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MD520 Series General-Purpose AC Drive

Manual Package

Industrial Automation | Intelligent Elevator | New Energy Vehicle | Industrial Robot | Rail Transit

Data code PS00012134B01

Preface

Introduction

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

This guide describes product selection, mechanical design, electrical design, installation, communication, commissioning, function application, troubleshooting, and compliant certifications and standards. For complete information on parameters and fault codes, see *MD520 Series General-Purpose AC Drive Parameter Guide.*

More Data

Data Name	Data Code	Description
MD520 Series General-Purpose AC Drive User Guide	PS00012134	This guide describes product selection, mechanical design, electrical design, installation, communication, commissioning, function application, troubleshooting, and standards.
MD520 Series General-Purpose AC Drive Manual Package	19012397	This guide describes parameters and fault codes.
MD520 Series General-Purpose AC Drive Quick Installation and Commissioning Guide	19011712	This guide describes the installation, wiring, commissioning, troubleshooting, and others.
MD520 Series General-Purpose AC Drive Hardware Guide	19011713	This guide describes the system composition, technical specifications, components, dimensions, options (including installation accessories, cables, and peripheral electrical components), expansion cards, routine inspection and maintenance, certifications, and standards of the AC drive.
MD520 Series General-Purpose AC Drive Installation Guide	19011714	This guide describes the installation dimensions, space design, specific installation steps, wiring requirements, routing requirements, option installation requirements, and common EMC troubleshooting suggestions.
MD520 Series General-Purpose AC Drive Commissioning Guide	19011715	This guide describes commissioning tools, commissioning flowchart, detailed commissioning steps, and troubleshooting.
MD520 Series General-Purpose AC Drive Communication Guide	19011716	This guide describes the communication mode, communication networking, and communication configuration of the product.
MD520 Series General-Purpose AC Drive Function Guide	19011717	This guide describes function applications, and troubleshooting of the product.
MD520 Series General-Purpose AC Drive Safety Function Guide	19011795	This guide describes the safety information, instructions for mechanical and electrical installation, commissioning and maintenance guidance, and safety-related parameters of the AC drive.

Revision History

Date	Document Version	Software Version	Revision
September 2024	B01	Version: A13 Version tag: F7-10=U60.07/ F7-11=U61.11/F7-15= 000.00/F7-16=000.00	**Modified the following content:** • Updated *"6.2 Technical Specifications" on page 155*. • Updated *"7.2.1 Installation Environment" on page 162*. • Updated *"21.1 Protocol Description" on page 414*. • Updated *"29.8 Monitoring" on page 823*. • Updated *"30.6.3 Logic Operation" on page 861*. • Made minor corrections.

Date	Document Version	Software Version	Revision
August 2024	B00	Version: A13 Version tag: F7-10=U60.07/ F7-11=U61.11/F7-15= 000.00/F7-16=000.00	**Modified the following content:** • Updated *"3.1 System Connection" on page 39*. • Updated *"3.2 Electrical Connection" on page 40*. • Updated *"3.4 Descriptions of Control Circuit Terminals" on page 45*. • Updated *"5.1 List of Options" on page 56*. • Updated *"5.3.1 Main Circuit Cables" on page 76*. • Updated *"6.1 Electrical Specifications" on page 142*. • Updated *"6.2 Technical Specifications" on page 155*. • Updated *"7.3.2 Tools for Wiring" on page 171*. • Updated *"9.2.4 Cabinet Heat Dissipation" on page 208*. • Updated *"10.3 Heat Dissipation Design" on page 224*. • Updated *"13.4.2 Wiring Descriptions of Control Circuit Terminals" on page 278*. • Updated *"16.1.1 Basic Commissioning Flowchart" on page 324*. • Updated *"16.1.2 Commissioning Flowchart in V/f Control Mode" on page 325*. • Updated *"16.1.3 Commissioning Flowchart in SVC Mode" on page 326*. • Updated *"16.1.4 Commissioning Flowchart in FVC Mode" on page 327*. • Updated *"16.2.1 Check Before Power-on" on page 328*. • Updated *"17.2 Parameter Communication Addresses" on page 374*. • Updated *"19.4 Communication Data Frame Structure" on page 386*. • Updated *"22.1 Protocol Description" on page 434*. • Updated *"26.7.1 Configuring Slaves on the STEP7 (V5.4) by Using S7-300" on page 537*. • Updated *"26.8 Troubleshooting" on page 552*. • Updated *"29.1.1.4 Setting Operation Commands through Communication" on page 626*. • Updated *"29.1.2.2 Selecting Source for Main Frequency Reference" on page 630*. • Updated *"29.1.2.4 Setting Main Frequency Through AI" on page 632*. • Updated *"29.1.2.5 Setting Main Frequency Through Multi-reference" on page 635*. • Updated *"29.1.2.7 Setting Main Frequency Through PID" on page 641*. • Updated *"29.1.3.1 Start Mode" on page 659*. • Updated *" Motor Configuration" on page 666*. • Updated *"29.2.1 Asynchronous motor parameter auto-tuning" on page 672*. • Updated *"29.2.2 Asynchronous motor parameter auto-tuning" on page 676*.

Date	Document Version	Software Version	Revision
Continued	Continued	Continued	**Modified the following content:** • Updated *"29.3.1 Digital Input Terminal (DI) Functions" on page 681*. • Updated *"29.3.3 Virtual Digital Input Terminal (VDI) Functions" on page 699*. • Updated *"29.4.4 Speed Loop" on page 736*. • Updated *"29.4.9 Torque Control" on page 752*. • Updated *"29.6.2 Undervoltage Threshold, Overvoltage Threshold, and Pulse-by-Pulse Current Limit Protection" on page 789*. • Updated *"29.6.7 Overspeed Protection" on page 796*. • Updated *"29.6.8 Protection Against Excessive Speed Deviation" on page 796*. • Updated *"29.6.9 Motor Stall Protection" on page 797*. • Updated *"29.6.13 Automatic Reset Upon Fault" on page 801*. • Updated *"30.4 Simple PLC Function" on page 839*. • Updated *"34.1.3 Common Troubleshooting" on page 919*. • Updated *"36.2 Object Dictionary Descriptions" on page 931*. • Updated parameters. • Made minor corrections. • Deleted the PMVVC function. **Added the following content:** • Added *"28.5 Device Level Ring Protocol" on page 593*.
February 2024	A02	Version: A12 Version tag: F7-10=U60.07/ F7-11=U61.10/F7-15= 000.00/F7-16=000.00	**Deleted the following content:** • Deleted the parameter list in *" Parameter list" on page 899*, and referred to the parameter guide for details. • Deleted 33.2 List of Fault Codes and 33.3 List of Fault Attributes and referred to the parameter guide for details. Added *"34.2 List of Faults and Alarms" on page 922*. For complete information on parameters and fault codes, see *MD520 Series General-Purpose AC Drive Parameter Guide*.

Date	Document Version	Software Version	Revision
November 2023	A01	Version: A10 Version tag: F7-10=U60.07/ F7-11=U61.08/F7-15= 000.00/F7-16=000.00	**Modified the following content:** • Updated *"3.4 Descriptions of Control Circuit Terminals" on page 45*. • Updated *"4.1 Dimensions of T1 to T9 Models" on page 49*. • Updated *"4.2 Dimensions of T10 to T12 Models (Without AC Output Reactor)" on page 51*. • Updated *"4.3 Dimensions of T10 to T12 Models (with AC Output Reactor)" on page 52*. • Updated *"5.5 External operating panel" on page 139*. • Updated *"15.1 LED Operating Panel" on page 305*. • Updated *"15.8 Driving the Motor with the Operating Panel" on page 319*. • Updated *"17.2 Parameter Communication Addresses" on page 374*. • Updated *" List of Communication Protocols" on page 381*. • Updated *" Motor Configuration" on page 666*. • Updated *"29.3.6 Analog Input Terminal (AI) Functions" on page 708*. • Updated the section of CANopen Communication (MD38CAN1). • Updated Parameter List. • Updated 33.2 List of Fault Codes. • Updated parameters. • Made minor corrections. **Added the following content:** • Added *" Modbus TCP Communication (MD500-EM1)" on page 401*. • Added *" CANlink Communication (MD38CAN1)" on page 434*. • Added *" Brake Control" on page 884*. • Added *" Appendix 6000H Group Object Dictionary" on page 930*.
July 2023	A00	–	First issue

Access to the Guide

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

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

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

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

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For details, see Product Warranty Card.

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Fundamental Safety Instructions

Safety Precautions

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

Safety Levels and Definitions



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



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



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

General Safety Instructions

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

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



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

Storage and Transportation



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



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

Installation



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

WARNING

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

CAUTION

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

Wiring

DANGER

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

WARNING

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



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

Power-on



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



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

Operation



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



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

Maintenance



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



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

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

Safety Labels

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

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

Product Model List

The following table lists the mapping between product models and structures.

Table –1 Mapping between product models and structures

Structure	Product Model		
	Three-Phase 380 V to 480 V	Three-Phase 200 V to 240 V	Single-Phase 200 V to 240 V
T1	MD520-4T0.4B(S) MD520-4T0.7B(S) MD520-4T1.1B(S) MD520-4T1.5B(S) MD520-4T2.2B(S) MD520-4T3.0B(S)	MD520-2T0.4B(S) MD520-2T0.7B(S) MD520-2T1.1B(S) MD520-2T1.5B(S)	-
T2	MD520-4T3.7B(S) MD520-4T5.5B(S)	MD520-2T2.2B(S) MD520-2T3.7B(S)	MD520-2S0.4B(S) MD520-2S0.7B(S) MD520-2S1.5B(S) MD520-2S2.2B(S)
T3	MD520-4T7.5B(S) MD520-4T11B(S)	MD520-2T5.5B(S)	-
T4	MD520-4T15B(S)	MD520-2T7.5B(S)	-
T5	MD520-4T18.5(B)(S)(-T) MD520-4T22(B)(S)(-T)	MD520-2T11(B)(S)	-
T6	MD520-4T30(B)(S) MD520-4T37(B)(S)	MD520-2T15(B)(S) MD520-2T18.5(B)(S)	-
T7	MD520-4T45(B)(S) MD520-4T55(B)(S)	MD520-2T22(B)(S) MD520-2T30(B)(S)	-
T8	MD520-4T75(B)(S) MD520-4T90(S) MD520-4T110(S)	MD520-2T37(B)(S) MD520-2T45(S) MD520-2T55(S)	-
T9	MD520-4T132(S) MD520-4T160(S)	MD520-2T75(S)	-
T10	MD520-4T200(S)(-L) MD520-4T220(S)(-L)	MD520-2T90(S) MD520-2T110(S)	-
T11	MD520-4T250(S)(-L) MD520-4T280(S)(-L)	MD520-2T132(S)	-
T12	MD520-4T315(S)(-L) MD520-4T355(S)(-L) MD520-4T400(S)(-L)	MD520-2T160(S) MD520-2T200(S)	-

Structure	Product Model		
	Three-Phase 380 V to 480 V	Three-Phase 200 V to 240 V	Single-Phase 200 V to 240 V
T13 (without the auxiliary power distribution cabinet)	MD520-4T500 MD520-4T500(S) MD520-4T560 MD520-4T560(S) MD520-4T630 MD520-4T630(S)	-	-
T13 (with the auxiliary power distribution cabinet)	MD520-4T500-A MD520-4T500(S)-A MD520-4T560-A MD520-4T560(S)-A MD520-4T630-A MD520-4T630(S)-A	-	-

Note:

- (B): with the braking unit
- (S): with the safe torque off (STO) function
- (-T): with the DC reactor
- (-L): with the AC output reactor

1 Product Information

1.1 Product Positioning and Features

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



Figure 1-1 Product appearance

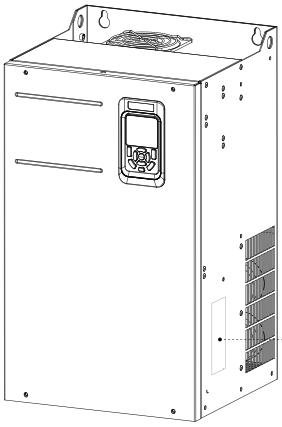
The AC drive has the following features:

- Various types of motors supported: The AC drive can drive asynchronous induction motors (IM), permanent magnet synchronous motors (PMSM), and synchronous reluctance motors (SynRM), facilitating energy saving and device upgrade.
- Performance improvement: The AC drive is fully upgraded with the maximum output of 150% at 0 Hz and an open-loop vector speed regulation range of 1:500, which facilitates high-quality and high-efficiency production.
- Rich functions: Featuring the STO, limp mode upon fault, position control, brake control, programming, and tension control functions, the AC drive is suitable for various applications.
- Flexible expansion: The AC drive supports five types of encoder expansion cards, seven types of communication cards, four types of I/O expansion cards, two types of positioning expansion cards, and programmable multi-function expansion cards, which makes the AC drive more flexible and easy to use.

1.2 Nameplate and Model

Note

The following nameplate is used as an example. The actual nameplate is subject to the product.



MODEL: MD520-4T22BS-T(a) Certification
INPUT: 3PH AC 380-480V 51.3A 50/60Hz
OUTPUT: 3PH AC 0-480V 45.0A 0-500Hz 22kW
S/N: 0101BS16YNA00002
Address: No. 16 YouxiangRoad, Yuexi Town, Wuzhong District, Suzhou 215104, P.R. China
Suzhou Inovance Technology Co., Ltd.

S/N:0101BS16YNA00002

Code	Year
N	2021
...	...
S	2024
*Letter I/L/O/Q are reserved.	

MD520 - 4T 22 B S -T (a)
① ② ③ ④ ⑤ ⑥ ⑦

① **Product name** MD520: AC drive series	⑤ **Safety function** Null: without the STO function S: with the STO function
② **Voltage class** 4T: three-phase 380 V to 480 V 2T: three-phase 200 V to 240 V 2S: single-phase 200 V to 240 V	⑥ **Reactor** Null: See the note below. -T: with the DC reactor; applicable to the T5 models -L: with the AC output reactor; applicable to the T10 to T12 models -A: with the auxiliary power distribution box; applicable to the T13 models
③ **Power rating** 0.4: 0.4 kW ... 630: 630 kW	⑦ **Model configuration** Null: no configuration
④ **Braking Unit** Null: without the braking unit B: with the braking unit	- -

Note

- For three-phase 380 V to 480 V drives, reactors are not available for T1 to T4 models, whereas DC reactors are optional for T5 models and standard for T6 models.
- For three-phase 380 V to 480 V drives, braking units are standard for T1 to T4 models and optional for T5 to T8 models; external braking units MDBUN are optional for T9 to T13 models.

2 Components

2.1 Overview

The AC drive is structured in either of the following types:

- Plastic structure for T1 to T6 models
- Sheet metal structure for T7 to T12 models

2.2 Components of T1 to T6 Models

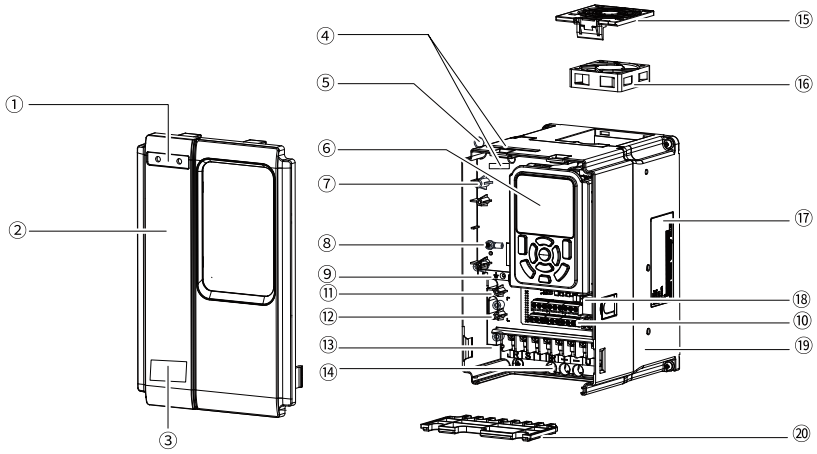


Figure 2-1 Components of T1 to T4 models

No.	Name	No.	Name	No.	Name
①	Logo	②	Cover	③	Mark Symbol / Description Note: Read through the user guide before installation and operation. Danger: Do not remove the upper cover with power ON or within 10 min after power-off.
④	Equipment bar code You can view the SN and model of the equipment.	⑤	Main circuit power supply indicator	⑥	Operating panel
⑦	Fixing base of the encoder expansion card	⑧	Trough and fixing base of the control board ground cable	⑨	Grounding sheet metal It is used to ground the PG card and control board.
⑩	Control circuit terminal	⑪	Fixing base of the expansion card	⑫	Grounding screws for safety capacitor and voltage dependent resistor
⑬	Main circuit terminal	⑭	Grounding terminal	⑮	Fan cover
⑯	Cooling fan	⑰	Nameplate	⑱	External operating panel interface
⑲	Enclosure	⑳	Comb-type wiring cover	-	-

Note

- The actual position of the equipment bar code may vary with models.
- Connect the control board ground cable to the grounding sheet metal only when the system is reliably grounded; otherwise, connect the control board ground cable to the fixing hole.
- Do not disassemble the machine or perform wiring when the main circuit power supply indicator is ON.

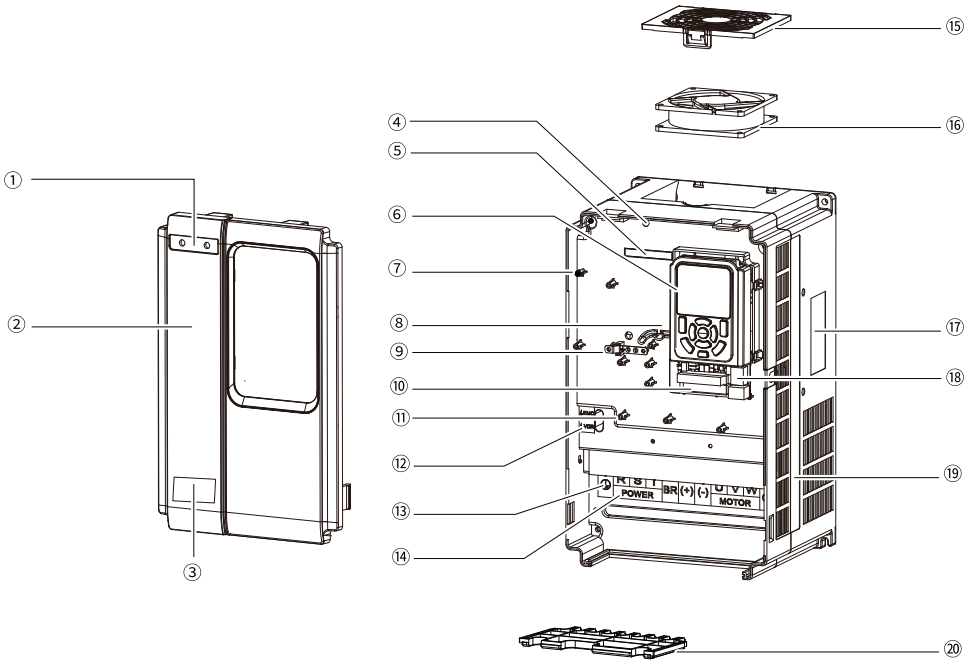


Figure 2-2 Components of T5 to T6 models

No.	Name	No.	Name	No.	Name
①	Logo	②	Cover	③	Mark Symbol / Description Note: Read through the user guide before installation and operation. Danger: Do not remove the upper cover with power ON or within 10 min after power-off.
④	Main circuit power supply indicator	⑤	Equipment bar code You can view the SN and model of the equipment.	⑥	Operating panel
⑦	Fixing base of encoder expansion card	⑧	Trough and fixing base of the control board ground cable	⑨	Grounding sheet metal It is used to ground the PG card and control board.
⑩	Control circuit terminal	⑪	Fixing base of the expansion card	⑫	Grounding screws for safety capacitor and voltage dependent resistor
⑬	Grounding terminal	⑭	Main circuit terminal	⑮	Fan cover
⑯	Cooling fan	⑰	Nameplate	⑱	External operating panel interface
⑲	Enclosure	⑳	Comb-type wiring cover	-	-

Note

- The actual position of the equipment bar code may vary with models.
- Connect the control board ground cable to the grounding sheet metal only when the system is reliably grounded; otherwise, connect the control board ground cable to the fixing hole.
- Do not disassemble the machine or perform wiring when the main circuit power supply indicator is ON.

2.3 Components of T7 to T9 Models

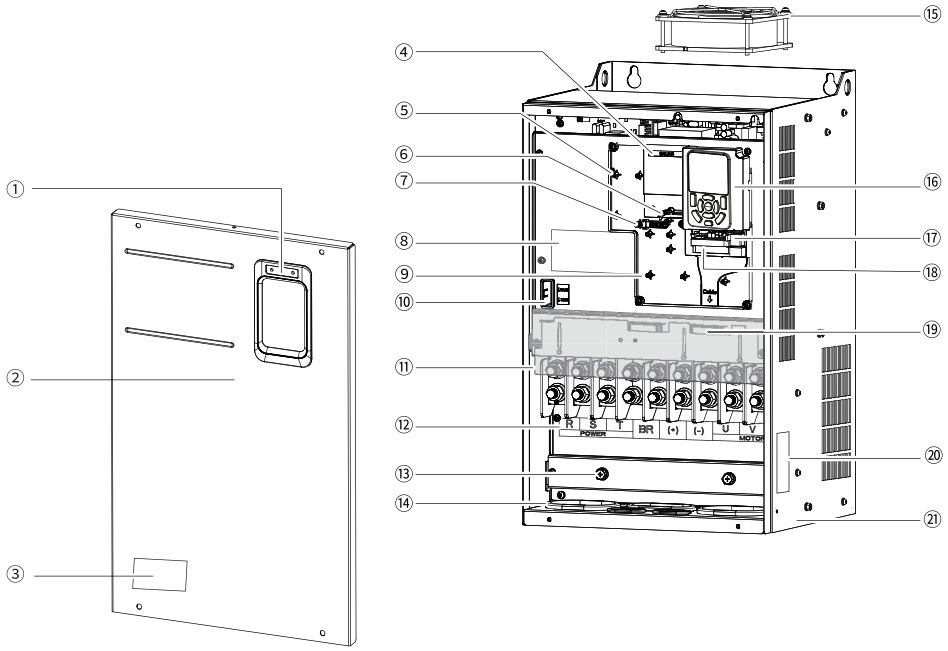


Figure 2-3 Components of T7 to T9 models

No.	Name	No.	Name	No.	Name
①	Logo	②	Cover	③	Mark Symbol / Description Note: Read through the user guide before installation and operation. Danger: Do not remove the upper cover with power ON or within 10 min after power-off.
④	Equipment bar code You can view the SN and model of the equipment.	⑤	Fixing base of the encoder expansion card	⑥	Trough and fixing base of the control board ground cable
⑦	Grounding sheet metal It is used to ground the PG card and control board.	⑧	Wiring description	⑨	Fixing base of the expansion card
⑩	Grounding screws for safety capacitor and voltage dependent resistor	⑪	Protective cover of the main circuit terminal	⑫	Main circuit terminal

No.	Name	No.	Name	No.	Name
⑬	Grounding terminal	⑭	Grommet	⑮	Cooling fan
⑯	Operating panel	⑰	External operating panel interface	⑱	Control circuit terminal
⑲	Cable tie It is used to fix the signal cable.	⑳	Nameplate	㉑	Enclosure

Note

- The actual position of the equipment bar code may vary with models.
- Connect the control board ground cable to the grounding sheet metal only when the system is reliably grounded; otherwise, connect the control board ground cable to the fixing hole.
- The quantity and positions of cooling fans vary with AC drive models.
  - T7 models have one cooling fan at the top.
  - T8 models have two cooling fans at the top.
  - T9 models have two cooling fans at the bottom.

2.4 Components of T10 to T12 Models

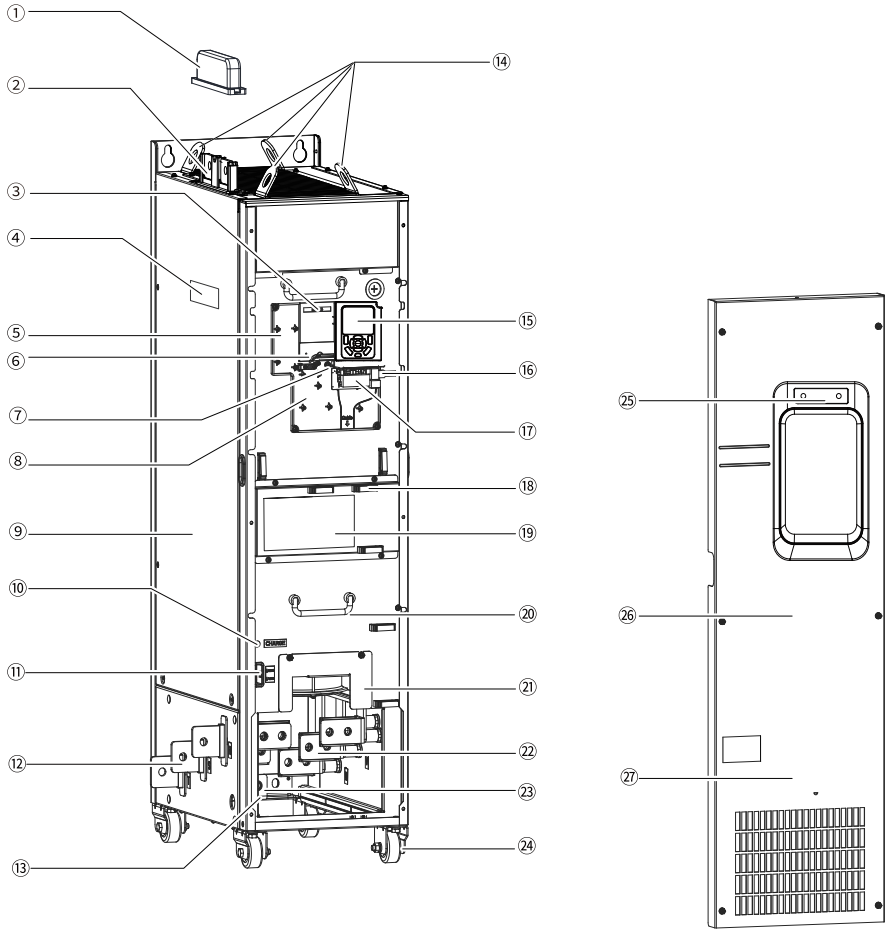


Figure 2-4 Components of T10 to T12 models (without AC output reactors)

No.	Name	No.	Name	No.	Name
①	Protective cover for positive and negative terminals	②	Positive and negative terminals of the DC bus	③	Equipment bar code You can view the SN and model of the equipment.
④	Nameplate	⑤	Fixing base of the encoder expansion card	⑥	Trough and fixing base of the control board ground cable Note: Connect the control board ground cable to the ground copper bar only when the system is reliably grounded; otherwise, connect it to the fixing base.
⑦	Grounding sheet metal It is used to ground the PG card and control board.	⑧	Fixing base for the expansion card	⑨	Enclosure
⑩	Main circuit power supply indicator Do not disassemble the machine or perform wiring when this indicator is ON.	⑪	Grounding screws for safety capacitor and voltage dependent resistor	⑫	Main circuit input terminal
⑬	Bottom hoisting position	⑭	Top hoisting position	⑮	Operating panel
⑯	External operating panel interface	⑰	Control circuit terminal	⑱	Cable tie
⑲	Wiring description	⑳	Handle	㉑	Fan box
㉒	Main circuit output terminal	㉓	Grounding terminal	㉔	Caster
㉕	Logo	㉖	Cover	㉗	Mark Symbol / Description Note: Read through the user guide before installation and operation. Danger: Do not remove the upper cover with power ON or within 10 min after power-off.

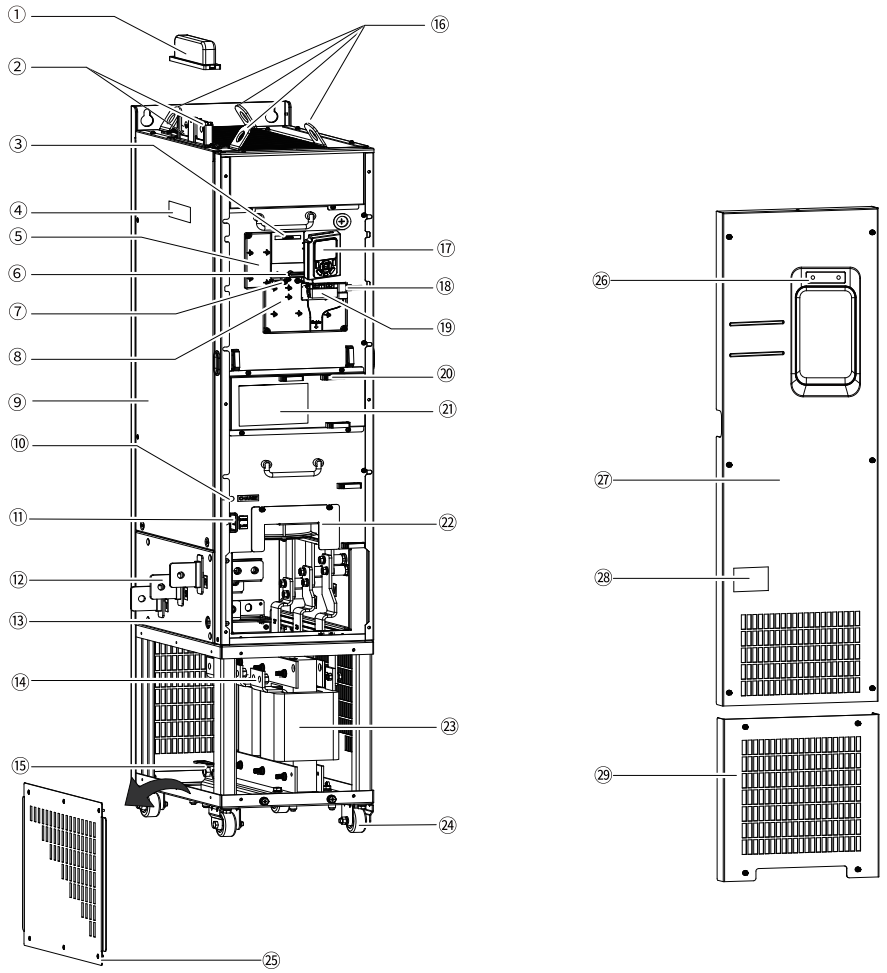


Figure 2-5 Components of T10 to T12 models (with AC output reactors)

No.	Name	No.	Name	No.	Name
①	Protective cover for positive and negative terminals	②	Positive and negative terminals of the DC bus	③	Equipment bar code You can view the SN and model of the equipment.
④	Nameplate	⑤	Fixing base of encoder expansion card	⑥	Trough and fixing base of the control board ground cable Note: Connect the control board ground cable to the ground copper bar only when the system is reliably grounded; otherwise, connect it to the fixing base.
⑦	Grounding sheet metal It is used to ground the PG card and control board.	⑧	Fixing base for the expansion card	⑨	Enclosure
⑩	Main circuit power supply indicator Do not disassemble the machine or perform wiring when this indicator is ON.	⑪	Grounding screws for safety capacitor and voltage dependent resistor	⑫	Main circuit input terminal

No.	Name	No.	Name	No.	Name
⑬	Bottom hoisting position	⑭	Main circuit output terminal	⑮	Grounding terminal
⑯	Top hoisting position	⑰	Operating panel	⑱	External operating panel interface
⑲	Control circuit terminal	⑳	Cable tie	㉑	Wiring description
㉒	Fan box	㉓	AC Output Reactor	㉔	Caster
㉕	Left cover of the base	㉖	Logo	㉗	Cover
㉘	Mark Symbol / Description Note: Read through the user guide before installation and operation. Danger: Do not remove the upper cover with power ON or within 10 min after power-off.	㉙	Bottom cover	-	-

2.5 Components of T13 Models

T13 models include two types in terms of structures: models with a standard cabinet and models with a standard cabinet including an auxiliary power distribution cabinet. For components of each structure, see *"Figure 2–6 Components of the standard cabinet" on page 37* and *"Figure 2–7 Components of the standard cabinet with auxiliary power distribution cabinet" on page 38*.

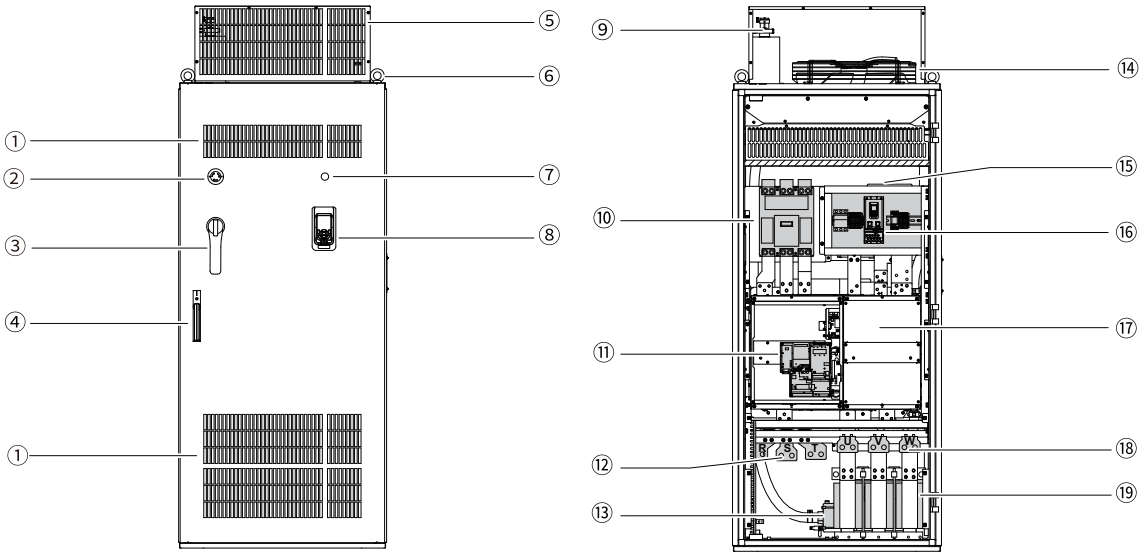


Figure 2-6 Components of the standard cabinet

No.	Name	No.	Name	No.	Name
①	Air inlet	②	Emergency stop switch	③	Circuit breaker operating handler
④	Door lock	⑤	Top protective cover	⑥	Lifting lug
⑦	Power supply indicator	⑧	Operating panel	⑨	Coolant inlet
⑩	Main circuit breaker	⑪	Control board	⑫	R/S/T terminal block
⑬	Input reactor	⑭	Top fan	⑮	DC reactor
⑯	Water cooling system controller	⑰	AC drive	⑱	U/V/W terminal block
⑲	Output reactor	-	-	-	-

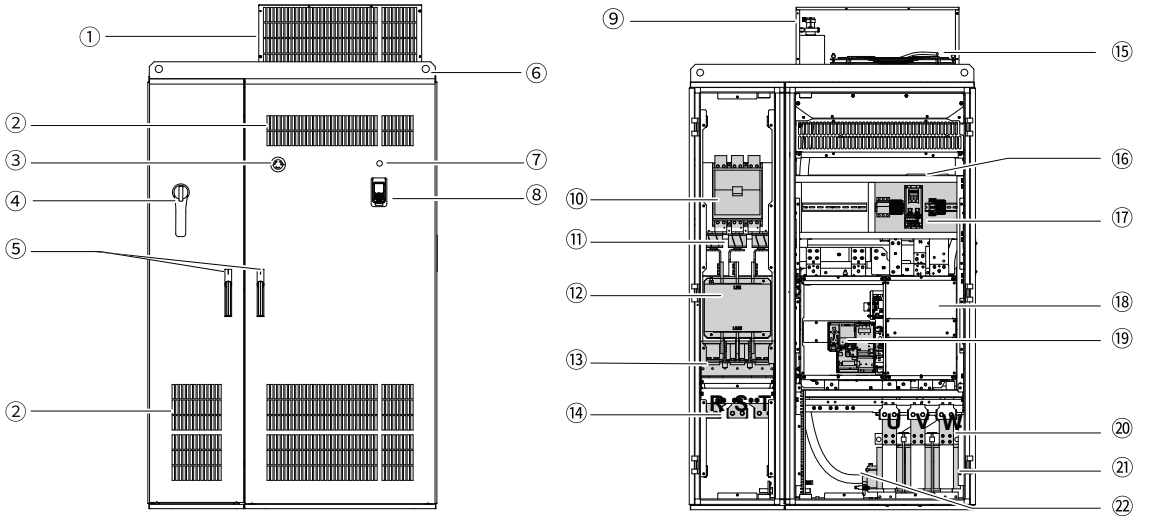


Figure 2-7 Components of the standard cabinet with auxiliary power distribution cabinet

No.	Name	No.	Name	No.	Name
①	Top protective cover	②	Air inlet	③	Emergency stop switch
④	Circuit breaker operating handler	⑤	Door lock	⑥	Lifting beam
⑦	Power supply indicator	⑧	Operating panel	⑨	Coolant inlet
⑩	Main circuit breaker	⑪	Fuse	⑫	EMC filter
⑬	Input reactor	⑭	R/S/T terminal block	⑮	Top fan
⑯	DC reactor	⑰	Water cooling system controller	⑱	AC drive
⑲	Control board	⑳	U/V/W terminal block	㉑	Output reactor
㉒	Water pump	-	-	-	-

3 System Composition

3.1 System Connection

When the AC drive is used to control motors, you must install a variety of electrical devices on the input and output sides of the AC drive to ensure system safety and stability. The following figure shows the system composition.

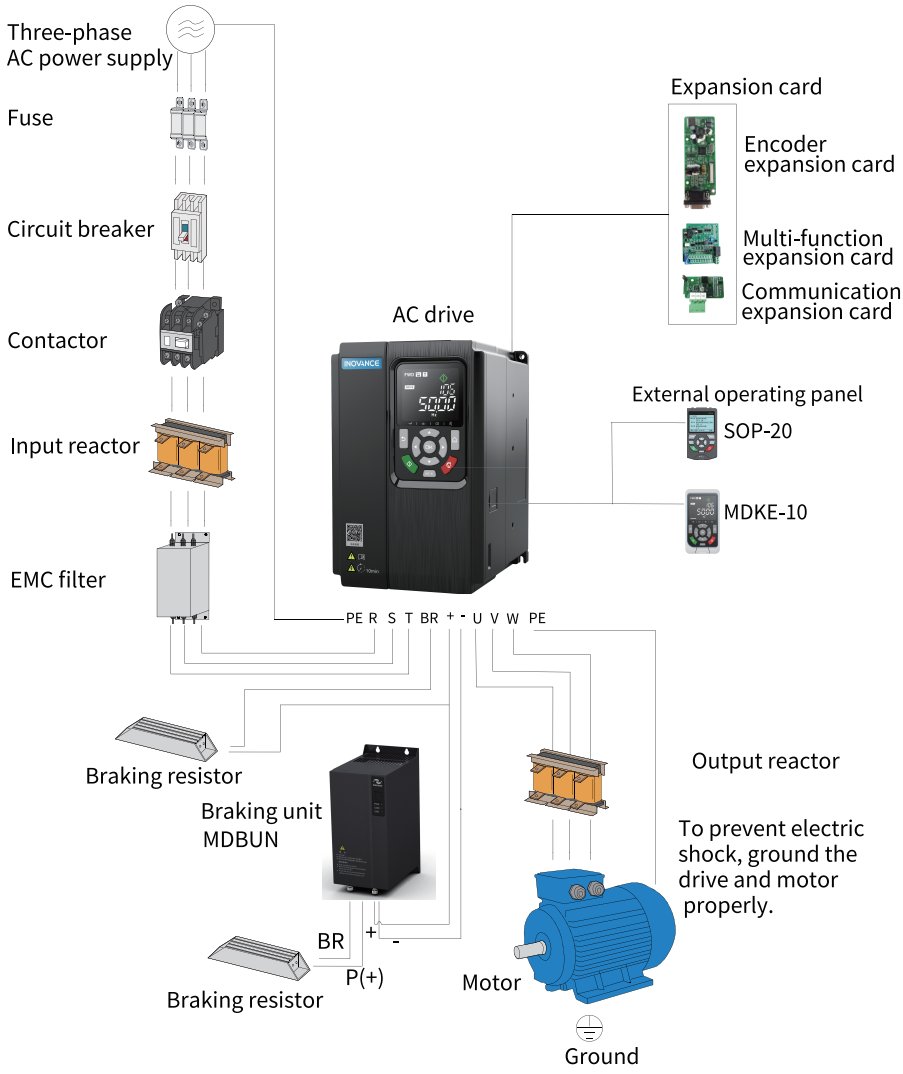


Figure 3-1 System composition

Table 3–1 Descriptions of peripheral electrical components

Name	Installation Position	Function description
Circuit breaker	AC drive input side	It is installed between the power supply and the AC drive input side. Circuit breaker for protection against short circuit: When overcurrent occurs on downstream devices, it cuts off the power supply to prevent incidents. Residual current device (RCD): The drive may generate high-frequency leakage current during running. To prevent electric shock which may cause a fire, select a proper RCD based on actual applications.
Fuse	AC drive input side	It protects downstream semiconductor components in case of short circuit.
Contactor	AC drive input side	It is used to connect to or cut off the power supply of the AC drive. Do not use the contactor to power on or off the drive frequently (interval: at least one hour) or use the contactor to directly start the drive.
Input reactor	AC drive input side	It is used to eliminate the high harmonics of the input side effectively and improve the power factor of the input side.
EMC filter	AC drive input side	It reduces the conduction and radiation interference generated by the AC drive to external devices.
Simple filter	AC drive input side	It reduces the conduction and radiation interference generated by the AC drive to external devices.
Braking resistor	AC drive input side	For AC drive models with the name containing letter B, the braking resistor is optional. The braking resistor consumes regenerative energy generated during motor deceleration.
Braking unit	AC drive input side	For AC drive models with the name not containing letter B, use the braking unit MDBUN of Inovance and the recommended braking resistor. The braking unit or braking resistor consumes regenerative energy during motor deceleration.
Active front end (AFE) unit	AC drive input side	An AFE is an optional unit used to feed the energy generated by the motor during braking back to the power grid. With the AFE installed, the braking unit and braking resistor are not required, which reduces heat emission. Inovance AFE units feature energy saving, low noise, low harmonics pollution, and high power factor.
Output reactor	AC drive output side	It ensures motor insulation and prolongs the service life of the motor.
Magnetic ring and ferrite clamp	AC drive output side	It reduces interferences to the outside and the bearing current.
	Signal cable	It improves the anti-interference performance of signals.
Motor	AC drive output side	Use a proper motor.
External operating panel	Connecting the external operating panel interface to the J11 interface	The external LED operating panel MDKE-10 and the LCD operating panel SOP-20 are supported.
Note: For selection of peripheral electrical devices, see "Options".		

3.2 Electrical Connection

T1 to T12 models

"Figure 3–2" on page 41 shows a typical wiring method of T1 to T12 models.

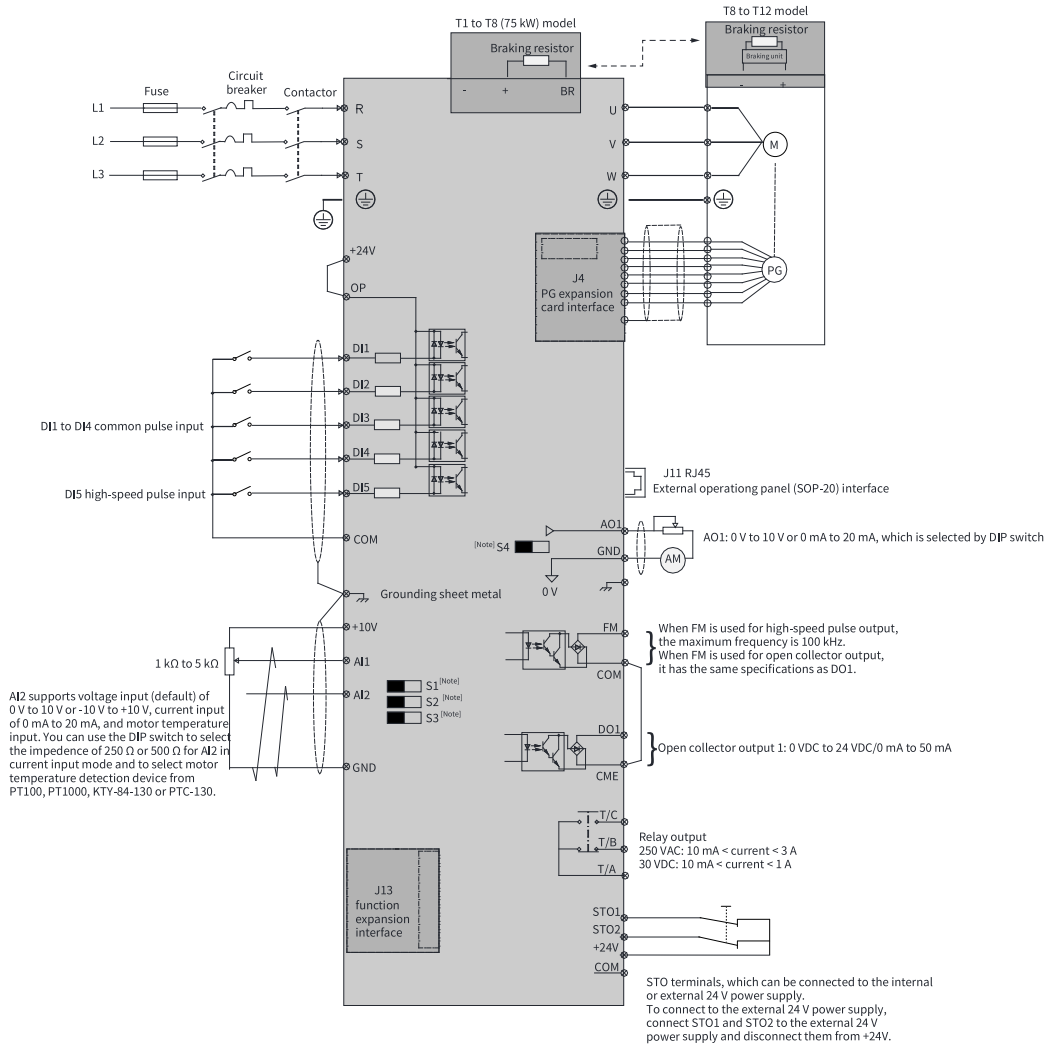


Figure 3-2 Standard wiring (T1 to T12)

Note

- For details on S1 to S4 DIP switches, see *"Table 3–5 Function description of control circuit terminals" on page 46*.
- For three-phase 380–480 V AC drives, a 0.4–75 kW model differs from a 90–450 kW model in the wiring detail marked by the double arrows in the figure.
- For three-phase 200–240 V AC drives, a 0.4–37 kW model differs from a 45–200 kW model in the wiring detail marked by the double arrows in the figure.

T13 models

"Figure 3–3" on page 42 shows the electrical connection in the cabinet.

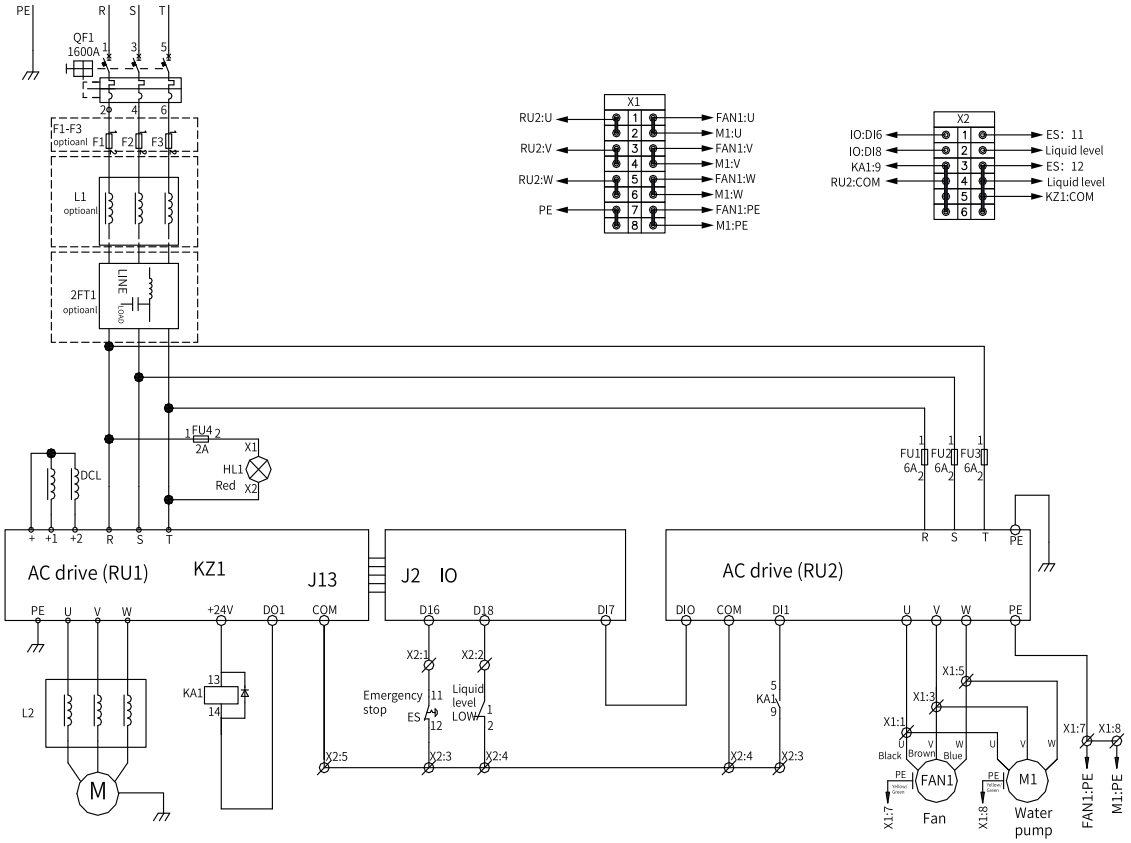


Figure 3-3 Electrical connection in the cabinet (T13)

T13 models

- The cabinet operates under high voltages. Do not attempt to connect any wires while the voltage is live.
- The cabinet can be operated only by qualified professionals.
- Take caution when operating the equipment disconnected from the power supply as external supply voltage may still be present. The main circuit and control circuit terminals may be live even when the motor is in the stop state.
- After disconnecting the input and output power supplies, wait for at least 15 minutes until the bus voltage is lower than 36 V and the power indicator is off before further operation.
- Ensure that the motors, cabinets, and other components are installed and connected in accordance with the recognized technical rules of the country and the region. Pay special attention to regulations on cable dimensions, fuses, grounding, open circuits, isolation, and overcurrent protection.
- If the fuse in a branch circuit trips, the fault current may have been disconnected. To reduce the risk of fire and electric shocks, check the conductive parts and other components of the cabinet and replace the damaged ones. After a fuse trips, identify and rectify the cause of the tripping.

3.3 Descriptions of Main Circuit Terminals

T1 to T9 models

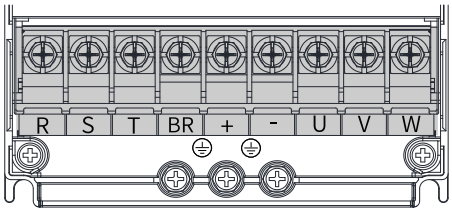


Figure 3-4 Layout of main circuit terminals for T1 to T4 models (three phase)

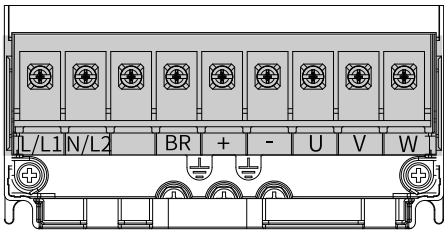


Figure 3-5 Layout of main circuit terminals for T2 models (single phase)

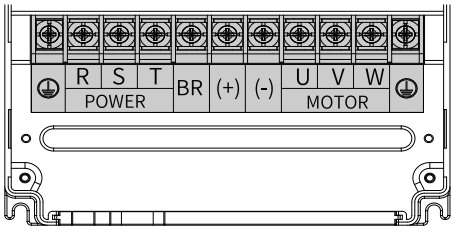


Figure 3-6 Layout of main circuit terminals for T5 to T8 models

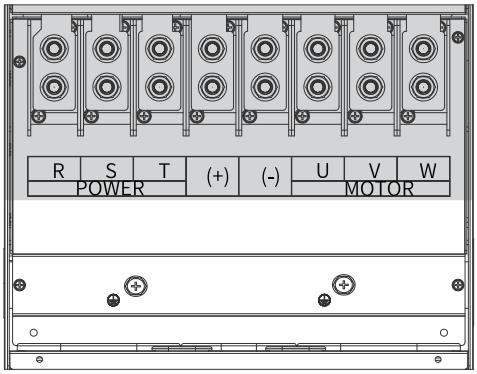


Figure 3-7 Layout of main circuit terminals for T9 models

Table 3–2 Descriptions of main circuit terminals

Terminal Mark	Terminal Name	Function Description
R, S, T	Input terminals of three-phase power supply	Used to connect the three-phase AC input power supply.
(+), (-)	Positive and negative terminals of the DC bus	Common DC busbar input; connected to the external braking unit of T9 models and above.

Terminal Mark	Terminal Name	Function Description
(+), BR	Braking resistor connection terminals	Used to connect to the braking resistor of T8 models and below. Note: Only models with the name containing "B" are equipped with brake resistor terminals. For models with the name excluding "B", external brake units are required.
U, V, W	Output terminals	Used to connect the three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

T10 to T12 models

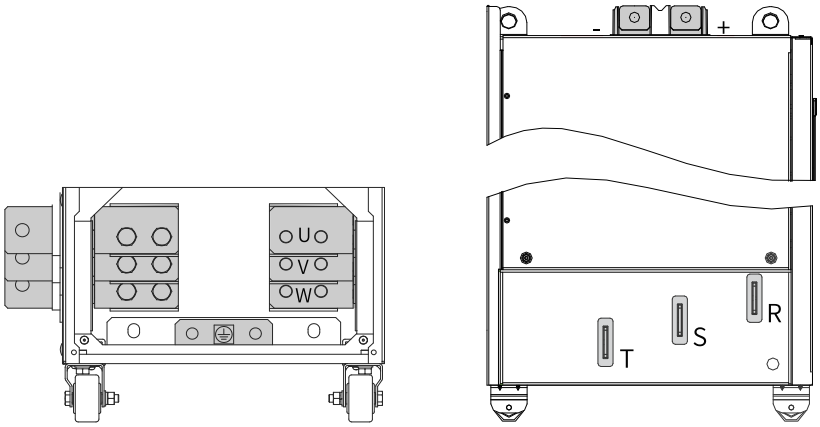


Figure 3-8 Layout of main circuit terminals for T10 to T12 models

Table 3–3 Descriptions of main circuit terminals

Terminal Mark	Terminal Name	Function Description
R, S, T	Input terminals of three-phase power supply	Used to connect the three-phase AC input power supply.
+, -	Positive and negative terminals of the DC bus	Common DC busbar input; connected to an external braking unit.
U, V, W	AC drive output terminals	Used to connect the three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

T13 models

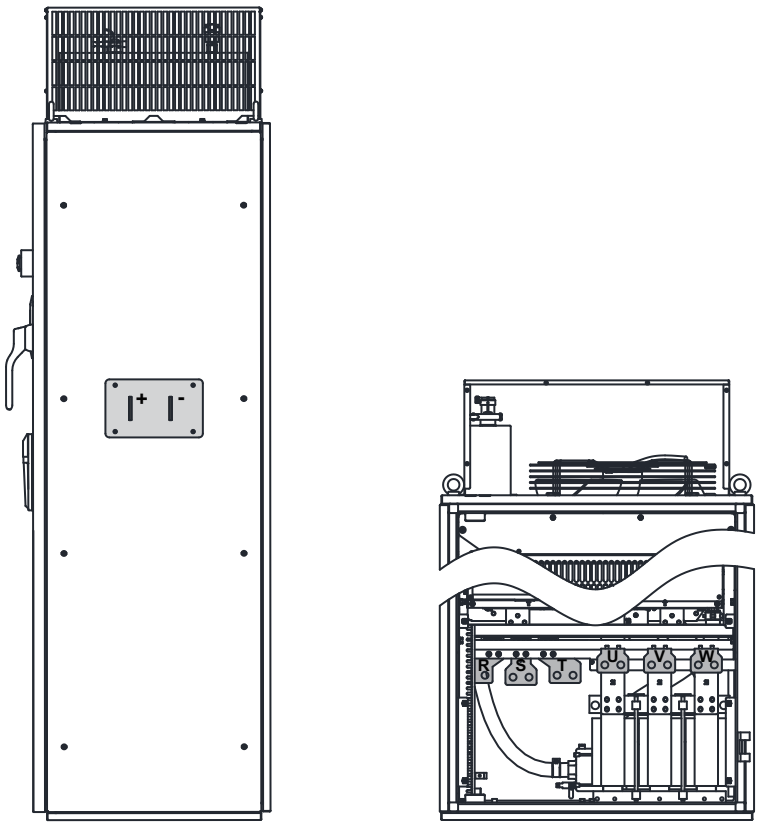


Figure 3-9 Layout of main circuit terminals for T13 models

Table 3–4 Descriptions of main circuit terminals

Terminal Mark	Terminal Name	Function Description
R, S, T	Input terminals of three-phase power supply	Used to connect the three-phase AC input power supply.
+, -	Positive and negative terminals of the DC bus	Common DC busbar input; connected to an external braking unit.
U, V, W	AC drive output terminals	Used to connect the three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

3.4 Descriptions of Control Circuit Terminals

"Table 3–7" on page 48 shows the layout of control circuit terminals.

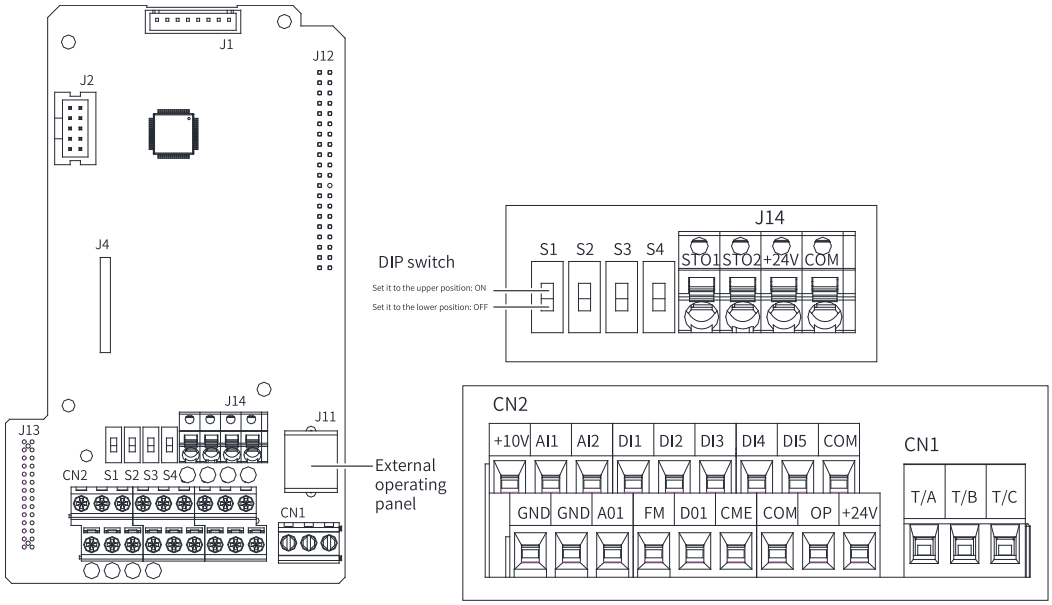


Figure 3-10 Layout of control circuit terminals

Table 3–5 Function description of control circuit terminals

Type	Terminal Mark	Terminal Name	Function Description
Power supply	+10V-GND	External +10 V power supply	The terminal is used to provide +10 V power supply to an external unit with the maximum output current of 10 mA. Generally, it is used to power an external potentiometer with resistance ranging from 1 kΩ to 5 kΩ.
	+24V-COM	External +24 V power supply	The terminal is used to provide +24 V power supply to external devices. Generally, it is used to power the DIs/DOs and external sensor. The maximum output current is 200 mA[Note 1].
	OP	Input terminal for external power supply	It is connected to +24V by default. When DI1 to DI5 are driven by external signals, OP must be disconnected from +24 V and connected to the external power supply.
Analog input	AI1-GND	AI1	Input voltage range: -10 VDC to +10 VDC Input impedance: 22 kΩ
	AI2-GND	AI2	The terminal supports voltage input (default), current input, and temperature input. When used as voltage/current input, the terminal supports 0 V to 10 V, -10 V to +10 V, or 0 mA to 20 mA, and supports 12-bit resolution and the correction accuracy of 1%. The input impedance is 22 kΩ for voltage input and 500 Ω or 250 Ω for current input, which is set by S2 and S3 DIP switches[Note 2].

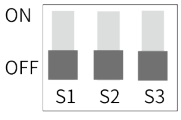
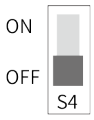
Type	Terminal Mark	Terminal Name	Function Description
Digital input	DI1-OP	DI1	Photocoupler isolation, compatible with dual-polarity input. Input impedance: 1.72 kΩ Operating voltage range: 9 V to 30 V
	DI2-OP	DI2	
	DI3-OP	DI3	
	DI4-OP	DI4	
	DI5-OP	DI5	Besides features of DI1 to DI4, DI5 can also be used for high-speed pulse input. Input impedance: 1.16 kΩ Maximum input frequency: 100 kHz Operating voltage range: 15 V to 30 V
Analog output	AO1-GND	Analog output 1	The DIP switch on the control board is used to determine voltage output (default) or current output. Output voltage range: 0 V to 10 V Output current range: 0 mA to 20 mA
Digital output	DO1-CME	Digital output 1	Optocoupler isolation; dual-polarity open collector output Output voltage range: 0 V to 24 V Output current range: 0 mA to 50 mA Note that digital output ground CME and digital input ground COM are internally insulated, but are shorted externally by jumper as the factory settings. In this case, DO1 is driven by +24V by default. To drive DO1 by external power supply, remove the jumper between CME and COM.
	FM-COM	High-speed pulse output	The terminal is set by F5-00 (FM terminal output selection). When the terminal is used for high-speed pulse output, the maximum frequency is 100 kHz. When the terminal is used for collector open output, it has the same specifications as DO1.
Relay output	T/A	Common terminal	Driving capacity of the contact: 250 VAC, 3 A, COS Ø = 0.4 30 VDC, 1 A
	T/B	Normally closed (NC) terminal	
	T/C	Normally open (NO) terminal	
Auxiliary interface	J4	Local PG card interface	It is used to connect the resolver, ABZ incremental encoder, 23-bit encoder, and sin-cos encoder.
	J11	External operating panel interface	It is used to connect the external LCD operating panel (SOP-20) or the LED operating panel (MDKE-10).
	J13	Expansion card interface	28-core terminal used to connect to expansion cards, including I/O cards, communication cards, and PG card
	J14	Safety function terminal	For details, see *"Table 3-6 STO terminal description" on page 48*.
DIP switch	S1		For details, see *"Table 3-7 DIP switch descriptions" on page 48*.
	S2		
	S3		
	S4		Current/Voltage mode selection for AO1 On: Current output mode Off: Voltage output mode

Table 3–6 STO terminal description

No.	Terminal Mark	Terminal Name	Performance Requirement
1	STO1	STO channel 1	Internal: STO1 and STO2 are connected to +24V by jumpers by default. External: You can connect STO1 and STO2 to the COM terminal. For detailed wiring methods, see the STO function.
2	STO2	STO channel 2	
3	+24V	STO channel 1 and STO channel 2 power supply+	
4	COM	Power supply ground of STO channel 1 and STO channel 2	

Table 3–7 DIP switch descriptions

DIP Switch Status			Description
S1	S2	S3	
OFF	OFF	OFF	Voltage mode with the range of 0 VDC to 10 VDC for AI2
ON	OFF	OFF	Temperature mode for AI2 Set the temperature sensor type through F9-75. 0: No temperature sensor (AI used for analog input) 1: PT100 temperature detection input signal, -25°C to 200°C, accuracy: ±8°C 2: PT1000 temperature detection input signal, -25°C to 200°C, accuracy: ±8°C 3: KTY84-130 temperature detection input signal, -40°C to 260°C, accuracy: ±15°C 4: PTC130 temperature detection input signal, -20°C to 180°C, accuracy: ±15°C
OFF	ON	OFF	Current mode for AI2; current range: 0 mA to 20 mA; input impedance: 500 Ω
OFF	ON	ON	Current mode for AI2; current range: 0 mA to 40 mA; input impedance: 250 Ω

Note

- [Note 1]: If the ambient temperature exceeds 23°C, the output current must be derated by 1.8 mA for every additional 1°C. The maximum output current is 170 mA at 40°C. When OP and +24V are shorted, the maximum output current is calculated by the following formula: 170 mA minus current over the DI.
- [Note 2]: Based on the maximum output voltage of the signal source, select impedance of 500 Ω or 250 Ω. For example, if 500 Ω is selected, the maximum output voltage cannot be lower than 10 V so that AI2 can measure 20 mA current.
- S1, S2, and S3 are DIP switches used together for the AI. S4 is the DIP switch for the AO.

4 AC Drive Dimensions

4.1 Dimensions of T1 to T9 Models

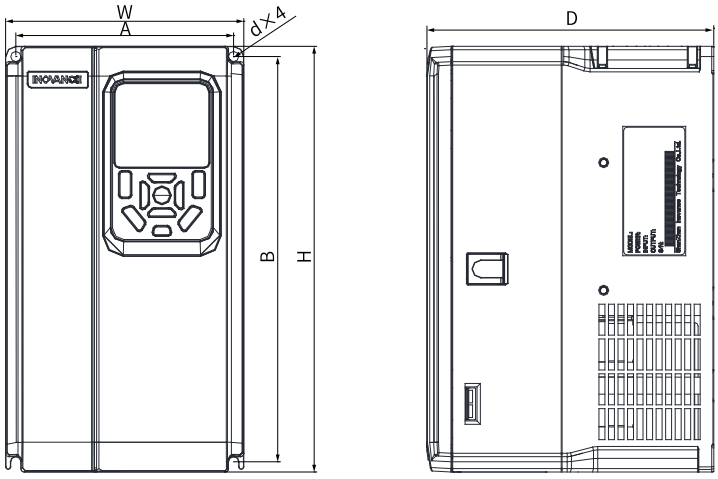


Figure 4-1 Outline dimensions and mounting dimensions of T1 to T4 models

Table 4–1 Outline dimensions and mounting dimensions of T1 to T4 models

Structure	Mounting Hole Dimension mm (in.)		Overall Dimension mm (in.)			Mounting Hole Diameter mm (in.)	Weight kg (lb)
	A	B	H	W	D	d x 4	
T1	119 (4.7)	189 (7.5)	200 (7.9)	130 (5.1)	150 (6.0)	Φ5 (0.2)	1.6 (3.5)
T2	119 (4.7)	189 (7.5)	200 (7.9)	130 (5.1)	160 (6.4)	Φ5 (0.2)	2.0 (4.4)
T3	128 (5.0)	238 (9.4)	250 (9.9)	140 (5.5)	168.3 (6.7)	Φ6 (0.2)	3.3 (7.3)
T4	166 (6.5)	266 (10.5)	280 (11.0)	180 (7.1)	169 (6.7)	Φ6 (0.2)	4.3 (9.5)

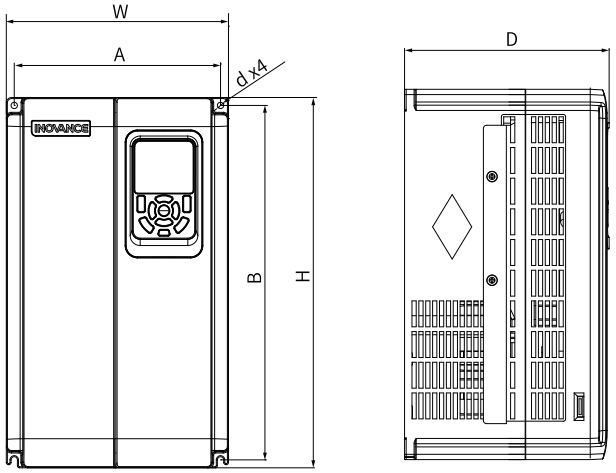


Figure 4-2 Outline dimensions and mounting dimensions of T5 and T6 models

Table 4–2 Outline dimensions and mounting dimensions of T5 to T6 models

Structure	Mounting Hole Dimension mm (in.)		Overall Dimension mm (in.)				Mounting Hole Diameter mm (in.)	Weight kg (lb)
	A	B	H	H1	W	D	d x 4	
T5 (without the DC reactor)	195 (7.7)	335 (13.2)	350 (13.8)	-	210 (8.3)	193.4 (7.6)	Φ6 (0.2)	7.6 (16.8)
T5 (-T models come with the DC reactor)	195 (7.7)	335 (13.2)	350 (13.8)	-	210 (8.3)	193.4 (7.6)	Φ6 (0.2)	10.0 (22.0)
T6	230 (9.1)	380 (15.0)	400 (15.8)	-	250 (9.9)	220.8 (8.7)	Φ7 (0.3)	17.5 (38.6)

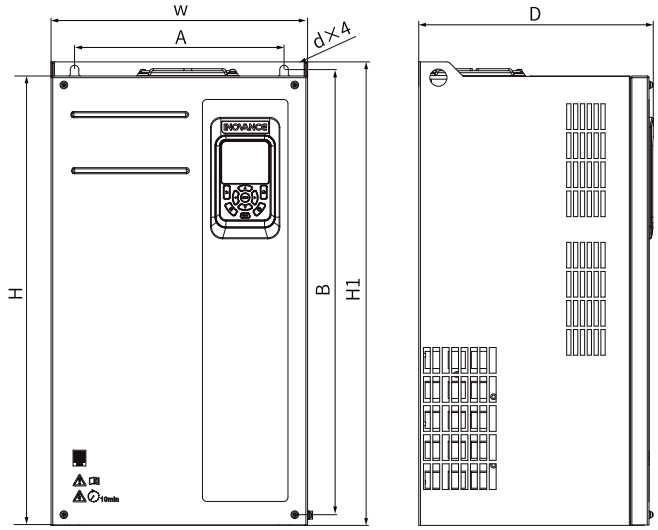


Figure 4-3 Outline dimensions and mounting dimensions of T7 and T9 models

Table 4–3 Outline dimensions and mounting dimensions of T7 to T9 models

Structure	Mounting Hole Dimension mm (in.)		Overall Dimension mm (in.)				Mounting Hole Dimension mm (in.)	Weight kg (lb)
	A	B	H	H1	W	D	d x 4	
T7	245 (9.7)	523 (20.6)	525 (20.7)	542 (21.4)	300 (11.8)	275 (10.8)	Φ10 (0.4)	35 (77.2)
T8	270 (10.6)	560 (22.1)	554 (21.8)	580 (22.9)	338 (13.3)	315 (12.4)	Φ10 (0.4)	51.5 (113.5)
T9	320 (12.6)	890 (35.1)	874 (34.4)	915 (36.1)	400 (15.8)	320 (12.6)	Φ10 (0.4)	85 (187.4)

4.2 Dimensions of T10 to T12 Models (Without AC Output Reactor)

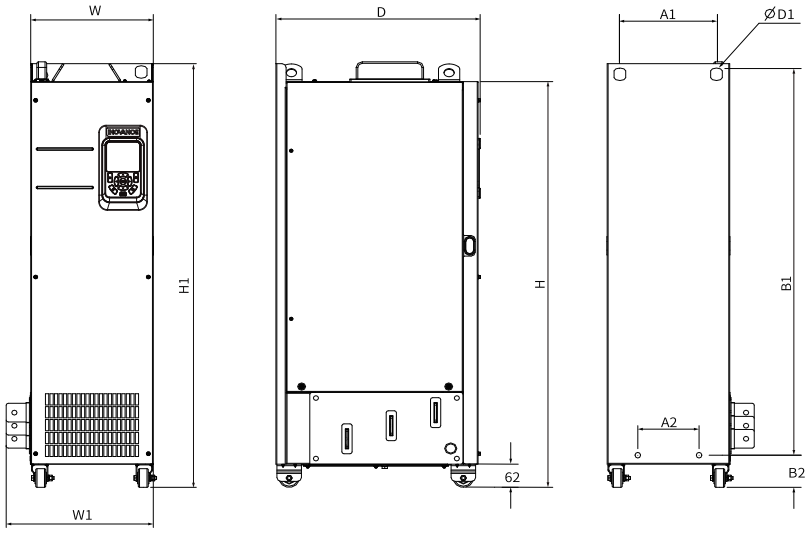


Figure 4-4 Outline dimensions and mounting dimensions of T10 to T12 models (without AC output reactors)

Table 4–4 Outline dimensions and mounting dimensions of T10 to T12 models (without AC output reactors)

Structure	Mounting Hole Dimension mm (in.)				Overall Dimension mm (in.)					Mounting Hole Diameter mm (in.)	Weight kg (lb)
	A1	A2	B1	B2	H	H1	W	W1	D	D1	
T10	240 (9.5)	150 (5.9)	1035 (40.8)	86 (3.4)	1086 (42.8)	1134 (44.7)	300 (11.8)	360 (14.2)	500 (19.7)	ϕ13 (0.5)	110 (242.5)
T11	225 (8.9)	185 (7.3)	1175 (46.3)	97 (3.8)	1248 (49.2)	1284 (50.6)	330 (13)	390 (15.4)	545 (21.5)	ϕ13 (0.5)	155 (341.7)
T12	240 (9.5)	200 (7.9)	1280 (50.4)	101 (4)	1355 (53.4)	1405 (55.4)	340 (13.4)	400 (15.8)	545 (21.5)	ϕ16 (0.6)	185 (407.9)

4.3 Dimensions of T10 to T12 Models (with AC Output Reactor)

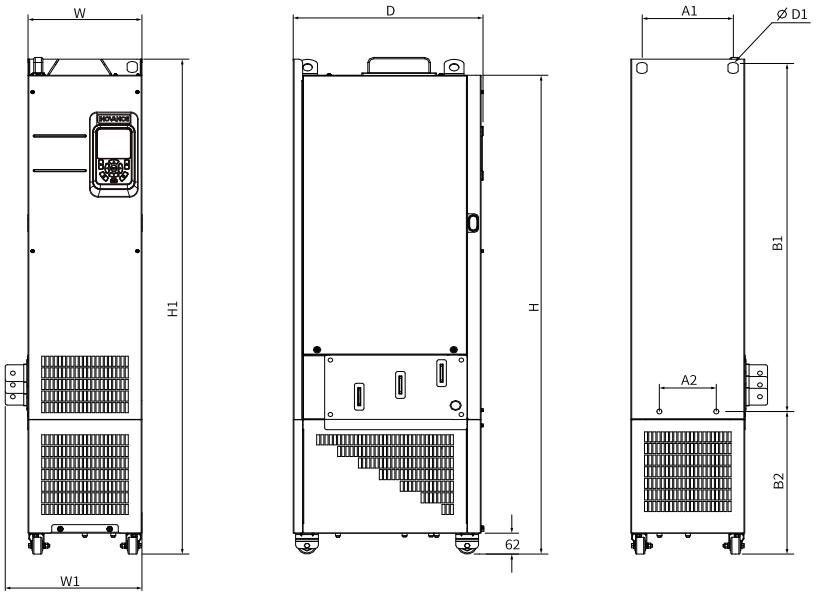


Figure 4-5 Outline dimensions and mounting dimensions of T10 to T12 models (with AC output reactors)

Table 4–5 Outline dimensions and mounting dimensions of T10 to T12 models (with AC output reactor)

Structure	Mounting Hole Diameter mm (in.)				Overall Dimension mm (in.)					Mounting Hole Diameter mm (in.)	Weight kg (lb)
	A1	A2	B1	B2	H	H1	W	W1	D	D1	
T10	240 (9.5)	150 (5.9)	1035 (40.8)	424 (16.7)	1424 (56.1)	1472 (58.0)	300 (11.8)	360 (14.2)	500 (19.7)	ϕ13 (0.5)	160 (352.7)
T11	225 (8.9)	185 (7.3)	1175 (46.3)	435 (17.1)	1586 (62.5)	1622 (63.9)	330 (13.0)	390 (15.4)	545 (21.5)	ϕ13 (0.5)	215 (474.0)
T12	240 (9.5)	200 (7.9)	1280 (50.4)	432 (17.0)	1683 (66.3)	1733 (68.3)	340 (13.4)	400 (15.8)	545 (21.5)	ϕ16 (0.6)	245 (540.1)

4.4 Dimensions of T13 Models (Without Auxiliary Power Distribution Cabinet)

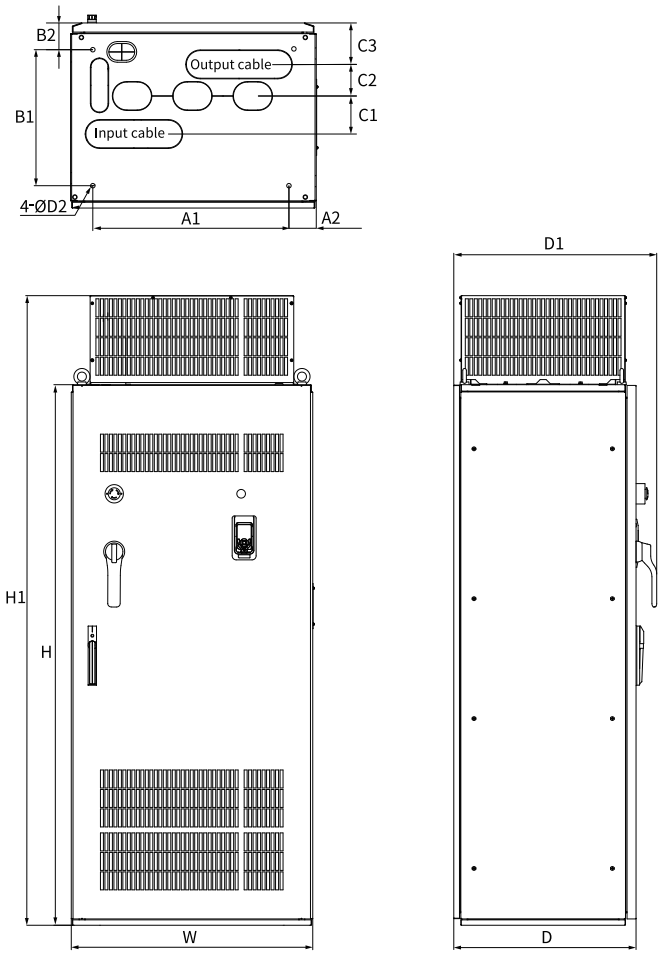


Figure 4-6 Outline dimensions and mounting dimensions of T13 models (without auxiliary power distribution cabinet)

Table 4–6 Outline dimensions and mounting dimensions of T13 models (without auxiliary power distribution cabinet)

Structure	Mounting Hole Dimension mm (in.)						
	A1	A2	B1	B2	C1	C2	C3
T13	660 (26.0)	73.5 (2.9)	450 (17.7)	85 (3.3)	125 (4.9)	104 (4.1)	136 (5.4)

Structure	Overall Dimension mm (in.)					Mounting Hole Diameter mm (in.)	Weight kg (lb)
	H	H1	W	D	D1	D2	
T13	1800 (70.9)	2100 (82.7)	805 (31.7)	610 (24.0)	680 (26.8)	15 (0.6)	530 (1168.4)

4.5 Dimensions of T13 Models (with Auxiliary Power Distribution Cabinet)

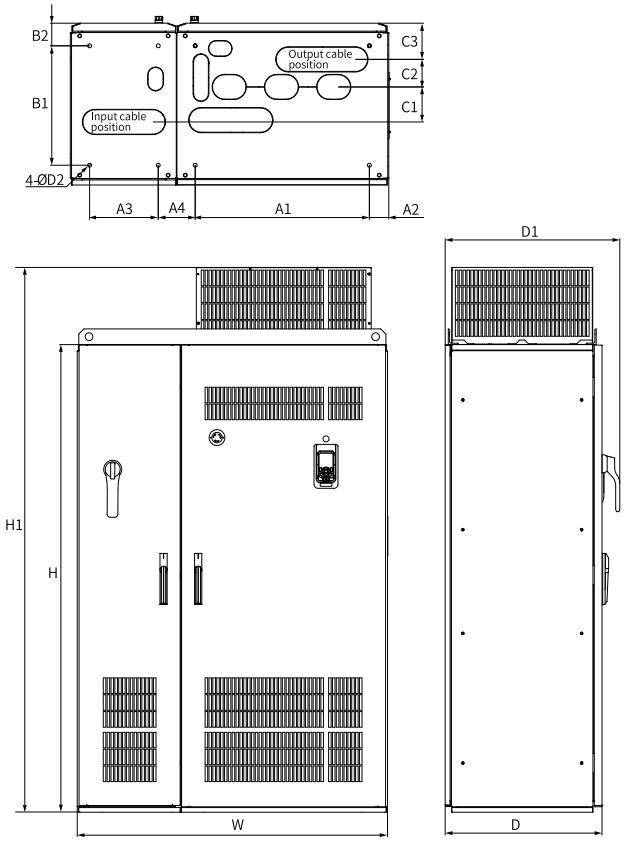


Figure 4-7 Outline dimensions and mounting dimensions of T13 models (with auxiliary power distribution cabinet)

Table 4–7 Outline dimensions and mounting dimensions of T13 models (with auxiliary power distribution cabinet)

Structure	Mounting Hole Dimension mm (in.)								
	A1	A2	A3	A4	B1	B2	C1	C2	C3
T13	660 (26.0)	73.5 (2.9)	260 (10.2)	140 (5.5)	450 (17.7)	85 (3.3)	132 (5.2)	104 (4.1)	136 (5.4)

Structure	Overall Dimension mm (in.)					Mounting Hole Diameter mm (in.)	Weight kg (lb)
	H	H1	W	D	D1	D2	
T13	1800 (70.9)	2100 (82.7)	1205 (47.5)	610 (24.0)	680 (26.8)	15 (0.6)	730 (1609.4)

5 Options

5.1 List of Options

Optional peripherals include braking units, function expansion cards, and external operating panels. For use of each option, see its user guide. If any option is required, specify it in your order.

Table 5–1 Option list

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Braking components	External braking unit [1]	MDBUN-60-T	01013133	All models	60 A, 380 VAC series
		MDBUN-60-5T	0101AR57	All models	60 A, 480 VAC series
		MDBUN-90-T	01013126	All models	90 A, 380 VAC series
		MDBUN-90-5T	0101AR58	All models	90 A, 480 VAC series
		MDBUN-200-T	01040104	All models	200 A, 380 VAC series
		MDBUN-200-5T	01040160	All models	200 A, 480 VAC series
	Built-in braking unit	Models with the name containing letter "B"	-	T1 to T8 (75 kW)	For T1 to T4 models (three phase 380 V to 480 V), the built-in braking unit is standard. For T5 to T8 models (three phase 380 V to 480 V, 75 kW), the braking unit is optional.

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Expansion card	I/O expansion card 1	MD38IO1	01013098	T4 and above	Five DIs, one DO, one RO, one AO, one AI (PT100/PT1000), one RS485 or CAN communication signal isolation input terminal
	I/O expansion card 2	MD38IO2	01013103	All models	Three DIs
	I/O expansion card 3	MD38IO3	01040051	All models	Three DIs, one RO, one RS485 communication signal isolation input terminal
	I/O expansion card 4	MD520IO1	01040250	All models	Three DIs, one RS485 communication signal isolation input terminal, one normally open relay output terminal, one AO
	RS485 communication card	MD38TX1	01013112	All models	Modbus communication card with the isolation feature
	CANopen/CANlink communication card	MD38CAN1	01013100	All models	CANopen/CANlink communication card
	PROFIBUS DP communication card	MD-SI-DP2	01040249	All models	PROFIBUS DP communication card
		MD38DP2	01013144	T4 and above	PROFIBUS DP communication card
	PROFINET communication card <1>	MD500-PN1	01040098	All models	PROFINET communication card
		MD500-PN2	01040198	All models	PROFINET communication card
	EtherCAT communication card	MD500-ECAT	01040113	All models	EtherCAT communication card
	Ethernet/IP communication card	MD500-EN1	01040167	All models	Ethernet/IP communication card
	Modbus TCP communication card	MD500-EM1	01040201	All models	Modbus TCP communication card

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Expansion card	Positioning expansion card 1	MD38DW1	01013096	T4 and above	Multi-function pulse input expansion card Five DIs, one DO, one RO, one AO, one AI, one RS485 or CAN communication signal isolation input terminal, one differential ABZ terminal
	Positioning expansion card 2	MD38DW2	01013097	All models	Mini pulse input expansion card One RS485 communication terminal, one differential ABZ terminal (positioning)
	Resolver frequency division encoder card	MD38PG4D	01040008	T4, T7 models and above	The MD38PG4D card is a PG card specially developed for resolvers. Featuring differential frequency division, it is suitable for various applications such as machine tool electric master axis, master-slave control, and synchronous control.
	Resolver interface card	MD38PG4	01013081	All models	It is applicable to the resolver with the excitation frequency of 10 kHz and with the DB9 interface To meet the MD38PG4 requirements, the excitation input DC resistance of the resolver must be greater than 17 Ω. Failure to comply will result in MD38PG4 malfunction. Select a resolver with a maximum of four pole pairs. Otherwise, the MD38PG4 card will be overloaded. The number of resolver pole pairs must be less than or equal to the number of motor pole pairs, and the number of motor pole pairs divided by the number of resolver pole pairs must be an integer.

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Expansion card	Multi-functional encoder card	MD38PGMD	01013147	All models	The card is an encoder interface card with the optional multiplied frequency division output function and supports 5 V or 15 V power supply. The card supports differential input, collector input, and push-pull input, as well as differential output and collector output; therefore, it can be used to connect to different encoders and supports A/B phase input of the host controller.
	23-bit PG card	ES510-PG-CT1	01320007	All models	Applicable to 23-bit encoders of Inovance; with a DB9 interface
	Sin-cos encoder	MD520-PG-S1	01040237	All models	The MD520-PG-S1 is a PG card that decodes sin-cos encoders. Working with the AC drive, it can measure the motor speed, and realize speed and position closed loop control and encoder frequency division output.
	Bus adaption card	MD520-CClick	01040283	All models	The MD520-CClink communication expansion card (hereinafter referred to as the MD520-CClink card) is an open fieldbus adaption card for MD520 series AC drives. It communicates with the CClink master through a dedicated interface to achieve efficient data interaction between CClink master and slave. It features flexible topology and easy operation.

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Mounting accessory	Through-hole mounting bracket	MD500-AZJ-A1T1	01040072	T1	The bracket is used for through-hole mounting. It applies only to T1 to T9 models.
		MD500-AZJ-A1T2	01040073	T2	
		MD500-AZJ-A1T3	01040074	T3	
		MD500-AZJ-A1T4	01040075	T4	
		MD500-AZJ-A1T5	01040001	T5	
		MD500-AZJ-A1T6	01040002	T6	
		MD500-AZJ-A1T7	01040003	T7	
		MD500-AZJ-A1T8	01040004	T8	
		MD500-AZJ-A1T9	01040005	T9	
	Grounding bracket of cable shield	MD500-AZJ-A2T1	01040085	T1	The accessory is used for re-fixing the power cable and stable grounding of the shield in 360°. It applies only to T1 to T9 models.
		MD500-AZJ-A2T2	01040088	T2	
		MD500-AZJ-A2T3	01040083	T3	
		MD500-AZJ-A2T4	01040082	T4	
		MD500-AZJ-A2T5	01040081	T5	
		MD500-AZJ-A2T6	01040086	T6	
		MD500-AZJ-A2T7	01040087	T7	
		MD500-AZJ-A2T8	01040084	T8	
		MD500-AZJ-A2T9	01040089	T9	
	Mounting guide rail	MD500-AZJ-A3T10	01040009	T10 to T12	The option is used for installing the AC drive in a cabinet. For T10 models and models above T10, it is recommended that a guide rail be used to push the AC drive into the cabinet.
	U/V/W output copper busbar	MD500-TP-T10	01040125	T10	MD520 models excluding that with the base (-L) are delivered with the U/V/W output copper busbar.
		MD500-TP-T11	01040126	T11	
		MD500-TP-T12	01040127	T12	

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Cable	Main circuit cable	Lugs from Suzhou Yuanli are recommended. For details of recommended lugs, see *"5.3.1" on page 76*.			It is recommended that the input and output main circuit cables use symmetrical shielded cables. Compared with four-conductor cables, symmetrical shielded cables can reduce electromagnetic radiation in the whole transmission system. It is recommended that power cables also use symmetrical shielded cables.
	Control circuit cable	All control circuit cables must be shielded cables. Use a separate shielded cable for each type of analog signal. It is recommended that digital signal cables use shielded twisted pair (STP) cables.			
	External LED operating panel	MDKE-10	01040182	All models	It supports parameter display and modification.
	External LCD operating panel	SOP-20	01040028	All models	It supports parameter copy and download, and supports English and Chinese.
	SOP-20 mounting base	CP600–BASE1	01040022	All models	It is used to install the SOP-20 to the cabinet door.
	MDKE-10 mounting base	MD580-AZJ1	01040202	All models	It is used to install the MDKE-10 to the cabinet door.
	Extension cable	MDCAB	01013008	All models	It is a three-meter cable for the external operating panel. The standard 8-conductor cable can connect to the LED operating panel MDKE-10 and the LCD operating panel SOP-20.
		MDCAB-1.5	15048471	All models	1.5-meter cable for the external operating panel

Note

For details on models and specifications of other peripheral electrical components, such as input reactors, EMC filters, output reactors, and fuses, see the section of peripheral electrical components.

<1> The difference between MD500-PN1 and MD500-PN2 is as follows:

1. Power-on time: The power-on time of the MD500-PN1 is 3s, and that of the MD500-PN2 is 30s.
2. GSD file: The GSD files of the MD500-PN1 and MD500-PN2 are different.
3. Media redundancy protocol: The MD500-PN1 supports the media redundancy protocol, and the MD500-PN2 does not support the media redundancy protocol.

5.2 Mounting Accessories

5.2.1 Through-hole Mounting Bracket

The through-hole mounting bracket is an option. Purchase a proper model based on actual needs.

Applicable model

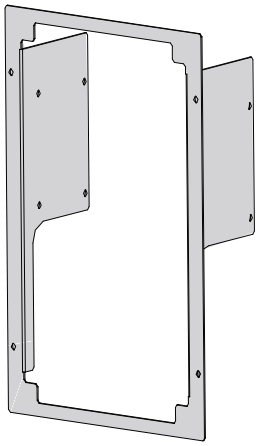


Figure 5-1 Through-hole mounting bracket

Table 5–2 Models of through-hole mounting brackets

Through-hole Mounting Bracket Model	Structure
MD500-AZJ-A1T1	T1
MD500-AZJ-A1T2	T2
MD500-AZJ-A1T3	T3
MD500-AZJ-A1T4	T4
MD500-AZJ-A1T5	T5
MD500-AZJ-A1T6	T6
MD500-AZJ-A1T7	T7
MD500-AZJ-A1T8	T8
MD500-AZJ-A1T9	T9

Mounting hole dimensions

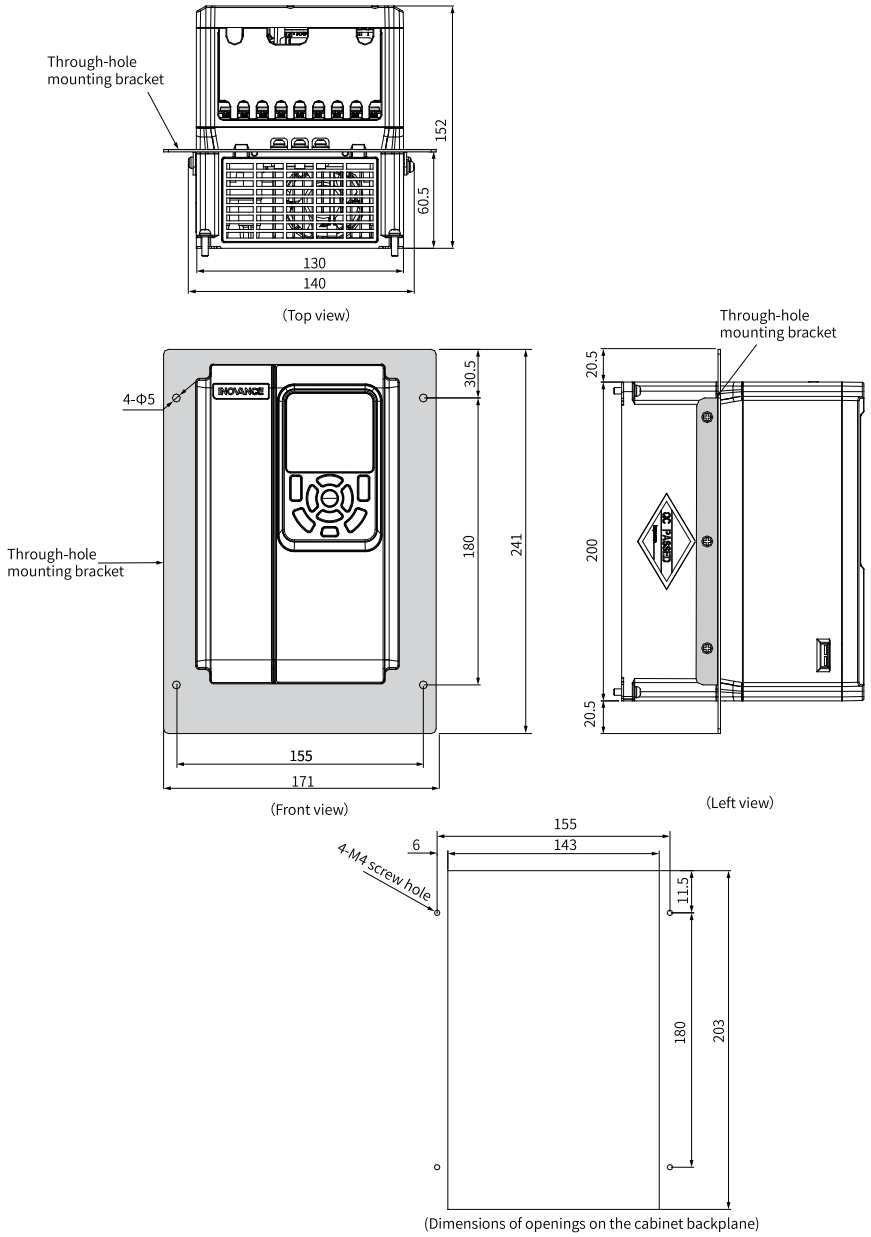


Figure 5-2 MD500-AZJ-A1T1 through-hole mounting bracket and mounting hole dimensions (mm)

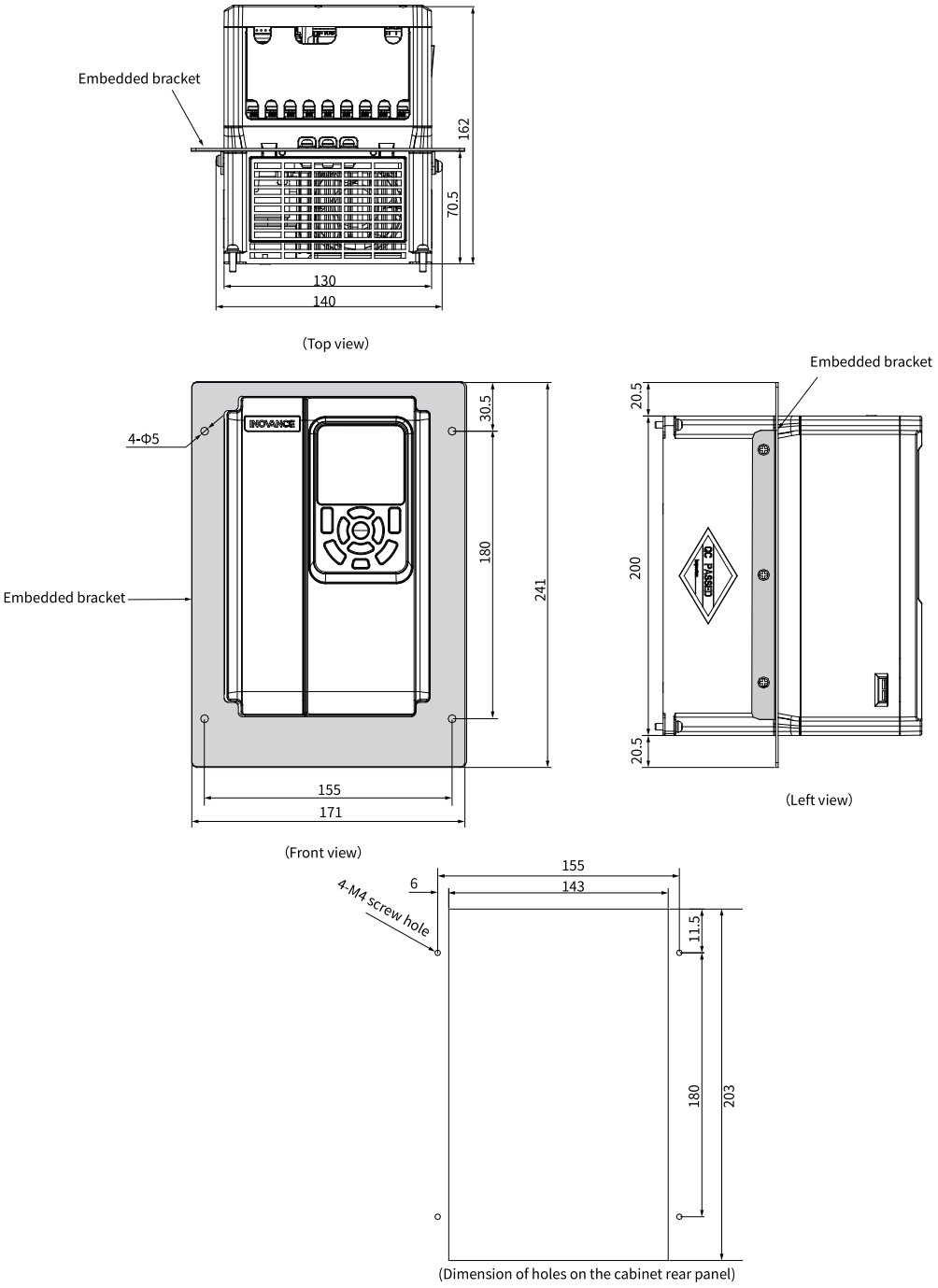


Figure 5-3 MD500-AZJ-A1T2 through-hole mounting bracket and mounting hole dimensions (mm)

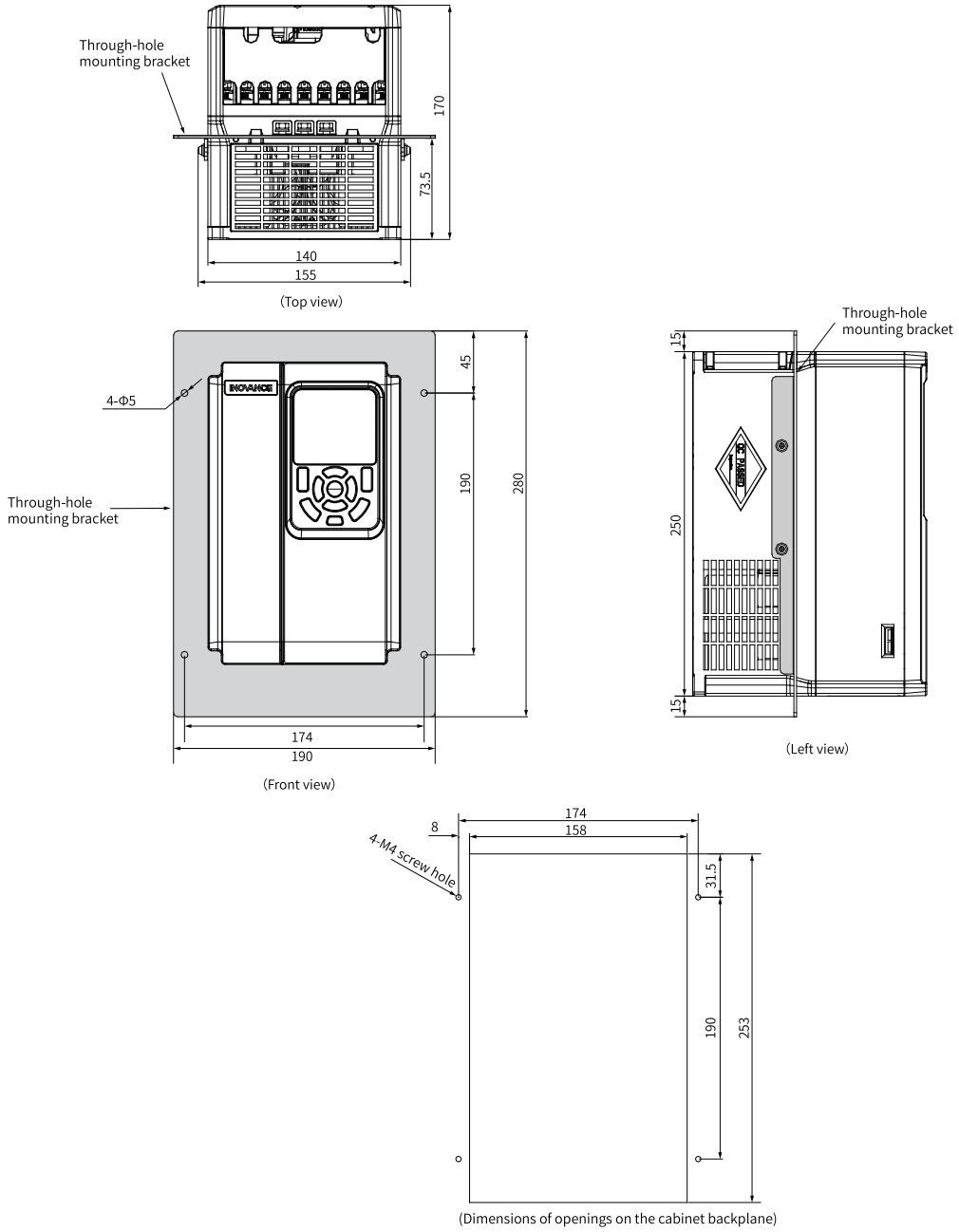


Figure 5-4 MD500-AZJ-A1T3 through-hole mounting bracket and mounting hole dimensions (mm)

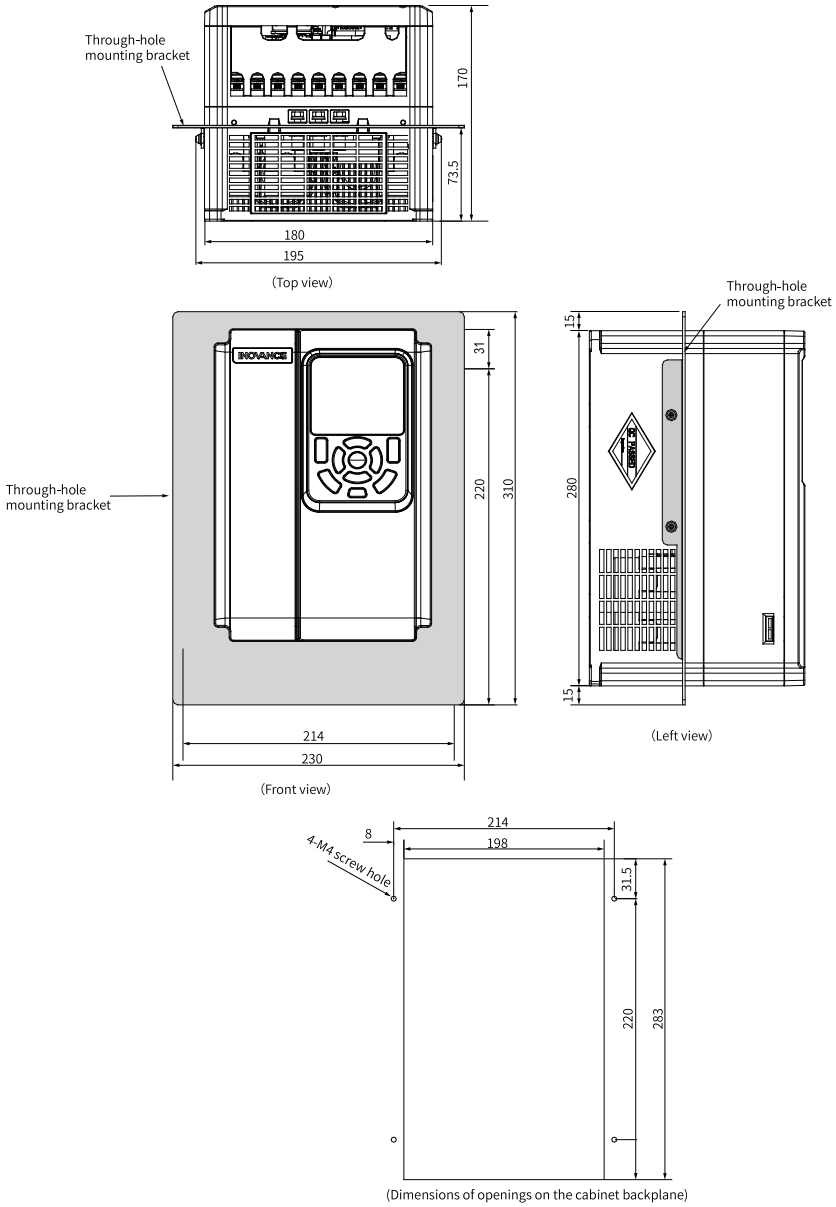


Figure 5-5 MD500-AZJ-A1T4 through-hole mounting bracket and mounting hole dimensions (mm)

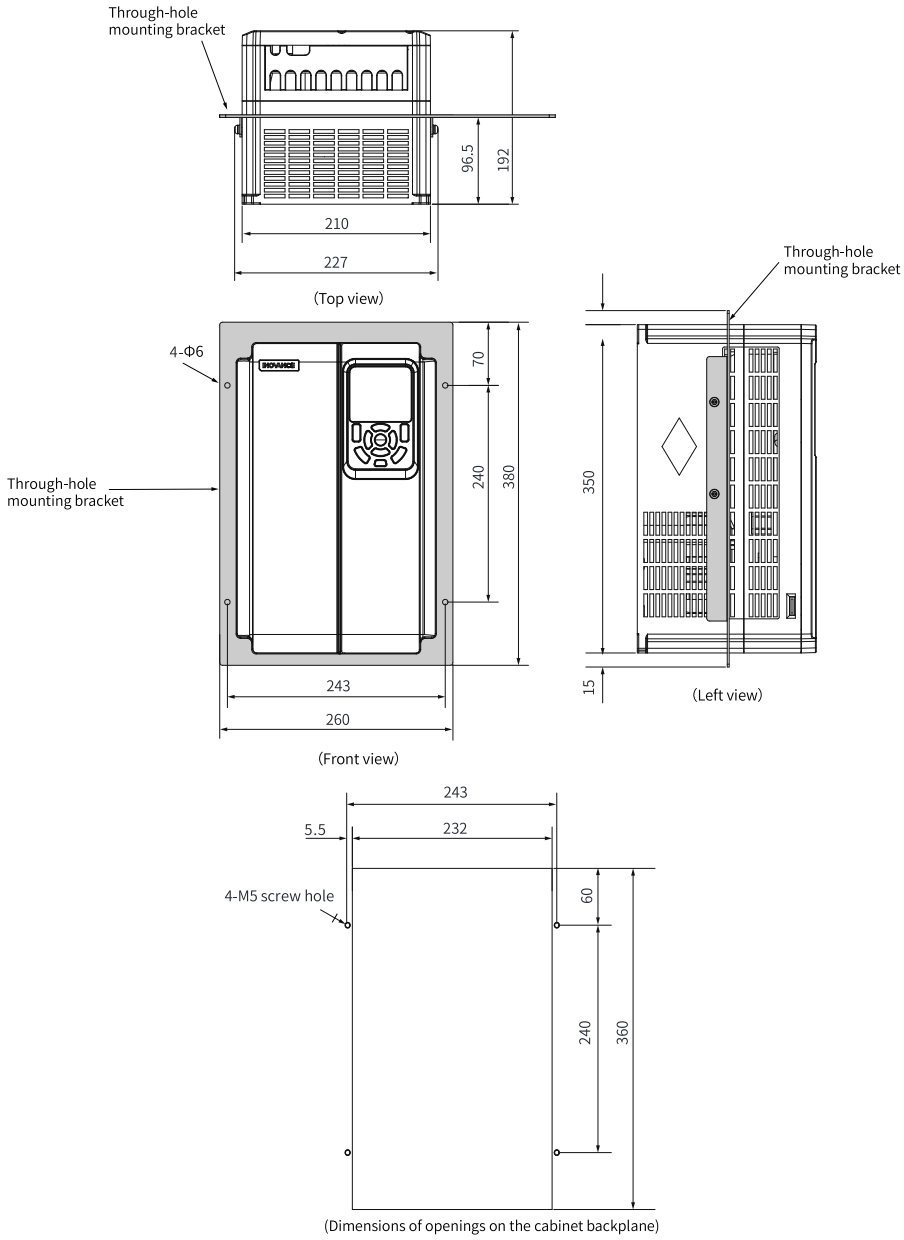


Figure 5-6 MD500-AZJ-A1T5 through-hole mounting bracket and mounting hole dimensions (mm)

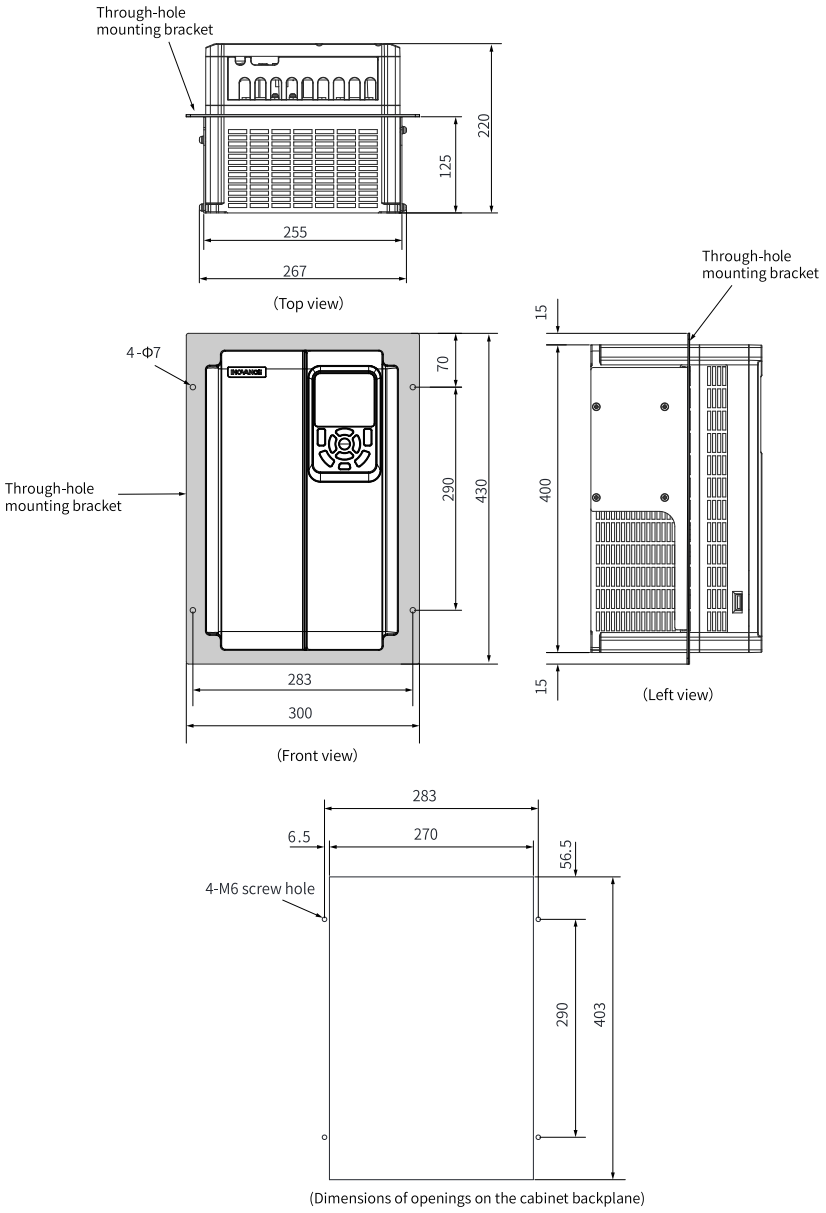


Figure 5-7 MD500-AZJ-A1T6 through-hole mounting bracket and mounting hole dimensions (mm)

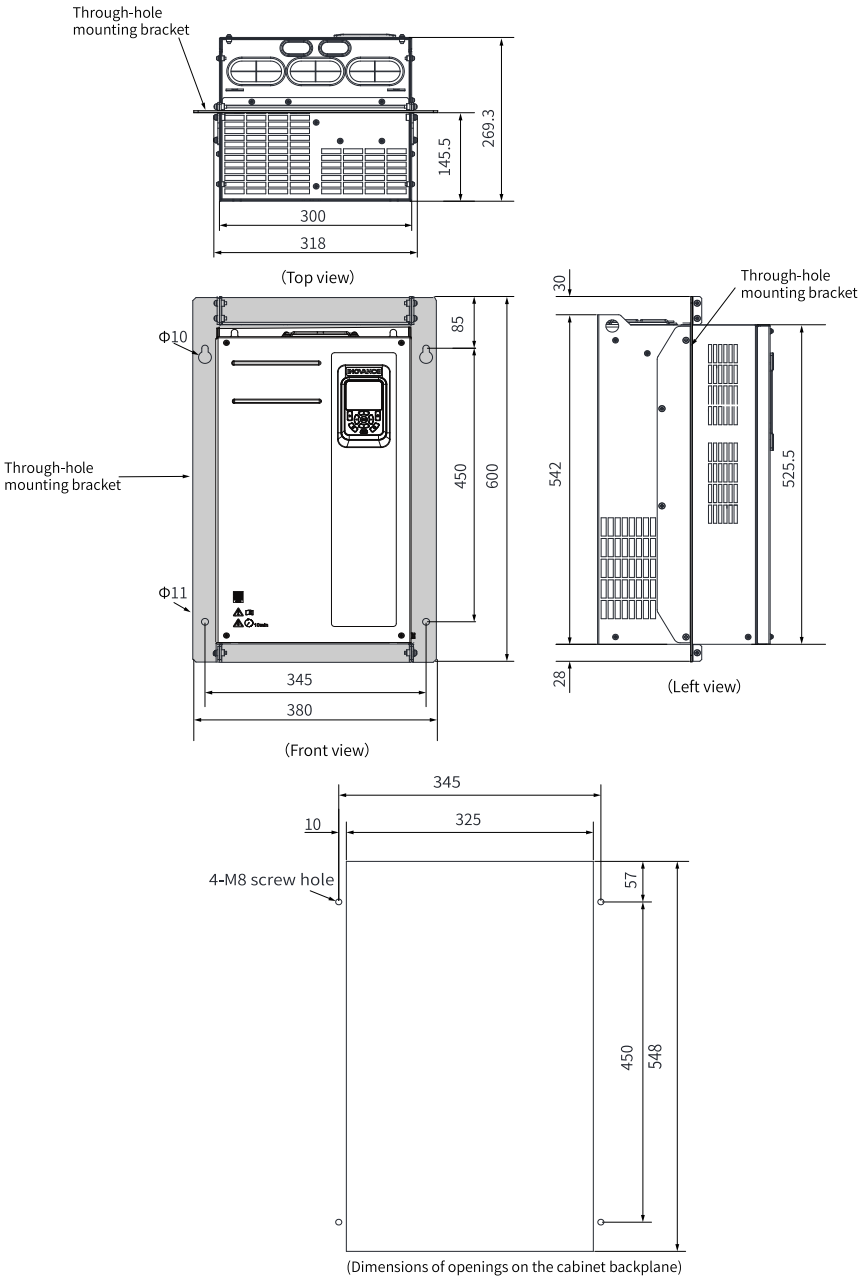


Figure 5-8 MD500-AZJ-A1T7 through-hole mounting bracket and mounting hole dimensions (mm)

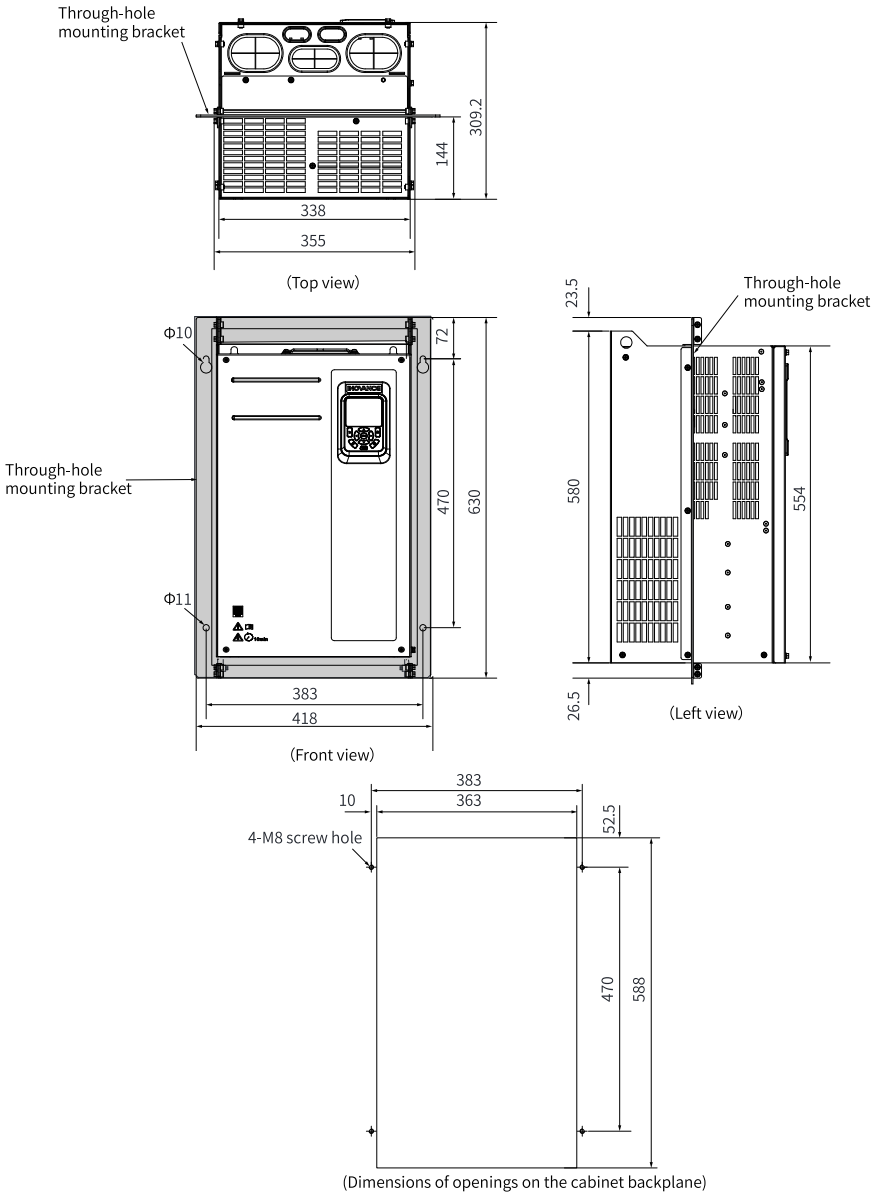


Figure 5-9 MD500-AZJ-A1T8 through-hole mounting bracket and mounting hole dimensions (mm)

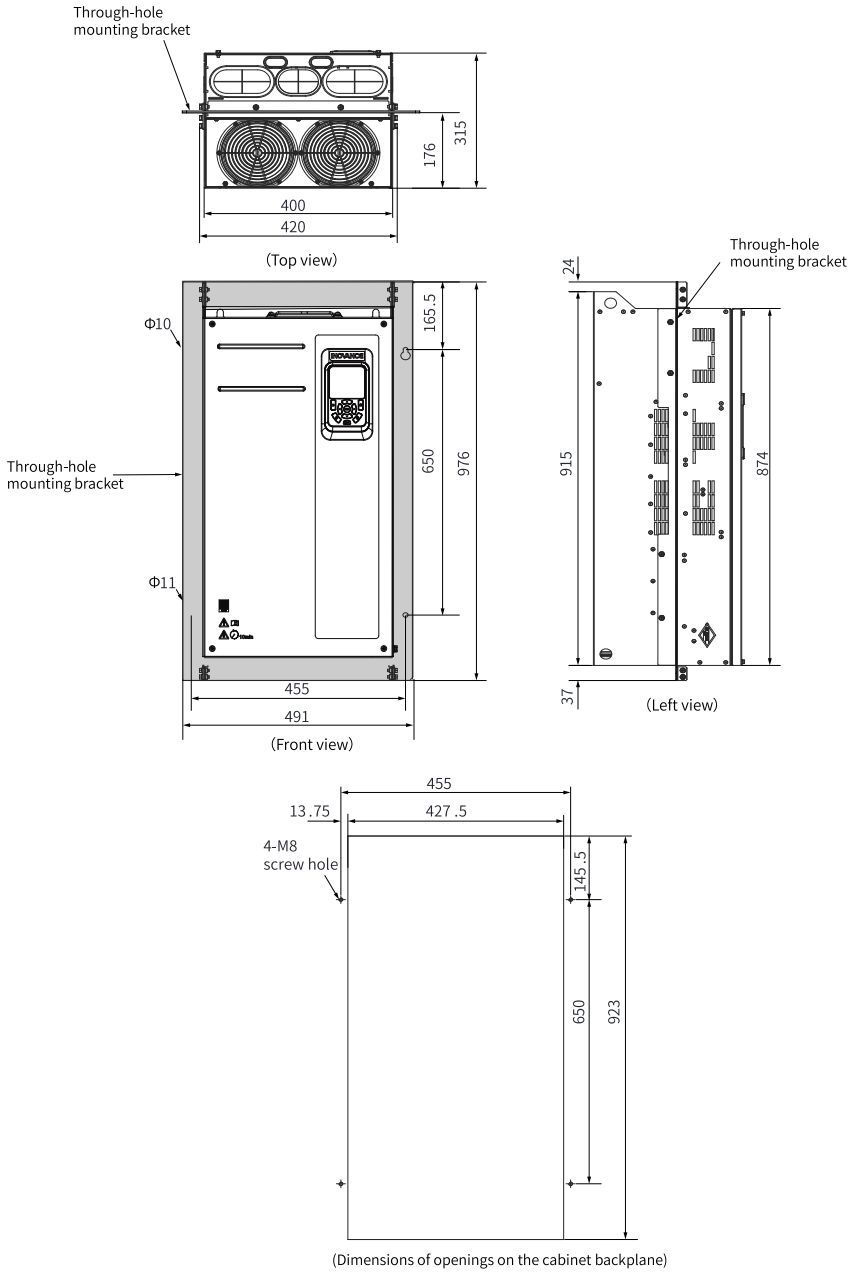


Figure 5-10 MD500-AZJ-A1T9 through-hole mounting bracket and mounting hole dimensions (mm)

5.2.2 Ground Bracket of Cable Shield

The grounding bracket of cable shield is optional and can be purchased separately as required (applicable to T9 models and below).

5.2.3 Bottom Mounting Bracket

T10 to T12 models come with a bottom mounting bracket as standard. When the AC drive is installed in a cabinet, the bottom mounting bracket is required for fixing the AC drive to the cabinet rack base. The dimensions of bottom mounting brackets vary with the power rating, weight, and size of the AC drive, as shown in the following figures.

The bracket delivered with the AC drive is applicable to cabinets with the depth of 600 mm. If you need a bracket for a cabinet with the depth of 800 mm, contact Inovance.

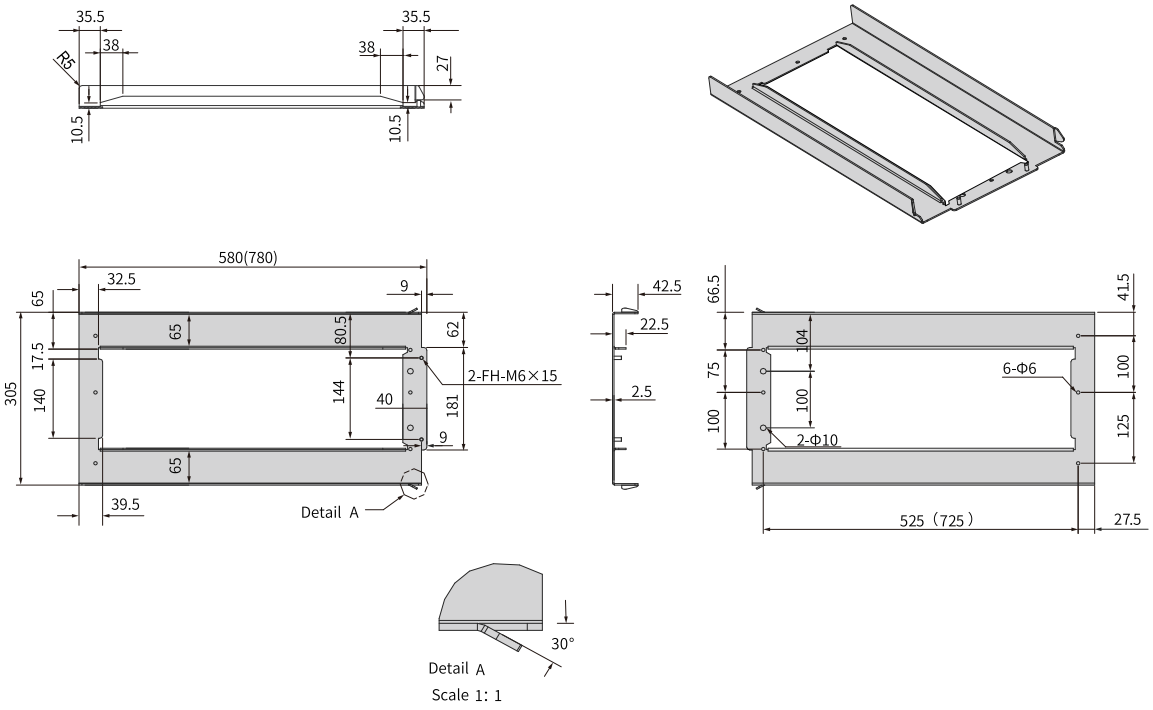


Figure 5-11 Dimensions (mm) of the bottom mounting bracket for T10 models

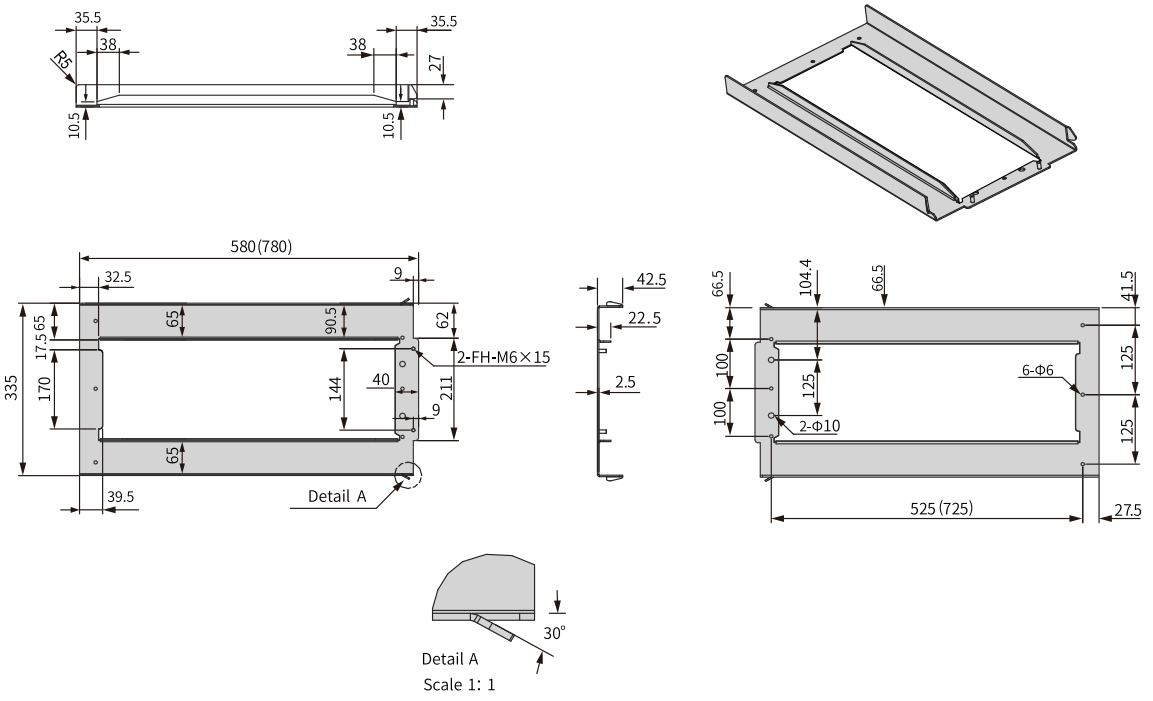


Figure 5-12 Dimensions (mm) of the bottom mounting bracket for T11 models

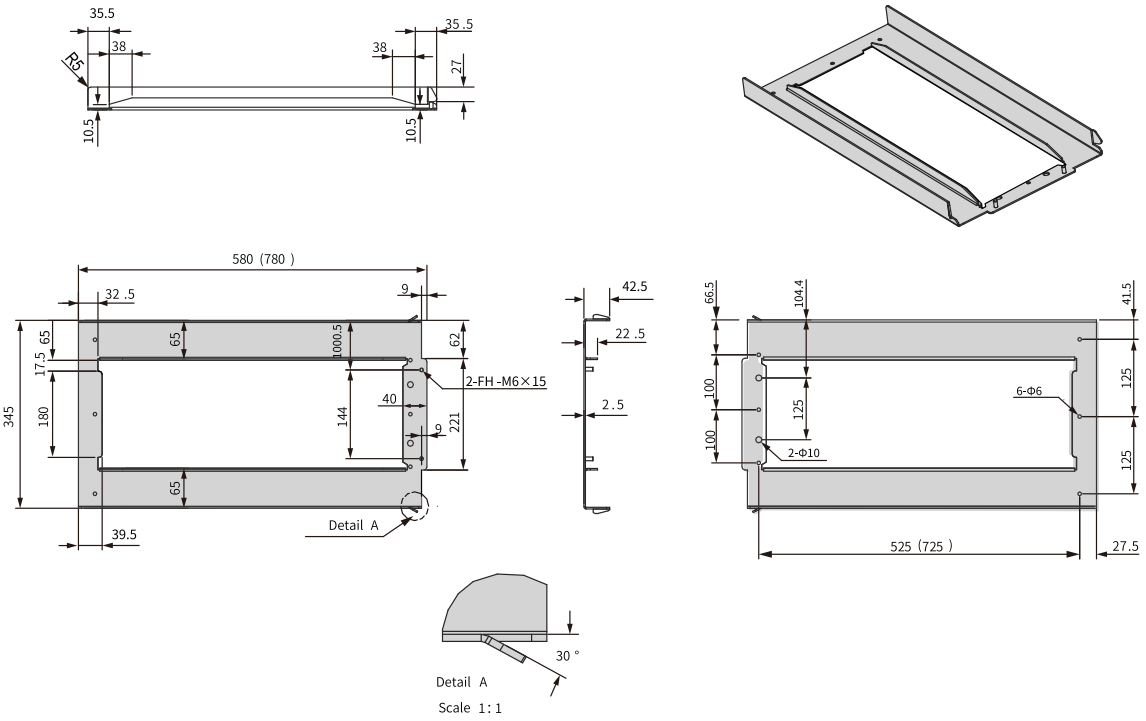


Figure 5-13 Dimensions (mm) of the bottom mounting bracket for T12 models

Note

- The bottom installation bracket applies to the PS standard cabinet, which is classified into two types: 800 mm (width) x 600 mm (depth) and 800 mm (width) x 800 mm (depth). The size described in the figure applies to the PS standard cabinet with 800 mm (width) x 800 mm (depth).
- The bottom installation bracket for T10 to T12 models applies only to the PS standard cabinet with 800 mm (width) x 600 mm (depth). To apply to the PS standard cabinet with 800 mm (width) x 800 mm (depth), contact Inovance.

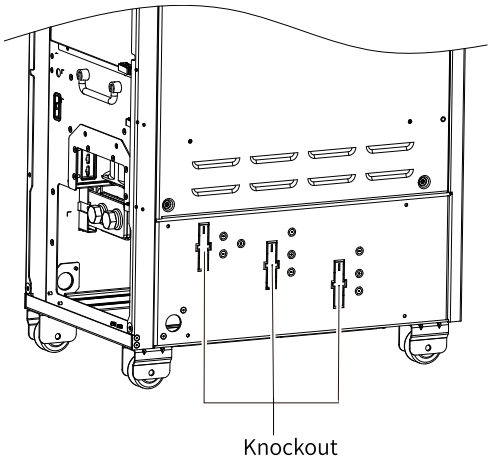
5.2.4 Mounting Guide Rail

For details of the guide rails, see *MD500-AZJ-A3T10 Guide Rail Operation Guide*.

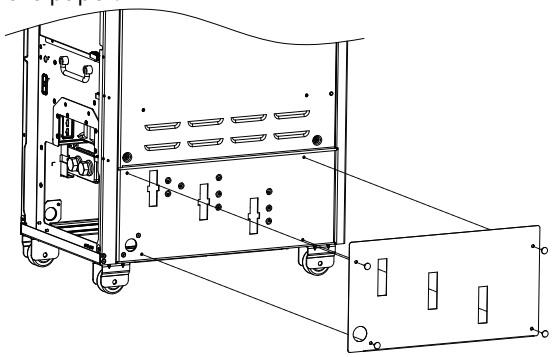
5.2.5 Installing the U/V/W Copper Busbar

All MD520 models excluding those with the base (-L) are delivered with U/V/W output side copper busbars. To install the U/V/W copper busbars, follow the steps below:

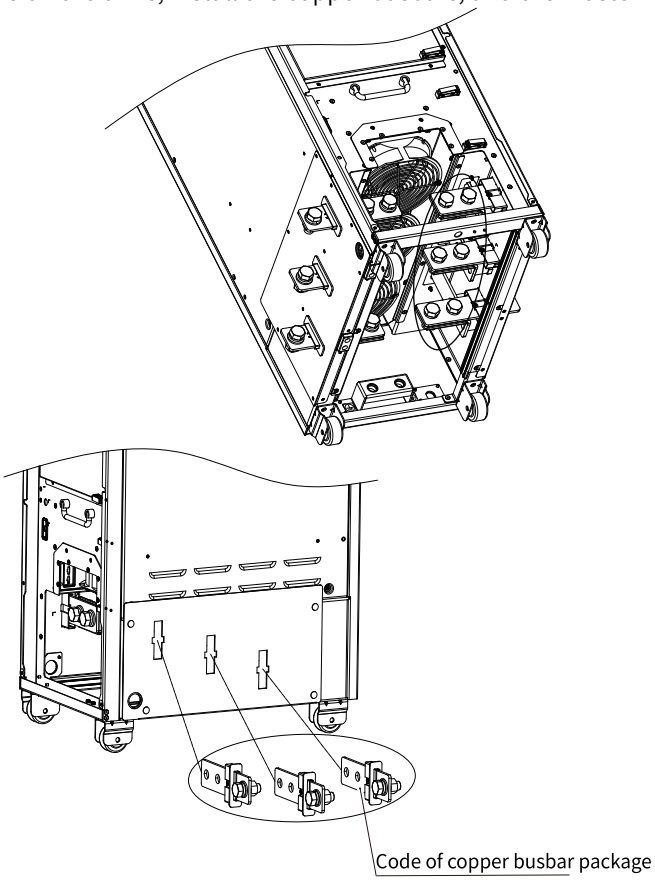
1. Use the screwdriver or cutting pliers to remove the three knockouts.



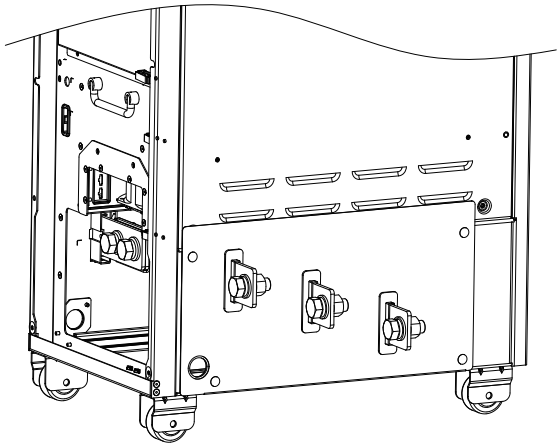
2. Use the four plastic snap-fit joints in the packing box to fasten the insulating paper to the chassis through the four holes on the paper.



3. Remove the six screws on the drive, install the copper busbars, and then fasten the six screws.



The following figure shows the installed copper busbars.



Note

For selection of the U/V/W output copper busbar, see *"5.1 List of Options" on page 56*.

5.3 Cable

5.3.1 Main Circuit Cables

Power cable selection requirements

For selection of power cables, follow national or regional regulations. Select IEC cables based on the following requirements:

- Compliant with IEC 60204-1 and IEC 60364-5-52 standards.
- PVC insulated cables with copper conductors
- Ambient temperature of 40°C and cable surface temperature of 70°C (Note: When the ambient temperature exceeds 40°C, contact Inovance.)
- Symmetrical cable with copper-braided shield

If recommended cables for peripheral devices or options are not suitable for the product, contact Inovance.

Use shielded cables to comply with the EMC requirements. The shielded cables are divided into three-conductor cables and four-conductor cables, as shown below. If the conductivity of the three-conductor cable shield cannot meet requirements, add an independent PE cable. Alternatively, use a four-conductor cable with one conductor as the PE cable. The shield of the shielded cable is comprised of coaxial cooper braids to suppress radio frequency interference. To enhance the shielding performance and conductivity, the braided density of the shield must be greater than 90%.

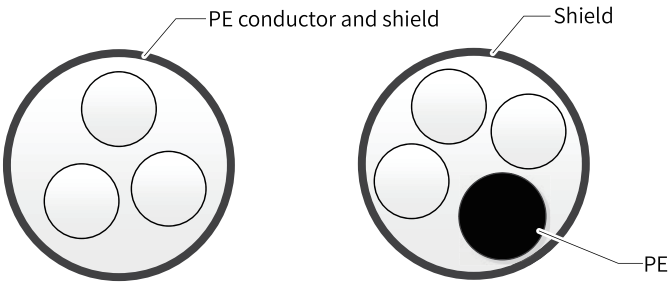


Figure 5-14 Recommended power cable

Recommended cable

Table 5–3 Cable selection (three-phase 380 V to 480 V, compliant with CE certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T1	MD520-4T0.4B(S)	1.8	1.5	3 x 0.75	TNR0.75–4	0.75	TNR0.75–4	M4	1.2 (10.6)
	MD520-4T0.7B(S)	2.4	2.1	3 x 0.75	TNR0.75–4	0.75	TNR0.75–4	M4	1.2 (10.6)
	MD520-4T1.1B(S)	3.7	3.1	3 x 0.75	TNR0.75–4	0.75	TNR0.75–4	M4	1.2 (10.6)
	MD520-4T1.5B(S)	4.6	3.8	3 x 0.75	TNR0.75–4	0.75	TNR0.75–4	M4	1.2 (10.6)
	MD520-4T2.2B(S)	6.3	5.1	3 x 1	TNR1.25–4	1	TNR1.25–4	M4	1.2 (10.6)
	MD520-4T3.0B(S)	9.0	7.2	3 x 1.5	TNR1.25–4	1.5	TNR1.25–4	M4	1.2 (10.6)
T2	MD520-4T3.7B(S)	11.4	9.0	3 x 2.5	TNR2-4	2.5	TNR2-4	M4	1.2 (10.6)
	MD520-4T5.5B(S)	16.7	13.0	3 x 4	TNR3.5–4	4	TNR3.5–4	M4	1.2 (10.6)
T3	MD520-4T7.5B(S)	21.9	17.0	3 x 6	TNR5.5–5	6	TNR5.5–5	M5	2.8 (24.8)
	MD520-4T11B(S)	32.2	25.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)
T4	MD520-4T15B(S)	41.3	32.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T5	MD520-4T18.5(B)(S)-T	37.2	37.0	3 x 16	GTNR16-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T18.5(B)(S)	49.5	37.0	3 x 16	GTNR16-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)-T	43.4	45.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)	59.0	45.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
T6	MD520-4T30(B)(S)	57.0	60.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T37(B)(S)	69.0	75.0	3 x 35	GTNR35-6	16	GTNR16-6	M6	4.8 (42.5)
T7	MD520-4T45(B)(S)	89.0	91.0	3 x 50	GTNR50-8	25	GTNR25-8	M8	13.0 (115.2)
	MD520-4T55(B)(S)	106.0	112.0	3 x 70	GTNR70-8	35	GTNR35-8	M8	13.0 (115.2)
T8	MD520-4T75(B)(S)	139.0	150.0	3 x 95	GTNR95-12	50	GTNR50-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T90(S)	164.0	176.0	3 x 120	GTNR120-12	70	GTNR70-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T110(S)	196.0	210.0	3 x 150	BC150-12	95	GTNR95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T9	MD520-4T132(S)	240.0	253.0	3 x 185	BC185-12	95	BC95-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
	MD520-4T160(S)*	287.0	304.0	2 x (3 x 120)	BC120-12	120	BC120-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
T10	MD520-4T200(S)-(L)	365.0	377.0	2 x (3 x 150)	BC150-12	150	BC150-12	M12	35.0 (310.1)
	MD520-4T220(S)-(L)	410.0	426.0	2 x (3 x 150)	BC150-12	150	BC150-12	M12	35.0 (310.1)
T11	MD520-4T250(S)-(L)*	441.0	465.0	3 x (3 x 120)	BC120-12	185	BC185-12	M12	35.0 (310.1)
	MD520-4T280(S)-(L)*	495.0	520.0	3 x (3 x 150)	BC150-12	2 x 120	BC120-12	M12	35.0 (310.1)
T12	MD520-4T315(S)-(L)*	565.0	585.0	3 x (3 x 185)	BC185-16	2 x 150	BC150-16	M16	85.0 (753.1)
	MD520-4T355(S)-(L)*	617.0	650.0	3 x (3 x 240)	BC240-16	2 x 185	BC185-16	M16	85.0 (753.1)
	MD520-4T400(S)-(L)*	687.0	725.0	3 x (3 x 240)	BC240-16	2 x 185	BC185-16	M16	85.0 (753.1)
T13	MD520-4T500(S)-(A)*	838.1	900.0	4 x (3 x 240)	BC240-16	2 x 240	BC240-16	M16	85.0 (753.1)
	MD520-4T560(S)-(A)*	949.6	1020.0	4 x (3 x 240)	BC240-16	2 x 240	BC240-16	M16	85.0 (753.1)
	MD520-4T630(S)-(A)*	1043.5	1120.0	4 x (3 x 300)	BC300-16	2 x 300	BC300-16	M16	85.0 (753.1)

Note

<1>: Applicable to GB standards. For example, 3 x 10 indicates one 3-conductor 10 mm^2 cable; 2 x (3 x 120) indicates two 3-conductor 120 mm^2 cables. The preceding recommended lugs are the TNR, GTNR, and BC series lugs from Suzhou Yuanli.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; Ambient temperature of 40°C and cable surface temperature of 70°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The cables with the asterisk mark (*) must be connected through the copper busbar.
3. If the conditions are different, you need to select the model according to actual conditions.

Table 5–4 Cable selection (three-phase 380 V to 480 V, compliant with UL certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug		
T1	MD520-4T0.4B(S)	1.8	1.5	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T0.7B(S)	2.4	2.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T1.1B(S)	3.7	3.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T1.5B(S)	4.6	3.8	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T2.2B(S)	6.3	5.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T3.0B(S)	9.0	7.2	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
T2	MD520-4T3.7B(S)	11.4	9.0	12	TLK4-4	12	TLK6-4	M4	1.2 (10.6)
	MD520-4T5.5B(S)	16.7	13.0	10	TLK6-4	10	TLK6-4	M4	1.2 (10.6)
T3	MD520-4T7.5B(S)	21.9	17.0	8	TLK10-5	8	TLK10-5	M5	2.8 (24.8)
	MD520-4T11B(S)	32.2	25.0	8	TLK10-5	8	TLK10-5	M5	2.8 (24.8)
T4	MD520-4T15B(S)	41.3	32.0	6	TLK16-5	6	TLK16-5	M5	2.8 (24.8)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug		
T5	MD520-4T18.5(B)(S)-T	37.2	37.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)
	MD520-4T18.5(B)(S)	49.5	37.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)-T	43.4	45.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)	59.0	45.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)
T6	MD520-4T30(B)(S)	57.0	60.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)
	MD520-4T37(B)(S)	69.0	75.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)
T7	MD520-4T45(B)(S)	89.0	91.0	1/0	TLK50-8	2	TLK35-8	M8	13.0 (115.2)
	MD520-4T55(B)(S)	106.0	112.0	3/0	TLK95-8	1/0	TLK50-8	M8	13.0 (115.2)
T8	MD520-4T75(B)(S)	139.0	150.0	4/0	TLK120-12	2/0	TLK70-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T90(S)	164.0	176.0	300 kcmil	SQNBS150-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T110(S)	196.0	210.0	2x3/0	TLK95-12	4/0	TLK120-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug		
T9	MD520-4T132(S)	240.0	253.0	500 kcmil	SQNBS250-12	300 kcmil	SQNBS150-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
	MD520-4T160(S)	287.0	304.0	2 x 300 kcmil	SQNBS150-12	300 kcmil	SQNBS150-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
T10	MD520-4T200(S)-(L)	365.0	377.0	2 x 350 kcmil	SQNBS180-12	350 kcmil	SQNBS180-12	M12	35.0 (310.1)
	MD520-4T220(S)-(L)*	410.0	426.0	2 x 400 kcmil	SQNBS250-12	400 kcmil	SQNBS250-12	M12	35.0 (310.1)
T11	MD520-4T250(S)-(L)*	441.0	465.0	2 x 500 kcmil	SQNBS250-12	500 kcmil	SQNBS250-12	M12	35.0 (310.1)
	MD520-4T280(S)-(L)*	495.0	520.0					M12	35.0 (310.1)
T12	MD520-4T315(S)-(L)*	565.0	585.0	4 x 300 kcmil	SQNBS150-12	2 x 300 kcmil	SQNBS150-12	M16	85.0 (753.1)
	MD520-4T355(S)-(L)*	617.0	650.0	4 x 350 kcmil	TLK185-16	2 x 350 kcmil	TLK185-16	M16	85.0 (753.1)
	MD520-4T400(S)-(L)*	687.0	725.0	4 x 400 kcmil	TLK240-16	2 x 400 kcmil	TLK240-16	M16	85.0 (753.1)
T13	MD520-4T500(S)-(A)*	838.1	900.0	4 x 500 kcmil	SQNBS325-16	2 x 500 kcmil	SQNBS325-16	M16	85.0 (753.1)
	MD520-4T560(S)-(A)*	949.6	1020.0	4 x 500 kcmil	SQNBS325-16	2 x 500 kcmil	SQNBS325-16	M16	85.0 (753.1)
	MD520-4T630(S)-(A)*	1043.5	1120.0	4 x 500 kcmil	SQNBS325-16	2 x 500 kcmil	SQNBS325-16	M16	85.0 (753.1)

Note

<2>: Applicable to AWG standards, in which 8 represents 8AWG, 1/0 represents 0AWG, 3/0 represents 000AWG, and 4/0 represents 0000AWG; 2 x 300 kcmil represents two 300 kcmil cables. The preceding recommended cable lugs are TLK and SQNBS series lugs from KST.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; Ambient temperature of 40°C and cable surface temperature of 75°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The recommended cables must meet requirements for 125% overload.
3. The cables with the asterisk mark (*) must be connected through the copper busbar.
4. If the conditions are different, you need to select the model according to actual conditions.

Table 5–5 Cable selection (three-phase 200 V to 240 V, compliant with CE certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T1	MD520-2T0.4B(S)	2.4	2.1	3 x 0.75	TNR0.75‑4	0.75	TNR0.75‑4	M4	1.2 (10.6)
	MD520-2T0.7B(S)	4.6	3.8	3 x 0.75	TNR0.75‑4	0.75	TNR0.75‑4	M4	1.2 (10.6)
	MD520-2T1.1B(S)	6.3	5.1	3 x 0.75	TNR0.75‑4	0.75	TNR0.75‑4	M4	1.2 (10.6)
	MD520-2T1.5B(S)	9.0	7.2	3 x 1.5	TNR1.25‑4	1.5	TNR1.25‑4	M4	1.2 (10.6)
T2	MD520-2T2.2B(S)	11.4	9.0	3 x 2.5	TNR2-4	2.5	TNR2-4	M4	1.2 (10.6)
	MD520-2T3.7B(S)	16.7	13.0	3 x 4	TNR3.5‑4	4	TNR3.5‑5	M4	1.2 (10.6)
T3	MD520-2T5.5B(S)	32.2	25.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)
T4	MD520-2T7.5B(S)	41.3	32.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)
T5	MD520-2T11(B)(S)	59.0	45.0	3 x 16	GTNR16-6	16	GTNR16-6	M6	4.8 (42.5)
T6	MD520-2T15(B)(S)	57.0	60.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-2T18.5(B)(S)	69.0	75.0	3 x 35	GTNR35-6	16	GTNR16-6	M6	4.8 (42.5)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T7	MD520-2T22(B)(S)	89.0	91.0	3 x 50	GTNR50-8	25	GTNR25-8	M8	4.8 (42.5)
	MD520-2T30(B)(S)	106.0	112.0	3 x 70	GTNR70-8	35	GTNR35-8	M8	4.8 (42.5)
T8	MD520-2T37(B)(S)	139.0	150.0	3 x 95	GTNR95-12	50	GTNR35-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T45(S)	164.0	176.0	3 x 120	GTNR120-12	70	GTNR50-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T55(S)	196.0	210.0	3 x 150	BC150-12	95	GTNR70-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
T9	MD520-2T75(S)	287.0	304.0	3 x 240	BC240–12	120	BC120-12	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
T10	MD520-2T90(S)	365.0	377.0	2 x (3 x 150)	BC150-12	150	BC150-12	M12	35.0 (310.1)
	MD520-2T110(S)*	410.0	426.0	2 x (3 x 185)	BC185-12	185	BC150-12	M12	35.0 (310.1)
T11	MD520-2T132(S)*	441.0	465.0	2 x (3 x 240)	BC240-12	240	BC240-12	M12	35.0 (310.1)
T12	MD520-2T160(S)	565.0	585.0	2 x (3 x 300)	BC300-16	300	BC300-16	M16	85.0 (753.1)
	MD520-2T200(S)*	687.0	725.0	4 x (3 x 185)	BC185-16	2 x 185	BC185-16	M16	85.0 (753.1)

Note

<1>: Applicable to GB standards. For example, 3 x 10 indicates one 3-conductor 10 mm^2 cable; 2 x (3 x 120) indicates two 3-conductor 120 mm^2 cables. The preceding recommended lugs are the TNR, GTNR, and BC series lugs from Suzhou Yuanli.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; Ambient temperature of 40°C and cable surface temperature of 70°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The cables with the asterisk mark (*) must be connected through the copper busbar.
3. If the conditions are different, you need to select the model according to actual conditions.

Table 5–6 Cable selection (three-phase 200 V to 240 V, compliant with UL certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug		
T1	MD520-2T0.4B(S)	2.4	2.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2T0.7B(S)	4.6	3.8	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2T1.1B(S)	6.3	5.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2T1.5B(S)	9.0	7.2	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
T2	MD520-2T2.2B(S)	11.4	9.0	12	TLK4-4	12	TLK4-4	M4	1.2 (10.6)
	MD520-2T3.7B(S)	16.7	13.0	10	TLK6-4	10	TLK6-4	M4	1.2 (10.6)
T3	MD520-2T5.5B(S)	32.2	25.0	8	TLK10-5	8	TLK10-5	M5	2.8 (24.8)
T4	MD520-2T7.5B(S)	41.3	32.0	6	TLK16-5	6	TLK16-5	M5	2.8 (24.8)
T5	MD520-2T11(B)(S)	59.0	45.0	4	TLK25-6	4	TLK25-6	M6	4.8 (42.5)
T6	MD520-2T15(B)(S)	57.0	60.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)
	MD520-2T18.5(B)(S)	69.0	75.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug		
T7	MD520-2T22(B)(S)	89.0	91.0	1/0	TLK50-8	2	TLK35-8	M8	4.8 (42.5)
	MD520-2T30(B)(S)	106.0	112.0	3/0	TLK95-8	1/0	TLK50-8	M8	4.8 (42.5)
T8	MD520-2T37(B)(S)	139.0	150.0	4/0	TLK120-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T45(S)	164.0	176.0	300 kcmil	SQNBS150-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T55(S)*	196.0	210.0	2x3/0	TLK95-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
T9	MD520-2T75(S)*	287.0	304.0	2 x 300 kcmil	SQNBS150-12	300 kcmil	SQNBS150-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
T10	MD520-2T90(S)	365.0	377.0	2 x 350 kcmil	SQNBS180-12	350 kcmil	SQNBS180-12	M12	35.0 (310.1)
	MD520-2T110(S)*	410.0	426.0	2 x 400 kcmil	SQNBS250-12	400 kcmil	SQNBS250-12	M12	35.0 (310.1)
T11	MD520-2T132(S)*	441.0	465.0	2 x 500 kcmil	SQNBS250-12	500 kcmil	SQNBS250-12	M12	35.0 (310.1)
T12	MD520-2T160(S)*	565.0	585.0	4 x 300 kcmil	SQNBS150-12	2 x 300 kcmil	SQNBS150-12	M16	85.0 (753.1)
	MD520-2T200(S)*	687.0	725.0	4 x 400 kcmil	TLK240-16	2 x 400 kcmil	TLK240-16	M16	85.0 (753.1)

Note

<2>: Applicable to AWG standards, in which 8 represents 8AWG, 1/0 represents 0AWG, 3/0 represents 000AWG, and 4/0 represents 0000AWG; 2 x 300 kcmil represents two 300 kcmil cables. The preceding recommended cable lugs are TLK and SQNBS series lugs from KST.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; ambient temperature of 40°C and cable surface temperature of 75°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The recommended cables must meet requirements for 125% overload.
3. The cables with the asterisk mark (*) must be connected through the copper busbar.
4. If the conditions are different, you need to select the model according to actual conditions.

Table 5–7 Cable selection (single-phase 200 V to 240 V) (with CE certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T2	MD520-2S0.4B(S)	5.4	2.3	3 x 0.75	TNR1.25-4	0.75	TNR1.25-4	M4	1.2 (10.6)
	MD520-2S0.7B(S)	8.2	4.0	3 x 1.5	TNR1.25-4	1.5	TNR1.25-4		
	MD520-2S1.5B(S)	14.0	7.0	3 x 2.5	TNR2-4	2.5	TNR2-4		
	MD520-2S2.2B(S)	20.0	9.6	3 x 4	TNR3.5-4	4	TNR3.5-4		

Note

<1>: Applicable to GB standards. For example, 3 x 4 indicates one 3-conductor 4 mm^2 cable; 3 x 150 indicates one 3-conductor 150 mm^2 cables. The preceding recommended cable lugs are the TNR series lugs of Suzhou Yuanli.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; ambient temperature of 40°C and cable surface temperature of 70°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. If the conditions are different, you need to select the model according to actual conditions.

Table 5–8 Cable selection (single-phase 200 V to 240 V) (with UL certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG)<2>	Recommended Cable Lug	Recommended Cable (AWG)<2>	Recommended Cable Lug		
T2	MD520-2S0.4B(S)	5.4	2.3	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2S0.7B(S)	8.2	4.0	14	TLK2.5-4	14	TLK2.5-4		
	MD520-2S1.5B(S)	14.0	7.0	12	TLK4-4	12	TLK4-4		
	MD520-2S2.2B(S)	23.0	9.6	10	RNBL5-4	10	RNBL5-4		

Note

<2>: Applicable to AWG standards; 14 represents 14AWG and 12 represents 12AWG. The preceding recommended cable lugs are TLK and RNB series lugs from KST.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; ambient temperature of 40°C and cable surface temperature of 75°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The recommended cables must meet requirements for 125% overload.
3. If the conditions are different, you need to select the model according to actual conditions.

Recommended Lug

The following table describes recommended lugs, namely, the TNR, GTNR, and BC series lugs of Suzhou Yuanli. The lugs with UL certifications are TLK and SQNBS series lugs of KST.

Table 5–9 Appearances, models, and dimensions of TNR series lugs (unit: mm)

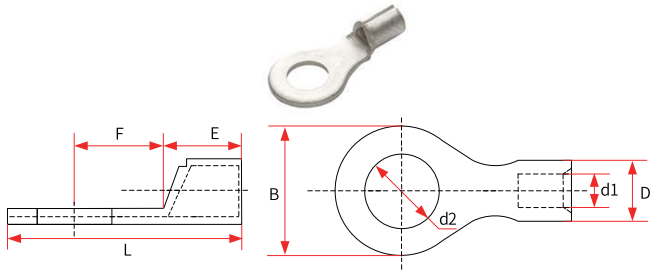
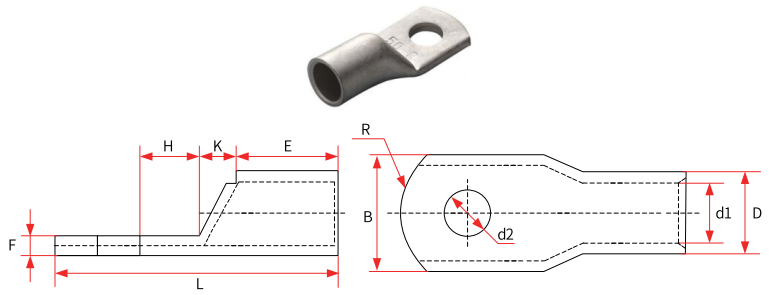
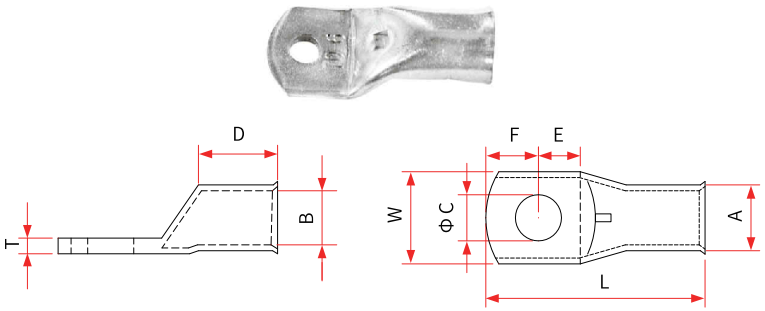
Model	Cable Specification		D	d1	E	F	B	d2	L	Current (A)	Crimping Pliers
	AWG/ MCM	mm^2									
											
TNR0.75-4	22–16	0.25-1.0	2.8	1.3	4.5	6.6	8.0	4.3	15.0	10	RYO-8
TNR1.25-4	22–16	0.25-1.65	3.4	1.7	4.5	7.3	8	5.3	15.8	19	AK-1M

Table 5–10 Appearances, models, and dimensions of GTNR series lugs (unit: mm)

Model	D	d1	E	H	K	B	d2	F	L	R	Crimping Pliers
											
GTNR1.5-5	4.0	2.2	5.0	5.0	2.0	8.0	5.3	1.0	16.0	5	RYO-8
GTNR2.5-4	4.5	2.9	7.0	5.0	2.0	8.0	4.3	1.0	18.0	5	YYT-8
GTNR2.5-5	4.5	2.9	7.0	6.0	2.0	8.0	5.3	1.0	20.0	7	RYO-14
GTNR2.5-6	4.5	2.9	7.0	6.0	2.0	10.2	6.4	0.8	20.0	7	
GTNR4-5	5.2	3.6	7.0	6.0	2.0	10.0	5.3	1.0	20.0	7	
GTNR4-6	5.2	3.6	7.0	6.0	2.0	10.0	6.4	1.0	20.0	7	
GTNR6-5	6.0	4.2	9.0	6.0	3.0	10.0	5.3	1.2	23.0	7	
GTNR6-6	6.0	4.2	9.0	7.5	3.0	10.0	6.4	1.2	26.0	7	
GTNR6-8	6.0	4.2	9.0	7.5	3.0	12.0	8.4	1.0	26.0	7	
GTNR10-6	7.0	5.0	9.0	8.0	3.5	12.4	6.4	1.3	26.5	7	
GTNR10-8	7.0	5.0	9.0	8.0	3.5	12.4	8.4	1.3	27.5	7	
GTNR16-6	7.8	5.8	12.0	8.0	4.0	12.4	6.4	1.3	31.0	7	CT-38
GTNR16-8	7.8	5.8	12.0	8.0	4.0	12.4	8.4	1.3	31.0	7	CT-100
GTNR25-6	9.5	7.5	12.0	8.0	4.5	14.0	6.4	2.0	32.0	10	
GTNR25-8	9.5	7.5	12.0	9.0	4.5	15.5	8.4	1.6	34.0	10	
GTNR25-10	9.5	7.5	12.0	10.5	4.5	17.5	10.5	1.4	37.0	10	
GTNR35-6	11.4	8.6	15.0	9.0	5.0	15.5	6.4	2.8	38.0	10	
GTNR35-8	11.4	8.6	15.0	9.0	5.0	15.5	8.4	2.8	38.0	10	
GTNR35-10	11.4	8.6	15.0	10.5	5.0	17.5	10.5	2.5	40.5	10	
GTNR50-8	12.6	9.6	16.0	11.0	6.0	18.0	8.4	2.8	43.5	10	CT-100
GTNR50-10	12.6	9.6	16.0	11.0	6.0	18.0	10.5	2.8	43.5	10	
GTNR70-8	15.0	12.0	18.0	13.0	7.0	21.0	8.4	2.8	50.0	14	
GTNR70-10	15.0	12.0	18.0	13.0	7.0	21.0	10.5	2.8	50.0	14	
GTNR70-12	15.0	12.0	18.0	13.0	7.0	21.0	13.0	2.8	50.0	14	
GTNR95-10	17.4	13.5	20.0	13.0	9.0	25.0	10.5	3.9	55.0	14	
GTNR95-12	17.4	13.5	20.0	13.0	9.0	25.0	13.0	3.9	55.0	14	

Model	D	d1	E	H	K	B	d2	F	L	R	Crimping Pliers
GTNR120-12	19.8	15.0	22.0	14.0	10.0	28.0	13.0	4.7	60.0	16	RYC-150
GTNR120-16	19.8	15.0	22.0	16.0	10.0	28.0	17.0	4.7	64.0	16	
GTNR150-12	21.2	16.5	26.0	16.0	11.0	30.0	13.0	4.7	69.0	24	
GTNR150-16	21.2	16.5	26.0	16.0	11.0	30.0	17.0	4.7	69.0	24	
GTNR185-16	23.5	18.5	32.0	17.0	12.0	34.0	17.0	5.0	78.0	24	
GTNR240-16	26.5	21.5	38.0	20.0	14.0	38.0	17.0	5.5	92.0	24	
GTNR240-20	26.5	21.5	38.0	20.0	14.0	38.0	21.0	5.5	92.0	24	

Table 5–11 Appearance, models, and dimensions of BC series cable lugs (unit: mm)

Model	A	B	W	E	D	L	T	C	F
									
120-8	19.0	15.0	27.2	16.5	27.0	73.0	4.0	8.5	16.5
120-10								10.5	
120-12								12.8	
120-14								14.7	
120-16								16.7	
120-20				18.8				20.7	14.3
150-8	21.0	16.5	30.0	16.5	27.0	78.0	4.5	8.5	16.5
150-10								10.5	
150-12								12.8	
150-14								14.7	
150-16								16.7	
150-20				18.8				20.7	14.3
185-10	23	18.5	33.5	16.5	30	82	4.5	10.5	16.5
185-12								12.8	
185-14								14.7	
185-16								16.7	
185-20				18.8				20.7	14.3
240-10	26	21	37.7	18.0	32.0	88.0	5.0	10.5	17.0
240-12								12.8	
240-14								14.7	
240-16								16.7	
240-20								20.7	

Model	A	B	W	E	D	L	T	C	F
300-10	28.0	23.0	41.0	18.0	37.0	97.0	5.0	10.5	17.0
300-12								12.8	
300-14								14.7	
300-16								16.7	
300-20								20.7	

5.3.2 Selection of Control Circuit Cables

Note

Wire the control circuit cable according to EN 60204-1.

To ensure that I/O signal cables are not affected by peripheral interference and noise, use shielded cables with the shield for signal cables. Install the signal shield bracket at each end of the shield to reliably connect the shield to the AC drive in 360°. Use separate shielded cables for different analog signals. It is recommended to use shielded twisted pair (STP) cables for digital signals.

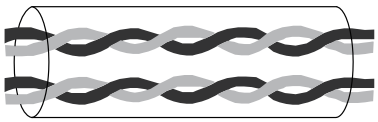


Figure 5-15 STP cable

5.4 Peripheral Electrical Component

5.4.1 Fuse, Contactor, and Circuit Breaker

Caution

To avoid electric shocks, do not power on the AC drive or operate peripherals immediately after a fuse burns or a circuit breaker trips. Instead, wait at least a period of time specified on the product warning label before further operations. Failure to comply will result in product damage, several injuries, or even death.

To comply with EN 61800-5-1 and UL 61800-5-1 standards, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit.

The following tables list recommended fuses and circuit breakers manufactured by Bussmann.

Table 5–12 Selection of fuses, contactors, and circuit breakers (three-phase 380 V to 480 V, compliant with CE certification)

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T1	MD520-4T0.4B(S)	5	FWP-5B	9	4
	MD520-4T0.7B(S)	10	FWP-10B	9	6.3
	MD520-4T1.1B(S)	10	FWP-10B	9	10
	MD520-4T1.5B(S)	10	FWP-10B	9	10
	MD520-4T2.2B(S)	15	FWP-15B	12	16
	MD520-4T3.0B(S)	20	FWP-20B	16	16
T2	MD520-4T3.7B(S)	30	FWP-30B	26	25
	MD520-4T5.5B(S)	35	FWP-35C	26	32
T3	MD520-4T7.5B(S)	50	FWH-50C	38	40
	MD520-4T11B(S)	60	FWH-60C	50	50
T4	MD520-4T15B(S)	70	FWH-70C	50	63
T5	MD520-4T18.5(B)(S)-T	90	FWH-90C	65	80
	MD520-4T18.5(B)(S)	80	FWH-80C	65	80
	MD520-4T22(B)(S)-T	100	FWH-100C	80	80
	MD520-4T22(B)(S)	100	FWH-100C	80	100
T6	MD520-4T30(B)(S)	125	FWH-125C	80	100
	MD520-4T37(B)(S)	150	FWH-150C	95	125
T7	MD520-4T45(B)(S)	175	FWH-175C	115	160
	MD520-4T55(B)(S)	225	FWH-225C	150	200
T8	MD520-4T75(B)(S)	250	FWH-250C	170	250
	MD520-4T90(S)	300	FWH-300C	205	250
	MD520-4T110(S)	400	FWH-400C	245	400
T9	MD520-4T132(S)	450	FWH-450C	300	400
	MD520-4T160(S)	600	FWH-600C	410	500
T10	MD520-4T200(S)-(L)	700	FWH-700C	410	630
	MD520-4T220(S)-(L)	800	FWH-800C	475	630
T11	MD520-4T250(S)-(L)	800	FWH-800C	475	630
	MD520-4T280(S)-(L)	1000	170M5016	620	800
T12	MD520-4T315(S)-(L)	1000	170M5016	620	800
	MD520-4T355(S)-(L)	1100	170M6015	800	1000
	MD520-4T400(S)-(L)	1250	170M6016	800	1000

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T13	MD520-4T500(S)-(A)	1500	170M6018	-	-
	MD520-4T560(S)-(A)	1600	170M6019	-	-
	MD520-4T630(S)-(A)	1800	170M6020	-	-
Note: The circuit breaker is configured in the T13 cabinet.					

Note

The recommended values in the preceding table are based on the following:

1. The ambient temperature of the device is 40°C, there is no forced air cooling method, and the altitude is 2000 m. A single product is installed. The conductor or copper busbar carrying current density is 1.3 A/mm^2.

2. If the conditions are different, you need to select the model according to actual conditions.

3. Fuses with the UL certification are recommended.

Table 5–13 Selection of fuses, contactors, and circuit breakers (three-phase 380 V to 480 V, compliant with UL certification)

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T1	MD520-4T0.4B(S)	5	FWP-5B	9	4
	MD520-4T0.7B(S)	10	FWP-10B	9	6.3
	MD520-4T1.1B(S)	10	FWP-10B	9	10
	MD520-4T1.5B(S)	10	FWP-10B	9	10
	MD520-4T2.2B(S)	15	FWP-15B	12	16
	MD520-4T3.0B(S)	20	FWP-20B	16	16
T2	MD520-4T3.7B(S)	30	FWP-30B	26	25
	MD520-4T5.5B(S)	35	FWH-35C	26	32
T3	MD520-4T7.5B(S)	50	FWH-50C	38	40
	MD520-4T11B(S)	60	FWH-60C	50	50
T4	MD520-4T15B(S)	70	FWH-70C	50	63
T5	MD520-4T18.5(B)(S)-T	90	FWH-90C	65	80
	MD520-4T18.5(B)(S)	80	FWH-80C	65	80
	MD520-4T22(B)(S)-T	100	FWH-100C	80	80
	MD520-4T22(B)(S)	100	FWH-100C	80	100
T6	MD520-4T30(B)(S)	125	FWH-125C	80	100
	MD520-4T37(B)(S)	150	FWH-150C	95	125

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T7	MD520-4T45(B)(S)	175	FWH-175C	115	160
	MD520-4T55(B)(S)	225	FWH-225C	150	200
T8	MD520-4T75(B)(S)	250	FWH-250C	170	250
	MD520-4T90(S)	300	FWH-300C	205	250
	MD520-4T110(S)	400	FWH-400C	245	400
T9	MD520-4T132(S)	450	FWH-450C	300	400
	MD520-4T160(S)	600	FWH-600C	410	500
T10	MD520-4T200(S)-(L)	700	FWH-700C	410	630
	MD520-4T220(S)-(L)	800	FWH-800C	475	630
T11	MD520-4T250(S)-(L)	800	FWH-800C	475	630
	MD520-4T280(S)-(L)	1000	170M5016	620	800
T12	MD520-4T315(S)-(L)	1000	170M5016	620	800
	MD520-4T355(S)-(L)	1100	170M6015	800	1000
	MD520-4T400(S)-(L)	1250	170M6016	800	1000
T13	MD520-4T500(S)-(A)	1400	170M6017	-	-
	MD520-4T560(S)-(A)	1500	170M6018	-	-
	MD520-4T630(S)-(A)	1600	170M6019	-	-
Note: The circuit breaker is configured in the T13 cabinet.					

Note

The recommended values in the preceding table are based on the following:

1. The ambient temperature of the device is 40°C, there is no forced air cooling method, and the altitude is 2000 m. A single product is installed. The conductor or copper busbar carrying current density is 1.3 A/mm^2.

2. If the conditions are different, you need to select the model according to actual conditions.

Table 5–14 Selection of fuses, contactors, and circuit breakers (three-phase 200 V to 240 V, compliant with CE certification)

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T1	MD520-2T0.4B(S)	10	FWP-10B	9	6.3
	MD520-2T0.7B(S)	10	FWP-10B	9	10
	MD520-2T1.1B(S)	15	FWP-15B	12	16
	MD520-2T1.5B(S)	20	FWP-20B	16	16
T2	MD520-2T2.2B(S)	30	FWP-30B	26	20
	MD520-2T3.7B(S)	35	FWH-35C	26	32
T3	MD520-2T5.5B(S)	60	FWH-60C	50	50
T4	MD520-2T7.5B(S)	70	FWH-70C	50	63
T5	MD520-2T11(B)(S)	100	FWH-100C	75	80
T6	MD520-2T15(B)(S)	125	FWH-125C	75	100
	MD520-2T18.5(B)(S)	150	FWH-150C	95	125
T7	MD520-2T22(B)(S)	175	FWH-175C	145	160
	MD520-2T30(B)(S)	225	FWH-225C	185	200
T8	MD520-2T37(B)(S)	250	FWH-250C	185	250
	MD520-2T45(S)	300	FWH-300C	210	250
	MD520-2T55(S)	400	FWH-400C	260	320
T9	MD520-2T75(S)	600	FWH-450C	400	500
T10	MD520-2T90(S)	700	FWH-600C	460	630
	MD520-2T110(S)	800	FWH-700C	580	800
T11	MD520-2T132(S)	1000	170M5016	580	1000
T12	MD520-2T160(S)	1100	170M6015	750	1000
	MD520-2T200(S)	1250	170M6016	1250	1250

Note

The recommended values in the preceding table are based on the following:

1. The ambient temperature of the device is 40°C, there is no forced air cooling method, and the altitude is 2000 m. A single product is installed. The conductor or copper busbar carrying current density is 1.3 A/mm^2.

2. If the conditions are different, you need to select the model according to actual conditions.

3. Fuses with the UL certification are recommended.

Table 5–15 Selection of fuses, contactors, and circuit breakers (three-phase 200 V to 240 V, compliant with UL certification)

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T1	MD520-2T0.4B(S)	10	FWP-10B	9	6.3
	MD520-2T0.7B(S)	10	FWP-10B	9	10
	MD520-2T1.1B(S)	15	FWP-15B	12	16
	MD520-2T1.5B(S)	20	FWP-20B	16	16
T2	MD520-2T2.2B(S)	30	FWP-30B	26	20
	MD520-2T3.7B(S)	35	FWH-35C	26	32
T3	MD520-2T5.5B(S)	60	FWH-60C	50	50
T4	MD520-2T7.5B(S)	70	FWH-70C	50	63
T5	MD520-2T11(B)(S)	100	FWH-100C	80	80
T6	MD520-2T15(B)(S)	125	FWH-125C	80	100
	MD520-2T18.5(B)(S)	150	FWH-150C	95	125
T7	MD520-2T22(B)(S)	175	FWH-175C	115	160
	MD520-2T30(B)(S)	225	FWH-225C	150	200
T8	MD520-2T37(B)(S)	250	FWH-250C	170	250
	MD520-2T45(S)	300	FWH-300C	205	250
	MD520-2T55(S)	400	FWH-400C	245	320
T9	MD520-2T75(S)	600	FWH-450C	400	500
T10	MD520-2T90(S)	700	FWH-600C	460	630
	MD520-2T110(S)	800	FWH-700C	580	800
T11	MD520-2T132(S)	1000	170M5016	580	1000
T12	MD520-2T160(S)	1100	170M6015	750	1000
	MD520-2T200(S)	1250	170M6016	1250	1250

Note

The recommended values in the preceding table are based on the following:

1. The ambient temperature of the device is 40°C, there is no forced air cooling method, and the altitude is 2000 m. A single product is installed. The conductor or copper busbar carrying current density is 1.3 A/mm^2.

2. If the conditions are different, you need to select the model according to actual conditions.

Table 5–16 Selection of fuses, contactors, and circuit breakers (single-phase 200 V to 240 V, compliance with CE certification)

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T2	MD520-2S0.4B(S)	10	FWP-10B	9	10
	MD520-2S0.7B(S)	15	FWP-15B	12	16
	MD520-2S1.5B(S)	25	FWP-20B	16	20
	MD520-2S2.2B(S)	35	FWP-30B	26	25

Note

The recommended values in the preceding table are based on the following:

1. The ambient temperature of the device is 40°C, there is no forced air cooling method, and the altitude is 2000 m. A single product is installed. The conductor or copper busbar carrying current density is 1.3 A/mm^2.

2. If the conditions are different, you need to select the model according to actual conditions.

Table 5–17 Selection of fuses, contactors, and circuit breakers (single-phase 200 V to 240 V, compliance with UL certification)

Structure	Drive Model	Recommended Fuse Specification (Bussmann)		Recommended Contactor Specification (A Series of ABB)	Recommended Circuit Breaker Specification (Tmax Series of ABB)
		Rated Current (A)	Drive Model	Rated Current (A)	Rated Current (A)
T2	MD520-2S0.4B(S)	10	FWP-10B	9	10
	MD520-2S0.7B(S)	15	FWP-15B	12	16
	MD520-2S1.5B(S)	25	FWP-20B	16	20
	MD520-2S2.2B(S)	35	FWP-30B	26	25

Note

The recommended values in the preceding table are based on the following:

1. The ambient temperature of the device is 40°C, there is no forced air cooling method, and the altitude is 2000 m. A single product is installed. The conductor or copper busbar carrying current density is 1.3 A/mm^2.

2. If the conditions are different, you need to select the model according to actual conditions.

Note

The Bussmann fuse in the following table is only for your reference and is not mandatory. You can select a fuse with higher performance than the recommended fuse.

5.4.2 AC Input Reactor

An AC input reactor is optional and mainly used to reduce harmonics in the input current. Install an external reactor as needed in actual applications.

If an AC input reactor is required for models with the power over 200 kW, reserve sufficient installation space in the cabinet for the reactor.

Models and dimensions (Inovance)

Recommended AC input reactor manufacturers and models are listed in the following tables.

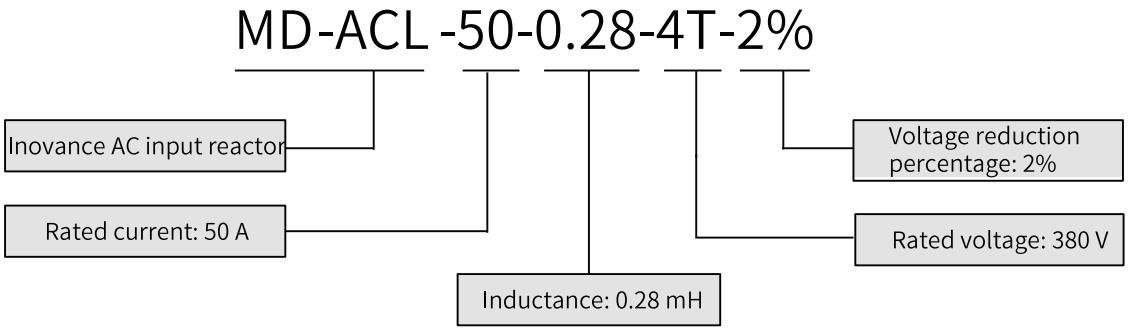


Figure 5-16 AC input reactor model

Table 5–18 Selection of Inovance AC input reactors (three-phase 380 V to 480 V)

Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T1	MD520-4T0.4B(S)	MD-ACL-10-5-4T	5	50
	MD520-4T0.7B(S)	MD-ACL-10-5-4T	5	50
	MD520-4T1.1B(S)	MD-ACL-10-5-4T	5	50
	MD520-4T1.5B(S)	MD-ACL-10-5-4T	5	50
	MD520-4T2.2B(S)	MD-ACL-10-5-4T	5	50
	MD520-4T3.0B(S)	MD-ACL-10-5-4T	5	50
T2	MD520-4T3.7B(S)	MD-ACL-15-3-4T	3	50
	MD520-4T5.5B(S)	MD-ACL-15-3-4T	3	50
T3	MD520-4T7.5B(S)	MD-ACL-40-1.45-4T	1.45	100
	MD520-4T11B(S)	MD-ACL-40-1.45-4T	1.45	100
T4	MD520-4T15B(S)	MD-ACL-50-1.2-4T	1.2	150
T5	MD520-4T18.5(B)(S) MD520-4T18.5(B)(S)-T	MD-ACL-50-0.28-4T-2	0.28	-
	MD520-4T22(B)(S) MD520-4T22(B)(S)-T	MD-ACL-60-0.24-4T-2%	0.24	-
T6	MD520-4T30(B)(S)	MD-ACL-80-0.17-4T-2%	0.17	-
	MD520-4T37(B)(S)	MD-ACL-90-0.16-4T-2%	0.16	-
T7	MD520-4T45(B)(S)	MD-ACL-120-0.12-4T-2%	0.12	-
	MD520-4T55(B)(S)	MD-ACL-150-0.095-4T-2%	0.095	-

Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T8	MD520-4T75(B)(S)	MD-ACL-200-0.07-4T-2%	0.07	-
	MD520-4T90(S)	MD-ACL-250-0.056-4T-2%	0.056	-
	MD520-4T110(S)	MD-ACL-250-0.056-4T-2%	0.056	-
T9	MD520-4T132(S)	MD-ACL-330-0.042-4T-2%	0.042	-
	MD520-4T160(S)	MD-ACL-330-0.042-4T-2%	0.042	-
T10	MD520-4T200(S)(-L)	MD-ACL-490-0.028-4T-2%	0.028	-
	MD520-4T220(S)(-L)	MD-ACL-490-0.028-4T-2%	0.028	-
T11	MD520-4T250(S)(-L)	MD-ACL-490-0.028-4T-2%	0.028	-
	MD520-4T280(S)(-L)	MD-ACL-660-0.021-4T-2%	0.021	-
T12	MD520-4T315(S)(-L)	MD-ACL-660-0.021-4T-2%	0.021	-
	MD520-4T355(S)(-L)	MD-ACL-800-0.017-4T-2%	0.017	-
	MD520-4T400(S)(-L)	MD-ACL-800-0.017-4T-2%	0.017	-
T13	MD520-4T500(S)(-A)	GH-MVT504ZG-L2	0.022	-
	MD520-4T560(S)(-A)	GH-MVT634ZG-L3	0.018	-
	MD520-4T630(S)(-A)	GH-MVT634ZG-L3	0.018	-
Note: For T13 models with the model name containing "-A", the reactor is standard.				

Table 5–19 Selection of Inovance AC input reactors (three-phase 200 V to 240 V)

Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T1	MD520-2T0.4B(S)	MD-ACL-10-5-4T	5	50
	MD520-2T0.7B(S)	MD-ACL-10-5-4T	5	50
	MD520-2T1.1B(S)	MD-ACL-10-5-4T	5	50
	MD520-2T1.5B(S)	MD-ACL-10-5-4T	5	50
T2	MD520-2T2.2B(S)	MD-ACL-15-3-4T	3	50
	MD520-2T3.7B(S)	MD-ACL-15-3-4T	3	50
T3	MD520-2T5.5B(S)	MD-ACL-40-1.45-4T	1.45	100
T4	MD520-2T7.5B(S)	MD-ACL-50-1.2-4T	1.2	150
T5	MD520-2T11(B)(S)	MD-ACL-80-0.17-4T-2%	0.17	-
T6	MD520-2T15(B)(S)	MD-ACL-80-0.17-4T-2%	0.17	-
	MD520-2T18.5(B)(S)	MD-ACL-90-0.16-4T-2%	0.16	-
T7	MD520-2T22(B)(S)	MD-ACL-120-0.12-4T-2%	0.12	-
	MD520-2T30(B)(S)	MD-ACL-150-0.095-4T-2%	0.095	-
T8	MD520-2T37(B)(S)	MD-ACL-200-0.07-4T-2%	0.07	-
	MD520-2T45(S)	MD-ACL-250-0.056-4T-2%	0.056	-
	MD520-2T55(S)	MD-ACL-250-0.056-4T-2%	0.056	-
T9	MD520-2T75(S)	MD-ACL-330-0.042-4T-2%	0.042	-

Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T10	MD520-2T90(S)	MD-ACL-490-0.028-4T-2%	0.028	-
	MD520-2T110(S)	MD-ACL-490-0.028-4T-2%	0.028	-
T11	MD520-2T132(S)	MD-ACL-660-0.021-4T-2%	0.021	-
T12	MD520-2T160(S)	MD-ACL-660-0.021-4T-2%	0.021	-
	MD520-2T200(S)	MD-ACL-800-0.017-4T-2%	0.017	-

Dimensions

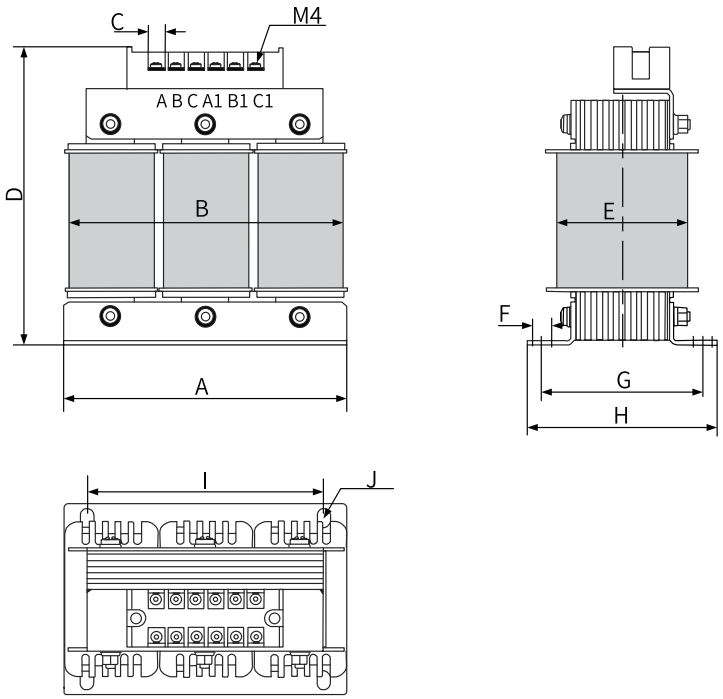


Figure 5-17 Dimensions of AC input reactors (10 A/15 A)

Table 5–20 Dimensions of AC input reactors (10 A/15 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J
10	150±2	155	8	160	80	10	85±2	100±2	125±1	Φ7x10
15	150±2	155	8	160	80	10	85±2	100±2	125±1	Φ7x10

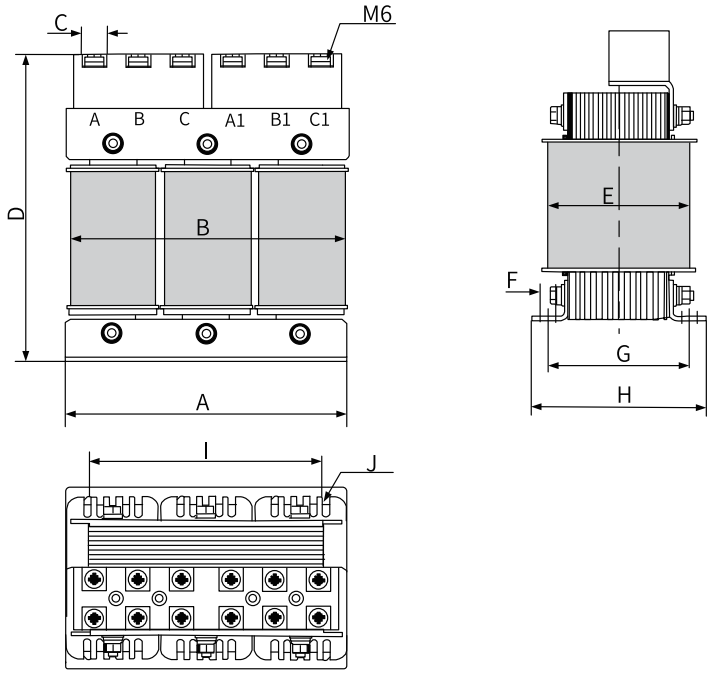


Figure 5-18 Dimensions of AC input reactors (40 A/50 A, 1.2 mH)

Table 5–21 Dimensions of AC input reactors (40 A/50 A, 1.2 mH, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J
40	180±2	185	16	200	105	10	95±2	117±2	150±1	Φ7x10
50	200±2	210	16	230	110	10	115±2	130±2	170±1	Φ7x10

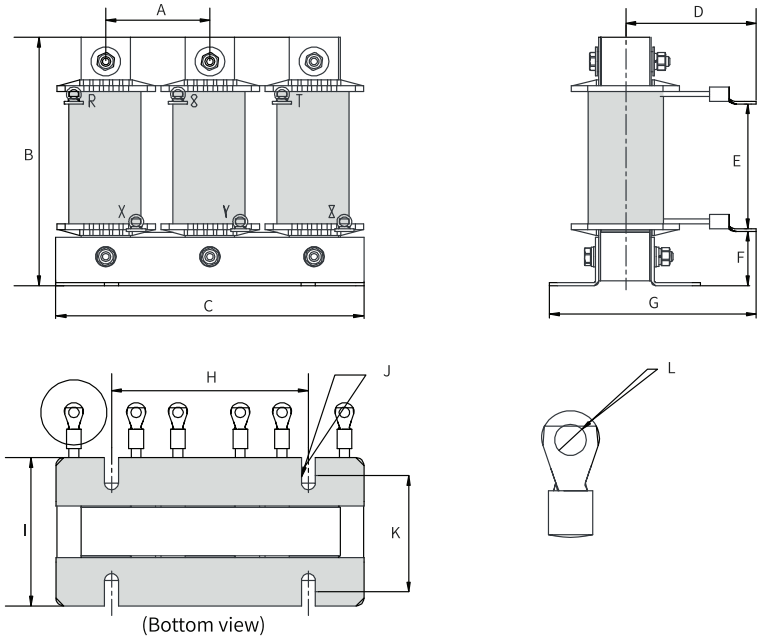


Figure 5-19 Dimensions of AC input reactors (50 A/0.28 mH, 60 A)

Table 5–22 Dimensions of AC input reactors (50 A/0.28 mH, 60 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L
50	64	160	195	80±10	75±5	35±5	135	120±1	92±2	Φ8.5x20	72±2	Φ6.4
60	64	160	195	80±10	75±5	35±5	135	120±1	92±2	Φ8.5x20	72±2	Φ6.4

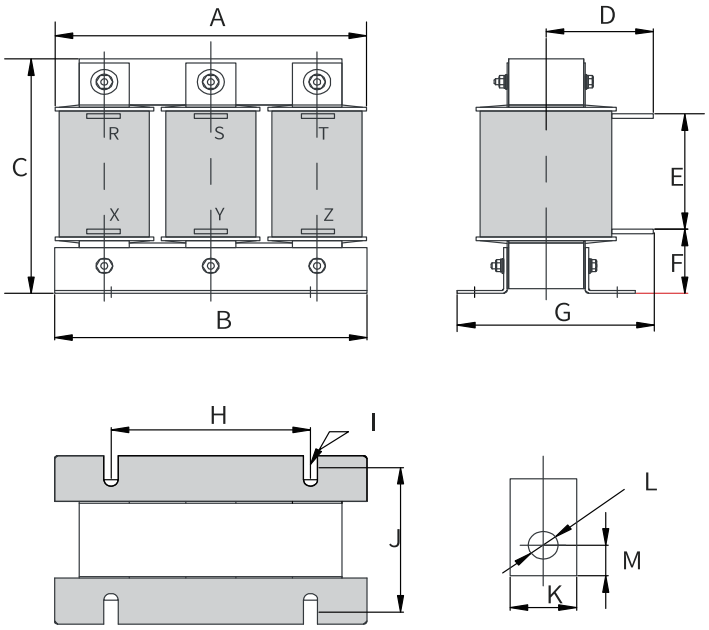


Figure 5-20 Dimensions of AC input reactors (80 A to 120 A)

Table 5–23 Dimensions of AC input reactors (80 A to 120 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M
80	195	188±1	160	-	-	-	150	120±1	Φ8.5x20	72±2	-	-	-
90	195	188±1	160	-	-	-	150	120±1	Φ8.5x20	72±2	-	-	-
120	195	188±1	160	78±10	79±5	40±5	135	120±1	Φ8.5x20	92±2	20	Φ9	10

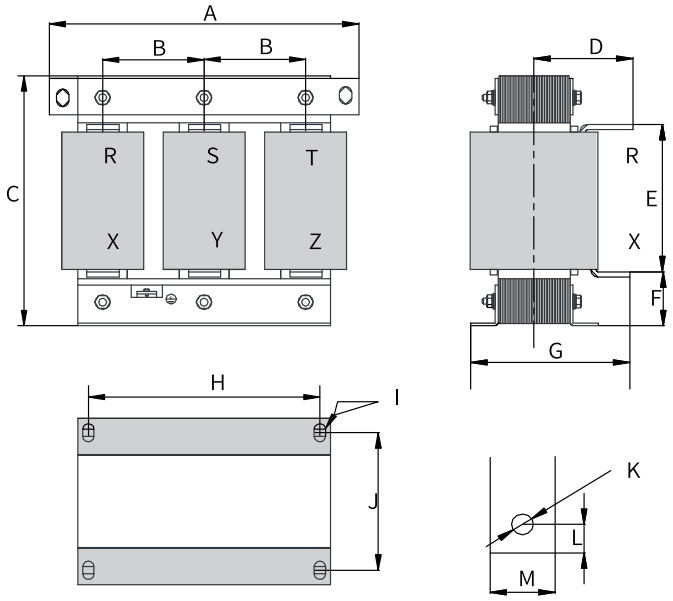


Figure 5-21 Dimensions of AC input reactors (150 A to 330 A)

Table 5–24 Dimensions of AC input reactors (150 A to 330 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M
150	250	81±5	230	92±10	145±5	38±5	155	182±1	Φ11x18	76±2	Φ11	13	25
200	250	81±5	230	102±10	145±5	40±5	175	182±1	Φ11x18	96±2	Φ11	13	25
250	250	81±5	260	102±10	160±5	50±5	175	182±1	Φ11x18	96±2	Φ11	13	25
330	290	95±5	275	107±10	160±5	60±5	180	214±1	Φ11x18	100±2	Φ12	15	30

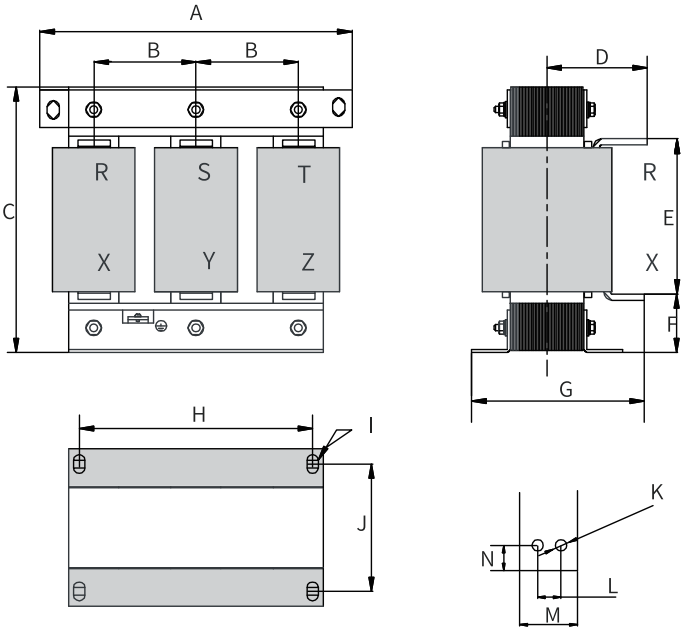


Figure 5-22 Dimensions of AC input reactors (490 A/660 A)

Table 5–25 Dimensions of AC input reactors (490 A/660 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
490	320	106±5	305	137±10	198±5	60±5	220	243±1	Φ12x20	122±2	Φ12	22	50	23
660	320	106±5	305	145±10	203±5	50±5	240	243±1	Φ12x20	137±2	Φ12	22	50	23

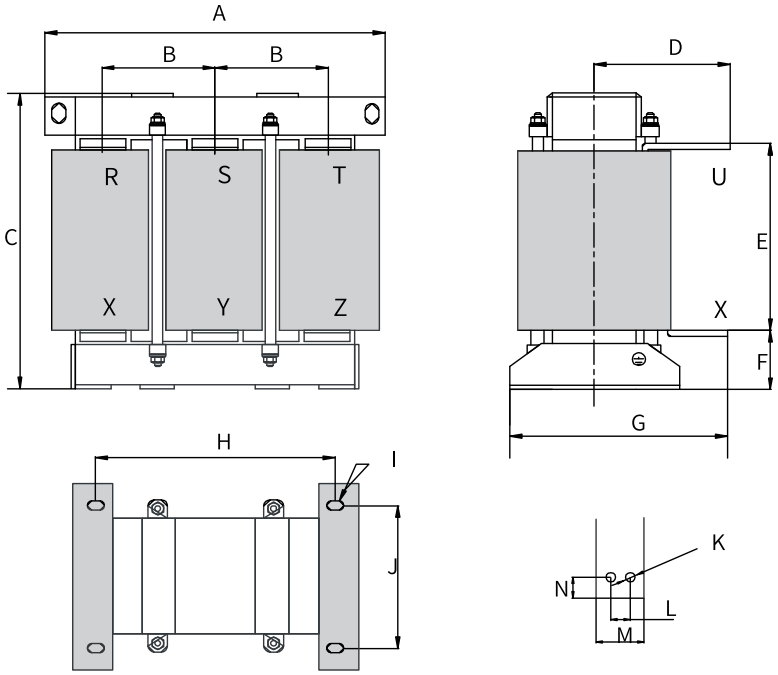


Figure 5-23 Dimensions of AC input reactors (800 A/1000 A)

Table 5–26 Dimensions of AC input reactors (800 A/1000 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
800	385	123±5	390	142±10	238±5	70±5	250	260±2	Φ12x20	175±1	Φ12	22	50	23
1000	385	123±5	390	142±10	238±5	70±5	250	260±2	Φ12x20	175±1	Φ12	22	50	23

Note

The dimensions of reactors provided are only for reference. Actual dimensions may vary with models.

Models and dimensions (Schaffner)

Table 5–27 Selection of Schaffner AC input reactors (three-phase 380 V to 480 V)

Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T1	MD520-4T0.4B(S)	RWK 3044-3.5-88-E0XXX	8.3	32
	MD520-4T0.7B(S)	RWK 3044-3.5-88-E0XXX	8.3	32
	MD520-4T1.1B(S)	RWK 3044-6.5-88-E0XXX	4.6	47
	MD520-4T1.5B(S)	RWK 3044-6.5-88-E0XXX	4.6	47
	MD520-4T2.2B(S)	RWK 3044-6.5-88-E0XXX	4.6	47
	MD520-4T3.0B(S)	RWK 3044-12-88-E0XXX	2.44	69
T2	MD520-4T3.7B(S)	RWK 3044-12-88-E0XXX	2.44	69
	MD520-4T5.5B(S)	RWK 3044-18-89-E0XXX	1.67	103
T3	MD520-4T7.5B(S)	RWK 3044-24-89-E0XXX	1.22	106
	MD520-4T11B(S)	RWK 3044-35-92-E0XXX	0.83	151
T4	MD520-4T15B(S)	RWK 3044-48-92-E0XXX	0.61	172
T5	MD520-4T18.5(B)(S) MD520-4T18.5(B)(S)-T	RWK 3044-59-92-E0XXX	0.5	206
	MD520-4T22(B)(S) MD520-4T22(B)(S)-T	RWK 3044-59-92-E0XXX	0.5	206
T6	MD520-4T30(B)(S)	RWK 3044-59-92-E0XXX	0.5	206
	MD520-4T37(B)(S)	RWK 3044-72-99-E0XXX	0.41	294
T7	MD520-4T45(B)(S)	RWK 3044-120-99-E0XXX	0.24	324
	MD520-4T55(B)(S)	RWK 3044-120-99-E0XXX	0.24	324
T8	MD520-4T75(B)(S)	RWK 3044-140-99-E0XXX	0.2	399
	MD520-4T90(S)	RWK 3044-180-99-E0XXX	0.17	456
	MD520-4T110(S)	RWK 3044-210-99-E0XXX	0.14	553
T9	MD520-4T132(S)	RWK 3044-260-99-E0XXX	0.11	593
	MD520-4T160(S)	RWK 3044-320-99-E0XXX	0.092	747
T10	MD520-4T200(S)(-L)	RWK 3044-400-99-E0XXX	0.073	1055
	MD520-4T220(S)(-L)	RWK 3044-510-99-E0XXX	0.058	1069
T11	MD520-4T250(S)(-L)	RWK 3044-510-99-E0XXX	0.058	1069
	MD520-4T280(S)(-L)	RWK 3044-510-99-E0XXX	0.058	1069
T12	MD520-4T315(S)(-L)	RWK 3044-570-99-E0XXX	0.052	1181
	MD520-4T355(S)(-L)	RWK 3044-640-99-E0XXX	0.046	1116
	MD520-4T400(S)(-L)	RWK 3044-800-99-E0XXX	0.037	1280
T13	MD520-4T500(S)(-A)	RWK 3044-1000-99-E0XXX	0.029	1167
	MD520-4T560(S)(-A)	RWK 3044-1000-99-E0XXX	0.029	1167
	MD520-4T630(S)(-A)	-	-	-
Note: For T13 models with the model name containing "-A", the reactor is standard.				

Table 5–28 Selection of Schaffner AC input reactors (three-phase 200 V to 240 V)

Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T1	MD520-2T0.4B(S)	RWK 3044-3.5-88-E0XXX	8.3	32
	MD520-2T0.7B(S)	RWK 3044-6.5-88-E0XXX	4.6	47
	MD520-2T1.1B(S)	RWK 3044-6.5-88-E0XXX	4.6	47
	MD520-2T1.5B(S)	RWK 3044-12-88-E0XXX	2.44	69
T2	MD520-2T2.2B(S)	RWK 3044-12-88-E0XXX	2.44	69
	MD520-2T3.7B(S)	RWK 3044-18-89-E0XXX	1.67	103
T3	MD520-2T5.5B(S)	RWK 3044-35-92-E0XXX	0.83	151
T4	MD520-2T7.5B(S)	RWK 3044-48-92-E0XXX	0.61	172
T5	MD520-2T11(B)(S)	RWK 3044-59-92-E0XXX	0.5	206
T6	MD520-2T15(B)(S)	RWK 3044-59-92-E0XXX	0.5	206
	MD520-2T18.5(B)(S)	RWK 3044-72-99-E0XXX	0.41	294
T7	MD520-2T22(B) (S)	RWK 3044-59-92-E0XXX	0.5	206
	MD520-2T30(B)(S)	RWK 3044-120-99-E0XXX	0.24	324
T8	MD520-2T37(B)(S)	RWK 3044-140-99-E0XXX	0.2	399
	MD520-2T45(S)	RWK 3044-180-99-E0XXX	0.17	456
	MD520-2T55(S)	RWK 3044-210-99-E0XXX	0.14	553
T9	MD520-2T75(S)	RWK 3044-320-99-E0XXX	0.092	747
T10	MD520-2T90(S)	RWK 3044-400-99-E0XXX	0.073	1055
	MD520-2T110(S)	RWK 3044-510-99-E0XXX	0.058	1069
T11	MD520-2T132(S)	RWK 3044-510-99-E0XXX	0.058	1069
T12	MD520-2T160(S)	RWK 3044-570-99-E0XXX	0.052	1181
	MD520-2T200(S)	RWK 3044-800-99-E0XXX	0.037	1280

5.4.3 EMC Filter

Overview

To comply with the radiated and conducted emission requirements of EN IEC 61800-3, install the EMC filter listed in the following table. The following EMC filters can be used.

- For AC drives with the power equal to or lower than 15 kW, built-in filters can meet requirements of EN IEC 61800-3 C3. Therefore, external filters are not required.
- For 18.5 kW to 110 kW AC drives, install external filters to meet requirements of EN IEC 61800-3 C3.
- For AC drives with the power equal to or higher than 132 kW, built-in filters can meet requirements of EN IEC 61800-3 C3. Therefore, external filters are not required.

Table 5–29 Standard EMC filter model and appearance

Filter Model		Appearance
Schaffner series	FN 2090 Series	
	FN 3258 series	
	FN 3359 series	
Jianli series	TH series	
	EBK5 Series	

Models and dimensions (Schaffner filters)

Table 5–30 Selection of Schaffner filters (three-phase 380 V to 480 V)

Structure	Drive Model	Filter Model	Loss (W)
T1	MD520-4T0.4B(S)	FN 3258-7-44	3.8
	MD520-4T0.7B(S)	FN 3258-7-44	3.8
	MD520-4T1.1B(S)	FN 3258-7-44	3.8
	MD520-4T1.5B(S)	FN 3258-7-44	3.8
	MD520-4T2.2B(S)	FN 3258-7-44	3.8
	MD520-4T3.0B(S)	FN 3258-16-44	6.1
T2	MD520-4T3.7B(S)	FN 3258-16-44	6.1
	MD520-4T5.5B(S)	FN 3258-30-33	11.8

Structure	Drive Model	Filter Model	Loss (W)
T3	MD520-4T7.5B(S)	FN 3258-30-33	11.8
	MD520-4T11B(S)	FN 3258-42-33	15.7
T4	MD520-4T15B(S)	FN 3258-42-33	15.7
T5	MD520-4T18.5(B)(S) MD520-4T18.5(B)(S)-T	FN 3258-55-34	25.9
	MD520-4T22(B)(S) MD520-4T22(B)(S)-T	FN 3258-75-34	31.2
T6	MD520-4T30(B)(S)	FN 3258-75-34	32.2
	MD520-4T37(B)(S)	FN 3258-75-34	32.2
T7	MD520-4T45(B)(S)	FN 3258-100-35	34.5
	MD520-4T55(B)(S)	FN 3258-130-35	43.1
T8	MD520-4T75(B)(S)	FN 3258-180-40	58.3
	MD520-4T90(S)	FN 3258-180-40	58.3
	MD520-4T110(S)	FN 3359-250-28	49
T9	MD520-4T132(S)	FN 3359-250-28	49
	MD520-4T160(S)	FN 3359-320-99	19
T10	MD520-4T200(S)(-L)	FN 3359-400-99	29
	MD520-4T220(S)(-L)	FN 3359-600-99	44
T11	MD520-4T250(S)(-L)	FN 3359-600-99	44
	MD520-4T280(S)(-L)	FN 3359-600-99	44
T12	MD520-4T315(S)(-L)	FN 3359-600-99	44
	MD520-4T355(S)(-L)	FN 3359-800-99	39
	MD520-4T400(S)(-L)	FN 3359-800-99	39
T13	MD520-4T500(S)(-A)	FN 3359-1000-99	60
	MD520-4T560(S)(-A)	FN 3359-1000-99	60
	MD520-4T630(S)(-A)	FN 3359-1600-99	131
Note: T13 models with the model name containing -A are equipped with the built-in EMC filter 1600EBK1-60-HV.			

