Value Range	Setpoint	Description
F0-28	Serial communication protocol	0: Modbus protocol 1: Communication card network bridge protocol	1	Select the special communication card network bridge as the serial communication protocol.

Communication Control Parameters

Parameter	Parameter Name	Value Range	Hexadecimal Address	Decimal Address
U3-16	Frequency reference	–Maximum frequency to +Maximum frequency Unit: 0.01 Hz	H7310	29456
U3-17	Control command	0001: Run in forward direction 0002: Run in reverse direction 0003: Jog in forward direction 0004: Jog in reverse direction 0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	H7311	29457
U3-18	DO control	Bit0: DO1 output control Bit1: DO2 output control Bit2: Relay 1 output control Bit3: Relay 2 output control Bit4: FMR output control Bit5: VDO1 Bit6: VDO2 Bit7: VDO3 Bit8: VDO4 Bit9: VDO5	H7312	29458
U3-19	AO1 control	0 to 7FFF, indicating 0% to 100%	H7313	29459

Parameter	Parameter Name	Value Range	Hexadecimal Address	Decimal Address
U3-20	AO2 control	0 to 7FFF, indicating 0% to 100%	H7314	29460
U3-21	FMP control	0 to 7FFF, indicating 0% to 100%	H7315	29461
U3-23	Speed control	Signed data, 1 RPM	H7317	29463

When the MD-SI-DP1 expansion 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 but 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 set to U3-17 and U3-16 respectively. If not, manually correct the values of FE-00 and FE-01.

Communication Monitoring Parameters

Parameter	Parameter Name	Unit	Hexadecimal Address	Decimal Address
U0-00	Running frequency (Hz)	0.01 Hz	H7000	28672
U0-01	Frequency reference (Hz)	0.01 Hz	H7001	28673
U0-02	Bus voltage (V)	0.1 V	H7002	28674
U0-03	Output voltage (V)	1 V	H7003	28675
U0-04	Output current (A)	0.01 A	H7004	28676
U0-05	Output power (kW)	0.1 kW	H7005	28677
U0-06	Output torque (%)	0.1%	H7006	28678
U0-07	DI state	1	H7007	28679
U0-08	DO state	1	H7008	28680
U0-09	AI1 voltage (V)	0.01 V	H7009	28681
U0-10	AI2 voltage (V)	0.01 V	H700A	28682
U0-11	AI3 voltage (V)	0.01 V	H700B	28683
U0-12	Count value	1	H700C	28684
U0-13	Length value	1	H700D	28685
U0-14	Load speed	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 reference (Hz)	0.01 kHz	H7012	28690

Parameter	Parameter Name	Unit	Hexadecimal Address	Decimal Address
U0-19	Feedback speed (Hz)	0.01 Hz	H7013	28691
U0-20	Remaining running duration	0.1 min	H7014	28692
U0-21	AI1 voltage before correction	0.001 V	H7015	28693
U0-22	AI2 voltage before correction	0.001 V	H7016	28694
U0-23	AI3 voltage before correction	0.001 V	H7017	28695
U0-24	Linear speed	1 m/min	H7018	28696
U0-25	Current power-on duration	1 min	H7019	28697
U0-26	Current running duration	0.1 min	H701A	28698
U0-27	Pulse input frequency	1 Hz	H701B	28699
U0-28	Communication reference	0.01%	H701C	28700
U0-29	Encoder feedback speed	0.01 Hz	H701D	28701
U0-30	Main frequency X	0.01 Hz	H701E	28702
U0-31	Auxiliary frequency Y	0.01 Hz	H701F	28703
U0-32	Any memory address	1	H7020	28704
U0-33	Synchronous motor rotor position	0.1°	H7021	28705
U0-34	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	V/f separation target voltage	1 V	H7027	28711
U0-40	V/f separation output voltage	1 V	H7028	28712
U0-41	DI state display	1	H7029	28713
U0-42	DO state display	1	H702A	28714
U0-43	DI state display 1	1	H702B	28715

Parameter	Parameter Name	Unit	Hexadecimal Address	Decimal Address
U0-44	DI state display 2	1	H702C	28716
U0-45	Fault information	1	H702D	28717
U0-58	Z signal counter	1	H703A	28730
U0-59	Frequency reference (%)	0.01%	H703B	28731
U0-60	Running frequency (%)	0.01%	H703C	28732
U0-61	AC drive state	1	H703D	28733
U0-62	Current fault code	1	H703E	28734
U0-63	Data sent by master during point-point communication	0.01%	H703F	28735
U0-64	Data sent by slave during point-point communication	0.01%	H7040	28736
U0-65	Torque upper limit	0.1%	H7041	28737
U0-66	Expansion card model	100: CANopen 200: PROFIBUS DP 300: CANlink	H7042	28738
U0-67	Expansion card version	1	H7043	28739
U0-68	AC drive state	1	H7044	28740
U0-69	Running frequency (Hz)	0.01 Hz	H7045	28741
U0-70	Motor speed	RPM	H7046	28742
U0-71	Output current	0.1 A	H7047	28743

When the MD-SI-DP1 expansion card is used, the read PZD1 and PZD2 are mapped to U0-68 and U0-69 respectively by default. 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.

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.

8.7 Communication Configurations

8.7.1 Communication Instance Description

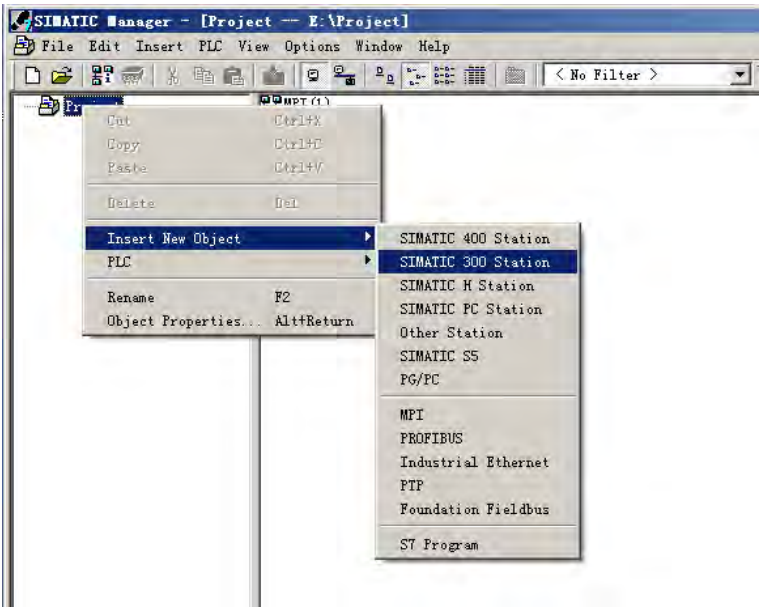
The MD-SI-DP1 card uses the same GSD file as the MD38DP2 card, and its usage is also the same as that of the MD38DP2 card. Therefore, this chapter still uses the screenshots of the communication and configuration interfaces displaying information about the MD38DP2 card.

8.7.2 Configuring a Slave on the S7-300 Master in STEP 7 V5.4

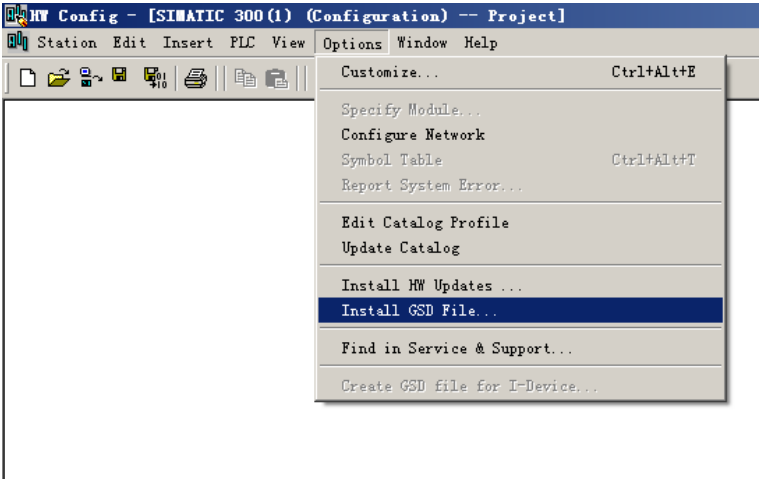
Before using the PROFIBUS master, you need to configure the GSD file of the slave to add the corresponding slave device to the system of the master. If the file exists, skip step 2. You can obtain the GSD file from Inovance or its agent.

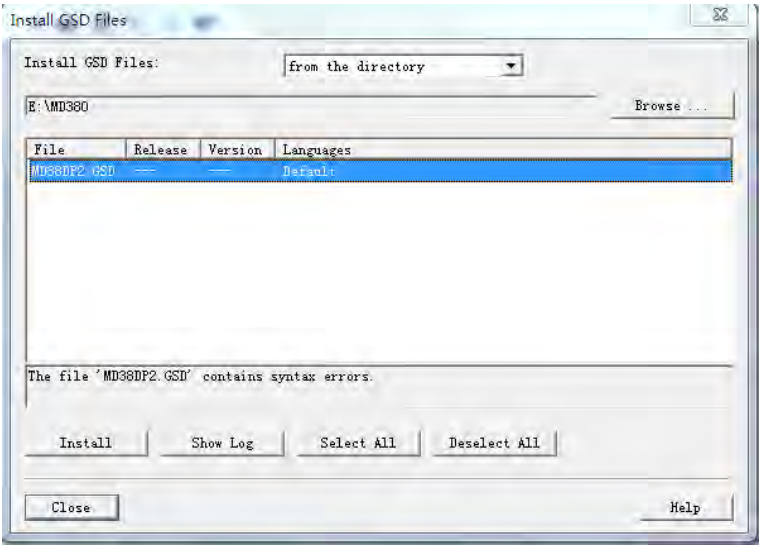
The configuration procedure is as follows:

1. Install the GSDML file. (Skip this step if the GSDML file has been installed.) Choose **Options** > **Manage general station description files (GSD)**.

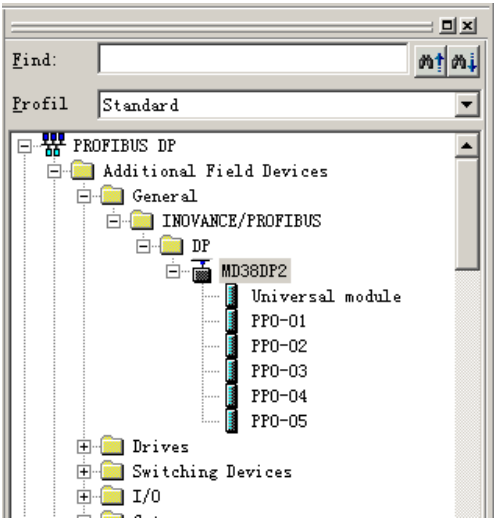


2. Double-click the hardware icon to access the **HW Config** interface, and choose **Options** > **Install GSD File** to add the **MD38DP2.GSD** file (English path required), as shown in the following figure.

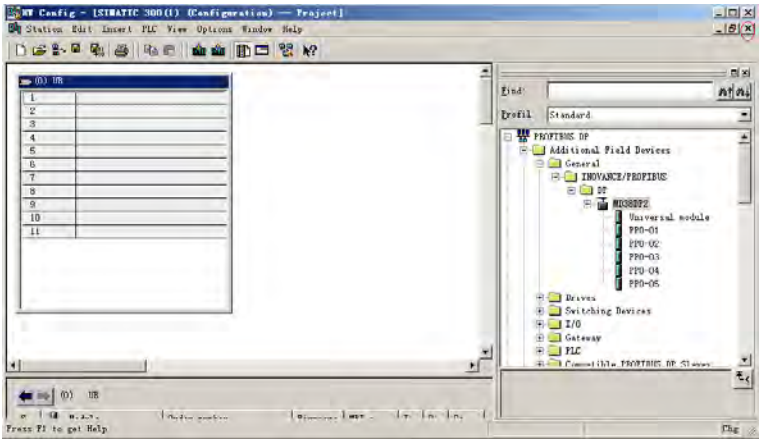




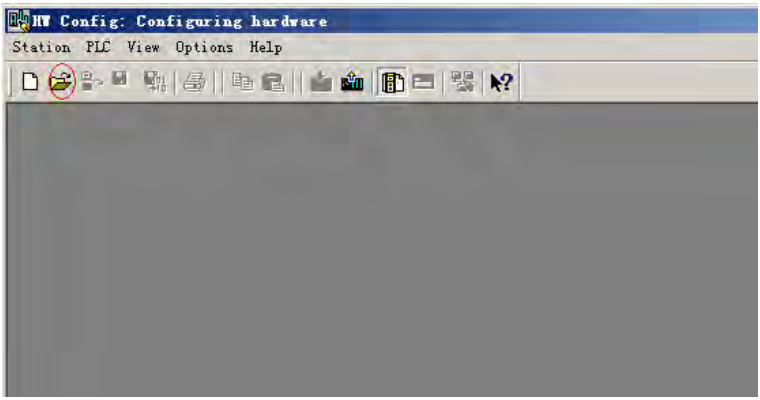
Click **Install**. After the installation is complete, the PROFIBUS DP module MD38DP2 is displayed, as shown in the following figure.