Table 5–31 Selection of Schaffner filters (three-phase 200 V to 240 V)

Structure	Drive Model	Filter Model	Loss (W)
T1	MD520-2T0.4B(S)	FN 3258-7-44	3.8
	MD520-2T0.7B(S)	FN 3258-7-44	3.8
	MD520-2T1.1B(S)	FN 3258-7-44	3.8
	MD520-2T1.5B(S)	FN 3258-16-44	6.1
T2	MD520-2T2.2B(S)	FN 3258-16-44	6.1
	MD520-2T3.7B(S)	FN 3258-30-33	11.8
T3	MD520-2T5.5B(S)	FN 3258-42-33	15.7
T4	MD520-2T7.5B(S)	FN 3258-42-33	15.7
T5	MD520-2T11(B)(S)	FN 3258-75-34	31.2
T6	MD520-2T15(B)(S)	FN 3258-75-34	31.2
	MD520-2T18.5(B)(S)	FN 3258-75-34	31.2
T7	MD520-2T22(B) (S)	FN 3258-100-35	34.5
	MD520-2T30(B)(S)	FN 3258-130-34	43.1

Structure	Drive Model	Filter Model	Loss (W)
T8	MD520-2T37(B)(S)	FN 3258-180-40	58.3
	MD520-2T45(S)	FN 3258-180-40	58.3
	MD520-2T55(S)	FN 3359-250-28	49
T9	MD520-2T75(S)	FN 3359-320-99	19
T10	MD520-2T90(S)	FN 3359-400-99	29
	MD520-2T110(S)	FN 3359-600-99	44
T11	MD520-2T132(S)	FN 3359-600-99	44
T12	MD520-2T160(S)	FN 3359-600-99	44
	MD520-2T200(S)	FN 3359-800-99	39

Table 5–32 Selection of Schaffner filters (single-phase 200 V to 240 V)

Structure	Drive Model	Filter Model	Loss (W)
T2	MD520-2S0.4B(S)	FN 2090-8-06	-
	MD520-2S0.7B(S)	FN 2090-12-06	-
	MD520-2S1.5B(S)	FN 2090-20-08	-
	MD520-2S2.2B(S)	FN 2090-30-08	-

The following figure shows the dimensions of FN 3258 series filters (7 A to 180 A).

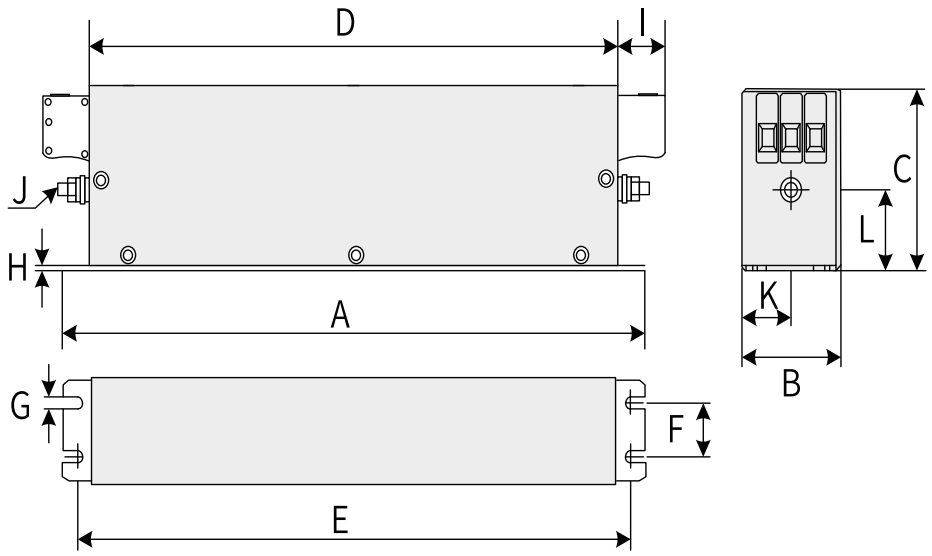


Figure 5-24 Dimensions of FN 3258 series filters (7 A to 180 A)

Table 5–33 Dimensions of FN 3258 series filters (7 A to 180 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L
7	190	40	70	160	180	20	4.5	1	22	M5	20	29.5
16	250	45	70	220	235	25	5.4	1	22	M5	22.5	29.5
30	270	50	85	240	255	30	5.4	1	25	M5	25	39.5
42	310	50	85	280	295	30	5.4	1	25	M6	25	37.5
55	250	85	90	220	235	60	5.4	1	39	M6	42.5	26.5
75	270	80	135	240	255	60	6.5	1.5	39	M6	40	70.5

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L
100	270	90	150	240	255	65	6.5	1.5	45	M10	45	64
130	270	90	150	240	255	65	6.5	1.5	45	M10	45	64
180	380	120	170	350	365	102	6.5	1.5	51	M10	60	47

The following figure shows the dimensions of FN 3359 series filters (150 A to 250 A).

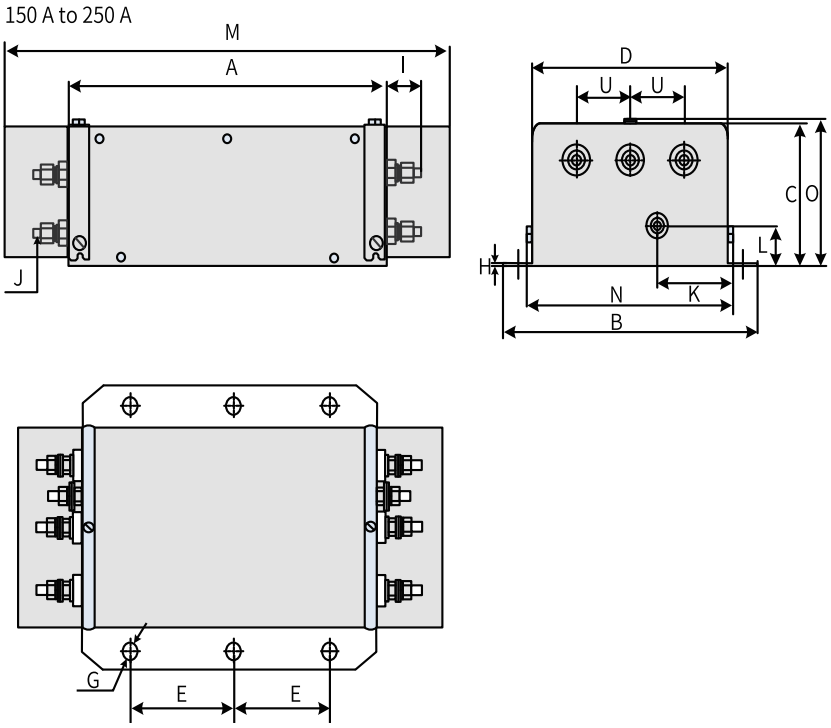


Figure 5-25 Dimensions of FN 3359 series filters (150 A to 250 A)

Table 5–34 Dimensions of FN 3359 series filters (150 A to 250 A, unit: mm)

Mark	Rated Current		
	150 A	180 A	250 A
A	300	300	300
B	210	210	230
C	120	120	125
D	160	160	180
E	120	120	120
F	185	185	205
G	ϕ12	ϕ12	ϕ12
H	2	2	2
I	33	33	33
J	M10	M10	M10
K	55	55	62.5
L	30	30	35
M	420	420	420
N	171	171	191
O	127	127	132
S	-	-	-

Mark	Rated Current		
	150 A	180 A	250 A
T	-	-	-
U	50	50	55
V	-	-	-
W	-	-	-
X	-	-	-
Y	-	-	-
Z	-	-	-

The following figure shows the dimensions of FN 3359 series filters (320 A to 2500 A).

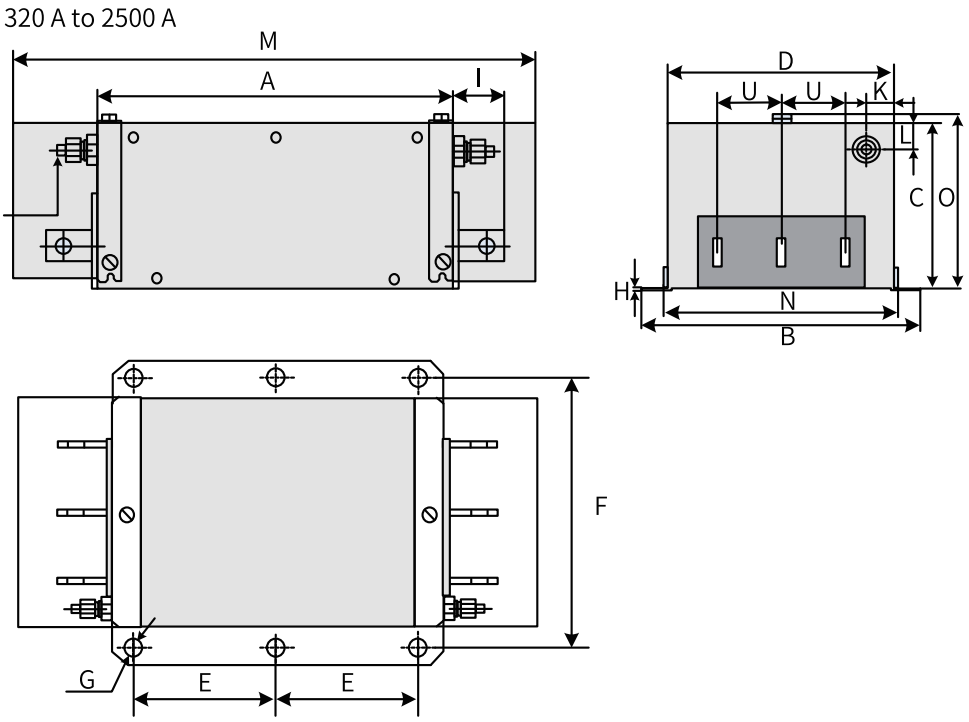


Figure 5-26 Dimensions of FN 3359 series filters (320 A to 2500 A)

The following figure shows the dimensions of the copper busbar.

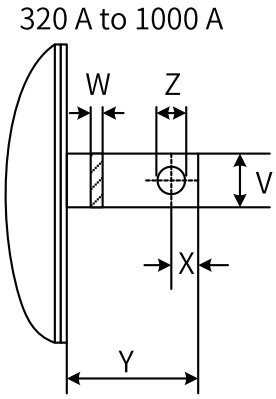


Figure 5-27 Dimensions of copper busbars

Table 5–35 Dimensions of FN 3359 series filters (320 A to 2500 A, unit: mm)

Mark	Rated Current						
	320 A	400 A	600 A	800 A	1000 A	1600 A	2500 A
A	300	300	300	350	350	400	600
B	260	260	260	280	280	300	370
C	115	115	135	170	170	160	200
D	210	210	210	230	230	250	300
E	120	120	120	145	145	170	250
F	235	235	235	255	255	275	330
G	ϕ12	ϕ12	ϕ12	ϕ12	ϕ12	ϕ12	ϕ14
H	2	2	2	3	3	3	3
I	43	43	43	53	53	93	98
J	M12	M12	M12	M12	M12	M12	M16
K	20	20	20	25	25	25	25
L	20	20	20	25	25	25	25
M	440	440	440	510	510	-	-
N	221	221	221	241	241	-	-
O	122	122	142	177	177	-	-
S	-	-	-	-	-	26	35
T	-	-	-	-	-	26	35
U	60	60	60	60	60	60	100
V	25	25	25	40	40	60	70
W	6	6	8	8	8	10	15
X	15	15	15	20	20	17	20
Y	40	40	40	50	50	90	95
Z	ϕ10.5	ϕ10.5	ϕ10.5	ϕ14	ϕ14	ϕ14	ϕ14

Models and dimensions (Jianli filters)

Table 5–36 Selection of Jianli filters (three-phase 380 V to 480 V)

Structure	Drive Model	Filter Model	Loss (W)
T1	MD520-4T0.4B(S)	DL-5EBK5	6.9
	MD520-4T0.7B(S)	DL-5EBK5	6.9
	MD520-4T1.1B(S)	DL-5EBK5	6.9
	MD520-4T1.5B(S)	DL-5EBK5	6.9
	MD520-4T2.2B(S)	DL-10EBK5	6.9
	MD520-4T3.0B(S)	DL-10EBK5	6.9
T2	MD520-4T3.7B(S)	DL-16EBK5	8.5
	MD520-4T5.5B(S)	DL-25EBK5	9.4
T3	MD520-4T7.5B(S)	DL-25EBK5	11
	MD520-4T11B(S)	DL-35EBK5	19.2
T4	MD520-4T15B(S)	DL-50EBK5	21.7

Structure	Drive Model	Filter Model	Loss (W)
T5	MD520-4T18.5(B)(S) MD520-4T18.5(B)(S)-T	DL-50EBK5	21.7
	MD520-4T22(B)(S) MD520-4T22(B)(S)-T	DL-65EBK5	27.4
T6	MD520-4T30(B)(S)	DL-65EBK5	27.4
	MD520-4T37(B)(S)	DL-80EBK5	32.6
T7	MD520-4T45(B)(S)	DL-100EBK5	33
	MD520-4T55(B)(S)	DL-130EBK5	37.5
T8	MD520-4T75(B)(S)	DL-160EBK5	38.4
	MD520-4T90(S)	DL-200EBK5	34
	MD520-4T110(S)	DL-250EBK5	49
T9	MD520-4T132(S)	DL-300EBK3	49
	MD520-4T160(S)	DL-400EBK3	19
T10	MD520-4T200(S)(-L)	DL-400EBK3	29
	MD520-4T220(S)(-L)	DL-600EBK3	44
T11	MD520-4T250(S)(-L)	DL-600EBK3	44
	MD520-4T280(S)(-L)	DL-600EBK3	44
T12	MD520-4T315(S)(-L)	DL-600EBK3	44
	MD520-4T355(S)(-L)	DL-700EBK3	39
	MD520-4T400(S)(-L)	DL-700EBK3	39
T13	MD520-4T500(S)(-A)	DL-1000EBK3	60
	MD520-4T560(S)(-A)	DL-1000EBK3	60
	MD520-4T630(S)(-A)	1600EBK1-60-HV	131
Note: T13 models with the model name containing -A are equipped with the built-in EMC filter 1600EBK1-60-HV.			

Table 5–37 Selection of Jianli filters (three-phase 200 V to 240 V)

Structure	Drive Model	Filter Model	Loss (W)
T1	MD520-2T0.4B(S)	DL-5EBK5	6.9
	MD520-2T0.7B(S)	DL-5EBK5	6.9
	MD520-2T1.1B(S)	DL-10EBK5	6.9
	MD520-2T1.5B(S)	DL-10EBK5	6.9
T2	MD520-2T2.2B(S)	DL-16EBK5	8.5
	MD520-2T3.7B(S)	DL-25EBK5	9.4
T3	MD520-2T5.5B(S)	DL-35EBK5	19.2
T4	MD520-2T7.5B(S)	DL-50EBK5	21.7
T5	MD520-2T11(B)(S)	DL-65EBK5	27.4
T6	MD520-2T15(B)(S)	DL-65EBK5	27.4
	MD520-2T18.5(B)(S)	DL-80EBK5	32.6
T7	MD520-2T22(B)(S)	DL-100EBK5	33
	MD520-2T30(B)(S)	DL-130EBK5	37.5
T8	MD520-2T37(B)(S)	DL-160EBK5	38.4
	MD520-2T45(S)	DL-250EBK5	49
	MD520-2T55(S)	DL-250EBK5	49
T9	MD520-2T75(S)	DL-300EBK3	49

Structure	Drive Model	Filter Model	Loss (W)
T10	MD520-2T90(S)	DL-400EBK3	29
	MD520-2T110(S)	DL-600EBK3	44
T11	MD520-2T132(S)	DL-600EBK3	44
T12	MD520-2T160(S)	DL-600EBK3	44
	MD520-2T200(S)	DL-700EBK3	39

Table 5–38 Selection of Jianli filters (single-phase 200 V to 240 V)

Structure	Drive Model	Filter Model	Loss (W)
T2	MD520-2S0.4B(S)	DL-10TH1	-
	MD520-2S0.7B(S)	DL-20TH1	-
	MD520-2S1.5B(S)	DL-20TH1	-
	MD520-2S2.2B(S)	DL-30TH1	-

The following figure shows the dimensions of Jianli filters (25 A to 200 A).

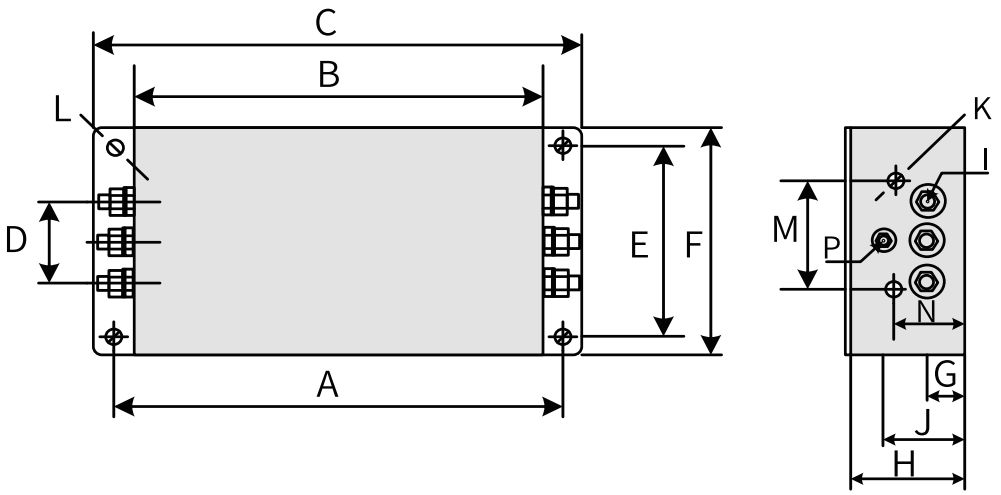


Figure 5-28 Dimensions of Jianli filters (25 A to 200 A, unit: mm)

Table 5–39 Dimensions of Jianli filters (25 A to 200 A, unit: mm)

Model	A	B	C	D	E	F	G	H	I	J	K	M	N	P	L
DL-25EBK5	243	224	265	58	70	102	25	92	M6	58	M4	74	49	M6	6.4 × 9.4
DL-35EBK5															
DL-50EBK5															
DL-65EBK5															
DL-80EBK5	354	323	388	66	155	188	30	92	M8	62	M4	86	56	M8	6.4 × 9.4
DL-100EBK5															
DL-130EBK5															
DL-160EBK5															
DL-200EBK5															

The following figure shows the dimensions of Jianli filters (250 A to 800 A).

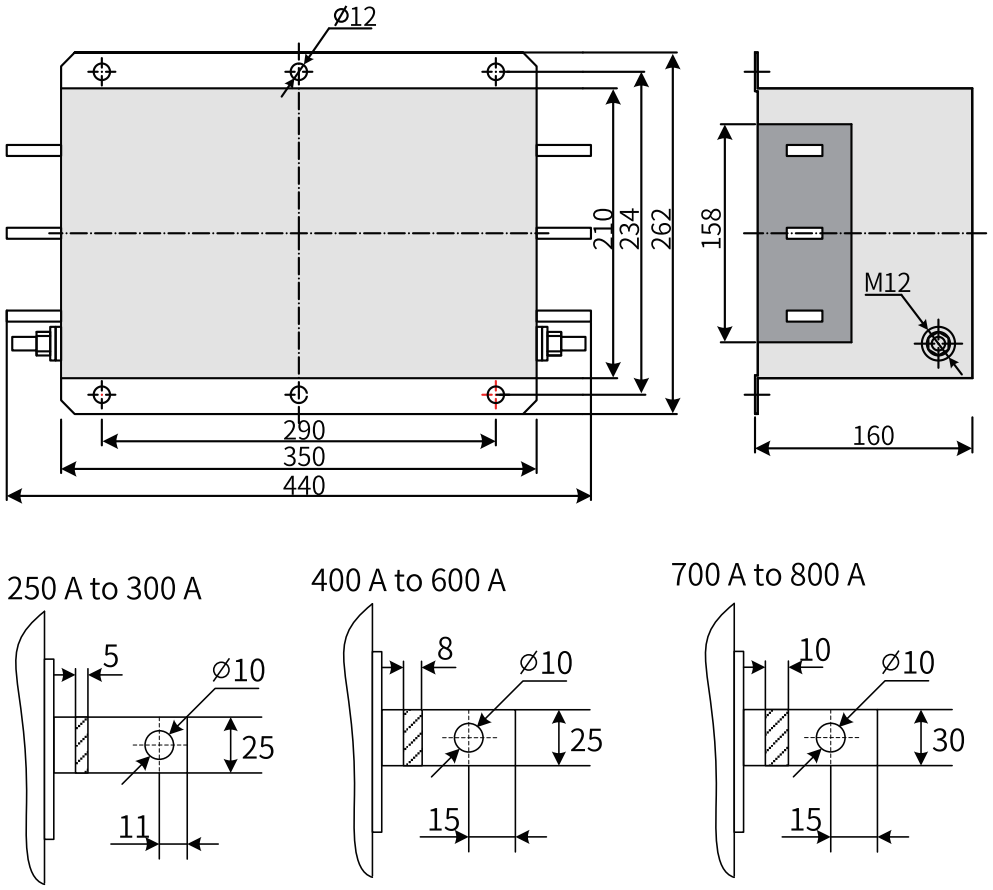


Figure 5-29 Dimensions of Jianli filters (250 A to 800 A, unit: mm)

The following figure shows the dimensions of Jianli filters (1000 A).

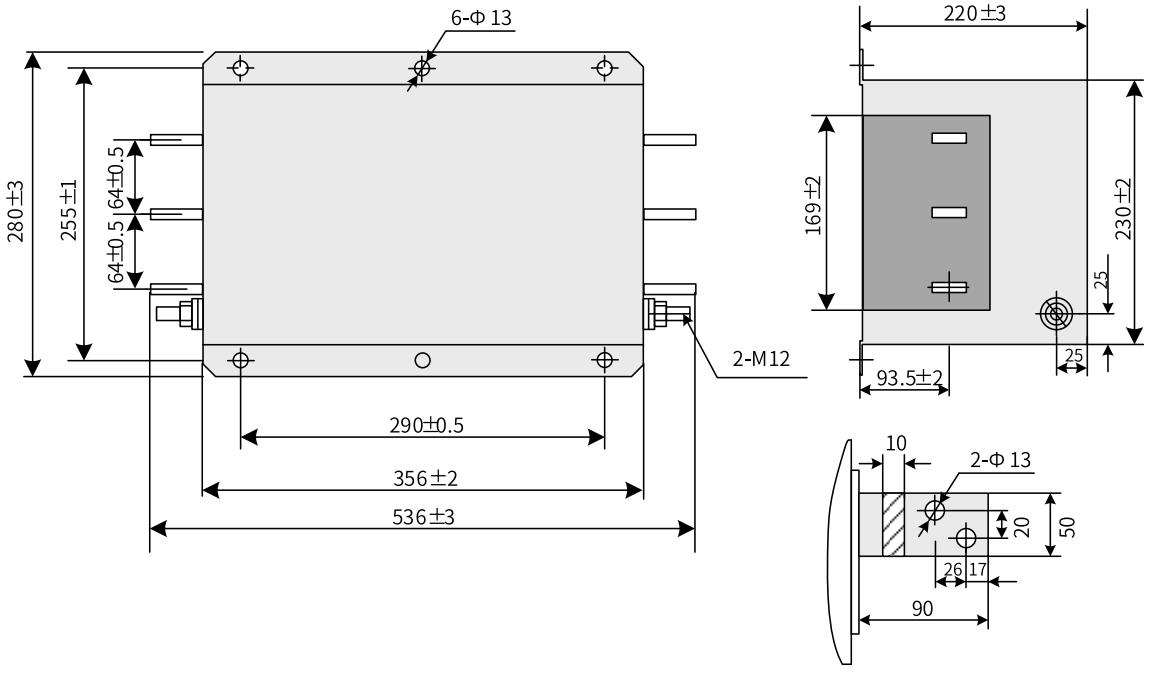


Figure 5-30 Dimensions of Jianli filters (1000 A, unit: mm)

5.4.4 Simple Filter

The simple EMC filter effectively attenuates radio frequency noise from the power grid and running AC drive. In addition, for devices equipped with the residual current device (RCD), if the RCD trips incorrectly, install a simple filter on the input side of the drive for suppression.

Ground the simple filter properly and use a cable shorter than 30 cm to connect the filter and the drive. The grounding terminal of the simple filter must be connected to that of the drive, and the grounding cable must be as short as possible (shorter than 30 cm).

Dimensions

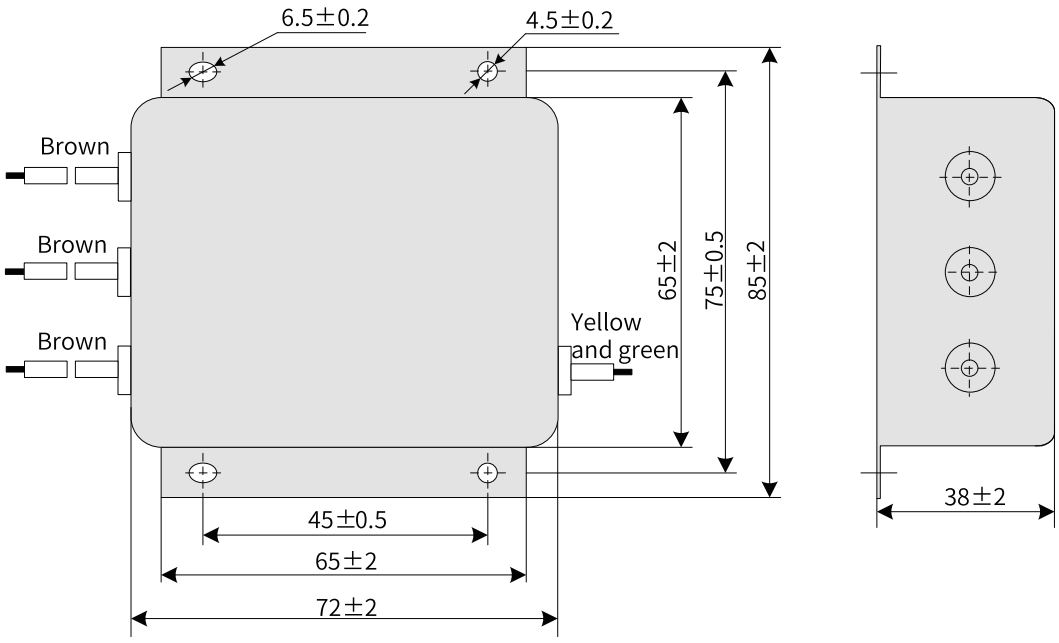


Figure 5-31 Outline dimensions of the simple filter (unit: mm)

Table 5–40 Outline dimensions of the simple filter

Model	Code	Outline Dimension (Width × Depth x Height) (Unit: mm)	Mounting Dimensions (Width x Depth) (Unit: mm)
Cxy-1-1	11025018	85 x 72 x 38	45 x 75

Mounting method

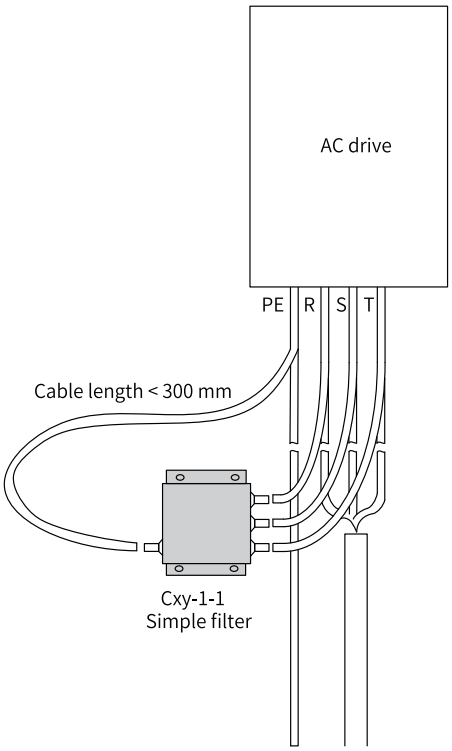
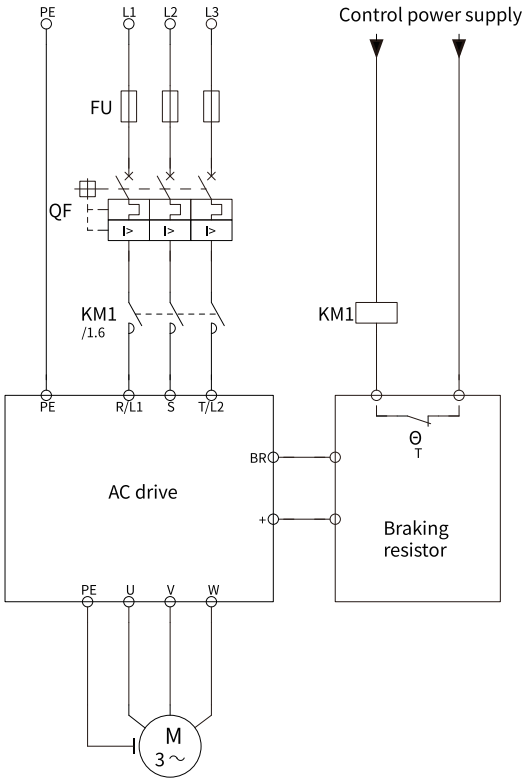


Figure 5-32 Simple filter installation

5.4.5 Braking Component

Braking resistor protection

In applications where a braking resistor is installed, it is recommended to use a resistor with a temperature switch to ensure safety and avoid overheating and burning of the braking resistor. Connect the temperature switch output to the electromagnetic contactor control circuit on the front end of the AC drive (as shown in the following figure) to implement the interlock protection function. When the resistor overheats, a tripping fault occurs, avoiding the resistor to be burned.



Resistance of braking resistors

During braking, almost all the regenerative energy of the motor is consumed by the braking resistor. The resistance of the braking resistor is calculated by the following formula: U x U/R = Pb.

U indicates the braking voltage for stable system braking. The value of U varies with systems. The default braking voltage of the AC drive is 760 V, which can be adjusted through F9-08.

Pb indicates the braking power.

Power of braking resistors

In theory, the power of the braking resistor is the same as the braking power. However, in consideration of the derating coefficient K, the power of the braking resistor is calculated by the following formula: K x Pr = Pb x D.

K: about 50%

Pr: power of the braking resistor

D: braking frequency, which is the proportion of the regenerative process to the whole working process

The following formulas can be generated based on the preceding equations:

K x Pr = Pb x D = U x U/R x D

Pr = (U x U x D)/(R x K)

The braking resistor power Pr can be calculated accordingly.

K is the derating coefficient of the braking resistor. A small value of K prevents the braking resistor from overheating. You can increase the value of K properly if heat can be well dissipated, but in no case should K exceed 50%. Failure to comply may result in a fire due to braking resistor overheating.

The braking frequency D is determined based on actual applications. *"Table 5–41" on page 119* lists the typical values in common applications.

Table 5–41 Typical braking frequencies in different applications

Scenario	Elevator	Decoiler and Recoiler	Centrifuge	Occasional Braking Load	Regular Application
Braking Frequency	20% to 30%	20% to 30%	50% to 60%	5%	10%

Dimensions of braking units

The following figures show dimensions of two braking unit series.

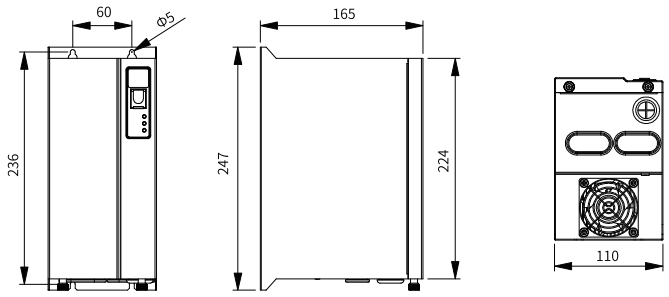


Figure 5-33 Dimensions of MDBUN series braking units (MDBUN-45-2T to MDBUN-90-2T; MDBUN-45-T to MDBUN-90-T; MDBUN-45-5T to MDBUN-90-5T) (mm)

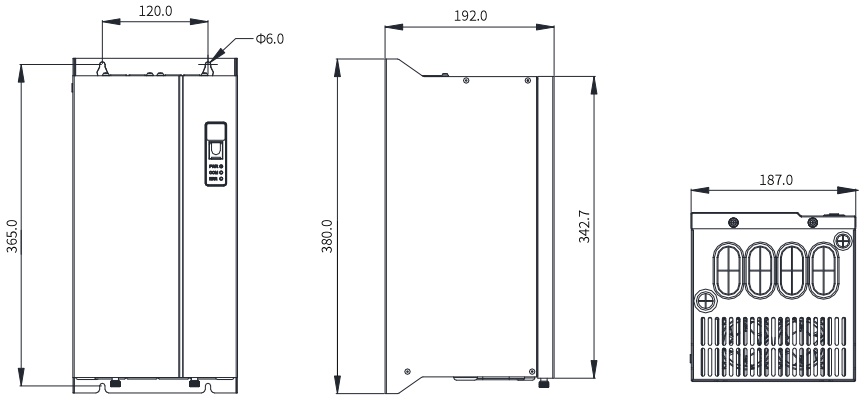


Figure 5-34 Dimensions of MDBUN series braking units (MDBUN-200-T, MDBUN-200-5T, MDBUN-200-7T) (mm)

Braking unit models

Note

The braking resistance in the table is obtained under working conditions featuring a braking usage ratio of 10% and the maximum braking time of 10s for heavy overload G-type equipment.

Table 5–42 Selection of braking components (three-phrase 380 V to 480 V)

Drive Model	Braking Unit		(125% of Braking Torque, ED: 10% ; Max. 10s)		Remarks	Minimum Braking Resistance (Ω)
	Model	Quantity	Recommended Braking Resistor Specification	Quantity of Braking Resistors		
MD520-4T0.4B(S)	Built-in, standard		80 W, 1450 Ω	1	AC drive model with the model name containing B	96
MD520-4T0.7B(S)			140 W, 800 Ω	1		96
MD520-4T1.1B(S)			220 W, 500 Ω	1		96
MD520-4T1.5B(S)			300 W, 380 Ω	1		96
MD520-4T2.2B(S)			440 W, 260 Ω	1		64
MD520-4T3.0B(S)			600 W, 190 Ω	1		64
MD520-4T3.7B(S)			740 W, 150 Ω	1		32
MD520-4T5.5B(S)			1100 W, 100 Ω	1		32
MD520-4T7.5B(S)			1500 W, 75 Ω	1		32
MD520-4T11B(S)			2200 W, 50 Ω	1		24
MD520-4T15B(S)			3000 W, 38 Ω	1		24
MD520-4T18.5(B)(S) MD520-4T18.5(B)(S)-T	Built-in, optional		4000 W, 32 Ω	1	AC drive model with the model name containing B	24
MD520-4T22(B)(S) MD520-4T22(B)(S)-T			4500 W, 27 Ω	1		24
MD520-4T30(B)(S)			6000 W, 20 Ω	1		19.2
MD520-4T37(B)(S)			7000 W, 16 Ω	1		14.8
MD520-4T45(B)(S)			9000 W, 13 Ω	1		12.8
MD520-4T55(B)(S)			11000 W, 10.5 Ω	1		9.6
MD520-4T75(B)(S)			15000 W, 7.7 Ω	1		6.8
MD520-4T90(S)	MDBUN-60-T	2	9000 W, 10.2 Ω	2	Input voltage ⩽ 440 VAC	10.2 x 2
	MDBUN-60-5T	2	9000 W, 12.8 Ω	2	Input voltage > 440 VAC	11.4 x 2
MD520-4T110(S)	MDBUN-90-T	2	11000 W, 8.0 Ω	2	Input voltage ⩽ 440 VAC	6.8 x 2
	MDBUN-90-5T	2	11000 W, 10.5 Ω	2	Input voltage > 440 VAC	7.7 x 2
MD520-4T132(S)	MDBUN-90-T	2	13000 W, 6.8 Ω	2	Input voltage ⩽ 440 VAC	6.8 x 2
	MDBUN-90-5T	2	13000 W, 8.8 Ω	2	Input voltage > 440 VAC	7.7 x 2
MD520-4T160(S)	MDBUN-200-T	2	16000 W, 2.8 Ω	2	Input voltage ⩽ 440 VAC	2.5 x 2
	MDBUN-200-5T	2	16000 W, 3.6 Ω	2	Input voltage > 440 VAC	2.8 x 2
MD520-4T200(S) (-L)	MDBUN-200-T	2	21000 W, 4.1 Ω	2	Input voltage ⩽ 440 VAC	2.5 x 2
	MDBUN-200-5T	2	21000 W, 5.3 Ω	2	Input voltage > 440 VAC	3.0 x 2

Drive Model	Braking Unit		(125% of Braking Torque, ED: 10% ; Max. 10s)		Remarks	Minimum Braking Resistance (Ω)
	Model	Quantity	Recommended Braking Resistor Specification	Quantity of Braking Resistors		
MD520-4T220(S) (-L)	MDBUN-200-T	2	27000 W, 3.2 Ω	2	Input voltage ⩽ 440 VAC	2.5 x 2
	MDBUN-200-5T	2	27000 W, 4.1 Ω	2	Input voltage > 440 VAC	3.0 x 2
MD520-4T250(S) (-L)	MDBUN-200-T	3	20000 W, 4.3 Ω	3	Input voltage ⩽ 440 VAC	2.5 x 3
	MDBUN-200-5T	3	20000 W, 5.5 Ω	3	Input voltage > 440 VAC	3.0 x 3
MD520-4T280(S) (-L)	MDBUN-200-T	3	23000 W, 3.8 Ω	3	Input voltage ⩽ 440 VAC	2.5 x 3
	MDBUN-200-5T	3	23000 W, 4.9 Ω	3	Input voltage > 440 VAC	3.0 x 3
MD520-4T315(S) (-L)	MDBUN-200-T	3	26000 W, 3.4 Ω	3	Input voltage ⩽ 440 VAC	2.5 x 3
	MDBUN-200-5T	3	26000 W, 4.3 Ω	3	Input voltage > 440 VAC	3.0 x 3
MD520-4T355(S) (-L)	MDBUN-200-T	3	29000 W, 3.0 Ω	3	Input voltage ⩽ 440 VAC	2.5 x 3
	MDBUN-200-5T	3	29000 W, 3.9 Ω	3	Input voltage > 440 VAC	3.0 x 3
MD520-4T400(S) (-L)	MDBUN-200-T	3	29000 W, 3.0 Ω	3	Input voltage ⩽ 440 VAC	2.5 x 3
	MDBUN-200-5T	3	29000 W, 3.9 Ω	3	Input voltage > 440 VAC	3.0 x 3
MD520-4T500(S) (-A)	MDBU-200-B	4	32000 W, 2.8 Ω	4	Input voltage ⩽ 440 VAC	2.5 x 4
	MDBU-200-C	4	32000 W, 3.7 Ω	4	Input voltage > 440 VAC	3.0 x 4
MD520-4T560(S) (-A)	MDBU-200-B	4	36000 W, 2.5 Ω	4	Input voltage ⩽ 440 VAC	2.5 x 4
	MDBU-200-C	4	39000 W, 3.0 Ω	4	Input voltage > 440 VAC	3.0 x 4
MD520-4T630(S) (-A)	MDBU-200-B	5	32000 W, 2.8 Ω	5	Input voltage ⩽ 440 VAC	2.5 x 5
	MDBU-200-C	5	32000 W, 3.7 Ω	5	Input voltage > 440 VAC	3.0 x 5

Table 5–43 Selection of braking components (three-phrase 200 V to 240 V)

Drive Model	Braking Unit		(125% of Braking Torque, ED: 10% ; Max. 10s)		Remarks	Minimum Braking Resistance (Ω)
	Model	Quantity	Recommended Braking Resistor Specification	Quantity of Braking Resistors		
MD520-2T0.4B(S)	Built-in, standard		90 W, 300 Ω	1	AC drive model with the model name containing B	48
MD520-2T0.7B(S)			160 W, 170 Ω	1		48
MD520-2T1.1B(S)			250 W, 110 Ω	1		32
MD520-2T1.5B(S)			340 W, 80 Ω	1		32
MD520-2T2.2B(S)			500 W, 55 Ω	1		16
MD520-2T3.7B(S)			800 W, 33 Ω	1		16
MD520-2T5.5B(S)			1300 W, 22 Ω	1		10
MD520-2T7.5B(S)			1700 W, 16 Ω	1		10
MD520-2T11(B)(S)	Built-in, optional		2300 W, 12 Ω	1		12
MD520-2T15(B)(S)			3000 W, 9 Ω	1		9
MD520-2T18.5(B)(S)			3900 W, 7 Ω	1		7
MD520-2T22(B)(S)			4600 W, 6 Ω	1		6
MD520-2T30(B)(S)			5500 W, 5 Ω	1		5
MD520-2T37(B)(S)			6800 W, 4 Ω	1		4
MD520-2T45(S)	MDBUN-60-2T	2	5000 W, 6 Ω	2	-	5.5
MD520-2T55(S)	MDBUN-60-2T	2	6000 W, 6 Ω	2	-	5.5
MD520-2T75(S)	MDBUN-90-2T	2	7500 W, 4.0 Ω	2	-	3.7
MD520-2T90(S)	MDBUN-90-2T	3	6000 W, 4.0 Ω	3	-	3.7
MD520-2T110(S)	MDBUN-90-2T	3	7500 W, 4.0 Ω	3	-	3.7
MD520-2T132(S)	MDBUN-90-2T	4	7000 W, 4.0 Ω	4	-	3.7
MD520-2T160(S)	MDBUN-90-2T	5	6500 W, 4.0 Ω	5	-	3.7
MD520-2T200(S)	MDBUN-90-2T	6	7000 W, 4.0 Ω	6	-	3.7

Table 5–44 Selection of braking components (single-phrase 200 V to 240 V)

Model	Braking Unit	(125% of Braking Torque, ED: 10% ; Max. 10s)		Remarks	Minimum Braking Resistance (Ω)
		Recommended Braking Resistor Specification	Quantity of Braking Resistors		
MD520-2S0.4B(S)	Built-in, standard	80 W, 200 Ω	1	AC drive model with the model name containing B	64
MD520-2S0.7B(S)		80 W, 150 Ω	1		64
MD520-2S1.5B(S)		100 W, 100 Ω	1		32
MD520-2S2.2B(S)		100 W, 70 Ω	1		32

Note

- The default starting braking voltages of built-in braking units for the 380-480 V models and 200-240 V models are 760 V and 350 V, respectively.
- The default starting braking voltage of the external braking units, including MDBUN-60-T, MDBUN-90-T, and MDBU-200-T is 670 V, which is suitable for power grids with input voltage ⩽ 440 VAC. The default starting braking voltage of the external braking units, including MDBUN-60-5T, MDBUN-90-5T, and MDBU-200-5T is 760 V, which is suitable for power grids with input voltage > 440 VAC. You can adjust the initial braking voltage based on the grid voltage. Higher initial braking voltage requires higher braking resistance.
- The data in the preceding table is only for reference. You can select the resistance and power of the braking resistor as required. (Note that the resistance cannot be lower than the recommended minimum value, whereas the power can exceed or be equal to the recommended value.) Select a braking resistor model based on the generation power of the motor in the actual application system, as well as system inertia, deceleration time, and potential energy load in the actual situation.
- Larger system inertia requires shorter deceleration time and more frequent braking. In this case, select a braking resistor with a higher power rating and lower resistance.
- For details on how to install and use the MDBUN, see MDBUN Series Braking Unit User Guide.

5.4.6 AFE Unit

The active front end (AFE) is an optional unit used to feed the energy generated by the motor during braking back to the mains power. With the AFE installed, the braking unit and braking resistor are not required, which reduces heat emission. Inovance AFE features energy efficiency, low noise, low harmonic, and high power factor.

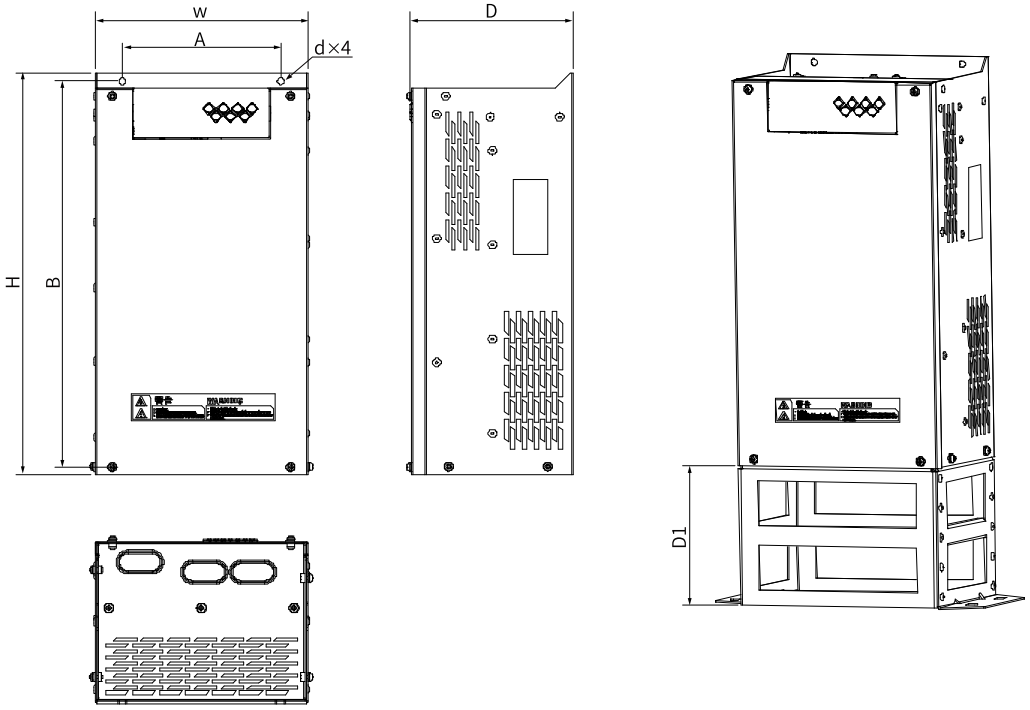


Figure 5-35 Outline dimensions of MD051 series AFE unit

Table 5–45 Outline dimensions of MD051 series AFE unit

Model	Outline Dimension (mm)			Bracket Dimension (mm)	Mounting Hole Dimension (mm)		Mounting Hole Diameter (mm)	Weight (kg)
	H	W	D	D1	A	B	d	
MD051T5.5G	365	200	153	121	160	350	Φ6	8.5
MD051T7.5G								8.7
MD051T11G								9.0
MD051T15G	405	215	165	142	160	390	Φ7	14.0
MD051T18.5G								14.8
MD051T22G	505	260	171	161	160	490	Φ7	18.2
MD051T30G								20.0

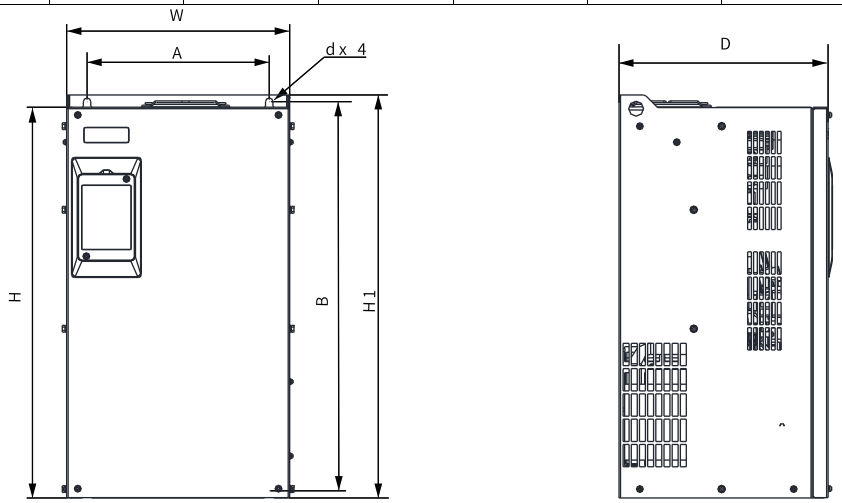


Figure 5-36 Outline and installation dimensions (unit: mm) of MD050NT55G-S to MD050NT160G-S models

Table 5–46 Outline dimensions of MD050NT55G-S to MD050NT160G-S models

Model	Outline Dimension (mm)				Mounting Dimension (mm)		Mounting Hole Diameter (mm)	Weight (kg)
	H	H1	W	D	A	B	d	
MD050NT55G-S	525	542	300	275	245	523	Φ10	35.0
MD050NT75G-S	554	580	338	315	270	560	Φ10	51.5
MD050NT90G-S								
MD050NT110G-S								
MD050NT132G-S	874	915	400	320	320	890	Φ10	85.0
MD050NT160G-S								

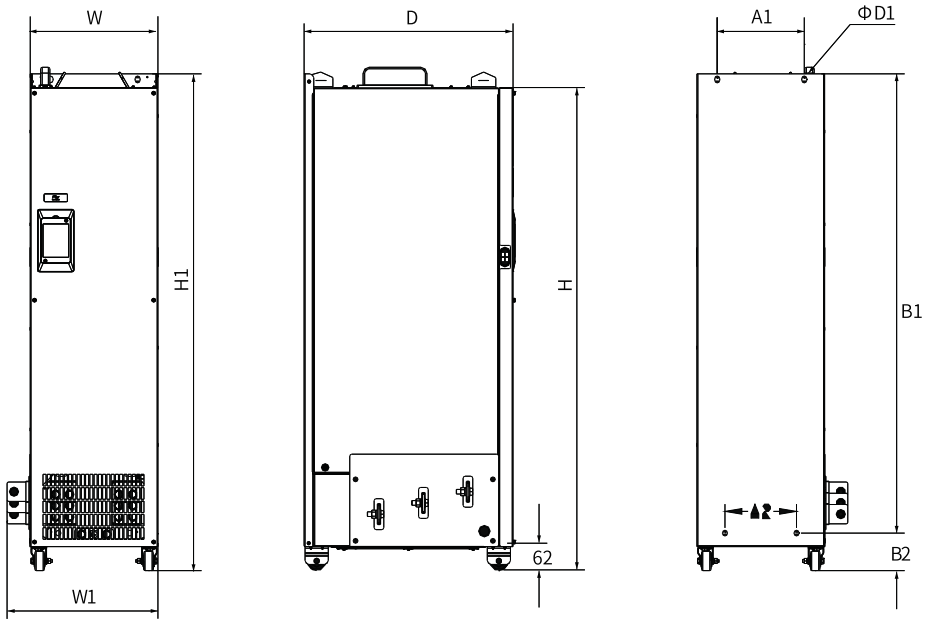


Figure 5-37 Outline and installation dimensions (unit: mm) of MD050NT200G-S to MD050NT400G-S models

Table 5–47 Outline dimensions of MD050NT200G-S to MD050NT400G-S models

Model	Outline Dimension (mm)					Mounting Hole Dimension (mm)				Mounting Hole Diameter (mm)	Weight (kg)
	H	H1	W	W1	D	A1	A2	B1	B2	D1	
MD050NT200G-S	1086	1134	300	360	500	240	150	1035	86	Φ3	110
MD050NT220G-S											
MD050NT250G-S	1248	1284	330	390	545	225	185	1175	97	Φ13	155
MD050NT280G-S											
MD050NT315G-S	1355	1405	340	400	320	240	200	1280	101	Φ16	185
MD050NT355G-S											
MD050NT400G-S											

Note

For installation and use of the energy feedback unit, see *MD051 Series Active Front End (AFE) User Guide* or *MD050N-S Series Active Front End (AFE) User Guide*.

5.4.7 Output Reactors

With an output reactor installed on the output side of the drive, the excessive dV/dt can be reduced. This can reduce the voltage stress on the motor winding to protect it, lower the motor temperature, and prolong the service life of the motor.

Table 5–48 Minimum cable length when the output reactor is configured (three-phase 380 V to 480 V)

AC Drive Power (kW)	Rated Voltage (V)	Min. Cable Length for Optional Output Reactor (m)
0.4 to 3.0	200 to 500	50
3.7	200 to 500	50
5.5	200 to 500	70
7.5	200 to 500	100
11	200 to 500	110
15	200 to 500	125
18.5	200 to 500	135
22	200 to 500	150
⩾ 30	280 to 690	150

Table 5–49 Minimum cable length when the output reactor is installed (three-phase 200 V to 240 V)

AC Drive Power (kW)	Rated Voltage (V)	Min. Cable Length for Optional Output Reactor (m)
0.4 to 3	200 to 500	50
3.7	200 to 500	70
5.5	200 to 500	110
7.5	200 to 500	125
⩾ 11	200 to 500	150

Models and dimensions (Inovance)

Models and dimensions of the recommended Inovance AC output reactors are as follows.

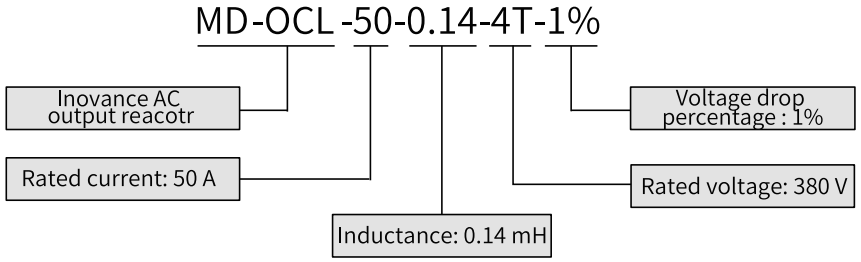


Figure 5-38 AC output reactor model

Note

- The following recommended AC output reactors are applicable only to T1 to T9 models.
- For T10 to T12 models, if AC output reactors are required, purchase the AC output reactors with the model name containing "-L".
- The T13 model is equipped with a built-in output reactor as standard.

Table 5–50 Selection of Inovance AC output reactors (three-phase 380 V to 480 V)

Drive Structure	Drive Model	Reactor Model	Inductance (mH)	Loss (W)
T1	MD520-4T0.4B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-4T0.7B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-4T1.1B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-4T1.5B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-4T2.2B(S)	MD-OCL-7-1.0-4T-1%	1.0	-
	MD520-4T3.0B(S)	MD-OCL-10-0.7-4T-1%	0.7	-
T2	MD520-4T3.7B(S)	MD-OCL-10-0.7-4T-1%	0.7	-
	MD520-4T5.5B(S)	MD-OCL-15-0.47-4T-1%	0.47	-
T3	MD520-4T7.5B(S)	MD-OCL-20-0.35-4T-1%	0.35	-
	MD520-4T11B(S)	MD-OCL-30-0.23-4T-1%	0.23	-
T4	MD520-4T15B(S)	MD-OCL-40-0.18-4T-1%	0.18	-
T5	MD520-4T18.5(B)(S) MD520-4T18.5(B)(S)-T	MD-OCL-40-0.18-4T-1%	0.18	-
	MD520-4T22(B)(S) MD520-4T22(B)(S)-T	MD-OCL-50-0.14-4T-1%	0.14	-
T6	MD520-4T30(B)(S)	MD-OCL-60-0.12-4T-1%	0.12	-
	MD520-4T37(B)(S)	MD-OCL-80-0.087-4T-1%	0.087	-
T7	MD520-4T45(B)(S)	MD-OCL-90-0.078-4T-1%	0.078	-
	MD520-4T55(B)(S)	MD-OCL-120-0.058-4T-1%	0.058	-
T8	MD520-4T75(B)(S)	MD-OCL-150-0.047-4T-1%	0.047	-
	MD520-4T90(S)	MD-OCL-200-0.035-4T-1%	0.035	-
	MD520-4T110(S)	MD-OCL-200-0.035-4T-1%	0.035	-
T9	MD520-4T132(S)	MD-OCL-250-0.028-4T-1%	0.028	-
	MD520-4T160(S)	MD-OCL-250-0.028-4T-1%	0.028	-

Note:

For T10 to T12 models, if AC output reactors are required, purchase AC output reactors with the model name containing "-L".

The T13 model is equipped with a built-in output reactor as standard.

Table 5–51 Selection of Inovance AC output reactors (three-phase 200 V to 240 V)

Drive Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T1	MD520-2T0.4B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-2T0.7B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-2T1.1B(S)	MD-OCL-7-1.0-4T-1%	1.0	-
	MD520-2T1.5B(S)	MD-OCL-10-0.7-4T-1%	0.7	-
T2	MD520-2T2.2B(S)	MD-OCL-10-0.7-4T-1%	0.7	-
	MD520-2T3.7B(S)	MD-OCL-15-0.47-4T-1%	0.47	-

Drive Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T3	MD520-2T5.5B(S)	MD-OCL-30-0.23-4T-1%	0.23	-
T4	MD520-2T7.5B(S)	MD-OCL-40-0.18-4T-1%	0.18	-
T5	MD520-2T11(B)(S)	MD-OCL-60-0.12-4T-1%	0.12	-
T6	MD520-2T15(B)(S)	MD-OCL-60-0.12-4T-1%	0.12	-
	MD520-2T18.5(B)(S)	MD-OCL-80-0.087-4T-1%	0.087	-
T7	MD520-2T22(B)(S)	MD-OCL-90-0.078-4T-1%	0.078	-
	MD520-2T30(B)(S)	MD-OCL-120-0.058-4T-1%	0.058	-
T8	MD520-2T37(B)(S)	MD-OCL-150-0.047-4T-1%	0.047	-
	MD520-2T45(S)	MD-OCL-200-0.035-4T-1%	0.035	-
	MD520-2T55(S)	MD-OCL-250-0.028-4T-1%	0.028	-
T9	MD520-2T75(S)	MD-OCL-330-0.021-4T-1%	0.021	-

Table 5–52 Selection of Inovance AC output reactors (single-phase 200 V to 240 V)

Drive Structure	Drive Model	Reactor Model	Inductance (mH)	Loss (W)
T2	MD520-2S0.4B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-2S0.7B(S)	MD-OCL-5-1.4-4T-1%	1.4	-
	MD520-2S1.5B(S)	MD-OCL-7-1.0-4T-1%	1.0	-
	MD520-2S2.2B(S)	MD-OCL-10-0.7-4T-1%	0.7	-

Dimensions of AC output reactors

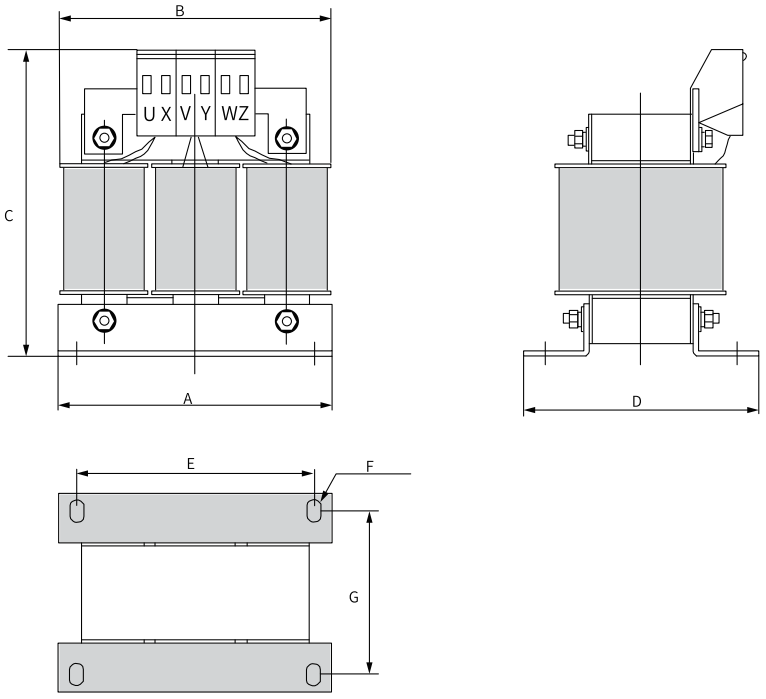


Figure 5-39 Dimensions of AC output reactors (5 A to 10 A)

Table 5–53 Dimensions of AC output reactors (5 A to 10 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G
5	105±1	110	130	84±2	91±1	Φ6x11	65±2
7	105±1	110	130	84±2	91±1	Φ6x11	65±2
10	105±1	110	130	84±2	91±1	Φ6x11	65±2

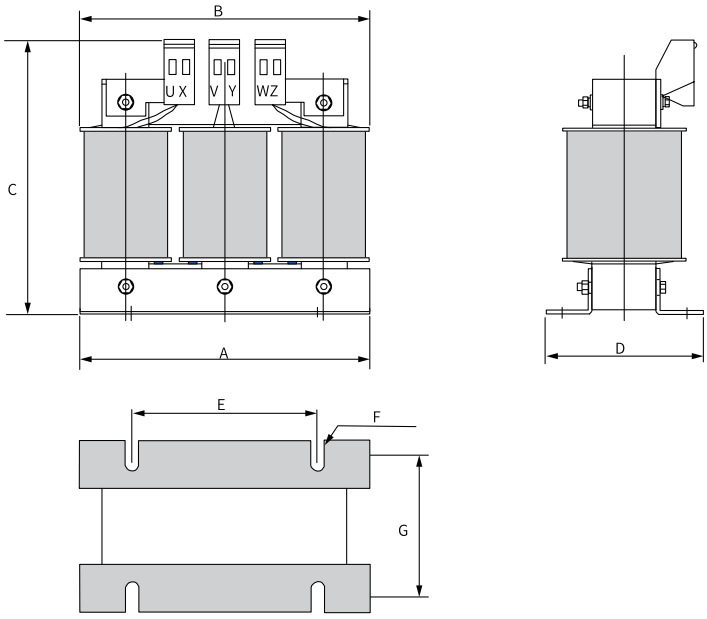


Figure 5-40 Dimensions of AC output reactors (15 A)

Table 5–54 Dimensions of AC output reactors (15 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G
15	148±1	155	140	76±2	95±1	Φ6x15	61±2

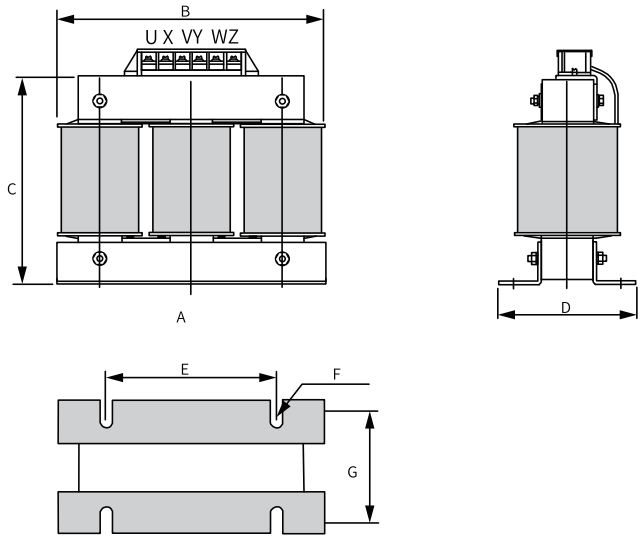


Figure 5-41 Dimensions of AC output reactors (20 A)

Table 5–55 Dimensions of AC output reactor (20 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G
20	148±1	155	165	76±2	95±1	Φ6x15	61±2

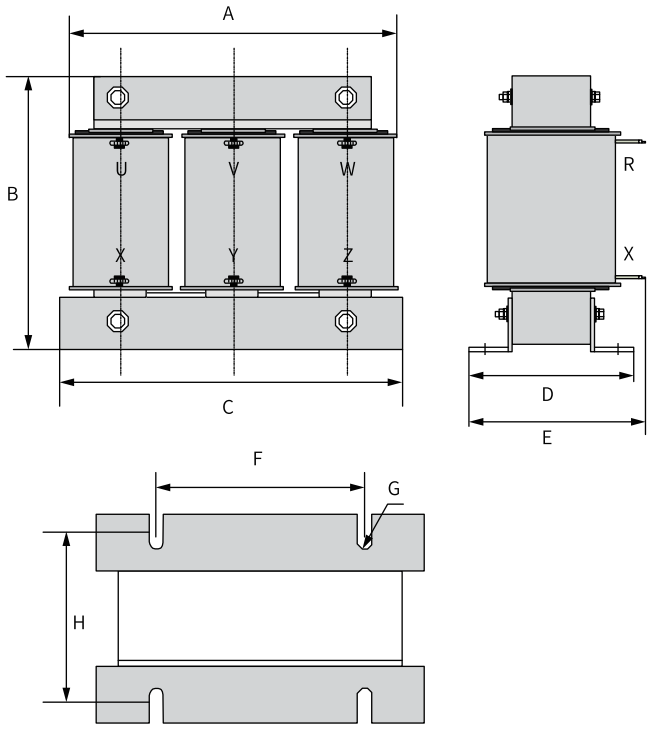


Figure 5-42 Dimensions of AC output reactors (30 A to 60 A)

Table 5–56 Dimensions of AC output reactors (30 A to 60 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H
30	155	130	148±1	95±2	135	95±1	Φ6x15	80±2
40	155	130	148±1	95±2	135	95±1	Φ6x15	80±2
50	155	130	148±1	95±2	135	95±1	Φ6x15	80±2
60	195	165	188±1	92±2	130	120±1	Φ8.5x20	72±2

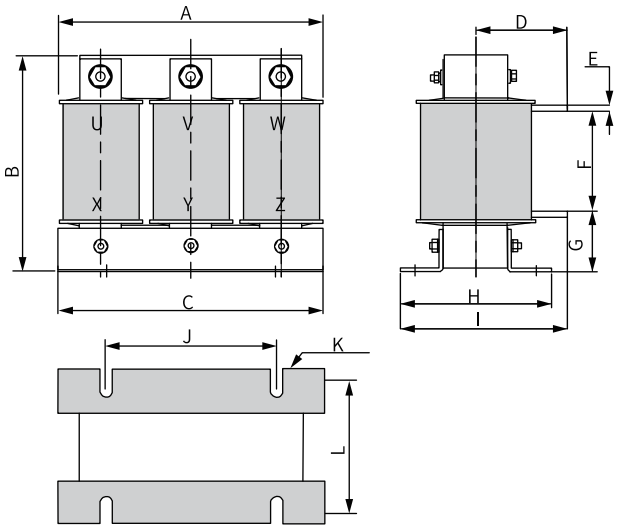


Figure 5-43 Dimensions of AC output reactors (80 A to 120 A)

Table 5–57 Dimensions of AC output reactors (80 A to 120 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L
80	195	165	188±1	68±10	4	75±5	40±5	92±2	130	120±1	Φ8.5x20	72±2
90	195	165	188±1	68±10	4	75±5	40±5	92±2	130	120±1	Φ8.5x20	72±2
120	195	165	188±1	78±10	4	75±5	40±5	112±2	135	120±1	Φ8.5x20	72±2

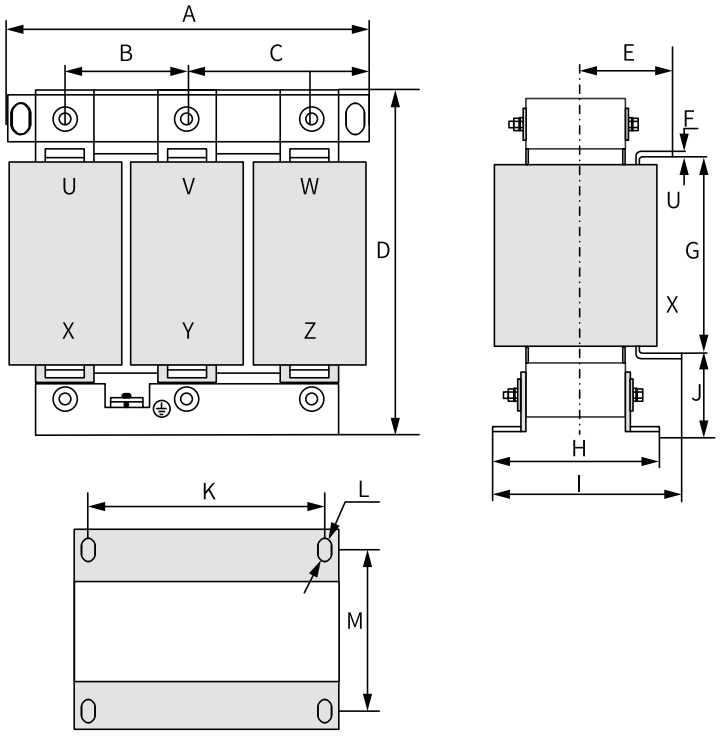


Figure 5-44 Dimensions of AC output reactors (150 A to 250 A)

Table 5–58 Dimensions of AC output reactors (150 A to 250 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M
150	250	81±5	81±5	230	97±10	5	140±5	113±2	170	42±5	182±1	Φ11x18	87±2
200	250	81±5	81±5	230	102±10	5	140±5	123±2	175	42±5	182±1	Φ11x18	97±2
250	250	81±5	81±5	230	102±10	5	140±5	123±2	175	42±5	182±1	Φ11x18	97±2

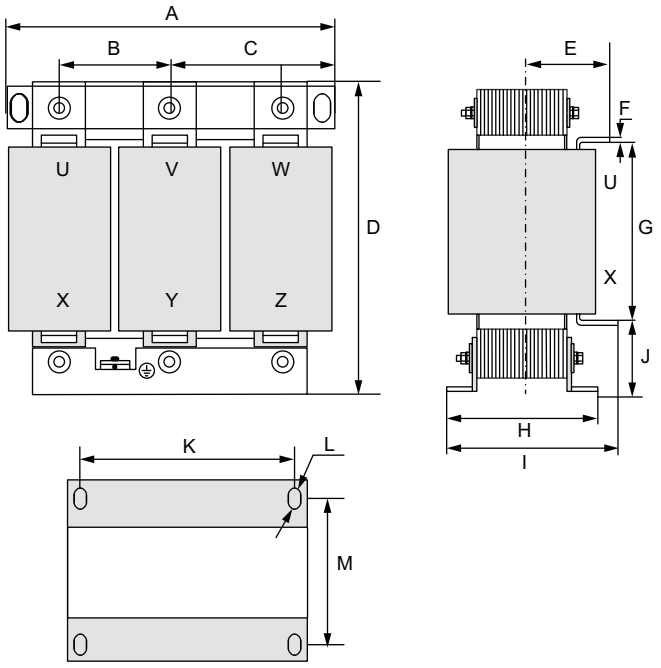


Figure 5-45 Dimensions of AC output reactors (330 A)

Table 5–59 Dimensions of AC output reactor (330 A, unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M
330	290	95±5	95±5	250	110±10	5	155±5	132±2	190	45±5	214±1	Φ11x18	106±2

Models and dimensions (Schaffner)

Models and dimensions of the recommended Schaffner AC output reactors are as follows.

Table 5–60 Selection of Schaffner output reactors (380 V to 480 V)

Drive Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T1	MD520-4T0.4B(S)	RWK 305-4-KL	1.47	22
	MD520-4T0.7B(S)	RWK 305-4-KL	1.47	22
	MD520-4T1.1B(S)	RWK 305-4-KL	1.47	22
	MD520-4T1.5B(S)	RWK 305-4-KL	1.47	22
	MD520-4T2.2B(S)	RWK 305-7.8-KL	0.754	25
	MD520-4T3.0B(S)	RWK 305-7.8-KL	0.754	25
T2	MD520-4T3.7B(S)	RWK 305-10-KL	0.588	30
	MD520-4T5.5B(S)	RWK 305-14-KL	0.42	34
T3	MD520-4T7.5B(S)	RWK 305-17-KL	0.364	38
	MD520-4T11B(S)	RWK 305-32-KL	0.184	55
T4	MD520-4T15B(S)	RWK 305-32-KL	0.184	55
T5	MD520-4T18.5(B)(S) MD520-4T18.5(B)(S)-T	RWK 305-45-KL	0.131	60
	MD520-4T22(B)(S) MD520-4T22(B)(S)-T	RWK 305-45-KL	0.131	60
T6	MD520-4T30(B)(S)	RWK 305-60-KL	0.098	65
	MD520-4T37(B)(S)	RWK 305-90-KL	0.065	75
T7	MD520-4T45(B)(S)	RWK 305-110-KL	0.053	90
	MD520-4T55(B)(S)	RWK 305-156-KS	0.038	120
T8	MD520-4T75(B)(S)	RWK 305-182-KS	0.032	140
	MD520-4T90(S)	RWK 305-230-KS	0.026	180
	MD520-4T110(S)	RWK 305-280-KS	0.021	220
T9	MD520-4T132(S)	RWK 305-330-KS	0.018	240
	MD520-4T160(S)	RWK 305-400-S	0.015	330
T10	MD520-4T200(S) (-L)	RWK 305-500-S	0.012	340
	MD520-4T220(S) (-L)	RWK 305-600-S	0.01	380
T11	MD520-4T250(S) (-L)	RWK 305-600-S	0.01	380
	MD520-4T280(S) (-L)	RWK 305-680-S	0.009	410
T12	MD520-4T315(S) (-L)	RWK 305-790-S	0.007	590
	MD520-4T355(S) (-L)	RWK 305-910-S	0.006	740
	MD520-4T400(S) (-L)	RWK 305-910-S	0.006	740
Note: The T13 model is equipped with an output reactor as standard.				

Table 5–61 Selection of Schaffner output reactors (three-phase 200 V to 240 V)

Drive Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T1	MD520-2T0.4B(S)	RWK 305-4-KL	1.47	22
	MD520-2T0.7B(S)	RWK 305-7.8-KL	0.754	25
	MD520-2T1.1B(S)	RWK 305-7.8-KL	0.754	25
	MD520-2T1.5B(S)	RWK 305-10-KL	0.588	30
T2	MD520-2T2.2B(S)	RWK 305-14-KL	0.42	34
	MD520-2T3.7B(S)	RWK 305-17-KL	0.364	38
T3	MD520-2T5.5B(S)	RWK 305-32-KL	0.184	55
T4	MD520-2T7.5B(S)	RWK 305-45-KL	0.131	60
T5	MD520-2T11(B)(S)	RWK 305-60-KL	0.098	65
T6	MD520-2T15(B)(S)	RWK 305-72-KL	0.082	70
	MD520-2T18.5(B)(S)	RWK 305-90-KL	0.065	75
T7	MD520-2T22(B) (S)	RWK 305-110-KL	0.053	90
	MD520-2T30(B)(S)	RWK 305-156-KS	0.038	120
T8	MD520-2T37(B)(S)	RWK 305-182-KS	0.032	140
	MD520-2T45(S)	RWK 305-230-KS	0.026	180
	MD520-2T55(S)	RWK 305-280-KS	0.021	220
T9	MD520-2T75(S)	RWK 305-330-KS	0.018	240
T10	MD520-2T90(S)	RWK 305-400-S	0.015	330
	MD520-2T110(S)	RWK 305-500-S	0.012	340
T11	MD520-2T132(S)	RWK 305-500-S	0.012	340
T12	MD520-2T160(S)	RWK 305-600-S	0.01	380
	MD520-2T200(S)	RWK 305-790-S	0.007	590

Table 5–62 Selection of Schaffner output reactors (single-phase 200 V to 240 V)

Drive Structure	Drive Model	Applicable Reactor	Inductance (mH)	Loss (W)
T2	MD520-2S0.4B(S)	RWK 305-4-KL	1.47	22
	MD520-2S0.7B(S)	RWK 305-7.8-KL	0.754	22
	MD520-2S1.5B(S)	RWK 305-10-KL	0.588	25
	MD520-2S2.2B(S)	RWK 305-14-KL	0.42	30

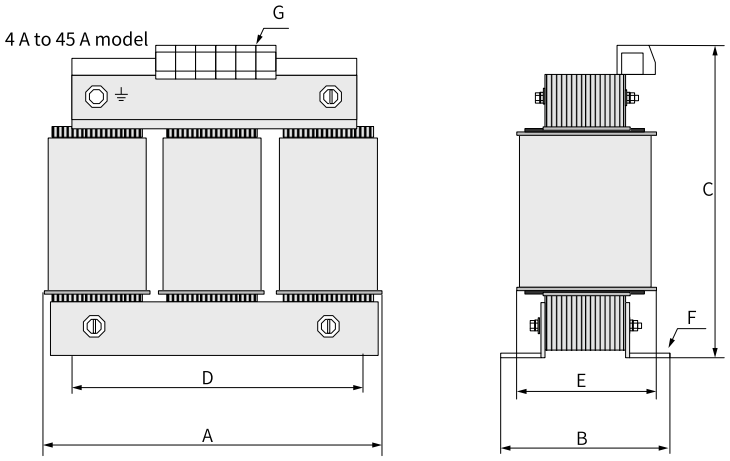


Figure 5-46 Dimensions of output reactors (4 A to 45 A)

Table 5–63 Dimensions of output reactors (4 A to 45 A, unit: mm)

Series	A	B	C	D	E	F	G
4 A and 7.8 A	100	Max. 60	Max. 115	56	34	4.8 x 9	2.5 mm^2
10 A	100	Max. 70	Max. 115	56	43	4.8 x 9	2.5 mm^2
14 A	125	Max. 70	Max. 135	100	45	5 x 8	2.5 mm^2
17 A	125	Max. 75	Max. 135	100	55	5 x 8	2.5 mm^2
24 A	125	Max. 75	Max. 135	100	55	5 x 8	4 mm^2
32 A	155	Max. 95	Max. 170	130	56	8 x 12	10 mm^2
45 A	155	Max. 110	Max. 190	130	72	8 x 12	10 mm^2

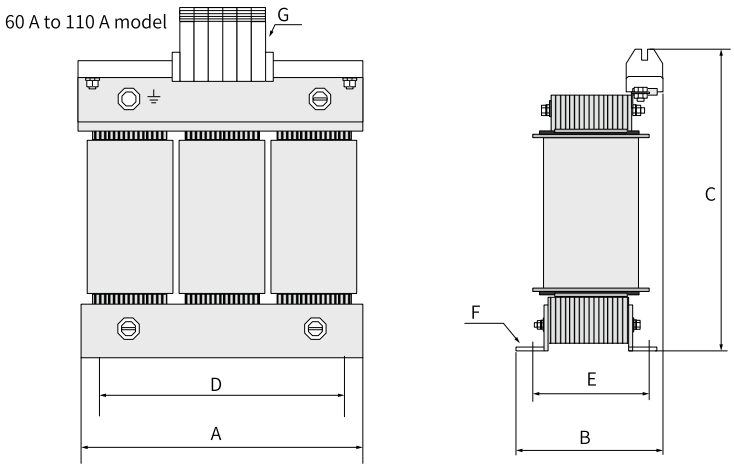


Figure 5-47 Dimensions of output reactors (60 A to 110 A)

Table 5–64 Dimensions of the output reactor (60 A to 110 A, unit: mm)

Series	A	B	C	D	E	F	G
60 A and 72 A	155	Max. 125	Max. 190	130	70	8 x 12	16 mm^2
90 A	190	Max. 115	Max. 225	170	57	8 x 12	35 mm^2
110 A	190	Max. 130	Max. 220	170	67	8 x 12	35 mm^2

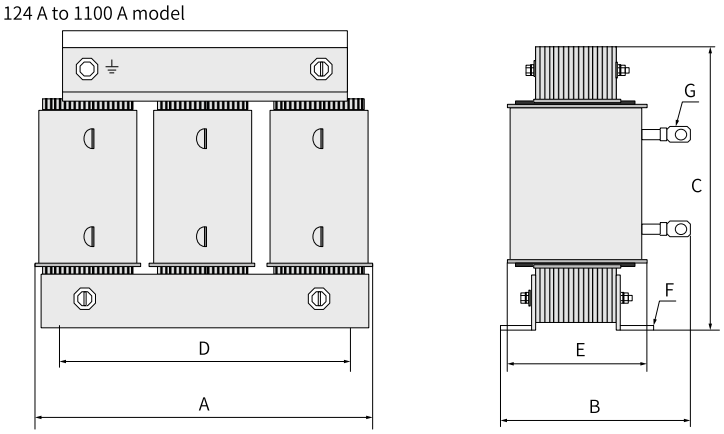


Figure 5-48 Dimensions of output reactors (124 A to 1100 A)

Table 5–65 Dimensions of output reactors (124 A to 1100 A, unit: mm)

Series	A	B	C	D	E	F	G
124 A	190	Max. 180	Max. 160	170	67	8 x 12	Φ8
143 A	190	Max. 180	Max. 160	170	77	8 x 12	Φ8
156 A and 170 A	190	Max. 180	Max. 160	170	77	8 x 12	Φ10
182 A	210	Max. 180	Max. 185	175	97	8 x 12	Φ10
230 A	240	220	220	190	119	11 x 15	Φ12
280 A	240	235	220	190	133	11 x 15	Φ12
330 A	240	240	220	190	135	11 x 15	Φ12
400 A and 500 A	240	220	325	190	119	11 x 15	Φ11
600 A and 680 A	240	230	325	190	128	11 x 15	Φ11
790 A	300	218	355	240	136	11 x 15	Φ11
910 A	300	228	355	240	148	11 x 15	Φ11
1100 A	360	250	380	310	144	11 x 15	Φ11

5.4.8 Magnetic Ring and Ferrite Clamp

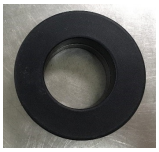
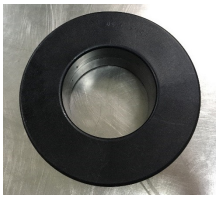
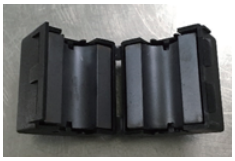
Model

The magnetic ring can be used on the input or output side of the AC drive. Install it as close to the AC drive as possible. When installed on the input side, the magnetic ring can suppress the noise in the input power supply system of the drive. When installed on the output side, the magnetic ring can suppress interference generated by the AC drive to external devices and reduce the bearing current.

In applications with leakage current and signal cable interference, install a magnetic ring or a ferrite clamp.

- Amorphous magnetic ring: featuring high permeability when the frequency is within 1 MHz and excellent anti-interference performance, but not as low-cost as the ferrite clamp
- Ferrite clamp: featuring high permeability when the frequency is above 1 MHz and excellent suppression performance on interference generated by low-power drives and signal cables

Table 5–66 Appearance and models of the magnetic ring and ferrite clamp

Type	Model	Appearance
Magnetic ring	DY644020H	
	DY805020H	
	DY1207030H	
Ferrite clamp	DYR-130-B	

Dimensions

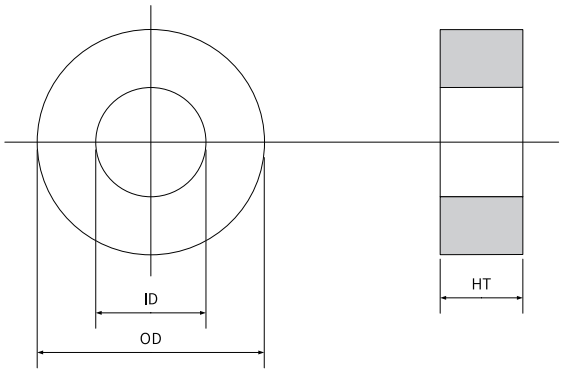


Figure 5-49 Dimensions of the magnetic ring

Table 5–67 Dimensions of the magnetic ring

Model	Dimension (OD x ID x HT) (mm)
DY644020H	64 x 40 x 20
DY805020H	80 x 50 x 20
DY1207030H	120 x 70 x 30

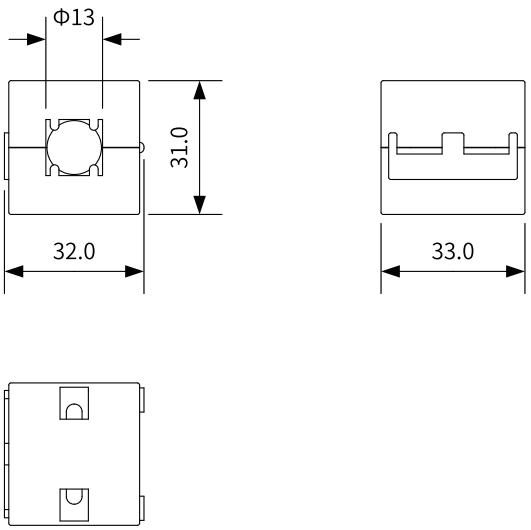


Figure 5-50 Dimensions of the ferrite clamp (unit: mm)

5.5 External operating panel

Model	Description	Appearance
MDKE-10	It is an optional LED operating panel that supports parameter display and modification. The dimensions are shown below.	
SOP-20	SOP-20 is an LCD operating panel (optional) through which you can copy and download parameters. The LCD operating panel offers an easy way of parameter modification and displays information in Chinese and English. It is easy to use. The dimensions are shown below.	

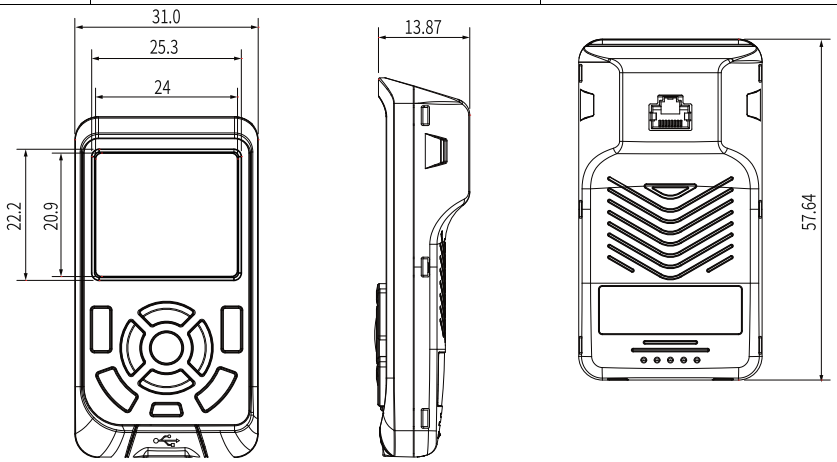
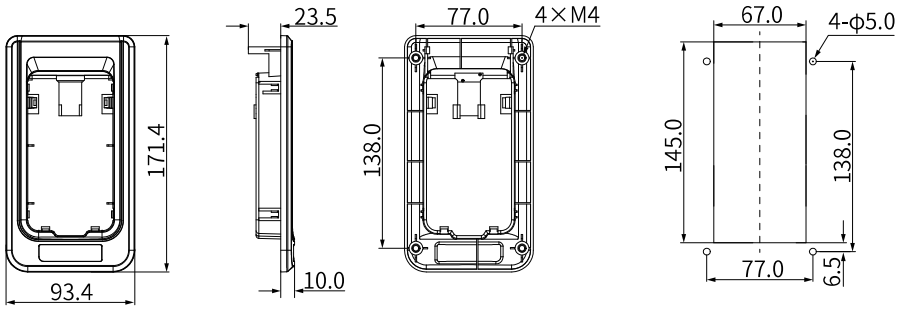


Figure 5-51 Dimensions (unit: mm) of the MDKE-10



Dimensions for the mounting bracket　　Hole dimensions

Figure 5-52 Mounting bracket dimensions and hole sizes (mm) of the MDKE-10

Note

If the thickness of the door is 1.5 mm, no bolts are required.

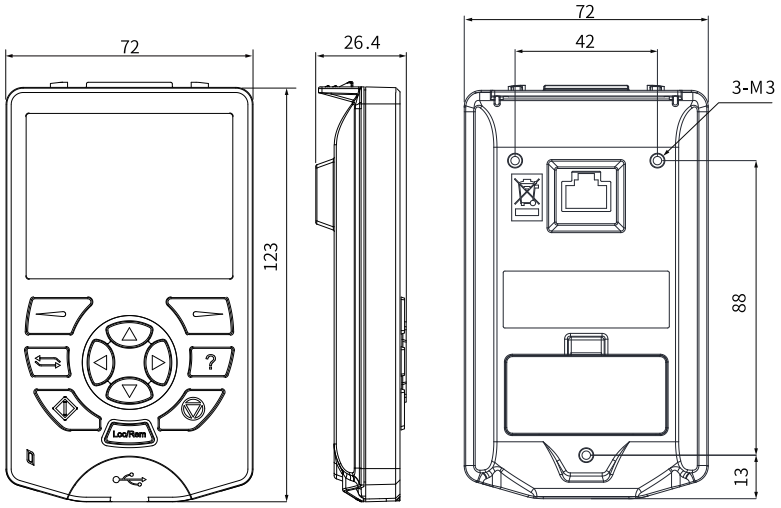
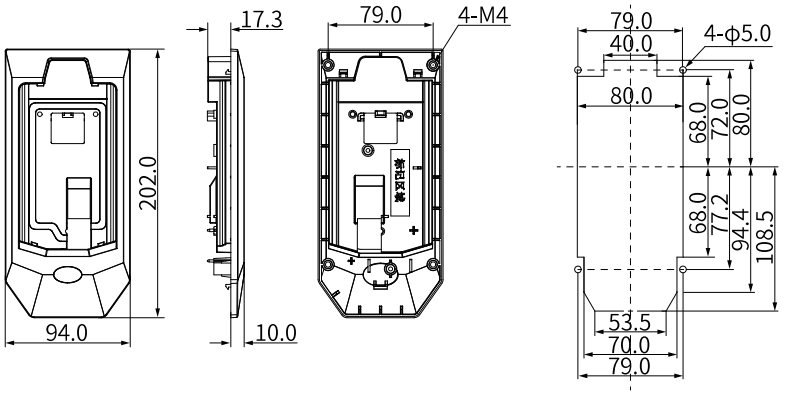


Figure 5-53 Dimensions (unit: mm) of the SOP-20



Dimensions of the mounting bracket　　Hole dimensions

Figure 5-54 Mounting bracket dimensions and hole sizes (mm) of the SOP-20

5.6 Expansion Card

For details on the expansion cards of the AC drive, see *"7.4.1 List of Options" on page 172*. The following table shows the installation position of the expansion cards. Before installing these cards, remove the front cover of the AC drive.

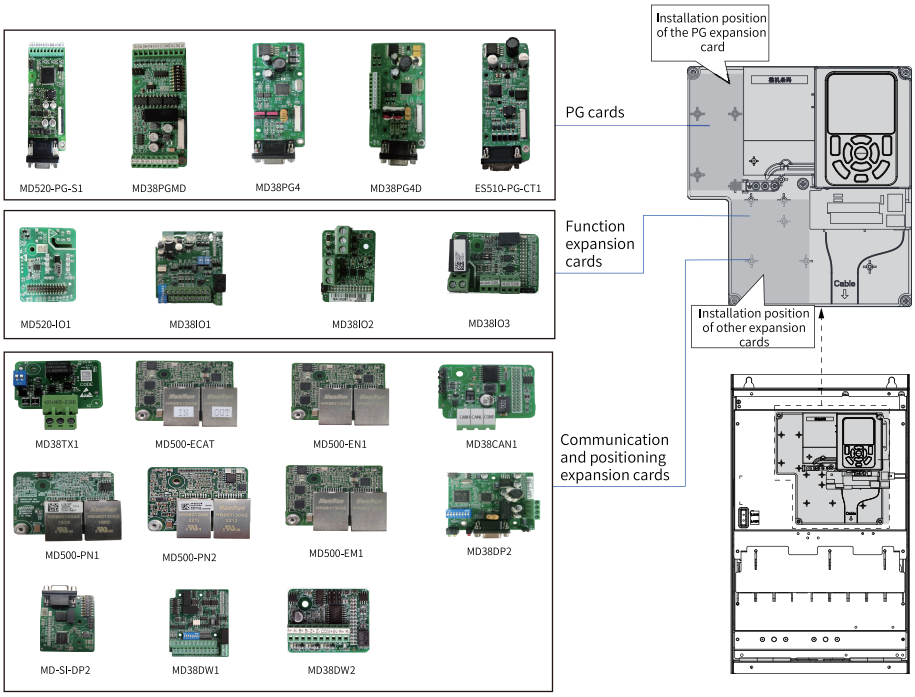


Figure 5-55 Installation position of the expansion card

6 Technical Data

6.1 Electrical Specifications

Note

In the following tables, the rated power of the AC drive is measured under the following conditions:

- For three-phase 380 V to 480 V models, the rated power is measured at the input voltage of 440 VAC.
- For three-phase 200 V to 240 V models, the rated power is measured at the input voltage of 220 VAC.
- For single-phase 200 V to 240 V models, the rated power is measured at the input voltage of 220 VAC.

Three-phase 380 V to 480 V

Table 6–1 Electrical parameters of T1 models (three-phase 380 V to 480 V)

Item		Specification					
Module: MD520-4Txxxxx		0.4B(S)	0.7B(S)	1.1B(S)	1.5B(S)	2.2B(S)	3.0B(S)
Structure		T1					
Output	Power (kW) (heavy load)	0.4	0.75	1.1	1.5	2.2	3
	Power (kW) (light load)	0.75	1.1	1.5	2.2	3	3.7
	Rated output current (A) (heavy load)	1.5	2.1	3.1	3.8	5.1	7.2
	Rated output current (A) (light load)	2.1	3.1	3.8	5.1	7.2	9
	Output voltage	Three-phase 0 V to input voltage					
	Maximum output frequency	599 Hz (edited by parameter)					
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)					
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously					
Input	Rated input current (A) (heavy load)	1.8	2.4	3.7	4.6	6.3	9
	Rated input current (A) (light load)	2.5	3.7	4.6	6.4	9.1	11.3
	Rated voltage/frequency	Three-phase 380 VAC to 480 VAC, 50/60 Hz					
	Allowable voltage fluctuation range	-15% to +10%, or 323 VAC to 528 VAC					
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz					
	Power capacity (kVA) (heavy load)	2	2.8	4.1	5	6.7	9.5
	Power capacity (kVA) (light load)	2.8	4.1	5	6.7	9.5	12
	Grid type	TN, TT, IT (Y)					

Item		Specification					
Module: MD520-4Txxxxx		0.4B(S)	0.7B(S)	1.1B(S)	1.5B(S)	2.2B(S)	3.0B(S)
Heat dissipation design	Thermal design power (kW) (heavy load)	0.039	0.046	0.057	0.068	0.081	0.109
	Thermal design power (kW) (light load)	0.046	0.057	0.068	0.081	0.109	0.138
	Air exhaust volume (CFM)	-	-	-	9	9	9
Overvoltage class	OVC III						
Pollution degree	PD2						
IP rating	IP20 (open type, applicable to IEC-certified products) Type 1 (enclosed type, applicable to UL-certified products)						
Protection category	Class I						

Table 6–2 Electrical parameters of T2 to T4 models (three-phase 380 V to 480 V)

Item		Specification				
Module: MD520-4Txxxxx		3.7B(S)	5.5B(S)	7.5B(S)	11B(S)	15B(S)
Structure		T2		T3		T4
Output	Power (kW) (heavy load)	3.7	5.5	7.5	11	15
	Power (kW) (light load)	5.5	7.5	11	15	18.5
	Rated output current (A) (heavy load)	9	13	17	25	32
	Rated output current (A) (light load)	13	17	25	32	37
	Output voltage	Three-phase 0 V to input voltage				
	Maximum output frequency	599 Hz (edited by parameter)				
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)				
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously				

Item		Specification				
Module: MD520-4Txxxxx		3.7B(S)	5.5B(S)	7.5B(S)	11B(S)	15B(S)
Input	Rated input current (A) (heavy load)	11.4	16.7	21.9	32.2	41.3
	Rated input current (A) (light load)	15.9	22.4	32.9	39.7	44
	Rated voltage/frequency	Three-phase 380 VAC to 480 VAC, 50/60 Hz				
	Allowable voltage fluctuation range	-15% to +10%, or 323 VAC to 528 VAC				
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz				
	Power supply capacity (kVA) (heavy load)	12	17.5	22.8	33.4	42.8
	Power supply capacity (kVA) (light load)	17.5	22.8	33.4	42.8	45
	Grid type	TN, TT, IT (Y)				
Heat dissipation design	Thermal design power (kW) (heavy load)	0.138	0.201	0.24	0.355	0.454
	Thermal design power (kW) (light load)	0.201	0.24	0.355	0.454	0.478
	Air exhaust volume (CFM)	20	24	30	40	42
Overvoltage class	OVC III					
Pollution degree	PD2					
IP rating	IP20 (open type, applicable to IEC-certified products) Type 1 (enclosed type, applicable to UL-certified products)					
Protection category	Class I					

Table 6–3 Electrical parameters of T5 to T6 models (three-phase 380 V to 480 V)

Item		Specification					
Module: MD520-4Txxxxx		18.5(B)(S)	22(B)(S)	18.5(B)(S)-T	22(B)(S)-T	30(B)(S)	37(B)(S)
Structure		T5				T6	
Output	Power (kW) (heavy load)	18.5	22	18.5	22	30	37
	Power (kW) (light load)	22	30	22	30	37	45
	Rated output current (A) (heavy load)	37	45	37	45	60	75
	Rated output current (A) (light load)	45	60	45	60	75	91
	Output voltage	Three-phase 0 V to input voltage					
	Maximum output frequency	599 Hz (edited by parameter)					
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)					
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously					

Item		Specification					
Module: MD520-4Txxxxx		18.5(B)(S)	22(B)(S)	18.5(B)(S)-T	22(B)(S)-T	30(B)(S)	37(B)(S)
Input	Rated input current (A) (heavy load)	49.5	59	37.2	43.4	57	69
	Rated input current (A) (light load)	59	79	43.4	55.3	71	86
	Rated voltage/frequency	Three-phase 380 VAC to 480 VAC, 50/60 Hz					
	Allowable voltage fluctuation range	-15% to +10%, or 323 VAC to 528 VAC					
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz					
	Power capacity (kVA) (heavy load)	36	44	33	39	52	63
	Power capacity (kVA) (light load)	44	59	39	52	65	79
	Grid type	TN, TT, IT (Y)					
Heat dissipation design	Thermal design power (kW) (heavy load)	0.478	0.551	0.478	0.551	0.694	0.815
	Thermal design power (kW) (light load)	0.551	0.694	0.551	0.694	0.815	1.01
	Air exhaust volume (CFM)	51.9	57.4	51.9	57.4	118.5	118.5
Overvoltage class	OVC III						
Pollution degree	PD2						
IP rating	IP20 (open type, applicable to IEC-certified products) Type 1 (enclosed type, applicable to UL-certified products)						
Protection category	Class I						

Table 6–4 Electrical parameters of T7 to T9 models (three-phase 380 V to 480 V)

Item		Specification						
Module: MD520-4Txxxxx		45(B)(S)	55(B)(S)	75(B)(S)	90(S)	110(S)	132(S)	160(S)
Structure		T7		T8			T9	
Output	Power (kW) (heavy load)	45	55	75	90	110	132	160
	Power (kW) (light load)	55	75	90	110	132	160	200
	Rated output current (A) (heavy load)	91	112	150	176	210	253	304
	Rated output current (A) (light load)	112	150	176	210	253	304	377
	Output voltage	Three-phase 0 V to input voltage						
	Maximum output frequency	599 Hz (edited by parameter)						
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)			0.8 kHz to 6.0 kHz (automatically adjusted according to the load characteristics)			
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously						
Input	Rated input current (A) (heavy load)	89	106	139	164	196	240	287
	Rated input current (A) (light load)	111	143	167	198	239	295	359
	Rated voltage/frequency	Three-phase 380 VAC to 480 VAC, 50/60 Hz						
	Allowable voltage fluctuation range	-15% to +10%, or 323 VAC to 528 VAC						
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz						
	Power capacity (kVA) (heavy load)	81	97	127	150	179	220	263
	Power capacity (kVA) (light load)	97	127	150	179	220	263	334
	Grid type	TN, TT, IT (Y)						
Heat dissipation design	Thermal design power (kW) (heavy load)	1.01	1.21	1.57	1.81	2.14	2.85	3.56
	Thermal design power (kW) (light load)	1.21	1.57	1.81	2.14	2.85	3.56	4.15
	Air exhaust volume (CFM)	122.2	122.2	218.6	287.2	354.2	547	627
Overvoltage class	OVC III							
Pollution degree	PD2							
IP rating	IP20 (open type, applicable to IEC-certified products)							
Protection category	Class I							

Table 6–5 Electrical parameters of T10 to T11 models (three-phase 380 V to 480 V)

Item		Specification			
Module: MD520-4Txxxxx		200(S)(-L)	220(S)(-L)	250(S)(-L)	280(S)(-L)
Structure		T10		T11	
Output	Power (kW) (heavy load)	200	220	250	280
	Power (kW) (light load)	250	280	315	355
	Rated output current (A) (heavy load)	377	426	465	520
	Rated output current (A) (light load)	465	520	585	650
	Output voltage	Three-phase 0 V to input voltage			
	Maximum output frequency	599 Hz (edited by parameter)			
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)			
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously			
Input	Rated input current (A) (heavy load)	365	410	441	495
	Rated input current (A) (light load)	456	507	559	624
	Rated voltage/frequency	Three-phase 380 VAC to 480 VAC, 50/60 Hz			
	Allowable voltage fluctuation range	-15% to +10%, or 323 VAC to 528 VAC			
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz			
	Power capacity (kVA) (heavy load)	334	375	404	453
	Power capacity (kVA) (light load)	404	453	517	565
	Grid type	TN, TT, IT (Y)			
Heat dissipation design	Thermal design power (kW) (heavy load)	4.15	4.55	5.06	5.33
	Thermal design power (kW) (light load)	5.06	5.33	5.69	6.31
	Air exhaust volume (CFM)	638.4	722.5	789.4	882
Overvoltage class	OVC III				
Pollution degree	PD2				
IP rating	IP00 (open type, applicable to IEC-certified products)				
Protection category	Class I				

Table 6–6 Electrical parameters of T12 models (three-phase 380 V to 480 V)

Item		Specification		
Module: MD520-4Txxxxx		315(S)(-L)	355(S)(-L)	400(S)(-L)
Structure		T12		
Output	Power (kW) (heavy load)	315	355	400
	Power (kW) (light load)	400	450	500
	Rated output current (A) (heavy load)	585	650	725
	Rated output current (A) (light load)	725	820	880
	Output voltage	Three-phase 0 V to input voltage		
	Maximum output frequency	599 Hz (edited by parameter)		
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)		
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously		
Input	Rated input current (A) (heavy load)	565	617	687
	Rated input current (A) (light load)	708	782	840
	Rated voltage/frequency	Three-phase 380 VAC to 480 VAC, 50/60 Hz		
	Allowable voltage fluctuation range	-15% to +10%, or 323 VAC to 528 VAC		
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz		
	Power capacity (kVA) (heavy load)	517	565	629
	Power capacity (kVA) (light load)	629	716	952
	Grid type	TN, TT, IT (Y)		
Heat dissipation design	Thermal design power (kW) (heavy load)	5.69	6.31	6.91
	Thermal design power (kW) (light load)	6.91	7.54	9.94
	Air exhaust volume (CFM)	645	860	860
Overvoltage class	OVC III			
Pollution degree	PD2			
IP rating	IP00 (open type, applicable to IEC-certified products)			
Protection category	Class I			

Table 6–7 Electrical parameters of T13 models (three-phase 380 V to 480 V)

Item		Specification		
Module: MD520-4Txxxxx		500(S)(-A)	560(S)(-A)	630(S)(-A)
Structure		T13		
Output	Power (kW) (heavy load)	500	560	630
	Power (kW) (light load)	630	710	800
	Rated output current (A) (heavy load)	900	1020	1120
	Rated output current (A) (light load)	1120	1260	1460
	Output voltage	Three-phase 0 V to input voltage		
	Maximum output frequency	599 Hz (edited by parameter)		
	Carrier frequency	0.8 kHz to 8.0 kHz (automatically adjusted according to the load characteristics)		
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously		
Input	Rated input current (A) (heavy load)	838.1	949.6	1043.5
	Rated input current (A) (light load)	1041	1170.9	1301.5
	Rated voltage/frequency	Three-phase 380 VAC to 480 VAC, 50/60 Hz		
	Allowable voltage fluctuation range	-15% to +10%, or 323 VAC to 528 VAC		
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz		
	Power capacity (kVA) (heavy load)	766	868	957
	Power capacity (kVA) (light load)	952	1070	1194
	Grid type	TN, TT, IT (Y)		
Heat dissipation design	Thermal design power (kW) (heavy load)	9.94	10.4	11.5
	Thermal design power (kW) (light load)	13.2	13.6	16.5
	Air exhaust volume (CFM)	2200	2200	2200
Overvoltage class	OVC III			
Pollution degree	PD2			
IP rating	IP20			
Protection category	Class I			

Three-phase 200 V to 240 V

Table 6–8 Electrical parameters of T1 to T2 models (three-phase 200 V to 240 V)

Item		Specification					
Module: MD520-2Txxxxx		0.4B(S)	0.7B(S)	1.1B(S)	1.5B(S)	2.2B(S)	3.7B(S)
Structure		T1				T2	
Output	Power (kW) (heavy load)	0.4	0.75	1.1	1.5	2.2	3.7
	Power (kW) (light load)	0.75	1.1	1.5	2.2	3.7	5.5
	Rated output current (A) (heavy load)	2.1	3.8	5.1	7.2	9	13
	Rated output current (A) (light load)	3.8	5.1	7.2	9	13	17
	Output voltage	Three-phase 0 V to input voltage					
	Maximum output frequency	599 Hz (edited by parameter)					
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)					
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously					
Input	Rated input current (A) (heavy load)	2.4	4.6	6.3	9	11.4	16.7
	Rated input current (A) (light load)	3.7	6.4	9.1	11.3	15.9	22.4
	Rated voltage and frequency	Three-phase 200 VAC to 240 VAC, 50/60 Hz					
	Allowable voltage fluctuation range	-15% to +10%, or 170 VAC to 264 VAC					
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz					
	Power capacity (kVA) (heavy load)	1.1	2.1	2.9	4.1	5.2	7.6
	Power capacity (kVA) (light load)	2.1	2.9	4.1	5.2	7.6	14.7
	Grid type	TN, TT, IT (Y)					
Heat dissipation design	Thermal design power (kW) (heavy load)	0.046	0.068	0.081	0.109	0.138	0.201
	Thermal design power (kW) (light load)	0.068	0.081	0.109	0.138	0.201	0.355
	Exhaust air volume (CFM)	-	9	9	9	20	24
Overvoltage class	OVC III						
Pollution degree	PD2						
IP rating	IP20						
Protection category	Class I						

Table 6–9 Electrical parameters of T3 to T6 models (three-phase 200 V to 240 V)

Item		Specification				
Module: MD520-2Txxxxx		5.5B(S)	7.5B(S)	11(B)(S)	15(B)(S)	18.5(B)(S)
Structure		T3	T4	T5	T6	
Output	Power (kW) (heavy load)	5.5	7.5	11	15	18.5
	Power (kW) (light load)	7.5	11	15	18.5	22
	Rated output current (A) (heavy load)	25	32	45	60	75
	Rated output current (A) (light load)	32	45	60	75	91
	Output voltage	Three-phase 0 V to input voltage				
	Maximum output frequency	599 Hz (edited by parameter)				
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)				
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously				
Input	Rated input current (A) (heavy load)	32.2	41.3	59	57	69
	Rated input current (A) (light load)	39.7	44	65.8	71	86
	Rated voltage and frequency	Three-phase 200 VAC to 240 VAC, 50/60 Hz				
	Allowable voltage fluctuation range	-15% to +10%, or 170 VAC to 264 VAC				
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz				
	Power capacity (kVA) (heavy load)	14.7	18.9	27	26.1	31.6
	Power capacity (kVA) (light load)	18.9	27	26.1	31.6	40.7
	Grid type	TN, TT, IT (Y)				
Heat dissipation design	Thermal design power (kW) (heavy load)	0.355	0.454	0.551	0.694	0.815
	Thermal design power (kW) (light load)	0.454	0.551	0.694	0.815	1.01
	Exhaust air volume (CFM)	40	42	57.4	118.5	118.5
Overvoltage class	OVC III					
Pollution degree	PD2					
IP rating	IP20					
Protection category	Class I					

Table 6–10 Electrical parameters of T7 to T8 models (three-phase 200 V to 240 V)

Item		Specification				
Module: MD520-2Txxxxx		22(B)(S)	30(B)(S)	37(B)(S)	45(S)	55(S)
Structure		T7		T8		
Output	Power (kW) (heavy load)	22	30	37	45	55
	Power (kW) (light load)	30	37	45	55	75
	Rated output current (A) (heavy load)	91	112	150	176	210
	Rated output current (A) (light load)	112	150	176	210	253
	Output voltage	Three-phase 0 V to input voltage				
	Maximum output frequency	599 Hz (edited by parameter)				
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)				
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously				
Input	Rated input current (A) (heavy load)	89	106	139	164	196
	Rated input current (A) (light load)	111	153	167	198	239
	Rated voltage and frequency	Three-phase 200 VAC to 240 VAC, 50/60 Hz				
	Allowable voltage fluctuation range	-15% to +10%, or 170 VAC to 264 VAC				
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz				
	Power capacity (kVA) (heavy load)	40.7	48.5	63.6	75	89.6
	Power capacity (kVA) (light load)	48.5	63.6	75	89.6	109
	Grid type	TN, TT, IT (Y)				
Heat dissipation design	Thermal design power (kW) (heavy load)	1.01	1.21	1.57	1.81	2.14
	Thermal design power (kW) (light load)	1.21	1.57	1.81	2.14	3.56
	Exhaust air volume (CFM)	122.2	122.2	218.6	287.2	354.2
Overvoltage class	OVC III					
Pollution degree	PD2					
IP rating	IP20					
Protection category	Class I					

Table 6–11 Electrical parameters of T9 to T12 models (three-phase 200 V to 240 V)

Item		Specification					
Module: MD520-2Txxxxx		75(S)	90(S)	110(S)	132(S)	160(S)	200(S)
Structure		T9	T10		T11	T12	
Output	Power (kW) (heavy load)	75	90	110	132	160	200
	Power (kW) (light load)	90	110	132	160	200	220
	Rated output current (A) (heavy load)	304	377	426	465	585	725
	Rated output current (A) (light load)	377	426	465	585	725	880
	Output voltage	Three-phase 0 V to input voltage					
	Maximum output frequency	599 Hz (edited by parameter)					
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)					
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously					
Input	Rated input current (A) (heavy load)	287	365	410	441	565	687
	Rated input current (A) (light load)	359	456	507	559	708	840
	Rated voltage and frequency	Three-phase 200 VAC to 240 VAC, 50/60 Hz					
	Allowable voltage fluctuation range	-15% to +10%, or 170 VAC to 264 VAC					
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz					
	Power capacity (kVA) (heavy load)	131	167	187	202	258	314
	Power capacity (kVA) (light load)	164	209	232	256	324	384
	Grid type	TN, TT, IT (Y)					
Heat dissipation design	Thermal design power (kW) (heavy load)	3.56	4.15	4.55	5.33	5.69	6.91
	Thermal design power (kW) (light load)	4.15	4.55	5.33	5.69	6.91	7.61
	Exhaust air volume (CFM)	627	638.4	722.5	882	645	860
Overvoltage class	OVC III						
Pollution degree	PD2						
IP rating	IP20						
Protection category	Class I						

Single-phase 200 V to 240 V

Table 6–12 Electrical parameters of T2 models (single-phase 200 V to 240 V)

Item		Specification			
Module: MD520-2Sxxxxx		0.4B(S)	0.7B(S)	1.5B(S)	2.2B(S)
Structure		T2			
Output	Power (kW) (heavy load)	0.4	0.75	1.5	2.2
	Rated output current (A) (heavy load)	2.3	4	7	9.6
	Output voltage	Three-phase 0 V to 240 V (subject to the input voltage)			
	Maximum output frequency	599 Hz (edited by parameter)			
	Carrier frequency	0.5 kHz to 16.0 kHz (automatically adjusted according to the load characteristics)			
	Overload capacity	Heavy load: 60s at 150% of the rated current continuously Light load: 60s at 110% of the rated current continuously			
Input	Rated input current (A) (heavy load)	5.4	8.2	14	20
	Rated voltage and frequency	Single-phase 200 VAC to 240 VAC, 50/60 Hz			
	Allowable voltage fluctuation range	-15% to +10%, or 170 VAC to 264 VAC			
	Allowable frequency fluctuation range	±5%, or 47.5 Hz to 63.0 Hz			
	Power capacity (kVA) (heavy load)	1.4	2.2	3.7	6
	Grid type	TN, TT, IT (Y)			
Heat dissipation design	Thermal design power (kW) (heavy load)	0.043	0.065	0.097	0.121
	Air exhaust volume (CFM)	20	20	20	20
Overvoltage class	OVC III				
Pollution degree	PD2				
IP rating	IP20 (open type, applicable to IEC-certified products) Type 1 (enclosed type, applicable to UL-certified products)				
Protection category	Class I				

6.2 Technical Specifications

Item			Technical Specification
Control perform-ance	Motor type		Asynchronous induction motors (IM), permanent magnet synchronous motors (PMSM), and synchronous reluctance motors (SynRM)
	Control mode		Sensorless vector control (SVC), feedback vector control (FVC), and voltage/frequency (V/f) control
	Asynchro-nous motor (V/f)	Supported function	Energy saving control, overvoltage suppression, overcurrent suppression, voltage dip suppression, oscillation suppression, torque boost, slip compensation, different V/f curve selection, V/f separation, DC braking, random PWM, overexcitation fast deceleration, and droop control
	Asynchro-nous motor (FVC)	Supported function	Energy saving control, inertia auto-tuning, acceleration feedforward, droop control, master-slave control, free programming and self-adaption of speed loop parameters, load observer, overvoltage suppression, voltage dip suppression, overexcitation fast deceleration, automatic voltage adjustment (AVR generator bus voltage control), DC braking, continuous operation after smooth switchover to SVC upon encoder abnormality, and FVC-to-SVC switchover at designated frequency (This can avoid abnormal operation caused by high-speed jitter of the encoder.)
		Supported encoder	23-bit communication encoder, ABZ encoder (differential, collector, push-pull), resolver, and sin-cos encoder
		Start torque	200%
		Torque step response	Within 2 ms
		Speed stability accuracy	0.02% when the motor and encoder are free from faults
		Speed fluctuation	0.05% when the motor and encoder are free from faults
		Torque control accuracy	±2%
		Flux weakening magnification	5

Item			Technical Specification
Control performance	Asynchronous motor (SVC)	Supported function	Energy saving control, inertia auto-tuning, acceleration feedforward, droop control, master-slave control, free programming and self-adaption of speed loop parameters, load observer, overvoltage suppression, voltage dip suppression, overexcitation fast deceleration, automatic voltage adjustment (AVR generator bus voltage control), flying start, DC braking, continuous operation after smooth switchover to SVC upon encoder abnormality, and FVC-to-SVC switchover at designated frequency (This can avoid abnormal operation caused by high-speed jitter of the encoder.)
		Speed regulation range	1: 500
		Start torque	200%
		Torque step response	Within 2 ms
		Torque control accuracy	±3% at the frequency above 5 Hz
		Speed stability accuracy	Within 10% of the rated slip value
		Flux weakening magnification	5
Control performance	Synchronous motor (FVC)	Supported function	Electronic motor stator shorting, overexcitation fast deceleration, master-slave control, maximum torque per ampere (MTPA) control, inertia auto-tuning, acceleration feedforward, droop control, free programming and self-adaption of speed loop parameters, overvoltage suppression, voltage dip suppression, automatic voltage adjustment (AVR generator bus voltage control), DC braking, continuous operation after smooth switchover to SVC upon encoder abnormality, and FVC-to-SVC switchover at designated frequency (This can avoid abnormal operation caused by high-speed jitter of the encoder.)
		Supported encoder	23-bit communication encoder, ABZ encoder (differential, collector, push-pull), resolver, and sin-cos encoder
		Start torque	200%
		Torque step response	Within 2 ms
		Speed stability accuracy	0.02% when the motor and encoder are free from faults
		Speed fluctuation	0.05% when the motor and encoder are free from faults
		Torque control accuracy	±2%

Item			Technical Specification
Control performance	Synchronous motor (SVC)	Supported function	Flying start, electronic motor stator shorting, overexcitation fast deceleration, master-slave control, MTPA control, inertia auto-tuning, acceleration feedforward, droop control, free programming and self-adaption of speed loop parameters, overvoltage suppression, voltage dip suppression, automatic voltage adjustment (AVR generator bus voltage control), DC braking, continuous operation after smooth switchover to SVC upon encoder abnormality, and FVC-to-SVC switchover at designated frequency (This can avoid abnormal operation caused by high-speed jitter of the encoder.)
		Speed regulation range	1: 200
		Start torque	200%
		Torque step response	Within 2 ms
		Speed stability accuracy	0.05% when the motor is free from faults
		Torque control accuracy	±3% at the frequency above 5 Hz
Basic functions	Command source		The commands are used to start or stop the motor. The command sources include the DI, DO, virtual DI, virtual DO, and DI/DO on the external expansion card. Switchover among four different sets of motor parameters and control parameters is supported. Start and stop commands can be set through programming.
	Reference channel	Input frequency resolution	Digital setting: 0.01 Hz Analog setting: maximum frequency x 0.1%
		Speed/Torque reference	Acceleration and deceleration curve, dynamic switchover among multiple acceleration and deceleration time sets, acceleration and deceleration S curve, external PID reference, AI (2 channels, supporting ±10 V or 0-20 mA), speed and torque set through communication, pulse reference (DI5), multi-reference, speed/torque set through programming
	Communication mode		Modbus (Modbus RTU, Modbus ASCII, Modbus TCP/IP), PROFIBUS DP, CANlink, CANopen, PROFINET, EtherCAT, and Ethernet/IP
	Output limit		Torque limit, power limit, current limit, maximum/minimum torque limit, speed limit, and jump frequency
	Process control	PID	Hibernation, configurable reference and feedback sources, 2-segment PID parameter switchover, feedback loss detection, configuration of output limit, configuration initialization
		Brake	Brake with or without feedback, start speed, start torque, and brake judgment condition settings
	Protection		AC drive and motor protection, including protection against overvoltage, overcurrent, overload, motor overheating (PT100, PT1000, KTY-84-130, PTC-130, PTC-150), and load loss, as well as automatic fault reset, automatic restart, and limp mode upon fault

Item		Technical Specification
Custom-ized function	Programming	Programming is supported. Word and bit conversion, word and double word conversion, logic (AND, OR, NOT, XOR, XNOT), arithmetic operations (fixed point and floating point addition/subtraction/ multiplication/division, absolute value, numerical comparison), selector switch, free filtering, switch-on and switch-off delay through logic, multi-point curve, and constant value
	Self-check	The AC drive and motor support self-check. IGBT shoot through, short circuit to ground, phase loss, and inter-phase short circuit tests are supported.
	Long-distance drive	The AC drive supports long-distance driving of the motor and various types of output filters.
	Reluctance motor	The drive can control reluctance motors in FVC/SVC mode, ferrite motors with magnet, pure reluctance motors, and permanent magnet and ferrite hybrid reluctance motors.
	Electromagnetic coil	The current frequency is set separately. The three-phase AC power supply with variable frequency is provided, which applies mainly to electromagnetic mixers and welding equipment.
	Powerful software	The software InoDriverShop allows you to upload and download AC drive parameters and supports the oscilloscope function. In addition, the InoDriverShop supports remote commissioning and fault diagnosis. With the oscilloscope function, you can monitor the internal state of the AC drive.
Operation	Operation command source	Operating panel, control terminal, and serial communication port (switchable in multiple ways)
	Frequency reference	The drive supports 10 frequency reference sources, including digital setting, analog voltage, analog current, pulse setting, and serial communication ports (switchable in multiple ways).
	Auxiliary frequency source	The drive supports 10 auxiliary frequency reference sources. It can implement fine tuning of the auxiliary frequency and frequency synthesis.
	Input terminal	Standard: Five DIs Two AIs, AI1 and AI2. AI1 supports only voltage input of -10 V to +10 V. AI2 supports voltage input of -10 V to +10 V, current input of 0 mA to 20 mA, and temperature input, which can be switched over through the DIP switch. Expansion capability: Five DIs
	Output terminal	Standard: One DO One relay output terminal One FM terminal (can be assigned with the high-speed pulse output or common DO function) One AO, supporting current output of 0 mA to 20 mA or voltage output of 0 V to 10 V Expansion capability: One DO One relay output terminal

Item		Technical Specification
Display and operating panel	LED operating panel	It can display parameters and AC drive status (forward running, reverse running, stop, operating panel/terminal/communication control, speed/torque control, STO state) and can be used to modify parameters.
	External LCD operating panel	It is optional and displays content in Chinese, English, or Russian. You can use it to modify parameters.
	Parameter copy	You can use the LCD operating panel to implement quick parameter upload and download.
	Key locking and function selection	Keys on the operating panel can be locked partially or all keys can be locked. In addition, functions with limited availability range can be assigned to some keys. This can prevent accidental operation.
Environ-ment	Operating location	Indoors without direct sunlight, dust, corrosive gas, combustible gas, oil mist, water vapor, drip, or salt
	Altitude	For altitude equal to or below 1000 m, derating is not required. For altitude ranging from 1000 m to 3000 m, derate 1% for every additional 100 m. For altitude above 3000 m, contact Inovance. ***Note*** • The maximum altitude for T1 models is 2000 m. If the altitude is above 2000 m, contact Inovance. • When the grid type of T13 models is TN and TT, the maximum altitude is 3000 m. When the grid type of T13 models is IT, the maximum altitude is 2000 m.
	Ambient temperature	-10°C to +50°C. 40°C to 50°C: derate by 1.5% for every additional 1°C.
	Relative humidity	Storage/Ambient humidity: <95% RH, non-condensing
	Vibration	Operating scenario: Test according to IEC 60068-2-6. Vibration Amplitude at 5 Hz to 8.4 Hz: 3.5 mm; acceleration at 8.4 Hz to 200 Hz: 1 g; 10 cycles/axis Transport scenario: Test according to IEC 60068-2-64. Power spectrum density at 5 Hz to 100 Hz: 0.01 g^2/Hz; power spectrum density at 200 Hz: 0.001 g^2/Hz; Grms: 1.14 g
	Shock	Operating/Transport scenario: Test according to IEC 60068-2-27. Acceleration: 15 g; pulse width; 11 ms; 18 times in total in each of X, Y, Z axes
	Storage temperature	-20°C to +60°C

7 Installation Preparations

7.1 Installation Flowchart

T1 to T9 models

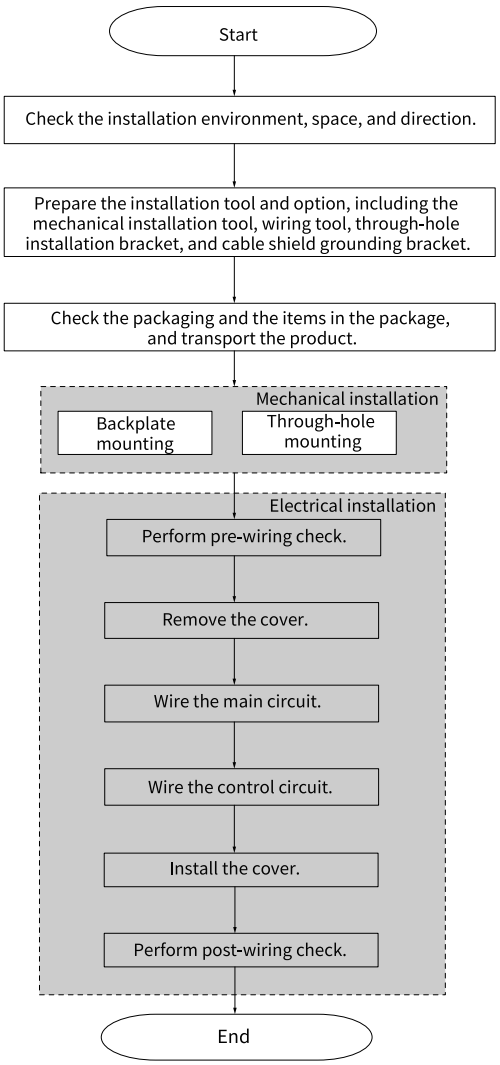


Figure 7-1 General installation process (T1 to T9 models)

T10 to T12 Models

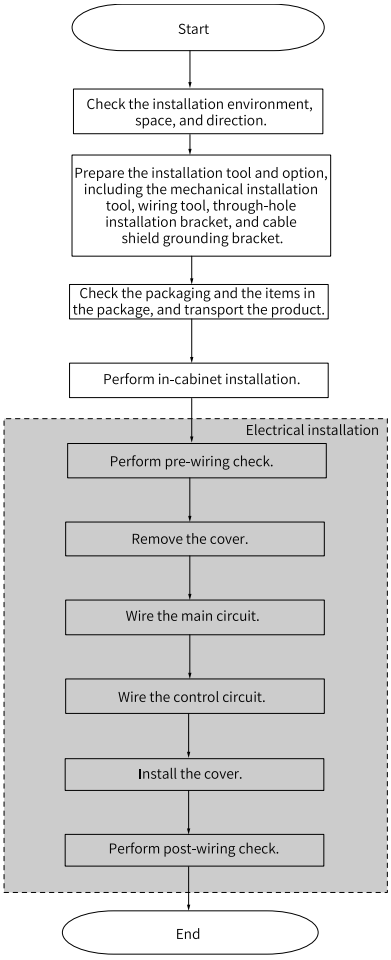


Figure 7-2 General installation process (T10 to T12 models)

T13 models

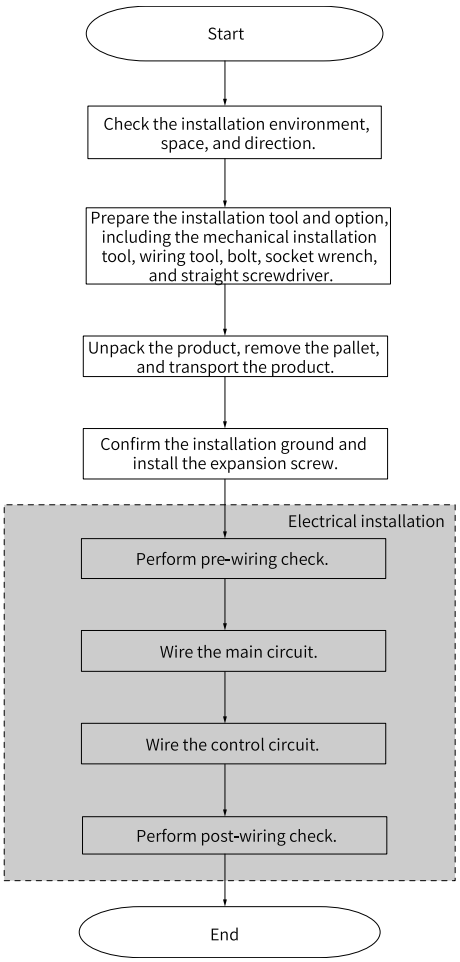


Figure 7-3 General installation process (T13 models)

7.2 Installation Site Inspection

7.2.1 Installation Environment

To maximum the product performance and ensure long-term use, install the drive in an environment meeting the following requirements.

Table 7–1 Environmental requirements

Environment	Requirement
Installation location	Indoor
Grid overvoltage	OVC III

Environment	Requirement
Temperature	• Installation/Ambient temperature: –10°C to +50°C. When the temperature ranges from –10°C to +40°C, no derating is required. For temperature above 40°C, derate 1.5% for every additional 1°C. • Storage/Transportation temperature: -20°C to +60°C. • For better reliability, use the AC drive in places without drastic temperature changes. • When installing the drive into an enclosed environment such as a control cabinet, use a cooling fan or air conditioner to keep the temperature of the inlet air below 50°C. Failure to comply will result in overheat or fire. • Install the drive on a flame-retardant surface, with sufficient clearance reserved for heat dissipation. • Take measures to prevent the drive from being frozen.
Humidity	Storage/Ambient humidity: ⩽ 95% RH, non-condensing
Environment	Pollution degree: 2 or below Install the drive in a location that meets the following descriptions: • Free from direct sunlight, dust, corrosive gas, combustible or explosive gas, oil mist, water vapor, drip, or salt • Insusceptible to vibration (away from equipment that may generate strong vibration, such as a punch press) • Free from unwanted objects such as metallic dust, oil, and water that may enter the AC drive • Free from radioactive substances, combustible materials, harmful gases and liquids, and salt corrosion • Away from combustible materials such as wood • Meeting Class 3C3 requirements in IEC 60721-3-3 in terms of chemically active substances.
Altitude	• 1000 m and below: derating is not required. • > 1000 m: derate 1% for every additional 100 m For 0.4 kW to 3 kW models, the maximum altitude is 2000 m; for altitudes above 2000 m, contact Inovance. For models with the power higher than 3 kW, the maximum altitude is 3000 m; for altitudes above 3000 m, contact Inovance.
Vibration resistance	• For transportation in the package: compliant with class 2M3 in EN 60721-3-2 • For installation with the package removed: compliant with ISTA 1H

7.2.2 Installation Personnel

The equipment can be operated only by professionals with electrical knowledge.

7.2.3 Installation Clearance

Reserve sufficient clearance according to the power rating of the AC drive.

T1 to T9 models

- Installing one drive

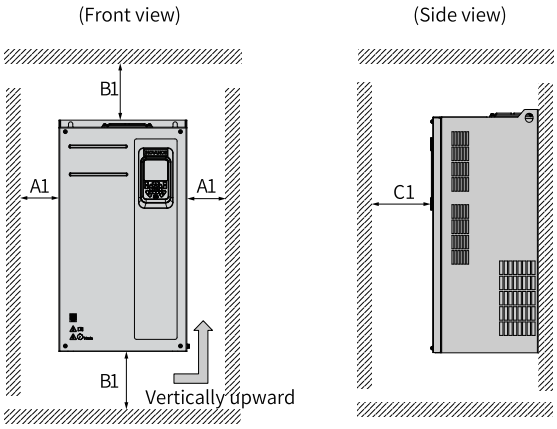


Figure 7-4 Clearance for installing one AC drive (T1 to T9 models)

Table 7–2 Installation clearance

Power Rating	Clearance (mm)		
0.4 kW to 15 kW	A1 ⩾ 10	B1 ⩾ 100	C1 ⩾ 40
18.5 kW to 22 kW	A1 ⩾ 10	B1 ⩾ 200	C1 ⩾ 40
30 kW to 37 kW	A1 ⩾ 50	B1 ⩾ 200	C1 ⩾ 40
45 kW to 160 kW	A1 ⩾ 50	B1 ⩾ 300	C1 ⩾ 40

Note

The distance between the air inlet and outlet of the AC drive is revered according to the extreme operating conditions. If the size required by customers is smaller than the recommended size, contact Inovance engineers for details.

- Installing multiple drives side by side

  The AC drive dissipates heat upward. When multiple AC drives are required to work together, install them side by side. Keep their tops level with each other, especially for those of different sizes.

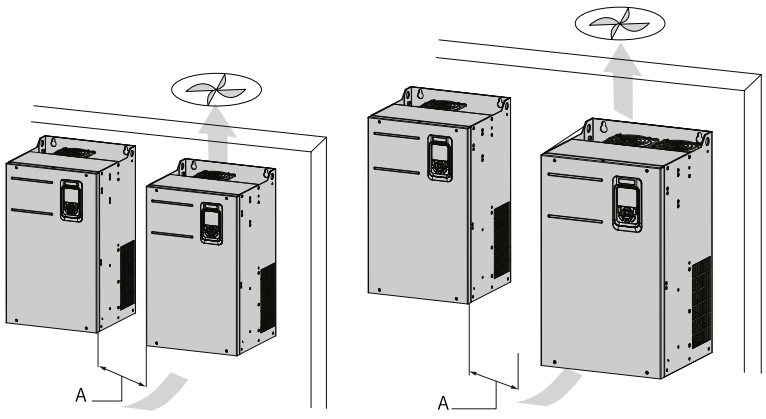


Figure 7-5 Installing multiple AC drives (T1 to T9 models) side by side

Table 7–3 Installation clearance

Power Rating	Clearance (mm)
0.4 kW to 15 kW	A ⩾ 10
18.5 kW to 22 kW	A ⩾ 10
30 kW to 37 kW	A ⩾ 50
45 kW to 160 kW	A ⩾ 50

Note

The distance between the air inlet and outlet of the AC drive is revered according to the extreme operating conditions. If the size required by customers is smaller than the recommended size, contact Inovance engineers for details.

- Dual-row installation
  If one drive needs to be installed above another one, install an air guide plate, as shown in *"Figure 7–6 Dual-row installation" on page 165*. This can prevent the drive in the lower row from heating that in the upper row, causing overheat or overload faults.

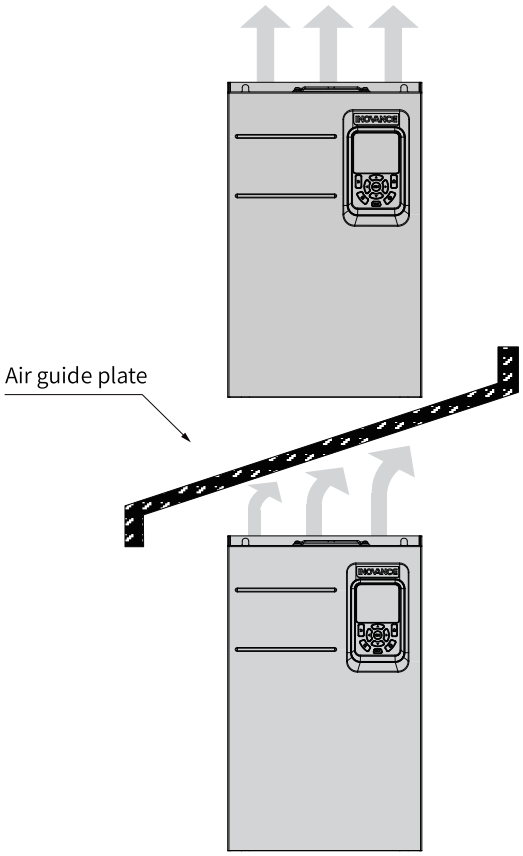


Figure 7-6 Dual-row installation

Air director design

The following figure shows the air director.

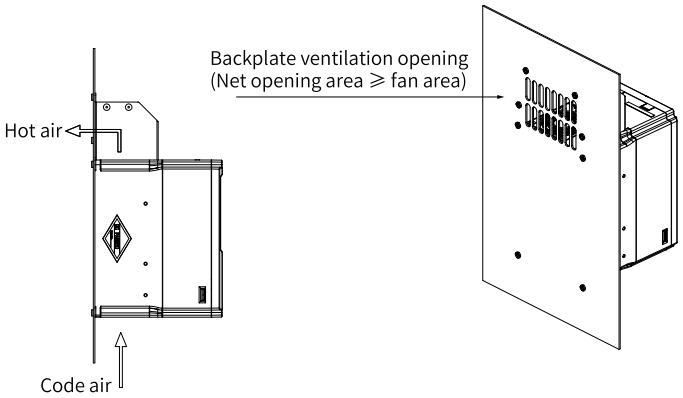


Figure 7-7 Air director

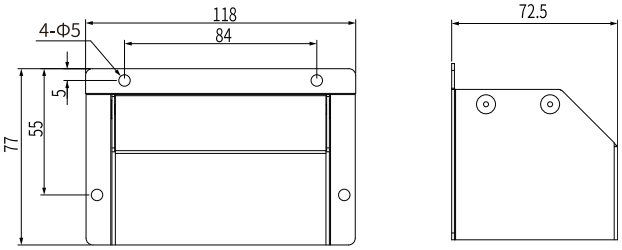


Figure 7-8 Air director dimensions (mm) of T1 models

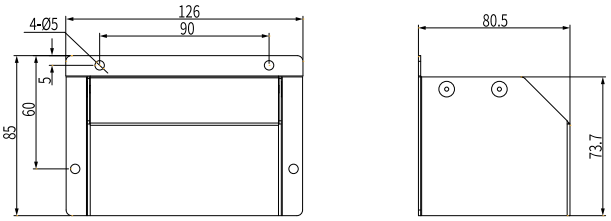


Figure 7-9 Air director dimensions (mm) of T2 models

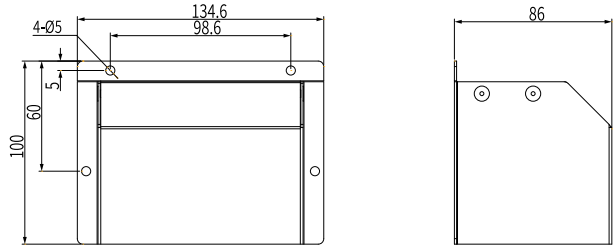


Figure 7-10 Air director dimensions (mm) of T3 models

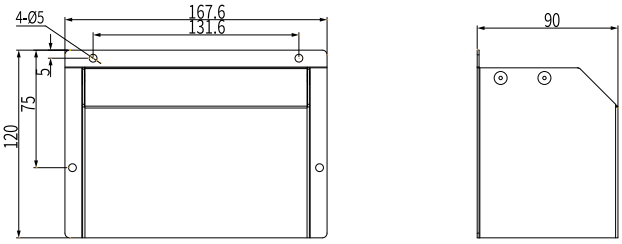


Figure 7-11 Air director dimensions (mm) of T4 models

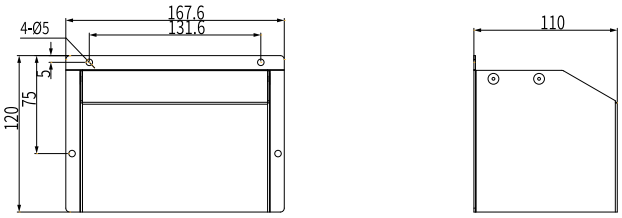


Figure 7-12 Air director dimensions (mm) of T5 models

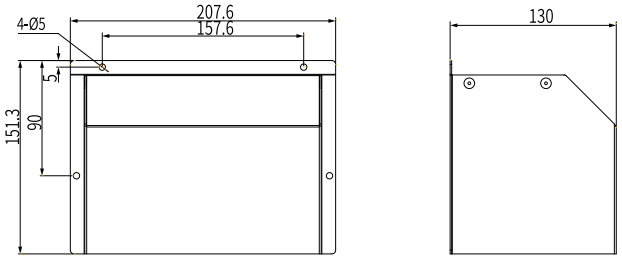


Figure 7-13 Air director dimensions (mm) of T6 models

Caution

Where multiple AC drives are installed in one cabinet, if the fan blows air into the air inlet from the outside, air distribution for the drives in the cabinet will be affected, resulting in poor cooling performance. Therefore, do not install a fan at the air inlet of the cabinet to blow air into the cabinet.

The following table describes the minimum effective ventilation area of the cabinet air inlet after the drive is installed in the cabinet.

Table 7–4 Minimum effective ventilation area of the cabinet air inlet

AC Drive	Minimum Effective Ventilation Area of the Cabinet Air Inlet (cm^2)
T1	20
T2	25
T3 (7.5 kW)	
T3 (11 kW)	50
T4	
T5	60
T6 to T7	102
T8	204
T9	318

The preceding table applies to situations where only one AC drive is mounted in the cabinet. For a cabinet containing multiple AC drives, calculate the total ventilation area by adding the ventilation area of each drive according to the table. For example, if eight T3 models (7.5 kW), two T5 models, and one T9 model are placed inside the cabinet, the minimum effective ventilation area of the cabinet air inlet is 8 x 25 + 2 x 60 + 1 x 318 = 638 cm^2.

If an air filter is installed at the air inlet, the air inlet resistance will rise significantly. Therefore, the ventilation area of the air inlet must be increased to 1.2 to 1.5 times the value indicated in the table.

*“Table 7–4 Minimum effective ventilation area of the cabinet air inlet” on page 167*The ventilation area in the preceding table refers to the actual through-hole area of an opening. The ventilation area is calculated by the following: opening area x opening rate.

T10 to T12 models

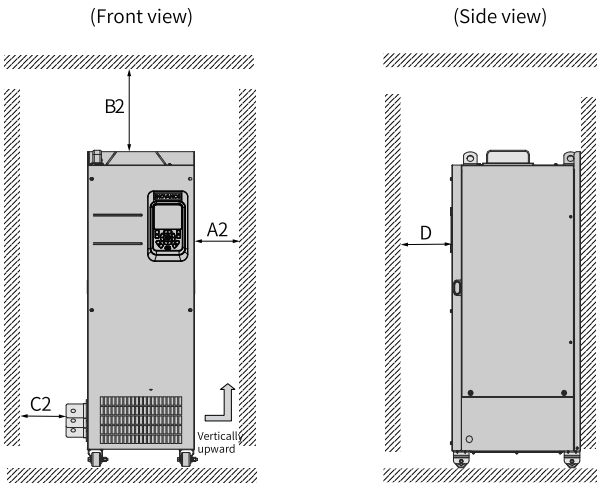


Figure 7-14 Requirements on installation clearance

Table 7–5 Installation clearance

Power Rating	Clearance (mm)			
200 kW to 400 kW	A2 ⩾ 10	B2 ⩾ 250	C2 ⩾ 20	D ⩾ 20

Note

T10 to T12 models can only be installed in cabinets individually. They cannot be installed in a side-by-side or up-down way. If side-by-side or up-down installation is required, contact Inovance.

T13 models

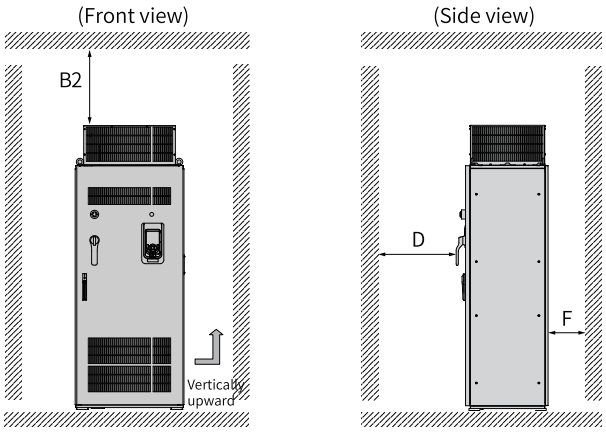


Figure 7-15 Requirements on installation clearance

Table 7–6 Installation clearance

Power Rating	Clearance (mm)		
500 kW to 630 kW	B2 ⩾ 250	D ⩾ 800	F ⩾ 100

7.2.4 Installation Direction

Install the AC drive vertically upright only, as shown in *"Figure 7–17" on page 169* . Do not lie down the AC drive horizontally or by its side, or install it in the upside-down direction.

If the AC drive needs to be placed in an upright position, ensure the tilt angle of the place that holds the drive does not exceed 5°. Failure to comply may lead to rollover of the drive due to its heavy weight (nearly 200 kg) and large size.

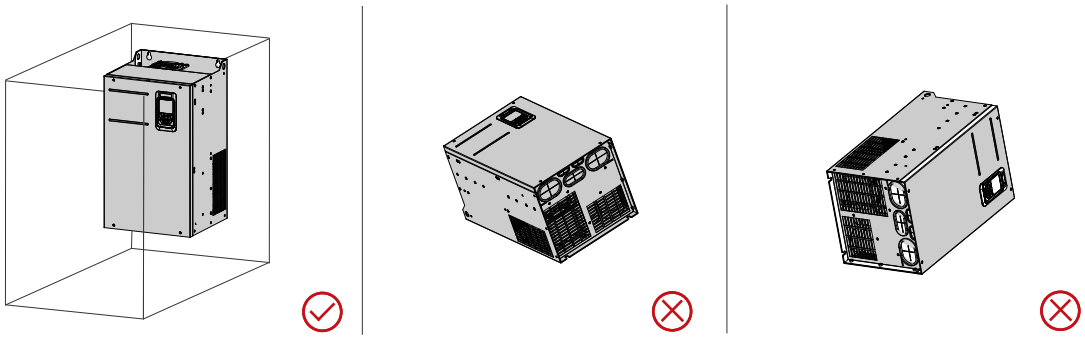


Figure 7-16 Installation direction (T1 to T9 models)

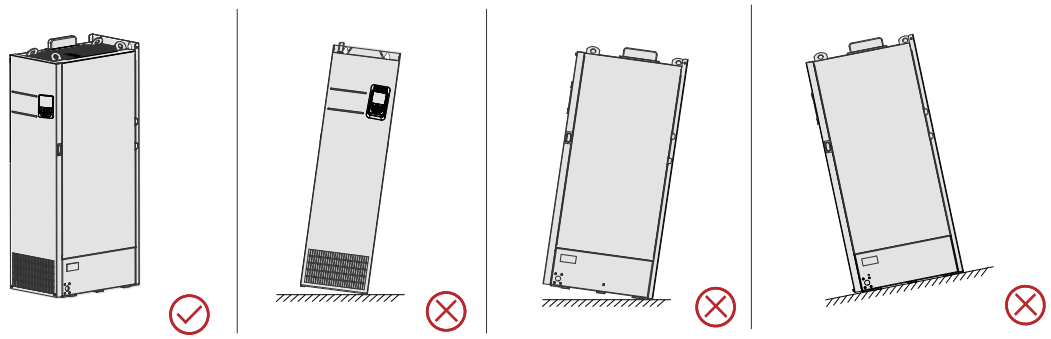


Figure 7-17 Installation direction (T10 to T12 models)

7.3 Installation Tools

7.3.1 Tools for Mechanical Installation

T1 to T9 models

"Table 7–7 Tools for mechanical installation" on page 170 lists the tools for mechanical installation.

Table 7–7 Tools for mechanical installation

Tool	Description
Electric drill with appropriate drilling bits	It is used to drill mounting holes on the mounting surface.
Nut wrench or socket wrench	It is used to tighten or loosen screws. The following specifications are required: #13, #16, and #18.
Phillips screwdriver and straight screwdriver (2.5 mm to 6 mm)	It is used to tighten or loosen screws.
Torque wrench	It is used to tighten or loosen screws.
Crowbar	It is used to pry off the cover to facilitate installation.
Crane	It is used to lift the equipment.
Tape measure	It is used to measure the installation dimensions of the equipment.
Gloves	They are used to prevent static electricity during mechanical installation.
Bottom mounting bracket (standard)	It is used to fix the AC drive in the cabinet.
Guide rail (optional)	It is connected to the bottom mounting bracket, enabling you to gently push the AC drive into the cabinet along the guide rails.
Screw	It is used to fix the equipment to the mounting surface.

"Table 7–8 Specifications and quantity of screws" on page 170 lists the specifications and quantity of screws required for mechanical installation.

Table 7–8 Specifications and quantity of screws

Installation Mode	Specification	Quantity (PCS)	Description
Backplate mounting	Users purchase the screw according to the mounting hole diameter.	4	Used to fix the drive onto the wall
Through-hole mounting	Users purchase the screw according to the mounting hole diameter.	4	Used to fix the drive to the backplate of the control cabinet.

T10 to T12 models

"Table 7–7 Tools for mechanical installation" on page 170 lists the tools for mechanical installation.

"Table 7–9 Specifications and quantity of screws" on page 171 lists the specifications and quantity of screws required for mechanical installation.

Table 7–9 Specifications and quantity of screws

Installation Mode	Screw Specification	Quantity (PCS)	Description
Installation within the cabinet	M5 self-tapping screw	6	It is used to fix the bottom mounting bracket to the bottom of the cabinet.
	M5 x 12 SEMS screw	8	It us used to assemble the guide rails.
	M6 nut	2	It is used to connect the guide rail assembly to the bottom mounting bracket.

T13 models

"Table 7–10 Tools for mechanical installation" on page 171 lists the tools for mechanical installation.

Table 7–10 Tools for mechanical installation

Tool	Description
Wrench or socket wrench (18 mm)	It is used to tighten or loosen screws.
Phillips screwdriver and straight screwdriver (2.5 mm to 6 mm)	It is used to tighten or loosen screws.
Torque wrench (torque above 100 N·m)	It is used to tighten or loosen screws.
Electric drill with an appropriate drilling bit	It is used to drill holes on the floor or steel plates for fastening the cabinet.
Crowbar	It is used to pry off the cover to facilitate installation.
Crane	It is used to lift the equipment.
Tape measure	It is used to measure the installation dimensions of the equipment.
Gloves	They are used to prevent static electricity during mechanical installation.



Select the screw with correct specifications; otherwise, improper installation may occur.

7.3.2 Tools for Wiring

When wiring the main circuit terminal, select an appropriate installation tool based on the terminal size. *"Table 7–11 Tools for wiring the main circuit terminal" on page 171* lists the tools for wiring the main circuit terminal.

Table 7–11 Tools for wiring the main circuit terminal

Drive Model	Recommended Fastener	Tool
T1 to T2	M4 SEMS screw	Phillips screwdriver (#3 slot)
T3 to T4	M5 SEMS screw	Phillips screwdriver (#3 slot)
T5 to T6	M6 SEMS screw	Phillips screwdriver (#3 slot)
T7	M8 nut, spring washer, and flat washer	Socket wrench (#13)
T8 to T9	M12 nut, spring washer, and flat washer	Socket wrench (#19) and socket wrench extension bar (150 mm)

Drive Model	Recommended Fastener	Tool
T10 to T11	M12 bolt, spring washer, and flat washer	Socket wrench (#19) and socket wrench extension bar (250 mm)
T12	M16 bolt, spring washer, and flat washer	Socket wrench (#24) and socket wrench extension bar (250 mm)
T13	M12 bolt, spring washer, and flat washer	Socket wrench (#24) and socket wrench extension bar (250 mm)

7.4 Accessories

7.4.1 List of Options

Optional peripherals include braking units, function expansion cards, and external operating panels. For use of each option, see its user guide. If any option is required, specify it in your order.

Table 7–12 Option list

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Braking components	External braking unit [1]	MDBUN-60-T	01013133	All models	60 A, 380 VAC series
		MDBUN-60-5T	0101AR57	All models	60 A, 480 VAC series
		MDBUN-90-T	01013126	All models	90 A, 380 VAC series
		MDBUN-90-5T	0101AR58	All models	90 A, 480 VAC series
		MDBUN-200-T	01040104	All models	200 A, 380 VAC series
		MDBUN-200-5T	01040160	All models	200 A, 480 VAC series
	Built-in braking unit	Models with the name containing letter "B"	-	T1 to T8 (75 kW)	For T1 to T4 models (three phase 380 V to 480 V), the built-in braking unit is standard. For T5 to T8 models (three phase 380 V to 480 V, 75 kW), the braking unit is optional.

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Expansion card	I/O expansion card 1	MD38IO1	01013098	T4 and above	Five DIs, one DO, one RO, one AO, one AI (PT100/PT1000), one RS485 or CAN communication signal isolation input terminal
	I/O expansion card 2	MD38IO2	01013103	All models	Three DIs
	I/O expansion card 3	MD38IO3	01040051	All models	Three DIs, one RO, one RS485 communication signal isolation input terminal
	I/O expansion card 4	MD520IO1	01040250	All models	Three DIs, one RS485 communication signal isolation input terminal, one normally open relay output terminal, one AO
	RS485 communication card	MD38TX1	01013112	All models	Modbus communication card with the isolation feature
	CANopen/CANlink communication card	MD38CAN1	01013100	All models	CANopen/CANlink communication card
	PROFIBUS DP communication card	MD-SI-DP2	01040249	All models	PROFIBUS DP communication card
		MD38DP2	01013144	T4 and above	PROFIBUS DP communication card
	PROFINET communication card <1>	MD500-PN1	01040098	All models	PROFINET communication card
		MD500-PN2	01040198	All models	PROFINET communication card
	EtherCAT communication card	MD500-ECAT	01040113	All models	EtherCAT communication card
	Ethernet/IP communication card	MD500-EN1	01040167	All models	Ethernet/IP communication card
	Modbus TCP communication card	MD500-EM1	01040201	All models	Modbus TCP communication card

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Expansion card	Positioning expansion card 1	MD38DW1	01013096	T4 and above	Multi-function pulse input expansion card Five DIs, one DO, one RO, one AO, one AI, one RS485 or CAN communication signal isolation input terminal, one differential ABZ terminal
	Positioning expansion card 2	MD38DW2	01013097	All models	Mini pulse input expansion card One RS485 communication terminal, one differential ABZ terminal (positioning)
	Resolver frequency division encoder card	MD38PG4D	01040008	T4, T7 models and above	The MD38PG4D card is a PG card specially developed for resolvers. Featuring differential frequency division, it is suitable for various applications such as machine tool electric master axis, master-slave control, and synchronous control.
	Resolver interface card	MD38PG4	01013081	All models	It is applicable to the resolver with the excitation frequency of 10 kHz and with the DB9 interface To meet the MD38PG4 requirements, the excitation input DC resistance of the resolver must be greater than 17 Ω. Failure to comply will result in MD38PG4 malfunction. Select a resolver with a maximum of four pole pairs. Otherwise, the MD38PG4 card will be overloaded. The number of resolver pole pairs must be less than or equal to the number of motor pole pairs, and the number of motor pole pairs divided by the number of resolver pole pairs must be an integer.

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Expansion card	Multi-functional encoder card	MD38PGMD	01013147	All models	The card is an encoder interface card with the optional multiplied frequency division output function and supports 5 V or 15 V power supply. The card supports differential input, collector input, and push-pull input, as well as differential output and collector output; therefore, it can be used to connect to different encoders and supports A/B phase input of the host controller.
	23-bit PG card	ES510-PG-CT1	01320007	All models	Applicable to 23-bit encoders of Inovance; with a DB9 interface
	Sin-cos encoder	MD520-PG-S1	01040237	All models	The MD520-PG-S1 is a PG card that decodes sin-cos encoders. Working with the AC drive, it can measure the motor speed, and realize speed and position closed loop control and encoder frequency division output.
	Bus adaption card	MD520-CClick	01040283	All models	The MD520-CClink communication expansion card (hereinafter referred to as the MD520-CClink card) is an open fieldbus adaption card for MD520 series AC drives. It communicates with the CClink master through a dedicated interface to achieve efficient data interaction between CClink master and slave. It features flexible topology and easy operation.

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Mounting accessory	Through-hole mounting bracket	MD500-AZJ-A1T1	01040072	T1	The bracket is used for through-hole mounting. It applies only to T1 to T9 models.
		MD500-AZJ-A1T2	01040073	T2	
		MD500-AZJ-A1T3	01040074	T3	
		MD500-AZJ-A1T4	01040075	T4	
		MD500-AZJ-A1T5	01040001	T5	
		MD500-AZJ-A1T6	01040002	T6	
		MD500-AZJ-A1T7	01040003	T7	
		MD500-AZJ-A1T8	01040004	T8	
		MD500-AZJ-A1T9	01040005	T9	
	Grounding bracket of cable shield	MD500-AZJ-A2T1	01040085	T1	The accessory is used for re-fixing the power cable and stable grounding of the shield in 360°. It applies only to T1 to T9 models.
		MD500-AZJ-A2T2	01040088	T2	
		MD500-AZJ-A2T3	01040083	T3	
		MD500-AZJ-A2T4	01040082	T4	
		MD500-AZJ-A2T5	01040081	T5	
		MD500-AZJ-A2T6	01040086	T6	
		MD500-AZJ-A2T7	01040087	T7	
		MD500-AZJ-A2T8	01040084	T8	
		MD500-AZJ-A2T9	01040089	T9	
	Mounting guide rail	MD500-AZJ-A3T10	01040009	T10 to T12	The option is used for installing the AC drive in a cabinet. For T10 models and models above T10, it is recommended that a guide rail be used to push the AC drive into the cabinet.
	U/V/W output copper busbar	MD500-TP-T10	01040125	T10	MD520 models excluding that with the base (-L) are delivered with the U/V/W output copper busbar.
		MD500-TP-T11	01040126	T11	
		MD500-TP-T12	01040127	T12	

Name		Option Model	Ordering Code	Supported AC Drive Model	Description
Cable	Main circuit cable	Lugs from Suzhou Yuanli are recommended. For details of recommended lugs, see *"5.3.1" on page 76*.			It is recommended that the input and output main circuit cables use symmetrical shielded cables. Compared with four-conductor cables, symmetrical shielded cables can reduce electromagnetic radiation in the whole transmission system. It is recommended that power cables also use symmetrical shielded cables.
	Control circuit cable	All control circuit cables must be shielded cables. Use a separate shielded cable for each type of analog signal. It is recommended that digital signal cables use shielded twisted pair (STP) cables.			
	External LED operating panel	MDKE-10	01040182	All models	It supports parameter display and modification.
	External LCD operating panel	SOP-20	01040028	All models	It supports parameter copy and download, and supports English and Chinese.
	SOP-20 mounting base	CP600–BASE1	01040022	All models	It is used to install the SOP-20 to the cabinet door.
	MDKE-10 mounting base	MD580-AZJ1	01040202	All models	It is used to install the MDKE-10 to the cabinet door.
	Extension cable	MDCAB	01013008	All models	It is a three-meter cable for the external operating panel. The standard 8-conductor cable can connect to the LED operating panel MDKE-10 and the LCD operating panel SOP-20.
		MDCAB-1.5	15048471	All models	1.5-meter cable for the external operating panel

Note

For details on models and specifications of other peripheral electrical components, such as input reactors, EMC filters, output reactors, and fuses, see the section of peripheral electrical components.

<1> The difference between MD500-PN1 and MD500-PN2 is as follows:

1. Power-on time: The power-on time of the MD500-PN1 is 3s, and that of the MD500-PN2 is 30s.
2. GSD file: The GSD files of the MD500-PN1 and MD500-PN2 are different.
3. Media redundancy protocol: The MD500-PN1 supports the media redundancy protocol, and the MD500-PN2 does not support the media redundancy protocol.

7.4.2 Through-hole Mounting Bracket

The through-hole mounting bracket is an option. Purchase a proper model based on actual needs.

Applicable model

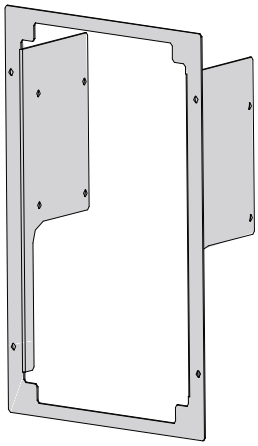


Figure 7-18 Through-hole mounting bracket

Table 7–13 Models of through-hole mounting brackets

Through-hole Mounting Bracket Model	Structure
MD500-AZJ-A1T1	T1
MD500-AZJ-A1T2	T2
MD500-AZJ-A1T3	T3
MD500-AZJ-A1T4	T4
MD500-AZJ-A1T5	T5
MD500-AZJ-A1T6	T6
MD500-AZJ-A1T7	T7
MD500-AZJ-A1T8	T8
MD500-AZJ-A1T9	T9

Mounting hole dimensions

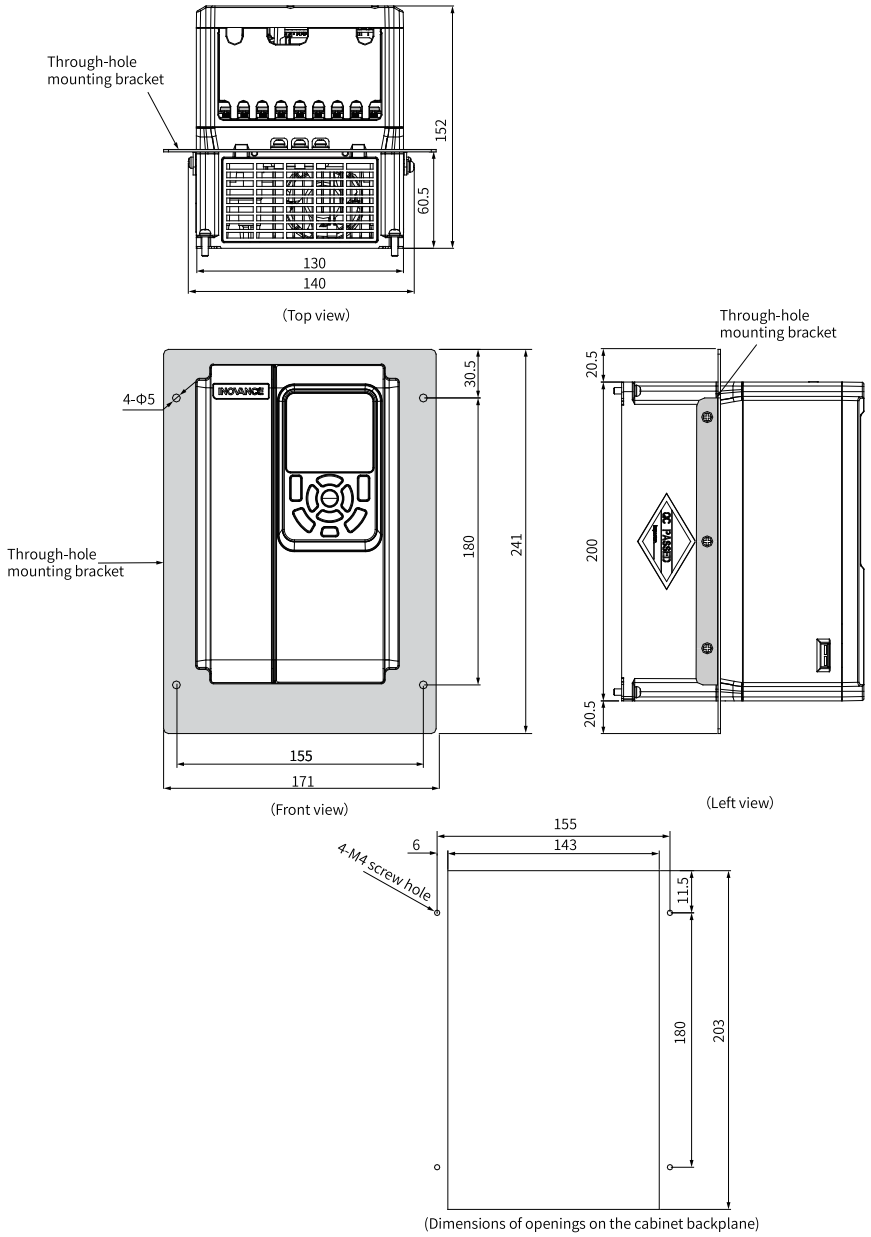


Figure 7-19 MD500-AZJ-A1T1 through-hole mounting bracket and mounting hole dimensions (mm)

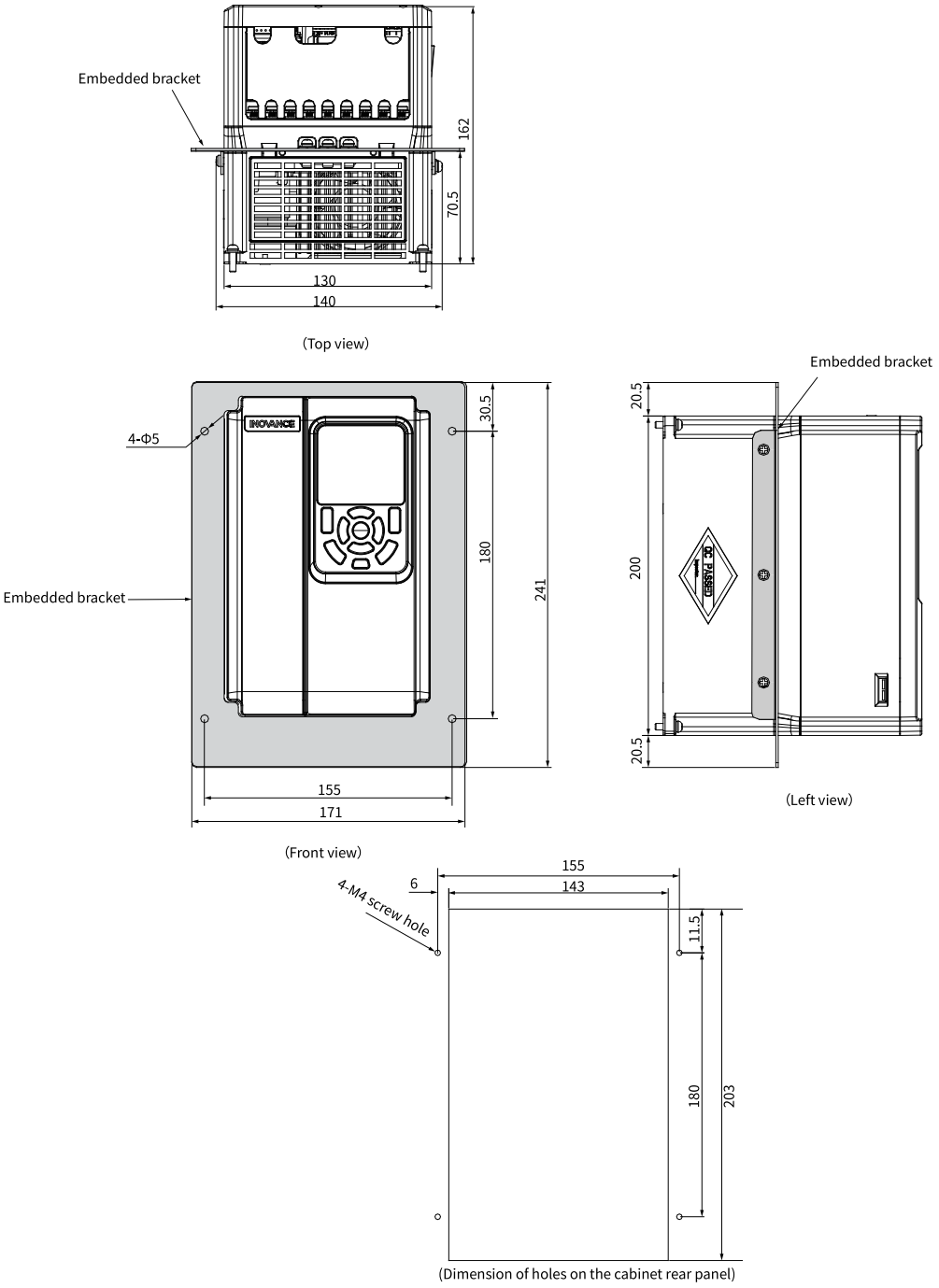


Figure 7-20 MD500-AZJ-A1T2 through-hole mounting bracket and mounting hole dimensions (mm)

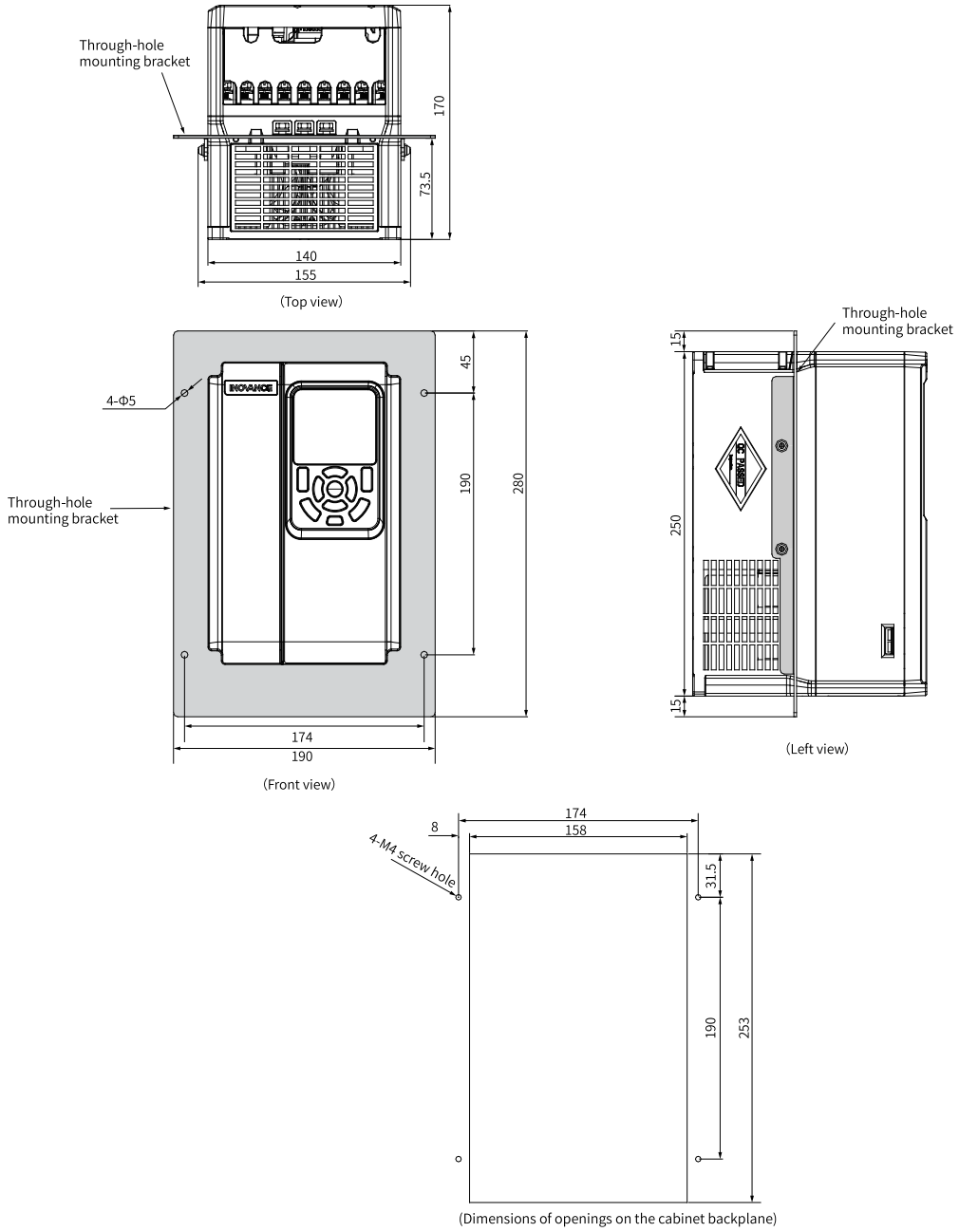


Figure 7-21 MD500-AZJ-A1T3 through-hole mounting bracket and mounting hole dimensions (mm)

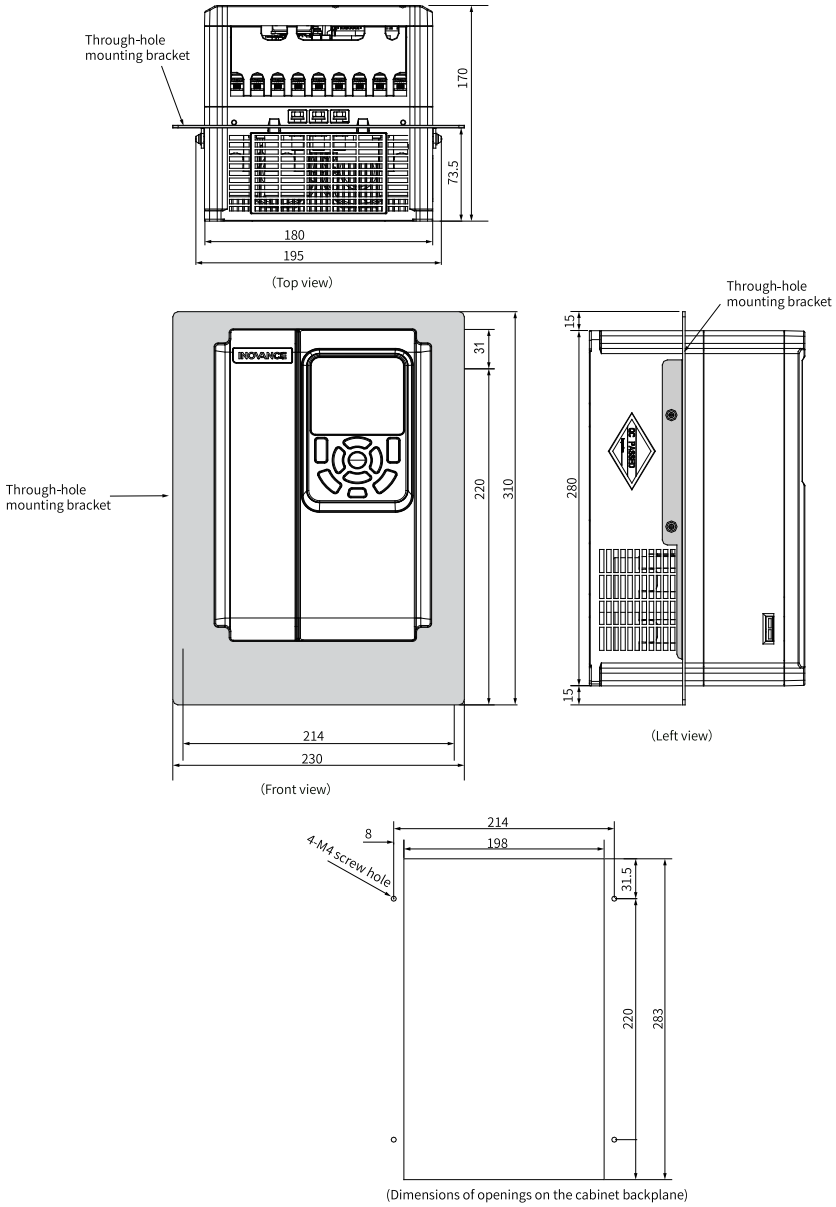


Figure 7-22 MD500-AZJ-A1T4 through-hole mounting bracket and mounting hole dimensions (mm)

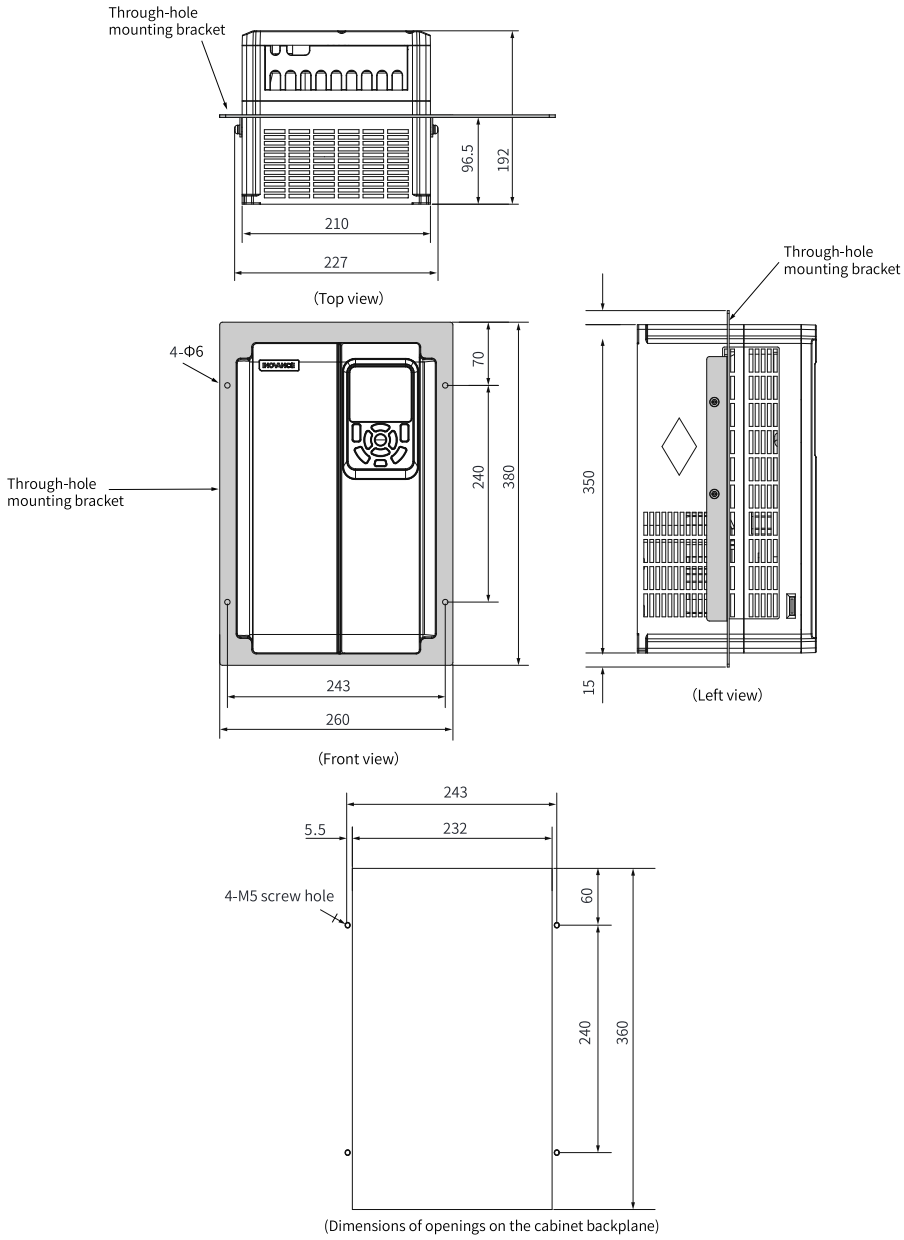


Figure 7-23 MD500-AZJ-A1T5 through-hole mounting bracket and mounting hole dimensions (mm)

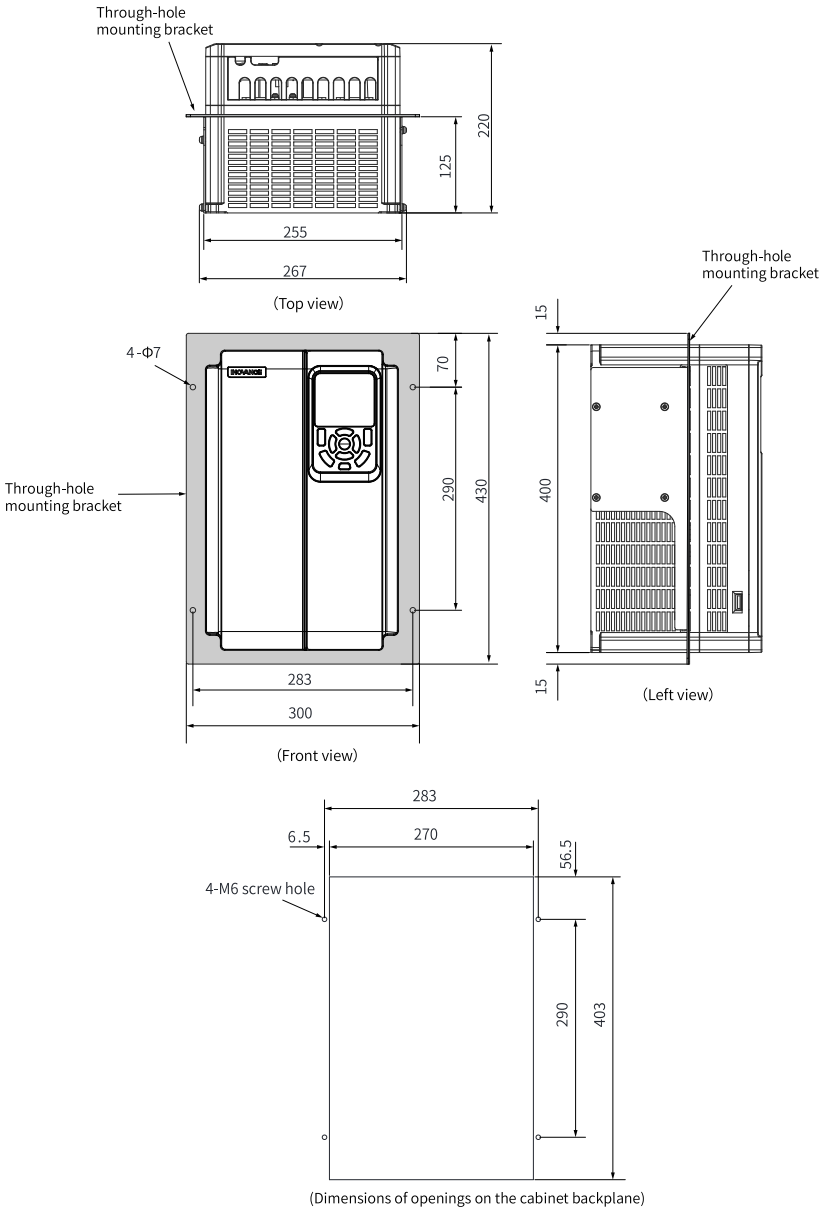


Figure 7-24 MD500-AZJ-A1T6 through-hole mounting bracket and mounting hole dimensions (mm)

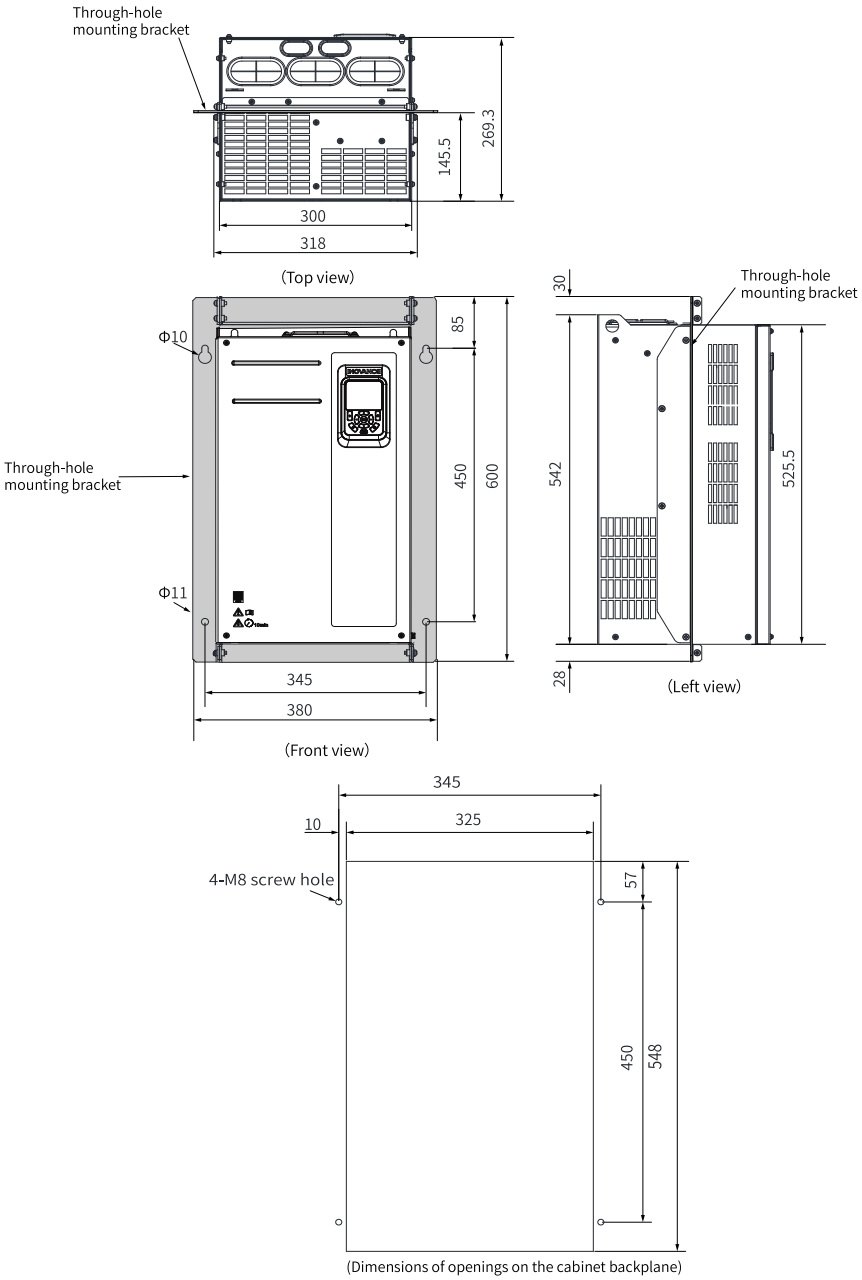


Figure 7-25 MD500-AZJ-A1T7 through-hole mounting bracket and mounting hole dimensions (mm)

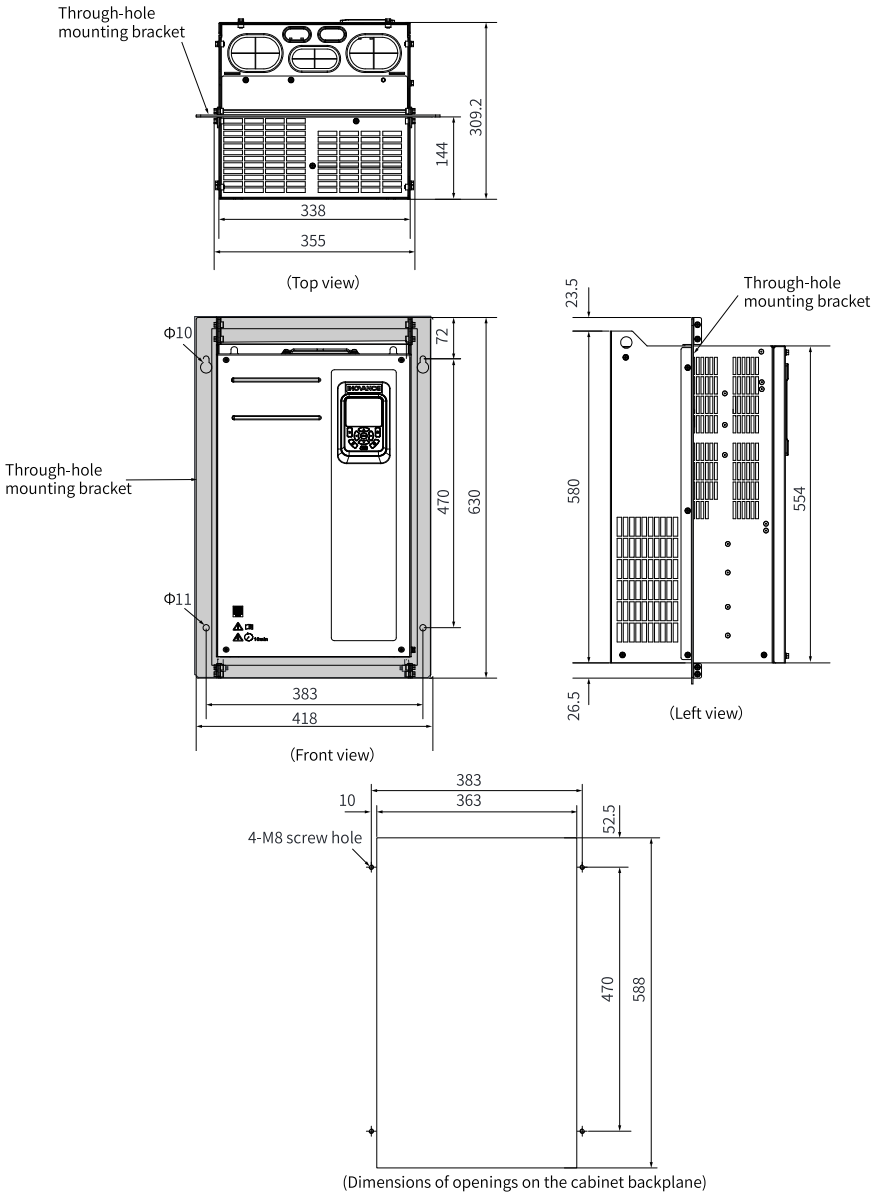


Figure 7-26 MD500-AZJ-A1T8 through-hole mounting bracket and mounting hole dimensions (mm)

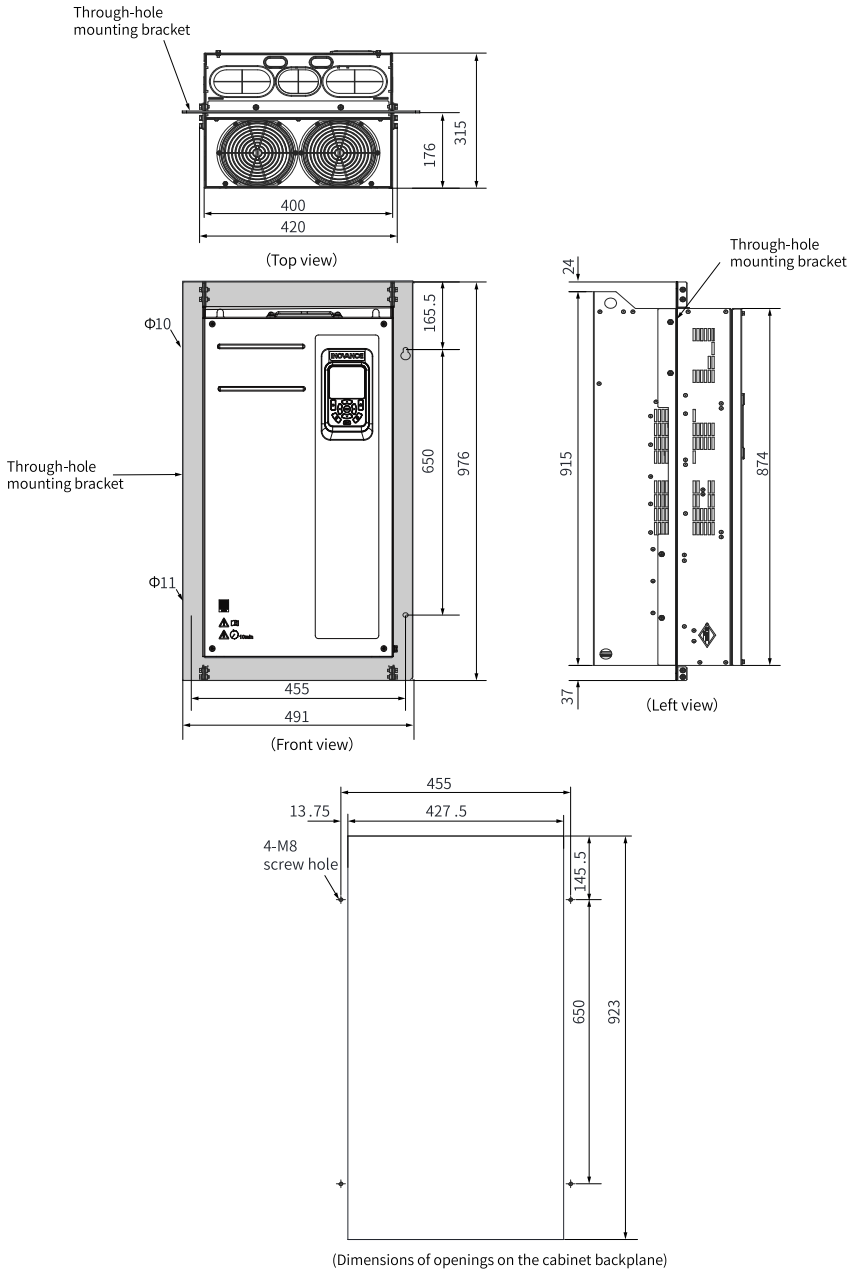


Figure 7-27 MD500-AZJ-A1T9 through-hole mounting bracket and mounting hole dimensions (mm)

7.4.3 Ground Bracket of Cable Shield

The grounding bracket of cable shield is optional and can be purchased separately as required (applicable to T9 models and below).

7.4.4 Bottom Mounting Bracket

T10 to T12 models come with a bottom mounting bracket as standard. When the AC drive is installed in a cabinet, the bottom mounting bracket is required for fixing the AC drive to the cabinet rack base. The dimensions of bottom mounting brackets vary with the power rating, weight, and size of the AC drive, as shown in the following figures.

The bottom mounting bracket provided with the AC drive is applicable to the cabinet with a depth of 600 mm.

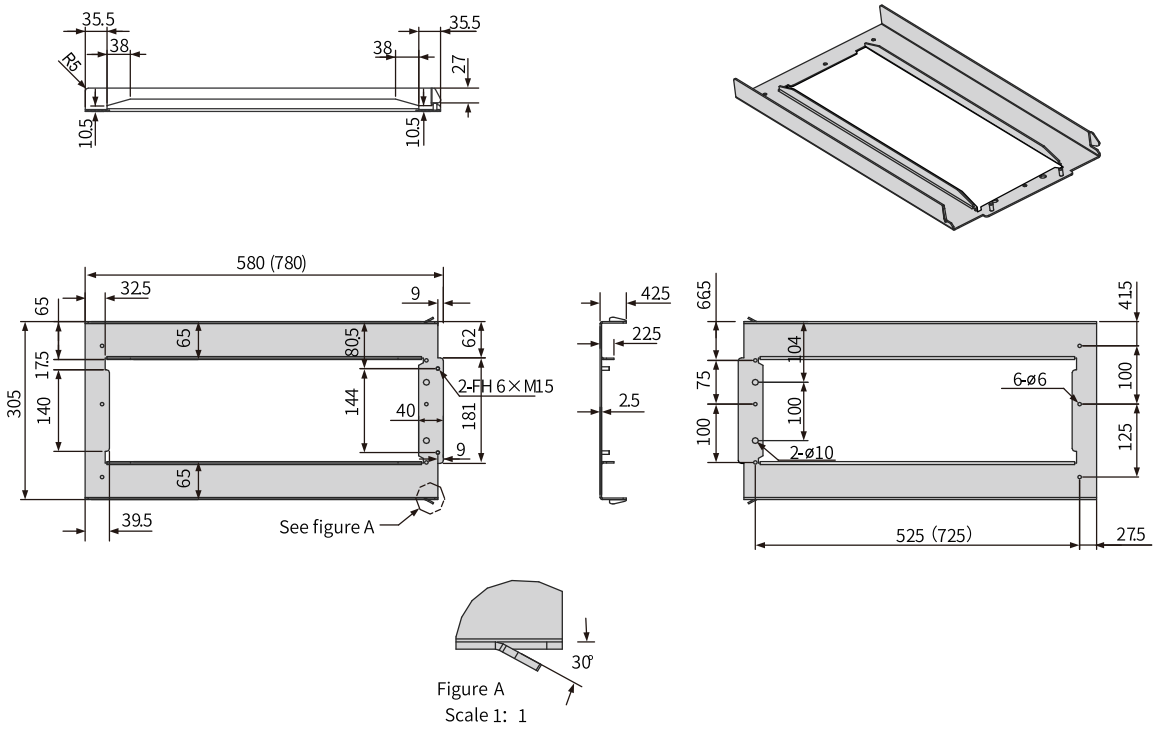


Figure 7-28 Dimensions (mm) of the bottom mounting bracket for T10 models

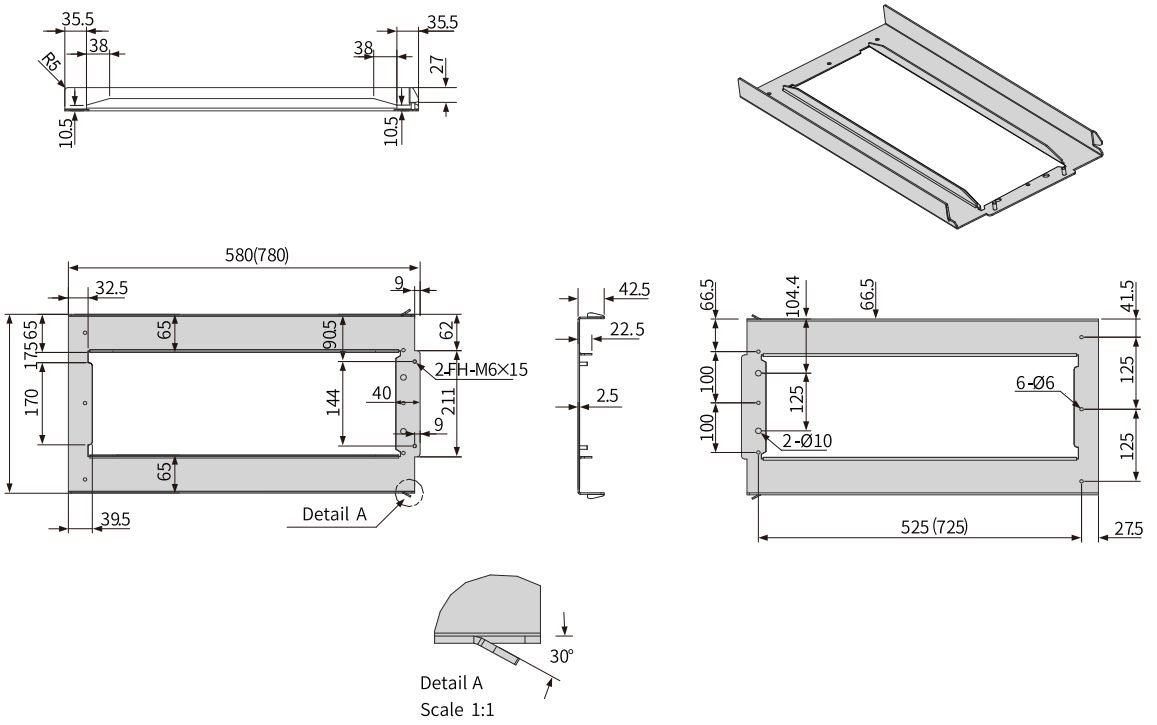


Figure 7-29 Dimensions (mm) of the bottom mounting bracket for T11 models

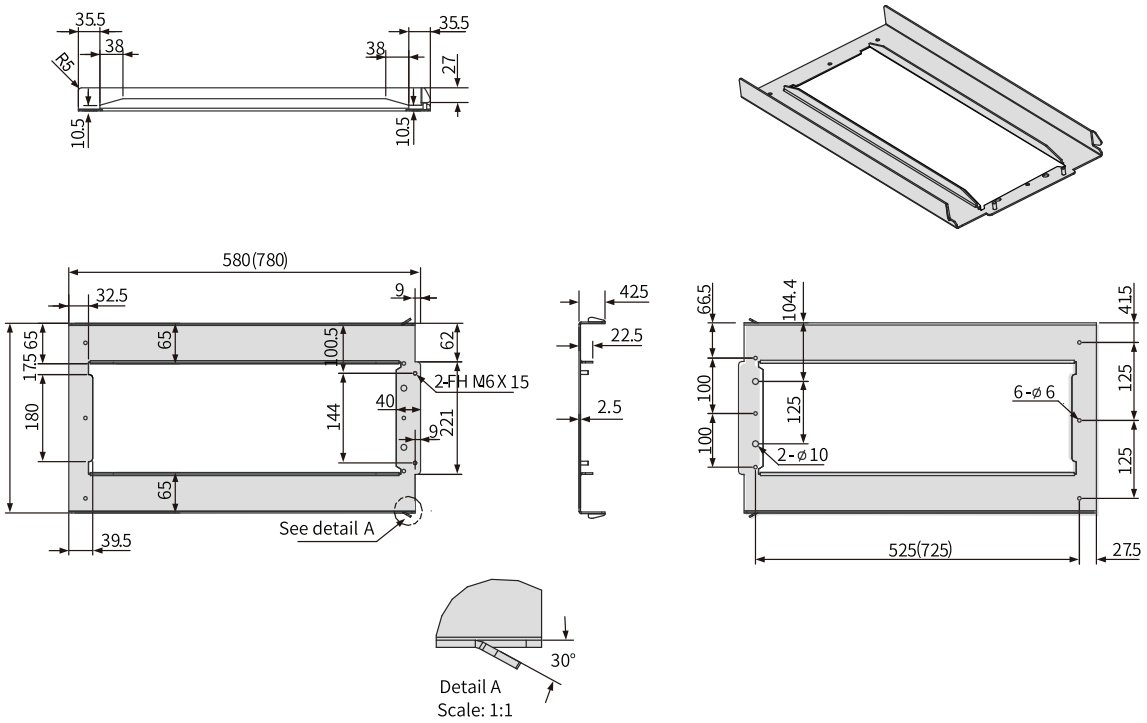


Figure 7-30 Dimensions (mm) of the bottom mounting bracket for T12 models

Note

- The bottom mounting brackets shown in the preceding figures are applicable to PS standard cabinets, sized either Width 800 mm x Depth 600 mm or Width 800 mm x Depth 800 mm. Dimensions in parentheses are applicable to PS standard cabinets sized Width 800 mm x Depth 800 mm.
- The bottom mounting brackets that come standard with T10 to T12 models are only applicable to PS standard cabinets sized Width 800 mm x Depth 600 mm.

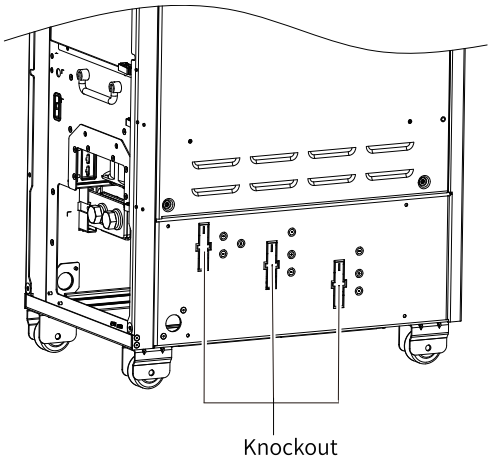
7.4.5 Mounting Guide Rail

For details of the guide rails, see *MD500-AZJ-A3T10 Guide Rail Operation Guide*.

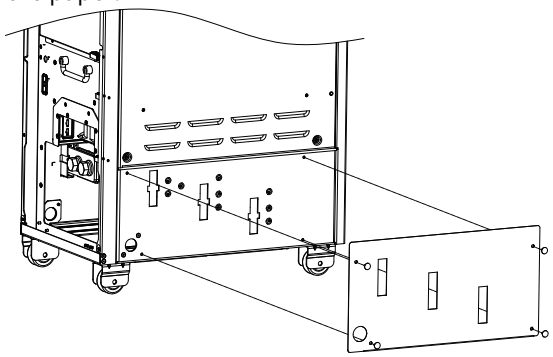
7.4.6 Installing the U/V/W Copper Busbar

All MD520 models excluding those with the base (-L) are delivered with U/V/W output side copper busbars. To install the U/V/W copper busbars, follow the steps below:

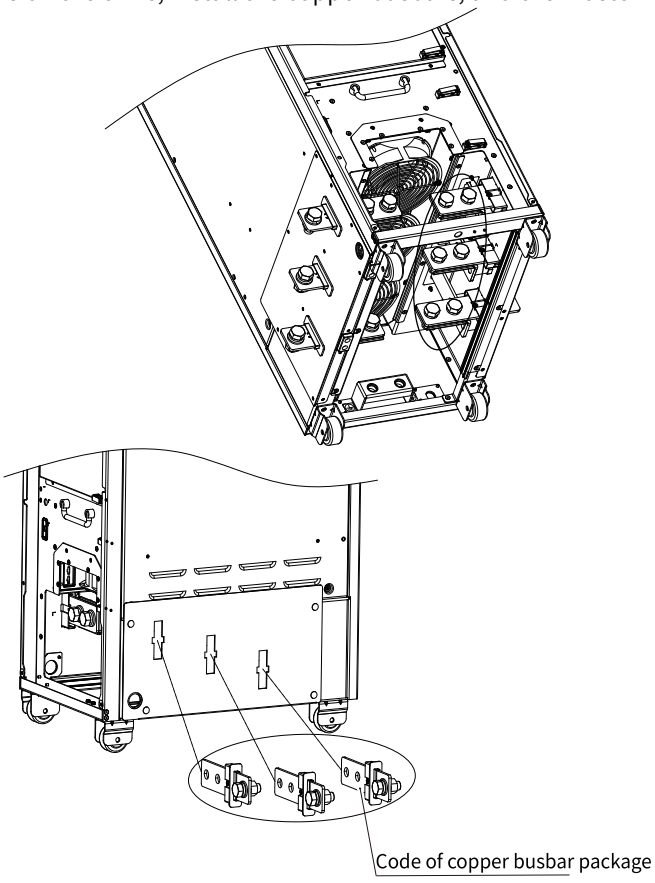
1. Use the screwdriver or cutting pliers to remove the three knockouts.



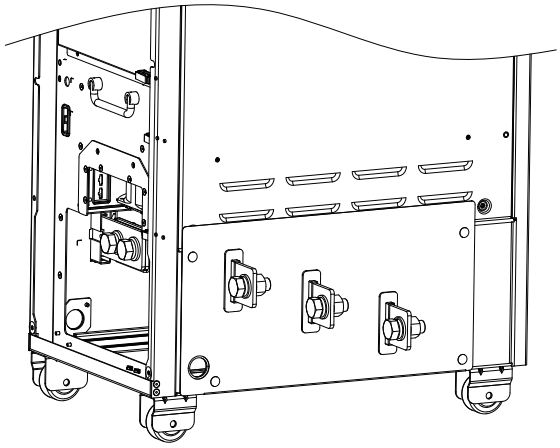
2. Use the four plastic snap-fit joints in the packing box to fasten the insulating paper to the chassis through the four holes on the paper.



3. Remove the six screws on the drive, install the copper busbars, and then fasten the six screws.



The following figure shows the installed copper busbars.