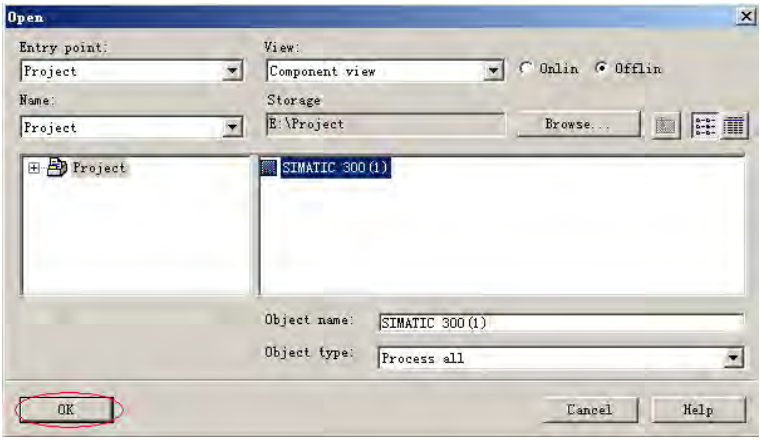
Note: If any master or slave already exists on the **HW.config** interface, close the current interface by clicking the X button (marked with a red circle as shown in the following figure) before importing the GSD file.



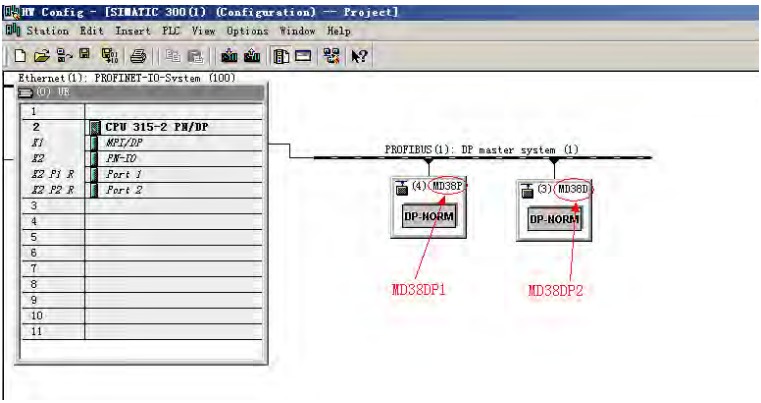
In this case, you can save the original project. If an alarm indicating that system data cannot be created is displayed, click **OK**. After closing the current configuration interface, you can install the GSD file by performing the preceding steps. After the installation is complete, click the button marked with the red circle in the following figure.



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

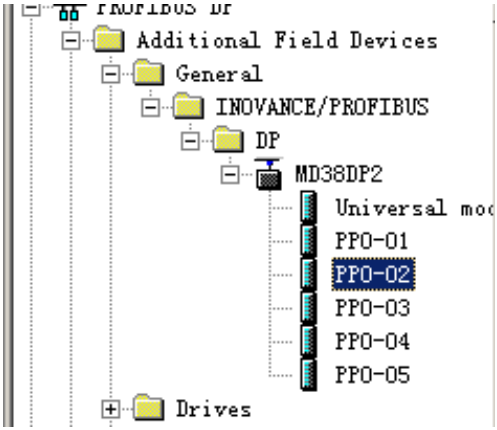


3. Configure the actual hardware system, as shown in the following figure.



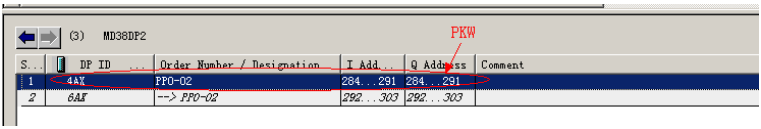
In the preceding figure, station 4 is MD38DP1, which is only used as an example. For details about its usage, see the MD380 Series PROFIBUS User Guide. MD38DP1 and MD38DP2 can coexist on the same network.

4. Configure data features of the slave.

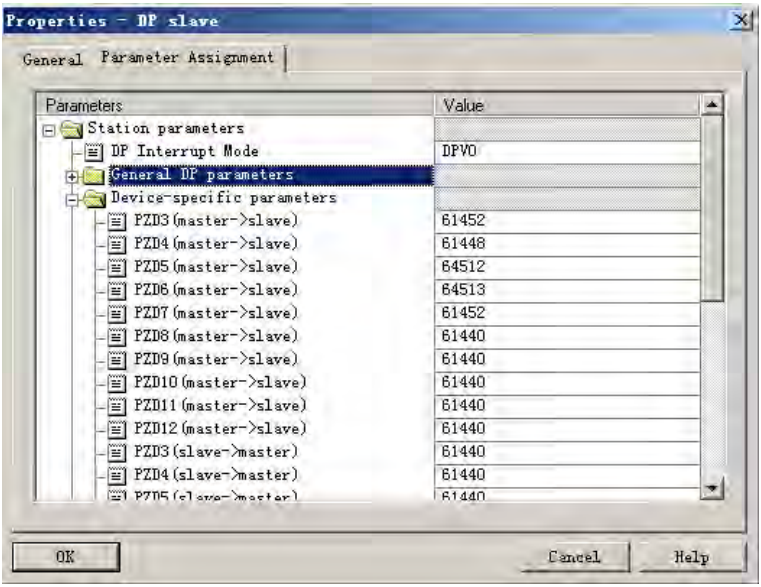


After the PPO type is added, the address assigned by the PLC to the slave is displayed, as shown in the following figure. Slot 1 marked with a red circle in the following figure indicates the PKW address (8 bytes). Slot 2 indicates the PZD address (12 bytes).

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



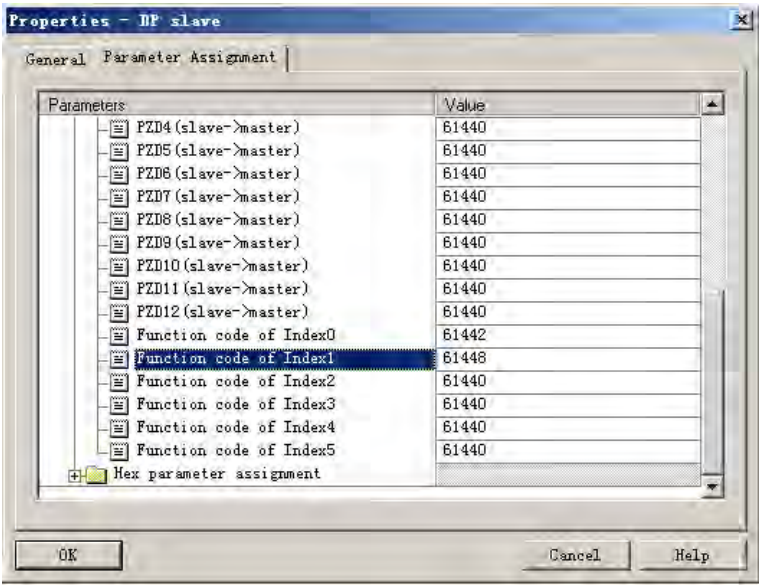
5. Configure PZDs.
The PZD1 and PZD2 configurations are fixed and cannot be modified by users. PZD3 to PZD12 are for customized periodic data exchange. They can be set in hardware configuration. Double-click the MD38DP icon in **HW Config**, click **Device-specific parameters**, and configure corresponding parameter addresses as required.



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

By default, all PZDs of MD380 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 the mappings of various slaves are the same, you can select a configured slave, press **Ctrl+C**, select the PROFINET bus in the configuration, press **Ctrl+V**, and modify the device name and IP address).

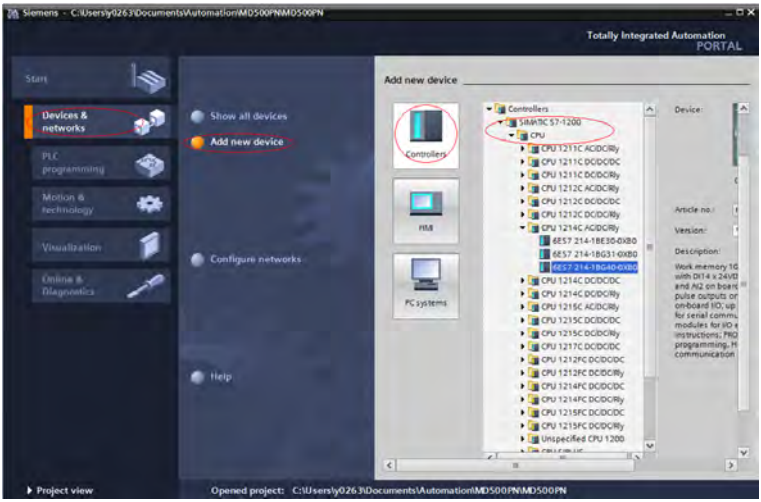
To enable the aperiodic parameter read and write function of DPV1, set corresponding parameters in customized indexes at the end of **Device-specific parameters** list. MD380 provides six customized indexes numbered from 0 to 5, as shown in the following figure. For example, you can set index 0 to F0-02 and index 1 to F0-08.



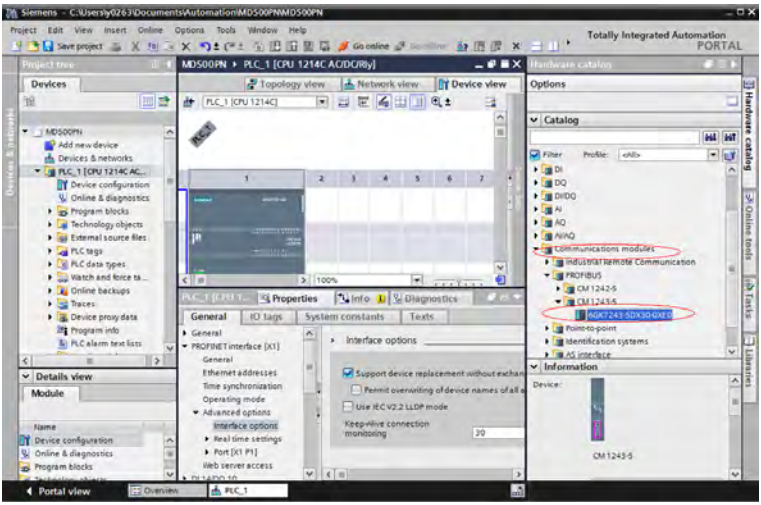
After the preceding steps, the PROFIBUS slave is configured. Now, you can compile programs in S7-300 to control the AC drive.

8.7.3 Configuring a Slave on the S7-1200 Master in TIA Portal V13

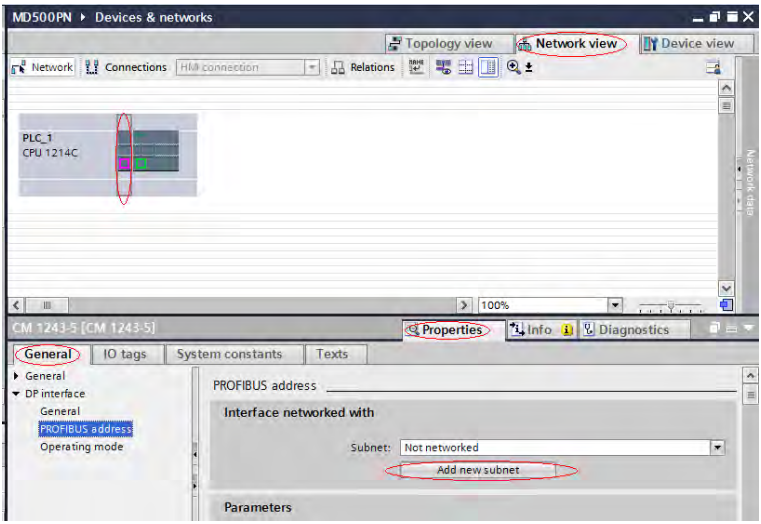
1. Open TIA Portal V13, create a project, and add an S7-1200 master according to actual situations.



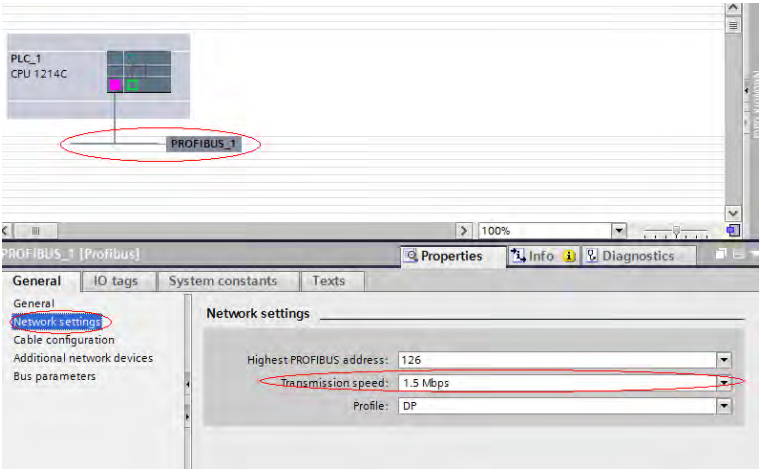
Since the S7-1200 CPU has no PROFIBUS interface, you need to add a PROFIBUS communication module. In this example, a CM1243-5 master module is added.



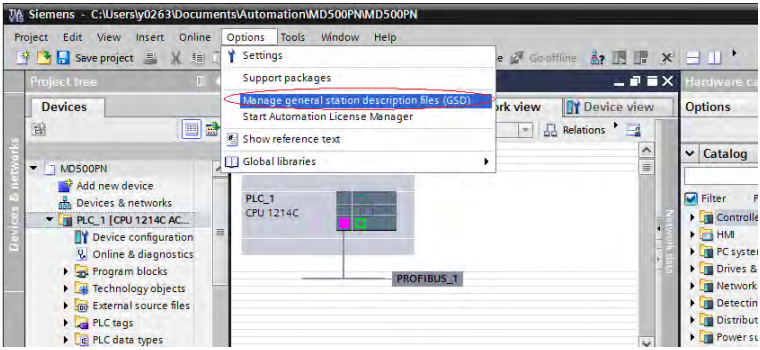
After adding the PROFIBUS master module, click **Network view**. Select the communication module, click **Properties** and then **General**, and click **Add new subnet** to create a PROFIBUS network. You can modify the master number here.