Note

For selection of the U/V/W output copper busbar, see *"7.4.1 List of Options" on page 172*.

8 Unpacking Inspection

8.1 Storage

- The drive must be stored in a clean and dry room, where the temperature ranges from -20°C and +60°C and temperature change rate is smaller than 1°C/min.
- If the drive needs to be stored for a long period of time, cover it or take other appropriate measures to keep it from contamination and environmental influences.
- Try to store the system with the original packing carton of the company.
- Do not expose the AC drive to environments with moisture, high temperatures, or direct sunlight for a long time.
- The electrolytic capacitor will deteriorate after long-term storage. Therefore, switch on the AC drive once for at least 5 hours every 6 months. Increase the input voltage slowly to the rated value by using a voltage regulator. Contact Inovance for technical support if necessary.

8.2 Transportation Before Unpacking

T1 to T12 models

Precautions for transportation of T1 to T12 models:

- T1 to T6 models are small and light and therefore can be handled manually. T7 to T12 models, however, must be transported with an appropriate lifting tool.
- When handling the drive with a forklift, fix the drive to a wooden pallet. When handling the drive with a crane, fix the drive to the pallet and lift them together, as shown below.

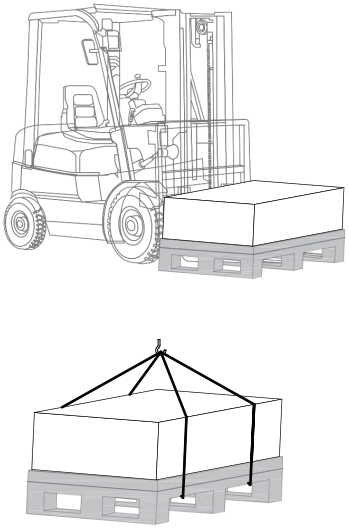


Figure 8-1 Lifting the drive

- T9 to T12 models are heavy with a high center of gravity. Therefore, avoid placing them on an inclined surface with an angle greater than 5 degrees. Place the AC drive on a flat and firm ground that can bear its weight.
- Transport the AC drive only when it is upright as indicated on the packaging box, as shown in the following figure. Never turn it upside down or place it on its side.

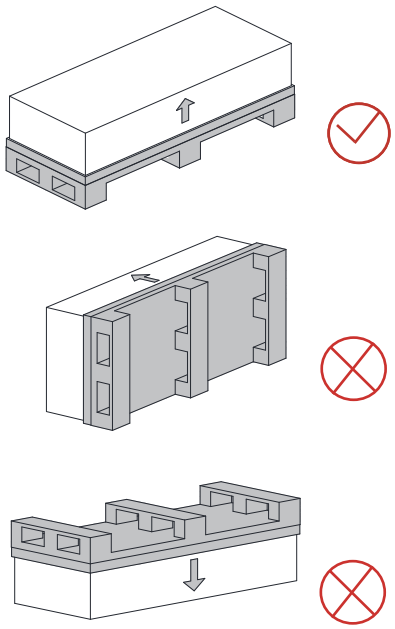


Figure 8-2 Placing the drive

T13 models

Precautions for transportation of T13 models:

- The AC drive is heavy with a high center of gravity. Therefore, avoid placing it on an inclined surface with an angle greater than 5 degrees. Place the AC drive on a flat and firm ground that can bear its weight.
- The equipment must be transported in the upright position as indicated on the packaging box. Never turn it upside down or place it on its side.

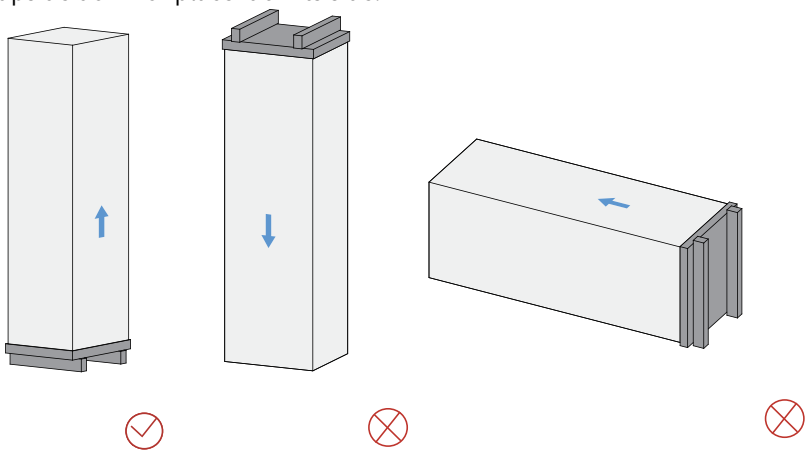


Figure 8-3 Upright position of the cabinet

- Suitable hoisting gear operated by trained personnel is required due to the heavy weight of the cabinet.
- Where applicable, use a forklift and a crane that have a carrying capacity greater than the cabinet weight to transport the cabinet.
- The cabinet must be carried on a wooden pallet when transported with the forklift. Do not remove the cabinet from the pallet during transport. Adjust the spacing between the forks to a distance greater than half the length of the cabinet.

- Considering the weight and length of the cabinet, use the lifting beam fixed at the top of the cabinet and the wooden pallet at the bottom of the cabinet to help lift the cabinet. The lifting strap of the hoist must pass through the pallet under the cabinet, with the relief height less than or equal to 0.3 m.
- The hydraulic vehicle must not move for a long distance or on the slop road.
- When being moved, the equipment must be held by persons from the left and right.

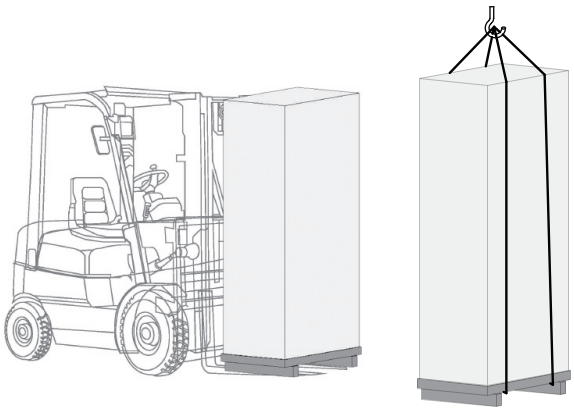


Figure 8-4 Transportation before unpacking

8.3 Package Check

When receiving goods from the shipping company, check that you have received all the items specified on the delivery note. Notify the shipping company immediately of any missing components or damage. Seek support from Inovance office or your local agent if necessary.

AC drives of different structural dimensions are different in size and weight, and hence are packed in different methods with different components incorporated.

Caution

If the equipment is damaged during transportation, its electrical safety can no longer be ensured. Do not connect the equipment before a professional high-voltage test is performed.

Packing list for T1 to T9 models

- T1 and T6 models are packed using cartons.
- T7 to T9 models are packed using cartons and plywood pallets.

The following figure shows the packing list.

- Packing list of T1 to T6 models

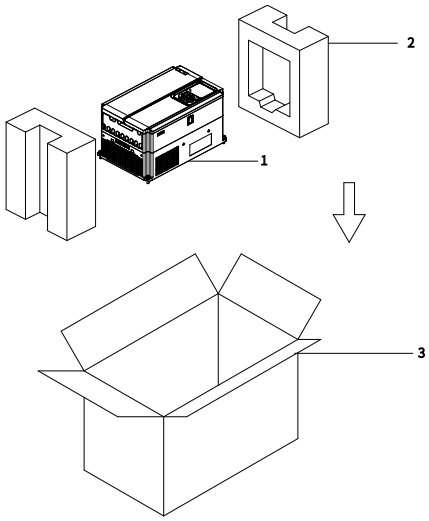


Figure 8-5 Packing list of T1 to T6 models

Table 8–1 Packing list of T1 to T6 models

No.	Name
1	AC drive
2	Cushion
3	Carton

- Packing list of T7 to T9 models

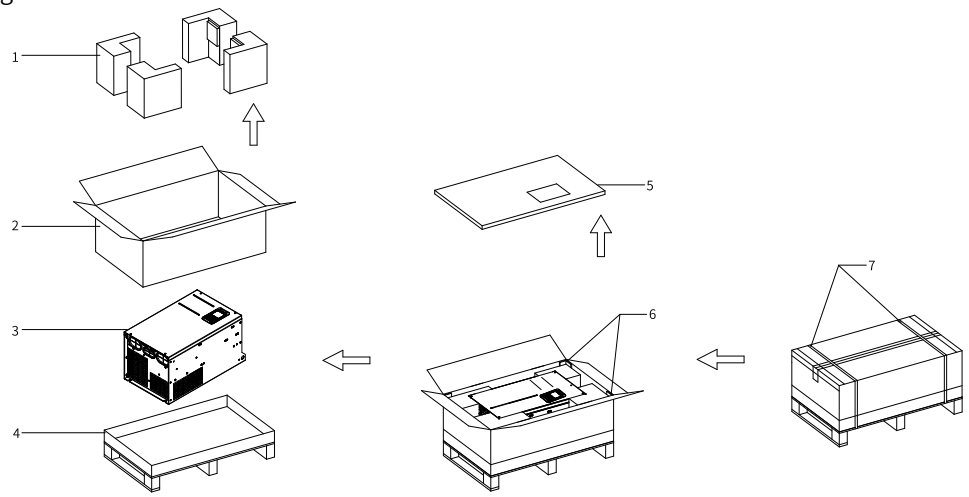


Figure 8-6 Packing list of T7 to T9 models

Table 8–2 Packing list of T7 to T9 models

No.	Name
1	Cushion
2	Carton
3	AC drive
4	Plywood pallet
5	Honeycomb cardboard
6	Paper corner protector
7	Packing strap

Packing list of T10 to T12 models

- T10 to T11 models are packed using cartons and plywood pallets.
- T12 models are packed using wooden crates.

The following figure shows the packing list.

- Packing list of T10 models

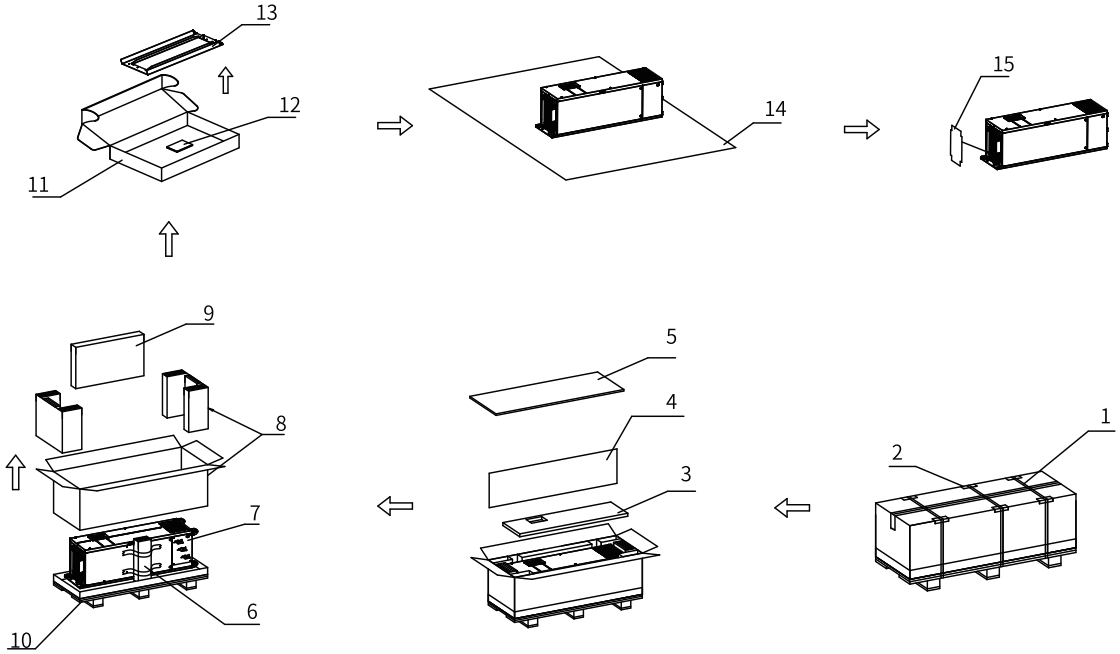


Figure 8-7 Packing list of T10 models

Table 8–3 Packing list of T10 models

No.	Name
1	Packing strap
2	Paper corner protector
3	Honeycomb cardboard
4	Corrugated cardboard
5	Wooden board
6	Paper column
7	AC drive
8	Carton
9	Bracket box
10	Wooden pallet
11	Carton
12	User guide
13	Bracket
14	Plastic bag
15	Corrugated cardboard

- Packing list of T11 models

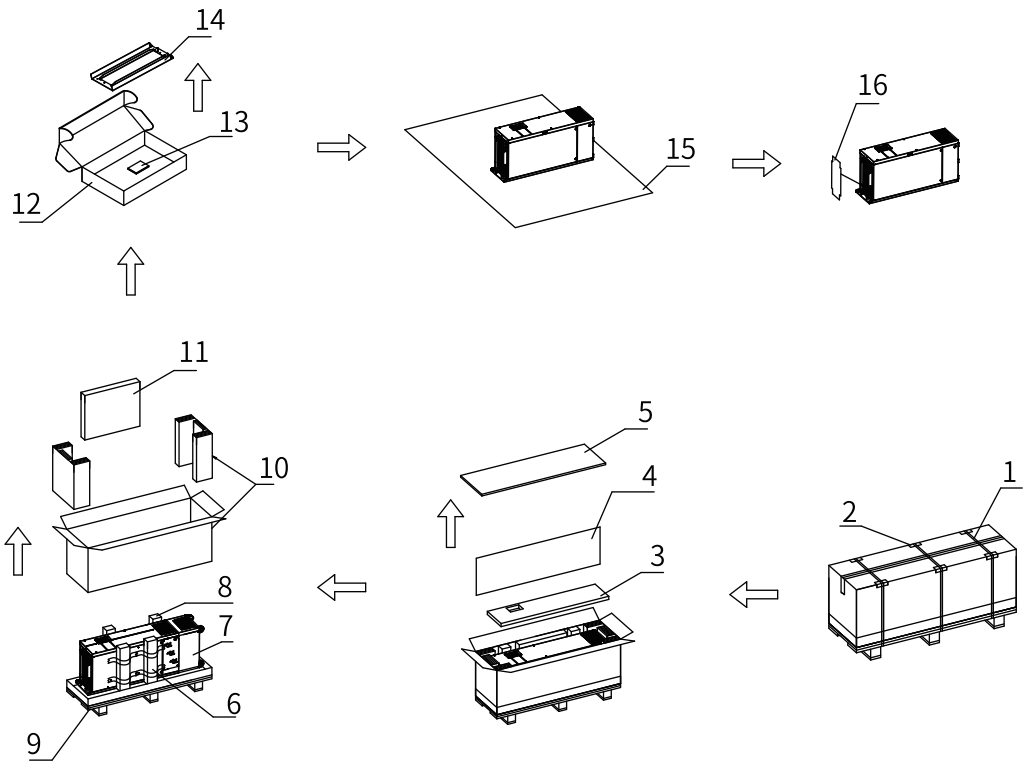


Figure 8-8 Packing list of T11 models

Table 8–4 Packing list of T11 models

No.	Name
1	Packing strap
2	Paper corner protector
3	Honeycomb cardboard
4	Corrugated cardboard
5	Wooden board
6	Paper column
7	AC drive
8	Paper column
9	Wooden pallet
10	Carton
11	Bracket box
12	Carton
13	User guide
14	Bracket
15	Plastic bag
16	Corrugated cardboard

- Packing list of T12 models

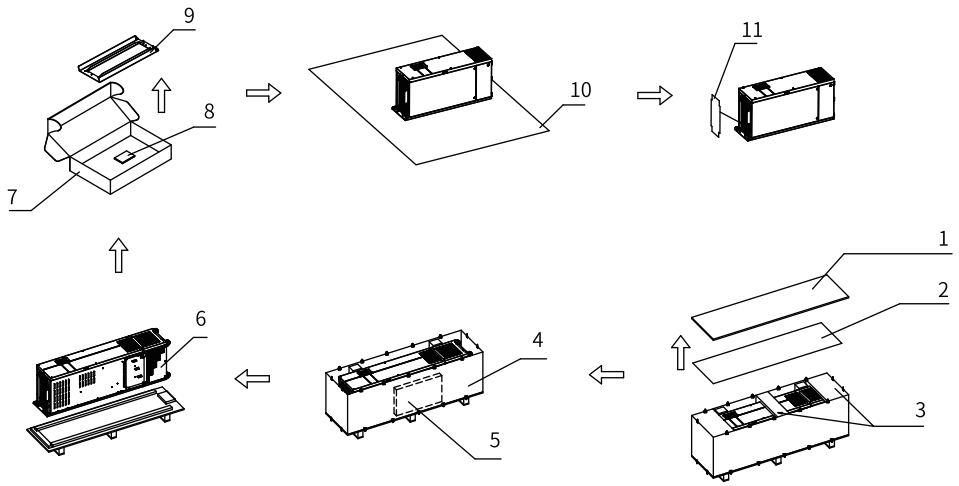


Figure 8-9 Packing list of T12 models

Table 8–5 Packing list of T12 models

No.	Name
1	Cover
2	Corrugated cardboard
3	Expanded polyethylene foam
4	Wooden crate
5	Bracket box
6	AC drive
7	Carton
8	User guide
9	Bracket
10	Plastic bag
11	Corrugated cardboard

Note

The T12 model without the reactor is packed in the same as the T11 model.

Packing list of T13 models

T13 models are provided with a standard cabinet or a cabinet with an auxiliary power distribution cabinet. For the two types of cabinets, the following components are packed.

- Packing list of a T13 model provided with a standard cabinet

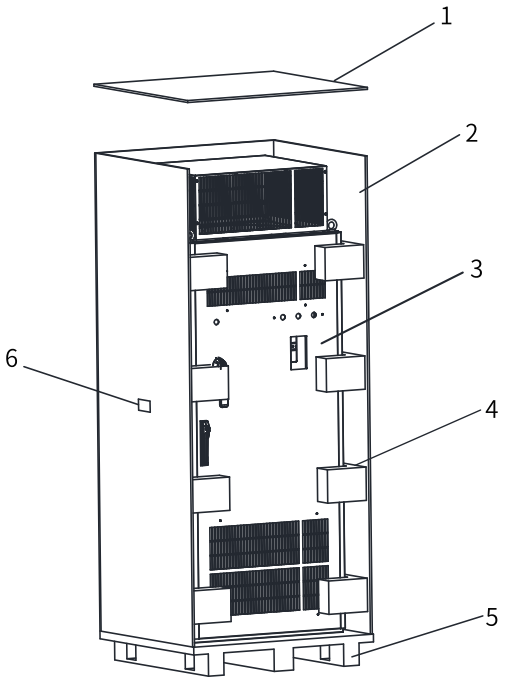


Figure 8-10 Packing list of a T13 model provided with a standard cabinet

No.	Name
1	Cover
2	Wooden crate
3	AC drive
4	Expanded polyethylene foam
5	Base
6	Anti-inclination label

- Packing list of a T13 model provided with a cabinet with an auxiliary power distribution cabinet

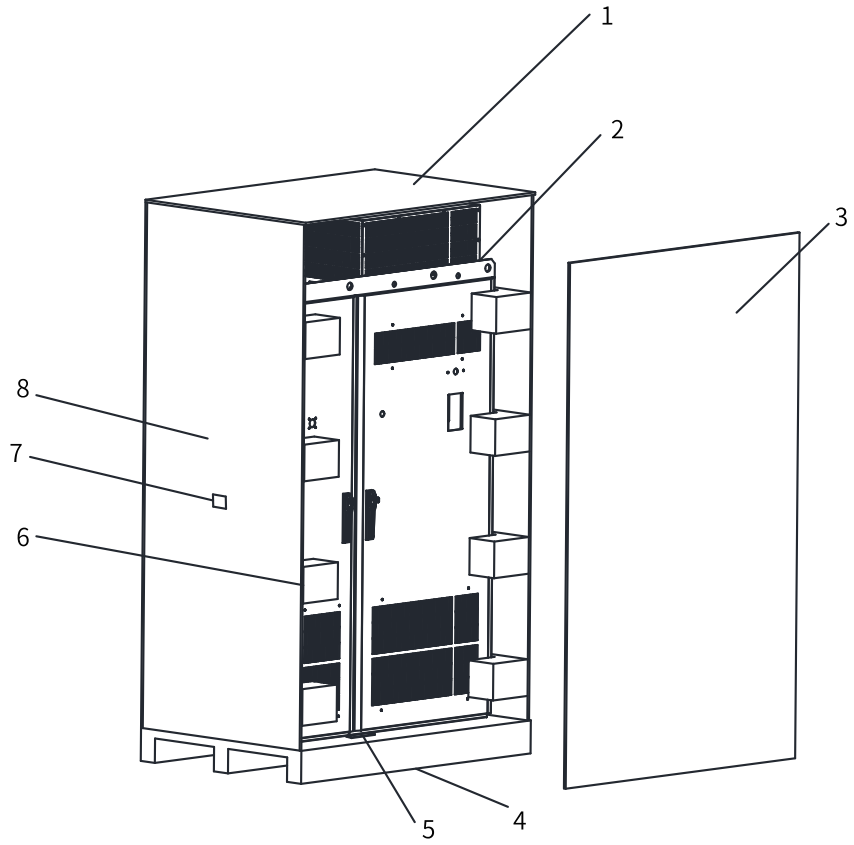


Figure 8-11 Packing list of a T13 model provided with a cabinet with an auxiliary power distribution cabinet

No.	Name
1	Cover
2	AC drive
3	Front panel
4	Base
5	Plywood
6	Expanded polyethylene foam
7	Anti-inclination label
8	Side panel

8.4 Handling and Hoisting After Unpacking

T1 to T6 models are small and light and therefore can be handled manually. T7 to T13 models, however, must be transported with an appropriate lifting tool.

AC Drive Weight	Personnel Required for Handling
< 15 kg	1
⩾ 15 kg	2, with proper lifting device

Precautions for handling and hoisting:

- Comply with local regulations when handling the AC drive.

- Avoid handling the AC drive by directly holding its upper cover or enclosure. Before handling, check that all screws have been tightened. Failure to comply may result in AC drive fall-off, causing personal injury.
- For T10 to T12 models, when fastening the AC drive, ensure that the four mounting holes on the back of the AC drive are securely connected to the fixing beam.
- Straighten the flat-lying equipment before further handling.
- Ensure that the load capacity of the crane for transportation is larger than the weight of the drive.
- Ensure that the upper cover, terminals, and other components of the AC drive are secured firmly with screws before vertical lifting. Failure to comply may result in physical injuries due to fall-off of the drive.
- When lifting the AC drive with the lifting rope, avoid subjecting the AC drive to excessive vibration or impact. Failure to comply may result in physical injuries due to fall-off of the drive.
- When lifting the AC drive with the lifting rope, do not turn the AC drive over or leave it suspended for long time. Failure to comply may result in physical injuries due to fall-off of the drive.

T1 to T9 models

To lift T1 to T9 models, do as follows:

1. Hook the lifting rope to the two auxiliary lifting lugs at the top of the drive.
   It is recommended that the lifting angle be greater than 45 degrees and the height fluctuation be no greater than 0.3 m.

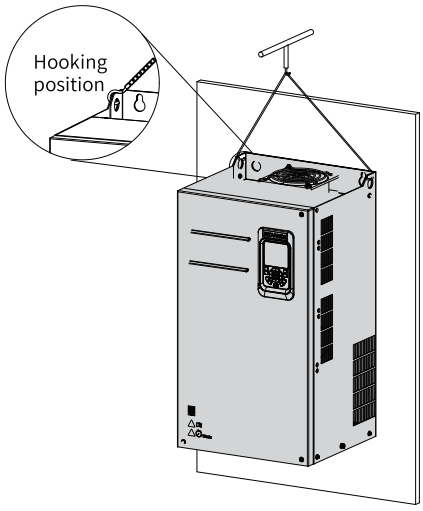


Figure 8-12 Lifting the AC drive

2. Roll up the lifting rope slowly with a crane. After the lifting rope is fully stressed, lift the drive up.
3. Lower the drive down slowly, with a pause at a certain height midway, then continue until the drive reaches the ground or mounting surface. Finally, install the drive to the control cabinet.

T10 to T12 models

To lift T10 to T12 models, do as follows:

1. Hook the lifting lugs at the top of the drive and the lifting holes at the bottom of the drive, take out the AC drive from the packing box, and lay it flat on the floor.
   Ensure that there is no stress on the positive and negative bus terminals.

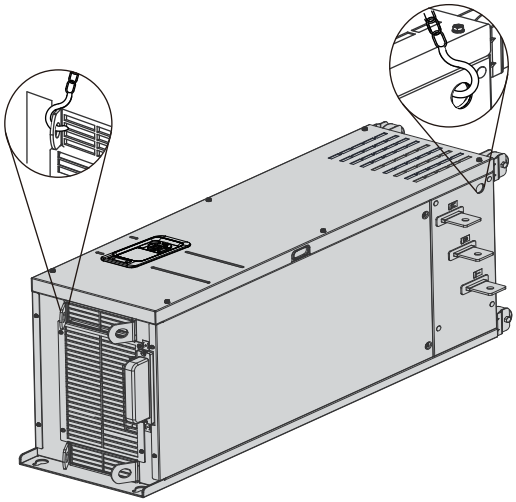


Figure 8-13 Lifting the AC drive

2. Hook the lifting rope to the lifting lugs diagonally placed at the top of the AC drive, slowly place the AC drive upright, and install it to the cabinet.

Caution

If the AC drive needs to be placed in an upright position, ensure the tilt angle of the place that holds the drive does not exceed 5°. Failure to comply may lead to rollover of the drive due to its heavy weight (nearly 200 kg) and large size.

T13 models

1. Before installation, remove the fixing screws from the four corners of the transportation pallet and the cabinet, and remove the pallet.

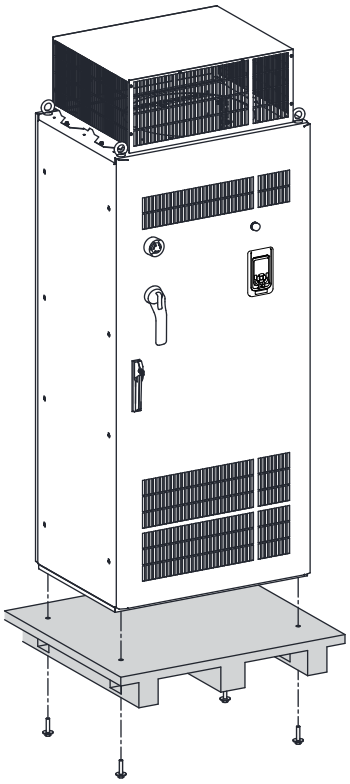


Figure 8-14 Unloading the cabinet from the pallet

2. Transport the cabinet with a crane whose carrying capacity is greater than the cabinet weight.
3. Lift the cabinet through the auxiliary lifting holes or lifting lugs at the top of the cabinet, with the relief height lower than or equal to 0.3 m.
4. Ensure that the cabinet has been locked before moving.
5. The cabinet must be held by hands on the left and right sides during movement.

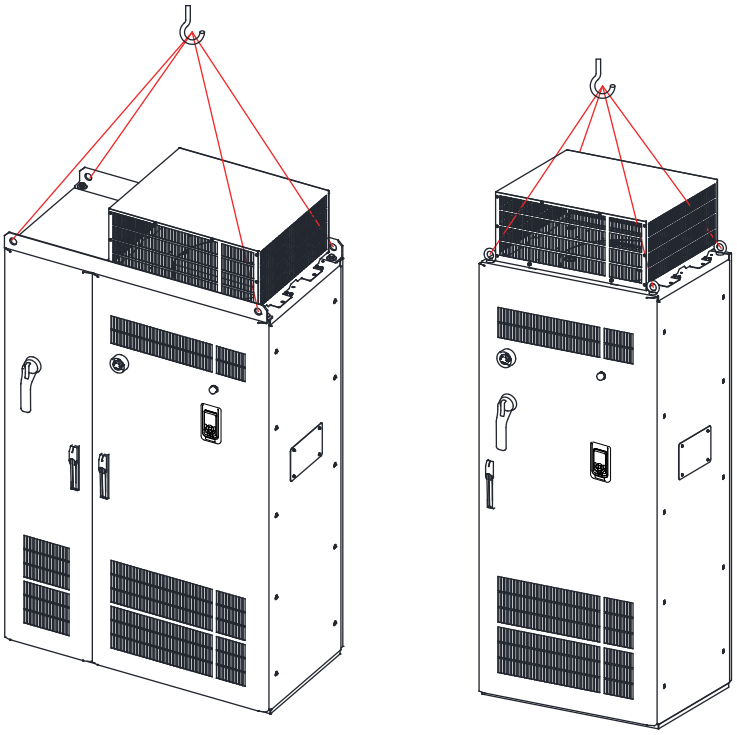


Figure 8-15 Transportation after unpacking

8.5 Unpacking

T1 to T12 models

Related documents and accessories are placed in different partitions in the carton. To unpack the carton, follow these steps:

1. Remove all the straps and ties and open the cover of the carton.
2. Remove all filler materials.
3. Take out the AC drive.
4. Cut and remove the plastic wrap around the AC drive.
5. Check the drive for any damage.
6. Dispose of or recycle the packing material according to local regulations.

T13 models

1. During unpacking, put the crowbar into the crate as short as possible to prevent damaging the equipment. Exercise caution to avoid injury by iron nails.
2. When removing the packing materials such as plastic film, do not use sharp tool to avoid scratching the equipment.
3. Place the packed product on the empty and flat ground of the workshop. Use appropriate tools, such as a crowbar, to pry off the crate along the gap at the plate edge. Then, remove the cover plate, side plate, and pallet in the sequence indicated in the figure.

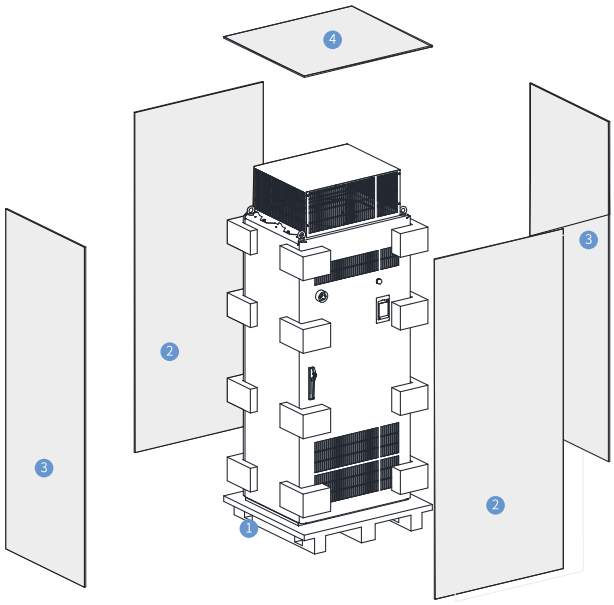


Figure 8-16 Unpacking the AC drive

Note

Dispose of the packing materials according to local laws and regulations.

9 Mechanical Installation (T1 to T9 Models)

9.1 Installation Mode

T1 to T9 models support backplate mounting and through-hole mounting.

9.2 Cabinet Design

9.2.1 Overview

Before installing the AC drive in the cabinet, design the cabinet to ensure sufficient clearances for installation and heat dissipation. Take the following factors into consideration:

- Cabinet clearance requirement
- Mounting backplate
- Cabinet heat dissipation

9.2.2 Cabinet Clearance Requirements

For T1 to T9 models, multi-layer installation is recommended. That is, install one AC drive above another. The following table lists the minimum clearance between the upper and lower AC drives. Install an air guide plate above each AC drive except the top one.

Table 9–1 Minimum clearance (mm) for multi-layer installation

Item	T1 to T4	T5	T6	T7 to T9
S1	⩾ 100	⩾ 200	⩾ 200	⩾ 300
S2	⩾ 100	⩾ 200	⩾ 200	⩾ 300
...	⩾ 100	⩾ 200	⩾ 200	⩾ 300
Sn	⩾ 100	⩾ 200	⩾ 200	⩾ 300

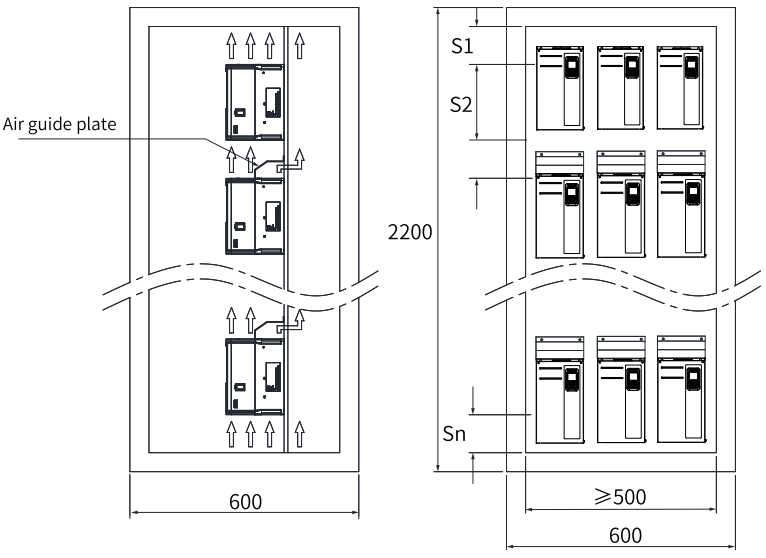


Figure 9-1 Minimum clearance (mm) for multi-layer installation

Note

Observe the ventilation direction when installing the fan to ensure smooth discharge of hot air. Failure to comply may cause failure in hot air exhaust, and over-temperature or damage to the AC drive. Ensure a distance of at least 200 mm between the air exhaust top cover and the fan outlet to avoid adverse effect on the cooling performance of the fan.

9.2.3 Mounting Backplate Requirements

Requirements of backplate thickness, dimensions, and stiffness

To avoid damage to the AC drive during transportation and ensure proper operation of the AC drive, use a mounting plate with excellent stiffness and strength performance, and a thickness of at least 2 mm. Reinforce the backplate where appropriate. For example, weld a lateral reinforcing beam on the back of the backplate, as shown in the following figure.

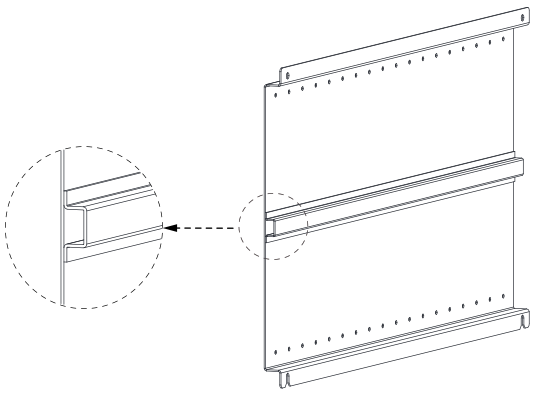


Figure 9-2 Welding a lateral reinforcing beam on the back of the backplate

Requirement on the mounting holes

- You can drill mounting holes on the backplate in advance. For detailed mounting hole dimensions, see *"4.1 Dimensions of T1 to T9 Models" on page 49*.
- To avoid damage to the AC drive during transportation, fix the drive to the mounting backplate by using screws. In addition, use self-clinching nuts or independent nuts on the back of the backplate to enhance screw-thread fitting and fastening effect.

9.2.4 Cabinet Heat Dissipation

Heat dissipation design of the cabinet door

The AC drive is forcibly cooled by a built-in fan. To ensure that enough cooling air enters the cabinet, open an air inlet with an appropriate size on the cabinet door.

The air flows from bottom to top after being heated. Therefore, the cabinet air inlet must be at least 50 mm lower than the air inlet of the drive, as shown below.

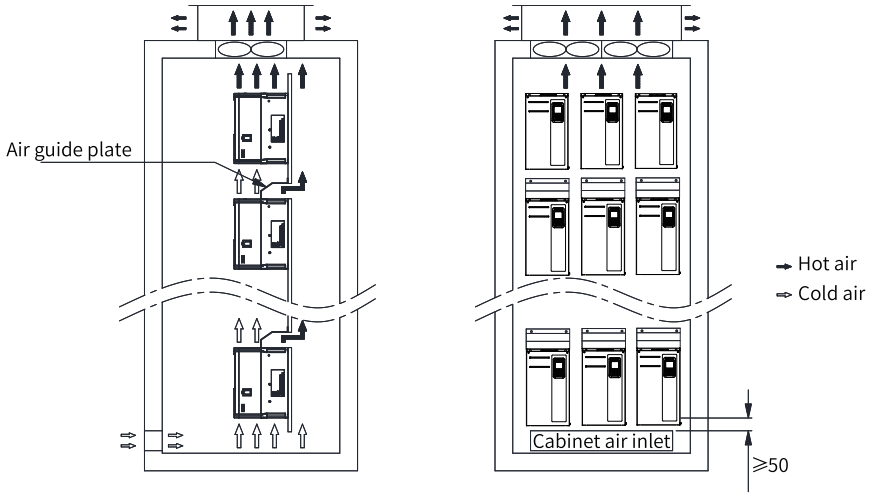


Figure 9-3 Position of the cabinet air inlet

Caution

Where multiple AC drives are installed in one cabinet, if the fan blows air into the air inlet from the outside, air distribution for the drives in the cabinet will be affected, resulting in poor cooling performance. Therefore, do not install a fan at the air inlet of the cabinet to blow air into the cabinet.

The following table describes the minimum effective ventilation area of the cabinet air inlet after the drive is installed in the cabinet.

Table 9–2 Minimum effective ventilation area of the cabinet air inlet

AC Drive	Minimum Effective Ventilation Area of the Cabinet Air Inlet (cm^2)
T1	20
T2	25
T3 (7.5 kW)	
T3 (11 kW)	50
T4	
T5	60
T6 to T7	102
T8	204
T9	318

The preceding table applies to situations where only one AC drive is mounted in the cabinet. For a cabinet containing multiple AC drives, calculate the total ventilation area by adding the ventilation area of each drive according to the table. For example, if eight T3 models (7.5 kW), two T5 models, and one T9 model are placed inside the cabinet, the minimum effective ventilation area of the cabinet air inlet is 8 x 25 + 2 x 60 + 1 x 318 = 638 cm^2.

If an air filter is installed at the air inlet, the air inlet resistance will rise significantly. Therefore, the ventilation area of the air inlet must be increased to 1.2 to 1.5 times the value indicated in the table.

The ventilation area in *"Table 9–2 Minimum effective ventilation area of the cabinet air inlet" on page 209* refers to the actual through-hole area of an opening. The ventilation area is calculated by the following: opening area x opening rate.

Top ventilation design

To ensure sufficient heat dissipation of the drive, hot air in the cabinet must be exhausted to the outside. The passive or active air ventilation mode can be adopted.

- Passive air ventilation (self-ventilated)
  The air flows from bottom to top after being heated. In this mode, the hot air discharged by the drive is exhausted to the outside from the air outlet at the top of the cabinet.

  This might cause accumulated hot air at the top of the cabinet, rising the air pressure. The air pressure at the cabinet air inlet is low due to suction of the fan for the drive. Therefore, there is an air pressure difference between the air outlet and air inlet of the cabinet to form an air flow in the cabinet. The air flow forces hot air at the air outlet to flow towards the air inlet so that it is absorbed into the drive again, causing a great temperature rise and an adverse effect on the performance of the drive.

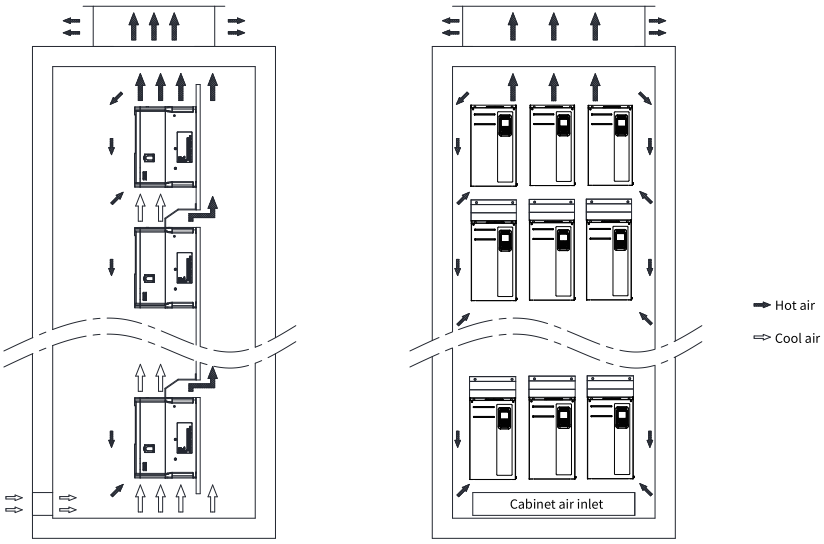


Figure 9-4 Hot air backflow in the passive air ventilation mode (without isolation devices)

For cabinets that adopt the passive air ventilation mode, use an isolation device to prevent hot air backflow, as shown below. The isolation device can be a plate or exhaust duct.

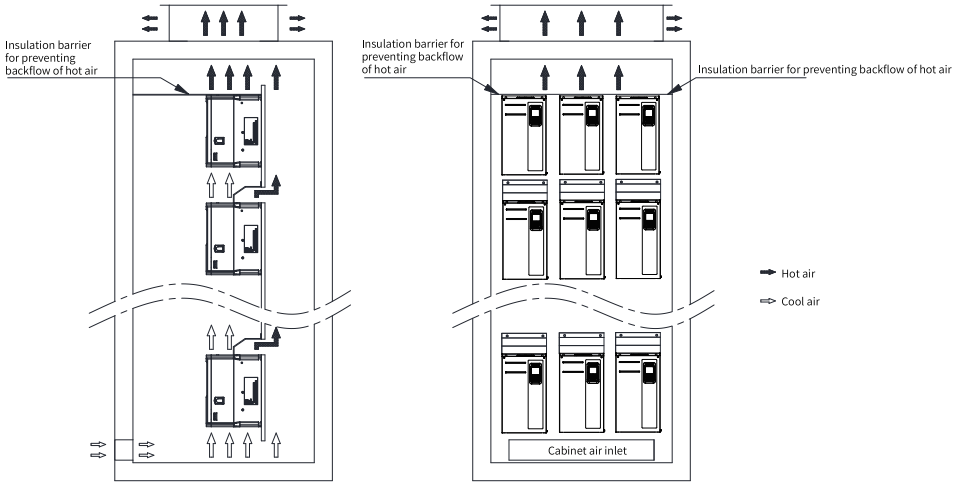


Figure 9-5 Hot air backflow in the passive air ventilation mode (with isolation device)

The temperature at the air outlet of the drive is higher than that at the air inlet and the density at the air outlet is lower than that at the air inlet. To ensure that hot air in the cabinet can be exhausted to the outside, the minimum effective ventilation areas of the cabinet air outlet must meet the requirements in *"Table 9–3 Minimum effective ventilation area of the air outlet in the passive air ventilation mode" on page 211* when passive air ventilation is used.

Table 9–3 Minimum effective ventilation area of the air outlet in the passive air ventilation mode

AC drive	Minimum Effective Ventilation Area (cm^2)
T1	32
T2	40
T3 (7.5 kW)	
T3 (11 kW)	80
T4	
T5	96
T6 to T7	163
T8	326
T9	509

"Table 9–3 Minimum effective ventilation area of the air outlet in the passive air ventilation mode" on page 211 applies to situations where only one AC drive is mounted in the cabinet. For a cabinet containing multiple AC drives, calculate the total ventilation outlet area by adding the ventilation area of each drive according to the table.

For the air outlet installed with a filtering net, the air outlet resistance increases substantially. In this case, the minimum ventilation area of the air outlet must be increased to 1.2 to 1.5 times the value listed in the preceding table.

The ventilation area in *"Table 9–3 Minimum effective ventilation area of the air outlet in the passive air ventilation mode" on page 211* refers to the actual through-hole area of the opening. The ventilation area is calculated by the following: opening area x opening rate.

- Active air ventilation
  In the active air exhaust mode, a fan is installed on the top of the cabinet to draw hot air out of the cabinet. This is a commonly used ventilation mode.

  To ensure that the hot air can be exhausted to the outside, the total air volume of the fan cannot be smaller than that of all drives in the cabinet. *"Table 9–4 AC drive cooling air volume" on page 211* lists the cooling air flow required by the drive.

Table 9–4 AC drive cooling air volume

AC Drive Power	Cooling Air Flow (CFM)
0.4 kW to 1.1 kW	/
1.5 kW to 3.0 kW	11
3.7 kW	20
5.5 kW	24
7.5 kW	29
11 kW to 15 kW	50
18.5 kW	52
22 kW	58
30 kW	130
37 kW	102

AC Drive Power	Cooling Air Flow (CFM)
45 kW to 55 kW	125
75 kW to 90 kW	225
110 kW	350
132 kW	541
160 kW	620
Note: 1 CFM = 0.02832 m^3/min	

Cabinet fan design

To select the fan for the cabinet, do as follows:

1. Calculate the sum of the cooling air volume required by all AC drives based on *"Table 9–4 AC drive cooling air volume" on page 211*.
2. Determine the maximum air volume (Qmax) of the cabinet fan.
3. Determine the specification and quantity of the fan based on the maximum air volume (Qmax).

Where:

- The maximum air volume of the cabinet is 1.3 to 1.5 times the sum of the cooling air volume.
- The maximum air volume of the cabinet is 1.6 to 2.2 times the sum of the cooling air volume if mesh filters, shutters, or other components are installed at the cabinet air outlet.

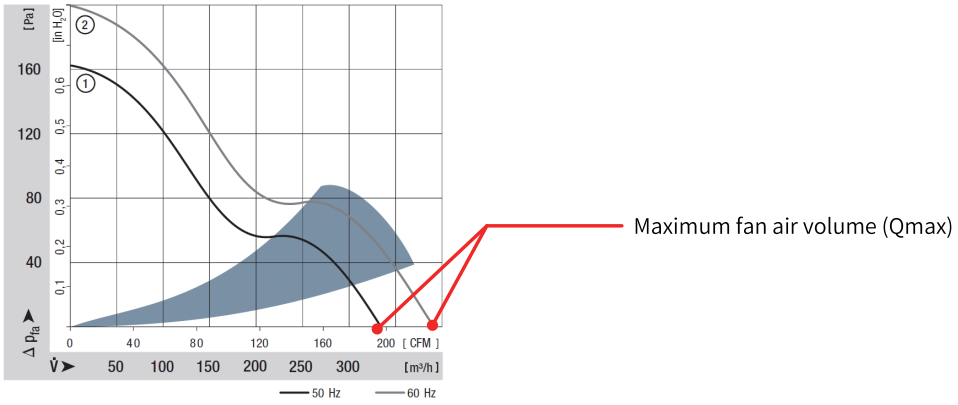
Note

Select a fan whose air volume is not smaller than the maximum air volume Qmax. Install multiple fans in parallel if one fan alone cannot meet the requirements.

The common specifications of the fan air volume is shown below.

Air flow	Air flow	Nominal voltage	Frequency	Sound pressure level	Sound power level	Sintec sleeve bearings / Ball bearings	Power input	Nominal speed	Temperature range	Service life L_{10} at 40 °C	at T max	Curve
m^3/h	CFM	V	Hz	dB(A)	Bel(A)	□/■	Watts	RPM	°C	Hours	Hours	
320	188,3	**230**	**50**	51	6,4	■	27,0	2 800	-25...+55	60 000 / 32 000		1
380	223,6	**115**	**60**	56	6,8	■	28,0	3 350	-25...+65	55 000 / 18 000		2

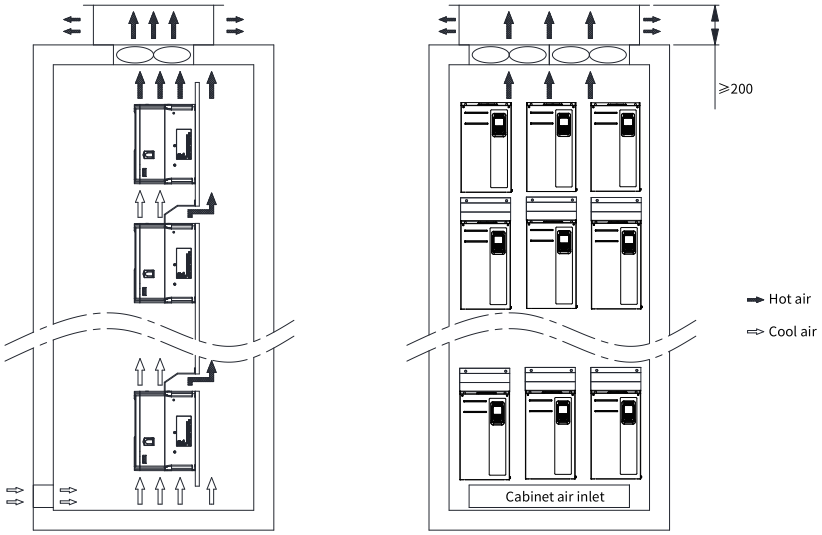
Maximum fan air volume (Qmax)



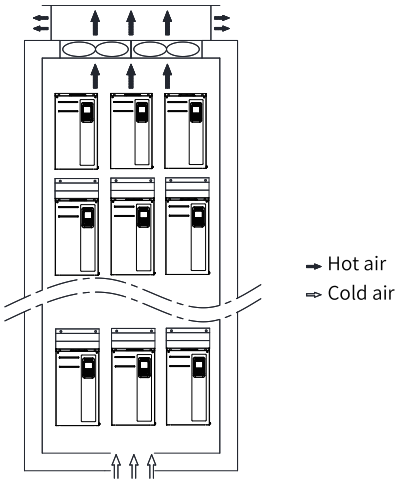
Maximum fan air volume (Qmax)

Figure 9-6 Q_{max} of a system fan

1. The air inlet is on the front door at the bottom of the cabinet and the air output is at the top of the cabinet.



2. The air inlet is at the bottom of the cabinet and the air output is at the top of the cabinet.



3. The air inlet is at the bottom of the cabinet and the air outlet is on the top side of the cabinet.

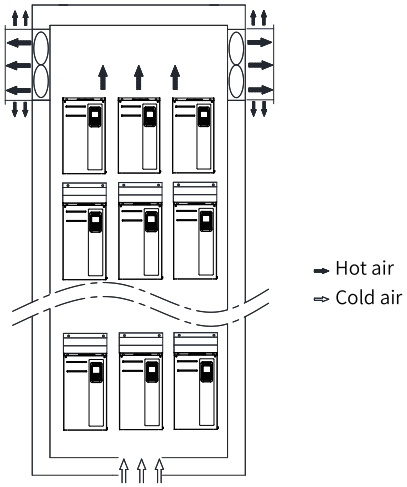


Figure 9-7 Cabinet ventilation system

The air duct layout of the cabinet can be adjusted properly if the installation dimensions are met.

Note

- When installing the fan, ensure a proper direction and smooth flow of hot air. Failure to comply may cause accumulation of hot air, leading to over-temperature or damage to the AC drive.
- Ensure a distance of at least 200 mm between the top vent and the fan outlet to avoid adverse effect on the cooling performance of the fan.

9.3 Pre-installation Precautions

- Ensure the installation location is sturdy enough to bear the mechanical strength of the drive.
- Cover the top of the AC drive with a piece of cloth or paper during installation to prevent unwanted objects such as metal chippings, oil, and water from falling into the drive. Failure to comply may cause malfunction of the AC drive. After installation is done, remove the cloth or paper. Failure to comply may degrade ventilation and result in unexpected heat.
- Reserve sufficient clearance for heat dissipation, including heat dissipation of other components in the cabinet. For details, see "Installing one drive" in *“7.2.3 Installation Clearance” on page 163*.

- Install the drive vertically upward to facilitate heat dissipation. To install multiple drives in one cabinet, arrange them side by side. When multiple drives need to be installed one above another, install an air guide plate between drives. For details, see "Installing drives one above another" in *"7.2.3 Installation Clearance" on page 163*.
- The mounting bracket (if needed) must be made of incombustible materials.
- In environments with metal dust, use an enclosed cabinet that can completely isolate the drive from the metal dust. In this case, ensure the maximum possible space in the cabinet and install cooling devices outside the cabinet.
- Tighten all screws with the specified tightening torque. Failure to comply may result in electric shock or fire.
- Keep combustible and explosive materials away from the AC drive.

9.4 Backplate Mounting

Fix the AC drive with all nuts. Do not fasten only the upper two nuts on the drive. Otherwise, the drive may fall off due to uneven force during long-time running.

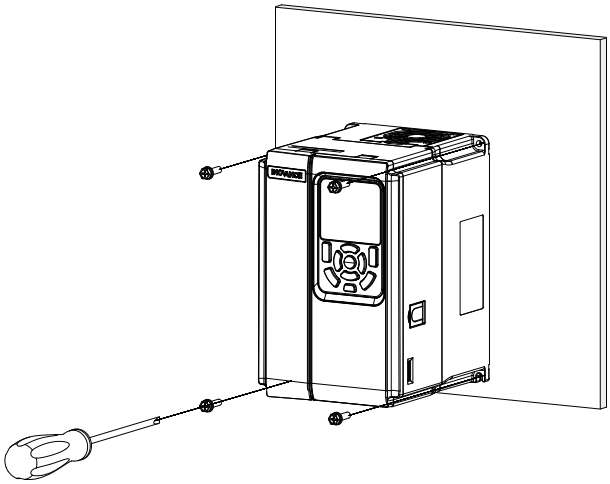


Figure 9-8 Backplate mounting of T1 and T6 models

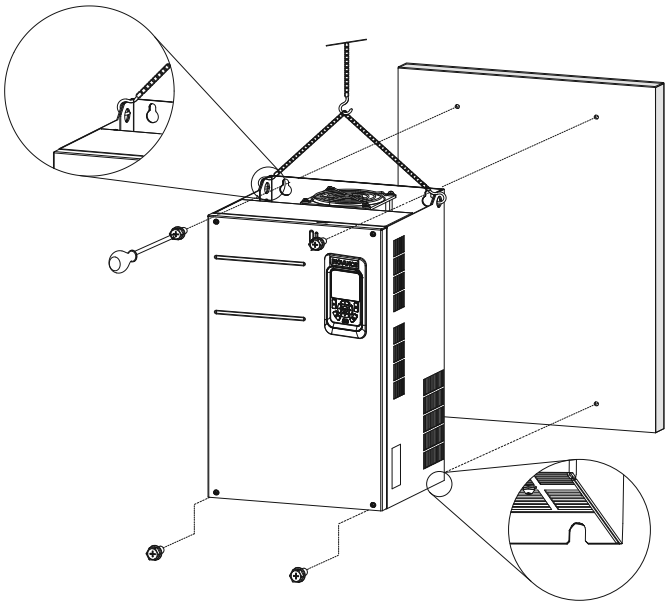
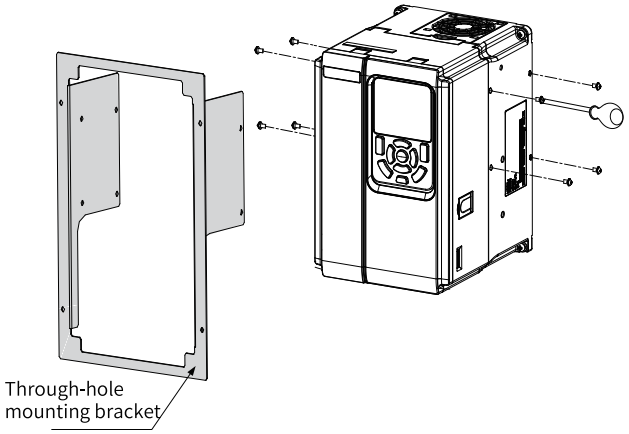


Figure 9-9 Backplate mounting of T7 and T9 models

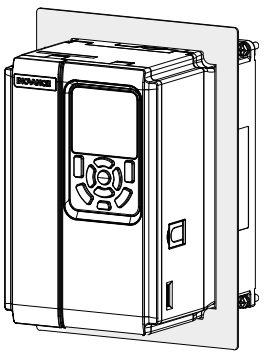
9.5 Through-Hole Mounting

T1 to T6 models

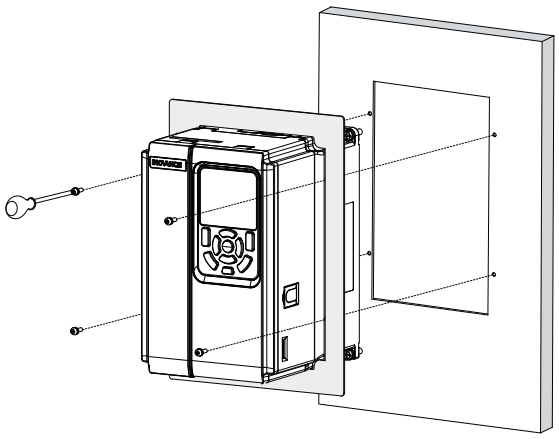
1. Install the AC drive through the mounting bracket, and then fix the screws at both sides of the bracket.



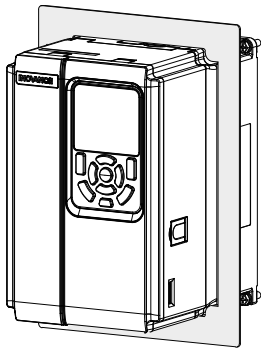
The following figure shows an AC drive with a bracket mounted.



2. Fix the AC drive with the bracket on the backplate of the control cabinet.

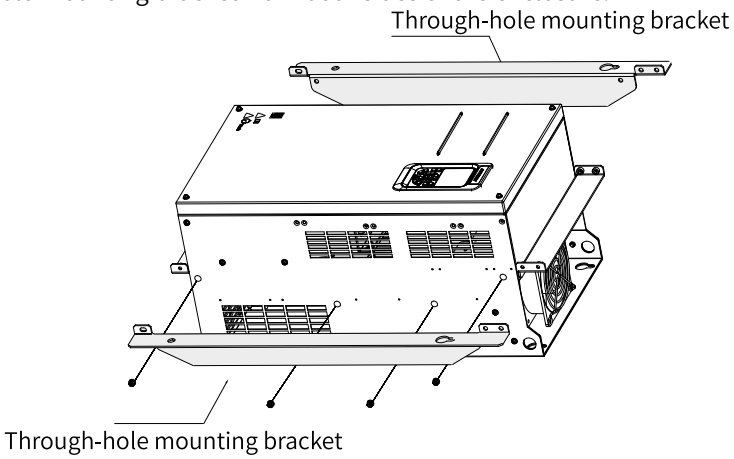


The following figure shows an AC drive with the bracket mounted in the cabinet.

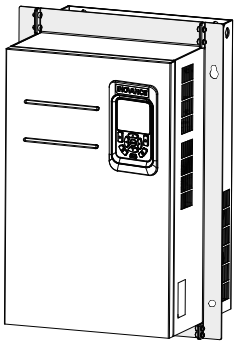


T7 to T9 models

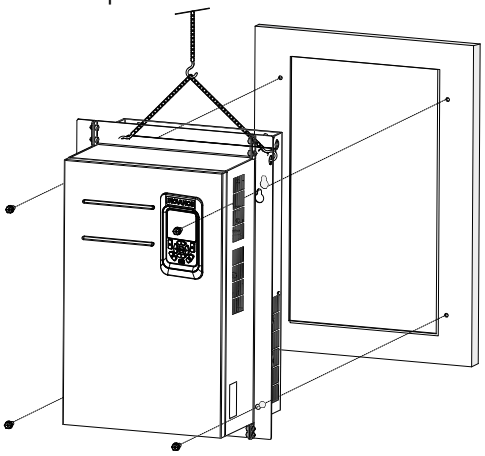
1. Fix the through-hole mounting bracket from both sides of the enclosure.



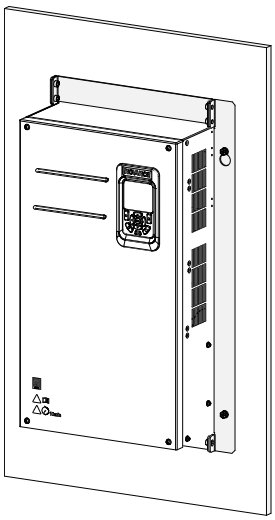
The following figure shows an AC drive with brackets mounted.



2. Fix the drive with brackets to the backplate of the control cabinet.



The following figure shows an AC drive with the bracket mounted in the cabinet.



9.6 Cover Removal and Installation

9.6.1 Removing the Cover

Before wiring the control circuit, for example, connecting the jumper, PG card, or functional expansion card, remove the cover of the AC drive. When removing the cover, hold the cover with your hands and carefully lift the lower part of the cover to prevent it from falling off. Failure to comply will result in equipment damage or personal injury.

Prerequisites

Before removing the cover, ensure that the machine has been powered off for over 10 minutes.

Context

The following figure shows the positions of the control board, jumper, and expansion card after the cover is removed.

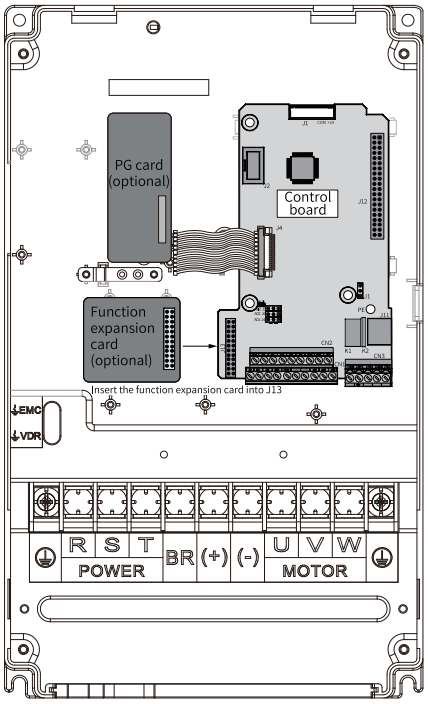
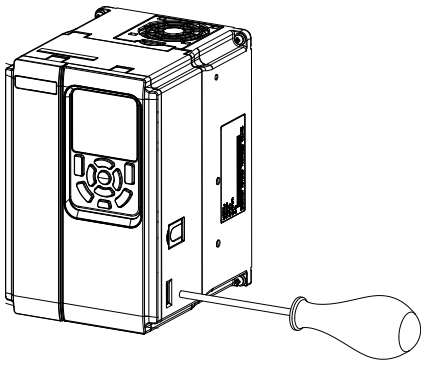
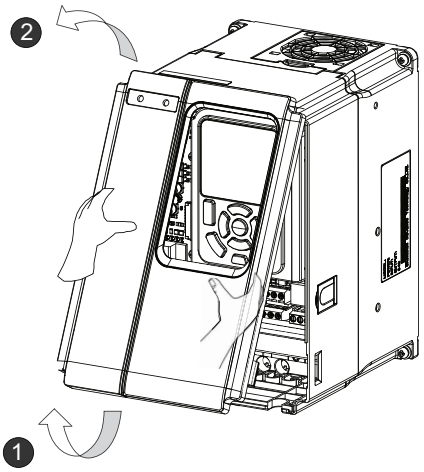


Figure 9-10 Control board position

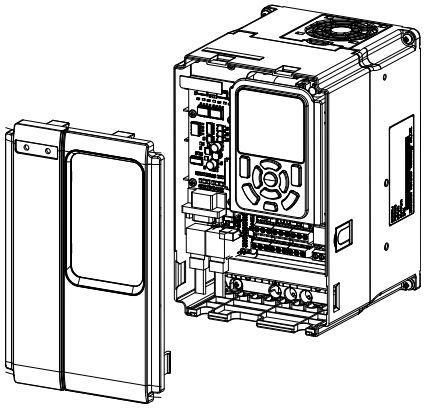
1. Remove the cover for T1 to T6 models.
   a. Use a tool to push the snap-fit joints inwards at both sides of the drive to release the cover.



   b. Hold the cover with your hands, lift the lower part of the cover (as shown in ①), push the cover upward, and lift the upper part of the cover (as shown in ②).

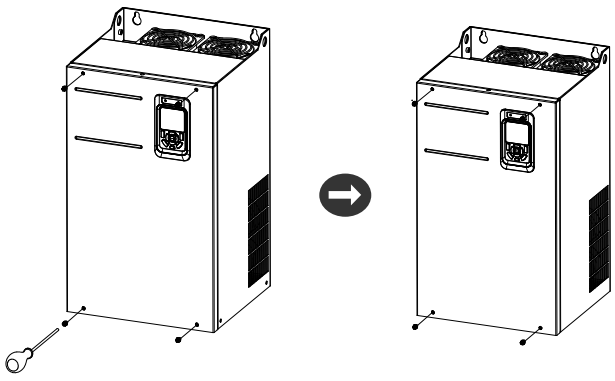


The following figure shows the drive without the cover.

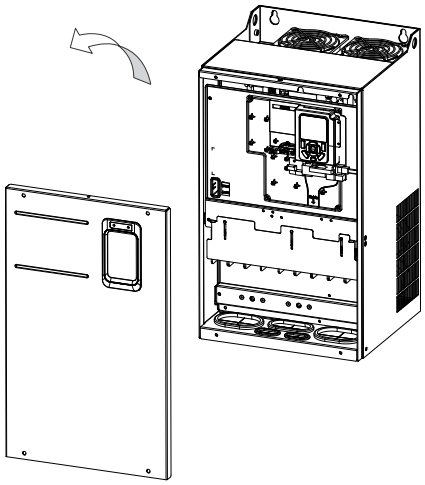


2. Remove the cover for T7 to T9 models.

   a. Release the four fixing screws on the cover with a screwdriver.



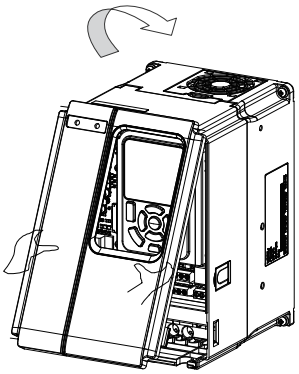
   b. Hold the cover with both hands and lift it up in the direction indicated by the arrow.



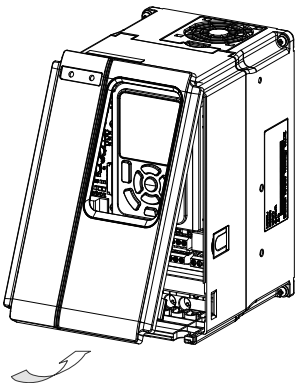
9.6.2 Installing the Cover

The cover of the AC drive must be removed before wiring the main circuit and control circuit. After wiring is done, re-install the cover.

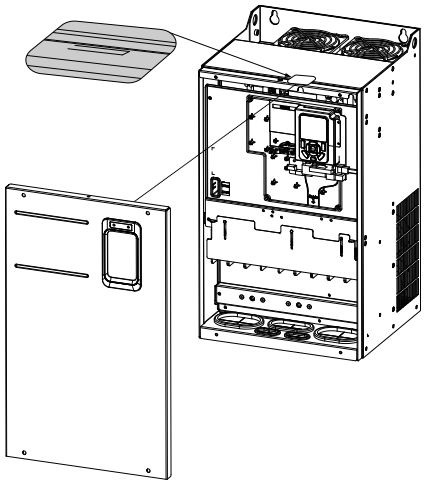
1. Install the cover for T1 to T6 models.
   a. Hold the cover with both hands and insert the upper edge snap-fit joint of the cover into the hole on the drive.



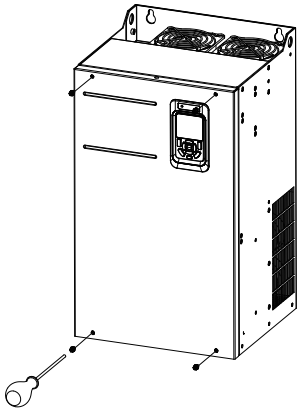
   b. Then, press down the cover in the direction indicated by the arrow.



2. Install the cover for T7 to T9 models.
   a. Hold the cover with both hands, align the cover with the upper edge snap-fit joint on the chassis and push it in place as shown in the following figure.



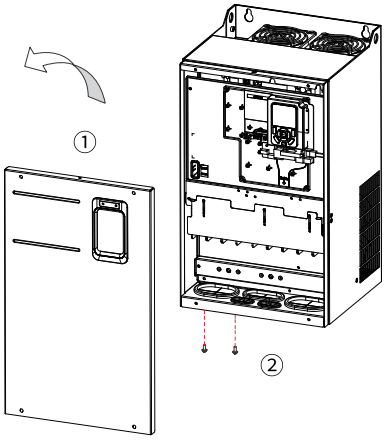
b. Install and fix the four fixing screws with a screwdriver.



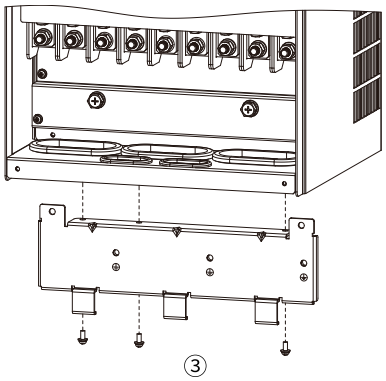
9.7 Installation of Cable Shield Grounding Bracket

Procedure

1. Remove the cover as shown in ①. Remove the two M4x12 SEMS screws on the air inlet plate, as shown in ②.

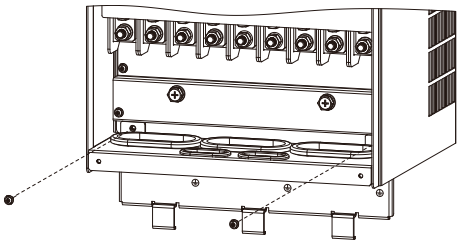


2. Place the ground bracket of the cable shield on the chassis, and fasten the bracket with three M4 x 12 SEMS screws at the positions shown in ③.



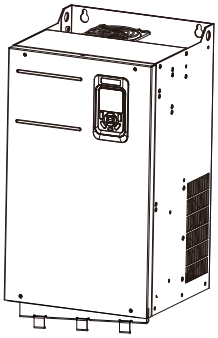
③

3. Tighten two M4x12 SEMS screws at the positions shown in ④.



④

4. Install the cover.



⑤

Note

For selection of the cable shield ground bracket, see *"7.4.1 List of Options" on page 172*.

10 Mechanical Installation (T10 to T12 Models)

10.1 Installation Mode

T10 to T12 models can be installed in a cabinet.

10.2 Pre-installation Precautions

- Before installing the AC drive, install the bottom mounting bracket and mounting guide rail in the cabinet, prepare mounting beams used for fixing the drive, and reserve fixing holes on the mounting beam. Reserve sufficient space for connecting the side copper busbar inside the cabinet.
- Use the guide rails and the four casters of the AC drive to move the AC drive into or out of the cabinet. Align the casters with the guide rails before a push or pull operation. To ensure safety, arrange two persons to pull or push the AC drive together.
- Reserve sufficient clearance for heat dissipation, including heat dissipation of other equipment in the cabinet.
- To push the AC drive into or pull it out of the cabinet, arrange two persons to work together. After pushing the AC drive into the cabinet, remove the cardboard from the air outlet of the cabinet to avoid over-temperature caused by failure to exhaust hot air.
- Install an air deflector at the top of the cabinet to avoid circulation of hot air inside the cabinet. Prepare air inlets at the lower part of the cabinet door.
- The cabinet is 2200 mm x 800 mm x 600 mm (including a ventilation top cover with the height of 200 mm). The cabinet needs to be installed on a base that is 100 mm in height.
- When the drive is installed in an enclosed environment, such as a cabinet or casing box, use a cooling fan or air conditioner to keep the temperature of the air taken in below 50°C. Failure to comply will result in overheat or fire.
- Cover the top of the AC drive with a piece of cloth or paper during installation to prevent unwanted objects such as metal chippings, oil, and water from falling into the drive. Failure to comply may cause malfunction of the AC drive. After installation is done, remove the cloth or paper. Failure to comply will degrade ventilation and result in unexpected heat.
- The mounting bracket (if needed) must be made of incombustible materials.
- In environments with metal dust, use an enclosed cabinet that can completely isolate the drive from the metal dust. In this case, ensure the maximum possible space in the cabinet and install cooling devices outside the cabinet.
- Tighten all screws with the specified tightening torque. Failure to comply may result in electric shock or fire.
- Keep combustible and explosive materials away from the AC drive.

10.3 Heat Dissipation Design

When installing T10 to T12 models in a cabinet, reserve sufficient space for heat dissipation. A passive-ventilated cabinet has no fan on the top.

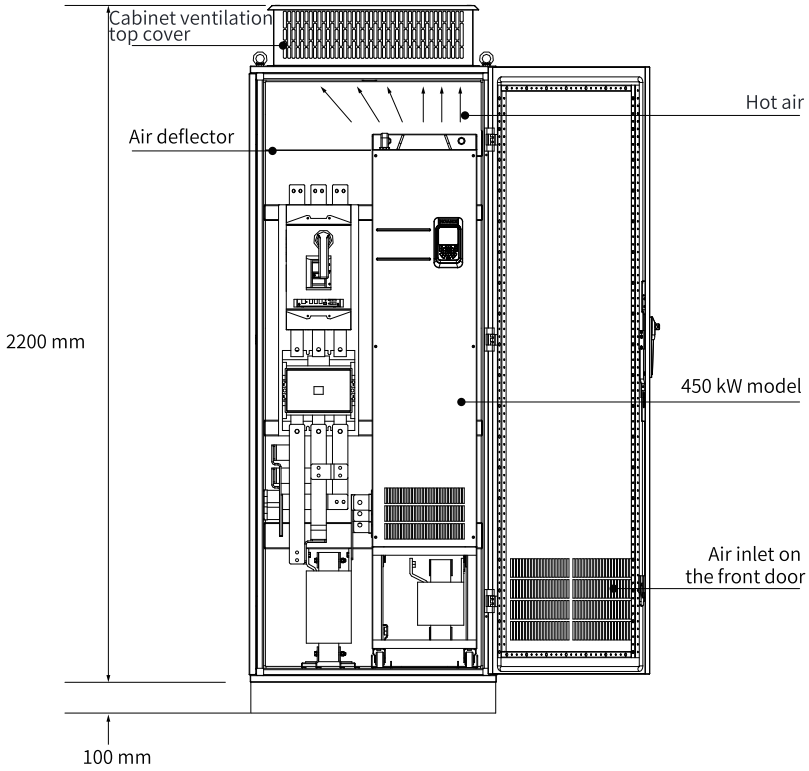


Figure 10-1 Passive-ventilated cabinet

Table 10–1 Parameters of a passive-ventilated cabinet

Model	Quantity of Fans	Total Air Volume (CFM)	Effective Area of the Cabinet Air Inlet (mm^2)	Effective Area of the Cabinet Air Outlet (mm^2)
T9 (132 kW)	2	541	31809	50894
T9 (160 kW)	2	620	31809	50894
T10 (200 kW)	2	586	31809	50894
T10 (220 kW)	2	722	31809	50894
T11 (250 kW)	3	789	47713	76341
T11 (280 kW)	3	882	47713	76341
T12 (315 kW)	3	644	47713	76341
T12 (355 kW)	3	796	47713	76341
T12 (400 kW)	3	796	47713	76341

Note

- CFM = 0.0283 m^3/min
- "Actual Effective Area" indicates through-hole area.

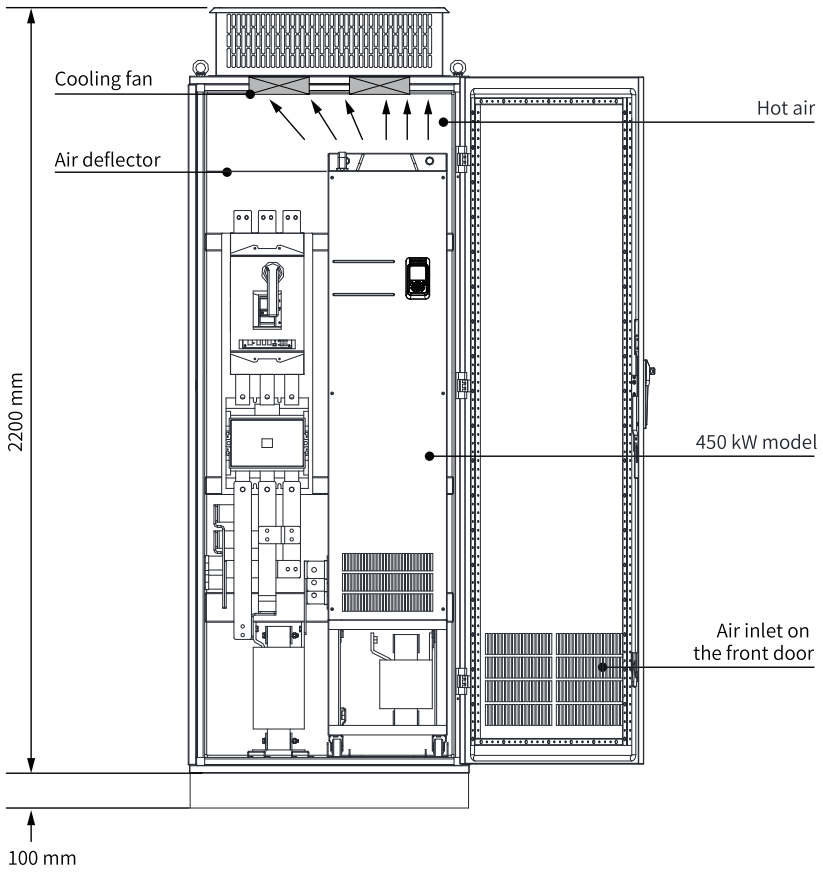


Figure 10-2 Cabinet with top-mounted fans

Table 10–2 Heat dissipation specifications for the cabinet with fans on the top

Model	Quantity of Fans	Total Air Volume (CFM)	Effective Area of the Cabinet Air Inlet (mm^2)	Max. Air Volume Required by Fan (CFM)	Effective Area of the Cabinet Air Outlet (mm^2)
T9 (132 kW)	2	541	31809	649	$S = 0.942 \times N \times (Dout^2 - DHUB^2)$ In the preceding formula, N indicates the quantity of top-mounted fans, Dout indicates the diameter of the top-mounted fan, and DHUB indicates the diameter of the top-mounted fan hub.
T9 (160 kW)	2	620	31809	744	
T10 (200 kW)	2	586	31809	703	
T10 (220 kW)	2	722	31809	866	
T11 (250 kW)	3	789	47713	947	
T11 (280 kW)	3	882	47713	1058	
T12 (315 kW)	3	644	47713	773	
T12 (355 kW)	3	796	47713	955	
T12 (400 kW)	3	796	47713	955	

Note

- CFM = 0.0283 m^3/min
- "Actual Effective Area" indicates through-hole area.

As shown in the following figure, the heat dissipation duct of the drive must be isolated in the cabinet to prevent the hot air from circulating in the cabinet. Use an air deflector for isolation to ensure that the hot air of the drive can be exhausted from the heat dissipation hole on the top of the cabinet.

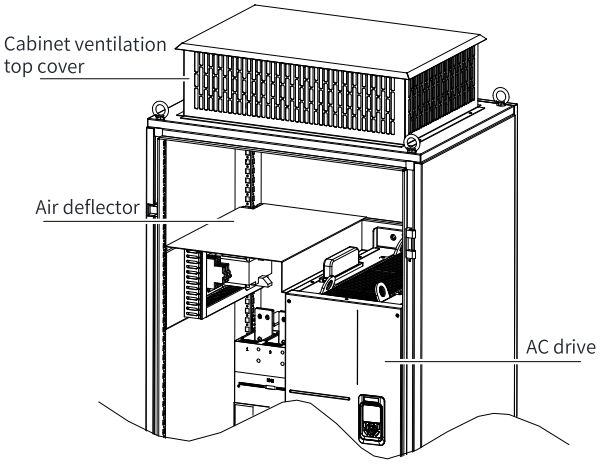


Figure 10-3 Air deflector in the cabinet

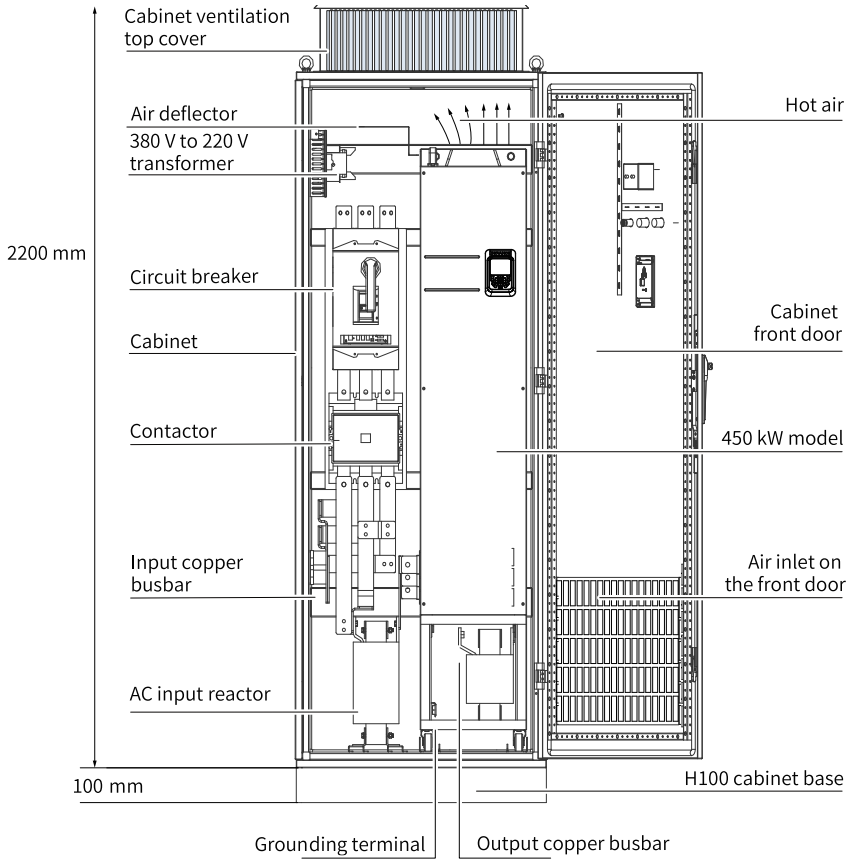


Figure 10-4 Recommended cabinet layout for T12 models

10.4 Installation Within the Cabinet

Context

The nine-fold profile cabinet (PS cabinet) is recommended. This kind of cabinet is in an assembled structure, which is cost effective. The openings on the main column of the cabinet meet the general standards, facilitating the design of mounting beams and structure strengthening. In summary, the nine-fold profile cabinet is a kind of industrial standard cabinet with high reliability. *“Figure 10–5” on page 228* shows the cross section of the nine-fold profile cabinet.

Procedure

1. In the nine-fold profile cabinet (PS cabinet), install the mounting beam for fixing the AC drive and reserve fixed holes.

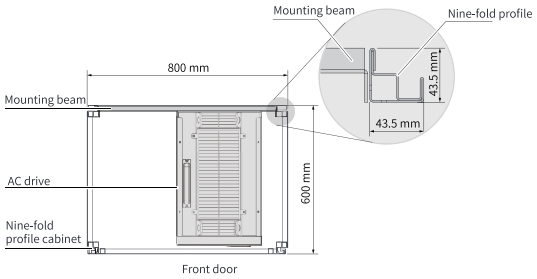


Figure 10-5 Top view of the cabinet for T11 and T12 models

To install T11 to T12 models into the nine-fold profile cabinet with the depth of 600 mm, bend the back mounting board inwards (not required for the cabinet with the depth of 800 mm), as shown in *“Figure 10–6” on page 228* . However, if the cabinet with the depth of 600 mm has both front and back doors, the AC drive cannot be installed in this kind of cabinet. Instead, install the AC drive into the cabinet with the depth of 800 mm.

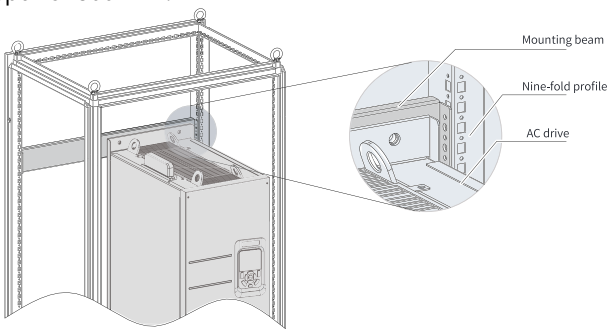


Figure 10-6 3D of the cabinet for T11 and T12 models

2. Fix the bottom mounting bracket in the nine-fold profile cabinet.
   Fix the mounting bracket to the base of the nine-fold profile cabinet by using six M5 self-tapping screws, as shown in *“Figure 10–7” on page 228* .

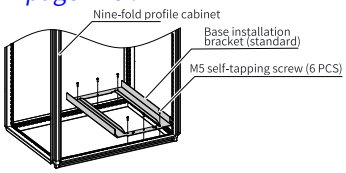


Figure 10-7 Installing the bottom mounting bracket

Note

Drill holes for the mounting bracket and assemble the bracket on site if the cabinet is not a nine-fold profile one.

3. Assemble the guide rails (model: MD500-AZJ-A3T10) and mount the guide rail assembly to the cabinet.
   a. Assemble the guide rail, as shown in *"Figure 10–8" on page 229* .

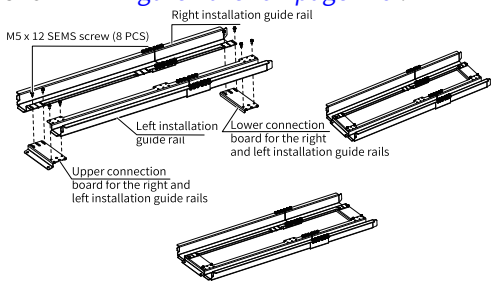


Figure 10-8 Assembling guide rails

   b. Align the two round holes at the front end of the mounting rail with the screws of the mounting bracket, and then lock the guide rail to the cabinet with two M6 nuts, as shown in *"Figure 10–9" on page 229* .

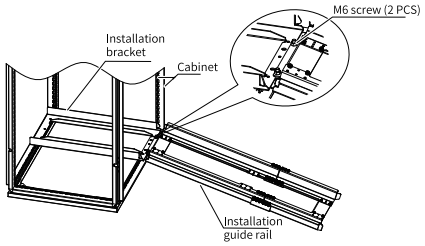


Figure 10-9 Mounting the guide rails to the cabinet

4. Remove the cover from the AC drive.
   For details, see *"10.5.1 Removing the Cover" on page 231*. After the cover is removed, the auxiliary handle will be exposed.
5. Align the casters of the AC drive with the guide rails and gently push the AC drive into the cabinet. During the push-in or pull-out process, use the auxiliary strap to prevent the drive from toppling over. It is recommended that two people work together.

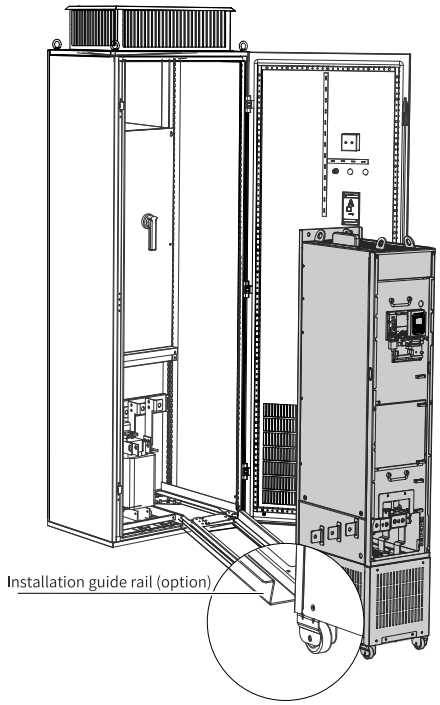


Figure 10-10 Aligning the AC drive caster with the guide rail

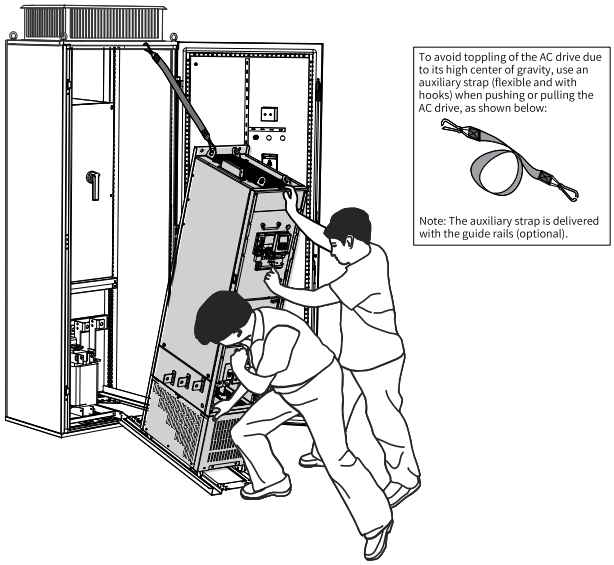


Figure 10-11 Pushing the AC drive into the cabinet

6. Remove the auxiliary strap, install the four screws on the back of the AC drive to fix it to the beam in the cabinet.

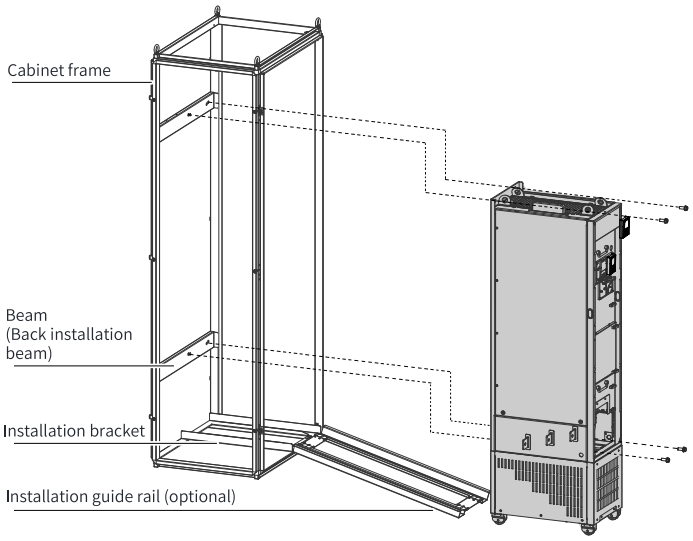


Figure 10-12 Installing the AC drive to the beam

7. After installation is done, remove the guide rail.
8. Remove the air filter paper board at the top of the AC drive. The air filter paper board is used to prevent foreign objects such as screws from falling into the air filter during installation of the AC drive into the cabinet.

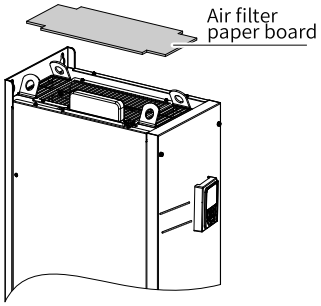


Figure 10-13 Removing the air filter paper board

10.5 Cover Removal and Installation

10.5.1 Removing the Cover

Before wiring the control circuit, such as operating jumpers or connecting PG cards or expansion cards, remove the cover from the AC drive. When removing the cover, hold the cover with your hands and carefully lift the lower part of the cover to prevent it from falling off. Failure to comply will result in equipment damage or personal injury.

Prerequisites

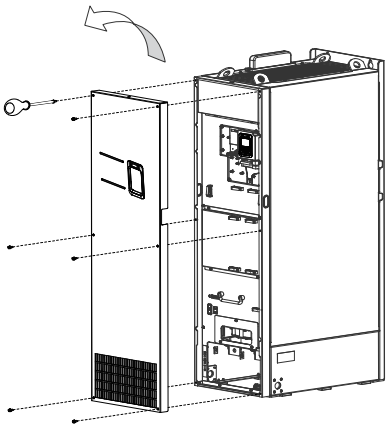
Before removing the cover, ensure that the machine has been powered off for over 10 minutes.

Procedure

1. Use a screwdriver to remove the six fixing screws on the cover.



2. Hold the cover with both hands, and lift it up in the direction indicated by the arrow to remove it.

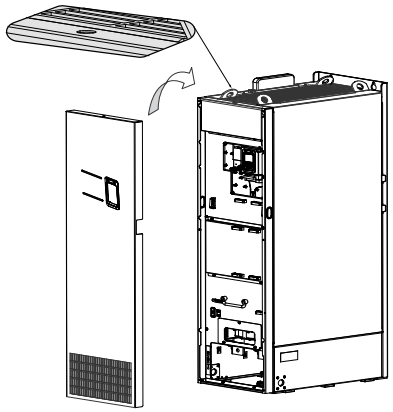


10.5.2 Installing the Cover

The cover of the AC drive must be removed before wiring the main circuit and control circuit. After wiring is done, re-install the cover.

Procedure

1. Hold the cover with both hands, align the upper edge of the cover with the upper edge snap-fit joint on the chassis, and snap them together, as shown in the following figure. Then align the six screw mounting holes in the cover with the cover fixing holes in the chassis and press them tightly against each other.



2. Install six fixing screws into the holes with a screwdriver to fasten the cover.



11 Mechanical Installation (T13 Models)

11.1 Installation Mode

T13 models are cabinet-type AC drives that should be vertically mounted on the floor. Multiple cabinets can be installed in parallel.

11.2 Pre-installation Precautions

- Reserve sufficient clearance for heat dissipation, including the heat dissipation of other devices around the AC drive.
- Cover the top of the AC drive with a piece of cloth or paper during installation to prevent unwanted objects such as metal chippings, oil, and water from falling into the drive. Failure to comply may cause malfunction of the AC drive. After installation is done, remove the cloth or paper. Failure to comply may degrade ventilation and result in unexpected heat.
- Tighten all screws with the specified tightening torque. Failure to comply may result in electric shock or fire.
- Keep combustible and explosive materials away from the AC drive.

11.3 Requirements on Ground Levelness

- The installation base must be level and firm enough to bear the weight of the cabinet.
- Use the door lock in a proper way to open and close the cabinet unit.
- Ensure there is no gap between the cabinet and the ground when cabinets are connected side by side. For any inevitable gap (shown by ①), use a pad (shown by ②) to level the cabinet, and use proper fillings (for example, fireproof mud) to fill the gap.

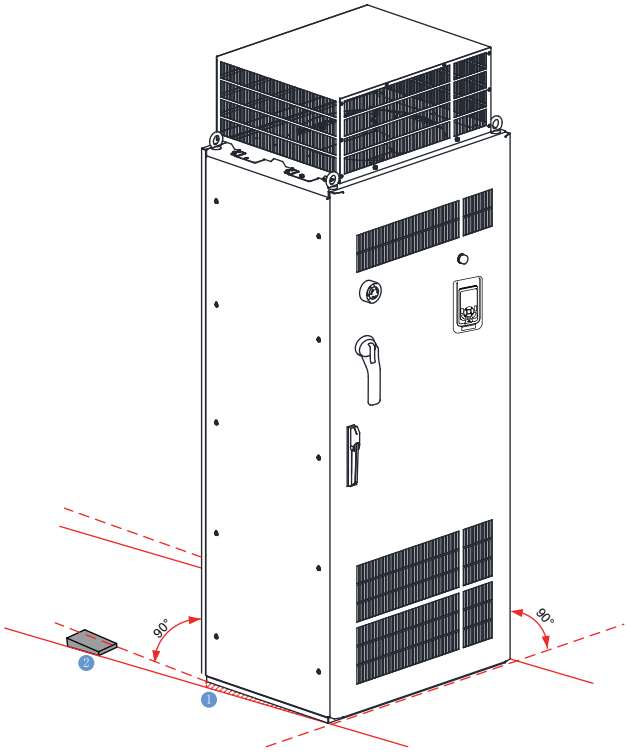


Figure 11-1 Ground requirements

11.4 Expansion Screw Installation

To install the cabinet on a cement floor, embed expansion nuts in advance in the floor at positions corresponding to the fixing holes of the cabinet for fixing the cabinet.

The following figure shows the steps of installing expansion screws, where ❶ indicates an expansion screw, ❷ indicates the cabinet, and ❸ indicates an M12 bolt.

1. Drill a hole for the expansion screw. The hole diameter shall be slightly smaller than the maximum outer diameter of the screw, and the hole depth shall be greater than the expansion screw length. The expansion screw must be vertical to the ground, as shown by Step 1 in the following figure.
2. The expansion screw consists of a bolt spring enclosure and a screw part. Use a hammer to knock the expansion screw into the hole and ensure that the screw head is below the ground surface, as shown by Step 2 in the following figure.
3. After placing the cabinet in the required position, fasten it with M12 bolts. The expansion screw stem will be pulled up, making the spring shell deform to fasten the cabinet, as shown in Step 3.

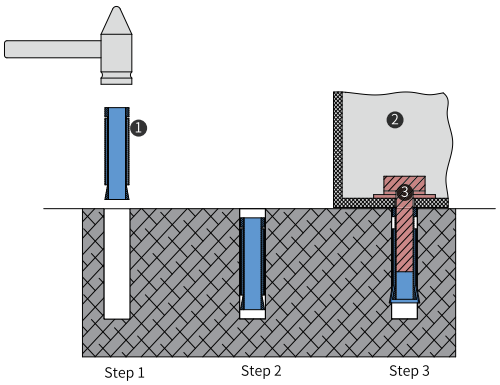


Figure 11-2 Installing an expansion screw

11.5 Requirements on foundation

- Separate high-voltage cables from low-voltage cables by using different brackets. If they cannot be separated, lay low-voltage cables in fully-enclosed metal ducts.
- The cable tray must be made of non-flammable materials and must be smooth, damp-proof, dust-proof, and rat-proof.
- During foundation design, take the following factors into consideration: sufficient space in front of the cabinet for inspection, and wiring and cabling of power supply cables, actuating motor cables, and system control cables. The cabinet comes with a cable tray or cable guide. Separate power cables from signal cables. Failure to comply will affect the operation of the AC drive. The following figure shows the routing and related requirements.

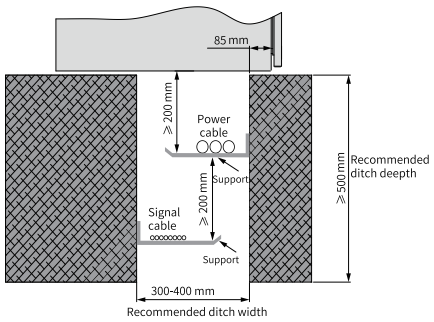
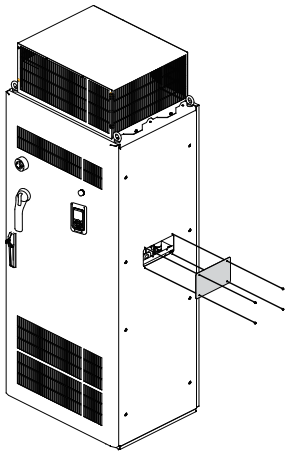


Figure 11-3 Foundation layout

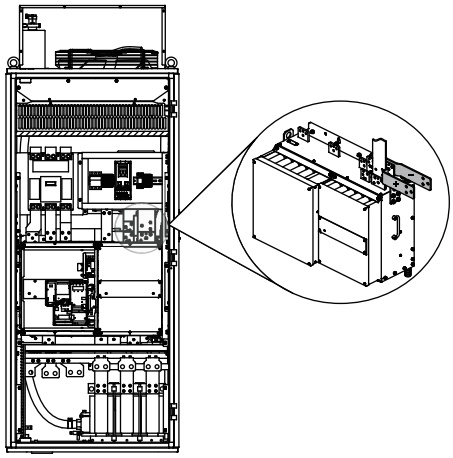
11.6 External Braking Unit Installation

Procedure

1. Remove the lateral closure plate of the cabinet.



2. Open the cabinet door and mount the adapter busbar for the external braking unit, as shown in the following figure.



3. Connect the AC drive to the external braking unit.

Note

The number of required braking units is subject to actual conditions. When multiple braking units are required, connect them in parallel. The following figure takes one braking unit as an example.

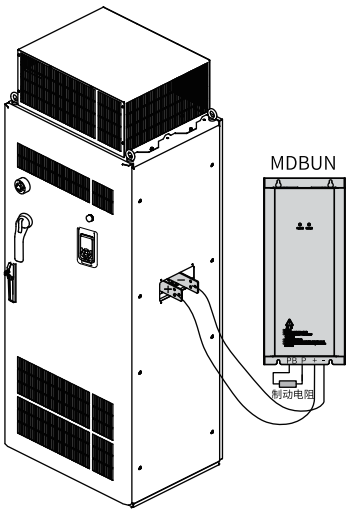


Figure 11-4 Connecting the AC drive to the external braking unit

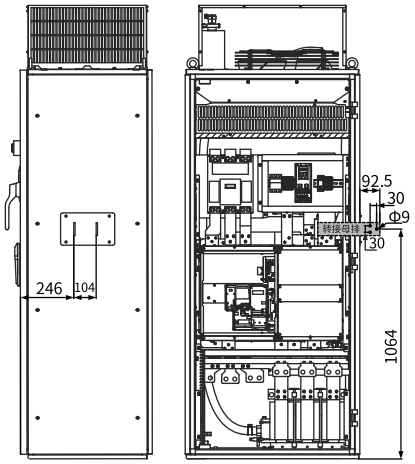


Figure 11-5 Dimensions of the position for installing the adapter busbar (unit: mm)

12 Checklist for Mechanical Installation

If the option in the following table is included in the delivery, check the box in the right column. Before installation, inspect the following items and tick the corresponding check-boxes for confirmation.

Table 12–1 Checklist for mechanical installation

Item	Operation	Passed	Completed
1	Check the anti-inclination label.	☐	☐
2	Check that the packing box is intact and dry.	☐	☐
3	Check that the load-bearing capacity of the floor and the environment meet the installation requirements. For details, see *"11.3 Requirements on Ground Levelness" on page 234* and *"7.2.1 Installation Environment" on page 162*.	☐	☐
4	Check that the ceiling height meets the minimum requirements (for smooth ventilation). There is sufficient space for air inlet and outlet without obstruction. Sufficient space is reserved for safe passing when the cabinet door is opened. For details, see *"7.2.3 Installation Clearance" on page 163*.	☐	☐
5	The cabinet enclosure is free of deformation, paint peeling, cracks, and other defects. The inside of the cabinet is free of water stains and other defects.	☐	☐
6	Check that the accessories (user guide and options) in the cabinet are complete.	☐	☐
7	The wooden pallet is removed before the cabinet is placed at the final installation site. For details, see *"8.5 Unpacking" on page 205*.	☐	☐
8	Install the cabinet to the pre-designed anchor point as required.	☐	☐
9	Install all contact protective devices (protection plates) inside and outside the cabinet before commissioning.	☐	☐

13 Electrical Installation

13.1 Electrical Connection

T1 to T12 models

"Figure 13–1" on page 240 shows a typical wiring method of T1 to T12 models.

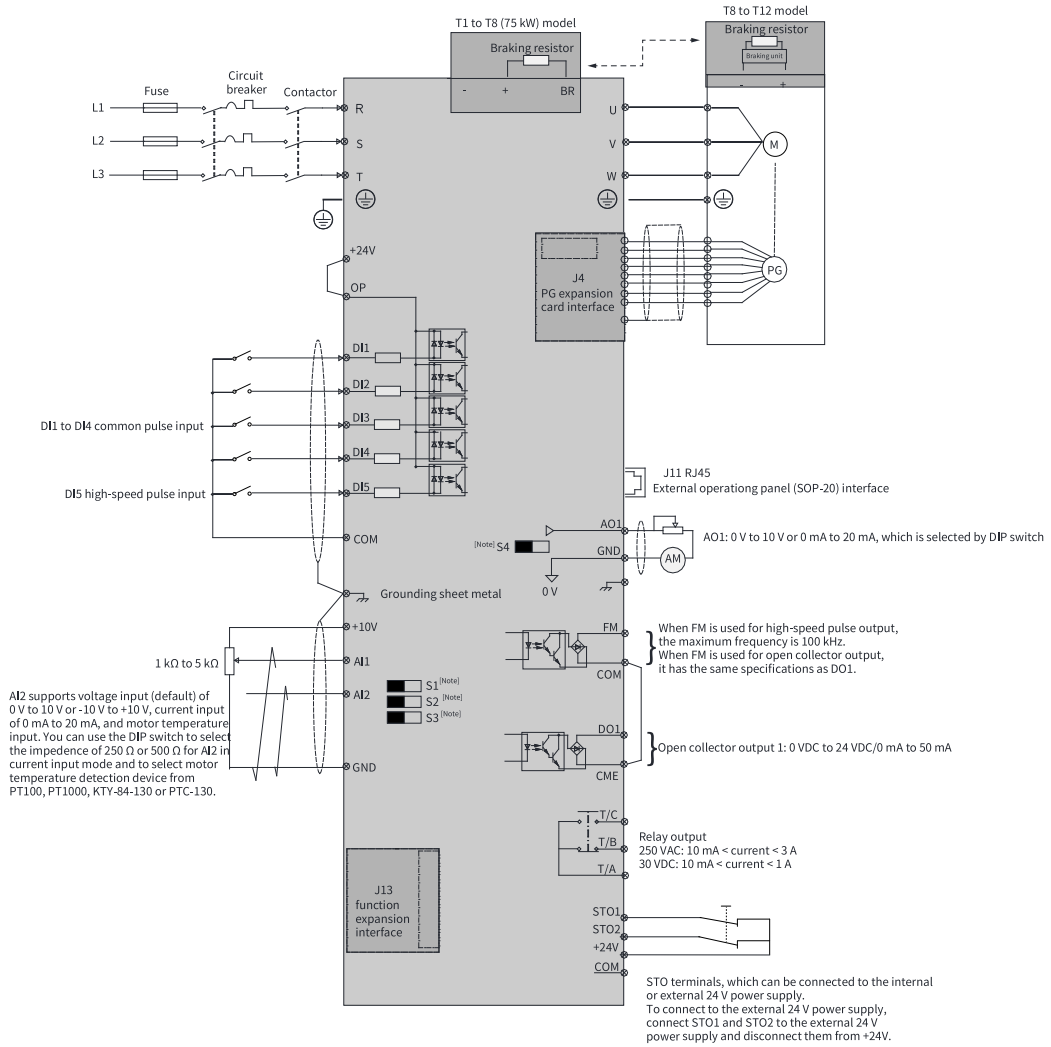


Figure 13-1 Standard wiring (T1 to T12)

Note

- For details on S1 to S4 DIP switches, see *"Table 13–15 Function description of control circuit terminals" on page 276*.
- For three-phase 380–480 V AC drives, a 0.4–75 kW model differs from a 90–450 kW model in the wiring detail marked by the double arrows in the figure.
- For three-phase 200–240 V AC drives, a 0.4–37 kW model differs from a 45–200 kW model in the wiring detail marked by the double arrows in the figure.

T13 models

"Figure 13–2" on page 241 shows the electrical connection in the cabinet.

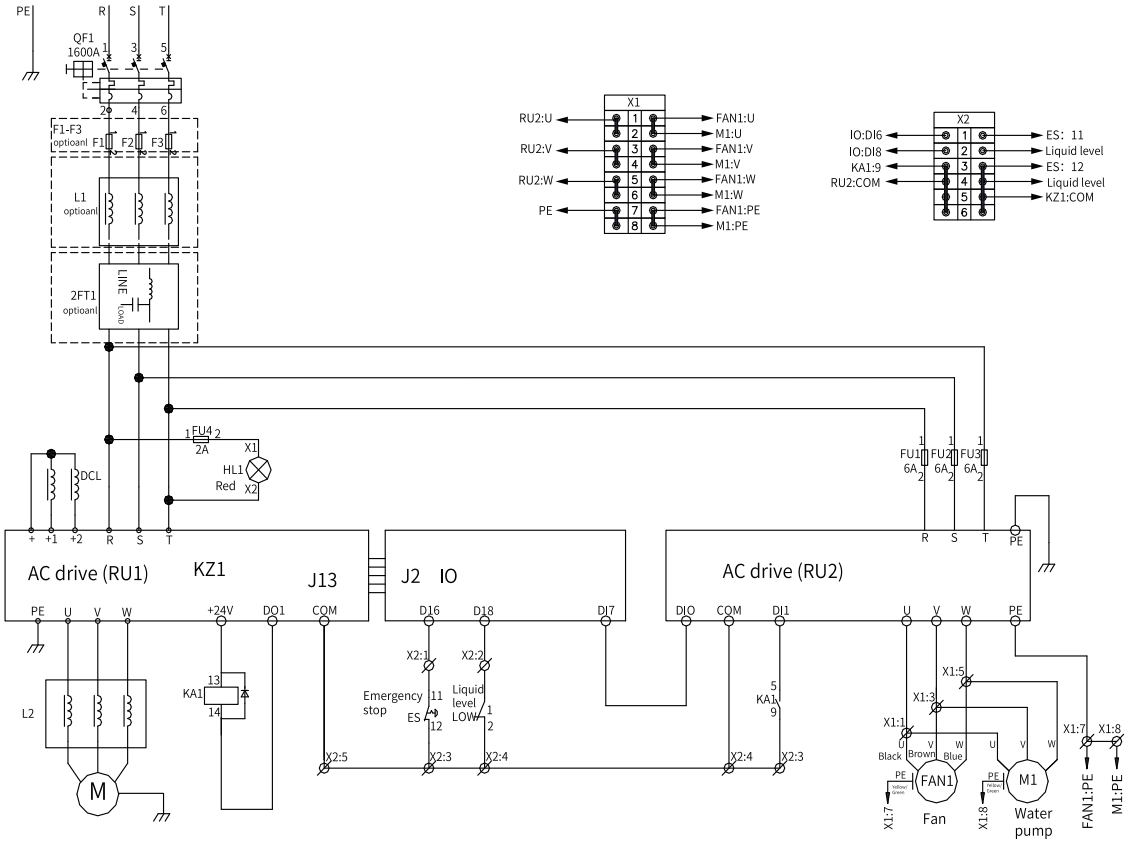


Figure 13-2 Electrical connection in the cabinet (T13)

T13 models

- The cabinet operates under high voltages. Do not attempt to connect any wires while the voltage is live.
- The cabinet can be operated only by qualified professionals.
- Take caution when operating the equipment disconnected from the power supply as external supply voltage may still be present. The main circuit and control circuit terminals may be live even when the motor is in the stop state.
- After disconnecting the input and output power supplies, wait for at least 15 minutes until the bus voltage is lower than 36 V and the power indicator is off before further operation.
- Ensure that the motors, cabinets, and other components are installed and connected in accordance with the recognized technical rules of the country and the region. Pay special attention to regulations on cable dimensions, fuses, grounding, open circuits, isolation, and overcurrent protection.
- If the fuse in a branch circuit trips, the fault current may have been disconnected. To reduce the risk of fire and electric shocks, check the conductive parts and other components of the cabinet and replace the damaged ones. After a fuse trips, identify and rectify the cause of the tripping.

13.2 Pre-wiring Check

Check the following items before wiring.

No.	Item
1	Cables used during wiring comply with the requirements on the cross sectional area and the shield.
2	The device and the drive are grounded properly.
3	Proper electrostatic discharge (ESD) procedures are followed and antistatic wrist straps are worn.
4	Wiring-related options, including cable shield brackets (applicable to T1 to T9 models), are available.

13.3 Main Circuit Connection

13.3.1 Descriptions of Main Circuit Terminals

T1 to T9 models

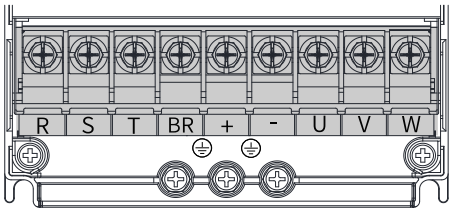


Figure 13-3 Layout of main circuit terminals for T1 to T4 models (three phase)

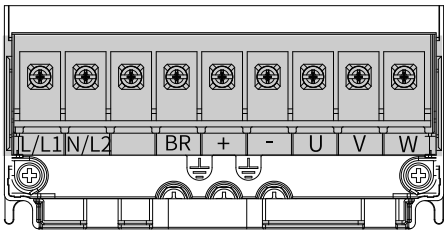


Figure 13-4 Layout of main circuit terminals for T2 models (single phase)

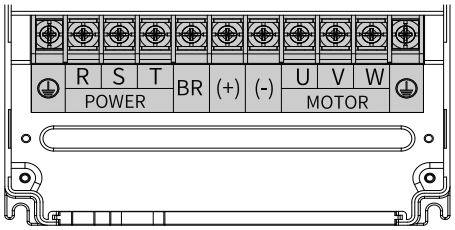


Figure 13-5 Layout of main circuit terminals for T5 to T8 models

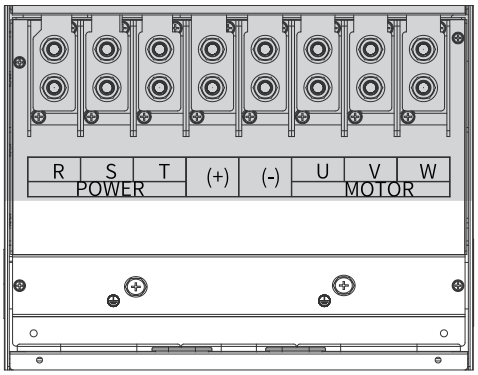


Figure 13-6 Layout of main circuit terminals for T9 models

Table 13–1 Descriptions of main circuit terminals

Terminal Mark	Terminal Name	Function Description
R, S, T	Input terminals of three-phase power supply	Used to connect the three-phase AC input power supply.
(+), (-)	Positive and negative terminals of the DC bus	Common DC busbar input; connected to the external braking unit of T9 models and above.
(+), BR	Braking resistor connection terminals	Used to connect to the braking resistor of T8 models and below. Note: Only models with the name containing "B" are equipped with brake resistor terminals. For models with the name excluding "B", external brake units are required.
U, V, W	Output terminals	Used to connect the three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

T10 to T12 models

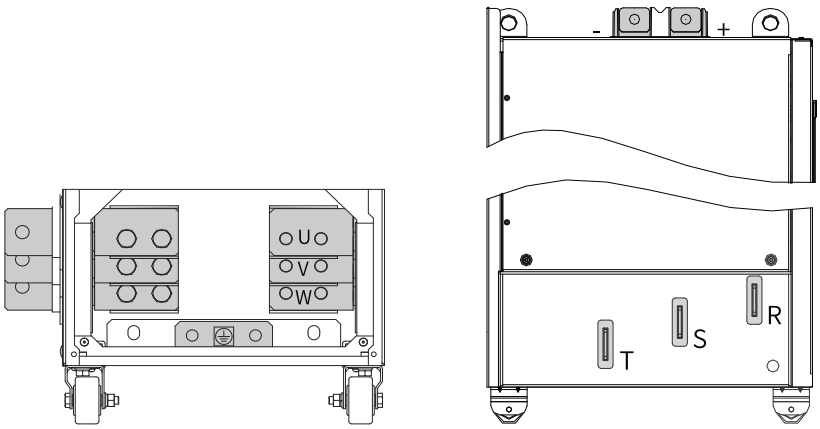


Figure 13-7 Layout of main circuit terminals for T10 to T12 models

Table 13–2 Descriptions of main circuit terminals

Terminal Mark	Terminal Name	Function Description
R, S, T	Input terminals of three-phase power supply	Used to connect the three-phase AC input power supply.
+, -	Positive and negative terminals of the DC bus	Common DC busbar input; connected to an external braking unit.
U, V, W	AC drive output terminals	Used to connect the three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

T13 models

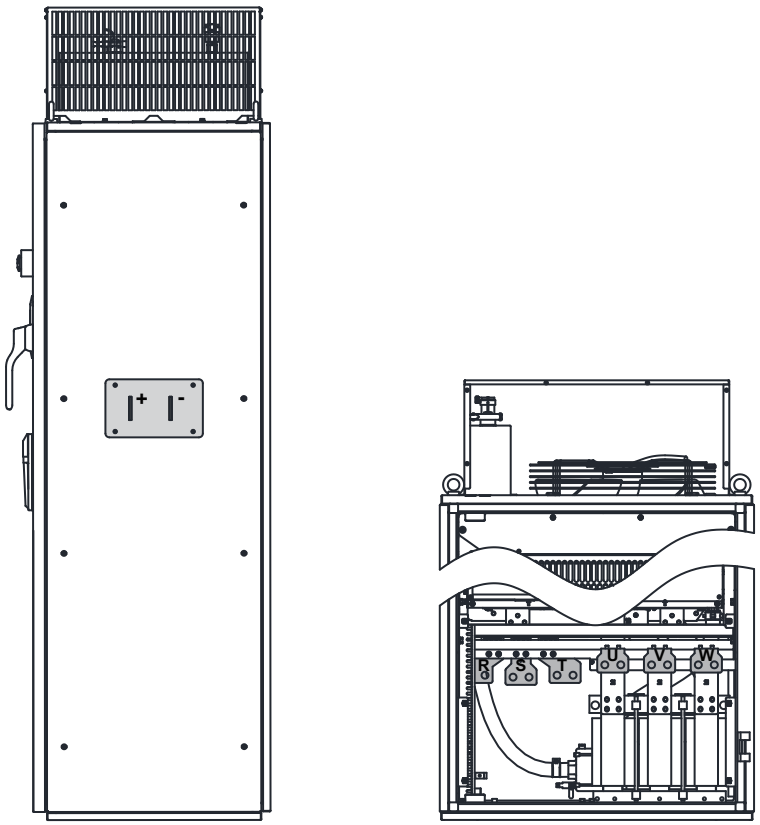


Figure 13-8 Layout of main circuit terminals for T13 models

Table 13–3 Descriptions of main circuit terminals

Terminal Mark	Terminal Name	Function Description
R, S, T	Input terminals of three-phase power supply	Used to connect the three-phase AC input power supply.
+, -	Positive and negative terminals of the DC bus	Common DC busbar input; connected to an external braking unit.
U, V, W	AC drive output terminals	Used to connect the three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

13.3.2 Dimensions of Main Circuit Terminals

T1 to T2 models

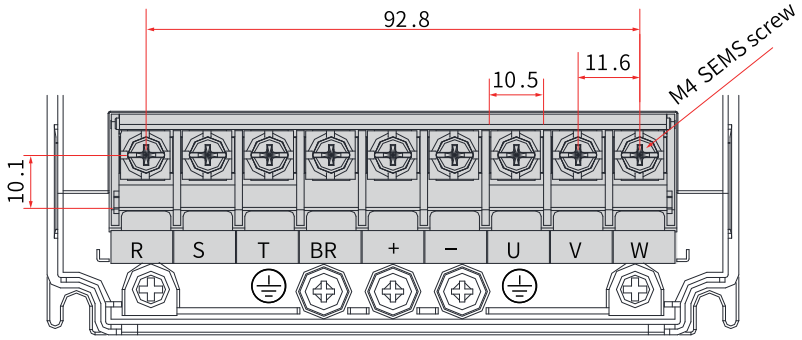


Figure 13-9 Main circuit terminal dimensions (mm) of T1 to T2 models

T3 models

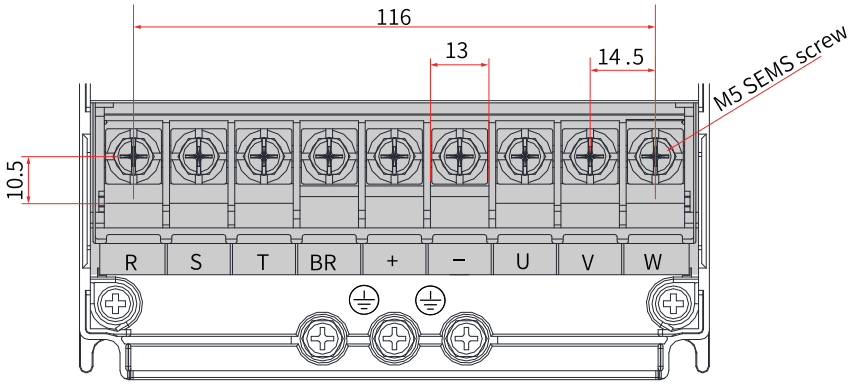


Figure 13-10 Main circuit terminal dimensions (mm) of T3 models

T4 models

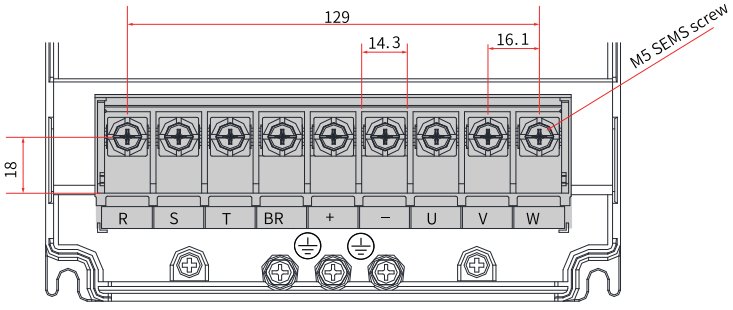


Figure 13-11 Main circuit terminal dimensions (mm) of T4 models

T5 models

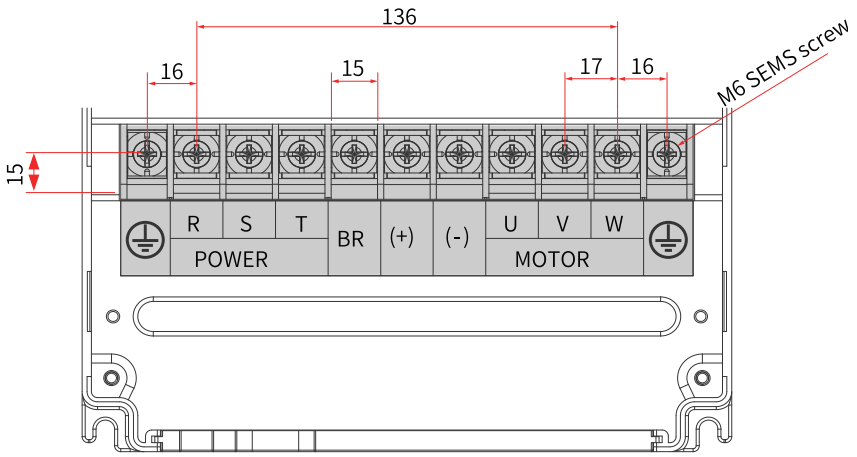


Figure 13-12 Main circuit terminal dimensions (mm) of T5 models

T6 models

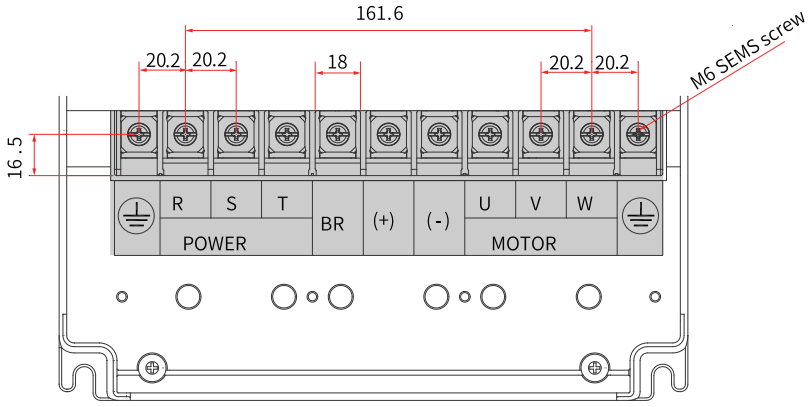


Figure 13-13 Main circuit terminal dimensions (mm) of T6 models

T7 models

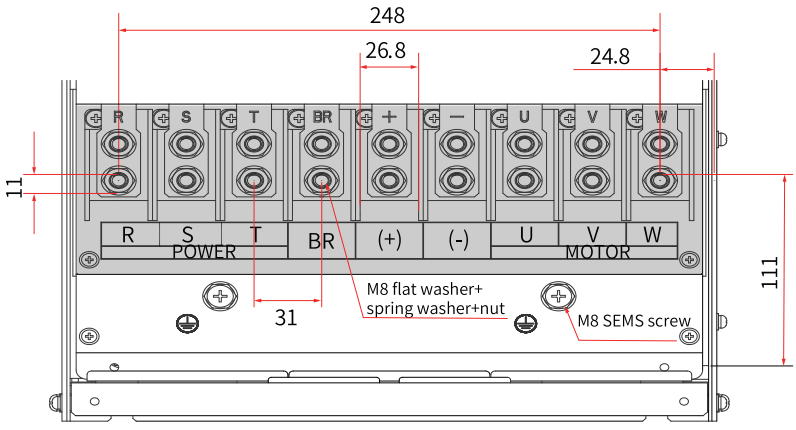


Figure 13-14 Main circuit terminal dimensions (mm) of T7 models

T8 models

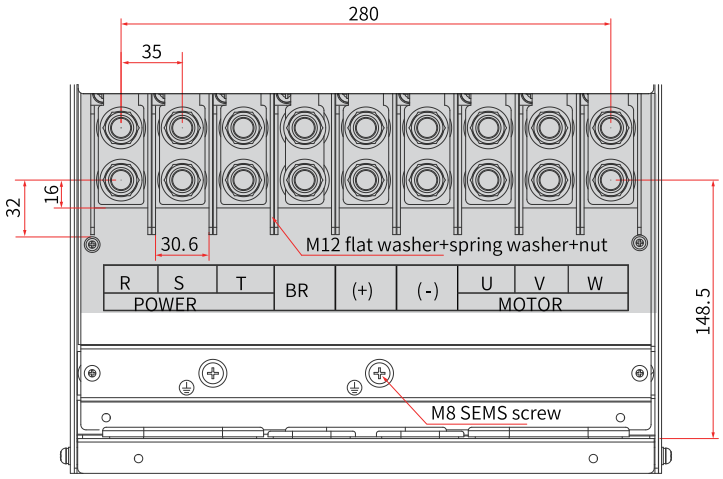


Figure 13-15 Main circuit terminal dimensions (mm) of T8 models

T9 models

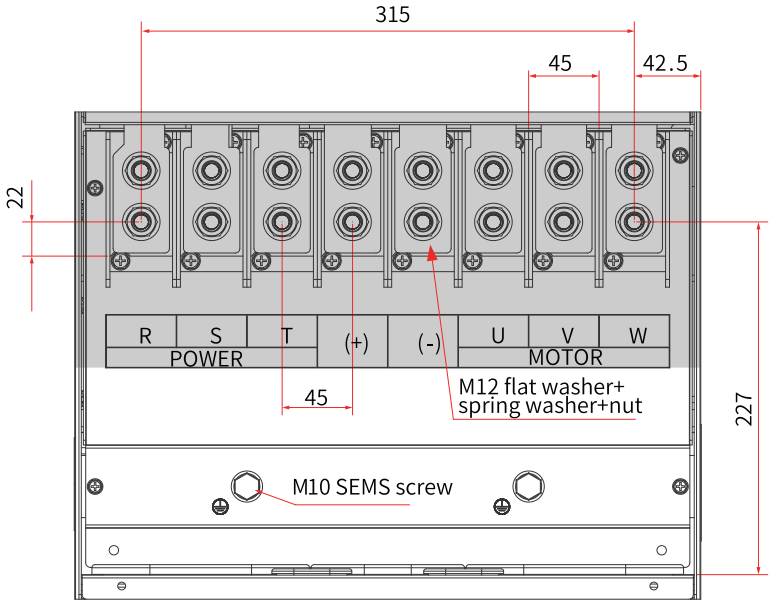


Figure 13-16 Main circuit terminal dimensions (mm) of T9 models

T10 models

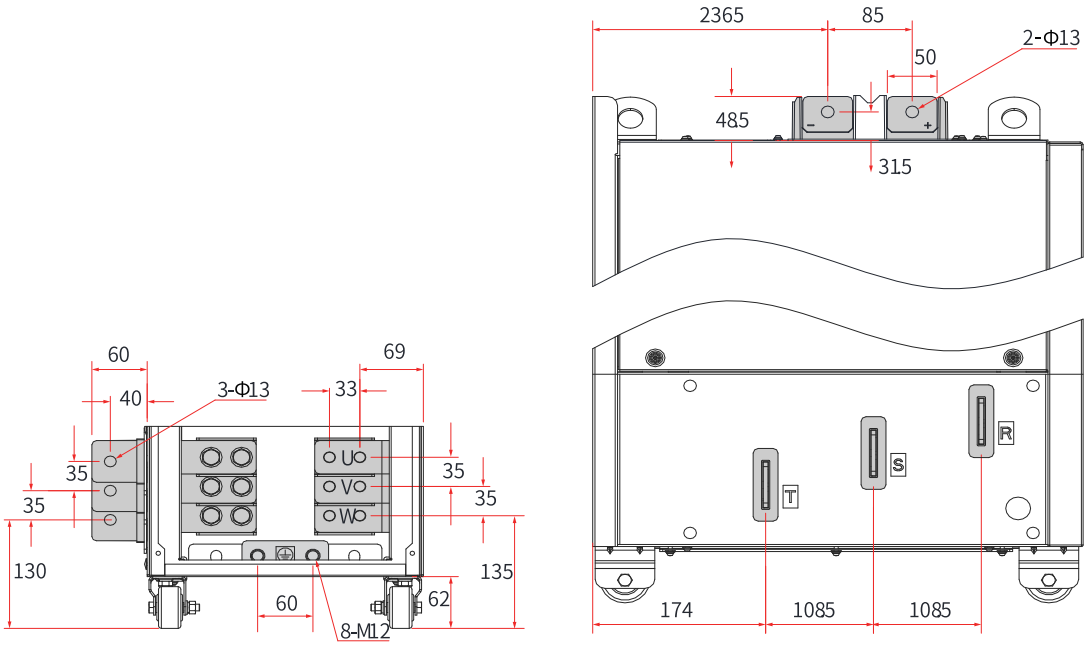


Figure 13-17 Main circuit terminal dimensions (mm) of T10 models (without output reactors)

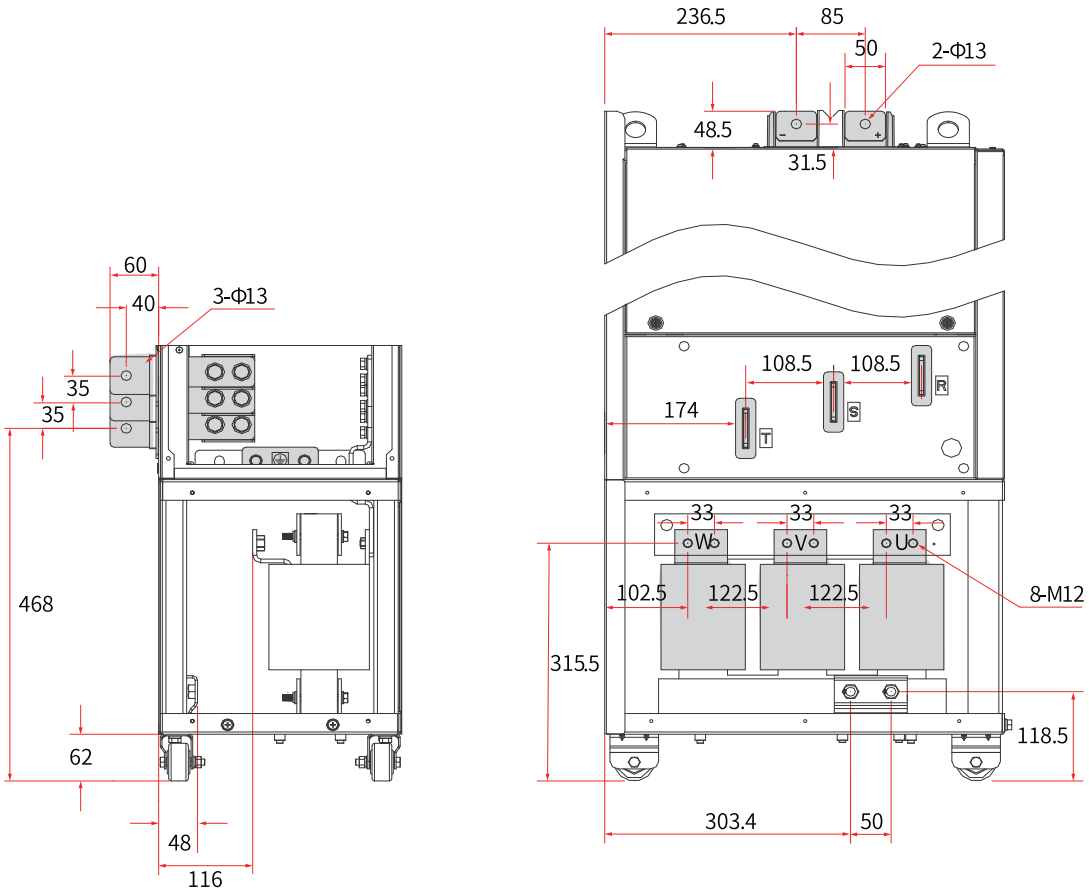


Figure 13-18 Main circuit terminal dimensions (mm) of T10 models (with output reactors)

The side copper busbars in the preceding figures can be removed if necessary. The following figure shows the dimensions of the main circuit terminals without the side copper busbars.

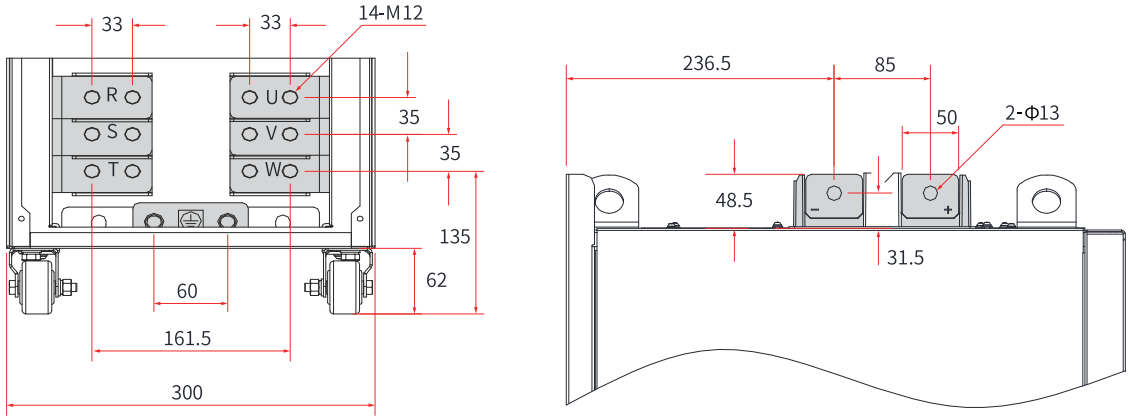


Figure 13-19 Main circuit terminal dimensions (mm) of T10 models without the output reactor or copper busbar

T11 models

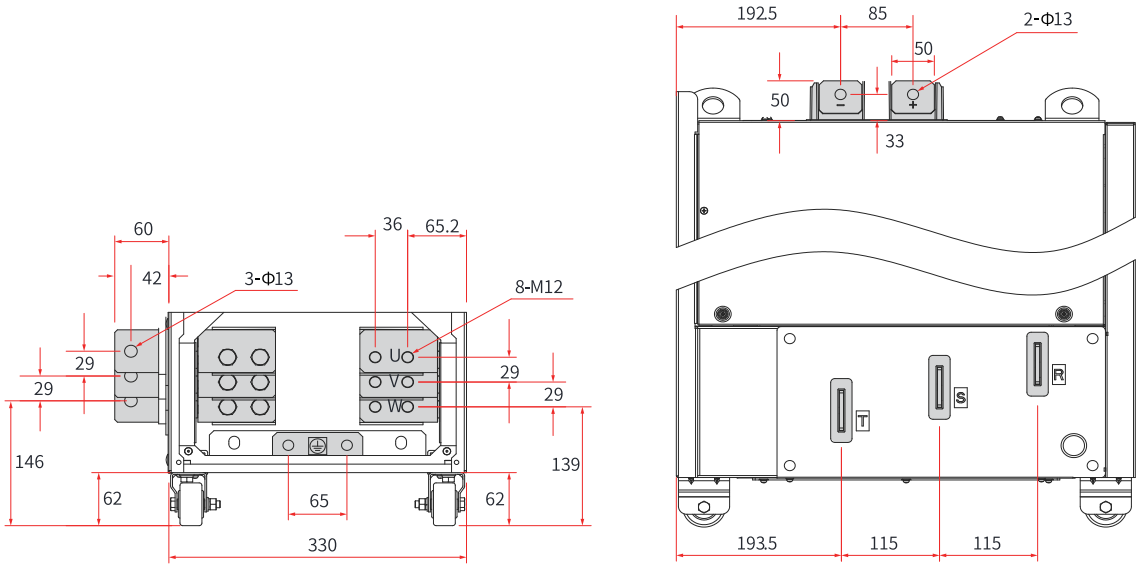


Figure 13-20 Main circuit terminal dimensions (mm) of T11 models (without output reactors)

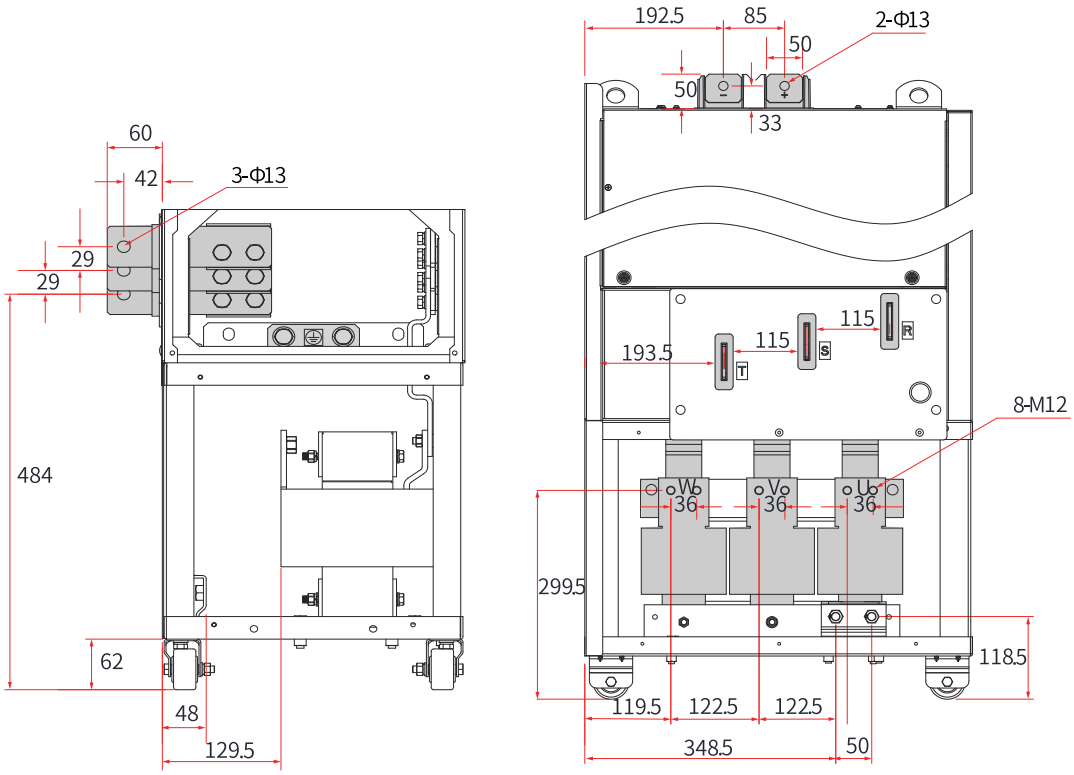


Figure 13-21 Main circuit terminal dimensions (mm) of T11 models (with output reactors)

The side copper busbars in the preceding figures can be removed if necessary. The following figure shows the dimensions of the main circuit terminals without the side copper busbars.

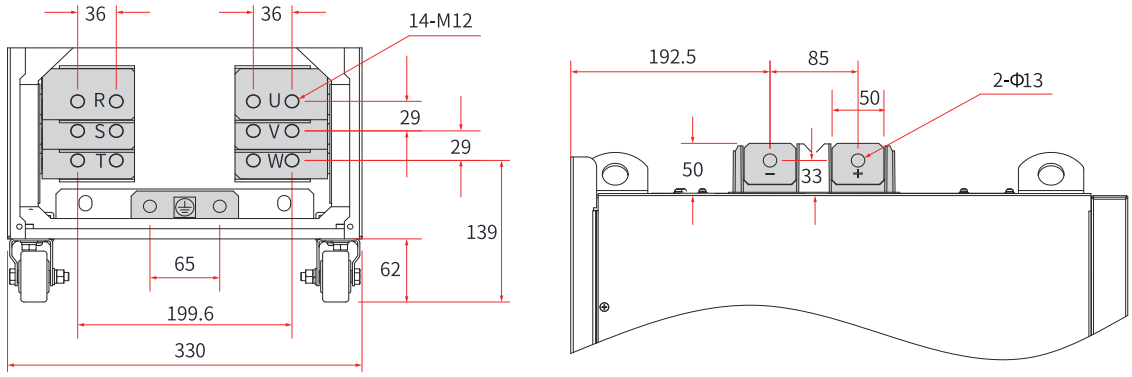


Figure 13-22 Main circuit terminal dimensions (mm) of T11 models without the output reactor or copper busbar

T12 models

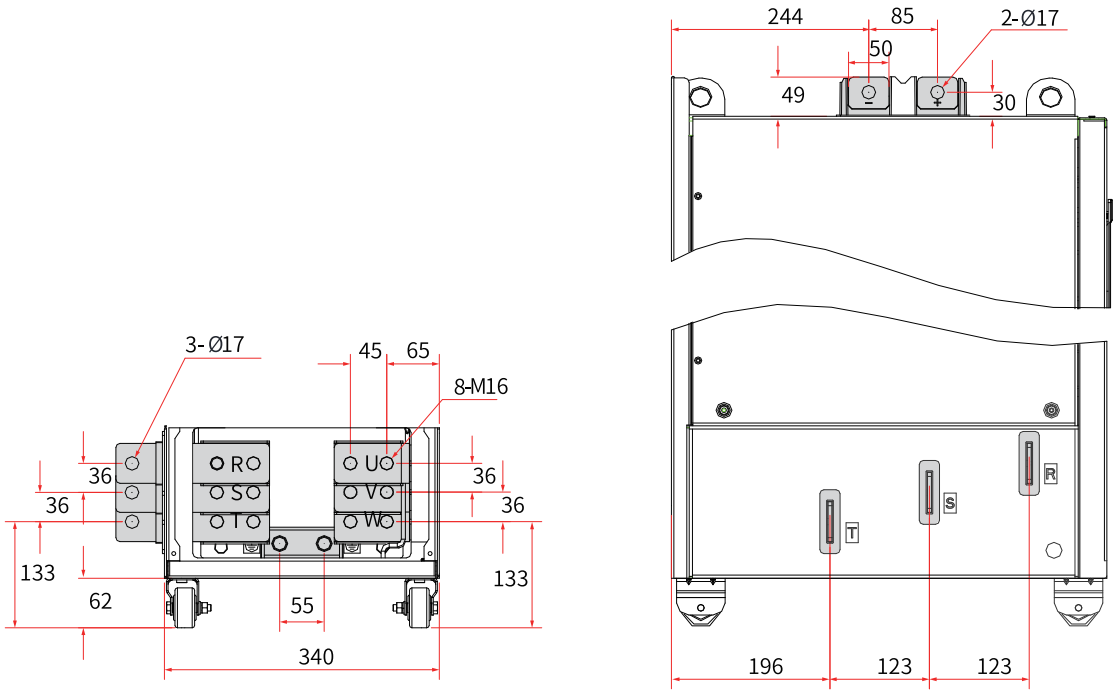


Figure 13-23 Main circuit terminal dimensions (mm) of T12 models (without output reactors)

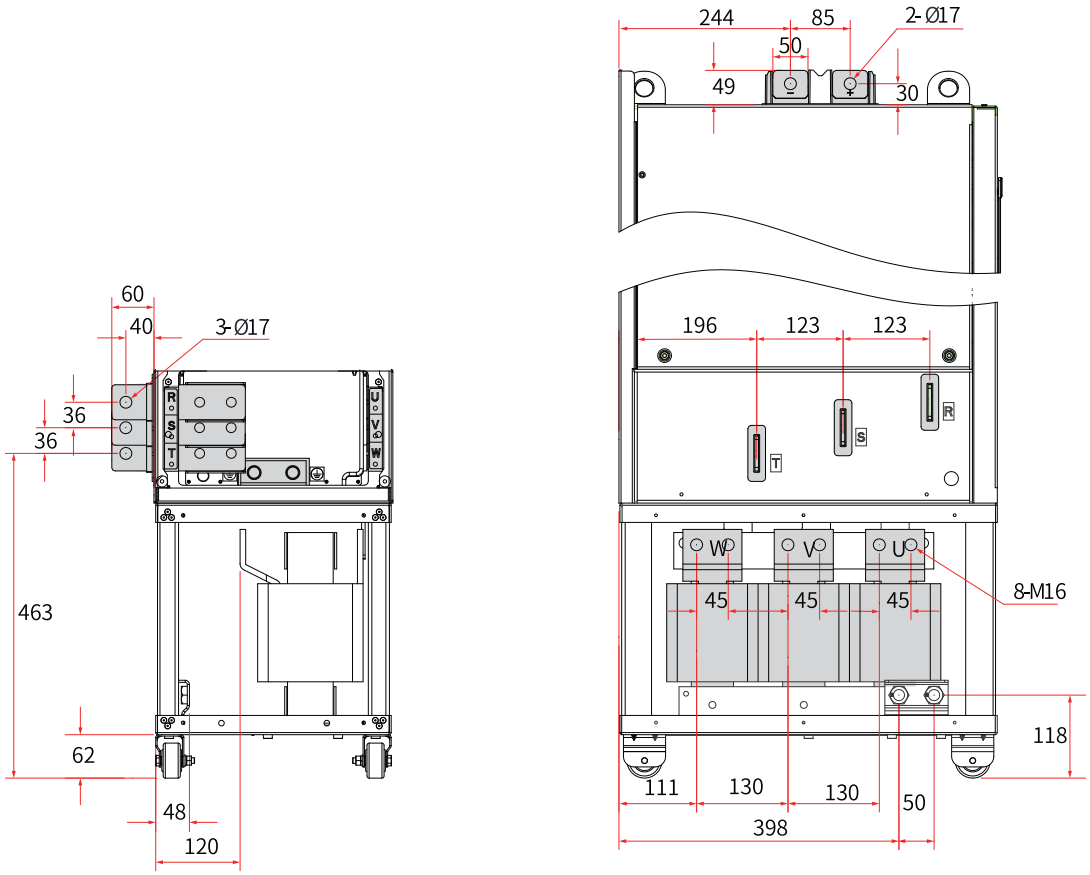


Figure 13-24 Main circuit terminal dimensions (mm) of T12 models (with output reactors)

The side copper busbars in the preceding figures can be removed if necessary. The following figure shows the dimensions of the main circuit terminals without the side copper busbars.

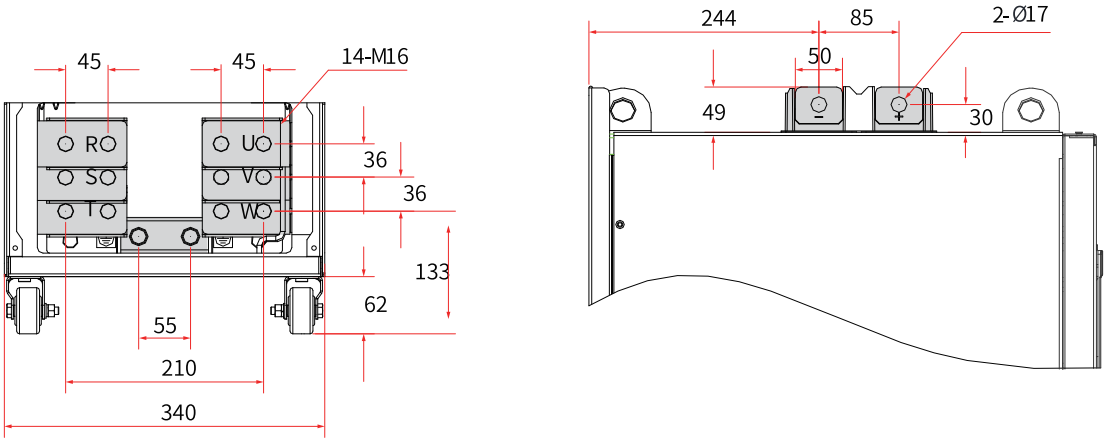


Figure 13-25 Main circuit terminal dimensions (mm) of T12 models without the output reactor or copper busbar

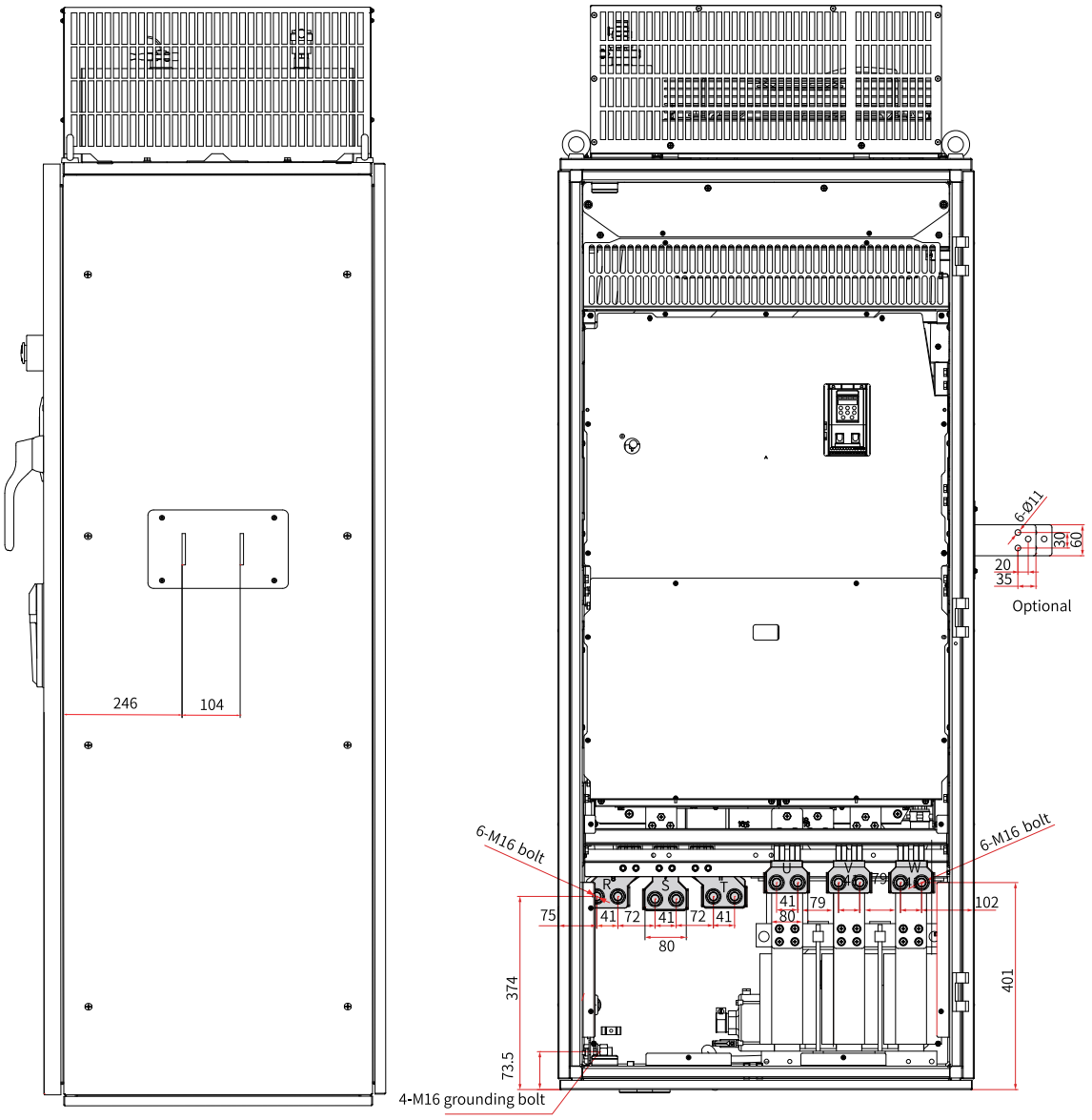


Figure 13-26 Main circuit terminal dimensions (mm) of T13 models (without auxiliary power distribution cabinets, three-phase 380 V to 480 V)

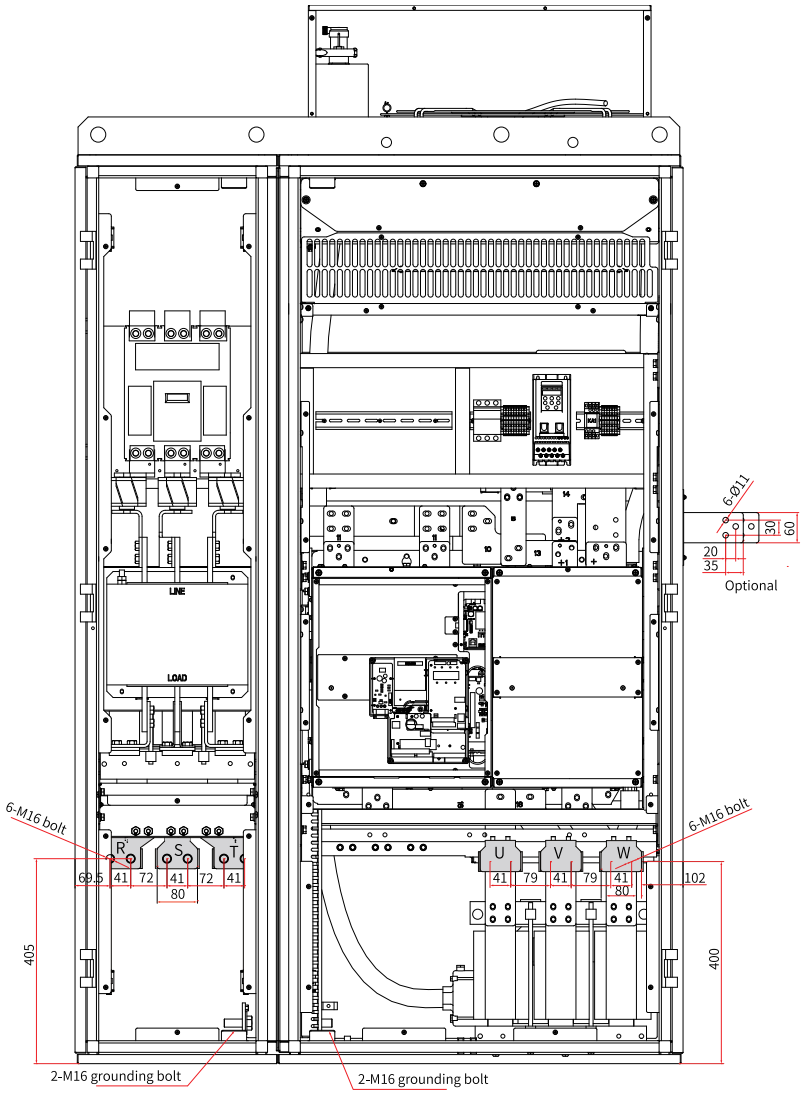


Figure 13-27 Main circuit terminal dimensions (mm) of T13 models (with auxiliary power distribution cabinets, three-phase 380 V to 480 V)

13.3.3 Main Circuit Cables

Power cable selection requirements

For selection of power cables, follow national or regional regulations. Select IEC cables based on the following requirements:

- Compliant with IEC 60204-1 and IEC 60364-5-52 standards.
- PVC insulated cables with copper conductors
- Ambient temperature of 40°C and cable surface temperature of 70°C (Note: When the ambient temperature exceeds 40°C, contact Inovance.)
- Symmetrical cable with copper-braided shield

If recommended cables for peripheral devices or options are not suitable for the product, contact Inovance.

Use shielded cables to comply with the EMC requirements. The shielded cables are divided into three-conductor cables and four-conductor cables, as shown below. If the conductivity of the three-conductor cable shield cannot meet requirements, add an independent PE cable. Alternatively, use a four-conductor cable with one conductor as the PE cable. The shield of the shielded cable is comprised of coaxial cooper braids to suppress radio frequency interference. To enhance the shielding performance and conductivity, the braided density of the shield must be greater than 90%.

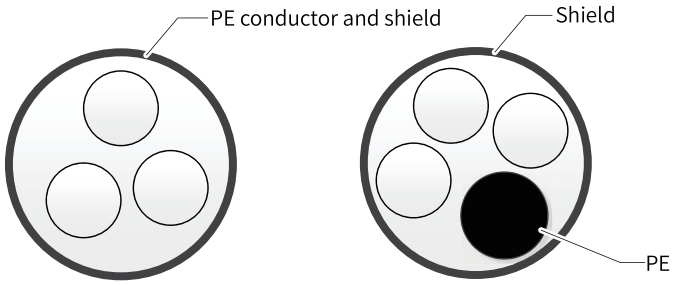


Figure 13-28 Recommended power cable

Recommended cable

Table 13–4 Cable selection (three-phase 380 V to 480 V, compliant with CE certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T1	MD520-4T0.4B(S)	1.8	1.5	3 x 0.75	TNR0.75 - 4	0.75	TNR0.75 - 4	M4	1.2 (10.6)
	MD520-4T0.7B(S)	2.4	2.1	3 x 0.75	TNR0.75 - 4	0.75	TNR0.75 - 4	M4	1.2 (10.6)
	MD520-4T1.1B(S)	3.7	3.1	3 x 0.75	TNR0.75 - 4	0.75	TNR0.75 - 4	M4	1.2 (10.6)
	MD520-4T1.5B(S)	4.6	3.8	3 x 0.75	TNR0.75 - 4	0.75	TNR0.75 - 4	M4	1.2 (10.6)
	MD520-4T2.2B(S)	6.3	5.1	3 x 1	TNR1.25 - 4	1	TNR1.25 - 4	M4	1.2 (10.6)
	MD520-4T3.0B(S)	9.0	7.2	3 x 1.5	TNR1.25 - 4	1.5	TNR1.25 - 4	M4	1.2 (10.6)
T2	MD520-4T3.7B(S)	11.4	9.0	3 x 2.5	TNR2-4	2.5	TNR2-4	M4	1.2 (10.6)
	MD520-4T5.5B(S)	16.7	13.0	3 x 4	TNR3.5 - 4	4	TNR3.5 - 4	M4	1.2 (10.6)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T3	MD520-4T7.5B(S)	21.9	17.0	3 x 6	TNR5.5‐5	6	TNR5.5‐5	M5	2.8 (24.8)
	MD520-4T11B(S)	32.2	25.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)
T4	MD520-4T15B(S)	41.3	32.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)
T5	MD520-4T18.5(B)(S)-T	37.2	37.0	3 x 16	GTNR16-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T18.5(B)(S)	49.5	37.0	3 x 16	GTNR16-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)-T	43.4	45.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)	59.0	45.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
T6	MD520-4T30(B)(S)	57.0	60.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-4T37(B)(S)	69.0	75.0	3 x 35	GTNR35-6	16	GTNR16-6	M6	4.8 (42.5)
T7	MD520-4T45(B)(S)	89.0	91.0	3 x 50	GTNR50-8	25	GTNR25-8	M8	13.0 (115.2)
	MD520-4T55(B)(S)	106.0	112.0	3 x 70	GTNR70-8	35	GTNR35-8	M8	13.0 (115.2)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T8	MD520-4T75(B)(S)	139.0	150.0	3 x 95	GTNR95-12	50	GTNR50-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T90(S)	164.0	176.0	3 x 120	GTNR120-12	70	GTNR70-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T110(S)	196.0	210.0	3 x 150	BC150-12	95	GTNR95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
T9	MD520-4T132(S)	240.0	253.0	3 x 185	BC185-12	95	BC95-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
	MD520-4T160(S)*	287.0	304.0	2 x (3 x 120)	BC120-12	120	BC120-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
T10	MD520-4T200(S)-(L)	365.0	377.0	2 x (3 x 150)	BC150-12	150	BC150-12	M12	35.0 (310.1)
	MD520-4T220(S)-(L)	410.0	426.0	2 x (3 x 150)	BC150-12	150	BC150-12	M12	35.0 (310.1)
T11	MD520-4T250(S)-(L)*	441.0	465.0	3 x (3 x 120)	BC120-12	185	BC185-12	M12	35.0 (310.1)
	MD520-4T280(S)-(L)*	495.0	520.0	3 x (3 x 150)	BC150-12	2 x 120	BC120-12	M12	35.0 (310.1)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T12	MD520-4T315(S)-(L)*	565.0	585.0	3 x (3 x 185)	BC185-16	2 x 150	BC150-16	M16	85.0 (753.1)
	MD520-4T355(S)-(L)*	617.0	650.0	3 x (3 x 240)	BC240-16	2 x 185	BC185-16	M16	85.0 (753.1)
	MD520-4T400(S)-(L)*	687.0	725.0	3 x (3 x 240)	BC240-16	2 x 185	BC185-16	M16	85.0 (753.1)
T13	MD520-4T500(S)-(A)*	838.1	900.0	4 x (3 x 240)	BC240-16	2 x 240	BC240-16	M16	85.0 (753.1)
	MD520-4T560(S)-(A)*	949.6	1020.0	4 x (3 x 240)	BC240-16	2 x 240	BC240-16	M16	85.0 (753.1)
	MD520-4T630(S)-(A)*	1043.5	1120.0	4 x (3 x 300)	BC300-16	2 x 300	BC300-16	M16	85.0 (753.1)

Note

<1>: Applicable to GB standards. For example, 3 x 10 indicates one 3-conductor 10 mm^2 cable; 2 x (3 x 120) indicates two 3-conductor 120 mm^2 cables. The preceding recommended lugs are the TNR, GTNR, and BC series lugs from Suzhou Yuanli.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; Ambient temperature of 40°C and cable surface temperature of 70°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The cables with the asterisk mark (*) must be connected through the copper busbar.
3. If the conditions are different, you need to select the model according to actual conditions.

Table 13–5 Cable selection (three-phase 380 V to 480 V, compliant with UL certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)[<2>]	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)[<2>]	Recommended Cable Lug		
T1	MD520-4T0.4B(S)	1.8	1.5	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T0.7B(S)	2.4	2.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T1.1B(S)	3.7	3.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T1.5B(S)	4.6	3.8	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T2.2B(S)	6.3	5.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-4T3.0B(S)	9.0	7.2	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
T2	MD520-4T3.7B(S)	11.4	9.0	12	TLK4-4	12	TLK6-4	M4	1.2 (10.6)
	MD520-4T5.5B(S)	16.7	13.0	10	TLK6-4	10	TLK6-4	M4	1.2 (10.6)
T3	MD520-4T7.5B(S)	21.9	17.0	8	TLK10-5	8	TLK10-5	M5	2.8 (24.8)
	MD520-4T11B(S)	32.2	25.0	8	TLK10-5	8	TLK10-5	M5	2.8 (24.8)
T4	MD520-4T15B(S)	41.3	32.0	6	TLK16-5	6	TLK16-5	M5	2.8 (24.8)
T5	MD520-4T18.5(B)(S)-T	37.2	37.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)
	MD520-4T18.5(B)(S)	49.5	37.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)-T	43.4	45.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)
	MD520-4T22(B)(S)	59.0	45.0	4	TLK25-6	6	TLK16-6	M6	4.8 (42.5)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug		
T6	MD520-4T30(B)(S)	57.0	60.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)
	MD520-4T37(B)(S)	69.0	75.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)
T7	MD520-4T45(B)(S)	89.0	91.0	1/0	TLK50-8	2	TLK35-8	M8	13.0 (115.2)
	MD520-4T55(B)(S)	106.0	112.0	3/0	TLK95-8	1/0	TLK50-8	M8	13.0 (115.2)
T8	MD520-4T75(B)(S)	139.0	150.0	4/0	TLK120-12	2/0	TLK70-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T90(S)	164.0	176.0	300 kcmil	SQNBS150-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-4T110(S)	196.0	210.0	2x3/0	TLK95-12	4/0	TLK120-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
T9	MD520-4T132(S)	240.0	253.0	500 kcmil	SQNBS250-12	300 kcmil	SQNBS150-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
	MD520-4T160(S)	287.0	304.0	2 x 300 kcmil	SQNBS150-12	300 kcmil	SQNBS150-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/kcmil)<2>	Recommended Cable Lug		
T10	MD520-4T200(S)-(L)	365.0	377.0	2 x 350 kcmil	SQNBS180-12	350 kcmil	SQNBS180-12	M12	35.0 (310.1)
	MD520-4T220(S)-(L)*	410.0	426.0	2 x 400 kcmil	SQNBS250-12	400 kcmil	SQNBS250-12	M12	35.0 (310.1)
T11	MD520-4T250(S)-(L)*	441.0	465.0	2 x 500 kcmil	SQNBS250-12	500 kcmil	SQNBS250-12	M12	35.0 (310.1)
	MD520-4T280(S)-(L)*	495.0	520.0					M12	35.0 (310.1)
T12	MD520-4T315(S)-(L)*	565.0	585.0	4 x 300 kcmil	SQNBS150-12	2 x 300 kcmil	SQNBS150-12	M16	85.0 (753.1)
	MD520-4T355(S)-(L)*	617.0	650.0	4 x 350 kcmil	TLK185-16	2 x 350 kcmil	TLK185-16	M16	85.0 (753.1)
	MD520-4T400(S)-(L)*	687.0	725.0	4 x 400 kcmil	TLK240-16	2 x 400 kcmil	TLK240-16	M16	85.0 (753.1)
T13	MD520-4T500(S)-(A)*	838.1	900.0	4 x 500 kcmil	SQNBS325-16	2 x 500 kcmil	SQNBS325-16	M16	85.0 (753.1)
	MD520-4T560(S)-(A)*	949.6	1020.0	4 x 500 kcmil	SQNBS325-16	2 x 500 kcmil	SQNBS325-16	M16	85.0 (753.1)
	MD520-4T630(S)-(A)*	1043.5	1120.0	4 x 500 kcmil	SQNBS325-16	2 x 500 kcmil	SQNBS325-16	M16	85.0 (753.1)

Note

<2>: Applicable to AWG standards, in which 8 represents 8AWG, 1/0 represents 0AWG, 3/0 represents 000AWG, and 4/0 represents 0000AWG; 2 x 300 kcmil represents two 300 kcmil cables. The preceding recommended cable lugs are TLK and SQNBS series lugs from KST.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; Ambient temperature of 40°C and cable surface temperature of 75°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The recommended cables must meet requirements for 125% overload.
3. The cables with the asterisk mark (*) must be connected through the copper busbar.
4. If the conditions are different, you need to select the model according to actual conditions.

Table 13–6 Cable selection (three-phase 200 V to 240 V, compliant with CE certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T1	MD520-2T0.4B(S)	2.4	2.1	3 x 0.75	TNR0.75–4	0.75	TNR0.75–4	M4	1.2 (10.6)
	MD520-2T0.7B(S)	4.6	3.8	3 x 0.75	TNR0.75–4	0.75	TNR0.75–4	M4	1.2 (10.6)
	MD520-2T1.1B(S)	6.3	5.1	3 x 0.75	TNR0.75–4	0.75	TNR0.75–4	M4	1.2 (10.6)
	MD520-2T1.5B(S)	9.0	7.2	3 x 1.5	TNR1.25–4	1.5	TNR1.25–4	M4	1.2 (10.6)
T2	MD520-2T2.2B(S)	11.4	9.0	3 x 2.5	TNR2-4	2.5	TNR2-4	M4	1.2 (10.6)
	MD520-2T3.7B(S)	16.7	13.0	3 x 4	TNR3.5–4	4	TNR3.5–5	M4	1.2 (10.6)
T3	MD520-2T5.5B(S)	32.2	25.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)
T4	MD520-2T7.5B(S)	41.3	32.0	3 x 10	TNR8-5	10	TNR8-5	M5	2.8 (24.8)
T5	MD520-2T11(B)(S)	59.0	45.0	3 x 16	GTNR16-6	16	GTNR16-6	M6	4.8 (42.5)
T6	MD520-2T15(B)(S)	57.0	60.0	3 x 25	GTNR25-6	16	GTNR16-6	M6	4.8 (42.5)
	MD520-2T18.5(B)(S)	69.0	75.0	3 x 35	GTNR35-6	16	GTNR16-6	M6	4.8 (42.5)
T7	MD520-2T22(B)(S)	89.0	91.0	3 x 50	GTNR50-8	25	GTNR25-8	M8	4.8 (42.5)
	MD520-2T30(B)(S)	106.0	112.0	3 x 70	GTNR70-8	35	GTNR35-8	M8	4.8 (42.5)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T8	MD520-2T37(B)(S)	139.0	150.0	3 x 95	GTNR95-12	50	GTNR35-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T45(S)	164.0	176.0	3 x 120	GTNR120-12	70	GTNR50-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T55(S)	196.0	210.0	3 x 150	BC150-12	95	GTNR70-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
T9	MD520-2T75(S)	287.0	304.0	3 x 240	BC240–12	120	BC120-12	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
T10	MD520-2T90(S)	365.0	377.0	2 x (3 x 150)	BC150-12	150	BC150-12	M12	35.0 (310.1)
	MD520-2T110(S)*	410.0	426.0	2 x (3 x 185)	BC185-12	185	BC150-12	M12	35.0 (310.1)
T11	MD520-2T132(S)*	441.0	465.0	2 x (3 x 240)	BC240-12	240	BC240-12	M12	35.0 (310.1)
T12	MD520-2T160(S)	565.0	585.0	2 x (3 x 300)	BC300-16	300	BC300-16	M16	85.0 (753.1)
	MD520-2T200(S)*	687.0	725.0	4 x (3 x 185)	BC185-16	2 x 185	BC185-16	M16	85.0 (753.1)

Note

<1>: Applicable to GB standards. For example, 3 x 10 indicates one 3-conductor 10 mm^2 cable; 2 x (3 x 120) indicates two 3-conductor 120 mm^2 cables. The preceding recommended lugs are the TNR, GTNR, and BC series lugs from Suzhou Yuanli.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; Ambient temperature of 40°C and cable surface temperature of 70°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The cables with the asterisk mark (*) must be connected through the copper busbar.
3. If the conditions are different, you need to select the model according to actual conditions.

Table 13–7 Cable selection (three-phase 200 V to 240 V, compliant with UL certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/kcmil)<2>	Recommended Cable Lug		
T1	MD520-2T0.4B(S)	2.4	2.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2T0.7B(S)	4.6	3.8	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2T1.1B(S)	6.3	5.1	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2T1.5B(S)	9.0	7.2	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
T2	MD520-2T2.2B(S)	11.4	9.0	12	TLK4-4	12	TLK4-4	M4	1.2 (10.6)
	MD520-2T3.7B(S)	16.7	13.0	10	TLK6-4	10	TLK6-4	M4	1.2 (10.6)
T3	MD520-2T5.5B(S)	32.2	25.0	8	TLK10-5	8	TLK10-5	M5	2.8 (24.8)
T4	MD520-2T7.5B(S)	41.3	32.0	6	TLK16-5	6	TLK16-5	M5	2.8 (24.8)
T5	MD520-2T11(B)(S)	59.0	45.0	4	TLK25-6	4	TLK25-6	M6	4.8 (42.5)
T6	MD520-2T15(B)(S)	57.0	60.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)
	MD520-2T18.5(B)(S)	69.0	75.0	2	TLK35-6	4	TLK25-6	M6	4.8 (42.5)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug	Recommended Cable (AWG/ kcmil)<2>	Recommended Cable Lug		
T7	MD520-2T22(B)(S)	89.0	91.0	1/0	TLK50-8	2	TLK35-8	M8	4.8 (42.5)
	MD520-2T30(B)(S)	106.0	112.0	3/0	TLK95-8	1/0	TLK50-8	M8	4.8 (42.5)
T8	MD520-2T37(B)(S)	139.0	150.0	4/0	TLK120-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T45(S)	164.0	176.0	300 kcmil	SQNBS150-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
	MD520-2T55(S)*	196.0	210.0	2x3/0	TLK95-12	3/0	TLK95-8	M12 (main power)	35.0 (310.1)
								M8 (grounding)	13.0 (115.2)
T9	MD520-2T75(S)*	287.0	304.0	2 x 300 kcmil	SQNBS150-12	300 kcmil	SQNBS150-10	M12 (main power)	35.0 (310.1)
								M10 (grounding)	20 (117)
T10	MD520-2T90(S)	365.0	377.0	2 x 350 kcmil	SQNBS180-12	350 kcmil	SQNBS180-12	M12	35.0 (310.1)
	MD520-2T110(S)*	410.0	426.0	2 x 400 kcmil	SQNBS250-12	400 kcmil	SQNBS250-12	M12	35.0 (310.1)
T11	MD520-2T132(S)*	441.0	465.0	2 x 500 kcmil	SQNBS250-12	500 kcmil	SQNBS250-12	M12	35.0 (310.1)
T12	MD520-2T160(S)*	565.0	585.0	4 x 300 kcmil	SQNBS150-12	2 x 300 kcmil	SQNBS150-12	M16	85.0 (753.1)
	MD520-2T200(S)*	687.0	725.0	4 x 400 kcmil	TLK240-16	2 x 400 kcmil	TLK240-16	M16	85.0 (753.1)

Note

<2>: Applicable to AWG standards, in which 8 represents 8AWG, 1/0 represents 0AWG, 3/0 represents 000AWG, and 4/0 represents 0000AWG; 2 x 300 kcmil represents two 300 kcmil cables. The preceding recommended cable lugs are TLK and SQNBS series lugs from KST.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; ambient temperature of 40°C and cable surface temperature of 75°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The recommended cables must meet requirements for 125% overload.
3. The cables with the asterisk mark (*) must be connected through the copper busbar.
4. If the conditions are different, you need to select the model according to actual conditions.

Table 13–8 Cable selection (single-phase 200 V to 240 V) (with CE certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (mm^2)<1>	Recommended Cable Lug	Recommended Cable (mm^2)<1>	Recommended Cable Lug		
T2	MD520-2S0.4B(S)	5.4	2.3	3 x 0.75	TNR1.25-4	0.75	TNR1.25-4	M4	1.2 (10.6)
	MD520-2S0.7B(S)	8.2	4.0	3 x 1.5	TNR1.25-4	1.5	TNR1.25-4		
	MD520-2S1.5B(S)	14.0	7.0	3 x 2.5	TNR2-4	2.5	TNR2-4		
	MD520-2S2.2B(S)	20.0	9.6	3 x 4	TNR3.5-4	4	TNR3.5-4		

Note

<1>: Applicable to GB standards. For example, 3 x 4 indicates one 3-conductor 4 mm^2 cable; 3 x 150 indicates one 3-conductor 150 mm^2 cables. The preceding recommended cable lugs are the TNR series lugs of Suzhou Yuanli.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; ambient temperature of 40°C and cable surface temperature of 70°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. If the conditions are different, you need to select the model according to actual conditions.

Table 13–9 Cable selection (single-phase 200 V to 240 V) (with UL certification)

Structure	Drive Model	Rated Input Current (A)	Rated Output Current (A)	R/S/T, U/V/W		Grounding Cable		Screw	Tightening Torque (N·m) (lb.in)
				Recommended Cable (AWG)<2>	Recommended Cable Lug	Recommended Cable (AWG)<2>	Recommended Cable Lug		
T2	MD520-2S0.4B(S)	5.4	2.3	14	TLK2.5-4	14	TLK2.5-4	M4	1.2 (10.6)
	MD520-2S0.7B(S)	8.2	4.0	14	TLK2.5-4	14	TLK2.5-4		
	MD520-2S1.5B(S)	14.0	7.0	12	TLK4-4	12	TLK4-4		
	MD520-2S2.2B(S)	23.0	9.6	10	RNBL5-4	10	RNBL5-4		

Note

<2>: Applicable to AWG standards; 14 represents 14AWG and 12 represents 12AWG. The preceding recommended cable lugs are TLK and RNB series lugs from KST.

Note:
1. Observe national or regional regulations during selection. The cables recommended in the preceding table meet the following conditions: PVC insulation and copper conductor; ambient temperature of 40°C and cable surface temperature of 75°C (When the ambient temperature exceeds 40°C, contact Inovance); Cable layout type E is adopted (see IEC 60204-1).
2. The recommended cables must meet requirements for 125% overload.
3. If the conditions are different, you need to select the model according to actual conditions.

Recommended Lug

The following table describes recommended lugs, namely, the TNR, GTNR, and BC series lugs of Suzhou Yuanli. The lugs with UL certifications are TLK and SQNBS series lugs of KST.

Table 13–10 Appearances, models, and dimensions of TNR series lugs (unit: mm)

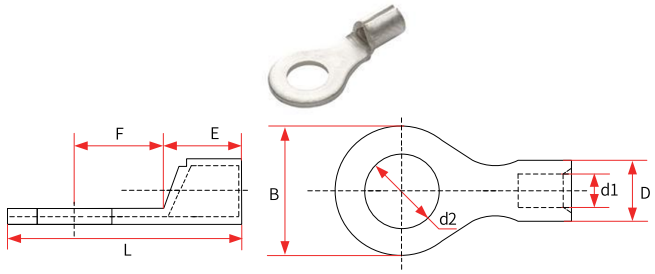
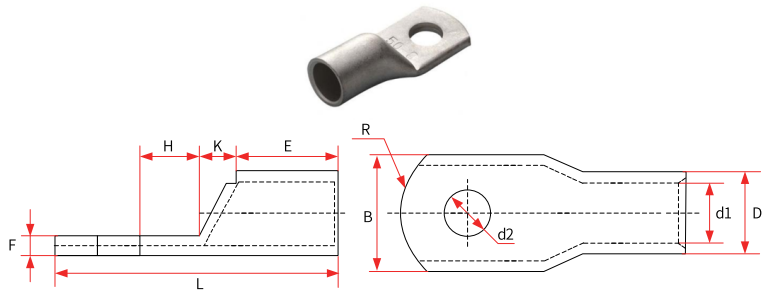
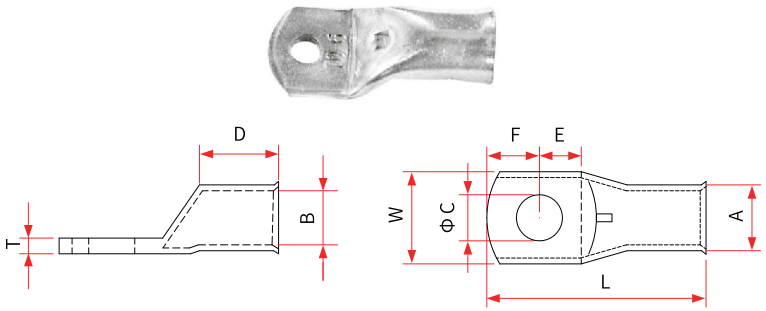
Model	Cable Specification		D	d1	E	F	B	d2	L	Current (A)	Crimping Pliers
	AWG/ MCM	mm^2									
											
TNR0.75-4	22–16	0.25-1.0	2.8	1.3	4.5	6.6	8.0	4.3	15.0	10	RYO-8
TNR1.25-4	22–16	0.25-1.65	3.4	1.7	4.5	7.3	8	5.3	15.8	19	AK-1M

Table 13–11 Appearances, models, and dimensions of GTNR series lugs (unit: mm)

Model	D	d1	E	H	K	B	d2	F	L	R	Crimping Pliers
											
GTNR1.5-5	4.0	2.2	5.0	5.0	2.0	8.0	5.3	1.0	16.0	5	RYO-8
GTNR2.5-4	4.5	2.9	7.0	5.0	2.0	8.0	4.3	1.0	18.0	5	YYT-8
GTNR2.5-5	4.5	2.9	7.0	6.0	2.0	8.0	5.3	1.0	20.0	7	RYO-14
GTNR2.5-6	4.5	2.9	7.0	6.0	2.0	10.2	6.4	0.8	20.0	7	
GTNR4-5	5.2	3.6	7.0	6.0	2.0	10.0	5.3	1.0	20.0	7	
GTNR4-6	5.2	3.6	7.0	6.0	2.0	10.0	6.4	1.0	20.0	7	
GTNR6-5	6.0	4.2	9.0	6.0	3.0	10.0	5.3	1.2	23.0	7	
GTNR6-6	6.0	4.2	9.0	7.5	3.0	10.0	6.4	1.2	26.0	7	
GTNR6-8	6.0	4.2	9.0	7.5	3.0	12.0	8.4	1.0	26.0	7	
GTNR10-6	7.0	5.0	9.0	8.0	3.5	12.4	6.4	1.3	26.5	7	
GTNR10-8	7.0	5.0	9.0	8.0	3.5	12.4	8.4	1.3	27.5	7	
GTNR16-6	7.8	5.8	12.0	8.0	4.0	12.4	6.4	1.3	31.0	7	CT-38
GTNR16-8	7.8	5.8	12.0	8.0	4.0	12.4	8.4	1.3	31.0	7	CT-100
GTNR25-6	9.5	7.5	12.0	8.0	4.5	14.0	6.4	2.0	32.0	10	
GTNR25-8	9.5	7.5	12.0	9.0	4.5	15.5	8.4	1.6	34.0	10	
GTNR25-10	9.5	7.5	12.0	10.5	4.5	17.5	10.5	1.4	37.0	10	
GTNR35-6	11.4	8.6	15.0	9.0	5.0	15.5	6.4	2.8	38.0	10	
GTNR35-8	11.4	8.6	15.0	9.0	5.0	15.5	8.4	2.8	38.0	10	
GTNR35-10	11.4	8.6	15.0	10.5	5.0	17.5	10.5	2.5	40.5	10	
GTNR50-8	12.6	9.6	16.0	11.0	6.0	18.0	8.4	2.8	43.5	10	CT-100
GTNR50-10	12.6	9.6	16.0	11.0	6.0	18.0	10.5	2.8	43.5	10	
GTNR70-8	15.0	12.0	18.0	13.0	7.0	21.0	8.4	2.8	50.0	14	
GTNR70-10	15.0	12.0	18.0	13.0	7.0	21.0	10.5	2.8	50.0	14	
GTNR70-12	15.0	12.0	18.0	13.0	7.0	21.0	13.0	2.8	50.0	14	
GTNR95-10	17.4	13.5	20.0	13.0	9.0	25.0	10.5	3.9	55.0	14	
GTNR95-12	17.4	13.5	20.0	13.0	9.0	25.0	13.0	3.9	55.0	14	

Model	D	d1	E	H	K	B	d2	F	L	R	Crimping Pliers
GTNR120-12	19.8	15.0	22.0	14.0	10.0	28.0	13.0	4.7	60.0	16	RYC-150
GTNR120-16	19.8	15.0	22.0	16.0	10.0	28.0	17.0	4.7	64.0	16	
GTNR150-12	21.2	16.5	26.0	16.0	11.0	30.0	13.0	4.7	69.0	24	
GTNR150-16	21.2	16.5	26.0	16.0	11.0	30.0	17.0	4.7	69.0	24	
GTNR185-16	23.5	18.5	32.0	17.0	12.0	34.0	17.0	5.0	78.0	24	
GTNR240-16	26.5	21.5	38.0	20.0	14.0	38.0	17.0	5.5	92.0	24	
GTNR240-20	26.5	21.5	38.0	20.0	14.0	38.0	21.0	5.5	92.0	24	

Table 13–12 Appearance, models, and dimensions of BC series cable lugs (unit: mm)

Model	A	B	W	E	D	L	T	C	F
									
120-8	19.0	15.0	27.2	16.5	27.0	73.0	4.0	8.5	16.5
120-10								10.5	
120-12								12.8	
120-14								14.7	
120-16								16.7	
120-20				18.8				20.7	14.3
150-8	21.0	16.5	30.0	16.5	27.0	78.0	4.5	8.5	16.5
150-10								10.5	
150-12								12.8	
150-14								14.7	
150-16								16.7	
150-20				18.8				20.7	14.3
185-10	23	18.5	33.5	16.5	30	82	4.5	10.5	16.5
185-12								12.8	
185-14								14.7	
185-16								16.7	
185-20				18.8				20.7	14.3
240-10	26	21	37.7	18.0	32.0	88.0	5.0	10.5	17.0
240-12								12.8	
240-14								14.7	
240-16								16.7	
240-20								20.7	

Model	A	B	W	E	D	L	T	C	F
300-10	28.0	23.0	41.0	18.0	37.0	97.0	5.0	10.5	17.0
300-12								12.8	
300-14								14.7	
300-16								16.7	
300-20								20.7	

13.3.4 Wiring Descriptions of Main Circuit Terminals

This section specifies requirements on wiring of main circuit terminals. For requirements on selection, routing, and wiring of main circuit cables, see *"13.3.5 Requirements on Main Circuit Wiring" on page 271*.

To prevent accidents caused by short circuit, install a fuse on the input side of the drive. For requirements and selection of fuses at the input side, see "Conditions for Compliance with the LVD" in the *MD520 Series General-Purpose AC Drive Hardware Guide*.

R, S, and T terminals of the input power supply

- The cable connection on the input side of the drive has no requirements on the phase sequence.
- The specification and installation method of external main circuit cables must comply with local regulations and related IEC standards.
- Use proper copper drain wires for main circuit cables according to the recommended values.

DC bus (+), (-)

- After the drive is switched off, DC bus terminals (+) and (-) have residual voltage. After the CHARGE indicator goes off, wait at least 10 minutes before operating the drive. Failure to comply will result in electric shock.
- When wiring an external braking component for a model with the power of 90 kW or above, ensure correct polarity (+)/(-). Failure to comply will result in damage to the AC drive and braking components or even fire.
- The cable length of the braking unit cannot exceed 10 m. Use the twisted pair cables or closely-paired cables for parallel connection.
- Avoid connecting the braking resistor directly to the DC bus. Failure to comply will result in damage to the AC drive or even fire.

U, V, and W terminals on the output side

- The specification and installation method of external main circuit cables must comply with the local regulations and related IEC standards.
- Use copper lead cables with appropriate dimensions for main circuit cables.
- Do not connect any capacitor or surge protection device at the output side. Failure to comply will result in malfunction or even damage to the AC drive.
- An excessively long motor cable may result in electrical resonance due to the distributed capacitance. The generated electrical resonance may cause damage to motor insulation or high

leakage current, triggering the overcurrent protection mechanism of the AC drive. When using a motor cable longer than 100 m, install an AC output reactor close to the AC drive.

Grounding terminal (PE)

For grounding requirements, see *"13.5.1 Grounding Requirement" on page 292*.

13.3.5 Requirements on Main Circuit Wiring

Main circuit wiring requirements

- Terminals BR, (-), and (+) are used to connect options. Avoid connecting these terminals to an AC power supply.
- To protect the main circuit, separate it from all surfaces that may come into contact with it and provide covers as required.
- The control circuit is the internal safety extra-low voltage (SELV) circuit, which must be insulated and isolated from other circuits. Make sure that the control circuit is connected to an external SELV circuit.
- Prevent foreign matters from entering the wiring part of the terminal block.
- Do not solder the twisted conductors.
- The tightening torque may vary with terminals. Tighten terminal screws with the specified tightening torque. You can use the torque screwdriver, ratchet, or wrench.
- When using an electric screwdriver to tighten terminal screws, set a low speed to prevent damage to the terminal screws.
- Tighten the terminal screws at an angle within 5 degrees. Failure to comply may result in screw damage.

Power cable selection requirements

For selection of power cables, follow national or regional regulations. Select IEC cables based on the following requirements:

- Compliant with EN 60204-1 and IEC 60364-5-52 standards.
- PVC insulated cables with copper conductors
- Ambient temperature of 40°C and cable surface temperature of 70°C (Remark: When the ambient temperature exceeds 40°C, contact Inovance.)
- Symmetrical cable with copper mesh shield

Note

If the recommended cables for peripheral equipment or options are not suitable for the product, contact Inovance.

Use shielded cables to comply with the EMC requirements. The shielded cables are divided into three-conductor cables and four-conductor cables, as shown below. If the conductivity of the three-conductor cable shield cannot meet requirements, add an independent PE cable. Alternatively, use a four-conductor cable with one conductor as the PE cable. The shield of the shielded cable is comprised of coaxial cooper braids to suppress radio frequency interference. To enhance the shielding performance and conductivity, the braided density of the shield must be greater than 90%.

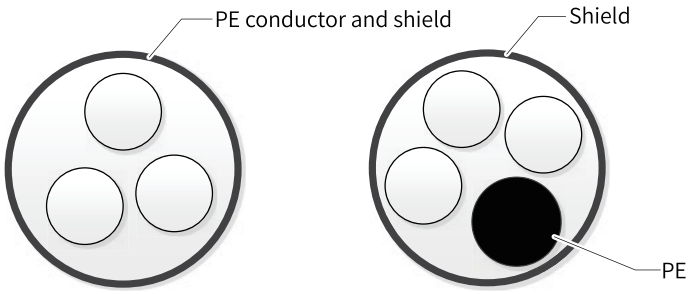


Figure 13-29 Recommended power cable

Requirements on main circuit routing

The power supply input cable of the AC drive and motor cable can generate strong electromagnetic interference. To avoid electromagnetic interference caused by long-distance parallel coupling between the strong disturbing cable and control circuit cable, ensure a distance longer than 30 cm between main circuit cables and signal cables when cabling. Common main circuit cables include input R/S/T cables, output U/V/W cables, DC buses, and braking cables. Signal cables include I/O signal cables, communication cables, and encoder cables.

Cable ducts must be in good connection and well grounded. Use aluminum cable ducts to ensure equipotentiality of the device. Connect the filter, AC drive, and motor to the system (machines or devices) properly. Protect all connections with spray coating and ensure good contact of conductive metal.

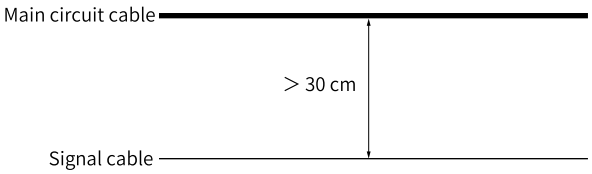


Figure 13-30 Cable layout

Wiring in an IT or delta grid system

Danger

Before wiring in an IT or angular grid system, disconnect the optional EMC grounding screw. Failure to comply will result in damage to the AC drive or even personal injury.

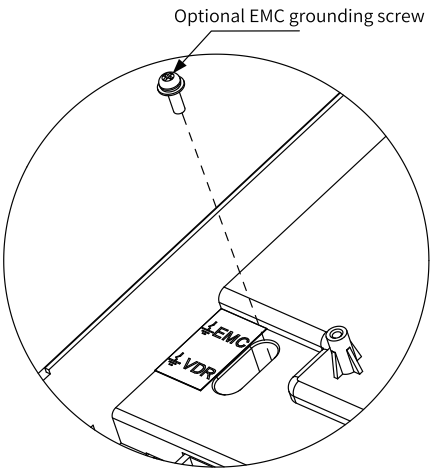


Figure 13-31 Disconnecting the optional EMC grounding screw

Shield of motor cables

Use shielded cables for motor output cables. Strip the cable to expose the shield, crimp the shield to the wire ferrule slot of the bracket with the wire ferrule, and crimp the lead wire of the shield to the PE terminal, as shown below. The following figure shows wiring of the shield.

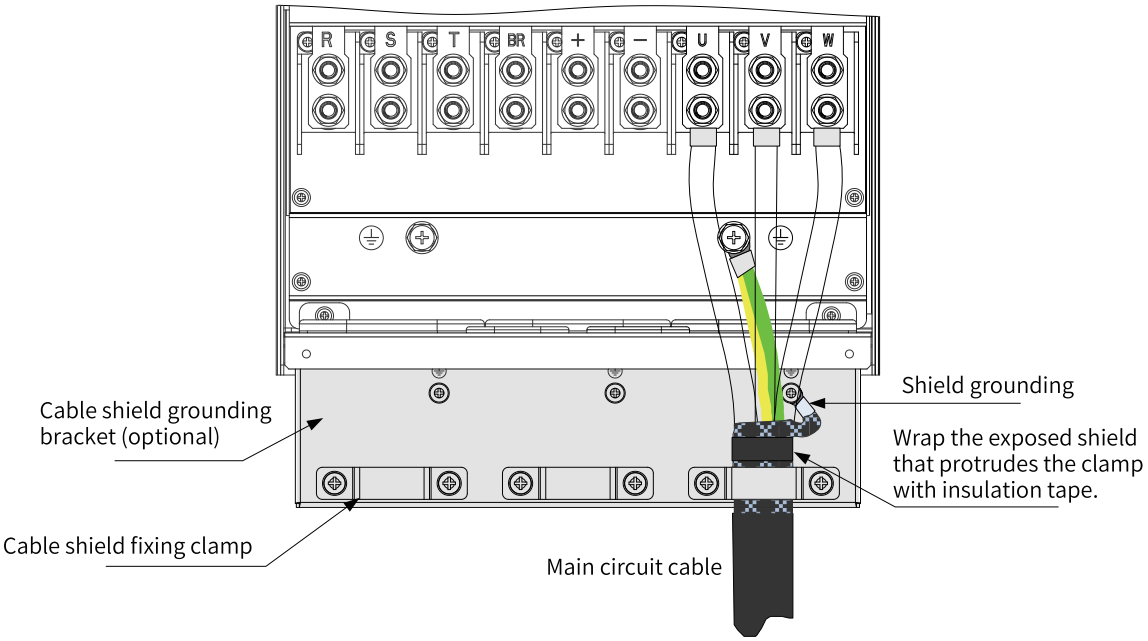


Figure 13-32 Wiring of the shield

Keep the drain wire of the motor cable shield as short as possible, with its width (b in the following figure) no shorter than 1/5 of its length (a in the following figure).

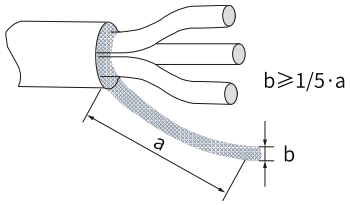


Figure 13-33 " " Lead wire of the motor cable shield

Length of motor cables

When the AC drive is working, the quick on-off of its power switch triode can lead to excessively large dU/dt at the output side. If the motor cable is too long, the motor winding will experience excessive voltage stress that may cause insulation breakdown. Use motors that comply with technical specifications in IEC 60034-25 IVIC B or motors with high voltage resistance. In addition, when the cable length increases, the distributed capacitance of the cable increases linearly, resulting in high harmonic current.

When the length of the motor cable is longer than the maximum length recommended in the following table, install an output reactor on the output side of the AC drive, or use a motor conforming to technical specifications in IEC 60034-25 IVIC B. The output reactor can reduce the voltage stress on the motor winding.

Table 13–13 Requirement for output reactor based on cable length and motor types

AC Drive Rated Power (kW)	Maximum Cable Length of the Common Asynchronous Motor (Without Output Reactor) (m)	Output Reactor Required (Motor Complying with IEC 60034-25 IVIC B)	Output Reactor Required (Common Asynchronous Induction Motor)
0.4–3.7	50	Not required	Required
5.5	70	Not required	Required
7.5	100	Not required	Required
11	110	Not required	Required
15	125	Not required	Required
18.5	135	Not required	Required
22	150	Not required	Required
⩾ 30	150	Not required	Required

Recommended terminal

The following table describes the appearances of the GTNR and BC series cable lugs of Suzhou Yuanli.

Table 13–14 Appearance of cable lugs

Series	Appearance
GTNR series	
TNR series	
BC series	

13.3.6 Protection Requirements

Requirements for protection of main circuit cables

Use the heat-shrinkable tube to wrap the copper tube of the main circuit cable terminal and the cable conductor and ensure the conductor is completely wrapped, as shown in *"Figure 13–34 Cable conductor with the heat-shrinkable tube" on page 275*.

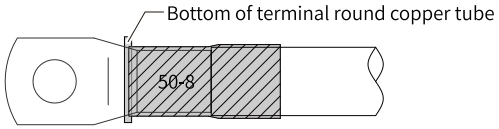


Figure 13-34 Cable conductor with the heat-shrinkable tube

Requirements on upstream protection device

- Install proper protection devices on the power supply input side to provide isolation functions and functions against overcurrent and short circuit.
- When selecting the protective devices, take the main circuit cable current capacity, system overload capacity, and short circuit capacity of upstream power distribution into account. The recommended values in the selection guide of peripheral components apply to most of applications.

13.4 Control Circuit Connection

13.4.1 Descriptions of Control Circuit Terminals

"Table 13–17" on page 278 shows the layout of control circuit terminals.

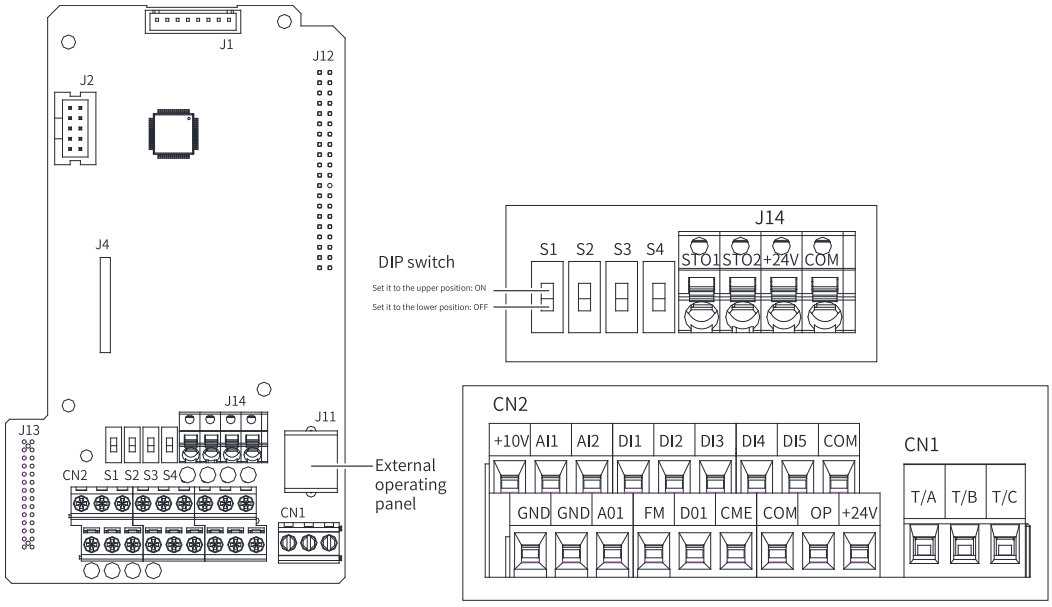


Figure 13-35 Layout of control circuit terminals

Table 13–15 Function description of control circuit terminals

Type	Terminal Mark	Terminal Name	Function Description
Power supply	+10V-GND	External +10 V power supply	The terminal is used to provide +10 V power supply to an external unit with the maximum output current of 10 mA. Generally, it is used to power an external potentiometer with resistance ranging from 1 kΩ to 5 kΩ.
	+24V-COM	External +24 V power supply	The terminal is used to provide +24 V power supply to external devices. Generally, it is used to power the DIs/DOs and external sensor. The maximum output current is 200 mA[Note 1].
	OP	Input terminal for external power supply	It is connected to +24V by default. When DI1 to DI5 are driven by external signals, OP must be disconnected from +24 V and connected to the external power supply.
Analog input	AI1-GND	AI1	Input voltage range: -10 VDC to +10 VDC Input impedance: 22 kΩ
	AI2-GND	AI2	The terminal supports voltage input (default), current input, and temperature input. When used as voltage/current input, the terminal supports 0 V to 10 V, -10 V to +10 V, or 0 mA to 20 mA, and supports 12-bit resolution and the correction accuracy of 1%. The input impedance is 22 kΩ for voltage input and 500 Ω or 250 Ω for current input, which is set by S2 and S3 DIP switches[Note 2].

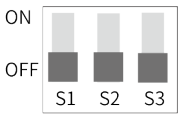
Type	Terminal Mark	Terminal Name	Function Description
Digital input	DI1-OP	DI1	Photocoupler isolation, compatible with dual-polarity input. Input impedance: 1.72 kΩ Operating voltage range: 9 V to 30 V
	DI2-OP	DI2	
	DI3-OP	DI3	
	DI4-OP	DI4	
	DI5-OP	DI5	Besides features of DI1 to DI4, DI5 can also be used for high-speed pulse input. Input impedance: 1.16 kΩ Maximum input frequency: 100 kHz Operating voltage range: 15 V to 30 V
Analog output	AO1-GND	Analog output 1	The DIP switch on the control board is used to determine voltage output (default) or current output. Output voltage range: 0 V to 10 V Output current range: 0 mA to 20 mA
Digital output	DO1-CME	Digital output 1	Optocoupler isolation; dual-polarity open collector output Output voltage range: 0 V to 24 V Output current range: 0 mA to 50 mA Note that digital output ground CME and digital input ground COM are internally insulated, but are shorted externally by jumper as the factory settings. In this case, DO1 is driven by +24V by default. To drive DO1 by external power supply, remove the jumper between CME and COM.
	FM-COM	High-speed pulse output	The terminal is set by F5-00 (FM terminal output selection). When the terminal is used for high-speed pulse output, the maximum frequency is 100 kHz. When the terminal is used for collector open output, it has the same specifications as DO1.
Relay output	T/A	Common terminal	Driving capacity of the contact: 250 VAC, 3 A, COS Ø = 0.4 30 VDC, 1 A
	T/B	Normally closed (NC) terminal	
	T/C	Normally open (NO) terminal	
Auxiliary interface	J4	Local PG card interface	It is used to connect the resolver, ABZ incremental encoder, 23-bit encoder, and sin-cos encoder.
	J11	External operating panel interface	It is used to connect the external LCD operating panel (SOP-20) or the LED operating panel (MDKE-10).
	J13	Expansion card interface	28-core terminal used to connect to expansion cards, including I/O cards, communication cards, and PG card
	J14	Safety function terminal	For details, see *"Table 13–16 STO terminal description" on page 278*.
DIP switch	S1		For details, see *"Table 13–17 DIP switch descriptions" on page 278*.
	S2		
	S3		
	S4		Current/Voltage mode selection for AO1 On: Current output mode Off: Voltage output mode

Table 13–16 STO terminal description

No.	Terminal Mark	Terminal Name	Performance Requirement
1	STO1	STO channel 1	Internal: STO1 and STO2 are connected to +24V by jumpers by default. External: You can connect STO1 and STO2 to the COM terminal. For detailed wiring methods, see the STO function.
2	STO2	STO channel 2	
3	+24V	STO channel 1 and STO channel 2 power supply+	
4	COM	Power supply ground of STO channel 1 and STO channel 2	

Table 13–17 DIP switch descriptions

DIP Switch Status			Description
S1	S2	S3	
OFF	OFF	OFF	Voltage mode with the range of 0 VDC to 10 VDC for AI2
ON	OFF	OFF	Temperature mode for AI2 Set the temperature sensor type through F9-75. 0: No temperature sensor (AI used for analog input) 1: PT100 temperature detection input signal, -25°C to 200°C, accuracy: ±8°C 2: PT1000 temperature detection input signal, -25°C to 200°C, accuracy: ±8°C 3: KTY84-130 temperature detection input signal, -40°C to 260°C, accuracy: ±15°C 4: PTC130 temperature detection input signal, -20°C to 180°C, accuracy: ±15°C
OFF	ON	OFF	Current mode for AI2; current range: 0 mA to 20 mA; input impedance: 500 Ω
OFF	ON	ON	Current mode for AI2; current range: 0 mA to 40 mA; input impedance: 250 Ω

Note

- [Note 1]: If the ambient temperature exceeds 23°C, the output current must be derated by 1.8 mA for every additional 1°C. The maximum output current is 170 mA at 40°C. When OP and +24V are shorted, the maximum output current is calculated by the following formula: 170 mA minus current over the DI.
- [Note 2]: Based on the maximum output voltage of the signal source, select impedance of 500 Ω or 250 Ω. For example, if 500 Ω is selected, the maximum output voltage cannot be lower than 10 V so that AI2 can measure 20 mA current.
- S1, S2, and S3 are DIP switches used together for the AI. S4 is the DIP switch for the AO.

13.4.2 Wiring Descriptions of Control Circuit Terminals

Wiring of AI1

Weak analog voltage signals are prone to suffer external interference. Therefore, a shielded cable is required, and the wiring distance must be as short as possible (no longer than 20 m), as shown in *"Figure 13–36 AI wiring" on page 279*. In scenarios where analog signals experience severe external interference, install a filter capacitor or a ferrite core on the analog signal source, as shown in *"Figure 13–37 Grounding the shield of the analog input cable" on page 279*. Connect the lead wire of the AI shield to the PE terminal of the AC drive.