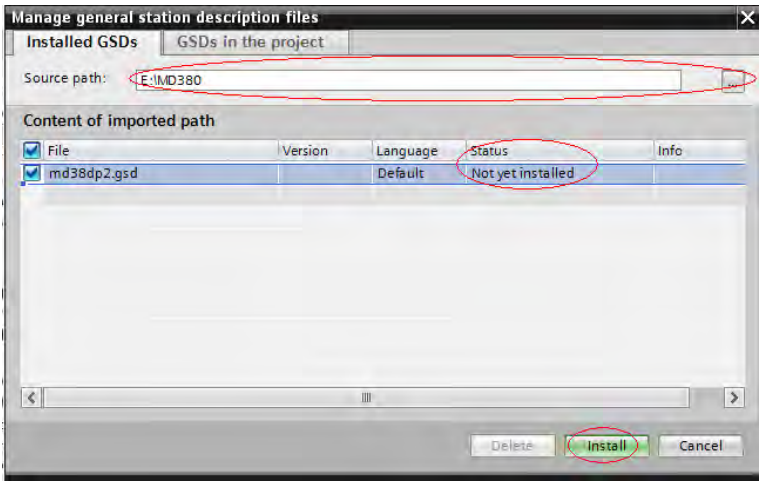


To modify the PROFIBUS baud rate, select the network in the view, and choose **General** > **Network settings** on the **Properties** tab page, and select a proper baud rate from the **Transmission speed** drop-down list.

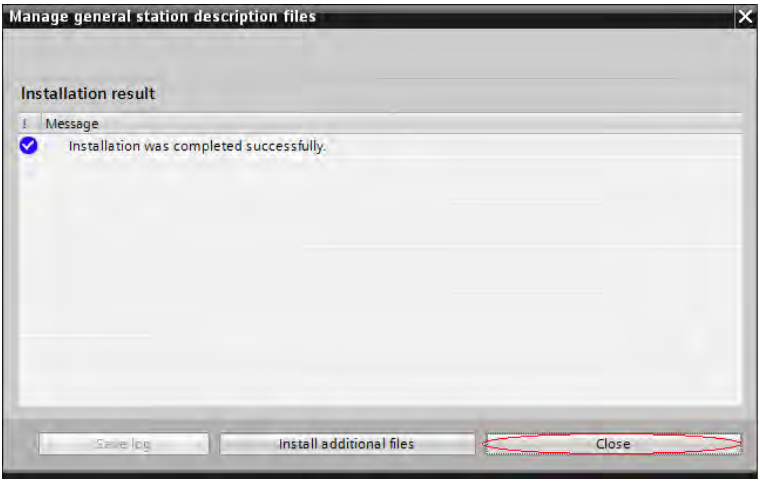


2. Install the GSD file. Skip this step if a GSD file has been installed.
   If a GSD file is not installed yet, **Not yet installed** will be displayed in the **Status** column. Select the GSD file and click **Install**. (Note that an error will occur if the installation path contains Chinese characters.)

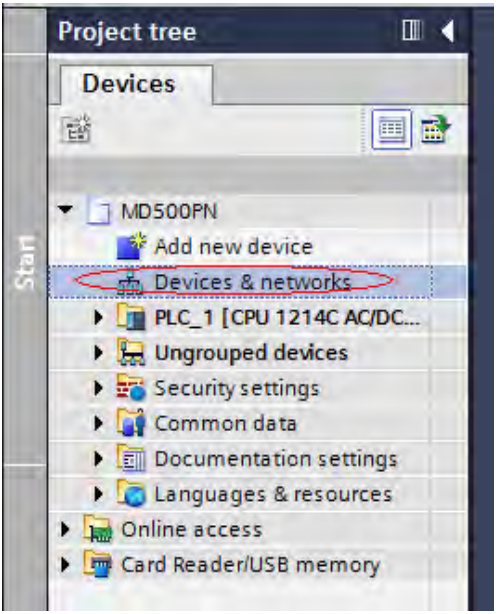




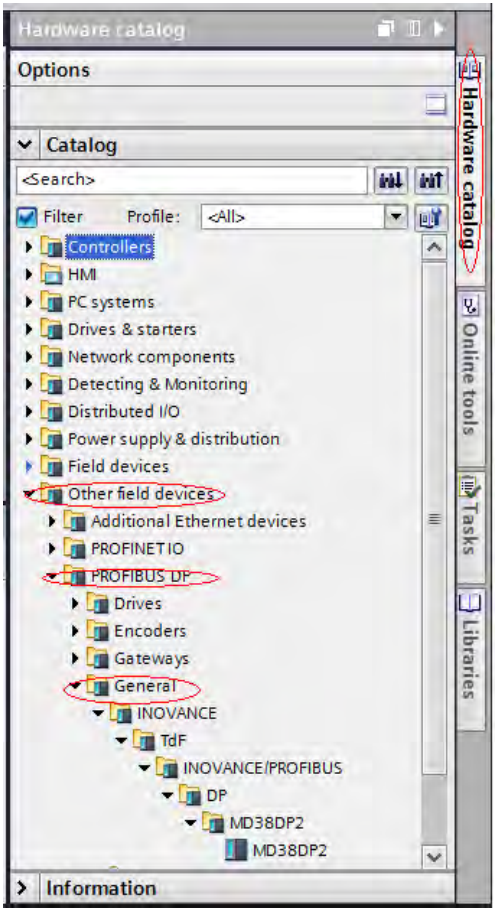
When the interface shown in the following figure is displayed, the installation is complete. Click **Close**.



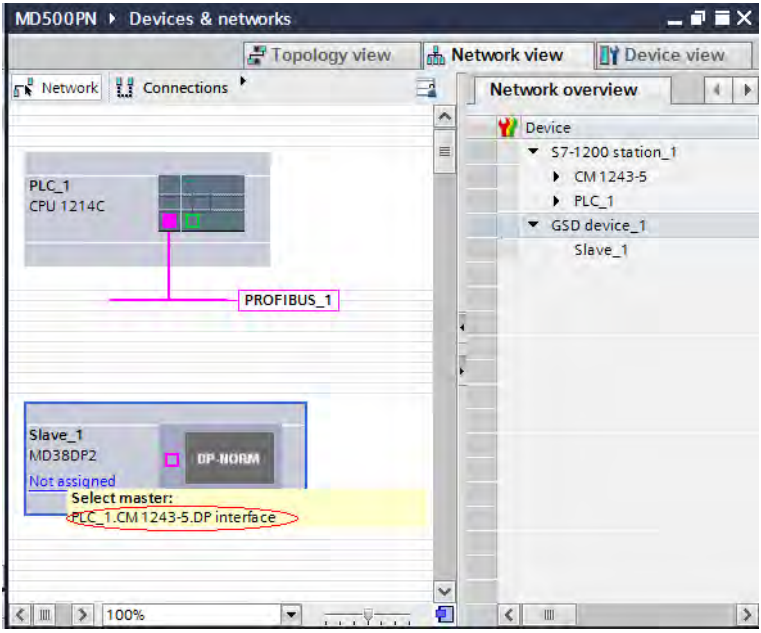
During installation of the GSD file, the PORTAL will automatically close the configuration interface. After the installation is complete, double-click **Devices & networks** on the left to open the original configuration interface.

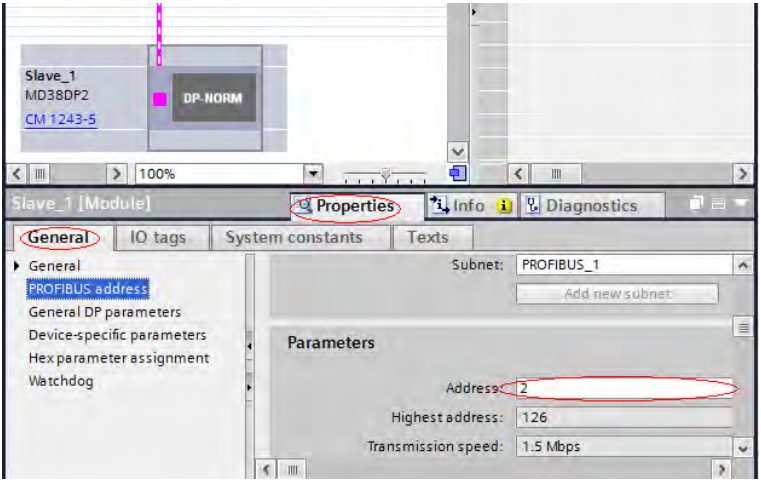


Choose **Hardware catalog** > **Other field devices** > **PROFIBUS-DP** > **General**. You can find the MD38DP2 in the list, which is the same as that in STEP 7. You need to fully expand the subordinate directories as shown in the following figure.

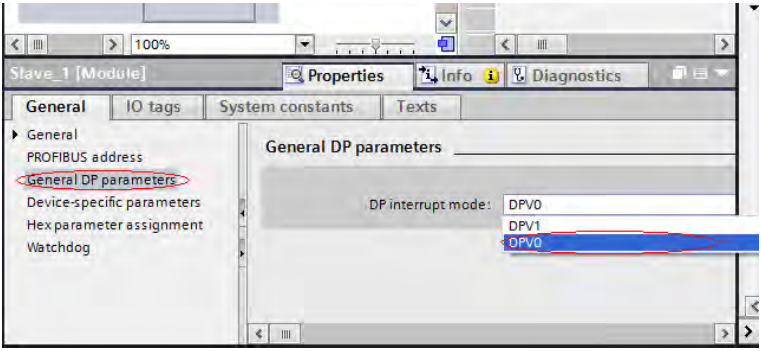


3. Start the configuration.
   On the **Hardware catalog** tab page, double-click **MD38DP2** or drag it to **Network view** under **Devices & networks**, and click **Not assigned** under the slave to select the corresponding PROFIBUS network. Select the slave, click **Properties** and then **General**, and set the slave number. Note that the setting must be consistent with that set by the DIP switch on the MD38DP2 expansion card.

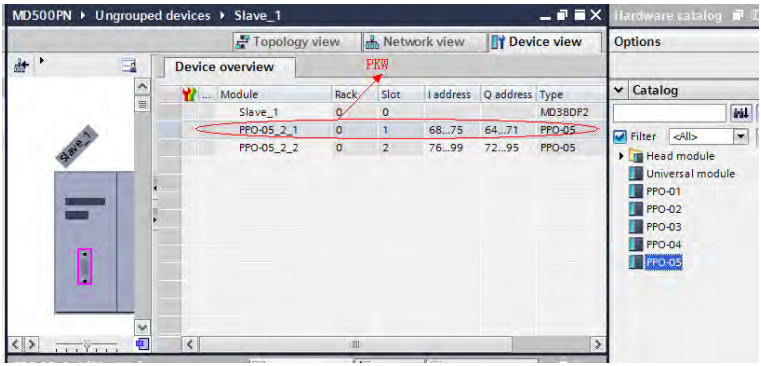




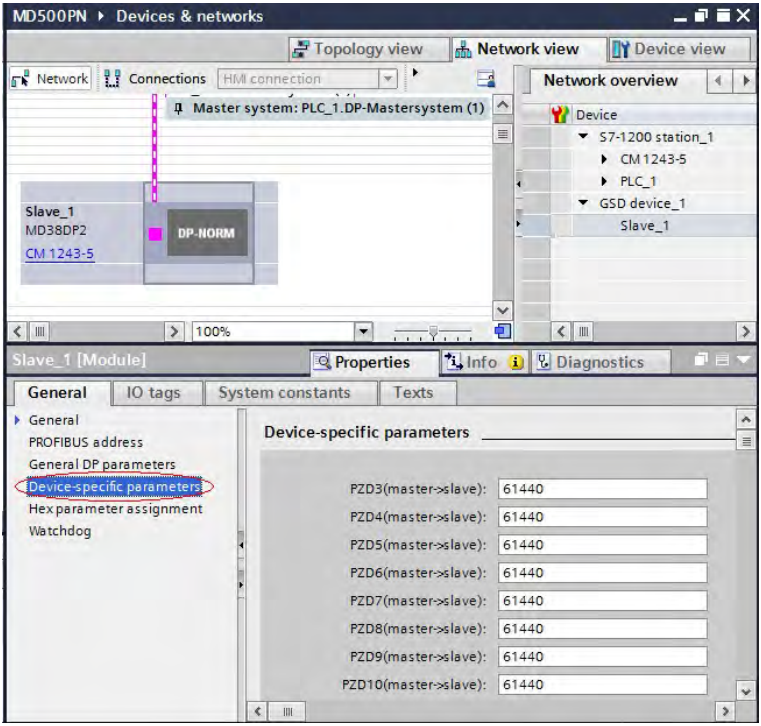
Click **General DP parameters**, and select **DPV0** from the **DP interrupt mode** drop-down list, as shown in the following figure.



Click **Device view**, and select a proper PPO type under **Hardware catalog**. The addresses assigned for each segment are displayed as follows. The PKW address is marked with a red circle in the following figure. If the selected PPO has no PKW, the column is blank.

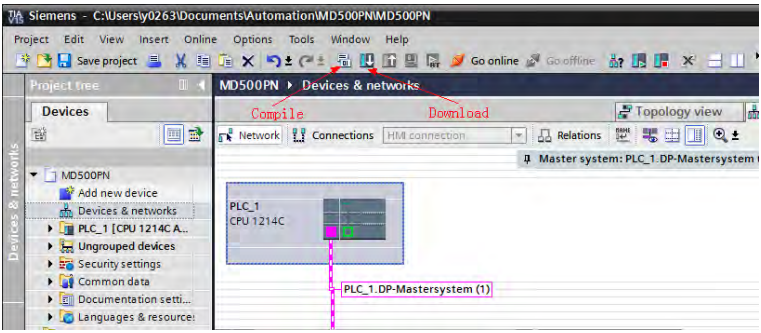


4. Set PZD mapping.
   Click **Network view** and then click **Device-specific parameters** to set the mapping for PZD3 to PZD12. Note that the PZD mappings for the PLC to read and write to the slave are set independently. For details, see *" " on page "8.7.2 Configuring a Slave on the S7-300 Master in STEP 7 V5.4" on page 198 " " on page* .