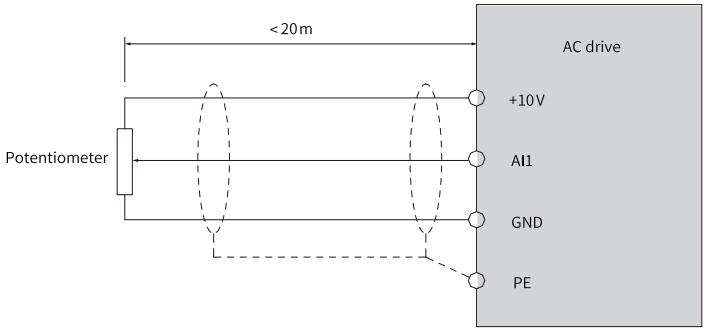


Figure 13-36 AI wiring

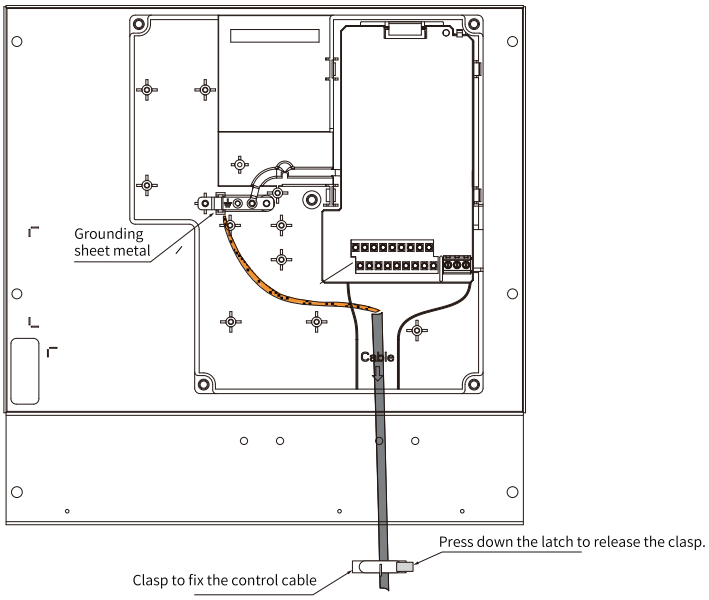


Figure 13-37 Grounding the shield of the analog input cable

Wiring of AI2

- If the AI2 is to be used for voltage signal input, wire it in the same way as that for the AI1.
- If the AI2 is used for current signal input, the current flows to AI2. Toggle S2 (or S2 and S3) to ON. If only S2 is toggled to ON, the impedance is 500 Ω. If both S2 and S3 are toggled to ON, the impedance is 250 Ω.

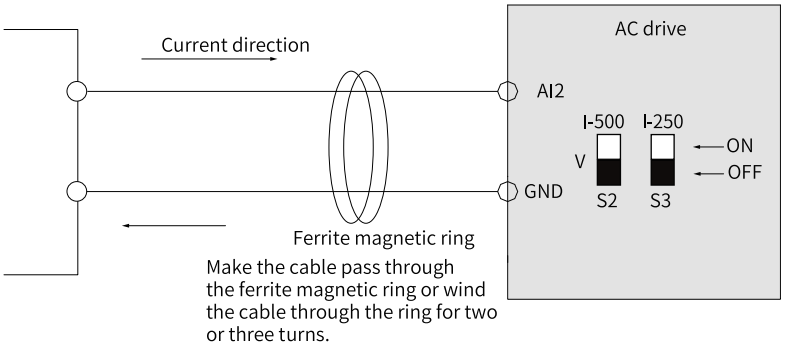


Figure 13-38 Wiring of AI2

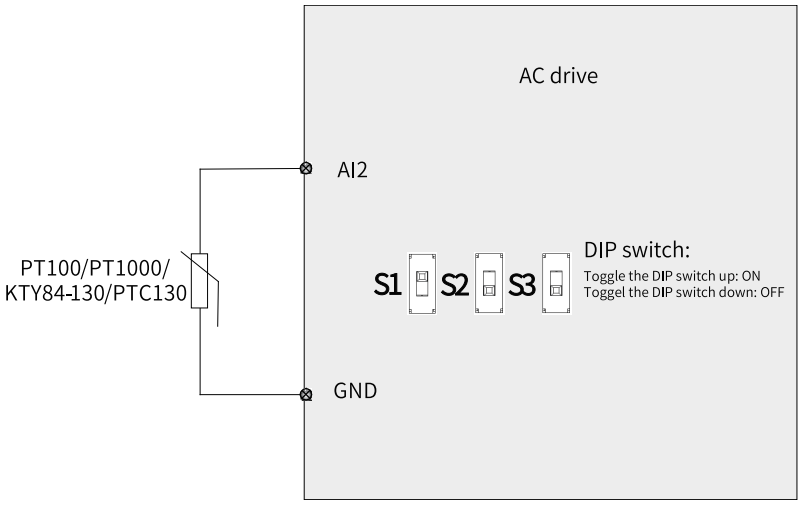


Figure 13-39 Wiring when the AI2 is used for temperature input

Wiring of DI1 to DI5

- Sink wiring mode

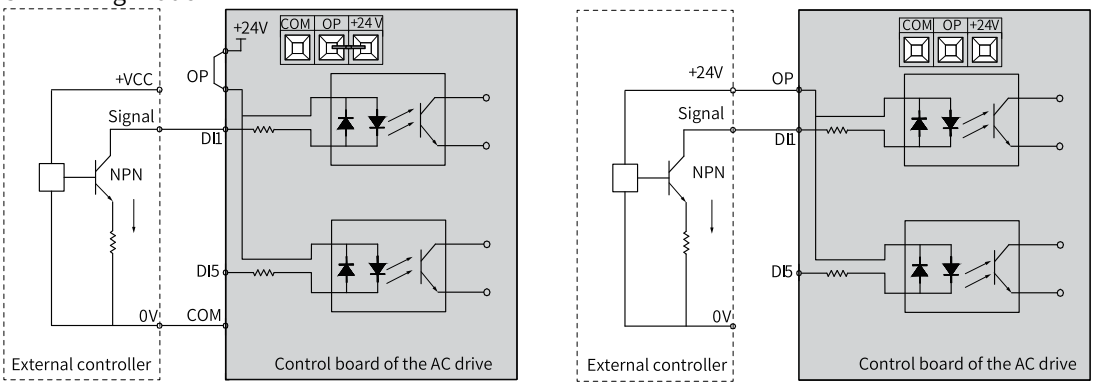


Figure 13-40 Sink wiring mode

The internal 24 V power supply of the drive is the most commonly wiring method. In the sink wiring mode, short the OP and 24V terminals of the drive, and connect the COM terminal of the drive to the 0V terminal of the external controller, as shown in the following figure.

If an external 24 V power supply is used, remove the jumper between +24V and OP. In addition, connect the 24 V positive electrode of the external power supply to the OP terminal. The current flows out of the DI and flows back to 0V of the external power supply via the external controller contact.

In the mode, the DIs of different AC drives cannot be connected in parallel. Otherwise, the DI may malfunction. If DIs of different AC drives must be connected in parallel, connect the anode of a diode to the DI in series and the diode needs to satisfy the following requirement: IF > 40 mA and VR > 40 V, as shown in *"Figure 13–41 Parallel connection of DIs of multiple AC drives in the sink mode" on page 281*.

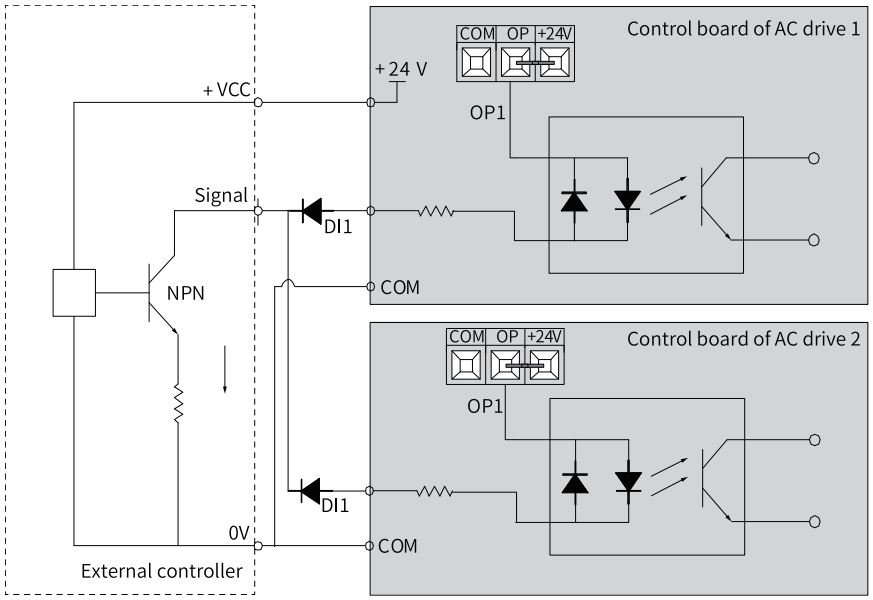


Figure 13-41 Parallel connection of DIs of multiple AC drives in the sink mode

- Source wiring mode

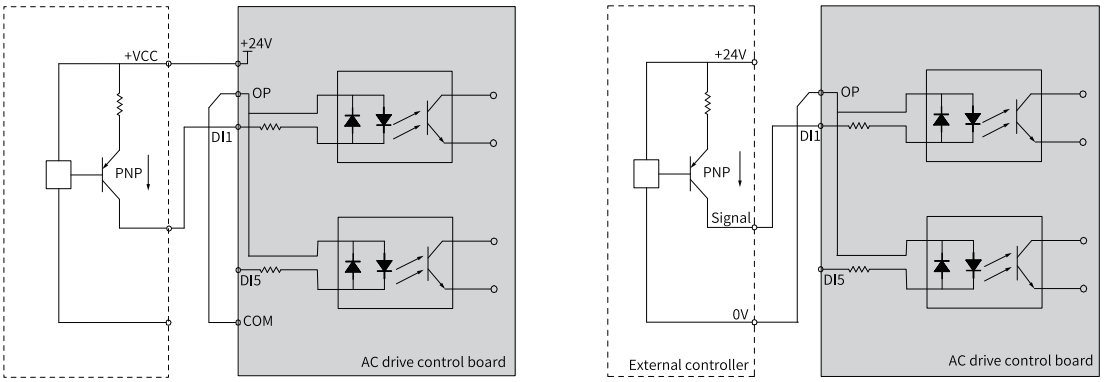


Figure 13-42 Source wiring mode

- To use the internal 24 V power supply of the drive, remove the jumper between the +24V and OP terminals, connect the OP terminal to the COM terminal, and connect the +24V terminal of the drive to the common terminal of the external controller, as shown in the following figure.
- To use an external power supply, remove the jumper between the +24V and the OP terminals, connect the OP terminal of the drive to the 0V terminal of the external power supply, and connect the 24 V positive electrode of the external power supply to the corresponding DI through the external controller contact.

Wiring of DO1

When the DO needs to drive a relay, connect a snubber diode on both sides of the relay coil. Otherwise, the 24 VDC power supply may be damaged. Ensure that the driving capacity does not exceed 50 mA.

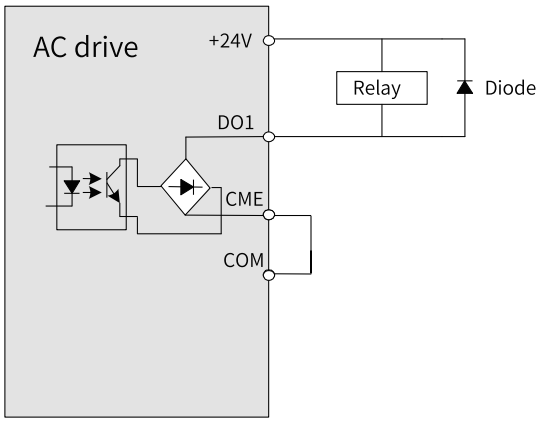


Figure 13-43 Wiring between DO and relay

Note

- Connect the snubber diode with the polarity placed correctly. Otherwise, the 24 VDC power supply will be damaged upon the DO output.
- The digital output ground CME and digital input ground COM are internally insulated, but are shorted externally by jumper as the factory settings. In this case, DO1 is driven by +24V by default. To drive DO1 by external power supply, remove the jumper between CME and COM.

DO1: Photocoupler isolation and bipolar open collector output

Output voltage range: 0 V to 24 V

Output current range: 0 mA to 50 mA

DO1 supports bipolar output. The following wiring methods are available.

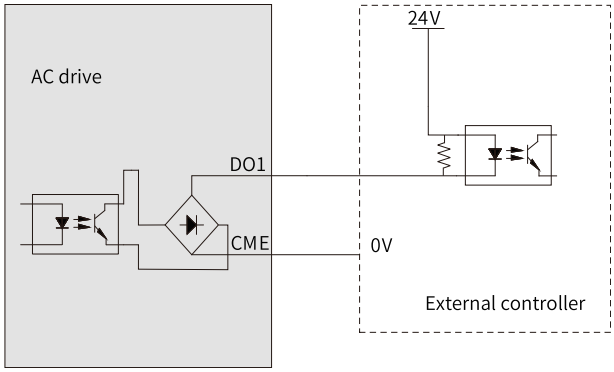


Figure 13-44 DO connecting to external controller 1

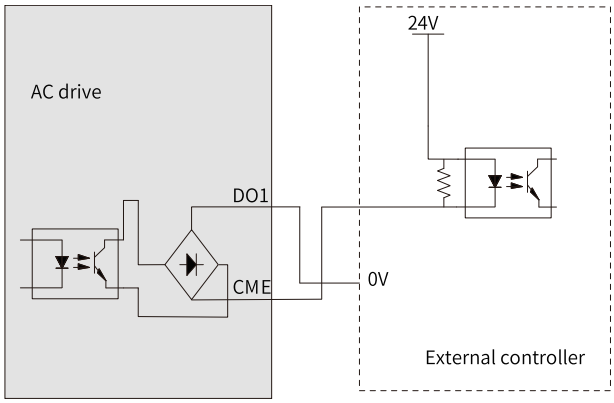


Figure 13-45 DO connecting to external controller 2

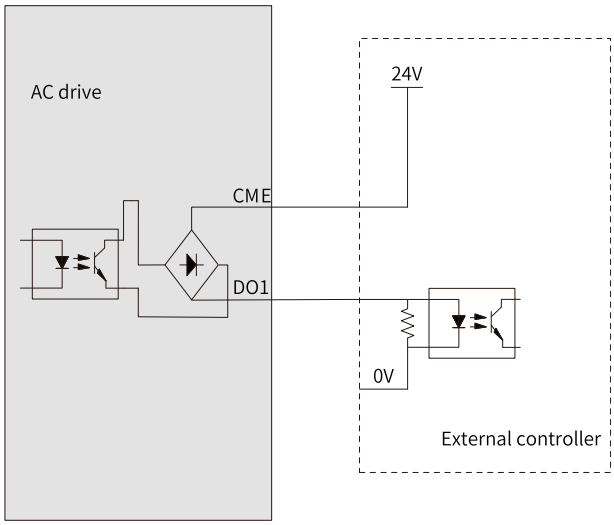


Figure 13-46 DO connecting to external controller 3

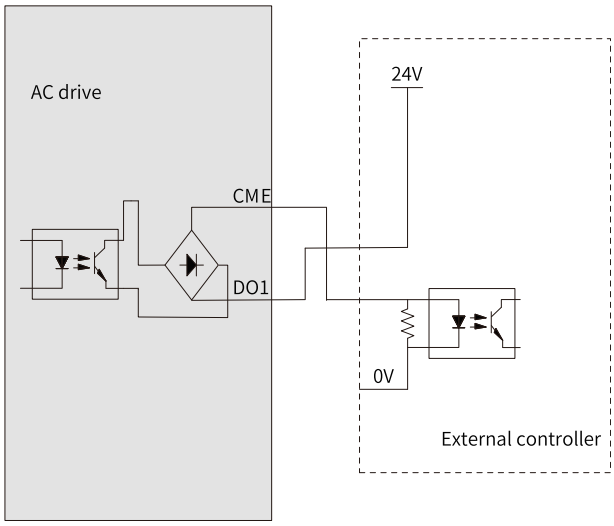


Figure 13-47 DO connecting to external controller 4

Wiring of the high-speed digital output terminal FM

When the FM terminal is used for FMP continuous pulse output, the allowed maximum frequency is 100 kHz.

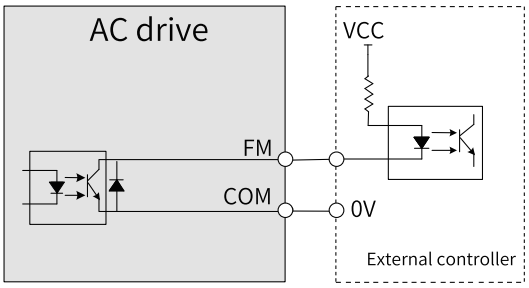


Figure 13-48 Wiring of the high-speed digital output terminal

Wiring of the relay output terminal

The inductive load (relay, contactor, and motor) causes voltage peak after the current is disconnected. To minimize the interference at cutoff, use a voltage dependent resistor (VDR) at the relay contact for protection and install absorption circuits such as VDRs, RC absorption circuits, and diodes on the inductive load, as shown in *"Figure 13–49 Anti-interference treatment for relay output terminals" on page 284*.

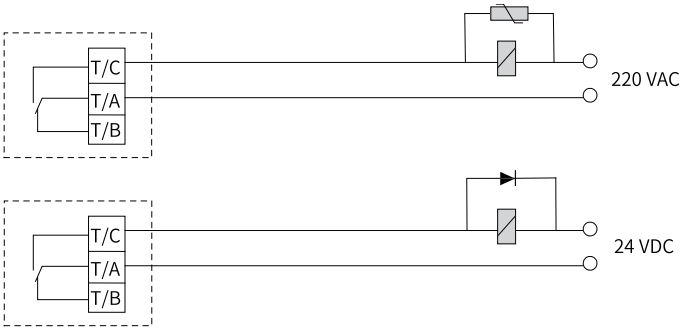


Figure 13-49 Anti-interference treatment for relay output terminals

Note

The power supply connected with the control circuit must use class 2 power supply; otherwise, the operation performance of the AC drive will be degraded.

Requirements on tubular terminals

Use tubular terminals with insulation sheath. Keep the exposed conductor of a single-conductor or twisted-pair cable no longer than 6 mm, as shown in *"Figure 13–50 Requirements on tubular terminals of the control circuit cable" on page 284*.

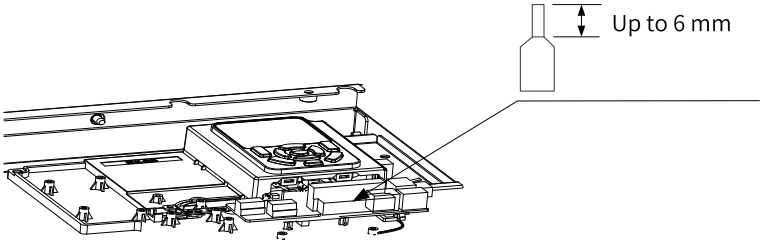


Figure 13-50 Requirements on tubular terminals of the control circuit cable

Table 13–18 Control circuit cable specifications

Single-Conductor Cable mm² (AWG)	Twisted-Pair Cable mm² (AWG)	Tightening Torque (N · m)
0.2 to 0.75 (18AWG to 24AWG)	0.75 mm	0.565

Wiring for connecting an external operating panel

To use an external operating panel, connect one end of the connecting cable to the RJ45 port of the AC drive, and lead the other end of the cable from either side of the AC drive, as shown in *"Figure 13–51 Wiring for connecting an external operating panel" on page 285*.

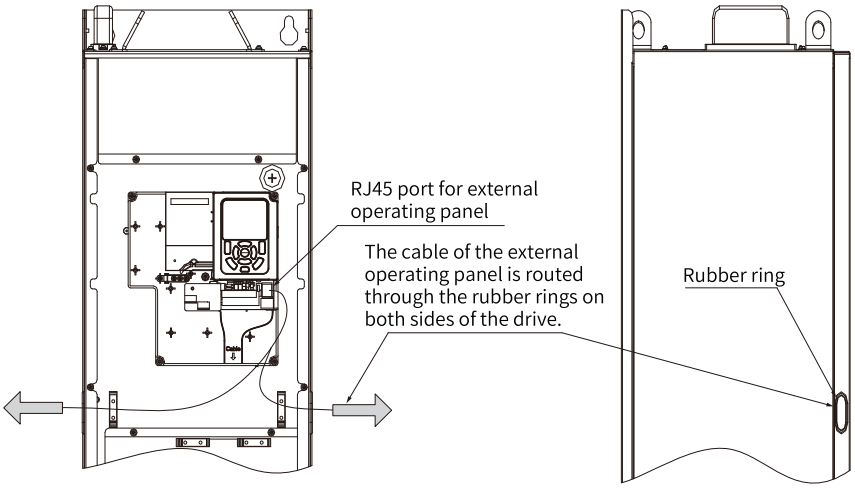
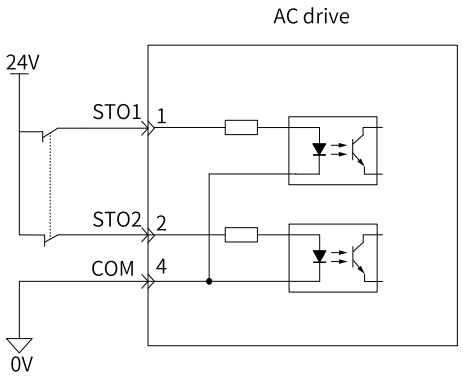


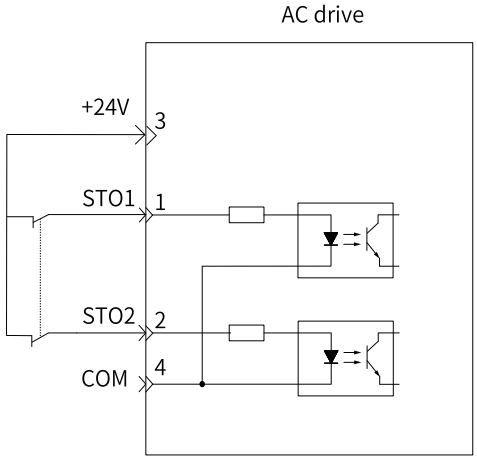
Figure 13-51 Wiring for connecting an external operating panel

STO wiring example

- Wiring example when the external 24 V is used



- Wiring example when the internal 24 V is used



Note

EMC Requirements

- To avoid short circuit between adjacent conductors, use shielded cables and connect the shield to the protective ground. Alternatively, use flat cables and connect a ground cable between adjacent signal conductors.
- Use cables that contain twisted pairs with dual shield layers or single shield layer.
- Fix and ground the cable protective cover using a piece of conductive metal.
- The maximum cable length allowed between the drive and safety switch is 30 m.

13.4.3 Requirements on Control Circuit Wiring

Note

Wire the control circuit cable according to EN 60204-1.

Selection requirements

To ensure that the control circuit will not be interfered by peripheries, use shielded cables with the shield for signal cables, and connect both ends of the shield to the drive 360 degrees with the shield bracket. Use separate shielded cables for different analog signals. It is recommended to use shielded twisted pair (STP) cables for digital signals.

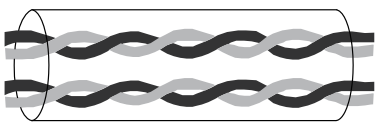


Figure 13-52 Shielded twisted pair cable

Requirements on shield grounding for analog terminals

Weak analog voltage signals are prone to suffer external interference. Therefore, a shielded cable is required, and the wiring distance must be as short as possible (no longer than 20 m). In applications where certain analog signals are subject to severe interference, install a filter capacitor or ferrite core on the analog signal source side.

- It is recommended to use the grounding bracket (optional) together with the shielded cable, so that the cable shield can be grounded 360 degrees.
- Minimize the length of the lead wire of the shield. Fasten the lead wire to the standard grounding copper busbar of the AC drive by using screws. The following figure shows the grounding.

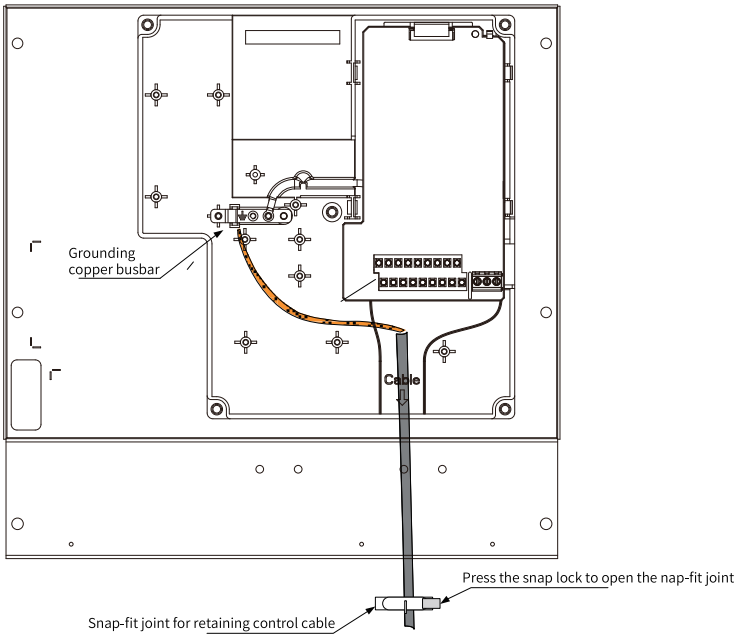


Figure 13-53 Grounding the shield of the analog input cable

Requirements on wiring of encoder signal cables

Before inserting a PG card, remove the screws shown in the enlarged area in the following figure, align the PG card with the three fixing pillars (left part of the enlarged area), and fix the PG card with M3 x 8 screws.

The entire AC drive is grounded in structure. When wiring the encoder after PG card installation, connect the drain wire of the shield of the encoder signal cable to the PE terminal of the PG card to complete shield grounding of the signal cable. Requirements for connecting the encoder cable:

- Route the encoder cable and power cable through different routes during installation and commissioning. Failure to comply will result in disturbance to the encoder signal.
- It is recommended to use shielded twisted pair cables. For differential encoders, connect the twisted pair cables based on the differential pairs, and connect the shield to the grounding terminal (PE terminal) of the AC drive.
- For large-scale equipment, when the drive is routed far away from the motor (motor cable longer than 10 m), the impedance of the encoder cable shield can be increased due to parasitic inductance of the cable. In this case, the encoder shield needs not be connected to the grounding terminal (PE) of the drive.

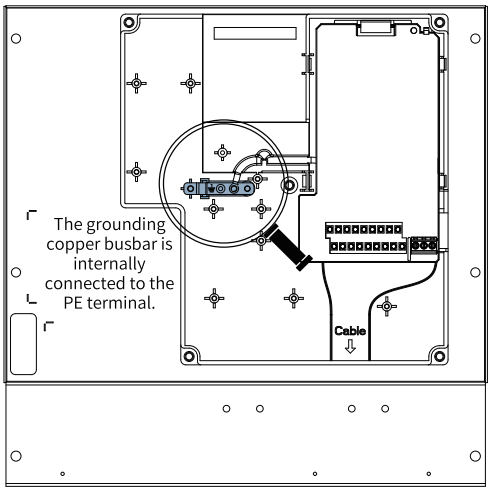


Figure 13-54 PG card installation screws

Requirements on wiring of I/O signal cables

- I/O signals include analog input (AI) signals, analog output (AO) signals, digital input (DI) signals, digital output (DO) signals, and relay output signals. Before wiring the I/O terminal, disconnect the main power supply and ensure that the danger indicator on the AC drive is off.
- To avoid interference to the I/O signals, separate the I/O signal cables at least 30 cm from the main circuit cables (R, S, and T cables and U, V, and W cables) and other power cables (or power supply cables).
- To avoid malfunction of the AC drive and equipment, separate the relay output terminal cable at least 30 cm away from other I/O signal cables.

13.4.4 Cable Routing Requirements

Separate routing of signal cables and power cables

When analog signals are used for remote control on the cabinet module, separate signal cables from high-voltage circuits (power supply input, inverter output, and braking resistor cables) by a distance of above 50 cm. This can reduce interference from the AC drive and other equipment to analog signals. This requirement must be met even inside the control cabinet.

Requirements on analog control signal cables

Use shielded twisted pair cables as analog control signal cables. When stripping the sheath of the cable, keep the stripped part as short as possible (5 mm to 7 mm), and wrap the stripped shield with the insulating tape to prevent the shielded cable from touching other devices, which may result in interference.

Requirement on motor cables

Use shielded cables for motor cables. Minimize the distance between the cabinet module and the motor, and route the motor cables separately from other cables. Also, avoid long-distance parallel routing of the motor cables and other cables to reduce electromagnetic interference caused by rapid changes in the output voltage of the AC drive.

Requirement on power cables

Use shielded cables for power cables, or shield all the cables from the cabinet module to the motor by using conduits.

Requirements on control cables and power supply cables

If the power supply cables and control cables must be intersected, make the intersection angle 90 degrees.

13.4.5 Routing Recommendations

Disturbing cable

Route cables that transmit different types of signals through different routes. Separate disturbing cables from sensitive cables with a minimum clearance of 30 cm wherever possible. When such cables must cross, make sure they are at an angle as near to 90° as possible to prevent interference.

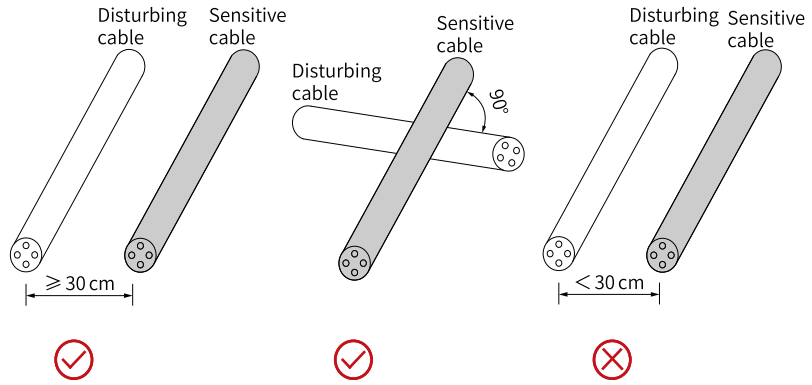


Figure 13-55 Routing of disturbing cables and sensitive cables

Signal cable

Route different signal cables separately and isolate them with the potential equalization cables. When routing cables that transmit the same type of signals, lay equipotential signal cables to the outer layers and lay equipotential bondings as many as possible in the middle, as shown below.

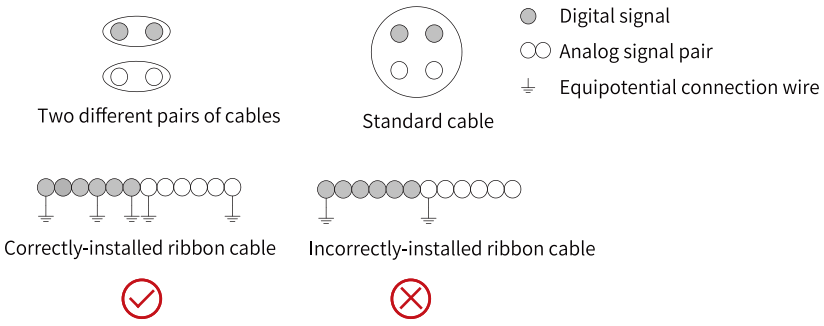


Figure 13-56 Routing cables that transmit different types of signals

Multi-conductor cables

For multi-conductor cables, it is recommended that one cable transmits one type of signals. If one cable is used to transmit different types of signals, use the cable with conductors shielded, as shown in the following figure.

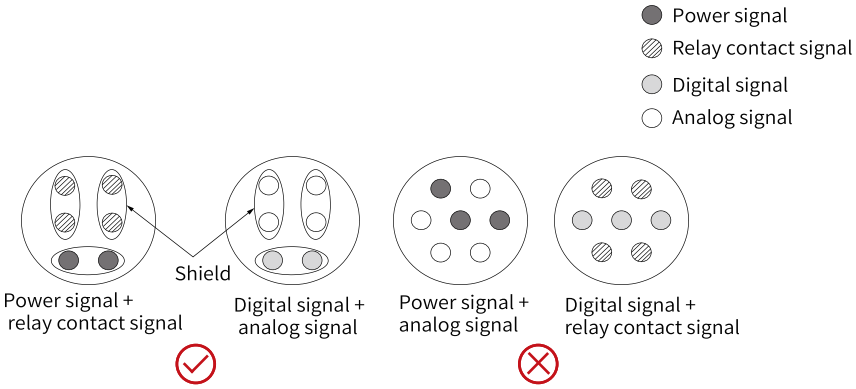


Figure 13-57 Routing of multi-conductor cables

For unused conductors in a multi-conductor cable, connect the unused (or reserved) conductors to the equipotential connection point.

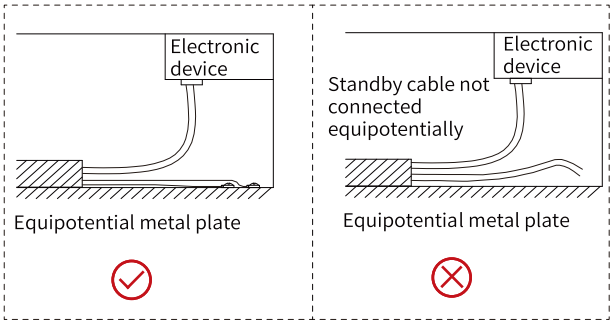


Figure 13-58 Handling reserved or unused conductors

Wiring loop

For cables that transmit low-level sensor signals and shared cables that transmit relay signals, lay them close to each other to avoid the large loop area. Use twisted pair cables for analog signals. Lay digital signal cables close to each other.

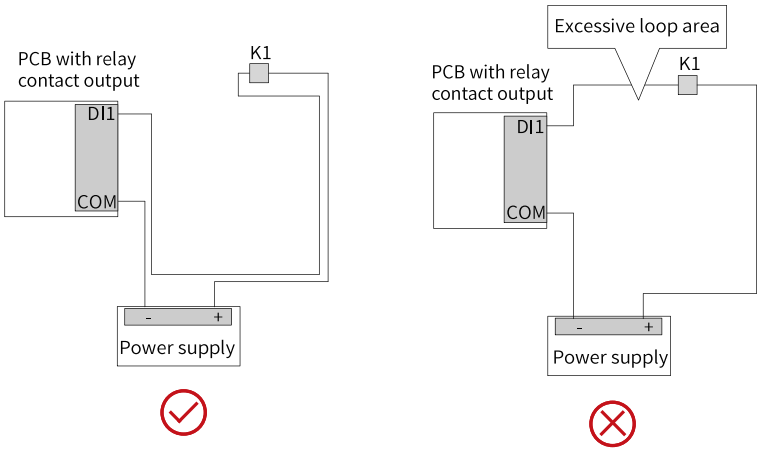


Figure 13-59 Recommended wiring loop area

Multiple types of cables

For cables of different types, route the cables along the equipotential metal plate. To enhance the internal EMC performance, separate different types of cables or separate cables with metal separators (recommended) in the same metal (zinc-iron or stainless steel) duct.

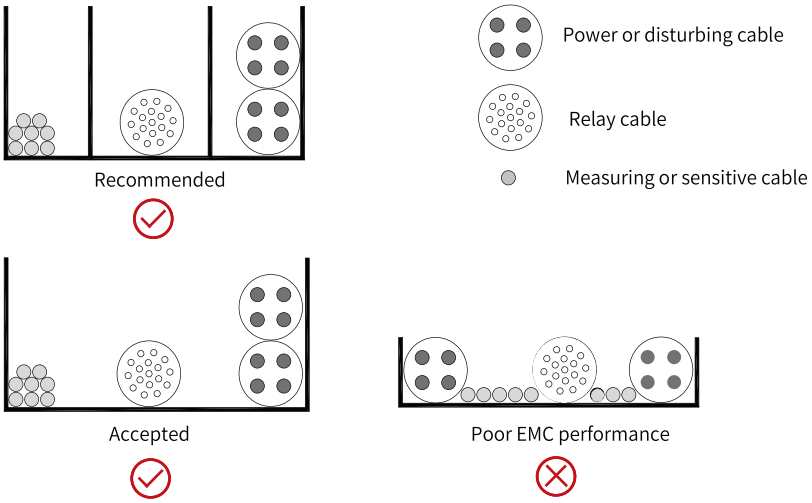


Figure 13-60 Laying multiple types of cables

Handing shielded cables

Minimize the unshielded part of the shielded cable, and connect the shield to the nearest PE terminal. If the unshielded part is too long, the conductor may be prone to signal interference, especially the encoder signals.

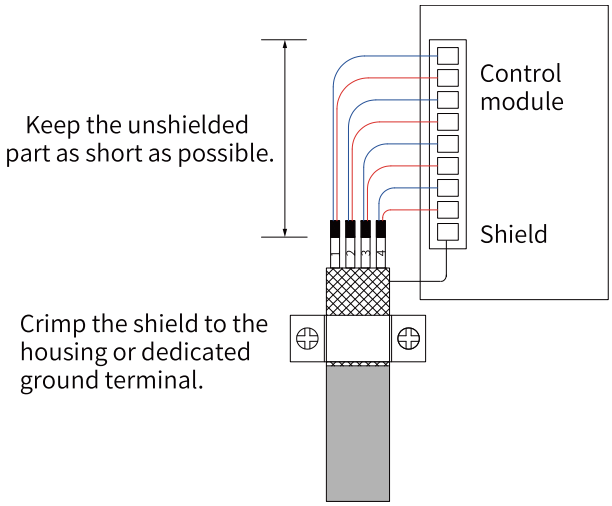


Figure 13-61 Requirements on handing of shielded cables

13.5 Grounding

13.5.1 Grounding Requirement

Observe the following requirements to ensure proper grounding of the drive.

Caution

1. Ground the grounding terminal to avoid electric shocks. Follow the relevant electrical regulations of specific countries or regions on the grounding method.
2. To prevent electric shocks, ensure the protective grounding conductor complies with technical specifications and local safety standards. Keep the grounding cable as short as possible.
3. In any case, the cross-sectional area of each protective grounding conductor that does not form part of the power cable or cable jacket cannot be less than 2.5 mm^2.
4. The leakage current of a single drive does not exceed 3.5 mA AC or 10 mA DC. You only need to configure one protective grounding conductor with the same specifications as the phase cable.
5. When using multiple devices, follow the instructions for grounding all devices. Incorrect grounding will cause malfunction of devices.

13.5.2 Grounding a Single Device

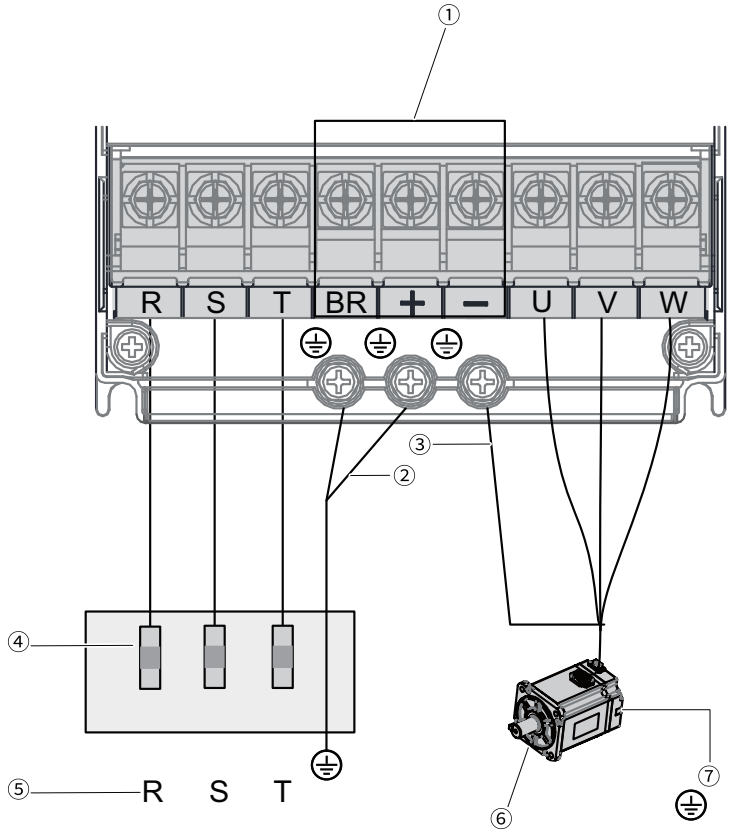


Figure 13-62 Main circuit grounding

Table 13–19 Grounding description of the main circuit

No.	Description
①	Avoid grounding the DC bus terminal and braking resistor terminal.
②	Connect the PE terminal on the input power supply side to the PE terminal on the input side of the AC drive.
③	Connect the output PE terminal of the AC drive to the output cable shield of the motor.
④	Input protection (fuse or circuit breaker). Connect the lower end of the fuse to the filter.
⑤	Input power supply
⑥	Three-phase motor
⑦	Ground the motor enclosure.

Note

The layout of main circuit terminals varies with different models.

13.5.3 Grounding Multiple Devices

The grounding diagram for side-by-side installation of multiple drives is shown below.

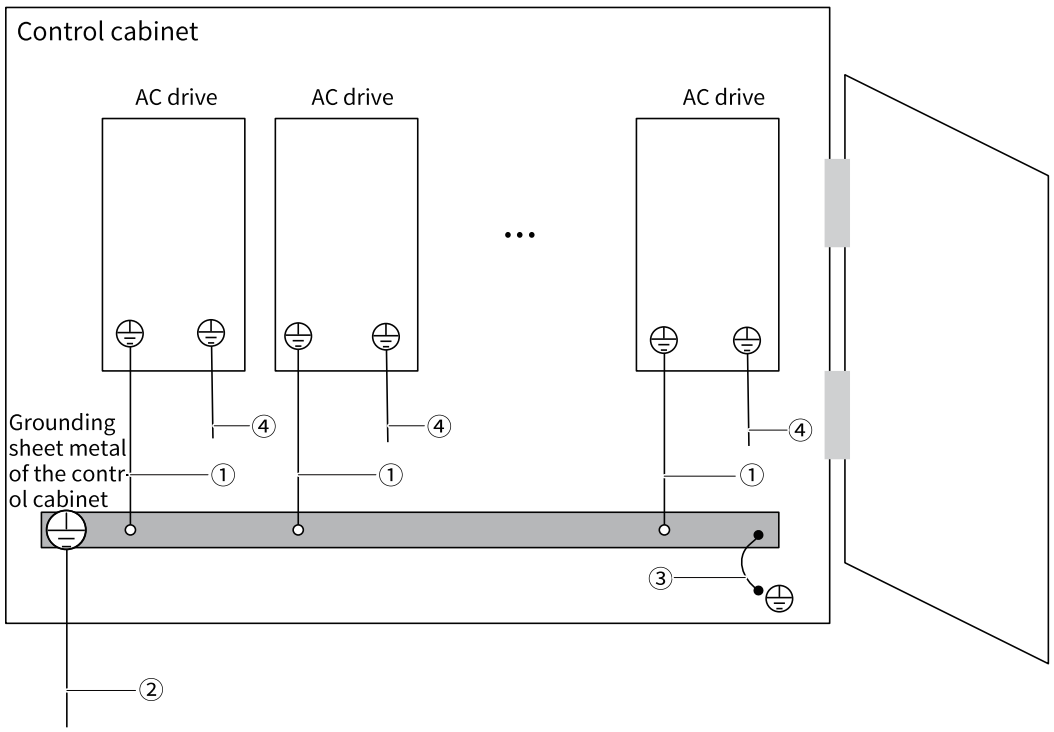


Figure 13-63 Grounding of paralleled drives

Table 13–20 Description for grounding of paralleled drives

No.	Description
①	Connect the main circuit input PE terminal to the grounding sheet metal of the control cabinet through the protective grounding conductor.
②	Connect the PE cable on the input power supply end to the grounding sheet metal of the control cabinet.
③	Connect the grounding sheet metal of the control cabinet to the metal enclosure of the control cabinet through the protective grounding conductor.
④	Connect the motor output cable shield to the output PE terminal of the drive.

13.5.4 Grounding the Cabinet System

The cost-effective method of suppressing interference in a cabinet is to isolate the interference source from the equipment that may be interfered with. Divide a cabinet into multiple EMC compartments or use multiple cabinets based on the intensity of interference sources, and install each device in accordance with the following wiring principles.

Table 13–21 Wiring requirements

No.	Wiring Requirement
1	Install the control devices and drive devices into two separate cabinets.
2	Use grounding cables with a cross-sectional area of at least 16 mm^2 to connect different cabinets, therefore realizing equipotential between the cabinets.
3	Place the devices in different areas in the cabinet according to the device signal strength.
4	Carry out equipotential bonding for the devices in different areas of the cabinet.

No.	Wiring Requirement
5	Shield all communication (for example, RS485) and signal cables leading from the electrical cabinet.
6	Install the power supply input filter close to the cabinet input interface.
7	Spray each grounding point in the cabinet.

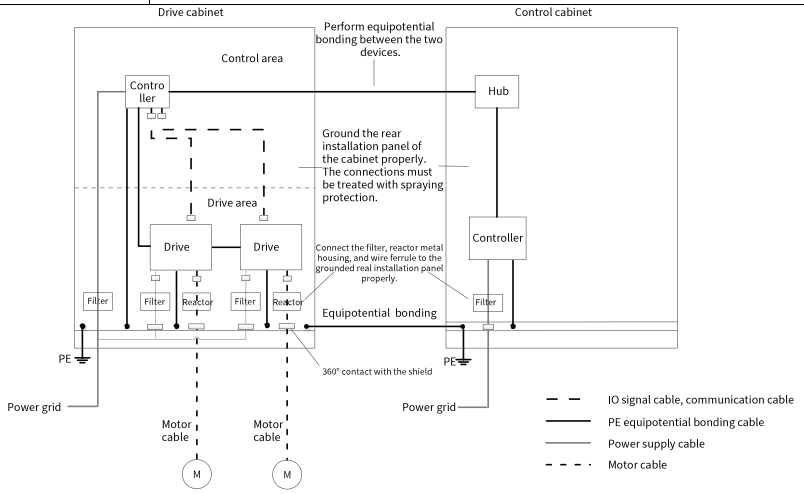


Figure 13-64 Recommended wiring for the cabinet system

13.6 Communication Connection

13.6.1 Wiring of RS485 Communication

RS485 communication connection with PLC

Use a three-conductor shielded cable as the RS485 bus to connect to 485+, 485-, and CGND terminals of the AC drive. Use the twisted pair cable to connect to the 485+ and 485- terminals and use the other cable to connect to the RS485 reference ground terminal CGND. Connect the shield to the equipment ground. Connect a 120 Ω termination resistor at each end of the bus to prevent RS485 signal reflection. The following table specifies the cable pin for the communication between the AC drive and PLC.

Table 13–22 Cable pin for communication between the AC drive and PLC

AC Drive			PLC		
Communication Type	Signal Name	Function Description	Communication Type	Signal Name	Function Description
RS485	485+	RS485 signal (+)	RS485	485+	RS485 signal (+)
	485-	RS485 signal (-)		485-	RS485 signal (-)
	CGND	Signal reference ground		CGND	Signal reference ground
-	GND (CGND)	Enclosure	-	GND (CGND)	Enclosure

RS485 communication for connections of multiple AC drives in parallel

The following table specifies the cable pin for connections of multiple AC drives in parallel in RS485 communication networking.

Table 13–23 Cable pin for parallel communication of multiple AC drives in parallel

AC Drive (Side A)			AC Drive (Side B)		
Communication Type	Signal Name	Function Description	Communication Type	Signal Name	Function Description
RS485	485+	RS485 signal (+)	RS485	485+	RS485 signal (+)
	485-	RS485 signal (-)		485-	RS485 signal (-)
	CGND	Signal reference ground		CGND	Signal reference ground
-	GND (CGND)	Enclosure	-	GND (CGND)	Enclosure

Communication networking

Use the daisy chain connection for the RS485 bus in case of a large number of nodes, as shown in the following figure. Connect the RS485 signal reference ground of all nodes (up to 128 nodes) together.

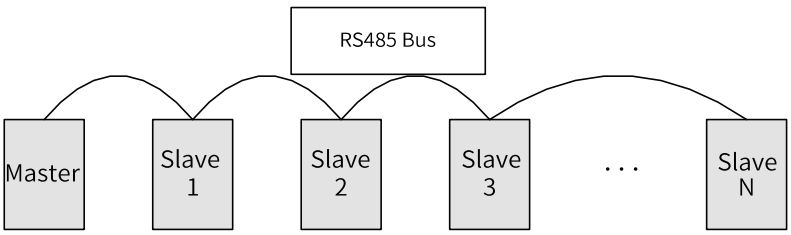


Figure 13-65 Daisy chain connection mode

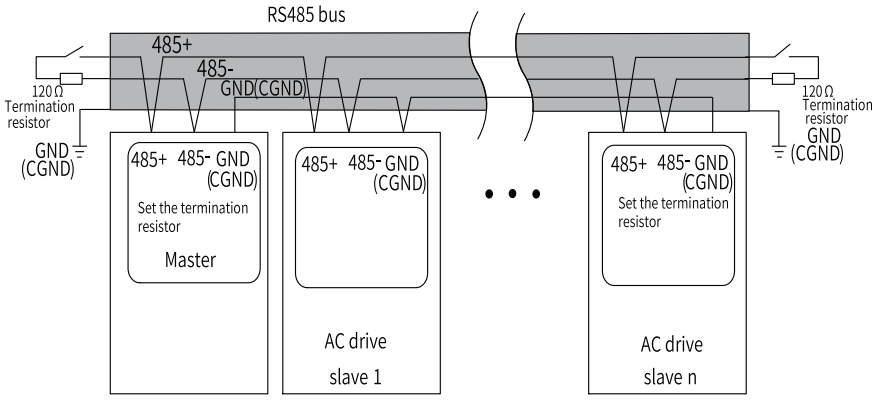


Figure 13-66 RS485 bus topology

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

Table 13–24 Transmission distance and number of nodes

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

13.6.2 Wiring of CAN Communication

CAN communication with the PLC

Use a three-conductor shielded cable for the CAN bus to connect to the CANH, CANL, and CGND terminals of the AC drive. Use the twisted pair cable to connect to the CANH and CANL terminals and use the other cable to connect to the CAN reference ground CGND. Connect the shield to the equipment ground. Connect a 120 Ω termination resistor at each end of the bus to prevent CAN signal reflection.

The following table specifies the cable pin for the CAN communication between the AC drive and PLC.

Table 13–25 Cable pin for communication between the AC drive and PLC

AC Drive			PLC		
Communication Type	Signal Name	Function Description	Communication Type	Signal Name	Function Description
CAN	CANH	CAN signal (positive)	CAN	CANH	CAN signal (positive)
	CANL	CAN signal (negative)		CANL	CAN signal (negative)
	CGND	Signal reference ground		CGND	Signal reference ground
-	GND (CGND)	Enclosure	-	GND (CGND)	Enclosure

CAN communication for connections of multiple AC drives in parallel

The following table specifies the cable pin for connections of multiple AC drives in parallel in CAN communication networking.

Table 13–26 Cable pin for connections of multiple AC drives in parallel

AC Drive (Side A)			AC Drive (Side B)		
Communication Type	Signal Name	Function Description	Communication Type	Signal Name	Function Description
CAN	CANH	CAN signal (positive)	CAN	CANH	CAN signal (positive)
	CANL	CAN signal (negative)		CANL	CAN signal (negative)
	CGND	Signal reference ground		CGND	Signal reference ground
-	GND (CGND)	Enclosure	-	GND (CGND)	Enclosure

Communication networking

Use the daisy chain mode for the CAN bus, as shown in the following figure. Use shielded twisted pair cables for the CAN bus, and use twisted pair cables for CANH and CANL signal cables. Connect a 120 Ω termination resistor at each end of the bus to prevent signal reflection. Connect the CAN signal reference ground of all the nodes (up to 64 nodes) together.

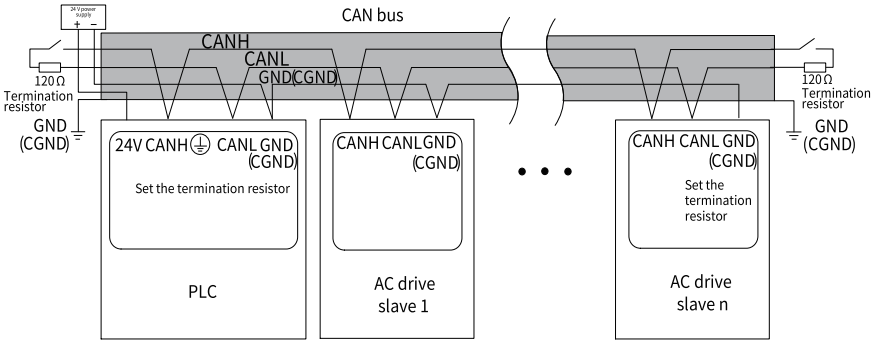


Figure 13-67 CAN bus topology

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

Table 13–27 Transmission distance and baud rate

Transmission Distance (m)	Rate (kbps)	Number of Nodes	Cable Specification
25	1024	64	0.205 mm^2
95	500	64	0.34 mm^2
560	100	64	0.5 mm^2
1100	50	64	0.75 mm^2

13.6.3 Wiring of EtherCAT Communication

The EtherCAT bus adopts standard RJ45 network port and standard RJ45 connector. Use Cat 5e shielded twisted pairs and injection cables with iron housing. According to FastEthernet, when an EtherCAT bus is used, the length of the cable between the devices cannot exceed 100 m. Otherwise, the signal will be attenuated, affecting communication.

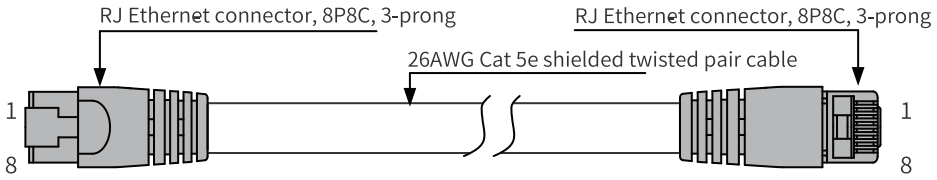


Figure 13-68 Requirement on the EtherCAT cable

Shielded twisted pairs are used as the EtherCAT bus for network data transmission. Cables with the following specifications are recommended.

Table 13–28 EtherCAT cable specifications

Item	Specification
Cable type	Flexible crossover cable, S-FTP, Cat 5e
Standards compliance	EIA/TIA568A, EN 50173, ISO/IEC 11801 EIA/TI Abulletin TSB, EIA/TIA SB40-A&TSB36
Cross sectional area	26AWG
Conductor type	Twisted pair
Number of pairs	4

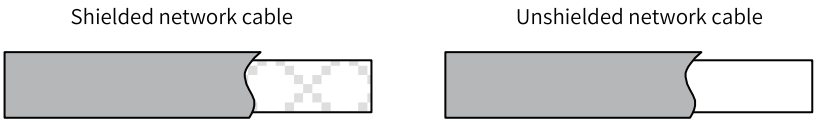


Figure 13-69 Shielded network cable

To connect the RJ45 network cable, hold the RJ45 connector of the cable and insert it into the RJ45 port of the communication module until you hear a "click" sound. To remove the RJ45 network cable, press down the clip of the RJ45 connector, and then pull it out along the direction parallel with the module.

Fix the cables to a place near one side of the device before EtherCAT communication. This prevents the communication cable from being affected by other tension to ensure communication stability.

13.6.4 Wiring of PROFINET Communication

After communication between the MD500-PN1/MD500-PN2 card and the AC drive is implemented, connect the AC drive to the PROFINET master station and configure related parameters. This can implement communication between the MD500-PN1/MD500-PN2 card and the PROFINET master station, thereby implementing AC drive networking.

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

Two ports on the AC drive can be used to realize ring topology or linear topology. Connect the cable to only one of the two ports. The cable between two nodes is no longer than 100 m in length.

13.7 Post-wiring Check

After wiring is completed, check the following items and tick compliant items.

Table 13–29 Post-wiring checklist

No.	Item	Compliance
1	The power supply input cables are connected to the R, S, and T terminals.	☐
2	The motor input cables are connected to the U, V, and W terminals.	☐
3	The dimensions of the main circuit cables meet the requirements.	☐
4	Heat-shrinkable tubes are applied to copper tubes of the main circuit cable and conductors, and heat-shrinkable tubes are completely cover the conductors.	☐
5	The motor output cable does not exceed 50 m. Otherwise, the carrier frequency needs to be reduced through F0-15.	☐
6	The ground cables are connected correctly.	☐
7	The output terminals and control signal terminals are securely fastened.	☐
8	The braking resistor and braking unit (if used) are connected correctly and have proper resistance.	☐

No.	Item	Compliance
9	The control circuit signal cables are shielded twisted pair cables.	☐
10	Optional cards are connected correctly.	☐
11	The control circuit cables and main circuit power cables are routed separately.	☐
12	There are no screws, gaskets, or exposed cables left inside the product.	☐

14 Installation Requirements on Options

14.1 Input reactor

Installing the input reactor on the input side of the AC drive can improve the input power factor, suppress the high harmonics of the input current of the AC drive, and reduce external conduction and radiation interference. The AC input reactor is an option. In applications where harmonics need to be suppressed, install an external AC input reactor to meet requirements of the EN IEC 6100032/12 standard.

If an AC input reactor is required, ensure that sufficient installation space is reserved in the cabinet.

14.2 Output Reactors

With an output reactor installed on the output side of the drive, the excessive dV/dt can be reduced. This can reduce the voltage stress on the motor winding to protect it, lower the motor temperature, and prolong the service life of the motor.

14.3 Fuse, Contactor, and Circuit Breaker



When the fuse is damaged or the circuit breaker trips, do not immediately energize the product or operate the peripheral equipment. Wait at least for the time specified on the warning label. Failure to comply will result in personal injury and equipment damage.

To comply with IEC/EN 61800-5-1 and UL 61800-5-1 standards, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit.

14.4 EMC Filter

The optional EMC filter can meet the EN IEC 618003 C2 emission requirements. For details about models and dimensions, see the *MD520 Series General-Purpose AC Drive Hardware Guide*. Install the EMC filter according to the following requirements:

- Install the EMC filter close to the input terminals, and keep the connection cable shorter than 30 cm.
- Connect the grounding terminal of the EMC filter to that of the AC drive, and install the EMC filter and the AC drive on the same conductive installation surface, which is connected to the main ground of the cabinet.
- Connect the LINE terminal of the EMC filter to the power grid, and the LOAD terminal to the AC drive.

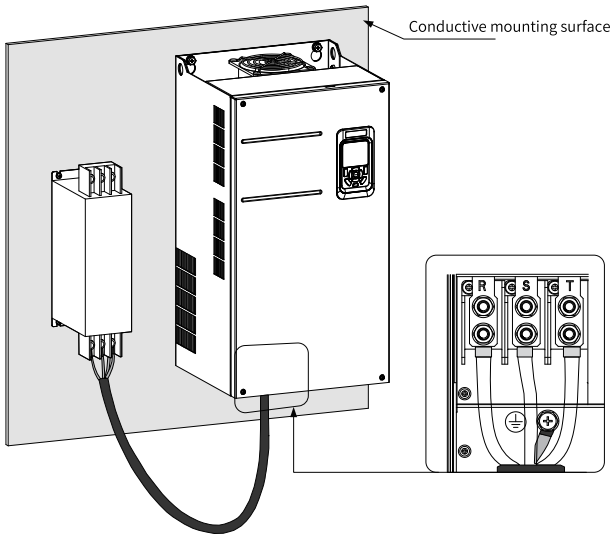


Figure 14-1 Installing an EMC filter

14.5 Magnetic Ring and Ferrite Clamp

The magnetic ring can be used on the input or output side of the AC drive. Install it as close to the AC drive as possible. When installed on the input side, the magnetic ring can suppress the noise in the input power supply system of the drive. When installed on the output side, the magnetic ring can suppress interference generated by the AC drive to external devices and reduce the bearing current.

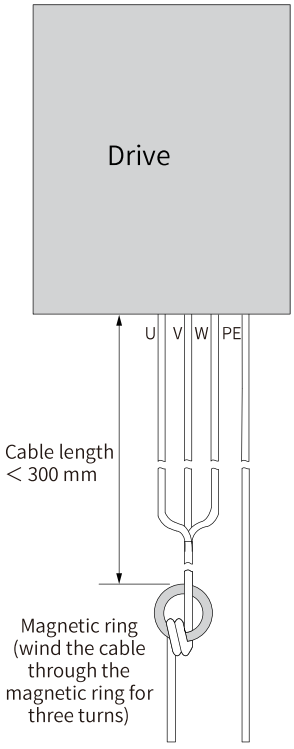


Figure 14-2 Installing the magnetic ring

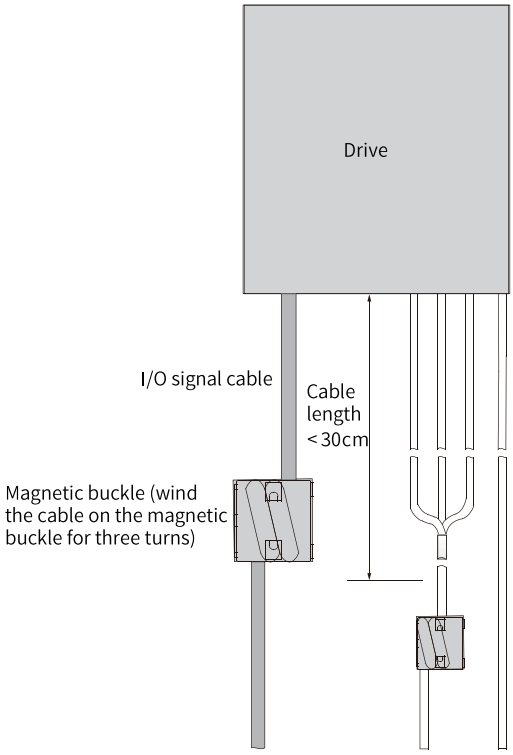


Figure 14-3 Installing the ferrite clamp

Note

The R/S/T or U/V/W cables must pass through the same ferrite core to suppress the common mode noise.

14.6 MDKE-10 Mounting Base

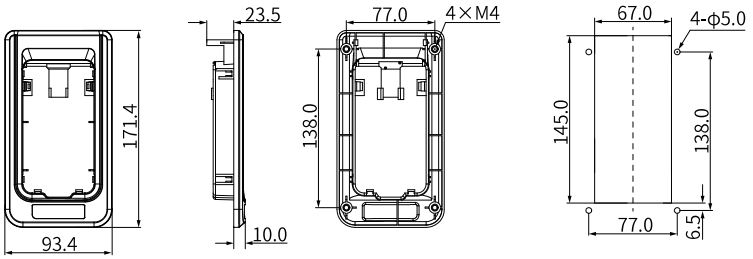


Figure 14-4 Dimensions and opening sizes (mm) of the MDKE-10 mounting base bracket

Note

If the thickness of the door is 1.5 mm, no bolts are required.

14.7 SOP-20 Mounting Base

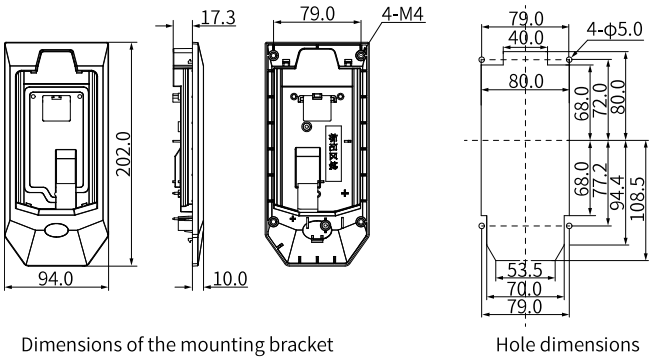


Figure 14-5 Dimensions and opening sizes (mm) of the SOP-20 mounting base bracket

15 Commissioning Tools

15.1 LED Operating Panel

Dimension

The following figures show the outline and installation dimensions of the LED operating panel.

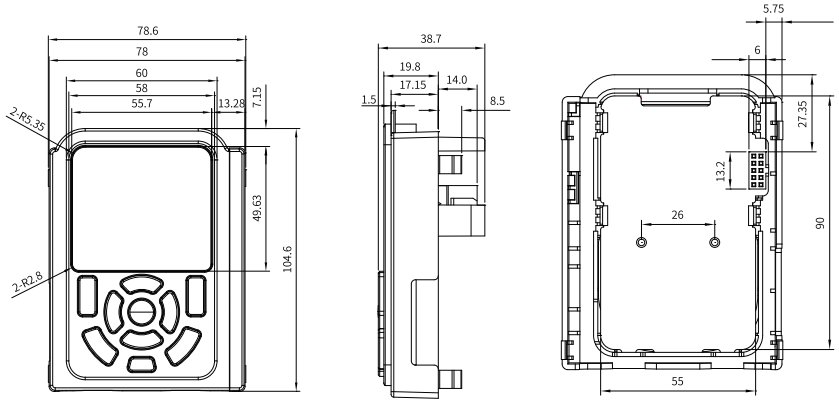


Figure 15-1 Outline and installation dimensions of LED operating panel for T1 to T4 models (mm)

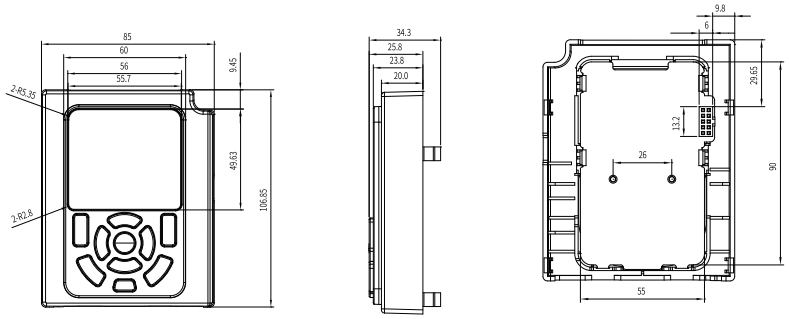


Figure 15-2 Outline and installation dimensions of LED operating panel for T5 to T12 models (mm)

Components

The LED operating panel can be used to view the operating status and fault information, set parameters, and so on. The following figure shows the operating panel.

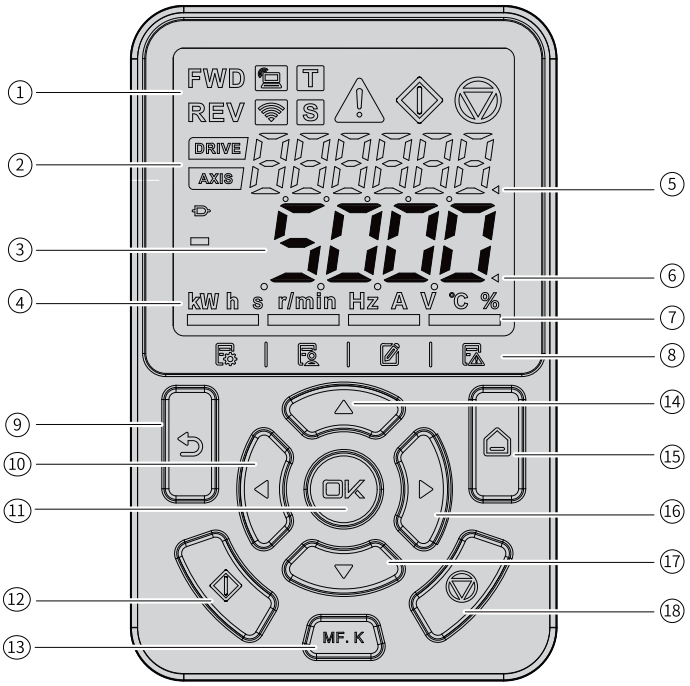


Figure 15-3 Components

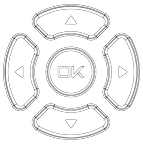
Table 15–1 Description of the operating panel

No.	Name	Description
①	Status indicators	/
②	Secondary display area	It displays the following information: • Information on key test and motor parameter auto-tuning • Fault and system status monitoring • Station number, motoring status, and STO status.
③	Primary display area	It displays parameter information.
④	Unit indicators	/
⑤	Cursor in the secondary display area	/
⑥	Cursor in the primary display area	/
⑦	Menu indicator	It indicates the current menu and can be switched via the menu key. Only one indicator can become on simultaneously.
⑧	Menu identification	From left to right, the icons indicate the basic menu, user-defined parameter, modified parameter (with default values changed), and fault list.
⑨	Program/Back key	/
⑩	Left shift key	/
⑪	OK key	/
⑫	RUN key	/
⑬	Multi-function key	/
⑭	UP key	/
⑮	Menu key	/
⑯	Right shift key	/

No.	Name	Description
⑰	DOWN key	/
⑱	Stop key	/

Key Descriptions

Table 15–2 Key descriptions

Key	Name	Function
	Menu key	Long press the key to switch between the primary display area and the secondary display area. In the primary display area, press the key to switch among different menus, including the basic menu, user-defined parameter, modified parameter (with default values changed), and fault list.
	Program/Back key	Return to the previous interface; Enter level 1 menu
	OK key	Press the key to enter the settings interface or confirm settings.
	Navigation key	In the secondary display area, press the right or left navigation key to switch the display status. Primary display area: • Basic menu, user menu, and calibration menu: On the monitoring interface, the down key is used as the potentiometer and the left and right keys are used to switch between monitored variables. On the parameter interface, the up and down keys are used to adjust the setpoint, the left and right keys are used to select the bit to set, and the OK key is used to confirm the setpoint. • Fault history menu: Press the left or right key to switch the fault history records.
	Multi-function key	You can allocate different functions, such as command source switch, forward run and reverse run switch, or jog to this key.
	RUNkey	In the operating panel control mode, press the key to operate the drive.
	Stop/Fault reset key	When the drive is running, press the key to stop the drive. When the drive is in the faulty state, press the key to perform a reset operation.

Status Indicator

Table 15–3 Status indicator

Status indicator		Status
FWD REV	FWD indicator steady on	Forward run/Positive direction
	REV indicator steady on	Reverse run/Negative direction
	FWD/REV indicator blinking	The AC drive is switching between forward running and reverse running.
	Local/Remote indicator off	Local control
	Local/Remote indicator on	Terminal control
	Local/Remote indicator blinking slowly	Communication control
	Local/Remote indicator blinking quickly	User-defined control mode
	Torque control indicator steady on	Torque control
	Speed control indicator steady on	Speed control
	Fault indicator steady on	Fault occurred
	Fault indicator off	No fault
	RUN indicator steady on	Running
	Stop indicator steady on	Stop
	Station number indicator steady on	The station number is displayed in the auxiliary display area.
	Station number indicator off	The value displayed in the auxiliary display area is not the station number.
	AXIS indicator steady on	The axis number is displayed in the auxiliary display area.
	AXIS indicator off	The value display in the auxiliary display area is not the axis number.
	Connector indicator steady on	The connector variable is displayed in the main display area.
	Connector indicator off	The variable displayed in the main display area is not the connector variable.
	Minus sign indicator steady on	The value displayed in the main display area is negative.
	Minus sign indicator off	The value displayed in the primary display area is positive.

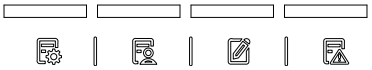
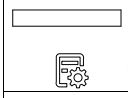
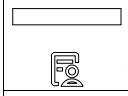
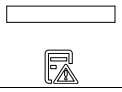
Status indicator		Status
	Cursor indicator in the primary display area steady on	The operating area is the primary display area.
	Cursor indicator in the secondary display area steady on	The operating area is the secondary display area.
kWh s r/min Hz A V ℃ %	Unit indicator steady on	The unit corresponding to the data displayed in the main display area is the unit with the indicator on. *"Table 15–4" on page 309*
	 Indicator steady on	The primary display area displays the basic menu.
	 Indicator steady on	The primary display area displays the user-defined parameter menu.
	 Indicator steady on	The primary display area displays the modified parameter (with the default value changed) menu.
	 Indicator steady on	The primary display area displays the fault menu.

Table 15–4 Unit description

Unit	Description
kW	Power unit
h	Time unit
kWh	Energy unit
s	Time unit
rpm	Rotational speed unit
Hz	Frequency unit
A	Current unit
V	Voltage unit
°C	Temperature unit
%	Percentage

Data Display

The operating panel provides two data display areas: the 6-digit LED secondary display area and the 5-digit LED primary display area.

The auxiliary display area displays the station No., axis No., current state, warning/fault, etc.

The primary display area displays the frequency reference, output frequency, and various monitoring data.

Table 15–5 LED display and actual data

LED Display	Actual Data	LED Display	Actual Data	LED Display	Actual Data	LED Display	Actual Data
	0		9		h		r
	1		A		c		t
	2		B		J		U
	3		C		L		y
	4		D		n		T
	5		E		N		u
	6		F		o		/
	7		H		P	/	/
	8		G		q	/	/

15.2 Related Parameters

Table 15–6 Parameters related to the operating panel

Parameter Code	Parameter Name	Default	Value Range	Description
F7-01	MF.K key function	0	0: MF.K key disabled 1: Forcibly change to operating panel control 2: Switchover between forward run and reverse run 3: Forward jog 4: Reverse jog	The MF.K key is a multi-functional key. This parameter is used to set the function of the MF.K key. 0: MF.K key disabled The MF.K key is invalid. 1: Forcibly change to operating panel control If F0-02 is set to 0 (operating panel), the MF.K key is unavailable. If F0-02 is set to 1 (terminal), 2 (communication), or 3 (self-defined control mode), pressing the MF.K key forcibly changes the control mode to the operating panel control mode. 2: Switchover between forward run and reverse run You can change the direction of the frequency reference by using the MF.K key. This function is valid only when the command source is set to the operating panel. 3: Forward jog Pressing the MF.K key implements forward jogging (FJOG). This function is valid only when the command source is set to the operating panel. 4: Reverse jog Pressing the MF.K key implements reverse jogging (RJOG). This function is valid only when the command source is set to the operating panel.
F7-02	STOP/RES key function	0	0: Valid only in the operating panel control mode 1: Valid in any control mode and OFF1 command-based stop 2: Valid in any control mode and OFF2 command-based stop 3: Valid in any control mode and OFF3 command-based stop	This parameter is used to set the function of the STOP/RESET key on the operating panel. 0: Valid only in the operating panel control mode The STOP/RES key is valid only in the operating panel control mode. 1: Valid in any control mode and OFF1 command-based stop The STOP/RES key is valid in any operating mode, and the AC drive stops according to the OFF1 stop mode. 2: Valid in any control mode and OFF2 command-based stop The STOP/RES key is valid in any operating mode, and the AC drive stops according to the OFF2 stop mode. 3: Valid in any control mode and OFF3 command-based stop The STOP/RES key is valid in any operating mode, and the AC drive stops according to the OFF3 stop mode.

Parameter Code	Parameter Name	Default	Value Range	Description
F7-03	Parameter 1 displayed on LED operating panel during operation	31	Bit 0: Running frequency (Hz) Bit 1: Frequency reference (Hz) Bit 2: Bus voltage (V) Bit 3: Output voltage (V) Bit 4: Output current (A) Bit 5: Output power (kW) Bit 6: Output torque (%) Bit 7: DI input status Bit 8: DO output status Bit 9: AI1 voltage (V) Bit 10: AI2 voltage (V) Bit 11: AI3 voltage (V) Bit 12: Counting value Bit 13: Length value Bit 14: Load speed Bit 15: PID reference	This parameter defines the parameters displayed on the LED operating panel when the AC drive is running. You can view the parameters corresponding to each bit by pressing the left and right shift keys. The value 1 of a bit indicates that the parameter is displayed, and the value 0 of the bit indicates that the parameter is hidden. Each parameter is displayed in the hexadecimal format.
F7-04	Parameter 2 displayed on LED operating panel during operation	0	Bit 0: PID feedback Bit 1: PLC stage Bit 2: Pulse input frequency (kHz) Bit 3: Running frequency 2 (Hz) Bit 4: Remaining running time Bit 5: AI1 voltage before correction (V) Bit 6: Free mapping 0 Bit 7: Free mapping 1 Bit 8: Motor speed Bit 9: Current power-on time (hour) Bit 10: Current running time (min) Bit 11: Pulse input frequency (Hz) Bit 12: Communication setting value Bit 13: Encoder feedback speed Bit 14: Main frequency X Bit 15: Auxiliary frequency Y	This parameter defines the parameters displayed on the LED operating panel when the AC drive is running. You can view the parameters corresponding to each bit by pressing the left and right shift keys. The value 1 of a bit indicates that the parameter is displayed, and the value 0 of the bit indicates that the parameter is hidden. Each parameter is displayed in the hexadecimal format.

Parameter Code	Parameter Name	Default	Value Range	Description
F7-05	Parameter displayed at stop	51	Bit 0: Frequency reference (Hz) Bit 1: Bus voltage (V) Bit 2: DI input status Bit 3: DO output status Bit 4: AI1 voltage (V) Bit 5: AI2 voltage (V) Bit 6: AI3 voltage (V) Bit 7: Counting value Bit 8: Length value Bit 9: PLC stage Bit 10: Load speed Bit 11: PID reference Bit 12: Pulse input frequency (kHz) Bit 13: Reserved Bit 14: Free mapping 0 Bit 15: Free mapping 1	This parameter defines the parameters displayed on the LED operating panel when the AC drive is in stop state. You can view the parameters corresponding to each bit by pressing the left and right shift keys. The value 1 of a bit indicates that the parameter is displayed, and the value 0 of the bit indicates that the parameter is hidden. Each parameter is displayed in the hexadecimal format.
FP-01	Parameter initialization	1	0: No action 1: Restore parameters (excluding motor parameters) to factory settings 2: Clear records 4: Back up current user parameters 501: Restore user parameters from backup 503: Restore parameters (including motor parameters) to factory settings	This parameter is used to select the parameter initialization mode. 0: The AC drive does not perform any operation. 1: Most of the AC drive parameters are restored to factory settings. However, motor parameters, frequency reference decimal (F0-22), maximum frequency (F0-10), frequency upper limit (F0-12), fault records, cumulative running time (F7-09), cumulative power-on time (F7-13), cumulative power consumption (F7-14), and drive unit heatsink temperature (F7-07) are not restored. 2: The fault records, cumulative running time (F7-09), cumulative power-on time (F7-13), and cumulative power consumption (F7-14) are cleared. 4: The current user-set parameters are backed up. 501: Parameters backed up by setting FP-01 to 4 are restored. 503: All AC drive parameters except FP-00, FP-01, and the parameters in group FF are restored to factory settings.

Parameter Code	Parameter Name	Default	Value Range	Description
FP-02	Display of function parameter groups	63	Bit 0: Group U 0: Hidden 1: Displayed Bit 1: Group A 0: Hidden 1: Displayed Bit 2: Group B 0: Hidden 1: Displayed Bit 3: Group C 0: Hidden 1: Displayed Bit 4: Group H 0: Hidden 1: Displayed Bit 5: Group L 0: Hidden 1: Displayed	This parameter is used to determine whether the parameter groups U, A, B, C, H, and L are displayed on the operating panel by each bit.
FP-03	Display of user parameters	111	Ones: 0: Hide user mode 1: Show user mode Tens: 0: Hide calibration mode 1: Show calibration mode Hundreds: 0: Hide error menu 1: Show error menu	This parameter is used to determine whether the user-defined parameter group, user-modified parameter group, and error menu are displayed on the operating panel through the ones, tens, and hundreds places.

15.3 Parameter Settings

The operating panel provides three levels of menus for parameter settings. You can press , , , and  to modify the blinking bit on a menu of the operating panel. The three levels of menus are described as follows:

- Level-1 menu: parameter groups
- Level-2 menu: parameters
- Level-3 menu: parameter values

For example, to change the value of F3-02 from 10.00 Hz to 15.00 Hz, perform settings according to the following figure.

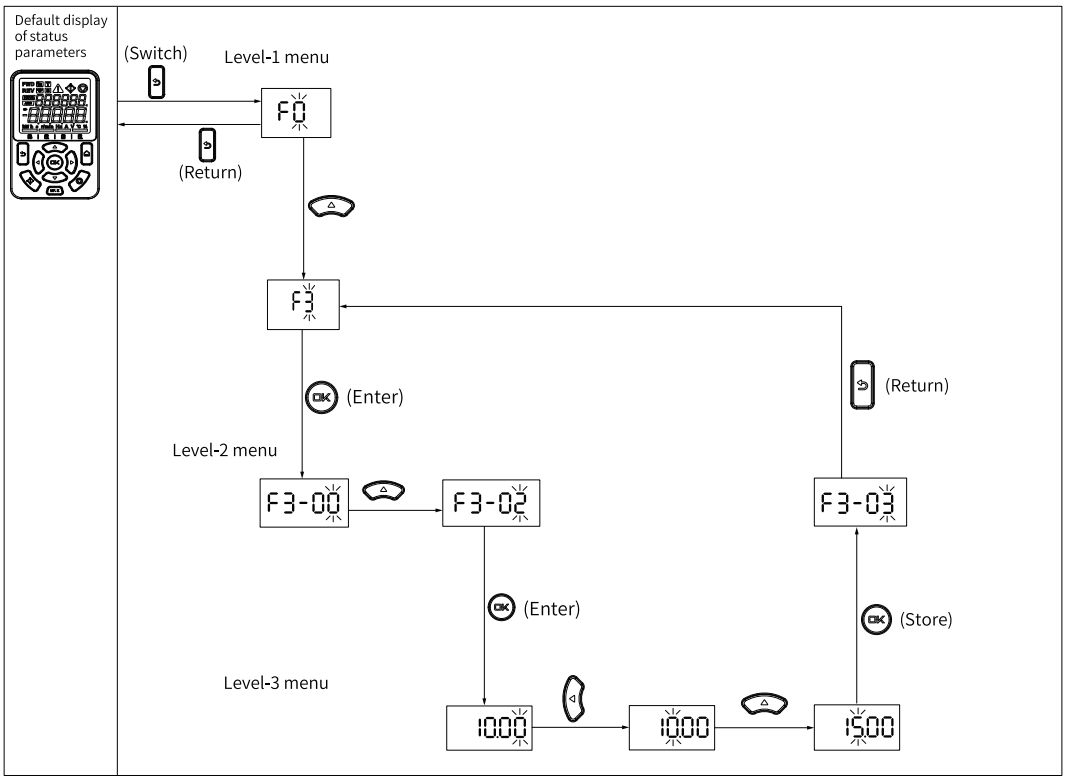


Figure 15-4 Modifying a parameter

Press  or  to return to a level-2 menu when operating a level-3 menu. The difference between the two keys is as follows:

- After you press , the system saves the parameter setting first, and then goes back to level-2 menu and shifts to the next parameter.
- Pressing  returns to level-2 menu corresponding to the current parameter without saving the current parameter setting.

If a parameter does not have a blinking bit in level-3 menu, the parameter cannot be modified. The reasons include the following:

- The parameter is an unmodifiable parameter, such as the product type, actual measurement value, and operation log.
- The parameter is unmodifiable when the drive is running. In this case, to modify the parameter, stop the drive first.

15.4 Parameter View

Set FP-02 to 11 and FP-03 to 11 to view all parameters through the operating panel. The operation procedure is shown in the following figure.

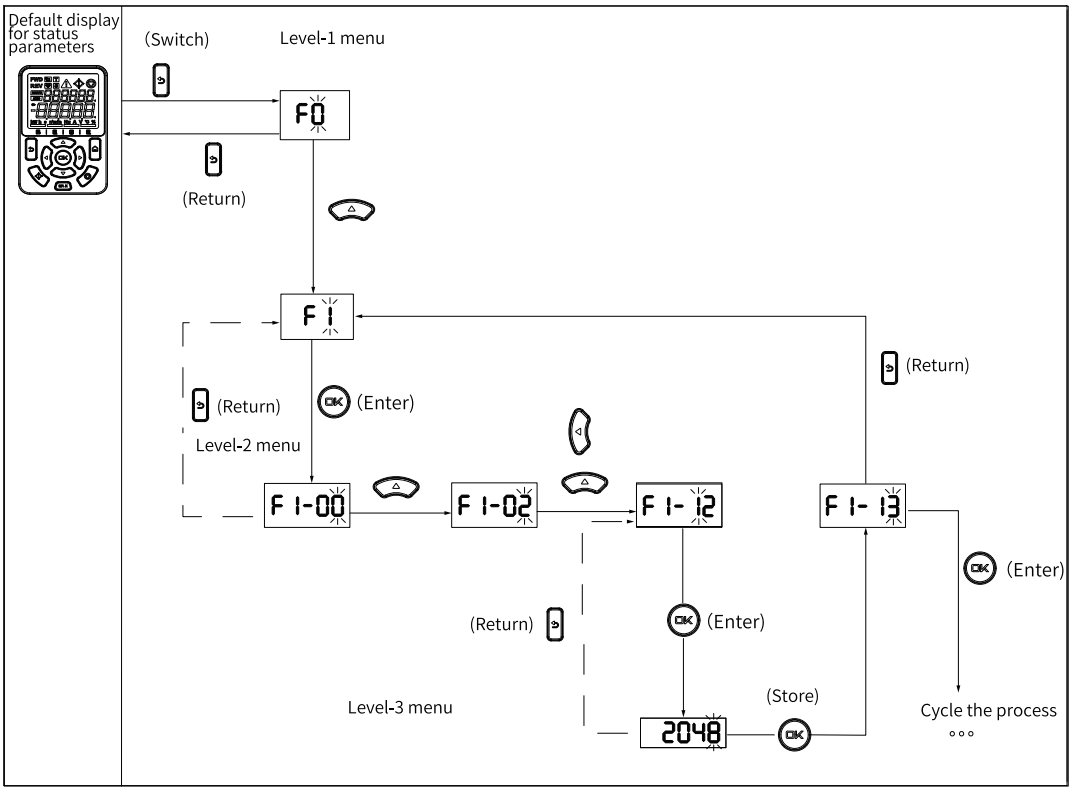


Figure 15-5 Parameter view

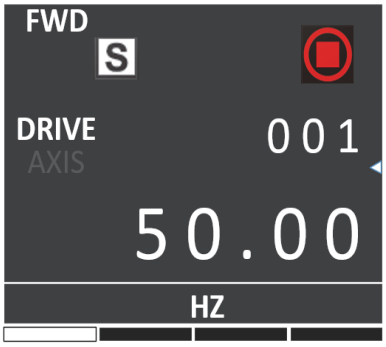
15.5 Status Parameter Display

The primary display area and the secondary display area are independent of each other. They have their own separate menus. The main display area is displayed by default.

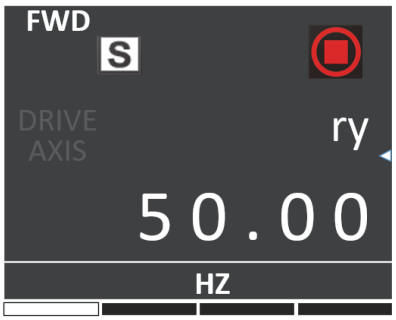
To switch between the main display area and auxiliary display area, press and hold . You can view the operating cursor corresponding to the display area in the current operation area.

1. Parameter display in the auxiliary display area

- Station number interface (displayed by default): It displays the current station number, which is 001.



- Status interface: On the station number interface, press the left/right key to view the current device status. In this case, the DRIVE and AXIS indicators are both OFF, as shown below.



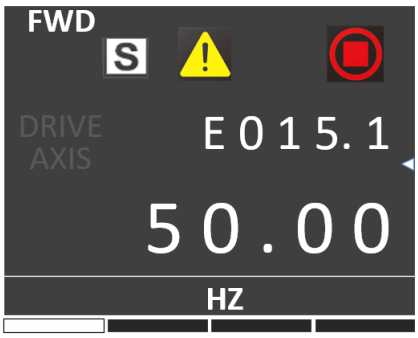
The following states can be displayed:

- reset (initialization): Initializing after power-on
- nr (not ready): Main circuit not powered on
- ry (ready): Wait for the operation command
- rn (in operation): In operation

When one of the following states appears, the corresponding display pops up. When the state ends, the corresponding display is cleared.

- STO: Displayed when the STO function is activated
- -JOG: Displayed during jogging
- HErE: Displayed upon the Here command
- CALL: Remote call
- busy: Displayed during parameter downloading or restoring parameters to default settings
- TUNE: Displayed upon auto-tuning

- Fault code interface E indicates faults, L indicates minor faults, and A indicates alarms. When a fault or an alarm occurs, the secondary display area displays the fault by default. In this case, pressing the up/down key can switch among different faults, whereas pressing the left/right key can switch among different menus.



2. Parameter display in the main display area

During operation, you can press the left shift key or right shift key to view status parameters. By default, the following status parameters are displayed: operating frequency, frequency reference, bus voltage, output voltage, and output current. To view more status parameters, see descriptions of F7-03 and F7-04 in "Related Parameters".

When the drive stops, you can press the left shift key or right shift key to view status parameters. The following status parameters are displayed by default: frequency reference, bus

voltage, AI1 voltage, and AI2 voltage. To view more status parameters, see descriptions of F7-05 in *"15.2 Related Parameters" on page 311*.

15.6 Fault and Alarm Display

When a fault occurs on the AC drive, the fault indicator turns on, and the secondary display area displays a fault code, as shown in the following figure.

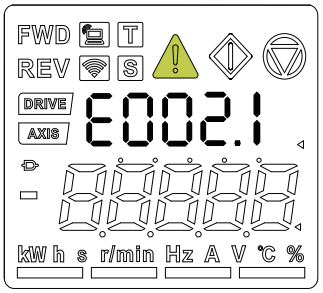


Figure 15-6 Fault code display

When the fault indicator blinks, the AC drive immediately stops output, and the contact of the faulty relay closes. In this case, see the *parameter guide* for troubleshooting or contact Inovance for technical support. Find the fault cause and rectify the fault based on the fault code displayed on the operating panel. Then reset the device.

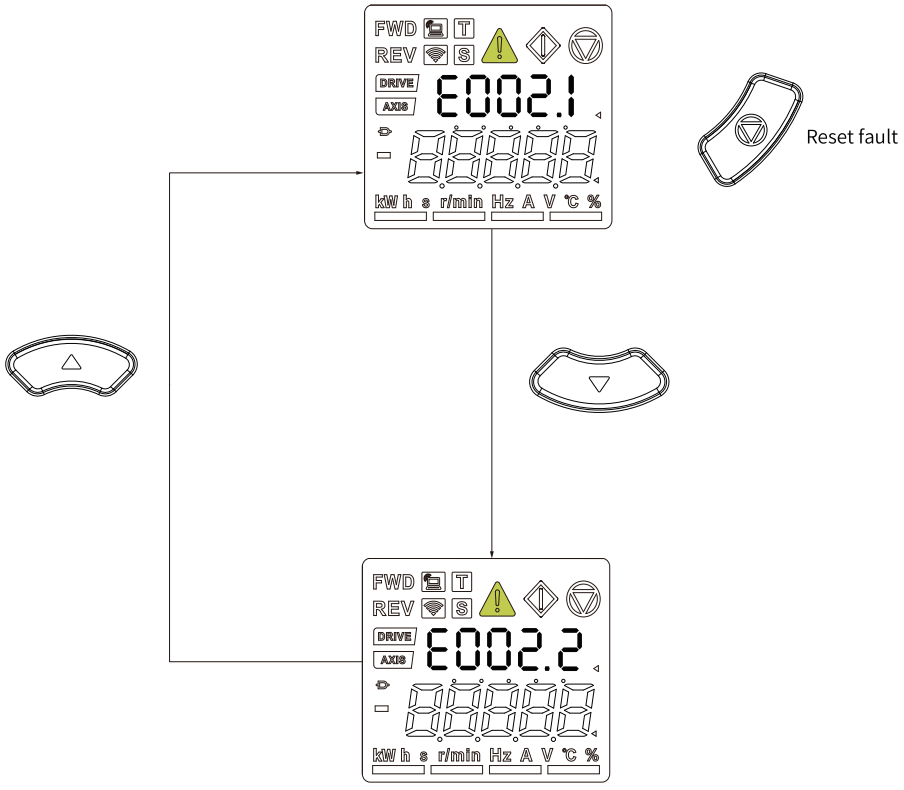


Figure 15-7 Viewing multiple faults and resetting the device

15.7 MF.K Multi-functional Key

The  key on the operating panel is a multi-functional key. Its function can be set using F7-01. In the stop or running state, you can press the key for control mode switchover, and switchover between forward and reverse run, and forward/reverse jog.

Table 15–7 MF.K key parameter descriptions

Parameter Code	Parameter Name	Default	Value Range	Description
F7-01	MF.K key function selection	0	0: MF.K key disabled 1: Forcibly change to operating panel control 2: Switchover between forward run and reverse run 3: Forward jog 4: Reverse jog	The MF.K key is a multi-functional key. This parameter is used to set the function of the MF.K key. 0: MF.K key disabled The MF.K key is invalid. 1: Forcibly change to operating panel control If F0-02 is set to 0 (operating panel), pressing the MF.K key produces no effect. If F0-02 is set to 1 (terminal), pressing the MF.K key can implement switchover between terminal control and operating panel control. If F0-02 is set to 2 (communication), pressing the MF.K key can implement switchover between communication control and operating panel control. 2: Switchover between forward run and reverse run You can change the direction of the frequency reference by using the MF.K key. This function is valid only when the command source is set to the operating panel. 3: Forward jog Pressing the MF.K key implements forward jogging (FJOG). This function is valid only when the command source is set to the operating panel. 4: Reverse jog Pressing the MF.K key implements reverse jog (RJOG). This function is valid only when the command source is set to the operating panel.

15.8 Driving the Motor with the Operating Panel

You can press  on the operating panel to enable the motor to jog forwardly or reversely, and press  or  to start or stop the motor.

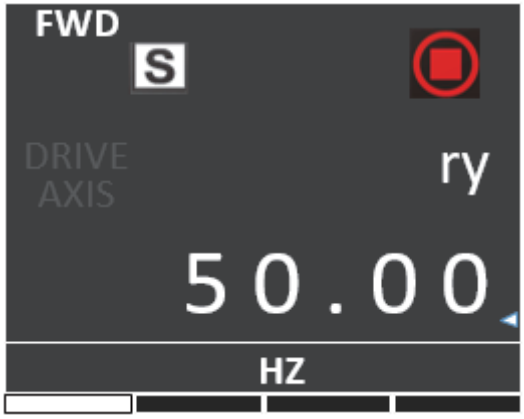
Procedure

1. Perform check before power-on.

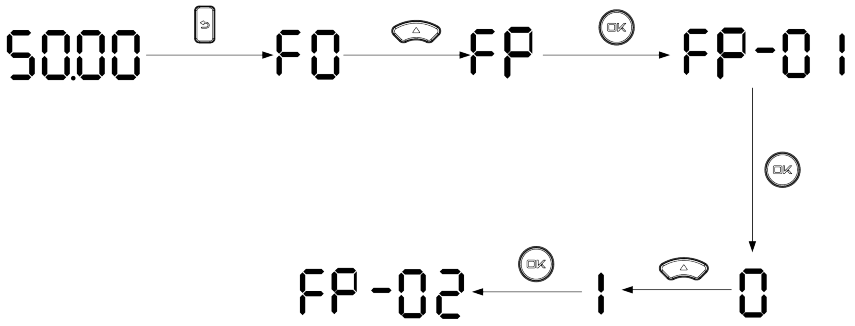
   Check the installation and wiring according to the installation guide. For detailed inspection, see the

description of check operations before power-on in the *MD520 Series General-Purpose AC Drive Installation Guide*.

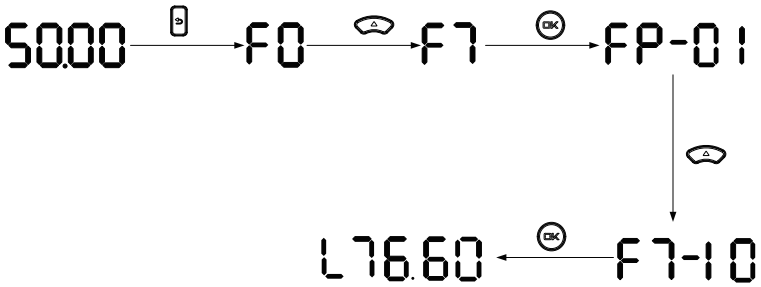
2. Press the power switch to power on the AC drive.
3. Check that "ry" is displayed in the secondary display area, and "50.00" is displayed on the operating panel, which indicates successful power-on.



4. Set FP-01 to 001 and restore all parameters to default values. The operation example is shown in the following figure.



5. Check the value of F7-10, which indicates the software version.



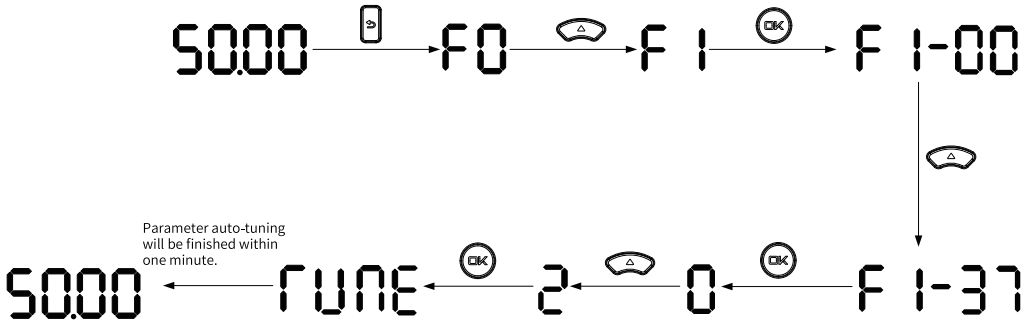
6. Set motor parameters in group F1 according to the motor nameplate.

Table 15–8 Motor parameters

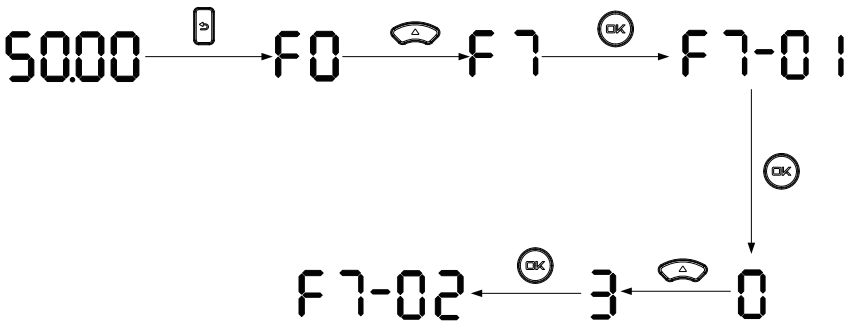
Parameter Code	Parameter Name	Default	Value Range	Description	Value
F1-00	Motor type	0	0: Common asynchronous motor 1: Variable frequency asynchronous motor 2: Permanent magnet synchronous motor 3: Reluctance motor without permanent magnet 4: Electromagnetic coil	This parameter is used to set the motor type. 0: Common asynchronous motor A common asynchronous motor is suitable for applications with normal voltage but often full load. It is designed based on constant frequency and constant voltage. Therefore, it may not meet all the frequency and speed control requirements. 1: Variable frequency asynchronous motor A variable frequency motor can adjust its frequency and speed according to the load. When the voltage is low, the variable frequency motor can reduce the frequency for a reliable start. When the load is light, it can reduce the frequency, speed, and current to save electric energy. 2: Permanent magnet synchronous motor A permanent magnet synchronous motor provides excitation with a permanent magnet. It features simple structure, small size, high efficiency, and high power factor. 3: Reluctance motor without permanent magnet The reluctance motor is a synchronous motor without permanent magnet, whose torque output is totally from the magnetic reluctance torque generated from q-axis and d-axis inductance difference. 4: Electromagnetic coil The electromagnetic coil is generally an inductive coil used for applications such as electromagnetic suction force and heating.	0
F1-01	Rated motor power	Model depend-ent	0.1 kW to 1000.0 kW	This parameter indicates the power of the motor during normal operation. The rated power of the motor is the rated voltage x rated current of the motor. Select a motor with a proper power rating on the premise that the motor can meet the requirements of mechanical load. Take the motor heat dissipation, allowable overload capacity, and starting capacity into account.	3.7 kW
F1-02	Rated motor voltage	Model depend-ent	1 V to 2000 V	The rated motor voltage indicates the voltage of the motor during normal operation, which usually refers to the line voltage.	380 V

Parameter Code	Parameter Name	Default	Value Range	Description	Value
F1-03	Rated motor current	Model dependent	0.01 A to 655.35 A	The rated motor current indicates the current of the motor during normal operation, which usually refers to the line current. For models with the power of 55 kW and below, two decimal places are displayed, such as 0.01 A to 655.35 A. For models with the power above 55 kW, one decimal place is displayed, such as 0.1 A to 6553.5 A.	9.00 A
F1-04	Rated motor frequency	Model dependent	0.01 Hz to F0-10	The rated motor frequency indicates the frequency of the power supply connected to the stator winding under the rated operation conditions of the motor.	50.00 Hz
F1-05	Rated motor speed	Model dependent	1 rpm to 65535 rpm	The rated motor speed indicates the speed (in the unit of rpm) of the rotor under the rated operation conditions.	1460 rpm

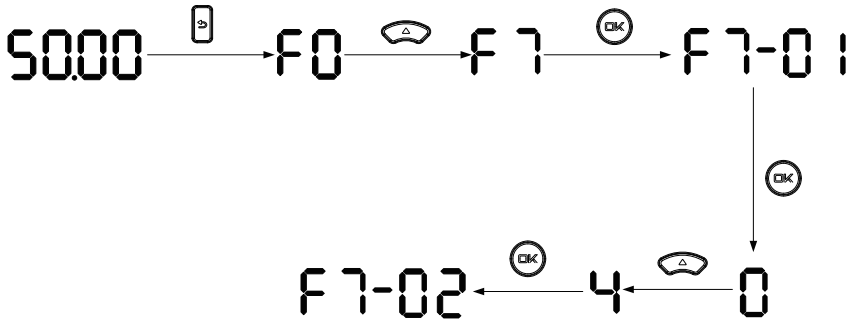
7. Select an auto-tuning mode by setting F1-37 and press ENTER. The operating panel will display . Press the Run key on the operating panel to start motor auto-tuning. During this process, the Run indicator is steady ON, the secondary display area displays "TUNE", and the AC drive energizes the motor. Later, the secondary display area displays "ry", and the primary display area displays "50.00", indicating that the auto-tuning is completed.



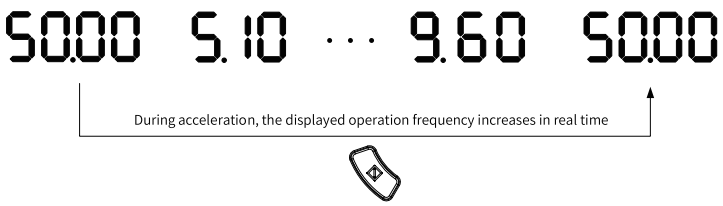
8. Set F7-01 to 3, and then press MF. K to enable the motor to jog forwardly.



9. Set F7-01 to 4, and then press MF. K to enable the motor to jog reversely.



10. Press to start the motor. The motor shaft starts to rotate and accelerate, and the operating panel displays the current running frequency, as shown in the following figure. After acceleration is completed, the displayed frequency is 50.00. Press to switch the displayed status parameter.



11. Press . The motor will decelerate to stop.

16 Commissioning and Trial Run

16.1 Commissioning Flowchart

16.1.1 Basic Commissioning Flowchart

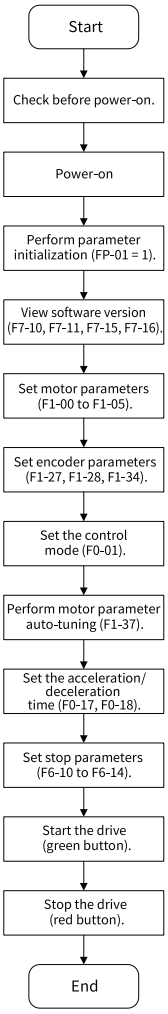


Figure 16-1 Basic commissioning flowchart

Table 16–1 Basic commissioning flowchart

No.	Step	Related Parameter
1	Check before power-on	/
2	Power-on	/
3	Parameter initialization	FP-01
4	View the software version.	F7-10, F7-11, F7-15, F7-16
5	Set motor parameters.	F1-00 to F1-05 Note that you must set the motor type.
6	Set encoder parameters.	F1-27, F1-28, F1-34
7	Set the control mode.	F0-01

No.	Step	Related Parameter
8	Perform motor parameter auto-tuning.	F1-37
9	Set the command source.	F0-02
10	Select the frequency source.	F0-03
11	Set the acceleration and deceleration time.	F0-17, F0-18
12	Set the stop parameters.	F6-10 to F6-14
13	Start	/
14	Stop	/

16.1.2 Commissioning Flowchart in V/f Control Mode

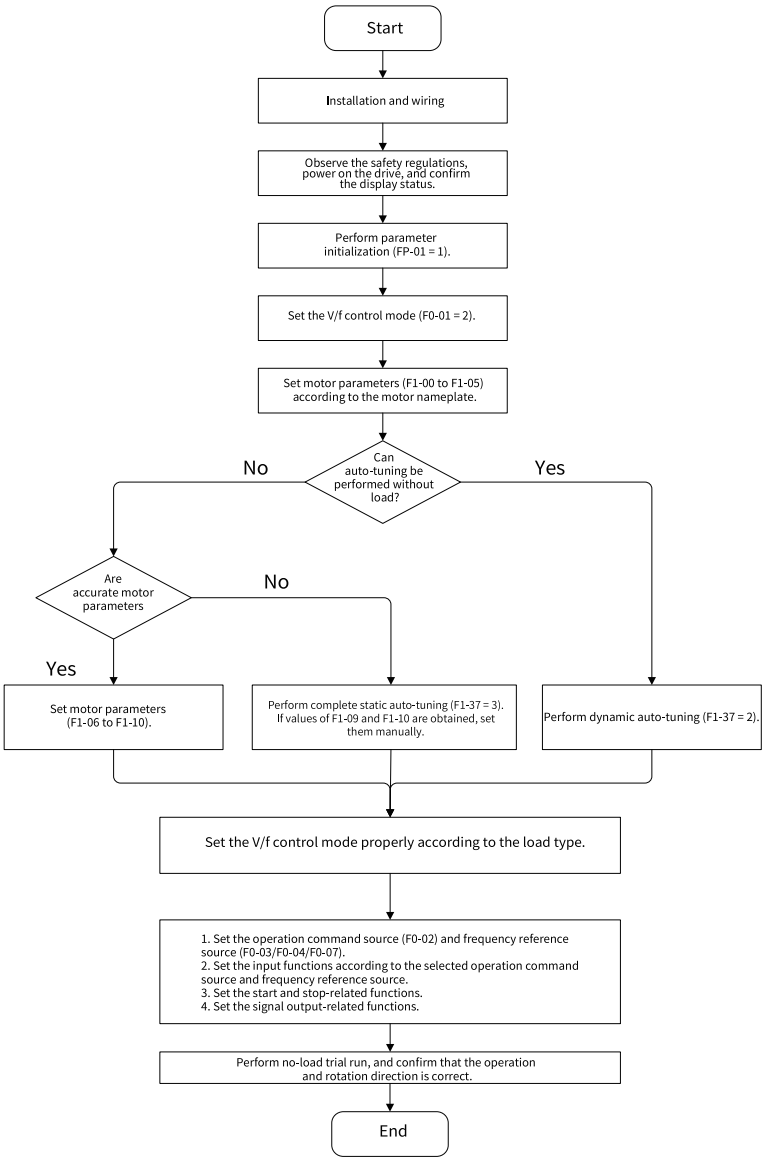


Figure 16-2 Commissioning flowchart in V/f control mode

Note

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

16.1.3 Commissioning Flowchart in SVC Mode

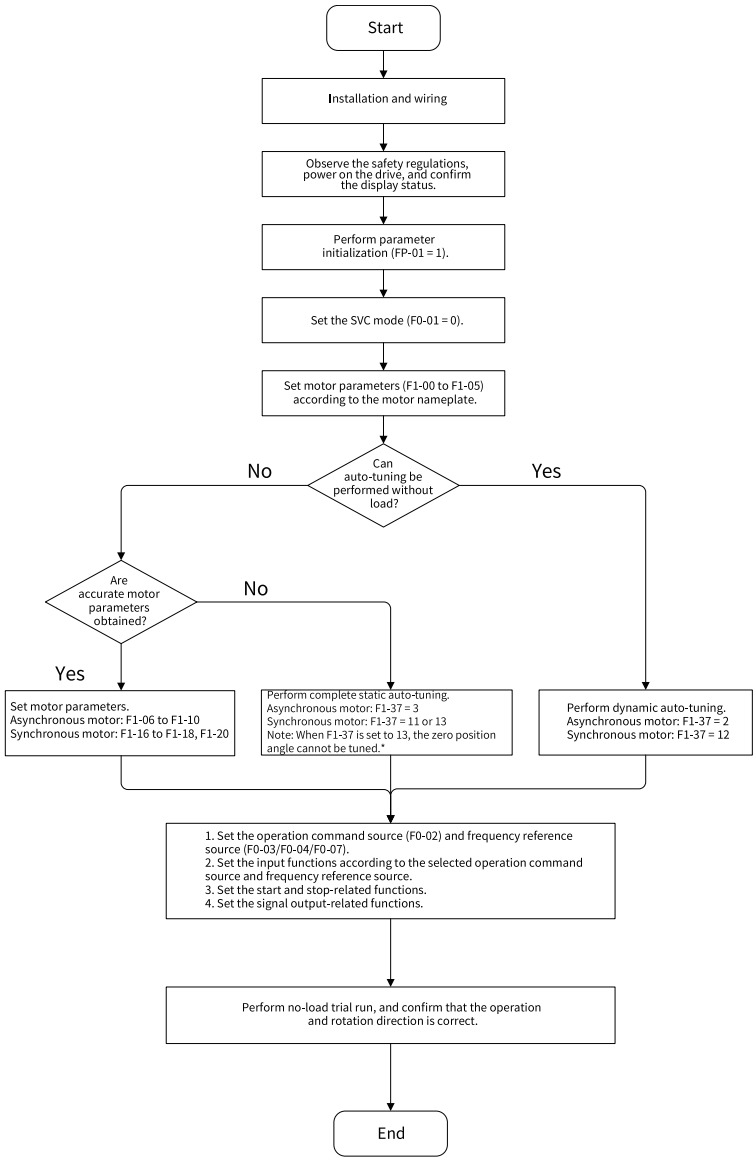


Figure 16-3 Commissioning flowchart in SVC mode

Note

* If bit 0 of A9-09 is enabled and F1-37 is set to 11, the encoder zero position angle will be tuned, but the encoder rotation direction will be not tuned. If F1-37 is set to 13, the encoder will not be tuned. If bit 0 of A9-09 is enabled and F1-37 is set to 11 or 13, the encoder will not be tuned.

During static auto-tuning, the motor will rotate slowly to a certain position when the encoder zero position angle is tuned.

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

16.1.4 Commissioning Flowchart in FVC Mode

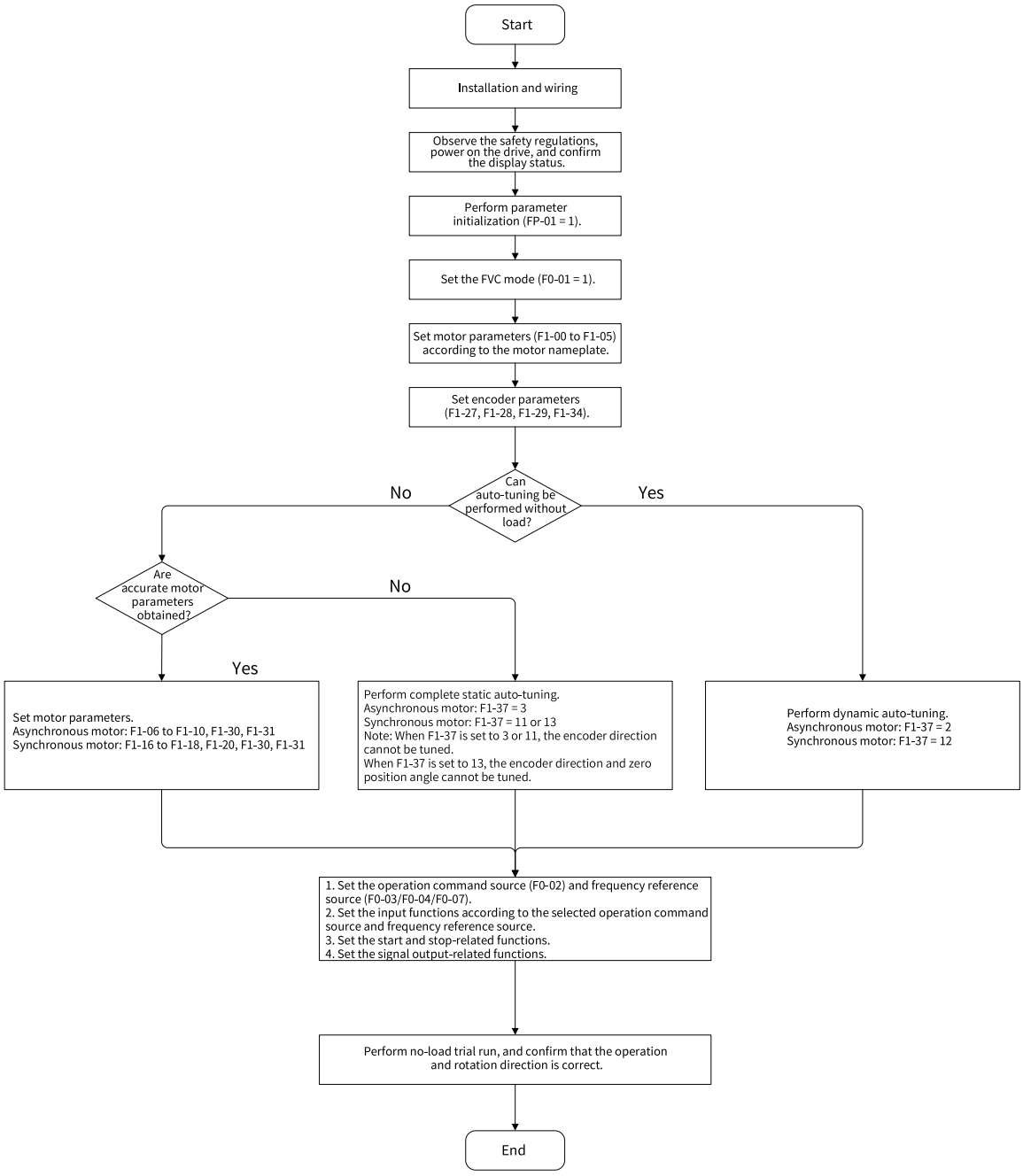


Figure 16-4 Commissioning flowchart in FVC mode

Note

Note:

1. During static auto-tuning, the motor will rotate slowly to a certain position when the encoder zero position angle is tuned.
2. Before static auto-tuning is performed (F1-37 = 11) to tune the zero position angle, check the encoder running direction (F1-30) and set it correctly. At the same time, the motor will rotate slightly static auto-tuning 11 rotates the motor slightly when the encoder zero position angle is tuned.

Encoder direction: The incorrect encoder direction can affect the precise control of the motor by the AC drive. For example, an incorrect direction may cause motor stall. The AC drive will report overload, overcurrent, overheat, and excessive speed deviation faults, which affects the safety and reliability of the system.

Zero position angle: The zero position angle of the motor indicates the position angle of the motor when the magnetic pole is aligned between the stator and the rotor. The following faults will occur when the zero position angle is incorrect:

1. **Positioning error:**An error will occur between the actual position of the motor and the set position. In this case, the position control system cannot locate the position accurately, affecting the operating accuracy of the equipment.
2. **Unstable motion:**Inaccurate zero point angle will cause unsuitability or vibration when the motor executes motion commands, affecting the stability and reliability of the system.
3. **Path deviation:**In applications requiring precise path control (such as manipulators and CNC machines), inaccurate zero position angle may cause path deviation, affecting the quality of processing or operation.
4. **Invalid system protection:**Some systems may rely on the zero position angle to set the safety boundary or limit position. If the zero position angle is not accurate, the system protection mechanism may fail, increasing the risk of mechanical collision or damage.

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

16.2 Commissioning Procedure

16.2.1 Check Before Power-on

Check the following items before power-on.

Table 16–2 Checklist before power-on

Item	Description
Main circuit wiring	Confirm that the power supply voltage is correct. • Three-phase 380 VAC: 3PH 380 VAC to 480 VAC, 50 Hz/60 Hz • Three-phase 220 V: 3PH 200 VAC to 240 VAC, 50 Hz/60 Hz • Single-phase 220 V: 1PH 200 VAC to 240 VAC, 50 Hz/60 Hz
	The power supply input terminals and the AC drive input terminals (R/S/T) are connected properly.
	The motor input terminals and the AC drive output terminals (U/V/W) are connected properly.
	The AC drive and motor are properly grounded.
	The cross sectional area of the main circuit cables meet the requirements.
	Heat-shrinkable tubes are applied to copper tubes of the main circuit cable and conductors, and heat-shrinkable tubes are completely cover the conductors.
	The motor output cable does not exceed 50 m. Otherwise, the carrier frequency needs to be reduced through F0-15.
Control circuit wiring	The control circuit terminals are reliably connected to other control devices.
	The control circuit cables are shielded twisted pairs cables.
	Optional cards are connected correctly.
	Control circuit cables and main circuit power cables are routed separately.
	The control circuit terminals of the AC drive are all in the OFF state (the AC drive is not running).
Load	The motor is in the no-load state and is not connected to any mechanical system.
Braking resistor	The braking resistor and braking unit (if have) with proper resistance are wired properly.

16.2.2 Power-On

Close the power supply switch and check the display on the operating panel of the AC drive. If the operating panel displays 50.00, the AC drive is powered on.



Figure 16-5 Display on the operating panel upon power-on

16.2.3 Parameter Initialization

Parameter Code	Parameter Name	Default	Value Range	Description
FP-01	Parameter initialization	0	0: No action 1: Restore parameters (excluding motor parameters) to factory settings 2: Clear records 4: Back up current user parameters 501: Restore user parameters from backup 503: Restore parameters (including motor parameters) to factory settings	This parameter is used to select the parameter initialization mode. 0: The AC drive does not perform any operation. 1: Most of the AC drive parameters are restored to factory settings. However, motor parameters, frequency reference decimal (F0-22), maximum frequency (F0-10), frequency upper limit (F0-12), fault records, cumulative running time (F7-09), cumulative power-on time (F7-13), cumulative power consumption (F7-14), and drive unit heatsink temperature (F7-07) are not restored. 2: The fault records, cumulative running time (F7-09), cumulative power-on time (F7-13), and cumulative power consumption (F7-14) are cleared. 4: The current parameter settings are backed up. 501: Parameters backed up by setting FP-01 to 4 are restored. 503: All AC drive parameters except FP-00, FP-01, and the parameters in group FF are restored to factory settings.

16.2.4 Software Version Check

Parameter Code	Parameter Name	Value Range	Description
F7-10	Performance software version	0.00 to 655.35	This parameter indicates the performance software version of the AC drive.
F7-11	Function software version	0.00 to 655.35	This parameter indicates the function software version of the AC drive.

Parameter Code	Parameter Name	Value Range	Description
F7-15	Temporary performance software version	0.00 to 655.35	This parameter indicates the temporary performance software version of the AC drive.
F7-16	Temporary function software version	0.00 to 655.35	This parameter indicates the temporary function software version of the AC drive.

16.2.5 Motor Parameter Settings

Parameter Code	Parameter Name	Value Range	Description
F1-00	Motor type	0: Common asynchronous motor 1: Variable frequency asynchronous motor 2: Permanent magnet synchronous motor 3: Reluctance motor without permanent magnet 4: Electromagnetic coil	This parameter is used to set the motor type. 0: Common asynchronous motor A common asynchronous motor is suitable for applications with normal voltage but often full load. It is designed based on constant frequency and constant voltage. Therefore, it may not meet all the frequency and speed control requirements. 1: Variable frequency asynchronous motor A variable frequency motor can adjust its frequency and speed according to the load. When the voltage is low, the variable frequency motor can reduce the frequency for a reliable start. When the load is light, it can reduce the frequency, speed, and current to save electric energy. 2: Permanent magnet synchronous motor A permanent magnet synchronous motor provides excitation with a permanent magnet. It features simple structure, small size, high efficiency, and high power factor. 3: Reluctance motor without permanent magnet The reluctance motor is a synchronous motor without permanent magnet, whose torque output is totally from the magnetic reluctance torque generated from q-axis and d-axis inductance difference. 4: Electromagnetic coil The electromagnetic coil is generally an inductive coil used for applications such as electromagnetic suction force and heating.
F1-01	Rated motor power	0.1 kW to 1000.0 kW	This parameter indicates the power of the motor during normal operation. The rated power of the motor is the rated voltage x rated current of the motor. Select a motor with a proper power rating on the premise that the motor can meet the requirements of mechanical load. Take the motor heat dissipation, allowable overload capacity, and starting capacity into account.
F1-02	Rated motor voltage	1 V to 2000 V	The rated motor voltage indicates the voltage of the motor during normal operation, which usually refers to the line voltage.
F1-03	Rated motor current	0.01 A to 655.35 A (AC drive power ⩽ 55 kW) 0.1 A to 6553.5 A (AC drive power > 55 kW)	The rated motor current indicates the current of the motor during normal operation, which usually refers to the line current.
F1-04	Rated motor frequency	0.01 Hz to F0-10	The rated motor frequency indicates the frequency of the power supply connected to the stator winding under the rated operation conditions of the motor.
F1-05	Rated motor speed	1 rpm to 65535 rpm	The rated motor speed indicates the speed (in the unit of rpm) of the rotor under the rated operation conditions.

Parameter Code	Parameter Name	Value Range	Description
F1-06	Asynchronous motor stator resistance	0.001 Ω to 65.535 Ω	This parameter indicates the DC resistance of stator winding of the asynchronous motor. This parameter can be obtained through motor auto-tuning.
F1-07	Asynchronous motor rotor resistance	0.001 Ω to 65.535 Ω	The motor rotor resistance is the DC resistance of the motor rotor winding, which can be obtained through motor static or dynamic auto-tuning.
F1-08	Leakage inductance of asynchronous motor	0.01 mH to 655.35 mH	The leakage inductance of the asynchronous motor is caused by the leakage flux of motor winding. This parameter can be obtained through motor auto-tuning.
F1-09	Mutual inductance of asynchronous motor	0.1 mH to 6553.5 mH	When the current in one coil of the motor changes, induced EMF is generated in the coil adjacent to it. This mutually induced EMF can be expressed by mutual inductance. The mutual inductance of a motor can be roughly divided into two types. One is the inter-phase inductance of the stator or rotor, which is the reactance between two phases of the stator or rotor. The other is the inductance between the stator and the rotor. The inductance of the first type does not change with the rotation of the rotor, whereas the inductance of the second type changes accordingly with the rotation of the rotor. Both types are motor mutual inductance, which can be obtained by dynamic motor auto-tuning.
F1-10	No-load current of asynchronous motor	0.01 A to F1-03	This parameter indicates the current that passes through the three-phase winding of the stator during no-load operation of the asynchronous motor. The parameter can be obtained by dynamic motor auto-tuning.
F1-17	D axis inductance of synchronous motor	0.01 mH to 655.35 mH	This parameter defines the inductance of the main magnetic pole axis (longitudinal axis) of the synchronous motor. Note: When the power is lower than or equal to 55 kW, the value has two decimal places. When the power is larger than 55 kW, the value has three decimal places.
F1-18	Q axis inductance of synchronous motor	0.01 mH to 655.35 mH	This parameter defines the inductance of the center line (quadrature axis) between the adjacent magnetic pole axes of the synchronous motor rotor.
F1-20	Back EMF of synchronous motor	0.0 V to 6553.5 V	This parameter indicates the valid value of the motor back EMF at the rated motor frequency defined by F1-04.
F1-27	Encoder PPR	1 to 65535	This parameter sets the number of ABZ encoder PPR (total AB pulses per revolution/4), or number of waves per revolution of the sin-cos encoder. In the FVC mode, the encoder PPR must be set properly. Otherwise, the motor cannot run normally. Note: The encoder PPR does not need to be set for the 23-bit encoder.
F1-28	Encoder type	0: ABZ incremental encoder 1: 23-bit encoder 2: Resolver 3: External input 4: Sin-cos encoder	After the PG card is installed, you need to set this parameter properly according to the onsite encoder type to ensure normal running of the AC drive. 0: ABZ incremental encoder 1: 23-bit encoder 2: Resolver 3: External input 4: Sin-cos encoder

Parameter Code	Parameter Name	Value Range	Description
F1-29	Speed feedback PG card	0: Main PG card 1: Auxiliary PG card	This parameter is used to select the speed measuring angle source. 0: Main PG card The main PG card is used to measure the speed. 1: Auxiliary PG card The auxiliary PG card is used to measure the speed. The main PG card and the auxiliary PG card are installed in the J4 and J13 slots of the control board, respectively. It is recommended to set use the main PG card as the speed feedback source for motor control. The auxiliary PG card can be used to obtain the processing control position/ speed.
F1-30	A/B phase sequence of encoder	0: Forward 1: Reverse	In some applications, the direction of the measured encoder speed is opposite to the actual setting. You can change the encoder speed measurement phase sequence through this parameter.
F1-31	Encoder installation angle	0.0° to 359.9°	This parameter indicates the angle between motor zero and encoder zero used by the synchronous motor, which can be obtained through motor auto-tuning.
F1-33	Rated speed of high-speed motor	0 rpm to 65535 rpm (10 rpm)	When the rated speed of the high-speed motor is higher than 60000 rpm, and the value of this parameter is larger than or equal to 6000 (corresponding to 60000 rpm), the parameter value applies; Otherwise, the value of F1-05 applies. The unit is 10 rpm.

16.2.6 Motor Parameter Auto-tuning

Enter motor parameters (F1-00 to F1-05) correctly according to its nameplate. Set F1-37 and press **ENTER**. The operating panel displays TUNE. Press **RUN**. The motor auto-tuning starts. When the operating panel displays the pre-set frequency set by F0-08, the auto-tuning is completed. After auto-tuning, parameters F1-06 to F1-10 are obtained and written.

Parameter Code	Parameter Name	Default	Value Range	Description
F1-37	Motor parameter auto-tuning mode	0	0: Disable 1: Static partial auto-tuning for asynchronous motor 2: Dynamic auto-tuning for asynchronous motor 3: Static complete auto-tuning for asynchronous motor 4: Inertia auto-tuning (To be continued)	For high-performance motor operation, accurate motor parameters are required. Select different motor auto-tuning modes based on the motor type to obtain motor parameters. 0: Disable Parameters are not tuned. 1: Static partial auto-tuning for asynchronous motor This mode is applicable to scenarios where the motor cannot be disconnected from loads and dynamic auto-tuning is not feasible. In this mode, some motor parameters are auto-tuned, including F1-06 (Asynchronous motor stator resistance), F1-07 (Asynchronous motor rotor resistance), and F1-08 (Asynchronous motor leakage inductance). Other parameters use the default values. 2: Dynamic auto-tuning for asynchronous motor This mode is applicable to scenarios requiring high-speed operation. Dynamic auto-tuning can be performed without load or with pure inertia load. Auto-tuning is performed on all the motor parameters, including F1-06 (Asynchronous motor stator resistance), F1-07 (Asynchronous motor rotor resistance), F1-08 (Asynchronous motor leakage inductance), F1-09 (Asynchronous motor mutual inductance), F1-10 (Asynchronous motor no-load current), F1-30 (Encoder phase sequence), motor inertia ratio (A9-17), and friction torque (A9-18). 3: Static complete auto-tuning for asynchronous motor This mode is applicable to scenarios where the motor cannot be disconnected from loads and dynamic complete auto-tuning is not feasible. Auto-tuning is performed on some motor parameters, including F1-06 (Asynchronous motor stator resistance), F1-07 (Asynchronous motor rotor resistance), F1-08 (Asynchronous motor leakage inductance), F1-09 (Asynchronous motor mutual inductance), and F1-10 (Asynchronous motor no-load current). However, F1-09 and F1-10 have higher precision in the dynamic auto-tuning mode than in this mode. 4: Inertia auto-tuning This mode is applicable to scenarios requiring high-speed operation. Auto-tuning can be performed without load or with light load (below 80% of the rated load) or pure inertia load. After auto-tuning is done, A9-17 (Inertia ratio), A9-18 (Friction torque), and A9-16 (Motor time constant) are updated. 5: Dead zone auto-tuning This mode is used to tune the non-linear characteristics of the drive, thus improving the voltage output precision and operation efficiency. The auto-tuned value is saved in BF-22, and BF-23 to BF-38. (To be continued)

Parameter Code	Parameter Name	Default	Value Range	Description
F1-37	Motor parameter auto-tuning mode	0	Continued 5: Dead zone auto-tuning 11: With-load auto-tuning (excluding back EMF) for synchronous motor 12: No-load auto-tuning for synchronous motor (To be continued)	Continued 11: With-load auto-tuning (excluding back EMF) for synchronous motor This mode is applicable to scenarios where the motor cannot be disconnected from the load. The motor may rotate for several revolutions slowly during auto-tuning. Auto-tuned motor parameters include F1-06 (Motor stator resistance), F1-17 (D-axis inductance of synchronous motor), F1-18 (Q-axis inductance of synchronous motor), and F1-31 (Encoder mounting angle) in the FVC mode. F1-30 (Encoder direction) in the FVC mode is not tuned. Note: Before setting the drive to the FVC mode, change the drive to the SVC mode and check that the encoder direction is correct. Then switch the drive to the FVC mode. 12: No-load dynamic complete auto-tuning for synchronous motor This mode is applicable to scenarios where the motor can be disconnected from the load. Auto-tuned motor parameters in the FVC mode include F1-06 (Motor stator resistance), F1-17 (D-axis inductance of synchronous motor), F1-18 (Q-axis inductance of synchronous motor), F1-19 (Synchronous motor back EMF), F1-30 (Encoder phase sequence), and F1-31 (Encoder mounting angle). F1-30 and F1-31 are not tuned in other control modes. (To be continued)
F1-37	Motor parameter auto-tuning mode	0	Continued 13: With-load rotation auto-tuning (excluding zero point angle) for synchronous motor 14: UV gain inter-phase deviation auto-tuning 15: No-load auto-tuning	Continued 13: With-load rotation auto-tuning (excluding zero point angle) for synchronous motor This mode is applicable to scenarios where the motor cannot be disconnected from the load and dynamic complete auto-tuning is not feasible. The motor does not rotate during auto-tuning. Auto-tuned motor parameters include F1-06 (Motor stator resistance), F1-17 (Synchronous motor d-axis inductance), and F1-18 (Synchronous motor q-axis inductance). Encoder parameters are not tuned. Note: Before setting the drive to the FVC mode, change the drive to the SVC mode and check that the encoder direction is correct. Then switch the drive to the FVC mode. 14: UV gain inter-phase deviation auto-tuning The current sampling gain deviation between output phases is tuned. The tuned result is updated in FF-05 (Current sampling gain error between U-phase current and V-phase current) and FF-06 (Current sampling gain error between U-phase current and W-phase current). 15: No-load auto-tuning Based on the tuned results, prepare a table to control the maximum torque-to-current ratio of synchronous reluctance motors.

16.2.7 Command Source Settings

Set F0-02 to select a command source, The command source is the source or input mode of commands to control the startup, stop, forward running, reverse running, and jogging of the AC drive.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-02	Operation command source selection	0	0: Operating panel 1: Terminal 2: Communication 3: User-defined mode	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run, and jog operation. 0: Operating panel Operation commands are input using the keys on the operating panel. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined mode The command source is defined by the user as needed for expansion.

16.2.8 Frequency Source Settings

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

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

16.2.9 Control Mode Settings

Parameter Code	Parameter Name	Default	Value Range	Description
F0-01	Motor 1 control mode	2	0: SVC 1: FVC 2: V/f	This parameter is used to set the motor control mode based on the application scenario and motor type. 0: Sensorless vector control (SVC) It is an open-loop vector control mode, which is applicable to high-performance control applications. In this case, one AC drive can drive only one motor. This mode applies to such loads as machine tools, centrifuges, wire drawing machines, and injection molding machines. Parameter auto-tuning is required in the SVC mode. The effect of the vector control mode is dependent on accurately tuned motor parameters. 1: Feedback vector control (FVC) It is a closed-loop vector control mode. The motor must be configured with an encoder and the AC drive must be installed with a PG card matching the encoder type. This mode is applicable to high-accuracy speed control or torque control applications, where one AC drive can drive only one motor. It is used for loads such as high-speed papermaking machinery, hoisting machinery, and elevators. Parameter auto-tuning is required in the FVC mode. The effect of the vector control mode is dependent on accurately tuned motor parameters. 2: V/f control (speed open loop control) This mode is applicable to scenarios without high requirements on load control performance, such as fans and pumps. The V/f control mode is the only choice if one AC drive needs to drive multiple motors. Motor parameters must be set accurately in this mode. If one AC drive needs to drive multiple motors, the total current and total power must be determined.

16.2.10 (Optional) V/f Parameter Settings

Parameter Code	Parameter Name	Default	Value Range	Description
F3-00	V/f curve setting	0	0: Linear V/f curve 1: Multi-point V/f curve 2-9: Reserved 10: V/f complete separation mode 11: V/f semi-separation mode	0: Linear V/f curve The output voltage changes linearly with the output frequency when the frequency is lower than the rated frequency. This curve applies to general mechanical transmission applications such as acceleration of high-inertia fans, punch presses, centrifuges, and water pumps. 1: Multi-point V/f curve The frequency ranges from 0.00 Hz to the rated motor frequency. The range of the voltage point is 0.0% to 100.0%, which corresponds to 0 V to the rated motor voltage. Set the multi-point V/f curve based on load characteristics of the motor. Observe this formula during settings: F3-03 ⩽ F3-05 ⩽ F3-07 10: V/f complete separation mode The output frequency and output voltage of the drive are independent of each other. The output frequency is determined by the frequency source, and the output voltage is determined by the V/f separation voltage source. This curve applies to torque motor control applications. 11: V/f semi-separation mode In this mode, the voltage and frequency are proportional, which can be set through the voltage source. The relationship between the voltage and frequency is also related to the rated voltage and rated frequency of the first group of the motor. The relationship between the output voltage of the drive (V) and frequency (f) is as follows: V/f = 2 x (Voltage source input) x (Rated motor voltage)/(Rated motor frequency). Note: The input value of the voltage source is 0 to 100%.

16.2.11 (Optional) SVC Parameter Settings

Parameter Code	Parameter Name	Value Range	Default	Description
F2-00	Speed loop proportional gain 1	1 to 300	Asynchronous motor: 30 Synchronous motor: 20	This parameter sets the low-speed speed loop gain Kp. This is the PID control parameter Kp for the speed loop, which affects the response to the motor speed. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity. The low-speed speed loop Kp is used at the low speed.
F2-01	Speed loop integral time 1	0.01s-10.0 0s	0.50s	This parameter sets the low-speed speed loop integral time Ti. The reciprocal of the speed loop integral time constant is the integral gain. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. If the speed loop integral time constant increases, the speed loop response slows down. At this time, the proportional gain of the speed loop needs to be increased to shorten the speed loop response time. The low-speed speed loop Ti is used at the low speed.

Parameter Code	Parameter Name	Value Range	Default	Description
F2-02	Switchover frequency 1	0.00 Hz to F2-05	5.00 Hz	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. The parameter value must be lower than F2-05 (Switchover frequency 2).
F2-03	Speed loop proportional gain 2	1 to 300	20	This parameter sets the high-speed speed loop gain Kp. This is the PID control parameter Kp for the speed loop, which affects the response to the motor speed. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity. The high-speed speed loop Kp is used at the high speed.
F2-04	Speed loop integral time 2	0.01s-10.0 0s	1.00s	This parameter sets the high-speed speed loop integral time Ti. The reciprocal of the speed loop integral time constant is the integral gain. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. If the speed loop integral time constant increases, the speed loop response slows down. At this time, the proportional gain of the speed loop needs to be increased to shorten the speed loop response time. The high-speed speed loop Ti is used at the high speed.
F2-05	Switchover frequency 2	F2-02 to F0-10	10.00 Hz	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. This parameter must be set to a value higher than F2-02 (Switchover frequency 1).
F2-06	Vector control slip gain	50% to 200%	100%	In the SVC mode, this parameter is used to adjust the speed stability accuracy of the motor. For example, when the running frequency of the motor is lower than the output frequency of the AC drive, you can increase the value of this parameter. In the FVC mode, this parameter is used to adjust the output current of the AC drive with the same load. For example, if the load capacity of a high-power AC drive is weak, decrease the value of this parameter gradually. No adjustment is required under normal circumstances.

16.2.12 (Optional) FVC Parameter Settings

Parameter Code	Parameter Name	Value Range	Default	Description
F1-27	Encoder PPR	1 to 65535	1024	This parameter sets the number of ABZ encoder PPR (total AB pulses per revolution/4), or number of waves per revolution of the sin-cos encoder. In the FVC mode, the encoder PPR mus be set properly. Otherwise, the motor cannot run normally. Note: The encoder PPR does not need to be set for the 23-bit encoder.
F1-28	Encoder type	0: ABZ incremental encoder 1: 23-bit encoder 2: Resolver 3: External input 4: Sin-cos encoder	0	After the PG card is installed, you need to set this parameter properly according to the onsite encoder type to ensure normal running of the AC drive. 0: ABZ incremental encoder 1: 23-bit encoder 2: Resolver 3: External input 4: Sin-cos encoder
F1-34	Number of resolver pole pairs	1 to 65535	1	This parameter indicates the number of pole pairs of the resolver. The higher the number of pole pairs, the higher the precision. A resolver is an electromagnetic transducer, also known as a synchronous resolver. It is a small AC motor used to measure angles, and measure shaft angular displacement and angular velocity of a rotating object. It consists of stators and rotors. If a resolver is applied, set the number of pole pairs of the resolver properly. The number of resolver pole pairs must be less than or equal to the number of motor pole pairs, and the number of motor pole pairs divided by the number of resolver pole pairs must be an integer.
F2-00	Speed loop proportional gain 1	1 to 300	30: Asynchronous motor 20: Synchronous motor	This parameter sets the low-speed speed loop gain Kp. The value of speed loop Kp affects the response speed of the motor speed. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity. The low-speed speed loop Kp is used at the low speed.
F2-01	Speed loop integral time 1	0.01s to 10.00s	0.50s	This parameter sets the low-speed speed loop integral time Ti. The reciprocal of the speed loop integral time constant is the integral gain. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. Increasing the speed loop integral time constant slows down the response of the speed loop. In this case, increase the speed loop proportional gain to shorten the response time of the speed loop. The low-speed speed loop Ti is used at the low speed.

Parameter Code	Parameter Name	Value Range	Default	Description
F2-02	Switchover frequency 1	0.00 Hz to F2-05	5.00 Hz	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. The parameter value must be lower than F2-05 (Switchover frequency 2).
F2-03	Speed loop proportional gain 2	1 to 300	20	This parameter sets the high-speed speed loop gain Kp. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity.
F2-04	Speed loop integral time 2	0.01s to 10.00s	1.00s	This parameter sets the high-speed speed loop integral time Ti. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. Increasing the speed loop integral time constant slows down the response of the speed loop. In this case, increase the speed loop proportional gain to shorten the response time of the speed loop.
F2-05	Switchover frequency 2	F2-02 to F0-10	10.00 Hz	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. This parameter must be set to a value higher than F2-02 (Switchover frequency 1).
F2-06	Vector control slip gain	50% to 200%	100%	In the SVC mode, this parameter is used to adjust the speed stability accuracy of the motor. For example, when the running frequency of the motor is lower than the output frequency of the AC drive, you can increase the value of this parameter. In the FVC mode, this parameter is used to adjust the output current of the AC drive under the same load. For example, if the load capacity of a high-power AC drive is weak, decrease the value of this parameter gradually. No adjustment is required under normal circumstances.
F2-07	Speed loop feedback filter time in SVC mode	0.000s to 0.100s	0.015s	In the SVC mode (F0-01 = 0), the speed loop feedback filter time is effective. Adjusting the parameter can improve the motor stability. Increasing the value of this parameter enhances motor stability but slows down the dynamic response speed. Decreasing the value of this parameter speeds up dynamic response. Note that an excessively low value will lead to motor oscillation. The default value of this parameter applies to most of applications.

16.2.13 Acceleration/Deceleration Time Settings

Parameter Code	Parameter Name	Default	Value Range	Description
F0-17	Acceleration time 1	20.0s	0.0s to 6500.0s	This parameter indicates the time required for the output frequency to increase from 0 to the value of F0-25. The acceleration time is usually determined by the rising of frequency setting signal. When the motor accelerates, the rising rate of the frequency reference must be limited to prevent overcurrent. Acceleration time setting requirements: The acceleration current must be limited below the overcurrent capacity of the AC drive, so as not to cause the AC drive to trip due to overcurrent stall.
F0-18	Deceleration time 1	20.0s	0.0s to 6500.0s	This parameter indicates the time required for the output frequency to decrease from the value of F0-25 to 0. The deceleration time is usually determined by the falling of frequency setting signal. When the motor decelerates, the dropping rate of the frequency must be limited to prevent overvoltage. Deceleration time setting requirements: Avoid too large smoothing circuit voltage, so as not to cause the AC drive to trip due to overvoltage stall.
F0-25	Acceleration/ deceleration time base frequency	0	0: F0-10 (Maximum frequency) 1: Frequency reference 2: 100 Hz 3: Rated frequency	This parameter sets the acceleration/deceleration time base frequency. This parameter defines the target frequency during acceleration and the starting frequency during deceleration.

16.2.14 (Optional) Startup Mode Settings

- Direct start: This mode is applicable to most load conditions. Startup with the startup frequency is applicable to load hoisting applications such as elevators and cranes.
- Flying start: This mode is applicable to scenarios where the motor is not static before AC drive startup, for example, restart of a large-inertia fan upon an instantaneous power failure. In some scenarios, the motor is rotating before the AC drive is started. This mode allows the AC drive to automatically follow the motor speed and direction to start smoothly without impacting the running motor. For example, when an instantaneous power failure of the grid occurs, the AC drive in the running state is powered off, but the motor is still running due to inertia. In this case, the AC drive must detect the actual speed of the motor to control the asynchronous motor again. Otherwise, overcurrent or overvoltage will occur on the AC drive during start, which may damage the power transistor of the AC drive.
- Vector pre-excitation start (AC asynchronous motor): This mode is applicable to scenarios with large static load resistance that requires large start torque. Pre-excitation start can increase the start torque. This mode is applicable to asynchronous motors only in the SVC and FVC modes. Before startup, the AC drive pre-excites the motor to speed up the motor response and reduce the startup current. This mode follows the same time sequence as startup after DC braking.
- SVC quick start: This mode is applicable to most load conditions. Startup with the startup frequency is applicable to load hoisting applications such as elevators and cranes.

Note

Note: Use flying start to start a motor that is rotating at a high speed. Pre-excitation start and SVC quick start are applicable only to AC asynchronous motors.

Parameter Code	Parameter Name	Default	Value Range	Description
F6-00	Start mode	0	0: Direct start 1: Flying start 2: Pre-excitation start (AC asynchronous motor) 3: SVC quick start	This parameter is used to set the start mode of the motor. Flying start is recommended if you need to start a motor that is rotating at a high speed. Pre-excitation start and SVC quick start apply only to AC asynchronous motors. 0: Direct start The direct start mode applies to most load conditions. 1: Flying start In this mode, the drive first determines the motor rotation speed and direction, and then starts at the detected frequency of the motor. 2: Pre-excitation start (AC asynchronous motor) This mode is applicable to inductive AC asynchronous motors only in the SVC and FVC modes. Before startup, the AC drive pre-excites the motor to speed up the motor response and reduce the startup current. 3: SVC quick start This mode is applicable to asynchronous motors only in SVC mode, which can shorten acceleration time. It is used when system inertia is large and quick start is required. However, torque impact exists in this mode.

16.2.15 (Optional) Startup Frequency Settings

Parameter Code	Parameter Name	Default	Value Range	Description
F6-03	Startup frequency	0.00 Hz	0.00 Hz to 10.00 Hz	This parameter defines the startup frequency for direct start of the AC drive. When the startup frequency is higher than the frequency reference, the AC drive will not start but stay standby.
F6-04	Startup frequency holding time	0.0s	0.0s to 100.0s	This parameter defines the time during which the output frequency remains at the startup frequency. After the time elapses, the AC drive will accelerate/decelerate from the output frequency to the reference frequency.

16.2.16 (Optional) S-curve Settings

Parameter Code	Parameter Name	Default	Value Range	Description
F6-07	Acceleration/ Deceleration mode	0	0: Linear acceleration/ deceleration 1: S-curve acceleration/ deceleration	This parameter is used to select the acceleration/deceleration mode of the AC drive. 0: Linear acceleration/deceleration The output frequency increases or decreases linearly. 1: S-curve acceleration/deceleration When the target frequency changes dynamically in real time, the output frequency increases or decreases based on the S-curve. This mode is applicable to applications requiring smooth operation and quick response in real time.
F6-08	Time proportion of S-curve start segment	30.0%	0.0% to (100.0% to F6-09)	The value ranges from 0.0 to 100.0% minus the value of F6-09.
F6-09	Time proportion of S-curve end segment	30.0%	0.0% to (100.0% to F6-08)	The value ranges from 0.0 to 100.0% minus the value of F6-08.

16.2.17 Stop Parameter Settings

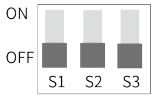
Parameter Code	Parameter Name	Value Range	Default	Description
F6-10	Stop mode	0: Decelerate to stop 1: Coast to stop 2: Stop at maximum capability	0	This parameter is used to select the stop mode of the AC drive. 0: Decelerate to stop After the stop command becomes active, the AC drive decreases the output frequency based on the deceleration time, and stops when the frequency is reduced to 0. 1: Coast to stop After the stop command becomes active, the drive stops output immediately and the motor coasts to stop based on the mechanical inertia. 2: Stop at maximum capability. The motor speed reference is set to 0 forcibly. The motor decelerates to 0 based on the maximum output capacity. The motor torque or current may reach the limit value during deceleration.
F6-11	Start frequency of DC braking for stop	0.00 Hz to F0-10	0.00 Hz	During decelerating to stop, the drive starts DC braking when the operating frequency drops below the value of F6-11.
F6-12	Waiting time of DC braking for stop	0.0s to 100.0s	0.0s	When the operating frequency decreases to the start frequency of DC braking for stop, the drive stops output for a period set by F6-12 and then starts DC braking. This prevents faults such as overcurrent caused by DC braking at a high speed.

Parameter Code	Parameter Name	Value Range	Default	Description
F6-13	DC braking current for stop	0% to 100%	50%	The higher the DC braking current, the stronger the braking force. The value 100.0% corresponds to the rated current of the motor. The default upper limit of the DC braking current for stop is 80% of the rated drive current, which can be set by F6-34. The maximum upper limit of the DC braking current for stop is 135% of the rated drive current.
F6-14	DC braking time for stop	0.0s to 100.0s	0.0s	This parameter specifies the holding time of DC braking. If it is set to 0, DC braking is disabled.

16.2.18 (Optional) AI Settings

Functions of the AI can be set by using the DIP switches on the main control board, as summarized in the following table.

Table 16–3 Descriptions of DIP switches S1 to S3

DIP Switch Diagram	DIP Switch Status			Function Description
	S1	S2	S3	
	OFF	OFF	OFF	Voltage mode with the range of 0 VDC to 10 VDC for AI2
	ON	OFF	OFF	Temperature mode for AI2 Set the temperature sensor type through F9-75. 0: Temperature sensor not supported (AI used for analog input) 1: PT100, supporting the temperature range of -25°C to 200°C 2: PT1000, supporting the temperature range of -25°C to 200°C 3: KTY84-130, supporting the temperature range of -40°C to 260°C 4: PTC130, supporting the temperature range of -20°C to 180°C
	OFF	ON	OFF	Current mode for AI2; current range: 0 mA to 20 mA; input impedance: 500 Ω
	OFF	ON	ON	Current mode for AI2; current range: 0 mA to 40 mA; input impedance: 250 Ω

Note

S1, S2, and S3 are DIP switches used in combination. For details, see *"Table 16–3" on page 347*.

Table 16–4 Related parameters

Parameter Code	Parameter Name	Value Range	Default	Description
F4-13	Minimum input of AI curve 1	-10.00 V to F4-15	0.00 V	When the main frequency is set by the AI, each AI supports five types of AI curves. The AI curve is used to set the relationship between the analog input voltage (or current) and the percentage corresponding to the maximum frequency (F0-10). The x axis of the AI curve represents the analog input voltage or current, and the y axis represents the set value corresponding to the analog input, which is the percentage of the maximum frequency (F0-10). Five AI curves are provided. Curves 1 to 3 are two-point curves, and their relevant parameters are F4-13 to F4-27. Curves 4 and 5 are four-point curves, and their relevant parameters are A6-00 to A6-15. The two points on curves 1 to 3 are the minimum input point and maximum input point, respectively. F4-13 corresponds to the x axis of the AI curve 1 minimum input, that is, the minimum analog input voltage or current.
F4-14	Percentage corresponding to minimum input of AI curve 1	-100.0% to 100.0%	0.0%	F4-14 corresponds to the y axis of AI curve 1 minimum input, that is, the set value corresponding to the minimum analog input.
F4-15	Maximum input of AI curve 1	F4-13 to 10.00 V	10.00 V	F4-15 corresponds to the x axis of AI curve 1 maximum input, that is, the maximum analog input voltage or current.
F4-16	Percentage corresponding to maximum input of AI curve 1	-100.0% to 100.0%	100.0%	F4-16 corresponds to the y axis of AI curve 1 maximum input, that is, the set value corresponding to the maximum analog input.
F4-17	AI1 filter time	0.00s to 10.00s	0.10s	This parameter indicates the software filter time of AI1. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-18	Minimum input of AI curve 2	-10.00 V to F4-20	0.00 V	F4-18 corresponds to the x axis of the AI curve 2 minimum input, that is, the minimum analog input voltage or current.
F4-19	Percentage corresponding to minimum input of AI curve 2	-100.0% to 100.0%	0.0%	F4-19 corresponds to the y axis of AI curve 2 minimum input, that is, the set value corresponding to the minimum analog input.
F4-20	Maximum input of AI curve 2	F4-18 to 10.00 V	10.00 V	F4-20 corresponds to the x axis of AI curve 2 maximum input, that is, the maximum analog input voltage or current.

Parameter Code	Parameter Name	Value Range	Default	Description
F4-21	Percentage corresponding to maximum input of AI curve 2	-100.0% to 100.0%	100.0%	F4-21 corresponds to the y axis of AI curve 2 maximum input, that is, the set value corresponding to the maximum analog input.
F4-22	AI2 filter time	0.00s to 10.00s	0.10s	This parameter indicates the software filter time of AI2. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-23	Minimum input of AI curve 3	-10.00 V to F4-25	-10.00 V	F4-23 corresponds to the x axis of the AI curve 3 minimum input, that is, the minimum analog input voltage or current.
F4-24	Percentage corresponding to minimum input of AI curve 3	-100.0% to 100.0%	-100.0%	F4-24 corresponds to the y axis of AI curve 3 minimum input, that is, the set value corresponding to the minimum analog input.
F4-25	Maximum input of AI curve 3	F4-23 to 10.00 V	10.00 V	F4-25 corresponds to the x axis of AI curve 3 maximum input, that is, the maximum analog input voltage or current.
F4-26	Percentage corresponding to maximum input of AI curve 3	-100.0% to 100.0%	100.0%	F4-26 corresponds to the y axis of AI curve 3 maximum input, that is, the set value corresponding to the maximum analog input.
F4-27	AI3 filter time	0.00s to 10.00s	0.10s	This parameter indicates the software filter time of AI3. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.

Parameter Code	Parameter Name	Value Range	Default	Description
F4-33	AI curve selection	Ones place: AI1 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15) Tens place: AI2 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15) Hundreds place: AI3 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15)	801	The ones to hundreds places of this parameter are used to select curves for AI1 to AI3. Each digit can be used to set a curve for an AI. Different AIs can be set with the same curve.
A6-00	Minimum input of AI curve 4	-10.00 V to A6-02	0.00 V	A6-00 corresponds to the x axis of the AI curve 4 minimum input, that is, the minimum analog input voltage or current.
A6-01	Percentage corresponding to minimum input of AI curve 4	-100.0% to 100.0%	0.0%	A6-01 corresponds to the y axis of AI curve 4 minimum input, that is, the set value corresponding to the minimum analog input.
A6-02	Inflection point 1 input of AI curve 4	A6-00 to A6-04	3.00 V	A6-02 corresponds to the x axis of the AI curve 4 inflection point 1, that is, the minimum analog input voltage.
A6-03	Percentage corresponding to inflection point 1 input of AI curve 4	-100.0% to 100.0%	30.0%	A6-03 corresponds to the y axis of the AI curve 4 inflection point 1, that is, the set value corresponding to the minimum analog input.
A6-04	Inflection point 2 input of AI curve 4	A6-02 to A6-06	6.00 V	A6-04 corresponds to the x axis of the AI curve 4 inflection point 2, that is, the minimum analog input voltage.

Parameter Code	Parameter Name	Value Range	Default	Description
A6-05	Percentage corresponding to inflection point 2 input of AI curve 4	-100.0% to 100.0%	60.0%	A6-05 corresponds to the y axis of the AI curve 4 inflection point 2, that is, the set value corresponding to the minimum analog input.
A6-06	Maximum input of AI curve 4	A6-04 to 10.00 V	10.00 V	A6-06 corresponds to the x axis of AI curve 4 maximum input, that is, the maximum analog input voltage or current.
A6-07	Percentage corresponding to maximum input of AI curve 4	-100.0% to 100.0%	100.0%	A6-07 corresponds to the y axis of AI curve 4 maximum input, that is, the set value corresponding to the maximum analog input.
A6-08	Minimum input of AI curve 5	-10.00 V to A6-10	-10.00 V	A6-08 corresponds to the x axis of the AI curve 5 minimum input, that is, the minimum analog input voltage or current.
A6-09	Percentage corresponding to minimum input of AI curve 5	-100.0% to 100.0%	-100.0%	A6-09 corresponds to the y axis of AI curve 5 minimum input, that is, the set value corresponding to the minimum analog input.
A6-10	Inflection point 1 input of AI curve 5	A6-08 to A6-12	-3.00 V	A6-10 corresponds to the x axis of the AI curve 5 inflection point 1, that is, the minimum analog input voltage.
A6-11	Percentage corresponding to inflection point 1 input of AI curve 5	-100.0% to 100.0%	-30.0%	A6-11 corresponds to the y axis of the AI curve 5 inflection point 1, that is, the set value corresponding to the minimum analog input.
A6-12	Inflection point 2 input of AI curve 5	A6-10 to A6-14	3.00 V	A6-12 corresponds to the x axis of the AI curve 5 inflection point 2, that is, the minimum analog input voltage.
A6-13	Percentage corresponding to inflection point 2 input of AI curve 5	-100.0% to 100.0%	30.0%	A6-13 corresponds to the y axis of the AI curve 5 inflection point 2, that is, the set value corresponding to the minimum analog input.
A6-14	Maximum input of AI curve 5	A6-12 to 10.00 V	10.00 V	A6-14 corresponds to the x axis of AI curve 5 maximum input, that is, the maximum analog input voltage or current.
A6-15	Percentage corresponding to maximum input of AI curve 5	-100.0% to 100.0%	100.0%	A6-15 corresponds to the y axis of AI curve 5 maximum input, that is, the set value corresponding to the maximum analog input.
A6-24	AI1 jump point	-100.0% to 100.0%	0.0%	This parameter is used to set the AI1 jump point. If the input value is within the range from A6-24 - A6-25 to A6-24 + A6-25, the value of the AI1 jump point (A6-24) will be output.
A6-25	AI1 jump amplitude	0.0% to 100.0%	0.1%	This parameter is used to set the AI1 jump amplitude. If the input value is within the range from A6-24 - A6-25 to A6-24 + A6-25, the value of the AI1 jump point (A6-24) will be output.
A6-26	AI2 jump point	-100.0% to 100.0%	0.0%	This parameter is used to set the AI2 jump point. If the input value is within the range from A6-26 - A6-27 to A6-26 + A6-27, the value of the AI2 jump point (A6-26) will be output.

Parameter Code	Parameter Name	Value Range	Default	Description
A6-27	AI2 jump amplitude	0.0% to 100.0%	0.1%	This parameter is used to set the AI2 jump amplitude. If the input value is within the range from A6-26 - A6-27 to A6-26 + A6-27, the value of the AI2 jump point (A6-26) will be output.
A6-28	AI3 jump point	-100.0% to 100.0%	0.0%	This parameter is used to set the AI3 jump point. If the input value is within the range from A6-28 - A6-29 to A6-28 + A6-29, the value of the AI3 jump point (A6-28) will be output.
A6-29	AI3 jump amplitude	0.0% to 100.0%	0.1%	This parameter is used to set the AI3 jump amplitude. If the input value is within the range from A6-28 - A6-29 to A6-28 + A6-29, the value of the AI3 jump point (A6-28) will be output.
A6-30	AI automatic adjustment curve	Ones place: Point selection (for settings) 0: Disable 1: Point 1 2: Point 2 3: Point 3 4: Point 4 Tens place: AI channel selection (for settings) 0: Disable 1: AI1 2: AI2 3: AI3 Hundreds place: Control function (for settings) 0: Disable 1: Enable Thousands place: X-point curve (for display) 0: The control function is disabled or the channel is not selected. 2: 2-point curve 4: 4-point curve Ten thousands place: Reserved	0	You can set different AI curves, curve types (2-point curve or 4-point curve), and control functions through the ones, tens, hundreds, thousands, and ten thousands places of this parameter.
A6-31	AI1 input	0: Disable 1: Enable Others: B connector	1	-
A6-32	AI2 input	0: Disable 1: Enable Others: B connector	1	-
A6-33	AI3 input	0: Disable 1: Enable Others: B connector	1	-

Parameter Code	Parameter Name	Value Range	Default	Description
A6-34	AI polarity selection	Ones position: AI1 0: Normal value 1: Absolute value 2: Opposite to the normal value 3: Opposite to the absolute value Tens position: AI2 0: Normal value 1: Absolute value 2: Opposite to the normal value 3: Opposite to the absolute value Hundreds position: AI3 0: Normal value 1: Absolute value 2: Opposite to the normal value 3: Opposite to the absolute value	0	You can set AI1, AI2, and AI3 input polarities through the ones, tens, and hundreds places of this parameter. 0: Normal value 1: Absolute value 2: Opposite to the normal value 3: Opposite to absolute value
A6-35	AI hardware source selection	Ones place: AI1 source 0: Hardware sampling 1: Forced value Tens place: AI2 source 0: Hardware sampling 1: Forced value Hundreds place: AI3 source 0: Hardware sampling 1: Forced value	0	You can set AI1, AI2, and AI3 hardware sources through the ones, tens, and hundreds places of this parameter. If the source is set to 0 (hardware sampling), the AI value is sourced from hardware sampling. If the source is set to 1 (forced value), the AI value can be forcibly set through parameters A6-36 to A6-38.
A6-36	AI1 forced value	-10.00 V to 10.00 V	0.00 V	If the ones place of A6-35 is set to 1 (forced value), you can set the AI1 value forcibly through A6-36.
A6-37	AI2 forced value	-10.00 V to 10.00 V	0.00 V	If the tens place of A6-35 is set to 1 (forced value), you can set the AI2 value forcibly through A6-37.
A6-38	AI3 forced value	-10.00 V to 10.00 V	0.00 V	If the hundreds place of A6-35 is set to 1 (forced value), you can set the AI3 value forcibly through A6-38.
A6-39	High level judgment threshold when AI uses as DI	5.5 V to 9.0 V	7.0 V	This parameter defines the threshold for judging high level when the AI is used as the DI.
A6-40	Low level judgment threshold when AI uses as DI	1.0 V to 4.5 V	3.0 V	This parameter defines the threshold for judging low level when the AI is used as the DI.
A6-41	AI1 gain	-10.00 to +10.00	1.00	This parameter defines the gain multiple of AI1 analog sampling value.
A6-42	AI1 offset	-10.00 V to 10.00 V	0.00 V	This parameter defines the zero offset coefficient for AI1 correction voltage.

Parameter Code	Parameter Name	Value Range	Default	Description
A6-43	AI1 denoising threshold	0.0% to 100.0%	0.0%	This parameter defines the AI1 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-44	AI1 dead zone width	0.0% to 100.0%	0.0%	This parameter defines the AI1 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.
A6-47	AI2 gain	-10.00 to +10.00	1.00	This parameter defines the gain multiple of AI2 analog sampling value.
A6-48	AI2 offset	-10.00 V to 10.00 V	0.00 V	This parameter defines the AI2 analog sampling offset.
A6-49	AI2 denoising threshold	0.0% to 100.0%	0.0%	This parameter defines AI2 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-50	AI2 dead zone width	0.0% to 100.0%	0.0%	This parameter defines the AI2 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.
A6-53	AI3 gain	-10.00 to +10.00	1.00	This parameter defines the gain factor of AI3 analog sampling measurement.
A6-54	AI3 offset	-10.00 V to 10.00 V	0.00 V	This parameter defines the AI3 analog sampling offset.
A6-55	AI3 denoising threshold	0.0% to 100.0%	0.0%	This parameter defines AI3 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-56	AI3 dead zone width	0.0% to 100.0%	0.0%	This parameter defines the AI3 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.

16.2.19 (Optional) AO Settings

Parameter Code	Parameter Name	Default	Value Range	Description
F5-07	AO1 output function selection	0	0: Operating frequency 1: Frequency reference 2: Output current 3: Output torque (absolute value) 4: Output power 5: Output voltage 6: Pulse input 7: AI1 8: AI2 9: AI3 10: Length 11: Count value 12: Communication 13: Motor speed 14: Output current (100.0% corresponds to 1000.0 A.) 15: Bus voltage (100.0% corresponding to 1000.0 V.) 16: Output torque (actual value) Others: F connector	0: Running frequency. 100.0% corresponds to the maximum frequency (F0-10). 1: Frequency reference. 100.0% corresponds to the maximum frequency (F0-10). 2: Output current. 100.0% corresponds to two times the rated motor current. 3: Output torque. 100.0% corresponds to two times the rated motor torque (absolute value). 4: Output power. 100.0% corresponds to two times the rated motor power. 5: Output voltage. 100.0% corresponds to 1.2 times the rated motor voltage. 6: Pulse input. 100.0% corresponds to 100.0 kHz. 7: AI1. 100.0% corresponds to 10 V. 8: AI2. 100.0% corresponds to 10 V. 9: AI3. 100.0% corresponds to 10 V. 10: Length. 100.0% corresponds to FB-05. 11: Count value. 100.0% corresponds to FB-08. 12: Communication. 100.0% corresponds to the AO communication setting value. 13: Motor speed. 100.0% corresponds to the maximum frequency (F0-10). 14: Output current. 100.0% corresponds to 1000.0 A. 15: Bus voltage. 100.0% corresponds to 1000.0 V. 16: Output torque. 100.0% corresponds to two times the rated motor torque, 50.0% corresponds to 0, and 0 corresponds to negative two times the rated motor torque (actual value). Others: F connector When this option is selected, the output function is the signal or function state of the parameter to which the connector is connected.
F5-08	Output function selection of AO2 on expansion card	1		

16.2.20 (Optional) DI Settings

Parameter Code	Parameter Name	Default	Value Range	Description
F4-00	DI1 function selection	1	0: No function 1: Forward run (IN1) 2: Reverse run (IN2) 3: Three-wire control (IN3) 4: Forward jog (FJOG) 5: Reverse jog (RJOG) 6: Function as UP key for frequency adjustment 7: Function as DOWN key for frequency adjustment 8: Coast to stop 9: Fault reset (RESET) 10: Running pause 11: NO input of external fault 12: Multi-reference terminal 1 13: Multi-reference terminal 2 14: Multi-reference terminal 3 15: Multi-reference terminal 4 16: Terminal 1 for acceleration/ deceleration selection 17: Terminal 2 for acceleration/ deceleration selection 18: Frequency command switchover 19: Clear data set by UP/DOWN key or by terminal functioning as UP/DOWN key 20: Command source switchover terminal 1 21: Acceleration/Deceleration inhibition 22: PID pause 23: Simple PLC state reset 24: Wobble frequency pause 25: Counter input 26: Counter reset 27: Length input 28: Length reset 29: Torque control inhibition 30: Pulse frequency input (valid only for DI5) 31: Reserved 32: Immediate DC braking 33: NC input of external fault 34: Frequency modification enable 35: Opposite to the PID action direction 36: External stop terminal 1 37: Command source switchover terminal 2 38: PID integral pause 39: Switchover between main frequency X and preset frequency 40: Switchover between auxiliary frequency Y and preset frequency 41: Motor selection terminal 1 42: Reserved 43: PID parameter switchover 44: User-defined fault 1 45: User-defined fault 2 46: Speed control/Torque control selection 47: Emergency stop 48: External stop terminal 2 49: Deceleration DC braking 50: Clear the current running time 51: Two-wire/Three-wire mode switchover 52: Reverse rotation inhibition 64: Forward limit switch 65: Reverse limit switch 66: Water-cooling fault input 67: Low liquid level fault input 70: Control channel selection 71: Setting channel selection (reserved) 72: Terminal module A/B selection 73: Startup mode selection bit 0 74: Startup mode selection bit 1 75: Command source switchover terminal 3 76: Motor selection terminal 2 77: Running enable 78: Forward run permission 79: Reverse run permission 80: Set RFG input to zero 86: Wire breakage detection (wire drawing machine)	See descriptions below.
F4-01	DI2 function selection	4		
F4-02	DI3 function selection	9		
F4-03	DI4 function selection	12		
F4-04	DI5 function selection	13		
F4-05	DI6 function selection	0		
F4-06	DI7 function selection	0		
F4-07	DI8 function selection	0		
F4-08	DI9 function selection	0		
F4-09	DI10 function selection	0		

Note

Function 30 (pulse frequency input) is available for F4-04 but not available for F4-00 to F4-03 and F4-05 to F4-09.

0: No function

No function is assigned to the DI.

1: Forward run (IN1)

The AC drive runs in the forward direction. FWD indicates forward running. In two-wire mode 1 (F4-11 = 0), activating DI function 1 triggers forward running. In two-wire operation mode 2 (F4-11 = 1), activating DI function 1 triggers a running command.

2: Reverse run (IN2)

The AC drive runs in the reverse direction. REV indicates reverse running. In two-wire mode 1 (F4-11 = 2), activating DI function 2 triggers reverse running. In two-wire mode 2 (F4-11 = 1),activating DI function 2 triggers forward/reverse running.

3: Three-wire control (IN3)

The DI is used to set the three-wire mode for the AC drive. To set the running command source to the terminal, set F4-11 (terminal command mode) to 2 (three-wire mode 1) or 3 (three-wire mode 2), and set the DI to function 3. The three-wire control modes include three-wire mode 1 and three-wire mode 2.

4: Forward jog (FJOG)

The terminal is used to set the AC drive to jog forwardly. In the jogging mode, the drive runs at the frequency set by F8-00 (Jogging frequency), which is generally used for maintenance and commissioning of the equipment on site.

5: Reverse jog (RJOG)

The terminal is used to set the AC drive to jog reversely. In the jogging mode, the drive runs at the frequency set by F8-00 (Jogging frequency), which is generally used for maintenance and commissioning of the equipment on site.

6: Function as UP key for frequency adjustment

The terminal is used to increase the frequency. Activating the terminal is equivalent to pressing and holding the increment key. Deactivating the terminal is equivalent to releasing the increment key.

7: Function as DOWN key for frequency adjustment

The terminal is used to decrease the frequency. Activating the terminal is equivalent to pressing and holding the decrement key. Deactivating the terminal is equivalent to releasing the decrement key.

8: Coast to stop

Once the drive receives a stop command, it immediately stops output. The load then coasts to stop based on the mechanical inertia. The AC drive stops output to shut down. At this time, the power supply of the motor is cut off and the driving system is in the free braking state. This is also known as inertia stop because the stop time is determined by the inertia of the driving system.

9: Fault reset (RESET)

The terminal is used to reset the fault of the drive, which functions the same as the STOP/RES key on the operating panel. This function allows you to perform a reset upon the fault remotely.

10: Running pause

This function is valid only when F0-02 is set to 1 (terminal). After this function is assigned to the terminal, the drive decelerates to stop with all the operating parameters memorized (such as PLC parameters, wobble frequency, and PID parameters). When the terminal is inactive, the drive resumes to the status before decelerating to stop.

11: NO input of external fault

When an external signal is sent to the drive, the drive reports E015.1.

12 to 15: Multi-reference terminals 1 to 4

Multi-reference is selected as the main frequency source. Sixteen speeds or sixteen references can be set through combinations of sixteen states of these four terminals. It is suitable for applications where the operating frequency of the drive does not require continuous adjustment, and only several frequency values need to be used.

16 and 17: Acceleration/Deceleration selection terminals 1 and 2

The acceleration time indicates the time required by the AC drive to accelerate from 0 Hz to the acceleration/deceleration base frequency (F0-25). The deceleration time indicates the time required by the AC drive to decelerate from the acceleration/deceleration base frequency (F0-25) to 0 Hz. Four groups of acceleration/deceleration time can be selected through combinations of four states of these two terminals.

For example, if DI1 is assigned with function 16 and DI2 is assigned with function 17, the active states of DI2 and DI1 can be used to indicate the following groups acceleration/deceleration time:

[0, 0]: Acceleration/deceleration time of group one

[0, 1]: Acceleration/deceleration time of group two

[1, 0]: Acceleration/deceleration time of group three

[1, 1]: Acceleration/deceleration time of group four

18: Frequency command switchover

The terminal is used to select the frequency reference input modes. The frequency reference is set through F0-07 (Frequency reference superposition).

19: Clear data set by UP/DOWN key or by terminal functioning as UP/DOWN key

Activating the terminal clears the frequency that is set by the increment or decrement key on the operating panel or the terminal functioning as UP/DOWN keys and resumes the frequency reference to the value specified by F0-08.

20: Command source switchover terminal 1

When the running command is set through the terminal (F0-02 = 1) and the terminal is valid, you can switch between the terminal control mode and the operating panel control mode. When the running command is set through communication (F0-02=2) and the terminal is valid, you can switch between the communication control mode and the operating panel control mode.

21: Acceleration/Deceleration inhibition

The drive runs at the current operating frequency without being affected by external input frequency except that a stop command is received.

22: PID pause

The PID is deactivated temporarily. The drive maintains the current output frequency without PID adjustment of the frequency source.

23: Simple PLC state reset

The terminal is used to restore the AC drive to the initial state of the simple PLC.

24: Wobble frequency pause

In the wobble process, when the terminal is active, the wobble frequency function is paused and the drive outputs at the center frequency.

25: Counter input

In the counting process, the counted pulse is input when the terminal is active.

26: Counter reset

In the counting process, the counter status is cleared when the terminal is active.

27: Length input

In the fixed length process, the counted length is input when the terminal is active.

28: Length reset

In the fixed length process, the length is set to zero when the terminal is active.

29: Torque control inhibition

When the terminal is active, the drive switches from the torque control mode to the speed control mode. When the terminal is inactive, the drive switches back to the torque control mode.

30: Pulse input

When DI5 is used as the pulse input terminal, DI5 must be assigned with this function.

31: Reserved

32: Immediate DC braking

The terminal is used to switch the drive to the DC braking state. DC braking indicates that the drive outputs direct current to the stator winding of the asynchronous motor to form a static magnetic field, enabling the motor to brake with energy consumption. In this state, the rotor cuts the static magnetic field to generate braking torque, which stops the motor quickly.

33: NC input of external fault

When an external signal is sent to the drive, the drive reports E015.2.

34: Frequency modification enable

When the terminal is active, the frequency can be modified. When the terminal is inactive, the frequency cannot be modified.

35: Opposite to the PID action direction

The terminal is used to reverse the PID action direction defined by FA-03 (PID action direction).

36: External stop terminal 1

The terminal is used to stop the drive regardless of the value of F0-02, which functions the same as the STOP/RES key on the operating panel.

37: Command source switchover terminal 2

The terminal is used to switch the drive between the terminal control mode and communication control mode. If the running command source is set to terminal control, the drive switches to communication control when the terminal is active. If the running command source is set to communication control, the system switches to terminal control when the terminal is active.

38: PID integral pause

The terminal is used to disable integral tuning of PID temporarily without affecting its proportional and derivative tuning.

39: Switchover between main frequency X and preset frequency

The terminal is used to switch from main frequency X to the preset frequency (F0-08).

40: Switchover between auxiliary frequency Y and preset frequency

The terminal is used to switch from auxiliary frequency Y to the preset frequency (F0-08).

41 and 76: Motor selection terminals 1 to 4

The terminal is used to select a motor. For example, when DI1 is assigned with function 41 and DI2 is assigned with function 76, motor 1 applies when DI1 and DI2 are inactive; motor 2 applies when DI1 is active and DI2 is inactive; motor 3 applies when DI1 is inactive and DI2 is active; motor 4 applies when DI1 and DI2 are both active.

42: Reserved

43: PID parameter switchover

If PID parameters are switched through the DI (FA-18 = 1), the PID parameters FA-05 (proportional gain Kp1), FA-06 (integral time Ti1), and FA-07 (derivative time Td1) are used when the terminal is inactive; the PID parameters FA-15 (proportional gain Kp2), FA-16 (integral time Ti2), and FA-17 (derivative time Td2) are used when the terminal is active.

44: User-defined fault 1

The AC drive reports E027.1, and acts according to the value of F9-49 (Fault protection action selection).

45: User-defined fault 2

The AC drive reports E027.2, and acts according to the value of F9-49 (Fault protection action selection).

46: Speed control/Torque control selection

The terminal is used to enable the drive to switch between the speed control mode and the torque control mode. If A0-00 (speed/torque control mode) is set to 0, the torque control mode is used when the terminal is active, and the speed control mode is used when the terminal is inactive. If A0-00

(speed/torque control mode) is set to 1, the speed control mode is used when the terminal is active, and the torque control mode is used when the terminal is inactive.

47: Emergency stop

When the system is in the emergency state, the drive decelerates according to F8-55 (Deceleration time for emergency stop) or according to the minimum unit time when the deceleration time for emergency stop is 0s in the V/f control mode. The input terminal does not need to be in the closed state continuously. Even if it is closed only for a moment, an emergency stop will occur immediately. Different from general deceleration time, the emergency stop input terminal is opened after the deceleration time for emergency stop expires. In this case, if the operation signal is still active, the drive will not restart. To restart the drive, disconnect the operation terminal and input the operation command again.

48: External stop terminal 2

The drive decelerates to stop in any control mode (operating panel, terminal, or communication). In this case, the deceleration time is fixed to the value of F8-08 (deceleration time 4).

49: Deceleration DC braking

The drive decelerates to the start frequency of DC braking for stop (F6-11) and then enters the DC braking state.

50: Clear the current running time

The current running time of the drive (U0-26) is cleared. When the terminal is active, the current running time of the drive is not cleared.

51: Two-wire/Three-wire mode switchover

The terminal is used to switch the drive between the two-wire mode and the three-wire mode. When F4-11 is set to 0 (two-wire mode 1) and the terminal is active, the drive switches to three-wire mode 1. When the terminal is inactive, two-wire mode 1 is used. When F4-11 is set to 1 (two-wire mode 2) and the terminal is active, the drive switches to three-wire mode 2. When F4-11 is set to 2 (three-wire mode 1) and the terminal is active, the drive switches to two-wire mode 1. When F4-11 is set to 3 (three-wire mode 2) and the terminal is active, the drive switches to two-wire mode 2.

52: Reverse rotation inhibition

When the terminal is active, even if the reverse frequency is set, the actual frequency of the AC drive is fixed to 0. This function is the same as F8-13 (Reverse frequency inhibited).

64: Forward limit switch

65: Reverse limit switch

66: Water-cooling fault input

When an external signal is sent to the drive and the terminal is active, E064.1 is reported.

67: Low liquid level fault input

When an external signal is sent to the drive and the terminal is active, A066.1 (thousands place of F9-50 = 2) or E066.1 (thousands place of F9-50 = 0) is reported.

68-69: Reserved

70: Control channel selection

The terminal is used to select a user-defined command channel. Value 0 represents channel 1, and value 1 represents channel 2.

71: Setting channel selection (reserved)

72: Terminal module A/B selection

The terminal is used to select a terminal module. Value 0 represents module A, and value 1 represents module B.

73 and 74: Startup mode selection bit 0/bit 1

The terminal is used to select a start mode. For example, if DI1 and DI2 are assigned with functions 73 and 74, respectively, direct start is selected when both DI1 and DI2 are inactive; flying start is selected when DI1 is active but DI2 is inactive; DC braking start is selected when DI1 is inactive but DI2 is active; and the last start mode is selected when both DI1 and DI2 are active.

75: Command source switchover terminal 3

The terminal is used to switch the command source between the terminal/communication control mode and the user-defined operation command.

77: Running enable

When the terminal is active at high level, running is allowed. Otherwise, running is not allowed or the AC drive must stop according to the setting of AA-09 (stop mode during running).

78: Forward run permission

When the terminal is active at high level, the frequency reference is allowed to be a positive value. Otherwise, the positive frequency reference is reset to zero.

79: Reverse run permission

When the terminal is active at high level, the frequency reference is allowed to be a negative value. Otherwise, the negative frequency reference is reset to zero.

80: Set RFG input to zero

When the terminal is active at low level, the target reference is reset to zero. When the terminal is inactive at high level, the target reference is restored to its original setting.

86: Wire breakage detection (wire drawing machine)

After the AC drive is started and the time set by A7-32 (Breakage detection time for startup delay) expires, the DI starts detecting an active signal. If the DI detects an active signal, the AC drive reports E031.2 (breakage detection fault).

16.2.21 (Optional) DO Settings

Parameter Code	Parameter Name	Default	Value Range		Description
F5-04	DO1 output function selection	0	0: No output 1: AC drive running 2: Fault 3: Frequency level detection FDT1 output 4: Frequency reach 5: Running at zero speed (no output at stop) 6: Motor overload warning 7: AC drive overload warning 8: Set count value reach 9: Designated count value reach 10: Length reach 11: Simple PLC cycle completed 12: Cumulative running time reach 13: Wobble frequency limit 14: Torque limit 15: Ready to run 16: AI1 > AI2 17: Frequency upper limit reach 18: Frequency lower limit reach (no output at stop) 19: Undervoltage 20: Communication setting 21: Brake output 22: Reserved	23: Running at zero speed 2 (output at stop) 24: Cumulative power-on time reach 25: Frequency level detection FDT2 output 26: Frequency 1 reach 27: Frequency 2 reach 28: Current 1 reach 29: Current 2 reach 30: Timing duration reach 31: AI1 input limit exceeded 32: Load loss 33: Reverse running 34: Zero current state 35: Module temperature reach 36: Output current limit exceeded 37: Frequency lower limit reach (output at stop) 38: Alarm (all faults) 39: Motor overtemperature 40: Current running time reach 41: Fault (excluding undervoltage) 42: STO 43: Operation restricted 44: Brake output at stop (wire drawing machine) Others: B connector	See descriptions below.
F5-05	Output function selection of DO2 on expansion card	4			

0: No output

The terminal has no function.

1: AC drive running

When the drive is operating and outputs frequency (can be zero), the terminal outputs an active signal.

2: Fault

When the drive encounters a fault, the terminal outputs an active signal.

3: Frequency level detection FDT1 output

When the running frequency exceeds the frequency detection value, the terminal outputs an active signal. When the running frequency falls below the result of the frequency detection value minus the FDT hysteresis (F8-19 x F8-20), the terminal stops outputting the active signal.

4: Frequency reach

When the running frequency of the AC drive is within a specific range (target frequency ± F8-21 x maximum frequency), the terminal outputs an active signal.

5: Running at zero speed (no output at stop)

The terminal outputs an active signal when the AC drive is running and its output frequency is 0. When the AC drive is in the stop state, the signal is inactive.

6: Motor overload warning

Before motor overload protection, the AC drive determines whether the motor load exceeds the overload warning threshold according to the overload warning coefficient (F9-02). If the threshold is exceeded, the terminal outputs an active signal. (For calculation of the alarm threshold, see the description of motor overload protection.)

7: AC drive overload warning

The terminal outputs an active signal 10s before AC drive overload protection applies.

8: Set count value reach

The terminal outputs an active signal when the counting value reaches the value of FB-08.

9: Designated count value reach

The terminal outputs an active signal when the counting value reaches the value of FB-09.

10: Length reach

The terminal outputs an active signal when the actual length detected exceeds the length defined by FB-05.

11: Simple PLC cycle completed

When the simple PLC completes one cycle, the terminal outputs a pulse signal with the width of 250 ms.

12: Cumulative running time reach

The AC drive compares the cumulative running time and the time set by F8-17 and F8-75. If the former is greater than or equal to the latter, the terminal outputs an active signal.

13: Wobble frequency limit

In a wobble process, the terminal outputs an active signal when the set frequency exceeds the upper or lower limit of frequency and the output frequency of AC drive reaches the upper or lower limit of frequency.

14: Torque limit

The terminal outputs an active signal when the output torque of the AC drive reaches the toque limit in the speed control mode.

15: Ready to run

The terminal outputs an active signal if no exception occurs after the AC drive is powered on.

16: AI1 > AI2

The terminal outputs an active signal when the value of AI1 is greater than that of AI2.

17: Frequency upper limit reach

The terminal outputs an active signal when the running frequency reaches the upper limit (F0-12).

18: Frequency lower limit reach (no output at stop)

When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 1 (stop), the terminal outputs an inactive signal no matter whether the operating frequency reaches the lower limit.

When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 0 (run at the frequency lower limit) or 2 (run at zero speed) and the running frequency reaches the lower limit, the terminal outputs an active signal.

19: Undervoltage

The terminal outputs an active signal when undervoltage occurs on the AC drive.

20: Communication setting

The active or inactive state of the terminal is controlled by the setpoint of communication address 0x2001.

21: Brake output

The terminal outputs an active signal upon brake release, and outputs an inactive signal upon brake applying.

22: Reserved

23: Running at zero speed 2 (output at stop)

The terminal outputs an active signal when the AC drive is running and its output frequency is 0. The signal is still active when the AC drive stops.

24: Cumulative power-on time reach

The AC drive compares the cumulative running time and the time set by F8-16 and F8-74. If the former is greater than or equal to the latter, the terminal outputs an active signal.

25: Frequency level detection FDT2 output

The terminal outputs an active signal when the running frequency exceeds the frequency detection value and stops outputting the active signal when the running frequency is lower than the result of the detection value minus the frequency detection hysteresis (F8-28 x F8-29).

26: Frequency 1 reach

The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-30 (Detection frequency 1). Frequency detection range: F8-30 - F8-31 x F0-10 (Maximum frequency) to F8-30 + F8-31 x F0-10

27: Frequency 2 reach

The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-32 (Detection frequency 2). Frequency detection range: F8-32 – F8-33 x F0-10 (Maximum frequency) to F8-32 + F8-33 x F0-10

28: Current 1 reach

The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-38 (Detection current 1). Current detection range: F8-38 - F8-39 x F1-03 (Rated motor current) to F8-38 + F8-39 x F1-03

29: Current 2 reach

The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-40 (Detection current 2). Current detection range = F8-40 - F8-41 x F1-03 (Rated motor current) to F8-40 + F8-41 x F1-03

30: Timing duration reach

The terminal outputs an active signal when F8-42 is active and the current operating time reaches the set timing duration. The timing duration is defined by F8-43 and F8-44.

31: AI1 input limit exceeded

If the value of AI1 input is larger than the value of F8-46 (AI1 input protection upper limit) or lower than the value of F8-45 (AI1 input protection lower limit), the terminal outputs an active signal.

32: Load loss

The terminal outputs an active signal when load loss occurs.

33: Reverse running

The terminal outputs an active signal when the AC drive is running reversely.

34: Zero current state

When the output current of the drive is within the zero current detection range for a duration longer than that defined by F8-35 (zero current detection delay), the terminal outputs an active signal. Zero current detection range: 0 to F8-34 x F1-03

35: Module temperature reach

The terminal outputs an active signal when the inverter heatsink temperature (F7-07) reaches the module temperature threshold (F8-47).

36: Output current limit exceeded

When the output current of the AC drive is higher than F8-36 (Output current threshold) for a period longer than F8-37 (Delay time for output current overlimit detection), the terminal outputs an active signal.

37: Frequency lower limit reach (output at stop)

The terminal outputs an active signal when the running frequency reaches the lower limit (F0-14). The terminal still outputs the active signal when the drive is in the stop state.

38: Alarm (all faults)

The terminal outputs an active signal when a fault occurs on the AC drive and the fault protection action is set to "continue to run". For details about the fault protection action, see F9-47 to F9-50.

39: Motor overtemperature

The terminal outputs an active signal when the motor temperature reaches the value of F9-58 (motor overtemperature warning threshold). You can check the motor temperature using U0-34.

40: Current running time reach

When the current operating time of the drive exceeds the time defined by F8-53 (Current running time reach), the terminal outputs an active signal.

41: Fault (excluding undervoltage)

The terminal outputs an active signal when a fault (other than the undervoltage fault) occurs on the AC drive.

42: STO

The terminal outputs an active signal when the STO function is triggered.

43: Operation restricted

When a minor fault that restricts the running of the AC drive occurs, the operating panel of the AC drive displays "Lxxx.y".

44: Brake output at stop (wire drawing machine)

When the AC drive stops and the running frequency is lower than the brake frequency set by A7-30, the terminal outputs an active signal. After the brake delay time set by A7-31 expires, the terminal outputs an active signal.

Others: B connector

When this option is selected, the output function is the signal or function state of the parameter to which the connector is connected.

16.2.22 (Optional) Multi-reference Settings

Application scenario of parameters in group FC: When simple PLC is used as the main frequency source, set parameters in group FC. In some industrial applications, the AC motor only needs to support the functions of start/stop, time- and segment-based speed regulation, and automatic forward and reverse run. In this case, using the simple PLC can provide the preceding control functions and a PLC is not required. The simple PLC is generally used in industrial equipment such as mixture mixing and industrial washing machines.

When the simple PLC is used as the main frequency source (F0-03=7), set parameters in group FC.

Parameter Code	Parameter Name	Default	Value Range	Description
FC-00	Multi-reference 1	0.0%	-100.0% to 100.0%	This parameter indicates the frequency reference of each speed in the unit of %. The actual frequency is the percentage of the maximum frequency. The value 100% corresponds to F0-10 (Maximum frequency). FC-55 to FC-58 can provide 16 state combinations, corresponding to 16 frequency references. The DIs assigned with functions 12 to 15 can also be used to provide 16 frequency references. The source of multi-reference 1 is selected by FC-51, and the other multi-references are set by other parameters. When outputting to a floating-point connector, the multi-reference can be used not only as the frequency reference, but also as the torque, voltage, or other reference input. The multi-reference value is a percentage of the rated value.
FC-01	Multi-reference 2			
FC-02	Multi-reference 3			
FC-03	Multi-reference 4			
FC-04	Multi-reference 5			
FC-05	Multi-reference 6			
FC-06	Multi-reference 7			
FC-07	Multi-reference 8			
FC-08	Multi-reference 9			
FC-09	Multi-reference 10			
FC-10	Multi-reference 11			
FC-11	Multi-reference 12			
FC-12	Multi-reference 13			
FC-13	Multi-reference 14			
FC-14	Multi-reference 15			
FC-15	Multi-reference 16			

16.2.23 (Optional) Relay Output Settings

Parameter Code	Parameter Name	Default	Value Range		Description
F5-02	Output function selection of control panel relay (T/A-T/B-T/C)	2	0: No output 1: AC drive running 2: Fault 3: Frequency level detection FDT1 output 4: Frequency reach 5: Running at zero speed (no output at stop) 6: Motor overload warning 7: AC drive overload warning 8: Set count value reach 9: Designated count value reach 10: Length reach 11: Simple PLC cycle completed 12: Cumulative running time reach 13: Wobble frequency limit 14: Torque limit 15: Ready to run 16: AI1 > AI2 17: Frequency upper limit reach 18: Frequency lower limit reach (no output at stop) 19: Undervoltage 20: Communication setting 21: Brake output 22: Reserved	23: Running at zero speed 2 (output at stop) 24: Cumulative power-on time reach 25: Frequency level detection FDT2 output 26: Frequency 1 reach 27: Frequency 2 reach 28: Current 1 reach 29: Current 2 reach 30: Timing duration reach 31: AI1 input limit exceeded 32: Load loss 33: Reverse running 34: Zero current state 35: Module temperature reach 36: Output current limit exceeded 37: Frequency lower limit reach (output at stop) 38: Alarm (all faults) 39: Motor overtemperature 40: Current running time reach 41: Fault (excluding undervoltage) 42: STO 43: Operation restricted 44: Brake output at stop (wire drawing machine) Others: B connector	See descriptions below.
F5-03	Output function selection of DO4 on expansion card relay (P/A-P/B-P/C)	0			

0: No output

The terminal has no function.

1: AC drive running

When the drive is operating and outputs frequency (can be zero), the terminal outputs an active signal.

2: Fault

When the drive encounters a fault, the terminal outputs an active signal.

3: Frequency level detection FDT1 output

When the running frequency exceeds the frequency detection value, the terminal outputs an active signal. When the running frequency falls below the result of the frequency detection value minus the FDT hysteresis (F8-19 x F8-20), the terminal stops outputting the active signal.

4: Frequency reach

When the running frequency of the AC drive is within a specific range (target frequency ± F8-21 x maximum frequency), the terminal outputs an active signal.

5: Running at zero speed (no output at stop)

The terminal outputs an active signal when the AC drive is running and its output frequency is 0. When the AC drive is in the stop state, the signal is inactive.

6: Motor overload warning

Before motor overload protection, the AC drive determines whether the motor load exceeds the overload warning threshold according to the overload warning coefficient (F9-02). If the threshold is exceeded, the terminal outputs an active signal. (For calculation of the alarm threshold, see the description of motor overload protection.)

7: AC drive overload warning

The terminal outputs an active signal 10s before AC drive overload protection applies.

8: Set count value reach

The terminal outputs an active signal when the counting value reaches the value of FB-08.

9: Designated count value reach

The terminal outputs an active signal when the counting value reaches the value of FB-09.

10: Length reach

The terminal outputs an active signal when the actual length detected exceeds the length defined by FB-05.

11: Simple PLC cycle completed

When the simple PLC completes one cycle, the terminal outputs a pulse signal with the width of 250 ms.

12: Cumulative running time reach

The AC drive compares the cumulative running time and the time set by F8-17 and F8-75. If the former is greater than or equal to the latter, the terminal outputs an active signal.

13: Wobble frequency limit

In a wobble process, the terminal outputs an active signal when the set frequency exceeds the upper or lower limit of frequency and the output frequency of AC drive reaches the upper or lower limit of frequency.

14: Torque limit

The terminal outputs an active signal when the output torque of the AC drive reaches the toque limit in the speed control mode.

15: Ready to run

The terminal outputs an active signal if no exception occurs after the AC drive is powered on.

16: AI1 > AI2

The terminal outputs an active signal when the value of AI1 is greater than that of AI2.

17: Frequency upper limit reach

The terminal outputs an active signal when the running frequency reaches the upper limit (F0-12).

18: Frequency lower limit reach (no output at stop)

When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 1 (stop), the terminal outputs an inactive signal no matter whether the operating frequency reaches the lower limit.

When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 0 (run at the frequency lower limit) or 2 (run at zero speed) and the running frequency reaches the lower limit, the terminal outputs an active signal.

19: Undervoltage

The terminal outputs an active signal when undervoltage occurs on the AC drive.

20: Communication setting

The active or inactive state of the terminal is controlled by the setpoint of communication address 0x2001.

21: Brake output

The terminal outputs an active signal upon brake release, and outputs an inactive signal upon brake applying.

22: Reserved

23: Running at zero speed 2 (output at stop)

The terminal outputs an active signal when the AC drive is running and its output frequency is 0. The signal is still active when the AC drive stops.

24: Cumulative power-on time reach

The AC drive compares the cumulative running time and the time set by F8-16 and F8-74. If the former is greater than or equal to the latter, the terminal outputs an active signal.

25: Frequency level detection FDT2 output

The terminal outputs an active signal when the running frequency exceeds the frequency detection value and stops outputting the active signal when the running frequency is lower than the result of the detection value minus the frequency detection hysteresis (F8-28 x F8-29).

26: Frequency 1 reach

The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-30 (Detection frequency 1). Frequency detection range: F8-30 - F8-31 x F0-10 (Maximum frequency) to F8-30 + F8-31 x F0-10

27: Frequency 2 reach

The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-32 (Detection frequency 2). Frequency detection range: F8-32 – F8-33 x F0-10 (Maximum frequency) to F8-32 + F8-33 x F0-10

28: Current 1 reach

The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-38 (Detection current 1). Current detection range: F8-38 - F8-39 x F1-03 (Rated motor current) to F8-38 + F8-39 x F1-03

29: Current 2 reach

The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-40 (Detection current 2). Current detection range = F8-40 - F8-41 x F1-03 (Rated motor current) to F8-40 + F8-41 x F1-03

30: Timing duration reach

The terminal outputs an active signal when F8-42 is active and the current operating time reaches the set timing duration. The timing duration is defined by F8-43 and F8-44.

31: AI1 input limit exceeded

If the value of AI1 input is larger than the value of F8-46 (AI1 input protection upper limit) or lower than the value of F8-45 (AI1 input protection lower limit), the terminal outputs an active signal.

32: Load loss

The terminal outputs an active signal when load loss occurs.

33: Reverse running

The terminal outputs an active signal when the AC drive is running reversely.

34: Zero current state

When the output current of the drive is within the zero current detection range for a duration longer than that defined by F8-35 (zero current detection delay), the terminal outputs an active signal. Zero current detection range: 0 to F8-34 x F1-03

35: Module temperature reach

The terminal outputs an active signal when the inverter heatsink temperature (F7-07) reaches the module temperature threshold (F8-47).

36: Output current limit exceeded

When the output current of the AC drive is higher than F8-36 (Output current threshold) for a period longer than F8-37 (Delay time for output current overlimit detection), the terminal outputs an active signal.

37: Frequency lower limit reach (output at stop)

The terminal outputs an active signal when the running frequency reaches the lower limit (F0-14). The terminal still outputs the active signal when the drive is in the stop state.

38: Alarm (all faults)

The terminal outputs an active signal when a fault occurs on the AC drive and the fault protection action is set to "continue to run". For details about the fault protection action, see F9-47 to F9-50.

39: Motor overtemperature

The terminal outputs an active signal when the motor temperature reaches the value of F9-58 (motor overtemperature warning threshold). You can check the motor temperature using U0-34.

40: Current running time reach

When the current operating time of the drive exceeds the time defined by F8-53 (Current running time reach), the terminal outputs an active signal.

41: Fault (excluding undervoltage)

The terminal outputs an active signal when a fault (other than the undervoltage fault) occurs on the AC drive.

42: STO

The terminal outputs an active signal when the STO function is triggered.

43: Operation restricted

When a minor fault that restricts the running of the AC drive occurs, the operating panel of the AC drive displays "Lxxx.y".

44: Brake output at stop (wire drawing machine)

When the AC drive stops and the running frequency is lower than the brake frequency set by A7-30, the terminal outputs an active signal. After the brake delay time set by A7-31 expires, the terminal outputs an active signal.

Others: B connector

When this option is selected, the output function is the signal or function state of the parameter to which the connector is connected.

17 Parameter Communication Addresses

17.1 Parameter Data

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

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

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

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

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

17.2 Parameter Communication Addresses

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

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

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

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

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

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

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

Note the following:

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

17.3 Modbus-specific Parameter Communication Addresses

Table 17–1 Modbus-specific Parameter Communication Addresses

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

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

Table 17–2 Description of Modbus-specific parameter addresses

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

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

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

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

18 List of Communication Protocols

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

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

19 Modbus Communication (MD38TX1)

19.1 Overview

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

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

19.2 Interface and Networking

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

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

Communication port

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

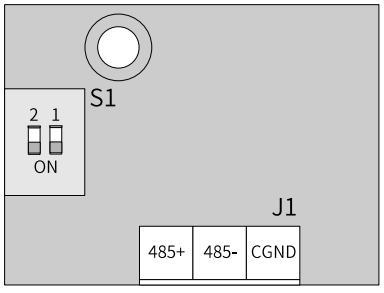


Figure 19-1 Front interface layout of the MD38TX1 card

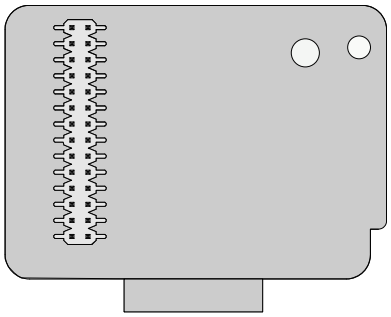


Figure 19-2 Bottom interface layout of the MD38TX1 card

Note

In *"Figure 19–1 Front interface layout of the MD38TX1 card" on page 382*, the gray block in the S1 terminal corresponds to the white bulging block in the product appearance diagram.

Table 19–1 Descriptions of MD38TX1 card terminals

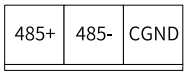
Terminal Mark		Terminal Name	Function Description	Layout
J1	485+	RS485 communication signal (+)	RS485 communication input terminal with the isolation function	
	485-	RS485 communication signal (-)	RS485 communication input terminal with the isolation function	
	CGND	Reference ground of RS485 communication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

Table 19–2 Descriptions of the MD38TX1 card jumper

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

Note

The MD38TX1 expansion card is connected through the DIP switch.

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

Communication networking

1. RS485 bus topology

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

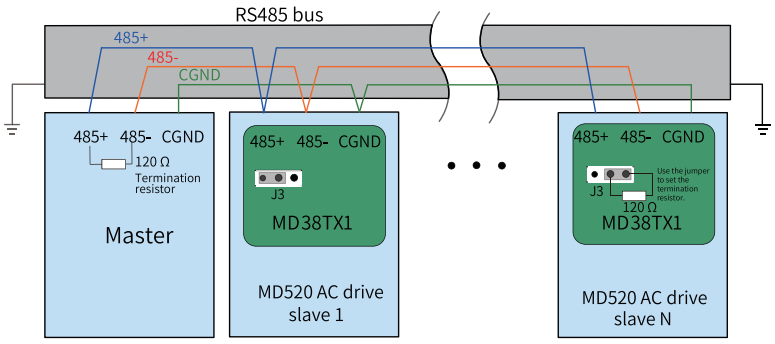


Figure 19-3 RS485 bus topology

2. Multi-node connection mode

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

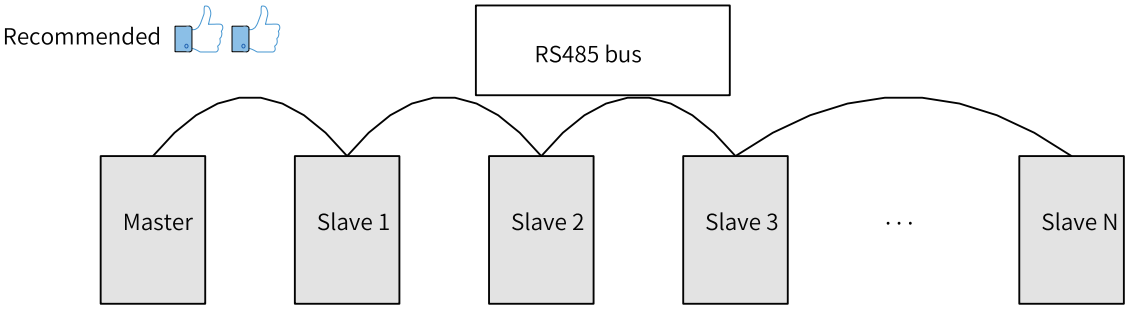


Figure 19-4 Daisy-type topology

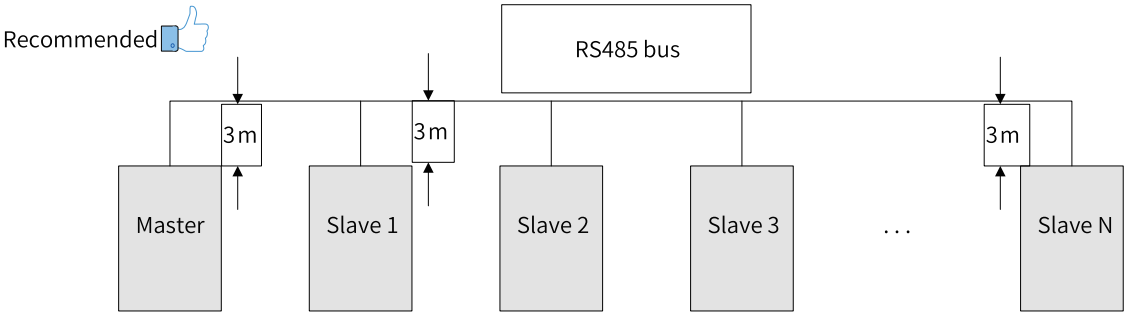


Figure 19-5 Branch topology

It is recommended that the branch not exceed 3 m.

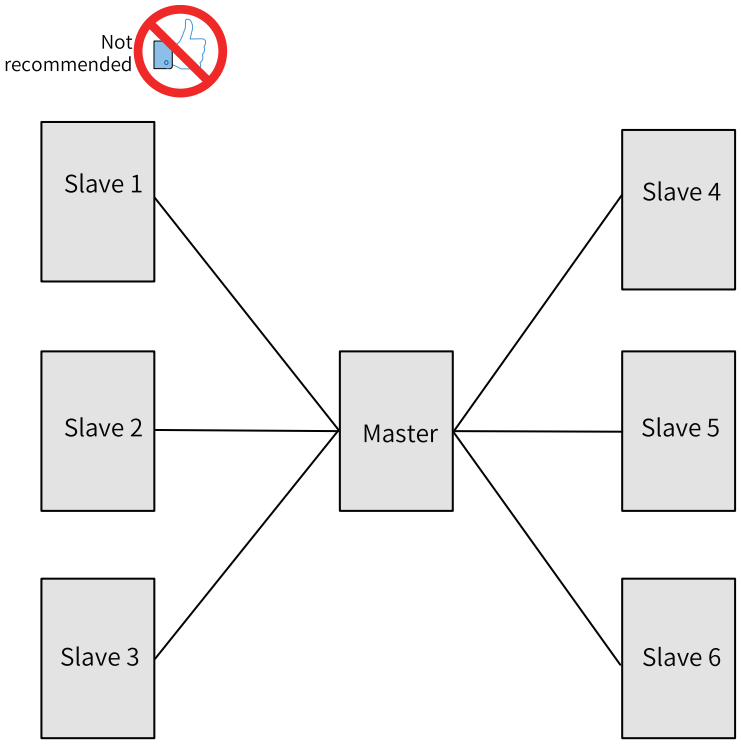
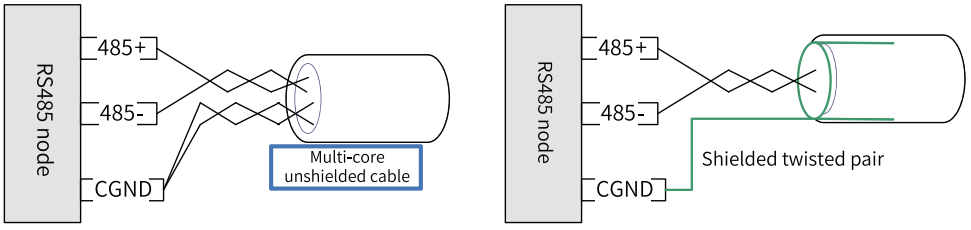


Figure 19-6 Star-type topology (prohibited)

3. Terminal wiring

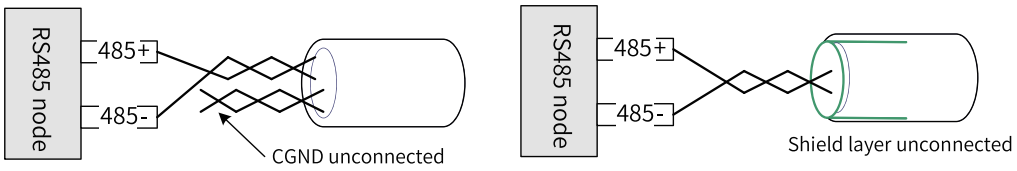
- Terminal wiring for nodes with CGND
  The RS485 bus has three cables, which are used to connect to the 485+, 485-, and CGND terminals of the MD38TX1 expansion card respectively. Check that the RS485 bus on site contains three cables and the wiring terminals are connected correctly. For use of shielded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

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



  - Recommended cable 1: Multi-conductor twisted pair cables. Connect the twisted pair cable to 485+ and 485-, and twist the remaining pairs together to connect CGND.
  - Recommended cable 2: Shielded twisted pair cables. Connect the twisted pair cable to 485+ and 485– and connect the shield to CGND.
  - In cases where the shielded cable is used as the connecting cable, connect the shield only to CGND.

- Terminal wiring for nodes without CGND
  For nodes without CGND, do not connect CGND or the shield to the PE terminal of the node directly. Do as follows:



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

Transmission distance

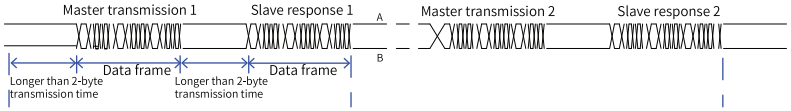
The following table lists the maximum number of nodes and transmission distance supported by the standard RS485 circuit at different transmission rates.