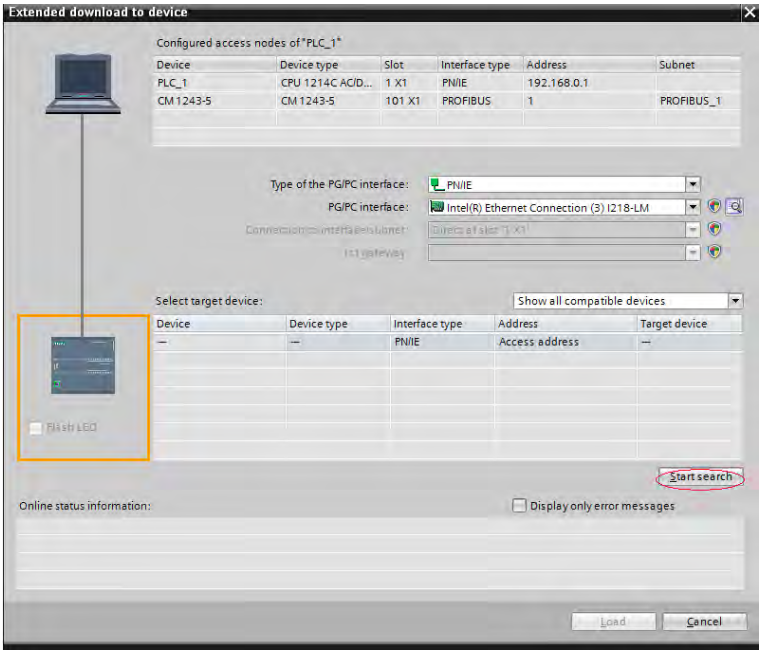


5. Compile and download the configuration.
   If the settings of multiple slaves are the same, select a configured slave, press **Ctrl** +**C** and then **Ctrl**+**V** (or right-click the configured slave and choose **Copy** and then **Paste**) to connect more slaves to the network, and then modify their station numbers.

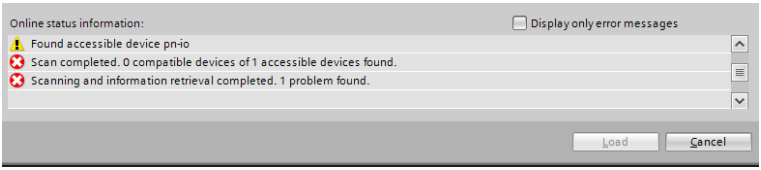
   After all slaves are configured, save the configurations, and click the compile button. After the compiling is completed successfully, click the download button.



Set the interface for the PC the communicate with the PLC as required on the displayed interface. In this example, a local network port is selected. Then click **Start search** to search for the PLC.



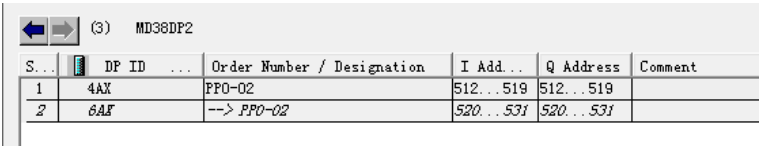
If no accessible device is found, the connection between the PC and PLC is faulty. Eliminate the fault first. (This problem also occurs when the PC was used for download through Ethernet in STEP 7 before. In this case, restart the PC or change the PG/PC interface to a non-Ethernet interface in STEP 7.)



If the connection is normal, the **Load** button is available. You can click **Load** to start download and perform subsequent operations as prompted to download the configuration to the PLC.

8.7.4 Performing Periodic 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.



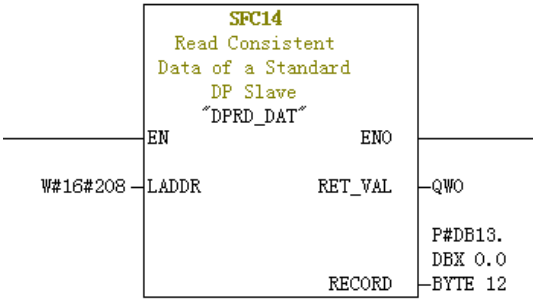
(3) MD38DP2

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

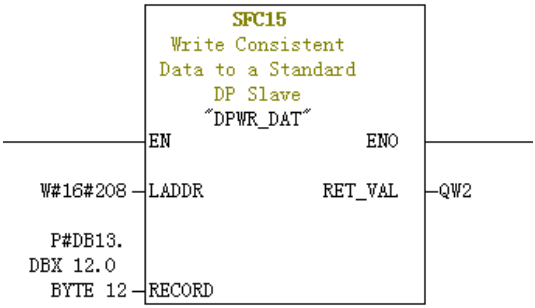
1. Directly use the MOVE command to enable the AC drive to run in forward direction at the target frequency of 30 Hz (F0-02 = 2, F0-03 = 9), as shown in the following figure.

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.

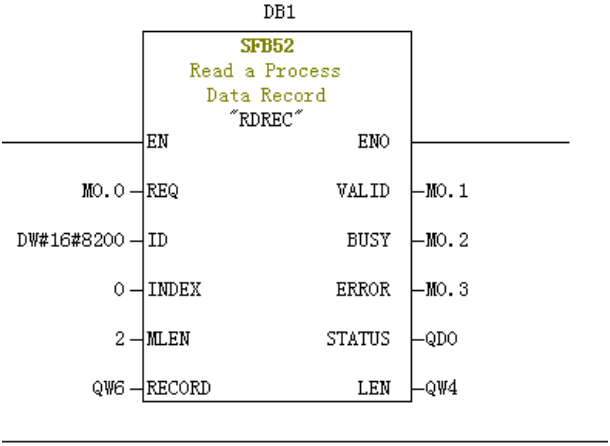


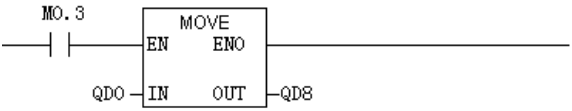
- **LADDR**: Starting address configured in the Q block of the module, which must be in hexadecimal format.
- **RET_VAL**: Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD**: Source area of the user data 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 converted from the I and Q starting addresses (in this example, the address is 520, which is H208 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).

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

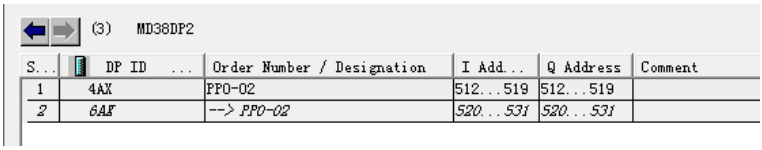
To perform aperiodic read and write operations on the AC drive PROFIBUS DP slave, Siemen's system function modules SFB52 (for reading) and SFB53 (for writing) are required. Create an organization block in the program, and add relevant function blocks and programs in the organization block.





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

- **REQ**: Command enable. When this field is set to 1, the function block is enabled.
- **ID**: Logic address. To specify this field, convert any Q address of the corresponding AC drive slave to a hexadecimal value, and set bit 15 of the value to 1. For example, for Q512, the hexadecimal value is H200. After bit 15 is set to 1, H8200 is obtained.



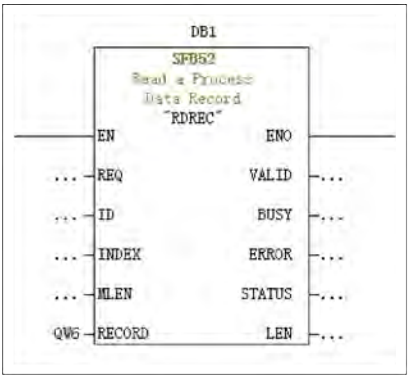
(3) MD38DP2

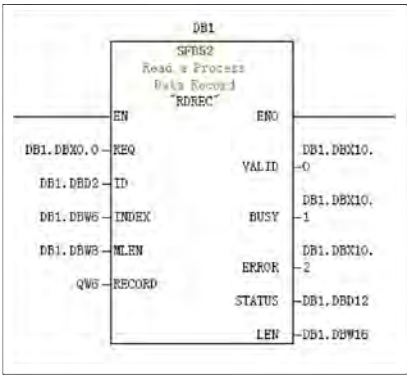
S...	DP ID ...	Order Number / Designation	I Add...	Q Address	Comment
1	4AX	PPO-02	512...519	512...519	
2	6AX	--> PPO-02	520...531	520...531	

- **INDEX**: Index number, ranging from 0 to 5. This field can be customized to an index mapping address of a slave as required.
- **MLEN**: Maximum length of the data to be obtained. For MD38DP2, this field must be set to **2**.
- **RECORD**: Target area of the 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 value is **ON**, the operation is not completed.
- **ERROR**: Error flag. When the value is **ON**, an error occurs.
- **STATUS**: Block status or error information.
- **LEN**: Length of the obtained data record.

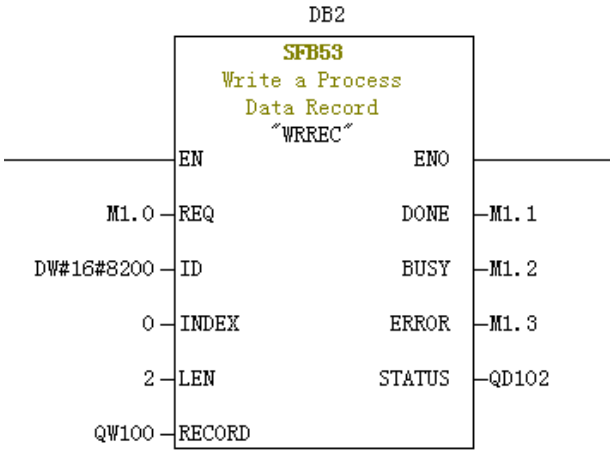
During invocation, you can customize parameters or use some or all default parameters, as shown in the following figure.





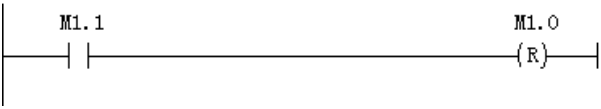
In the preceding figure, default parameters are used on the left. In this case, parameters are set according to the information shown on the right. You can set customized or default parameters for corresponding blocks as required.

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.

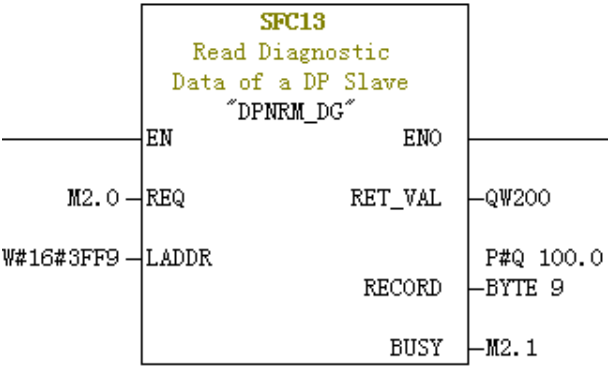
SFB53 is used to perform operations on the EEPROM. Therefore, the program is required to invoke relevant operations when required and disable relevant operations in time. As shown in the following figure, after the write operation is complete (M1.1 is set to 1), the program is invoked to reset M1.0.



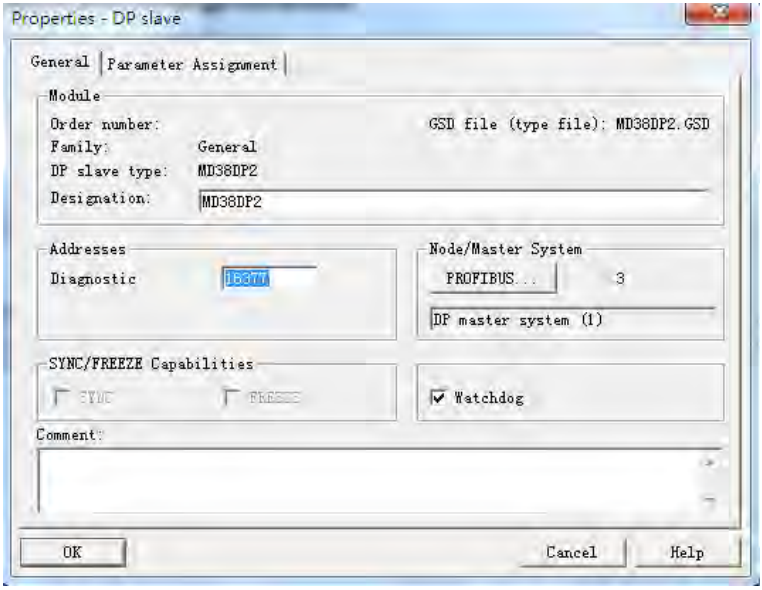
When SFB52 and SFB53 are executed, relevant blocks need to be invoked for multiple times. Therefore, do not invoke them when single execution is required.

8.7.6 Diagnosis

You can use SFC13 in the program to obtain specific diagnosis information of each slave, as shown in the following figure.



- **REQ**: Command enable. When this field is set to **ON**, diagnosis information reading is initiated.
- **LADDR**: Configured diagnosis address of the PROFIBUS DP slave. The following figure shows the actual value. For SFC13, the address must be specified in hexadecimal.



- **RET_VAL**: Error code (negative) when an invocation error occurs or actual length of transmitted data (positive) when no error occurs.
- **RECORD**: Target area of the read diagnosis data. The value must be 9 bytes. Otherwise, an error is reported during invocation. The 9 bytes are defined as follows:
  Bytes 0–2: 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 MD-SI-DP1 expansion card and AC drive is interrupted, 0x34 is returned.

8.8 Fault Diagnosis

8.8.1 Troubleshooting

The following table describes the faults that may occur during use of the MD-SI-DP1 expansion card and the AC drive.

Symptom	Solution
After the AC drive is powered on, only the power indicator (D4) is on, indicating that communication between the MD-SI-DP1 expansion card and the AC drive is not established.	1. Check that F0-28 is set to 1.
	2. Check the AC drive type. This user guide only describes the usage of MD520. For other AC drive models, contact the technical engineers to obtain the correct user guide.
	3. Check whether the AC drive software version supports the MD-SI-DP1 card.
After the AC drive is powered on, the power indicator (D4) is on and the indicator of communication with the AC drive (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.

Symptom		Solution
The connection fails after the configuration is downloaded.	After the configuration is downloaded, indicators D2 and D4 are steady on while the yellow indicator D3 is off on the MD-SI-DP1 expansion card.	1. Check that the cable is properly connected.
		2. Check the DIP switches on the PROFIBUS DP interfaces. The DIP switches on the PROFIBUS DP interfaces at both ends of the network must be set to ON, and the DIP switches on other PROFIBUS DP interfaces must be set to OFF.
		3. If the AC drive is connected at the end, check that the communication cable is connected through IN of the PROFIBUS DP interface. (If the communication cable is connected through OUT, it cannot be connected to the network when the PROFIBUS DP interface is set to ON.)
		4. Check that the station number settings on the MD-SI-DP1 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 are steady on while the yellow indicator D3 blinks slowly at the frequency of about 1 Hz to 2 Hz on the MD-SI-DP1 expansion card.	1. Check that the GSD file used is correct.
		2. Check that the PZD mapping is set correctly. Device-specific parameters in STEP 7 and PORTAL must be set in decimal format. Therefore, you need to convert the parameter numbers into decimal values when setting device-specific parameters. For example, the decimal value of FC-11 is 64523 (0xFC0B in hexadecimal format). If a parameter number that the AC drive does not support is entered, the connection fails. Note that PZD mapping does not support Modbus addresses such as H2000 and H8000.
	After the configuration is downloaded, the yellow indicator D3 on the MD-SI-DP1 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).

Symptom		Solution
After the connection is successful, all indicators on the PLC are 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. No matter whether the PPO type used contains the PKW area, the address for the read and write operations is located in the second row (also the last row). For example, 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 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 the SFC15 block is **0**. If not, an invocation error exists. Eliminate this error first and invoke the block again. For details, see section "8.7.4 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 that F0-02 is set to 2 and F0-03 is set to 9. 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 is set to U3-17 and FE-01 is set to U3-16. 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 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 ERR164, which cannot be cleared. However, the indicators on the MD-SI-DP1 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 that this solution applies to MD520 only. For other AC drives, consult the technical personnel.

Symptom	Solution
After communication is established, the communication is normal when the AC drive is not running. However, when one or more AC drives are running, the AC drive is disconnected randomly.	1. Disconnect the power supply, and measure the resistance between A1 and B1 of the PROFIBUS DP slave interface at the farthest end with a multimeter. The resistance should be 100±20 Ω.
	2. Check that the shield layers of cables are connected together and the shield layers are in contact with the sheet metal in the PROFIBUS DP interface. The shield layers are not required to connect with other GND.
After the connection is established, if the AC drive reports a fault, the faulty slave cannot connect to the network when the PLC configuration is changed and downloaded or when only the AC drive is powered on again.	MD-SI-DP1 only supports the interruption mode DPV0. If the interruption mode is set to DPV1, when a slave is faulty, the PLC master may close the PROFIBUS DP connection channel of the slave or interrupt all the PLC communication (which usually occurs on S7-1200). When such a symptom occurs, change the PROFIBUS 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 and Troubleshooting

Table 8–2

Indicator※	Status	Symptom	Solution
Red (D4)	OFF	The MD-SI-DP1 expansion card is not powered on.	Check that connection between the MD-SI-DP1 expansion card and the AC drive is secure.
Green (D2)	OFF	The connection between the MD-SI-DP1 expansion card and the AC drive fails.	Check that F0-28 is set to 1 and the connection between the MD-SI-DP1 expansion card and the AC drive is secure.
Green (D2)	Blinking at 1 Hz	The connection between the MD-SI-DP1 expansion card and the AC drive fails.	Check that the PROFIBUS DP station number is within the range of 1 to 125.
Yellow (D3)	Blinking at 1 Hz	A configuration error occurs.	Check that the GSD file is correct.
Yellow (D3)	Blinking at 2 Hz	A parameter error occurs.	Check that all parameter addresses in **Device-specific parameters** are supported by the AC drive.

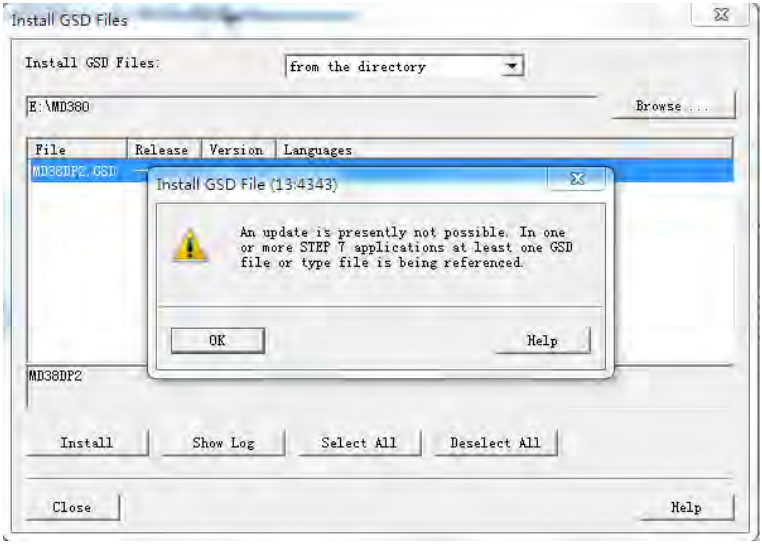
Indicator※	Status	Symptom	Solution
Yellow (D3)	Blinking at 5 Hz	The master is not running.	Check the master state.
Yellow (D3)	OFF	The connection between the MD-SI-DP1 expansion card and the PROFIBUS master fails.	Check that the slave address is correct and the PROFIBUS cable is connected properly.

Note

Note※: For some products, the indicator color and the terminal symbol may not match. In this case, the terminal symbol prevails. The indicators are D2, D3, and D4 from left to right. See *" " on page* .

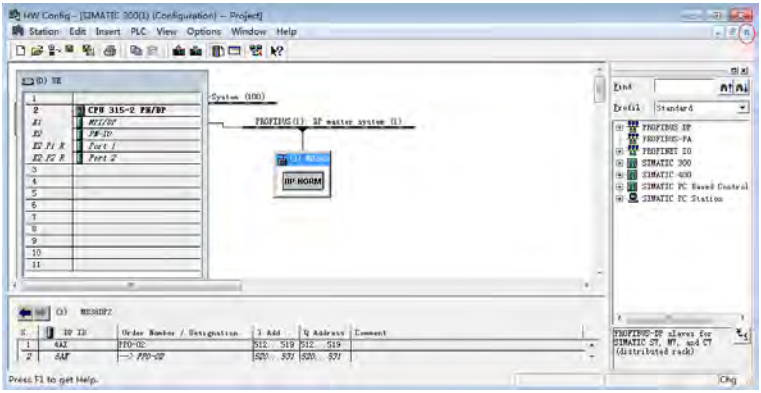
Troubleshooting for GSD Installation Failure

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

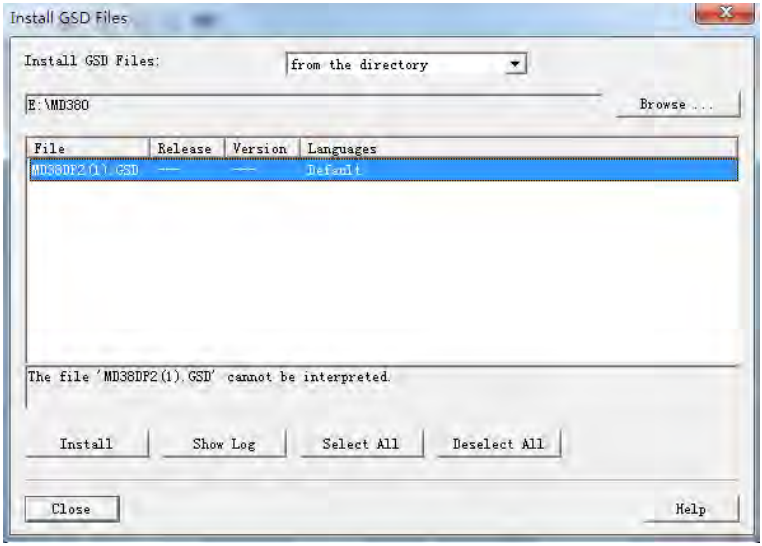


Possible cause: The current hardware configuration has been opened and the GSD file is being used by other components.

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



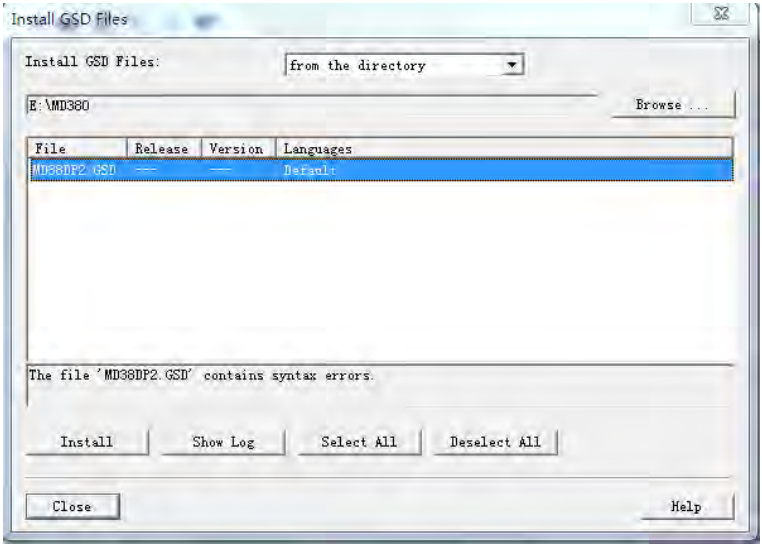
- Symptom 2: The file cannot be interpreted.



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**.

- Symptom 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 for installing the GSD file. In this case, store the GSD file in a path that does not contain Chinese characters.

9 EtherNet/IP Communication

9.1 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 on an MD series AC drive to improve the communication efficiency and facilitate implementation of the AC drive networking function, enabling the AC drive to be a slave controlled by the fieldbus master.

This user guide is applicable to the MD500-EN1 card with software of version 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 powered on). The corresponding EDS file is **MD500P_EIP_V1.00.eds**.

9.2 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 for about 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 the pulling force of the external signal cable. *"Figure 9–1 " on page 227* shows the installation.

After installing the MD500-EN1 card on the AC drive, connect the ground terminals of the MD500-EN1 card and the AC drive properly, as shown in *"Figure 9–2 Connecting ground terminals of the MD500-EN1 card and AC drive" on page 228*.

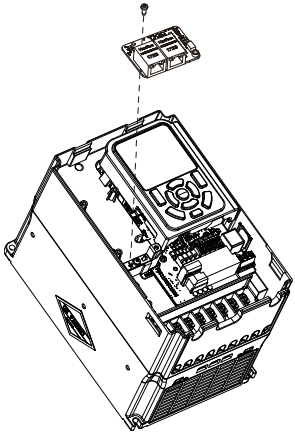


Figure 9-1 Installation of MD500-EN1

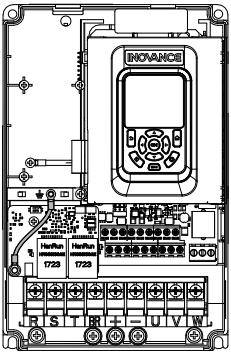


Figure 9-2 Connecting ground terminals of the MD500-EN1 card and AC drive

9.3 Interface Layout and Description

"Table 9–1 " on page 229 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 AC drive. The MD500-EN1 card provides two network ports (J4 and J6) for communication with the EtherNet/IP master (or other slaves). For details about the hardware, see *"Table 9–1 " on page 229*.

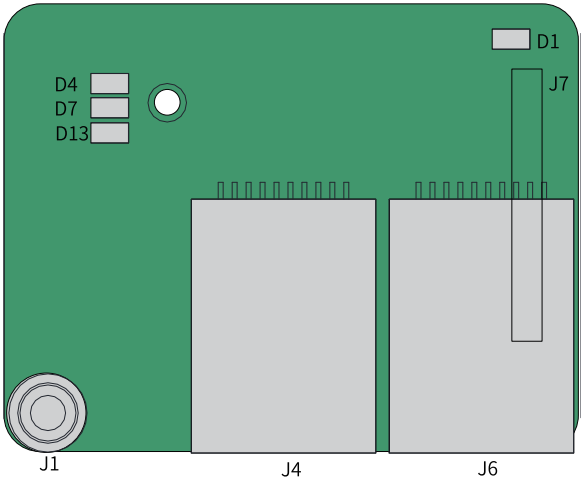


Figure 9-3 Interface layout of the MD500-EN1 card

Table 9–1 Hardware description of the MD500-EN1 card

Symbol	Hardware Name	Function
J7	Pin header	It connects to the AC drive.
J4	Network ports	The MD500-EN1 card is connected to the EtherNet/IP master using the standard Ethernet RJ45 socket (direction-insensitive). The pin signal definitions are the same as those of the standard Ethernet pins. They support both cross-connected lines or direct-connected lines.
J6		
J1	EMC ground terminal	It connects to the EMC ground terminal of the AC drive.
D13	Power indicator (green)	It indicates the power status. ON indicates normal. OFF indicates abnormal, and you need to check whether the installation is correct.
D1	Status indicator of communication with the AC drive (green)	For details, see *"Table 9–2 Indicators of the MD500-EN1 card" on page 229*
D4	Ethernet/IP RUN indicator (green)	
D7	Ethernet/IP fault indicator (red)	

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 9–2 Indicators of the MD500-EN1 card

Indicator	State Description	Solution
D1 steady green	Normal	N/A
D1 is steady off.	Abnormal communication with the AC drive	Check whether FD-00 is set to 9 and FD-01 is set to 3.
D4 is steady off, and D7 is steady red.	Faulty	See the following AC drive fault codes and troubleshooting.