Table 19–3 Maximum number of nodes and transmission distance

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

19.3 Communication Transmission Mode

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



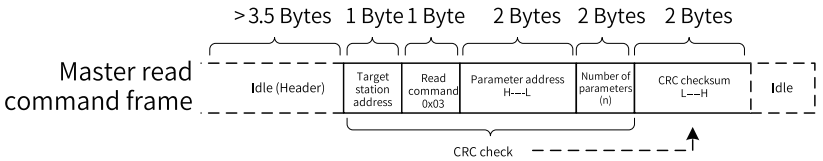
The built-in communication protocol of the AC drive is the Modbus RTU slave communication protocol, which allows the AC drive to respond to the query command from the master or execute the action according to query command from the master and respond with communication data.

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

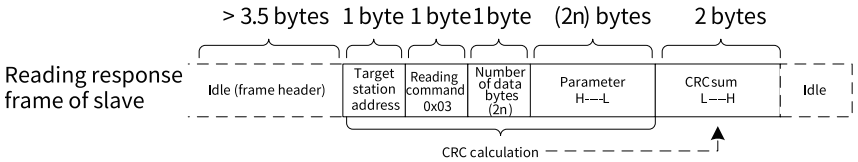
19.4 Communication Data Frame Structure

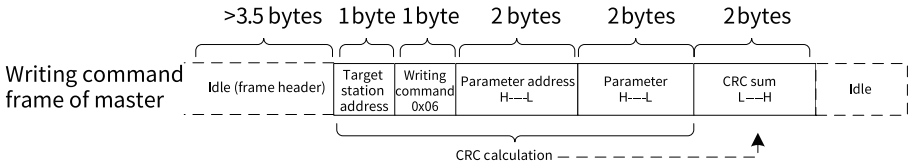
The following figure shows the communication data format of the Modbus RTU protocol. The AC drive supports reading or writing only of word type parameters, and does not support reading or writing of

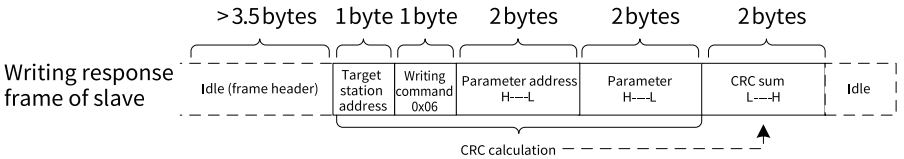
bytes or bits. The read operation command is 0x03, the write operation command is 0x06, and the multi-data write operation command is 0x10.

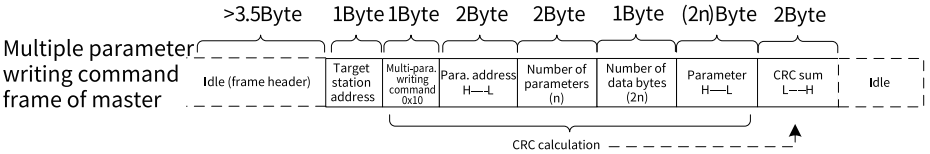


In theory, the host controller can read or write a maximum of 12 consecutive parameters. However, these parameters must be in the same group. Otherwise, a response error occurs.

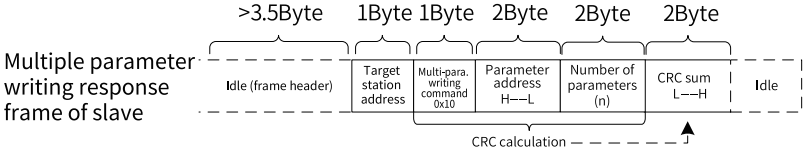








A maximum of 12 consecutive parameters can be read or written.



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

Note

No response is returned for CRC check error.

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

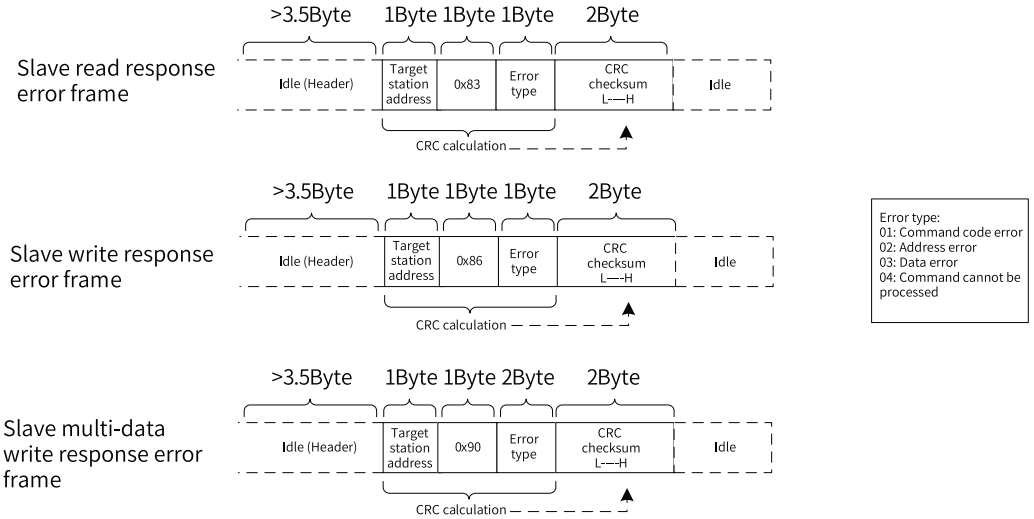


Table 19–4 Data frame fields

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

CRC check:

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

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

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

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

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

Definition of communication parameter addresses:

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

19.5 Related Parameters

Table 19–5 Parameters related to Modbus communication

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

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

19.6 Configure communication parameters.

19.6.1 Configuration for RS485 Communication Between AC Drive and H5U

Software acquisition and hardware connection

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

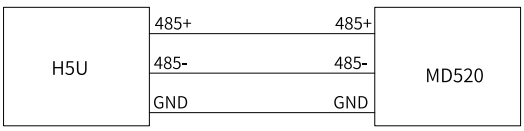
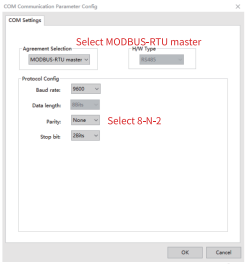


Figure 19-7 Connecting communication interfaces

Master and slave configuration

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

2. Click COM in the left pane 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 **Add**.

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

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

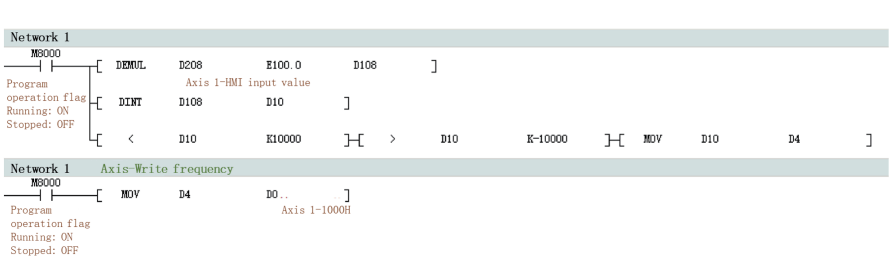
   After the read and write operation settings, click **OK** to return to the programming interface.

Instances

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

   The following figure shows the configuration and the program.

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

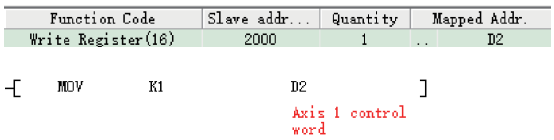


2. Start or stop the AC drive (F0-02 is set to 2).

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

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

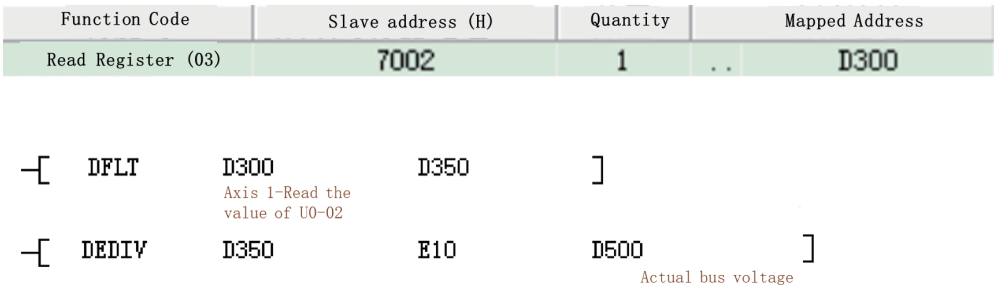
The following figure shows the configuration and the program.



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

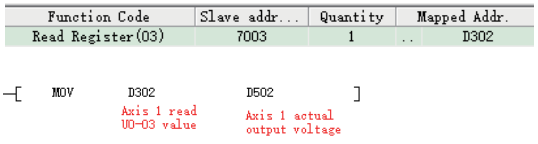
3. Read the bus voltage.
   Based on the conversion rule, convert the bus voltage U0-02 to 7002 (convert U in the high-order 2 bits to 7, and convert the low-order 2 bits to a hexadecimal equivalent). The actual bus voltage is the read bus voltage (a) divided by 10. According to the communication configuration,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

   The following figure shows the configuration and the program.



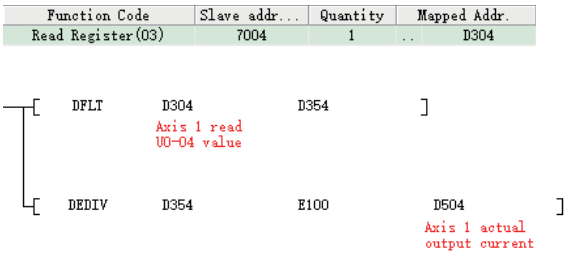
4. Read the output voltage.
   Convert the output voltage U0-03 to 7003 based on the conversion rule. The read value is the actual output voltage. According to the communication configuration, you only need to move the value of D302 to another D component (or not).

   The following figure shows the configuration and the program.



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

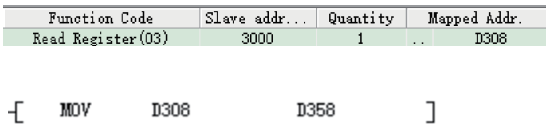
   The following figure shows the configuration and the program.



6. Read the AC drive state.

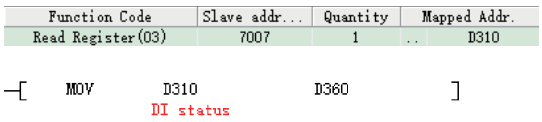
   Read 3000H to directly obtain the current state of the AC drive (0001: Forward running; 0002: Reverse running; 0003: Stopped; 0004: Motor parameter auto-tuning; 0005: Fault).

   The following figure shows the configuration and the program.



7. Read the DI state.

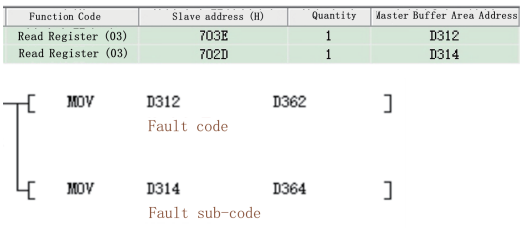
   According to the conversion rule, convert the DI state U0-07 to 7007. Convert the read value into a binary value. The LSB indicates DI1, the second bit indicates DI2, and so on.



8. Read the fault code.

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

   The following figure shows the configuration and the program.



Common faults and solutions

The must-dos are listed as follows:

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

Table 19–6 Common faults and solutions

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

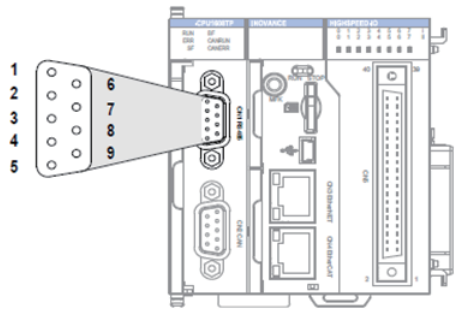
19.6.2 Configuration for RS485 Communication Between AC Drive and AM600

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

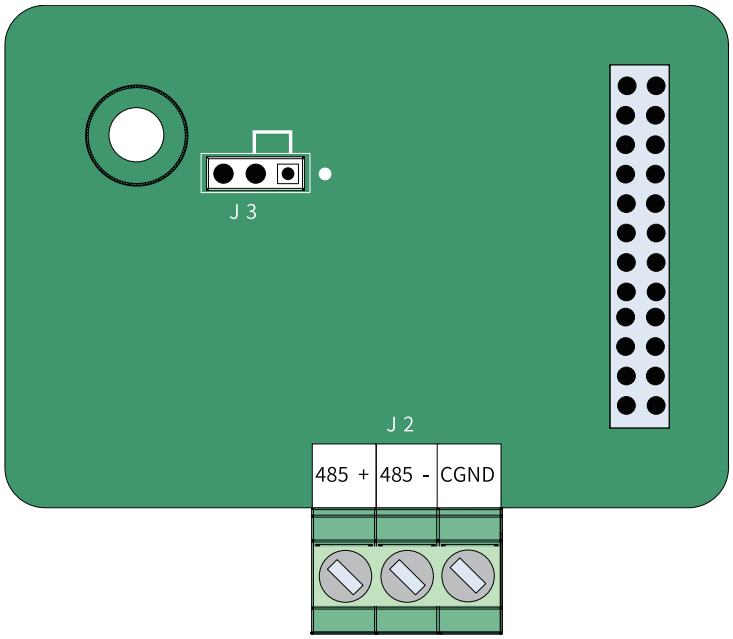
Hardware connection

Interfaces:

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

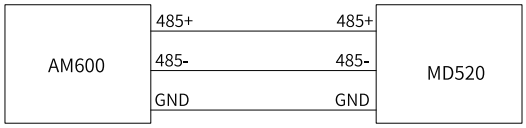
RS485 port on CPU module	Pin	Channel	Assignment	Function
	1	COM0 (RS485)	RS485-	Negative signal of the RS485 differential pair of COM0
	2		RS485+	Positive signal of the RS485 differential pair of COM0
	5		GND0	Power ground of COM0
	6	COM1 (RS485)	RS485-	Negative signal of the RS485 differential pair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

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



Hardware connection procedure:

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



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

Configuration on the drive side

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

Ones place of FD-00 = 5

FD-01 = 0

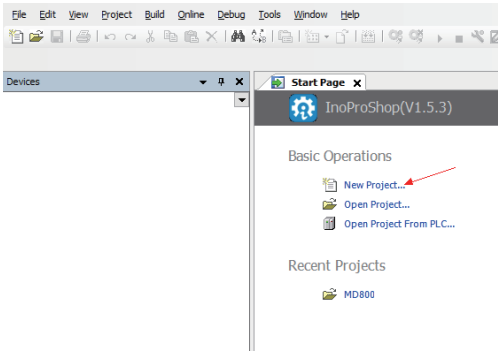
FD-03 = 2

FD-04 = 0.0

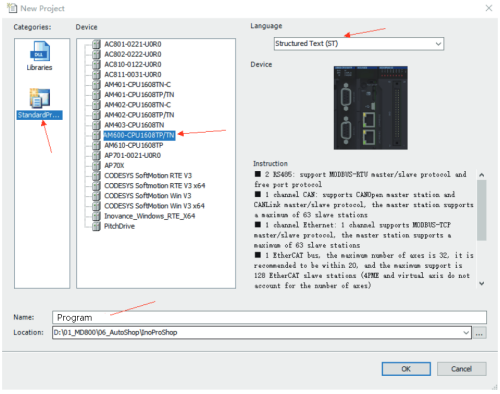
Record the address of FD-02, which is the station number of the AC drive.

Configuration on the PLC side

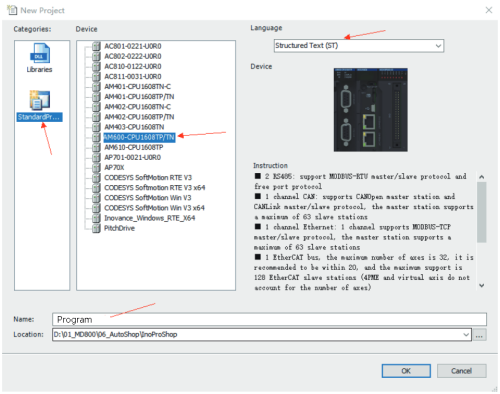
1. Connect the PC and PLC through a network cable or USB, open InoProShop, and create a new project.



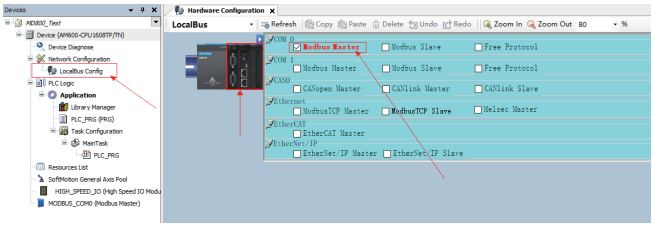
2. Click **Standard Project**, change the project name and location, and click **OK**.



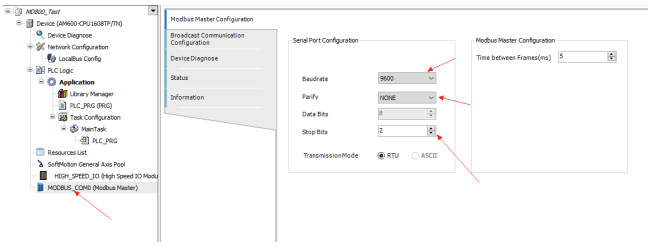
3. Select **AM600-CPU1608TP/TN**, select **Structured Text (ST)** from the **Language** drop-down list, and click **OK**.



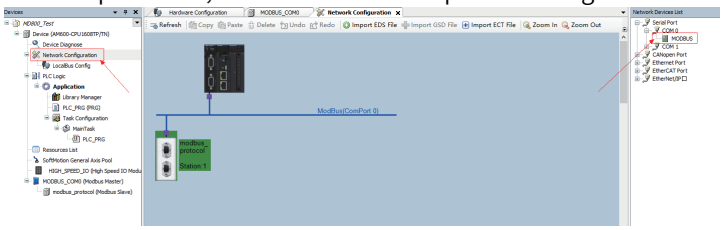
4. Click **LocalBus Config**, and click the CPU module. In hardware connection, the RS485 cable of the COM0 is connected to the RS485 terminal of the MD520. Therefore, select the Modbus master station of the serial port 0.



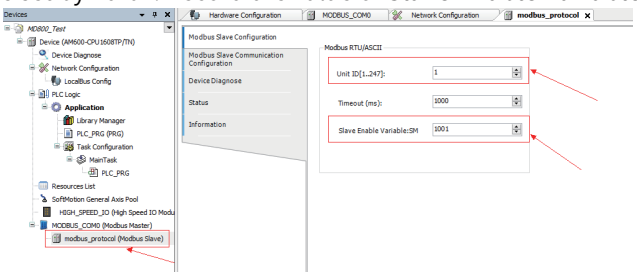
5. Click **MODBUS_COM0** in the left pane, and set the baud rate, parity, and stop bit according to the settings of FD-01.



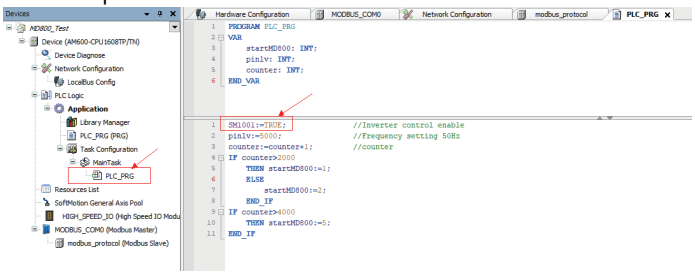
6. Double-click **Network Configuration** in the left pane. Choose **Serial Port** > **COM 0** in the right pane, and double-click **MODBUS**. A new slave is displayed on the Modbus bus in the center of the interface. If there are multiple slaves, click **MODBUS** multiple times to generate multiple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



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



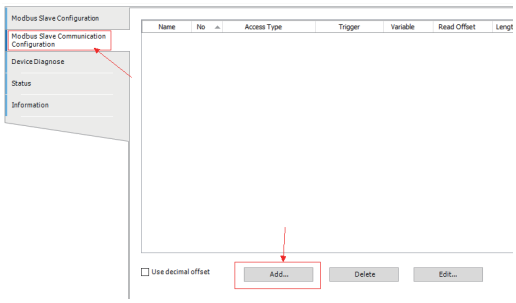
8. Compile the PLC program as follows: Enable the slave enable variable. Set the frequency of the AC drive to 50 Hz. Make the PLC run for 4000 scanning cycles. During the first 2000 scanning cycles, make the PLC control the AC drive to run in the forward direction. During the last 2000 scanning cycles,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



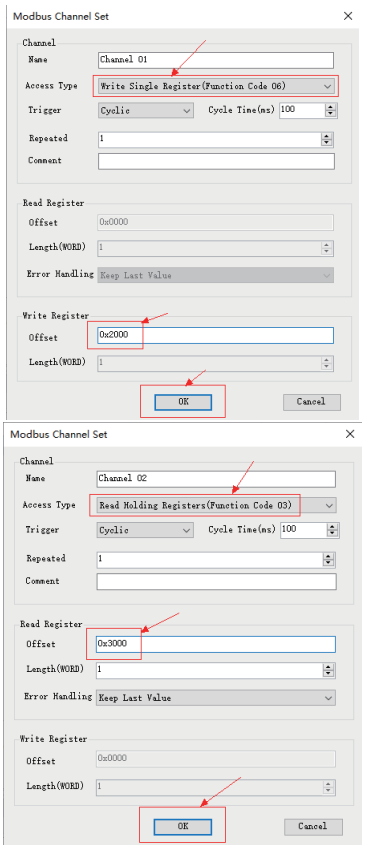
```
PROGRAM PLC_PRG
VAR
    startMD800: INT;
    pinlv: INT;
    counter: INT;
END_VAR
```

```
SM1001:=TRUE;                   //Inverter control enable
pinlv:=5000;                    //Frequency setting 50Hz
counter:=counter+1;             //counter
IF counter>2000
    THEN startMD800:=1;
    ELSE
        startMD800:=2;
    END_IF
IF counter>4000
    THEN startMD800:=5;
END_IF
```

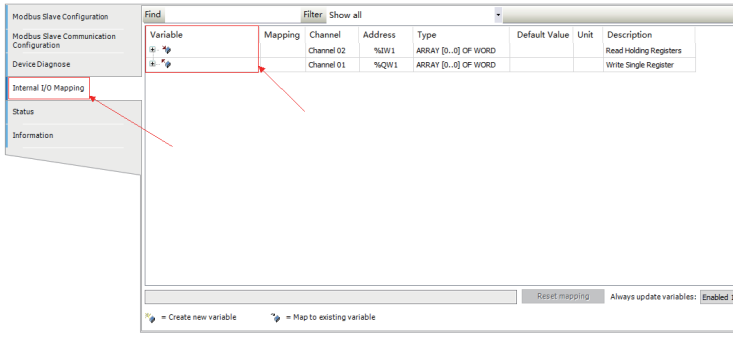
9. Add configuration information on the **Modbus Slave Communication Configuration** tab.



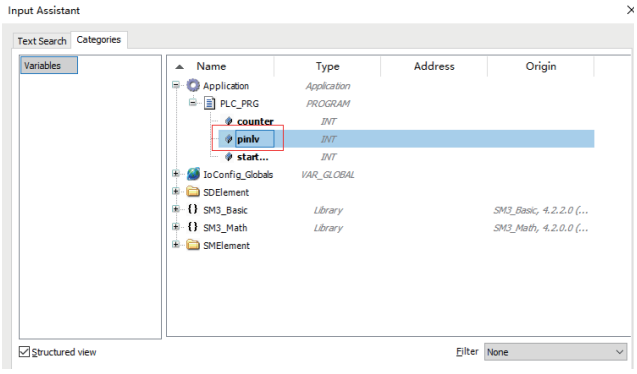
10. Configure the register in the displayed dialog box. The control word reading address of the AC drive is 3000H, the writing address is 2000H, and the frequency address is 1000H.



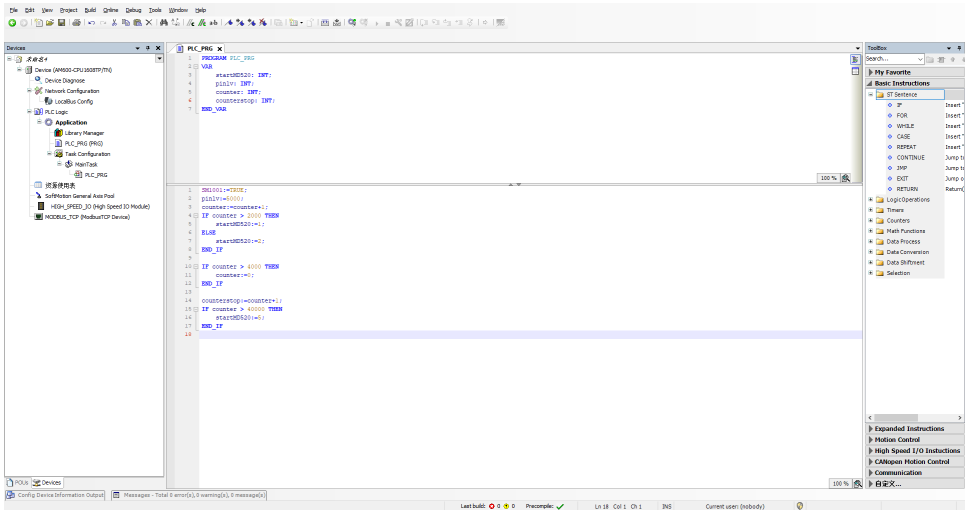
11. On the **Internal I/O Mapping** tab, map the variable of the PLC to the address of the AC drive.



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 the **Execute** button to execute the program.


PROGRAM PLC_PRG
VAR
startMD520: INT;
pinlv: INT;
counter: INT;
counterstop: INT;
END_VAR
SM1001:=TRUE;
pinlv:=5000;
counter:=counter+1;
IF counter > 2000 THEN
startMD520:=1;
ELSE
startMD520:=2;
END_IF
IF counter > 4000 THEN
counter:=0;
END_IF
counterstop:=counter+1;
IF counter > 40000 THEN
startMD520:=0;
END_IF

20 Modbus TCP Communication (MD500-EM1)

20.1 Overview

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

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

20.2 Networking and Interfaces

Communication port

The AC drive can communicate with the master based on the Modbus TCP through the MD500-EM1 card. *"Table 20–1" on page 401* shows the hardware layout of the MD500-EM1 card. The pin header J7 on the back of the MD500-EM1 card is used to connect the drive. The MD500-EM1 card provides two Ethernet ports J4 and J6 to enable the card to communicate with the Modbus TCP master (or other slaves). For details about the hardware, see *"Table 20–1" on page 401*.

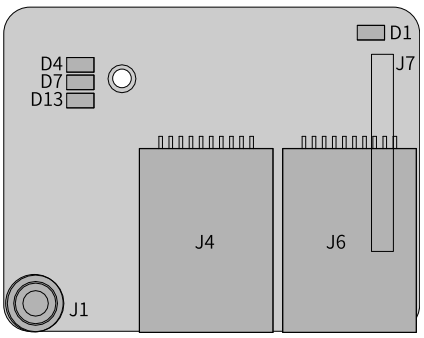


Figure 20-1 MD500-EM1 card terminal layout

Table 20–1 Descriptions of MD500-EM1 card terminals

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

Mark	Hardware Name	Description
D13	Power supply indicator (green)	It is used to indicate the status of the power supply. On: Normal OFF: Abnormal. Check whether the card is installed properly.
D1	Status indicator of communication with the AC drive (green)	For details, see *"Table 20–2 Indicators of the MD500-EM1 card" on page 402*.
D4	Modbus TCP master running indicator (green)	
D7	Modbus TCP master fault indicator (red)	

Caution

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

Table 20–2 Indicators of the MD500-EM1 card

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

Communication networking

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

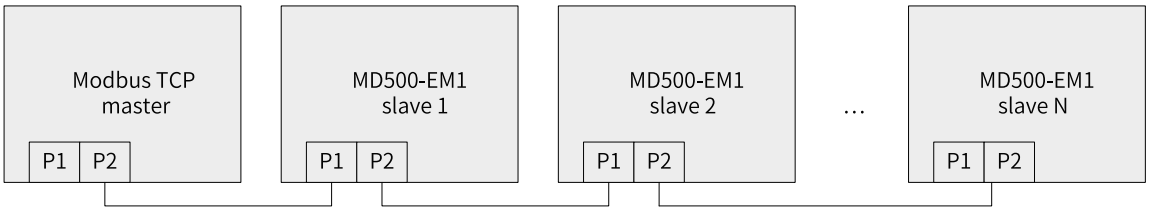


Figure 20-2 Bus-type topology

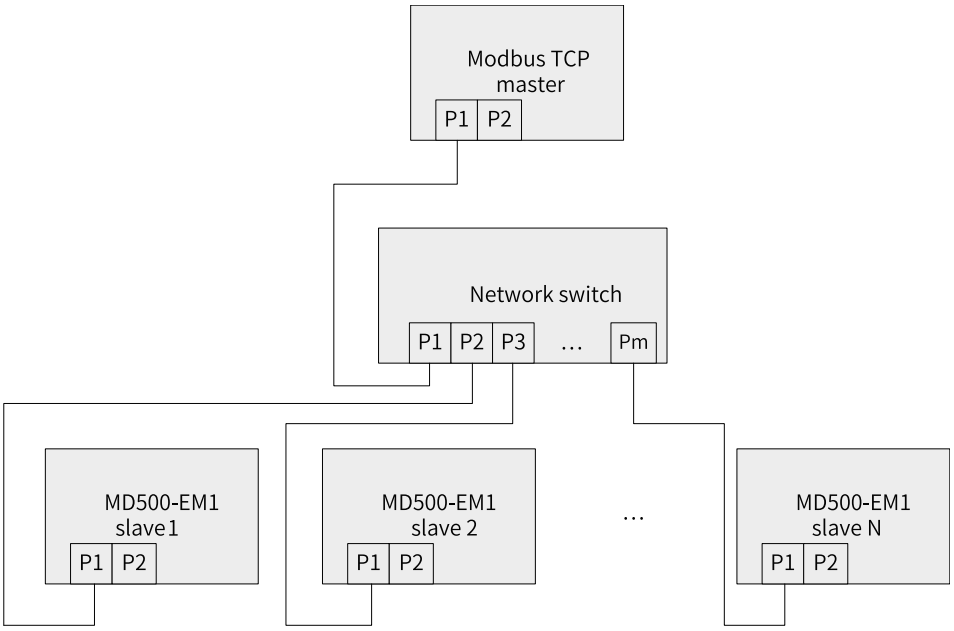


Figure 20-3 Star-type topology

20.3 Communication Data Frame Structure

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

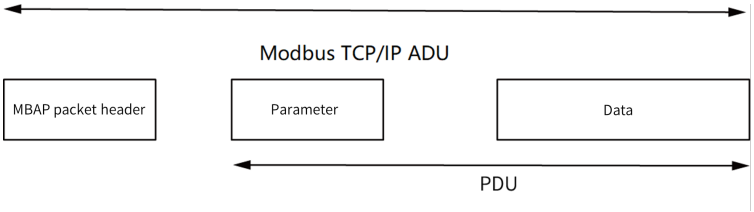
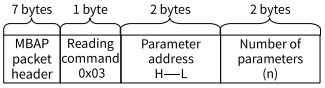


Figure 20-4 Modbus request/response over TCP/IP

The MBAP header includes the following fields.

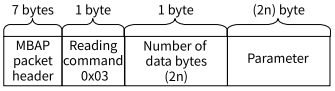
Field	Length	Description	Client	Server
Transaction meta identifier	2 bytes	Identifier of the Modbus request/ response transaction	Started by the client	Recopied by the server from the received request
Protocol identifier	2 bytes	0: Modbus protocol	Started by the client	Recopied by the server from the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

Reading command frame of master

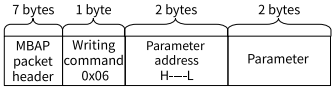


In theory, the host controller can read or write a maximum of 12 consecutive parameters. However, these parameters must be in the same group. Otherwise, a response error occurs.

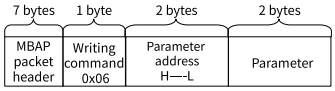
Reading response frame of slave



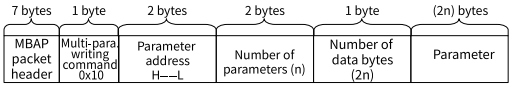
Writing command frame of master



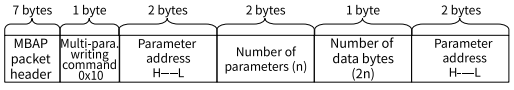
Writing response frame of slave



Multiple parameter writing command frame of master

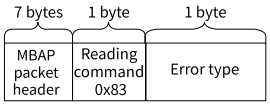


Multiple parameter writing response frame of slave

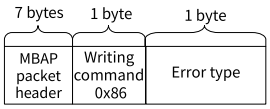


The command for a reading error responded by the slave is 0x83. The command for a writing error responded by the slave is 0x86. The command for a multi-data writing error responded by the slave is 0x90.

Reading response error frame of slave



Writing response error frame of slave



Multi-parameter writing response error frame of slave

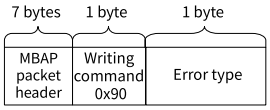


Table 20–3 Description of data frame fields

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

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

20.4 Communication Parameters

20.4.1 Communication Card Type Setting

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

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

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

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

20.4.2 IP Address Setting of MD500-EM1 Card

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

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

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

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

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

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

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

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

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

Note

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

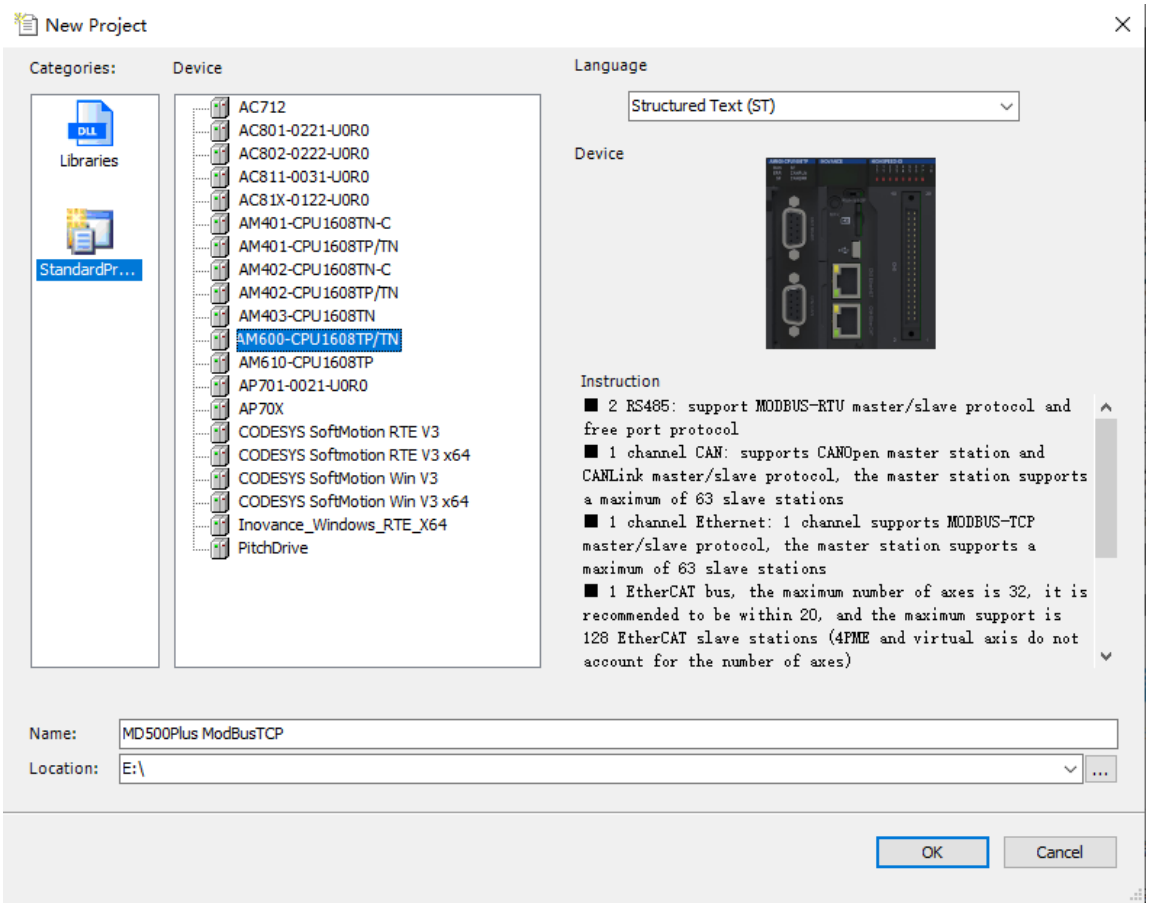
20.4.3 Parameters Related to AC Drive Communication Card

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

20.5 Communication Examples

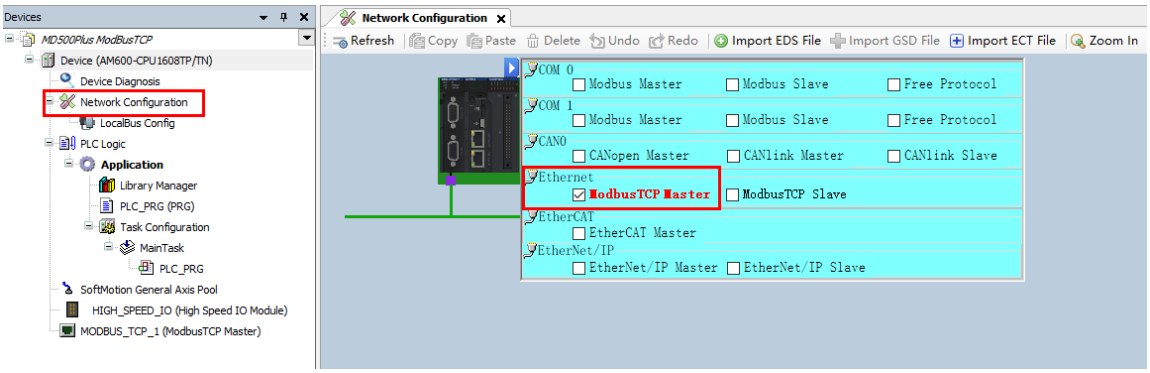
Step 1: Create a project.

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



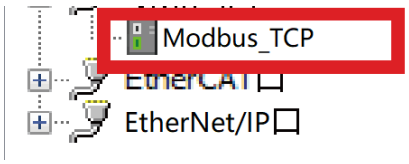
Step 2: Configure the network.

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



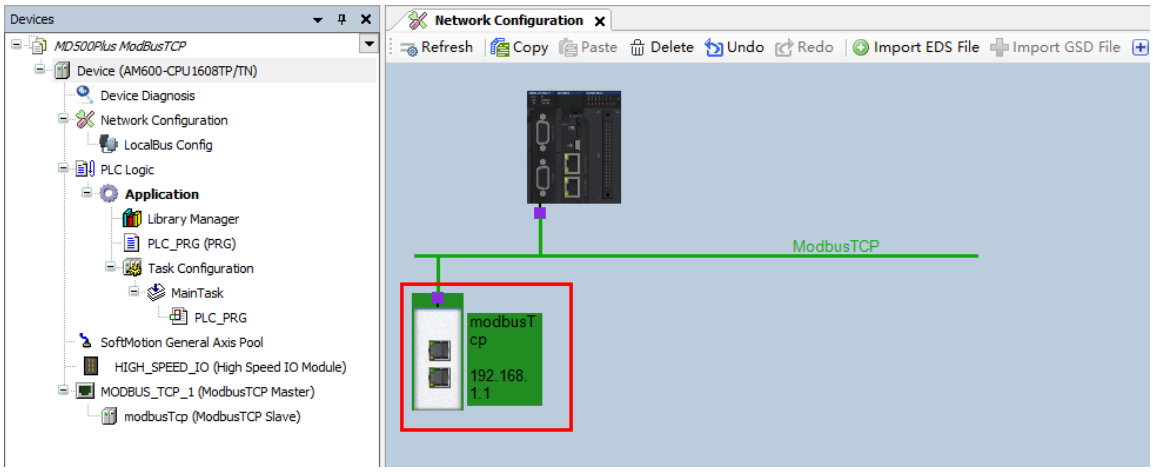
Step 3: Add a slave.

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

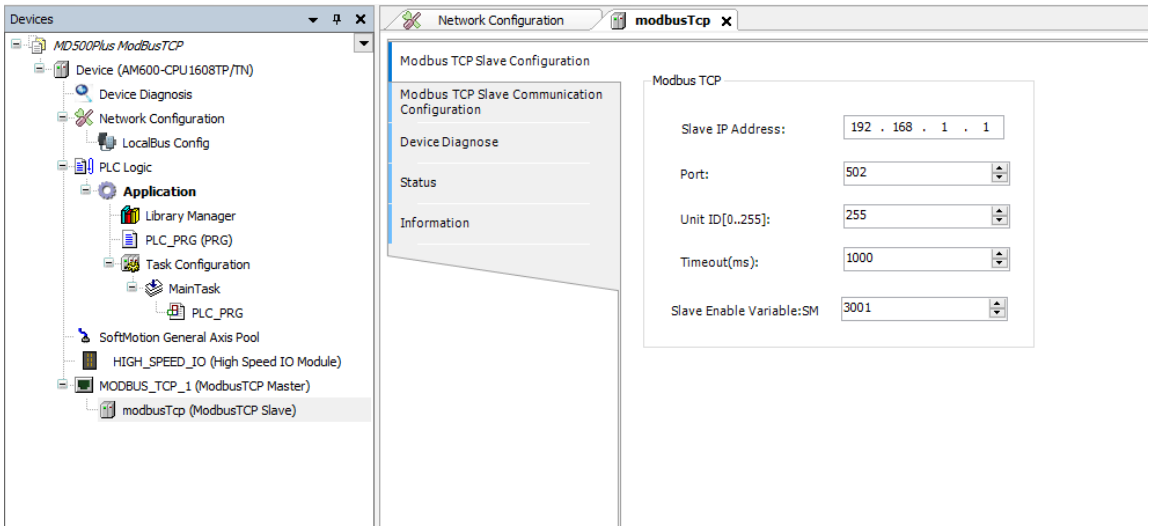


Step 4: Configure the slave.

Double-click the slave to access the configuration interface.

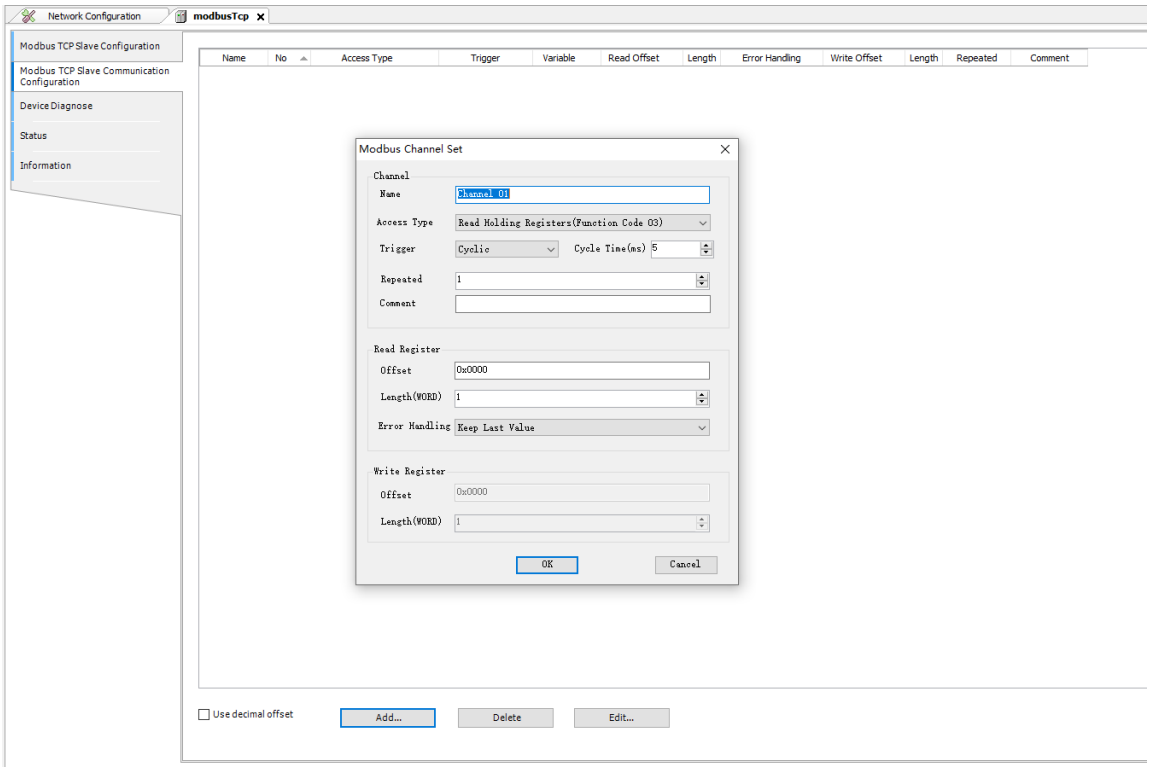


Configure the slave parameters, such as **Slave IP Address**, **Port**, and **Slave Enable Variable**.



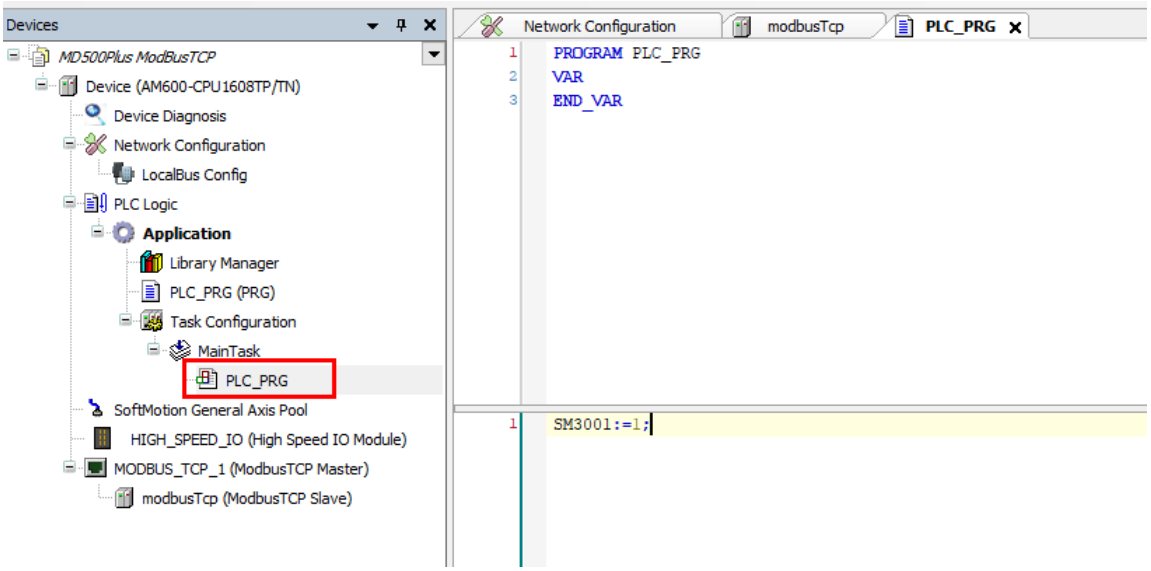
Step 5: Configure the read/write command.

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

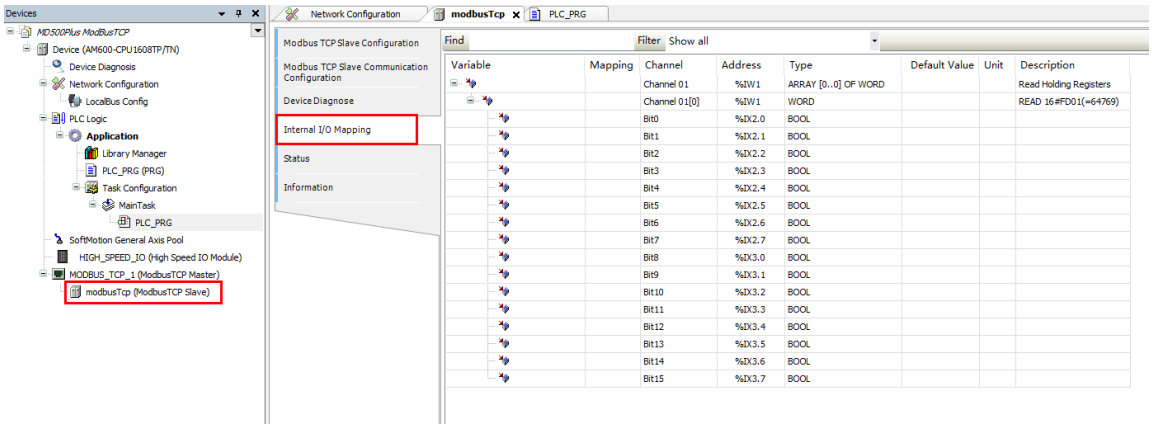


Step 6: Enable the Modbus TCP communication.

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



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


Devices
MD500Plus ModBusTCP
Device (AM600-CPU1608TP/TN)
Device Diagnosis
Network Configuration
LocalBus Config
PLC Logic
Application
Library Manager
PLC_PRG (PRG)
Task Configuration
MainTask
PLC_PRG
SoftMotion General Axis Pool
HIGH_SPEED_IO (High Speed IO Module)
MODBUS_TCP_1 (ModbusTCP Master)
modbusTcp (ModbusTCP Slave)
Network Configuration
modbusTcp
PLC_PRG
Modbus TCP Slave Configuration
Modbus TCP Slave Communication Configuration
Device Diagnose
Internal I/O Mapping
Status
Information
Find
Filter
Show all
Variable
Mapping
Channel
Address
Type
Default Value
Unit
Description
Channel 01
%IW1
ARRAY [0..0] OF WORD
Read Holding Registers
Channel 01[0]
%IW1
WORD
READ 16#FD01(=64769)
Bit0
%IX2.0
BOOL
Bit1
%IX2.1
BOOL
Bit2
%IX2.2
BOOL
Bit3
%IX2.3
BOOL
Bit4
%IX2.4
BOOL
Bit5
%IX2.5
BOOL
Bit6
%IX2.6
BOOL
Bit7
%IX2.7
BOOL
Bit8
%IX3.0
BOOL
Bit9
%IX3.1
BOOL
Bit10
%IX3.2
BOOL
Bit11
%IX3.3
BOOL
Bit12
%IX3.4
BOOL
Bit13
%IX3.5
BOOL
Bit14
%IX3.6
BOOL
Bit15
%IX3.7
BOOL

21 CANopen Communication (MD38CAN1)

21.1 Protocol Description

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

Communication model

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

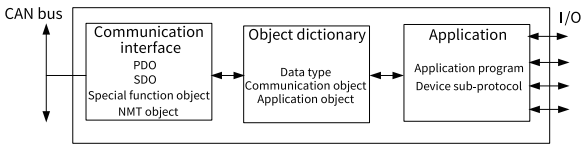


Figure 21-1 CANopen communication model

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

Protocol features

CANopen supports six protocols and is described as follows:

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

Object dictionary

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

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

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

Figure 21-2 Structure of the object dictionary

Common communication object

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

- NMT object: 0x000
- SYNC object: 0x080
- SDO object:
  Transmit SDO— 0x600+Node-Id

  Receive SDO — 0x580+Node-Id
- PDO object:
  RPDO1 — 0x200+Node-Id

  RPDO2 — 0x300+Node-Id

  RPDO3 — 0x400+Node-Id

  RPDO4 — 0x500+Node-Id

  TPDO1 — 0x180+Node-Id

  TPDO2 — 0x280+Node-Id

  TPDO3 — 0x380+Node-Id

  TPDO4 — 0x480+Node-Id
- EMCY object: 0x80+Node-Id
  Node-Id: Device ID (station address), which is defined by FD-02

Communication objects are defined as follows:

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

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

CANopen packet format

- NMT module control message
  Only an NMT master node can send NMTModuleControlNMT messages. For details about the message format, see *"Table 21–1 NMT message format" on page 416*. COB-ID is fixed at 0x000. Data0 is the command word, which occupies one byte. See *"Table 21–2 NMT packet command format" on page 416*. Data1 is a CANopen network device address occupying one byte. When it is 0, it indicates a broadcast message that is valid for all slave devices in the network.

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

Table 21–1 NMT message format

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

Table 21–2 NMT packet command format

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

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

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

"Table 21–3 NodeGuarding packet sent by the master node" on page 417 describes the remote frame sent by the NMT master node.

Table 21–3 NodeGuarding packet sent by the master node

COB-ID	RTR
0x700+Node-ID	1

"Table 21–4 NodeGuarding response packet returned from a slave node" on page 417 is the response message returned by the NMT slave node. *"Table 21–5 Status word returned by the NodeGuarding slave node" on page 417* describes the status word in the one-byte format.

Table 21–4 NodeGuarding response packet returned from a slave node

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

Table 21–5 Status word returned by the NodeGuarding slave node

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

- Heartbeat message
  A node can be configured to produce periodic heartbeat messages, in which bit 7 is 0, and bit 6 to bit 0 are the same as those of the NodeGuarding message. See *"Table 21–6 Heartbeat message" on page 417* for details. The heartbeat time is defined by the standard protocol object 0x1017. A node can support either the NodeGuarding protocol or the Heartbeat protocol.

Table 21–6 Heartbeat message

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

21.2 Networking and Interfaces

Communication port

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

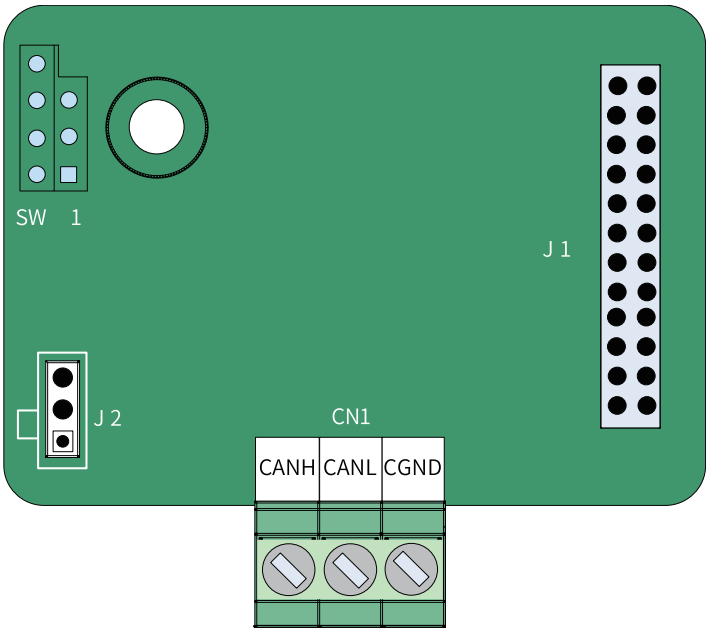


Figure 21-3 Layout of MD38CAN1 terminals

Table 21–7 Function descriptions of MD38CAN1 terminals

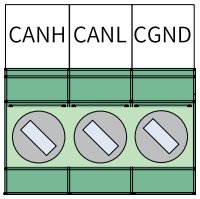
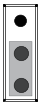
Mark		Terminal Name	Function Description	Layout
CN1	CANH	Positive CAN input	It is used to connect to the positive end of the CAN bus.	
	CANL	Negative CAN input	It is used to connect to the negative end of the CAN bus.	
	CGND	Power supply ground	It is used to connect to the reference ground of all CAN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

Table 21–8 Jumper on the MD38CAN1 expansion card

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

The jumper is set when you view from the top of the expansion card with the main wiring terminal at the bottom.

For the position of the jumper, see the PCB silkscreen.

Communication networking

1. CAN bus topology

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

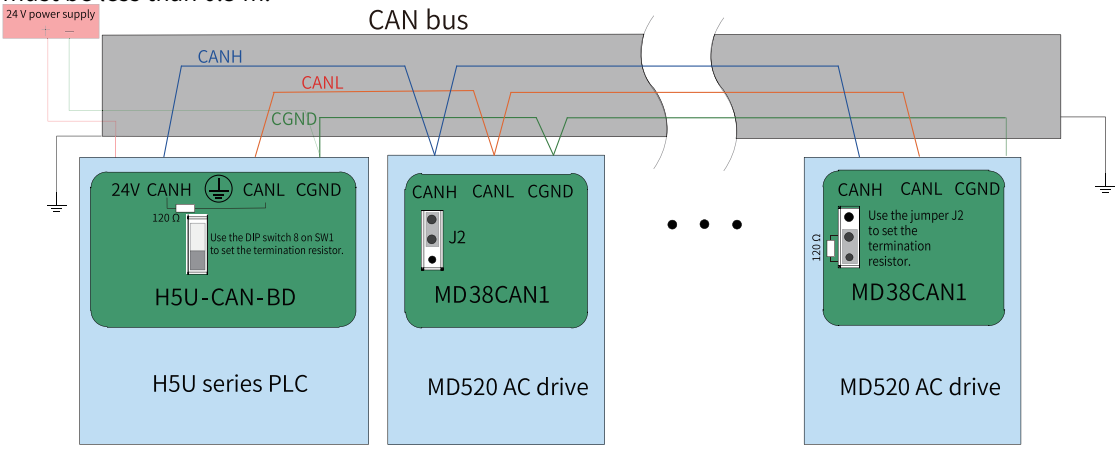
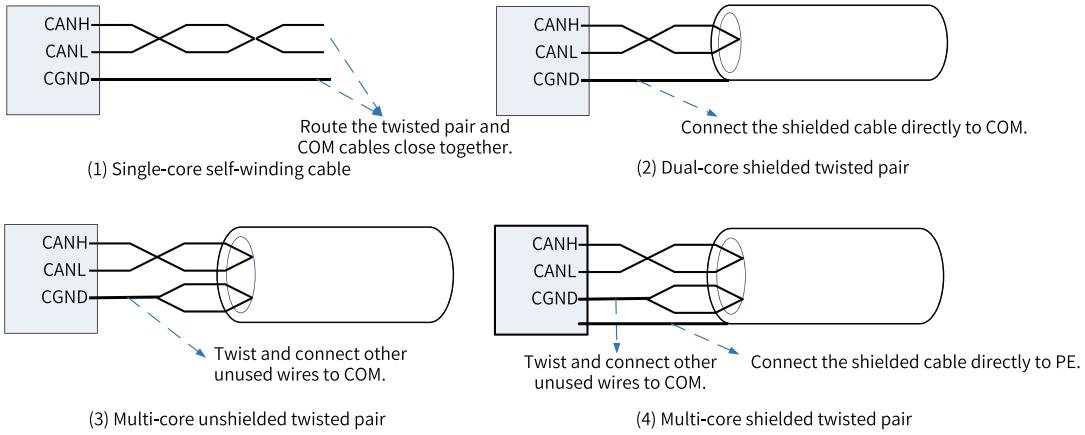


Figure 21-4 CANlink/CANopen bus topology

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



Transmission distance

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

Table 21–9 Relationship between the bus length and baud rate

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

21.3 Related Parameters

Table 21–10 Related parameters

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

Parameter Code	Parameter Name	Default	Value Range	Description
FD-11	CiA 402	0	0: Enable 1: Enable	This parameter sets whether to enable the CiA 402 mode. When it is set to 0, the common mode is used. When it is set to 1, the CiA 402 mode is used. For details, see *"36.1 List of Object Dictionary in Group 6000h" on page 930* and *"36.2 Object Dictionary Descriptions" on page 931*.
FD-14	Number of frames received per unit time	0	0 to 65535	This parameter is used to monitor the bus load. It defines the number of CAN frames received by the station per second. It is valid only for the CANlink communication expansion card.
FD-15	Maximum number of error frames received by node	0	0 to 65535	This parameter is used to monitor bus errors. It defines the maximum number of error frames received by the node. It is valid only for the CANlink communication expansion card.
FD-16	Maximum number of error frame sent by node	0	0 to 65535	This parameter defines the maximum number of error frames sent by the node. It is valid only for the CANlink communication expansion card.
FD-17	Number of disconnections from bus	0	0 to 65535	This parameter is used to monitor bus errors. It defines the number that the node disconnects from the CAN bus. It is valid only for the CANlink communication expansion card.
FD-19	CAN communication disconnection coefficient	3	1 to 15	This parameter is used to set the number of timeout events allowed in CANopen communication before a warning is reported.

21.4 Application

21.4.1 Communication Data Frame Structure

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

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

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

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

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

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

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

Table 21–11 Corresponding relationship between parameter groups and object dictionary indexes

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

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

Table 21–12 Corresponding relationship between parameter indexes in parameter groups and object dictionary sub-indexes

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

21.4.2 Operation Example (SDO)

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

1. The communication master station uses a CANopen SDO to read data from the AC drive.
   Take F0-02 as an example. The index and sub-index for F0-02 are 0x20F0 and 0x03, respectively. The following table describes the format of data sent by the master.

Table 21–13 SDO object sent for the read operation

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

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

2. The following table shows the SDO responded by the slave to the read operation.
   If the operation is successful, the returned value of the command code is "0x4B". The index remains unchanged. DATA4 and DATA5 return the read data, and DATA6 and DATA7 return "0".

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

Table 21–14 SDO returned for the read operation

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

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

Table 21–15 SDO sent for the write operation

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

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

4. The following table shows the SDO responded by the slave for the write operation.
   If the operation is successful, the returned value of the command code is "0x60". The index remains unchanged. DATA4, DATA5, DATA6, and DATA7 return "0".

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

Table 21–16 SDO returned for the write operation

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

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

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

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

Table 21–17 Message sent by the master to read F0-02

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

6. The AC drive returns a CANopen response message, as described in the following table.
   The current value of F0-02 is "0x0002", indicating that the current command source of the AC drive is communication.

Table 21–18 Message returned by the AC drive for the read operation of F0-02

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

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

Table 21–19 Message sent by the master for the write operation on F0-02

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

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

Table 21–20 Message returned by the AC drive for the write operation of F0-02

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

21.4.3 Operation Example (PDO)

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

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

Table 21–21 PDO mapping

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

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

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

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

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

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

Table 21–22 Mapping example of group AF

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

Note

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

21.5 Configure communication parameters.

21.5.1 Configuration for 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.

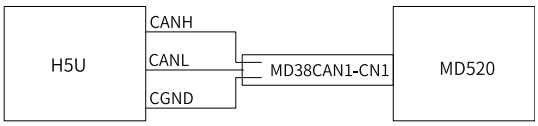


Figure 21-5 Connecting communication interfaces

Master and slave configuration

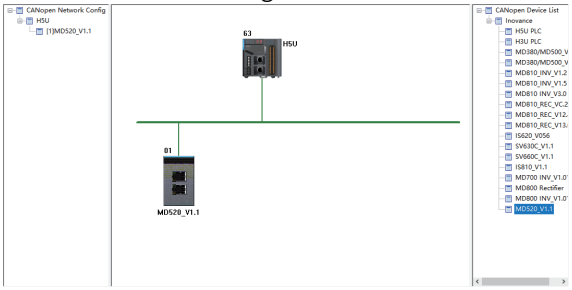
1. Open AutoShop, click **New Project**, check that **Series and models** is **H5U**, and click **OK** to enter the programming interface.
2. Click CAN(CANopen) in the left pane, set parameters as follows, and click **OK**.
   Protocol: Select **CANopen.**

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

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

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

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

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

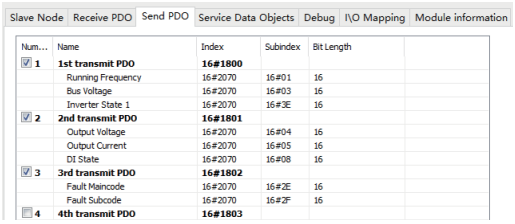
Index: For groups F0 to FF, convert F in the high-order bit to 0 and then add 0x2000.

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

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

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

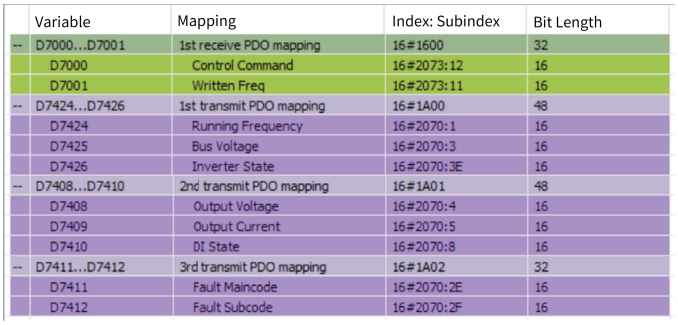
According to the conversion rule, the index of the bus voltage U0-02 is 0x2070, and the sub-index is 03.



Caution

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

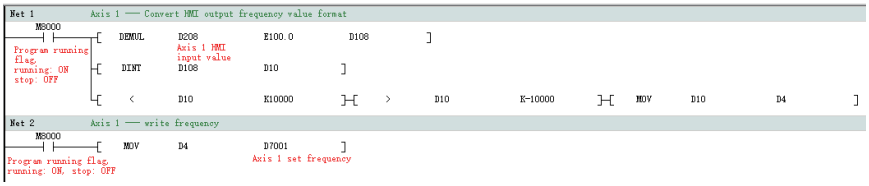
5. Perform I/O mapping.
   This step is to map data (that is, the value to be read or written) in the PDO. The D component is used as a bridge to implement data exchange between the PLC and the AC drive. The H5U high-performance small-sized PLC of Inovance automatically performs I/O mapping based on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



Instances

1. Write the frequency (F0-03 is set to 9).
   Data conversion: Multiply the required frequency (a) by 100 to obtain an integer, and then write the integer to D7001.

   The program is as follows:



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

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

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

   The program is as follows:

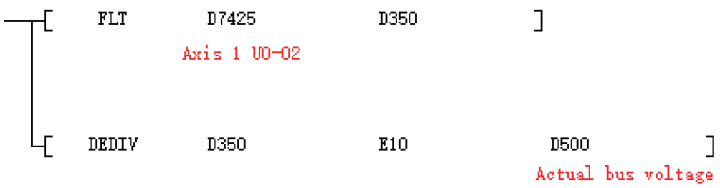


   The PLC soft component address corresponding to the control word is D7000. Therefore, to control the AC drive to run in forward direction through communication, write 1 to D7000. Similarly, to control the AC drive to decelerate to stop, set D7000 to 6.

3. Read the bus voltage.

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

   The program is as follows:



4. Read the output voltage.

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

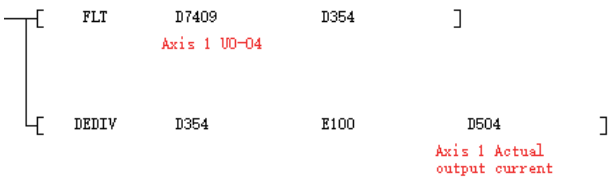
   The program is as follows:



5. Read the output current.

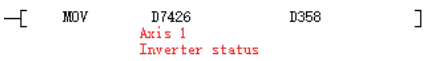
   According to the conversion rule, the actual output current is the read output current divided by 100.

   The program is as follows:



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

   The program is as follows:



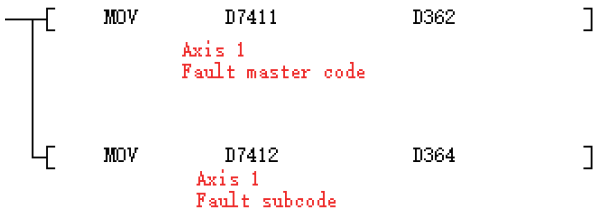
7. Read the DI state.
   According to the conversion rule, the DI state maps to D7410 based on the I/O mapping. Convert the read value into a binary value. The LSB indicates DI1, the second bit indicates DI2, and so on.

   The program is as follows:



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

   The program is as follows:



Common faults and solutions

The must-dos are listed as follows:

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

Table 21–23 Common faults and solutions

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

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

21.6 Troubleshooting

21.6.1 Emergency Message and AC Drive Fault

Emergency message data

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

Table 21–24 **Emergency message data**

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

Note

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

Fault code

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

Table 21–25 Fault code

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

21.6.2 Simple Diagnosis

Status

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

Diagnosis

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

Solution

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

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

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

22 CANlink Communication (MD38CAN1)

22.1 Protocol Description

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

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

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

Address

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

The address range of Inovance products is 1–63.

Note

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

Device

The CANlink devices include nodes, monitors, and configurators.

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

Transmission rate

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

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

Timeout

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

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

Network load rate

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

CANlink frame priority

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

CAN data structure

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

Table 22–1 CANlink data structure

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

CANlink mode

The CANlink node contains the following three running modes:

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

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

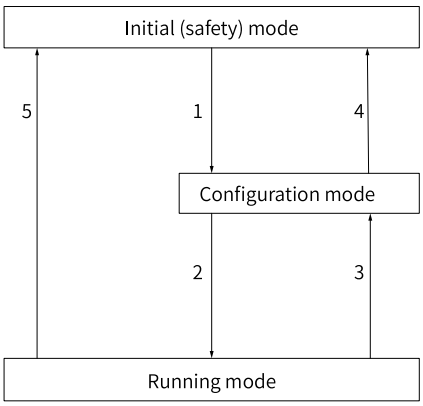


Figure 22-1 CANlink mode switch

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

22.2 Networking and Interfaces

For details, see *“21.2 Networking and Interfaces” on page 417*.

22.3 Related Parameters

Table 22–2 Related parameters

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

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

22.4 Configure communication parameters.

22.4.1 Configuration for CANlink Communication Between AC Drive and H5U

Software acquisition and hardware connection

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

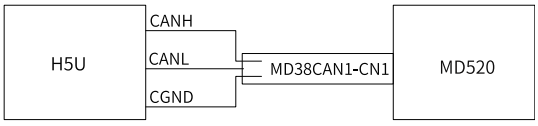


Figure 22-2 Connecting communication interfaces

Master and slave configuration

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

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

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

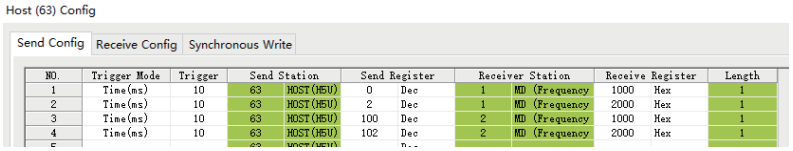
3. Click CAN(CANLink), and click **AddCAN Config**. CAN(CANLink) / CANlink Config is displayed. Double-click **CANlink Config**, click **Next** on the displayed interface, and then set parameter as follows.

   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**.

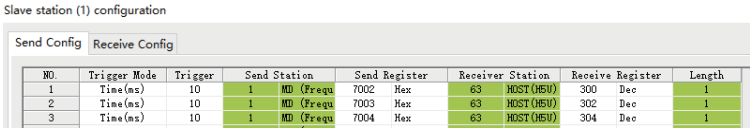
4. Write operation: After a slave is added, select the PLC to set the configuration to be written to the D element of the AC drive.

Station number	Device type
63	Host(H5U Series)
1	MD (Frequency Converter)
2	MD (Frequency Converter)



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

5. Read operation: Select the station (AC drive) to be read and enter the configuration interface for reading the D component of the AC drive.
   To read station 1, click number 1 to start configuration. To read station 2, click number 2 to start configuration. You cannot read the required value correctly if the station number is incorrect.



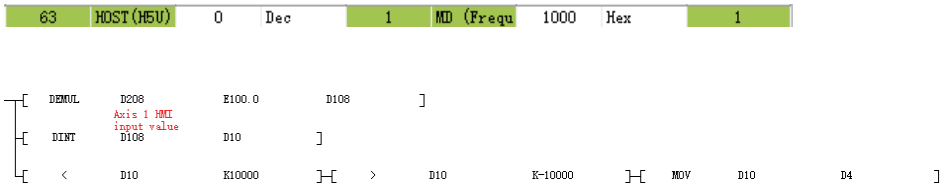
   As shown in the preceding figure, the bus voltage, output voltage, and output frequency of the AC drive are sent to D300, D302, and D304 of the PLC. Configure the transmission register address and D component correctly as needed. After the read and write operation settings, keep clicking **OK** until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

Instances

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

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

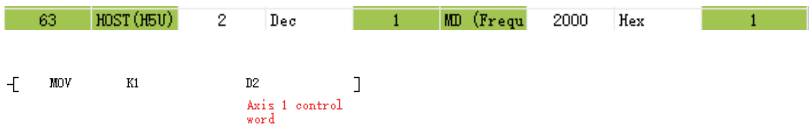
The following figure shows the configuration and the program.



2. Start or stop the AC drive (F0-02 is set to 2).
   Assign a value to the D component corresponding to the station address 2000H to control forward running, reverse running, and stop of the AC drive through communication. Definitions of 2000H are as follows:

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

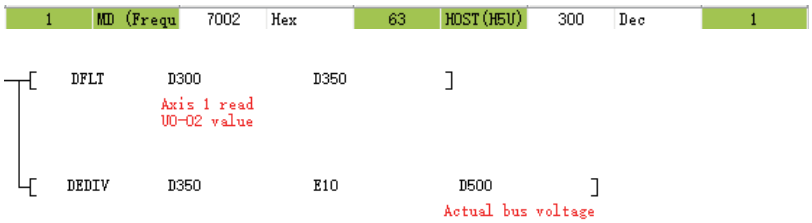
   The following figure shows the configuration and the program.



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

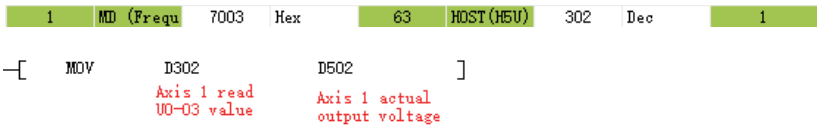
3. Read the bus voltage.
   Convert the bus voltage U0-02 to 7002 based on the conversion rule (convert U in the high-order two bits to 7, and convert the low-order two bits to a hexadecimal equivalent). The actual bus voltage is the read bus voltage (a) divided by 10. According to the communication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

   The following figure shows the configuration and the program.



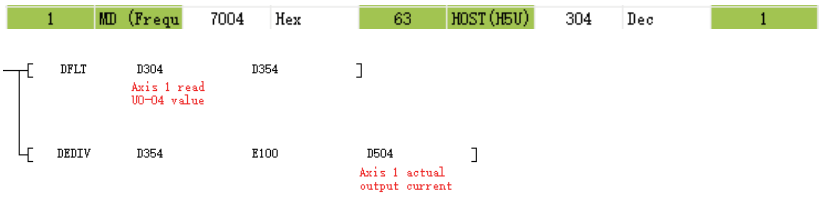
4. Read the output voltage.
   Convert the output voltage U0-03 to 7003 based on the conversion rule. The read value is the actual output voltage. According to the communication configuration, you only need to move the value of D302 to another D component (or not).

   The following figure shows the configuration and the program.



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

   The following figure shows the configuration and the program.



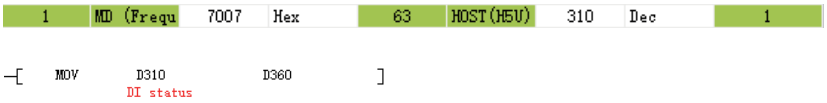
6. Read the AC drive state.
   Read 3000H to directly obtain the current state of the AC drive (1: Running in forward direction; 2: Running in reverse direction; 3: Stopped).

   The following figure shows the configuration and the program.



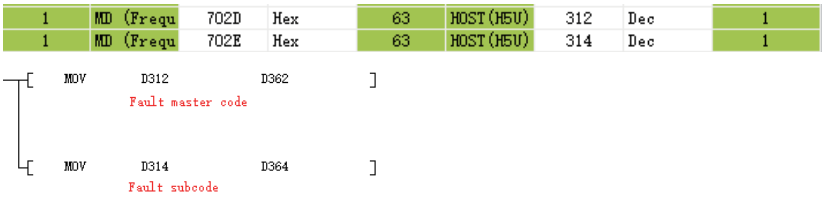
7. Read the DI state.
   According to the conversion rule, convert the DI state U0-07 to 7007. Convert the read value into a binary value. The LSB indicates DI1, the second bit indicates DI2, and so on.

   The following figure shows the configuration and the program.



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

   The following figure shows the configuration and the program.



Common faults and solutions

The must-dos are listed as follows:

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

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

Table 22–3 Common problems and solutions

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

23 PROFINET Communication (MD500-PN1)

23.1 Introduction

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

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

23.2 Installation

The MD500-PN1 card is embedded in the MD520 series AC drive. Before installation, power off the AC drive, wait at least 10 minutes until the charging indicator on the AC drive becomes off. Then, insert the MD500-PN1 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. *"Figure 23–1" on page 443* describes the installation of the card.

Note that the ground terminals of both the MD500-PN1 card and AC drive must be connected properly, as shown in *"Figure 23–2" on page 443* .

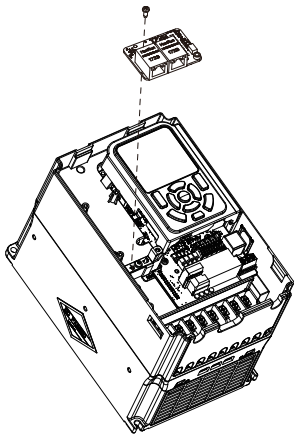


Figure 23-1 MD500-PN1 card installation

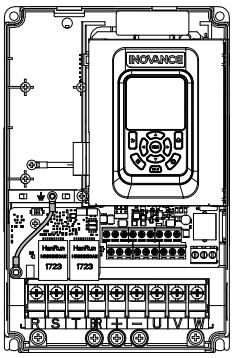


Figure 23-2 Connecting ground terminals of the MD500-PN1 card and AC drive

23.3 Terminal Layout and Description

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

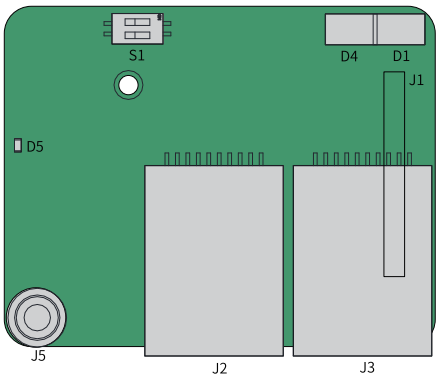


Figure 23-3 MD500-PN1 card terminal layout

Table 23–1 Indicators of the MD500-PN1 card

Mark	Hardware Name	Function Description
J1	Pin header	Check that FD-00 is set to 9 and FD-01 is set to 3.
J2	Network port	The ports are standard Ethernet RJ45 ports and are direction-insensitive. The J3 port is used by the PN card (drive) to communicate with the PN card (PLC).
J3		
D5	Power supply indicator	It is used to indicate the status of the power supply. ON: Normal; OFF: Abnormal. Check whether the card is installed properly.
D1	PLC communication status indicator (PLCLINK)	For details, see *"Table 23–2" on page 445*.
D4	AC drive communication status indicator (DSPLINK)	
S1	2-bit DIP switch	Used by the manufacturer for upgrade purpose only.

Caution

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

Table 23–2 Status indicators of the MD500-PN1 card

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

23.4 PROFINET Topology

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

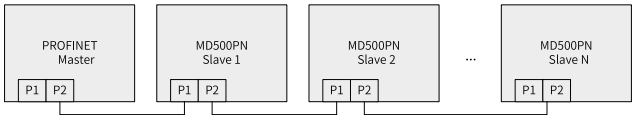


Figure 23-4 Bus-type topology

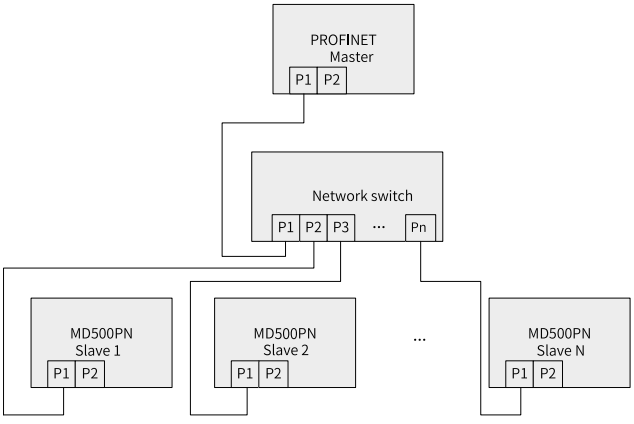


Figure 23-5 Star-type topology

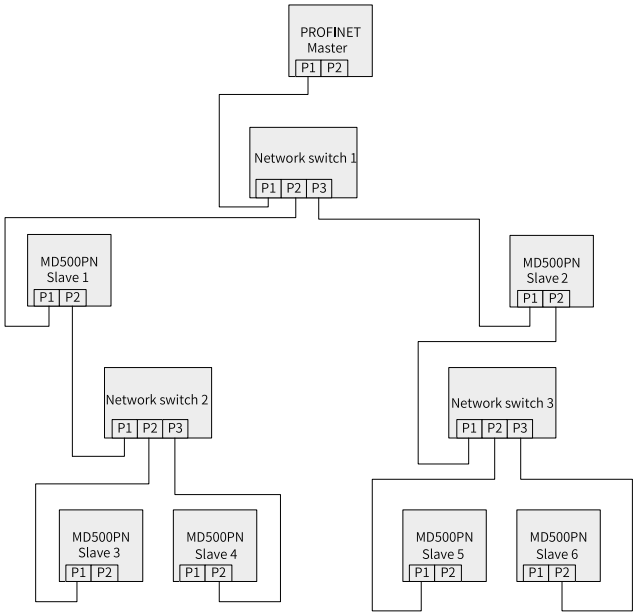


Figure 23-6 Tree-type topology

23.5 Data Transmission Format

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

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

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

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

23.6 PZD Data

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

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

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

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

The following table lists the interactive data.

Table 23–3 Interactive data

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

Table 23–4 Interactive data

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

23.7 Related Parameters

PN card configuration of the AC drive

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

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

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

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

Parameters related to expansion cards

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

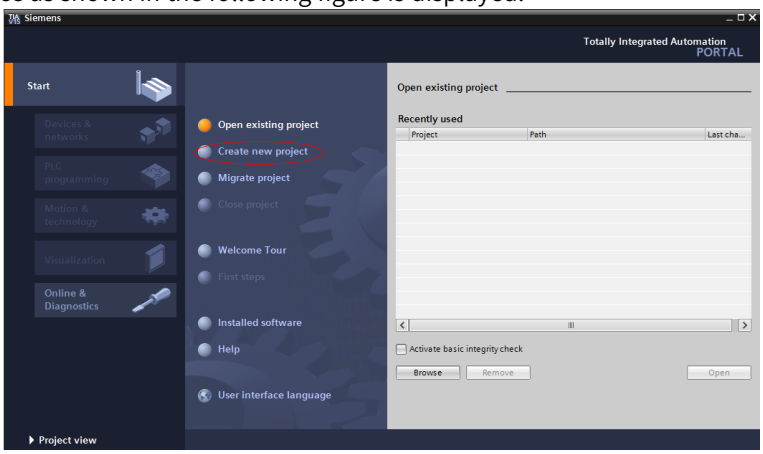
23.8 Configure communication parameters.

23.8.1 Configuring Slaves on the S7-1200 Master

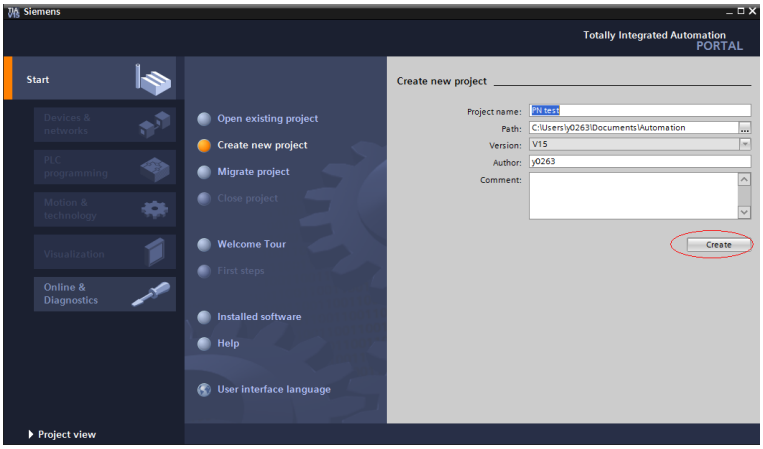
Before using the PROFINET master, you need to configure the GSDML file of the slave to add the corresponding slave stations to the master. If the file exists, skip step 2. You can obtain the GSDML file from the Inovance agent or the manufacturer.

To configure the slave, do as follows:

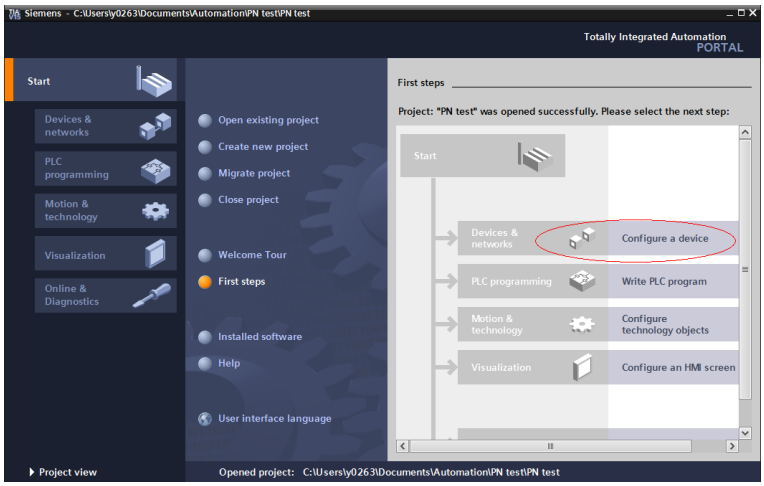
1. Create a project and add the S7-1200 master to the project in PORTAL. To be specific, open PORTAL first. The interface as shown in the following figure is displayed.



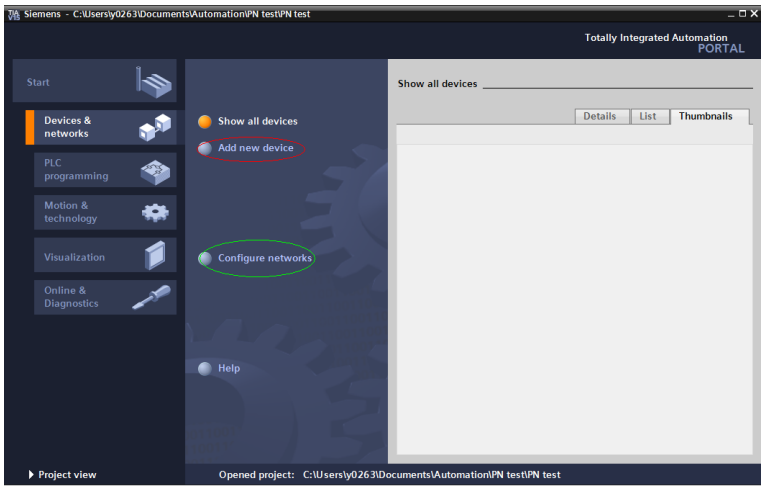
Click **Create new project**, enter a project name and storage path, and click **Create**.



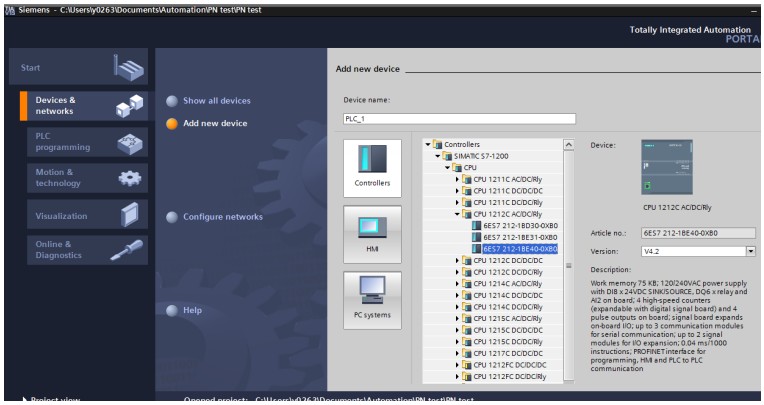
Click **Configure a device**.



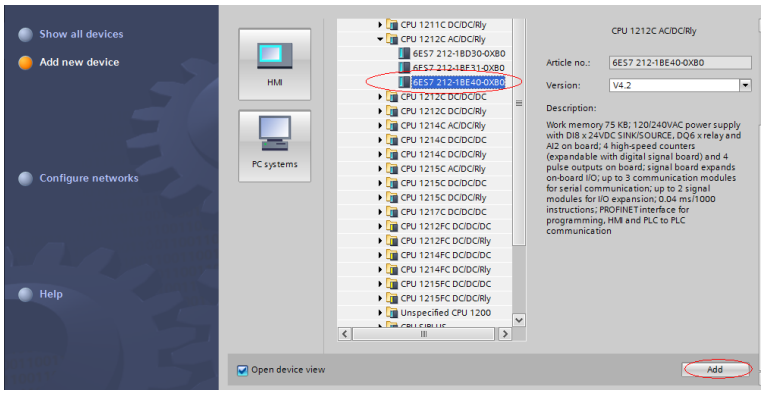
For a new project, click **Add new device** (marked with a red circle in the following figure). For an existing project, click **Configure networks** (marked with a green circle in the following figure).



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

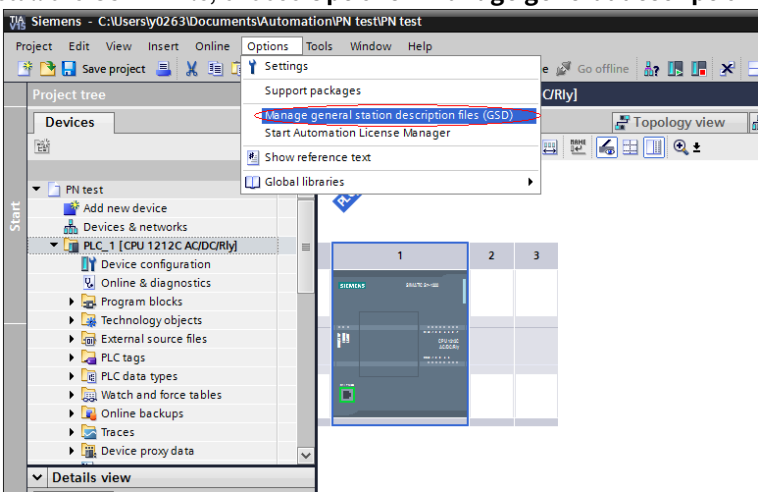


Click **Add** or double-click the selected master station.

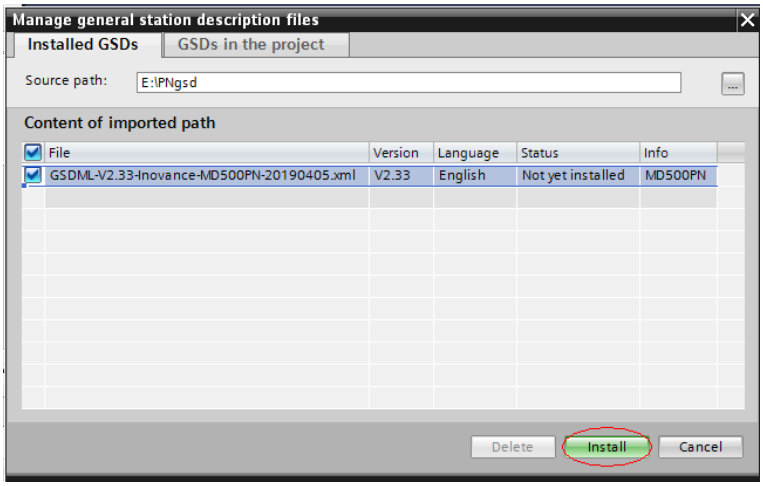


The master is added.

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



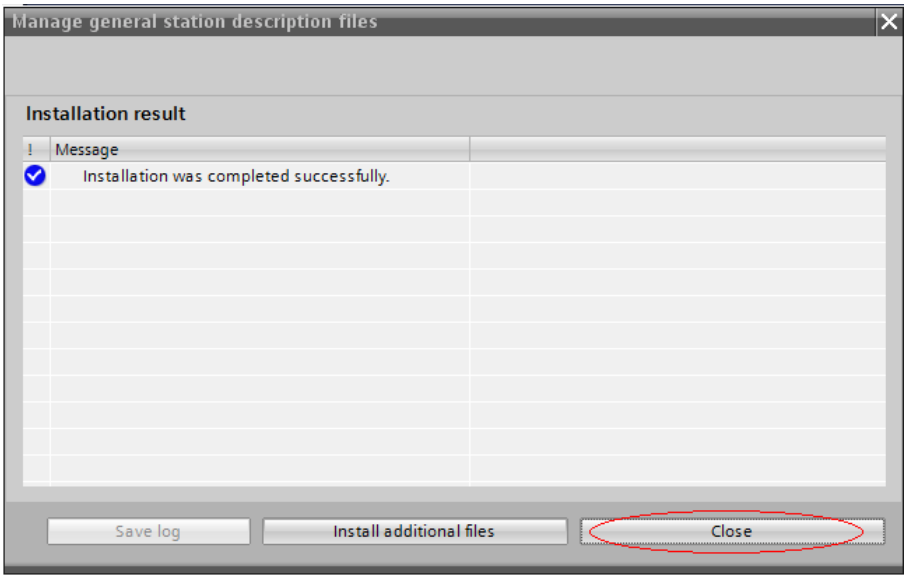
Select the storage path that does not contain any Chinese characters for the GSDML file, select the GSDML file to be installed, and click **Install**.



Caution

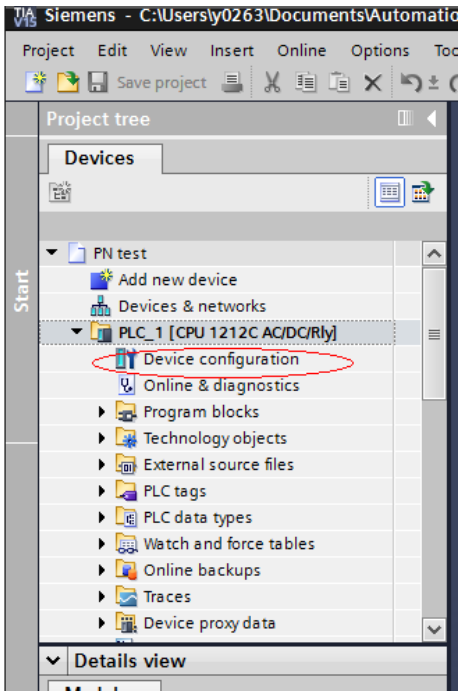
The GSDML file name varies with the AC drive series. For details, see the corresponding user guide.

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

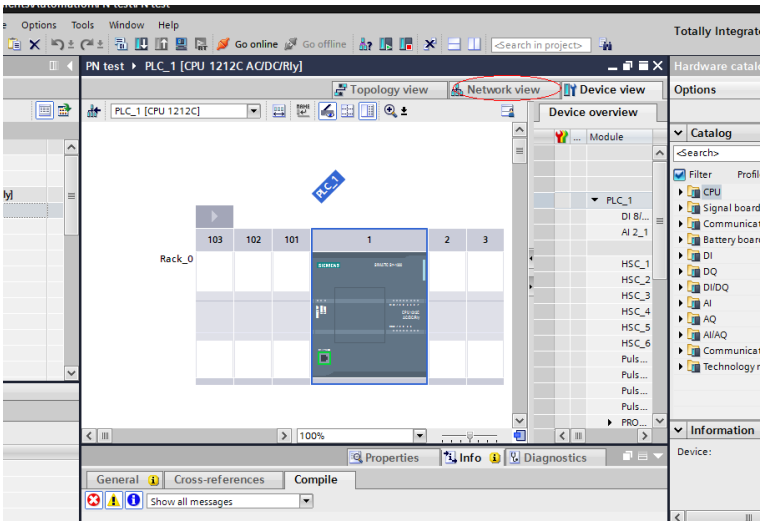


3. Configure a slave.

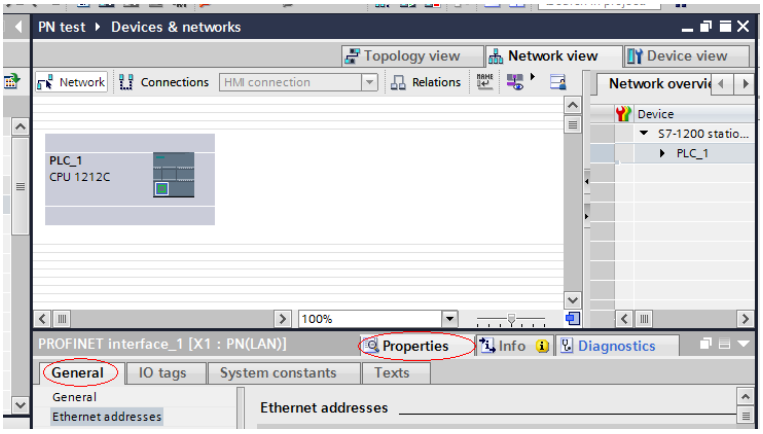
   Click **Device configuration**.



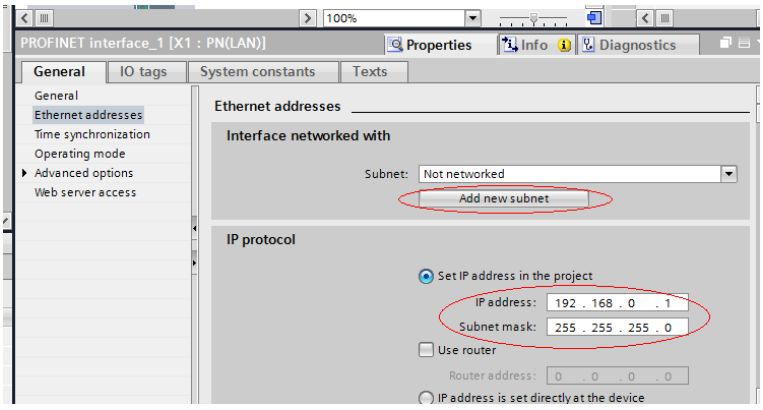
   Switch to **Network View**.



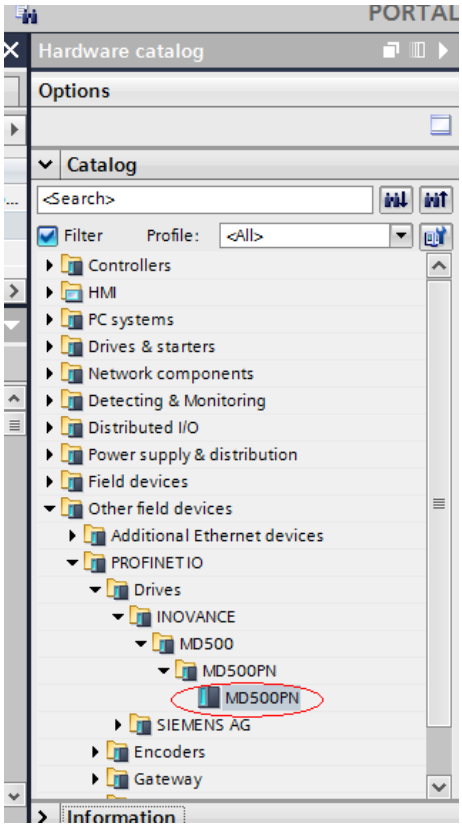
Select the Ethernet interface of the PLC, and choose **Properties** > **General**.



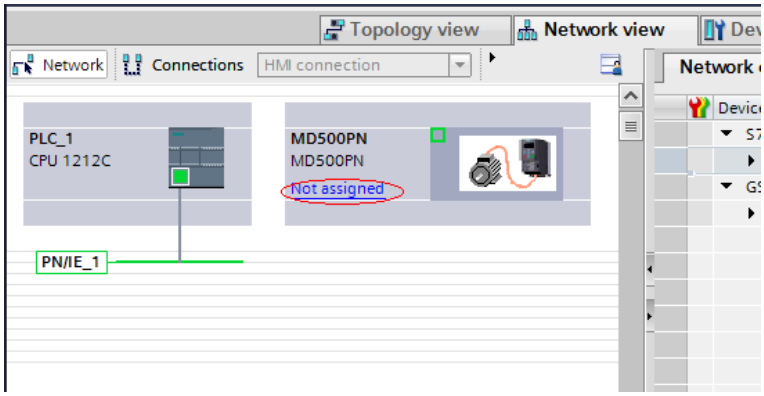
Set the IP address and subnet mask of the PLC, and click **Add new subnet**.



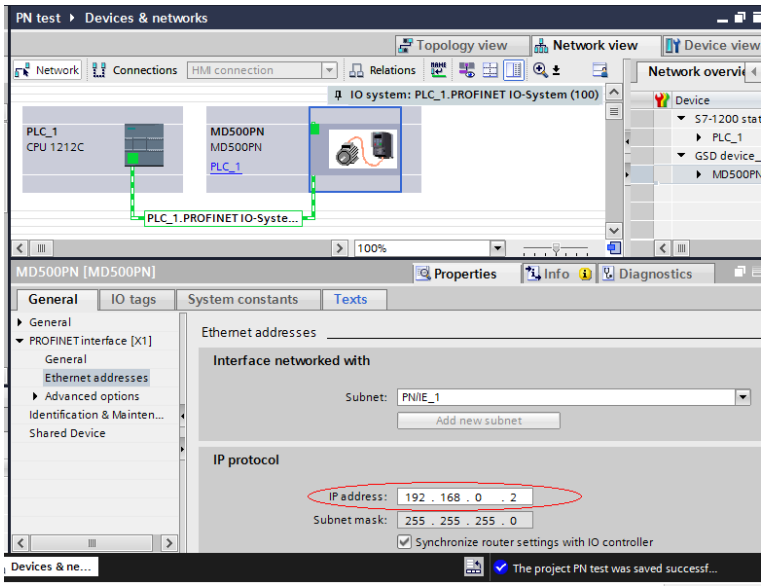
Locate MD500PN under **Hardware catalog** on the right, and double-click **MD500PN**.



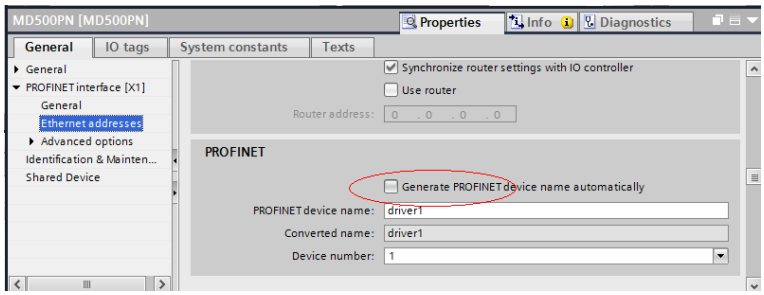
Click **Not assigned** to select the master system for the slave.



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

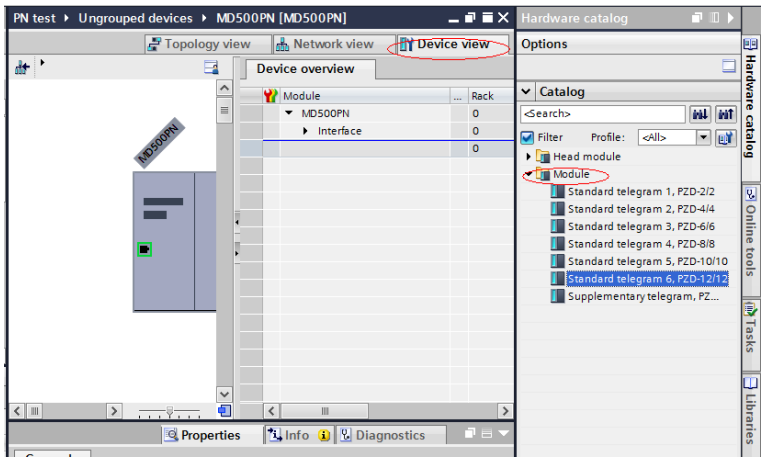


Scroll down the interface to locate the **PROFINET** area. Clear **Generate PROFINET device name automatically**, and name the slave device in the **PROFINET device name** text box. Alternatively, select **Generate PROFINET device name automatically** to enable the system to generate a device name automatically.



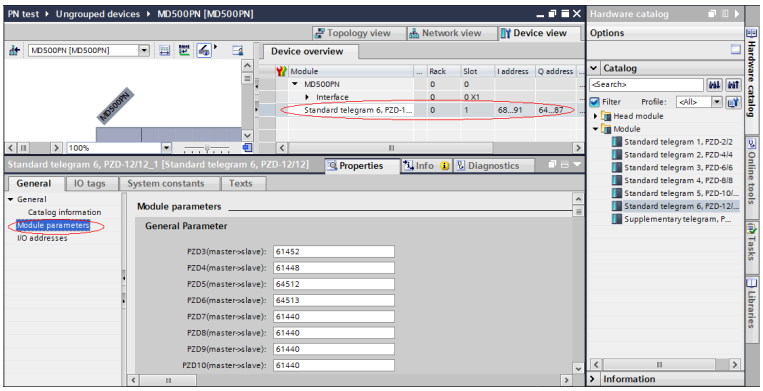
4. Configure data features of the slave.

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



5. Configure the PZD.

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

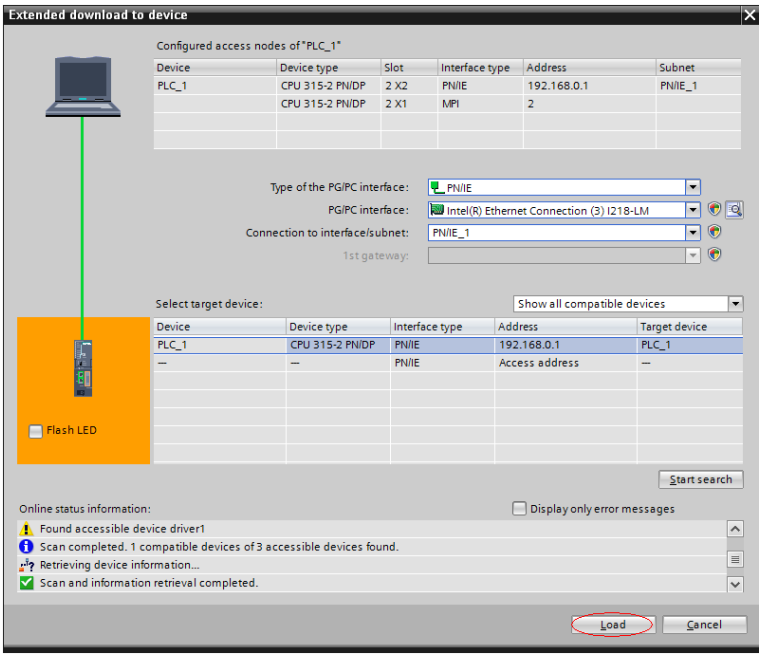


PZDx(master->slave) indicates the address of the slave used by the master to write data to the slave, and PZDx(slave->master) indicates the address of the slave used by the master to read data from the slave. PZD3 to PZD12 (determined by the selected message type) are displayed in decimal and can be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

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

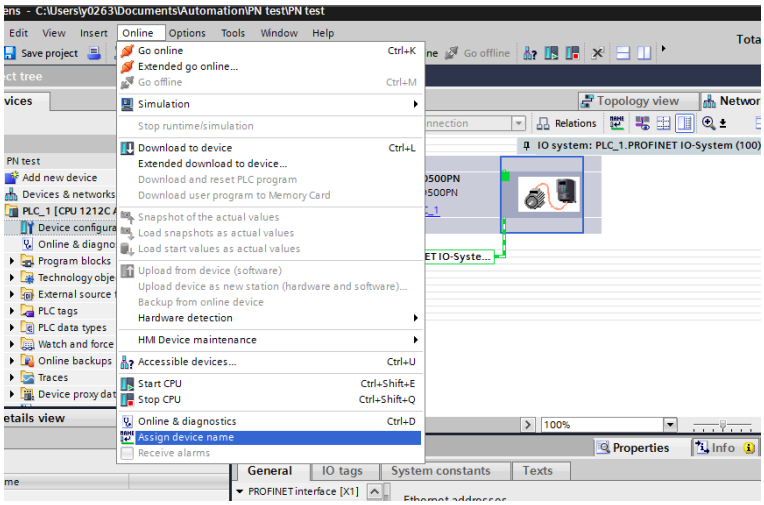
Switch to **Network view**. To add more stations, repeat the preceding steps. If the configuration is the same, select and copy a configured slave and modify the IP address and device name (note that the device name must be unique).

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

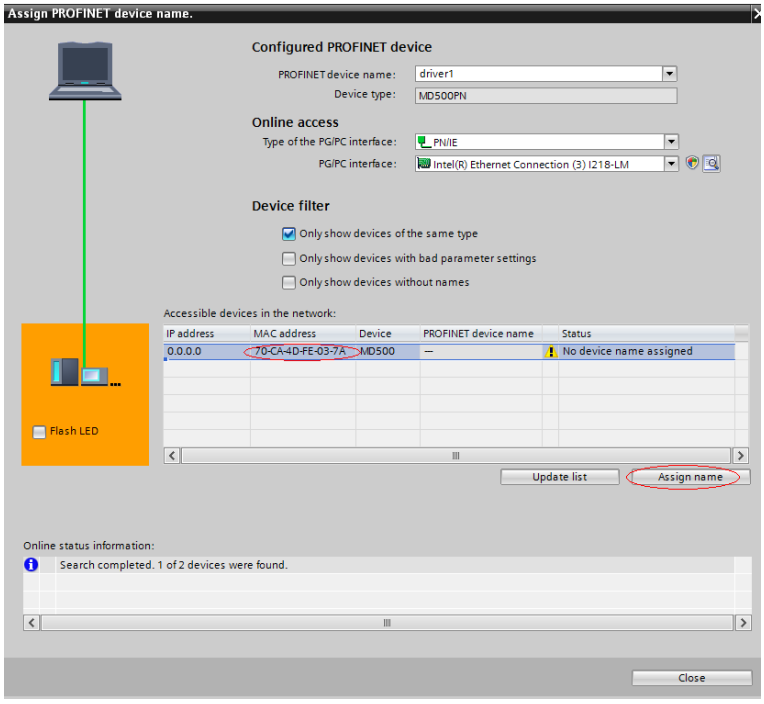


7. Assign a device name.

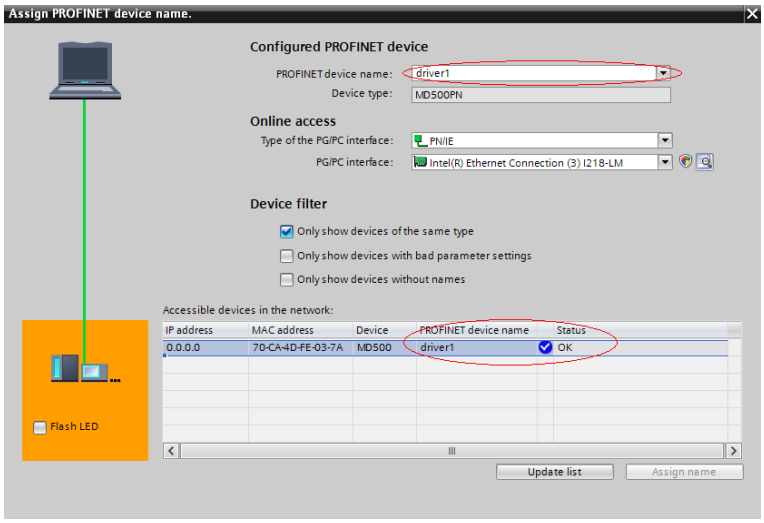
After downloading is complete, assign device names for slave stations without names. Select a slave, and choose **Online** > **Assign device name**, or right-click the slave and select **Assign device name**.



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



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



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

Caution

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

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

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

23.8.2 MRP Functions of MD500-PN1 Card

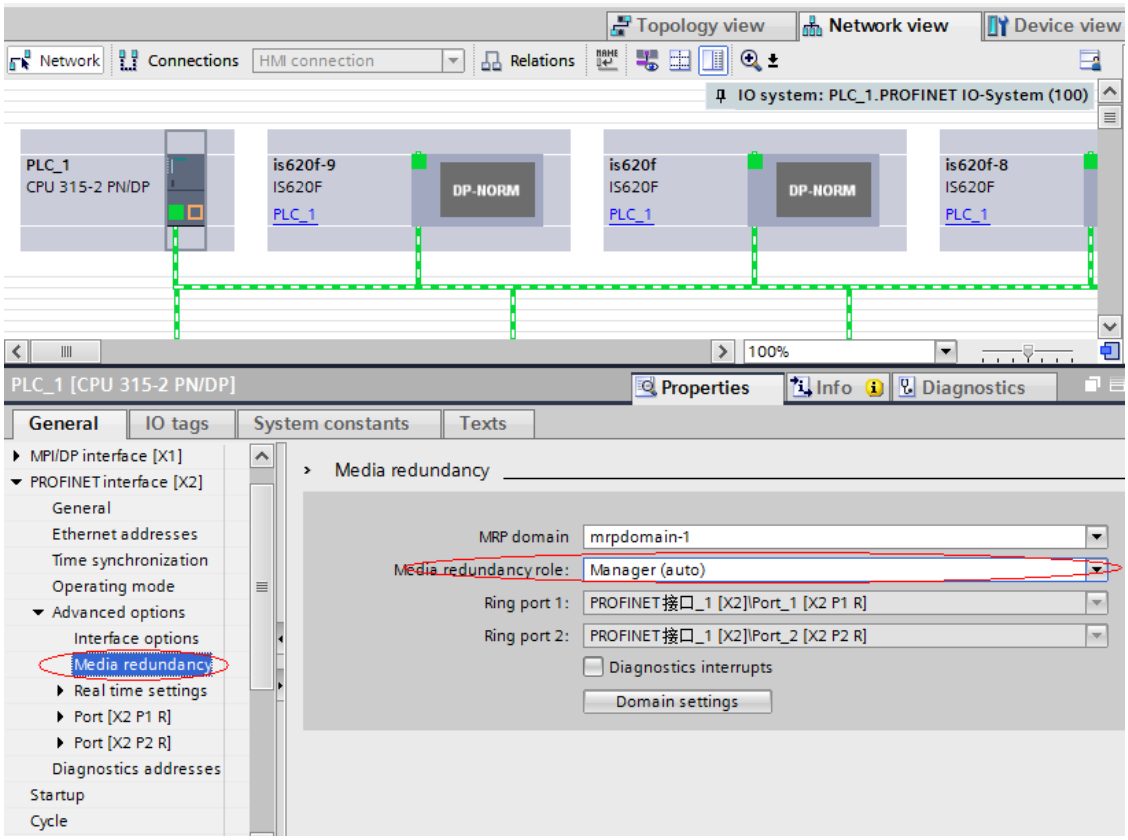
The Media Redundancy Protocol (MRP) function is implemented by the MRP ring network in PROFINET. Only one MRP ring network is allowed in one PROFINET network.

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

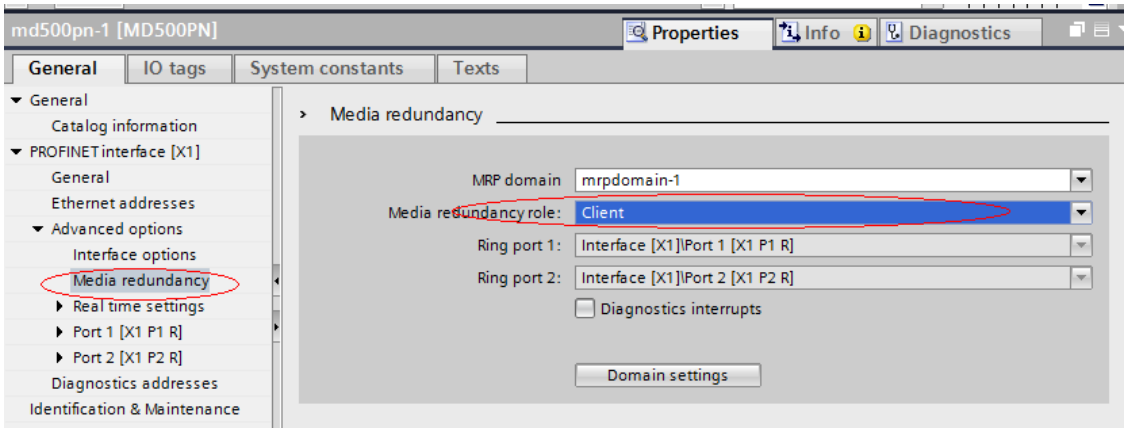
Configuring the MRP function in PORTAL

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

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



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



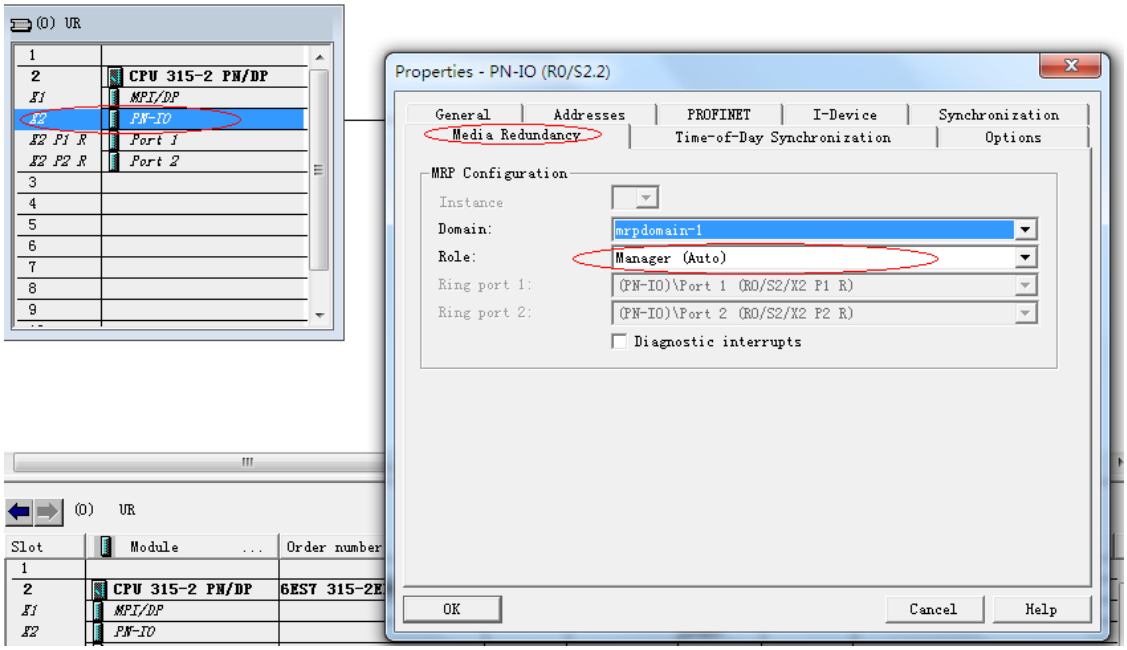
3. Configure the watchdog time.
   The MRP function requires that the watchdog time cannot be shorter than 200 ms. Therefore, you need to modify the watchdog time, as shown in the following figure. Click **IO cycle**. Under **Watchdog time**, modify **Watchdog time** to a value not less than 200 ms.

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

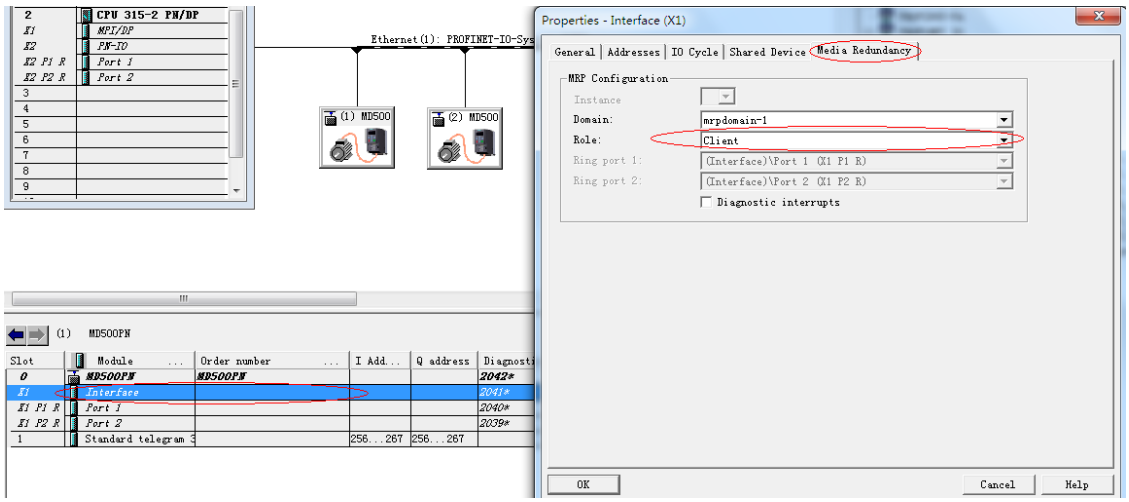
4. Download the configuration.
   After configuring all devices in the MRP ring network, compile and download the configuration to the PLC.

Configuring the MRP function in STEP 7

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



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



3. Configure the watchdog time.

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

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

Click **OK**.

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

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

Caution

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

23.9 Troubleshooting

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

The following table describes the fault code of the rectifier.

Table 23–5 Fault code of the rectifier

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

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

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

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

Caution

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

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

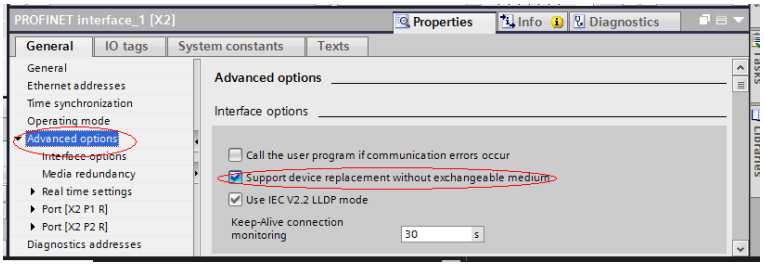
Prerequisites for directly replacing the MD500-PN1 card are as follows:

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

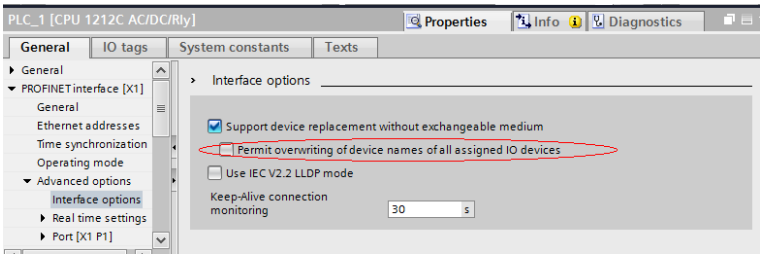
To replace the MD500-PN1 card directly, you need to perform corresponding settings during configuration. Settings in STEP 7 and PORTAL are different.

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

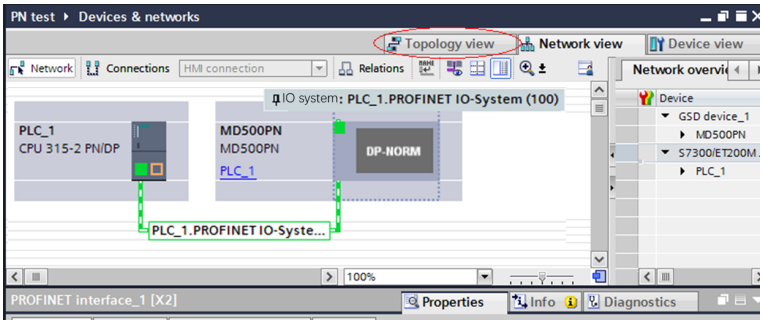
Open PORTAL, and select the PROFINET interface of the master station in the hardware configuration. Go to **Properties** > **General** > **Advanced options**, and select **Support device replacement without exchangeable medium**, as shown in the following figure.



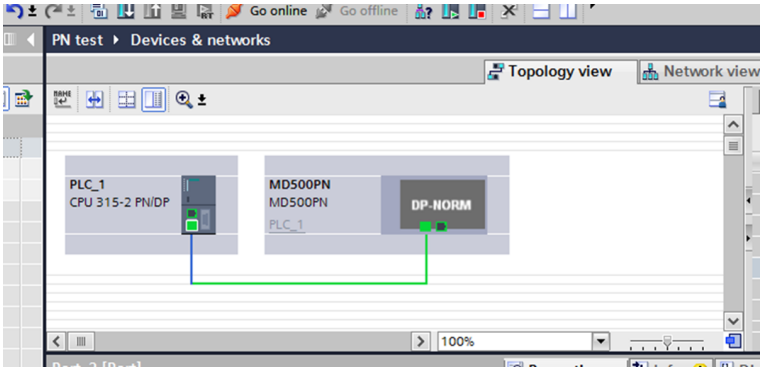
For the S7-1200 or S7-1500 PLC, the check box **Permit overwriting of device names of all assigned IO devices** is provided. If the check box is selected, the second prerequisite for directly replacing the device is not required.



Click the **Topology view** tab.



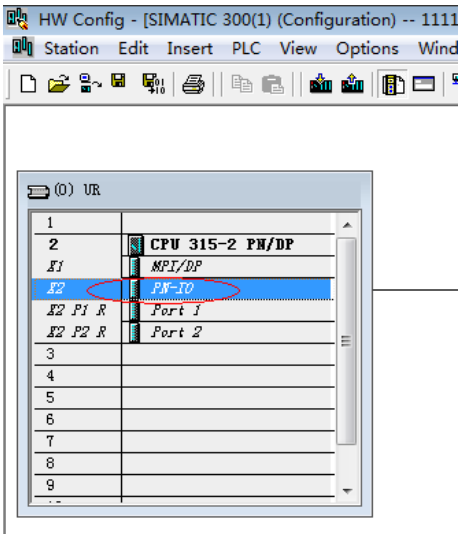
In the topology view, click and drag an interface to the interface of another device which is directly connected with the first interface, and release the mouse button. Note that the preceding connection must be consistent with the actual network connection of devices. For example, if P1 of the PLC is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



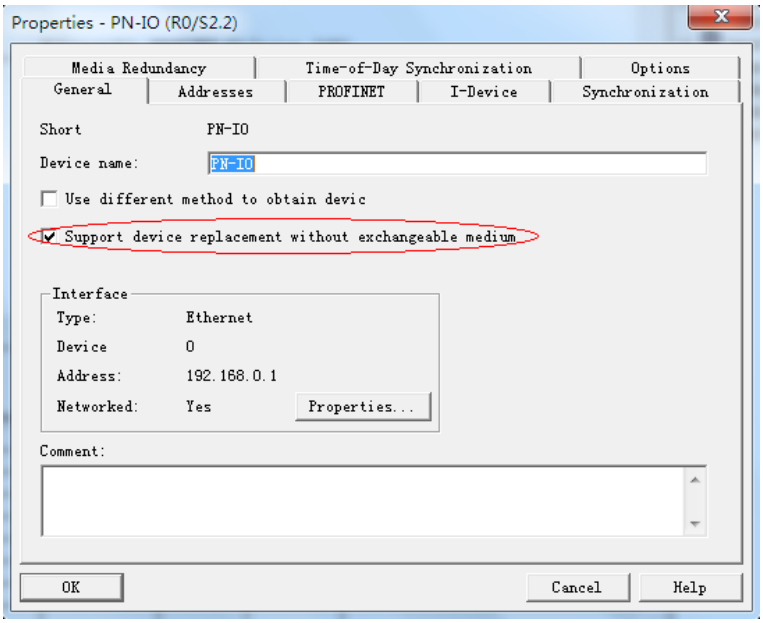
After completing the topology, start compiling and download it to the PLC.

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

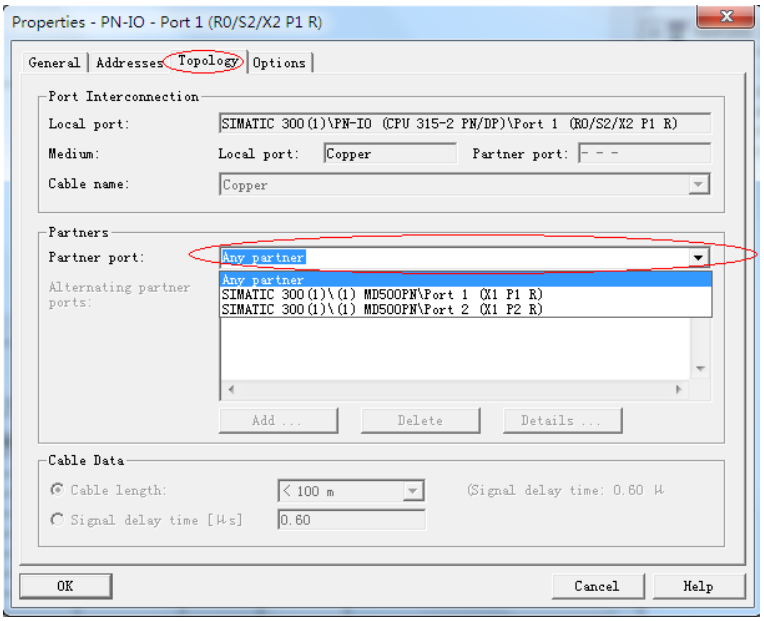
In hardware configuration, double-click **PN-IO**, as shown in the following figure.



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



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



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

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

24 PROFINET Communication (MD500-PN2)

24.1 Introduction

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

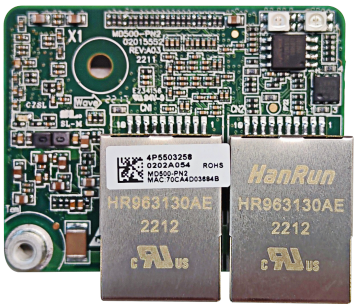


Figure 24-1 MD500-PN2 card appearance

24.2 Installation

The MD500-PN2 card is embedded in the MD520 or MD500 series AC drive. Before installation, power off the AC drive, wait at least 10 minutes until the charging indicator on the AC drive becomes off. Then, insert the MD500-PN2 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. *"Figure 24–2" on page 470* describes the installation of the card.

Note that the ground terminals of both the MD500-PN2 card and AC drive must be connected properly, as shown in *"Figure 24–3" on page 471* .

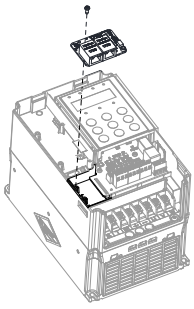


Figure 24-2 MD500-PN2 card installation

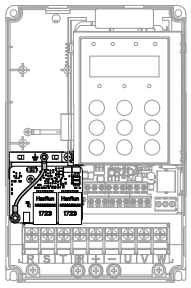


Figure 24-3 Connecting ground terminals of the MD500-PN2 card and AC drive

Caution

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

24.3 Interface Description

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

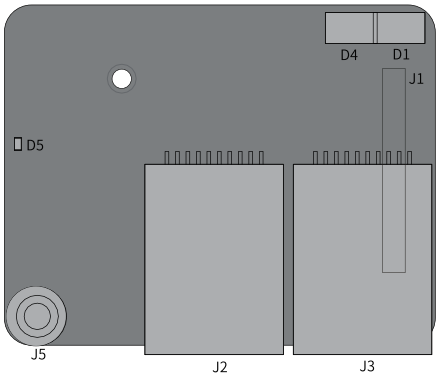


Figure 24-4 MD500-PN2 card terminal layout

Table 24–1 Indicators of the MD500-PN2 card

Mark	Hardware Name	Function Description
J1	Pin header	Check whether FD-00 is 9 and FD-01 is 3.
J2	Network port	The ports are standard Ethernet RJ45 ports and are direction-insensitive. The port is used by the MD500-PN2 card to communicate with the PN card (PLC).
J3		
D5	Power supply indicator	It is used to indicate the status of the power supply. ON: Normal; OFF: Abnormal. Check whether the card is installed properly.
D1	PLC communication status indicator (PLCLINK)	See *"Table 24–2" on page 472*.
D4	AC drive communication status indicator (DSPLINK)	

Note

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

Table 24–2 Status indicators of the MD500-PN2 card

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

24.4 PROFINET Topology

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

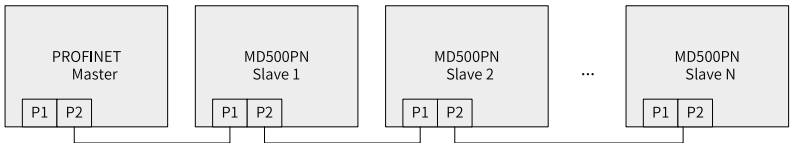


Figure 24-5 Bus-type topology

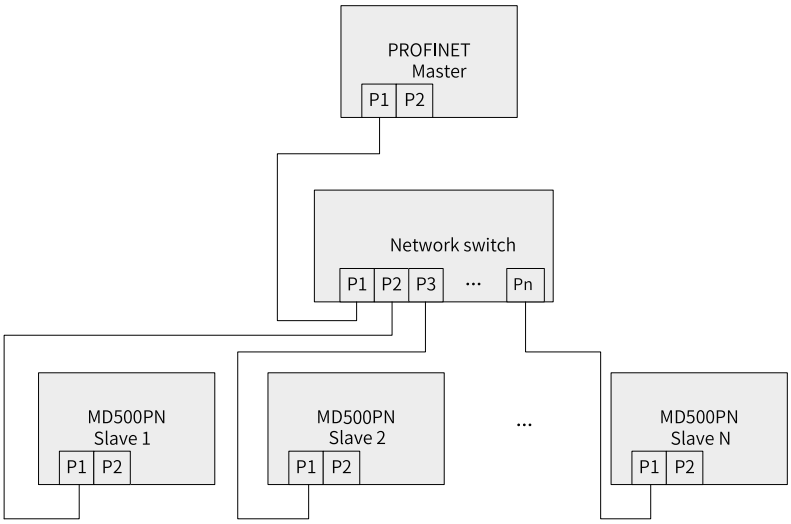


Figure 24-6 Star-type topology

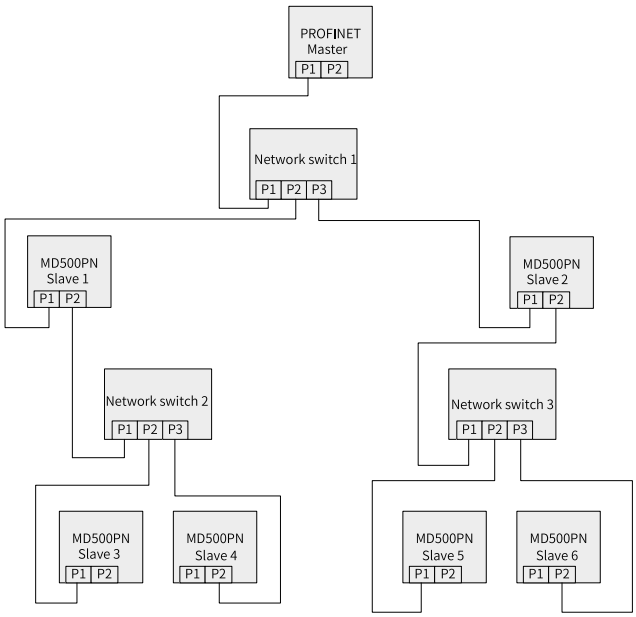


Figure 24-7 Tree-type topology

24.5 PROFINET Communication Protocol

Data transmission formats

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

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

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

PZD data

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

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

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

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

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

Descriptions of data sent by the master

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

Descriptions of data responded by the AC drive

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

24.6 Parameters

24.6.1 Parameters Related to Communication

AC drive communication card settings

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

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

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

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

Communication control parameters

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

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

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

Parameters related to communication monitoring

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

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

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

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

Note

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

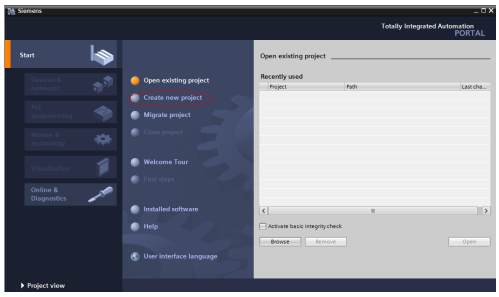
24.7 通信实例

24.7.1 Configuring Slaves on the S7-1200 Master

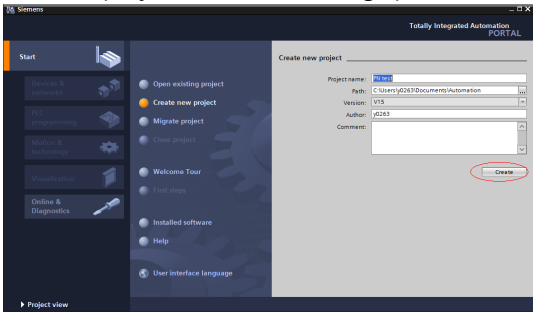
Before using the PROFINET master, you need to configure the GSDML file of the slave to add the corresponding slave stations to the master. If the file exists, skip step 2. You can obtain the GSDML file from the Inovance agent or the manufacturer.

To configure the slave, do as follows:

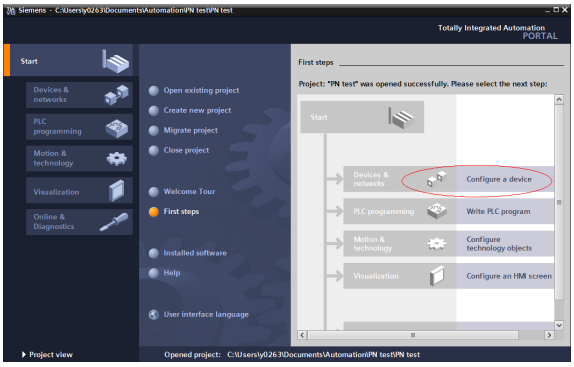
1. Create a project and add the S7-1200 master to the project in PORTAL. To be specific, open PORTAL first. The interface as shown in the following figure is displayed.



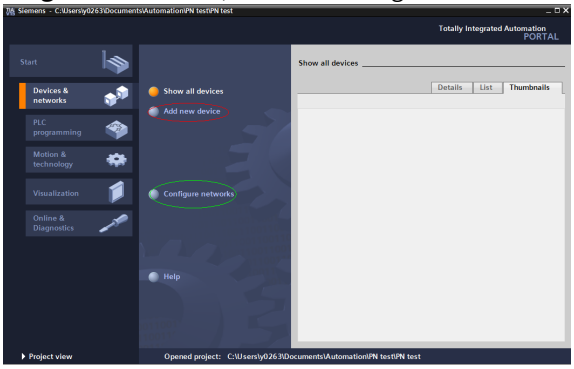
a. Click **Create new project**, enter a project name and storage path, and click **Create**.



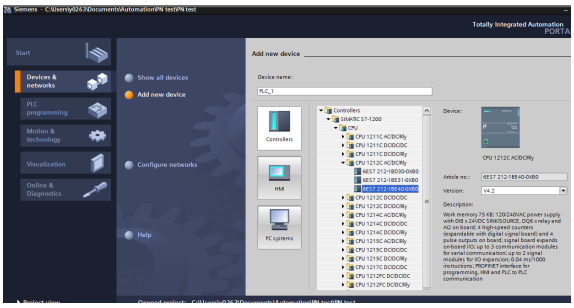
b. Click **Configure a device**.



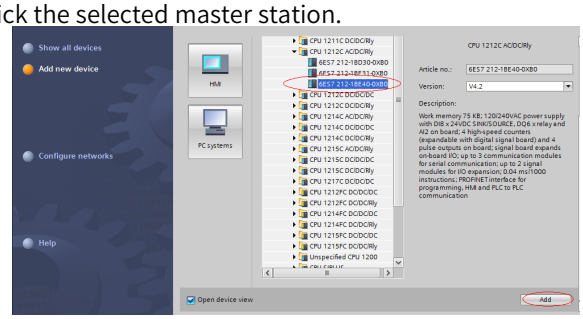
c. For a new project, click **Add new device** (marked with a red circle in the following figure). For an existing project, click **Configure networks** (marked with a green circle in the following figure).



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

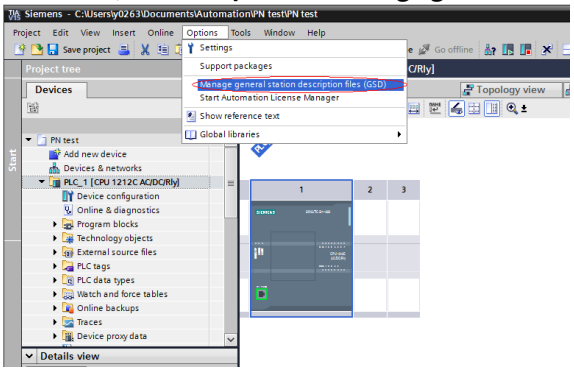


e. Click **Add** or double-click the selected master station.

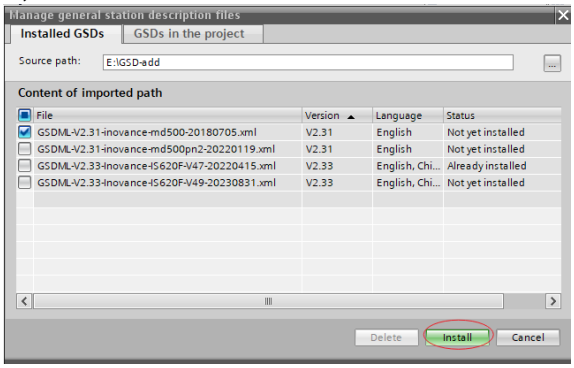


The master is added.

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



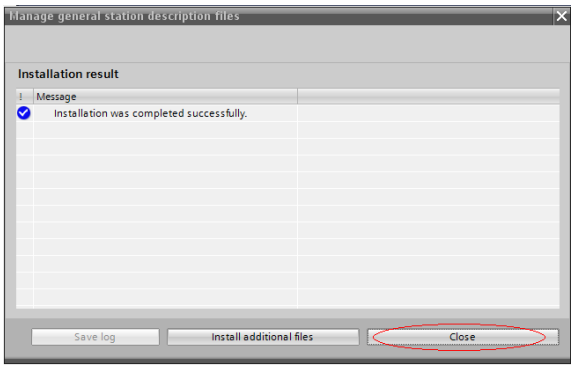
a. Select the storage path that does not contain any Chinese characters for the GSDML file, select the GSDML file to be installed, and click **Install**.



Caution

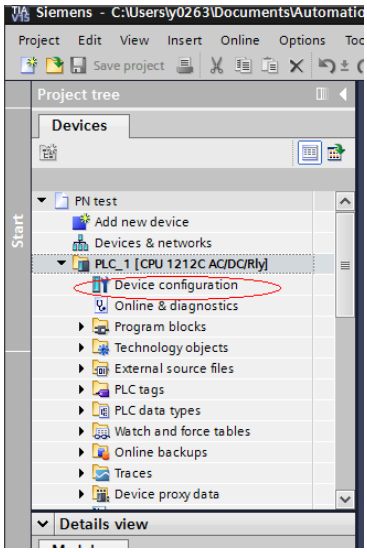
The GSDML file name varies with the AC drive series. For details, see the corresponding user guide.

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

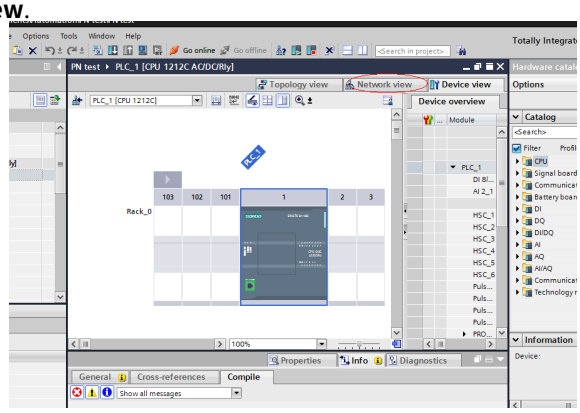


3. Configure a slave.

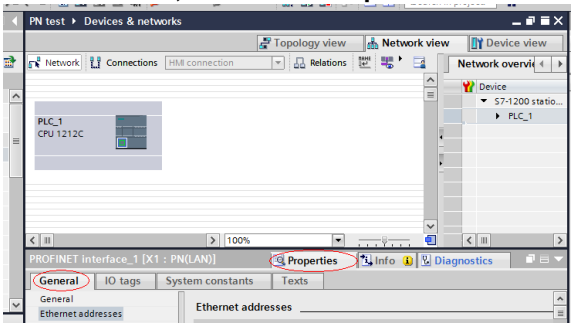
a. Click **Device configuration**.



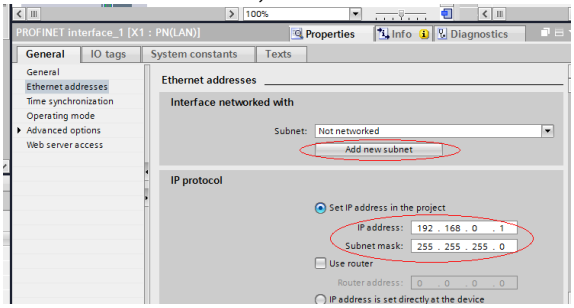
b. Switch to **Network View**.



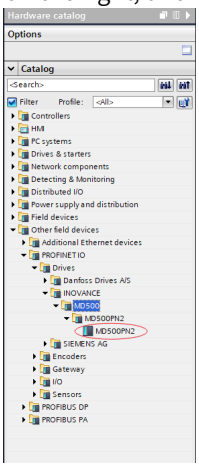
c. Select the Ethernet interface of the PLC, and choose **Properties** > **General**.



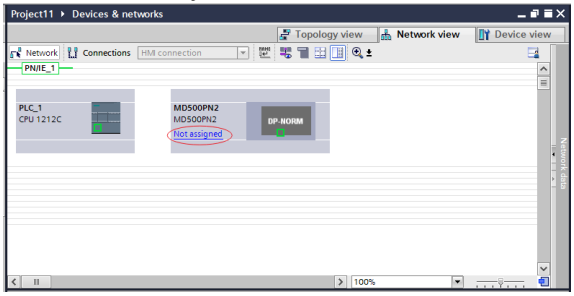
d. Set the IP address and subnet mask of the PLC, and click **Add new subnet**.



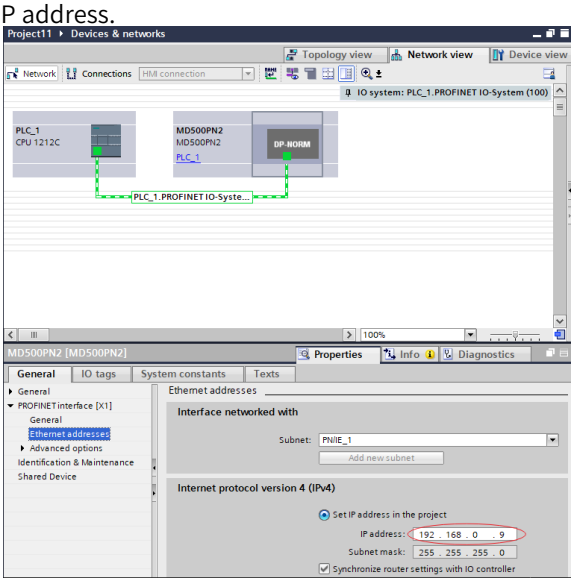
e. Locate MD500 under **Hardware catalog** on the right, and double-click **MD500PN2**.



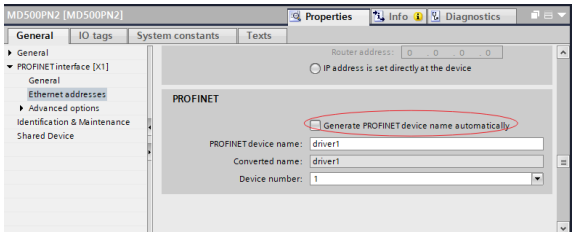
f. Click **Not assigned** to select the master system for the slave.



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

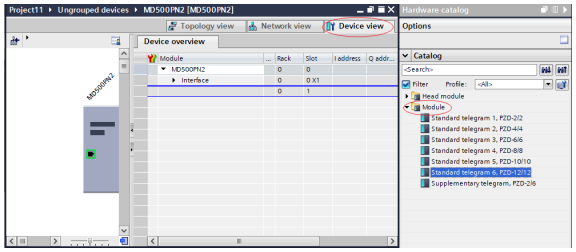


Scroll down the interface to locate the **PROFINET** area. Clear **Generate PROFINET device name automatically**, and name the slave device in the **PROFINET device name** text box. Alternatively, select **Generate PROFINET device name automatically** to enable the system to generate a device name automatically.



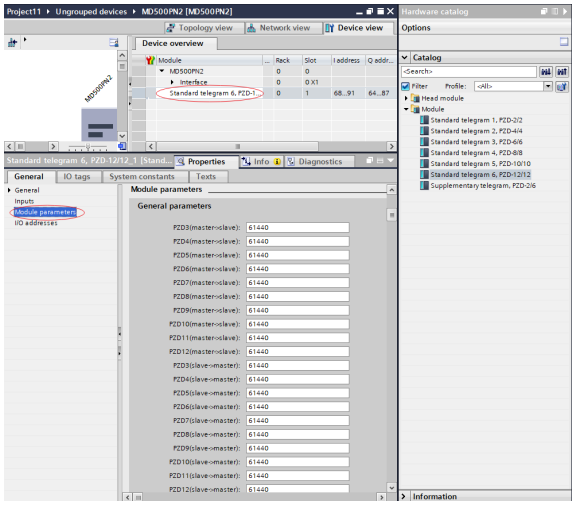
4. Configure data features of the slave.

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



5. Configure the PZD.

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



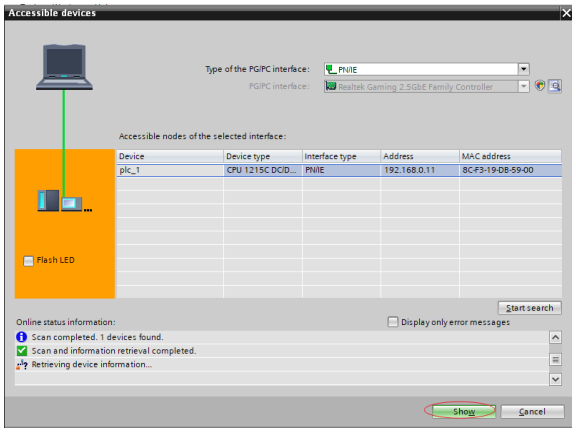
PZDx(master->slave) indicates the address of the slave used by the master to write data to the slave, and PZDx(slave->master) indicates the address of the slave used by the master to read data from the slave. PZD3 to PZD12 (determined by the selected message type) are displayed in decimal and can be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

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

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

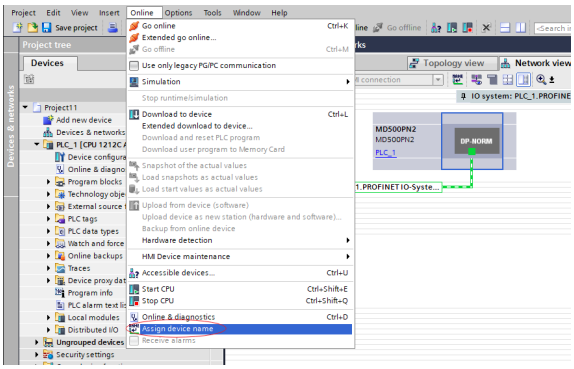
6. Download the configuration.

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

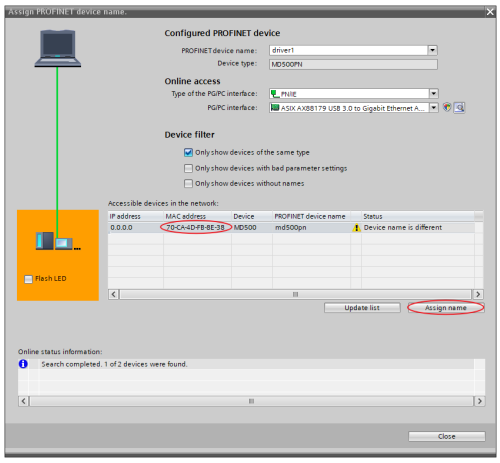


7. Assign a device name.

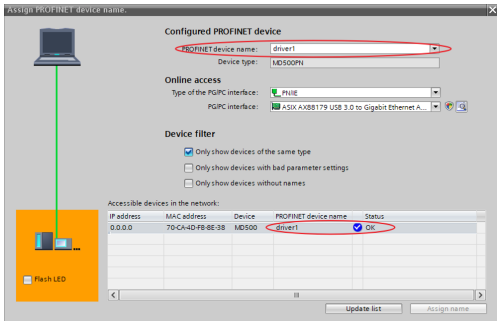
   a. After downloading is complete, assign device names for slave stations without names. Select a slave, and choose **Online** > **Assign device name**, or right-click the slave and select **Assign device name**.



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



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



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

Caution

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

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

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

24.7.2 MRP Function

MRP overview

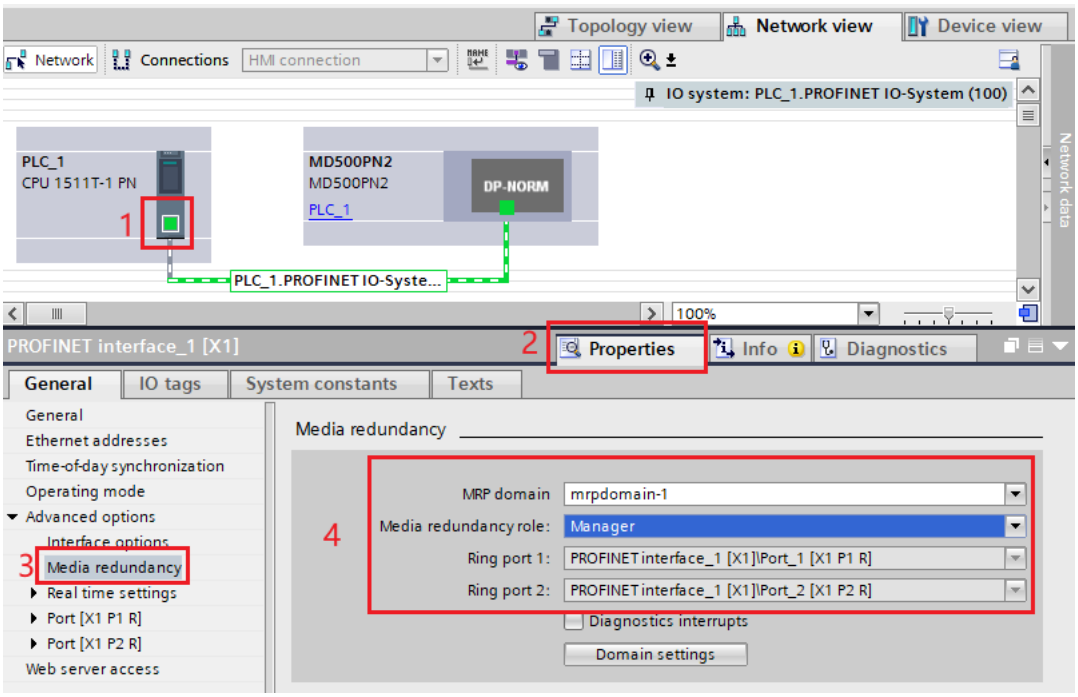
The AC drive adopts the standard Media Redundancy Protocol (MRP) which meets the IEC 62439-2 standard. The typical reconstruction time is 200 ms and each ring network supports up to 32 devices.

MRP basic rules:

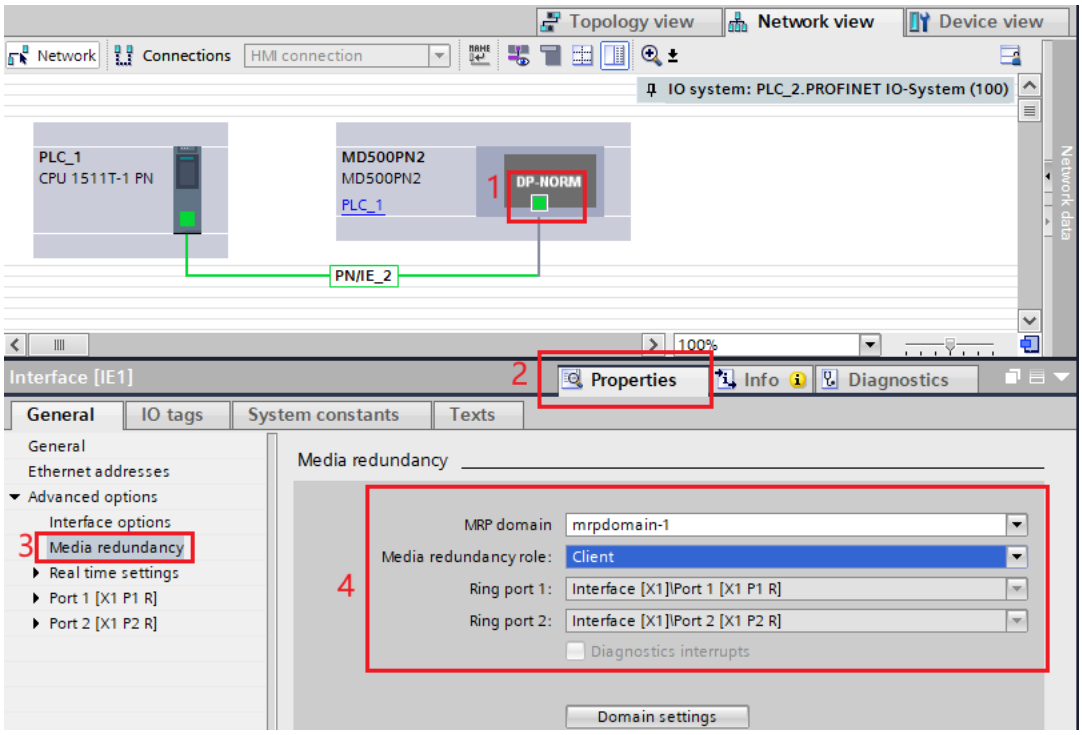
- All nodes on the ring network must support the MRP and have the MRP function enabled.
- All devices are interconnected through ports on the ring network.
- All devices on the ring network are in the same redundancy domain.
- It is recommended that the number of devices on a ring network not exceed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

MRP settings

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



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

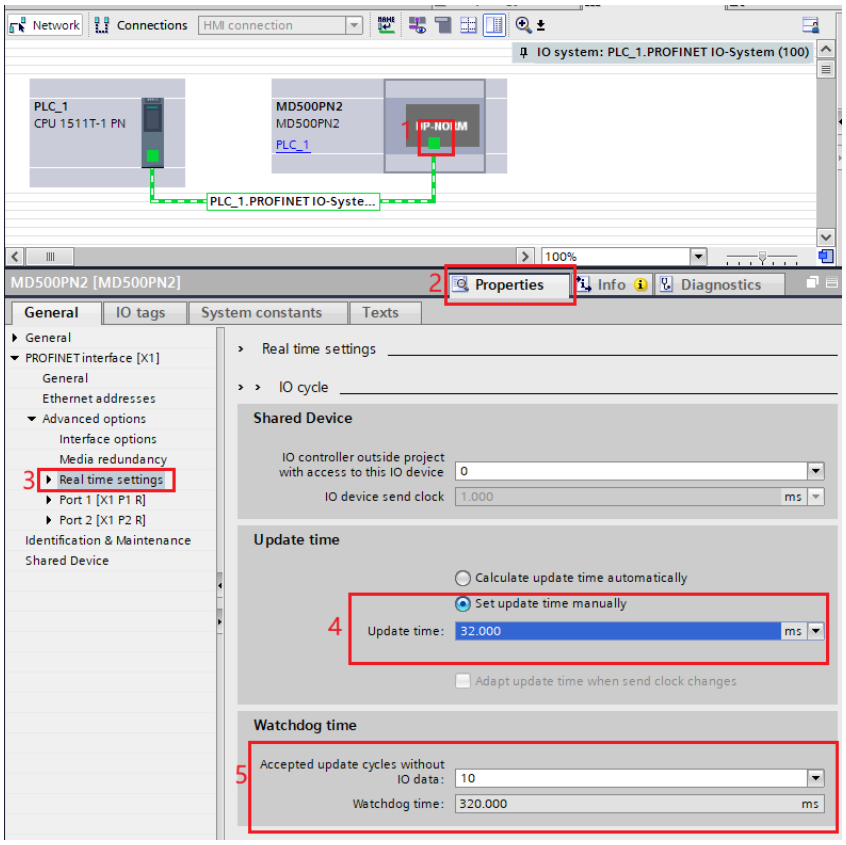


3. Reconstructing the MRP network takes time. If the default value of **Update time** and the value 3 of **Accepted update cycles without IO data** are used and the MRP function is enabled, an alarm will be reported upon network cable plugging and removing. In this case, reset **Update time** and **Accepted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

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

Note

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



Note

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

24.8 Troubleshooting

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

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

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

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

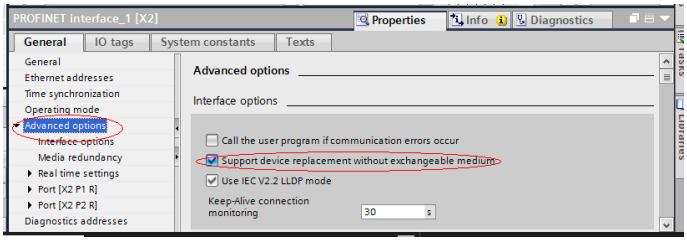
Prerequisites for directly replacing the MD500-PN2 card are as follows:

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

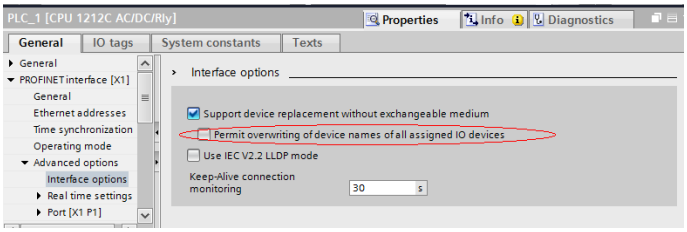
To replace the MD500-PN2 card directly, you need to perform corresponding settings during configuration. Settings in STEP 7 and PORTAL are different.

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

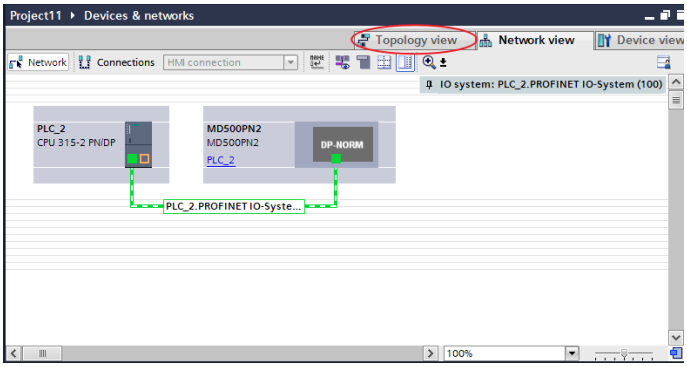
1. Open PORTAL, and select the PROFINET interface of the master station in the hardware configuration. Go to **Properties** > **General** > **Advanced options**, and select **Support device replacement without exchangeable medium**, as shown in the following figure.



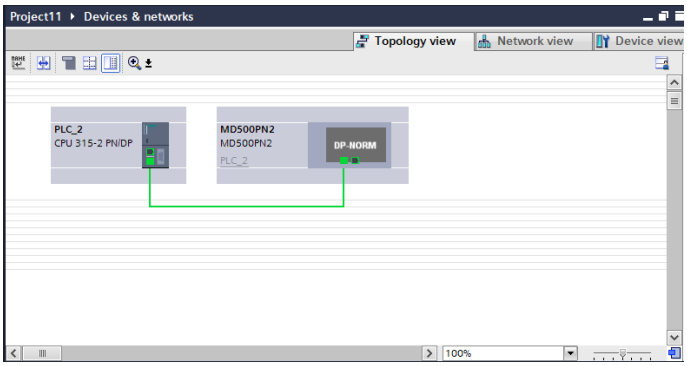
2. For the S7-1200 or S7-1500 PLC, the check box **Permit overwriting of device names of all assigned IO devices** is provided. If the check box is selected, the second prerequisite for directly replacing the device is not required.



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



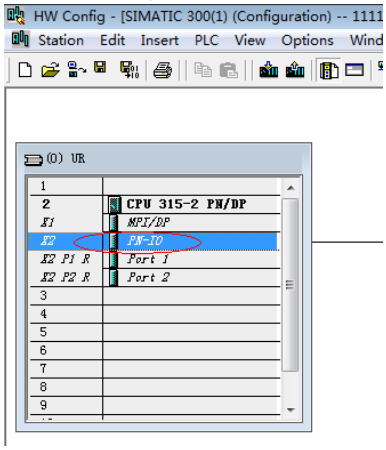
4. In the topology view, click and drag an interface to the interface of another device which is directly connected with the first interface, and release the mouse button. Note that the preceding connection must be consistent with the actual network connection of devices. For example, if P1 of the PLC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



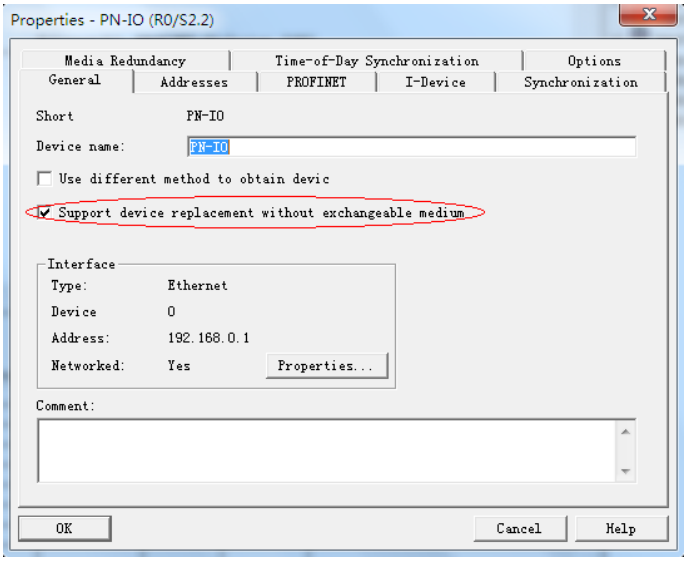
5. After completing the topology, start compiling and download it to the PLC.

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

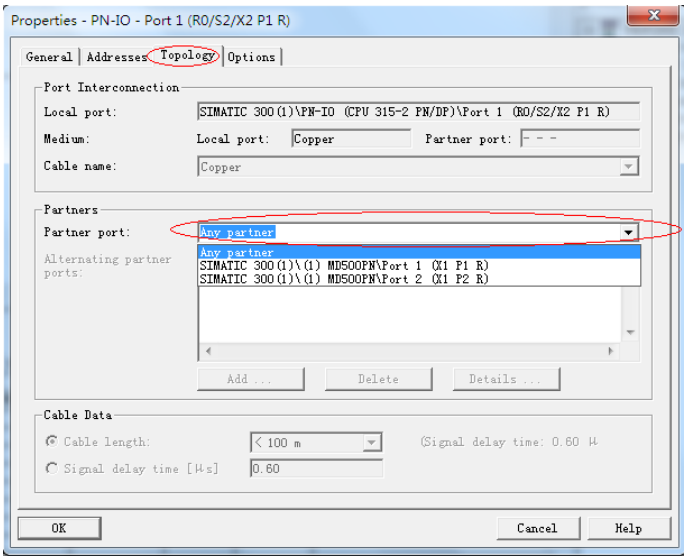
1. In hardware configuration, double-click **PN-IO**, as shown in the following figure.



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



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



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

25 EtherCAT Communication (MD500-ECAT)

25.1 Introduction

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

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

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

25.2 Installation

The MD500-ECAT card is embedded in the MD520 series AC drive. Before installation, cut off the power supply of the AC drive and wait at least 10 minutes until the charging indicator of the AC drive becomes off. Then, insert the MD500-ECAT card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. *“Figure 25–1” on page 494* describes the installation of the card.

Note that the ground terminals of both the MD500-ECAT card and AC drive must be connected properly, as shown in *“Figure 25–2 Connecting ground terminals of the MD500-ECAT card and AC drive” on page 495*.

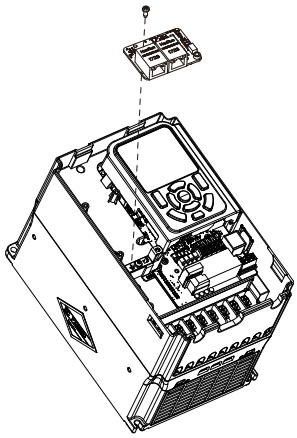


Figure 25-1 MD500-ECAT card installation

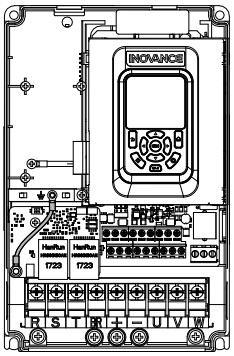


Figure 25-2 Connecting ground terminals of the MD500-ECAT card and AC drive

25.3 Terminal Layout and Description

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

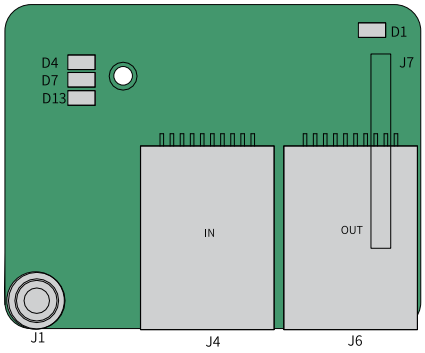


Figure 25-3 MD500-ECAT card terminal layout

Table 25–1 Interfaces and indicators of the MD500-ECAT card

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

Mark	Hardware Name	Function Description
D1	Status indicator of communication with AC drive (green)	For details, see *"Table 25–2 Status indicators of the MD500-ECAT card" on page 496*.
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 25–2 Status indicators of the MD500-ECAT card

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

25.4 Networking Topology

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

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

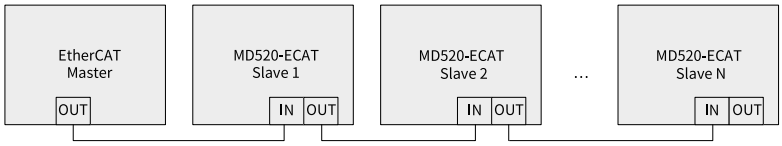


Figure 25-4 EtherCAT bus topology

25.5 PDO Data

PDO data description

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

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

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

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

Data sent by the master

Table 25–3 Descriptions of RPDO sent by the master

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

Note

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

TPDO data returned by the AC Drive

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



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

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

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

25.6 SDO Mailbox Data

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

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

The MD520 supports the SDO request and SDO response.

25.7 Related Parameters

MD500-ECAT card settings

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

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

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

Parameter Code	Parameter Name	Value Range	Value	Description
Continued	Continued	Continued	Continued	Continued 7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources.
FD-11	CiA 402 protocol	0: Disable 1: Enable	Set it as needed.	This parameter sets whether to enable the CiA 402 mode. When it is set to 0, the common mode is used. When it is set to 1, the CiA 402 mode is used. For details, see *"36.1 List of Object Dictionary in Group 6000h" on page 930* and *"36.2 Object Dictionary Descriptions" on page 931*.

Communication control parameters

Table 25–4 Communication control parameters

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

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

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

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

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

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

Object dictionary index = 0x2000 + Parameter group number

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

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

Communication monitoring parameters

Table 25–5 Communication monitoring parameters

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

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

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

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

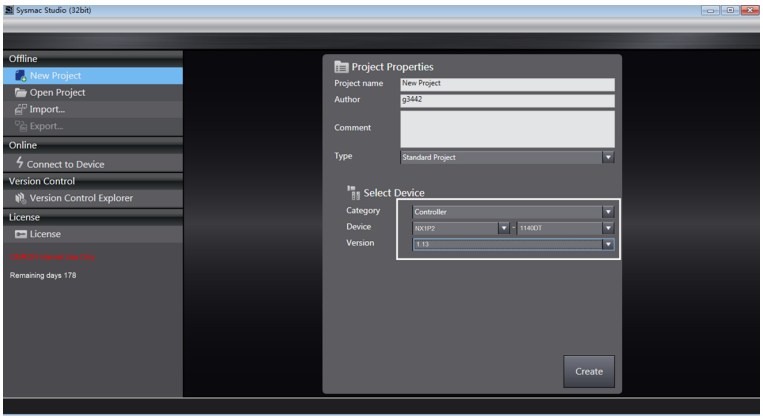
25.8 Configure communication parameters.

25.8.1 Communication Instance of Controlling the MD520 with an Omron Controller

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

1. Create a project.

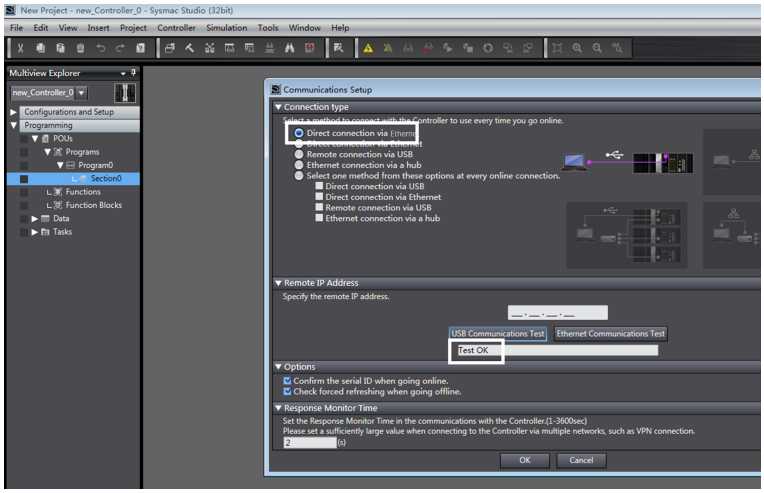
- Device: Select the actual controller model.
- Version: 1.09 or later version. NX1P2-1140DT only supports 1.13.



2. Configure communication.

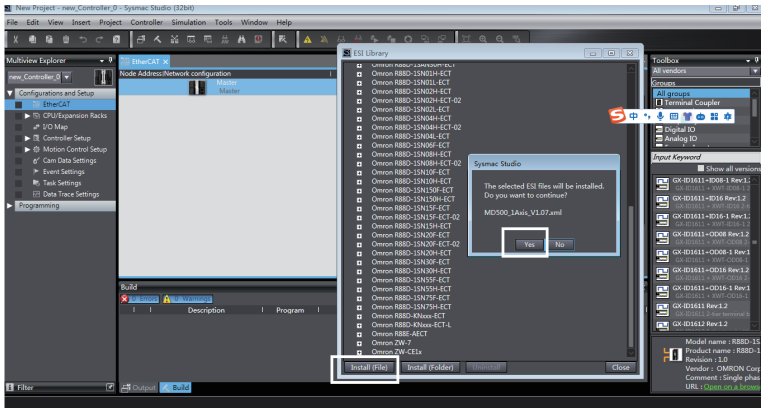
   a. Enter the main interface and choose **Controller** > **Communications Setup** to set the connection mode for the computer and controller.

   b. Select **Direct connection via Ethernet**, and click **Ethernet Communications Test**. After **Test OK** is displayed, go to the next step.



3. Import the XML configuration file.

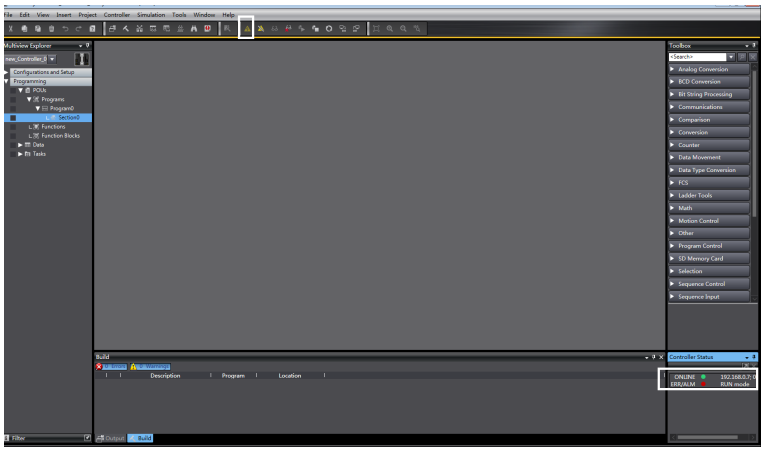
   Double-click **EtherCAT** in the left pane. Right-click the master device and select **ESI Library**. Click **Install (File)**. Select the MD500-ECAT card XML configuration file and import it.



4. Scan the device.

   Switch the controller to the online and running mode.

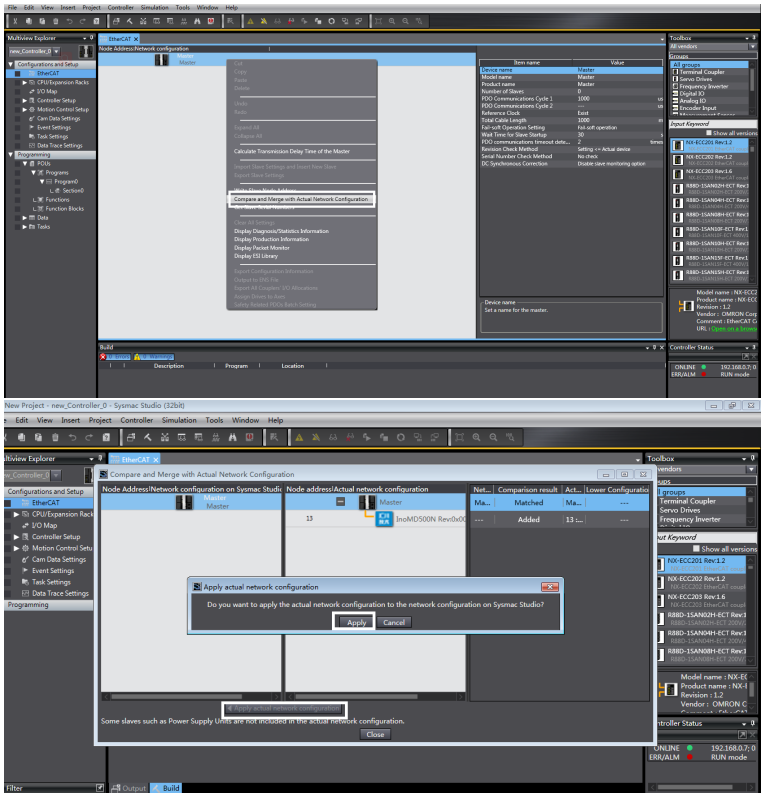
   Check that the controller status in the lower right corner is online and running.

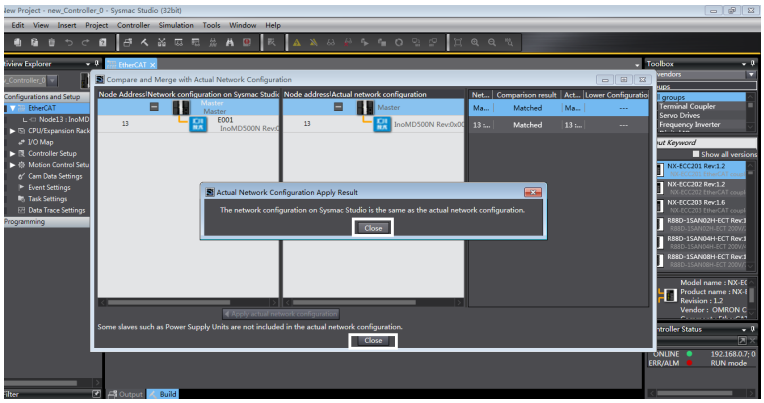


Scan for devices and add slaves. Choose **Configurations and Setup** > **EtherCAT**. Right-click **Master**, and then select **Compare and Merge with Actual Network Configuration**. The controller automatically scans all slaves in the network. A fault will be reported if any station number is 0. After the scanning is complete, click **Apply actual network configuration** in the displayed dialog box to add the slave. You can view the added slave on the main interface.

Note

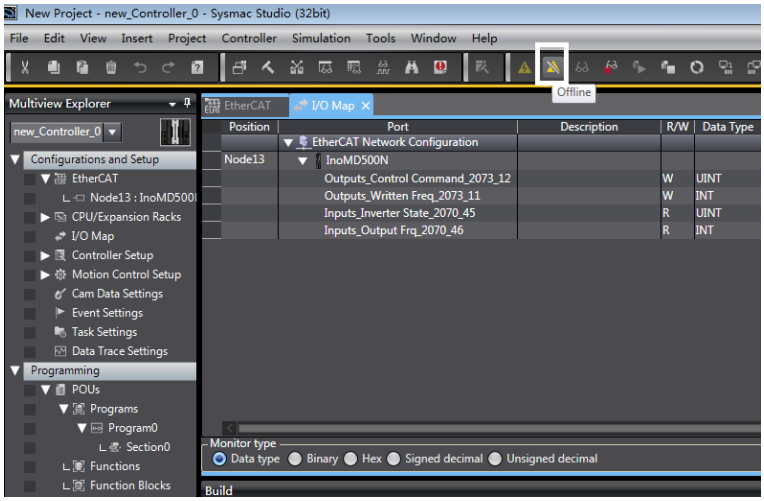
The MD500-ECAT card allows the station alias to be modified by using the parameter FD-02 or the software tool of the master station. The modified station alias takes effect upon next power-on.



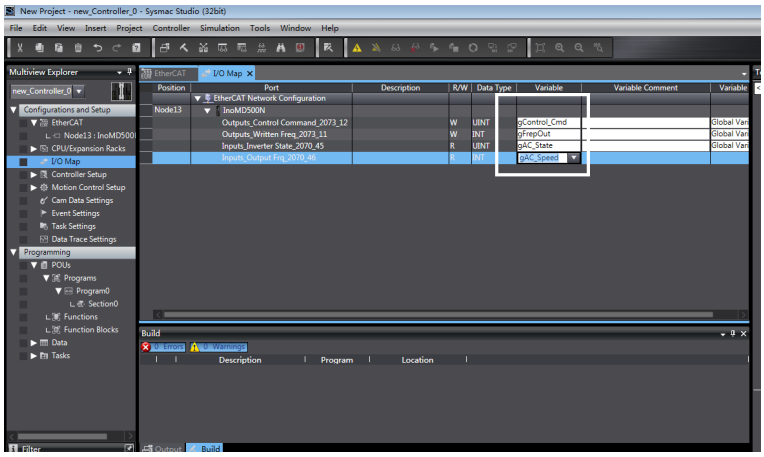


5. Configure parameters.

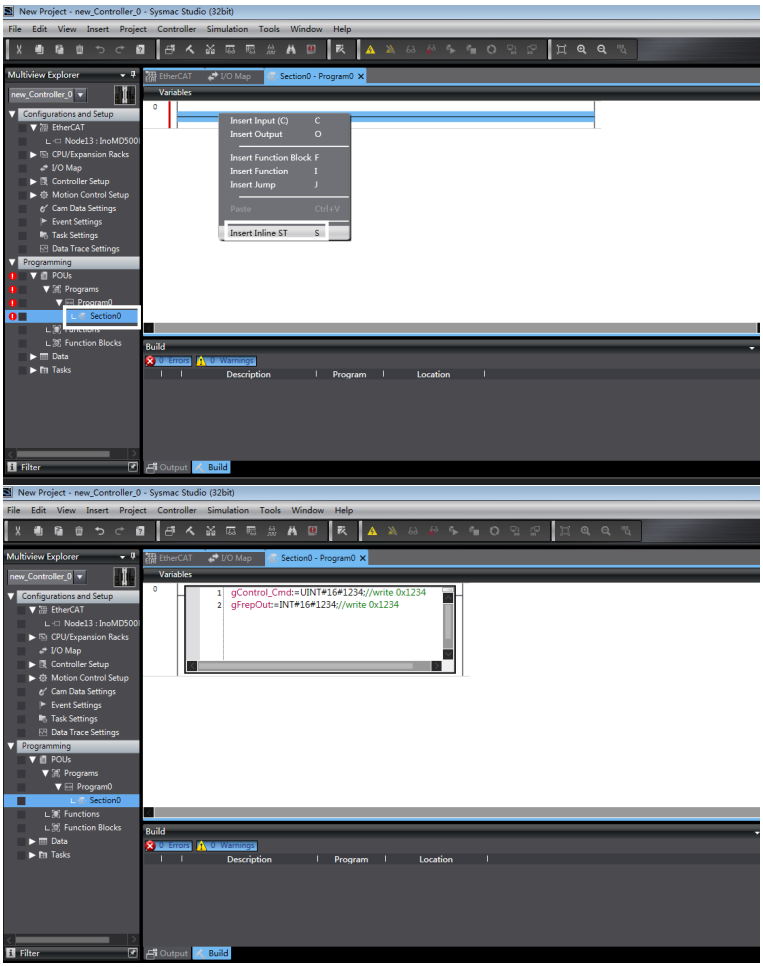
   Switch the controller to the offline mode.



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

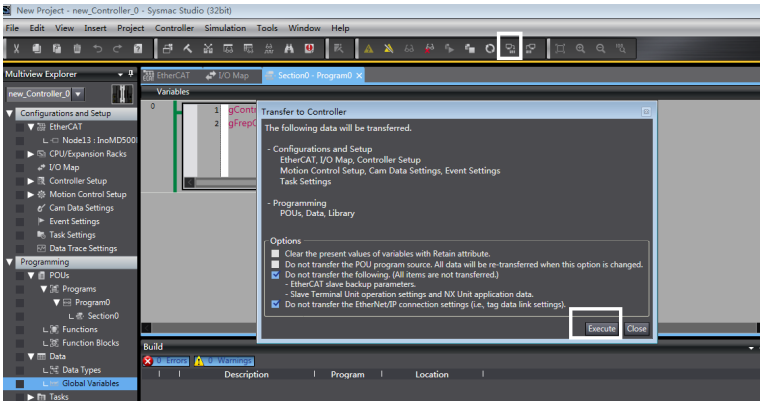


6. Edit the PLC program.



7. Download the program to the controller.

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

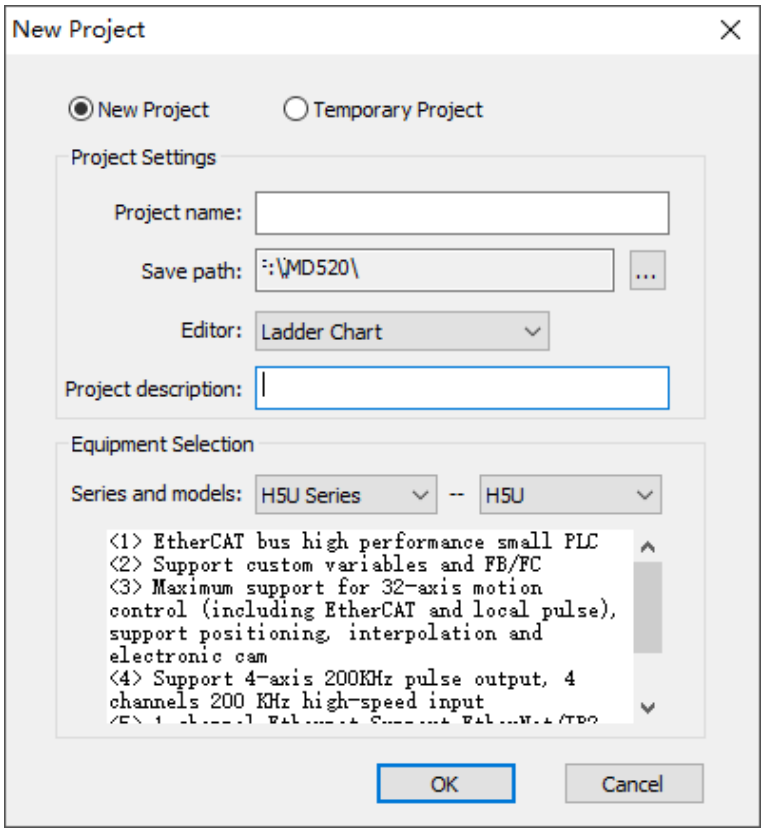


25.8.2 Communication Instance of Controlling MD520 with an H5U Controller

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

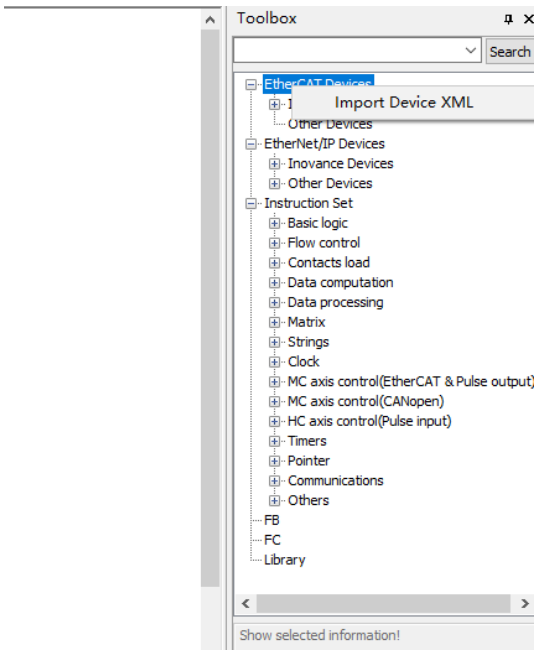
1. Open the software and create an H5U project.

   Select **H5U/TN** from the **Device** drop-down list.



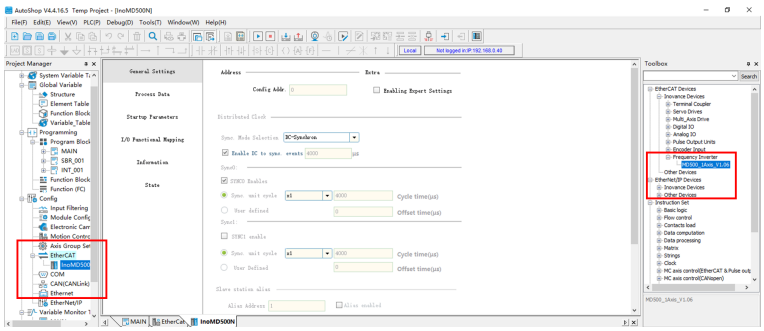
2. Import the EtherCAT configuration file of the MD520.

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



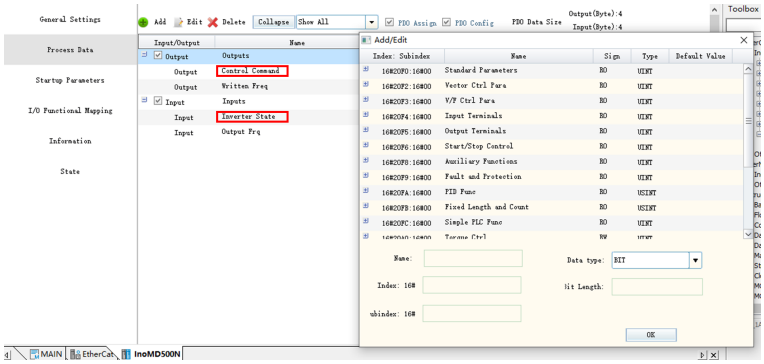
3. Add an MD520 AC drive slave.

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



4. Configure PDO parameters.

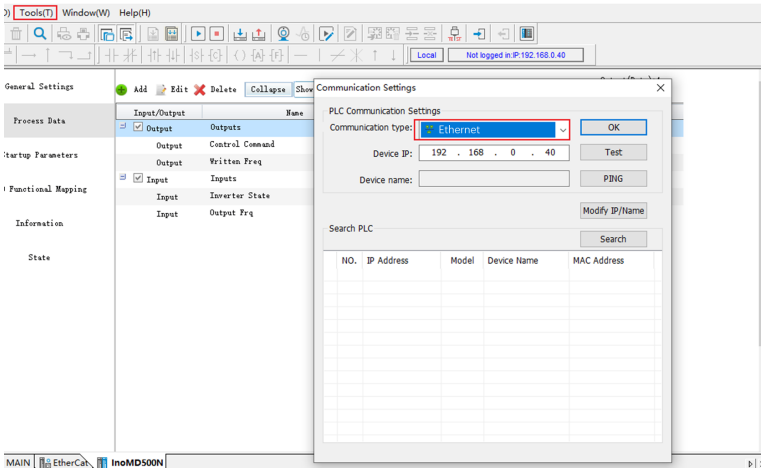
   On the **Process Data** tab, add the TPDO mapping as required.



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

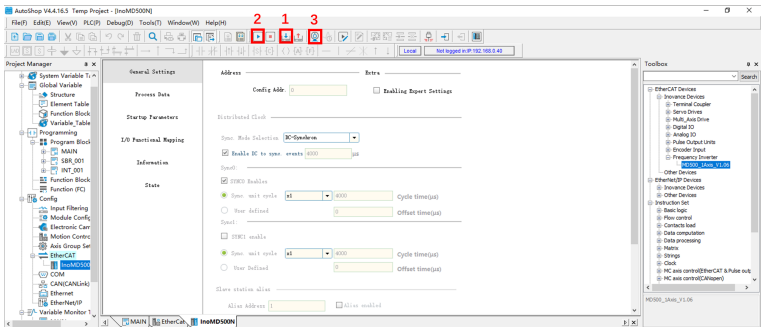
5. Scan the H5U PLC.

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

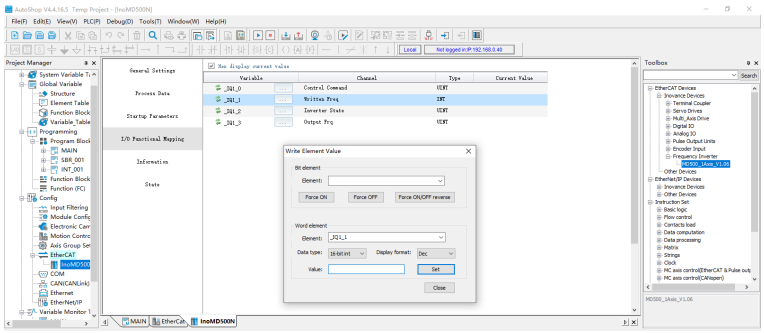


6. Download the project to the PLC and activate the PLC.

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



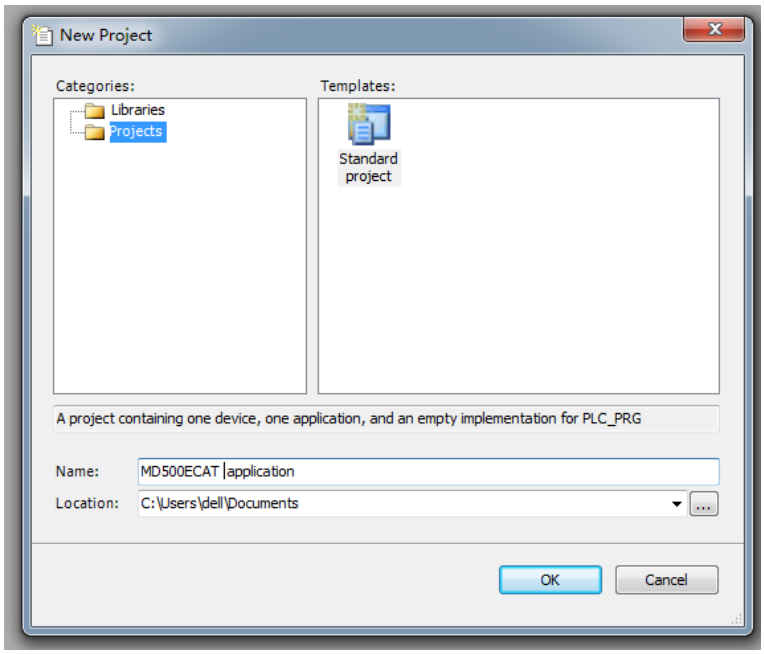
You can view TPDO data and write RPDO data in real time through EtherCAT I/O mappings.

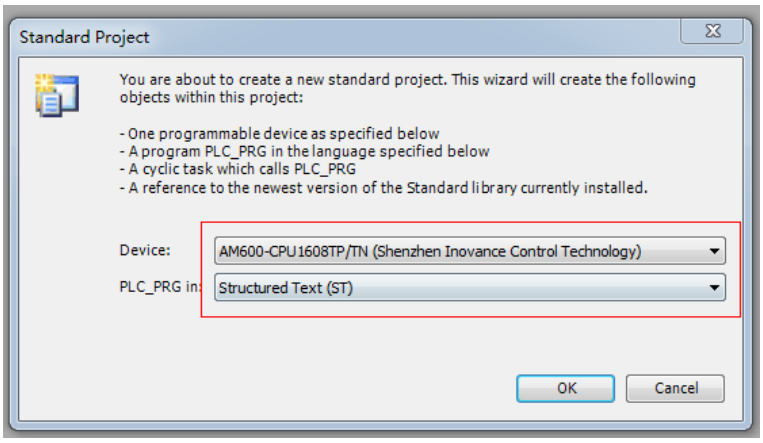


25.8.3 Communication Instance of Controlling MD520 with an AM600 Controller

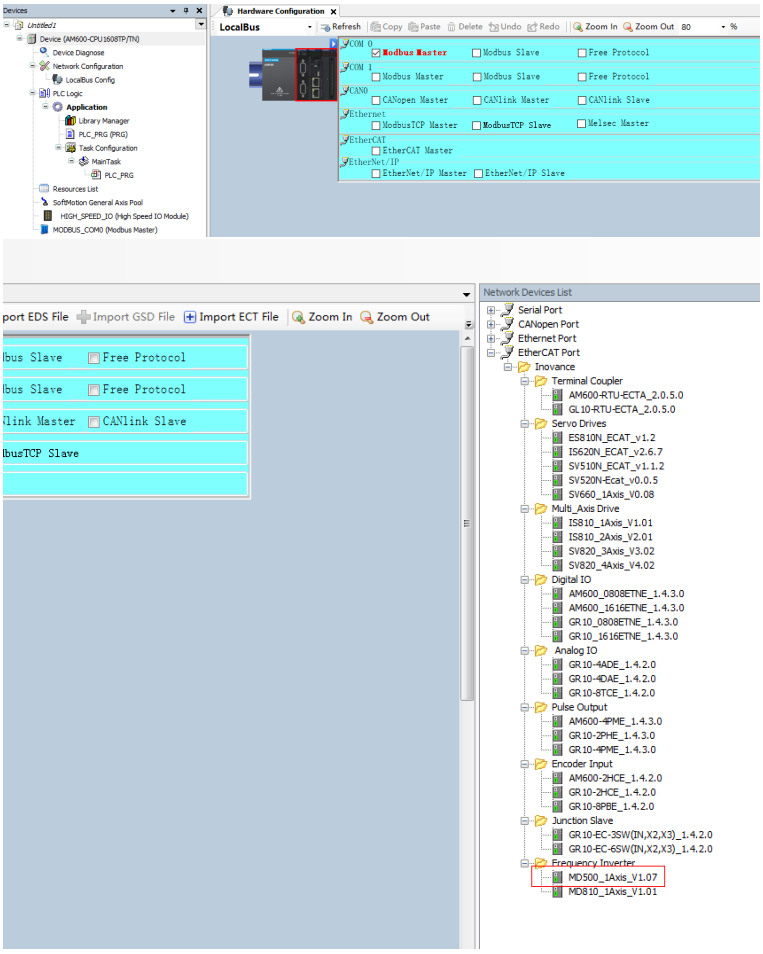
This section describes how to configure the MD520 on the AM600.

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



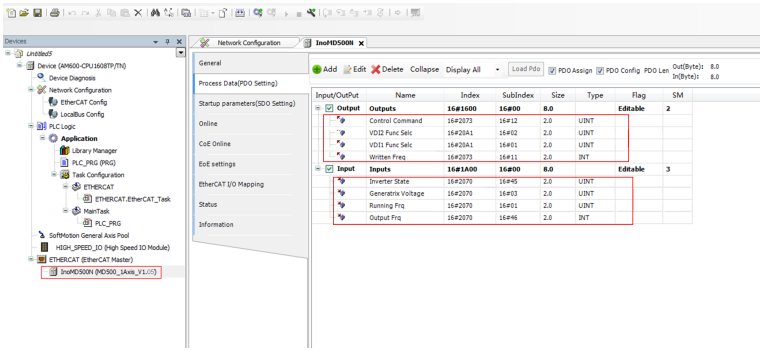


2. Add an MD520 AC drive slave. Open the network configuration, and import the EtherCAT configuration file of the MD520. If a configuration file of other versions exists, delete the existed file before importing a new one. Drag the device in the network device list to add the AC drive slave station,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

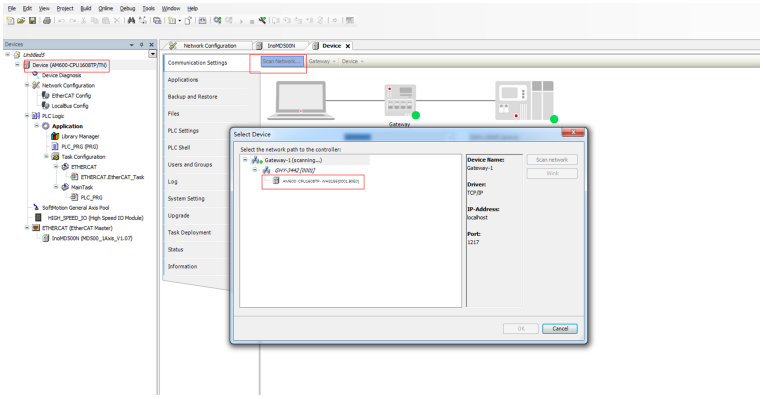


3. Configure the PDO parameters.

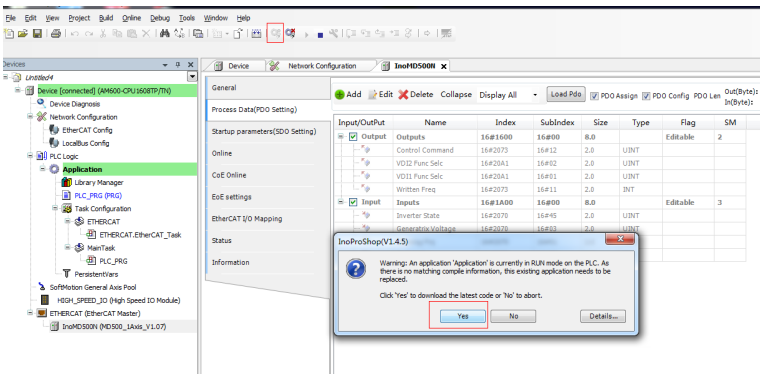
   Add the TPDO mapping as required in the following figure. Control Command of the RPDO and Inverter State of the TPDO cannot be changed and must be set as the first items. Otherwise, an exception will occur during operation.



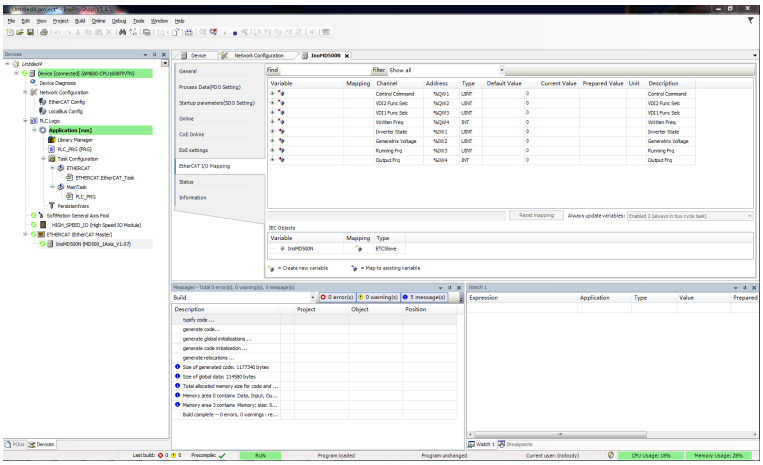
Scan the device.



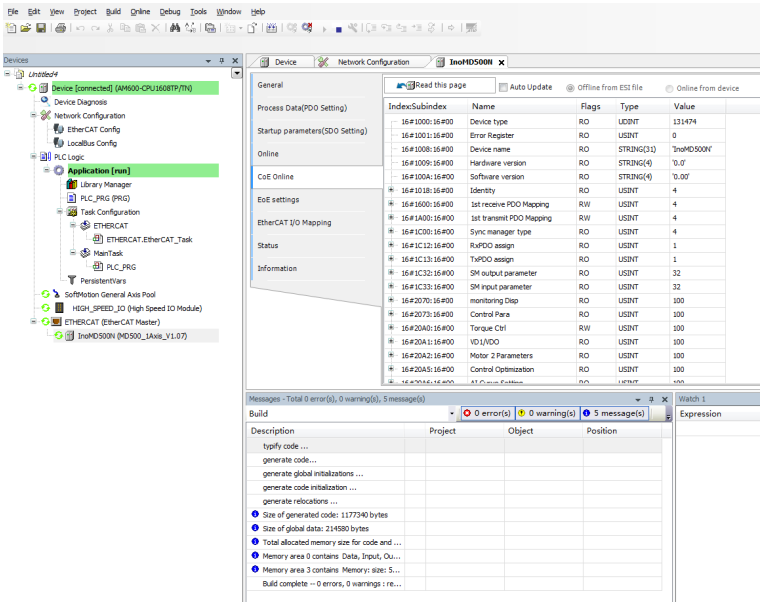
Download the project to the PLC.



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



View and write parameter values through the online CoE.



25.8.4 Communication Instance of Controlling the MD520 with an Beckhoff Controller

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

Caution

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

---

1. Install TwinCAT.

   - Windows XP: tcat_2110_2230 is recommended.
   - Windows 7 (32-bit): tcat_2110_2248 is recommended.

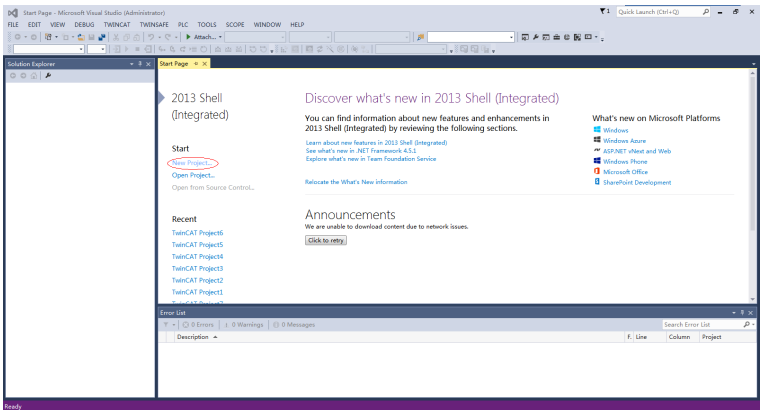
2. Copy the EtherCAT configuration file (MD500_1Axis_V1.03.xml) of the MD520 to the TwinCAT installation directory.

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

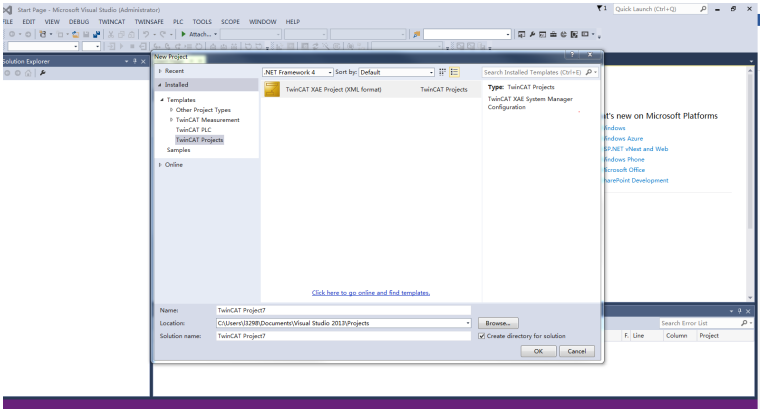
   TwinCAT3 is used as an example in the following section. The operation steps for TwinCAT2 are similar to those for TwinCAT3.

3. Run TwinCAT.

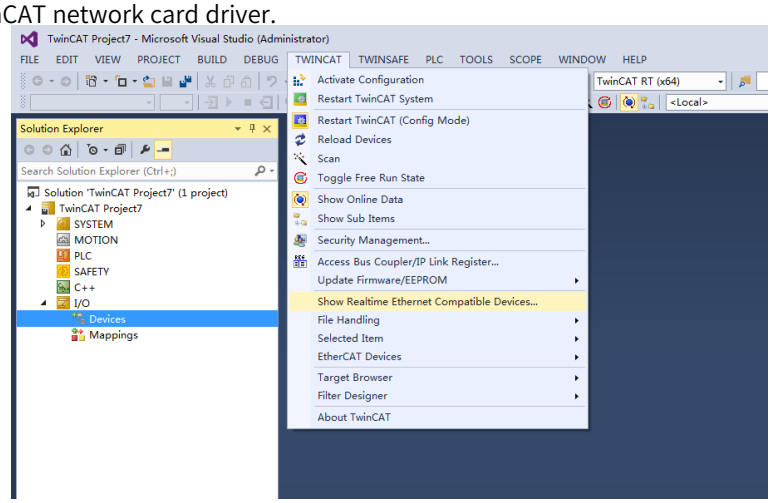
   a. Click **New Project** to create a project.



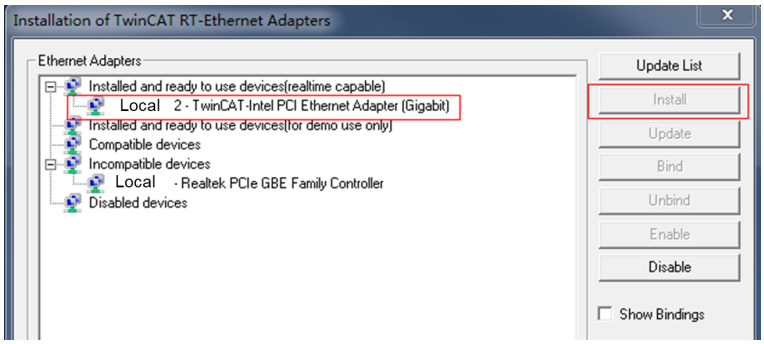
b. Click **OK**.



4. Install the TwinCAT network card driver.

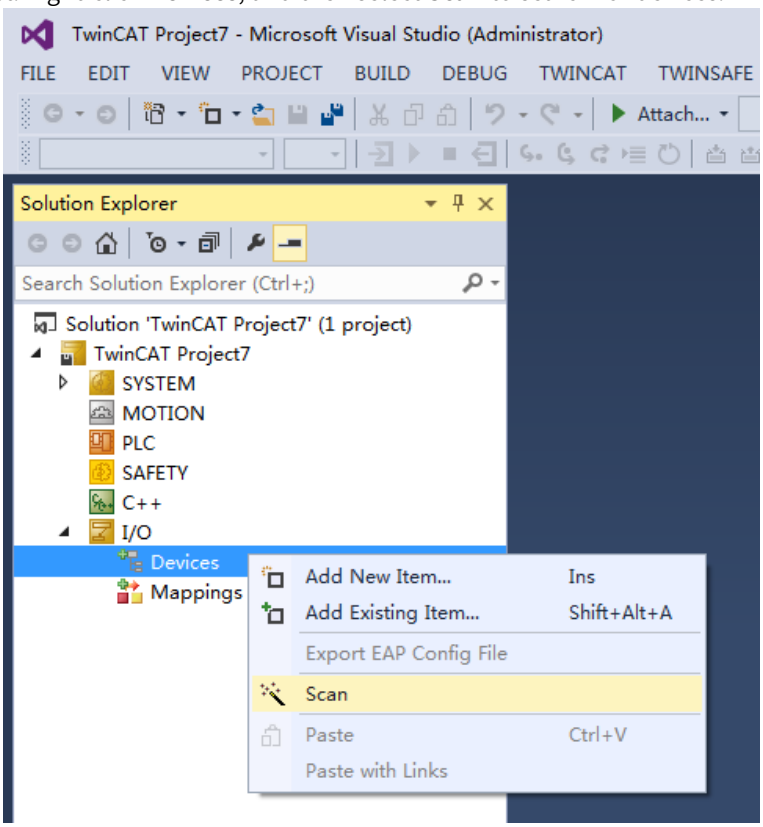


Choose **TWINCAT** > **Show Real Time Ethernet Compatible Devices...**. In the displayed dialog box, select the local network card under **Incompatible devices**, and click **Install**. After installation is done, the network adapter installed will be displayed under **Installed and ready to use devices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

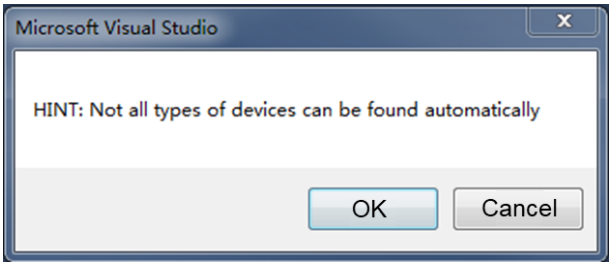


5. Search for devices.

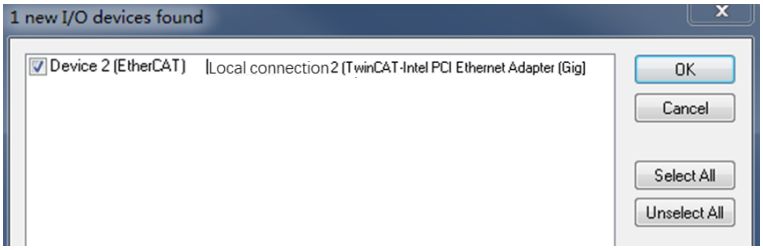
a. Create a project. Right-click **Devices**, and then select **Scan** to search for devices.



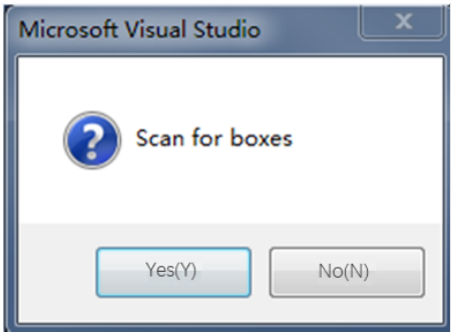
b. Click **OK**.



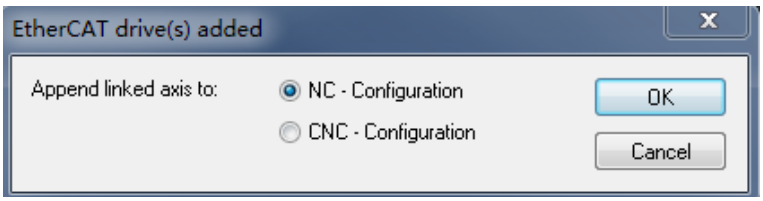
c. Click **OK**.



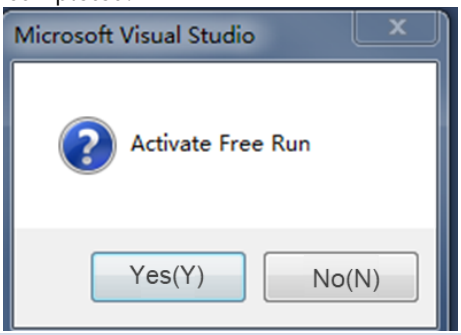
d. Click **Yes**.

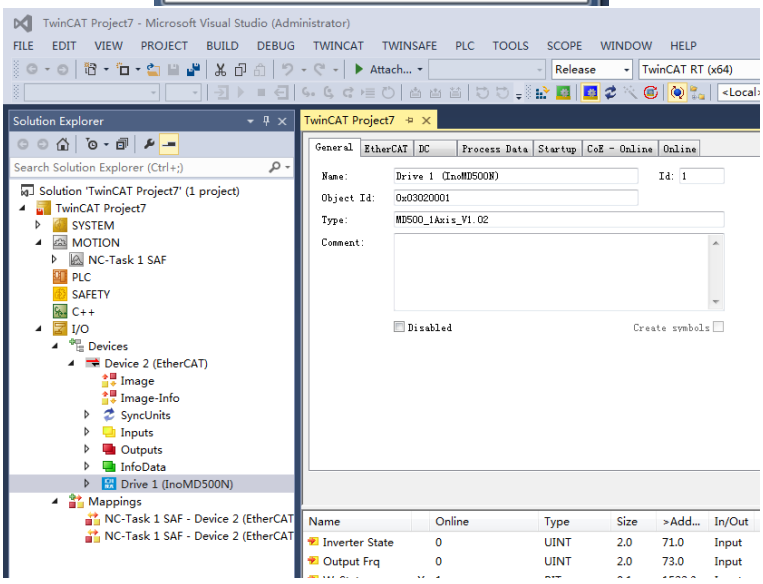


e. Click **OK**.



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

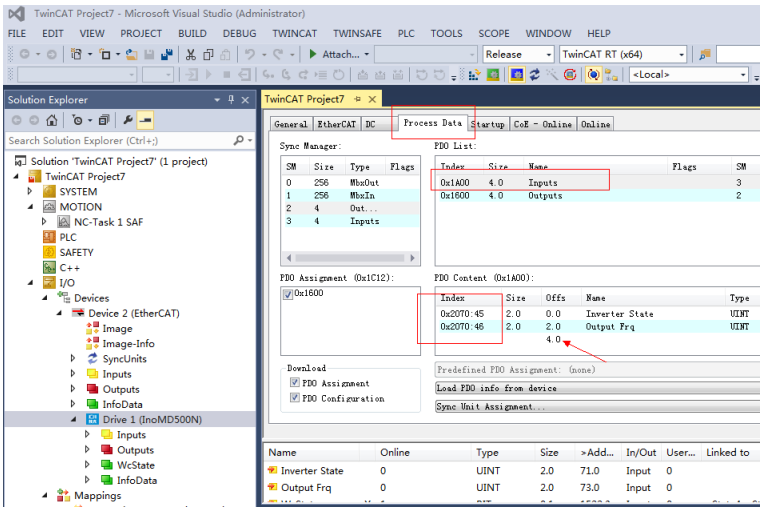




6. Configure PDO parameters.

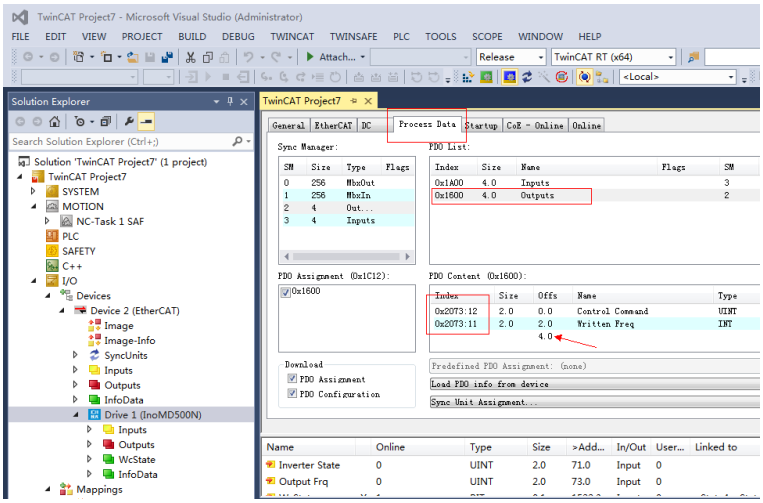
a. Configure the TPDO.

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



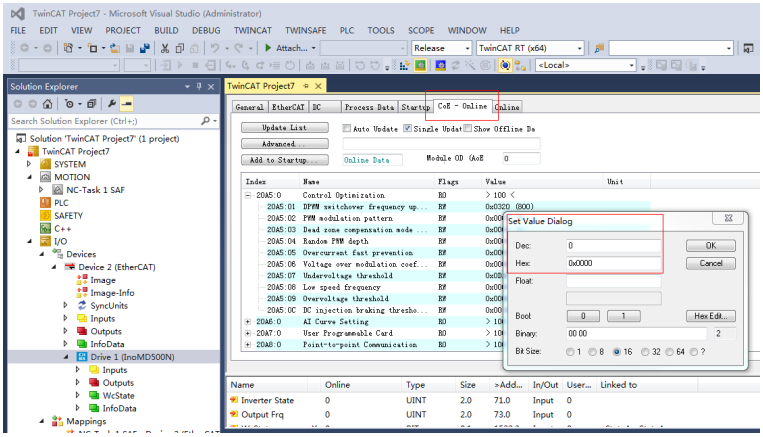
b. Configure the RPDO.

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



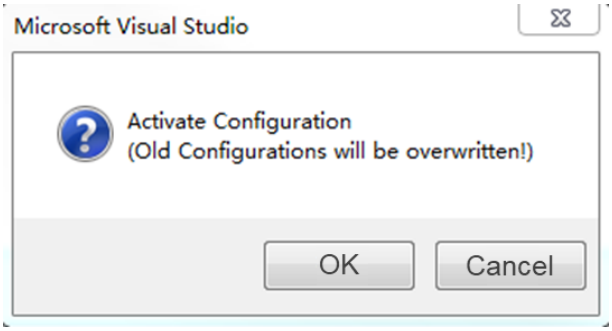
c. View the SDO data list.

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

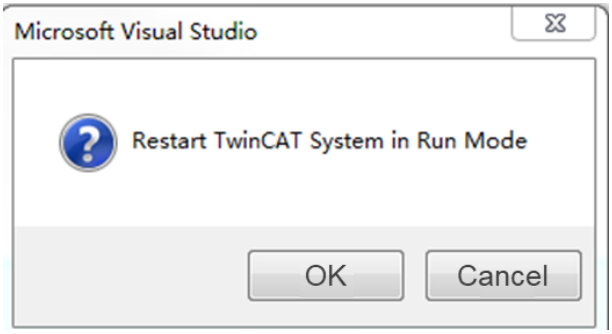


d. Activate the configuration and switch to the running mode.

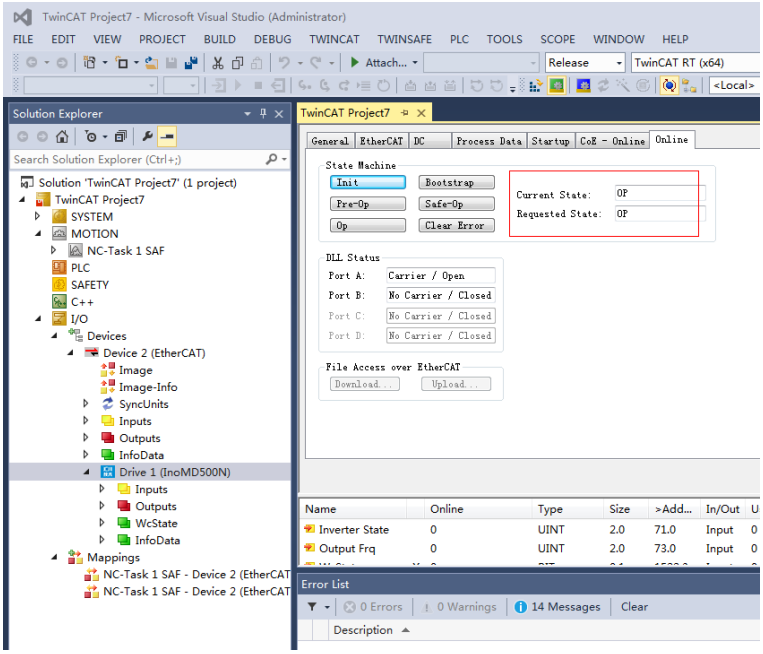
Click . The following figure appears.



Click **OK**.

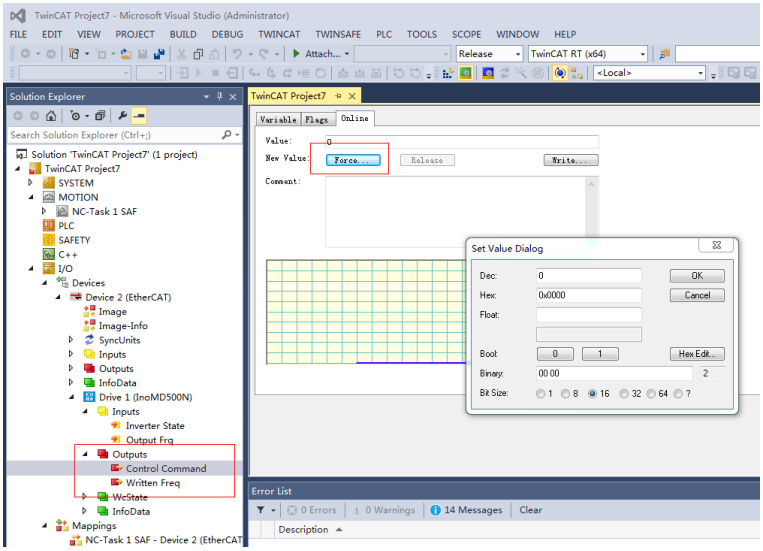


Click **OK** to enter the OP state.



e. Control the AC drive through the PDO.

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



25.9 Troubleshooting

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

Table 25–6 Troubleshooting

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

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

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

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

26 PROFIBUS DP Communication (MD38DP2)

26.1 Introduction

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

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

26.2 Installation

The MD38DP2 card is embedded in the MD520 series AC drive. Before installation, power off the AC drive, wait at least 10 minutes until the charging indicator on the AC drive becomes off. Then, insert the MD38DP2 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. *"Figure 26–1" on page 524* shows the installation.

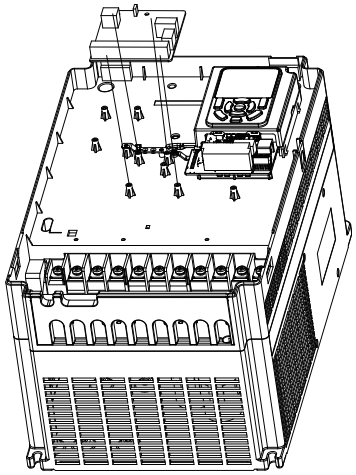


Figure 26-1 MD38DP2 card installation

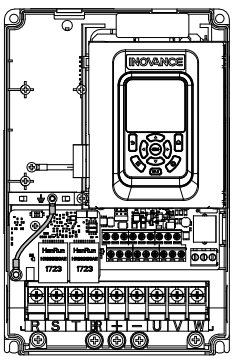


Figure 26-2 Connecting ground terminals of the MD38DP2 card and AC drive

26.3 Terminal Layout and Description

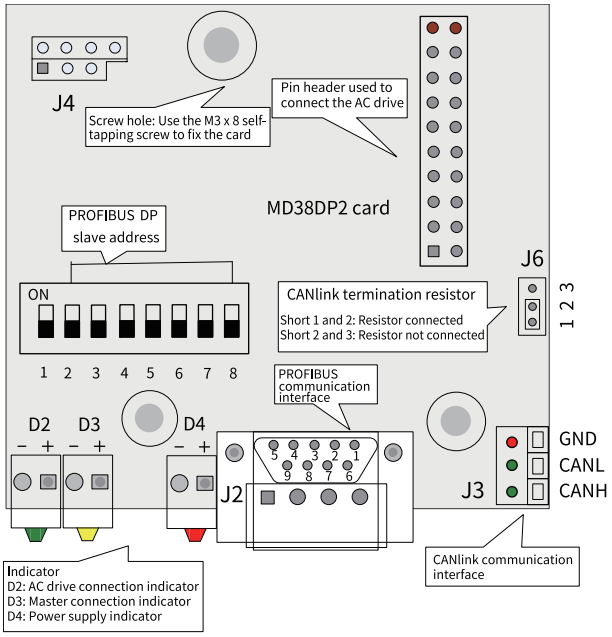


Figure 26-3 MD38DP2 card terminal layout

DIP switch



MD38DP2 DIP switch description

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

Caution

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

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

Description of standard 9-pin PROFIBUS interface

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

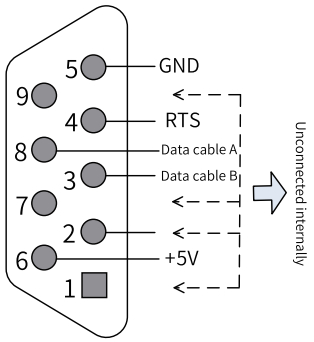


Figure 26-4 DP9 port pin

Description of control terminal functions

Table 26–1 Description of control terminal functions

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

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

Note

Note: For some products, the indicator color and the terminal indication may not match. In this case, the terminal indication prevails. The indicators are D2, D3, and D4 from left to right. See *"Figure 26–3" on page 525* .

26.4 PROFIBUS Topology and Transmission Distance

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

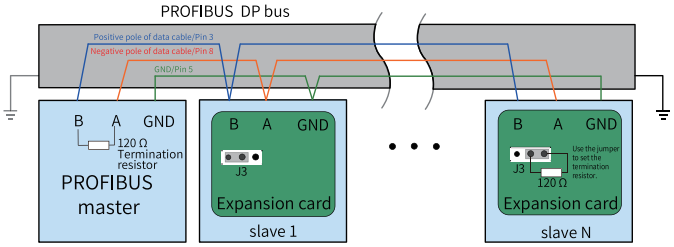
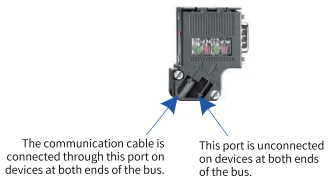


Figure 26-5 Connection between the DP card and PROFIBUS master

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



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

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

The following table lists the technical specifications of cables.

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

26.5 Communication Protocol

Data transmission formats

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

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

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

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

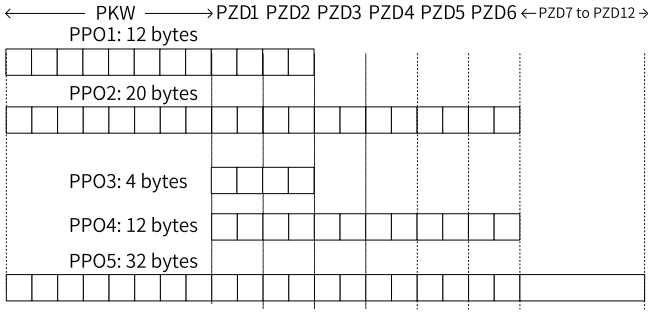


Figure 26-6 PPO data format

PKW data

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

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

Data format

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

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

Data description

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

Application example

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

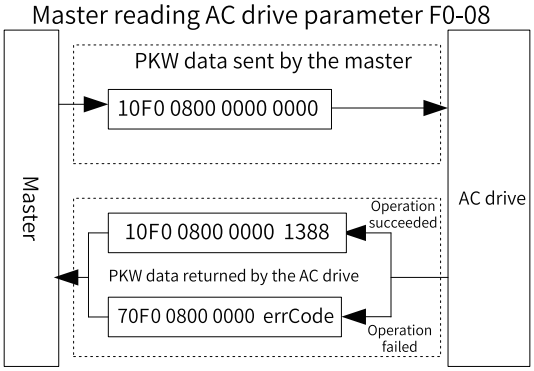


Figure 26-7 Example of PKW data transmitted when the master requests to read an AC drive parameter

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

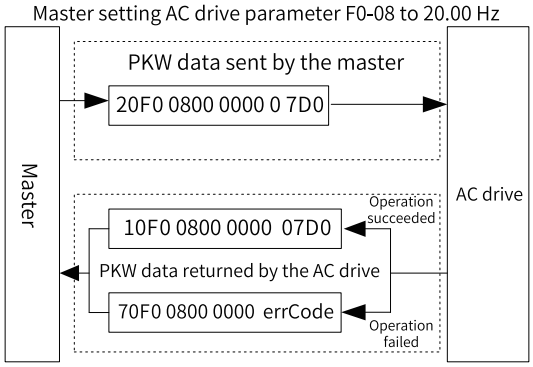


Figure 26-8 Example of PKW data transmitted when the master requests to write an AC drive parameter

PKW data exchange with the AC drive is performed cyclically. Continuous access to the EEPROM with the write command (PKE = 0x20xx) will significantly reduce the service life of the AC drive's main control chip. Therefore, to modify AC drive parameters, it is advisable to use the acyclic write command (see SFB53 described in *"26.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave" on page 550*) or operate the RAM addresses in PKW. The following table lists the RAM addresses of the parameters.

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

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

PZD data

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

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

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

Data sent by the master

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

Data responded by the AC drive

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

26.6 Parameters

26.6.1 Communication Card Type Setting

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

Table 26–2 Related parameters

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

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

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

26.6.2 Communication Control Parameters

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

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

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

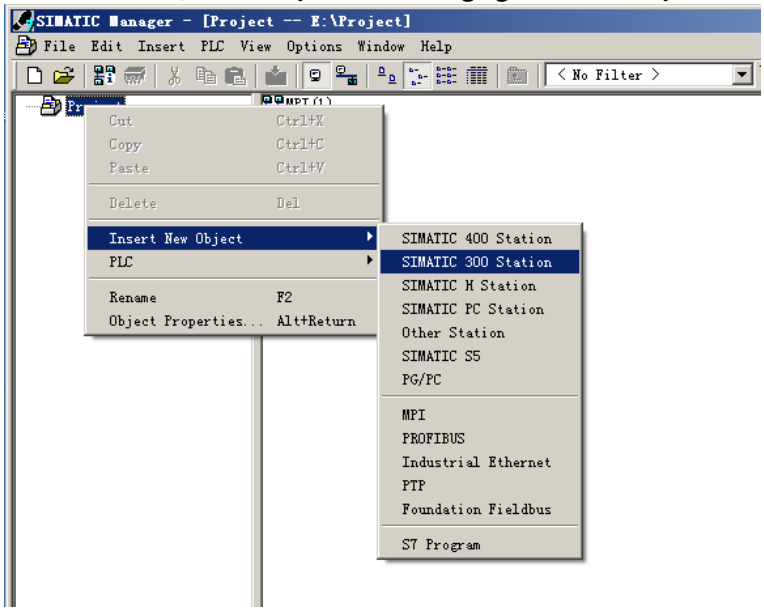
26.7 Configure communication parameters.

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

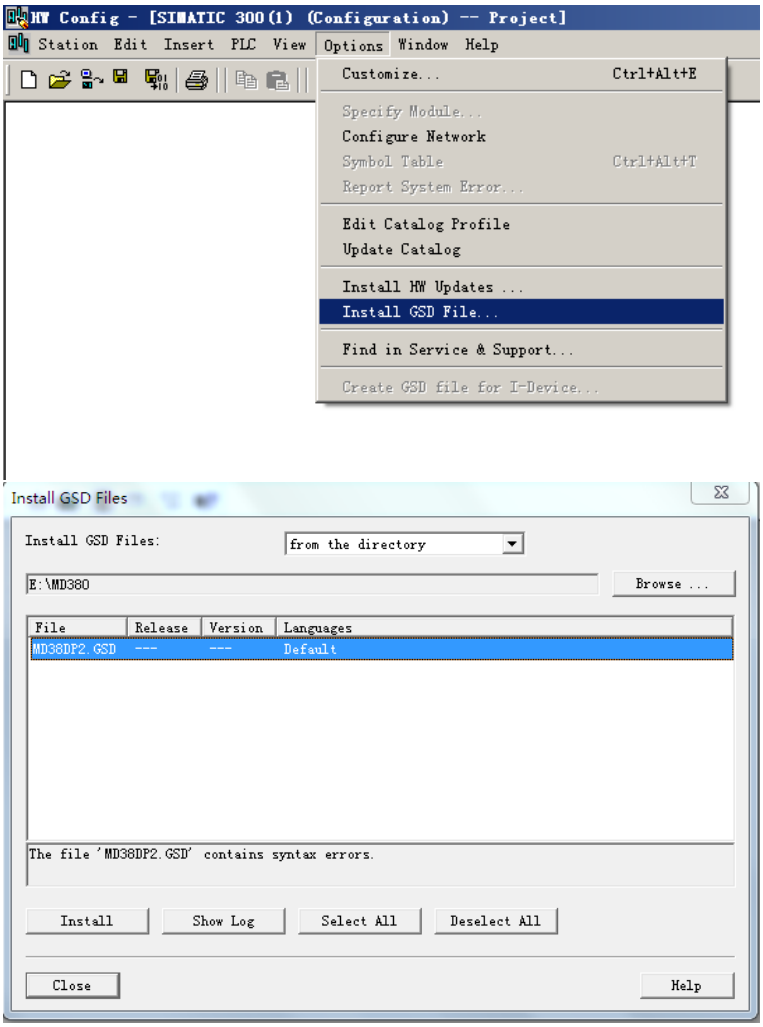
Before using the PROFIBUS master, you need to configure the GSD file of the slave to add the slave to the system of the master. If the GSD file is already configured, skip step 2. You can obtain the GSD file from Inovance or its agent.

To configure the slave, do as follows:

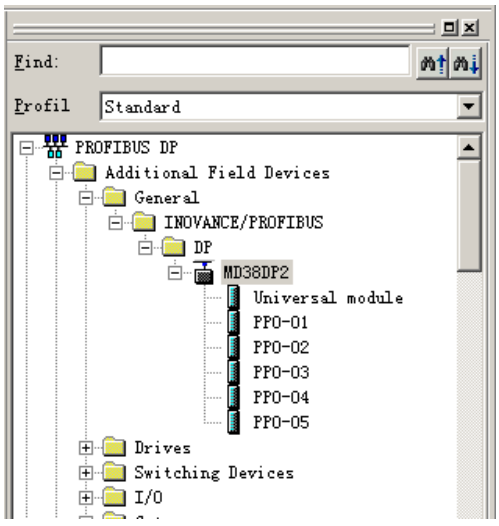
1. (Optional) To install the GSD file, choose **Options** > **Manage general description files (GSD)**.



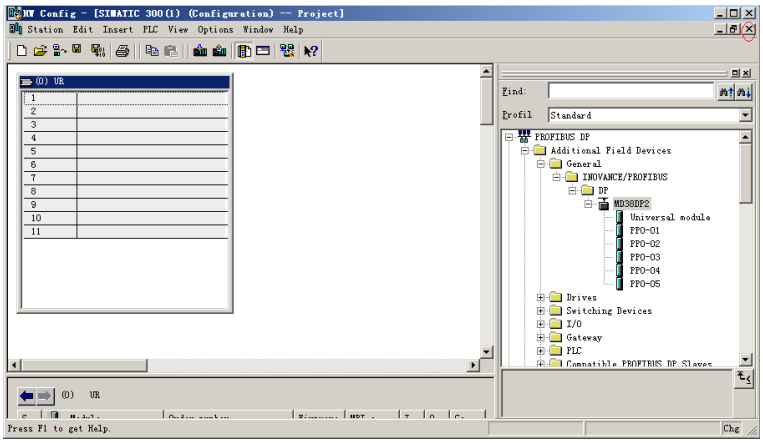
2. Double-click the hardware icon to access the **HW Config** interface, and choose **Options** > **Install GSD File** to add the MD38DP2.GSD file (Note that the file must be stored in an English path; otherwise, the STEP7 may fail to recognize the file).



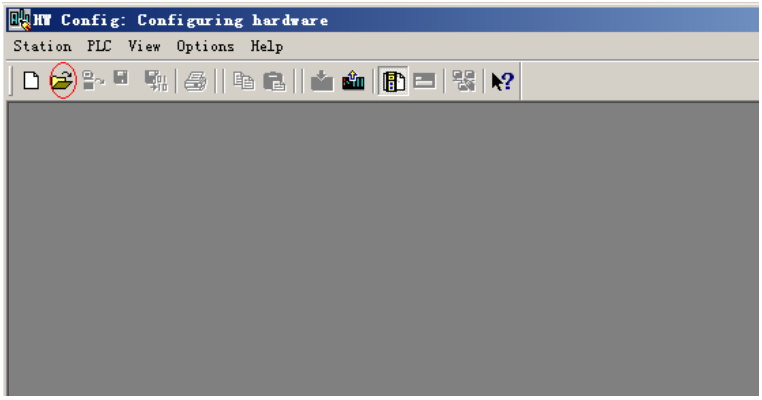
Click **Install**. After the installation is complete, the PROFIBUS DP module named MD38DP2 is displayed.



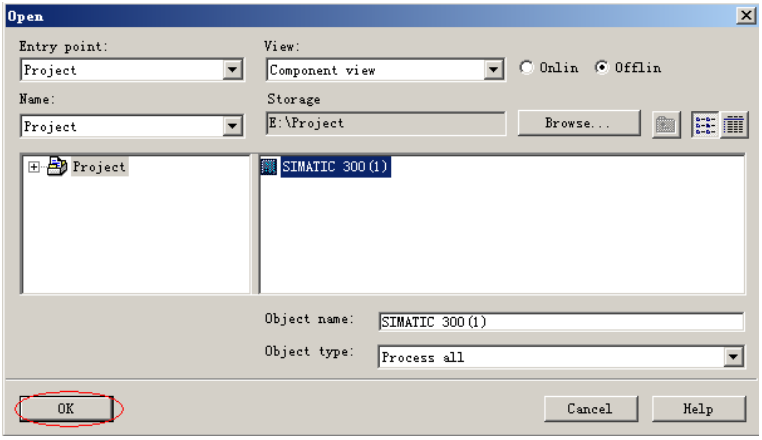
Note: If any master or slave already exists on the **HW.config** interface, close the current interface by clicking the X button (marked with a red circle in the following figure) before importing the GSD file.



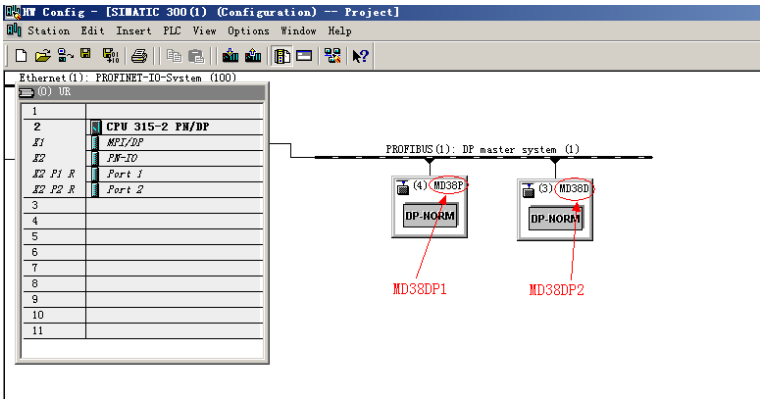
In this case, you can save the existing project. If a warning indicating that system data cannot be created is displayed, click **OK**. After closing the interface of the existing configuration project, you can install the GSD file by following the preceding steps. After the installation is completed,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



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

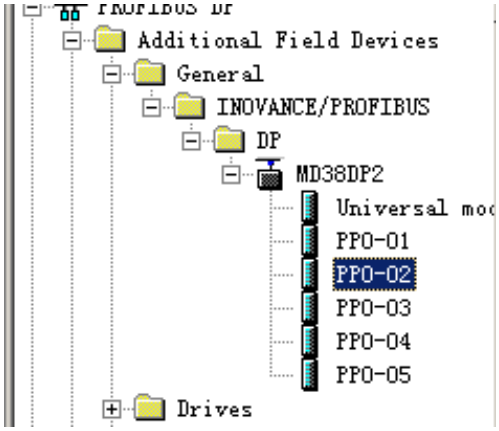


3. Configure the actual hardware system, as shown in the following figure.



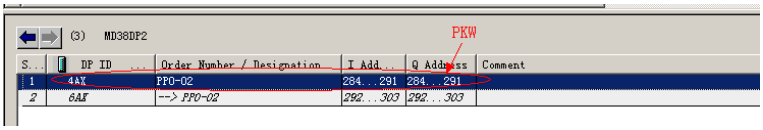
In the preceding figure, station 4 is MD38DP1, which is only used for illustration. For details about its usage, see the MD380 Series PROFIBUS User Guide. MD38DP1 cards and the MD38DP2 cards can be valid on the same network.

4. Configure data features of the slave.



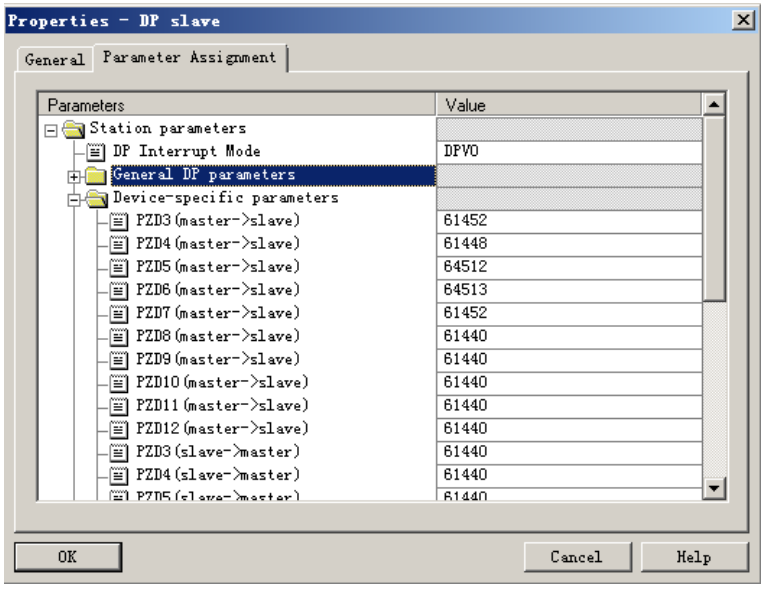
After the PPO type is added, the address assigned by the PLC to the slave is displayed. Slot 1 marked with a red circle in the following figure indicates the PKW address (8 bytes). Slot 2 indicates the PZD address (12 bytes).

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



5. Configure the PZD.

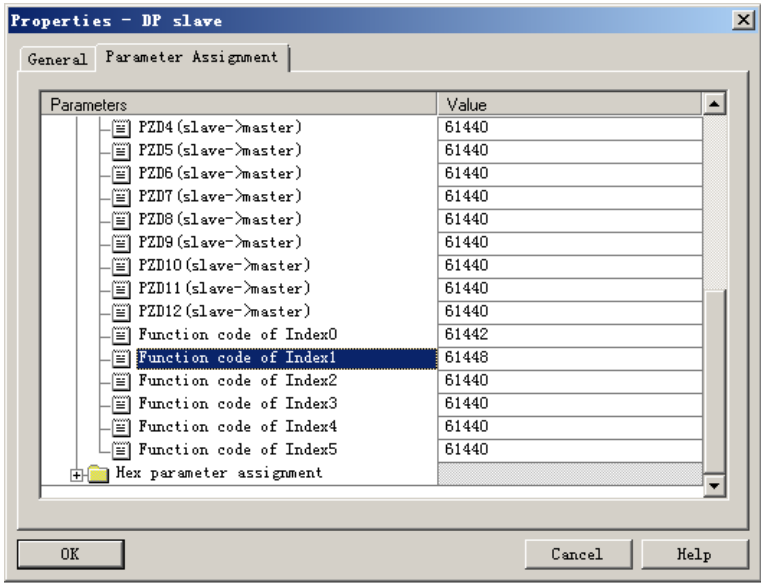
The fixed configuration of PZD1 and PZD2 cannot be modified. PZD3 to PZD12 are intended for exchange of user-defined cyclic data. They can be set in hardware configuration. On the **HW Config** interface, double-click the MD38DP icon and then click **Device-specific parameters** to configure parameter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



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

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

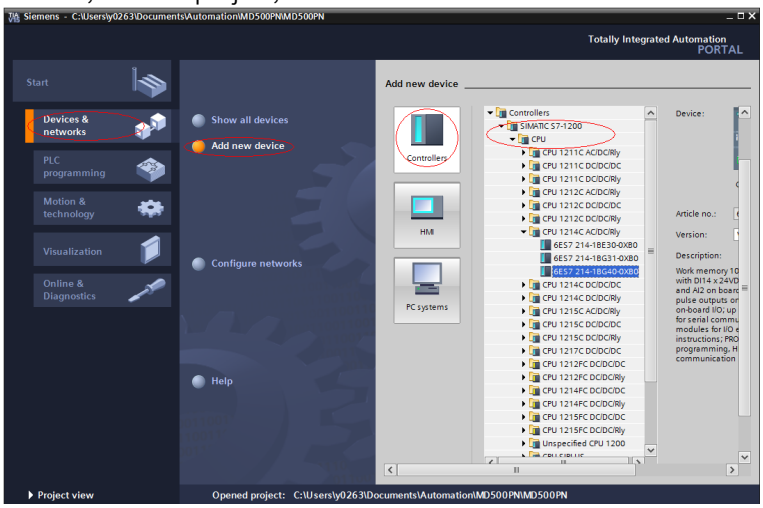
To enable the function of non-periodically reading and writing parameters of DPV1, set corresponding parameters in customized indexes at the end of **Device-specific parameters**. The AC drive provides six customized indexes numbered from 0 to 5. For example, set indexes 0 and 1 to F0-02 and F0-08, respectively.



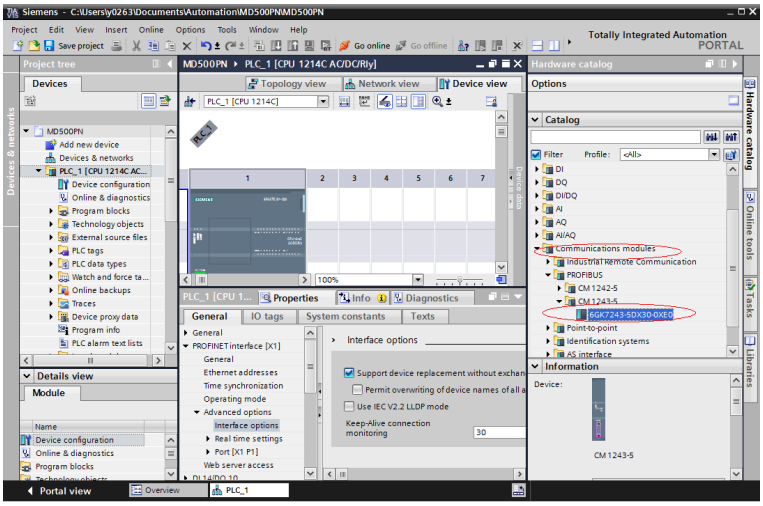
After all the preceding operations are completed, the PROFIBUS slave station is configured. Then, you can compile programs in the S7-300 to control the AC drive.

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

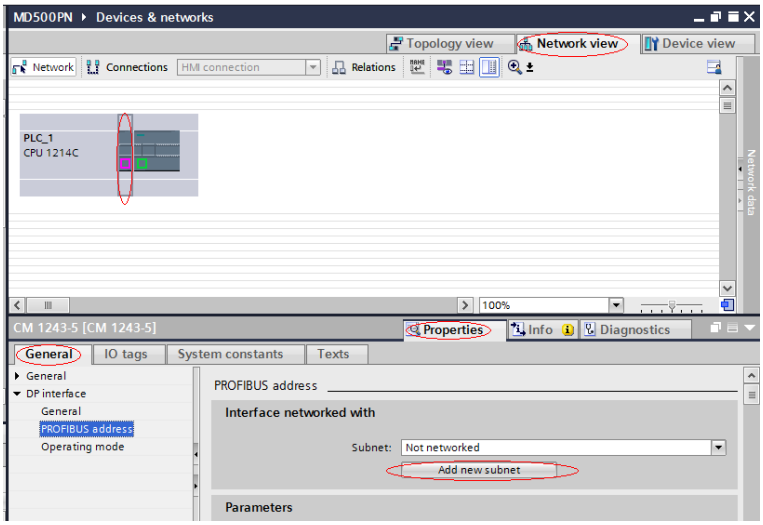
1. Open the TIA Portal V13, create a project, and add an S7-1200 master based on the actual situations.



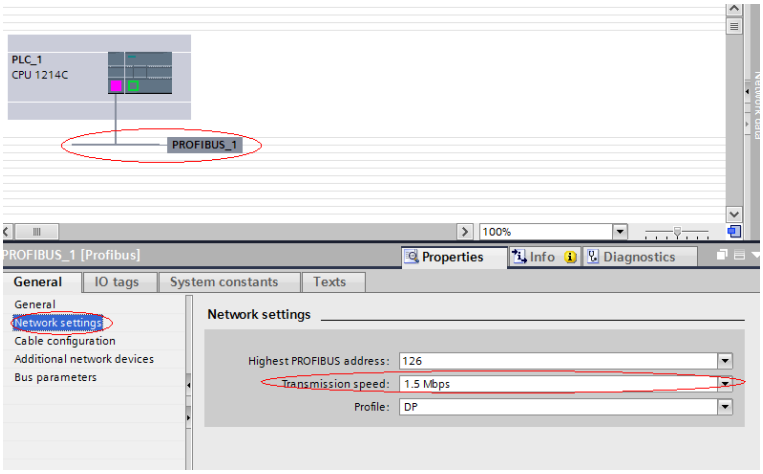
The S7-1200 CPU does not have a PROFIBUS interface, so you need to add a PROFIBUS communication module first. In this example, a CM1243-5 master module is added.



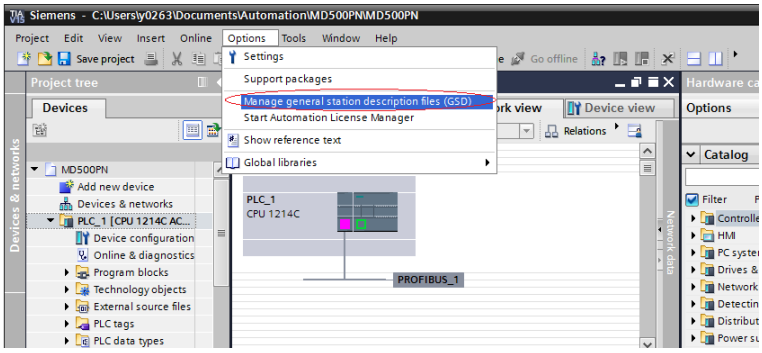
After adding the PROFIBUS master module, click the **Network view** tab. After selecting the communication module, choose **Properties** > **General** > **Add new subnet** to create a PROFIBUS network. You can also modify the master ID on this interface.

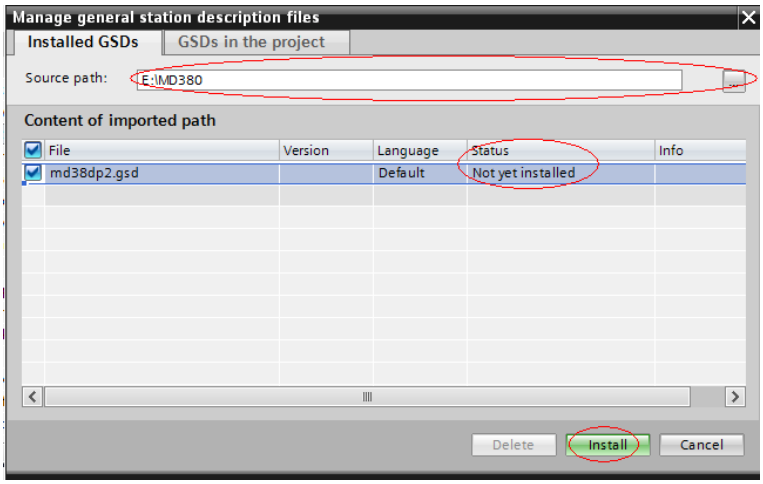


To modify the PROFIBUS baud rate, select the network, and choose **Properties** > **General** > **Network settings**. Select a baud rate from the **Transmission speed** drop-down list.

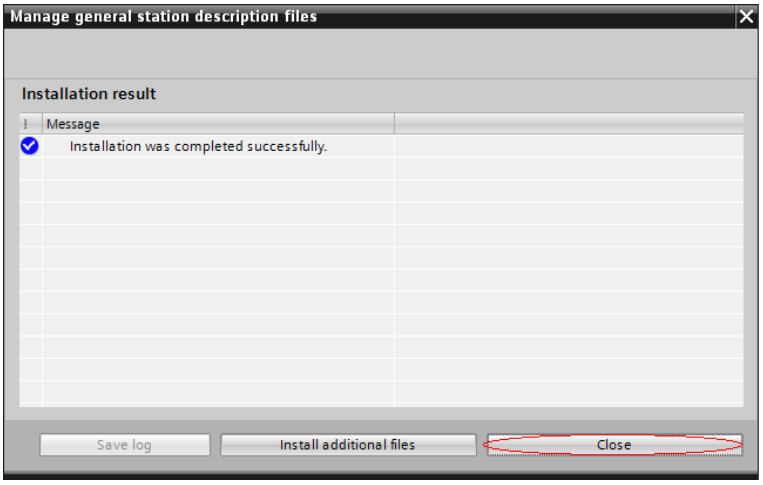


2. Install the GSD file. Skip this step if the GSD file is already installed.
   If the GSD file is not installed, the message **Not yet installed** is displayed in the **Status** column. Select the GSD file and click **Install**. Note that an error will occur if the installation path contains Chinese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

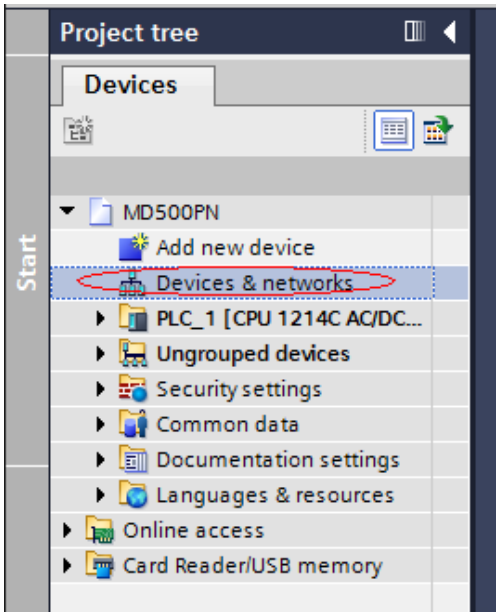




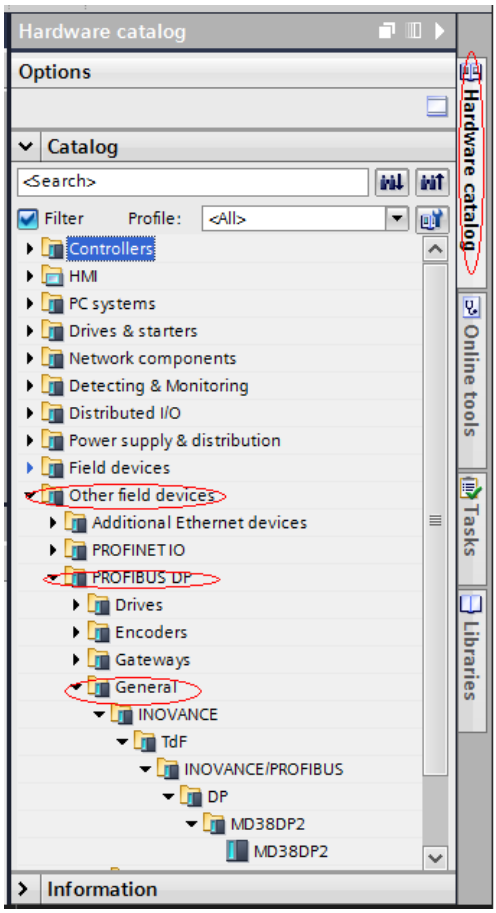
If the following figure is displayed, the installation is complete. In this case, click **Close**.



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

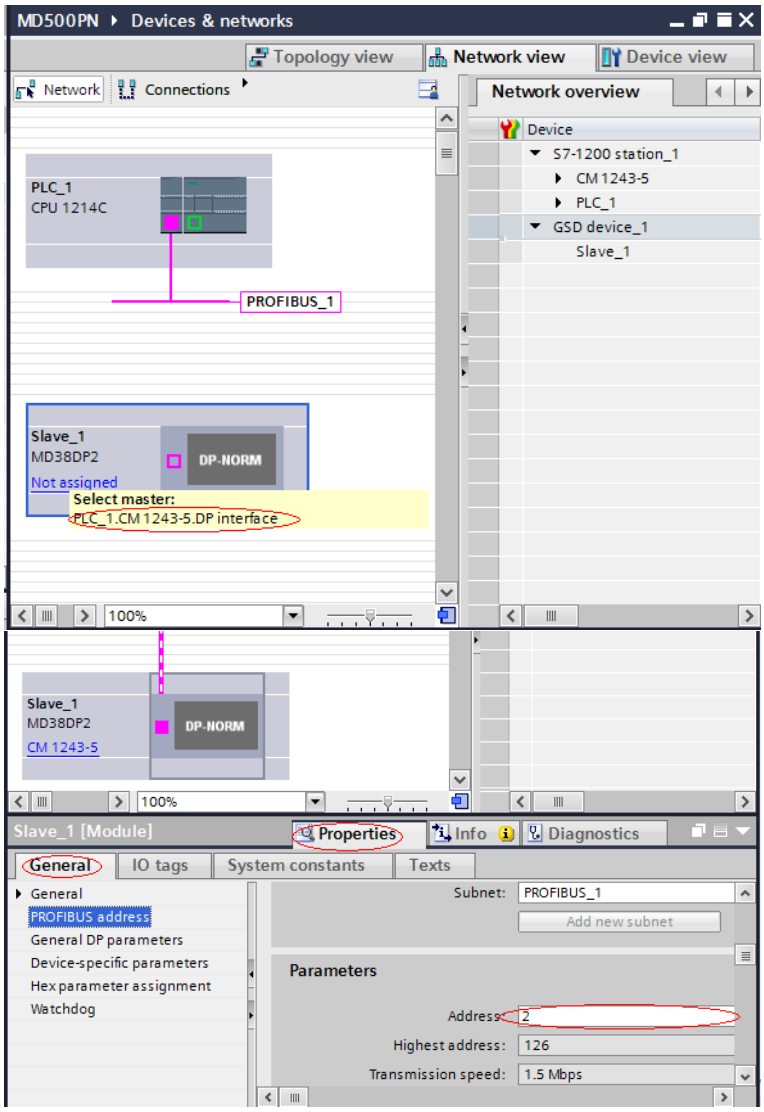


After the installation, you can choose **Hardware catalog** > **Other field devices** > **PROFIBUS DP** > **General** to locate the MD38DP2, which is the same for the STEP7. Expand all the sub-directories as shown in the following figure.

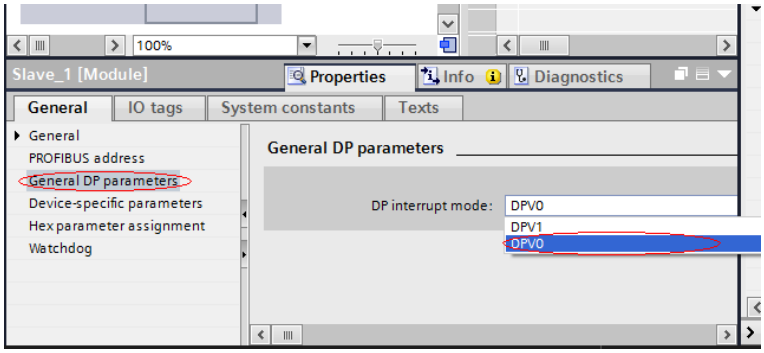


3. Start the configuration.

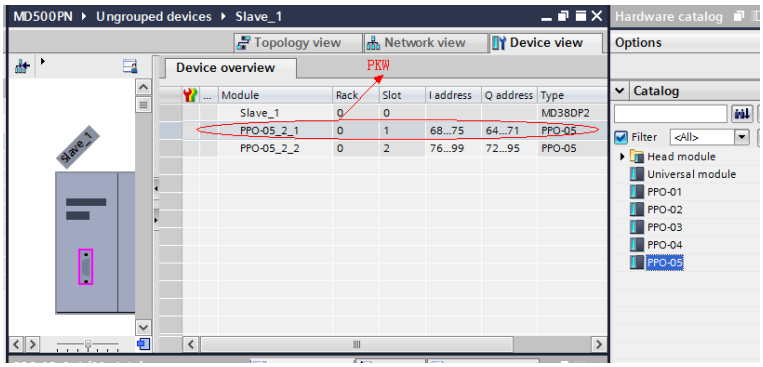
   On the **Hardware catalog** tab, double-click MD38DP2 or drag it to **Network view** under **Devices & networks**. Click **Not assigned** below the slave name to select the corresponding PROFIBUS network. Select the slave, choose **Properties** > **General**, and set the slave ID. Note that the setting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



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

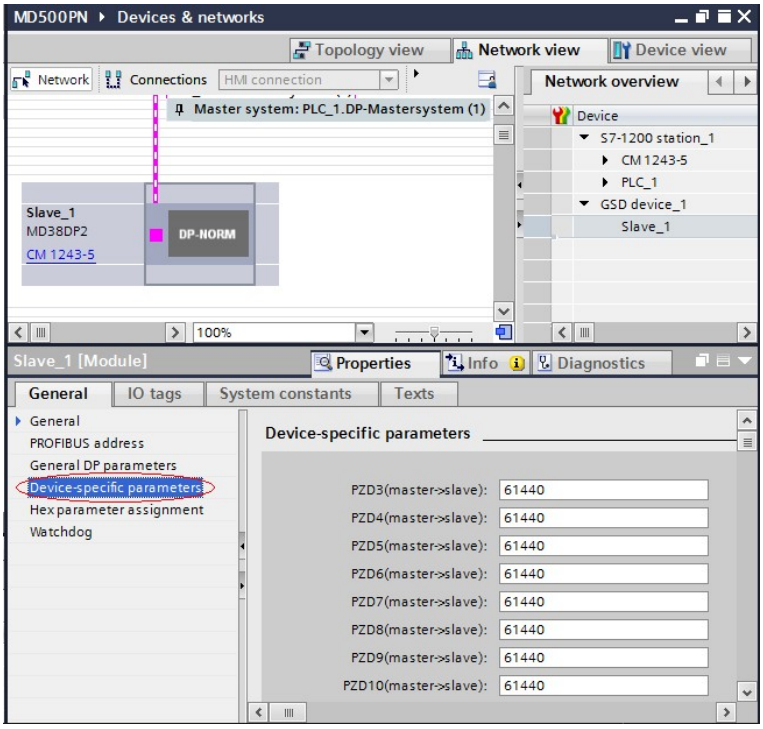


Click the **Device view** tab. Select a suitable PPO type under **Hardware catalog**. Check the addresses assigned for each segment. The row marked with a red circle in the following figure indicates the PKW address. If the selected PPO type has no PKW, the address column is blank.



4. Set PZD mappings.

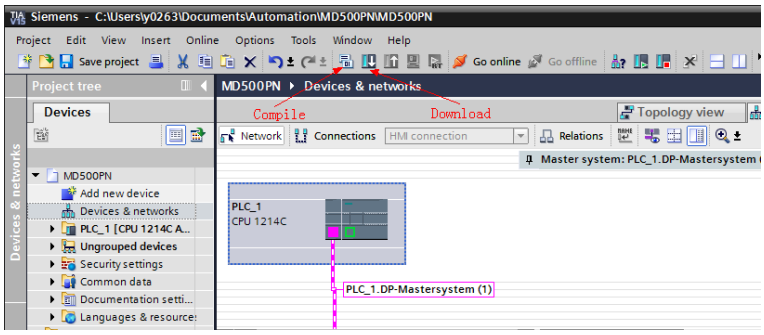
   Click the **Network view** tab. Click **Device-specific parameters** to set the mapping for PZD3 to PZD12. The PZD mapping relationships for the PLC to read data from and write data to the slave must be set independently. For details, see *"26.7.1 Configuring Slaves on the STEP7 (V5.4) by Using S7-300" on page 537*.



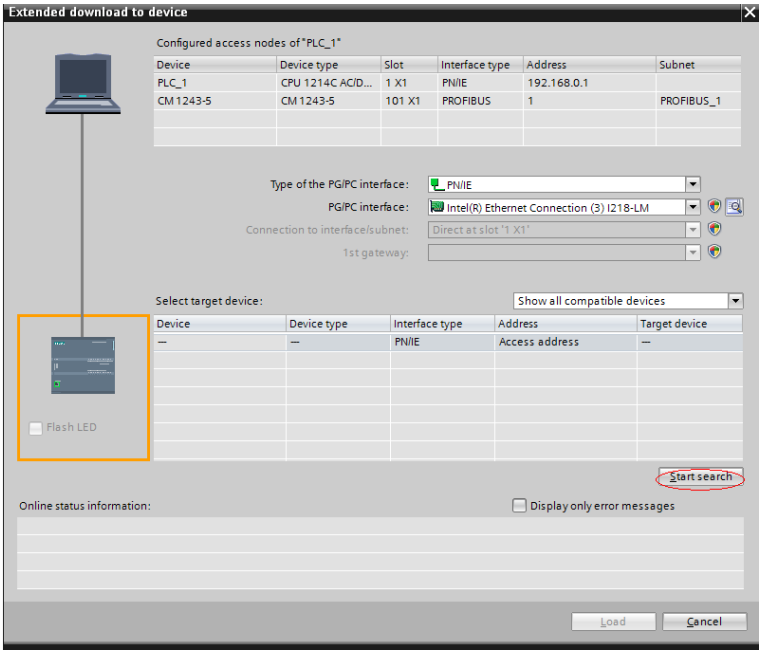
5. Compile and download the configuration.

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

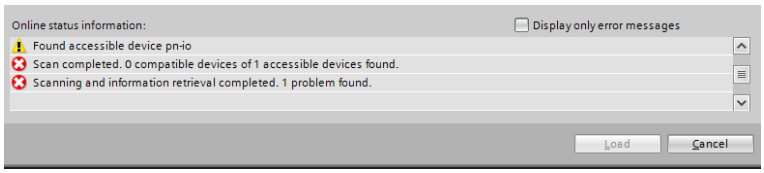
   After all slaves are configured, save the configurations, and then click the **Compile** button. After the compiling is completed successfully, click the **Download** button.



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



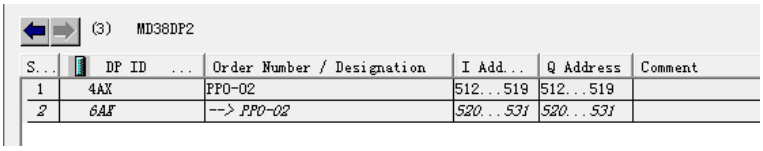
If no accessible device is found, the connection between the PC and PLC is faulty. Rectify the fault first. If the STEP7 is used for downloading through the Ethernet and then the PORTAL is used for downloading on the same PC, the problem also occurs. In this case, restart the PC or change the PG/PC interface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



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

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

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

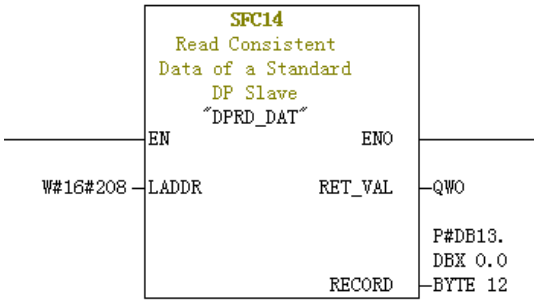


1. Directly use the MOVE command to enable the AC drive to run in the forward direction at the target frequency of 30 Hz (F0-02 = 2, F0-03 = 9), as shown in the following figure.

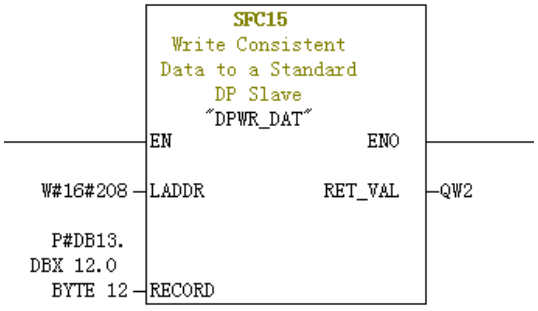


Other data is written in a similar way. The read data can also be transmitted from the PIW register to the common Q, I, L, M, or D register using the MOVE command for parsing.

2. Use SFC14 and SFC15.



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

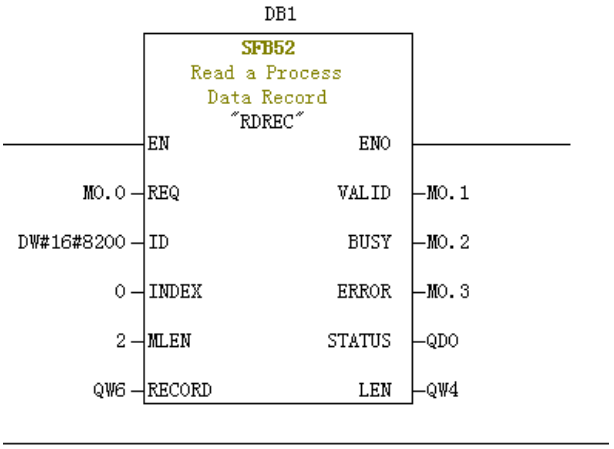


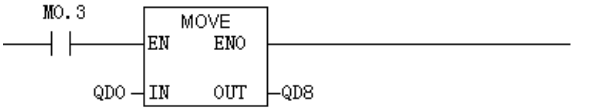
- **LADDR**: Starting address configured in the Q block of the module, which must be in hexadecimal format.
- **RET_VAL**: Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD**: Source area of the user data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

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

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

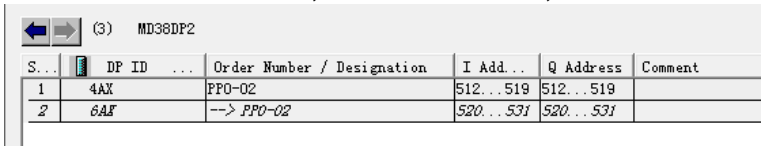
To perform aperiodic read and write operations on the AC drive PROFIBUS DP slave, Siemen's system function modules SFB52 (for reading) and SFB53 (for writing) are required. Create an organization block in the program, and add relevant function blocks and programs in the organization block.





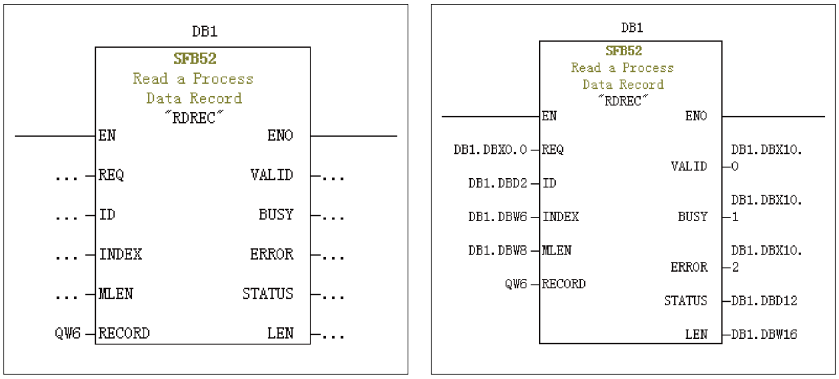
After M0.0 is set, the function block reads F0-02 (Index 0 has been set to F0-02) of the AC drive No. 3 and saves it in QW6. Field definitions are as follows:

- REQ: It is used to enable or disable the function block. When it is set to 1, the function block is enabled.
- ID: It indicates the logic address. To specify this field, convert any bit in the Q address of the AC drive slave station to a hexadecimal value, and set bit 15 of the value to 1. For example, after Q512 is converted to the hexadecimal value H200, and bit 15 is set to 1, H8200 is obtained.



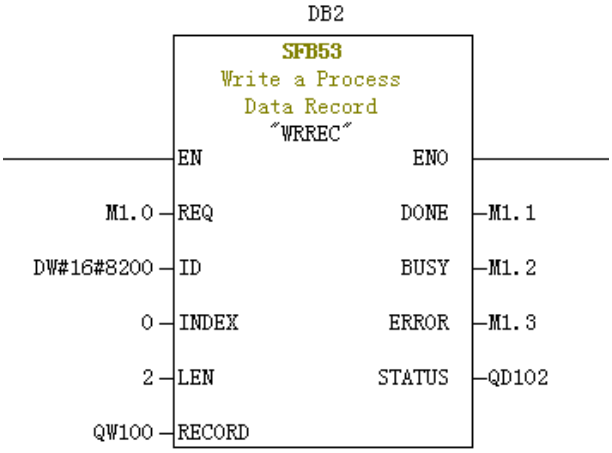
- INDEX: It is an index number ranging from 0 to 5. You can define the index mapping address of a slave as required.
- MLEN: It indicates the maximum length of the data to be obtained. For MD38DP2, this field must be set to 2.
- RECORD: It indicates the target area of an obtained data record. This field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

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



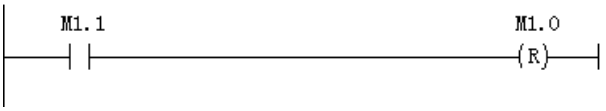
The left figure shows all the default parameters. If you want to customize parameters, set them according to the right figure. You can set customized or default parameters for corresponding blocks as required.

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



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

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



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

26.8 Troubleshooting

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

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

<table>
<tr><th colspan="2">Description</th><th>Solution</th></tr>
<tr><td rowspan="4">After the connection is successful, all indicators on the PLC are on in green, but data cannot be written into or read from the AC drive.</td><td>No data can be written/ read.</td><td>Check whether the operation address is correct. No matter whether the PPO type used contains the PKW zone, the read/write operation address always locates in the second row (that is, the last row). If the I address and Q address in the last row of the station are both 520 to 531 (note that the I and Q addresses may start from different numbers), the PZD1 data written into the AC drive is stored in QW520, the PZD2 data written into the AC drive is stored QW522, and so on. If the PLC is S7-300 and S7-400, PQW is used. If SFC15 is used, check whether RET_VAL of the SFC15 block is 0. If not, an invocation error exists. Eliminate this error first and invoke the block again. For details, see section "Performing Periodic Read/ Write Operations on the AC Drive Slave".</td></tr>
<tr><td>PZD3 or subsequent data can be written, but PZD1 or PZD2 cannot be written/read.</td><td>Check whether F0-02 and F0-03 are set to 2 and 9, respectively. Check whether the command reference is in the range of 1 to 7 (not bit) or frequency reference is in the range of -F0-10 to +F0-10. If not, the write operation fails. Check whether FE-00 and FE-01 are U3-17 and U3-16, respectively. If not, manually correct the parameter values or restore to factory settings.</td></tr>
<tr><td>PZD1 and PZD2 can be written/read, while PZD3 or subsequent data cannot be written/ read.</td><td>Check whether the PPO type supports the relevant PZD. Check whether device-specific parameters are set correctly.</td></tr>
<tr><td>-</td><td>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).</td></tr>
<tr><td colspan="2">After communication is established, the AC drive reports E164.1, which cannot be cleared. However, the indicator on the DP expansion card and the BF indicator on the PLC are normal.</td><td>Check whether the high-order 8 bits of the PZD1 data (QW data) written into the AC drive are 0 in the PLC program. If not, change them to 0. The PZD1 command in this user guide refers to values instead of bits.
Note: This solution applies only to MD520. For other AC drives, consult the technical engineers.</td></tr>
<tr><td colspan="2" rowspan="2">After communication is established, the communication is normal when the AC drive is not running. However, when one or more AC drives are running, they are disconnected randomly.</td><td>1. Disconnect the power supply. Use a multimeter to measure the A1/B1 resistance of the DP slave station interface at the farthest end. The correct resistance should be 100±20 Ω.</td></tr>
<tr><td>2. Check that the cable shields are connected together and the shields are in contact with the sheet metal in the DP interface. The shields are not required to connect with other GND terminals.</td></tr>
<tr><td colspan="2">After the connection is established, the AC drive reports a fault. After the PLC configuration is changed and downloaded again or after the AC drive alone is powered on again, the faulty slave still cannot connect to the network.</td><td>The DP expansion card supports only the interruption mode DPV0. If the interruption mode is set to DPV1, when a slave is faulty, the PLC master may disable the DP connection channel of the slave or disable all the PLC communication (which usually occurs on the S7-1200). When such a symptom occurs, change the DP interruption mode (which is DPV0 by default in STEP 7 and DPV1 by default in PORTAL) of the slave to DPV0 under General DP parameters. Then, compile and download the configuration, and power on the PLC again.</td></tr>
</table>

Indicator status of the DP expansion card and troubleshooting

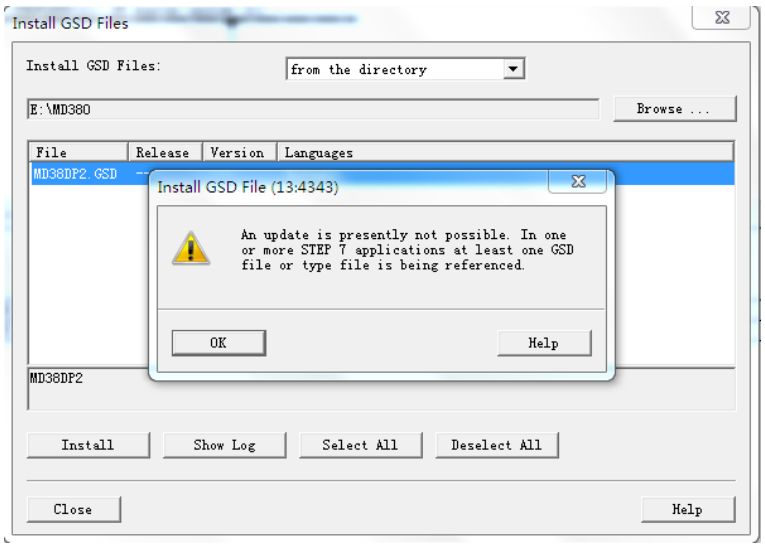
Indicator[Note]	Fault Status	Description	Solution
Red (D4)	Off	The DP expansion card is not powered on.	Check that the DP card is securely connected to the AC drive.
Green (D2)	Off	The connection between the DP expansion card and the AC drive fails.	Check that F0-28 is set to 1 and the DP expansion card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

Note

Note 1: For some products, the indicator color and the terminal indication may not match. In this case, the terminal indication prevails. The indicators are D2, D3, and D4 from left to right. See *"Figure 26–3" on page 525* .

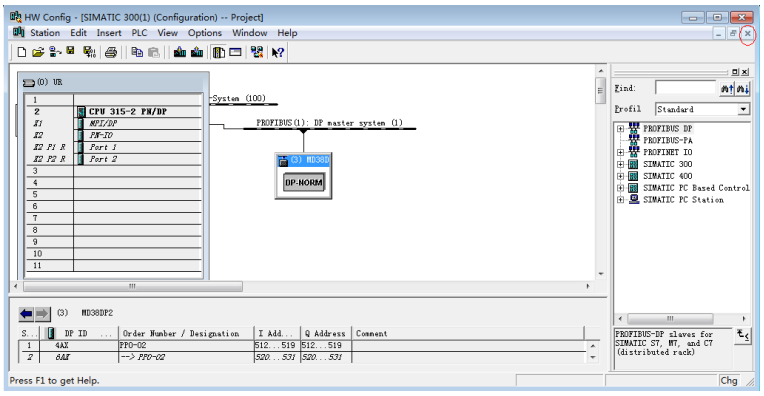
Troubleshooting for GSD installation failure

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

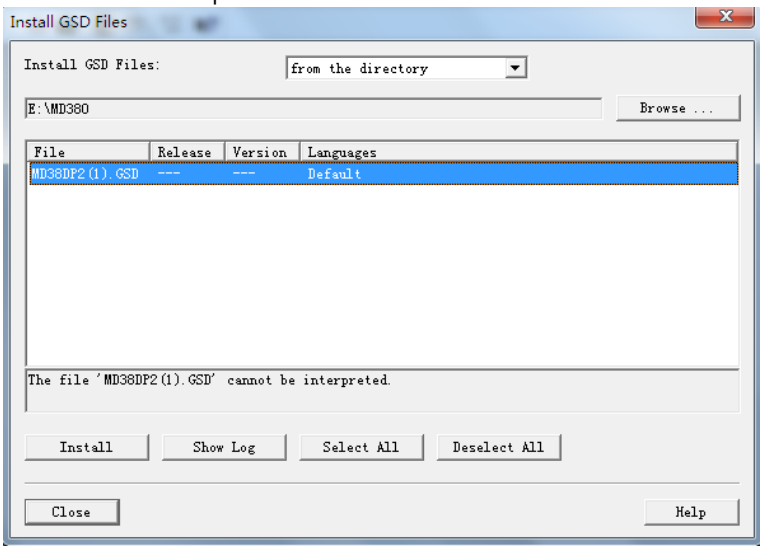


Possible cause: The current hardware configuration interface is opened and the GSD file is being used by other components.

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



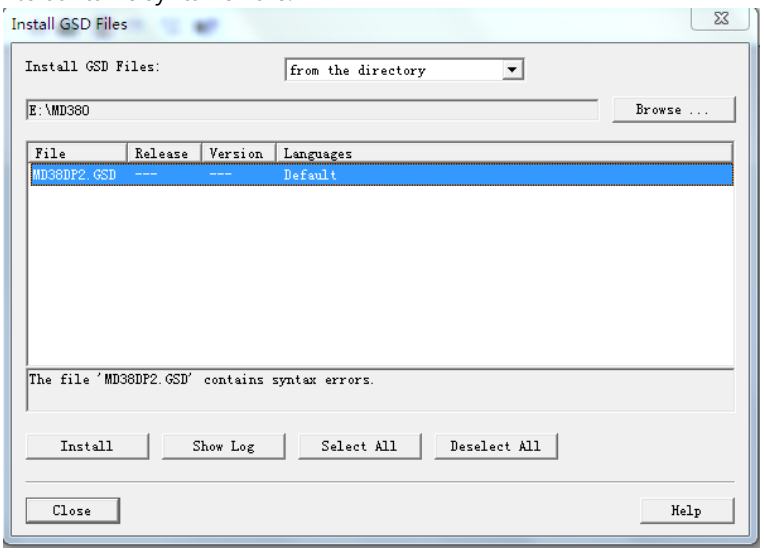
- Problem 2: The file cannot be interpreted.



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

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

- Problem 3: The file contains syntax errors.



Possible cause: The GSD file is modified.

Solution: Use a correct GSD file.

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

27 PROFIBUS DP Communication (MD-SI-DP2)

27.1 Introduction

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

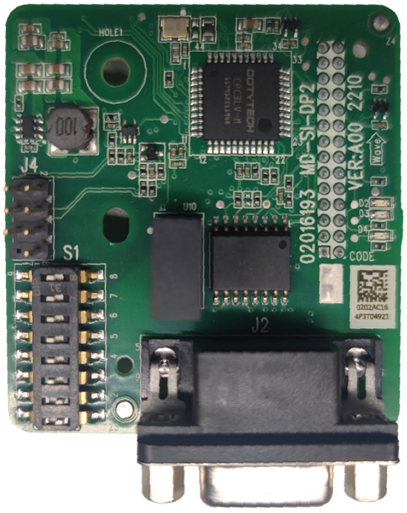


Figure 27-1 MD-SI-DP2 card appearance

27.2 Installation

The DP card is designed to be embedded in the AC drive. Before installation, cut off the power supply of the AC drive and wait for about 10 minutes until the charging indicator of the AC drive becomes off. Then, insert the DP card into the AC drive and fasten the screws to protect the signal socket between boards from being damaged by the pulling force of the external signal cable. See *"Figure 27–2" on page 557* for installation.

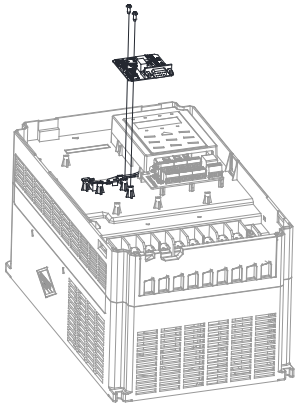


Figure 27-2 Installing the DP card

Caution

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

27.3 Interface Description

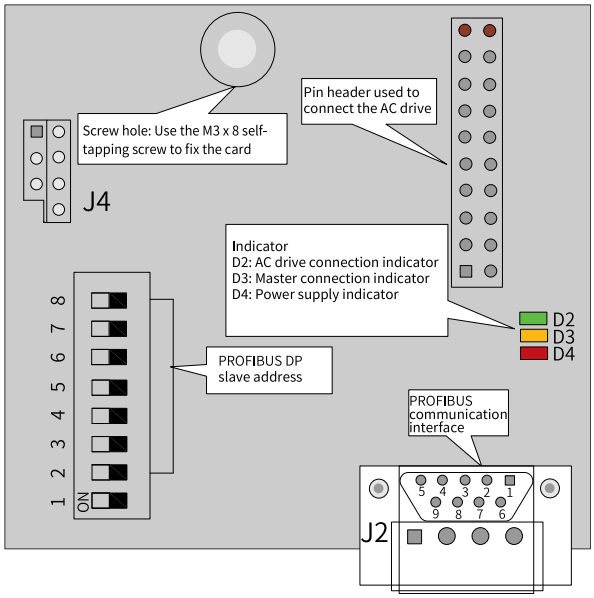
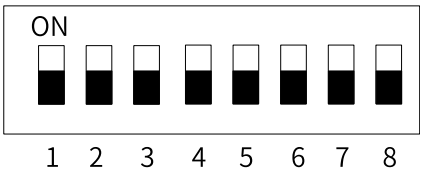


Figure 27-3 MD-SI-DP2 card terminals

DIP switch



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

Caution

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

Description of standard 9-pin PROFIBUS interface

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

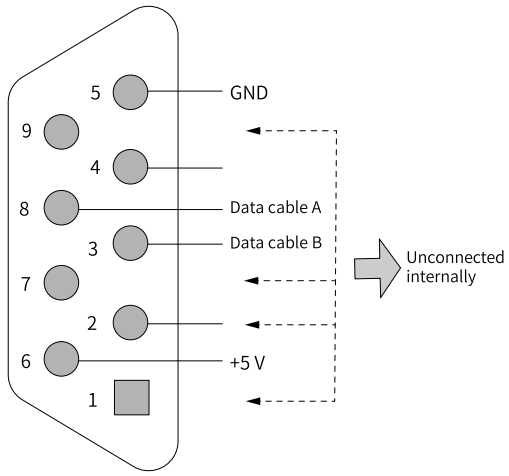


Figure 27-4 DP9 port pin

Description of control terminal functions

Table 27–1 Description of control terminal functions

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

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

27.4 PROFIBUS Topology and Transmission Distance

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

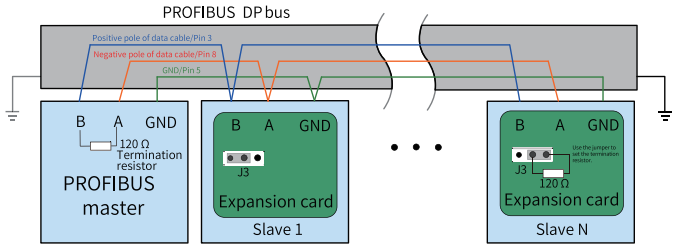
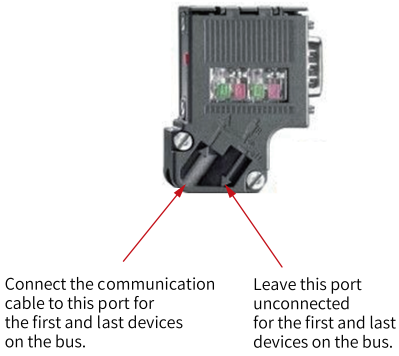


Figure 27-5 Connection between the DP card and PROFIBUS master

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



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

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

The following table lists the technical specifications of cables.

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

27.5 Communication Protocol

Data transmission formats

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

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

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

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

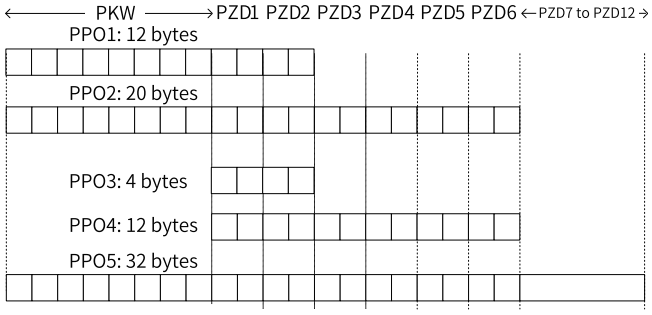


Figure 27-6 PPO data format

PKW data

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

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

Data format

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

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

Data description

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

Application example

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

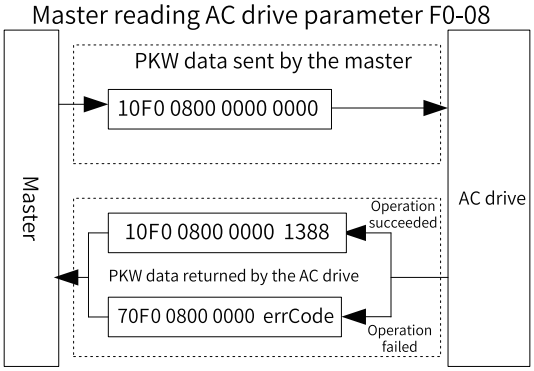


Figure 27-7 Example of PKW data transmitted when the master requests to read an AC drive parameter

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

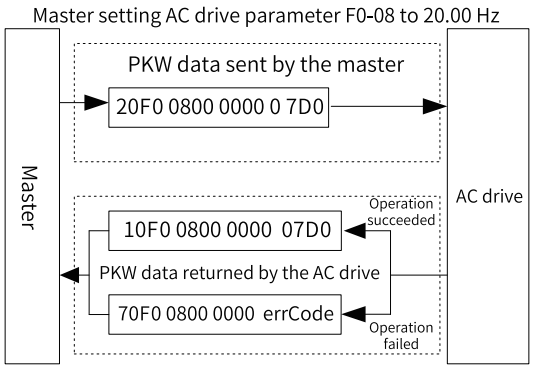


Figure 27-8 Example of PKW data transmitted when the master requests to write an AC drive parameter

PKW data exchange with the AC drive is performed cyclically. Continuous access to the EEPROM with the write command (PKE = 0x20xx) will significantly reduce the service life of the AC drive's main control chip. Therefore, to modify AC drive parameters, it is advisable to use the acyclic write command (see SFB53 described in *"26.7.4 Performing Aperiodic Read/Write Operations on the AC Drive Slave" on page 550*) or operate the RAM addresses in PKW. The following table lists the RAM addresses of the parameters.

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

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

PZD data

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

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

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

Data sent by the master

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

Data responded by the AC drive

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

27.6 Parameters

27.6.1 Parameters Related to Communication

AC drive communication card settings

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

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

Communication control parameters

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

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

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

Communication monitoring parameters

Parameter Code	Parameter Name	Min. unit	Hexadecimal Address	Decimal Address
U0-00	Operating frequency	0.01 Hz	H7000	28672
U0-01	Frequency reference	0.01 Hz	H7001	28673
U0-02	Bus voltage	0.1 V	H7002	28674
U0-03	Output voltage	1 V	H7003	28675
U0-04	Output current	0.01 A	H7004	28676
U0-05	Output power	0.1 kW	H7005	28677
U0-06	Output torque	0.1%	H7006	28678
U0-07	DI input state	1	H7007	28679
U0-08	DO output state	1	H7008	28680
U0-09	AI1 voltage	0.01 V	H7009	28681

Parameter Code	Parameter Name	Min. unit	Hexadecimal Address	Decimal Address
U0-10	AI2 voltage	0.01 V	H700A	28682
U0-11	AI3 voltage	0.01 V	H700B	28683
U0-12	Count value	1	H700C	28684
U0-13	Length	1	H700D	28685
U0-14	Load speed display	1	H700E	28686
U0-15	PID reference	1	H700F	28687
U0-16	PID feedback	1	H7010	28688
U0-17	PLC stage	1	H7011	28689
U0-18	Pulse input frequency	0.01 kHz	H7012	28690
U0-19	Feedback speed	0.01 Hz	H7013	28691
U0-20	Remaining running time	0.1 min	H7014	28692
U0-21	AI1 voltage before calibration	0.001 V	H7015	28693
U0-22	AI2 voltage before calibration	0.001 V	H7016	28694
U0-23	AI3 voltage before calibration	0.001 V	H7017	28695
U0-24	Motor speed	1 rpm	H7018	28696
U0-25	Current power-on time	1 min	H7019	28697
U0-26	Current operating time	0.1 min	H701A	28698
U0-27	Pulse input frequency	1 Hz	H701B	28699
U0-28	Communication setpoint	0.01%	H701C	28700
U0-29	Encoder feedback speed	0.01 Hz	H701D	28701
U0-30	Display of main frequency X	0.01 Hz	H701E	28702
U0-31	Display of auxiliary frequency Y	0.01 Hz	H701F	28703
U0-32	Memory address view	1	H7020	28704
U0-33	Synchronous motor rotor position	0.1°	H7021	28705
U0-34	AI3 temperature mode - motor temperature	1°C	H7022	28706
U0-35	Target torque	0.1%	H7023	28707
U0-36	Resolver position	1	H7024	28708
U0-37	Power factor angle	0.1°	H7025	28709
U0-38	ABZ position	1	H7026	28710
U0-39	Target voltage upon V/f separation	1 V	H7027	28711
U0-40	Output voltage upon V/f separation	1 V	H7028	28712
U0-45	Fault subcode	1	H702D	28717
U0-58	Number of motor revolutions	1	H703A	28730
U0-59	Frequency reference	0.01%	H703B	28731
U0-60	Operating frequency	0.01%	H703C	28732
U0-61	AC drive state	1	H703D	28733

Parameter Code	Parameter Name	Min. unit	Hexadecimal Address	Decimal Address
U0-62	Current fault code	1	H703E	28734
U0-63	Torque sent in point-to-point communication	0.01%	H703F	28735
U0-64	Number of slaves in master-slave control	1	H7040	28736
U0-65	Torque upper limit	0.1%	H7041	28737
U0-66	Model of communication expansion card	100: CANopen 200. PROFIBUS DP 300: CANlink 400. PROFINET 500: EtherCAT 600: EtherNet/IP	H7042	28738
U0-67	Software version of communication extension card	1	H7043	28739
U0-68	AC drive state read through DP card	1	H7044	28740
U0-69	Frequency read through communication expansion card	0.01 Hz	H7045	28741
U0-70	Speed read through communication expansion card	1 rpm	H7046	28742
U0-71	Current read through communication expansion card	0.1 A	H7047	28743

When the DP card is used, the read PZD1 and PZD2 are mapped to parameters U0-68 and U0-69, respectively, by default. If the state or running frequency cannot be read but PZD3 to PZD12 can be read, check whether parameters FE-20 and FE-21 are consistent with parameters U0-68 and U0-69, respectively. If not, manually correct the values of parameters FE-20 and FE-21.

Caution

If the AC drive is updated from an earlier version that supports MD38DP1 to a later version that supports MD38DP2, the preceding operations must be performed or the AC drive must be reset after the update is complete.

27.7 Configure communication parameters.

27.7.1 Communication Instance Description

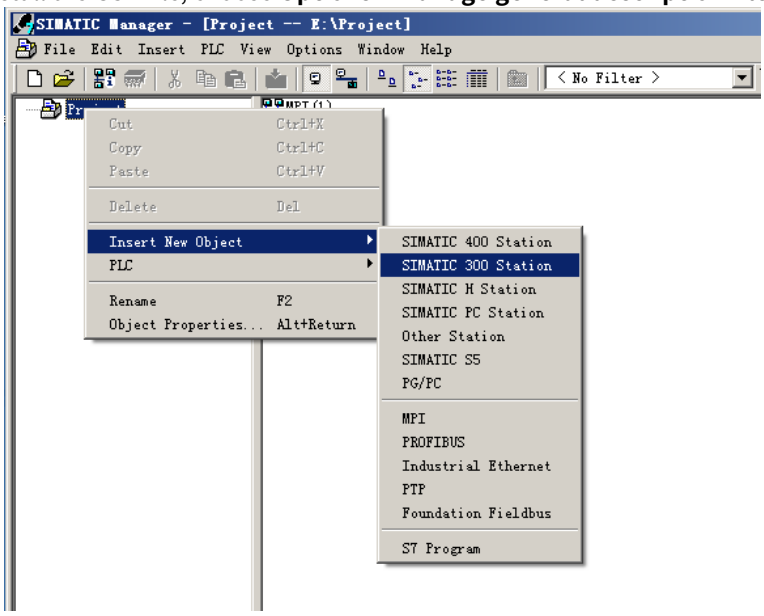
The MD-SI-DP1 expansion card uses the same GSD file as the MD38DP2 card in the same way as the MD38DP2 card. Therefore, this chapter still uses the screenshots of the communication and configuration interfaces displaying information about the MD38DP2 card. For details, see the communication examples in this section.

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

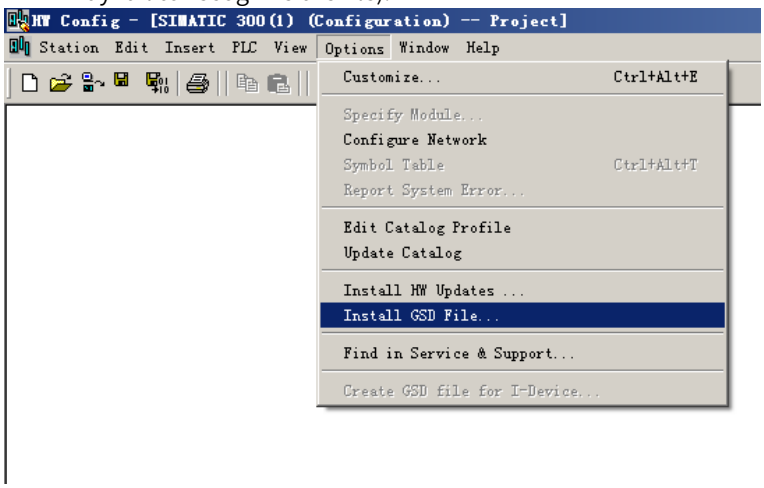
Before using the PROFIBUS master, you need to configure the GSD file of the slave to add the slave to the system of the master. If the GSD file is already configured, skip step 2. You can obtain the GSD file from Inovance or its agent.

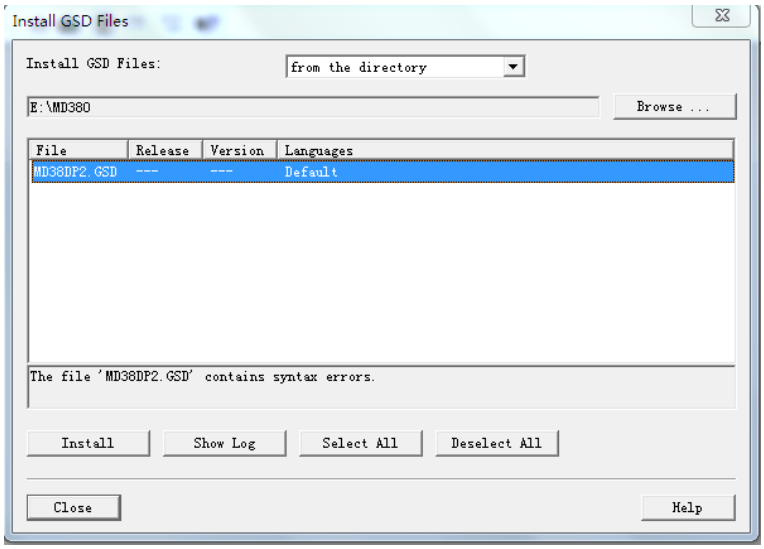
To configure the slave, do as follows:

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

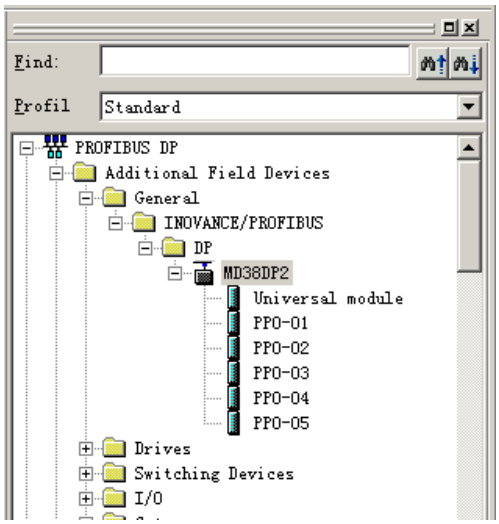


2. Double-click the hardware icon to access the **HW Config** interface, and choose **Options** > **Install GSD File** to add the MD38DP2.GSD file (Note that the file must be stored in an English path; otherwise, the STEP7 may fail to recognize the file).

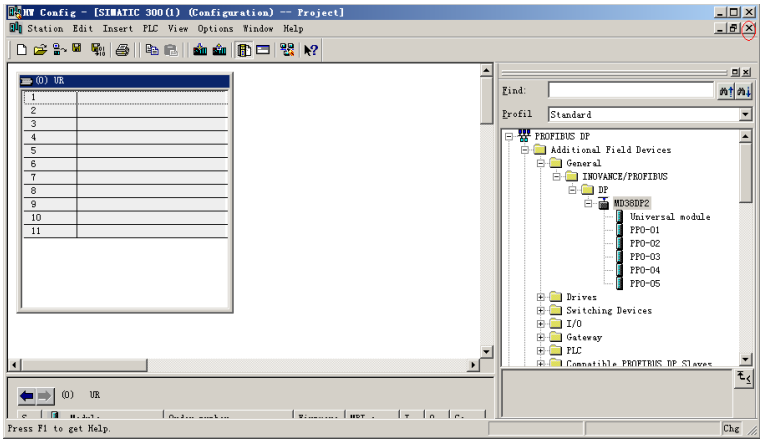




Click **Install**. After the installation is complete, the PROFIBUS DP module named MD38DP2 is displayed.

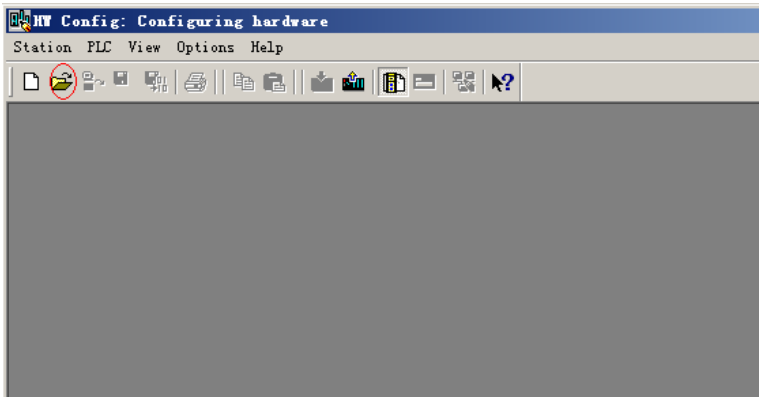


Note: If any master or slave already exists on the **HW.config** interface, close the current interface by clicking the X button (marked with a red circle in the following figure) before importing the GSD file.

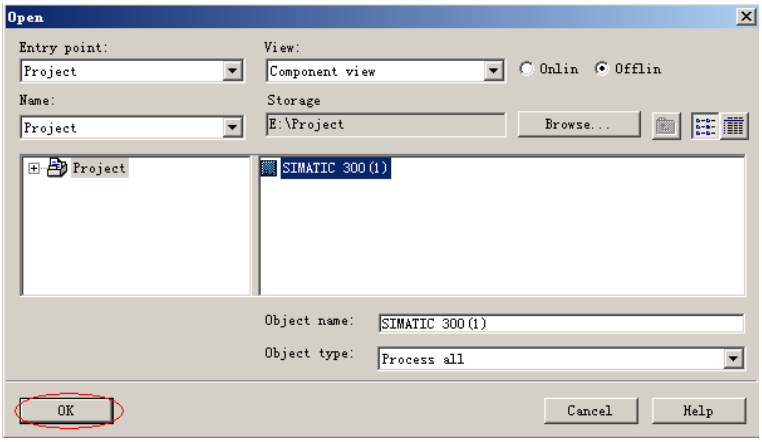


In this case, you can save the existing project. If a warning indicating that system data cannot be created is displayed, click **OK**. After closing the interface of the existing configuration project, you

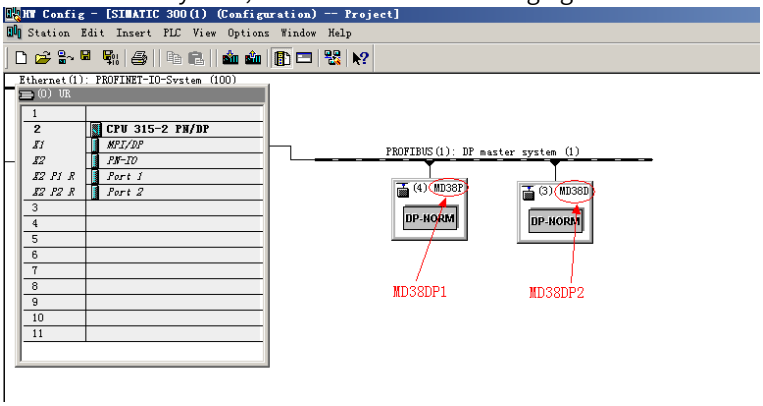
can install the GSD file by following the preceding steps. After the installation is completed, click the Open button, as shown in the following figure.



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

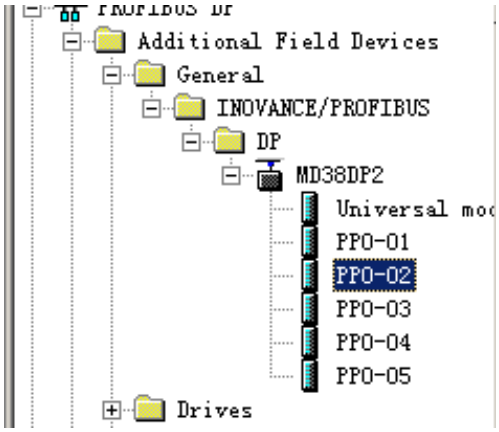


3. Configure the actual hardware system, as shown in the following figure.



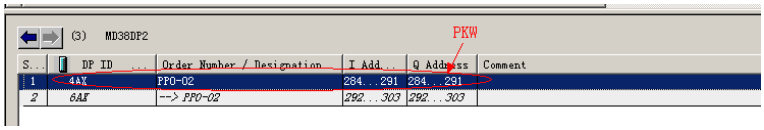
In the preceding figure, station 4 is MD38DP1, which is only used for illustration. For details about its usage, see the MD380 Series PROFIBUS User Guide. MD38DP1 cards and the MD38DP2 cards can be valid on the same network.

4. Configure data features of the slave.



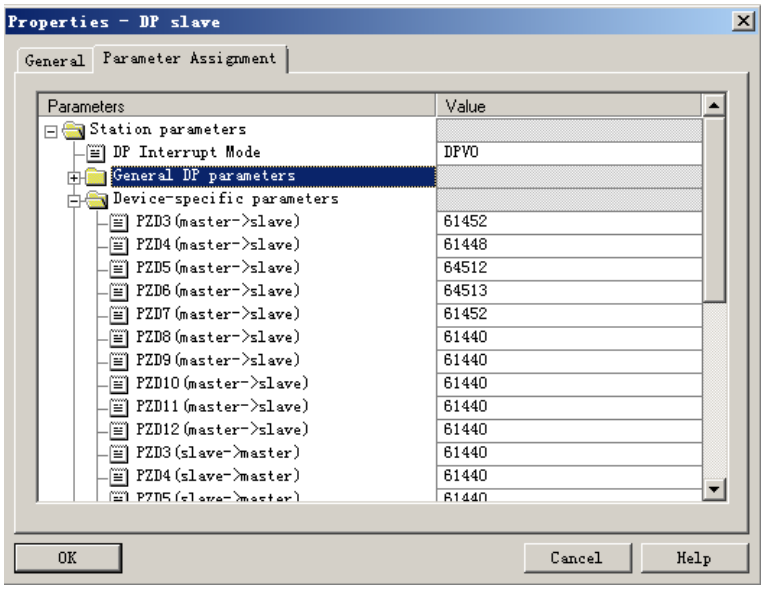
After the PPO type is added, the address assigned by the PLC to the slave is displayed. Slot 1 marked with a red circle in the following figure indicates the PKW address (8 bytes). Slot 2 indicates the PZD address (12 bytes).

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



5. Configure the PZD.

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

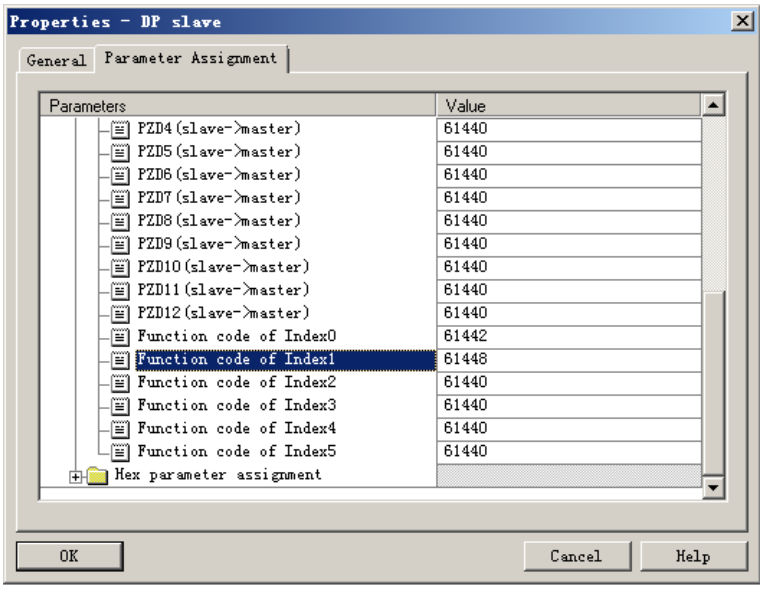


PZDx (master->slave) indicates the address used by the master to write data to the slave, whereas PZDx (slave->master) indicates the address used by the master to read data from the slave. PZD3 to PZD12 are displayed in decimal and can be set. For example, to set PZD3(master->slaver) to F0-12, enter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

By default, all PZDs of the MD520 are set to F0-00 (61440 in decimal). For unused PZDs, modification is not required and default values can be retained. PZD mapping relations must be set independently for each slave as required. If mapping relations of various slaves are the same, you

can select one configured slave, press **Ctrl**+**C**, select the PROFIBUS-DP bus in the configuration, press **Ctrl**+**V**, and modify the station number.

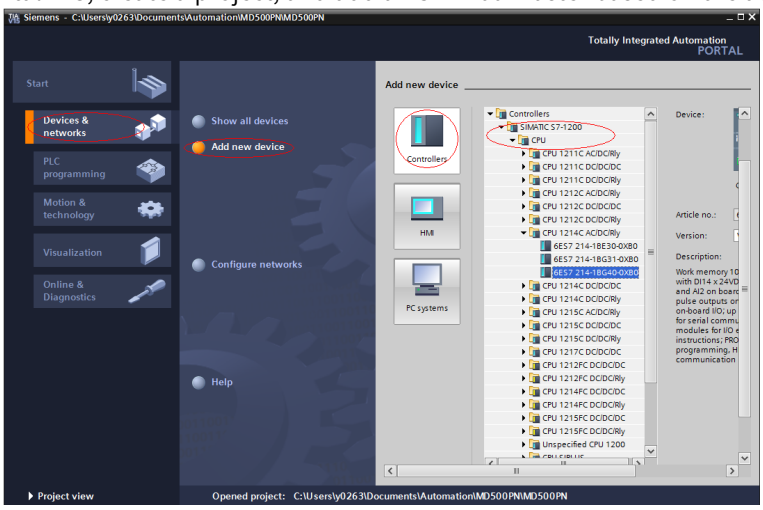
To enable the function of non-periodically reading and writing parameters of DPV1, set corresponding parameters in customized indexes at the end of **Device-specific parameters**. The AC drive provides six customized indexes numbered from 0 to 5. For example, set indexes 0 and 1 to F0-02 and F0-08, respectively.



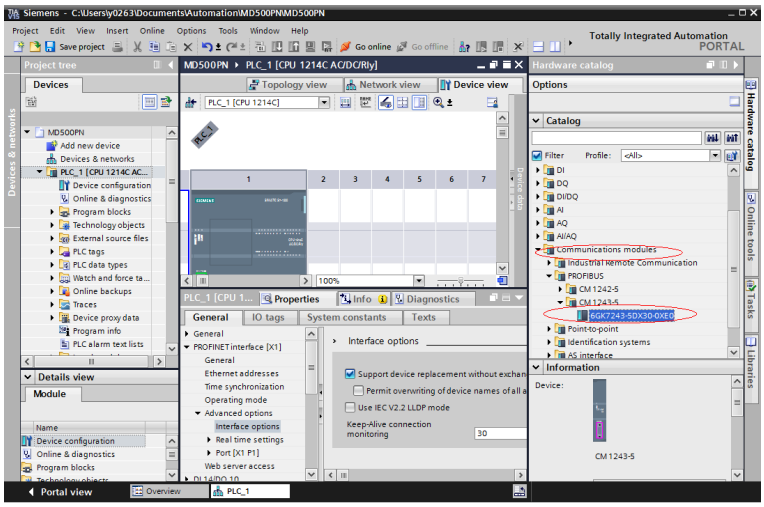
After all the preceding operations are completed, the PROFIBUS slave station is configured. Then, you can compile programs in the S7-300 to control the AC drive.

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

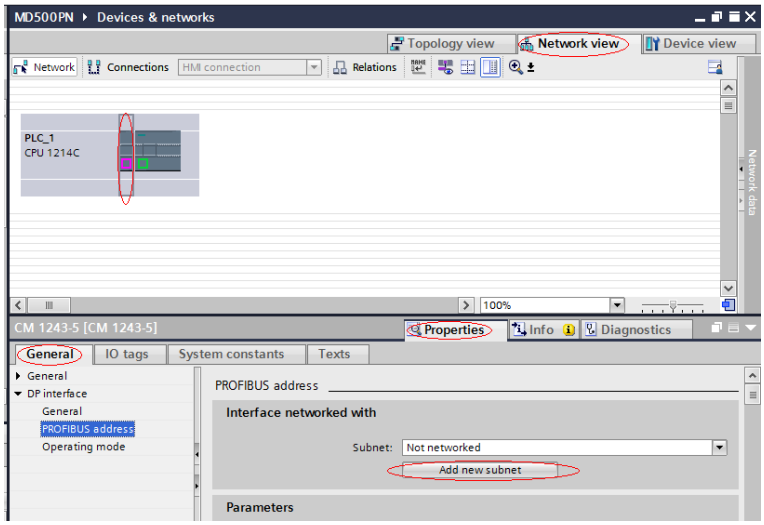
1. Open the TIA Portal V13, create a project, and add an S7-1200 master based on the actual situations.



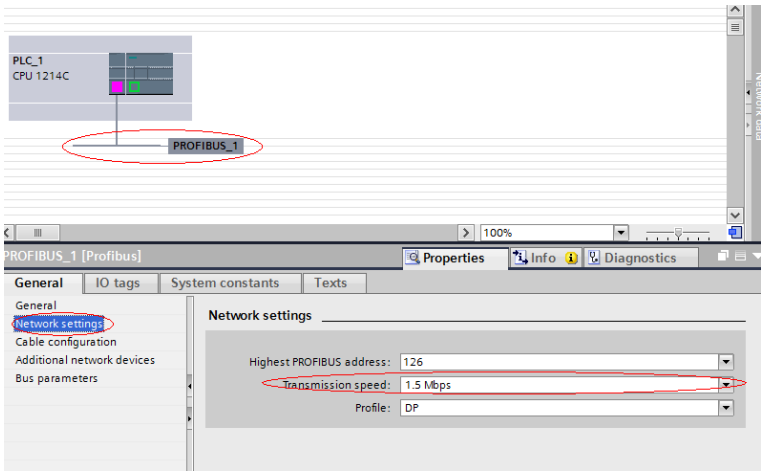
The S7-1200 CPU does not have a PROFIBUS interface, so you need to add a PROFIBUS communication module first. In this example, a CM1243-5 master module is added.



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

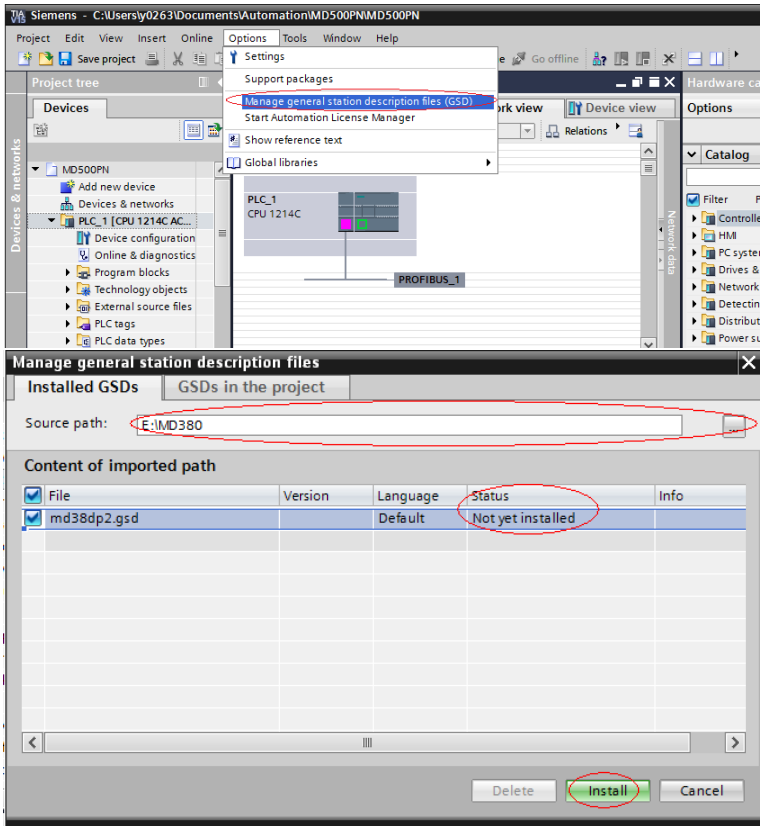


To modify the PROFIBUS baud rate, select the network, and choose **Properties** > **General** > **Network settings**. Select a baud rate from the **Transmission speed** drop-down list.

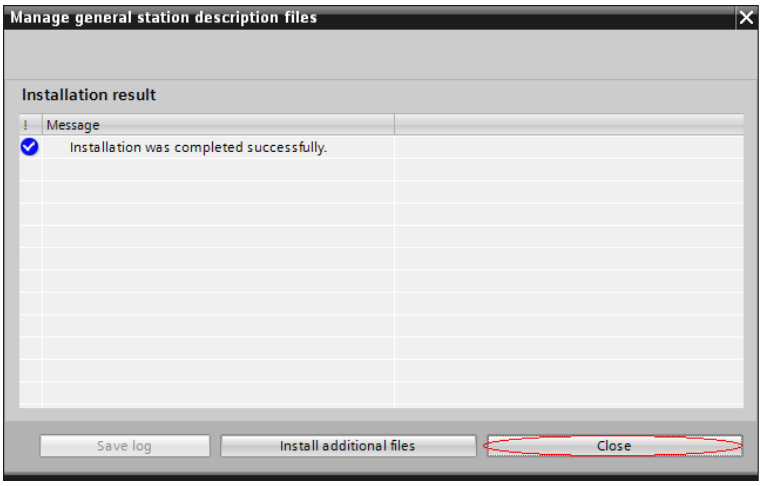


2. Install the GSD file. Skip this step if the GSD file is already installed.

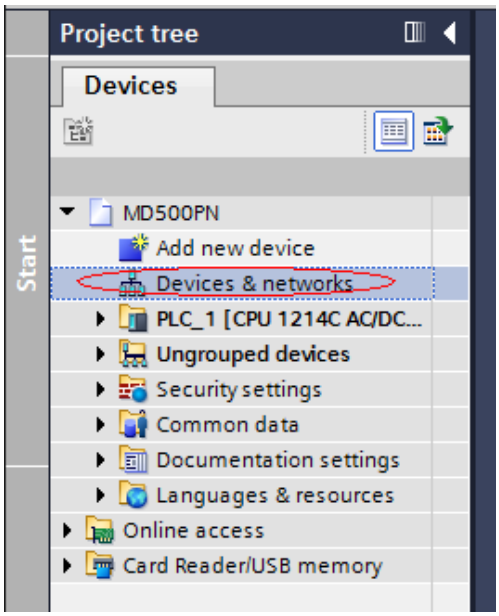
If the GSD file is not installed, the message **Not yet installed** is displayed in the **Status** column. Select the GSD file and click **Install**. Note that an error will occur if the installation path contains Chinese characters.



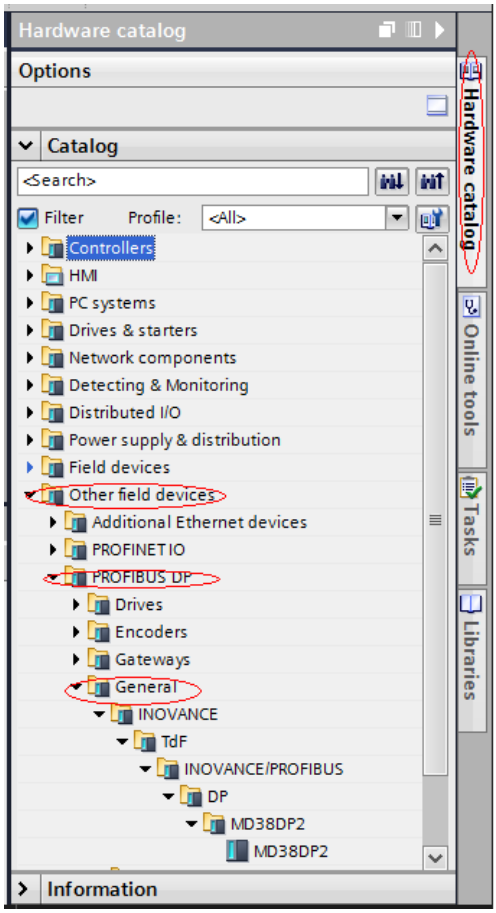
If the following figure is displayed, the installation is complete. In this case, click **Close**.



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

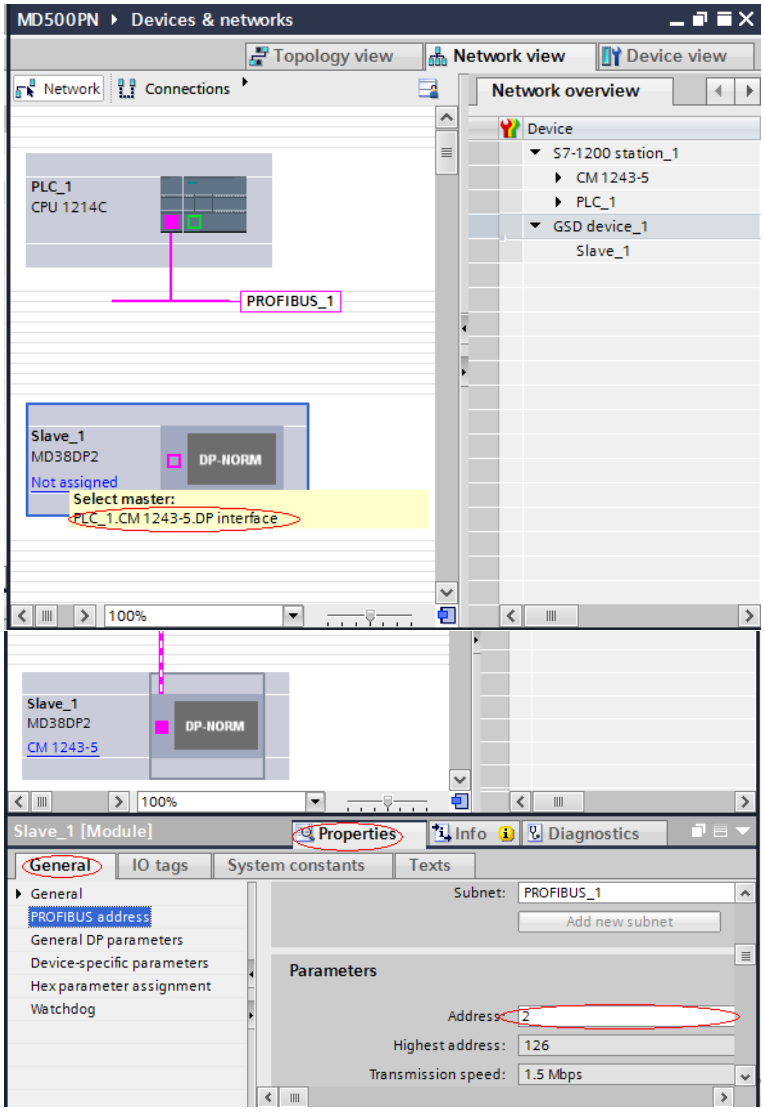


After the installation, you can choose **Hardware catalog** > **Other field devices** > **PROFIBUS DP** > **General** to locate the MD38DP2, which is the same for the STEP7. Expand all the sub-directories as shown in the following figure.

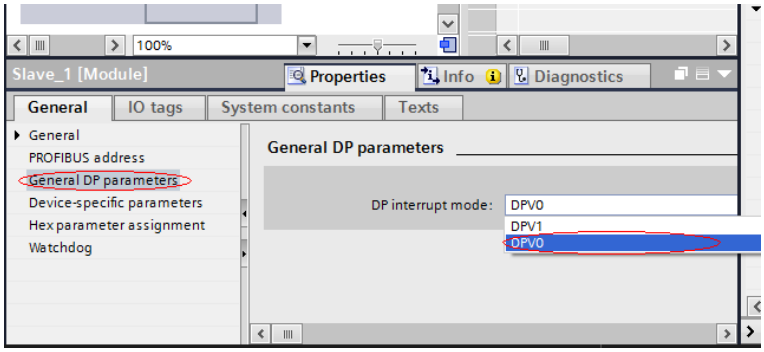


3. Start the configuration.
   On the **Hardware catalog** tab, double-click MD38DP2 or drag it to **Network view** under **Devices & networks**. Click **Not assigned** below the slave name to select the corresponding PROFIBUS

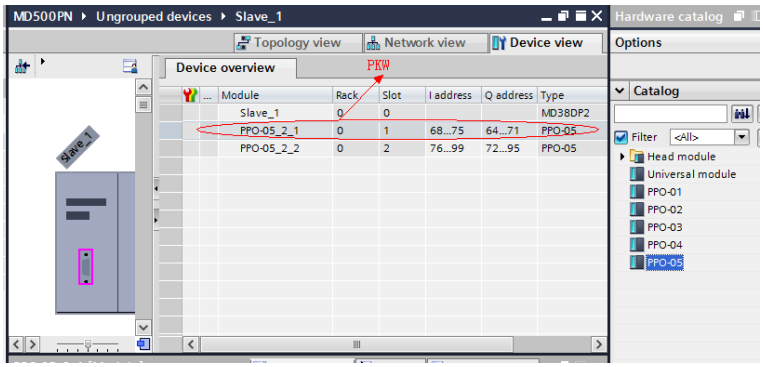
network. Select the slave, choose **Properties** > **General**, and set the slave ID. Note that the setting must be consistent with that set by the DIP switch on the DP expansion card.



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

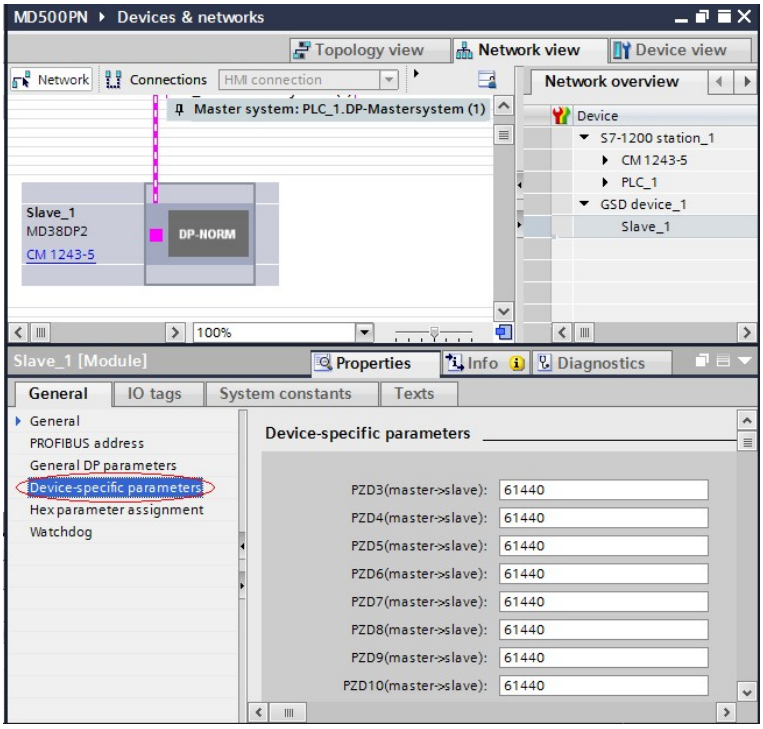


Click the **Device view** tab. Select a suitable PPO type under **Hardware catalog**. Check the addresses assigned for each segment. The row marked with a red circle in the following figure indicates the PKW address. If the selected PPO type has no PKW, the address column is blank.



4. Set PZD mappings.

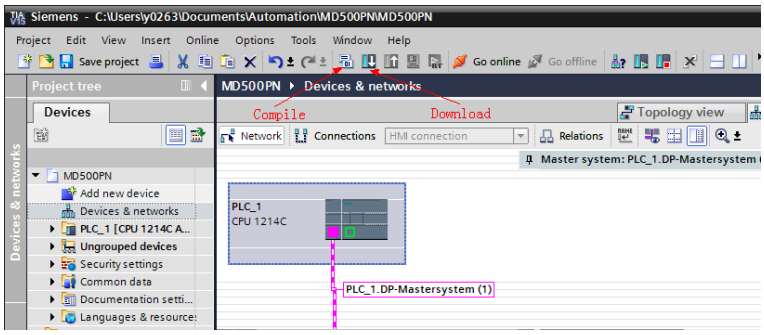
   Click the **Network view** tab. Click **Device-specific parameters** to set the mapping for PZD3 to PZD12. The PZD mapping relationships for the PLC to read data from and write data to the slave must be set independently. For details, see *"27.7.2 Configuring Slaves on the STEP7 (V5.4) by Using S7-300" on page 570*.



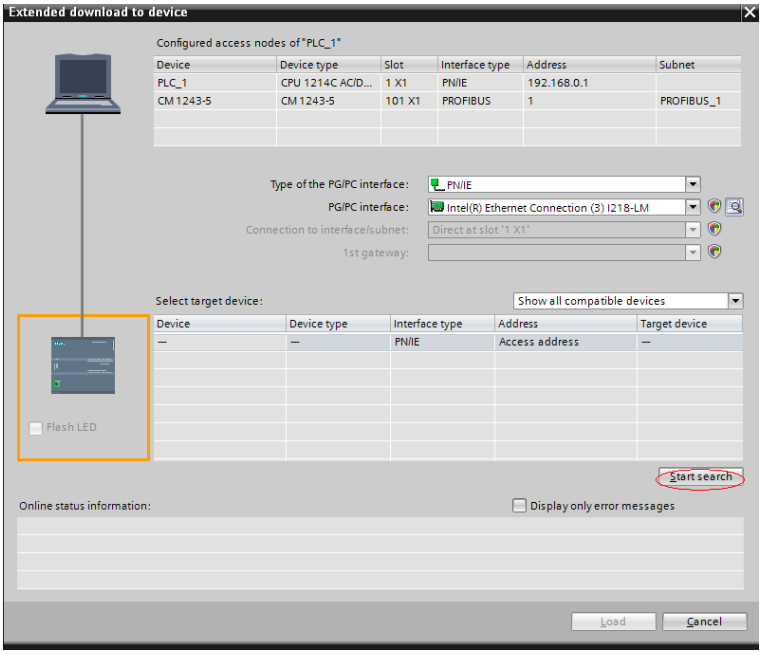
5. Compile and download the configuration.

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

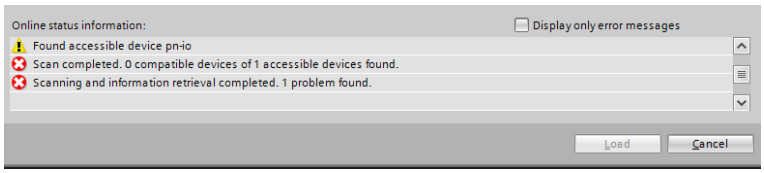
   After all slaves are configured, save the configurations, and then click the **Compile** button. After the compiling is completed successfully, click the **Download** button.



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



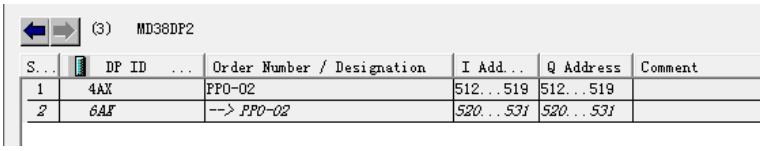
If no accessible device is found, the connection between the PC and PLC is faulty. Rectify the fault first. If the STEP7 is used for downloading through the Ethernet and then the PORTAL is used for downloading on the same PC, the problem also occurs. In this case, restart the PC or change the PG/PC interface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



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

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

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

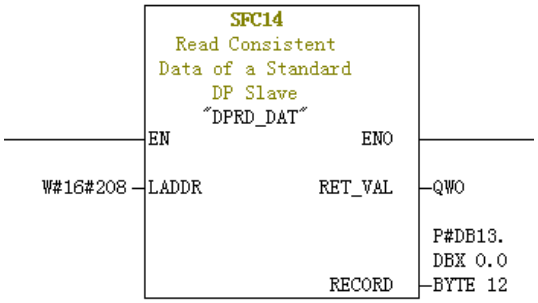


1. Directly use the MOVE command to enable the AC drive to run in the forward direction at the target frequency of 30 Hz (F0-02 = 2, F0-03 = 9), as shown in the following figure.

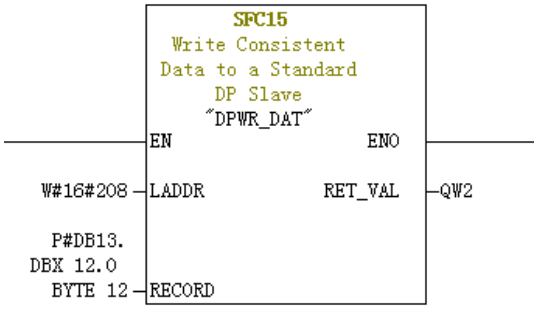


Other data is written in a similar way. The read data can also be transmitted from the PIW register to the common Q, I, L, M, or D register using the MOVE command for parsing.

2. Use SFC14 and SFC15.



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

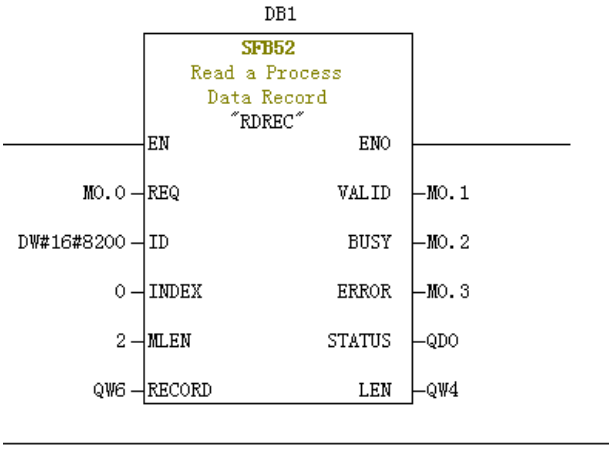


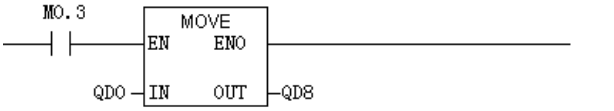
- **LADDR**: Starting address configured in the Q block of the module, which must be in hexadecimal format.
- **RET_VAL**: Return value. If an error occurs during function activation, the return value contains an error code. If no error occurs, 0 is returned.
- **RECORD**: Source area of the user data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

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

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

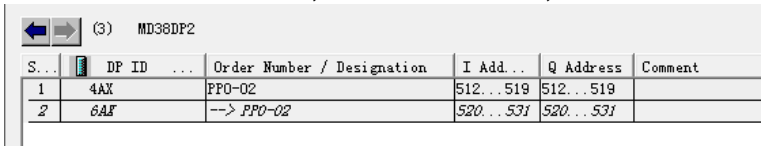
To perform aperiodic read and write operations on the AC drive PROFIBUS DP slave, Siemen's system function modules SFB52 (for reading) and SFB53 (for writing) are required. Create an organization block in the program, and add relevant function blocks and programs in the organization block.





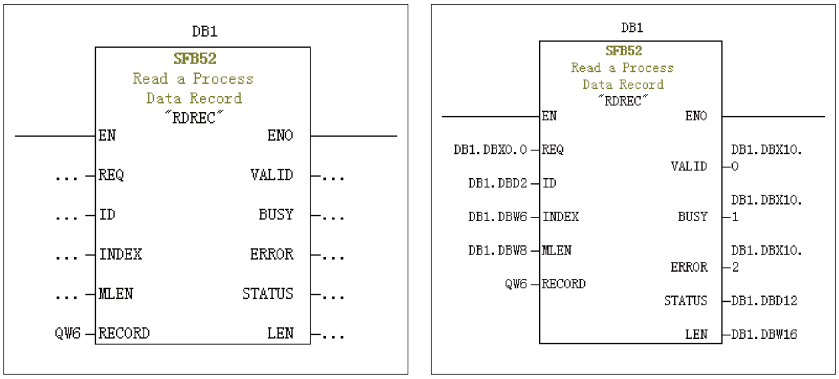
After M0.0 is set, the function block reads F0-02 (Index 0 has been set to F0-02) of the AC drive No. 3 and saves it in QW6. Field definitions are as follows:

- REQ: It is used to enable or disable the function block. When it is set to 1, the function block is enabled.
- ID: It indicates the logic address. To specify this field, convert any bit in the Q address of the AC drive slave station to a hexadecimal value, and set bit 15 of the value to 1. For example, after Q512 is converted to the hexadecimal value H200, and bit 15 is set to 1, H8200 is obtained.



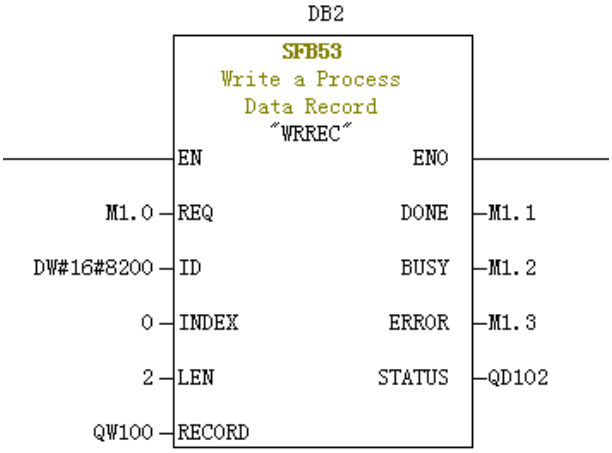
- INDEX: It is an index number ranging from 0 to 5. You can define the index mapping address of a slave as required.
- MLEN: It indicates the maximum length of the data to be obtained. For MD38DP2, this field must be set to 2.
- RECORD: It indicates the target area of an obtained data record. This field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

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



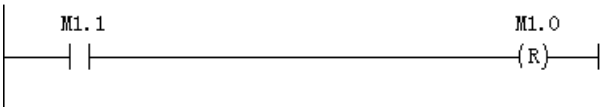
The left figure shows all the default parameters. If you want to customize parameters, set them according to the right figure. You can set customized or default parameters for corresponding blocks as required.

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



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

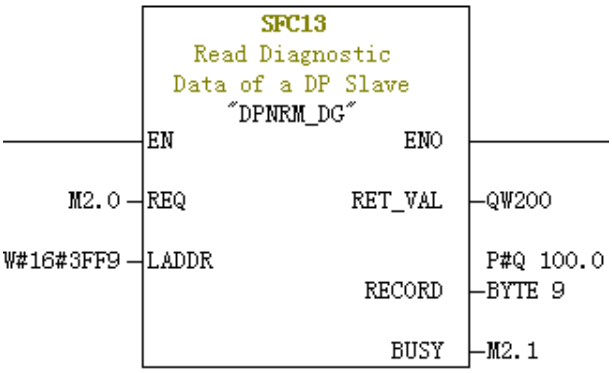
SFB53 is used to perform operations on the EEPROM. Therefore, the program is required to invoke relevant operations when required and disable relevant operations in time. As shown in the following figure, after the write operation is complete (M1.1 is set to 1), the program is invoked to reset M1.0.



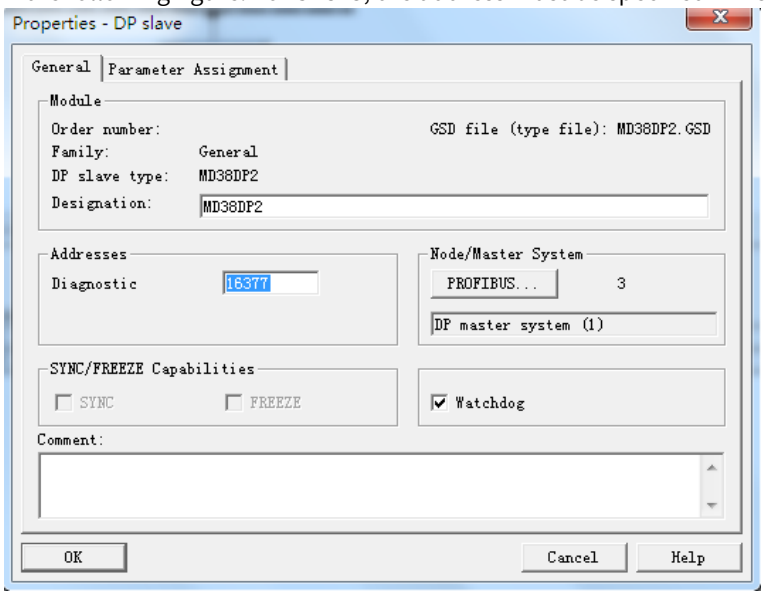
When SFB52 and SFB53 are executed once, relevant blocks need to be invoked for multiple times. Therefore, do not invoke them when single execution is required.

27.7.6 Diagnosis

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



- REQ: It is used to enable or disable diagnosis information reading. When this field is set to ON, diagnosis information reading is enabled.
- LADDR: It indicates the configured diagnosis address of the PROFIBUS DP slave station. The actual value is shown in the following figure. For SFC13, the address must be specified in hexadecimal.



- RET_VAL: It displays the error code (negative) when invocation errors occur or the actual transmitted data length (positive) when no error occurs.
- RECORD: It indicates the target area of the read diagnosis data. The value must be 9 bytes. Otherwise, an error is reported during invocation. The nine bytes are defined as follows:
  Bytes 0 to 2: Station status

  Byte 3: Master number

  Byte 4: Supplier ID (high-order byte)

  Byte 5: Supplier ID (low-order byte)

  Byte 6: Dedicated device diagnosis length (fixed to 3)

  Byte 7: Dedicated device diagnosis (high-order byte)

Byte 8: Dedicated device diagnosis (low-order byte)

- BUSY: When this field is **1**, reading is not complete.
  Device-specific diagnosis provides relevant AC drive fault information, which is consistent with the value of U0-62. When the communication between the DP expansion card and AC drive is interrupted, 0x34 is returned.

27.8 Troubleshooting

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

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

<table>
<tr><th colspan="2">Description</th><th>Solution</th></tr>
<tr><td rowspan="4">After the connection is successful, all indicators on the PLC are on in green, but data cannot be written into or read from the AC drive.</td><td>No data can be written/ read.</td><td>Check whether the operation address is correct. No matter whether the PPO type used contains the PKW zone, the read/write operation address always locates in the second row (that is, the last row). If the I address and Q address in the last row of the station are both 520 to 531 (note that the I and Q addresses may start from different numbers), the PZD1 data written into the AC drive is stored in QW520, the PZD2 data written into the AC drive is stored QW522, and so on. If the PLC is S7-300 and S7-400, PQW is used. If SFC15 is used, check whether RET_VAL of the SFC15 block is 0. If not, an invocation error exists. Eliminate this error first and invoke the block again. For details, see section "Performing Periodic Read/ Write Operations on the AC Drive Slave".</td></tr>
<tr><td>PZD3 or subsequent data can be written, but PZD1 or PZD2 cannot be written/read.</td><td>Check whether F0-02 and F0-03 are set to 2 and 9, respectively. Check whether the command reference is in the range of 1 to 7 (not bit) or frequency reference is in the range of -F0-10 to +F0-10. If not, the write operation fails. Check whether FE-00 and FE-01 are U3-17 and U3-16, respectively. If not, manually correct the parameter values or restore to factory settings.</td></tr>
<tr><td>PZD1 and PZD2 can be written/read, while PZD3 or subsequent data cannot be written/ read.</td><td>Check whether the PPO type supports the relevant PZD. Check whether device-specific parameters are set correctly.</td></tr>
<tr><td>-</td><td>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).</td></tr>
<tr><td colspan="2">After communication is established, the AC drive reports E164.1, which cannot be cleared. However, the indicator on the DP expansion card and the BF indicator on the PLC are normal.</td><td>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.</td></tr>
<tr><td colspan="2" rowspan="2">After communication is established, the communication is normal when the AC drive is not running. However, when one or more AC drives are running, they are disconnected randomly.</td><td>1. Disconnect the power supply. Use a multimeter to measure the A1/B1 resistance of the DP slave station interface at the farthest end. The correct resistance should be 100±20 Ω.</td></tr>
<tr><td>2. Check that the cable shields are connected together and the shields are in contact with the sheet metal in the DP interface. The shields are not required to connect with other GND terminals.</td></tr>
<tr><td colspan="2">After the connection is established, the AC drive reports a fault. After the PLC configuration is changed and downloaded again or after the AC drive alone is powered on again, the faulty slave still cannot connect to the network.</td><td>The DP expansion card supports only the interruption mode DPV0. If the interruption mode is set to DPV1, when a slave is faulty, the PLC master may disable the DP connection channel of the slave or disable all the PLC communication (which usually occurs on the S7-1200). When such a symptom occurs, change the DP interruption mode (which is DPV0 by default in STEP 7 and DPV1 by default in PORTAL) of the slave to DPV0 under General DP parameters. Then, compile and download the configuration, and power on the PLC again.</td></tr>
</table>

Indicator status of the DP expansion card and troubleshooting

Table 27–2

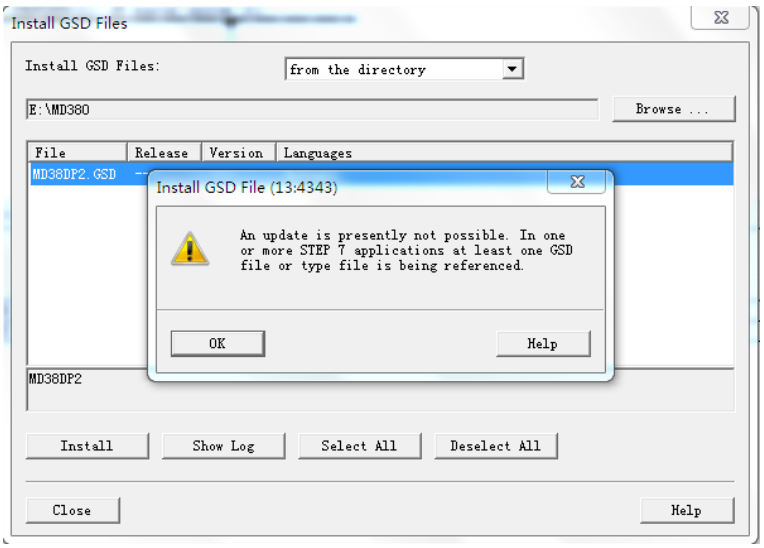
Indicator[Note]	Fault Status	Description	Solution
Red (D4)	Off	The DP expansion card is not powered on.	Check that the DP card is securely connected to the AC drive.
Green (D2)	Off	The connection between the DP expansion card and the AC drive fails.	Check that F0-28 is set to 1 and the DP expansion card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

Note

Note 1: For some products, the indicator color and the terminal indication may not match. In this case, the terminal indication prevails. The indicators are D2, D3, and D4 from left to right. See *"Figure 27–3" on page 558* .

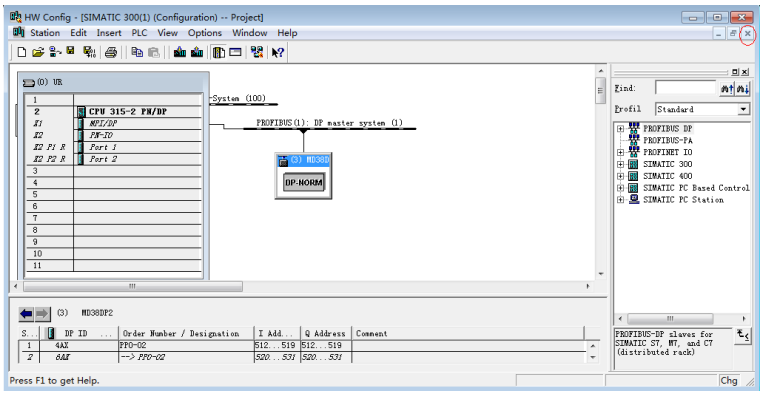
Troubleshooting for GSD installation failure

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

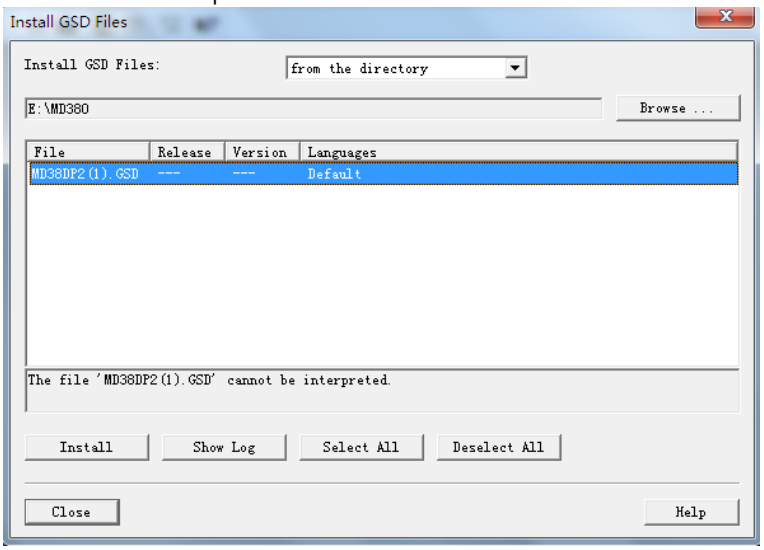


Possible cause: The current hardware configuration interface is opened and the GSD file is being used by other components.

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



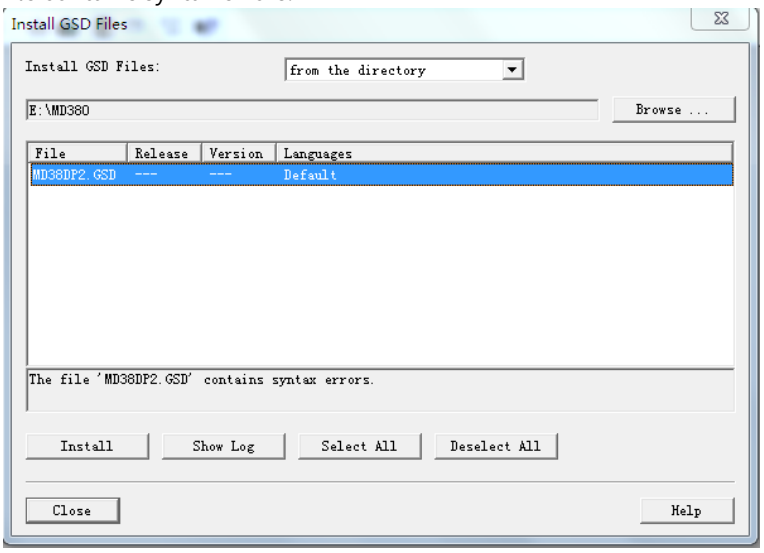
- Problem 2: The file cannot be interpreted.



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

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

- Problem 3: The file contains syntax errors.



Possible cause: The GSD file is modified.

Solution: Use a correct GSD file.

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

28 Ethernet/IP Communication (MD500-EN1)

28.1 Introduction

As an EtherNet/IP fieldbus adapter that complies with international EtherNet/IP bus standards, the MD520 series EtherNet/IP communication expansion card (MD500-EN1 card for short) features high efficiency, flexible topology, and easy operation. It is installed in the MD series AC drive to improve the communication efficiency and implement the AC drive networking function, which enables the AC drive to be a slave controlled by the field bus master station.

This user guide is applicable to the MD500-EN1 card with the software version of 1.00 or later. You can query the version by viewing the parameter U0-67 of the AC drive after the card is installed and the drive is powered on. The corresponding EDS file is MD500P_EIP_V1.00.eds.

28.2 Installation

The MD500-EN1 card is embedded in the MD520 series AC drive. Before installation, cut off the power supply of the AC drive and wait at least 10 minutes until the charging indicator of the AC drive becomes off. Then, insert the MD500-EN1 card into the AC drive and fasten the screws to prevent the signal socket between boards from being damaged by external signal cable tension. The following figure describes the installation of the card.

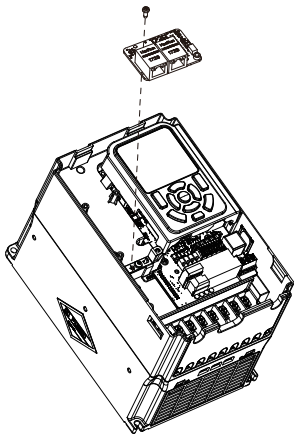


Figure 28-1 MD500-EN1 card installation

Note that the ground terminals of both the MD500-EN1 card and AC drive must be connected properly, as shown in *"Figure 28–2 Connecting ground terminals of the MD500-EN1 card and AC drive" on page 591*.

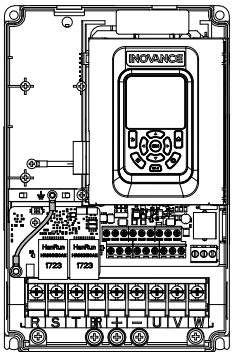


Figure 28-2 Connecting ground terminals of the MD500-EN1 card and AC drive

28.3 Interface Description

Terminal layout

"Table 28–1" on page 591 shows the hardware layout of the MD500-EN1 card. The pin header J7 on the back of the MD500-EN1 card is used to connect the drive. The MD500-EN1 card provides two Ethernet ports J4 and J6 to enable the card to communicate with the EtherNet/IP master (or other slaves). For details about the hardware, see *"Table 28–1" on page 591*.

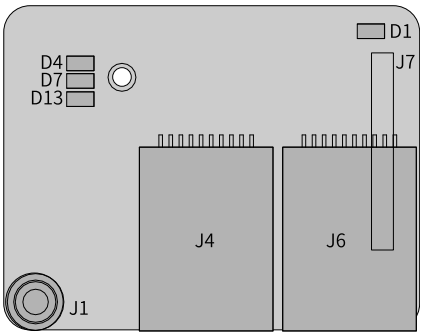


Figure 28-3 MD500-EN1 card terminal layout

Interface description

Table 28–1 Descriptions of MD500-EN1 card terminals

Terminal Mark	Terminal Name	Description
J7	Pin header	It is used to connect the AC drive.
J4	Network port	The ports are standard Ethernet RJ45 ports and are direction-insensitive. The MD500-EN1 card uses the ports to communicate with the EtherNet/IP master (or other slaves). The pin definition is consistent with the standard Ethernet pin definition. The crossed or straight cables are supported.
J6		
J1	EMC grounding terminal	It is used to connect the EMC grounding terminal of the AC drive.

Terminal Mark	Terminal Name	Description
D13	Power supply indicator (green)	It is used to indicate the status of the power supply. On: Normal OFF: Abnormal. Check whether the card is installed properly.
D1	Status indicator of communication with the AC drive (green)	For details, see *"Table 28–2 Indicators of the MD500-EN1 card" on page 592*.
D4	Ethernet/IP master running indicator (green)	
D7	Ethernet/IP master fault indicator (red)	

Caution

- After the MD500-EN1 card is installed, J2 is on the left and J3 is on the right when you face the RJ45 interface. J2 and J3 are direction-insensitive. You can connect either one to the PLC.
- It is recommended to use shielded Cat 5e twisted pair cables to ensure stable operation.

Status indicators

Table 28–2 Indicators of the MD500-EN1 card

Indicator	Status	Solution
D1 (green): steady on	Normal	None
D1 (green): off	Abnormal communication with the AC drive	Check that FD-00 is set to 9 and FD-01 is set to 3.
D4 (green): off; D7 (red): steady on	System fault	See the following AC drive fault codes and solutions.
D4 (green): off; D7 (red): blinking	Waiting for obtaining IP address	The DHCP function is enabled, and the expansion card is waiting for IP address assignment by using the BOOTP or DHCP.
D4 (green): blinking; D7 (red): blinking	Connection disconnected or timed out	Check whether the network cable is disconnected and whether the master is running.
D4 (green): blinking; D7 (red): off	Waiting for connecting to the master	Check whether the network cable is properly connected and whether the master is running.
D4 (green): steady on; D7 (red): off	Normal	None

28.4 Networking Topology

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

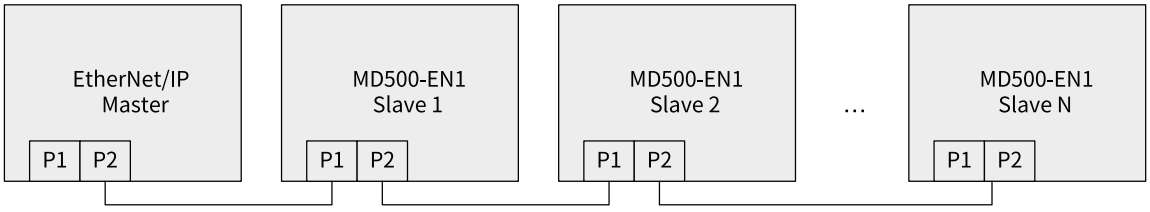


Figure 28-4 Bus topology

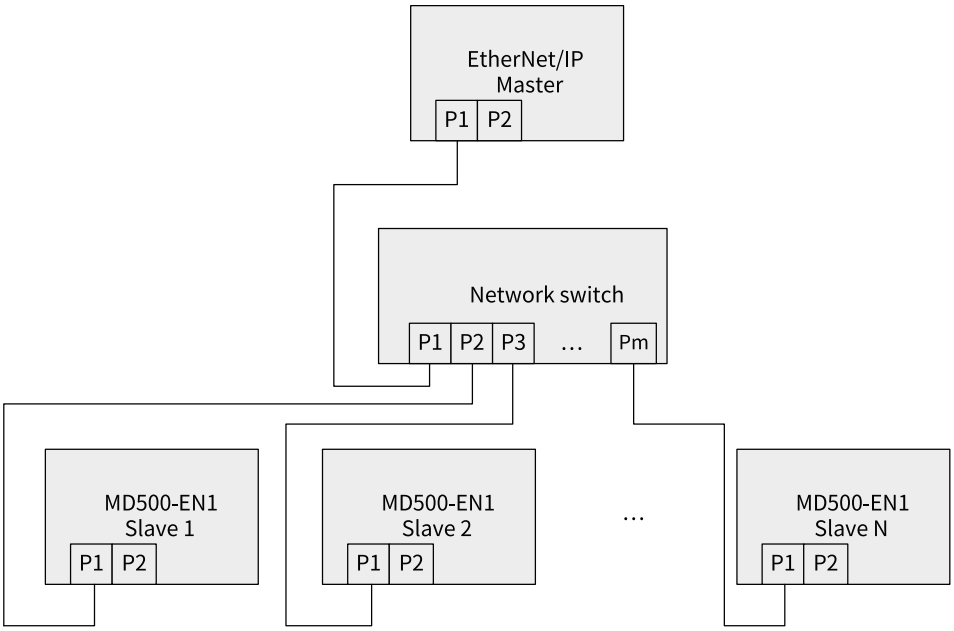


Figure 28-5 Star topology

28.5 Device Level Ring Protocol

The device level ring (DLR) protocol is the second layer protocol of the OSI. It is mainly used for EtherNet/IP devices with multiple Ethernet ports and embedded switch technologies. The DLR protocol provides quick network fault detection and re-configuration functions, and provides configuration and diagnostic interfaces (DLR Object) for EtherNet/IP devices. When the DLR protocol is used, at least one ring network manager exists in the network topology.

The MD500-EN1 card acts as the node of the DLR-based beacon frame in the ring network. When the MD500-EN1 card detects a ring network topology fault or detects that the ring network topology recovers, the switchover between the ring network and the linear network can be completed within 1 ms.

To use the DLR protocol for networking, do the following:

1. Connect the MD500-EN1 card and EtherNet/IP master to form a linear network.
2. Enable the ring network manager function of the EtherNet/IP master.
3. Connect the MD500-EN1 card and EtherNet/IP master to form a ring topology.

Note the following:

1. The MD500-EN1 card with the version V1.12 or later supports the DLR protocol. Therefore, ensure that the software version of the MD500-EN1 card is V1.12 or later.
2. When networking by the DLR protocol, enable or keep the ring network manager function of the EtherNet/IP master station enabled before connecting to the ring network. If the ring network manager function of the EtherNet/IP master is enabled after the ring network is formed, the network link may be fully loaded and communication faults may occur.
3. When the MD500-EN1 card is used for ring networking, non-DLR devices that meet the following conditions are allowed for networking:
   - Non-DLR devices that disable unicast MAC address learning or do not use MAC address learning

- Non-DLR devices that disable the multicast MAC address filtering function of the networking port
- Non-DLR devices that support receiving 802.1 Q Ethernet frame and retaining the VLAN field
- Non-DLR devices that forward VLAN fields according to the priority to prevent ring network performance from being affected

4. When the switch is used for networking, the DLR switch is preferred. Using a non-DLR switch may result in the loss of unicast frames for a period of time after the loop fails or recovers until the MAC learning table of the switch is re-established. To avoid this, non-DLR switches that meet the following conditions can be used:

   - The static unicast MAC address is configured.
   - Unicast MAC learning is disabled for the switch.
   - The non-DLR switch is connected to a multi-port DLR device (such as a 3-port DLR switch), and the multi-port DLR device is connected to the ring network.

28.6 Communication Protocol

28.6.1 I/O Messages

The MMD500-EN1 expansion card supports 24 I/O messages for data transmission, of which 12 messages are sent from the master to slave and 12 messages are sent from the slave to the master.

The I/O messages enable the master to modify and read AC drive data in real time and perform periodic data exchange. The data communication addresses are directly configured by the AC drive. The specific functions are as follows:

- Real-time settings of AC drive control commands and target frequencies
- Real-time reading of AC drive current state and running frequency
- Real-time exchange of function parameters and monitoring parameters between the AC drive and EtherNet/IP master
  The I/O message data is used for periodic data exchange between the master and the AC drive, as described in the following table.

I/O Messages (O->T) Sent by Master		
AC drive command	AC drive target frequency	Real-time modification of AC drive function parameters
Output I/O Messages[0]	Output I/O Messages[1]	Output I/O messages 2 to 11
I/O messages (T->O) Returned by AC Drive		
AC drive state	AC drive running frequency	Real-time reading of AC drive function parameters
Input I/O Messages[0]	Input I/O Messages[1]	Input I/O messages 2 to 11

28.6.2 Data Sent by the Master

The following table describes the data sent by the master.

I/O Message Data Sent by the Master		
I/O Messages 0	AC drive command word (command source set to communication)	
	00: Stop according to the stop mode defined by F6-10; 01: Run in forward direction; 02: Run in reverse direction; 03: Jog in forward direction;	04: Jog in reverse direction; 05: Coast to stop; 06: Stop according to the stop mode defined by F6-10; 07: Reset upon fault
I/O Messages 1	It indicates the AC drive target frequency (frequency source set to communication), which ranges from the reverse frequency upper limit (negative value) to forward frequency upper limit (decimal places included, for example, 2000 corresponds to 20.00 Hz on the AC drive). When the target frequency exceeds this range, the AC drive runs at the frequency upper limit.	
I/O Messages 2 to I/O Messages 11	Function parameter values (group F and group A) are modified in real time, which are not written into the EEPROM. FE-02 to FE-11 correspond to I/O Messages 2 to I/O Messages 11. For details about the configuration, see the I/O message data configuration.	

28.6.3 Data Returned by the AC drive

The following table describes the data returned by the AC drive.

I/O Message Data Returned by the AC Drive	
I/O Messages 0	It indicates the AC drive state, which is described as follows by bit: Bit 0: 0: Stopped; 1: Running Bit 1: 0: Running in forward direction; 1: Running in reverse direction Bit 2: 0: Not faulty; 1: Faulty Bit 3: 0: Running frequency not reached; 1: Running frequency reached Bit 4 to bit 7: Reserved Bit 8 to bit 15: AC drive fault code
I/O Messages 1	It indicates the AC drive running frequency (unit: 0.01 Hz). The current AC drive running frequency is returned as 16-bit signed data.
I/O Messages 2 to I/O Messages 11	Function parameter values (group F and group A) and monitoring parameter values (group U) are read in real time. FE-22 to FE-31 correspond to I/O Messages 2 to I/O Messages 11. For details about the configuration, see the I/O message data configuration.

28.7 Parameters

28.7.1 Communication Card Type Setting

After powering on the AC drive, set F0-28 to 1 to enable communication between the MD500-EN1 card and the AC drive.

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

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

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

28.7.2 IP Address Setting of MD500-EN1 Card

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

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

Parameter Code	Parameter Name	Value Range	Description
FD-42 to FD-45	Expansion card subnet mask	0-255	These parameters define the subnet mask of the EtherNet/ IP expansion card.
FD-46 to FD-49	Expansion card gateway IP address	0-255	These parameters define the gateway address of the EtherNet/IP expansion card.

The IP address can be a static one or dynamic one assigned by DHCP function. The IP address type is selected by FD-37. The static IP address is set by FD-37 to FD-49. For example, if the static IP address is 192.168.0.6, the subnet mask is 255.255.255.0, and the gateway IP address is 192.168.0.1, set parameters as follows:

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

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

The expansion card also supports the IP address conflict detection function. When the IP address of this card is the same as that of another device in the network, the red indicator D7 becomes steady on, and bit 2 of FD-58 changes to 1.

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

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

Note

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

28.7.3 Parameters Related to AC Drive Communication Card

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

28.7.4 Communication Control Parameters

Parameter Code	Parameter Name	Value Range		Decimal Address
U3-16	Frequency set through communication	-320.00 Hz to 320.00 Hz		29456
U3-17	Communication setting control word	0001: Forward run 0002: Reverse run 0003: Forward jog 0004: Reverse jog	0005: Coast to stop 0006: Decelerate to stop 0007: Reset upon fault	29457
U3-18	DO state (terminal function defined by parameters in group F5: communication control)	Bit 0: DO1 output control Bit 1: DO2 output control Bit 2: Relay 1 output control Bit 3: Relay 2 output control Bit 4: FMR output control	Bit 5: VDO1 Bit 6: VDO2 Bit 7: VDO3 Bit 8: VDO4 Bit 9: VDO5	29458
U3-19	AO1 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29459
U3-20	AO2 output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29460
U3-21	HDO output (terminal function defined by parameters in group F5: communication control)	0 to 32767		29461
U3-22	Communication card error state	0 to 65535		29462
U3-23	Speed set through communication	-32000 rpm to 32000 rpm		29463

When the MD500-EN1 card is used, the written I/O Messages0 and I/O Messages1 are mapped to U3-17 and U3-16 respectively by default. If a command or frequency fails to be written into the AC drive while I/O Messages2 to I/O Messages11 can be written and F0-02 and F0-03 are set to 2 and 9 respectively, check whether FE-00 and FE-01 are U3-17 and U3-16 respectively. If not, manually correct the parameter values.

28.7.5 Communication Monitoring Parameters

Table 28–3 Communication monitoring parameters

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-00	Operating frequency	0.01 Hz	28672
U0-01	Frequency reference	0.01 Hz	28673
U0-02	Bus voltage	0.1 V	28674
U0-03	Output voltage	1 V	28675
U0-04	Output current	0.1 A	28676
U0-05	Output power	0.1 kW	28677

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-06	Output torque	0.1%	28678
U0-07	DI input state	1	28679
U0-08	DO output state	1	28680
U0-09	AI1 voltage	0.01 V	28681
U0-10	AI2 voltage	0.01 V	28682
U0-11	AI3 voltage	0.01 V	28683
U0-12	Count value	1	28684
U0-13	Length value	1	28685
U0-14	Load speed display	1	28686
U0-15	PID reference	1	28687
U0-16	PID feedback	1	28688
U0-17	PLC stage	1	28689
U0-18	Pulse input frequency	0.01 kHz	28690
U0-19	Feedback speed	0.01 Hz	28691
U0-20	Remaining running time	0.1 min	28692
U0-21	AI1 voltage before calibration	0.001 V	28693
U0-22	AI2 voltage before calibration	0.001 V	28694
U0-23	AI3 voltage before calibration	0.001 V	28695
U0-24	Motor speed	1 rpm	28696
U0-25	Current power-on time	1 min	28697
U0-26	Current operating time	0.1 min	28698
U0-27	Pulse input frequency	1 Hz	28699
U0-28	Communication setpoint	0.01%	28700
U0-29	Encoder feedback speed	0.01 Hz	28701
U0-30	Display of main frequency X	0.01 Hz	28702
U0-31	Display of auxiliary frequency Y	0.01 Hz	28703
U0-32	Memory address view	1	28704
U0-33	Synchronous motor rotor position	0.1°	28705
U0-34	AI3 temperature mode - motor temperature	1°C	28706
U0-35	Target torque	0.1%	28707
U0-36	Resolver position	1	28708
U0-37	Power factor angle	0.1°	28709
U0-38	ABZ position	1	28710
U0-39	Target voltage upon V/f separation	1 V	28711
U0-40	Output voltage upon V/f separation	1 V	28712
U0-45	Fault subcode	1	28717
U0-58	Number of motor revolutions	1	28730
U0-59	Frequency reference	0.01%	28731

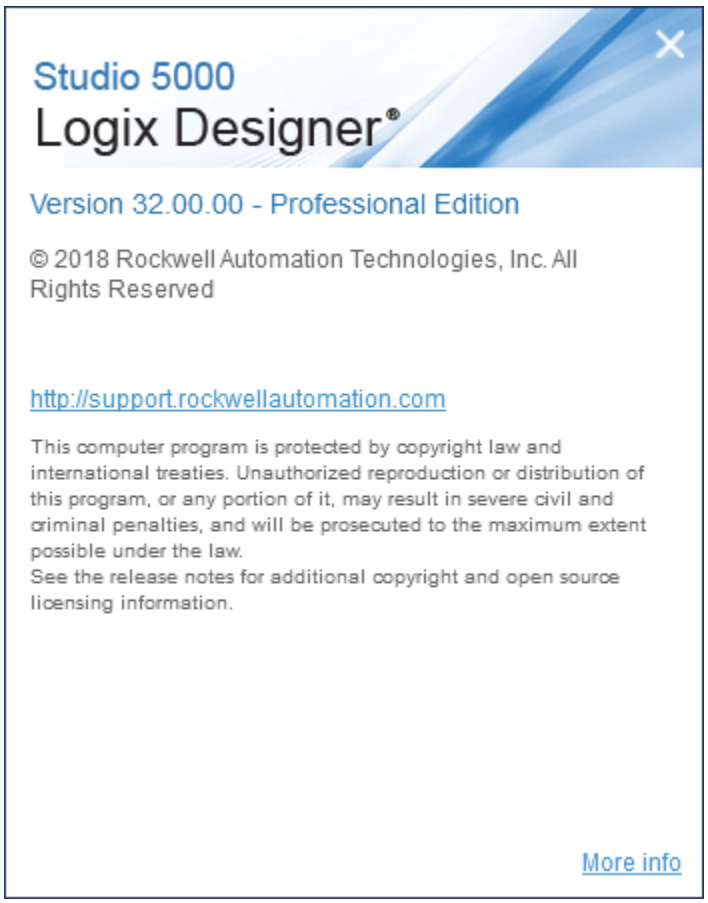
Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-60	Operating frequency	0.01%	28732
U0-61	AC drive state	1	28733
U0-62	Current fault code	1	28734
U0-63	Torque sent in point-to-point communication	0.01%	28735
U0-64	Number of slaves in master-slave control	1	28736
U0-65	Torque upper limit	0.1%	28737
U0-66	Model of communication expansion card	100: CANopen 200. PROFIBUS DP 300: CANlink 400. PROFINET 500: EtherCAT 600: EtherNet/IP	28738
U0-67	Software version of communication extension card	1	28739
U0-68	AC drive state read through DP card	1	28740
U0-69	Frequency read through communication expansion card	0.01 Hz	28741
U0-70	Speed read through communication expansion card	1 rpm	28742
U0-71	Communication card-specific current	0.1 A	28743
U0-80	EtherCAT slave name	1	28752
U0-81	EtherCAT slave alias	1	28753
U0-83	EtherCAT XML file version	1	28755
U0-84	Number of lost EtherCAT synchronization frames	1	28756
U0-85	Maximum number of error frames and invalid frames over EtherCAT port 0 per unit time	1	28757
U0-86	Maximum number of error frames and invalid frames of EtherCAT port 1 per unit time	1	28758
U0-87	Maximum number of error frames forwarded by EtherCAT port per unit time	1	28759

Parameter Code	Parameter Name	Min. unit	Decimal Address
U0-88	Maximum number of error frames processed by EtherCAT data frame processing unit per unit time	1	28760
U0-89	Maximum number of lost links over the EtherCAT port per unit time	1	28761

28.8 Configure communication parameters.

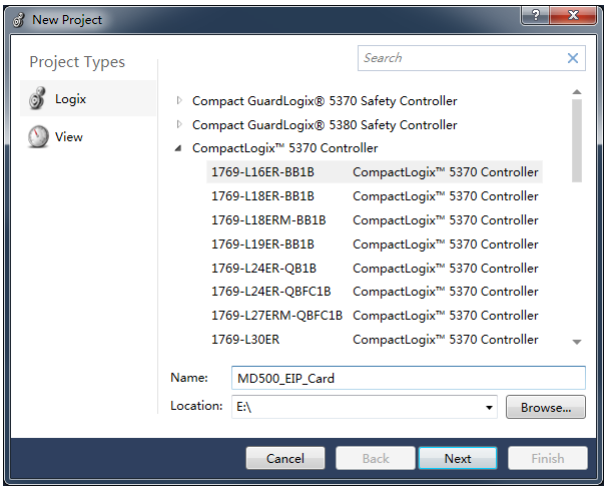
28.8.1 Using an MD500-EN1 Expansion Card on an Allen-Bradley L16ER Master

In this section, Studio 5000 version 32.00.00 is used, the master is 1769-L16ER-BB1B, and the IP address and other information have been configured in advance according to the user guide. Both network ports on the expansion card are available. To use the expansion card, set F0-02 to 2, F0-03 to 9, FD-00 to 9, and FD-01 to 3 on the AC drive.



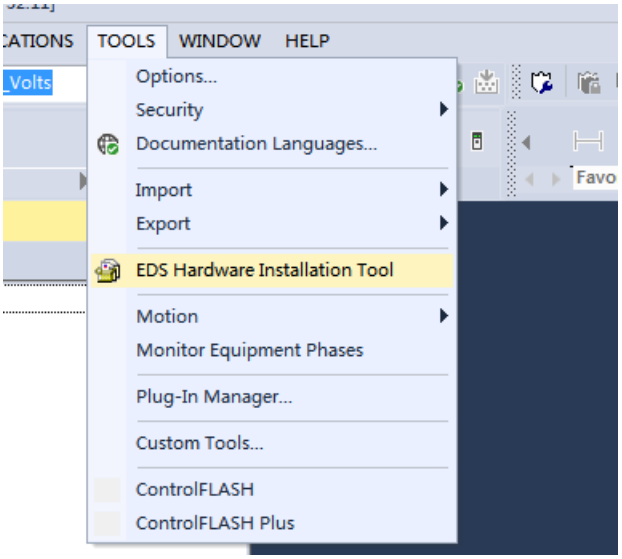
Step 1: Create a project.

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

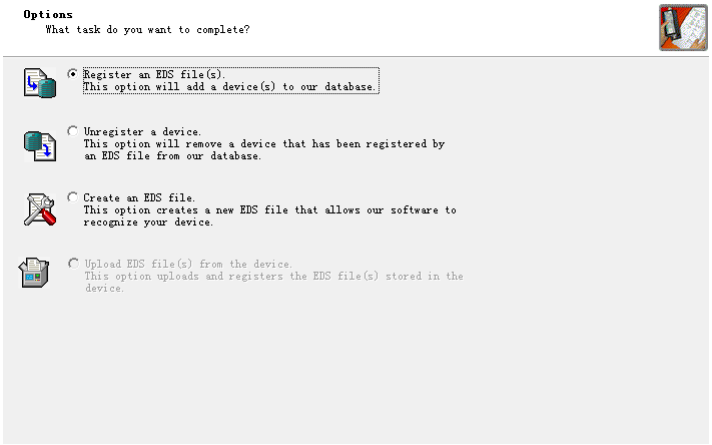


Step 2: Import the EDS file.

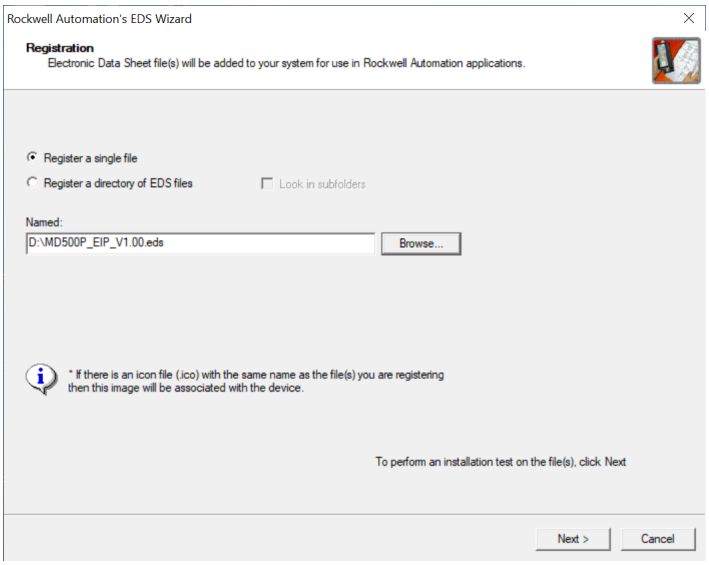
Choose **Tools** > **EDS Hardware Installation Tool**.



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



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



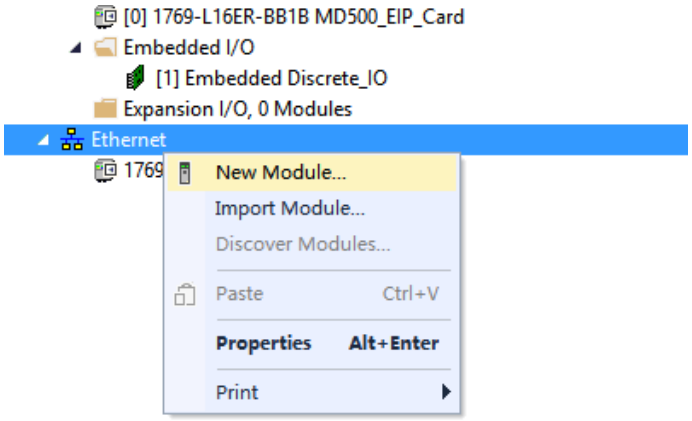
Keep clicking **Next** until the **Finish** button appears, and then click **Finish**.

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

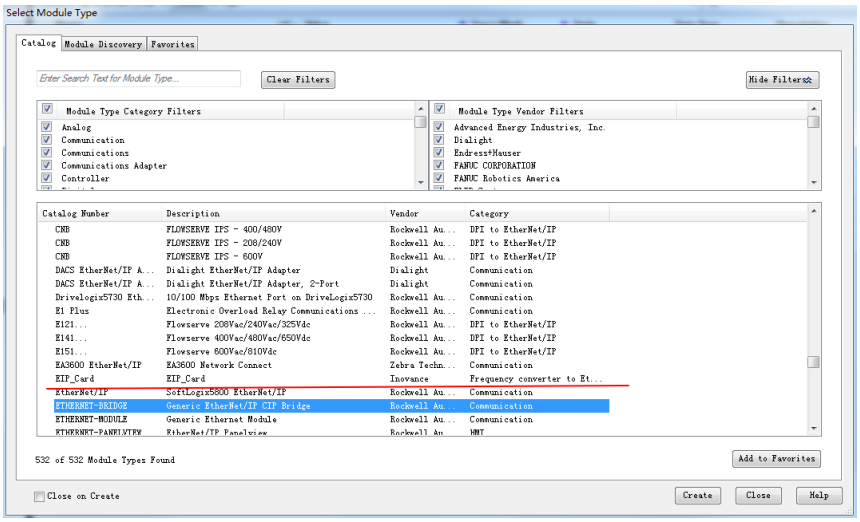
Set the AC drive parameters FD-37 to FD-49 to 0, set the IP address to 192.168.0.6, set the subnet mask to 255.255.255.0, and set the gateway address to 192.168.0.1.

Step 4: Configure the Studio 5000 project.

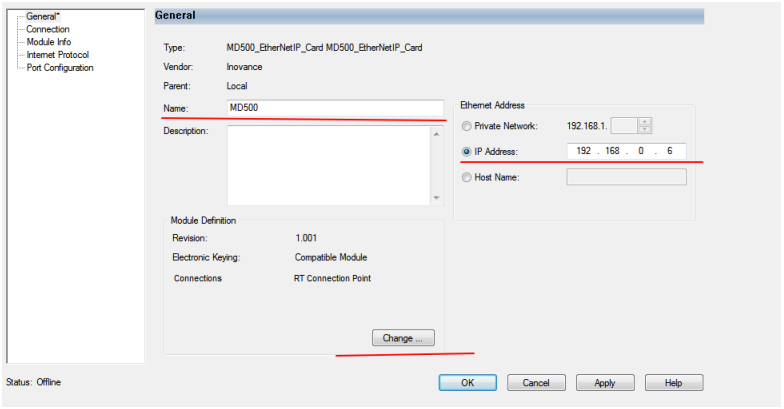
Click **Ethernet** on the left and choose **New Module**.



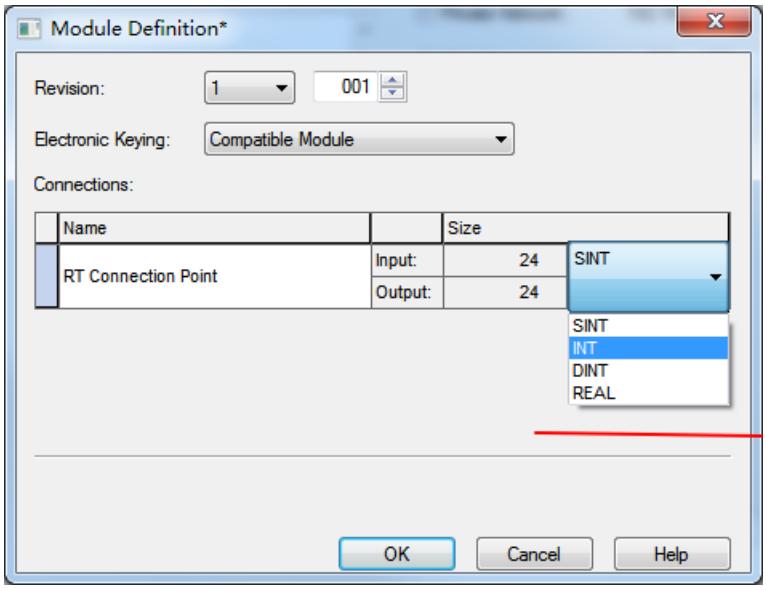
Locate **EIP_Card** and click **Create**.



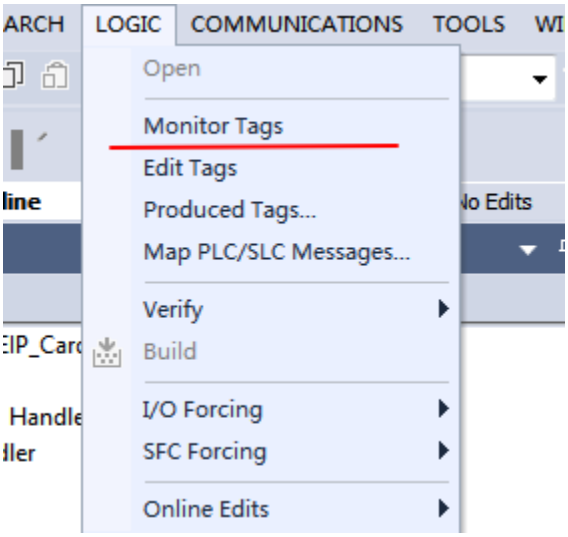
On the displayed configuration interface, enter the configured IP address and specify the name.



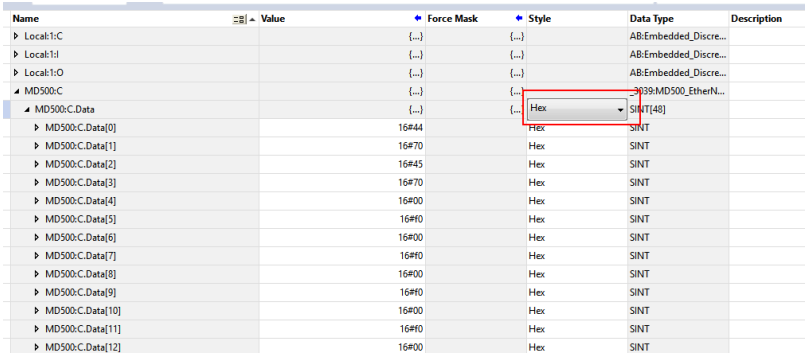
Click **Change**, select **INT** from the **SINT** drop-down list on the right, click **OK**, ignore the warning and click **Yes**.



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



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



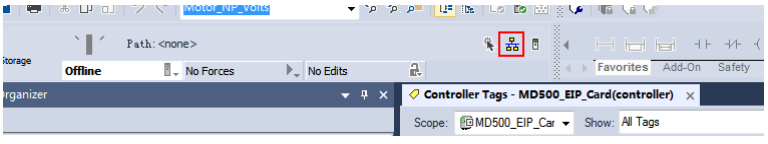
Name	Value	Force Mask	Style	Data Type	Description
Local:1:C	{...}	{...}		AB:Embedded_Discre...	
Local:1:I	{...}	{...}		AB:Embedded_Discre...	
Local:1:O	{...}	{...}		AB:Embedded_Discre...	
MD500:C	{...}	{...}		9039:MD500_EtherN...	
MD500:C.Data	{...}	{...}	Hex	SINT[48]	
MD500:C.Data[0]	16#44		Hex	SINT	
MD500:C.Data[1]	16#70		Hex	SINT	
MD500:C.Data[2]	16#45		Hex	SINT	
MD500:C.Data[3]	16#70		Hex	SINT	
MD500:C.Data[4]	16#00		Hex	SINT	
MD500:C.Data[5]	16#f0		Hex	SINT	
MD500:C.Data[6]	16#00		Hex	SINT	
MD500:C.Data[7]	16#f0		Hex	SINT	
MD500:C.Data[8]	16#00		Hex	SINT	
MD500:C.Data[9]	16#f0		Hex	SINT	
MD500:C.Data[10]	16#00		Hex	SINT	
MD500:C.Data[11]	16#f0		Hex	SINT	
MD500:C.Data[12]	16#00		Hex	SINT	

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

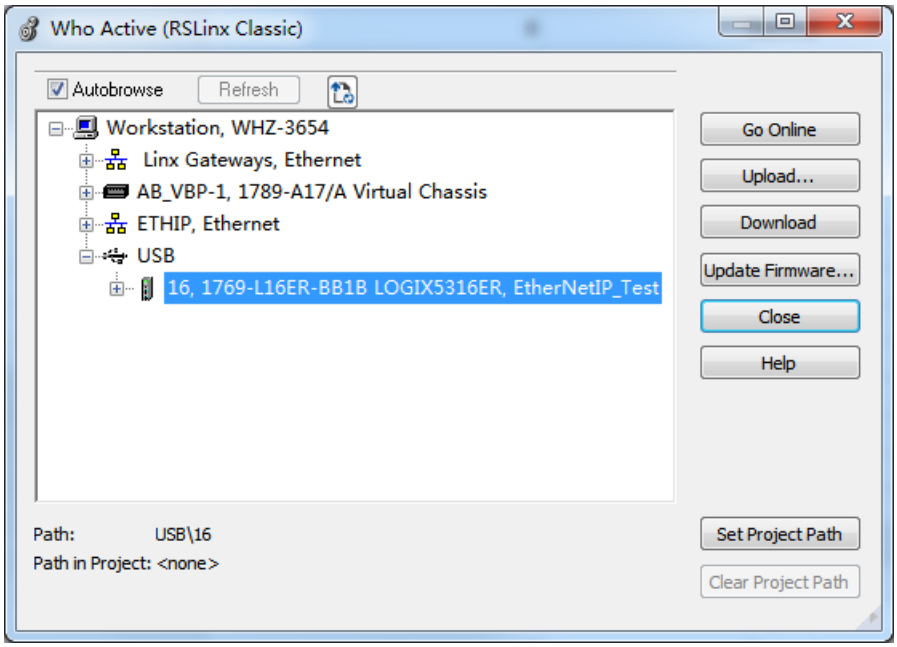
By default, I/O Messages Mapping(T->O)[0] is U0-68, I/O Messages Mapping(T->O)[1] is U0-69, I/O Messages Mapping(O->T)[0] is U3-17, and I/O Messages Mapping(O->T)[1] is U3-16. These four entries cannot be modified. Otherwise, a fault will occur. Other entries can be customized.

MD500:I.Data and MD500:O.Data are I/O data during transmission. Values written to O.Data are actually written into the corresponding parameters according to the configured mapping. The parameter configured in I/O Messages Mapping(T->O)[0] is uploaded to I.Data regularly.

After the configuration is complete, click the button marked with the red square in the figure below to search for the device.

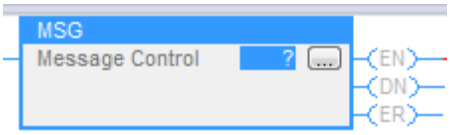


In this example, USB is used to connect the device. Select the device and click **Download** to download the code to the PLC.

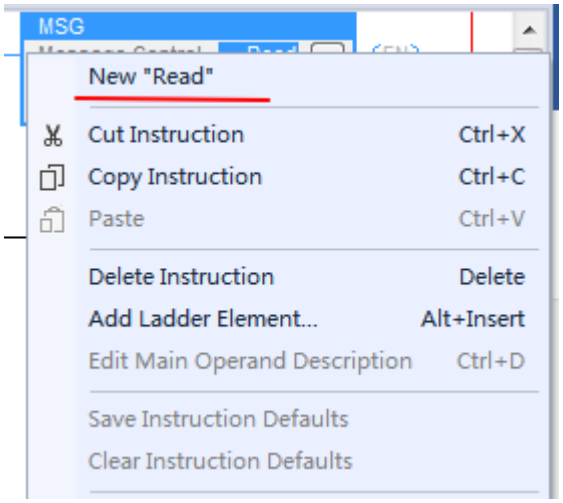


Step 5: Transmit data using explicit messages.

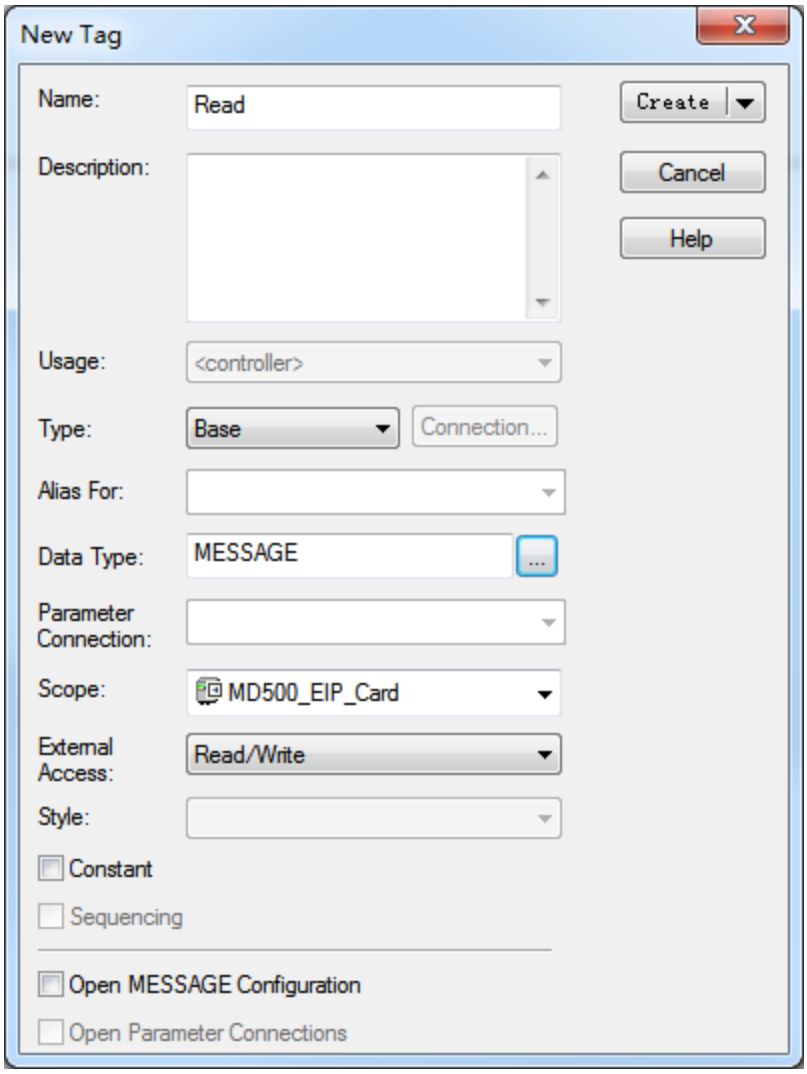
Open the program compiling part in the PLC, and click **MSG** under **Input/Output**.



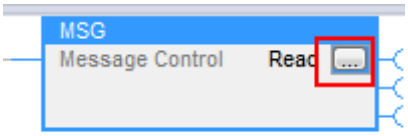
Enter a name at the question mark (?), right-click the name, and choose **New "Read"**.



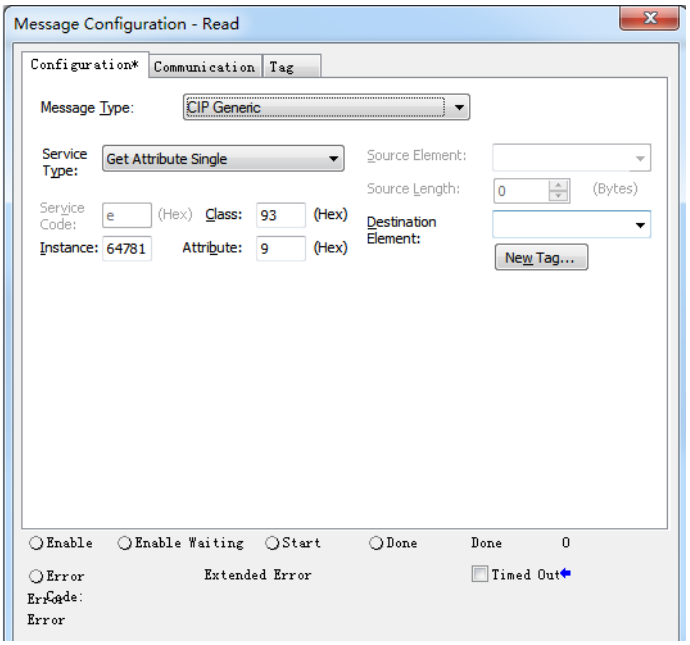
Click **Create**.



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

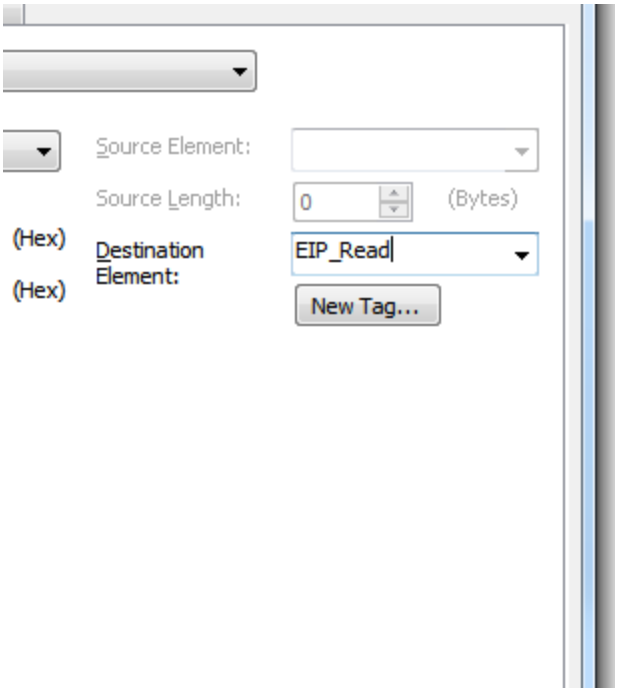


Set the parameters according to the following figure.

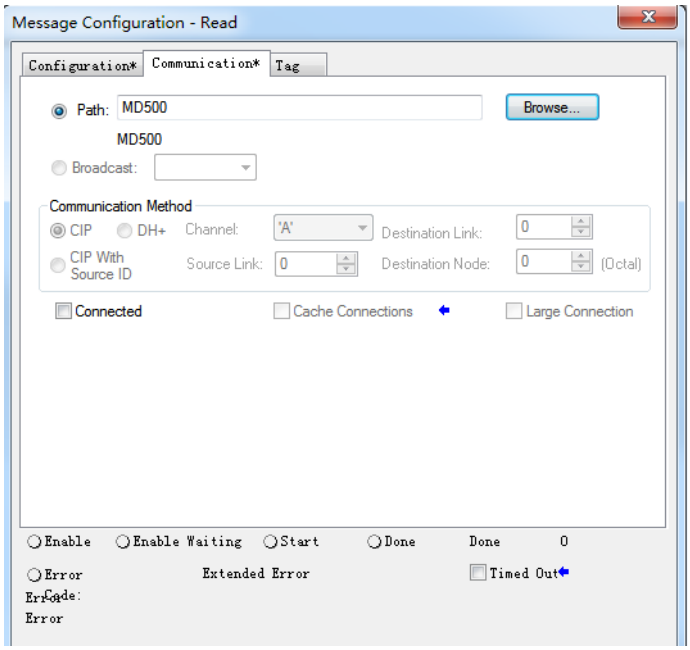


Set **Service Type** to **Get Attribute Single** for reading parameters or **Set Attribute Single** for writing parameters. **Class** is fixed to 0x93, **Attribute** is fixed to 0x9, and **Instance** is the decimal value converted from the parameter to be read. For example, FD-13, that is, FD0D, needs to be converted to the decimal value 64781, as shown in the preceding figure.

Select a position for storing the parameter from the **Destination Element** drop-down list on the right. You can also click **New Tag** to create a variable.



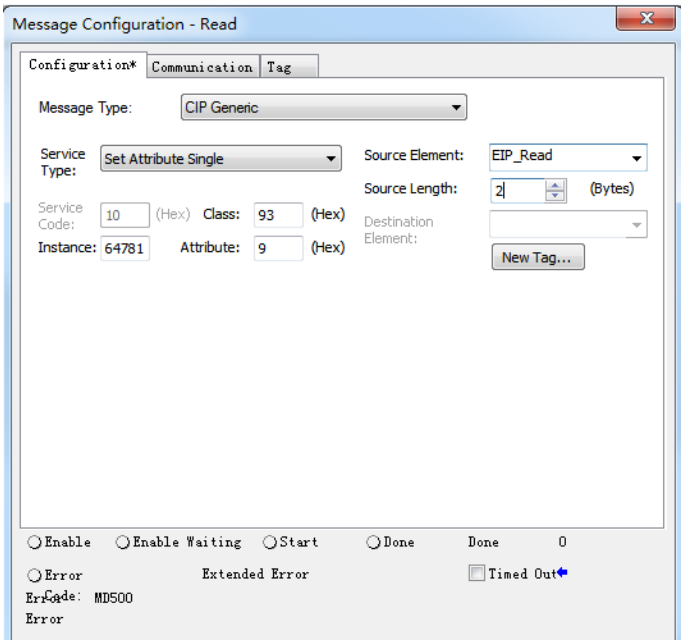
Click the **Communication** tab to select the AC drive.



Click **OK**. The master will read the parameter and store the data to the selected variable. You can choose **LOGIC** > **Monitor Tags** to view the value of the variable.

MD500:I	{...}	{...}		_3039:MD500_EtherN...
MD500:O	{...}	{...}		_3039:MD500_EtherN...
Read	{...}	{...}		MESSAGE
EIP_Read	1		Decimal	DINT
key	0		Decimal	BOOL

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

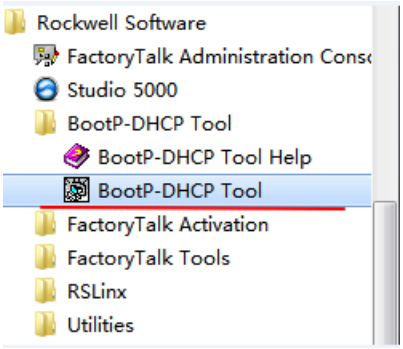


Step 6: Set the DHCP function.

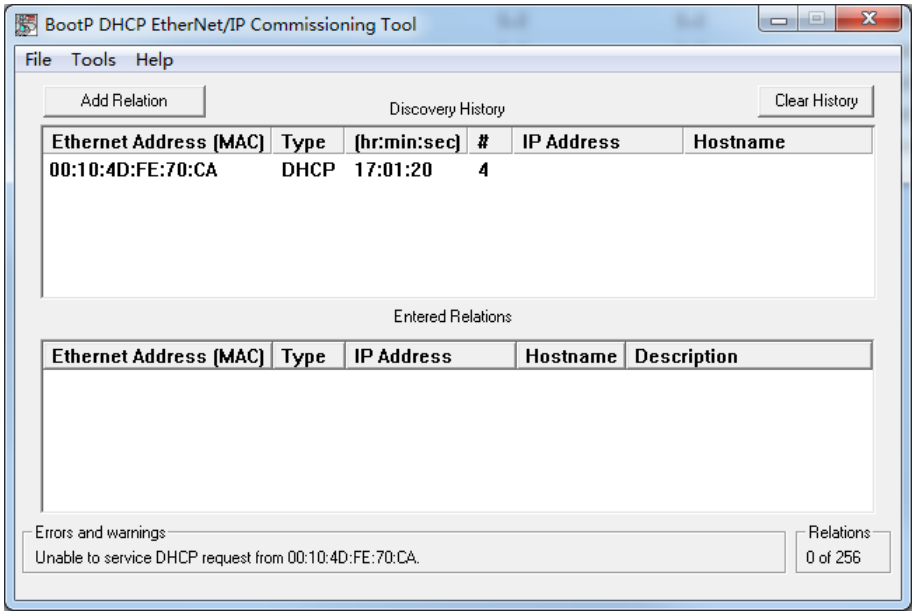
Note: IP addresses assigned by using the DHCP function are not retained upon power failure.

Set FD-37 to 1 to enable the DHCP function, power on the AC drive again, and connect the PC and AC drive to the same network.

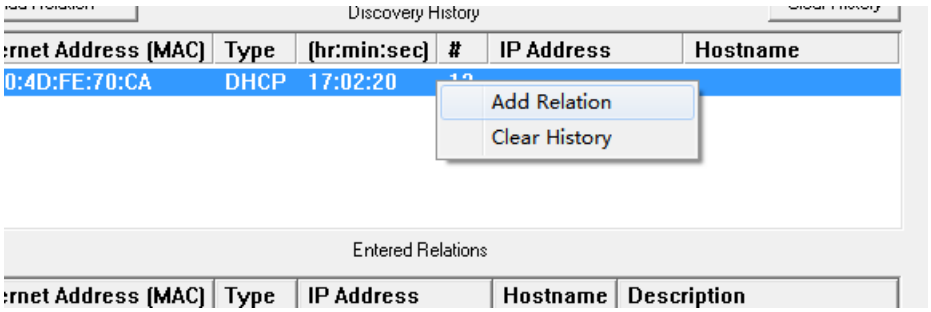
Choose **BootP-DHCP Tool** from the start menu, and select the network adapter.



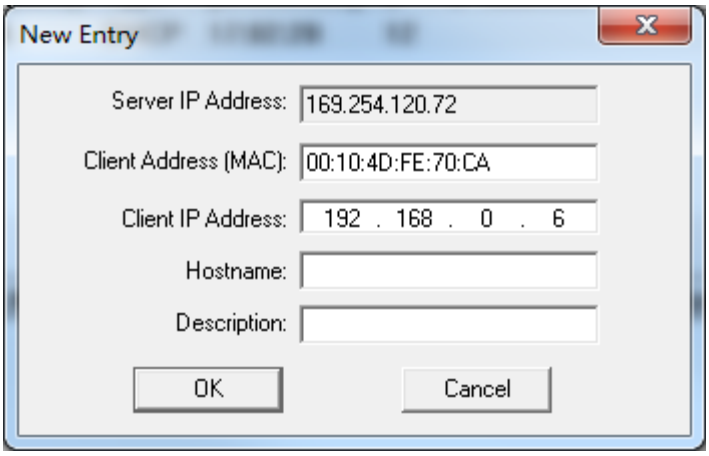
After power-on, find the device request in the BootP DHCP EtherNet/IP Commissioning Tool.



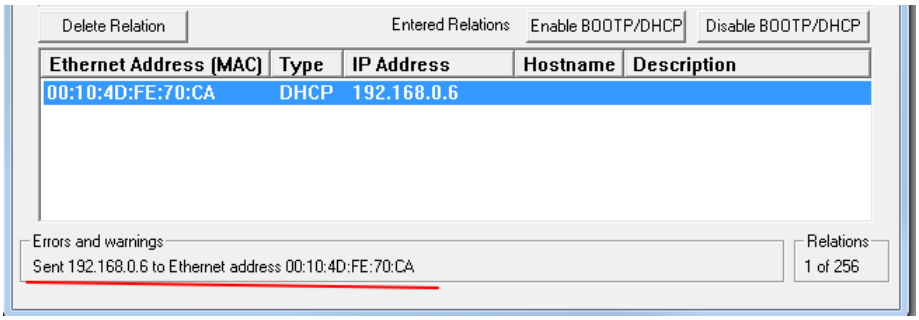
Right-click the request and select **Add Relation**.