Indicator	State Description	Solution
D4 is steady off, and D7 is blinking red.	Waiting for obtaining IP address	The expansion card is in DHCP mode. Assign an IP address to the device by using BOOTP or DHCP.
D4 is blinking green, and D7 is blinking red.	Connection disconnected or timed out	Check whether the network cable is disconnected and whether the master is running.
D4 is blinking green, and D7 is steady off.	Waiting for connecting to the master	Check whether the network cable is properly connected and whether the master is running.
D4 is steady green, and D7 is steady off.	Normal	N/A

9.4 Topology

EtherNet/IP supports a variety of topologies, including bus, star, and tree topologies. Diversified networking modes can be implemented by using switches.

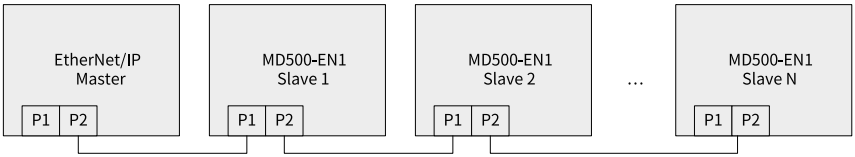


Figure 9-4 Bus topology

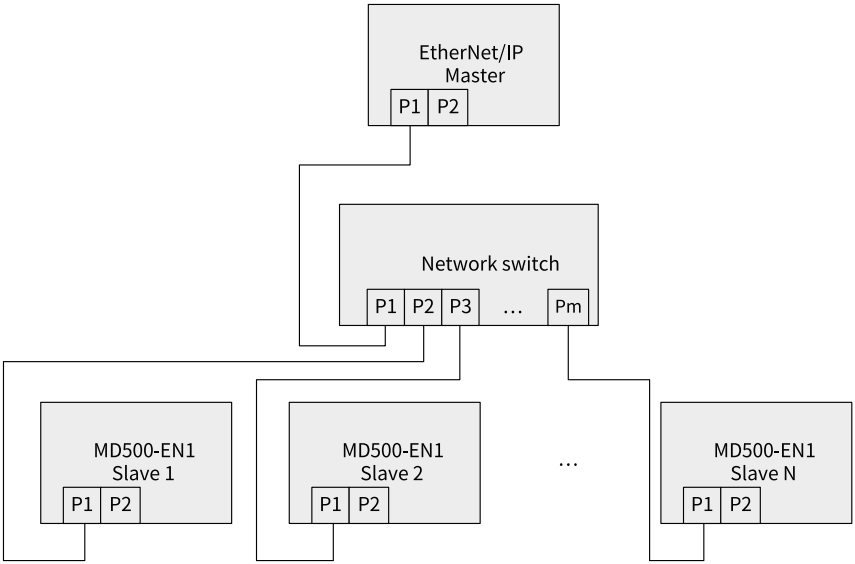


Figure 9-5 Star topology

9.5 Protocol Description

9.5.1 I/O Messages

The MD500-EN1 expansion card supports 24 I/O messages for data transmission, of which 12 are master-to-slave messages and 12 are slave-to-master messages.

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:

- Setting the AC drive control command and target frequency in real time
- Reading the current state and running frequency of the AC drive in real time
- Exchanging function parameter and monitoring parameter data between the AC drive and EtherNet/IP master in real time
  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	AC Drive Parameters Modified in Real Time
Output I/O Messages[0]	Output I/O Messages[1]	Output I/O Messages[2–11]
I/O Messages (T->T) Returned by AC Drive		

AC Drive State	AC Drive Running Frequency	AC Drive Parameters Read in Real Time
Input I/O Messages[0]	Input I/O Messages[1]	Input I/O Messages[2–11]

9.5.2 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	AC drive target frequency (frequency reference 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 reference 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) modified in real time, not written into 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.	

9.5.3 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	AC drive running state, which is described as follows by bit: Bit0: 0: Stopped; 1: Running Bit1: 0: Running in forward direction; 1: Running in reverse direction Bit2: 0: Not faulty; 1: Faulty Bit3: 0: Running frequency not reached; 1: Running frequency reached Bit4 to Bit7: Reserved Bit8 to bit15: AC drive fault code
I/O Messages 1	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) 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.

9.6 Related Parameters

9.6.1 AC Drive Communication Card Type Setting

After powering on the AC drive, the MD500-EN1 card can communicate with the AC drive properly only after F0-28 is set to 1.

Parameter	Parameter Name	Value Range	Setpoint	Description
F0-28	Serial communication protocol	0: Modbus protocol 1: Communication card network bridge protocol	1	Select the special communication card network bridge protocol as the serial communication protocol.
F0-02	Command source	0: Operating panel 1: Terminal 2: Communication	2	Set the command source to communication.
F0-03	Main frequency reference source	0: Digital setting (non-retentive at power failure) 1: Digital setting (retentive at power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	9	Set the target frequency through communication.

9.6.2 MD500-EN1 Card IP Address Configuration

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

Parameter No.	Parameter Name	Value Range	Description
FD-37	DHCP function	0: Disabled 1: Enabled	Defines 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	Defines the IP address of the EtherNet/IP expansion card.
FD-42 to FD-45	Expansion card subnet mask	0–255	Defines the subnet mask of the EtherNet/IP expansion card.
FD-46 to FD-49	Expansion card gateway address	0–255	Defines the gateway address of the EtherNet/IP expansion card.

The IP address can be a static IP address or DHCP dynamic IP address. The IP mode is defined by FD-37. The static IP address is set by FD-37 to FD-39. For example, if the static IP address is 192.168.0.6, the subnet mask is 255.255.255.0, and the gateway is 192.168.0.1, set as follows:

Parameter	Function	Setpoint
FD-37	DHCP function	0
FD-38	Most significant byte of the IP address	192
FD-39	Second most significant byte of the IP address	168
FD-40	Third byte of the IP address	0
FD-41	Least significant byte of the IP address	6
FD-42	Most significant byte of the subnet mask	255
FD-43	Second most significant byte of the subnet mask	255
FD-44	Third byte of the subnet mask	255
FD-45	Least significant byte of the subnet mask	0

Parameter	Function	Setpoint
FD-46	Most significant byte of the gateway	192
FD-47	Second most significant byte of the gateway	168
FD-48	Third byte of the gateway	0
FD-49	Least significant byte of the gateway	1

When the DHCP or BOOTP function is used, the MAC address of the expansion card is required. You can obtain the MAC address by checking the label on the expansion card, or viewing the related parameter of the AC drive.

The MD500-EN1 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 bit2 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 powered on first keeps the IP address and continues to run, and the other device enters conflict mode.	Check device IP addresses and change duplicate addresses.
2	Both devices support IP address conflict detection. The two devices are powered on at almost the same time.	Both devices enter IP address conflict mode.	
3	One device supports IP address conflict detection while the other does not.	The device that does not support IP address conflict detection occupies the IP address no matter whether it is powered on first. The device that supports IP address conflict detection enters conflict mode.	

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.

9.6.3 Parameters Related to AC Drive Communication Card

Parameter No.	Parameter Name	Unit	Description
FD-61	First two bytes of the expansion card MAC address	1	MAC address of the expansion card
FD-62	Middle two bytes of the expansion card MAC address	1	MAC address of the expansion card
FD-63	Last two bytes of the expansion card MAC address	1	MAC address of the expansion card
FD-58	Expansion card error code	1	Error code of the expansion card

9.6.4 Communication Control Parameters

Parameter No.	Parameter Name	Value Range		Decimal Address
U3-16	Frequency reference	–Maximum frequency to +Maximum frequency 0.01 Hz		29456
U3-17	Control command	0000: Stop according to the stop mode defined by F6-10 0001: Run in forward direction 0002: Run in reverse direction 0003: Jog in forward direction	0004: Jog in reverse direction 0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	29457

Parameter No.	Parameter Name	Value Range	Decimal Address
U3-18	DO control	Bit0: DO1 output control Bit1: DO2 output control Bit2: Relay 1 output control Bit3: Relay 2 output control	29458
U3-19	AO1 control	0 to 7FFF, indicating 0% to 100%	29459
U3-20	AO2 control	0 to 7FFF, indicating 0% to 100%	29460
U3-21	FMP control	0 to 7FFF, indicating 0% to 100%	29461
U3-22	Reserved	Reserved	
U3-23	Speed control	Signed data, 1 RPM	29463

When the MD500-EN1 expansion card is used, the written I/O Messages 0 and I/O Messages 1 are mapped to U3-17 and U3-16 respectively by default. If a command or frequency fails to be written into the AC drive but I/O Messages 2 to I/O Messages 11 can be written and F0-02 and F0-03 are set to 2 and 9 respectively, check whether FE-00 and FE-01 are set to U3-17 and U3-16 respectively. If not, manually correct the values of FE-00 and FE-01.

9.6.5 Communication Monitoring Parameters

Table 9–3 Communication monitoring parameters

Parameter	Parameter Name	Unit	Decimal Address
U0-00	Running 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
U0-06	Output torque	0.1%	28678
U0-07	DI state	1	28679
U0-08	DO/RO 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	1	28686
U0-15	PID reference	1	28687
U0-16	PID feedback	1	28688
U0-17	PLC stage	1	28689

Parameter	Parameter Name	Unit	Decimal Address
U0-18	Pulse input frequency	0.01 kHz	28690
U0-19	Feedback speed	0.01 Hz	28691
U0-20	Remaining running duration	0.1 min	28692
U0-21	AI1 voltage before correction	0.001 V	28693
U0-22	AI2 voltage before correction	0.001 V	28694
U0-23	AI3 voltage before correction	0.001 V	28695
U0-24	Linear speed	1 m/min	28696
U0-25	Current power-on duration	1 min	28697
U0-26	Current running duration	0.1 min	28698
U0-27	Pulse input frequency	1 Hz	28699
U0-28	Communication reference	0.01%	28700
U0-29	Encoder feedback speed	0.01 Hz	28701
U0-30	Main frequency X	0.01 Hz	28702
U0-31	Auxiliary frequency Y	0.01 Hz	28703
U0-32	Any memory address	1	28704
U0-33	Synchronous motor rotor position	0.1°	28705
U0-34	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	V/f separation target voltage	1 V	28711
U0-40	V/f separation output voltage	1 V	28712
U0-41	DI state display	1	28713
U0-42	DO state display	1	28714
U0-43	DI state display 1	1	28715
U0-44	DI state display 2	1	28716
U0-45	Fault information	1	28717

Parameter	Parameter Name	Unit	Decimal Address
U0-58	Z signal counter	1	28730
U0-59	Frequency reference	0.01%	28731
U0-60	Running frequency	0.01%	28732
U0-61	AC drive state	1	28733
U0-62	Current fault code	1	28734
U0-63	Data sent by master during point-point communication	0.01%	28735
U0-64	Data sent by slave during point-point communication	0.01%	28736
U0-65	Torque upper limit	0.1%	28737
U0-66	Expansion card model	100: CANopen 200: PROFIBUS DP 400: PROFINET 500: EtherCAT 600: EtherNet/IP	28738
U0-67	Expansion card version	0.01	28739
U0-68	AC drive state	1	28740
U0-69	Running frequency	0.01 Hz	28741
U0-70	Motor speed	1 RMP	28742
U0-71	Output current	0.1 A	28743
U0-80	Name of EtherCAT slave	1	28752
U0-81	Alias of EtherCAT slave	1	28753
U0-82	EtherCAT ESM transmission error code	1	28754
U0-83	EtherCAT XML file version	0.01	28755
U0-84	EtherCAT synchronization loss count	1	28756
U0-85	Maximum errors and invalid frames of EtherCAT port 0 per unit time	1	28757
U0-86	Maximum errors and invalid frames of EtherCAT port 1 per unit time	1	28758

Parameter	Parameter Name	Unit	Decimal Address
U0-87	Maximum forwarding errors of EtherCAT port per unit time	1	28759
U0-88	Maximum error count of EtherCAT data frame processing unit per unit time	1	28760
U0-89	Maximum link loss of the EtherCAT port per unit time	1	28761

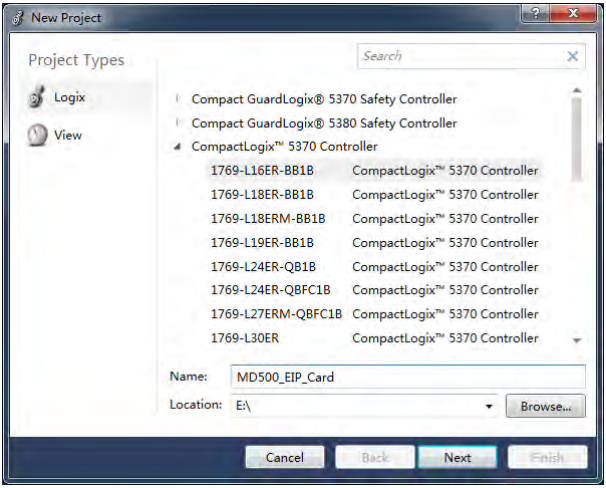
9.7 Communication Configurations

9.7.1 Using an MD500-EN1 Expansion Card on an Allen-Bradley L16ER Master

In this example, Studio5000 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 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.