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

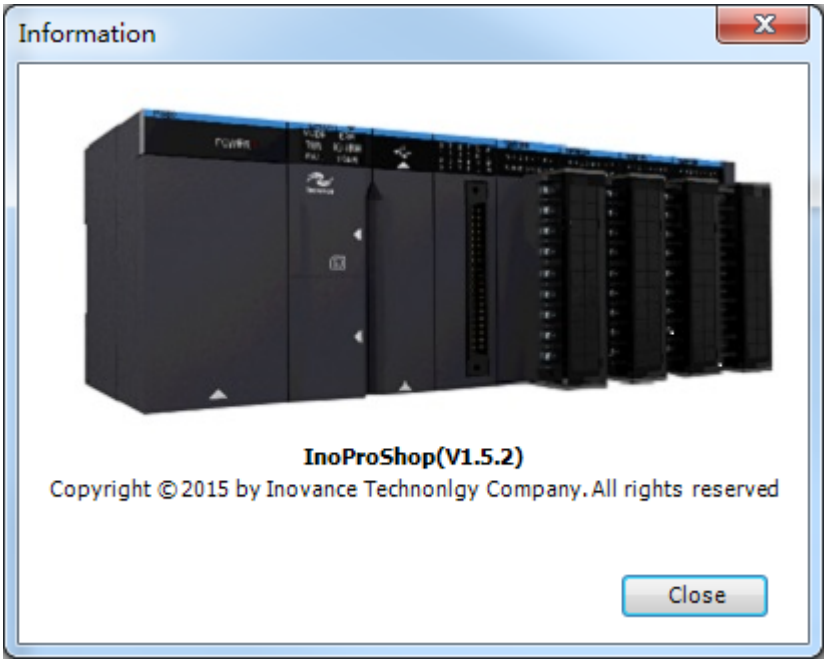


The IP address is written to the device.



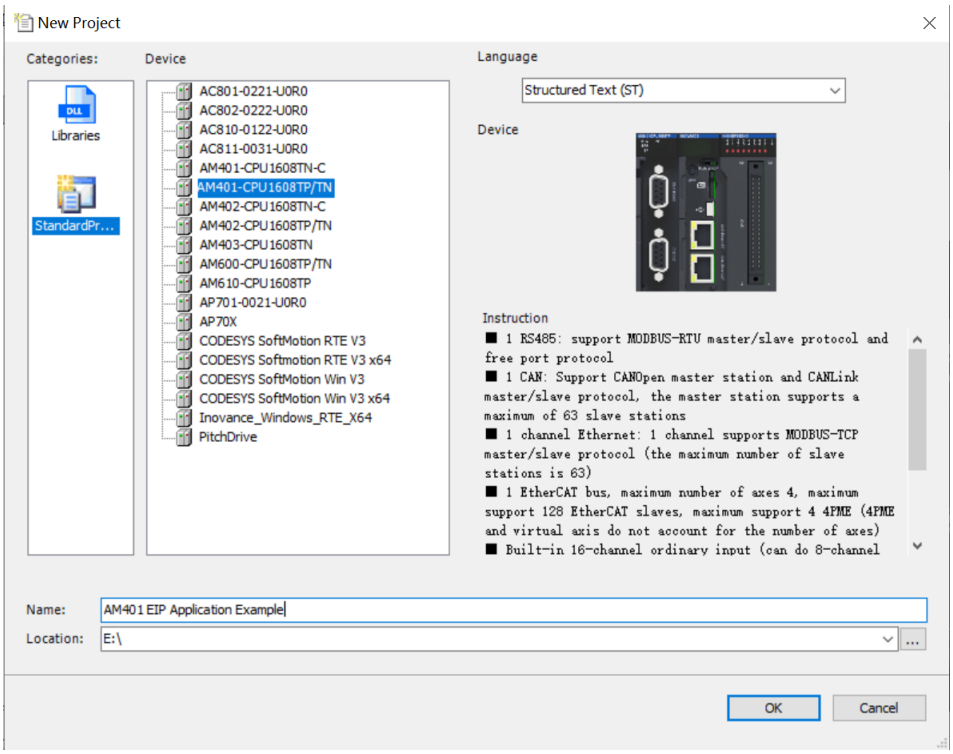
28.8.2 Using an MD500-EN1 Expansion Card on an Inovance AM600 Master

In this example, InoProShop V1.5.2 is used, the master is AM600, and the IP address and other information have been configured in advance according to the guide. You can use either the right or left network port on the expansion card. To use the expansion card, set F0-02 to 2, F0-03 to 9, FD-00 to 9, and FD-01 to 3 on the AC drive.



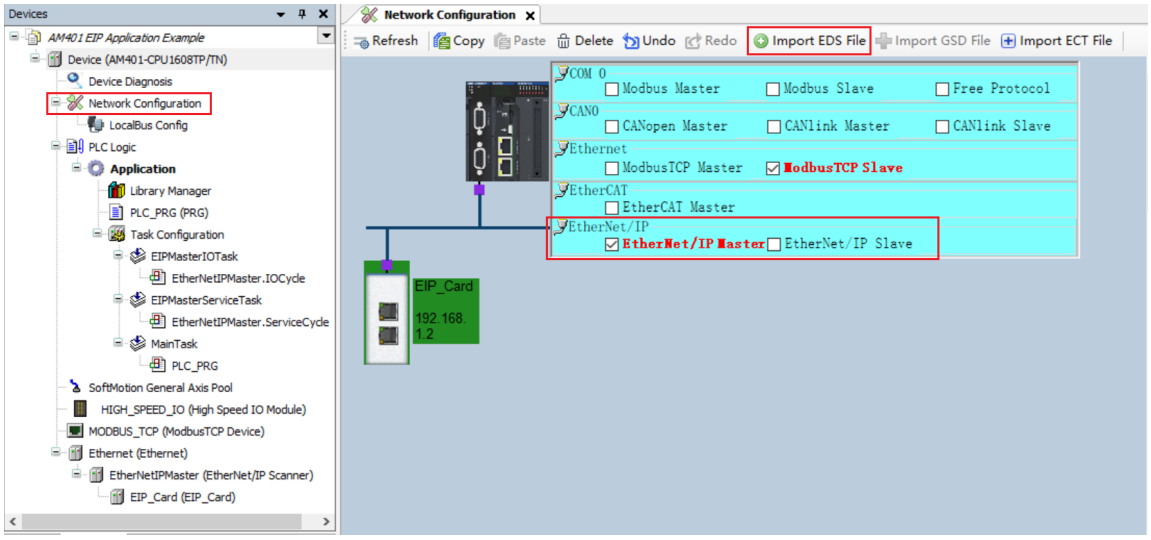
Step 1: Create a project.

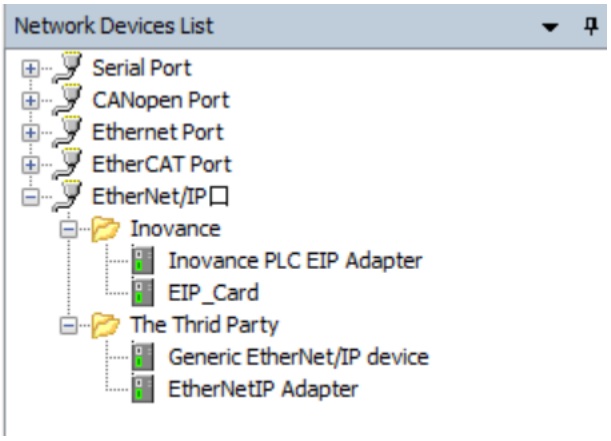
Open InoProShop and create a project. Select the device model AM600-CPU1608TP/TN.



Step 2: Import the EDS file and add a slave.

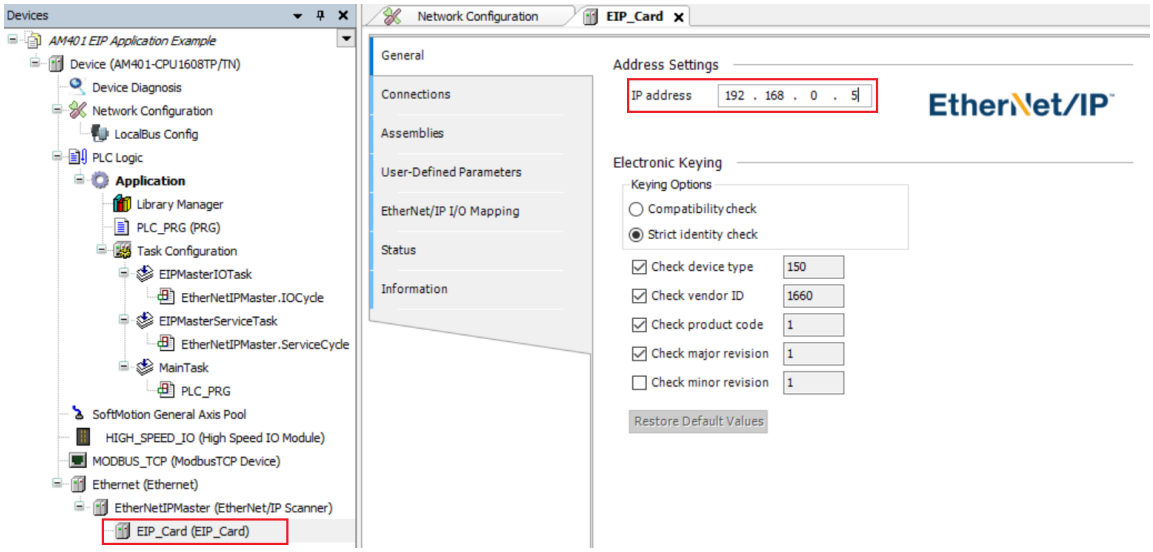
Click **Network Configuration** on the left, click the PLC, select **EtherNet/IP Master**, and click **Import EDS File** to import the EDS file for the EtherNet/IP expansion card. Import the device in the **Network Device List** on the right.



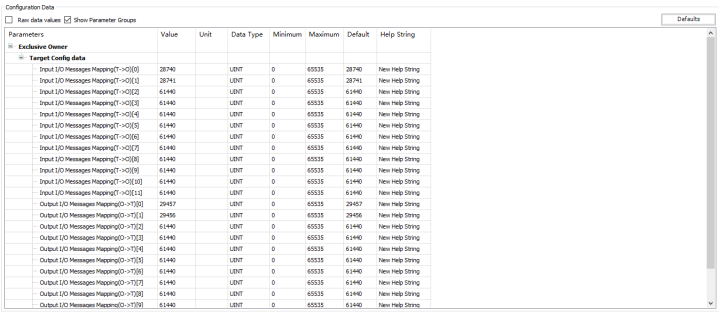


Step 3: Configure parameters for the slave.

Configure an IP address for the slave.

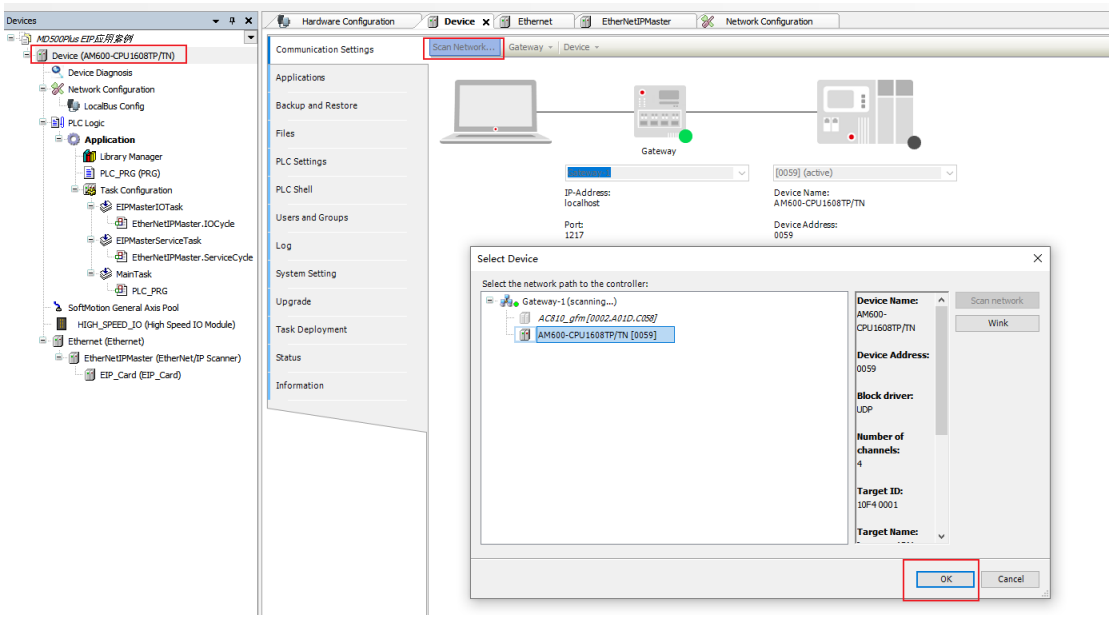


Click **Connections** on the left to configure the implicit message mapping. **Input I/O Messages Mapping(T->O)[*X*]** is the mapping of data sent from the slave to the master, and **Output I/O Messages Mapping (O->T)[*X*]** is the mapping of data sent from the master to the slave. Each entry can be configured with up to 12 mappings. By default, **Input I/O Messages Mapping(T->O)[0]** is mapped to U0-68 (28740 in decimal), **Input I/O Messages Mapping(T->O)[1]** is mapped to U0-69 (28741 in decimal); **Output I/O Messages Mapping(O->T)[0]** is mapped to U3-17 (29457 in decimal), and **Output I/O Messages Mapping(O->T)[1]** is mapped to U3-16 (29456 in decimal). Do not change these four default mappings. Other mappings are set to F0-00 (61440 in decimal) by default. You can modify the mappings as required here. Convert the parameter address into a decimal value and enter the value. For example, for F0-12, enter 61452. Retain the default values for unneeded mappings.

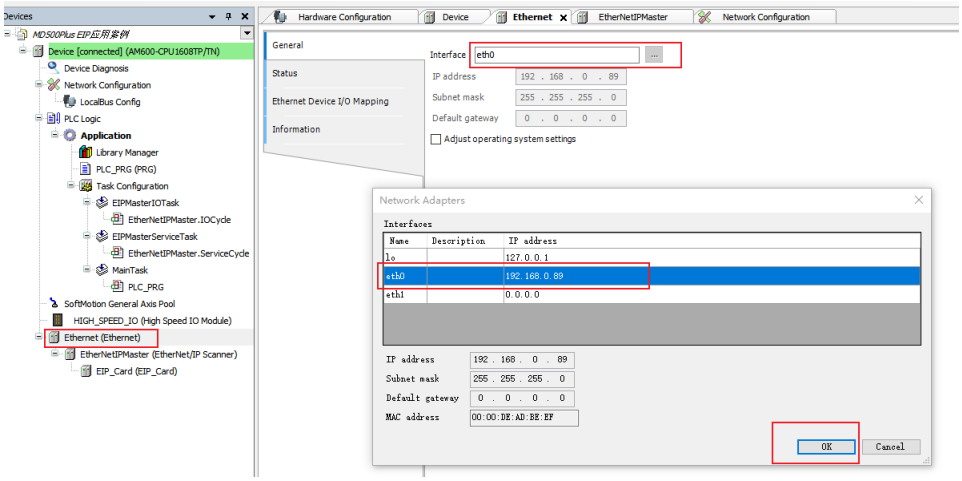


Step 4: Configure the IP address for the master.

Scan the network for the master to be configured.

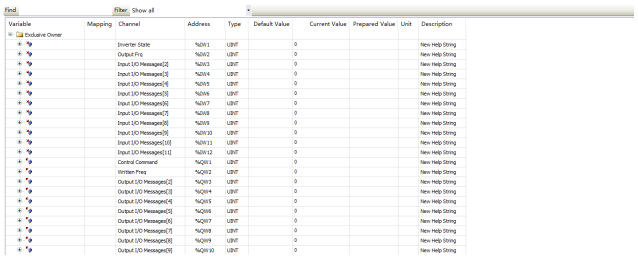


Assign an IP address to the network port of the master.



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.



28.9 Troubleshooting

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

Table 28–4 Fault analysis and solutions

Symptom	Cause	Solution
Communication between the MD500-EN1 card and AC drive fails.	1. The AC drive does not support EtherNet/IP communication. 2. The communication configuration of the MD500-EN1 card is incorrect. 3. The MD500-EN1 card hardware is faulty.	1. Check whether the AC drive supports EtherNet/IP communication. 2. Set the communication parameters of the MD500-EN1 card correctly. 3. Replace the MD500-EN1 card.
A communication error (E164.1) is reported by the AC drive during running.	1. The communication data is abnormal. 2. The network cable is damaged or connected incorrectly. 3. The AC drive suffers external interference.	1. Check whether the EtherNet/IP master program is normal. 2. Check whether the network cable is connected correctly. Replace the network cable if required. 3. Use the Cat 5e shielded twisted pair (STP) cable as required. Check that the MD500-EN1 card is grounded correctly. Eliminate the external interference. Contact the technical support personnel if necessary.

A fault code is an 8-bit binary integer, of which each bit indicates a different fault. To obtain the fault code, read the value of FD-58 of the AC drive, and convert it to an 8-bit binary number. For example, if the read value of FD-58 is 3, its binary equivalent is 0000 0011, then the fault code is bit 0 and bit 1. The following table describes the faults and solutions.

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

Fault Code	Description	Solution
Bit 7	N/A	N/A
Bit 6	Communication with the AC drive fails, or the AC drive version is incorrect.	Upgrade the AC drive software to the version that supports EtherNet/IP.
Bit 5	The I/O Messages mapping configuration is incorrect.	Check the PLC configurations.
Bit 4	Connection times out.	Check the connections and whether the master is running properly.
Bit 3	Link loss occurs.	Check the wiring.
Bit 2	The IP addresses conflict.	Check whether there is another device with the same IP address as this device.
Bit 1	The MAC address is lost or not programed.	Contact Inovance for technical support.
Bit 0	An error occurs on the Ethernet hardware.	Contact Inovance for technical support.

If the fault code is 0, the green indicator D4 is steady off, and the red indicator D7 is steady on, the troubleshooting is the same as that of bit 6.

29 Function Applications

29.1 Drive Configuration

29.1.1 Operation Command Setting

29.1.1.1 Operation Command Setting Mode

Operation commands are used to control start, stop, forward run, reverse run, and jog of the AC drive. Commands can be given by the operating panel, terminal, communication, or self-defined method. Select the operation command setting mode through F0-02.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-02	Operation command source selection	0	0: Operating panel 1: Terminal 2: Communication 3: User-defined	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run and jog operation. 0: Operating panel Operation commands are input using the RUN, STOP/RES, and MF.K keys on the operating panel. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined The command source is defined by the user as needed for expansion.

29.1.1.2 Setting Operation Commands Through Operating Panel and Software

Setting operating commands through the operating panel

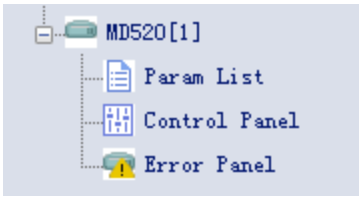
Set F0-02 to 0 and use the  and  keys on the operating panel to control the AC drive.

- Press  to start the AC drive. The RUN indicator becomes on.
- When the AC drive is running, press  to stop the AC drive. The RUN indicator becomes off.

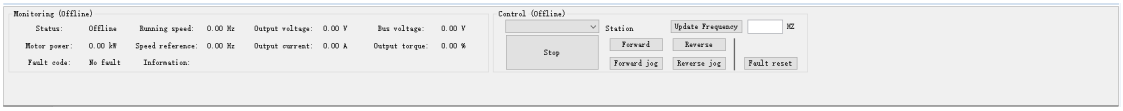
Setting operation commands through software

Set F0-02 to 0 to use the software to control the running command of the AC drive.

1. Open the InoDriverShop software and connect the AC drive to the software, as shown in the following figure.



2. Double-click the control panel menu under the AC drive to open the control panel of the software, as shown below.



- Enter the frequency in the text box Update Frequency HZ, and click **Update Frequency**. The value of F0-08 (Pre-set frequency) is changed.
- Click Forward on the control panel.The AC drive starts to run in the forward direction.
- Click Reverse on the control panel. The AC drive starts to run in the reverse direction.
- When the AC drive is running, click Stop on the control panel to stop the AC drive.
- Click and hold Forward jog on the control panel. The AC drive starts to jog in the forward direction. When you release the key, the AC drive stops jogging.
- Click and hold Reverse jog on the control panel. The AC drive starts to jog in the reverse direction. When you release the key, the AC drive stops jogging.
- When the AC drive encounters a fault, click Fault reset to reset the AC drive.

29.1.1.3 Setting Operation Commands Through Terminal

After setting F0-02 to 1, you can control the startup and stop of the AC drive through terminals.

F4-11 is used to set the terminal control mode. Four terminal control modes are available, including two-wire mode 1, two-wire mode 2, three-wire mode 1, and three-wire mode 2.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-11	Terminal command mode	0	0: Two-wire mode 1 1: Two-wire mode 2 2: Three-wire mode 1 3: Three-wire mode 2	0: Two-wire mode 1 Two DI terminals are connected. One is used to start/stop the AC drive in forward run mode, and the other is used to start/stop the AC drive in reverse run mode. 1: Two-wire mode 2 Two DI terminals are connected. One is used to start/stop the AC drive, and the other is used to control the running direction. 2: Three-wire mode 1 Three DI terminals are connected. One is used to start/stop the AC drive, and the other two are used to control the running direction. 3: Three-wire mode 2 Three DI terminals are connected. One is used to start the AC drive, one is used to stop the AC drive, and the last one is used to control the running direction.

You can use multi-functional input terminals DI1 to DI10 as external input terminals. That is, set parameters F4-00 to F4-09 to select functions of input terminals DI1 to DI10. For details about function definitions, see descriptions of F4-00 (DI1 function) to F4-09 (DI10 function).

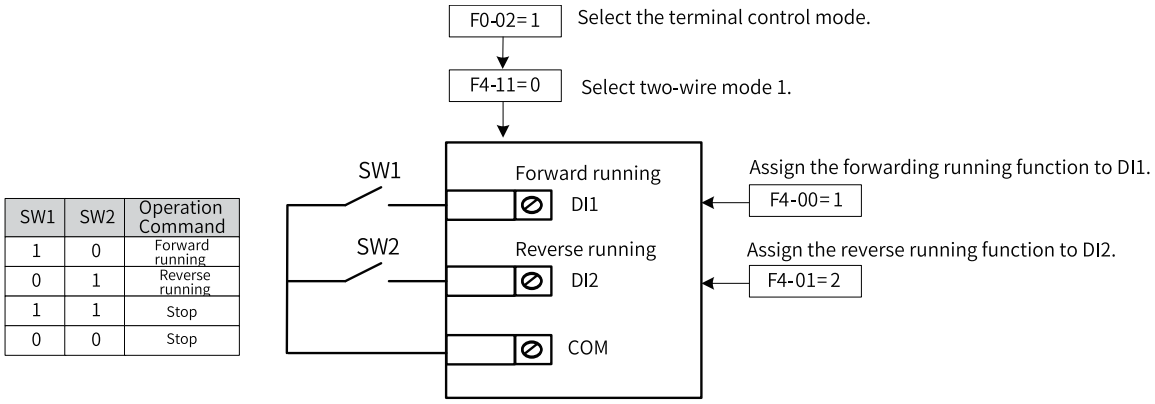
Two-wire mode 1

Set F4-11 to 0 to select two-wire mode 1, which is the most commonly used mode.

For example, DI1 is allocated with the forward running function and DI2 is allocated with the reverse running function. Connect the forward running switch to DI1 and the reverse running switch to DI2.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	0	Two-wire mode 1
F4-00	DI1 function selection	1	Forward running (FWD)
F4-01	DI2 function selection	2	Reverse running (REV)

When SW1 is closed and SW2 is open, the motor rotates in the forward direction. When SW1 is open and SW2 is closed, the motor rotates in the reverse direction. When SW1 and SW2 are both open or closed, the motor stops. It is shown in the following figure.



SW1	SW2	Operation Command
1	0	Forward running
0	1	Reverse running
1	1	Stop
0	0	Stop

Figure 29-1 Wiring and parameter settings for two-wire mode 1

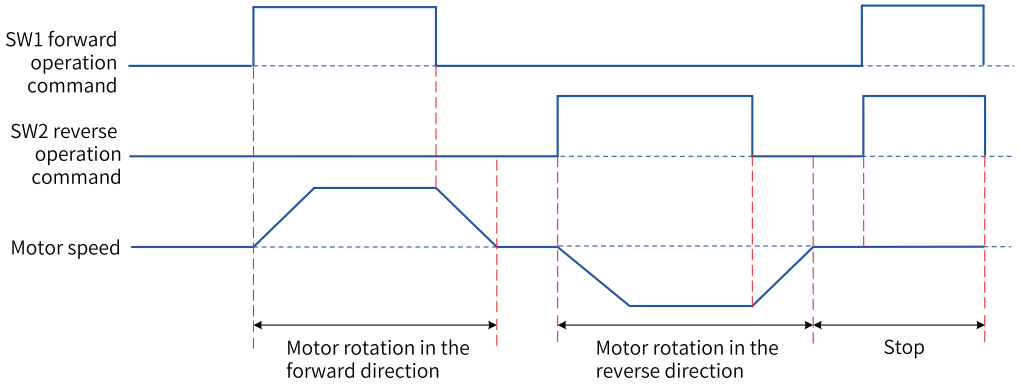


Figure 29-2 Time sequence (normal) for two-wire mode 1

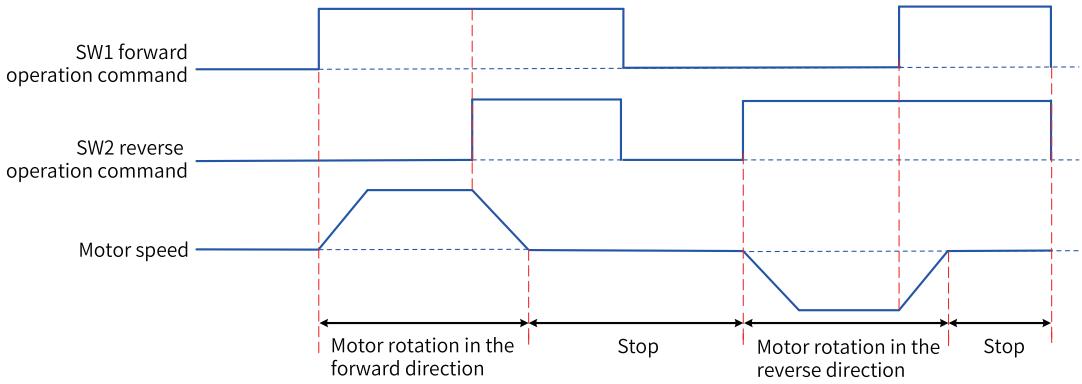


Figure 29-3 Time sequence (abnormal) for two-wire mode 1

Two-wire mode 2

For example, DI1 is allocated with the operation function, and DI2 is allocated with the forward and reverse running function. Set the parameters as follows.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	1	Two-wire mode 2
F4-00	DI1 function selection	1	Operation command
F4-01	DI2 function selection	2	Forward/reverse running direction

When SW1 is closed, the motor starts to run. When SW2 is open, the motor runs in the forward direction. When SW2 is closed, the motor runs in the reverse direction. When SW1 is open, the motor does not run regardless of the status of SW2. It is shown in the following figure.

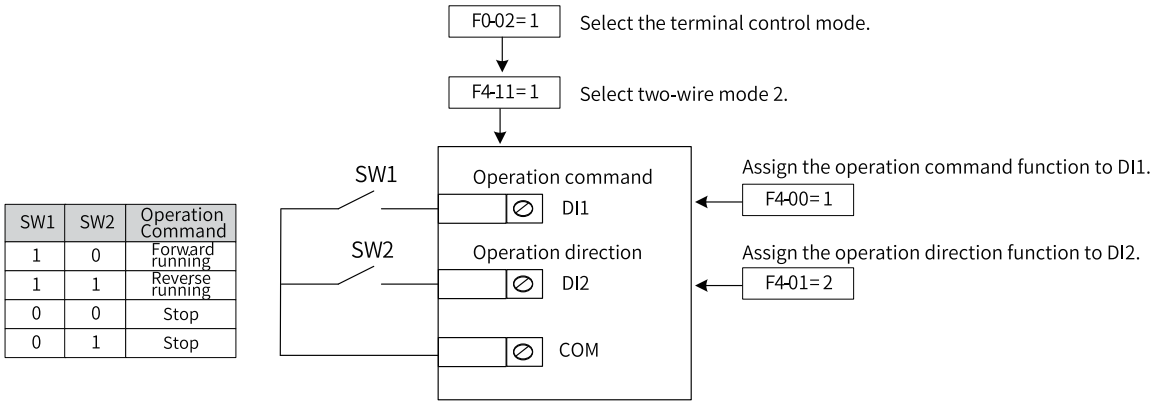


Figure 29-4 Wiring and parameter settings for two-wire mode 2

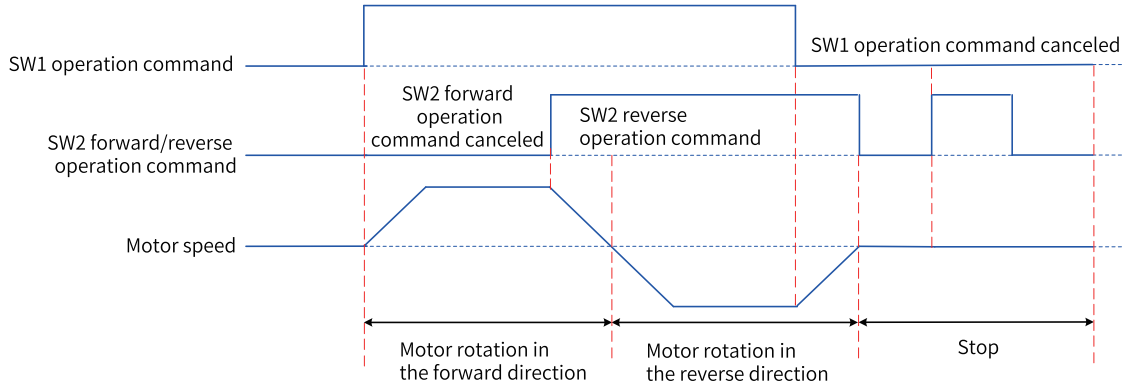


Figure 29-5 Two-wire mode 2 time sequence

Three-wire mode 1

For example, DI3 is allocated with the operation control function, DI1 is allocated with the forward running function, and DI2 is allocated with the reverse running function. In this mode, keys of the AC drive are used to start and stop it. Connect the start/stop key to DI3, the forward running key to DI1, and the reverse running key to DI2. The parameters are set as follows.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	2	Three-wire mode 1
F4-00	DI1 function selection	1	Forward running (FWD)
F4-01	DI2 function selection	2	Reverse running (REV)
F4-02	DI3 function selection	3	Three-wire control

SW3 is normally closed, and SW1 and SW2 are normally open. If SW3 is closed, the motor rotates in the forward direction when you press down SW1, and rotates in the reverse direction when you press down SW2. The motor stops immediately when SW3 opens. SW3 must remain closed during normal start and running. A signal from SW1 or SW2 takes effect once SW1 or SW2 is closed.

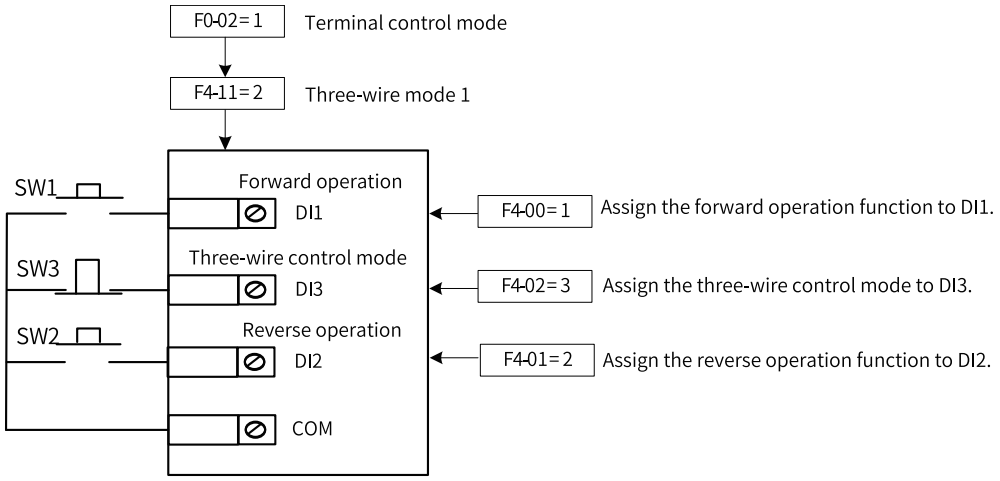


Figure 29-6 Wiring and parameter settings for three-wire mode 1

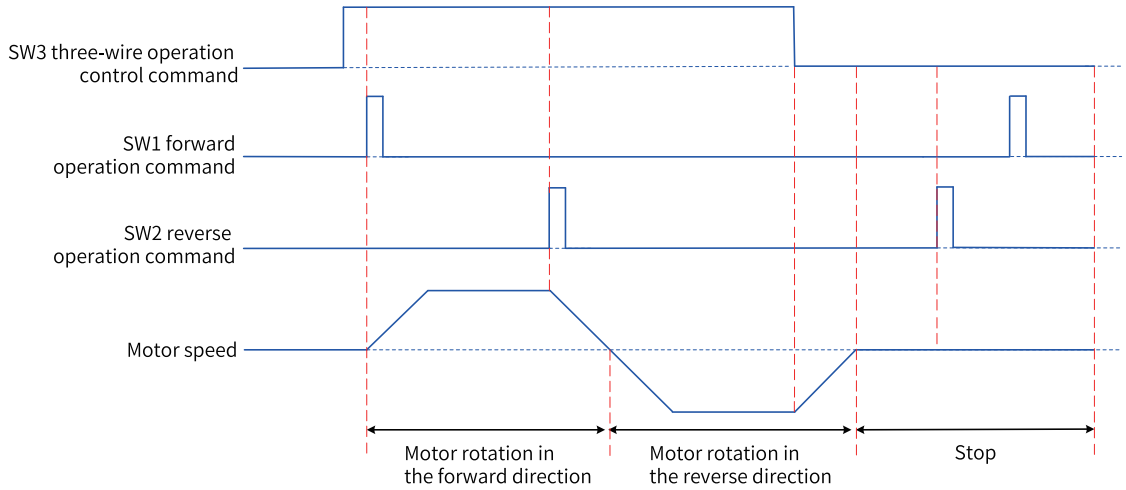


Figure 29-7 Three-wire mode 1 time sequence

Three-wire mode 2

For example, DI3 is allocated with the three-wire control function, DI1 is allocated with the operation function, and DI2 is allocated with the forward/reverse running function. Connect the start/stop key to DI3, the operation key to DI1, and the forward/reverse running key to the DI2. The parameters are set as follows.

Parameter Code	Parameter Name	Value Range	Description
F4-11	Terminal command mode	3	Three-wire mode 2
F4-00	DI1 function selection	1	Operation command
F4-01	DI2 function selection	2	Forward/reverse running direction
F4-02	DI3 function selection	3	Three-wire control

When SW3 is closed, the AC drive starts to run after you press SW1. If SW2 is open, the motor rotates in the forward direction. If SW2 is closed, the motor rotates in reverse direction. The drive stops immediately at the moment when SW3 becomes open. SW3 must remain closed during normal start and running. A signal from SW1 takes effect once SW1 is closed.

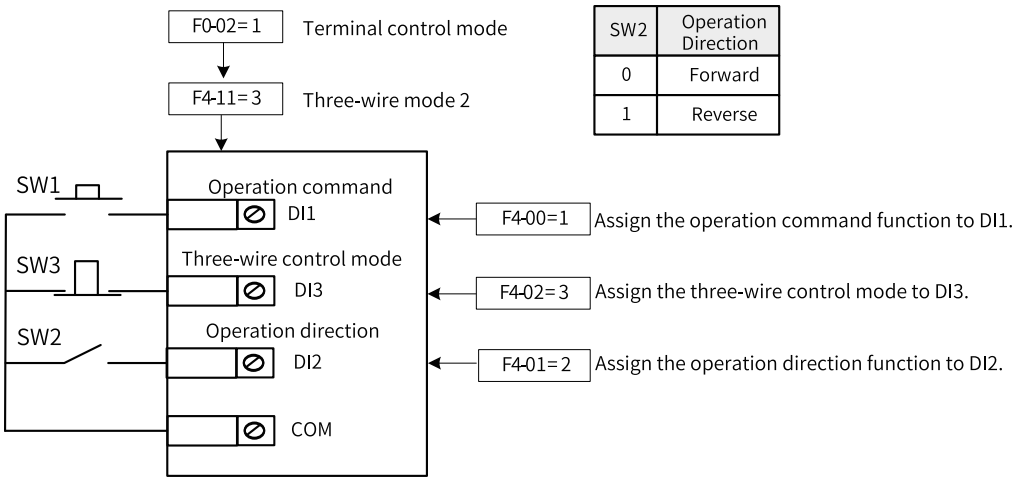


Figure 29-8 Wiring and parameter settings for three-wire mode 2

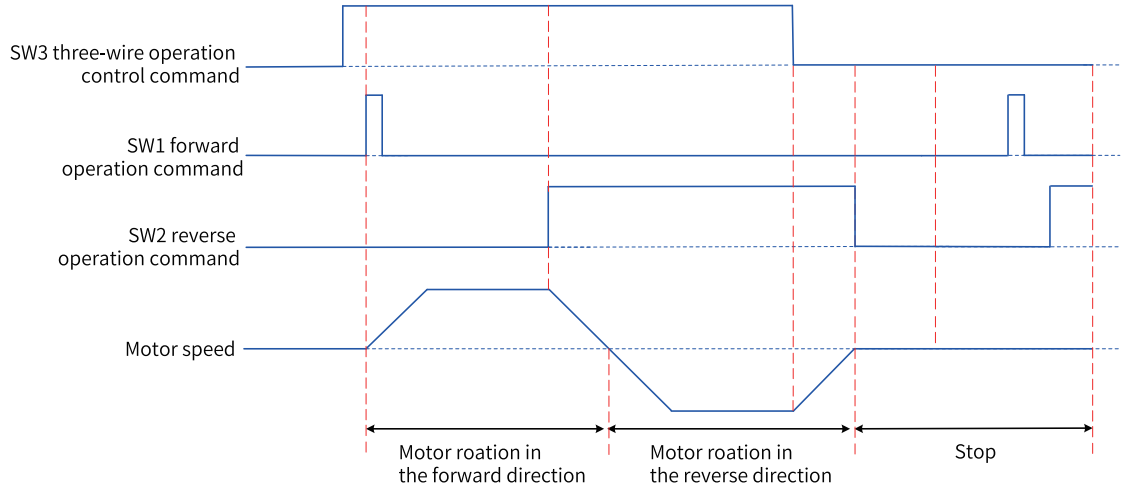


Figure 29-9 Three-wire mode 2 time sequence

29.1.1.4 Setting Operation Commands through Communication

You can set F0-02 to 2 to select communication as the command source for controlling start/stop of the AC drive.

The AC drive supports communication with the host controller through the following communication protocols: Modbus (Modbus RTU, Modbus ASCII, Modbus TCP), PROFIBUS DP, CANopen, CANlink, PROFINET, EtherCAT, and Ethernet/IP. Only one communication protocol is supported at a time. To enable the drive to communicate with the host controller through one of the previous protocol, you must install the related communication card. All the seven communication protocol is optional. If Modbus, PROFIBUS DP, CANopen, PROFINET, EtherCAT, or Ethernet/IP is used, set F0-28 (communication protocol selection) to select an applicable serial communication protocol. The CANlink protocol is valid all the time.

When running commands are given through communication, the host controller sends write commands to the AC drive. This part takes the Modbus protocol as an example to describe the process of giving running commands through communication.

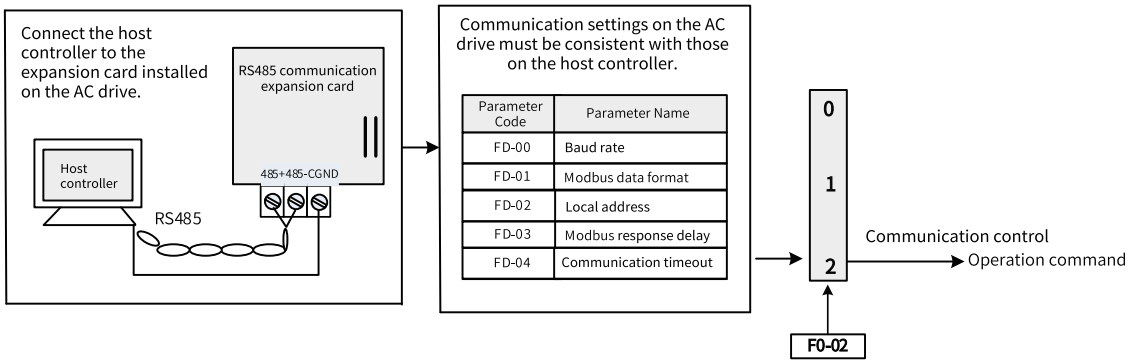


Figure 29-10 Sending running commands through communication

To make the AC drive run in the reverse direction, the host controller sends the write command 01 06 20 00 00 02 03 CB. The following table describes the definition of each byte. The command is in hexadecimal format. For other communication addresses and control commands, see "Appendix B: Communication Data Address Definition and Modbus Protocol".

Command	Definition
01H (settable)	Drive address
06H	Write command
2000H	Communication address of the control command
02H (reverse run)	Control command
03CBH	CRC check

The following table describes the relationship between master commands and slave responses.

Command from the Master		Response from the Slave	
ADDR	01H	ADDR	01H
CMD	06H	CMD	06H
High-order bit of the parameter address	20H	High-order bit of the parameter address	20H
Low-order bit of the parameter address	00H	Low-order bit of the parameter address	00H
High-order bit of the data content	00H	High-order bit of the data content	00H
Low-order bit of the data content	02H	Low-order bit of the data content	02H
CRC high-order bits	03H	CRC high-order bits	03H
CRC low-order bit	CBH	CRC low-order bit	CBH

29.1.1.5 Setting Operation Commands Through Customized Channel

Set F0-02 to 3 to configure the start and stop command source of the AC drive through a customized channel. Two groups of parameters for setting customized channels are provided.

Table 29–1

Parameter Code	Name	Default	Value Range	Description
A4-00	Control channel selection	0	0: Control channel 1 1: Control channel 2	This parameter is used to select a self-defined channel. When control channel 1 is selected, A4-01 to A4-18 are active. When control channel 2 is selected, A4-21 to A4-38 are active.
A4-01	Self-defined OFF1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of start/stop control command OFF1 for self-defined channel 1.
A4-02	Self-defined OFF2 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of coast to stop command OFF2 for self-defined channel 1. The coast to stop command OFF2 is valid if any of the three sources is active low.
A4-03	Self-defined OFF3 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of emergency stop command OFF3 for self-defined channel 1. The emergency stop command OFF3 is valid if any of the three sources is active low.
A4-04	Self-defined running permission command source	0	0: Operation inhibited 1: Operation allowed 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the running permission command source for self-defined channel 1.
A4-05	Self-defined fault reset command source 1	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of the fault reset command for self-defined channel 1. The fault reset command is valid if any of the three sources is active high.
A4-06	Self-defined JOG1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG1 command for self-defined channel 1.
A4-07	Self-defined JOG2 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG2 command for self-defined channel 1.
A4-08	Self-defined speed inversion source	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the command opposite to the command reference for self-defined channel 1.

Parameter Code	Name	Default	Value Range	Description
A4-21	Self-defined OFF1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of start/stop control command OFF1 for self-defined channel 2.
A4-22	Self-defined OFF2 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of coast to stop command OFF2 for self-defined channel 2. The coast to stop command OFF2 is valid if any of the three sources is active low.
A4-23	Self-defined OFF3 source 1	0	0: Enable 1: Disable 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of emergency stop command OFF3 for self-defined channel 2. The emergency stop command OFF3 is valid if any of the three sources is active low.
A4-24	Self-defined running permission command source	0	0: Operation inhibited 1: Operation allowed 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the running permission command source for self-defined channel 2.
A4-25	Self-defined fault reset command source 1	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines source 1 of the fault reset command for self-defined channel 2. The fault reset command is valid if any of the three sources is active high.
A4-26	Self-defined JOG1 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG1 command for self-defined channel 2.
A4-27	Self-defined JOG2 source	0	0: Disabled 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the JOG2 command for self-defined channel 2.
A4-28	Self-defined speed inversion source	0	0: Disabled 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector	This parameter defines the source of the command opposite to the command reference for self-defined channel 2.

29.1.2 Frequency Reference Setting

29.1.2.1 Frequency Reference Source Selection

The AC drive supports three frequency reference sources, including main frequency reference, auxiliary frequency reference, and main and auxiliary frequency superposition.

29.1.2.2 Selecting Source for Main Frequency Reference

There are ten main frequency reference sources in total, including digital setting (non-retentive at power failure), digital setting (retentive at power failure), AI1, AI2, AI3, pulse input, multi-reference, simple PLC, PID, communication setting, and F connector. You can set F0-03 to a value ranging from 0 to 9 to define the source.

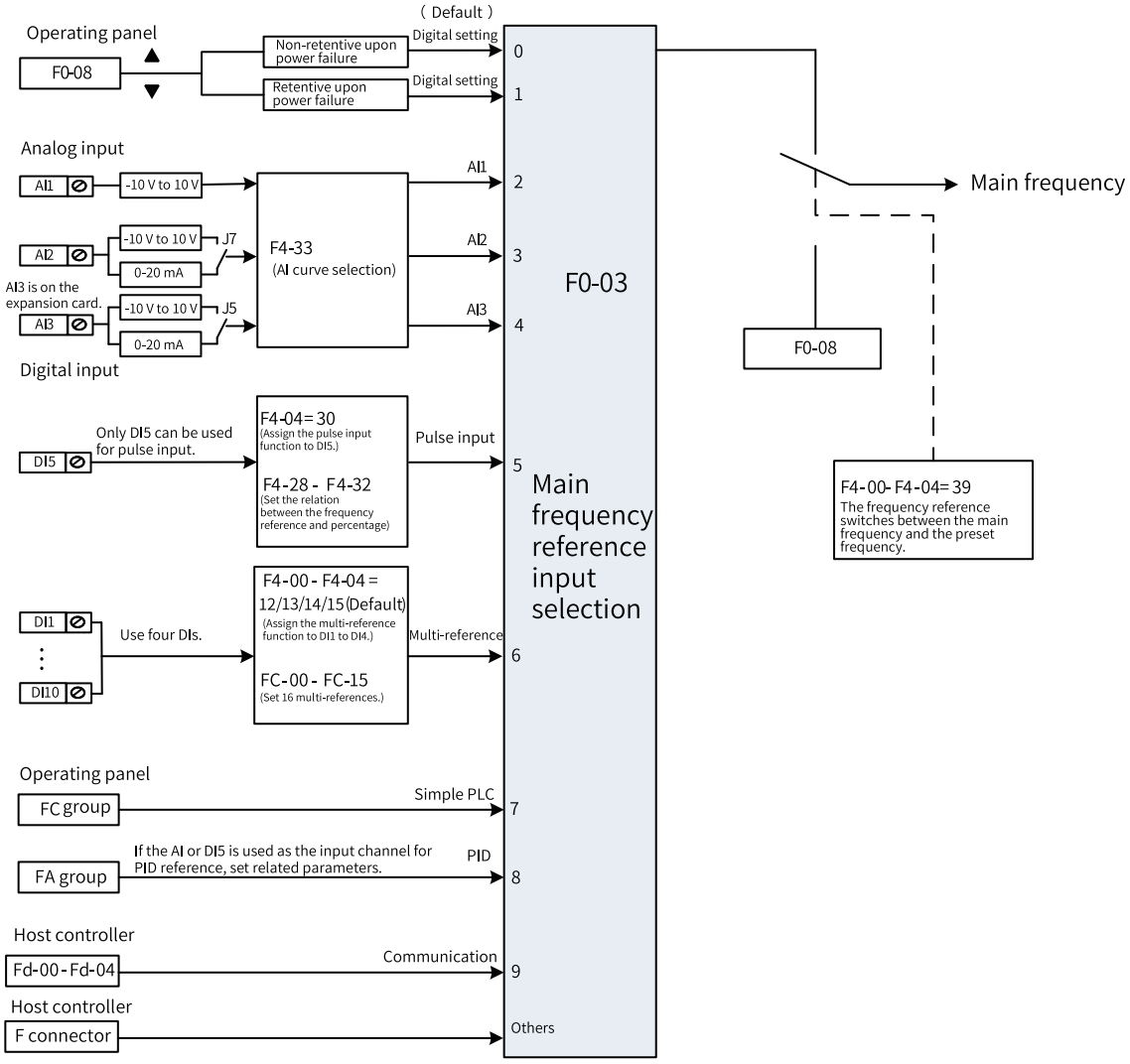


Figure 29-11 Main frequency source selection

Parameter Code	Parameter Name	Value Range	Default
F0-03	Main frequency source X selection	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	0

29.1.2.3 Setting Main Frequency Through Operating Panel

There are two ways to set the main frequency by using the operating panel:

- F0-03 = 0 (non-retentive at power failure): When the AC drive is powered on again after stop or power failure, the frequency reference is restored to the preset frequency (F0-08). The preset frequency (F0-08) can be changed by the  and  keys on the operating panel or by terminal functioning as the UP and DOWN keys. When the AC drive stops, the changed frequency will be reset.
- F0-03 = 1 (retentive at power failure): When the AC drive is powered on again after stop or power failure, the preset frequency is restored to the value memorized at the moment of the last power failure. The preset frequency (F0-08) can be changed by the  and  keys on the operating panel or by terminal functioning as the UP and DOWN keys. When the AC drive stops, the changed frequency will be retained.

  Example: The preset frequency (F0-08) is set to 40 Hz and then changed to 45 Hz by the  key on the operating panel. If F0-23 is set to 0 (non-retentive at power failure), the frequency is restored to 40 Hz (value of F0-08) after the AC drive stops. If F0-23 is set to 1 (retentive at power failure), the frequency is still 45 Hz after the AC drive stops.

Note

Note that F0-23 (Retention of digital-set frequency at stop) differs from F0-03. F0-23 determines whether the changed frequency is retained when the AC drive stops. F0-23 is related to the stop state, rather than power failures.

Related parameter

Parameter Code	Name	Default	Value Range
F0-08	Preset frequency	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)
F0-10	Maximum frequency	50.00 Hz	50.00 Hz to 600.00 Hz

Parameter Code	Name	Default	Value Range
F0-23	Retention of digital setting of frequency upon stop	0	0: Non-retentive at stop 1: Retentive at stop

29.1.2.4 Setting Main Frequency Through AI

When the main frequency is to be set through the AI, AI1, AI2, or AI3 can be selected.

- F0-03 = 2: AI1 is used to set the main frequency reference.
- F0-03 = 3: AI2 is used to set the main frequency reference.
- F0-03 = 4: AI3 is used to set the main frequency reference.

When the AI is used to as the frequency source, each AI supports five types of AI curves. The AI curve defines the relationship between the analog input voltage (or current) and the corresponding set values.

Procedure	Parameter	Description
Step 1: Set the AI curve. Set the relationship between AI voltage/current inputs and the set values.	F4-13 to F4-16	Curve 1 setting
	F4-18 to F4-21	Curve 2 setting
	F4-23 to F4-26	Curve 3 setting
	A6-00 to A6-07	Curve 4 setting
	A6-08 to A6-15	Curve 5 setting
	F4-34	This parameter is used to set the value when the AI value is lower than the minimum input. When the frequency is set through the AI, voltage/current input 100% corresponds to the maximum frequency F0-10.
Step 2: Select the AI curve for the AI. Select the AI curve and set the filter time.	F4-33	This parameter is used to select the AI curve. You can select any AI curve for an AI. The default value 0x321 of F4-33 is used. Select curve 1, curve 2, and curve 3 for AI1, AI2, and AI3, respectively.
	F4-17, F4-22, F4-27	Filter time of AI1 and AI3
Step 3: Set the AI as the frequency source. Select the AI for setting the frequency reference based on terminal characteristics.	F0-03 (Main frequency source)	F0-03 = 2 AI1 is used.
		F0-03 = 3 AI2 is used. DIP switches S1 to S3 on the control board are used to select voltage input or current input.
		F0-03 = 4 AI3 is used. Select the input mode (voltage or current) by setting S1 on the expansion card.

AI curve setting methods

There are five types of AI curves in total. Curves 1, 2, and 3 are 2-point curves, with relevant parameters being F4-13 to F4-27. Curves 4 and 5 are four-point curves. The related parameters are in group A6.

In the following example, AI curve 1 is set through F4-13 to F4-16.

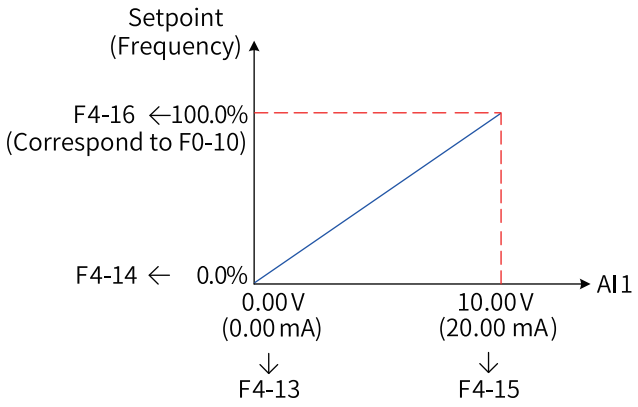


Figure 29-12 Setting AI curve 1

When the AI is used as the frequency setting source, the voltage/current input 100% corresponds to the value of F0-10 (maximum frequency).

When current mode 1 is selected for analog input, current of 1 mA corresponds to voltage of 0.5 V, and current of 0 mA to 20 mA corresponds to voltage of –10 V to +10 V.

When current mode 2 is selected for analog input, current of 1 mA corresponds to voltage of 0.25 V, and current of 0 mA to 40 mA corresponds to voltage of –10 V to +10 V.

Curve 2 and curve 3 are set in a similar way as curve 1. F4-18 to F4-21 are used to set curve 2. F4-23 to F4-26 are used to set curve 3.

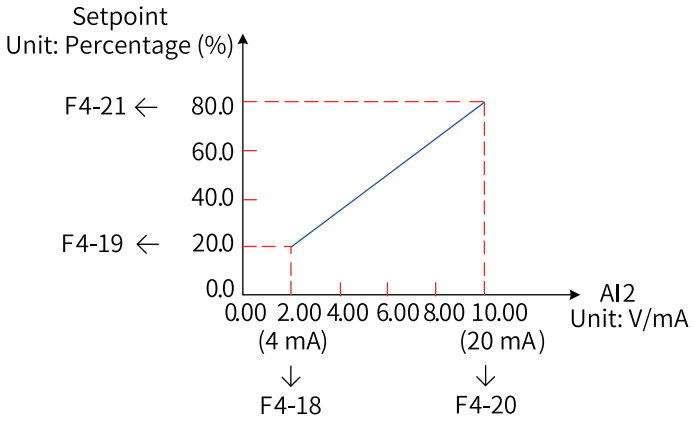


Figure 29-13 Setting AI curve 2

The function of curve 4 and curve 5 is similar to that of curve 1 to curve 3, but curve 1 to curve 3 are lines, and curve 4 and curve 5 are 4-point curves, implementing more flexible corresponding relationship. The x axis in AI curves 4 and 5 represents the analog input voltage (or current), and the y axis represents the set value corresponding to the analog input, that is, the percentage relative to the maximum frequency (F0-10). The four points on curves 4 and 5 are the minimum input point, inflection point 1, inflection point 2, and maximum input point. A6-00 corresponds to the minimum input point on the x axis, that is, the minimum analog input voltage (or current).

When setting curve 4 and curve 5, the minimum input voltage, inflection point 1 voltage, inflection point 2 voltage, and maximum input voltage must be increased in ascending order. A6-00 to A6-07 are used to set curve 4. A6-08 to A6-15 are used to set curve 5.

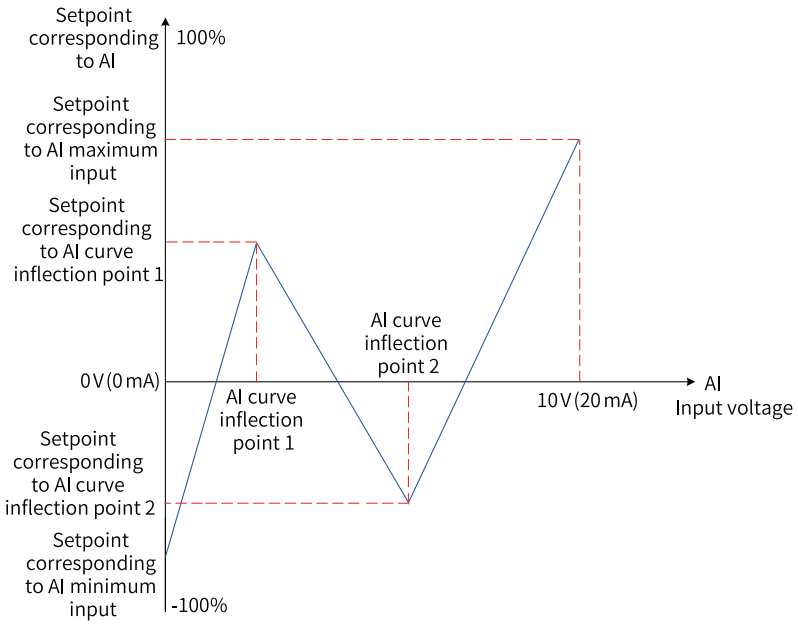


Figure 29-14 Schematic diagram for curve 4 and curve 5

AI curve selection

The ones and tens places of F4-33 are used to set the curve for AI1 and AI2, respectively. The two AIs can use any of the five curves.

The longer the AI input filter time, the stronger the anti-interference capability, but the slower the adjustment response. The shorter the filter time, the quicker the adjustment response, but the weaker the anti-interference capability. If the analog signal is prone to interference, increase the filter time to stabilize the detected analog signal. However, increasing the filter time will slow the response speed of analog detection. Set the filter time properly based on actual conditions.

AI as the main frequency reference source

The control board provides three AI terminals: AI1, AI2, and AI3. AI1 supports voltage input of –10 V to +10 V. AI2 and AI3 supports voltage input of –10 V to +10 V or current input of 0 mA to 20 mA/40 mA. DIP switches S1 to S3 on the control board are used to select voltage input, current input, or temperature input for AI2. DIP switch S1 on the expansion card is used to select voltage input or temperature input for AI3. The following describes the setting of each AI used as the main frequency reference source.

For example, assume that curve 1 is selected for AI1 (the ones place of F4-33 is set to 1) and voltage-type AI1 is used as the main frequency reference source. To make input voltage of 2 V to 10 V be mapped to frequency of 10 Hz to 40 Hz, set as follows.

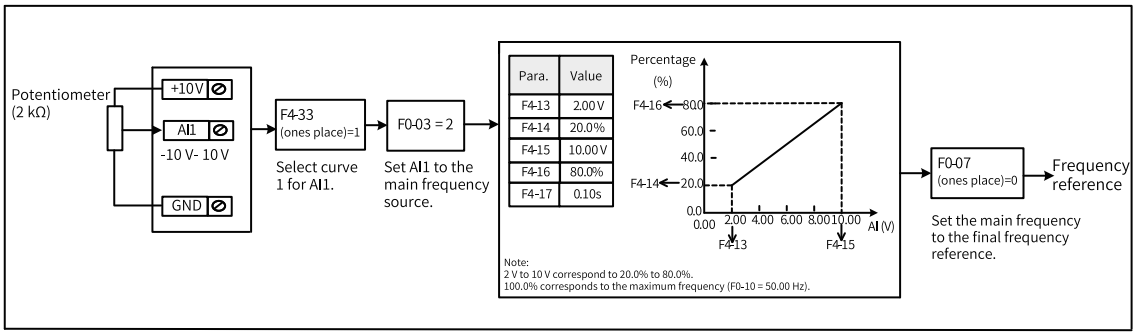


Figure 29-15 Parameter settings for voltage-type AI1 to be used as the main frequency reference source

AI2 supports analog voltage input (-10 V to 10 V) or analog current input (0 mA to 20 mA).

When AI2 is used for analog current input, input current of 0 mA to 20 mA corresponds to input voltage of 0 V to 10 V. If the input current ranges from 4 mA to 20 mA, current of 4 mA corresponds to voltage of 2 V, and current of 20 mA corresponds to voltage of 10 V.

For example, assume that curve 2 is selected for AI2 (the tens place of F4-33 is set to 2) and current-type AI2 is used as the main frequency reference source. To make input current of 4 mA to 20 mA be mapped to frequency of 0 Hz to 50 Hz, set as follows.

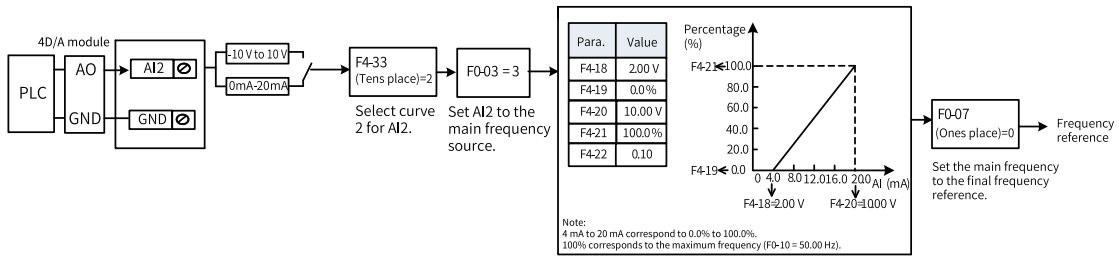


Figure 29-16 Parameter settings for current-type AI2 to be used as the main frequency reference source

29.1.2.5 Setting Main Frequency Through Multi-reference

When F0-03 is set to 6, multi-reference is selected as the main frequency reference source. This mode is suitable for applications where the operating frequency of the drive does not require continuous adjustment, and only several frequency values need to be used.

You can set a maximum of 16 operating frequencies through parameters FC-55 to FC-58 or through combinations of input signals of four DIs. The settings by terminal are preferred to those by parameters. For example, if DI1 is allocated with multi-reference terminal function 1, the setting of FC-55 is inactive. You can also use fewer than four DIs as the multi-reference source. In this case, missing digits are populated with 0.

The relationship between the reference quantity and DI quantity is as follows:

- Two multi-references: One DI K1; FC-55 to FC-58 set to 0
- Three to four multi-references: Two DIs K1 and K2; FC-57 to FC-58 set to 0
- Five to eight multi-references: Three DIs K1, K2, and K3; FC-58 set to 0
- Nine to sixteen multi-references: Four DIs K1, K2, K3, and K4

The multi-references are set through parameters in group FC, as listed in the following table.

Parameter Code	Parameter Name	Default	Value Range	Description
FC-00	Multi-reference 1	0.00%	-100.0% to 100.0%	This parameter indicates the frequency reference of each speed in the unit of %. The actual frequency is the percentage of the maximum frequency. The value 100% corresponds to F0-10 (Maximum frequency). FC-55 to FC-58 can provide 16 state combinations, corresponding to 16 frequency references. The DIs assigned with functions 12 to 15 can also be used to provide 16 frequency references. The source of multi-reference 1 is selected by FC-51, and the other multi-references are set by other parameters. When outputting to a floating-point connector, the multi-reference can be used not only as the frequency reference, but also as the torque, voltage, or other reference input. The multi-reference value is a percentage of the rated value.
FC-01	Multi-reference 2	0.00%	-100.0% to 100.0%	
FC-02	Multi-reference 3	0.00%	-100.0% to 100.0%	
FC-03	Multi-reference 4	0.00%	-100.0% to 100.0%	
FC-04	Multi-reference 5	0.00%	-100.0% to 100.0%	
FC-05	Multi-reference 6	0.00%	-100.0% to 100.0%	
FC-06	Multi-reference 7	0.00%	-100.0% to 100.0%	
FC-07	Multi-reference 8	0.00%	-100.0% to 100.0%	
FC-08	Multi-reference 9	0.00%	-100.0% to 100.0%	
FC-09	Multi-reference 10	0.00%	-100.0% to 100.0%	
FC-10	Multi-reference 11	0.00%	-100.0% to 100.0%	
FC-11	Multi-reference 12	0.00%	-100.0% to 100.0%	
FC-12	Multi-reference 13	0.00%	-100.0% to 100.0%	
FC-13	Multi-reference 14	0.00%	-100.0% to 100.0%	
FC-14	Multi-reference 15	0.00%	-100.0% to 100.0%	
FC-15	Multi-reference 16	0.00%	-100.0% to 100.0%	

Parameter Code	Parameter Name	Default	Value Range	Description
FC-51	Multi-reference 1 source	0	0 to 6	The frequency reference of multi-reference 1 can be selected through seven ways, including digital setting, analog input, pulse frequency, PID, and preset frequency. 0: FC-00 The frequency reference is set by FC-00. 1: AI1 The frequency reference is set by AI1. 2: AI2 The frequency reference is set by AI2. 3: AI3 The frequency reference is set by AI3. 4: Pulse reference The frequency reference is set by pulse frequency. 5: PID The frequency reference is set by PID. 6: Preset frequency (F0-08) The frequency reference is set by F0-08 Others: F connector The frequency reference is set by connector.

To set multi-reference as the main frequency reference source, assign functions 12 to 15 to the DIs.

Parameter Code	Parameter Name	Value Range	Description
F4-01	DI2 function selection	12	Multi-reference terminal 1
F4-03	DI4 function selection	13	Multi-reference terminal 2
F4-06	DI7 function selection	14	Multi-reference terminal 3
F4-07	DI8 function selection	15	Multi-reference terminal 4

Example

In the following figure, DI2, DI4, DI7, and DI8 are used as the multi-frequency input terminals, which form a four-bit binary number. The state combinations of these terminals represent different frequencies. When values of DI8, DI7, DI4, and DI2 are 0, 0, 1, and 0, the frequency set through FC-02 is selected. For details, see *"Table 29–2" on page 639*. The target operating frequency is automatically calculated from "FC-02 x F0-10". The following figure shows the frequency setting.

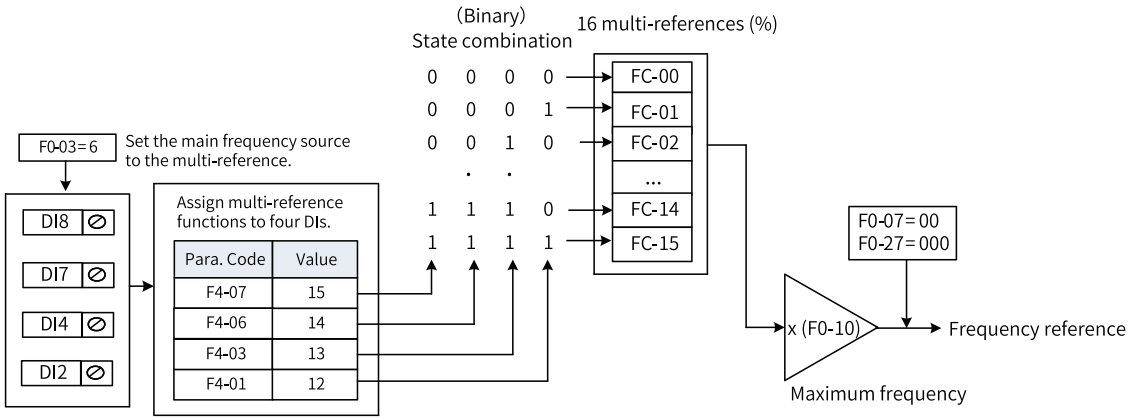


Figure 29-17 Multi-reference setting

The four multi-reference terminals can make up 16 state combinations, corresponding to 16 frequency reference values, as listed in the following table.

Table 29–2 Description of multi-reference function

K4	K3	K2	K1	Reference	Parameter
OFF	OFF	OFF	OFF	Multi-reference 1	FC-00 (FC-51 = 0)
OFF	OFF	OFF	ON	Multi-reference 2	FC-01
OFF	OFF	ON	OFF	Multi-reference 3	FC-02
OFF	OFF	ON	ON	Multi-reference 4	FC-03
OFF	ON	OFF	OFF	Multi-reference 5	FC-04
OFF	ON	OFF	ON	Multi-reference 6	FC-05
OFF	ON	ON	OFF	Multi-reference 7	FC-06
OFF	ON	ON	ON	Multi-reference 8	FC-07
ON	OFF	OFF	OFF	Multi-reference 9	FC-08
ON	OFF	OFF	ON	Multi-reference 10	FC-09
ON	OFF	ON	OFF	Multi-reference 11	FC-10
ON	OFF	ON	ON	Multi-reference 12	FC-11
ON	ON	OFF	OFF	Multi-reference 13	FC-12
ON	ON	OFF	ON	Multi-reference 14	FC-13
ON	ON	ON	OFF	Multi-reference 15	FC-14
ON	ON	ON	ON	Multi-reference 16	FC-15

In the preceding section, the multi-reference values are determined by assigning functions to terminals through parameters in group F4. You can also set the multi-reference values through parameters in group FC.

Parameter Code	Parameter Name	Value	Description
FC-51	Multi-reference 1 source	0: FC-00 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: PID 6: Preset frequency (F0-08) Others: F connector	The frequency reference of multi-reference 1 can be selected through seven ways, including digital setting, analog input, pulse frequency, PID, and preset frequency. 0: FC-00 The frequency reference is set by FC-00. 1: AI1 The frequency reference is set by AI1. 2: AI2 The frequency reference is set by AI2. 3: AI3 The frequency reference is set by AI3. 4: Pulse reference The frequency reference is set by pulse frequency. 5: PID The frequency reference is set by PID. 6: Preset frequency (F0-08) The frequency reference is set by F0-08 Others: F connector The frequency reference is set by connector.
FC-55	Multi-reference selection through K1	0: 0 1: 1 2: Terminal input function 3-18: DI1 to DI16 Others: B connector	This parameter is used to select K1 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "12: Multi-reference terminal 1".
FC-56	Multi-reference selection through K2		This parameter is used to select K2 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "13: Multi-reference terminal 2".
FC-57	Multi-reference selection through K3		This parameter is used to select K3 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "14: Multi-reference terminal 3".
FC-58	Multi-reference selection through K4		This parameter is used to select K4 as the multi-reference setting source. Note: This parameter is invalid when the DI is allocated with function "15: Multi-reference terminal 4".

29.1.2.6 Setting Main Frequency Through Simple PLC

1: Set F0-03 to 7 to select simple PLC as the main frequency source.

2: Set parameters FC-00 to FC-15 and FC-18 to FC-49 to define the running time and acceleration/deceleration time for each multi-speed reference.

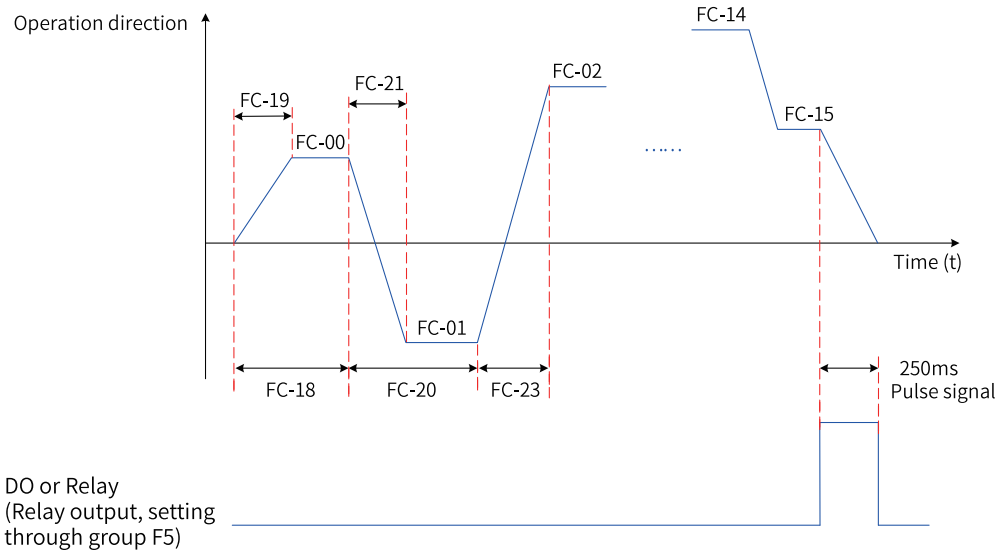


Figure 29-18 Use of simple PLC as the main frequency source

3: Set FC-16 to select the simple PLC running mode.

4: Set FC-17 to determine whether to retain the PLC running stage and running frequency upon a power failure or stop.

29.1.2.7 Setting Main Frequency Through PID

As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. The PID-controlled output is used as the running frequency. The PID control is generally used for field process closed-loop control, such as constant pressure closed-loop control and constant tension closed-loop control.

- Proportional gain Kp: When there is a deviation between the PID input and output, the PID regulator adjusts the output to reduce the deviation of the controlled variable. The deviation reduction speed depends on the proportionality coefficient Kp. A greater Kp value means faster deviation reduction but causes oscillation, especially in the case of long hysteresis. A smaller Kp value means lower probability of oscillation but leads to slow adjustment. (A proportional gain of 100.0 indicates that when the deviation between PID feedback and PID reference is 100.0%, the PID regulator regulates the output frequency reference at the amplitude of the maximum frequency.)
- Integral time Ti: Ti determines the integral regulation intensity of the PID regulator. The shorter the integral time, the greater the adjustment intensity. (When the deviation between PID feedback and PID reference is 100.0%, the integral regulator performs continuous regulation within the time. The regulation amount reaches the maximum frequency.)
- Differential time Td: Td determines the regulation intensity of the PID regulator on the deviation change. Longer differential time indicates greater adjustment intensity. (Differential time indicates the time within which the feedback change reaches 100.0%. The regulation amount reaches the maximum frequency.)

Example

Step 1: Set F0-03 or F0-04 to 8 to select PID as the main frequency reference input source and auxiliary frequency input source.

Step 2: Set FA-00 to select a source of PID target reference. If FA-00 is set to 0, set FA-01 (digital setting of PID). The value 100% of this parameter corresponds to the maximum value of PID feedback.

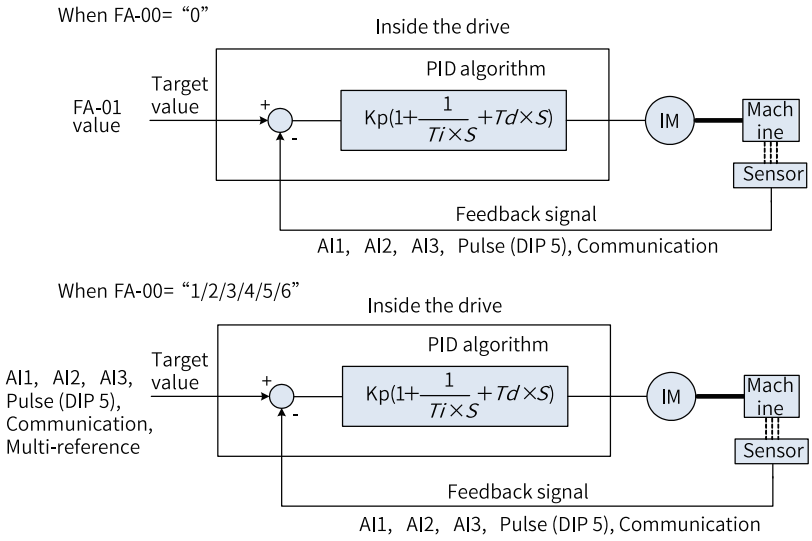


Figure 29-19 Principle of process PID control

Step 3: Set FA-02 to select a PID feedback source.

Step 4: Set FA-03 to select a PID action direction.

The following figure shows the logic of process PID control parameter configuration.

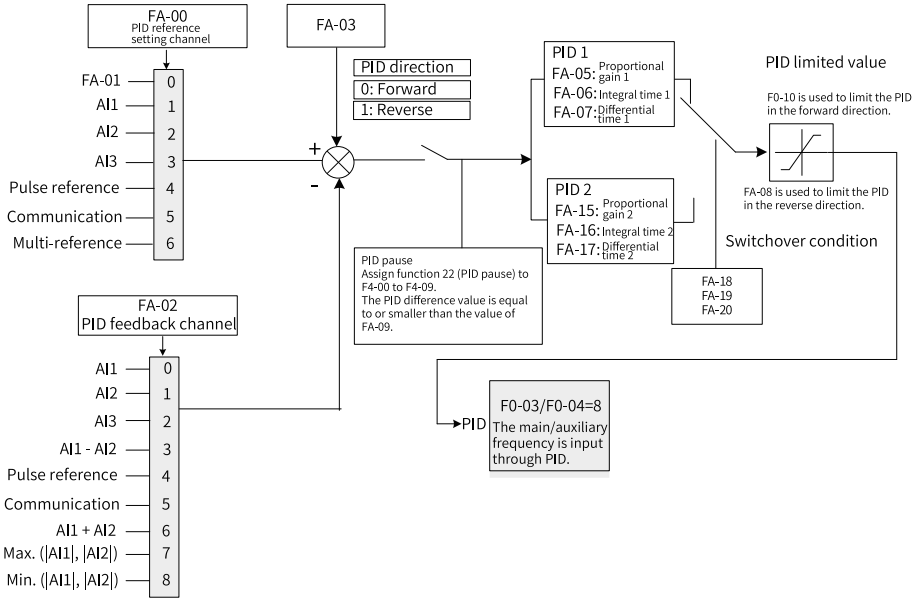


Figure 29-20 Parameter settings for process PID control

The upper and lower limits and range of the frequency output when the PID is used as the main frequency source are described as follows (for example, when the frequency source is only PID or main frequency + PID).

The reverse cut-off frequency is 0 or reverse running is prohibited (any one of the following three situations).

① FA-08 = 0, F8-13 = 0; ② FA-08 = 0, F8-13 = 1; ③ FA-08 ≠ 0, F8-13 = 1

Output upper limit = Frequency upper limit

Output lower limit = Frequency lower limit

Output range = Frequency lower limit to frequency upper limit (F0-14 to F0-12)

The reverse cut-off frequency is non-zero and reverse running is allowed (FA-08 ≠ 0, F8-13 = 0).

Output upper limit = +Frequency upper limit; Output lower limit = –Reverse cut-off frequency

Output range = –Reverse cut-off frequency to +Frequency upper limit (–FA-08 to +F0-12)

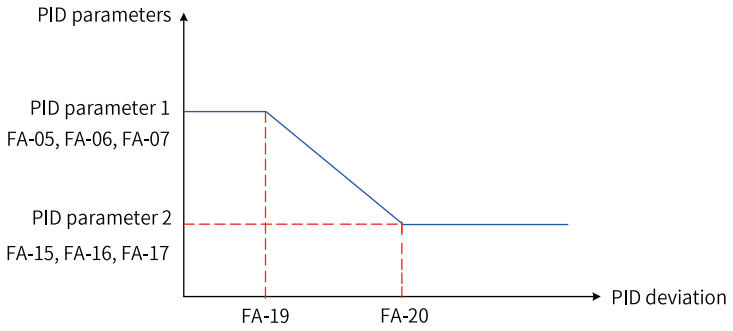


Figure 29-21 PID parameter switchover

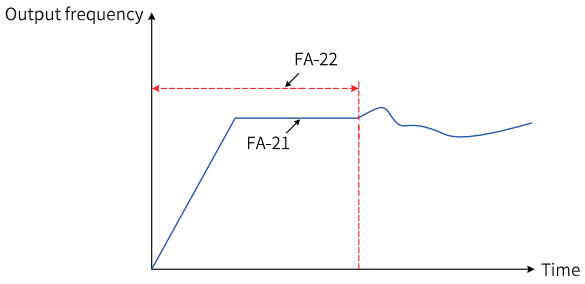


Figure 29-22 PID initial value

29.1.2.8 Setting Main Frequency Through Communication

The drive supports seven communication protocols, including Modbus, PROFIBUS DP, CANopen, CANlink, PROFINET, EtherCAT, and Ethernet/IP.

- When PROFIBUS DP, PROFINET, EtherCAT, Ethernet/IP, or CANopen (CANopen expansion card) is selected, set FD-00 to 9 and FD-01 to 3.
- When a CANlink card is used for CANopen communication, set FD-10 to 1. Set the CAN communication baud rate through FD-00 and CAN station No. through FD-02.
- When a CANlink card is used for CANlink communication, set FD-10 to 2. Set the CAN communication baud rate through FD-00 and CAN station No. through FD-02.

- When Modbus is used for communication, set the baud rate, data format, and station No. through FD-00, FD-01, and FD-02.

Example

Step 1: Set F0-03 to 9 to select communication as the main frequency source.

Step 2: Use the host controller to send a write command to the drive.

The following section describes how to set the main frequency through Modbus communication. For example, to set the frequency reference to 10000 through communication, send the write command 01 06 10 00 27 10 97 36.

The following table describes the definition of each byte.

Byte	Description
01H (settable)	Drive address
06H	Write command
1000H	Frequency reference address
2710H (10000 in decimal)	Target frequency
9736H	CRC check

Similarly, to set the frequency reference to –10000 through communication, send the write command 01 06 10 00 D8 F0 D7 4E. In the command, D8F0 is the low-order four bits of the hexadecimal number converted from -10000.

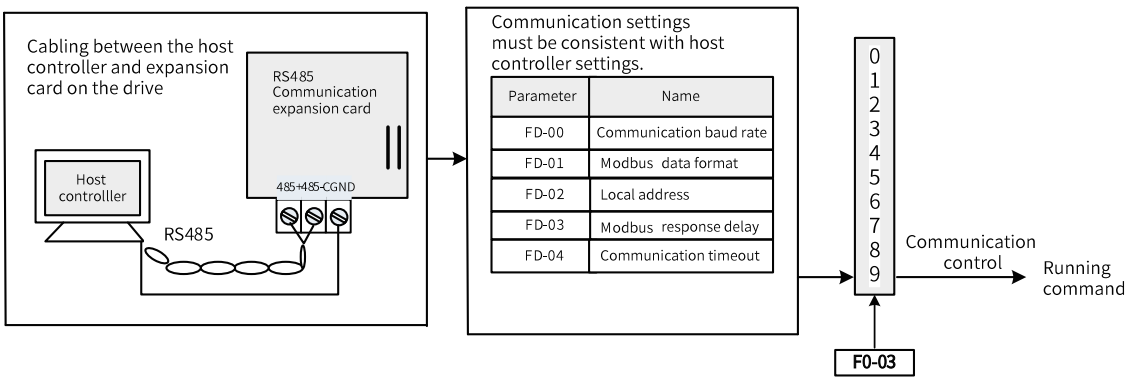


Figure 29-23 Parameters used to set the main frequency through communication

Table 29–3 Relationship between master commands and slave responses

Command from the Master		Response from the Slave	
ADDR	01H	ADDR	01H
CMD	06H	CMD	06H
High-order bit of the parameter address	10H	High-order bit of the parameter address	10H
Low-order bit of the parameter address	00H	Low-order bit of the parameter address	00H
High-order bit of the data content	27H	High-order bit of the data content	27H
Low-order bit of the data content	10H	Low-order bit of the data content	10H

Command from the Master		Response from the Slave	
CRC high-order bits	97H	CRC high-order bits	97H
CRC low-order Bit	36H	CRC low-order Bit	36H

The range of the frequency reference set through communication is -10000 to +10000 (decimal), corresponding to -100.00% (negative maximum frequency) to +100.00% (positive maximum frequency). Assume that F0-10 (maximum frequency) is set to 50 Hz. If the frequency reference in the write command is 2710H, which is equivalent to 10000 in the decimal format, the actual written frequency reference is 50 Hz (50 x 100%).

29.1.2.9 Selecting Source of Auxiliary Frequency Reference

There are ten auxiliary frequency sources in total, including digital setting (non-retentive at power failure), digital setting (retentive at power failure), AI1, AI2, AI3, pulse input, multi-reference, simple PLC, PID, and communication setting. You can set F0-04 to a value ranging from 0 to 9 to define the source.

When the auxiliary frequency reference is used as a separate frequency reference source, it is set in the same way as the main frequency reference. The following figure shows the logic block diagram. The auxiliary frequency reference can also be used together with the main frequency reference for frequency setting. For details, see *"29.1.2.10 Selecting Source of Main Frequency and Auxiliary Frequency Superposition" on page 648*.

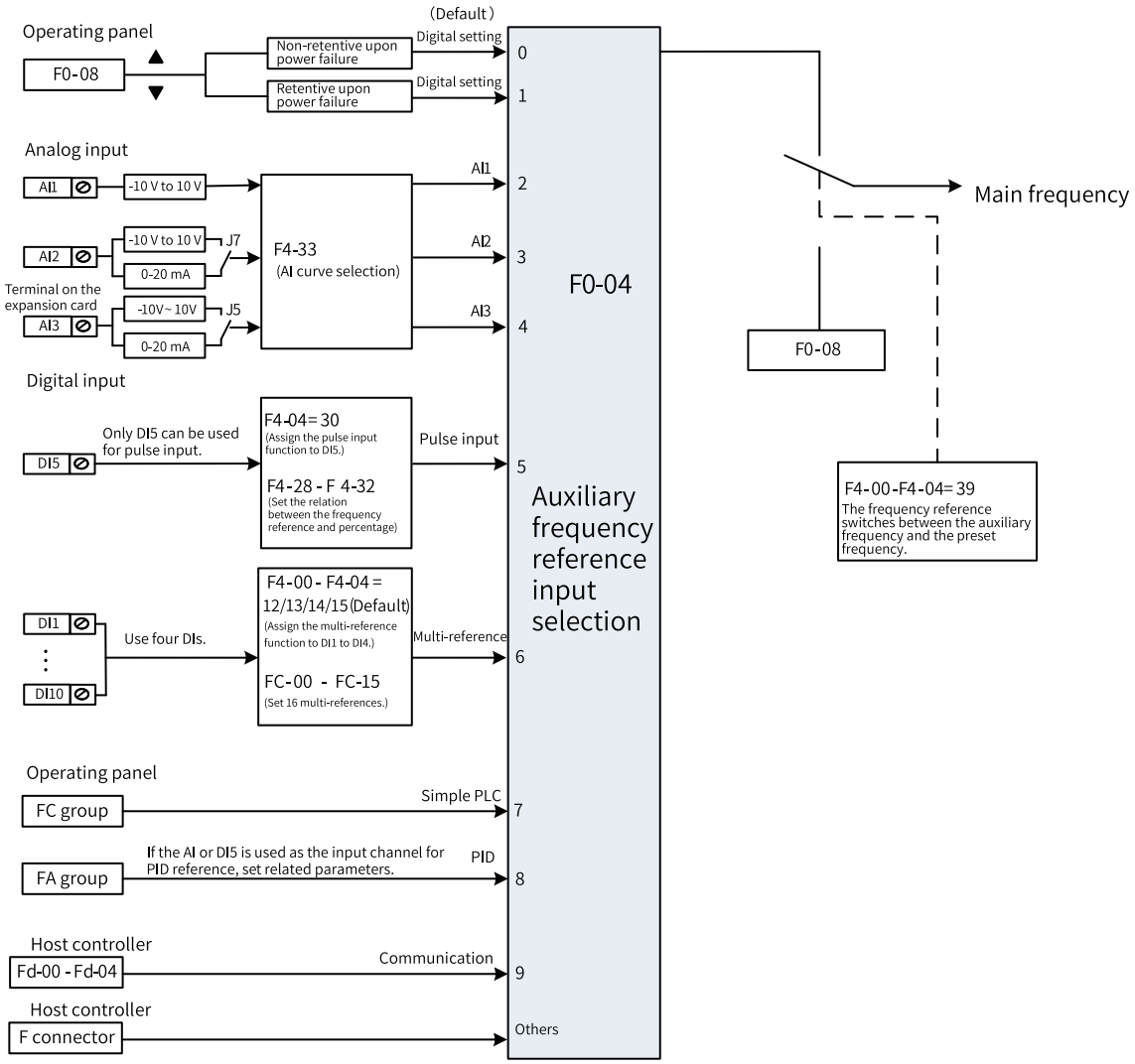


Figure 29-24 Auxiliary frequency reference source selection

Parameter Code	Parameter Name	Value Range	Default	Description
F0-04	Auxiliary frequency Y source	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communica-tion (To be continued)	0	This parameter is used to set the source of the auxiliary frequency Y, as shown below. 0: Digital setting (non-retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is restored to the value of F0-08. 1: Digital setting (retentive upon power failure) The initial value of the frequency reference is the value of F0-08 (Preset frequency). The frequency can be changed by using the ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP/DOWN key. When the AC drive is powered on again after a power failure, the frequency reference is the same as that at the moment of the last power failure. Modifications made by using keys ▲ and ▼ keys on the operating panel or the multi-functional input terminal functioning as the UP and DOWN key remain effective. 2: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
F0-04	Auxiliary frequency Y source	Continued 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	0	Continued 7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. 9: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication (address 0x7310). In this case, the AC drive must be installed with a communication card for communicating with the host controller. (To be continued)
F0-04	Auxiliary frequency Y source	Continued Others: F connector	0	Continued Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources. Note: If this parameter cannot be set to the desired value, check whether F0-03 is set repeatedly.

29.1.2.10 Selecting Source of Main Frequency and Auxiliary Frequency Superposition

Main and auxiliary frequency superposition is used to set the frequency reference by performing operations on the main frequency and auxiliary frequency. The relationship between the target frequency and the main and auxiliary frequencies is set in F0-07, which is described as follows.

Table 29–4 Relationship between target frequency and main and auxiliary frequencies

No.	Relationship Between Target Frequency and Main and Auxiliary Frequencies	
1	Main frequency	The main frequency reference is used as the target frequency source directly.
2	Auxiliary frequency source	The auxiliary frequency reference is used as the target frequency source directly.
3	Main and auxiliary frequency operation	Four operations are supported, including main frequency + auxiliary frequency, main frequency - auxiliary frequency, max. (main frequency, auxiliary frequency), and min. (main frequency, auxiliary frequency).
4	Frequency switchover	You can use the DI to select any of the preceding three frequency sources. In this case, allocate function 18 (frequency reference switchover) to the DI.

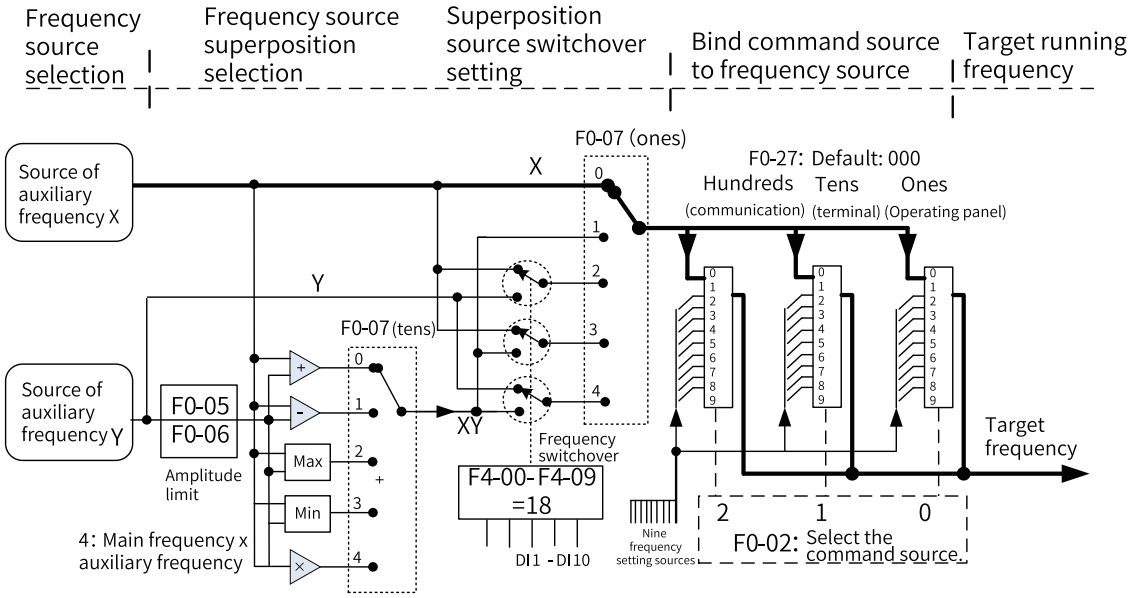


Figure 29-25 Main and auxiliary frequency superposition

Table 29–5 Main and auxiliary frequency superposition

Parameter Code	Parameter Name	Default	Value Range	Description
F0-05	Auxiliary frequency source Y at superposition	0	0: Relative to the maximum frequency 1: Relative to main frequency X	The auxiliary frequency source range is set as a percentage. This parameter is used to set the base value of the frequency source range percentage. 0: Relative to the maximum frequency The auxiliary frequency at superposition is equal to the auxiliary frequency source range (F0-06) multiplied by the maximum frequency (F0-10). 1: Relative to main frequency reference The auxiliary frequency at superposition is equal to the auxiliary frequency source range (F0-06) multiplied by the main frequency X.
F0-06	Range of auxiliary frequency Y upon superposition	100%	0% to 150%	This parameter defines the range of auxiliary frequency Y.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-07	Frequency superposition selection	0	Ones: Frequency reference selection 0: Main frequency X 1: Main and auxiliary frequency operation result (based on tens place) 2: Switchover between main frequency X and auxiliary frequency Y 3: Switchover between main frequency X and the main and auxiliary frequency operation result 4: Switchover between auxiliary frequency Y and the main and auxiliary frequency operation result	This parameter is used to set the superposition mode of the main frequency X and auxiliary frequency Y. The ones place is used to select the frequency reference, and the tens place is used to set the main and auxiliary frequency operation. Ones 0: Main frequency X The running frequency of the AC drive is determined by the main frequency X (F0-03). 1: Main and auxiliary frequency operation (based on tens place) The running frequency of the AC drive is the calculation result of the main and auxiliary frequencies, and the calculation method is determined by the tens place of F0-07 (Frequency source superposition). 2: Switchover between main frequency X and auxiliary frequency Y The operating frequency of the AC drive is selected or switched between the main frequency X and the auxiliary frequency Y through the DI. In this case, the corresponding DI must be assigned with the frequency source switching function. If the DI2 terminal is used for switchover, set F4-01 to 18. 3: Switchover between main frequency X and the main and auxiliary frequency operation result The operating frequency of the AC drive is selected or switched between the main frequency X and operation result of X and Y. If the DI2 terminal is used for switchover, set F4-01 to 18. 4: Switchover between auxiliary frequency Y and the main and auxiliary frequency operation result The operating frequency of the AC drive is selected or switched between the auxiliary frequency Y and operation result of X and Y. If the DI2 terminal is used for switchover, set F4-01 to 18.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-07	Frequency superposition selection	0	Continued Tens: Main and auxiliary frequency operation 0: Main frequency + auxiliary frequency 1: Main frequency - auxiliary frequency 2: Max. (main frequency, auxiliary frequency) 3: Min. (main frequency, auxiliary frequency)	Continued Tens: 0: Main frequency + auxiliary frequency The main and auxiliary operation result is the product of main frequency X plus the auxiliary frequency Y. 1: Main frequency - auxiliary frequency The main and auxiliary operation result is the product of main frequency X minus the auxiliary frequency Y. 2: Max. (main frequency, auxiliary frequency) The main and auxiliary operation result is the larger value between the main frequency X and the auxiliary frequency Y. 3: Min. (main frequency, auxiliary frequency) The main and auxiliary operation result is the smaller value between the main frequency X and the auxiliary frequency Y.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-27	Bind command source to frequency source	0	Ones: Bind operation panel to frequency source 0: No binding 1: Digital setting 2: AI1 3: AI2 4: AI3 5: Pulse reference 6: Multi-reference 7: Simple PLC 8: PID 9: Communication	This parameter defines the binding relationship between the three operation command sources and nine frequency reference sources to facilitate synchronous switchover. For details on the frequency sources, see the description of F0-03 (Main frequency source X selection). Different command sources can be bound to the same frequency reference source. If a command source has a bound frequency source, the frequency sources set in F0-03 to F0-07 no longer take effect when the command source is effective. 0: No binding 1: Digital setting The initial value of the frequency reference is the value of F0-08 (Preset frequency). 2: AI1 The frequency reference is input through AI1, which inputs current or voltage signals. The frequency is calculated according to the AI curve, 3: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve. 4: AI3 The frequency reference is input through AI3, which inputs current or voltage signals. The frequency is calculated according to the AI curve. 5: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated according to the relationship curve between the pulse frequency and the frequency reference.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-27	Bind command source to frequency source	0	Continued Tens: Bind terminal to frequency source Values 0 to 9 for the tens place are the same as those for the ones place. Hundreds: Bind communication to frequency source Values 0 to 9 for the tens place are the same as those for the ones place.	Continued 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals can provide 16 states, corresponding to 16 frequencies. 7: Simple PLC Simple PLC is a multi-reference used to control the running time and acceleration/deceleration time. Parameters FC-00 to FC-15 are used to set the values of each frequency. FC-18 to FC-49 are used to set the running time and acceleration and deceleration time of each frequency. Up to 16 frequencies can be set. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. 9: Communication The frequency is set through communication. The frequency can be input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment.

F0-05 and F0-06 are only valid in the main frequency + auxiliary frequency operation to limit the range of the auxiliary frequency.

The three command sources can be bound to different frequency sources through F0-27. When the specified command source (F0-02) is bound to a frequency source, the frequency is determined by the frequency setting channel set by F0-27. In this case, both main and auxiliary frequencies are invalid.

29.1.2.11 Setting Offset Frequency and Additional Frequency

Offset frequency: The offset frequency is set through F0-21 as the correction value that is superimposed on the main and auxiliary frequency. The offset frequency is superimposed directly on the original setting value before the ramp function generator acts.

Parameter Code	Parameter Name	Value Range	Default	Description
F0-21	Digital setting of offset frequency	0.00 Hz to F0-10	0.00	This parameter defines the offset frequency. It is used to adjust the frequency reference when the main/auxiliary frequency is set by an external analog signal (voltage or current). Output frequency = Current frequency reference+ F0-21 Note: The offset frequency is also valid when the main/ auxiliary frequency is set by other sources.

Additional frequency: Set A4-61 to set the additional frequency, which is used for speed adjustment without acceleration/deceleration time. The additional frequency takes effect only during normal operation. The effective value is superimposed directly to the output of the ramp function generator.

Parameter Code	Parameter Name	Value Range	Default	Description
A4-61	Source of additional speed in speed control	0: 0 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference 7: Motorized potentiometer 8: PID Others: F connector	0	This parameter sets the source of the additional speed in the speed control mode. 0: 0 The additional speed in the speed control mode is set to 0. 1: AI1 The additional speed in the speed control mode is input through AI1, which inputs current or voltage signals. The speed is calculated according to the set AI curve. 2: AI2 The additional speed in the speed control mode is input through AI2, which inputs current or voltage signals. The speed is calculated according to the set AI curve. 3: AI3 The additional speed in the speed control mode is input through AI3, which inputs current or voltage signals. The speed is calculated according to the set AI curve. 4: Pulse reference The additional speed in the speed control mode is input through DI5 pulse frequency. 5: Communication The additional speed in the speed control mode is input through communication. The additional speed in the speed control mode is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals can be grouped in different ways to indicate 16 states, which correspond to 16 frequency references (percentage x maximum frequency) in group FC. 7: Motorized potentiometer The additional speed in the speed control mode is set by the motorized potentiometer module output. 8: PID The additional speed in the speed control mode is set by PID output. Others: F connector The additional speed in the speed control mode is input through the connector.

29.1.2.12 Setting Frequency Reference Limit

Frequency upper limit: Defines the maximum running frequency of the motor.

Frequency lower limit: Defines the minimum running frequency of the motor.

Maximum frequency: Defines the maximum output frequency.

Frequency upper limit source: Defines the source of the frequency upper limit.

Frequency upper limit offset: Defines the offset of the frequency upper limit. This parameter is valid only when the frequency upper limit source is set to the AI.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-10	Maximum frequency	50.00 Hz	5.00 Hz to 599.00 Hz	This parameter defines the maximum output frequency of the AC drive.
F0-11	Frequency upper limit source	0	0: F0-12 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication Others: F connector	This parameter defines the source of frequency upper limit, as described below. 0: F0-12 The frequency upper limit is set by F0-12. 1: AI1 The frequency upper limit is input through AI1, which inputs current or voltage signals. The frequency is calculated according to the set AI curve. 2: AI2 The frequency upper limit is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the set AI curve. 3: AI3 The frequency upper limit is through AI3, which inputs current or voltage signals. The frequency is calculated according to the set AI curve. 4: Pulse reference (DI5) The frequency upper limit is set through the DI5. The frequency is calculated based on the curve of the relationship between the pulse frequency and the maximum frequency. 5: Communication The frequency upper limit is set through communication. Others: F connector The frequency upper limit is set through the connector. Read the connector value through setting the parameter No. of a float connector. The value being read is used as the frequency upper limit. This mode is used for expansion besides the common sources.
F0-12	Frequency upper limit	50.00 Hz	F0-14 (frequency lower limit) to F0-10 (maximum frequency)	This parameter defines the maximum operating frequency of motors.

Parameter Code	Parameter Name	Default	Value Range	Description
F0-13	Frequency upper limit offset	0.00 Hz	0.00 Hz to maximum frequency (F0-10)	This parameter defines the offset of the frequency upper limit. It is used to adjust the output frequency value upon the minimum frequency reference when the frequency is set by an external analog signal (voltage or current). Note: When the upper frequency source is selected to a value other than digital setting, the upper frequency offset is valid.
F0-14	Frequency lower limit	0.00 Hz	0.00 Hz to frequency upper limit (F0-12)	This parameter defines the minimum operating frequency of motors. If the frequency is lower than the lower limit, you can determine whether to stop, run at the lower limit, or run at zero speed by F8-14.

29.1.2.13 Setting Action When Frequency Is Below Lower Limit

The frequency lower limit defines the minimum running frequency for the motor.

If the frequency reference of the AC drive is lower than the frequency lower limit (F0-14), you need to set F8-14 to further specify the corresponding action of the AC drive, as described below.

- 0: Run at frequency lower limit
  If the running frequency is below the frequency lower limit, the AC drive will run at the frequency lower limit.
- 1: Stop
  If the running frequency is below the frequency lower limit, the AC drive stops.
- 2: Run at zero speed
  If the running frequency is below the frequency lower limit, the AC drive runs at zero speed.
- 3: Coast to stop
  If the running frequency is below the frequency lower limit, the AC drive coasts to stop.

Parameter Code	Parameter Name	Default	Value Range	Description
F8-14	Running mode when frequency reference is below lower limit	0	0: Run at frequency lower limit 1: Stop 2: Run at zero speed 3: Coast to stop	-

29.1.2.14 Setting Main Frequency Through Pulse

Select the input pulse as the main frequency source by setting F0-03 to 5. In this mode, the pulse reference must be input only from multi-functional input terminal DI5. The signal specifications set by pulse are 9 V to 30 V (voltage) and 0 Hz to 100 kHz (frequency).

The setting procedure is as follows.

Step 1: Set F0-03 to 5 to select "pulse reference" as the main frequency source. In this mode, the pulse reference must be input only from multi-functional input terminal DI5.

Step 2: Set F4-04 to 30 to assign DI5 with the "pulse frequency input" function.

Step 3: Set F0-07 to 00 to set frequency reference superposition to "main frequency reference".

Step 4: Set the pulse reference curve. Set F4-28 to F4-31 to set the two-point straight line relationship between the pulse frequency input from DI5 and the corresponding percentage.

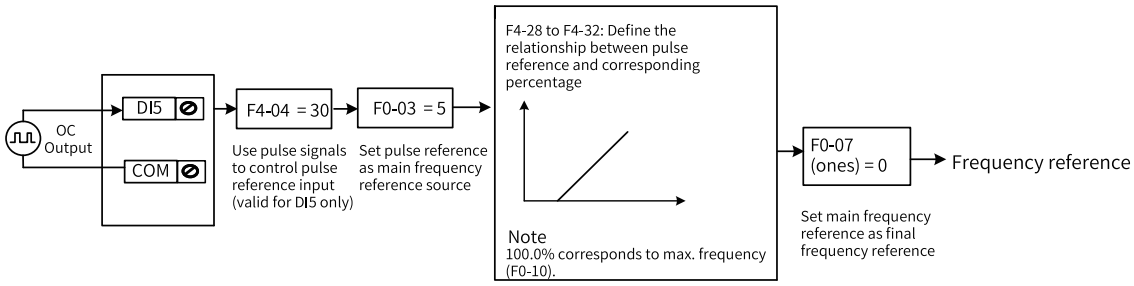


Figure 29-26 Parameters used to set the main frequency through pulse input

Step 5: Set F4-32 to select the filter time of pulse frequency.

Set this parameter to balance the response speed and anti-interference capability. If quick response is required, reduce the value of F4-32. If the interference on site is strong, increase the value of F4-32.

The longer the filter time, the stronger the anti-interference capability, but the slower the adjustment response speed. The shorter the filter time, the faster the adjustment response speed, but the weaker the anti-interference capability. When the pulse signal on site may easily be disturbed, increase the filter time to stabilize the detected pulse signals. However, long filter time slows down the response speed of the pulse signal detection. Therefore, set the filter time properly based on the actual application environment.

Parameter Code	Parameter Name	Default	Description
F4-29	Corresponding percentage of pulse minimum input	0.0%	F4-29 corresponds to the y axis of the minimum pulse input, that is, the set value corresponding to the minimum pulse input.
F4-30	Pulse maximum input	50.00 kHz	F4-30 corresponds to the x axis of the maximum pulse input, that is, the maximum input frequency of the pulse.
F4-31	Percentage corresponding to maximum pulse input frequency	100.0%	F4-31 corresponds to the y axis of the maximum pulse input, that is, the set value corresponding to the maximum pulse input.
F4-32	Pulse filter time	0.10s	Used to set the time coefficient for pulse curve filter processing.

29.1.3 Start/Stop Mode Setting

29.1.3.1 Start Mode

The drive supports four start modes: direct start, flying start, pre-excitation start, and SVC quick start. Set F6-00 to select a start mode of the drive.

Direct start

The direct start mode (F6-00 = 0) applies to most of loads.

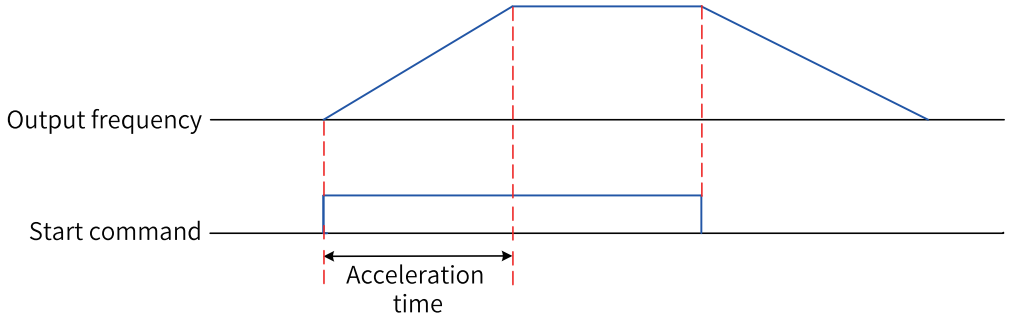


Figure 29-27 Direct start time sequence

The setting of starting frequency before start applies to lifting loads, such as elevators and cranes.

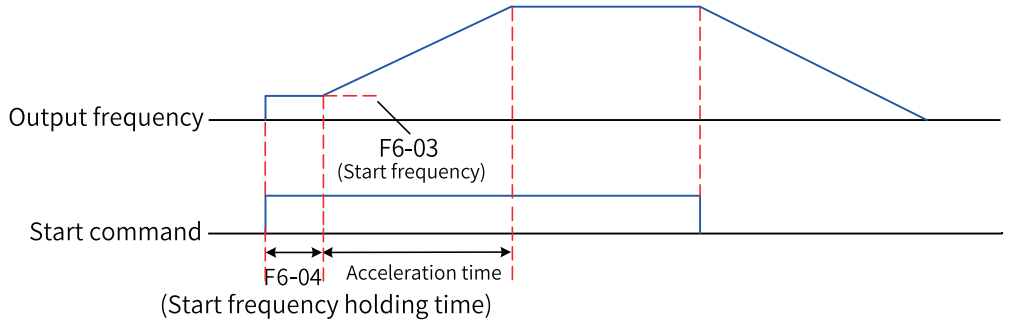


Figure 29-28 Time sequence for start with the starting frequency set

The setting of DC braking time at startup before start applies to applications where the motor may rotate at start.

If the DC braking time at startup is set to 0, the drive starts operating at the starting frequency. If the DC braking time at startup is not 0, the AC drive performs DC braking first and then running from the starting frequency. This method is applicable to most low-inertia loads. The motor may rotate during startup.

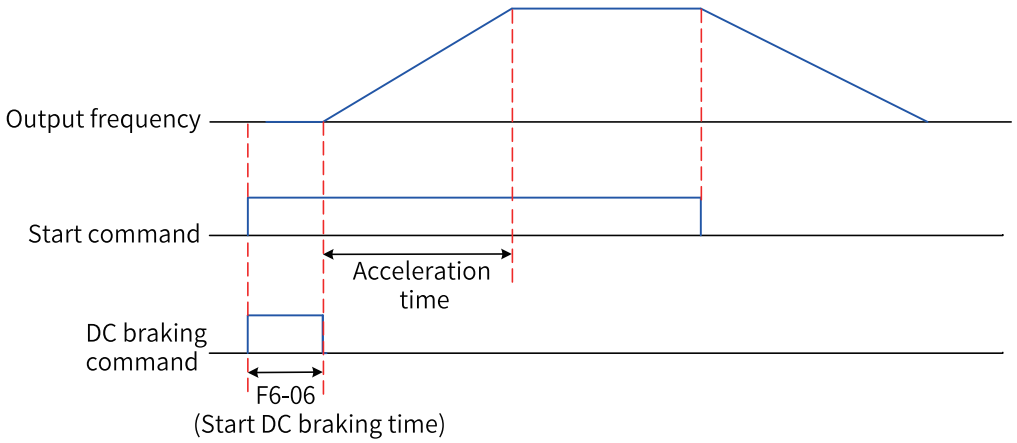


Figure 29-29 Time sequence for start with DC braking

Start with DC braking is suitable for driving loads such as elevators and lifting machines. Start with startup frequency is suitable for driving equipment that requires starting torque, such as cement mixers. The following figure describes the frequency curve during start.

The following figure shows the frequency change after F6-00 is set to direct start and the running command is executed.

After the running command is executed and the DC braking time (F6-06) elapses, the frequency starts from F6-03 and remains the time set by F6-04 (startup frequency holding time). Then the frequency changes to the value of F0-10 (maximum frequency) according to F6-07 (acceleration/deceleration mode) and F0-17 (acceleration time).

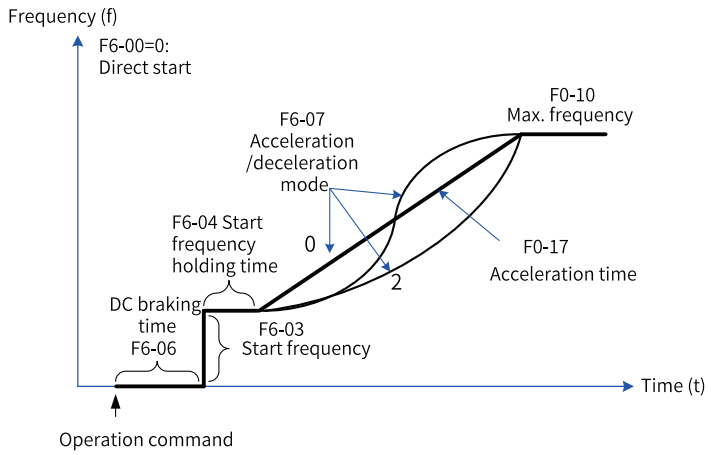


Figure 29-30 Direct start

The following figure describes the frequency curve during start when parameter default values are set. After the running command is executed, 0 Hz changes to the value of F0-10 (maximum frequency) linearly from 0s after the time set by F0-17.

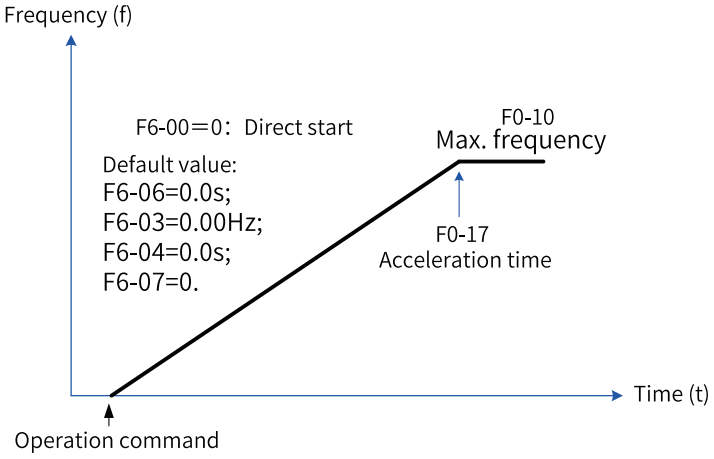


Figure 29-31 Frequency curve during start

Flying start

When F6-00 is set to 1, the drive uses the flying start mode. In this mode, the drive first determines the motor rotation speed and direction, and then starts at the detected frequency of the motor. This mode is applicable to applications where the drive is used to drive large-inertia machinery loads.

If the load motor is still rotating due to inertia when the drive needs a restart, using flying start can prevent overcurrent upon start. The following figure describes the frequency curve during start.

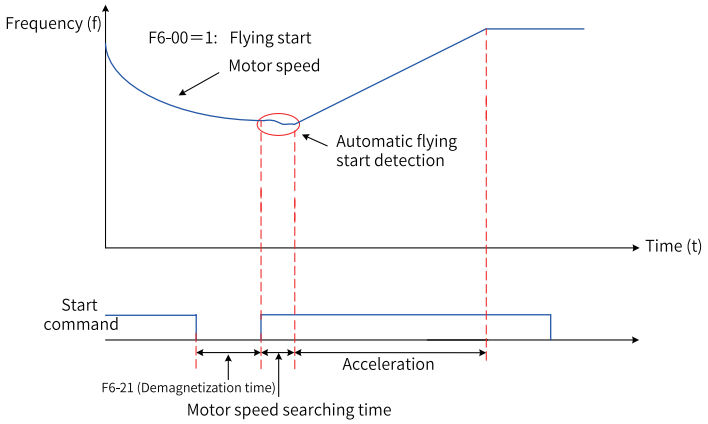


Figure 29-32 Flying start

Pre-excitation start

Set F6-00 to 0, 2, or 3, and F6-06 (DC braking time) to 0. The AC drive enters the pre-excitation startup mode. This mode is applicable to asynchronous motors only in the SVC and FVC modes. Before startup, the AC drive pre-excites the motor to speed up the motor response and reduce the startup current.

Changing bits 11 and 12 of the flux linkage control command word (AB-32 for the first motor and B9-32, BE-32, and CE-32 for the other motors) can modify the pre-excitation mode. By default, current pre-excitation is used. The value of AB-51, B9-51, BE-51, or CE-51 is the percentage of the pre-excitation current to the rated current. The higher the pre-excitation current, the shorter the pre-excitation time.

SVC quick start

This mode is the quick pre-excitation start mode.

Note

- Flying start is recommended if you need to start a motor that is rotating at a high speed.
- Pre-excitation start and SVC quick start apply only to AC asynchronous motors.

29.1.3.2 Stop Mode

The drive supports three stop modes, including decelerate to stop, coast to stop, and stop at the maximum capability.

You can set F6-10 to select a stop mode for the AC drive.

Parameter Code	Parameter Name	Default	Value Range	Description
F6-10	Stop mode	0	0: Decelerate to stop 1: Coast to stop 2: Stop at maximum capability	This parameter is used to select the stop mode of the AC drive. 0: Decelerate to stop After the stop command becomes active, the AC drive decreases the output frequency based on the deceleration time, and stops when the frequency is reduced to 0. 1: Coast to stop After the stop command becomes active, the drive stops output immediately and the motor coasts to stop based on the mechanical inertia. 2: Stop at maximum capability. The motor speed reference is set to 0 forcibly. The motor decelerates to 0 based on the maximum output capacity. The motor torque or current may reach the limit value during deceleration.
F6-11	Start frequency of DC braking for stop	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The AC drive starts DC braking when the running frequency decreases to the value of this parameter during deceleration to stop.
F6-12	Waiting time of DC braking for stop	0.0s	0.0s to 100.0s	When the operating frequency decreases to the start frequency of DC braking for stop, the drive stops output temporarily and then starts DC braking. This prevents faults such as overcurrent caused by DC braking at a high speed.
F6-13	DC braking current for stop	50%	0% to 100%	A greater DC braking current indicates greater braking force. The setpoint 100% corresponds to the rated motor current. The upper limit of the current is 80% of the rated current of the drive. The upper limit is set by F6-34. The maximum upper limit of the DC braking current for stop is 135% of the rated drive current.
F6-14	DC braking time for stop	0.0s	0.0s to 100.0s	This parameter specifies the holding time of DC braking. If this parameter is set to 0, DC braking is disabled.

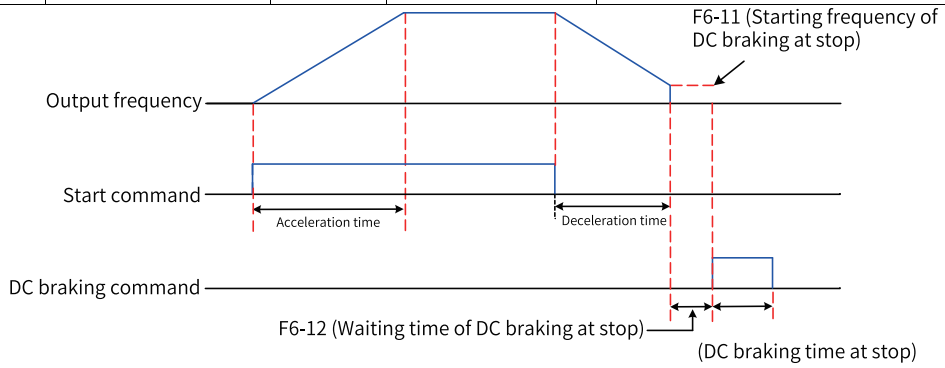


Figure 29-33 Time sequence of DC braking for stop

Decelerate to stop

When F6-10 is set to 0, the AC drive decelerates to stop. After the stop command is input, the drive decreases the output frequency based on the deceleration time and stops when the frequency declines to 0.

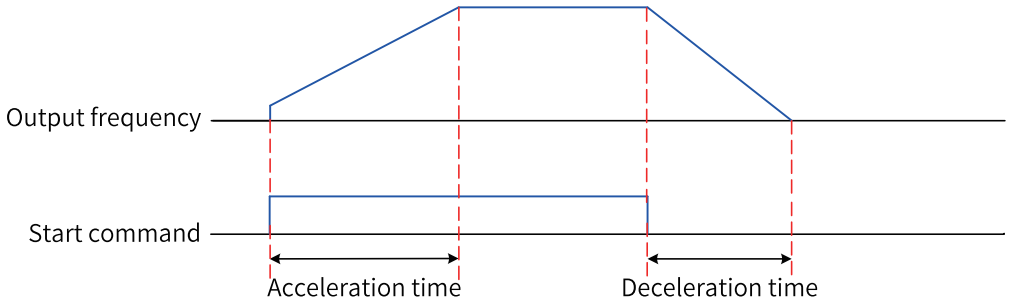


Figure 29-34 Sequence diagram for decelerate-to-stop

Coast to stop

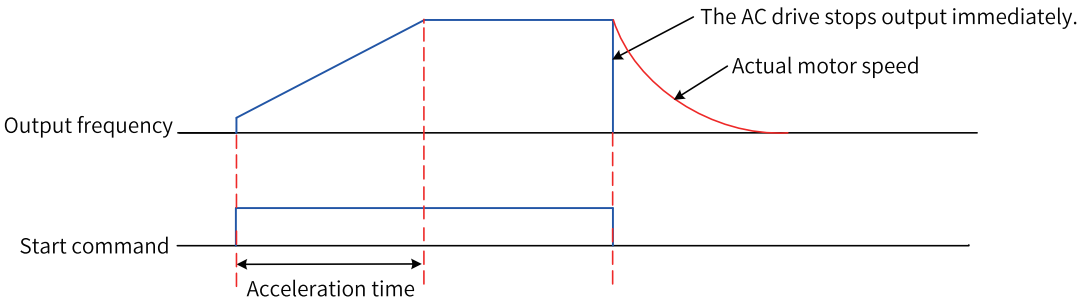


Figure 29-35 Sequence diagram for coast-to-stop

29.1.3.3 Acceleration/Deceleration Time Setting

The acceleration time indicates the time required for the AC drive to accelerate from 0 Hz to F0-25 (base frequency for acceleration/deceleration time). The deceleration time indicates the time required for the AC drive to decelerate from F0-25 (base frequency for acceleration/deceleration time) to 0 Hz.

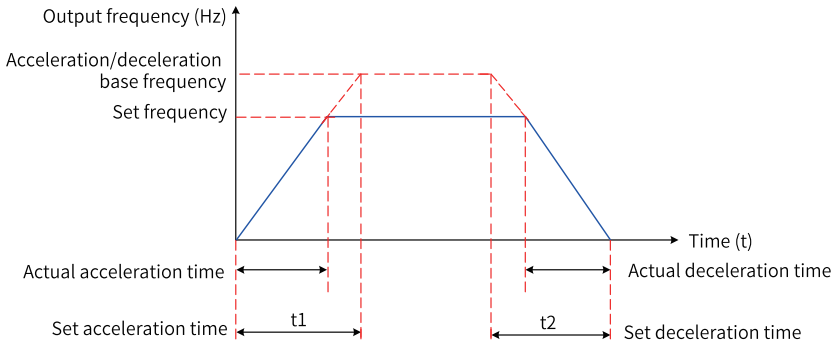


Figure 29-36 Acceleration/Deceleration time

The AC drive provides four groups of acceleration/deceleration time, which can be selected by using the DI assigned with functions 16 and 17. The acceleration/deceleration time is defined by the following parameters:

Group 1: F0-17, F0-18

Group 2: F8-03, F8-04

Group 3: F8-05, F8-06

Group 4: F8-07, F8-08

Example

The following example uses DI7 and DI8 as the input switchover terminals to describe how to set the acceleration/deceleration time.

1. Set F4-06 and F4-07 to select DI7 and DI8 for switchover.

Parameter Code	Parameter Name	Value Range	Description
F4-06	DI7 function selection	16	Acceleration/deceleration time selection terminal 1
F4-07	DI8 function selection	17	Acceleration/deceleration time selection terminal 2

2. Set the corresponding acceleration/deceleration time through parameters.

DI8 State	DI7 State	Acceleration/Deceleration Time
OFF	OFF	Group 1: F0-17, F0-18 (Acceleration time 1)
OFF	ON	Group 2: F8-03, F8-04 (Acceleration time 2. For details, see F0-17 and F0-18.)
ON	OFF	Group 3: F8-05, F8-06 (Acceleration time 3. For details, see F0-17 and F0-18.)
ON	ON	Group 4: F8-07, F8-08 (Acceleration time 4. For details, see F0-17 and F0-18.)

3. Set F0-19 (acceleration/deceleration time unit). Note that when this parameter is modified, the decimal places of the four groups of acceleration/deceleration time will change, and the corresponding acceleration/deceleration time will also change.
4. Set F6-07 (acceleration/deceleration mode) to select the frequency change mode during the start and stop process of the AC drive.
   - 0: The output frequency increases or decreases linearly.
   - 1: The output frequency increases or decreases according to the S-curve in real time when the target frequency changes. You must select the arc symmetric mode or the acceleration and deceleration segment setting through F6-20. This mode is applicable to applications requiring smooth running and quick response in real time.
5. Set F6-08 and F6-09 to select the time proportion of S-curve start segment and time proportion of S-curve end segment. The following condition must be met: F6-08 + F6-09 ⩽ 100.0%
6. Select the arc type.

In case of abrupt acceleration or deceleration, the output frequency of the ramp function generator is not smooth and the acceleration rate of the output frequency is discontinuous, which may cause motor torque oscillation and damage to mechanical gears.

A4-65 = 0 (incontinuous smoothing): The motor immediately decelerates in case of input value change.

A4-65 = 1 (continuous smoothing): During acceleration, even if the input value suddenly decreases, the motor will execute the end arc (causing overshoot) before deceleration. During deceleration, even if the input value suddenly increases, the motor will execute the end arc (causing overshoot) before acceleration.

The following description takes sudden deceleration during forward acceleration as an example. The target frequency at t0 is F3 and the motor accelerates to frequency F2 at t1. At this time, the target frequency is set to F1. The RFG output frequency will change according to curve 3 rather than curve 2 (decelerate to run after the acceleration rate is set to 0). Curve 3 indicates that acceleration v is reduced to 0 based on the jerk (time derivative of acceleration, standing for the acceleration change rate) of the end arc in the acceleration range and then the motor decelerates to run. This helps to solve abrupt change of acceleration v at t1 and reduces impact of the abrupt change response on the device.

29.2 Motor Configuration

The following figure describes quick commissioning of the AC drive.

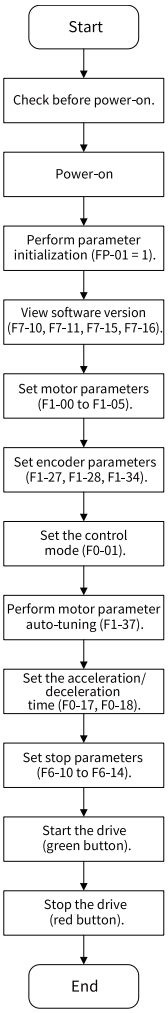


Figure 29-37 Basic commissioning flowchart

The following figure describes the overall commissioning procedure.

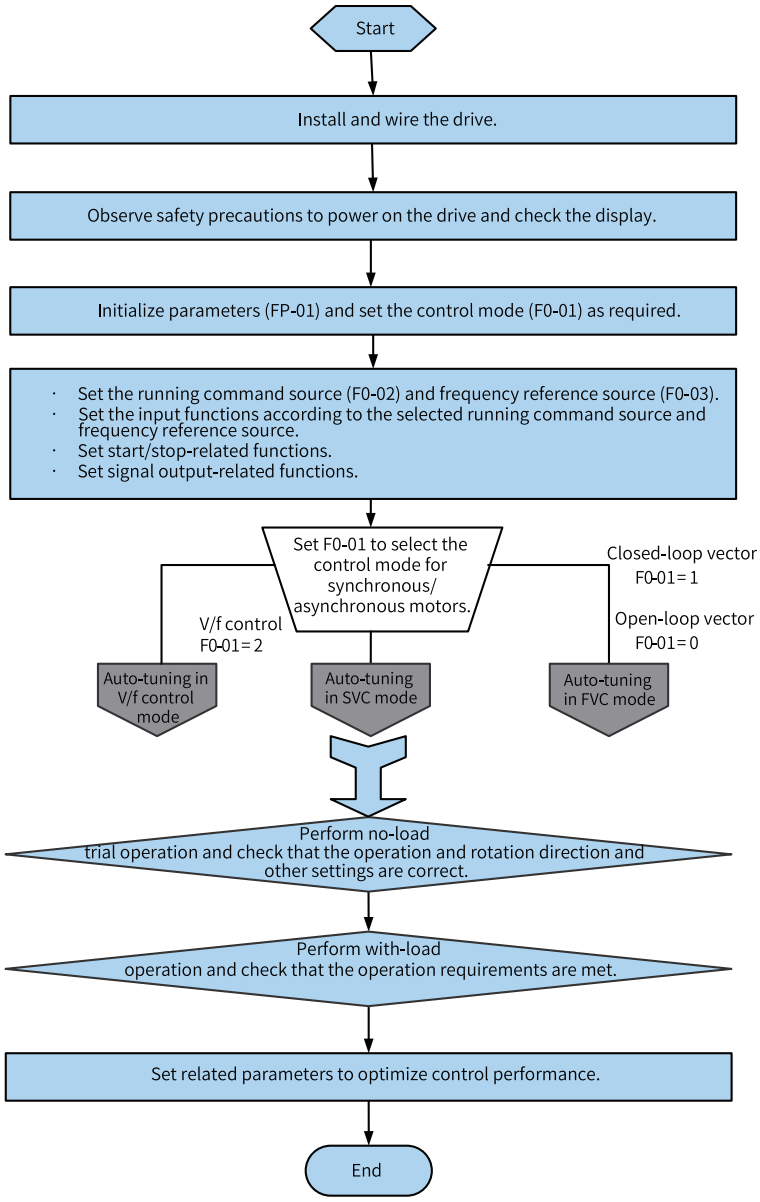


Figure 29-38 Overall commissioning flowchart

F1-37 can be used to select different tuning modes:

- 1: Static partial auto-tuning for asynchronous motor
- 2: Dynamic auto-tuning for asynchronous motor
- 3: Static complete auto-tuning for asynchronous motor
- 4: Inertia auto-tuning
- 5: Dead zone auto-tuning
- 11: With-load auto-tuning for synchronous motor
- 12: Dynamic no-load auto-tuning for synchronous motor
- 13: Complete static auto-tuning for synchronous motor

For permanent magnet synchronous motors and excited synchronous motors, select 11, 12, or 13.

Commissioning Flowchart in V/f Control Mode

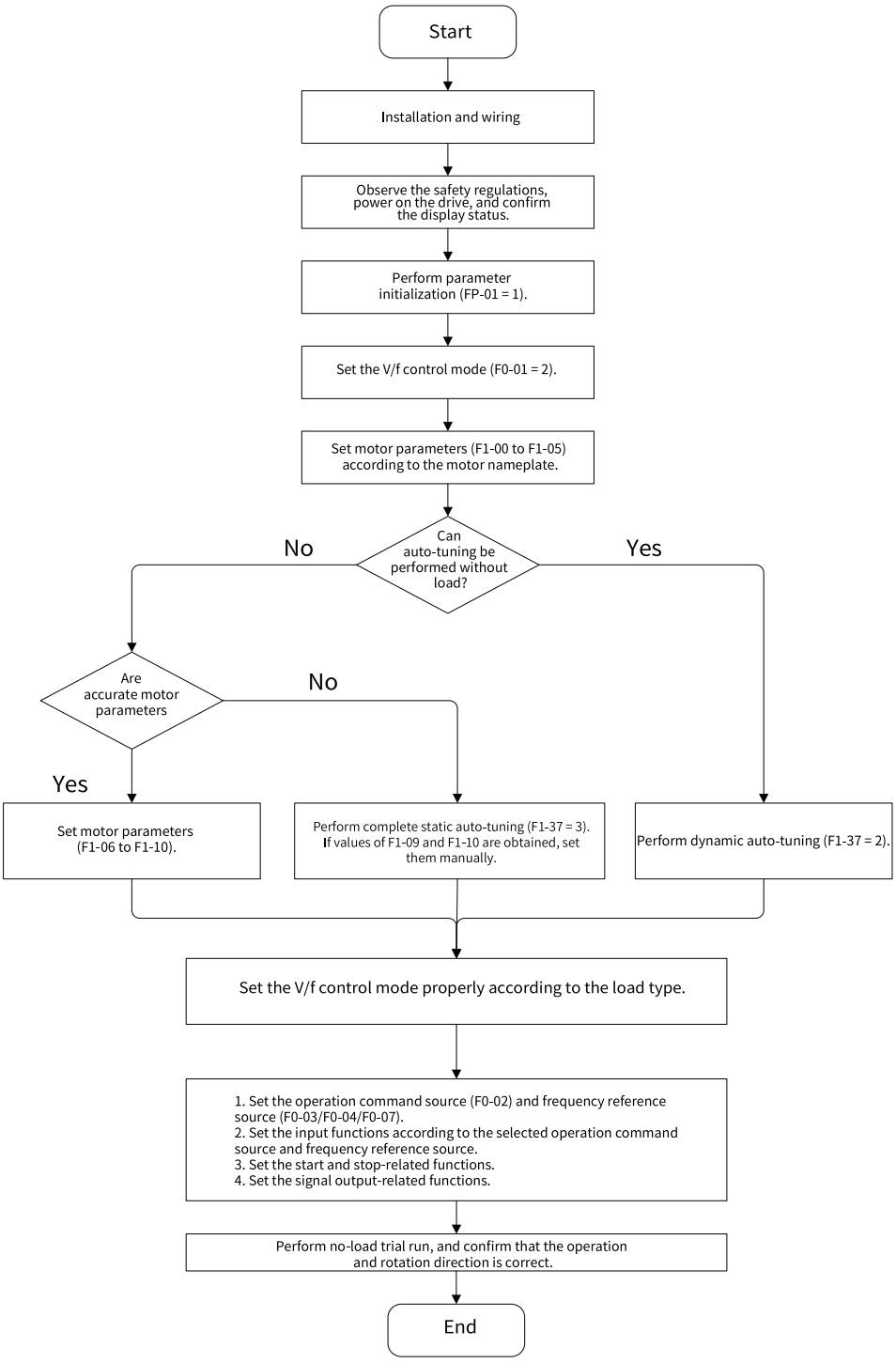


Figure 29-39 Commissioning flowchart in V/f control mode

Note

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

Commissioning Flowchart in SVC Mode

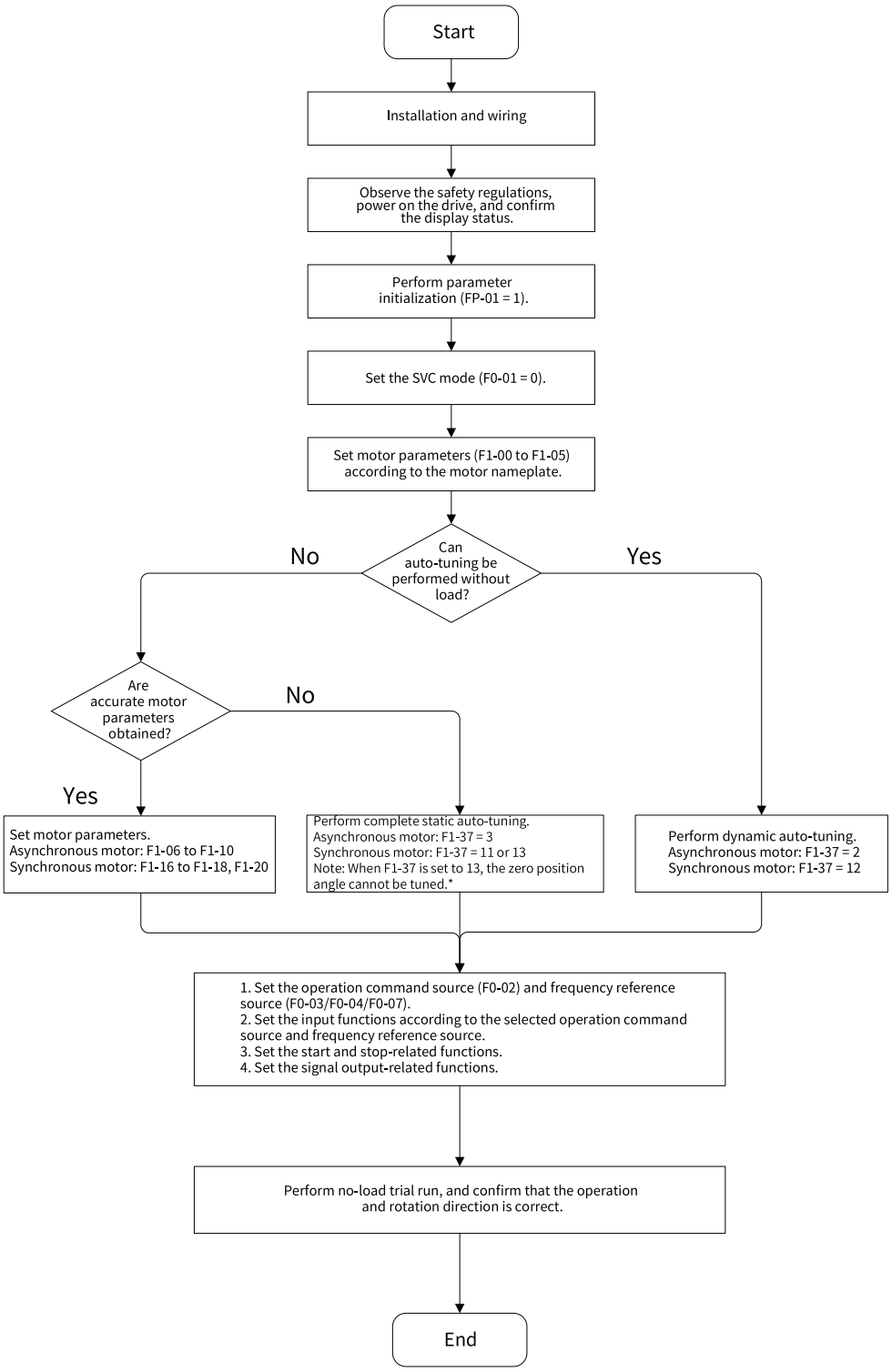


Figure 29-40 Commissioning flowchart in SVC mode

Note

* If bit 0 of A9-09 is enabled and F1-37 is set to 11, the encoder zero position angle will be tuned, but the encoder rotation direction will be not tuned. If F1-37 is set to 13, the encoder will not be tuned. If bit 0 of A9-09 is enabled and F1-37 is set to 11 or 13, the encoder will not be tuned.

During static auto-tuning, the motor will rotate slowly to a certain position when the encoder zero position angle is tuned.

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

Commissioning Flowchart in FVC Mode

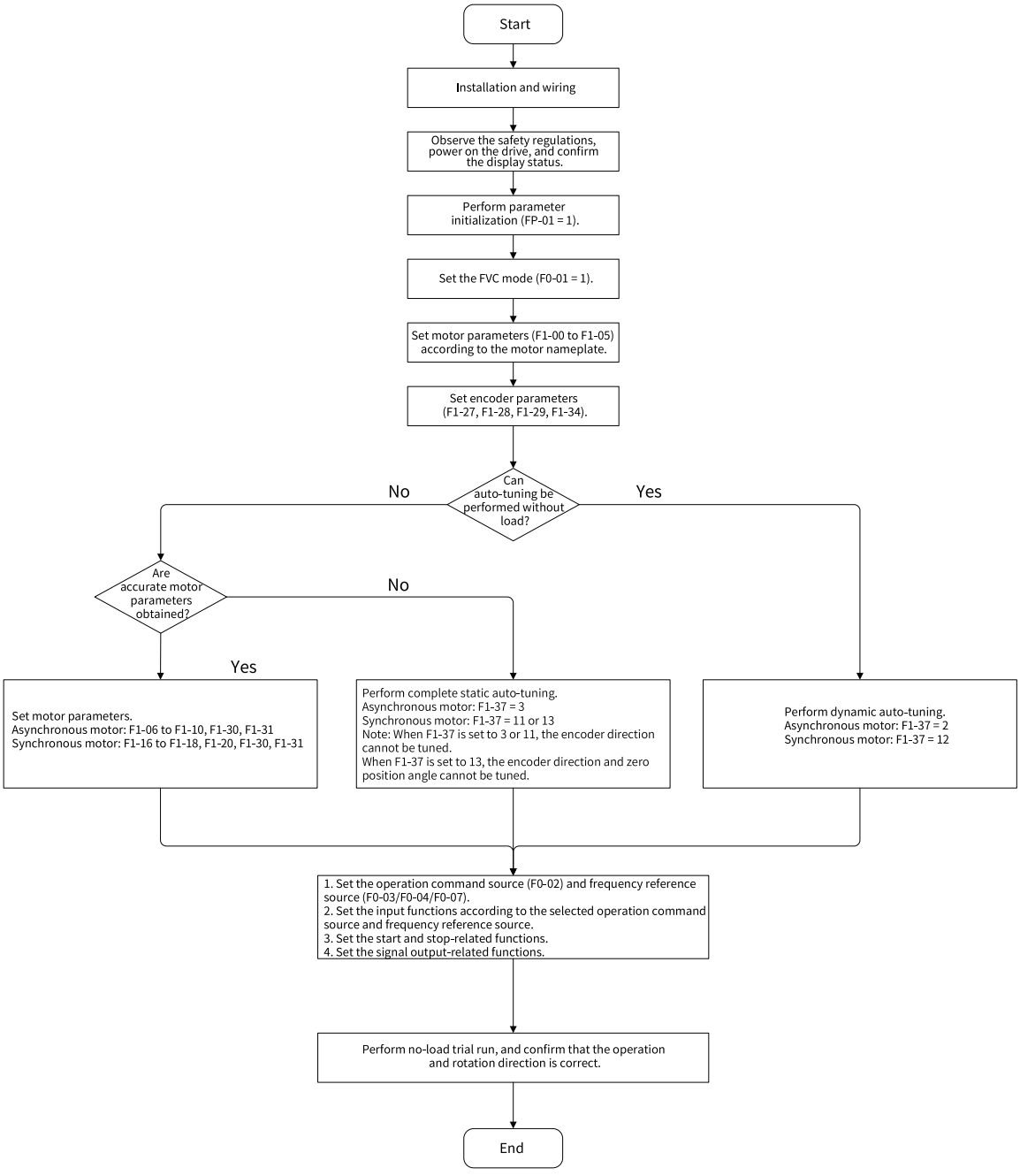


Figure 29-41 Commissioning flowchart in FVC mode

Note

Note:

1. During static auto-tuning, the motor will rotate slowly to a certain position when the encoder zero position angle is tuned.
2. Before static auto-tuning is performed (F1-37 = 11) to tune the zero position angle, check the encoder running direction (F1-30) and set it correctly. At the same time, the motor will rotate slightly static auto-tuning 11 rotates the motor slightly when the encoder zero position angle is tuned.

Encoder direction: The incorrect encoder direction can affect the precise control of the motor by the AC drive. For example, an incorrect direction may cause motor stall. The AC drive will report overload, overcurrent, overheat, and excessive speed deviation faults, which affects the safety and reliability of the system.

Zero position angle: The zero position angle of the motor indicates the position angle of the motor when the magnetic pole is aligned between the stator and the rotor. The following faults will occur when the zero position angle is incorrect:

1. **Positioning error:**An error will occur between the actual position of the motor and the set position. In this case, the position control system cannot locate the position accurately, affecting the operating accuracy of the equipment.
2. **Unstable motion:**Inaccurate zero point angle will cause unsuitability or vibration when the motor executes motion commands, affecting the stability and reliability of the system.
3. **Path deviation:**In applications requiring precise path control (such as manipulators and CNC machines), inaccurate zero position angle may cause path deviation, affecting the quality of processing or operation.
4. **Invalid system protection:**Some systems may rely on the zero position angle to set the safety boundary or limit position. If the zero position angle is not accurate, the system protection mechanism may fail, increasing the risk of mechanical collision or damage.

In the static auto-tuning mode, some parameters are not tuned. For details, see *Asynchronous Motor Parameter Auto-tuning* and *Synchronous Motor Parameter Auto-tuning* sections.

29.2.1 Asynchronous motor parameter auto-tuning

Auto-tuning must be performed in the vector control mode. Otherwise, overcurrent will occur. It is also recommended to perform parameter auto-tuning in the V/f control mode. If parameters are accurate, better control performance can be achieved for flying start (complete static auto-tuning of asynchronous motors), overcurrent stall suppression, and torque boost. The following table describes the range and performance of different auto-tuning modes.

Method	Application scenario	Effect
Partial static auto-tuning of asynchronous motor	This mode applies to scenarios where the motor cannot be disconnected from the load and dynamic auto-tuning is not allowed.	Normal
Asynchronous motor parameter auto-tuning	This mode applies to scenarios where the motor is easily disconnected from the application system. If the motor load is the roller type (pure inertia load), parameters can be directly tuned without the roller removed.	Optimal
No-load complete auto-tuning of asynchronous motors	It applies to scenarios where the motor cannot be disconnected from the load and dynamic complete auto-tuning is not allowed.	Good

Take motor parameter group 1 as an example. The following table lists parameters tuned in different auto-tuning modes of asynchronous motors.

Parameter Code	Parameter Name	F1-37 = 1	F1-37 = 2	F1-37 = 3	F1-37=4[2]
F1-06	Motor stator resistance	✓	✓	✓	-
F1-07	Asynchronous motor rotor resistance	✓	✓	✓	-
F1-08	Asynchronous motor leakage inductance	✓	✓	✓	-
F1-09	Asynchronous motor mutual inductance	√[4]	✓	√[3]	-
F1-10	No-load current of asynchronous motor	√[4]	✓	√[3]	-
F1-31	Phase sequence of encoder	-	√[1]	-	-
A9-19	Magnetic field saturation current coefficient 1 of asynchronous motor	-	✓	-	-
A9-20	Magnetic field saturation current coefficient 2 of asynchronous motor	-	✓	-	-
A9-21	Magnetic field saturation current coefficient 3 of asynchronous motor	-	✓	-	-
A9-22	Magnetic field saturation current coefficient 4 of asynchronous motor	-	✓	-	-
A9-23	Magnetic field saturation flux coefficient 1 of asynchronous motor	-	✓	-	-
A9-24	Magnetic field saturation flux coefficient 2 of asynchronous motor	-	✓	-	-
A9-25	Magnetic field saturation flux coefficient 3 of asynchronous motor	-	✓	-	-

Parameter Code	Parameter Name	F1-37 = 1	F1-37 = 2	F1-37 = 3	F1-37=4[2]
A9-26	Magnetic field saturation flux coefficient 4 of asynchronous motor	-	✓	-	-
F1-30	Input A/B phase sequence	-	✓	-	-
A9-16	Inertia ratio	-	✓	-	✓
A9-17	Inertia	-	✓	-	✓
A9-18	Friction torque	-	✓	-	✓
F2-00	Speed loop Kp in FVC mode	-	✓	-	✓
F2-01	Speed loop Ti in FVC mode	-	✓	-	✓
F2-03	Speed loop Kp in SVC mode	-	✓	-	✓
F2-04	Speed loop Ti in SVC mode	-	✓	-	✓

Note [1]: If the encoder detection function set by bit 1 of A9-09 is enabled or the motor control mode is set to the FVC mode, the corresponding encoder phase sequence will be detected and the result is written to F1-30.

Note [2]: If the motor control mode is set to V/f, FVC, or SVC, inertia auto-tuning is performed.

Note [3]: When conditions are allowed, set F1-37 to 2 to select no-load complete auto-tuning. After F1-37 is set to 2 for auto-tuning during rotation, more accurate motor mutual inductance and no-load current can be obtained. The magnetic field saturation coefficient of asynchronous motors can be auto-tuned to improve the torque control accuracy. When F1-37 is set to 3, the auto-tuning mode is applicable to scenarios where the motor cannot rotate during auto-tuning. In this mode, the saturation coefficient cannot be tuned. The motor mutual inductance and no-load current obtained when F1-37 is set to 3 are less accurate than those obtained when F1-37 is set to 2.

Note [4]: When F1-37 is set to 1, the static auto-tuning mode is selected. The calculated mutual inductance and no-load current are used and are less accurate than those obtained when F1-37 is set to 2 or 3.

Note [5]: You can tune project configurations and optimize the tuning project through AA-09.

Note [6]: In addition to the preceding auto-tuning modes, you can also enter motor parameters manually or download the parameter file.

Note [7]: You can perform motor auto-tuning either through commands from the operating panel or communication commands. Select the operation command source through F0-02. The PKW areas of the Modbus, PROFIBUS DP, and CANopen support auto-tuning through communication, whereas their PZD areas do not support auto-tuning through communication. To start auto-tuning through communication, write the auto-tuning parameter to F1-37/A2-37 and then write operation commands.

Note

When F1-37 is set to 2 (no-load complete auto-tuning), the motor will rotate at a high speed. Therefore, ensure that it is set under conditions allowed by mechanical safety. Besides, keep the load torque close to no-load torque as much as possible when the motor rotates at a constant speed. Lower load means more accurate auto-tuning results. Heavy load may cause drive overload or overcurrent.

Application example

Parameters of motor 1 (F0-24 = 0, motor parameter group 1) are used to describe the motor auto-tuning mode. If you need to perform auto-tuning on motor 2, set F0-24 to 1 (motor parameter group 2) first. The auto-tuning mode for motor 2 is similar to that for motor 1. Parameters of motor 2 are those in A2 group.

- Procedure of partial static auto-tuning of the asynchronous motor

Table 29–6 Procedure of partial static auto-tuning of the asynchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	Set F1-37 to 1 (partial static auto-tuning of asynchronous motor), and press **ENTER**. The following information is displayed on the operating panel: 
Step 4	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. During auto-tuning, the RUN indicator keeps on and the TUNE/TC indicator blinks. The drive energizes the motor but the motor does not rotate. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06 to F1-08 will be computed by the AC drive automatically.

- Procedure of dynamic complete auto-tuning of the asynchronous motor
  If the motor has constant output or is used for high-accuracy applications, perform complete dynamic auto-tuning after disconnecting the motor from the load for optimal auto-tuning effect.

Table 29–7 Procedure of dynamic complete auto-tuning of the asynchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	If F0-01 is set to 1 (FVC), input encoder parameters (F1-27, F1-28, and F1-30).

Procedure	Description
Step 4	Set F1-37 to 2 to select dynamic complete auto-tuning of the asynchronous motor. Press ENTER on the keypad. The following information is displayed on the keypad: 
Step 5	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. During auto-tuning, the RUN indicator is steady on and the TUNE/TC indicator blinks. The drive drives the motor to accelerate/decelerate and run in the forward/reverse direction. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06, F1-10, and F1-30 will be computed by the AC drive automatically.

Note

- If the encoder phase sequence is known, set F1-30 (Encoder A/B phase sequence) in step 3.
- If the encoder phase sequence is unknown, you do not need to set F1-30 in step 3. The value of F1-30 can be obtained through motor parameter auto-tuning.

- No-load complete auto-tuning of asynchronous motors
  If the motor cannot be disconnected from the load, perform with-load complete auto-tuning, namely, complete static auto-tuning.

Table 29–8 3: Static complete auto-tuning of asynchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 = 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	Set F1-37 to 3 (Complete static auto-tuning of asynchronous motor). Press ENTER on the operating panel. The following information is displayed on the operating panel: 
Step 4	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. During auto-tuning, the RUN indicator keeps on and the TUNE/TC indicator blinks. The drive energizes the motor but the motor does not rotate. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06 to F1-10 will be computed by the AC drive automatically.

29.2.2 Asynchronous motor parameter auto-tuning

Motor auto-tuning is the process by which the AC drive obtains the parameters of the controlled motor.

Auto-tuning modes of the synchronous motor include partial static auto-tuning (excluding back EMF), no-load complete dynamic auto-tuning, and complete static auto-tuning.

The following table describes differences among these auto-tuning modes.

Table 29–9 Motor Parameter Auto-tuning

Motor Parameter Auto-tuning	Application scenario	Motor Parameter Auto-tuning
13: Static partial auto-tuning of synchronous motor	Scenarios where the motor cannot be disconnected from the load and dynamic auto-tuning is not allowed Set the back EMF (SVC) and encoder phase sequence after auto-tuning is done.	Good
12: No-load dynamic complete auto-tuning of synchronous motor	It applies to scenarios where motors can be disconnected from the load easily.	Best
Static auto-tuning of synchronous motors	This mode applies to scenarios where the motor cannot be disconnected from the load and the motor rotation is not allowed. After auto-tuning, manually set the back EMF (SVC and PMVVC), encoder zero position angle (FVC), and encoder phase sequence (FVC).	Normal

The rated motor frequency is limited by the maximum frequency and frequency upper and lower limits. The default value of the maximum frequency is 50 Hz. Before tuning the synchronous motor, set F0-10 (maximum frequency), F0-12 (frequency upper limit), and F0-14 (frequency lower limit). If the rated motor frequency is greater than 50 Hz, set the maximum frequency and frequency upper and lower limits properly. Ensure that the maximum frequency is not lower than the frequency upper limit and that the rated motor frequency ranges from the frequency lower limit to the frequency upper limit.

Parameter Code	Parameter Name	F1-37 = 11	F1-37 = 12	F1-37 = 13	F1-37 = 4
F1-16	Synchronous motor stator resistance	✓	✓	✓	-
F1-17	D axis inductance of synchronous motor	✓	✓	✓	-
F1-18	Axis Q inductance of synchronous motor	✓	✓	✓	-
F1-20	Back EMF of synchronous motor	√[1]	✓	-	-
F1-30	A/B phase sequence of encoder	-	√[3]	-	-
F1-31	Encoder installation angle	√[2]	√[3]	-	-
A9-16	Electromechanical time constant	-	✓	-	✓
A9-17	Inertia ratio	-	✓	-	✓
A9-18	Friction torque	-	✓	-	✓
F2-00	Speed loop proportional gain 1	-	✓	-	✓
F2-01	Speed loop integral time 1	-	✓	-	✓

Parameter Code	Parameter Name	F1-37 = 11	F1-37 = 12	F1-37 = 13	F1-37 = 4
F2-03	Speed loop proportional gain 2	-	✓	-	✓
F2-04	Speed loop integral time 2	-	✓	-	✓

Note [1]: If F1-37 is set to 11 (with-load auto-tuning of synchronous motor), the back EMF is not tuned and is an estimated value, which is less accurate than that when F1-37 is set to 12 or 13.

Note [2]: If F1-37 is set to 11 (with-load auto-tuning of synchronous motor), the encoder phase sequence is not tuned. Before auto-tuning, check that the encoder direction is consistent with the motor rotation direction. System rotation inertia

Note [3]: In the SVC or V/f (SVC) control mode, if the encoder test (bit 1 of A9-09) is not enabled, the encoder zero position angle will not be tuned.

Note [4]: If a resolver or 23-bit encoder is used, the motor does not rotate during auto-tuning. If an ABZ encoder is used, the motor rotates for a short period of time during auto-tuning.

Note [5]: You can also manually enter motor parameters or download parameter files (accurate motor direction and encoder direction).

Note [6]: You can use the LED operating panel as the command source for motor auto-tuning. Besides, you can also use the LCD operating panel (F0-02 = 0), DI (F0-02 = 1), or communication channel (F0-02 = 2) as the command source for motor auto-tuning. The PKW areas of the Modbus, PROFIBUS DP, and CANopen support auto-tuning through communication, whereas their PZD areas do not support auto-tuning through communication. To perform auto-tuning through communication, write the value of F1-37 and then write operation commands.

When F1-37 is set to 12 (no-load complete auto-tuning), the motor will rotate at a high speed. Therefore, ensure that it is set under conditions allowed by mechanical safety. Besides, keep the load torque close to no-load torque as much as possible when the motor rotates at a constant speed. Lower load means more accurate auto-tuning results. Heavy load may cause drive overload or overcurrent.



In the FVC mode, before starting a synchronous motor, correctly set the installation position angle of the encoder or obtain it through auto-tuning. If no-load complete auto-tuning (F1-37 = 12) cannot be performed because the load cannot be disengaged, set F1-37 to 11 to select with-load auto-tuning for the synchronous motor.

Application example

- Procedure for partial static auto-tuning of synchronous motors

Table 29–10 Procedure for partial static auto-tuning of synchronous motors

Procedure	Description
Step 1	Power on the drive, and then set F0-02 = 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.

Procedure	Description
Step 3	Set F1-37 to 11 (static partial auto-tuning of the asynchronous motor), and press ENTER. The following information is displayed on the keypad: 
Step 4	Press the **RUN** key on the operating panel for more than 1 s to start motor auto-tuning. During this process, the Run indicator is steady ON, the secondary display area displays "TUNE", and the AC drive energizes the motor. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-16, F1-17, F1-18, and F1-31 (FVC) will be calculated by the AC drive automatically. F1-19 (SVC) needs to be set manually.

- 12: No-load dynamic complete auto-tuning of synchronous motor
  If the motor features constant output or high accuracy is required, perform dynamic complete auto-tuning after disconnecting the motor from the load for optimal auto-tuning effect.

Table 29–11 Procedure for complete dynamic auto-tuning of synchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.
Step 3	If F0-01 is set to 1 (FVC), enter encoder parameters (F1-27 and F1-28).
Step 4	Set F1-37 to 12 (no-load complete dynamic auto-tuning of synchronous motor), and press **Enter** on the operating panel. The following information is displayed. 
Step 5	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. The RUN indicator is steady on, the TUNE/TC indicator blinks, and the AC drive energizes the motor. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06, F1-17, F1-18, F1-20, F1-30 (FVC), and F1-31 (FVC) will be computed by the AC drive automatically.

- Complete static auto-tuning of synchronous motors
  The mode applies when motor rotation is not allowed.

Table 29–12 Procedure for complete static auto-tuning of synchronous motor

Procedure	Description
Step 1	Power on the drive, and then set F0-02 to 0 to select the operating panel as the command source.
Step 2	Input motor nameplate parameters (F1-00 to F1-05) correctly.

Procedure	Description
Step 3	Set F1-37 to 13 (complete static auto-tuning of synchronous motor), and press **Enter** on the operating panel. The following information is displayed. 
Step 4	Press the **RUN** key on the operating panel for more than 3 s to start motor auto-tuning. The RUN indicator is steady on, the TUNE/TC indicator blinks, and the AC drive energizes the motor. After the preceding display disappears and the operating panel returns to the parameter display state, it indicates that auto-tuning is done. The values of F1-06, F1-17, and F1-18 will be computed by the AC drive automatically. Manually set F1-20 (SVC and PMVVC), F1-31 (FVC), and F1-30 (FVC).

29.2.3 Motor Parameter Group Switchover

The MD520 supports switchover of four groups of motor parameters. The following table describes four groups of motor parameters.

Parameter Group Number	Parameter Group
Motor parameter group 1	F0, F1, F2, F3, F6, F8, A9, AA, AB
Motor parameter group 2	A2, A3, B6, B7, B8, B9
Motor parameter group 3	BA, BB, BC, BD, BE
Motor parameter group 4	CA, CB, CC, CD, CE

You can select the required motor parameter group in the following two methods:

- Set F0-24 to select the motor parameter group. Set F0-24 to 0, 1, 2, or 3 to select motor parameter group 1, 2, 3, or 4, respectively.
- Select the currently valid motor parameter group through the DI. Assign any two of the DIs from DI1 to DI10 (F4-00 to F4-09) with function 41 (motor selection terminal 1) and function 76 (motor selection terminal 2). The following table describes the relationship between DI states and motor parameter groups.

State of DI with Function 41 Assigned	State of DI with Function 76 Assigned	Motor Parameter Group Selection
0	0	1
1	0	2
0	1	3
1	1	4

If any terminal (F4-00 to F4-09) is assigned with function 41 (motor selection terminal 1) or function 76 (motor selection terminal 2), the DI is used to determine which motor parameter group is selected. In this case, the setting of F0-24 is invalid. When no terminal (F4-00 to F4-09) is assigned with function 41 (motor selection terminal 1) or function 76 (motor selection terminal 2), the motor parameter group is determined by F0-24.

You can also view the selected motor parameter group by U2-00. When U2-00 is set 0, 1, 2, or 3, the motor parameter group 1, 2, 3, or 4 is selected, respectively.

Note

During running, the motor parameter group switchover command is invalid, and the motor parameter group cannot be switched. To switch parameter groups, stop the AC drive first.

29.3 Control Terminal

29.3.1 Digital Input Terminal (DI) Functions

The drive provides multiple multi-functional DIs, among which DI5 can be used as the pulse input terminal. Each DI can be assigned with a specific function.

Table 29–13 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
F4-00	DI1 function selection	1	0-86 (function 30 pulse frequency input is valid only for DI5)	See *"Table 29–14" on page 687*.
F4-01	DI2 function selection	4		
F4-02	DI3 function selection	9		
F4-03	DI4 function selection	12		
F4-04	DI5 function selection	13		
F4-05	DI6 function selection	0		
F4-06	DI7 function selection	0		
F4-07	DI8 function selection	0		
F4-08	DI9 function selection	0		
F4-09	DI10 function selection	0		
F4-10	DI filter time	0.010s	0.000s to 1.000s	This parameter defines the delay time for the DI status change.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-38	DI active mode selection 1	0	Ones: DI1 0: Active high 1: Active low Tens: DI2 0: Active high 1: Active low Hundreds: DI3 0: Active high 1: Active low Thousands: DI4 0: Active high 1: Active low Ten thousands: DI5 0: Active high 1: Active low	The active mode for terminals DI1 to DI5 are set through the ones, tens, hundreds, thousands, and ten thousands places of this parameter. 0: Active high The DI (DI1 to DI5) is active when connected to the COM terminal and inactive when disconnected from the COM terminal. 1: Active low The DI (DI1 to DI5) is inactive when connected to the COM terminal and active when disconnected from the COM terminal.
F4-39	DI active mode selection 2	0		
F4-41	DI1 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI1 function is turned on.
F4-42	DI1 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI1 function is turned off.
F4-43	DI2 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI2 function is turned on.
F4-44	DI2 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI2 function is turned off.
F4-45	DI3 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI3 function is turned on.
F4-46	DI3 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI3 function is turned off.
F4-47	DI4 switch-on delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI4 function is turned on.
F4-48	DI4 switch-off delay time	0.0s	0.0s to 3600.0s	This parameter defines the delay coefficient when DI4 function is turned off.
F4-49	DI forced data	0x0	Bit 0 to bit 9 correspond to DI1 to DI10 respectively. Bit 10 to bit 15 are reserved. 0: Inactive level; 1: Active level	This parameter is used to set the level state of DI1 to DI10 forcibly according to the bit sequence. 0: The level is forced to be inactive 1: The level is forced to be active

Parameter Code	Parameter Name	Default	Value Range	Description
F4-51	DI1 hardware source	0	0: Hardware 1: Forced value Others: B connector	Generally, the active state of the DI is obtained from hardware sampling. This function provides a software setting method to force the DIx to be active or inactive. 0: Hardware Whether the DIx input state is valid depends on whether the result of the DIx terminal sampling by hardware is valid. 1: Forced value Whether the DIx input state is valid depends on whether the bit x of F4-49 is valid. For example, if bit 0 is valid, the DI1 input state is valid. Others: B connector Whether the DIx terminal input state is valid depends on the state of the parameter connected to the connector.
F4-52	DI2 hardware source	0		
F4-53	DI3 hardware source	0		
F4-54	DI4 hardware source	0		
F4-55	DI5/HDI hardware source	0		

Parameter Code	Parameter Name	Default	Value Range	Description
F4-56	DI6 hardware source	0	0: Hardware 1: Forced value 2: Communication 4: AI1 5: AI2 6: AI3 11: DI1 12: DI2 13: DI3 14: DI4 (To be continued)	This parameter is used to select the DI6 input state source. 0: Hardware The DI input status is sourced from hardware sampling. 1: Forced value Software is used to set the forced status value of DI input (corresponding bit of F4-49). 2: Communication The DI input is sourced through communication. 4: AI1 AI1 is used as the DI input source. 5: AI2 AI2 is used as the DI input source. 6: AI3 AI3 is used as the DI input source. 11: DI1 DI1 is used as the DI input source. 12: DI2 DI2 is used as the DI input source. 13: DI3 DI3 is used as the DI input source. 14: DI4 DI3 is used as the DI input source. 15: DI5/HDI DI5/HDI is used as the DI input source. 17: DI7 DI7 is used as the DI input source. 18: DI8 DI8 is used as the DI input source. 19: DI9 DI9 is used as the DI input source. (To be continued)

Parameter Code	Parameter Name	Default	Value Range	Description
F4-56	DI6 hardware source	0	(Continued) 15: DI5/HDI 17: DI7 18: DI8 19: DI9 20: DI10 21: VDI1 22: VDI2 23: VDI3 24: VDI4 25: VDI5 (To be continued)	(Continued) 20: DI10 DI10 is used as the DI input source. 21: VDI1 VDI1 is used as the DI input source. 22: VDI2 VDI2 is used as the DI input source. 23: VDI3 VDI3 is used as the DI input source. 24: VDI4 VDI4 is used as the DI input source. 25: VDI5 VDI5 is used as the DI input source. (To be continued)

Parameter Code	Parameter Name	Default	Value Range	Description
F4-56	DI6 hardware source	0	(Continued) 26: VDI6 51: Relay 1 52: Relay 2 53: DO1 54: Relay on expansion card 55: DO2 on expansion card 56: VDO1 57: VDO2 58: VDO3 59: VDO4 60: VDO5 61: VDO6 62: VDO7 63: VDO8 64: VDO9 65: VDO10 66: VDO11 Others: B connector	(Continued) 26: VDI6 VDI6 is used as the DI input source. 51: Relay 1 Relay 1 is used as the DI input source. 52: Relay 2 Relay 2 is used as the DI input source. 53: DO1 DO1 is used as the DI input source. 54: Relay on expansion card The relay port of the expansion card is used as the DI input source. 55: DO2 on expansion card DO2 on the expansion card is used as the DI input source. 56: VDO1 VDO1 is used as the DI input source. 57: VDO2 VDO2 is used as the DI input source. 58: VDO3 VDO3 is used as the DI input source. 59: VDO4 VDO4 is used as the DI input source. 60: VDO5 VDO5 is used as the DI input source. 61: VDO6 VDO6 is used as the DI input source. 62: VDO7 VDO7 is used as the DI input source. 63: VDO8 VDO8 is used as the DI input source. 64: VDO9 VDO9 is used as the DI input source. 65: VDO10 VDO10 is used as the DI input source. 66: VDO11 VDO11 is used as the DI input source.
F4-57	DI7 hardware source	0	Same as F4-56	This parameter is used to select the DI7 input state source.
F4-58	DI8 hardware source	0	Same as F4-56	This parameter is used to select the DI8 input state source.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-59	DI9 hardware source	0	Same as F4-56	This parameter is used to select the DI9 input state source.
F4-60	DI10 hardware source	0	Same as F4-56	This parameter is used to select the DI10 input state source.
F4-61	DI5/HDI terminal type selection	1	0: Used as HDI 1: Used as DI	Set DI5 function as normal DI or HDI terminal.

Table 29–14 Descriptions of DI functions

Value	Function	Description
0	No function	No function is assigned to the DI.
1	Forward running (IN1)	The AC drive runs in the forward direction. FWD indicates forward running. In two-wire mode 1 (F4-11 = 0), activating DI function 1 triggers forward running. In two-wire mode 2 (F4-11 = 1), activating DI function 1 triggers a running command.
2	Reverse running (IN2)	The AC drive runs in the reverse direction. REV indicates reverse running. In three-wire mode 1 (F4-11 = 2), activating DI function 2 triggers reverse running. In three-wire mode 2 (F4-11 = 3), activating DI function 2 triggers forward/reverse running.
3	Three-wire mode (IN3)	The DI is used to set the three-wire mode for the AC drive. To set the running command source to the terminal, set F4-11 (terminal command mode) to 2 (three-wire mode 1) or 3 (three-wire mode 2), and set the DI to function 3. The three-wire control modes include three-wire mode 1 and three-wire mode 2.
4	Forward jog (FJOG)	The terminal is used to set the AC drive to jog forwardly. In the jogging mode, the drive runs at the frequency set by F8-00 (Jogging frequency), which is generally used for maintenance and commissioning of the equipment on site.
5	Reverse jog (RJOG)	The terminal is used to set the AC drive to jog reversely. In the jogging mode, the drive runs at the frequency set by F8-00 (Jogging frequency), which is generally used for maintenance and commissioning of the equipment on site.
6	Function as UP key for frequency adjustment	The terminal is used to increase the frequency. Activating the terminal is equivalent to pressing and holding the increment key. Deactivating the terminal is equivalent to releasing the increment key.
7	Function as DOWN key for frequency adjustment	The terminal is used to decrease the frequency. Activating the terminal is equivalent to pressing and holding the decrement key. Deactivating the terminal is equivalent to releasing the decrement key.
8	Coast to stop	Once the drive receives a stop command, it immediately stops output. The load then coasts to stop based on the mechanical inertia. The AC drive stops output to shut down. At this time, the power supply of the motor is cut off and the driving system is in the free braking state. This is also known as inertia stop because the stop time is determined by the inertia of the driving system.
9	Fault reset (RESET)	This function is used to reset the drive upon a fault, which is equivalent to the function of the STOP/RES key on the operating panel. This function allows you to perform a reset upon the fault remotely.

Value	Function	Description
10	Running pause	This function is valid only when F0-02 is set to 1 (terminal). After this function is assigned to the terminal, the drive decelerates to stop with all the operating parameters memorized (such as PLC parameters, wobble frequency, and PID parameters). When the terminal is inactive, the drive resumes to the status before decelerating to stop.
11	NO input of external fault	When an external signal is sent to the drive, the drive reports E015.1.
12	Multi-reference terminal 1	Multi-reference is selected as the main frequency source. Sixteen speeds or sixteen references can be set through combinations of sixteen states of these four terminals. It is suitable for applications where the operating frequency of the drive does not require continuous adjustment, and only several frequency values need to be used.
13	Multi-reference terminal 2	
14	Multi-reference terminal 3	
15	Multi-reference terminal 4	
16	Acceleration/deceleration time selection terminal 1	The acceleration time indicates the time required by the AC drive to accelerate from 0 Hz to the acceleration/deceleration base frequency (F0-25). The deceleration time indicates the time required by the AC drive to decelerate from the acceleration/deceleration base frequency (F0-25) to 0 Hz. Four groups of acceleration/deceleration time can be selected through combinations of four states of these two terminals. For example, if DI1 is assigned with function 16 and DI2 is assigned with function 17, the active states of DI2 and DI1 can be used to indicate the following groups acceleration/deceleration time: [0, 0]: Acceleration/deceleration time of group one [0, 1]: Acceleration/deceleration time of group two [1, 0]: Acceleration/deceleration time of group three [1, 1]: Acceleration/deceleration time of group four
17	Acceleration/deceleration time selection terminal 2	
18	Frequency source switchover	The terminal is used to select the frequency reference input modes. The frequency reference is set through F0-07 (Frequency reference superposition).
19	Clear data set by UP/DOWN key or by terminal functioning as UP/DOWN key	Activating the terminal clears the frequency that is set by the increment or decrement key on the operating panel or the terminal functioning as UP/DOWN keys and resumes the frequency reference to the value specified by F0-08.
20	Command source switchover terminal 1	When the running command is set through the terminal (F0-02 = 1) and the terminal is valid, you can switch between the terminal control mode and the operating panel control mode through the terminal. When the command is set through communication (F0-02 = 2) and the terminal is active, you can switch between the communication control mode and operating panel control mode through the terminal.
21	Acceleration/Deceleration inhibition	The drive runs at the current operating frequency without being affected by external input frequency except that a stop command is received.
22	PID invalid	The PID is deactivated temporarily. The drive maintains the current output frequency without PID adjustment of the frequency source.
23	Simple PLC status reset	The terminal is used to restore the AC drive to the initial state of the simple PLC.
24	Wobble frequency pause	In the wobble process, when the terminal is active, the wobble frequency function is paused and the drive outputs at the center frequency.
25	Counter input	In the counting process, the counted pulse is input when the terminal is active.

Value	Function	Description
26	Counter reset	In the counting process, the counter status is cleared when the terminal is active.
27	Length counting input	In the fixed length process, the counted length is input when the terminal is active.
28	Length reset	In the fixed length process, the length is set to zero when the terminal is active.
29	Torque control prohibited	When the terminal is active, the drive switches from the torque control mode to the speed control mode. When the terminal is inactive, the drive switches back to the torque control mode.
30	Pulse frequency input (valid only for DI5)	When DI5 is used as the pulse input terminal, DI5 must be assigned with this function.
32	Immediate DC braking	The terminal is used to switch the drive to the DC braking state. DC braking indicates that the drive outputs direct current to the stator winding of the asynchronous motor to form a static magnetic field, enabling the motor to brake with energy consumption. In this state, the rotor cuts the static magnetic field to generate braking torque, which stops the motor quickly.
33	NC of external fault	When an external signal is sent to the drive, the drive reports E015.2.
34	Frequency modification enable	When the terminal is active, the frequency can be modified. When the terminal is inactive, the frequency cannot be modified.
35	Opposite to PID action direction	The terminal is used to reverse the PID action direction defined by FA-03 (PID action direction).
36	External stop terminal 1	The terminal is used to stop the drive regardless of the value of F0-02, which functions the same as the STOP/RES key on the operating panel.
37	Control command switchover terminal 2	The terminal is used to switch the drive between the terminal control mode and communication control mode. If the command source is set to terminal control, activating the terminal switches the AC drive to communication control. If the command source is set to communication control, activating the terminal switches the AC drive to terminal control.
38	PID integral pause	After this function is active, the integral adjustment function pauses. However, the proportional and derivative adjustment functions are still valid.
39	Switchover between main frequency X and preset frequency	The terminal is used to switch from main frequency X to the preset frequency (F0-08).
40	Switchover between auxiliary frequency Y and preset frequency	The terminal is used to switch from auxiliary frequency Y to the preset frequency (F0-08).
41 and 76	Motor selection terminal 1/ 2	The terminal is used to select the motor. For example, when function 41 and function 76 are allocated to DI1 and DI2, respectively, motor 1 applies when DI1 and DI2 are inactive; motor 2 applies when DI1 is active and DI2 is inactive; motor 3 applies when DI1 is inactive and DI2 is active; motor 4 applies when DI1 and DI2 are active.
43	PID parameter switchover	If PID parameters are switched through the DI (FA-18 = 1), the PID parameters FA-05 (proportional gain Kp1), FA-06 (integral time Ti1), and FA-07 (derivative time Td1) are used when the terminal is inactive; the PID parameters FA-15 (proportional gain Kp2), FA-16 (integral time Ti2), and FA-17 (derivative time Td2) are used when the terminal is active.

Value	Function	Description
44	User-defined fault 1	The AC drive reports E027.1, and acts according to the value of F9-49 (Fault protection action selection).
45	User-defined fault 2	The AC drive reports E027.2, and acts according to the value of F9-49 (Fault protection action selection).
46	Speed control/Torque control selection	The terminal is used to switch the AC drive between the speed control mode and torque control mode. If A0-00 (speed/torque control mode) is set to 0, the torque control mode is used when the terminal is active, and the speed control mode is used when the terminal is inactive. If A0-00 (speed/torque control mode) is set to 1, the speed control mode is used when the terminal is active, and the torque control mode is used when the terminal is inactive.
47	Emergency stop	When the system is in the emergency state, the drive decelerates according to F8-55 (Deceleration time for emergency stop) or according to the minimum unit time when the deceleration time for emergency stop is 0s in the V/f control mode. The input terminal does not need to be in the closed state continuously. Even if it is closed only for a moment, an emergency stop will occur immediately. Different from general deceleration time, the emergency stop input terminal is opened after the deceleration time for emergency stop expires. In this case, if the operation signal is still active, the drive will not restart. To restart the drive, disconnect the operation terminal and input the operation command again.
48	External stop terminal 2	The terminal is used to make the drive decelerate to stop in any control mode (operating panel, terminal, or communication). In this case, the deceleration time is fixed to the value of F8-08 (deceleration time 4).
49	Decelerate to DC braking	The drive decelerates to the start frequency of DC braking for stop (F6-11) and then enters the DC braking state.
50	Clear current running time	The current running time of the drive (U0-26) is cleared. When the terminal is active, the current running time of the drive is not cleared.
51	Two-wire/Three-wire mode switchover	The terminal is used to switch the drive between the two-wire mode and the three-wire mode. When F4-11 is set to 0 (two-wire mode 1) and the terminal is active, the drive switches to three-wire mode 1. When the terminal is inactive, two-wire mode 1 is used. When F4-11 is set to 1 (two-wire mode 2) and the terminal is active, the drive switches to three-wire mode 2. When F4-11 is set to 2 (three-wire mode 1) and the terminal is active, the drive switches to two-wire mode 1. When F4-11 is set to 3 (three-wire mode 2) and the terminal is active, the drive switches to two-wire mode 2.
52	Reverse running prohibited	When the terminal is active, even if the reverse frequency is set, the actual frequency of the AC drive is fixed to 0. This function is the same as F8-13 (Reverse frequency inhibited).
64	Forward limit switch (NO signal)	-
65	Reverse limit switch (NO signal)	-
66	Water cooling fault input	When an external signal is sent to the drive and the terminal is active, E064.1 is reported.

Value	Function	Description
67	Low liquid level fault input	When an external signal is sent to the drive and the terminal is active, A066.1 (thousands place of F9-50 = 2) or E066.1 (thousands place of F9-50 = 0) is reported.
70	Control channel	The terminal is used to select a user-defined command channel. Value 0 represents channel 1, and value 1 represents channel 2.
72	Terminal module A/B selection	The terminal is used to select a terminal module. Value 0 represents module A, and value 1 represents module B.
73	Startup mode selection bit 0	The terminal is used to select a start mode. For example, if DI1 and DI2 are assigned with functions 73 and 74, respectively, direct start is selected when both DI1 and DI2 are inactive; flying start is selected when DI1 is active but DI2 is inactive; DC braking start is selected when DI1 is inactive but DI2 is active; and the last start mode is selected when both DI1 and DI2 are active.
74	Startup mode selection bit 1	
75	Control command switchover terminal 3	The terminal is used to switch the command source between the terminal/communication control mode and the user-defined operation command.
77	Running enabling	When the terminal is active at high level, running is allowed. Otherwise, running is not allowed or the AC drive must stop according to the setting of AA-09 (stop mode during running).
78	Forward operation permission	When the terminal is active at high level, the frequency reference is allowed to be a positive value. Otherwise, the positive frequency reference is reset to zero.
79	Reverse operation permission	When the terminal is active at high level, the frequency reference is allowed to be a negative value. Otherwise, the negative frequency reference is reset to zero.
80	RFG input clear	When the terminal is active at low level, the target reference is reset to zero. When the terminal is inactive at high level, the target reference is restored to its original setting.
86	Wire breakage detection (wire drawing machine)	After the AC drive is started and the time set by A7-32 (Breakage detection time for startup delay) expires, the DI starts detecting an active signal. If the DI detects an active signal, the AC drive reports E031.2 (breakage detection fault).

29.3.2 Digital Output Function (DO) Functions

Table 29–15 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
F5-01	FMR output function selection	0	0-44 (Others: B connector)	See *"Table 29–16" on page 697*.
F5-02	Output function selection of control panel relay (T/A-T/B-T/C)	2		
F5-03	Output function selection of DO4 on expansion card relay (P/A-P/B-P/C)	0		
F5-04	DO1 output function selection	1		
F5-05	Output function selection of DO2 on expansion card	4		
F5-22	DO valid status selection	0	Ones: FMR 0: Positive logic 1: Negative logic Tens: Relay 1 (DO3) 0: Positive logic 1: Negative logic Hundreds: Relay 2 (DO4) 0: Positive logic 1: Negative logic Thousands: DO1 0: Positive logic 1: Negative logic Ten thousands: DO2 0: Positive logic 1: Negative logic	The ones, tens, hundreds, thousands, and ten thousands places of this parameter are used to set the valid state of DOs to which F5-01 to F5-05 correspond. 0: Positive logic (equivalent to a NO contact) Valid state: The DO is connected to the COM/CME terminal internally. Invalid state: The DO is disconnected from the COM/CME terminal. 1: Negative logic (equivalent to a NC contact) Valid state: The DO is disconnected from the COM/CME terminal. Invalid state: The DO is connected to the COM/CME terminal internally.
F5-24	Control board relay (DO3) switch-on delay time	0.0s	0.0s to 3600.0s	It indicates the output delay of the control board relay. The output function set by F5-02 is active after the set delay time elapses.
F5-25	Control board relay (DO3) switch-off delay	0.0s	0.0s to 3600.0s	
F5-26	FMR output switch-on delay time	0.0	0.0s to 3600.0s	This parameter indicates the FMR output delay. The output function set by F5-01 is active after the set delay time elapses.
F5-27	FMR output switch-off delay time	0.0s	0.0s to 3600.0s	

Parameter Code	Parameter Name	Default	Value Range	Description
F5-28	DO1 output switch-on delay	0.0s	0.0s to 3600.0s	This parameter indicates the delay of DO1 output. The output function set by F5-04 is active after the set delay time elapses.
F5-29	DO1 output switch-off delay time	0.0s	0.0s to 3600.0s	
F5-30	Switch-on delay time of expansion card relay (DO4)	0.0s	0.0s to 3600.0s	This parameter indicates the output delay time of expansion card DO4. The output function set by F5-03 is active after the set delay time elapses.
F5-31	Switch-off delay time of expansion card relay (DO4)	0.0s	0.0s to 3600.0s	
F5-32	Switch-on delay time of expansion card DO2	0.0s	0.0s to 3600.0s	This parameter indicates the output delay time of expansion card DO2. The output function set by F5-05 is active after the set delay time elapses.
F5-33	Switch-off delay time of expansion card DO2	0.0s	0.0s to 3600.0s	

Parameter Code	Parameter Name	Default	Value Range	Description
F5-34	DO/RO output source	0x0	Bit 0: Relay 1 (DO3) output source 0: Output function 1: Communication Bit 1: FMR output source 0: Output function 1: Communication Bit 2: DO1 output source 0: Output function 1: Communication Bit 3: Relay 2 (DO4) output source 0: Output function 1: Communication Bit 4: DO2 output source 0: Output function 1: Communication Bit 5: VDO1 output source 0: Output function 1: Communication	Bit 0 to bit 16 of this parameter are used to set DO, VDO, and FMR output sources. 0: Output function The output source is determined based on the output functions of DO, VDO, and FMR. 1: Communication The output source is set through communication.

Parameter Code	Parameter Name	Default	Value Range	Description
Continued	Continued	Continued	Continued Bit 6: VDO2 output source 0: Output function 1: Communication Bit 7: VDO3 output source 0: Output function 1: Communication Bit 8: VDO4 output source 0: Output function 1: Communication (To be continued)	Continued

Parameter Code	Parameter Name	Default	Value Range	Description
Continued	Continued	Continued	(Continued) Bit 9: VDO5 output source 0: Output function 1: Communication Bit 10: VDO6 output source 0: Output function 1: Communication Bit 11: VDO7 output source 0: Output function 1: Communication Bit 12: VDO8 output source 0: Output function 1: Communication Bit 13: VDO9 output source 0: Output function 1: Communication Bit 14: VDO10 output source 0: Output function 1: Communication Bit 15: VDO11 output source 0: Output function 1: Communication	Continued

Parameter Code	Parameter Name	Default	Value Range	Description
F5-35	DO/RO output set through communication	0x0	Same as F5-34	After F5-34 (DO/RO output source) is set communication, bit 0 to bit 15 of this parameter are used to set written values of DO, VDO, and FMR terminals through communication. 0: Invalid level 1: Valid level The output source is set through communication.

Table 29–16 Descriptions of output terminal functions

Value	Function	Description
0	No output	The output terminal has no function.
1	AC drive running	The terminal outputs an active signal when the AC drive is running with output frequency (which can be 0).
2	Fault output	When the drive encounters a fault, the terminal outputs an active signal.
3	Frequency-level detection FDT1 output	When the running frequency exceeds the frequency detection value, the terminal outputs an active signal. When the running frequency falls below the result of the frequency detection value minus the FDT hysteresis (F8-19 x F8-20), the terminal stops outputting the active signal.
4	Frequency reach	When the running frequency of the AC drive is within a specific range (target frequency ± F8-21 x maximum frequency), the terminal outputs an active signal.
5	Running at zero speed (no output at stop)	When the drive is operating and the output frequency is 0, the terminal outputs an active signal. When the AC drive is in the stop state, the signal is inactive.
6	Motor overload warning	Before motor overload protection, the AC drive determines whether the motor load exceeds the overload warning threshold according to the overload warning coefficient (F9-02). If the threshold is exceeded, the terminal outputs an active signal. (For calculation of the alarm threshold, see the description of motor overload protection.)
7	Drive overload warning	The terminal outputs an active signal 10s before AC drive overload protection applies.
8	Counting value reach	The terminal outputs an active signal when the counting value reaches the value of FB-08.
9	Designated counting value reach	The terminal outputs an active signal when the counting value reaches the value of FB-09.
10	Length reach	The terminal outputs an active signal when the actual length detected exceeds the length defined by FB-05.
11	Simple PLC cycle completed	When the simple PLC completes one cycle, the terminal outputs a pulse signal with the width of 250 ms.
12	Cumulative running time reach	The AC drive compares the cumulative running time and the time set by F8-17 and F8-75. If the former is greater than or equal to the latter, the terminal outputs an active signal.
13	Wobble frequency limited	In a wobble process, the terminal outputs an active signal when the set frequency exceeds the upper or lower limit of frequency and the output frequency of AC drive reaches the upper or lower limit of frequency.
14	Torque limited	The terminal outputs an active signal when the output torque reaches the torque limit in the speed control mode.

Value	Function	Description
15	Ready for running	The terminal outputs an active signal if no exception occurs on the AC drive after power-on.
16	AI1 > AI2	The terminal outputs an active signal when the AI1 input value is higher than the AI2 input value.
17	Frequency upper limit reach	The terminal outputs an active signal when the operating frequency reaches the frequency upper limit (F0-12).
18	Frequency lower limit reach (no output at stop)	When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 1 (stop), the terminal outputs an inactive signal no matter whether the operating frequency reaches the lower limit. When F8-14 (Running mode when frequency reference < frequency lower limit) is set to 0 (run at the frequency lower limit) or 2 (run at zero speed) and the running frequency reaches the lower limit, the terminal outputs an active signal.
19	Undervoltage state output	The terminal outputs an active signal when the drive is in the undervoltage state.
20	Communication control	The active or inactive state of the terminal is controlled by the setpoint of communication address 0x2001.
21	Brake output	The terminal outputs an active signal upon brake release, and outputs an inactive signal upon brake applying.
23	Running at zero speed 2 (output at stop)	The terminal outputs an active signal when the drive is operating and the output frequency is 0. The signal remains active when the drive is in the stop state.
24	Cumulative power-on time reached	The terminal outputs an active signal when the cumulative power-on time of the AC drive (F7–13) exceeds the time defined by F8–16.
25	Frequency-level detection FDT2 output	The terminal outputs an active signal when the running frequency exceeds the frequency detection value and stops outputting the active signal when the running frequency is lower than the result of the detection value minus the frequency detection hysteresis (F8-28 x F8-29).
26	Frequency 1 reached	The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-30 (Detection frequency 1). Frequency detection range: F8-30 - F8-31 x F0-10 (Maximum frequency) to F8-30 + F8-31 x F0-10
27	Frequency 2 reached	The terminal outputs an active signal when the running frequency of the AC drive is within the frequency detection range specified by F8-32 (Detection frequency 2). Frequency detection range: F8-32 – F8-33 x F0-10 (Maximum frequency) to F8-32 + F8-33 x F0-10
28	Current 1 reached	The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-38 (Detection current 1). Current detection range = F8-38 - F8-39 x F1-03 (Rated motor current) to F8-38 + F8-39 x F1-03
29	Current 2 reached	The terminal outputs an active signal when the output current of the AC drive is within the current detection range specified by F8-40 (Detection current 2). Current detection range = F8-40 - F8-41 x F1-03 (Rated motor current) to F8-40 + F8-41 x F1-03
30	Timing reached	When the timing function set by F8-42 is enabled and the operating time reaches the set timing duration, the terminal outputs an active signal. The timing duration is defined by F8-43 and F8-44.
31	AI1 input limit exceeded	If the value of AI1 input is larger than the value of F8-46 (AI1 input protection upper limit) or lower than the value of F8-45 (AI1 input protection lower limit), the terminal outputs an active signal.
32	Load loss	The terminal outputs an active signal when the drive is in the load loss state.
33	Reverse running	The terminal outputs an active signal when the drive is operating in the reverse direction.

Value	Function	Description
34	Zero current state	When the output current of the drive is within the zero current range for a duration longer than that defined by F8-35 (zero current detection delay), the terminal outputs an active signal. Zero current detection range = 0 to F8-34 x F1-03
35	Module temperature reached	The terminal outputs an active signal when F7-07 (drive unit heatsink temperature) reaches the value of F8-47 (module temperature threshold).
36	Output current overlimit	When the output current of the AC drive is higher than F8-36 (Output current threshold) for a period longer than F8-37 (Delay time for output current overlimit detection), the terminal outputs an active signal.
37	Frequency lower limit reached (output at stop)	The terminal outputs an active signal when the operating frequency reaches the lower limit (F0-14). The terminal still outputs the active signal when the drive is in the stop state.
38	Alarm (all faults)	The terminal outputs an active signal when a fault occurs and the drive continues operating. For details about the fault protection action, see F9-47 to F9-50.
39	Motor overtempera-ture	The terminal outputs an active signal when the motor temperature reaches the value of F9-58 (motor overtemperature warning threshold). You can check the motor temperature using U0-34.
40	Current operating time reached	When the current operating time of the drive exceeds the time defined by F8-53 (Current running time reach), the terminal outputs an active signal.
41	Fault output (excluding undervoltage)	The terminal outputs an active signal when a fault (other than the undervoltage fault) occurs on the AC drive.
42	STO output	The terminal outputs an active signal when the STO is triggered.
43	Operation restricted	When a minor fault that restricts the running of the AC drive occurs, the operating panel of the AC drive displays "Lxxx.y".
44	Brake output at stop (wire drawing machine)	When the AC drive stops and the running frequency is lower than the brake frequency set by A7-30, the terminal outputs an active signal. After the brake delay time set by A7-31 expires, the terminal outputs an active signal.
Others	B connector	When this option is selected, the output function is the signal or function state of the parameter to which the connector is connected.

29.3.3 Virtual Digital Input Terminal (VDI) Functions

The virtual digital input terminals (VDIs), which can be used for multi-functional digital inputs, have the similar functions as the DIs on the control board.

There are four VDI sources.

- The VDI is set by writing values to A1-06 and A1-42. This mode applies to communication scenarios, where physical DIs are not used. The relationship between A1-06 and VDIs are as follows: The ones to ten thousands places of A1-06 correspond to VDI1 to VDI5, respectively. A1-42 corresponds to VDI6.
- The VDI is set by VDO state. There are six VDOs from VDO1 to VDO6, corresponding to VDI1 to VDI6.
- VDI1 to VDI6 are set by DI1 to DI6, respectively.
- VDI1 to VDI3 are set by AI1 to AI3, respectively.

Example

The following examples show how to use VDIs.

- Example 1: When A1-05 (VDI state setting mode) is set to 00001 (determined by DO), the following function needs to be implemented: The AC drive reports an alarm and stops when AI1 input exceeds the upper limit or lower limit. Do as follows.

Step	Parameter Setting
1	Set the VDI1 function to "User-defined fault 1" (A1-00 = 44).
2	Set the DO1 function to "AI input limit exceeded" (F5-04 = 31).
3	Set the VDI1 state setting mode to the DO (A1-05 = 00000).

  When AI1 input exceeds the upper/lower limit, DO1 output becomes ON. In this case, VDI1 is active. The drive reports E27.00 after receiving user-defined fault 1 through VDI1 and then stops.

- Example 2: In a communication scenario, implement emergency stop through the VDI without using the physical DI.

Step	Parameter Setting
1	Set the VDI1 function to "Emergency stop" (A1-00 = 47).
2	Set the VDI1 state to be determined by parameters (A1-05 = 00001).
3	Modify the ones place of A1-06 through communication.

  After the preceding steps, set the ones place of A1-06 to 1 to implement the emergency stop function.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A1-00	VDI1 function selection	0	0 to 86	Same as F4-00
A1-01	VDI2 function selection	0		
A1-02	VDI3 function selection	0		
A1-03	VDI4 function selection	0		
A1-04	VDI5 function selection	0		
A1-05	VDI state setting source	0	Ones: VDI1 0: VDO1 state 1: A1-06 2: DI1 state 3: Communication value (bit 10 of F4-50) 4: AI1 5: Reserved Tens: VDI2 0: VDO2 state 1: A1-06 2: DI2 state 3: Communication value (bit 11 of F4-50) 4: AI2 5: Reserved (To be continued)	The VDIx (x ranges from 1 to 5) state is set by the ones to ten thousands places of this parameter. 0: VDOx state The VDIx state is determined by the VDOx state. VDIx is uniquely bound to VDOx. x in VDIx and VODx ranges from 1 to 5. 1: A1-06 The VDIx (x ranges from 1 to 5) state is set through the binary bits of A1-06. 2: DIx state The VDIx state is determined by the DIx state. VDIx is uniquely bound to DIx. x in VDIx and DIx ranges from 1 to 5. 3: Communication value (bit 10 to bit 14 of F4-50) 4: AIx state The VDIx state is determined by the AIx state. VDIx is uniquely bound to AIx. x in VDIx and AIx ranges from 1 to 3. 5: Reserved

Parameter Code	Parameter Name	Default	Value Range	Description
Continued	Continued	Continued	(Continued) Hundreds: VDI3 0: VDO3 state 1: A1-06 2: DI3 state 3: Communication value (bit 12 of F4-50) 4: AI3 5: Reserved Thousands: VDI4 0: VDO4 state 1: A1-06 2: DI4 state 3: Communication value (bit 13 of F4-50) 4-5: Reserved Ten thousands: VDI5 0: VDO5 state 1: A1-06 2: DI5 state 3: Communication value (bit 14 of F4-50) 4-5: Reserved	Continued
A1-06	VDI state setting	0	Ones: VDI1 0: Invalid 1: Valid Tens: VDI2 0: Invalid 1: Valid Hundreds: VDI3 0: Invalid 1: Valid Thousands: VDI4 0: Invalid 1: Valid Ten thousands: VDI5 0: Invalid 1: Valid	The VDIx (x ranges from 1 to 5) state is set by the ones to ten thousands places of this parameter.
A1-40	VDI6 function selection	0	0 to 80	Same as F4–00

Parameter Code	Parameter Name	Default	Value Range	Description
A1-41	VDI6 hardware source	0	Ones: VDI6 0: VDO6 state 1: A1-42 2: DI6 state 3: Communication value (bit 15 of F4-50) 4-5: Reserved	Same as A1-05
A1-42	VDI6 state setting	0	Ones: VDI6 0: Invalid 1: Valid	Same as A1-06
A1-43	VDI1 to VDI5 active mode	0	Ones position: VDI1 0: Active low 1: Active high Tens: VDI2 0: Active low 1: Active high Hundreds: VDI3 0: Active low 1: Active high Thousands: VDI4 0: Active low 1: Active high Ten thousands: VDI5 0: Active low 1: Active high	The VDIx (x ranging from 1 to 5) state is set by the ones to ten thousands places of this parameter.
A1-44	VDI6 active mode	0	Ones position: VDI6 0: Active low 1: Active high	Same as A1-43

29.3.4 Virtual Digital Output Terminal (VDO) Functions

The virtual digital output (VDO) functions are similar to the DO functions on the control board. The VDO can be used together with the virtual digital input (VDI) to implement some simple logic control.

VDO and VDI can be used together to achieve flexible control. For detailed examples, see the VDI section.

Parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A1-11	VDO1 output selection	0	0-44 (others: B connector)	Same as F5-01
A1-12	VDO2 output selection	0		
A1-13	VDO3 output selection	0		
A1-14	VDO4 output selection	0		
A1-15	VDO5 output selection	0		
A1-21	VDO valid status selection	0	Ones: VDO1 0: Positive logic 1: Negative logic Tens: VDO2 0: Positive logic 1: Negative logic Hundreds: VDO3 0: Positive logic 1: Negative logic Thousands: VDO4 0: Positive logic 1: Negative logic Ten thousands: VDO5 0: Positive logic 1: Negative logic	Positive logic: When the terminal is invalid, 0 is output. When the terminal is valid, 1 is output. Negative logic: When the terminal is invalid, 1 is output. When the terminal is valid, 0 is output.
A1-22	VDO1 output switch-on delay	0.0	0.0s to 3600.0s	-
A1-23	VDO2 output switch-on delay	0.0	0.0s to 3600.0s	
A1-24	VDO3 output switch-on delay	0.0	0.0s to 3600.0s	
A1-25	VDO4 output switch-on delay	0.0	0.0s to 3600.0s	
A1-26	VDO5 output switch-on delay	0.0	0.0s to 3600.0s	
A1-27	VDO1 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-28	VDO2 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-29	VDO3 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-30	VDO4 output switch-off delay time	0.0	0.0s to 3600.0s	
A1-31	VDO5 output switch-off delay time	0.0	0.0s to 3600.0s	

Parameter Code	Parameter Name	Default	Value Range	Description
A1-32	VDO6 output function selection	0	0-44 (others: B connector)	Same as F5-01
A1-33	VDO7 output function selection	0		
A1-34	VDO8 output function selection	0		
A1-35	VDO9 output function selection	0		
A1-36	VDO10 output function selection	0		
A1-37	VDO11 output function selection	0		
A1-38	VDO6 to VDO10 active mode selection	0	Ones: VDO6 0: Positive logic 1: Negative logic Tens: VDO7 0: Positive logic 1: Negative logic Hundreds: VDO8 0: Positive logic 1: Negative logic Thousands: VDO9 0: Positive logic 1: Negative logic Ten thousands: VDO10 0: Positive logic 1: Negative logic	Positive logic: When the terminal is invalid, 0 is output. When the terminal is valid, 1 is output. Negative logic: When the terminal is invalid, 1 is output. When the terminal is valid, 0 is output.
A1-39	VDO11 active mode selection	0	0: Positive logic 1: Negative logic	

29.3.5 Digital Input and Output Terminal Counting Function

The DIO edge counting function helps you record the number of active edges of a signal (retentive upon power failure) to realize functions such as device life cycle measurement and warning of level jump times.

Example

The following examples show how to use the DIO edge counting function.

The product provides four counting modules, which can count simultaneously without affecting each other, and 32 counting channels (DI/VDI/DO/RO/VDO).

Step	Parameter Setting
1	1. Select one counting module from the four to be used and set A1-50 to 1 to reset the count module. 2. Set A1-50 to 0 to disable reset.
2	Set the number warning threshold of the counting module through A1-55/ A1-56/A1-57/A1-58.
3	Set the active level (positive logic or negative logic) through F4-38/F4-39/A1-43/A1-44/F5-22/A1-21/A1-38/A1-39.
4	Select a counting channel from the 32 channels through A1-51/A1-52/A1-53/ A1-54.
5	After the program runs for a certain period of time, you can view the counting value through A1-59/A1-60/A1-61/A1-62 and the comparison result through L1-03/L1-04/L1-05/L1-06.

Example 1: Assume that the first counting module is used to count the number of times that DO1 changes from active level to inactive level and the warning threshold is 100. Set parameters as follows:

Step	Parameter Setting
1	1. Set A1-50 to 1 to reset the first counting module. 2. Set A1-50 to 0 to disable reset after the historical parameter is cleared.
2	Set A1-55 to 100, which is the number warning threshold of the first counting module.
3	Set DO1 to "1: Negative logic" through F5-22.
4	Set A1-51 to 19, which is the counting channel DO1 of the first counting module.
5	After the program runs for a period of time, you can view the counting value through A1-59 and the comparison result through L1-03.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A1-50	DIO edge counting channel selection for reset	0	0: Disable 1: First counting module 2: Second counting module 3: Third counting module 4: Fourth counting module 5: All counting modules	When a counting module needs to be reset, you can clear it by selecting the corresponding value of this parameter. Note: After the reset, you need to set A1-50 to 0. 0: No counting module is reset. 1: The value calculated by the first counting module is reset. 2: The value calculated by the second counting module is reset. 3: The value calculated by the third counting module is reset. 4: The value calculated by the fourth counting module is reset. 5: The value calculated by the fifth counting module is reset.
A1-51	Channel selection for DIO edge counting module 1	0	0: Disable 1: DI1 2: DI2 3: DI3 4: DI4 5: DI5 6: DI6 7: DI7 8: DI8 9: DI9 10: DI10 11: VDI1 12: VDI2 13: VDI3 14: VDI4 15: VDI5 (To be continued)	This parameter is used to select the channel for the first counting module.
A1-52	DIO edge counting channel selection 2	0		This parameter is used to select the channel for the second counting module.
A1-53	DIO edge counting channel selection 3	0		This parameter is used to select the channel for the third counting module.
A1-54	DIO edge counting channel selection 4	0		This parameter is used to select the channel for the fourth counting module.

Parameter Code	Parameter Name	Default	Value Range	Description
A1-51	Channel selection for DIO edge counting module 1	0	Continued 16: VDI6 17: RELAY1 (DO3) 18: FMR 19: DO1 20: RELAY2 (DO4) 21: DO2 22: VDO1 23: VDO2 24: VDO3 25: VDO4 26: VDO5 27: VDO6 28: VDO7 29: VDO8 30: VDO9 31: VDO10 32: VDO11	This parameter is used to select the channel for the first counting module.
A1-52	DIO edge counting channel selection 2	0		This parameter is used to select the channel for the second counting module.
A1-53	DIO edge counting channel selection 3	0		This parameter is used to select the channel for the third counting module.
A1-54	DIO edge counting channel selection 4	0		This parameter is used to select the channel for the fourth counting module.
A1-55	Comparison value of DIO edge counting module 1	0	0 to 65535	This parameter is used to set the comparison value of the first counting module.
A1-56	DIO edge counting comparison value setting 2	0	0 to 65535	This parameter is used to set the comparison value of the second counting module.
A1-57	Comparison value of DIO edge counting module 3	0	0 to 65535	This parameter is used to set the comparison value of the third counting module.
A1-58	Comparison value of DIO edge counting module 4	0	0 to 65535	This parameter is used to set the comparison value of the fourth counting module.
A1-59	Counting value of DIO edge counting module 1	0	0 to 65535	This parameter indicates the counted value of the first counting module.
A1-60	Counting value of DIO edge counting module 2	0	0 to 65535	This parameter indicates the counted value of the second counting module.
A1-61	Counting value of DIO edge counting module 3	0	0 to 65535	This parameter indicates the counted value of the third counting module.
A1-62	Counting value of DIO edge counting module 4	0	0 to 65535	This parameter indicates the counted value of the fourth counting module.

29.3.6 Analog Input Terminal (AI) Functions

The AC drive provides two multi-functional AIs by default. If more AIs are required by field applications, an I/O expansion card can be selected. For the number of AIs on each expansion card, see "Expansion Card". For example, the expansion card MD38IO1 provides one analog input terminal AI3.

To use AIs as DIs, the following parameters need to be set. When an AI is used as an DI, the AI state is high level if the input voltage of the AI is higher than 7 V and is low level if the input voltage of the AI is lower than 3 V. The AI is in hysteresis state if the input voltage ranges from 3 V and 7 V. The following figure shows the relationship between AI input voltages and DI states.

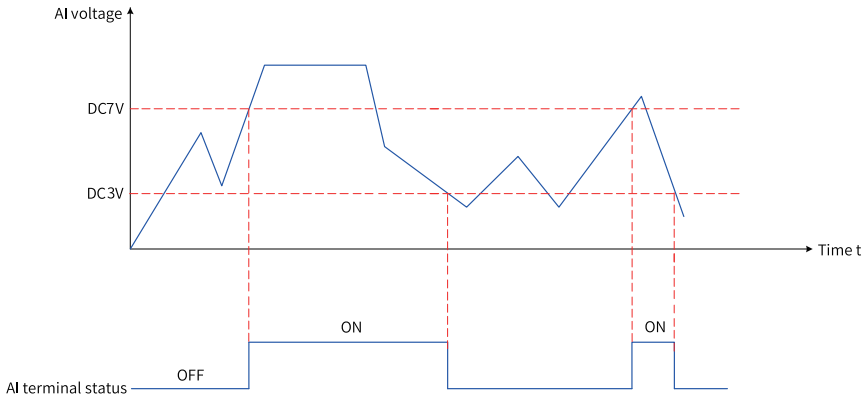


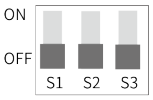
Figure 29-42 Relationship between AI input voltages and DI states

Table 29–17 Related parameter list

Terminal	Name	Type	Input Range
AI1-GND	Control board AI 1	Voltage type	0 VDC to 10 VDC
AI2-GND	Control board AI 2	Voltage type	0 VDC to 10 VDC
		Current type (500 Ω impedance)	0 mA to 20 mA
		Current type (250 Ω impedance)	0 mA to 40 mA
		Temperature	Select different input types and temperature sensor types based on the DIP switch on the main control board and F9-75. PT100: -25°C to +200°C PT1000: -25°C to +200°C KTY84-130: -40°C to +260°C PTC130: -20°C to +180°C
AI3-GND	I/O expansion card AI	Voltage type	0 VDC to 10 VDC
		Temperature	Select different input types and temperature sensor types based on the DIP switch on the expansion board and F9-56. PT100: 0°C to 200°C PT1000: 0°C to 200°C

Functions of the AI can be set by the DIP switches on the main control board, as summarized in the following table.