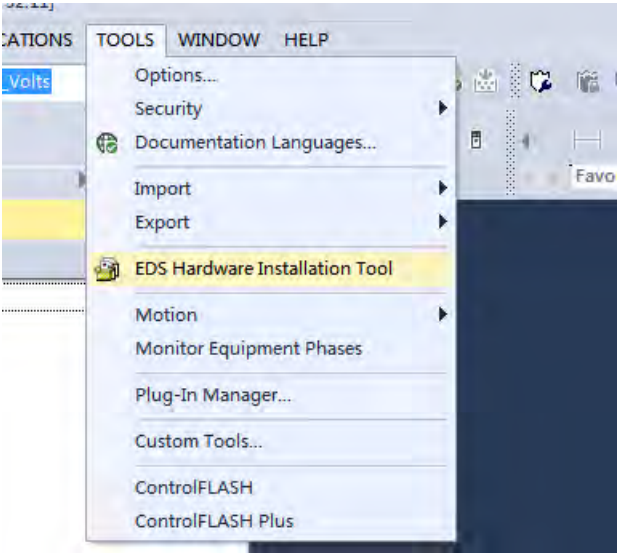
Step 1: Create a project.

Open Studio 5000 and create a project. Select **1769-L16ER-BB1B** under **CompactLogix 5370 Controller** as the controller model.

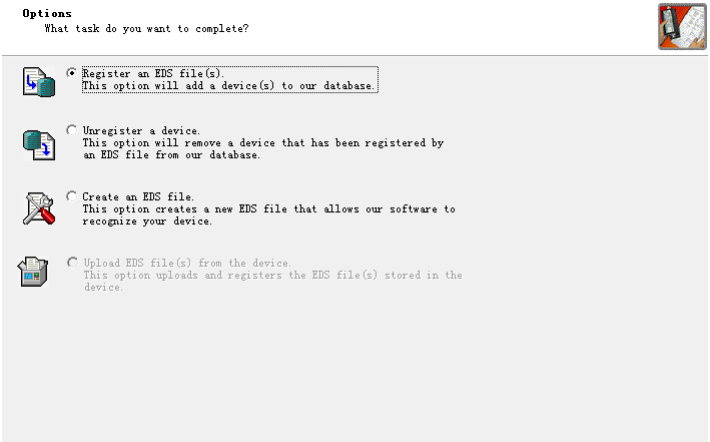


Step 2: Import the EDS file.

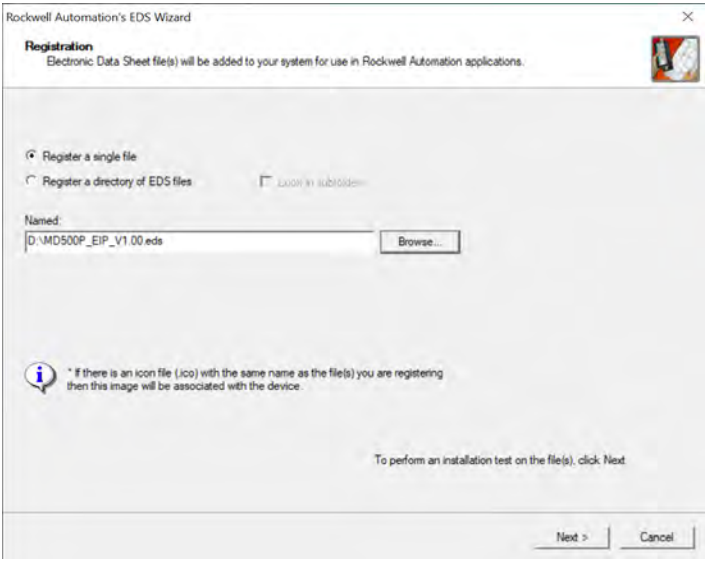
Choose **Tools** > **EDS Hardware Installation Tool**.



Click **Next**, and select **Register an EDS file(s)**.



Select the EDS file in your computer and click **Next**.



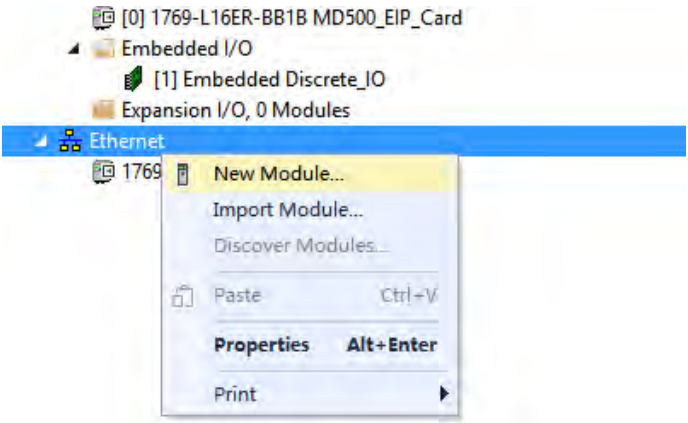
Then keep clicking **Next** until the **Finish** button appears, click **Finish**.

Step 3: Set the IP address for the expansion card. Take a static IP address as an example.

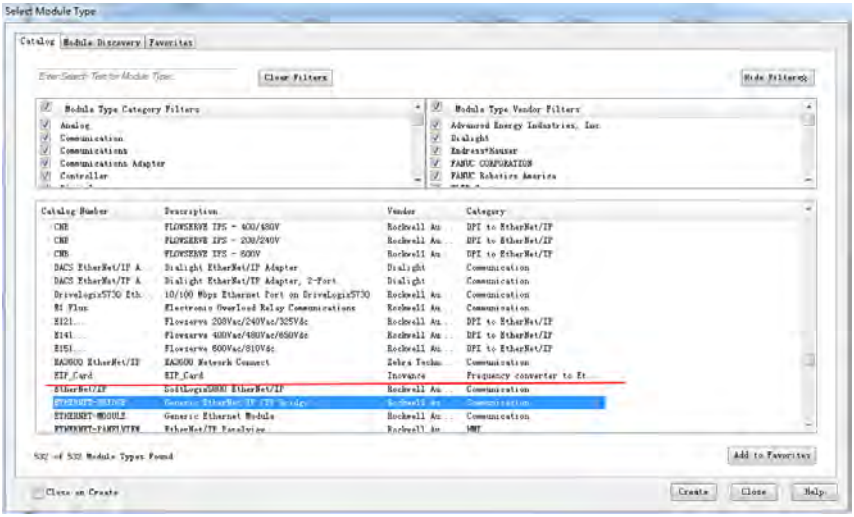
Set the AC drive parameters FD-37 to FD-49 to disable the DHCP function, set the IP address to 192.168.0.6, set the subnet mask to 255.255.255.0, and set the gateway address to 192.168.0.1.

Step 4: Configure the Studio 5000 project.

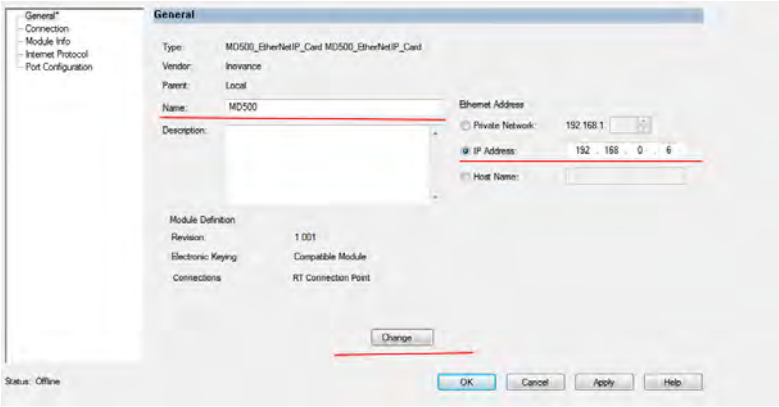
Click **Ethernet** on the left and choose **New Module**.



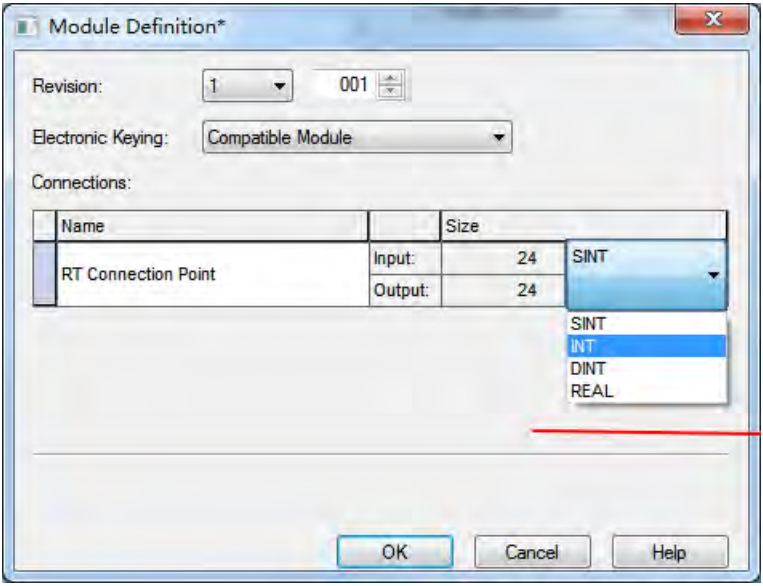
Locate **EIP_Card** and click **Create**.



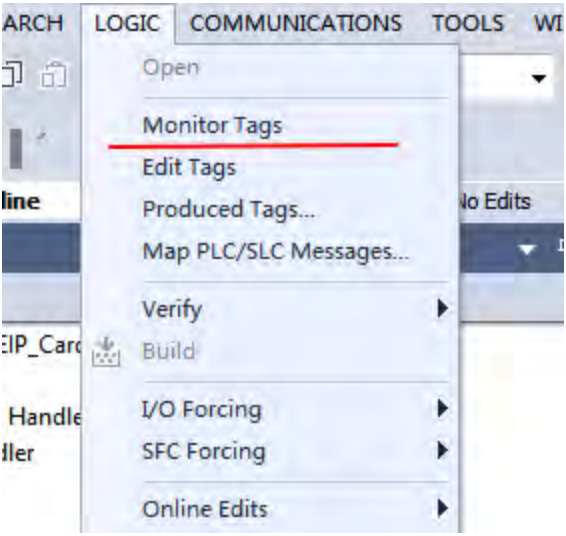
On the displayed configuration interface, enter the configured IP address and specify the name.



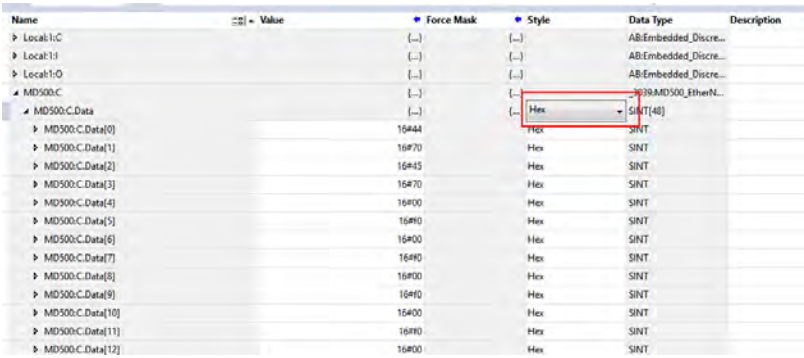
Click **Change**, select **INT** from the **SINT** drop-down list on the right, click **OK**, ignore the warning and click **Yes**.



Choose **LOGIC** > **Monitor Tags**.



Unfold **MD500:C.Data**, and select **Hex** in the **Style** column.

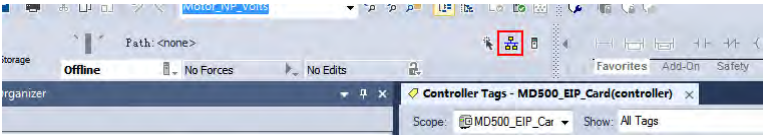


The parameters under **MD500:C.Data** are related to PDO mapping. Every two parameters form a group. 0–23 are I/O Messages Mapping(T->O), and 24–27 are I/O Messages Mapping(O->T). As shown in the figure, Data[0] is 0x44, and Data[1] is 0x70, indicating that TPDO1 is mapped to U0-68.

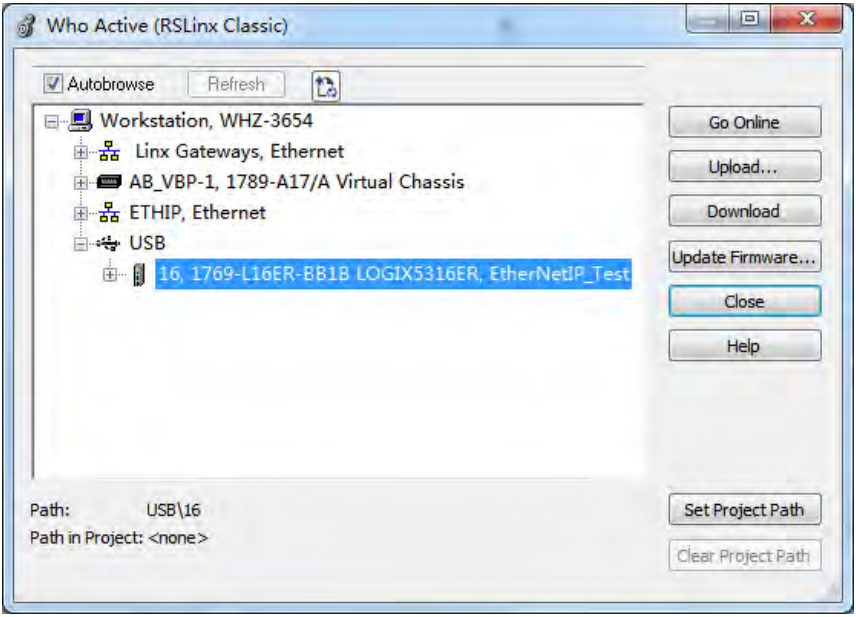
By default, I/O Messages Mapping(T->O)[0] is U0-68, I/O Messages Mapping(T->O)[1] is U0-69, I/O Messages Mapping(O->T)[0] is U3-17, and I/O Messages Mapping(O->T)[1] is U3-16. These four entries cannot be modified. Otherwise, a fault will occur. Other entries can be customized.

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.

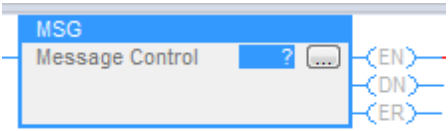


In this example, USB is used to connect the device. Select the device and click **Download** to download the code to the PLC.

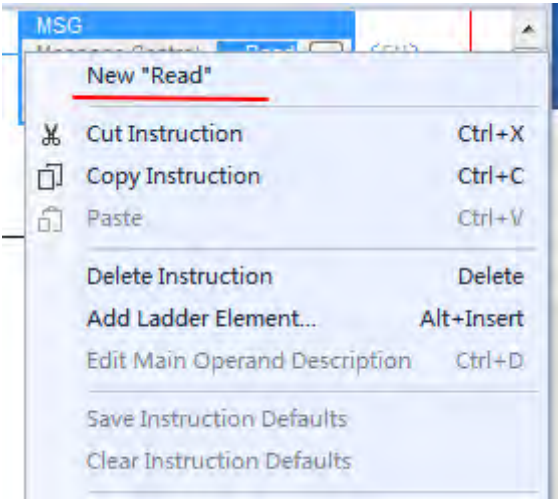


Step 5: Transmit data using explicit messages.

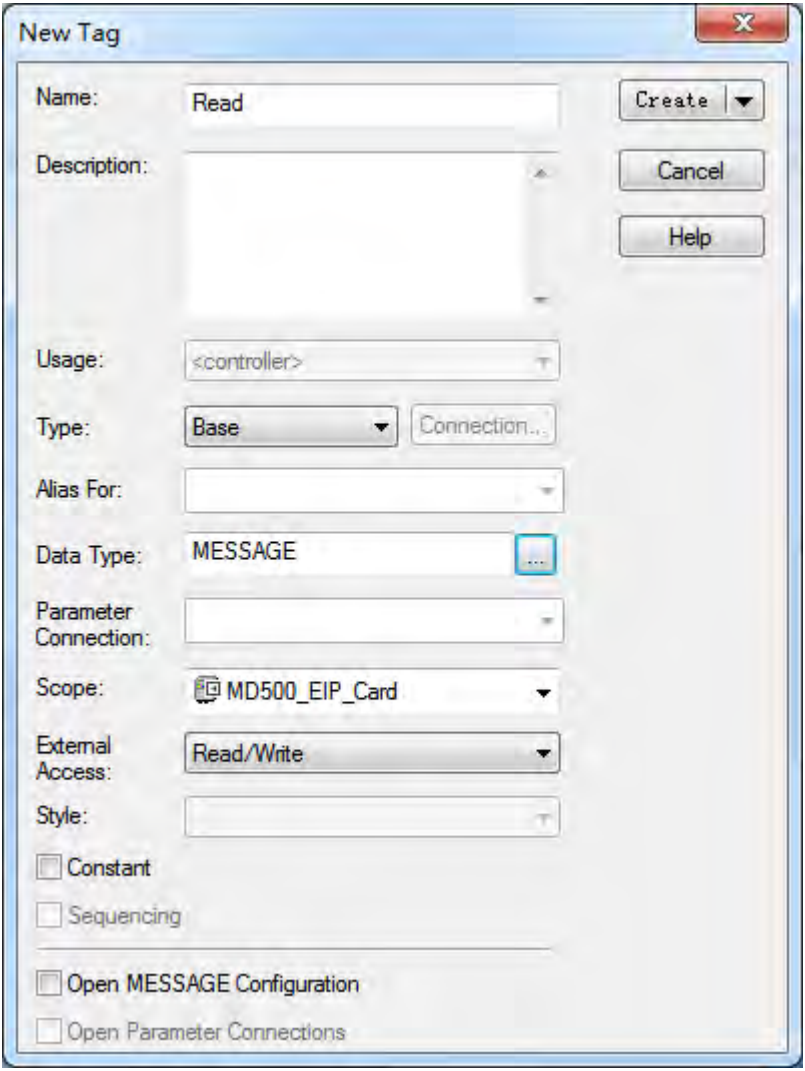
Open the program compiling part in the PLC, and click **MSG** under **Input/Output**.



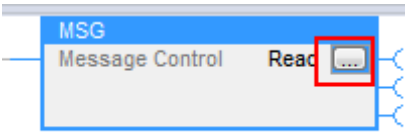
Enter a name at the question mark (?), right-click the name, and choose **New "Read"**.



Click **Create**.



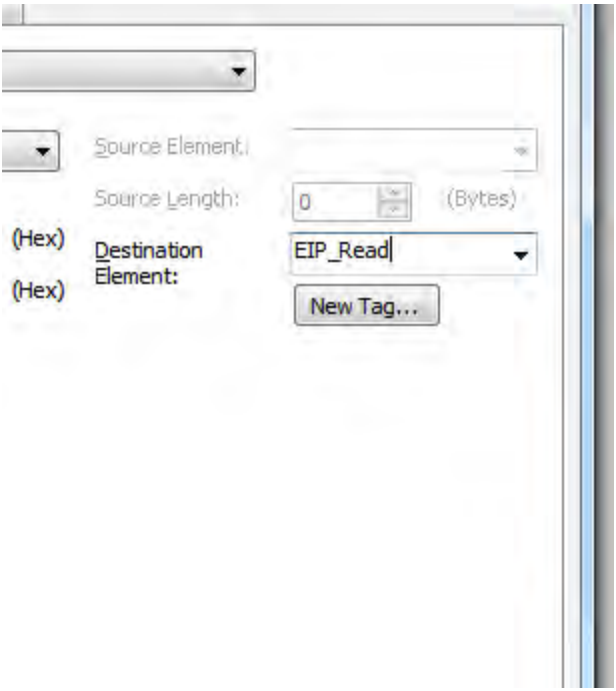
Click **...** on the right under **MSG**.



Set the parameters according to the following figure.

Set **Service Type** to **Get Attribute Single** for reading parameters or **Set Attribute Single** for writing to 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.

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.

To write to a parameter, set the parameters according to the following figure.

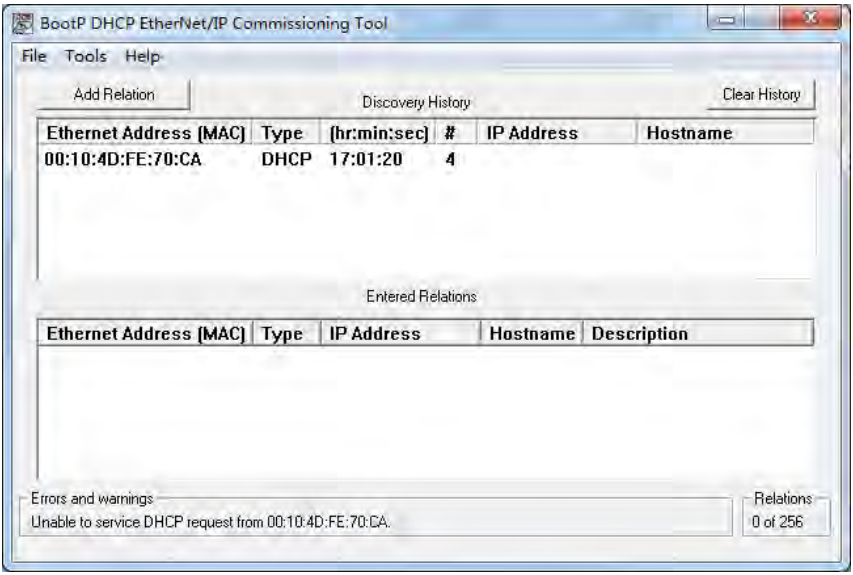
Step 6: Set the DHCP function.

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.

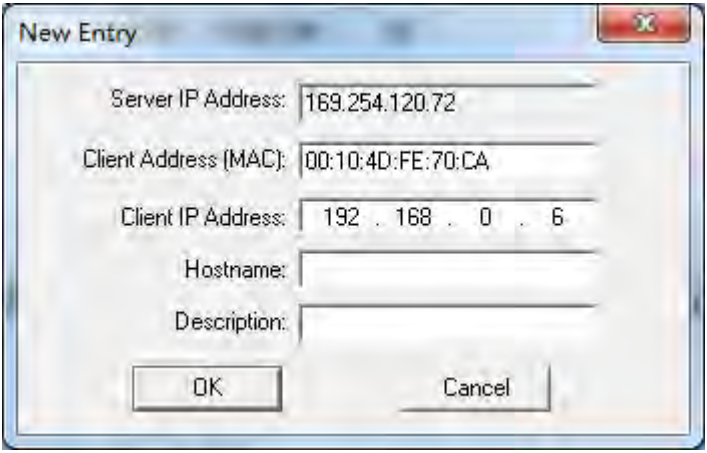
Choose **BootP-DHCP Tool** from the start menu, and select the network adapter.

After power-on, you can find the device request in the BootP DHCP EtherNet/IP Commissioning Tool.

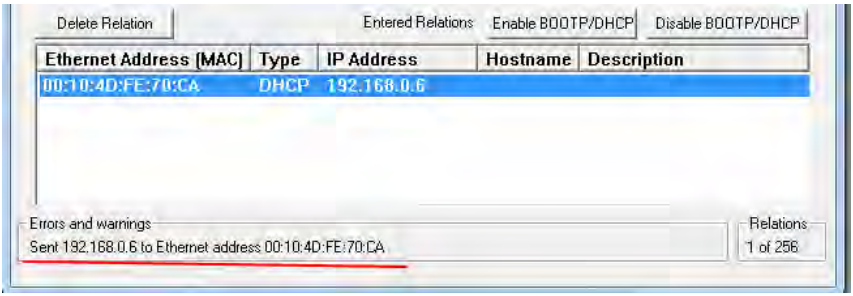


Right-click the request and choose **Add Relation**.

Set the IP address and click **OK**.

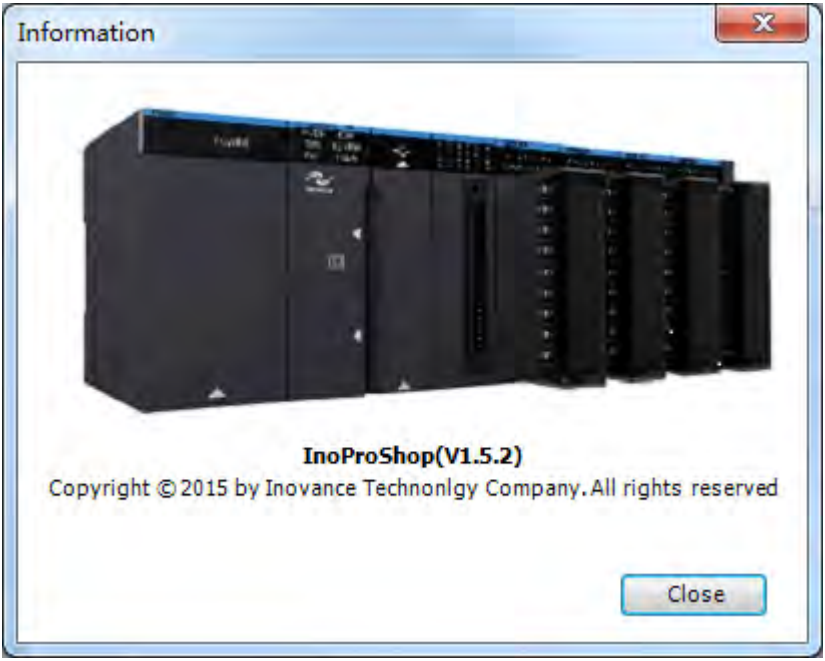


The IP address is written to the device.



9.7.2 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 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.

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.

9.8 Fault Diagnosis

9.8.1 Troubleshooting

The following table describes the faults that may occur during use of the MD500-EN1 card and the AC drive.

Table 9–4 Fault analysis and solutions

Symptom	Possible Cause	Solution
Communication failure between the MD500-EN1 card and AC drive	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 that the AC drive supports EtherNet/IP communication. 2. Set the MD500-EN1 communication parameters correctly. 3. Replace the MD500-EN1 card.
Err164 communication error reported by the AC drive during running	1. The communication data is abnormal. 2. The network cable is damaged or connected incorrectly. 3. External interference exists.	1. Check that the EtherNet/IP master program is normal. 2. Check that the network cable is connected properly, and replace the cable if necessary. 3. Use the Cat5e shielded twisted pair network 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 into 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 corresponding fault description and troubleshooting.

Note: A fault code may be a combination of multiple faults.

Fault Code	Description	Solution
Bit7	None	None
Bit6	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.
Bit5	The I/O Messages mapping configuration is incorrect.	Check the PLC configurations.
Bit4	Connection times out.	Check the connections and whether the master is running properly.
Bit3	Link loss occurs.	Check the wiring.
Bit2	An IP conflict occurs.	Check whether there is another device with the same IP address as this device.
Bit1	The MAC address is lost or not programed.	Contact Inovance for technical support.
Bit0	An Ethernet hardware error occurs.	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 bit6.

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