Table 29–18 Descriptions of DIP switches S1 to S3

DIP Switch Diagram	DIP Switch Status			Function Description
	S1	S2	S3	
	OFF	OFF	OFF	Voltage mode with the range of 0 VDC to 10 VDC for AI2
	ON	OFF	OFF	Temperature mode for AI2 Set the temperature sensor type through F9-75. 0: Temperature sensor not supported (AI used for analog input) 1: PT100, supporting the temperature range of -25°C to +200°C 2: PT1000, supporting the temperature range of -25°C to +200°C 3: KTY84-130, supporting the temperature range of -40°C to +260°C 4: PTC130, supporting the temperature range of -20°C to +180°C
	OFF	ON	OFF	Current mode for AI2; current range: 0 mA to 20 mA; input impedance: 500 Ω
	OFF	ON	ON	Current mode for AI2; current range: 0 mA to 40 mA; input impedance: 250 Ω

Note

S1, S2, and S3 are DIP switches used in combination. For details, see *"Table 29–18" on page 710*.

Use F9-56 and F9-75 to select a temperature sensor for the AI. Note that if AI2/AI3 is not used as temperature input, you need to set F9-56 and F9-75 to 0 (No temperature sensor).

Table 29–19 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
A1-07	AI1 (used as DI) function	0	0 to 86	Same as F4-00
A1-08	AI2 (used as DI) function	0		
A1-09	AI3 (used as DI) function	0		
A1-10	Active mode selection for AI used as DI	000	Ones: AI1 0: Active low 1: Active high Tens: AI2 0: Active low 1: Active high Hundreds: AI3 0: Active low 1: Active high	When the AI is active low, the AI is inactive if the corresponding digit of A1-10 is set to 0, and active if the corresponding digit of A1-10 is set to 1. When the AI is active low, the AI is active if the corresponding digit of A1-10 is set to 0, and inactive if the corresponding digit of A1-10 is set to 1.
F4-13	Minimum input of AI curve 1	0.00 V	-10.00 V to F4-15	When the main frequency is set by the AI, each AI supports five types of AI curves. The AI curve is used to set the relationship between the analog input voltage (or current) and the percentage corresponding to the maximum frequency (F0-10). The x axis of the AI curve represents the analog input voltage or current, and the y axis represents the set value corresponding to the analog input, which is the percentage of the maximum frequency (F0-10). Five AI curves are provided. Curves 1 to 3 are two-point curves, and their relevant parameters are F4-13 to F4-27. Curves 4 and 5 are four-point curves, and their relevant parameters are A6-00 to A6-15. The two points on curves 1 to 3 are the minimum input point and maximum input point, respectively. F4-13 corresponds to the x axis of the AI curve 1 minimum input, that is, the minimum analog input voltage or current.
F4-14	Percentage corresponding to minimum input of AI curve 1	0.0%	-100.0% to 100.0%	F4-14 corresponds to the y axis of AI curve 1 minimum input, that is, the set value corresponding to the minimum analog input.
F4-15	Maximum input of AI curve 1	10.00 V	F4-13 to 10.00 V	F4-15 corresponds to the x axis of AI curve 1 maximum input, that is, the maximum analog input voltage or current.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-16	Percentage corresponding to maximum input of AI curve 1	100.0%	-100.0% to 100.0%	F4-16 corresponds to the y axis of AI curve 1 maximum input, that is, the set value corresponding to the maximum analog input.
F4-17	AI1 filter time	0.10s	0.00s to 10.00s	This parameter indicates the software filter time of AI1. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-18	Minimum input of AI curve 2	0.00 V	-10.00 V to F4-20	F4-18 corresponds to the x axis of the AI curve 2 minimum input, that is, the minimum analog input voltage or current.
F4-19	Percentage corresponding to minimum input of AI curve 2	0.0%	-100.0% to 100.0%	F4-19 corresponds to the y axis of AI curve 2 minimum input, that is, the set value corresponding to the minimum analog input.
F4-20	Maximum input of AI curve 2	10.00 V	F4-18 to 10.00 V	F4-20 corresponds to the x axis of AI curve 2 maximum input, that is, the maximum analog input voltage or current.
F4-21	Percentage corresponding to maximum input of AI curve 2	100.0%	-100.0% to 100.0%	F4-21 corresponds to the y axis of AI curve 2 maximum input, that is, the set value corresponding to the maximum analog input.
F4-22	AI2 filter time	0.10s	0.00s to 10.00s	This parameter indicates the software filter time of AI2. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-23	Minimum input of AI curve 3	0.00 V	-10.00 V to F4-25	F4-23 corresponds to the x axis of the AI curve 3 minimum input, that is, the minimum analog input voltage or current.
F4-24	Percentage corresponding to minimum input of AI curve 3	0.0%	-100.0% to 100.0%	F4-24 corresponds to the y axis of AI curve 3 minimum input, that is, the set value corresponding to the minimum analog input.
F4-25	Maximum input of AI curve 3	10.00 V	F4-23 to 10.00 V	F4-25 corresponds to the x axis of AI curve 3 maximum input, that is, the maximum analog input voltage or current.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-26	Percentage corresponding to maximum input of AI curve 3	100.0%	-100.0% to 100.0%	F4-26 corresponds to the y axis of AI curve 3 maximum input, that is, the set value corresponding to the maximum analog input.
F4-27	AI3 filter time	0.10s	0.00s to 10.00s	This parameter indicates the software filter time of AI3. The longer the AI filter time, the stronger the anti-interference capability and the slower the speed of response to analog detection. The shorter the AI filter time, the weaker the anti-interference capability and the faster the speed of response to analog detection. When analog signals on the site are susceptible to interference, increase the AI filter time to enhance the stability of analog signals.
F4-33	AI curve selection	0x321	Ones: AI1 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15) Tens: AI2 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15)	The ones to hundreds places of this parameter are used to select curves for AI1 to AI3. Each digit can be used to set a curve for an AI. Different AIs can be set with the same curve.

Parameter Code	Parameter Name	Default	Value Range	Description
F4-33	AI curve selection	0x321	Continued Hundreds: AI3 curve selection 1: Curve 1 (2 points, see F4-13 to F4-16) 2: Curve 2 (2 points, see F4-18 to F4-21) 3: Curve 3 (2 points, see F4-23 to F4-26) 4: Curve 4 (4 points, see A6-00 to A6-07) 5: Curve 5 (4 points, see A6-08 to A6-15)	Continued
F4-34	Selection when AI value < minimum input value	0x0	Ones place: Selection when AI1 value < minimum input value 0: Corresponding to the minimum input 1: 0.0% Tens: Selection when AI2 value < minimum input value 0: Corresponding to the minimum input 1: 0.0% Hundreds: Selection when AI3 value < minimum input value 0: Corresponding to the minimum input 1: 0.0%	The ones to hundreds places of this parameter are used to select curves for AI1 to AI3.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-56	AI3 temperature mode - motor temperature sensor type	0	0: Temperature sensor not supported (AI used for analog input) 1: PT100 2: PT1000	A motor temperature sensor needs to be connected to the AI3 and PGND terminals on the MD38IO1 expansion card. The AC drive supports PT100 and PT1000 motor temperature sensors. Set the sensor type properly. Set the DIP switch on the MD38IO1 expansion card. For details, see section MD38IO1 expansion card in the AC drive expansion card selection guide. You can view the motor temperature in U0-34.
F9-57	AI3 temperature mode - motor overheat protection threshold	110°C	F9-58 to 200°C	This parameter is used to set the motor overtemperature protection threshold. When the motor temperature exceeds the value of F9-57 (motor overtemperature protection threshold), the AC drive generates the motor overtemperature alarm (E045.1).
F9-58	AI3 temperature mode - motor overheat warning threshold	90°C	0°C to F9-57	When the motor temperature exceeds the motor overtemperature warning threshold (F9-58), the DO allocated with function 39 (Motor overtemperature warning) outputs a valid signal.
F9-75	AI2 temperature mode - motor temperature sensor type	0	0: Temperature sensor not supported (AI used for analog input) 1: PT100 2: PT1000 3: KTY84-130 4: Single-conductor PTC130 5: Three-conductor PTC130 6: Single-conductor PTC150 7: Three-conductor PTC150 8: Three PT100s connected in series	This parameter is used to select the temperature sensor type when AI2 is used for temperature input.
F9-76	AI2 temperature mode - motor overheat protection threshold	110°C	F9-77 to 200°C	This parameter is used to set the overheat protection threshold when AI2 is used for temperature sampling.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-77	AI2 temperature mode - motor overheat warning threshold	90°C	0°C to F9-76	This parameter is used to set the overheat warning threshold when AI2 is used for temperature sampling.
F9-78	AI2 temperature mode - motor temperature reach	75°C	0°C to 100°C	This parameter is used to set the temperature reach threshold when AI2 is used for temperature sampling.
F9-80	AI3 temperature mode - motor temperature reach	75°C	0°C to 100°C	This parameter is used to set the temperature reach threshold when AI3 is used for temperature sampling.
A6-00	Minimum input of AI curve 4	0.00 V	-10.00 V to A6-02	A6-00 corresponds to the x axis of the AI curve 4 minimum input, that is, the minimum analog input voltage or current.
A6-01	Percentage corresponding to minimum input of AI curve 4	0.0%	-100.0% to 100.0%	A6-01 corresponds to the y axis of AI curve 4 minimum input, that is, the set value corresponding to the minimum analog input.
A6-02	Inflection point 1 input of AI curve 4	3.00 V	A6-00 to A6-04	A6-02 corresponds to the x axis of the AI curve 4 inflection point 1, that is, the minimum analog input voltage.
A6-03	Percentage corresponding to inflection point 1 input of AI curve 4	30.0%	-100.0% to 100.0%	A6-03 corresponds to the y axis of the AI curve 4 inflection point 1, that is, the set value corresponding to the minimum analog input.
A6-04	Inflection point 2 input of AI curve 4	6.00 V	A6-02 to A6-06	A6-04 corresponds to the x axis of the AI curve 4 inflection point 2, that is, the minimum analog input voltage.
A6-05	Percentage corresponding to inflection point 2 input of AI curve 4	60.0%	-100.0% to 100.0%	A6-05 corresponds to the y axis of the AI curve 4 inflection point 2, that is, the set value corresponding to the minimum analog input.
A6-06	Maximum input of AI curve 4	10.00 V	A6-04 to 10.00 V	A6-06 corresponds to the x axis of AI curve 4 maximum input, that is, the maximum analog input voltage or current.
A6-07	Percentage corresponding to maximum input of AI curve 4	100.0%	-100.0% to 100.0%	A6-07 corresponds to the y axis of AI curve 4 maximum input, that is, the set value corresponding to the maximum analog input.
A6-08	Minimum input of AI curve 5	-10.00 V	-10.00 V to A6-10	A6-08 corresponds to the x axis of the AI curve 5 minimum input, that is, the minimum analog input voltage or current.

Parameter Code	Parameter Name	Default	Value Range	Description
A6-09	Percentage corresponding to minimum input of AI curve 5	-100.0%	-100.0% to 100.0%	A6-09 corresponds to the y axis of AI curve 5 minimum input, that is, the set value corresponding to the minimum analog input.
A6-10	Inflection point 1 input of AI curve 5	-3.00 V	A6-08 to A6-12	A6-10 corresponds to the x axis of the AI curve 5 inflection point 1, that is, the minimum analog input voltage.
A6-11	Percentage corresponding to inflection point 1 input of AI curve 5	-30.0%	-100.0% to 100.0%	A6-11 corresponds to the y axis of the AI curve 5 inflection point 1, that is, the set value corresponding to the minimum analog input.
A6-12	Inflection point 2 input of AI curve 5	3.00 V	A6-10 to A6-14	A6-12 corresponds to the x axis of the AI curve 5 inflection point 2, that is, the minimum analog input voltage.
A6-13	Percentage corresponding to inflection point 2 input of AI curve 5	30.0%	-100.0% to 100.0%	A6-13 corresponds to the y axis of the AI curve 5 inflection point 2, that is, the set value corresponding to the minimum analog input.
A6-14	Maximum input of AI curve 5	10.00 V	A6-12 to 10.00 V	A6-14 corresponds to the x axis of AI curve 5 maximum input, that is, the maximum analog input voltage or current.
A6-15	Percentage corresponding to maximum input of AI curve 5	100.0%	-100.0% to 100.0%	A6-15 corresponds to the y axis of AI curve 5 maximum input, that is, the set value corresponding to the maximum analog input.
A6-24	AI1 jump point	0.0%	-100.0% to 100.0%	This parameter is used to set the AI1 jump point. If the input value is within the range from A6-24 - A6-25 to A6-24 + A6-25, the value of the AI1 jump point (A6-24) will be output.
A6-25	AI1 jump amplitude	0.1%	0.0% to 100.0%	This parameter is used to set the AI1 jump amplitude. If the input value is within the range from A6-24 - A6-25 to A6-24 + A6-25, the value of the AI1 jump point (A6-24) will be output.
A6-26	AI2 jump point	0.0%	-100.0% to 100.0%	This parameter is used to set the AI2 jump point. If the input value is within the range from A6-26 - A6-27 to A6-26 + A6-27, the value of the AI2 jump point (A6-26) will be output.
A6-27	AI2 jump amplitude	0.1%	0.0% to 100.0%	This parameter is used to set the AI2 jump amplitude. If the input value is within the range from A6-26 - A6-27 to A6-26 + A6-27, the value of the AI2 jump point (A6-26) will be output.
A6-28	AI3 jump point	0.0%	-100.0% to 100.0%	This parameter is used to set the AI3 jump point. If the input value is within the range from A6-28 - A6-29 to A6-28 + A6-29, the value of the AI3 jump point (A6-28) will be output.

Parameter Code	Parameter Name	Default	Value Range	Description
A6-29	AI3 jump amplitude	0.1%	0.0% to 100.0%	This parameter is used to set the AI3 jump amplitude. If the input value is within the range from A6-28 - A6-29 to A6-28 + A6-29, the value of the AI3 jump point (A6-28) will be output.
A6-30	AI automatic adjustment curve	0	Ones: Point selection (for setting) 0: Disable 1: Point 1 2: Point 2 3: Point 3 4: Point 4 Tens: AI channel selection (for setting) 0: Disable 1: Corrected AI1 2: Corrected AI2 3: Corrected AI3 Hundreds: AI automatic adjustment curve (for setting) 0: Disable 1: Enable Thousands: X-point curve (for display) 0: Enabling or channel is not selected 2: 2-point curve 4: 4-point curve Ten thousands: Reserved	You can set different AI curves, control functions, and curve types (2-point curve or 4-point curve) through the ones, tens, hundreds, thousands, and ten thousands places of this parameter.
A6-31	AI1 input	0	0: Disable 1: Enable Other: B connector	-
A6-32	AI2 input	0	0: Disable 1: Enable Other: B connector	-

Parameter Code	Parameter Name	Default	Value Range	Description
A6-33	AI3 input	0	0: Disable 1: Enable Other: B connector	-
A6-34	AI polarity selection	0	Ones: AI1 polarity 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value Tens: AI2 polarity 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value Hundreds: AI3 polarity 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value	You can set AI1, AI2, and AI3 input polarities through the ones, tens, and hundreds places of this parameter. 0: Normal value 1: Absolute value 2: Opposite to the normal value 3: Opposite to absolute value
A6-35	AI hardware source selection	0	Ones: AI1 source 0: Hardware sampling 1: Forced value Tens: AI2 source 0: Hardware sampling 1: Forced value Hundreds: AI3 source 0: Hardware sampling 1: Forced value	You can set AI1, AI2, and AI3 hardware sources through the ones, tens, and hundreds places of this parameter. If the source is set to 0 (hardware sampling), the AI value is sourced from hardware sampling. If the source is set to 1 (forced value), the AI value can be forcibly set through parameters A6-36 to A6-38.
A6-36	AI1 forced value	0.00 V	-10.00 V to 10.00 V	If the ones place of A6-35 is set to 1 (forced value), you can set the AI1 value forcibly through A6-36.
A6-37	AI2 forced value	0.00 V	-10.00 V to 10.00 V	If the tens place of A6-35 is set to 1 (forced value), you can set the AI2 value forcibly through A6-37.

Parameter Code	Parameter Name	Default	Value Range	Description
A6-38	AI3 forced value	0.00 V	-10.00 V to 10.00 V	If the hundreds place of A6-35 is set to 1 (forced value), you can set the AI3 value forcibly through A6-38.
A6-39	High level judgment threshold when AI uses as DI	7.0 V	5.5 V to 9.0 V	This parameter defines the threshold for judging high level when the AI is used as the DI.
A6-40	Low level judgment threshold when AI uses as DI	3.0 V	1.0 V to 4.5 V	This parameter defines the threshold for judging low level when the AI is used as the DI.
A6-41	AI1 gain	1.00	-10.00 to 10.00	This parameter defines the gain multiple of AI1 analog sampling value.
A6-42	AI1 offset	0.00 V	-10.00 V to 10.00 V	This parameter defines the zero offset coefficient for AI1 correction voltage.
A6-43	AI1 denoising threshold	0.5%	0.0% to 100.0%	This parameter defines the AI1 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-44	AI1 dead zone width	0.5%	0.0% to 100.0%	This parameter defines the AI1 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.
A6-47	AI2 gain	1.00	-10.00 to 10.00	This parameter defines the gain multiple of AI2 analog sampling value.
A6-48	AI2 offset	0.00 V	-10.00 V to 10.00 V	This parameter defines the AI2 analog sampling offset.
A6-49	AI2 denoising threshold	0.5%	0.0% to 100.0%	This parameter defines the AI2 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-50	AI2 dead zone width	0.5%	0.0% to 100.0%	This parameter defines the AI2 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.
A6-53	AI3 gain	1.00	-10.00 to 10.00	This parameter defines the gain multiple of AI3 analog sampling value.
A6-54	AI3 offset	0.00 V	-10.00 V to 10.00 V	This parameter defines the AI3 analog sampling offset.
A6-55	AI3 denoising threshold	0.5%	0.0% to 100.0%	This parameter defines the AI3 denoising threshold. If the absolute value of the difference between the current input and the last input is below the threshold, denoising will be applied.
A6-56	AI3 dead zone width	0.5%	0.0% to 100.0%	This parameter defines the AI3 dead zone width. The output 0.0% within the dead zone range is used to eliminate the fluctuation near zero.

Table 29–20 Procedure for setting the AI as the frequency reference

Procedure	Parameter	Description	
AI selection: Select the AI for setting the frequency reference based on terminal characteristics.	F0-03	F0-03 = 2	AI1 is used.
		F0-03 = 3	AI2 is used.
		F0-03 = 4	AI3 is used.
Curve between AI voltage[1] and frequency: Select any of the five curves.	F4-33	Generally, F4-33 is set to the default value 321. That is, AI1 uses curve 1, AI2 uses curve 2, and AI3 uses curve 3.	
Curve between AI voltage[1] and frequency: Set the relationship between AI voltage inputs and the set values.	F4-13 to F4-16 [2]	Curve 1 setting	Typical curve [3]
	F4-18 to F4-21	Curve 2 setting	Typical curve [4]
	F4-23 to F4-27	Curve 3 setting	Typical curve [5]
	A6-00 to A6-07	Curve 4 setting	
	A6-08 to A6-15	Curve 5 setting	
	F4-34	Selection when AI value < minimum input value[2]	
	F0-10	When the AI is used as the frequency reference source, the value 100% of the voltage/current input corresponds to the value of F0-10 (Maximum frequency).	
AI filter time	F4-17	The default value is 0.1s. Set this parameter to balance the response speed and anti-interference capability. If quick response is required, reduce the setpoint of F4-17. If the interference on site is strong, increase the setpoint of F4-17.	

[1] For the current-type AI curve, 1 mA current corresponds to 0.5 V voltage. That is, 20 mA corresponds to 10 V.

[2] When the analog input voltage exceeds the maximum value (F4-15), the maximum value is used as the analog input voltage. When the analog input voltage is less than the minimum value (F4-13), the value (minimum input value or 0.0%) of F4-34 (selection when AI value < minimum input value) is used as the analog input voltage.

[3] The typical curve of AI1 is shown in the following figure.

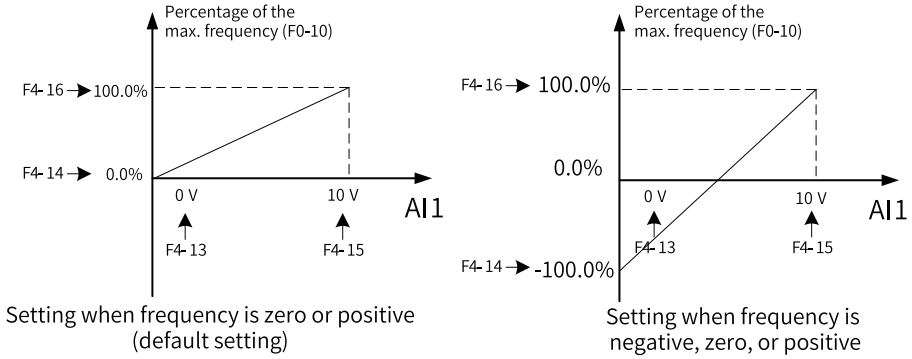


Figure 29-43 Typical curve of AI1

[4] The typical curve of AI2 for voltage input is consistent with that of AI1. When AI2 is used for current input, set 4 mA to 20 mA, which corresponds to 0 Hz to 50 Hz or -50 Hz to 50 Hz.

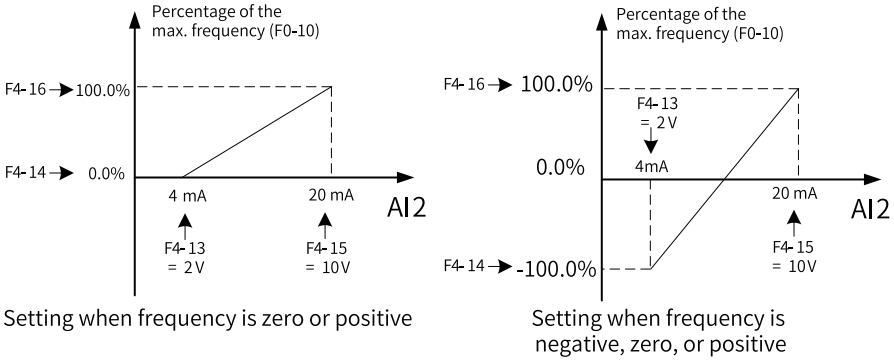


Figure 29-44 Typical curve of AI2

[5] The typical curve of AI3 is shown in the following figure. The corresponding relations in the following two setting methods are the same in the voltage range from 0 V to 10 V. However, when the negative voltage is input, the voltage will be limited to 0 V (F4-24) in the setting method shown in the left figure.

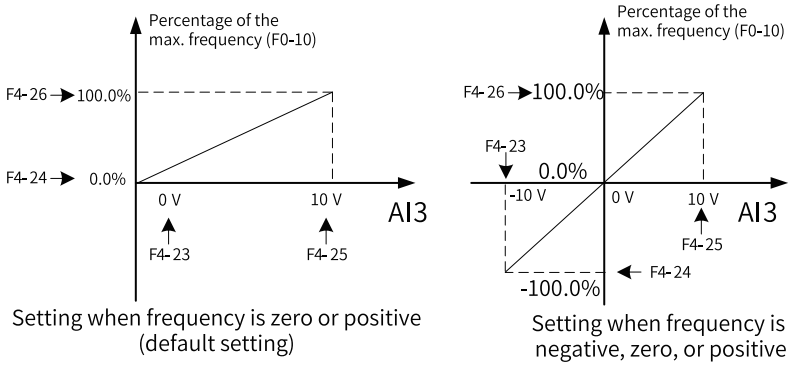


Figure 29-45 Typical curve of AI3

Different from the manually corrected curve, the voltage of the correction point can be filled in automatically to the AI automatically corrected curve. The function of each decimal digital place of A6-30 (AI curve automatic correction) is as follows.

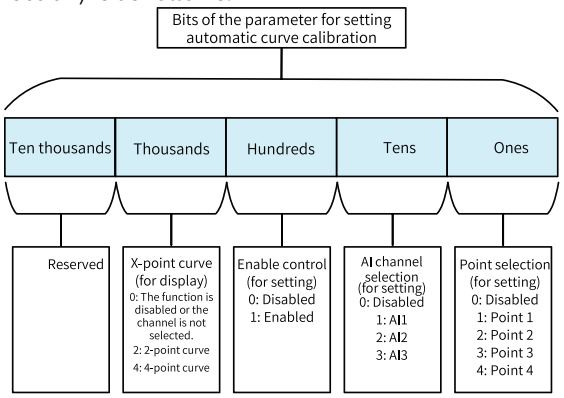


Figure 29-46 Function of each decimal digital place of A6-30

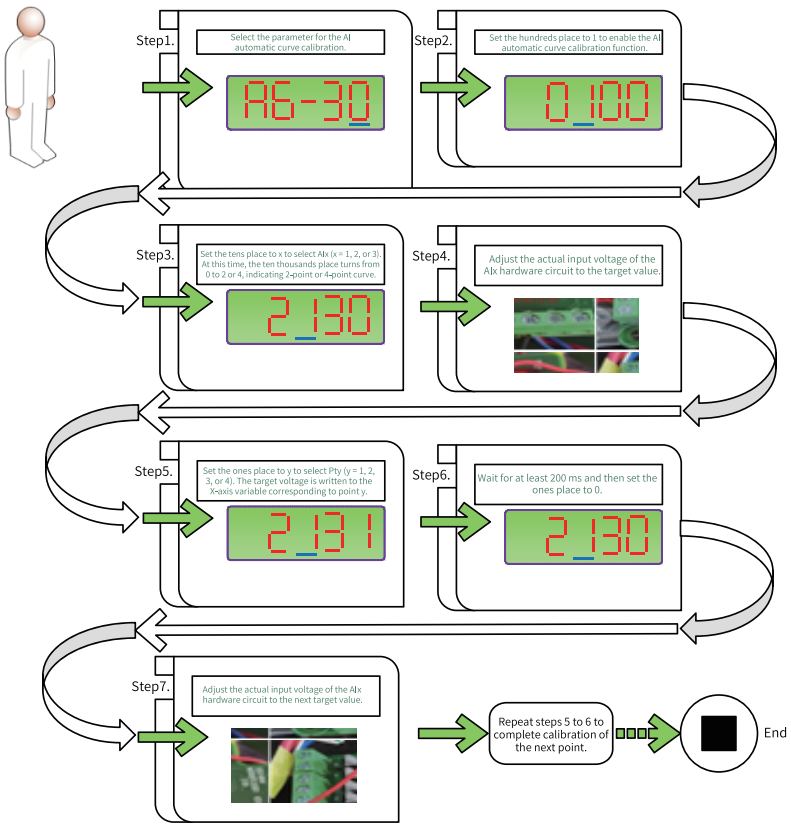


Figure 29-47 Operation of AI curve automatic correction

29.3.7 Analog and Pulse Output Terminal (AO and HDO) Functions

The AC drive is equipped with one analog output terminal AO and one high-speed pulse output terminal HDO as standard. If more AOs are required by field applications, an I/O expansion card can be selected. For the number of AOs on each expansion card, see "Expansion Card". For example, the expansion card MD38IO1 provides one analog output terminal AO2.

The following parameters are used to rectify the zero drift of the AO and the deviation of output amplitude, and customize AO/HDO output curves.

Table 29–21 Related parameter list

Parameter Code	Parameter Name	Default	Value Range	Description
F5-00	FM multi-functional terminal output selection	0	0: Pulse output (FMP) 1: Switch output (FMR)	The FM terminal is a programmable multi-functional terminal, which can be used as the high-speed pulse output (FMP) terminal or open collector digital output terminal (FMR). 0: When the terminal is used for high-speed pulse output, the maximum frequency is 100 kHz. 1: When the terminal is used as open collector output, specifications are the same as DO1.
F5-06	FMP output function selection	0	0: Operating frequency 1: Frequency reference 2: Output current 3: Output torque (absolute value) 4: Output power 5: Output voltage 6: Pulse input 7: AI1 8: AI2 9: AI3 10: Length 11: Count value 12: Communication 13: Motor speed 14: Output current. 100.0% corresponds to 1000.0 A. 15: Bus voltage. 100.0% corresponds to 1000.0 V. 16: Output torque (actual value) Others: F connector	0: Running frequency. 100.0% corresponds to the maximum frequency (F0-10). 1: Frequency reference. 100.0% corresponds to the maximum frequency (F0-10). 2: Output current. 100.0% corresponds to two times the rated motor current. 3: Output torque. 100.0% corresponds to two times the rated motor torque (absolute value). 4: Output power. 100.0% corresponds to two times the rated motor power. 5: Output voltage. 100.0% corresponds to 1.2 times the rated motor voltage. 6: Pulse input. 100.0% corresponds to 100.0 kHz. 7: AI1. 100.0% corresponds to 10 V. 8: AI2. 100.0% corresponds to 10 V. 9: AI3. 100.0% corresponds to 10 V. 10: Length. 100.0% corresponds to FB-05. 11: Count value. 100.0% corresponds to FB-08. 12: Communication. 100.0% corresponds to the AO communication setting value. 13: Motor speed. 100.0% corresponds to the maximum frequency (F0-10). 14: Output current. 100.0% corresponds to 1000.0 A. 15: Bus voltage. 100.0% corresponds to 1000.0 V. 16: Output torque. 100.0% corresponds to two times the rated motor torque, 50.0% corresponds to 0, and 0 corresponds to negative two times the rated motor torque (actual value). Others: F connector When this option is selected, the output function is the signal or function state of the parameter to which the connector is connected.
F5-07	AO1 output function selection	0		
F5-08	Output function selection of AO2 on expansion card	1		
F5-09	Maximum frequency of FMP output	50.00 kHz	0.01 kHz to 100.00 kHz	This parameter indicates the maximum frequency (0.01 kHz to 100.00 kHz) of the FMP terminal output pulse.

Parameter Code	Parameter Name	Default	Value Range	Description
F5-10	AO1 zero offset coefficient	0.0%	-100.0% to 100.0%	On the AO curve, if b indicates zero offset, k indicates gain, and X indicates standard output, the actual output Y is kX plus b (Y = kX + b). The zero offset coefficient 100% of AO1 and AO2 corresponds to 10 V (or 20 mA). The standard output refers to the value corresponding to the analog output of 0 V to 10 V (or 0 mA to 20 mA) with no zero offset or gain correction. Zero offset = Zero offset coefficient x 10 V (or 20 mA) The drive supports two AOs, AO1 and AO2, which can be used to indicate the internal operating parameters in the analog mode. The parameter property indicated is defined by F5-07 and F5-08.
F5-11	AO1 gain	1.00	-10.00 to 10.00	
F5-12	AO2 zero offset coefficient	0.0%	-100.0% to 100.0%	
F5-13	AO2 gain	1.00	-10.00 to 10.00	
F5-36	Minimum input of AO1 curve	0.0%	-100.0 to F5-38	This parameter corresponds to the x axis of the minimum input, that is, the minimum output frequency of AO1 curve.
F5-37	Setting corresponding to AO1 curve minimum input	0.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the minimum input, that is, the set value corresponding to the minimum output of AO1 curve.
F5-38	Maximum input of AO1 curve	100.0%	F5-36 to 100.0%	This parameter corresponds to the x axis of the maximum input, that is, the maximum output frequency of AO1 curve.
F5-39	Setting corresponding to AO1 curve maximum input	10.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the maximum input, that is, the set value corresponding to the maximum output of AO1 curve.
F5-40	AO1 output offset	0.00 V	-10.00 V to 10.00 V	AO1 curve linear parameters
F5-41	Minimum input of AO2 curve	0.0%	-100.0 to F5-43	This parameter corresponds to the x axis of the minimum input, that is, the minimum output frequency of AO2 curve.
F5-42	Setting corresponding to AO2 curve minimum input	0.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the minimum input, that is, the set value corresponding to the minimum output of AO2 curve.
F5-43	Maximum input of AO2 curve	100.0%	F5-41 to 100.0%	This parameter corresponds to the x axis of the maximum input, that is, the maximum output frequency of AO2 curve.

Parameter Code	Parameter Name	Default	Value Range	Description
F5-44	Setting corresponding to AO2 curve maximum input	10.00 V	0.00 V to 10.00 V	This parameter corresponds to the y axis of the maximum input, that is, the set value corresponding to the maximum output of AO2 curve.
F5-45	AO2 output offset	0.00 V	-10.00 V to 10.00 V	AO2 curve linear parameters
F5-46	AO curve selection	11	Ones: AO1 curve 0: Two-point curve 1: Gain + deviation Tens: AO2 curve 0: Two-point curve 1: Gain + deviation	The ones and tens places of this parameter are used to set the AO1 and AO2 curve types. 0: Two-point curve Set the 2-point curve parameters of AO1 and AO2 through F5-36 to F5-45. 1: Gain + deviation Set the gain and deviation parameters of AO1 and AO2 through F5-10 to F5-13.
F5-47	AO polarity selection	00	Ones: AO1 selection 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value Tens: AO2 selection 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value	Set the AO1 and AO2 curve output polarity through the ones and tens of this parameter. 0: Normal value AO curve output value unchanged 1: Absolute value Absolute value of the AO curve output value used 2: Opposite to normal value AO curve output value inverted 3: Opposite to absolute value Absolute value of the AO curve output value inverted
F5-48	AO hardware source selection	00	Ones: AO1 source 0: Output function 1: Forced value Tens: AO2 source 0: Output function 1: Forced value	Set the AO1 and AO2 curve input source through the ones and tens of this parameter. 0: Output function Select the reference source based on F5-07 and F5-08. 1: Forced value Select the forced output value based on F5-49 and F5-50.
F5-49	AO forced value 1	0.00 V	0.00 V to 10.00 V	If the ones place of F5-48 is set to "1: Forced value", you can set the AO1 forced value through F5-49.
F5-50	AO forced value 2	0.00 V	0.00 V to 10.00 V	If the tens place of F5-48 is set to "1: Forced value", you can set the AO2 forced value through F5-50.
F5-51	Minimum input of HDO curve	0.00%	-100.00 to F5-53	This parameter corresponds to the x axis of the minimum input, that is, the minimum input frequency of HDO curve.

Parameter Code	Parameter Name	Default	Value Range	Description
F5-52	Percentage corresponding to minimum input of HDO curve	0.00%	0.00% to 100.00%	This parameter corresponds to the y axis of the minimum input, that is, the set value corresponding to the minimum input frequency of HDO curve.
F5-53	Maximum input of HDO curve	100.00%	F5-51 to 100.00%	This parameter corresponds to the x axis of the maximum input, that is, the maximum input frequency of HDO curve.
F5-54	Percentage corresponding to maximum input of HDO curve	100.00%	0.00% to 100.00%	This parameter corresponds to the y axis of the maximum input, that is, the set value corresponding to the maximum input frequency of HDO curve.
F5-55	HDO polarity selection	0	Ones: HDO selection 0: Normal value 1: Absolute value 2: Opposite to normal value 3: Opposite to absolute value	Set the HDO output polarity through the ones place of this parameter. 0: Normal value HDO output value unchanged 1: Absolute value Absolute value of the HDO output value used 2: Opposite to normal value HDO output value inverted 3: Opposite to absolute value Absolute value of the HDO output value inverted
F5-56	HDO hardware source selection	0	0: Output function 1: Forced value	0: Set F5-51 to F5-55 to set the HDO output value. 1: The forced value set by F5-57 is used as the HDO output value.
F5-57	HDO forced value	0	0.00% to 100.00%	This parameter is used to set the HDO output value forcibly. This parameter is valid only when F5-56 is set to 1.

The analog output 0 V to 10 V corresponds to 0% to 100%. When the AO function is set to 1 (frequency setting), and the drive frequency is set to 50% of the maximum frequency, the output voltage of the AO is 5 V (50% x 10 V).

The FM (pulse output) 0 kHz to 100 kHz corresponds to 0% to 100%. When the FM output function is set to 1 (frequency setting), the drive frequency is set to 50% of the maximum frequency, and F5-09 is set to 100 kHz, the output frequency of the FM terminal is 50 kHz (50% x 100 kHz).

The following is an example of how to calculate AO zero offset coefficient (F5-10) and AO gain (F5-11).

Assume that the AO outputs the operating frequency. The rectified output needs to be 8 V (Y1) when the frequency is 0 Hz (X1) and 4 V (Y2) when the frequency is 40 Hz (X2).

Formula for calculating the gain:

$$K = \frac{(Y1-Y2) \times Xmax}{(X1-X2) \times Ymax}$$

Formula for calculating zero offset coefficient:

$$b = \frac{(X1 \times Y2) - (X2 \times Y1)}{(X1 - X2) \times Ymax} \times 100\%$$

Xmax is the maximum output frequency 50 Hz (assume that the maximum frequency F0-10 is 50 Hz). Ymax is the voltage and the value is 10 V.

The value of F5-11 (AO gain) is -0.5 and the value of F5-10 (AO zero offset coefficient) is 80%.

Table 29–22 Relationship between analog output signal types and corresponding maximum values (Ymax)

Analog Output Signal Type	Corresponding Max. Value (Ymax)
Voltage	10 V
Current	20 mA/40 mA

Table 29–23 Relationship between analog output content and corresponding maximum values (Xmax)

Analog Output Content	Corresponding Max. Value (Xmax)
Operating frequency	Maximum output frequency
Frequency reference	Maximum output frequency
Output current	2 x Rated motor current
Output torque (absolute value)	2 x Rated motor torque
Output power	2 x Rated power
Output voltage	1.2 x Rated drive voltage
Pulse input	100.00 kHz
AI1	10 V
AI2	10 V, 20 mA, or 40 mA
AI3	10 V
Length	Maximum set length
Count value	Maximum counting value
Communication setting	100.0%
Motor speed	Speed at the maximum output frequency
Output current	1000.0 A
Output voltage	1000.0 V
Output torque (actual value)	2 x Rated motor torque

29.4 Control Performance

29.4.1 V/f Curve Setting

Table 29–24 Straight-line, multi-point, and square V/f curve reference parameters

Param.	Name	Default	Value range	Descriptions
F3-00	V/f curve setting	0	0: Linear V/f 1: Multi-point V/f 2, 9: Reserved 10: V/f complete separation mode 11: V/f semi-separation mode	V/f curve setting. In V/f mode, different V/f curves can be set according to different application conditions. 0: Linear V/f curve The output voltage changes linearly with the output frequency when the frequency is lower than the rated frequency. This curve applies to general mechanical transmission applications such as acceleration of high-inertia fans, punch presses, centrifuges, and water pumps. 1: Multi-point V/f curve The frequency ranges from 0.00 Hz to the rated motor frequency. The range of the voltage point is 0.0% to 100.0%, which corresponds to 0 V to the rated motor voltage. Set the multi-point V/f curve based on load characteristics of the motor. Observe this formula during settings: F3-03 ⩽ F3-05 ⩽ F3-07 10: V/f complete separation mode The output frequency and output voltage of the drive are independent of each other. The output frequency is determined by the frequency source, and the output voltage is determined by the V/f separation voltage source. This curve applies to torque motor control applications. 11: V/f semi-separation mode In this mode, the voltage and frequency are proportional, which can be set through the voltage source. The relationship between the voltage and frequency is also related to the rated motor voltage and rated motor frequency. The relationship between the AC drive output voltage V and frequency f is: V/f = 2 x (voltage source input) x (rated motor voltage) ÷ (rated motor frequency). Note: The input value of the voltage source is 0% to 100%.
F3-01	Torque boost	2.0%	0.0% to 30.0%	The torque boost function is generally applicable to low-frequency operations of the drive. The output torque of the AC drive in the V/f control mode is proportional to the frequency. During operation at low frequencies, the motor torque is low when the motor runs at a low speed. In this case, you can set this parameter to increase the output voltage of the drive to improve the output torque. Note that the torque boost value must be set properly. Otherwise, overload protection will be triggered.
F3-02	Cut-off frequency of torque boost	50.00 Hz	0.00 Hz to F0-10	When the operating frequency reaches the cutoff frequency of torque boost, the torque boost function is disabled.

Param.	Name	Default	Value range	Descriptions
F3-03	Multi-point V/f frequency 1	0.00 Hz	0.00 Hz to F3-05	Frequency point 1 set by multi-point V/f curve
F3-04	Multi-point V/f voltage 1	0.0%	0.0% to 100.0%	
F3-05	Multi-point V/F frequency 2	0.00 Hz	F3-03 to F3-07	
F3-06	Multi-point V/f voltage 2	0.0%	0.0% to 100.0%	
F3-07	Multi-point V/f frequency 3	0.00 Hz	F3-05 to F1-04	
F3-08	Multi-point V/f voltage 3	0.0%	0.0% to 100.0%	

Straight-line V/f curve

The following figure shows the general constant-torque straight-line V/f curve.

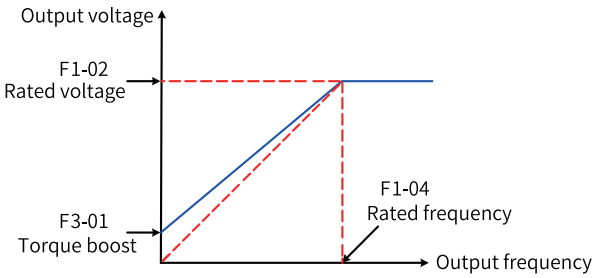


Figure 29-48 General constant-torque linear V/f curve

The output voltage and output frequency change linearly at frequencies lower than the rated frequency. It is applicable to general mechanical transmission applications such as acceleration of high-inertia fans, punch presses, centrifuges, and water pumps.

Multi-point V/f curve

User-defined multi-point V/f curve

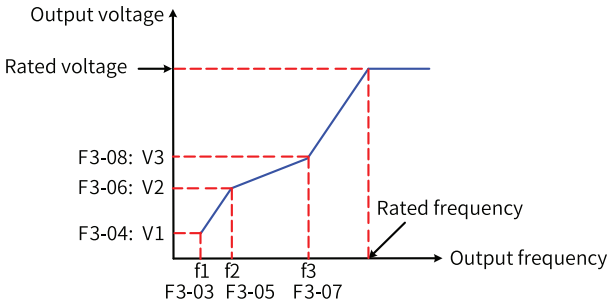


Figure 29-49 User-defined multi-point V/f curve

The multi-point V/f curve is defined by F3-03 to F3-08. The range of the frequency point is 0.00 Hz to the rated frequency of the motor. The range of the voltage point is 0.0% to 100%, corresponding to 0 V

to the rated voltage of the motor. Set the multi-point V/f curve based on motor load characteristics. Observe this formula during setting: F3-03 ≤ F3-05 ≤ F3-07. To ensure correct setting, the drive limits F3-03, F3-05 and F3-07. Set F3-07 first, then F3-05 and finally F3-03.

Table 29–25 V/f separation curve parameters

Param.	Name	Default	Value range	Descriptions
F3-13	Voltage source for separated V/f	0	0: F3-14 1: AI1 2: AI2 3: AI3 4: Pulse reference (DI5) 5: Multi-reference 6: Simple PLC 7: PID 8: Communication Others: F connector	Defines the target voltage reference source in case of separated V/f. 0: F3-14 The V/f separated voltage is set by F3-14. 1: AI1 The V/f separated voltage is input with the current or voltage signal through the AI1 terminal. The frequency is calculated according to the set AI curve. 2: AI2 The V/f separated voltage is input with the current or voltage signal through the AI2 terminal. The frequency is calculated according to the set AI curve. 3: AI3 The V/f separated voltage is input with the current or voltage signal through the AI3 terminal. The frequency is calculated according to the set AI curve. The AC drive has two AI terminals by default, and the AI3 terminal needs to be provided through the I/O expansion card. 4: Pulse reference (DI5) The V/f separated voltage is input with the pulse frequency through the DI5 terminal. The frequency is calculated according to the corresponding relationship curve between the pulse frequency and operating frequency. 5: Multi-reference In the multi-reference mode, combinations of different DI terminal states correspond to different setting values. The four multi-reference terminals can be grouped in different ways to indicate 16 states, which correspond to 16 frequency references (percentage x maximum frequency) in group FC. 6: Simple PLC The V/f separated voltage is set by simple PLC. For details, see the function description of simple PLC.
(Continued)				7: PID The V/f separated voltage is set by PID. For details, see the PID function description. 8: Communication The V/F separation output voltage is set via communication. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. Others: F connector Read the value of a floating-point connector as the V/f separation voltage in speed control mode by setting the function code number of the connector. This mode is used for expansion besides the common sources.

Param.	Name	Default	Value range	Descriptions
F3-14	Voltage digital setting for V/f separation	0V	0 V to rated motor voltage (F1-02)	The setting range is 0 V to the rated voltage.
F3-15	Voltage rise time of V/f separation	0.0s	0.0s to 1000.0s	This parameter indicates the time required for the output voltage to accelerate from 0 to the rated motor voltage.
F3-16	Voltage decline time of V/f separation	0.0s	0.0s to 1000.0s	This parameter indicates the time required for the output voltage to decelerate from the rated motor voltage to 0.
F3-17	Stop mode for separated V/f	0	0: The frequency and the voltage decline to 0 separately. 1: Te frequency declines to 0 after the voltage declines to 0. 2: Free stop (new)	Stop mode of frequency/voltage 0: The frequency/voltage declines to 0 independently based on respective deceleration time. 1: The voltage declines to 0 based on the deceleration time. Then the frequency declines to 0 based on the deceleration time. 2: The voltage/frequency coasts to stop, regardless of the deceleration curve.

Voltage acceleration time indicates time needed to rise from 0 to rated motor voltage. See t1 in the figure.

Voltage deceleration time indicates time needed to decline from rated motor voltage to 0. See t2 in the figure.

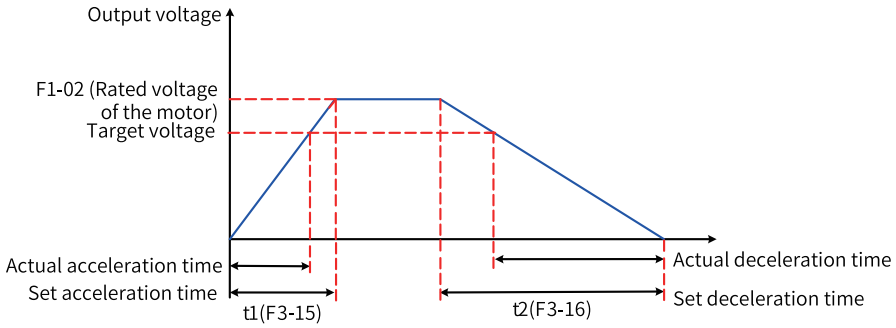


Figure 29-50 Diagram for separated V/f

29.4.2 Output Current (Torque) Limit

During acceleration, operation at constant speed, or deceleration, if the current exceeds the overcurrent stall action current (default: 150%, indicating 1.5 times the rated AC drive current), the current limit mechanism is activated. In this case, the output frequency decreases until the current drops below the overcurrent stall action current. Then, the output frequency increases toward the target frequency. Therefore, the acceleration is prolonged. If the actual acceleration time cannot meet your requirement, increase the value of overcurrent stall action current (F3-18) accordingly.

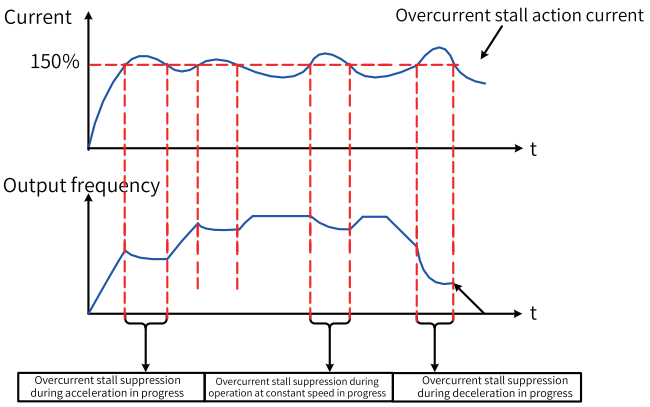


Figure 29-51 Overcurrent stall action

Table 29–26 Related parameter list

Parameter	Name	Default	Value range	Descriptions
F3-18	V/f current limit level	150%	50% to 200%	When the motor current reaches this value, the AC drive starts overcurrent stall function. The default value is 150%, corresponding to 1.5 x rated current of the AC drive.
F3-19	V/f current limit selection	1	0: Enable 1: Disable	Determines whether the V/f current limit function is enabled.
F3-20	V/f current limit gain	20	0 to 100	When the current exceeds the action current of overcurrent stall, the overcurrent stall function is enabled and output frequency decreases. After the current falls below the overcurrent stall threshold, the output frequency increases to the target frequency again, which prolongs the actual acceleration time automatically. The higher the setpoint, the better the suppression effect.
F3-21	Compensation coefficient of V/f speed multiplying current limit	100%	50% to 200%	This parameter reduces the overcurrent stall actuating current at high speed. It is invalid when set to 50%. The recommended value for F3-18 in the field weakening area is 100%.

In the high frequency area, the motor drive current is small. At the same stall current, the motor speed drops faster when the motor runs below the rated frequency than when the motor runs above the rated frequency. To improve motor running characteristic, you can lower down the stall action current when the motor runs above the rated frequency. The method improves acceleration performance and prevents the motor from stall in the application where high running frequency and several times the field weakening are required and load inertia is large, such as centrifuges.

The following is the expression of overcurrent action current exceeding the rated frequency.

$$\text{Overcurrent stall action current} = \left(\frac{fn}{fs}\right) \times k \times \text{LimitCur}$$

fs: running frequency; fn: rated motor frequency; k: compensation factor of speed multiplying current limit level (F3-21); LimitCur: current limit level (F3-18)

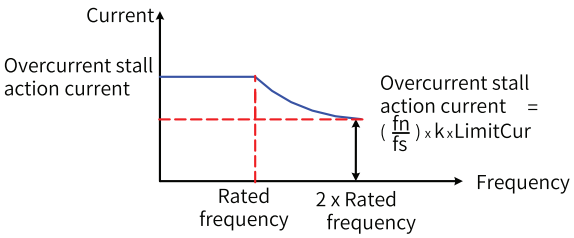


Figure 29-52 Overcurrent stall action at multiplied rated frequency

Note

For high-power motors with carrier frequency below 2 kHz, lower the overcurrent stall action current. Otherwise, the pulse-by-pulse current limit function is enabled before the overcurrent stall prevention function as ripple current increases, resulting in insufficient torque output.

29.4.3 Overvoltage stall suppression

When the bus voltage rises above the value of F3-22 (overvoltage stall action voltage), the motor enters the generating state (motor speed > output frequency). In this case, the overvoltage stall function is activated, which adjusts the output frequency and extends the deceleration time to prevent trip. If the actual deceleration time cannot satisfy the requirement, increase the over-excitation gain.

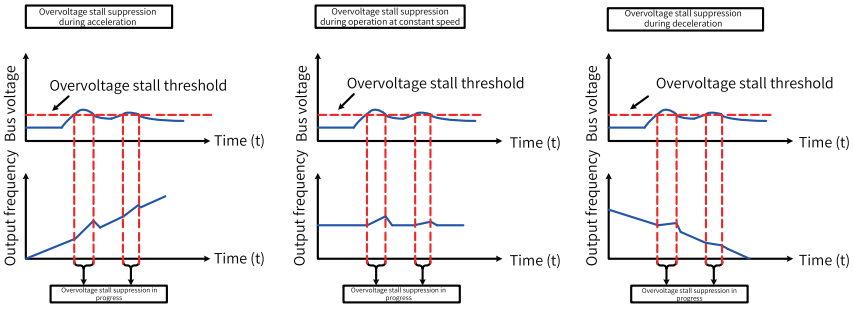


Figure 29-53 Overvoltage stall suppression action

Parameter	Name	Default	Value range	Descriptions
F3-22	V/f voltage limit level	770.0V	330.0 V to 800.0 V	When the bus voltage reaches this value, the AC drive starts overvoltage stall protection.
F3-23	V/f voltage limit selection	1	0: Enable 1: Disable	V/f overvoltage stall suppression is enabled. 0: Inactive 1: Enable (default) The function of F3-23 is equivalent to F9-04 (V/f overvoltage stall suppression protection voltage). When a braking resistor, braking unit, or energy feedback unit is used, set this parameter to 0. Otherwise, the deceleration time may be prolonged.

Parameter	Name	Default	Value range	Descriptions
F3-24	V/f frequency gain for voltage limit	30	1 to 500	Increasing F3-24 improves the control effect of bus voltage, but the output frequency will fluctuate. If the output frequency fluctuates greatly, reduce F3-24 appropriately. The function of F3-24 is the same as F9-03 (Overvoltage stall suppression gain).
F3-25	V/f voltage gain for voltage limit	30	1 to 500	This parameter suppresses the bus voltage. Increasing the parameter value can reduce the overshoot of the bus voltage.
F3-26	Frequency rise threshold for overvoltage stall suppression	5 Hz	0 Hz to 50 Hz	The operating frequency may increase during overvoltage stall suppression. This parameter defines the upper limit of frequency rise.
F3-10	V/f over-excitation gain	64	0 to 200	The higher the over-excitation gain, the better the suppression effect will be. When a braking resistor, braking unit, or energy feedback unit is used, set this parameter to 0. Otherwise, overcurrent may occur during operation.
F3-11	V/f oscillation suppression gain	40	0 to 100	The higher the oscillation gain, the better the suppression effect will be.

Note

Observe the following requirements when using the braking resistor or energy feedback unit.

- Set F3–10 (Overexcitation gain) to 0. Failure to comply may lead to overcurrent during operation.
- Set F3–23 (Overvoltage stall selection) to 0. Failure to comply may prolong the deceleration time.

29.4.4 Speed Loop

Speed loop PI parameters are divided into low-speed parameters and high-speed parameters. If the running frequency is lower than F2-02 (Switchover frequency 1), PI parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI parameters are F2-03 and F2-04. If the running frequency is between F2-02 and F2-05, PI parameters are switched over linearly between two groups of PI parameters, as shown below.

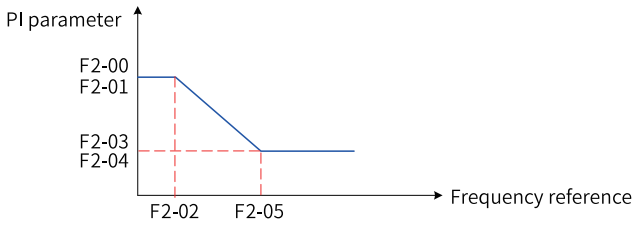


Figure 29-54 Speed loop PI parameters

When the running frequency is smaller than "Switchover frequency 1" (F2-02), the parameters of the speed loop are F2-00 (Speed loop proportional gain 1) and F2-01 (Speed loop integral time 1). When

the running frequency is larger than "Switchover frequency 2" (F2-05), The speed loop parameters are F2-03 (speed loop proportional gain 2) and F2-04 (speed loop integral time 2). When the running frequency is between F2-02 and F2-05, the speed loop parameters are linear changes of the low-speed and high-speed PI parameters.

By setting the proportional coefficient and integral time of the speed regulator, you can adjust the dynamic response of the speed vector control (the response of the control system output from the initial state to the final state under the influence of a typical input signal).

Increasing the proportional gain or reducing the integral time can speed up dynamic response of the speed loop. However, too large proportional gain or too small integral time may cause system oscillation.

The recommended adjustment method is to perform dynamic complete motor parameter auto-tuning first, and the AC drive will identify a group of parameters. If the motor parameters cannot be auto-tuned by the AC drive, fine-tune the auto-tuning parameters based on auto-tuning. Increase the proportional gain to ensure that the system does not oscillate. Then reduce the integral time to ensure that the system has a fast response characteristic and overshoot (an important parameter of the dynamic performance indicator of the control system). It indicates that the ratio between the maximum instantaneous deviation value and the steady state value of the modulation is small under step input.

Note

Improper PI parameter settings may lead to a high speed overshoot. In addition, overvoltage may occur when overshoot drops.

Increasing F2-07 improves motor stability but weakens dynamic responsiveness. Decreasing F2-07 weakens motor stability but improves dynamic responsiveness. Note that setting F2-07 to an excessively low value may cause motor oscillation. The default value of F2-07 applies to most of applications.

Parameter	Name	Default	Value range	Descriptions
F2-00	Speed loop proportional gain 1	30	1 to 300	This parameter sets the low-speed speed loop gain Kp. The value of speed loop Kp affects the response speed of the motor speed. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity. The low-speed speed loop Kp is used at the low speed.
F2-01	Speed loop integral time 1	0.500s	0.001 to 10.000	This parameter sets the low-speed speed loop integral time Ti. The reciprocal of the speed loop integral time constant is the integral gain. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. Increasing the speed loop integral time constant slows down the response of the speed loop. In this case, increase the speed loop proportional gain to shorten the response time of the speed loop. The low-speed speed loop Ti is used at the low speed.
F2-02	Switchover frequency 1	5.00 Hz	0.00 to F2-05	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. The parameter value must be lower than F2-05 (Switchover frequency 2).
F2-03	Speed loop proportional gain 2	20	1 to 300	This parameter sets the high-speed speed loop gain Kp. A larger Kp value indicates higher adjustment sensitivity and adjustment intensity. A smaller Kp value indicates lower adjustment sensitivity and adjustment intensity.
F2-04	Speed loop integral time 2	1.00s	0.01s to 10.00s	This parameter sets the high-speed speed loop integral time Ti. The speed loop integral time constant affects the steady-state speed error of the motor and the stability of the speed loop system. Increasing the speed loop integral time constant slows down the response of the speed loop. In this case, increase the speed loop proportional gain to shorten the response time of the speed loop.

Parameter	Name	Default	Value range	Descriptions
F2-05	Switchover frequency 2	10.00 Hz	F2-02 to F0-10	The speed loop PI parameters are divided into low-speed and high-speed groups. If the running frequency is lower than F2-02 (Switchover frequency 1), the speed loop PI adjustment parameters are F2-00 and F2-01. If the running frequency is higher than F2-05 (Switchover frequency 2), the speed loop PI adjustment parameters are F2-03 and F3-04. If the running frequency falls between switchover frequency 1 and switchover frequency 2, speed loop PI adjustment parameters are switched between F2-00/F2-01 and F2-03/F2-04 linearly. This parameter must be set to a value higher than F2-02 (Switchover frequency 1).
F2-07	Speed loop feedback filter time in SVC mode	0.004s	0.000–0.100s	In the SVC mode, this parameter is used to adjust the speed stability accuracy of the motor. For example, when the running frequency of the motor is lower than the output frequency of the AC drive, you can increase the value of this parameter. In the FVC mode, this parameter is used to adjust the output current of the AC drive under the same load. For example, if the load capacity of a high-power AC drive is weak, decrease the value of this parameter gradually. No adjustment is required under normal circumstances.

29.4.5 Torque Feedforward

Torque feedforward used in the speed control mode improves the torque reference response speed and decreases the speed deviation at the fixed speed. The following figure describes the torque feedforward function.

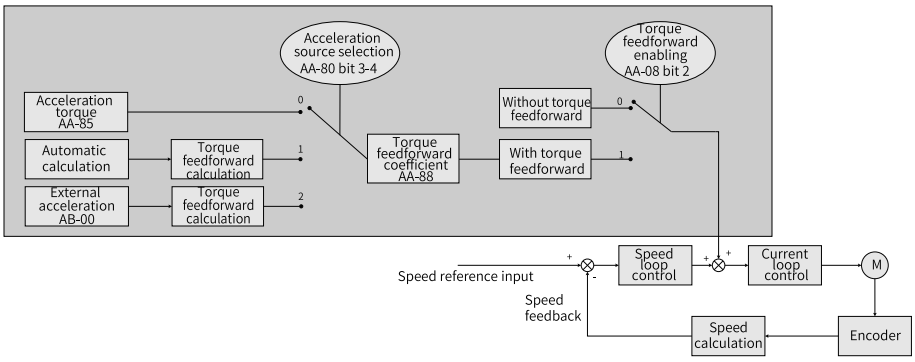


Figure 29-55 Torque feedforward function

Parameter Code	Parameter Name	Value Range	Default	Description
AA-80	Speed loop command word	Bit 0: Speed loop 0: Disable 1: Enable Bit 1: Integral mode 0: Traditional integral 1: Position integral Bit 2: Torque feedforward 0: Disable 1: Enable Bit 3 to bit 4: Acceleration source selection 0: Torque set by parameter 1: Automatic calculation 2: Acceleration set by parameter Bit 5: Anti-load disturbance 0: Disable 1: Enable	19	This parameter specifies the speed loop command word. Bit 0: The speed loop can be disabled in a specific process application. 0: Disable 1: Enable Bit 1: Integral mode 0: Traditional integral 1: Position integral Bit 2: It is used to enable or disable acceleration feedforward. If bit 2 is set to 1, speed deviation can be reduced when the speed reference changes. 0: Disable 1: Enable Bit 3: It is used to select the acceleration feedforward torque source. 0: Torque set by parameter The torque is set by AA-85. 1: Automatic calculation The torque required for acceleration is automatically calculated internally based on the set speed change and inertia. 2: Acceleration set by parameter The software automatically calculates the torque required during acceleration based on the acceleration set by AB-00 and the motor inertia. Bit 5: When the load changes suddenly, setting bit 5 to 1 can reduce the impact of sudden load change on the motor speed and achieve better speed dynamic performance. 0: Disable 1: Enable

Parameter Code	Parameter Name	Value Range	Default	Description
AA-85	Acceleration torque	0: Inactive 1: AI1 2: AI2 (To be continued)	0	When the acceleration feedforward torque source is set to a value other than 0, this parameter is used to set the acceleration torque. 0: Inactive The acceleration torque function is disabled. 1: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 2: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
AA-85	Acceleration torque	(Continued) 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference 7: Motorized potentiometer 8: PID Others: F connector	0	(Continued) 3: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 5: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication. In this case, the AC drive must be installed with a communication card for communicating with the host controller. The communication address is 0x1000, indicating the percentage reference. The value ranges from -10000 to 10000. 0 represents 0%, 10000 represents 100%, and -10000 represents -100%. Note: Communication settings are generally used to write the frequency. It is recommended to select a connector for other parameter source selection. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). 7: Motorized potentiometer The real-time target speed is set by the motorized potentiometer module output. (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
AA-85	Acceleration torque	(Continued)	0	(Continued) 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources. Note: When analog/pulse/communication is used as the reference source, 0 to full range correspond to 0 to 100% of the rated motor torque.
AA-88	Torque feedforward coefficient	0.0% to 6553.5%	100.0	This parameter is used to adjust the feedforward torque. With the acceleration feedforward enabled, if the speed still does not reach the speed reference after the feedback speed adjustment during acceleration, increase this parameter value.

Parameter Code	Parameter Name	Value Range	Default	Description
AB-00	Externally transferred acceleration	0: Inactive 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference (To be continued)	0	When set to a value other than 0, this parameter is used to set the acceleration. 0: Inactive 1: AI1 The frequency reference is input through AI1, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 2: AI2 The frequency reference is input through AI2, which inputs current or voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 3: AI3 The frequency reference is input through AI3, which inputs voltage signals. The frequency is calculated according to the AI curve, which is set by parameters in group F4. 4: Pulse reference (DI5) The frequency reference is set by using the pulse frequency input through DI5. The frequency is calculated (F4-28 to F4-31) according to the relationship curve between the pulse frequency and the frequency reference. 5: Communication The frequency is set through communication. This mode is applicable to applications requiring remote control or centralized control of multiple devices. In this mode, you can input the frequency through remote communication. In this case, the AC drive must be installed with a communication card for communicating with the host controller. The communication address is 0x1000, indicating the percentage reference. The value ranges from -10000 to 10000. 0 represents 0%, 10000 represents 100%, and -10000 represents -100%. (To be continued)

Parameter Code	Parameter Name	Value Range	Default	Description
AB-00	Externally transferred acceleration	(Continued) 7: Motorized potentiometer 8: PID (To be continued)	0	(Continued) Note: Communication settings are generally used to write the frequency. It is recommended to select a connector for other parameter source selection. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals (assigned with functions 12 to 15) can provide 16 states, corresponding to 16 frequencies (set by FC-00 to FC-15). 7: Motorized potentiometer The real-time target speed is set by the motorized potentiometer module output. 8: PID PID is selected as the frequency source. As a general process control method, PID control is a closed-loop mechanism in which each controlled variable is stabilized at the target level. This is implemented through proportional, integral, and differential calculation of the difference between the feedback signal and the target signal of the controlled variable and through adjustment of the AC drive output frequency. PID control is generally used in closed-loop control scenarios, such as constant pressure closed-loop control and constant tension closed-loop control. Set PID-related parameters in group FA. (To be continued)
AB-00	Externally transferred acceleration	(Continued) Others: F connector	0	(Continued) Others: F connector This parameter is set to the number of a floating connector. In this case, the value of the connector is read as an auxiliary frequency reference. This mode is used for expansion besides the common sources. Note: When analog/pulse/communication is used as the reference source, 0 to full range correspond to 0 to 100% of the rated motor torque. When the externally transferred acceleration multiplies the inertia ratio, the value is the torque of the corresponding percentage.

29.4.6 Vector Control Slip Adjustment

In vector control mode (F0-01 is set to 0 or 1), this parameter can be used to adjust the speed stability accuracy. For example, increase this parameter when the running frequency of the motor is lower than the output frequency of the AC drive.

Slip: The slip ratio is an important parameter in motor running, especially in asynchronous motors. It reflects the difference between the rotor speed of the motor and the rotational magnetic field speed of the stator.

Steady-speed accuracy: The degree to which the actual speed deviates from the set speed when the motor runs at a constant speed.

Steady-speed accuracy = (maximum speed - minimum speed) ÷ Set speed × 100%.

For FVC (F0-01 = 1), it can adjust output current of the AC drive. Decrease this parameter gradually when a large rating AC drive is controlling a lightly loaded motor. Adjustment of this parameter is not required normally.

Parameter	Name	Default	Value range	Descriptions
F2-06	Vector control slip gain	100%	50% to 200%	In the SVC mode, this parameter is used to adjust the speed stability accuracy of the motor. For example, when the running frequency of the motor is lower than the output frequency of the AC drive, you can increase the value of this parameter. In the FVC mode, this parameter is used to adjust the output current of the AC drive under the same load. For example, if the load capacity of a high-power AC drive is weak, decrease the value of this parameter gradually. No adjustment is required under normal circumstances.

29.4.7 Vector Control Overexcitation

For high-inertia loads, vector control over-excitation can speed up the motor deceleration. A larger over-excitation gain means better improvement. However, vector control over-excitation increases the output current of the AC drive.

The parameter setting takes the first motor as an example. For other motors, changes parameters in the motor control group.

Parameter	Name	De fault	Value range	Descriptions
F6-23	Overexcita-tion selection	0	0: Disabled 1: Deceleration is effective 2: The deceleration bus overvoltage is effective	Overexcitation trigger condition. When the energy generated during deceleration is too large, the energy generated can be partially consumed by switching on the overexcitation. 0: Disabled 1: Active when the motor is decelerating and generating 2: When the motor decelerates and the bus voltage pump rises above the threshold, the bus voltage threshold is the value of overvoltage suppression minus 100 V.
F6-24	Overexcita-tion suppres-sion additional current value	100%	0% to 200%	Indicates the current amplitude superimposed based on the original excitation current, which is a ratio to the rated motor current.
F6-25	Overexcita-tion gain	1.25	0.01 to 2.50	Overexcitation function adjustment coefficient

29.4.8 Torque Upper Limit

The torque upper limit is set as follows in the vector control mode (FVC or SVC).

Parameter Code	Parameter Name	Default	Value Range	Description
F2-09	Torque upper limit source in speed control mode (motoring)	0	0: F2-10 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) Others: F connector	This parameter sets the torque upper limit source in the speed control mode in the motoring status. The details are as follows: 0: F2-10 The torque upper limit in the speed control mode is set by F2-10 (digital setting of torque upper limit in speed control). 1: AI1 The torque upper limit is input by current or voltage signal through the AI1. The torque is calculated according to the preset AI curve. 2: AI2 The torque upper limit is input by current or voltage signal through the AI2. The torque is calculated according to the preset AI curve. 3: AI3 The torque upper limit is input by current or voltage signal through the AI3. The torque is calculated according to the preset AI curve. 4: Pulse reference (DI5) The torque upper limit in the speed control mode is input through DI5 (pulse frequency). The torque is calculated based on the curve of relationship between the pulse frequency and running frequency. 5: Communication setting The frequency is set through communication. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to realize communication with the host controller. This mode is suitable for remote control or centralized control on multiple equipment.

Parameter Code	Parameter Name	Default	Value Range	Description
Continued	Continued	Continued	Continued	Continued 6: Min. (AI1, AI2) The torque upper limit in the speed control mode is the smaller value between AI1 and AI2 inputs. 7: Max. (AI1, AI2) The torque upper limit in the speed control mode is the larger value between AI1 and AI2 inputs. Others: F connector Read the connector value through setting the parameter No. of a floating point connector. The value read is used as the motoring torque upper limit in the speed control mode. In addition to the setting sources of 0 to 7, you can use the connector to expand the setting sources. The maximum value (full range) of options other than 0 is the value of F2-10. The motor is in the motoring state when the actual running direction of the motor is the same as the torque direction. The motor is in the generating state when the actual running direction of the motor is opposite to the torque direction.
F2-10	Digital setting of torque limit in speed control mode	150.0%	0.0% to 600.0%	This parameter defines the digital setting of torque upper limit in the speed control mode.

Parameter Code	Parameter Name	Default	Value Range	Description
F2-11	Torque upper limit source in speed control mode (generating)	0	0: F2-10 1: AI1 2: AI2 3: AI3 4: Pulse reference (DI5) 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) 8: F2-12 Others: F connector	This parameter sets the torque upper limit source in the speed control mode in the generating status. The details are as follows: 0: F2-10 The torque upper limit in the speed control mode is set by F2-10 (digital setting of torque upper limit in speed control). 1: AI1 The torque upper limit is input by current or voltage signal through the AI1. The torque is calculated according to the preset AI curve. 2: AI2 The torque upper limit is input by current or voltage signal through the AI2. The torque is calculated according to the preset AI curve. 3: AI3 The torque upper limit is input by current or voltage signal through the AI3. The torque is calculated according to the preset AI curve. 4: Pulse reference (DI5) The torque upper limit in the speed control mode is input through DI5 (pulse frequency). The torque is calculated based on the curve of relationship between the pulse frequency and running frequency. 5: Communication setting The frequency is set through communication. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to realize communication with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 6: Min. (AI1, AI2) The torque upper limit in the speed control mode is the smaller value between AI1 and AI2 inputs. 7: Max. (AI1, AI2) The torque upper limit in the speed control mode is the larger value between AI1 and AI2 inputs. Others: F connector Read the connector value through setting the parameter No. of a floating point connector. The value read is used as the generating torque upper limit in the speed control mode. This mode is used for expansion besides the common sources. The full range of options other than 0 and 8 is the value of F2-12. The motor is in the motoring state when the actual running direction of the motor is the same as the torque direction. The motor is in the generating state when the actual running direction of the motor is opposite to the torque direction.

Parameter Code	Parameter Name	Default	Value Range	Description
F2-12	Digital setting of torque upper limit in speed control (generating)	150.0%	0.0% to 600.0%	This parameter defines the generating torque upper limit in the speed control mode.

In the speed control mode, there are eight modes to set the torque upper limit. In the motoring state, the torque upper limit source is defined by F2-09; in the generating state, the torque upper limit source is defined by F2-11.

In the speed control mode, if F2-11 is set to a value ranging from 1 to 8, the torque upper limit differs in the motoring state and in the generating state. In the motoring state, the full range of the torque upper limit is defined by F2-10. In the generating state, the full range of the torque upper limit is defined by F2-12, as shown in the following figure.

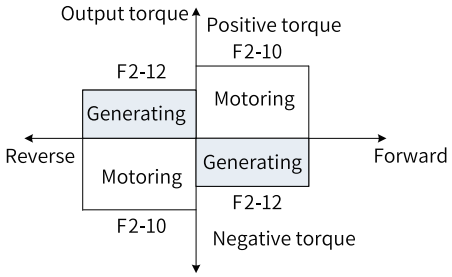


Figure 29-56 Torque upper limit in the speed control mode

Parameter Code	Parameter Name	Default	Value Range	Description
F2-22	Generating power limit selection	0	0: Disabled 1: Enabled in whole process 2: Enabled at constant speed 3: Enabled during deceleration	This parameter is used to set the valid range of the generating power limit. 0: Disabled Generating power limit invalid 1: Enabled in whole process Generating power limit valid in the whole process 2: Enabled at constant speed Generating power limit valid at constant speed 3: Enabled during deceleration Generating power limit valid during deceleration
F2-23	Generating power upper limit	20.0%	0.0% to 200.0%	This parameter is a percentage of the generating power upper limit to the rated motor power. If overvoltage still occurs after enabling the generating power limit function, decrease the value of F2-23.

In scenarios where braking resistors are not used for cam load, quick acceleration/deceleration, and sudden unloading, enabling generating power limit can effectively reduce bus voltage overshoot during motor braking, so as to prevent overvoltage. This parameter is a percentage of the generating power upper limit to the rated motor power. If overvoltage still occurs after enabling the generating power limit function, decrease the value of F2-23.

29.4.9 Torque Control

1. **Select the speed/torque control mode (A0-00).**
   The speed/torque control mode is set by A0-00.

   The multi-function DI supports two torque control-related functions: torque control inhibited (function 29), speed control/torque control switchover (function 46). The two DI functions need to be used together with A0-00 to implement speed control/torque control switchover.

   If the speed control/torque control switchover function (function 46) is invalid, the control mode is determined by A0-00. If the function 46 is valid, the control mode is reverse to the value of A0-00.

   When function 29 (torque control inhibited) is valid, the drive always runs in the speed control mode.

2. **Select the torque mode (A0-10).**
   Torque control supports speed loop output torque limit mode (A0-10 = 0) and direct torque setting mode (A0-10 = 1).

   a. Speed loop output torque limit mode
      Set A0-10 to 0 to select this mode.

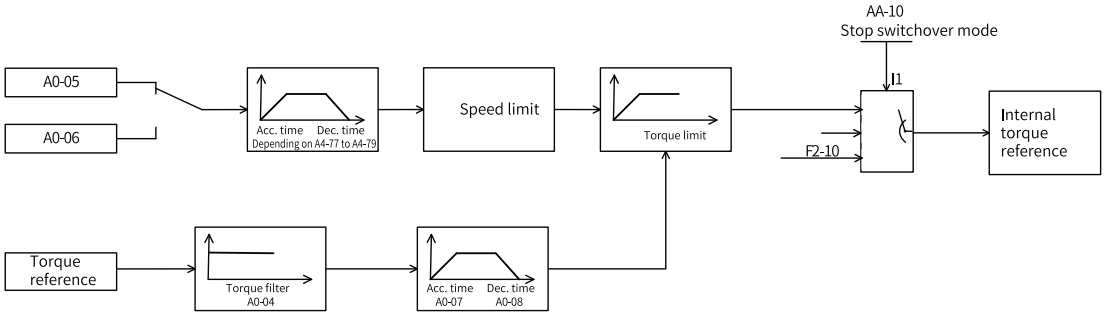


Figure 29-57 Speed loop output torque limit mode

Related parameters

Param.	Name	Default	Value range	Description
A0-01	Mode A - Torque reference source in torque control (drive torque upper limit source)	0	0: A0-03 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) Others: F connector	This parameter is used to set the torque command source. Seven torque sources are available. 0: A0-03 The torque is set numerically in torque control mode. The value is set to A0-03 (Torque digital setting in torque control mode). 1: AI1 The torque upper limit is input by current or voltage signal through the AI1. The torque is calculated according to the preset AI curve. 2: AI2 The torque upper limit is input by current or voltage signal through the AI2. The torque is calculated according to the preset AI curve. 3: AI3 The torque upper limit is input by current or voltage signal through the AI3. The torque is calculated according to the preset AI curve. The AC drive has two AI terminals by default, and the AI3 terminal needs to be provided through the I/O expansion card. 4: Pulse reference (DI5) The torque upper limit in the speed control mode is input through DI5 (pulse frequency). The torque is calculated based on the curve of relationship between the pulse frequency and running frequency. 5: Communication The torque is set by communication in the torque control mode. The running frequency is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. Note: For details on the communication address, see the Communication Guide.
(Continued)				6: Min. (AI1, AI2) In torque control mode, the value calculated by AI1 and AI2 is compared to the smaller value. 7: Max. (AI1, AI2) In torque control mode, the torque is compared with the value calculated by AI1 and AI2. Others: F connector Read the connector value through setting the parameter No. of a floating point connector. The value read is used as the generating torque upper limit in the torque control mode. This mode is used for expansion besides the common sources. Supplementary explanation: 100% corresponds to the A0-03 value when the analog/pulse/communication setting is used as the reference source. For example, if A0-03 is set to 200%, A0-01 selects AI1 analog setting. When AI1 is set to 50%, the actual setting is equal to 50% x 200%.

Param.	Name	Default	Value range	Description
A0-03	Mode A - Torque digital setting in torque control	150.0%	-200.0% to 200.0%	This parameter defines the torque reference in the torque control mode. The torque reference is a relative value. 100.0% corresponds to the rated AC drive torque. The Value ranges from -200.0% to +200.0%, indicating that the maximum torque of the drive is two times the rated torque of the motor. When the torque reference value is positive, the drive operates in the forward direction. When the torque reference value is negative, the drive operates in the reverse direction.
A0-04	Mode A– Torque reference filter time (upper limit)	0 ms	0 ms to 10000 ms	Used to set the torque reference filter time in mode A.
A0-05	Mode A - Maximum positive frequency in torque control	50.00 Hz	0.00 to F0-10	Used to set the maximum positive frequency in mode A.
A0-06	Mode A - Maximum negative frequency in torque control	50.00 Hz	0.00 to F0-10	This parameter defines the maximum running frequency of the AC drive that operates reversely in the torque control mode.
A0-07	Torque rising filter time	0.00s	0.00s to 650.00s	Used to set the torque reference ramp rise time (relative to rated torque) in mode A.
A0-08	Torque falling filter time	0.00s	0.00s to 650.00s	Used to set the reference ramp drop time (relative to rated torque) in mode A.
A4-77	Frequency acceleration time in torque control	0.0s	0.0 to 6500.0	Frequency acceleration time in torque control
A4-78	Frequency deceleration time in torque control	0.0s	0.0 to 6500.0	Frequency deceleration time in torque control
A4-79	Forced use of the fourth set of time in torque control	0	0: Disabled 1: Enable	Forced use of the fourth set of time in torque control

b. Used to set the torque in the torque upper limit mode (mode A). The digital setting of torque reference uses relative value. 100.0% corresponds to the rated motor torque. The Value ranges from -200.0% to 200.0%, indicating that the maximum torque of the drive is two times the rated torque of the motor.
When the torque reference value is positive, the drive operates in the forward direction. When the torque reference value is negative, the drive operates in the reverse direction.

Direct torque setting mode

Set A0-10 to 1 to select this mode.

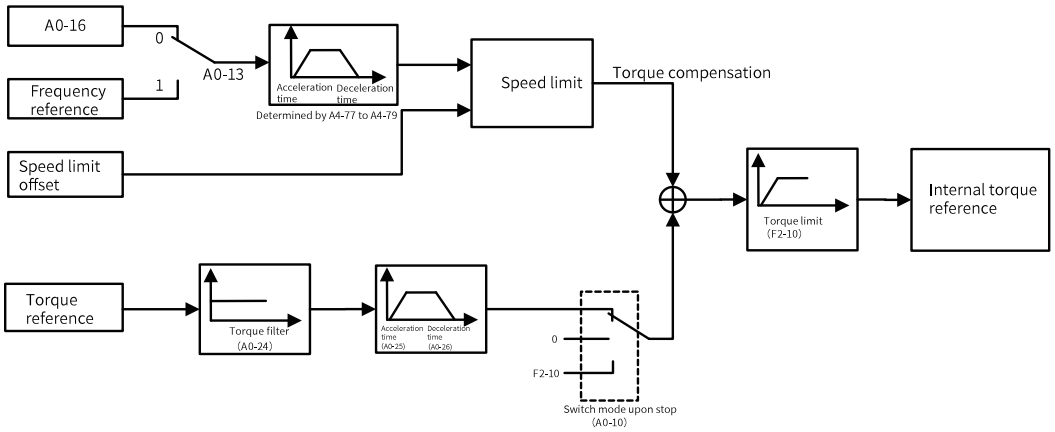
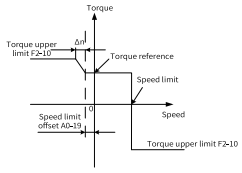
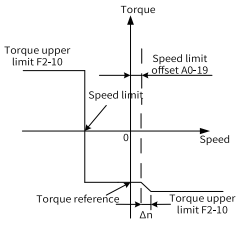
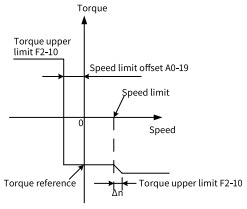
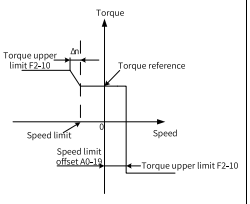
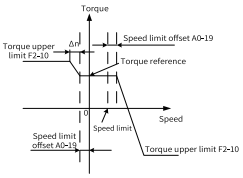
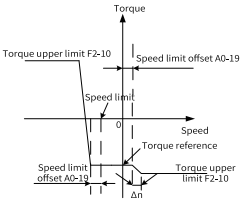
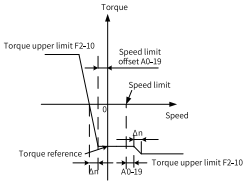
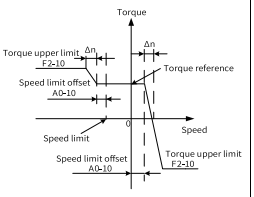
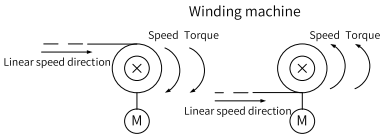
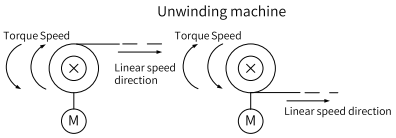


Figure 29-58 Direct torque setting mode

Table 29–27 Speed limit/speed limit offset

Item	Operating Condition			
Operation command	Forward run	Forward run	Forward run	Forward run
Torque reference direction	+	-	-	+
Speed limit direction	+	-	+	-
Normal running direction	Forward run	Reverse run	Forward run	Reverse run
Uni-directional speed limit offset (A0-17 = 1)				
Bi-directional speed limit offset (A0-17 = 0)				
Application example				

3. **Set the torque reference in the torque control mode.**

   In the direct torque setting mode, set the torque reference through A0-13 and A0-14. In addition, additional torque settings through A0-20 to A0-23 are supported.

   The torque reference is a relative value. The value 100.0% corresponds to the rated motor torque. View the motor output torque through U0-06, and the value 100% corresponds to the rated motor torque.

   Set the frequency upper limit in the torque control mode (A0-05, A0-10, A0-11).

In the torque control mode, the frequency upper limit can be defined by A0-05 or the frequency source.

4. **Set the frequency upper limit in the torque control mode.**
   In the torque control mode, if the load torque is lower than the output torque of the motor, the motor speed keeps increasing. Therefore, the motor speed (that is, the frequency upper limit) must be restricted to prevent accidents such as runaway.

   In the speed loop output limit mode, set the frequency upper limit through A0-05 and A0-06.

   In the direct torque setting mode, set e frequency limit and limit offset through A0-15 to A0-19.

   Set the acceleration/deceleration time of the torque upper limit through A4-77 to A4-79.

5. **Set the torque reference acceleration/deceleration time.**
   In the speed loop output limit mode, set the torque reference filter and acceleration/deceleration time through A0-04, A0-07, and A0-08.

   In the direct torque setting mode, set the torque reference filter and acceleration/deceleration time through A0-24, A0-25, and A0-26.

   In the torque control mode, the difference between the motor output torque and the load torque determines the speed change rate of the motor and load. The motor speed may change quickly, causing noise or mechanical stress. (This refers to internal forces that interact between parts of the object when the object is deformed due to external causes (force and humidity change). To resist this external cause, and to restore the object from the deformed position to the pre-deformed position.) Oversize. Setting the acceleration/deceleration time in the torque control mode helps smooth the motor speed. The acceleration time indicates the time required by the motor to increase from 0 to the motor rated torque. The deceleration time indicates the time required by the motor to decelerate from the motor rated torque to 0.

   In the torque control mode, the acceleration/deceleration time is not required for start with small torque. For applications requiring quick torque response, set the acceleration/deceleration time to 0.00s.

   For example, two AC drives are connected to drive the same load. To balance the load distribution, set one AC drive as the master and select the speed control mode. Set the other one as the slave and select the torque control mode. The slave receives the output torque of the master as the torque command and follows the master rapidly. In this case, the acceleration/deceleration time of the slave in the torque control mode is set to 0.00s.

29.4.10 Current Loop

The PI adjustment parameters of the vector control current loop are automatically calculated based on the motor parameters and do not need to be modified. The PI parameter of the current loop is automatically calculated based on the motor parameters. The parameter value is a multiple of the automatically calculated value (for example, if the proportional gain is 1.5 and the parameter is 2, the actual proportional gain effective is 1.5 x 2 = 3). 1.0 corresponds to the calculated value.

A large current loop PI gain may result in oscillation of the entire control loop. In the case of severe current oscillation or torque fluctuation, manually reduce the PI proportional gain or integral gain.

The parameter setting takes the first motor as an example. For other motors, changes parameters in the motor control group.

Parameter	Name	Default	Value range	Descriptions
AB-59	Current loop Kp adjustment at low speed	1.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-60	Current loop Kp adjustment at high speed	1.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-61	Current loop Ki adjustment at low speed	1.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-62	Current loop Ki adjustment at high speed	2.0	0.1 to 10.0	The AC drive automatically calculates the current loop gain based on motor parameters. When the current oscillates at low speed or the torque fluctuates greatly, the set value can be reduced appropriately.
AB-63	Used to set D-axis current loop complex vector adjustment.	1.0	0.1 to 10.0	-
AB-64	Used to set Q-axis current loop complex vector adjustment.	1.0	0.1 to 10.0	-

29.4.11 Improvement of Filed Weakening Performance

Parameter	Name	Default	Value range	Description
F2-19	Field weakening gain	3.0	0.1 to 200.0	Increasing the value of this parameter can improve dynamic response, but too large can cause current oscillation. Therefore, it is recommended to increase the value of this parameter gradually for commissioning. In general, no change is required. Use the default value.
A5-05	Voltage overmodulation coefficient	103%	100% to 115%	By increasing the voltage overmodulation coefficient, the output capacity of the voltage can be increased to effectively increase the carrying capacity of the motor in the weak magnetic zone. At the same time, the output current distortion will be increased.
AB-33	Voltage margin	3%	1% to 50%	Decrease this value to improve the voltage utilization. The current is smaller when the same load is applied in the weak magnetic zone. However, the value is too small, which affects the dynamic performance. The second motor is B9-33. The third motor is BE-33. The fourth motor is CE-33.

29.4.12 Operation and Performance Improvement in FVC Mode

Table 29–28 Procedure for speed control mode with speed sensor

Procedure	Parameter	Description
Check that the drive is wired correctly.	-	If the drive reports E019. xx during auto-tuning, check whether the drive is wired improperly and whether motor parameter are set improperly.
Set the motor parameters.	F1-01, F1-02, F1-03, F1-04, F1-05	
Set the encoder type and pulses per revolution.	F1-27 to F1-28	If the drive reports E020.xx, check whether the encoder and PG card work properly.
Select a control mode.	F0-01	-
Perform motor parameter auto-tuning.	F1-37	Select dynamic complete auto-tuning (2 for asynchronous motor and 12 for synchronous motor) and disconnect the load. The motor can run at a high speed. If the load cannot be disconnected from the motor (such as crane applications), select static complete auto-tuning. Dynamic complete auto-tuning may take a while. Wait until auto-tuning is done before proceeding to the next step.
Set the command source and frequency reference source accordingly.	F0-02, F0-03, F0-08	-
Trial run	A0-00 = 0	-

Table 29–29 Procedure for torque control mode with speed sensor

Procedure	Parameter	Description
Check that the drive is wired correctly.	-	If the drive reports E019.00 during auto-tuning, check whether the drive is wired improperly and whether motor parameter are set improperly.
Set the motor parameters.	F1-01, F1-02, F1-03, F1-04, F1-05	
Set the encoder type and pulses per revolution.	F1-27 to F1-28	If the drive reports E020.00, check whether the encoder and PG card work properly.
Select a control mode.	F0-01	-
Perform motor parameter auto-tuning.	F1-37	Select dynamic complete auto-tuning (2 for asynchronous motor and 12 for synchronous motor) and disconnect the load. The motor can run at a high speed. If the load cannot be disconnected from the motor (such as crane applications), select static complete auto-tuning. Dynamic complete auto-tuning may take a while. Wait until auto-tuning is done before proceeding to the next step.
Set the command source.	F0-02	-
Set torque control parameters.	A0-00, A0-01, A0-03, A0-05	-
Trial run	-	-

Speed loop settings

If the value of the speed loop gain are set too high, the motor may vibrate or produce unusual noise when operating at the frequency lower than the rated frequency. In this case, decrease the values of F2-00 and F2-03, and increase the values of F2-01 and F2-04.

If the system speed overshoot is high during rapid acceleration, increase the speed loop Kp (increase the values of F2-00 and F2-03) and reduce the speed loop Ki (increase the values of F2-01 and F2-04).

In winding/unwinding applications, the roll diameter changes in inverse proportion to the motor speed. Therefore, when the roll diameter is large, increase the value of the speed loop gain to ensure dynamic response of the system (increase the value of F2-00 and reduce the value of F2-01).

For a device running at an extremely low speed (for example, a milling machine running at 0.01 Hz), increase the value of the speed loop gain (especially the speed loop integral gain) to ensure smooth operation. That is, increase the value of F2-00 and decrease the value of F2-01.

Note

In scenarios with poor encoder feedback signals, the speed loop gains cannot be too high. Otherwise, the dynamic response speed of the system is affected. In this case, first take measures to improve the quality of encoder feedback signals (for example, separate power cables of the motor from signal cables of the encoder, and ensure good grounding of the system). Otherwise, directly reducing the speed loop gains will slow down dynamic response of the system, degrading the system operation performance.

Current loop settings

Current loop parameters are automatically obtained after complete auto-tuning. The auto-tuned parameters apply to most of applications. However, you can fine tune these parameters in the following conditions.

If a motor running in FVC mode vibrates or produces usual noise, and the situation is not improved after decreasing the value of the speed loop parameter, decrease the value of the current loop parameter properly.

If the system requires a low overshoot, the value of the speed loop parameter cannot be too low. In this case, if the motor vibrates or produces abnormal noise when running in the FVC mode, decrease the value of the current loop parameter properly.

Solutions to errors during high-speed operation in the FVC mode

Vibrations or operation errors may occur when a motor runs at a high frequency (for example, above 200 Hz) in the FVC mode. In this case, operate the motor with the same frequency in the V/f mode and check whether the feedback frequency (U0-29) is the same as the frequency reference. If there is a large difference (greater than 4 Hz) between these two frequencies, the encoder signal may be distorted (non-orthogonal or abnormal duty cycle). In this case, take the following measures:

Replace the encoder. Check whether the encoder is normal or installed properly and whether the encoder model supports the pulse frequency.

Shortening acceleration/deceleration time in the FVC control mode

During rapid acceleration/deceleration, the actual acceleration/deceleration time is longer than the preset value. To shorten the acceleration/deceleration time, take the following measures.

To shorten the motor acceleration time, increase the torque upper limit in the FVC control mode (increase the value of F2-10 properly, but in no case greater than 180%).

Increasing the torque upper limit shortens the motor acceleration time but also leads to an increase in the motor current, which may easily cause faults such as overload.

Limiting the bus voltage to prevent overvoltage in the FVC control mode

In high inertia or rapid deceleration applications, overvoltage may occur during deceleration. The optimization measures are the same as those used in V/f control mode.

1. Enable overvoltage suppression: Set bit 1 (overvoltage suppression) of AB-25 to 1 in the FVC mode for motor 1. For other motors, set bit 1 of B9-25, BE-25, and CE-25 to 1.
2. Enable the over-excitation function (F6-23).
3. Use an appropriate braking resistor to shorten the deceleration time.

29.4.13 Auxiliary Control

Parameter Code	Parameter Name	Default	Value Range	Description
A5-00	Frequency upper limit for DPWM switchover	2000.0 Hz	5.0 Hz to 6000.0 Hz	The drive supports two PWM wave modulation modes, including CPWM and DPWM. When the operating frequency is higher than the value of A5-00, the DPWM mode is used. When the operating frequency is lower than the value of A5-00, the CPWM mode is used. The DPWM mode can improve the AC drive efficiency, whereas the CPWM mode can reduce the motor noise. Increasing A5-00 to the maximum frequency will reduce the motor noise.
A5-01	PWM modulation mode	0	0: Asynchronous modulation 1: Synchronous modulation	When the result of the carrier frequency divided by the running frequency is smaller than 10, output current oscillation or large current harmonic waves may occur. To address the problem, set this parameter to 1 (synchronous modulation). 0: Asynchronous modulation In this mode, the carrier frequency and signal wave frequency are modulated asynchronously. The carrier frequency usually remains unchanged. The carrier ratio changes with the signal wave frequency. 1: Synchronous modulation When the result of the carrier frequency divided by the running frequency is smaller than 10, output current oscillation or large current harmonic waves may occur. To address the problem, set this parameter to 1 (synchronous modulation).
A5-02	Dead-zone compensation mode	1	0: Disable 1: Compensation mode 1	The dead-zone is set for the drive in the PWM mode to ensure that it is switched off and then switched on. This avoids shoot-through between the upper and lower bridge arms. The presence of the dead zone will result in additional voltage loss caused by PWM wave modulation, resulting in output current distortion. The lower the running frequency, the more obvious the current distortion. Dead zone compensation is required to reduce the effect of the dead zone. 0: Disable Dead zone compensation is disabled. 1: Compensation mode 1 Dead zone compensation is enabled.

Parameter Code	Parameter Name	Default	Value Range	Description
A5-03	Random PWM depth	0	0: Random PWM inactive 1 to 10: Random PWM carrier frequency depth	If the motor noise is loud, setting A5-03 to a non-zero value can suppress the motor noise. The higher the value, the better the effect. However, if the value is too high, the motor control may be affected. Therefore, set this parameter to 1 first during commissioning and then increase it by 1 each time as required.
A5-04	Pulse-by-pulse current limit protection	0	0: Disable 1: Enable	This function is used to minimize the risk of overcurrent faults, ensuring normal operation of the AC drive. It is recommended to disable this function in hoisting applications, such as cranes.
A5-05	Voltage overmodulation coefficient	103%	100% to 115%	Increasing the voltage overmodulation coefficient can enhance the voltage output capacity and effectively improve the load capacity of the motor in the field weakening region, but will increase output current distortion at the same time.
A5-08	Carrier frequency upper limit at low speed	0.0 kHz	0.0 kHz to 8.0 kHz: Carrier frequency upper limit	This parameter defines the upper limit of the carrier frequency when the AC drive is running at a low speed. The limit takes effect when the value is greater than 0.
A5-10	Energy saving control	0	0: Invalid 1: Valid	This function is active only for asynchronous motors in the V/f control mode (F0-01 = 2, F1-00 = 0). 0: Invalid Energy saving control is disabled. 1: Valid Energy saving control is enabled. Enabling energy conservation control can reduce energy consumption of the asynchronous motor when running with no load or light load.

29.4.14 Encoder Signal Processing

The parameter setting takes the first motor as an example. For other motors, change parameters in the motor control group.

Parameter Code	Parameter Name	Default	Value Range	Description
A9-07	Filter time constant for encoder speed measurement	0.004s	0.000s to 10.000s	By adjusting the encoder speed measurement filter time constant, the filtering effect on the encoder signal can be changed. The higher the filter time, the smoother the encoder feedback speed, but the greater the feedback speed delay; the lower the filter time, the greater the encoder feedback speed fluctuation, but the smaller the feedback speed delay; under the FVC control mode, the filter time constant cannot be too low when the resolver and other encoder signal quality is not good.

By adjusting the filter time constant for encoder speed measurement, the filtering effect on the encoder signal can be changed. The longer the filter time, the smoother the encoder feedback speed, but the longer the feedback speed delay time. The shorter the filter time, the greater the encoder

feedback speed fluctuation, but the shorter the feedback speed delay time. Set the filter time constant according to working conditions and encoder speed measurement quality. When the resolver and other encoder signal quality is not good, the filter time cannot be too short.

Table 29–30 Encoder disconnection detection

Parameter Code	Parameter Name	Default	Value Range	Description
F1-36	PG disconnection detection time during speed feedback	0	0.0s to 10.0s	This parameter is used to set the encoder disconnection detection time. If it is set to 0.0s, the drive does not detect the encoder disconnection fault. If hardware detection of encoder disconnection is enabled (bit 02 of A9-09 is set to 1), the AC drive reports E020.X when the AC drive detects a disconnection fault and the fault lasts for a period longer than the time specified by F1-36.

The PG card features the encoder disconnection detection by hardware function. This function is available only for the differential encoder. To enable the function, set bit 02 of AA-30. When the AC drive detects a disconnection fault for the time longer than the value of F1-36, the AC drive reports E020.X.

29.4.15 PID Adjustment Methods

This section describes general rules for PID parameter adjustment, which can be used as reference for adjusting process closed-loop control PID parameters (FA-05 to FA-07, and FA-15 to FA-17) and speed loop PI parameters (F2-00 to F2-04).

1. In case of slow response, increase Kp.

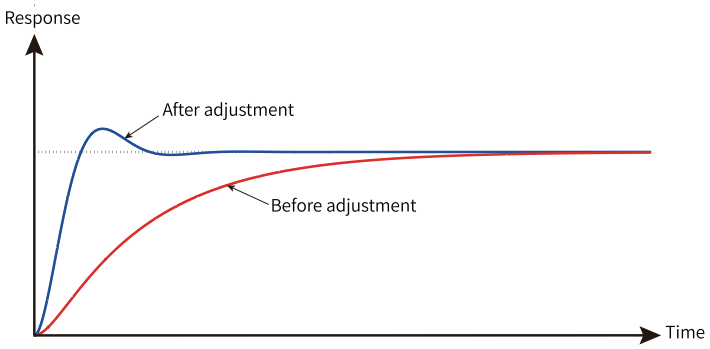


Figure 29-59 Response-time trend after increasing Kp

2. In case of frequent vibration, reduce Kp.

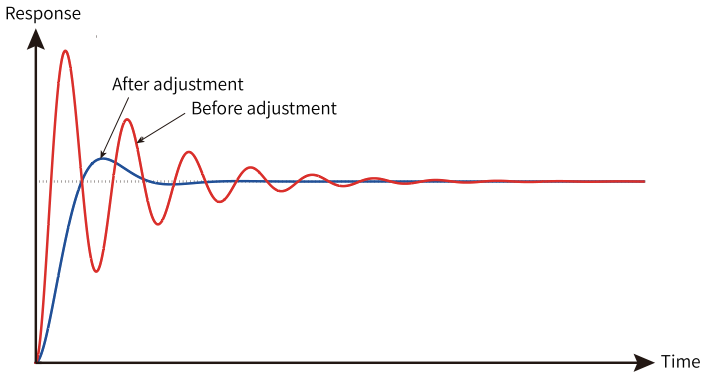


Figure 29-60 Response-time trend after decreasing Kp

3. In case of large overshoot and slow fluctuation, increase Ti.

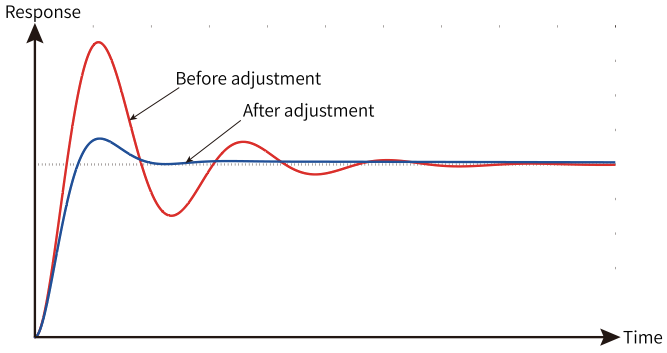


Figure 29-61 Response-time trend after increasing Ti

4. In case of large static difference and slow response at load fluctuation, increase Kp or decrease Ti.

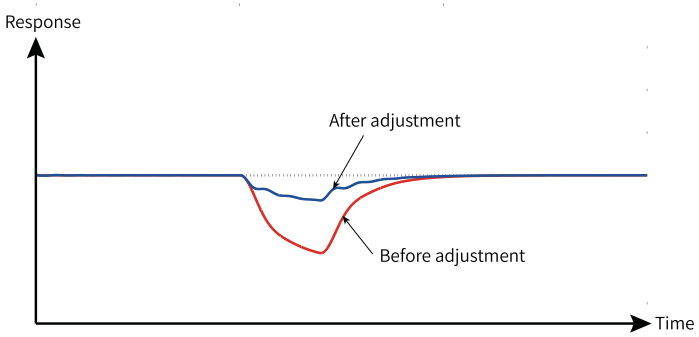


Figure 29-62 Response-time trend after increasing Kp at load fluctuation

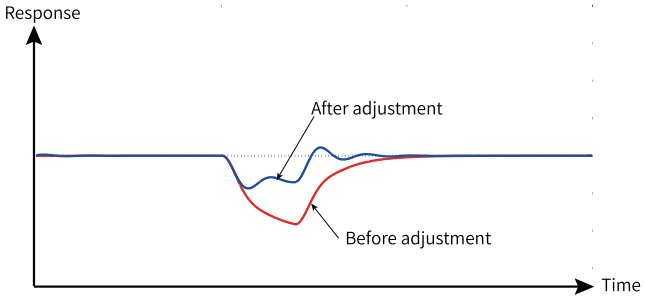


Figure 29-63 Response-time trend after decreasing Ti at load fluctuation

5. If the derivative time Td is set properly, the system stability can be improved. Note that if the derivative time Td is too long, interference and vibration may be caused.

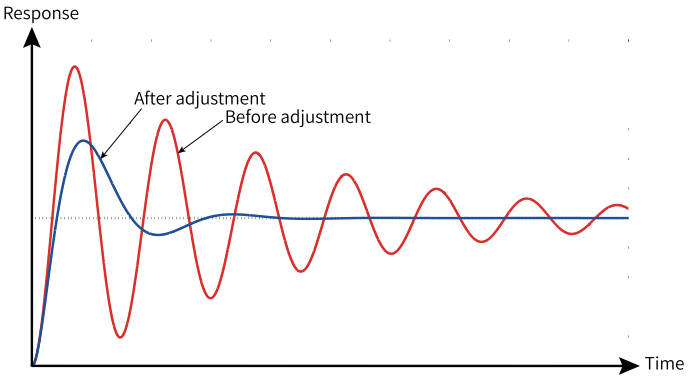


Figure 29-64 Response-time trend after setting the Td

29.5 Application Control

29.5.1 Jog

In some applications, the AC drive needs to run at a low speed temporarily to facilitate equipment testing. In this case, jogging applies. The following figure shows the relationship between the output frequency and acceleration/deceleration time during jogging.

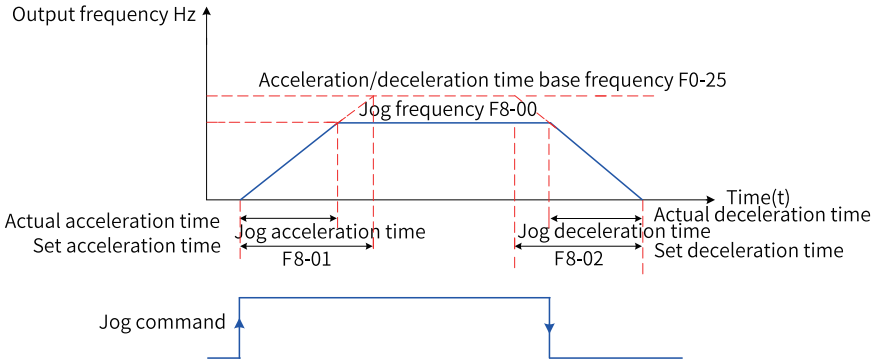


Figure 29-65 Jogging

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F0-02	Operation command source selection	0	0: Operating panel 1: Terminal 2: Communication 3: User-defined	This parameter is used to select the input channel of the AC drive control commands, such as run, stop, forward run, reverse run, and jog operation. 0: Operating panel The RUN/STOP key on the operating panel can be used to start or stop the drive. This mode is suitable for initial commissioning. 1: Terminal Operation commands are input using the DI of the AC drive. The DI can be assigned with different functions such as start/stop, forward/reverse run, jog, two-wire/ three-wire mode, and multi-reference. This mode is suitable for most applications. 2: Communication Operation commands are input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 3: User-defined mode The command source is defined by the user as needed for expansion.
F0-25	Accelera-tion/ deceleration time base frequency	1	0: F0-10 (Maximum frequency) 1: Frequency reference 2: 100 Hz 3: Rated frequency	This parameter sets the acceleration/deceleration time base frequency. This parameter defines the target frequency during acceleration and the starting frequency during deceleration.

Parameter Code	Parameter Name	Default	Value Range	Description
F7-01	MF.K key function	0	0: MF.K key disabled 1: Forcibly change to operating panel control 2: Switchover between forward and reverse run 3: Forward jog 4: Reverse jog	This parameter is used to select the MF.K key function selection. 0: MF.K key disabled The MF.K key has no function. 1: 1: Forcibly change to operating panel control If F0-02 is set to 0 (operating panel), the MF.K key is unavailable. If F0-02 is set to 1 (terminal), 2 (communication), or 3 (self-defined control mode), pressing the MF.K key forcibly changes the control mode to the operating panel control mode. 2: Switchover between forward and reverse run Pressing the MF.K key changes the direction of the frequency reference. This function is valid only when the command source is set to the operating panel. 3: Forward jog Pressing the MF.K key implements forward jog (FJOG). This function is valid only when the command source is set to the operating panel. 4: Reverse jog Pressing the MF.K key implements reverse jog (RJOG). This function is valid only when the command source is set to the operating panel.
F8-00	Jog frequency	2.00 Hz	0 to F0-10 (Maximum frequency)	This parameter defines the running frequency of the AC drive in jogging mode.
F8-01	Jog acceleration time	20.0s	0.0s to 6500.0s	This parameter defines the acceleration time of the AC drive in jogging mode.
F8-02	Jog deceleration time	20.0s	0.0s to 6500.0s	This parameter defines the deceleration time of the AC drive in jogging mode.
F8-13	Reverse running prohibition	0	0: Disable 1: Enable	When the frequency defined by communication or analog reference is a negative value, the motor operating direction changes. The frequency in this case is called reverse frequency. You can set whether to allow the motor to operate in reverse state through this parameter. When reverse operation of the motor is not allowed, set F8-13 to 1. When reverse operation of the motor is allowed, set F8-13 to 0.
F8-27	Jog priority mode	0	0: No priority 1: Jog preferred 2: OFF1 preferred	This parameter defines the priority of the jog command and normal operation commands. 0: No priority. The AC drive responds to the operation command that arrives first. 1: Jog preferred. The jog command can interrupt normal running. 2: OFF1 preferred. Normal operation commands can interrupt jogging.

Parameter Code	Parameter Name	Default	Value Range	Description
A4-62	Jog speed 1 source	0	0: Digital setting 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Multi-reference 7: Motorized potentiometer 8: PID Others: F connector	It is used to set the jog speed 1. 0: Digital setting The jog speed 1 is set by F8-00. 1: AI1 The jog speed 1 is input through AI1, which inputs current or voltage signals. The jog speed 1 is calculated according to the AI curve. 2: AI2 The jog speed 1 is input through AI2, which inputs current or voltage signals. The jog speed 1 is calculated according to the AI curve. 3: AI3 The jog speed 1 is input through AI3, which inputs current or voltage signals. The jog speed 1 is calculated according to the AI curve. 4: Pulse reference The jog speed 1 is set through DI5 pulse frequency. 5: Communication The jog speed 1 is set through communication. The jog speed 1 is input through remote communication. The AC drive must be equipped with a communication card to communicate with the host controller. This mode is suitable for remote control or centralized control on multiple equipment. 6: Multi-reference When the parameter is set to 6, combinations of different DI states correspond to different frequency references. The four multi-reference terminals can be grouped in different ways to indicate 16 states, which correspond to 16 frequency references (percentage x maximum frequency) in group FC. 7: Motorized potentiometer The jog speed 1 is set by the motorized potentiometer module output. 8: PID The jog speed 1 is set through PID output. Others: F connector The jog speed 1 is set through the connector.
A4-66	Jogging ramp source	1	0: Ramp time of normal running 1: Ramp time of jogging	0: Ramp time of normal running The jogging ramp time is the same as the normal running time. 1: Ramp time of jogging The jog ramp time is set separately (F8-01, F8-02).

Example

The following section introduces how to set parameters related to jogging when the operating panel is used as the jogging command source.

Table 29–31 Setting parameters related to jog running

Step	Forward Jogging	Reverse Jogging
1	Set F7-01 to 3 to select forward jogging for the MF.K key.	Set F7-01 to 4 to select reverse jogging for the MF.K key. Set F8-13 to 0 to allow reverse running.
2	Set F0-02 to 0 to select the operating panel as the command source.	Set F0-02 to 0 to select the operating panel as the command source.
3	Set F8-00 (jog frequency), F8-01 (jog acceleration time), and F8-02 (jog deceleration time) properly.	Set F8-00 (jog frequency), F8-01 (jog acceleration time), and F8-02 (jog deceleration time) properly.
4	In the stop status, when the MF.K key is pressed down, the AC drive starts to jog in the forward direction. When the MF.K key is released, the AC drive decelerates to stop.	In the stop status, when the MF.K key is pressed down, the AC drive starts to jog in the reverse direction. When the MF.K key is released, the AC drive decelerates to stop.

29.5.2 Frequency Detection

29.5.2.1 Multi-reference

If multi-reference is selected as the frequency reference source, frequency references are input through different state combinations of the DIs.

Table 29–32 Using multi-reference as the frequency reference source

Procedure	Parameter	Description
Step 1: Select multi-reference as the frequency reference source.	F0-03	F0-03 = 6
Step 2: Determine the number of multi-references.	/	A total of 16 multi-references are supported, which requires four DIs. The relationship between the number of multi-references and the number of DIs is as follows: 2 multi-references: One DI (K1) 3-4 multi-references: Two DIs (K1 and K2) 5-8 multi-references: Three DIs (K1, K2, and K3) 9-16 multi-references: Four DIs (K1, K2, K3, and K4)
Step 3-1: Set the multi-reference function for the DI through parameters in group F4.	F4-00 to F4-09	Multi-reference terminal K1: Set to 12.
		Multi-reference terminal K2: Set to 13.
		Multi-reference terminal K3: Set to 14.
		Multi-reference terminal K4: Set to 15.

Procedure	Parameter	Description
Step 3-2: Set the multi-reference function for the DI through parameters in group F4.	FC-55 = K1	0: Invalid 1: Valid 2: Terminal function input 3 to 18: Corresponds to DI1 to DI16 Others: B connector
	FC-56 = K2	0: Invalid 1: Valid 2: Terminal function input 3 to 18: Corresponds to DI1 to DI16 Others: B connector
	FC-57 = K3	0: Invalid 1: Valid 2: Terminal function input 3 to 18: Corresponds to DI1 to DI16 Others: B connector
	FC-58 = K4	0: Inactive 1: Valid 3 to 18: Corresponds to DI1 to DI16 Others: B connector
Step 4: Set the frequency for each multi-reference.[Note]	FC-00 to FC-15	The frequency corresponding to each speed reference is set to a percentage value. 100% corresponds to the maximum frequency (F0-10).
	F0-10	If the frequency reference source is set multi-reference, the value 100% of FC-00 to FC-15 corresponds to the value of F0-10 (Maximum frequency).

Note: The four multi-reference terminals can make up 16 state combinations, corresponding to 16 frequency reference values. For details, see the following table.

Table 29–33 State combinations of the four multi-reference terminals

K4 = FC-58	K3 = FC-57	K2 = FC-56	K1 = FC-55	Reference	Percentage to Maximum Frequency
OFF	OFF	OFF	OFF	Multi-reference 1	FC-00
OFF	OFF	OFF	ON	Multi-reference 2	FC-01
OFF	OFF	ON	OFF	Multi-reference 3	FC-02
OFF	OFF	ON	ON	Multi-reference 4	FC-03
OFF	ON	OFF	OFF	Multi-reference 5	FC-04
OFF	ON	OFF	ON	Multi-reference 6	FC-05
OFF	ON	ON	OFF	Multi-reference 7	FC-06
OFF	ON	ON	ON	Multi-reference 8	FC-07
ON	OFF	OFF	OFF	Multi-reference 9	FC-08
ON	OFF	OFF	ON	Multi-reference 10	FC-09
ON	OFF	ON	OFF	Multi-reference 11	FC-10

K4 = FC-58	K3 = FC-57	K2 = FC-56	K1 = FC-55	Reference	Percentage to Maximum Frequency
ON	OFF	ON	ON	Multi-reference 12	FC-11
ON	ON	OFF	OFF	Multi-reference 13	FC-12
ON	ON	OFF	ON	Multi-reference 14	FC-13
ON	ON	ON	OFF	Multi-reference 15	FC-14
ON	ON	ON	ON	Multi-reference 16	FC-15

29.5.2.2 Frequency Detection (FDT)

This function sets the detection value of the output frequency as well as the hysteresis value upon output cancellation. The hysteresis value is valid only during deceleration. Hysteresis does not occur in detection during acceleration. The following figure shows the frequency detection function.

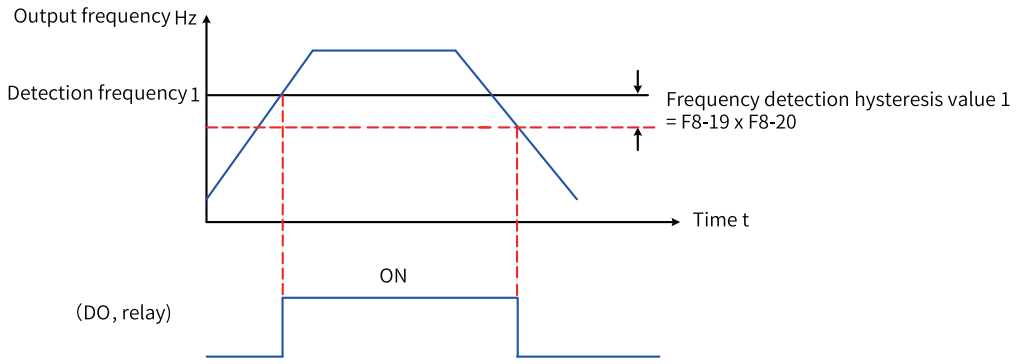


Figure 29-66 Parameters related to frequency detection

Table 29–34 Parameters related to frequency detection

Parameter Code	Parameter Name	Default	Value Range	Description
F8-19	Frequency detection value (FDT1)	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is higher than or equal to the frequency detection value (FDT1), the DO outputs an active signal. When the running frequency of the AC drive is lower than the result of frequency detection value (FDT1) minus frequency detection hysteresis value (FDT1), the DO outputs an inactive signal. The valid range is from 0.00 Hz to F0-10 (maximum frequency).
F8-20	Frequency detection hysteresis rate (FDT1)	5.0%	0.0% to 100.0%	The frequency detection hysteresis value (FDT1) is the result of F8-19 multiplied by F8-20. When the running frequency of the AC drive is higher than or equal to the value of F8-19, the DO outputs an active signal. When the running frequency is lower than a specific value (F8-19 - F8-19 x F8-20), the DO outputs an inactive signal.
F8-28	Frequency detection value (FDT2 level)	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is higher than or equal to the frequency detection value (FDT2), the DO outputs an active signal. When the running frequency of the AC drive is lower than the result of frequency detection value (FDT2) minus frequency detection hysteresis value (FDT2), the DO outputs an inactive signal. The valid range is from 0.00 Hz to F0-10 (maximum frequency).
F8-29	Frequency detection hysteresis rate (FDT2)	5.0%	0.0% to 100.0%	The frequency detection hysteresis value (FDT2) is the result of F8-28 multiplied by F8-29. When the running frequency of the AC drive is higher than or equal to the value of F8-28, the DO outputs an active signal. When the running frequency is lower than a specific value (F8-28 - F8-28 x F8-29), the DO outputs an inactive signal.

29.5.2.3 Jump Frequency

The jump frequency enables the AC drive to avoid mechanical resonance points of the load. The AC drive supports four jump frequencies. If the four frequencies are set to 0, the frequency jump function is disabled.

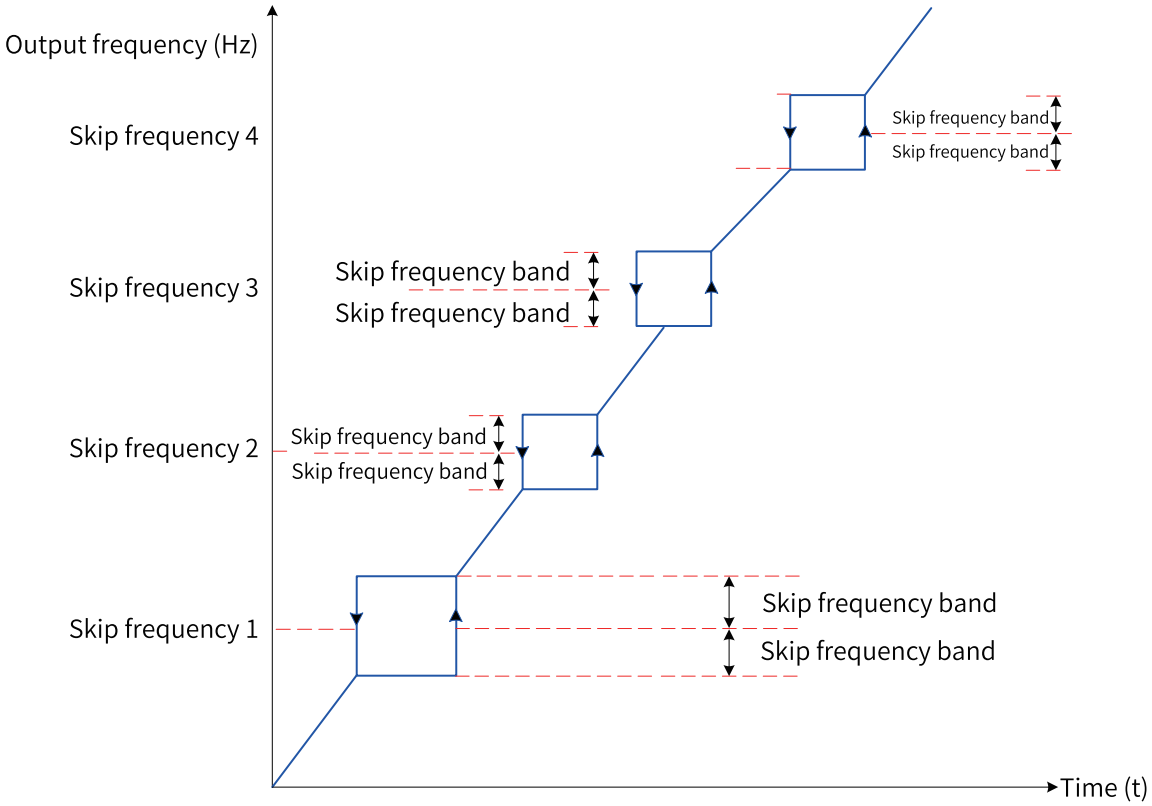


Figure 29-67 Jump frequency

As shown in the preceding figure, when the running frequency approaches the jump frequency during acceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11 (jump frequency amplitude).

When the running frequency approaches the jump frequency during deceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-09	Jump frequency 1	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. For details, see MD520 Series General-Purpose AC Drive Function Guide. Note: This parameter defines the first jump frequency. If it is set to 0, the first jump frequency function is canceled.
F8-10	Jump frequency 2	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. Note: This parameter defines the second jump frequency. If it is set to 0, the second jump frequency function is canceled.
F8-72	Jump frequency 3	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. Note: This parameter defines the third jump frequency. If it is set to 0, the third jump frequency function is disabled.

Parameter Code	Parameter Name	Default	Value Range	Description
F8-73	Jump frequency 4	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	The jump frequency enables the AC drive to avoid mechanical resonance points of the load. Note: This parameter defines the fourth jump frequency. If it is set to 0, the fourth jump frequency function is disabled.
F8-11	Jump frequency amplitude	0.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency approaches the jump frequency during acceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11 (jump frequency amplitude). When the running frequency approaches the jump frequency during deceleration, the AC drive runs at the current frequency for a period and then skips over the jump frequency. The jump range is twice the value of F8-11.
F8-22	Jump frequency valid status during acceleration/ deceleration	0	0: Invalid 1: Valid	This parameter is used to enable or disable the jump frequency function during acceleration/deceleration. When it is disabled, the AC drive continues to run at the running frequency when the running frequency is near the jump frequency during acceleration and deceleration. When it is enabled, the AC drive skips over the jump frequency when the running frequency is near the jump frequency during acceleration and deceleration. The jump range is twice the value of F8-11 (jump frequency amplitude).

29.5.2.4 Reverse Running Prohibition

F8-13 is used to set whether reverse running inhibition is enabled, as shown in the following figure.

F0-09 defines the running direction of the motor. You can change the rotation direction of the motor by modifying this parameter without changing the motor wiring. Modifying this parameter is equivalent to exchanging any two of the motor's U, V, W wires.

Note

After the parameter is initialized, the original rotation direction of the motor is resumed. Exercise cautions when using this function if motor rotation direction change is prohibited after system commissioning is complete.

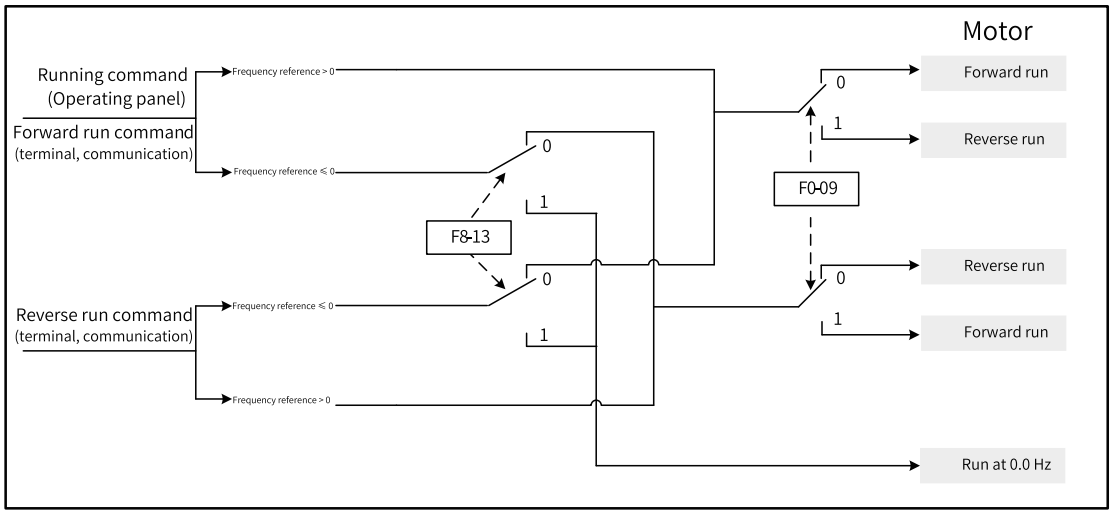


Figure 29-68 Reverse running prohibition

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-13	Reverse running prohibition	0	0: Disable 1: Enable	When the frequency defined by communication or analog reference is a negative value, the motor operating direction changes. The frequency in this case is called reverse frequency. You can set whether to allow the motor to operate in reverse state through this parameter. When reverse operation of the motor is not allowed, set F8-13 to 1. When reverse operation of the motor is allowed, set F8-13 to 0.
F0-09	Running direction selection	0	0: Default direction 1: Direction opposite to the default direction	You can change the rotation direction of the motor by modifying this parameter without changing the motor wiring. Modifying this parameter is equivalent to exchanging any two of the motor's U, V, W wires.

29.5.2.5 Detection Frequency Amplitude

F8-21 defines the detection frequency amplitude. The following figure shows the time sequence diagram of the frequency detection range.

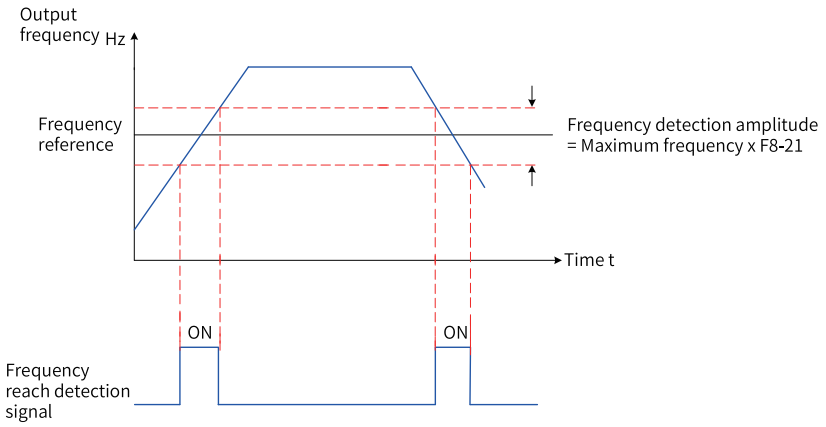


Figure 29-69 Time sequence of the frequency detection range

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-21	Detection frequency amplitude	0.0%	0.0% to 100.0% (maximum frequency)	When the running frequency of the AC drive is within the range of Reference frequency ± Maximum frequency (F0-10) x Detection frequency amplitude (F8-21), the DO outputs an active signal. Note 1: The detection frequency amplitude value is F8-21 x maximum frequency. Note 2: The range includes the maximum and minimum values.

29.5.2.6 Acceleration/Deceleration Time Switchover Frequency

This function enables selection of different acceleration/deceleration time based on the running frequency during running of the AC drive.

The following figure shows the schematic diagram of acceleration/deceleration time switchover. During acceleration, if the running frequency is lower than the value of F8-25, acceleration time 2 is selected. If the running frequency is higher than the value of F8-25, acceleration time 1 is selected. During deceleration, if the running frequency is higher than the value of F8-26, deceleration time 1 is selected. If the running frequency is lower than the value of F8-26, deceleration time 2 is selected.

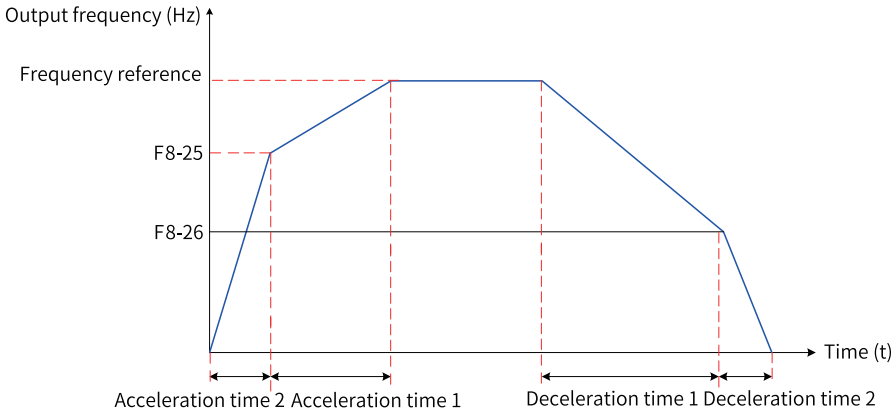


Figure 29-70 Frequency for acceleration/deceleration time switchover

This function is valid only when the DI is not assigned with function 16 (acceleration/deceleration time selection terminal 1) or 17 (acceleration/deceleration time selection terminal 2).

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-25	Frequency for switchover between acceleration time 1 and acceleration time 2	0.00 Hz	0 to F0-10 (Maximum frequency)	This function is used to switch the acceleration/deceleration time based on the running frequency range when the AC drive is running. Note 1: This function is valid only when the DI is not assigned with function 16 (acceleration/deceleration time selection terminal 1) or 17 (acceleration/ deceleration time selection terminal 2). Note 2: The valid range is from 0.00 Hz to F0-10 (maximum frequency).
F8-26	Frequency for switchover between deceleration time 1 and deceleration time 2	0.00 Hz	0 to F0-10 (Maximum frequency)	

29.5.2.7 Detection Frequency

When the running frequency of the AC drive is within the frequency detection range (F8-30 - F8-31 x F0-10 to F8-30 + F8-31 x F0-10, or F8-32 - F8-33 x F0-10 to F8-32 + F8-33 x F0-10), the DO outputs an active signal.

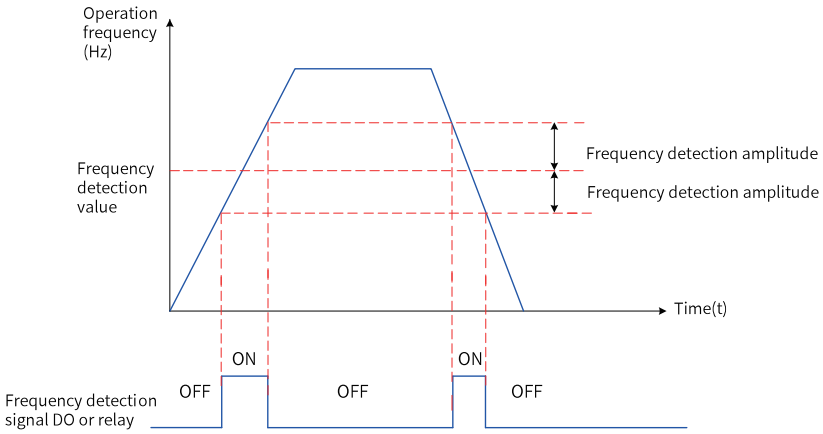


Figure 29-71 Detection frequency

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-30	Detection frequency 1	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is within the frequency detection range (F8-30 - F8-31 x F0-10 to F8-30 + F8-31 x F0-10), the DO outputs an active signal. Note: The following formula must be met: (F8-30 - F8-31 x F0-10) ⩽ operating frequency ⩽ (F8-30 + F8-31 x F0-10).
F8-31	Detection frequency amplitude 1	0.0%	0.1% to 100.0%	When the running frequency of the AC drive is within the frequency detection range (F8-30 - F8-31 x F0-10 to F8-30 + F8-31 x F0-10), the DO outputs an active signal. Note 1: The max. frequency (F0-10) is used as the base of percentage.
F8-32	Detection frequency 2	50.00 Hz	0.00 Hz to F0-10 (maximum frequency)	When the running frequency of the AC drive is within the frequency detection range (F8-32 - F8-33 x F0-10 to F8-32 + F8-33 x F0-10), the DO outputs an active signal. Note: The following formula must be met: (F8-32 - F8-33 x F0-10) ⩽ operating frequency ⩽ (F8-32 + F8-33 x F0-10).
F8-33	Detection frequency amplitude 2	0.1%	0.1% to 100.0%	When the running frequency of the AC drive is within the frequency detection range (F8-32 - F8-33 x F0-10 to F8-32 + F8-33 x F0-10), the DO outputs an active signal. Note 1: The max. frequency (F0-10) is used as the base of percentage.

29.5.3 Current Detection

29.5.3.1 Zero Current Detection

The DO outputs an active signal when the output current of the AC drive remains at or below the zero current detection level (F8-34) for a period greater than the value of F8-35 (zero current detection delay time).

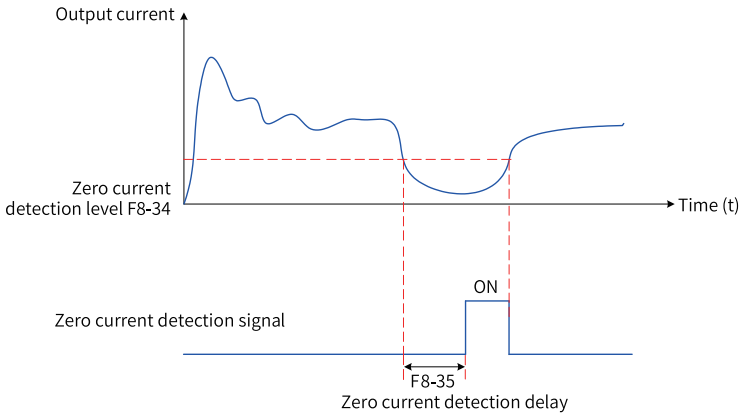


Figure 29-72 Zero current detection

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-34	Zero current detection level	5.0%	0.0% to 300.0% (rated motor current)	The DO outputs an active signal when the output current of the AC drive remains at or below the zero current detection level (F8-34) for a period greater than the value of F8-35 (zero current detection delay time).
F8-35	Zero current detection delay	0.10s	0.01s to 600.00s	

29.5.3.2 Output Current Overlimit

When the output current of the AC drive remains above the output current overlimit threshold (F8-36) for a period longer than the value of F8-37 (output current overlimit detection delay), the DO outputs an active signal.

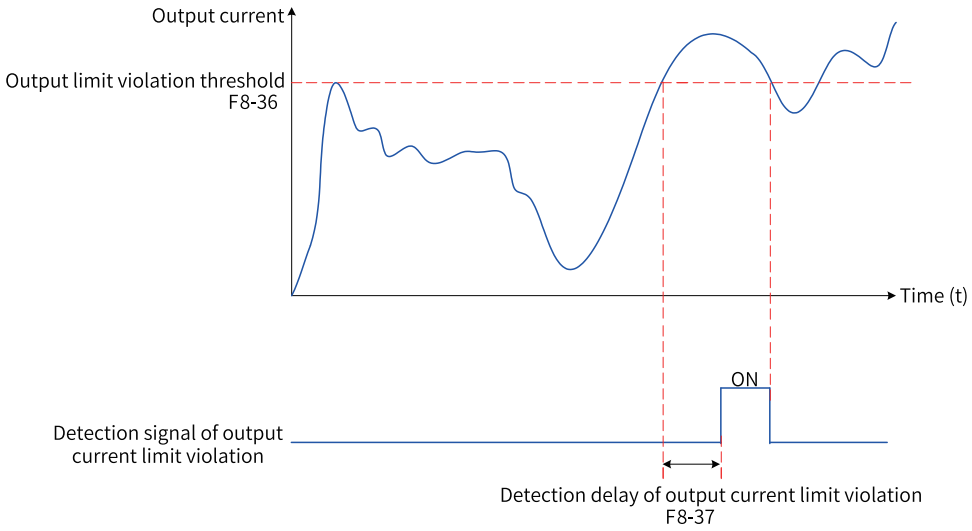


Figure 29-73 Output current overlimit threshold

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-36	Output current overlimit threshold	200.0%	0.0% (no detection) 0.1% to 300.0% (rated motor current)	When the output current of the AC drive remains above the output current overlimit threshold (F8-36) for a period longer than the value of F8-37 (output current overlimit detection delay), the DO outputs an active signal.
F8-37	Output current overlimit detection delay	0.00s	0.00s to 600.00s	

29.5.3.3 Detection Current

When the output current of the AC drive is within the range from Detection current - Detection current amplitude x Rated motor current to Detection current + Detection current amplitude x Rated motor current, the DO outputs an active signal.

The AC drive provides two groups of detection current and amplitude parameters, as shown below.

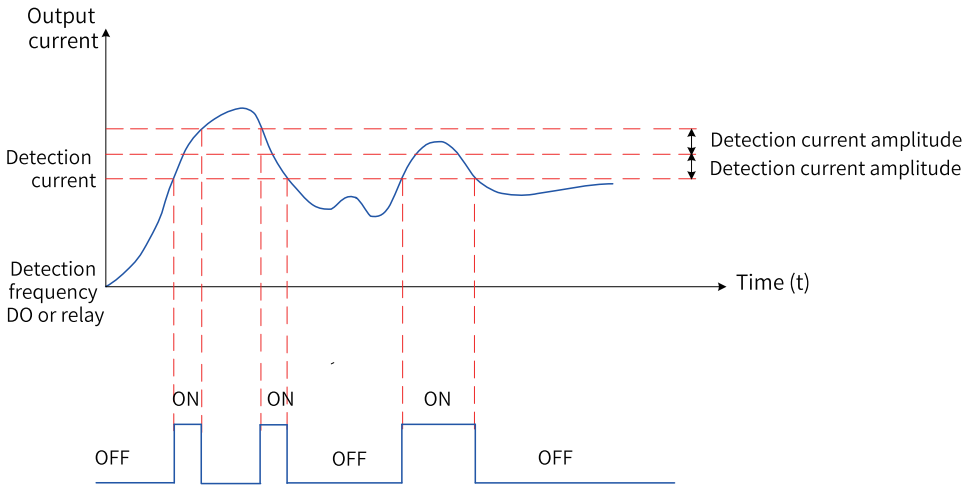


Figure 29-74 Current detection timing diagram

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-38	Detection current 1	100.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-38±F8-39) x Rated motor current, the DO terminal outputs an active signal. Note: The DO is allocated with function 28 "Current 1 reach".
F8-39	Detection current amplitude 1	0.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-38±F8-39) x Rated motor current, the DO terminal outputs an active signal.

Parameter Code	Parameter Name	Default	Value Range	Description
F8-40	Detection current 2	100.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-40±F8-41) x Rated motor current, the DO terminal outputs an active signal. Note 1: The DO is allocated with function 29 "Current 2 reach".
F8-41	Detection current amplitude 2	0.0%	0.0% to 300.0%	When the output current of the AC drive is within the range of (F8-40±F8-41) x Rated motor current, the DO terminal outputs an active signal.

29.5.4 Dead Zone Time of Forward/Reverse Run Switchover

This function is used to specify the transition period when the output is 0 Hz during forward/reverse run switchover of the AC drive. The transition period is called dead zone time of forward/reverse run switchover, which can be set through F8-12.

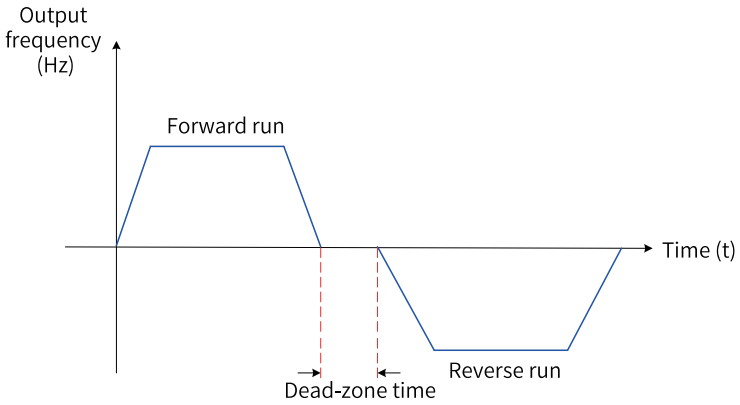


Figure 29-75 Dead zone time of forward/reverse run switchover

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-12	Dead zone time of forward/reverse run switchover	0.0s	0.0s to 3000.0s	This parameter defines the transition time at 0 Hz output during switchover between forward run and reverse run.

29.5.5 Timing Function

The timer starts from 0 upon startup of the AC drive. When the timing duration (F8-44) expires, the AC drive automatically stops, and the DO outputs an active signal. The remaining timing duration can be viewed through U0-20.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-42	Timing function	0	0: Disable 1: Enable	This parameter is used to enable timed operation of the drive. If F8-42 is set to 1, the AC drive starts timing at startup. When the set timing duration is reached, the AC drive stops automatically and meanwhile the corresponding multi-function DO outputs ON signal. The timing duration is set in F8-43 and F8-44, in unit of minute. The AC drive starts timing from 0 each time it starts up and the remaining timing duration can be viewed in U0-20. Note: The DO is allocated with function 30 "Timed operation reached".
F8-43	Timing operation time setting source	0	0: F8-44 1: AI1 2: AI2 3: AI3 Others: F connector	This parameter is used to set the source of timed operation. When other input sources are selected, the input range 100.0% corresponds to the setpoint of F8-44. If AI1 is selected, 10 V corresponds to the setpoint of F8-44.
F8-44	Timing operation time	0.0 min	0.0 min to 6500.0 min	This parameter is used to set the duration of timed operation.

29.5.6 Cumulative Time Reach

When the cumulative power-on time (F7-13) x 3600 + cumulative power-on time (F7-29) exceeds the set cumulative power-on time (F8-16) x 3600 + set power-on time (F8-74), the DO outputs an active signal.

Parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-16	Power-on time reach (hour)	0h	0h to 65535h	If the cumulative power-on time reaches the value set by F8-16 and F8-74, and the set power-on time is not zero, the multi-function DO outputs ON signal. Note: The DO is allocated with function 24 "Cumulative power-on time reach".
F8-74	Power-on time reach (second)	0s	0s to 3599s	

When the cumulative running time (F7-09) x 3600 + cumulative running time (F7-28) exceeds the set cumulative running time (F8-17) x 3600 + set running time (F8-75), the DO outputs an active signal.

Parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-17	Running time threshold (hour)	0h	0h to 65535h	These parameters are used to set the running time threshold of the AC drive. If the cumulative running time reaches the value set by F8-17 and F8-75, and the set running time is not zero, the multi-function DO outputs ON signal.
F8-75	Running time threshold (second)	0s	0s to 3599s	

29.5.7 Current Running Time Reach

Current running time reach

Parameter Code	Parameter Name	Default	Value Range	Description
F8-53	Current running time reach	0.0 min	0.0 min to 6500.0 min	If the current running time reaches the value set by this parameter, the corresponding DO outputs ON signal, indicating that the current running time is reached. Note: The DO is allocated with function 40.

29.5.8 AI1 Voltage Upper/Lower Limit

Parameter Code	Parameter Name	Default	Value Range	Description
F8-45	Lower limit threshold of AI1 input voltage protection value	3.10 V	0.00 V to F8-46	When the AI1 input voltage is higher than the value of F8-46 or lower than the value of F8-45, the DO outputs an active signal indicating "AI1 input limit exceeded".
F8-46	Upper limit threshold of AI1 input voltage protection value	6.80 V	F8-45 to 10.00 V	
A6-51	Lower limit threshold of AI2 input voltage protection value	8.00 V	A6-52 to 10.00 V	When the AI2 input voltage is higher than the value of A6-51 or lower than the value of A6-52, the DO outputs an active signal indicating "AI2 input limit exceeded".
A6-52	Upper limit threshold of AI2 input voltage protection value	2.00 V	0.00 V to A6-51	

Parameter Code	Parameter Name	Default	Value Range	Description
A6-57	Lower limit threshold of AI3 input voltage protection value	8.00 V	A6-58 to 10.00 V	When the AI3 input voltage is higher than the value of A6-57 or lower than the value of A6-58, the DO outputs an active signal indicating "AI3 input limit exceeded".
A6-58	Upper limit threshold of AI3 input voltage protection value	2.00 V	0.00 V to A6-57	
A6-59	AI input protection time	0.01s	0.00s to 1.00s	When the AI input limit keeps being exceeded after the time defined by this parameter elapses, the fault flag will be set.

29.5.9 Module Temperature

Parameter Code	Parameter Name	Default	Value Range	Description
F8-47	Module temperature reach (threshold)	75°C	0°C to 100°C	When the temperature of the inverter heatsink reaches the value of F8-47, the DO outputs an active signal.
F7-07	Inverter heatsink temperature	0°C	-20°C to 120°C	This parameter indicates the temperature of the inverter heatsink.

29.5.10 Fan Control

Parameter Code	Parameter Name	Default	Value Range	Description
F8-48	Cooling fan control	0	0: The cooling fan works when the drive is running.	The fan keeps working during drive running. When the drive stops, the fan works for 10s and then stops if the heatsink temperature is above 40°C and stops immediately if the heatsink temperature is below 40°C.
			1: The cooling fan works always.	When this parameter is set to 1, the fan keeps working after power-on.

29.5.11 Output Power Correction

Parameter Code	Parameter Name	Default	Value Range	Description
F8-54	Output power correction coefficient	100.0%	0.0% to 200.0%	When the output power (U0-05) is not equal to expected value, perform linear correction on the output power via this parameter.

29.5.12 User-Defined Parameters

Group FE consists of user-defined parameters (FE-00 to FE-31). Users can define up to 30 commonly used parameters for easier check and modification.

- If F0.00 is displayed, the corresponding user-defined parameter is empty. In the user-defined parameter mode, the displayed parameters are defined by FE-00 to FE-31, and the sequence is consistent with that in group FE. The parameter is skipped if F0-00 is displayed.
- This group is user-defined. You can select the required parameters from the parameter list and add them to group FE, which facilitates view and modification.
  When the communication protocol is extension protocol, this group of parameters will be mapped automatically after PDOs are configured by the host controller.

  U3-17 and U3-16 indicate PZD1 (AC drive command word) in the communication control mode and PZD2 (AC drive target frequency) in the communication control mode, respectively.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
FP-03	Individualized parameter display	111	Ones: User-defined parameter group 0: Hidden 1: Displayed Tens: User-modified parameter group 0: Hidden 1: Displayed hundreds: Error menu 0: Hidden 1: Displayed	This parameter is used to determine whether the user-defined parameter group, user-modified parameter group, and error menu are displayed on the operating panel through the ones, tens, and hundreds places.
FE-00	User-defined parameter 0	F0-00	0x0 to 0xFFFF	This group is user-defined. You can select the required parameters from the parameter list and add them to group FE, which facilitates view and modification. When the communication protocol is extension protocol, this group of parameters will be mapped automatically after PDOs are configured by the host controller.

Parameter Code	Parameter Name	Default	Value Range	Description
FE-01	User-defined parameter 1	Same as FE-00	Same as FE-00	Same as FE-00
FE-02	User-defined parameter 2			
FE-03	User-defined parameter 3			
FE-04	User-defined parameter 4			
FE-05	User-defined parameter 5			
FE-06	User-defined parameter 6			
FE-07	User-defined parameter 7			
FE-08	User-defined parameter 8			
FE-09	User-defined parameter 9			
FE-10	User-defined parameter 10			
FE-11	User-defined parameter 11	Same as FE-00	Same as FE-00	Same as FE-00
FE-12	User-defined parameter 12			
FE-13	User-defined parameter 13			
FE-14	User-defined parameter 14			
FE-15	User-defined parameter 15			
FE-16	User-defined parameter 16			
FE-17	User-defined parameter 17			
FE-18	User-defined parameter 18			
FE-19	User-defined parameter 19			
FE-20	User-defined parameter 20			
FE-21	User-defined parameter 21			
FE-22	User-defined parameter 22			
FE-23	User-defined parameter 23			

Parameter Code	Parameter Name	Default	Value Range	Description
FE-24	User-defined parameter 24	Same as FE-00	Same as FE-00	Same as FE-00
FE-25	User-defined parameter 25			
FE-26	User-defined parameter 26			
FE-27	User-defined parameter 27			
FE-28	User-defined parameter 28			
FE-29	User-defined parameter 29			
FE-30	User-defined parameter 30			
FE-31	User-defined parameter 31			

29.5.13 Hibernation and Wakeup

Hibernation enables you to set any time period within 24 hours, during which the AC drive stops running and hibernates.

Wakeup is a process that the AC drive wakes up from the hibernation state and starts to run.

To use the hibernation and wakeup functions, set the wakeup frequency, hibernation frequency, and hibernation duration. Generally, set the wakeup frequency (F8-49) equal to or greater than the hibernation frequency (F8-51). The hibernation and wakeup function is disabled if both the wakeup frequency and hibernation frequency are set to 0.00 Hz.

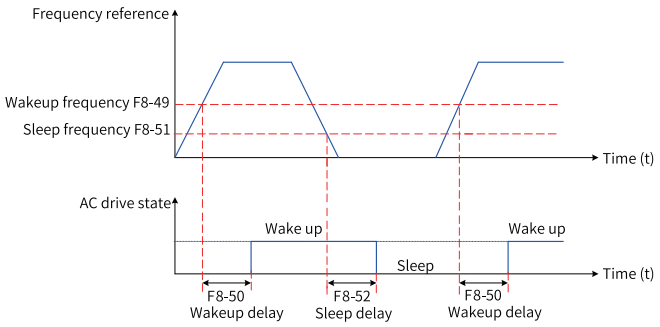


Figure 29-76 Hibernation and wakeup

Note

When sleep is enabled during PID operation, you can set FA-28 (selection of PID operation at stop) to 1 to continue the PID operation or to 0 to stop PID operation.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F8-49	Wakeup frequency	0.00 Hz	F8-51 (hibernation frequency) to F0-10 (maximum frequency)	In the hibernation state, when the frequency reference keeps equal to or larger than the wakeup frequency (F8-49) for the time set by F8-50 and the current running command is valid, the AC drive starts directly.
F8-50	Wakeup delay	0.0s	0.0s to 6500.0s	
F8-51	Hibernation frequency	0.00 Hz	0.00 Hz to wakeup frequency (F8-49)	During the AC drive running, when the frequency reference keeps lower than or equal to the hibernating frequency (F8-51) for the time set by F8-52, the AC drive enters the hibernation state and coasts to stop.
F8-52	Hibernation delay	0.0s	0.0s to 6500.0s	

29.6 Faults and Protection

29.6.1 Startup Protection

When F8-18 is set to 1, startup protection is enabled to prevent the motor from responding to a command upon power-on or fault reset of the AC drive.

Startup protection can be used in the following scenarios:

- If the running command is valid when the AC drive is powered on (for example, an input terminal is ON before power-on), the AC drive does not respond to the command. The AC drive responds only after the running command is canceled and becomes valid again.
- If the running command is valid when the AC drive fault is reset, the AC drive does not respond to the running command. The startup protection can be disabled only after the running command is canceled.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F8-18	Startup protection	0	0: Disable 1: Enable	The AC drive is equipped with startup protection to prevent the motor from responding to commands upon unexpected power-on or fault reset. In addition, the AC drive does not respond to the run command valid upon fault reset of the AC drive. The run protection can be disabled only after the run command has been cancelled.

29.6.2 Undervoltage Threshold, Overvoltage Threshold, and Pulse-by-Pulse Current Limit Protection

When the bus voltage falls below the value of A5-06 or exceeds the value of A5-09, the AC drive generates an alarm.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
A5-06	Undervoltage threshold	350.0 V	140.0 V to 420.0 V	When the bus voltage is lower than the value of A5-06, the AC drive reports E009.1.
A5-09	Overvoltage threshold	820.0V	330.0 V to 820.0 V	When the bus voltage is higher than the value of A5-09, the AC drive reports E005.1. The default value is recommended.
A5-04	Pulse-by-pulse current limit protection	1	0: Enable 1: Enable	This function is used to minimize the possibility of overcurrent faults, ensuring normal operation of the AC drive. It is recommended to disable this function in hoisting applications, such as cranes.

29.6.3 Phase Loss Protection

Parameter Code	Parameter Name	Default	Value Range	Description
F9-12	Protection function selection	11	Ones: Input phase loss protection 0: Disable 1: Protection enabled when both software and hardware input phase loss conditions are met 2: Protection enabled when software input phase loss conditions are met 3: Protection enabled when hardware input phase loss conditions are met Tens: Contactor close protection 0: Disable 1: Enable Hundreds: T13 rectifier fault protection 0: Disable 1: Enable	This parameter determines whether to perform input phase loss or contactor close protection through the ones and tens places. After the input phase loss protection function is enabled, if the three-phase input power supply, driver board, lightning protection board, main control board, or rectifier bridge is abnormal, the drive will report E012.0 (input phase loss). Ones: Input phase loss protection 0: Disable Input phase loss is not detected. 1: Protection enabled when both software and hardware input phase loss conditions are met Input phase loss protection is performed only when the hardware detection and software detection meet the conditions. 2: Protection enabled when software input phase loss conditions are met Input phase loss protection is performed when the software detection meets the conditions. 3: Protection enabled when hardware input phase loss conditions are met Input phase loss protection is performed when the hardware detection meets the conditions. Tens: For models of 450 kW and below, the tens place is used to set the contactor close protection function. For models of 500 kW and above, the tens place is used to set the fan fault selection. 0: Disable contactor close protection 1: Enable contactor close protection Hundreds: T13 rectifier fault protection 0: Disable 1: Enable

Parameter Code	Parameter Name	Default	Value Range	Description
F9-13	Output phase loss protection	01	Ones: Protection against output phase loss during running 0: Disable 1: Enable Tens: Protection against output phase loss before running 0: Disable 1: Enable	The default value 1 indicates the output phase loss protection is enabled. Related options are described as below. Ones: It is used to determine whether to perform output phase loss protection. If the ones place of F9-13 is set to 0, the output phase loss will not be reported when it occurs. In this case, the actual current is larger than the current displayed on the operating panel. Use this function cautiously. 0: Disable Protection against output phase loss during running is disabled. 1: Enable Protection against output phase loss during running is enabled. Tens: Output phase loss detection during running takes about several seconds. In low-frequency operations or applications where risks exist in start with phase loss, this function can be used to detect phase loss fault upon start. However, in applications where short start time is required, do not use this function. 0: Disable Protection against output phase loss before running is disabled. 1: Enable Protection against output phase loss before running is enabled.

29.6.4 Motor Overtemperature Protection

You can view the motor temperature in U0-34. The following table describes parameters related to motor overtemperature protection.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F9-56	AI3 temperature mode - motor temperature sensor type	0°C	0: Temperature sensor not supported (AI used for analog input) 1: PT100 2: PT1000	A motor temperature sensor needs to be connected to the AI3 and PGND terminals on the MD38IO1 expansion card. The AC drive supports PT100 and PT1000 motor temperature sensors. Set the sensor type properly. Set the DIP switch on the MD38IO1 expansion card. For details, see section MD38IO1 expansion card in the AC drive expansion card selection guide. You can view the motor temperature in U0-34.
F9-57	AI3 temperature mode - motor overheat protection threshold	110°C	F9-58 to 200°C	This parameter is used to set the motor overtemperature protection threshold. When the motor temperature exceeds the value of F9-57 (motor overtemperature protection threshold), the AC drive generates the motor overtemperature alarm (E045.1).
F9-58	AI3 temperature mode - motor overheat warning threshold	90°C	0°C to F9-57	When the motor temperature exceeds the motor overtemperature warning threshold (F9-58), the DO terminal allocated with function 39 (Motor overtemperature warning) outputs a valid signal.

29.6.5 Motor Overload Protection

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
F9-00	Motor overload protection selection	1	0: Disable 1: Enable	This parameter specifies whether to enable the motor overload protection function. The AC drive determines whether the motor is overloaded according to the inverse time lag curve. When the motor overload is detected, the AC drive will report an overload fault. 0: Enable The motor overload protection function is disabled. If this parameter is set to 0, you are advised to install a thermal relay before the motor for protection. 1: Enable The motor overload protection function is enabled.
F9-01	Motor overload protection gain	1	0.20 to 10.00	It is used to adjust the actual overload fault report time of the AC drive when motor overload occurs. The higher the value of this parameter, the longer the overload time. Note: See the description in the motor overload protection section in the this guide.
F9-02	Motor overload warning coefficient	80%	50% to 100%	The motor overload alarm coefficient is calculated according to the percentage of time during which the motor runs continuously at a certain overload threshold without reporting overload alarm. An alarm signal is sent to the control system through the DO before motor overload protection. This signal is used to determine how long in advance to send the alarm signal before the motor overload protection applies. The higher the coefficient is, the later the alarm signal is sent. When the cumulative output current of the drive exceeds the product of the overload time (Y value of motor overload protection inverse time lag curve) multiplied by F9-02 (motor overload alarm coefficient), the DO outputs a motor overload alarm signal.

To protect different load motors, set the motor overload protection gain based on the overload capacity of the motor. The motor overload protection curve is an inverse time lag curve, as shown in the following figure.

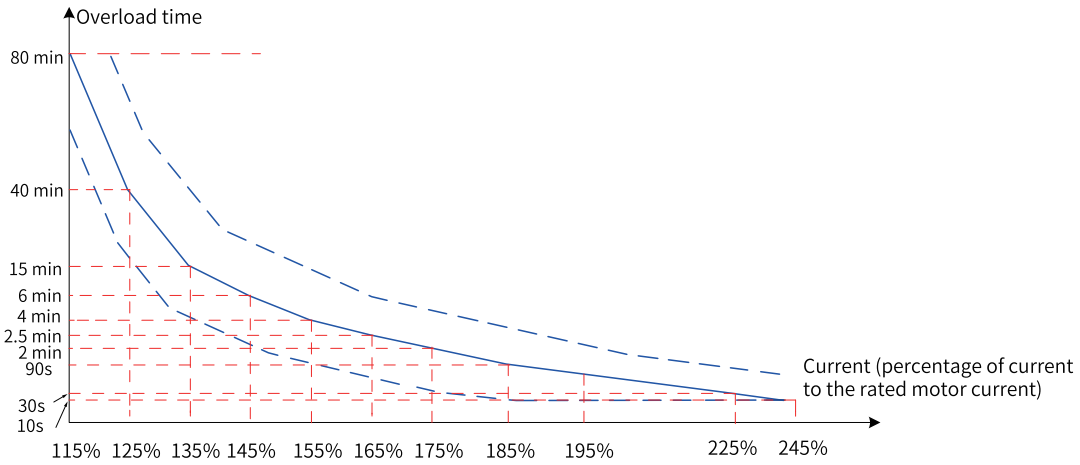


Figure 29-77 Inverse time-lag curve of protection

When the running current reaches 175% of the rated motor current and the motor runs at this level for 2 minutes, or when the running current reaches 115% of the rated motor current and the motor runs at this level for 80 minutes, the AC drive reports a motor overload alarm (E011.1).

1. Example 1

- Assume that the rated motor current is 100 A and F9-01 is set to 1.00. If the running current reaches 125 A (125% of 100 A) and the motor runs at this level for 40 minutes, the AC drive reports a motor overload alarm (E011.1).
- Assume that the rated motor current is 100 A and F9-01 is set to 1.20. If the running current reaches 125 A (125% of 100 A) and the motor runs at this level for 48 minutes (40 x 1.2), the AC drive reports a motor overload alarm (E011.1).

Note

The maximum overload time is 80 minutes and the minimum overload time is 10 seconds.

2. Example 2

The AC drive reports a motor overload error after the motor runs for 2 minutes at 150% of the rated motor current. As shown by the overload curve, 150% (I) of the rated motor current is between 145% (I1) and 155% (I2) of the rated motor current. The overload error reporting time for 145% of the rated motor current is 6 minutes (T1), and that for 155% of the rated motor current is 4 minutes (T2). Therefore, the overload error reporting time for 150% of the rated motor current in default settings can be calculated. The calculation formula is as follows:

“T = T1 + (T2 – T1) x (I – I1)/(I2 – I1) = 4 + (6 – 4) x (150% – 145%)/(155% – 145%) = 5 (minute)”

Therefore, if the overload fault needs to be reported when the motor runs at 150% of the rated motor current for 2 minutes, set the motor overload protection gain F9-01 to 0.4 (F9-01 = 2/5).



Note: Set F9-01 properly based on the actual overload capacity. If the value of F9-01 is set too high, the motor may be damaged because the motor overheats but the AC drive does not report the alarm timely.

When the motor overload detection level reaches the value of F9-02 (Motor overload warning coefficient), the DO or fault relay outputs the motor overload warning signal. The value of F9-02 is the percentage of the time duration during which the motor runs continuously at a certain overload point without reporting the overload fault.

On the condition that the motor overload protection gain is set to 1.00 and motor overload warning coefficient is set to 80%, when the motor running current reaches 145% of the rated motor current and the motor runs at this level for 4.8 min (80% x 6), the DO or fault relay outputs the motor overload warning signal.

The motor overload warning function is used to send a warning signal to the control system via the DO before the motor overload protection applies. The motor overload warning coefficient is used to determine how early the alarm signal is sent before the motor overload protection applies. The higher the value is, the later the warning signal is sent. When the cumulative output current of the AC drive exceeds the product of multiplying the overload time (Y value of motor overload protection

inverse time lag curve) and F9-02 (motor overload warning coefficient), the DO outputs a motor overload warning signal. When F9-02 is set to 100% and the warning advance value is 0, the motor overload warning and the motor overload protection are triggered simultaneously.

29.6.6 Load Loss Protection

Set F9-63 to 1 to enable load loss detection. When the output current of the AC drive falls below F9-64 (Load loss detection level) for longer than the value of F9-65 (Load loss detection time), the AC drive performs load loss protection action. Once the load recovers during protection, the drive will restore to run at the set frequency.

Parameter	Name	Default	Value range	Descriptions
F9-51	Fault protection action selection 5	10111	Ones: Modbus timeout (E160.X) Tens position: CANopen fault (E161.X) Hundreds position: CANlink fault (E162.X) Thousands position: Reserved Ten thousands position: Expansion card fault (E164.X) The meaning of 0 to 5 is described in the parameter description	The protective actions are set through the ones, tens, hundreds, thousands, and ten thousands of this parameter. 0: Coast to stop The drive coasts to stop. 1: Stop according to the stop mode The AC drive enters the stop state in the stop mode. 2: Continue operation The drive continues to run. 3: Operation with limited power AC drive power limit 4: Operation with limited current Current limit of the AC drive. 5: Ignore fault The fault type is ignored by the drive.
F9-63	Protection upon load loss	0	0: Disabled 1: Enable	If load loss protection is enabled, when output current of the AC drive falls below detection level (F9-64) for longer than time set in F9-65, the AC drive initiates load loss protection action (the action can be selected from F9-49 and the default is coast-to-stop.) Once the load recovers during protection, the drive will restore to run at the set frequency. 0: Inactive The load loss protection detection is invalid. This detection will not be performed. 1: Active The load loss protection detection is active.

Parameter	Name	Default	Value range	Descriptions
F9-64	Load loss detection level	10.0%	0.0% to 100.0%	If load loss protection is enabled, when output current of the AC drive falls below detection level (F9-64) for longer than time set in F9-65, the AC drive initiates load loss protection action (the action can be selected from F9-49 and the default is coast-to-stop.) Once the load recovers during protection, the drive will restore to run at the set frequency.
F9-65	Load loss detection time	1.0s	0.0 to 60.0	

29.6.7 Overspeed Protection

Overspeed protection is available only when the AC drive works in the FVC mode (F0-01 = 1).

During overspeed protection, when the detected motor speed exceeds F0-10 (Maximum frequency) for a percentage higher than F9-67 (Overspeed detection level) and for longer than the time set by F9-68 (Overspeed detection time), the AC drive reports a motor overspeed fault (E043.1) and acts as selected by F9-50 (Fault protection action).

When F9-68 (Overspeed detection time) is set to 0.0s, the overspeed detection function is disabled.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F9-67	Over-speed detection level	20.0%	0.0% to 50.0% (maximum frequency)	During overspeed protection, when the detected motor speed exceeds F0-10 (Maximum frequency) for a percentage higher than F9-67 (Overspeed detection level) and for longer than the time set by F9-68 (Overspeed detection time), the AC drive reports a motor overspeed fault (E043.1) and acts as selected by F9-50 (Fault protection action). When F9-68 (Overspeed detection time) is set to 0.0s, the overspeed detection function is disabled. The overspeed protection is valid only in the FVC mode (F0-01 = 1).
F9-68	Over-speed detection time	1.0s	0.0 to 60.0	

29.6.8 Protection Against Excessive Speed Deviation

The excessive speed deviation detection function is active only when the FVC mode is selected for the AC drive (F0-01 = 1).

When the motor speed detected is higher than the set frequency and the difference is higher than F9-69 for a period longer than the time set by F9-70, the drive reports excessive speed deviation fault (E042.1) and acts accordingly as defined by F9-50.

If F9-70 is set to 0.0s, the excessive speed deviation detection is disabled.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F9-69	Detection level for excessive speed deviation	20.0%	0.0% to 50.0%	When the motor speed detected is higher than the set frequency and the difference is higher than F9-69 for a period longer than the time set by F9-70, the drive reports excessive speed deviation fault (E042.1) and acts accordingly as defined by F9-50. If F9-70 is set to 0.0s, the excessive speed deviation detection is disabled. The speed deviation protection function is valid only when the AC drive is running in SVC (vector control without speed sensor)/FVC (vector control with speed sensor).
F9-70	Detection time for excessive speed deviation	5.0s	0.0 to 60.0	

29.6.9 Motor Stall Protection

Take motor 1 as an example.

Parameter Code	Parameter Name	Default	Value Range	Description
AA-30	Motor protection	1	Bit 0 to bit 2: Reserved Bit 3: Current control error detection Bit 4: Motor step loss error detection Bit 5: Motor stall detection Bit 6: Demagnetization protection for synchronous motor Bit 7 to bit 8: Reserved Bit 9: Parameter setting error Bit 10: Reserved Bit 11: Runaway Protection Bit 12 to bit15: Reserved	This parameter is used to set the protective function of the motor.
AA-31	Motor stall protection time	2.0s	0.0s-65.0s	When the motor speed setpoint exceeds the fault frequency, the torque reaches the limit state, and the fault time is exceeded, a fault indicating the motor is stalled (E093.1) will be reported.
AA-32	Motor stall frequency	6.0%	0.0% to 600.0%	

29.6.10 Motor Step Loss Protection

Parameter Code	Parameter Name	Default	Value Range	Description
AA-30	Motor protection	1	Bit 0 to bit 2: Reserved Bit 3: Current control error detection Bit 4: Motor step loss error detection Bit 5: Motor stall detection Bit 6: Demagnetization protection for synchronous motor Bit 7 to bit 8: Reserved Bit 9: Parameter setting error bit10: Reserved Bit 11: Runaway Protection Bit 12 to bit15: Reserved	This parameter is used to set the protective function of the motor.
AA-33	Step loss detection time	0.5s	0.0s-10.0s	When the feedback flux of asynchronous motor flux controller and the set flux exceed the detection threshold and reach the set time, a step loss fault (E093.2) will be reported.
AA-34	Step loss detection threshold	30.0%	0.0% to 100.0%	

29.6.11 Current Control Error Protection

Parameter	Name	Default	Value range	Description
AA-30	Motor overload protection	1	Bt0 to bit2: Reserved Bit3: Current control error detection Bit 4: Motor stall error detection Bit 5: Motor stall detection Bit6: Synchronous motor demagnetization protection Bit7 to bit8: Reserved Bit9: parameter setting error bit10: Reserved Bit11: Protection of dispersed motorcycles bit12 to bit15: Reserved	Function switches for motor protection.
AA-35	Current control fault detection time	0.05s	0.00s-1.00s	Used to judge whether the motor feedback current follows the set deviation threshold. If the error exceeds the threshold and reaches the set time, a fault (E093.3) will be reported.
AA-36	Motor control error protection threshold	25.0%	0.0% to 200.0%	

29.6.12 Power Dip Ride-Through

The power dip ride-through function ensures continuous system running upon an instantaneous power failure. When an instantaneous power failure occurs, the AC drive keeps the motor in the power generation state to keep the bus voltage at a value around the threshold for enabling power dip ride-through. This prevents the AC drive from stopping due to undervoltage, as shown in the following figure.

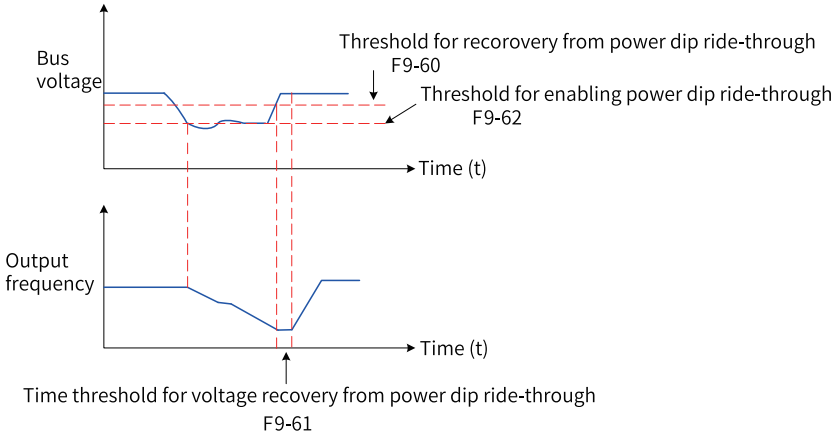


Figure 29-78 The following figure shows the power dip ride-through process.

In the "bus voltage constant control" mode, when the power grid recovers from the failure, the AC drive restores the output frequency to the target output frequency based on the acceleration time. In the "decelerate to stop" mode, when the power grid recovers from the failure, the AC drive decelerates to 0 Hz and stops, and will start only after receiving a start command.

Related Parameters

Parameter Code	Parameter Name	Default	Value Range	Description
F9-59	Power dip ride-through function	0	0: Disable 1: Deceleration (constant control of bus voltage) 2: Decelerate to stop 3: Voltage dip depression	The function enables the AC drive to keep running upon an instantaneous power failure. When an instantaneous power failure occurs, the AC drive keeps the motor in the power generation state to keep the bus voltage at a value around the threshold for enabling power dip ride-through. This prevents the AC drive from stopping due to undervoltage. 0: Disable The power dip ride-through function is disabled. 1: Constant control of bus voltage When a power failure occurs, the bus voltage is retained at a value around the threshold for enabling power dip ride-through. In this mode, when the power grid recovers from the failure, the AC drive restores the output frequency to the target output frequency based on the acceleration time. 2: Decelerate to stop When a power failure occurs, the AC drive decelerates to stop. In this mode, if the drive does not decelerate to 0 and the power supply recovers, the drive continues running. 3: Voltage dip depression This function prevents AC drive stop caused by undervoltage when instantaneous power failure occurs due to voltage dip. You can use F9-66 to set a voltage dip suppression time.
F9-60	Threshold for recovering from power dip ride-through	85%	80% to 100%	This parameter defines the voltage threshold for disabling power dip ride-through. 100% corresponds to 540 V. This value is slightly lower than the bus voltage before a power failure. Upon a power failure, the bus voltage is maintained at about F9-62 (threshold for enabling power dip ride-through). When the power supply recovers, the bus voltage rises from F9-62 (threshold for enabling power dip ride-through) to F9-60 (threshold for recovery from power dip ride-through). During this period, the output frequency of the AC drive keeps decreasing until the bus voltage reaches F9-60 (threshold for recovery from power dip ride-through).
F9-61	Duration for judging voltage recovery from power dip ride-through	0.5s	0.0s to 100.0s	This parameter is used to set the time required for the bus voltage to rise from F9-60 (Threshold of recovery from power dip ride-through) to the voltage before a power failure.
F9-62	Threshold for enabling power dip ride-through	80%	60% to 100%	This parameter defines the bus voltage level upon a power failure. When a power failure occurs, the bus voltage is retained at a value around F9-62 (Threshold for enabling power dip ride-through).

Parameter Code	Parameter Name	Default	Value Range	Description
F9-71	Power dip ride-through gain Kp	40	1 to 100	This parameter is valid only in the constant control of the bus voltage (F9-59 = 1). If undervoltage is likely to occur during power dip ride-through, increase the values of F9-71 and F9-72.
F9-72	Power dip ride-through integral coefficient Ki	30	1 to 100	This parameter is valid only when F9-59 is set to 2. If undervoltage is likely to occur during power dip ride-through, increase the values of F9-71 and F9-72.
F9-73	Deceleration time of power dip ride-through	20.0s	0s to 300.0s	This parameter is valid only when F9-59 (power dip ride-through function) is set to 2 (decelerate to stop). When the bus voltage is lower than the value of F9-62, the AC drive decelerates to stop. The deceleration time is determined by this parameter instead of F0-18.

29.6.13 Automatic Reset Upon Fault

In the case of an undervoltage fault (E009.1), the AC drive resets automatically when the bus voltage restores to the normal range. This reset is not counted in the number of fault auto reset times. In the case of a short circuit to ground (E023.1) and STO BUFFER chip fault (E047.5), the AC drive does not support automatic or manual reset, and you need to reset the AC drive by powering it off and then powering it on again. The fault protection action selection is performed after the number of automatic reset times upon fault is reached.

Related parameters

Parameter	Name	Default	Value range	Descriptions
F9-09	Number of automatic resets upon fault	0	0 to 100	Used to set the automatic fault reset times of the drive. If the number of reset times exceed the value of this parameter, the AC drive remains in the faulty state.
F9-10	Relay action during automatic reset	0	0: The DO does not act 1: The DO acts.	Check whether the fault output function of the digital output terminal is active during automatic fault reset of the AC drive. The fault output function of the digital output terminal is defined by F5-04 = 2. 0: The DO does not act The relay does not act during automatic reset. 1: The DO acts. The relay acts during automatic reset.
F9-11	Interval time of automatic fault reset	1.0s	0.1s to 600.0s	Used to set the delay of auto reset after the AC drive reports a fault.
H2-12	Automatic fault reset enable	1	0: Enable 1: Disable	Used to enable automatic fault reset, which is enabled by default.

Parameter	Name	Default	Value range	Descriptions
H2-15	Auto reset/ Manual reset	1	0: Cancels automatic reset 1: Continue automatic reset	Used to set whether the automatic reset process can be terminated by manual reset. If it is equal to 0, the operator manually resets the fault when a fault occurs. The next time the machine changes to a false signal, the operator manually resets the fault. The machine does not reset automatically. If it is equal to 1, the operator manually resets the fault when it occurs. The machine is reset automatically.
H2-16	Restore the time setting of the automatic reset times	10 min	0 min to 6000min	Sets the time for restoring the Auto Reset Count. 1. When the value is set to 10 minutes, when the number of automatic fault reset times is exhausted (H2-17), the number of automatic fault reset times is reloaded to the number of fault reset times set in F9-09. 2. When set to 0, the number of "automatic fault reset" times is restored.
H2-17	The number of fault reset times has been generated	0	0 to 65535	1. Displays the number of fault reset times that have occurred. 2. When the manual reset and "Restore automatic reset times time" H2-16 are reached, the value of this parameter is automatically cleared.
H2-18	The fault reset times are exhausted	0	0: Number of automatic reset times resumed 1: Auto reset times are not restored	Set whether the fault reset times (H2-17) are restored when the fault reset times are exhausted. 0: When the number of automatic fault reset times is exhausted, the number of automatic fault reset times (H2-17) will be restored automatically after the time of automatic reset times (H2-16). When it is set to 1, the number of automatic fault resets will not be restored automatically after the set number of automatic fault resets is reached.

You can set the automatic fault reset blacklist to prevent automatic fault reset. The AC drive supports 10 fault codes that cannot be reset automatically.

Related parameters

Parameter	Name	Default	Value range	Descriptions
H2-20	Reset failure error code 1 main code	0	0 to 200	This parameter is equivalent to the black list of automatic fault reset. If a fault occurs in the black list, the automatic bit fault action will not be performed.
H2-21	Reset failure error code 1 subcode	0	0 to 9	
H2-22	Reset failure error code 2 main code	0	0 to 200	
H2-23	Reset failure error code 2 subcode	0	0 to 9	
H2-24	Reset failure error code 3 main code	0	0 to 200	
H2-25	Reset failure error code 3 subcode	0	0 to 9	
H2-26	Reset failure error code 4 main code	0	0 to 200	
H2-27	Reset failure error code 4 subcode	0	0 to 9	
H2-28	Reset failure error code 5 main code	0	0 to 200	Same as above
H2-29	Reset failure error code 5 subcode	0	0 to 9	
H2-30	Reset failure error code 6 main code	0	0 to 200	
H2-31	Reset failure error code 6 subcode	0	0 to 9	
H2-32	Reset failure error code 7 main code	0	0 to 200	
H2-33	Reset failure error code 7 subcode	0	0 to 9	
H2-34	Reset failure error code 8 main code	0	0 to 200	
H2-35	Reset failure error code 8 subcode	0	0 to 9	Same as above
H2-36	Reset failure error code 9 main code	0	0 to 200	
H2-37	Reset failure error code 9 subcode	0	0 to 9	
H2-38	Reset failure error code 10 main code	0	0 to 200	
H2-39	Reset failure error code 10 subcode	0	0 to 9	

29.6.14 Automatic Restart upon Fault

When the AC drive reports a fault during operation, the automatic reset upon a fault and automatic restart upon a fault functions enable the AC drive to restart after the AC drive resets upon the fault and after the waiting time for automatic restart upon a fault expires. During restart, if the AC drive receives a stop/manual reset command, it will stop and not restart.

Related parameter

Parameter Code	Parameter Name	Default	Value Range	Description
H2-42	Restart after automatic reset	0	0: Disable 1: Enable	0: The AC drive does not restart after a fault occurs and the fault is automatically reset. 1: The AC drive automatically restarts after a fault occurs and the fault is automatically reset. Note: This function is available only when the automatic fault reset function is enabled.
H2-43	Waiting time for restart after automatic reset upon fault	0.5s	0.0s to 600.0s	This parameter sets the waiting time from automatic fault reset to automatic restart.
H2-44	Forced flying start for automatic restart	0	0: Disable 1: Enable	This parameter sets whether to enable flying start for automatic restart upon fault. 0: The drive restarts according to the start mode set by F6-00 upon a fault. 1: The drive performs flying start upon a fault for restart no matter the settings of F6-00.

You can set a white list containing up to six faults, upon which the AC drive will reset and then restart. Or you can also set a black list containing up to six faults, upon which the AC drive is not allowed to reset or restart.

Related Parameters

Parameter Code	Parameter Name	Default	Value Range	Description
H2-45	Source of fault upon which drive is allowed for restart	1	0: White list 1: Black list	This parameter sets the source of fault upon which the drive is allowed for restart 0: White list. The drive is allowed for restart upon the faults set by H2-46 to H2-57. 1: Black list. The drive is allowed for restart upon faults not set by H2-46 to H2-57.
H2-46	Specified fault master code 1	0	0 to 200	Six groups of fault master codes and subcodes are provided to form fault codes. Determine whether automatic restart after a reset upon a fault is allowed based on the setting of H2-45.
H2-47	Specified fault subcode 1	0	0 to 9	
H2-48	Specified fault master code 2	0	0 to 200	
H2-49	Specified fault subcode 2	0	0 to 9	
H2-50	Specified fault master code 3	0	0 to 200	
H2-51	Specified fault subcode 3	0	0 to 9	
H2-52	Specified fault master code 4	0	0 to 200	
H2-53	Specified fault subcode 4	0	0 to 9	
H2-54	Specified fault master code 5	0	0 to 200	
H2-55	Specified fault subcode 5	0	0 to 9	
H2-56	Specified fault master code 6	0	0 to 200	
H2-57	Specified fault subcode 6	0	0 to 9	

29.6.15 Protective Action Against Fault

The AC drive provides six types of protective actions upon a fault, including coasting to stop, stopping according to the stop mode, continuing operation, operation with limited power, operation with limited current, and ignoring fault.

The actions of coasting to stop, stopping according to the stop mode, limited operation (continuing operation, operation with limited power, and operation with limited current), and ignoring fault are adopted according to the severity of the fault from high to low.

Continuing operation, operation with limited power, and operation with limited current are of the same level.

When continuing operation, operation with limited power, or operation with limited current is selected, the operating panel displays Lxxx.x, such as 

.

When "fault cancellation" is selected as the protective action against fault, no prompt will be displayed when a fault occurs. Select this option only when necessary.

Related Parameters

Parameter Code	Parameter Name	Default	Value Range	Description
F9-47	Fault protection action selection 1	0	Ones: Motor overload (E011.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Tens: Input phase loss (E012.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Hundreds: Output phase loss (E013.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Thousands: External fault (E015.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Ten thousands: Reserved	The protective actions are set through the ones, tens, hundreds, thousands, and ten thousands places of this parameter. 0: Coast to stop The drive coasts to stop. 1: Stop according to the stop mode The drive stops according the specified stop mode. 2: Continue to run The drive continues to run. 3: Operation with limited power The drive operates with limited power. 4: Operation with limited current The drive operates with limited current. 5: Ignore fault The fault type is ignored by the drive.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-48	Fault protection action selection 2	0	Ones: Encoder/PG card fault (E020.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Tens: Parameter reading/writing error (E021.x) 0: Coast to stop 1: Stop according to the stop mode Hundreds: PG card fault (E024.x) 0: Coast to stop Ten thousands: Inverter fault (E025.x) 0: Coast to stop Ten thousands: Running time reached (E026.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current	Same as F9–47

Parameter Code	Parameter Name	Default	Value Range	Description
F9-49	Fault protection action selection 3	20	Ones: User-defined fault 1 (E027.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Tens: User-defined fault 2 (E028.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Hundreds: Power-on time reached (E029.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current Thousands: Load lost (E030.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Ten thousands: PID feedback lost during running (E031.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current	Same as F9–47

Parameter Code	Parameter Name	Default	Value Range	Description
F9-50	Fault protection action selection 4	2000	Ones: Excessive speed deviation (E042.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Tens: Motor overspeed (E043.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Hundreds: Error in identifying magnetic pole position (E051.x) 0: Coast to stop Thousands: Low liquid level fault (E066.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current 5: Ignore fault Ten thousands: Internal fan fault (E65.x) 0: Coast to stop 1: Stop according to the stop mode 2: Continue operation 3: Operation with limited power 4: Operation with limited current	Same as F9–47

Parameter Code	Parameter Name	Default	Value Range	Description
F9-54	Frequency for continuing to run upon fault	1	0: Current running frequency 1: Frequency reference 2: Frequency upper limit 3: Frequency lower limit 4: Backup frequency upon fault (F9-55) 5: Current running frequency after filtering	This parameter is used to select the frequency at which the AC drive continues operation upon a fault. If this parameter is set to 1, the drive displays A** and continues to run at the frequency defined by F9-54.
F9-55	Backup frequency upon fault	100.0%	0.0% to 100.0%. 100.0% corresponds to the maximum frequency F0-10.	This parameter defines the backup frequency of the drive upon a fault. If a fault occurs during the operation of the drive and the fault protection action is set to "Operating at backup frequency" (F9-54 = 4), the drive displays A** and continues to operate at the backup frequency.
A4-80	Operation with the limited speed	1	0: Limit the maximum operation speed 1: Run at a specified safe speed	0: Limit the maximum operation speed When the drive operates at a limited speed (for example, in case of a fault), the maximum running speed is limited by A4-81 and A4-82. 1: Run at a specified safe speed The drive operates at the frequency set by F9-54.
A4-81	Forward speed limit in limited operation mode	100.0%	0.0% to 100.0%	When A4-80 is set to 0, the positive speed limit is limited by the setpoint of A4-81.
A4-82	Reverse speed limit in limited operation mode	100.0%	0.0% to 100.0%	When A4-80 is set to 0, the negative speed limit is limited by the setpoint of A4-81.
A4-83	Maximum motoring power in limited operation mode	50.0%	0.0% to 400.0%	Maximum motoring power in limited operation mode
A4-84	Maximum regenerative power in limited operation mode	50.0%	0.0% to 400.0%	This parameter sets the maximum regenerative power in the limited operation mode.
A4-87	Maximum allowable current in limited operation mode	90.0%	0.0% to 400.0%	This parameter sets the maximum allowable current in the limited operation mode.

29.6.16 Self-Check

Self-check is a function that automatically checks the abnormality of the AC drive. It is recommended that self-check be performed when the device is used for the first time to check whether internal wiring and external wiring are correct.

The self-check function includes four items: IGBT shoot through self-check, short circuit to ground self-check, output phase loss self-check, and encoder self-check.

Self-check can be started in two ways: manual self-check and pre-running self-check.

- Manual self-check
  The manual self-check consists of static self-check and full self-check, which can be selected through F6-29. The following table lists the sub-items for static self-check and full self-check. Each sub-item can be configured as "Enable" or "Disable" through different bits of F6-28.

F6-28 (Self-Check Configuration)	F6-29 = 1 (Static Self-Check)	F6-29 = 2 (Full Self-Check)
IGBT shoot through self-check (bit 1)	✓	✓
Short circuit to ground self-check (bit 2)	✓	✓
Output phase loss self-check (bit 3)	✓	✓
Encoder self-check (bit 4)	-	✓

  The motor does not rotate during static self-check. During the encoder self-check, the motor accelerates to 50% of the rated motor speed according to the acceleration/deceleration time set by F0-17 and F0-18. After the self-check completes, the motor decelerates back to zero speed.

  1. If the encoder self-check is selected during the full self-check, ensure that the motor can rotate freely. Check the following conditions before starting the self-check:
     - Ensure that the device is not on the construction site.
     - Check for obstacles that affect shaft rotation around the motor shaft.
     - Check whether the motor brake (if any) is closed. If yes, release the brake.
     - Check whether the motor fan works properly.
     - Check whether the device (if any) connected to the motor meets the running conditions, for example, whether the device needs lubrication.
  2. The encoder self-check will be performed in the vector control mode without encoder. Therefore, ensure that the parameter is auto-tuned before self-check.

- Pre-running self-check
  The pre-running self-check is performed every time before AC drive operation. In this mode, only IGBT shoot through self-check, short circuit to ground self-check, and output phase loss self-check are available. Encoder self-check is not supported.

  Each sub-item can be enabled or disabled through different parameters.

  - IGBT shoot through self-check is configured by bit 4 of AA-00.
  - Short circuit to ground self-check is configured by bit 2 of F9-07.
  - Output phase loss self-check is configured by bit 2 of F9-13.

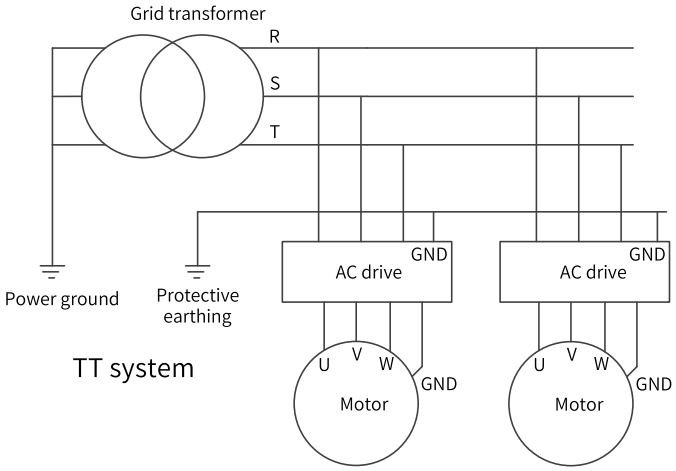
  Precautions for pre-running self-check:

  When flying start is configured for the motor, the pre-running self-check is disabled.

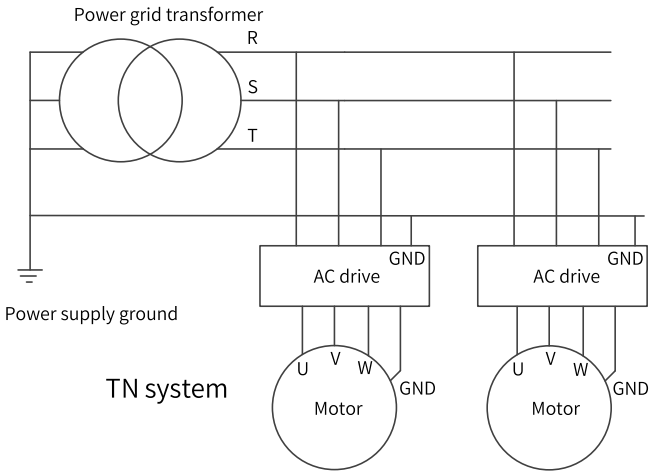
Precautions for self-check:

1. When using the self-check function, ensure that the rated motor current is greater than 0.2 times the rated AC drive current. If the motor power is much lower than the AC drive power, the self-check may fail. In this case, self-check is not recommended.
2. Do not start self-check when the motor is rotating. If self-check is started when the motor still has back EMF, a false fault may be reported.
3. When the grid is an IT system, short circuit to ground cannot be detected during self-check. To enable this function, install an insulation monitor to the IT system. The following figures show different types of grids:

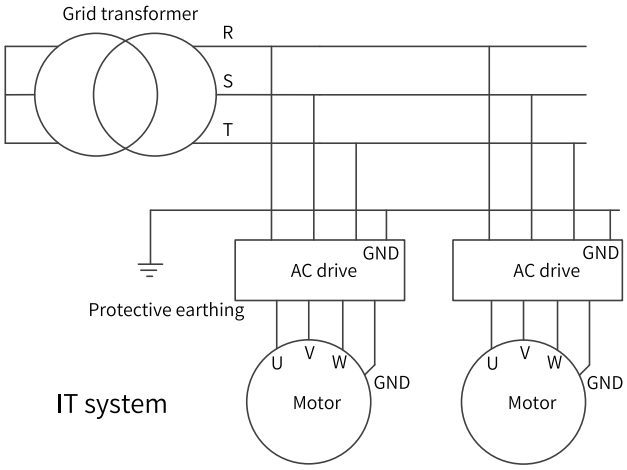
- **TT system**



- **TN system**



- **IT system**



Parameters related to self-check

Parameter Code	Parameter Name	Default	Value Range	Description
F6-28	Manual self-check	7	Bit 0: IGBT shoot through self-check 0: Disable 1: Enable Bit 1: Short circuit to ground self-check 0: Disable 1: Enable Bit 2: Phase loss self-check 0: Disable 1: Enable Bit 3: Reserved	This parameter defines the sub items of manual self-check. After enabling self-check by setting this parameter, you can select different self-check commands through F6-29. Self-check on each sub item is enabled separately by using a bit. The value 1 indicates "Enable", and 0 indicates "Disable". Bit 0: IGBT shoot through self-check 0: Disable 1: Enable Bit 1: Short circuit to ground self-check 0: Disable 1: Enable Bit 2: Phase loss self-check 0: Disable 1: Enable bit3: Reserved
F6-29	Manual self-check command	0	0: Disable 1: Static self-check 2: Full self-check 3: Static fault automatic diagnosis 4: Automatic diagnosis for with-load rotation fault 5: Automatic diagnosis for no-load rotation fault	This parameter is used to select different self-test modes. The self-check items are configured through F6-28. After the self-check is performed, the parameter restores to 0. 0: Disable 1: Static self-check is performed. In this mode, self-check on the encoder cannot be performed. 2: Full self-check is performed. 3: Static fault automatic diagnosis is performed. 4: Automatic diagnosis for with-load rotation fault is performed. 5: Automatic diagnosis for no-load rotation fault is performed.

Parameter Code	Parameter Name	Default	Value Range	Description
F9-07	Short circuit to ground protection	1	Ones: Protection against short circuit to ground upon power-on 0: Invalid 1: Valid Tens: Protection against short circuit to ground before running 0: Invalid 1: Valid	Ones: Perform short circuit to ground self-check upon power-on. Tens: Short circuit to ground self-check before running is performed. If flying start (F6-00 = 1) is enabled, short circuit to ground self-check before running is forcibly disabled.
F9-13	Output phase loss protection	1	Ones: Protection against output phase loss during running 0: Disable 1: Enable Tens: Protection against output phase loss before running 0: Enable 1: Enable	The default value 1 indicates the output phase loss protection is enabled. Related options are described as below. Ones: It is used to determine whether to perform output phase loss protection. If F9-13 is set to 0, the output phase loss will not be reported when it occurs. In this case, the actual current is larger than the current displayed on the operating panel. Use this function cautiously. 0: Disable Protection against output phase loss during running is disabled. 1: Enable Protection against output phase loss during running is enabled. Tens: Output phase loss detection during running takes about several seconds. In low-frequency operations or applications where risks exist in start with phase loss, this function can be used to detect phase loss fault upon start. However, in applications where short start time is required, do not use this function. 0: Disable Protection against output phase loss before running is disabled. 1: Enable Protection against output phase loss before running is enabled.

Parameter Code	Parameter Name	Default	Value Range	Description
AA-00	Parameter auto-tuning before startup	1	Bit 0: Magnetic pole position auto-tuning of the synchronous motor 0: Disable 1: Enable Bit 1: Quick auto-tuning of stator resistance 0: Disable 1: Enable Bit 2 to Bit 3: Magnetic pole position auto-tuning during high-frequency injection 0: Disable 1: Enable 2: Self-adaptive Bit 4: IGBT shoot through self-check 0: Disable 1: Enable Bit 5 to bit 6: reserved 0: Disable 1: Enable Bit 7: Pre-positioning before start of synchronous motor 0: Disable 1: Enable Bit 8: Auto-tuning of stator resistance upon power-on 0: Disable 1: Enable	This parameter is used to configure steps related to automatic inspection and auto-tuning before start of the motor.

29.7 Safety Functions

29.7.1 Safety Overview

29.7.1.1 List of Safety Functions

List of Safety Functions

- Safe torque off (STO)
  The STO function immediately shuts off the torque or force output of the motor based on an input signal from an external device. This function complies with stop category 0 of EN 60204-1. If the motor is running when the STO function is activated, it coasts to stop.

29.7.1.2 Terms and Abbreviations

Terms and Abbreviations	Description
Cat.	Safety category. It includes B, 1, 2, 3, and 4.
DCavg	Average diagnostic coverage (%)
DTI	Diagnostic test interval time
SFF	Safe failure fraction
PFHd	Probability of dangerous Failure per Hour
PL	Performance level
SC	Systematic capability
SIL	Safety integrity level
T_1	Proof test interval
DI	Digital input
DO	Digital output
MTTFd	Mean time to dangerous failure

29.7.1.3 Safety Standards and Specifications

Standards Compliance

- North American standards (UL)
  UL 61800-5-1

  CSA C22.2 No. 274
- EU Directives and Standards
  Low Voltage Directive 2014/35/EU, EN 61800-5-1

  EMC Directive 2014/30/ EU, EN 61800-3

  Machinery Directive 2006/42/EC (Function Safety), IEC 61800-5-2
- Safety standard

Option Model	Safety standards	Reference standards
MD520	Functional safety	IEC 61508: 2010 ISO 13849-1: 2015 ISO 13849-2: 2012 IEC 62061: 2021 IEC 61800-3: 2017 EN 61508: 2010 EN ISO 13849-1: 2015 EN ISO 13849-2: 2012 EN IEC 62061: 2021 EN IEC 61800-3: 2018
	EMC	IEC 61000-6-7: 2014 IEC 61326-3-1: 2017 IEC 61800-5-2: 2016 IEC 61800-3: 2017 EN 61000-6-7: 2015 EN 61326-3-1: 2017 EN 61800-5-2: 2017 EN IEC 61800-3: 2018
	LVD	IEC 61800-5-1:2007/AMD1: 2016 EN 61800-5-1:2007/A1: 2017

- Safety specifications

Items	Safety parameters
SIL	SIL3, IEC61508
PFHd	3.13E-09, 3.1% of SIL3, IEC 61508
Cat.	3, EN ISO 13849–1
PL	e, EN ISO 13849-1
MTTFd	326 years (high)
DCavg	⩾ 90% (medium)
T_1	20 years
HFT	1
SC	SC3
Application mode	High demand or continuous mode
Response time (under nominal voltage)	⩽ 20 ms

29.7.1.4 Precautions for Use

Safety Instructions

The chapter contains the warning symbols used in this guide and the safety precautions that you must obey when you install or service the safe option module of the drive. Failure to comply with the safety instructions may lead to injury, death or damage. Please read this chapter before installation.

Illustrations, pictures, or figures used in this manual are intended as examples only and may not cover all products to which this manual applies.

The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.

Table 29–35 Description for warning symbols

Key	Indication	Description	Consequences in case of disregard
Example:  General hazards  Special hazards Electric shock	DANGER	Major risk	Ignoring the warning can result in severe physical injury or even death.
	WARNINGS	General risk	Ignoring the warning may result in severe physical injury or even death.
	CAUTION	Minor risk	Ignoring the warning may result in minor physical injury.
	STOP!	Damage to equipment or environment	Ignoring the warning may result in damage to equipment or environment.

Note

- Users must incorporate safety measures in system design and electrical installation for both normal operation and troubleshooting.
- The design, installation, commissioning, and maintenance of the system must be implemented by trained and experienced professionals. They should read the operation guide and related safety information.

It is the responsibility of the machine builder/OEM/system integrator to make sure that the essential health and safety function requirements specified in the Machinery Directive are met. Risk analysis and risk assessment is needed before using a product. Make sure that adequate measures are taken to eliminate/reduce the relating risks and components chosen must meet the safety requirements.

This section describes the information that is required before starting operation.

- Read the following safety precautions, risk assessment information, and limitations before starting operation.
- Use of the safety function: Use the safety function after properly understanding all of these information.

Note

If the safety function is used incorrectly or the safety function does not meet safety requirements at the site, physical injuries may arise.

Safety Precautions

Carefully read and observe the following important precautions when using safety functions:

- STO function is not intended as a replacement for the emergency stop function (E-stop). If no other measures are taken and the power supply cannot be cut off in case of emergency, the high voltage parts of motors and AC drives are still charged, which may brings the risk of electric shock or other

risks caused by electricity. Therefore, the maintenance of electrical parts of the AC drives or motors can only be implemented after the AC drive system is isolated from the main power supply.

- Depending on the standards and requirements for a particular application, it may be possible to use STO as an integral part of an E-stop system. However, its main purpose is for use in a dedicated safety control arrangement whose purpose is to prevent any hazard from occurring, without the use of an E-stop.
- An E-stop is often provided in a machine to allow for unexpected situations where an operator sees a hazard and can take action to prevent an accident.
- The design requirement for an E-stop differs from that of a safety interlock. Generally, the E-stop is required to be independent from any complex or "intelligent" control. It may use purely electromechanical devices to either disconnect the power or initiate a controlled rapid stop using other means such as dynamic or regenerative braking.

Caution

- The design of safety-related systems requires specialist knowledge. To ensure that a complete control system is safe, it is necessary for the whole system to be designed according to recognized safety principles. The use of individual sub-systems such as drives with STO function, which are intended for safety-related applications, does not in itself ensure that the complete system is safe.
- The STO function can be used to stop the AC drive in emergency stop situations.
- In processes without personnel protection, it is recommended not to stop the AC drive by using the STO function. If the STO function is used to stop a running AC drive, the AC drive will gradually stop. If this is not acceptable, the system should be stopped using the correct mode instead of the STO function.
- This publication is a guide to the application of Inovance STO function, and also on the design of safety-related systems for machinery control.
- It is the responsibility of designer of the end product or application to ensure that it is safe and in compliance with the relevant regulations.

Risk Assessment

- Before using the safety function, perform risk assessment on AC drive system in advance Make sure that the safety integrity level of the standards is met.
- The following residual risks can be present even when the safety functions operate. Therefore, safety must always be given consideration during risk assessment.
- If external forces (such as gravitational force with a vertical axis) are applied when the safety functions are operating, the motor will rotate due to the action of these external forces. Therefore, you must use a separate mechanical brake to secure the motor.

Note

- When multiple IGBT power transistors are faulty, the AC drive generates an alignment torque no matter whether STO function is triggered, which may maximally rotate the motor shaft by 180/p degrees.
- p: Number of motor pole pairs.

To ensure safety, users should decide all the risk assessments and residual risks in the entire machine equipment. A company and individual who constructed the safety related system must take full responsibility for installation and commissioning of the system. Additionally, when complying with a European machinery directive, the related sub system must acquire safety standards certification, and the whole equipment or system is subject to all risk assessments and safety class certification.

The following shows residual risks concerning the safety function of this product.

Common residual risks

- At the shipment to end-users, check the settings of safety related components with programming tools and monitored/displayed contents on display and record and save the setting data concerning the safety observation function and the programming tools you used. Perform them using a check sheet, etc.
- The safety will not be ensured such as in assembling machine until installing, wiring, and adjustment are completed properly. Install, wire, and adjust your system referring to installation guide for each unit.
- Only qualified personnel are authorized to install, start-up, repair or adjust the machines in which these components are installed. Only trained engineers should install and operate the equipment.
- Separate the wiring for safety observation function from other signal wiring.
- Protect the cables with appropriate ways (routing them in a cabinet, using a cable guard, etc.).
- We recommend using a switch, relay, sensor, etc. which comply with safety standards. When using a switch, relay, sensor, etc. which do not comply with safety standards, perform a safety confirmation.
- Keep the required clearance/creepage distance depending on voltage you use.
- The time to a safety observation error depends on parameter settings.
- **Safe torque off (STO)**
  This function only cuts off the torque of the motor, and does not cut off the power supply of the AC drive. Cut off the power supply of the AC drive to make sure the AC drive is powered off before maintenance.

Note

Trigger the STO function for the AC drive at least once every three months.

29.7.2 Safe Torque Off (STO)

29.7.2.1 Function Overview

Safety torque off (Safe Torque Off) is a safety function that complies with IEC 61800- 5- 2:2016. The AC drive is optionally integrated with the STO function. When the STO function is triggered, the drive turns off the RDY signal and enters the safety state, in which the drive control signal of the power semiconductor is blocked and the motor input current is cut off, preventing the drive from generating torque on the motor shaft end and stopping the motor.

The STO function blocks the output of PWM signals to the power layer of the AC drive through external redundant hardware terminals STO1 and STO2, thus preventing the movement of the motor. These two +24 VDC signals must be at high level to enable normal operation of the drive. If either one or both signals are set to "low" level, the PWM signals will be blocked.

29.7.2.2 Parameters

Parameters related to the safety function module are shown as follows.

Item	Parameter	Range	Default	Description
F9-79	STO status reset	0: Manual reset 1: Automatic reset	1	Used to enable STO fault reset mode. If this function is enabled, STO is reset automatically when STO1 and STO2 are recovered.
U0-96	STO status word monitoring	0 to 65535	0	It displays the monitored STO status word. Bit 0: STO1 disconnection flag. 1: STO1 disconnected; 0: STO1 connected Bit 1: STO2 disconnection flag. 1: STO2 disconnected; 0: STO2 connected Bit 2: DO output flag (active when the DO is assigned with function 42). 1: DO output; 0: DO not output Bit 3: STO status flag. (If the STO function is activated, the panel displays STO status.) 1: STO activated; 0: STO deactivated

29.7.2.3 Function Triggering

To use the input signal function of the safety module, connect cables correctly. If either the STO1 or STO2 signal is disconnected, the system enters the safety state.

Table 29–36 STO function

STO2 input	STO1 input	PWM state	System State	Reset
H	H	Normal	Normal	/
H	L	Blocked	E047.2; inconsistent inputs	Manual reset
L	H	Blocked	E047.2; inconsistent inputs	Manual reset
L	L	Blocked	STO activated	Reset automatically or manually as defined by F9-79.

Note

- H (1): The corresponding input is connected to the 24 V voltage.
- L (0): The corresponding input is disconnected from the 24 V voltage.

29.7.2.4 Sequence Diagrams

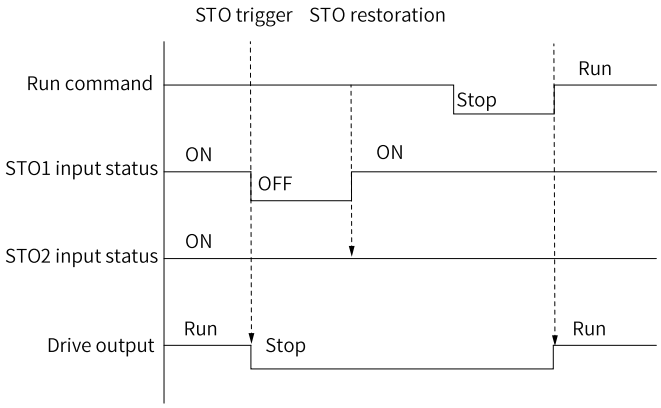


Figure 29-79 Safety function (turned off when triggered by STO1)

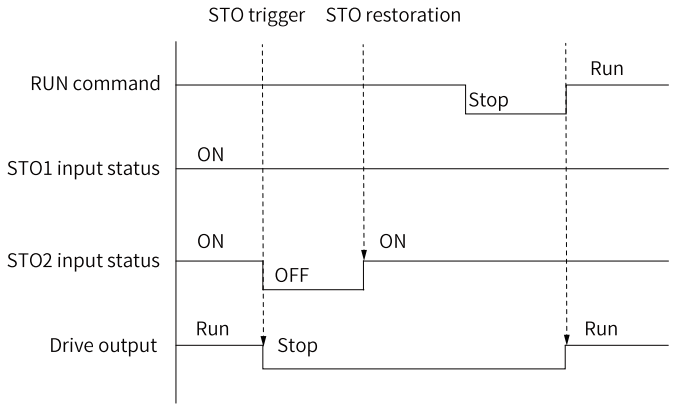


Figure 29-80 Safety function (turned off when triggered by STO2)

29.8 Monitoring

The monitoring function enables you to view the drive state on the operating panel. You can view monitoring parameters in the following two ways.

1. In the stop or operation state, you can view multiple status parameters by switching every bit of F7-03, F7-04, and F7-05 through the keys on the operating panel.
   In the operation state, 32 operating status parameters are available. F7-03 (Parameter 1 displayed during operation) and F7-04 (Parameter 2 during operation) determine whether to display the parameter corresponding to each binary bit. In the stop state, 16 stop status parameters are available. Each binary bit of F7-05 (Parameter displayed at stop) determines whether the corresponding parameter is displayed.

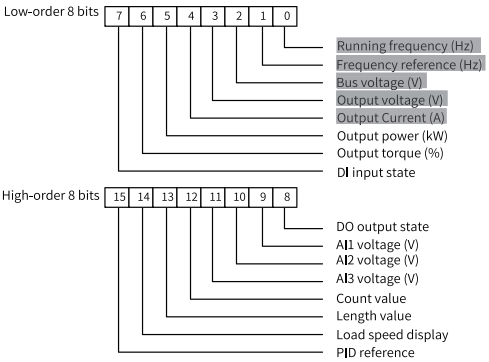
   For example, to view the parameters in the operation status on the operating panel, such as the running frequency, bus voltage, output voltage, output current, output power, and PID reference, perform the following operations.

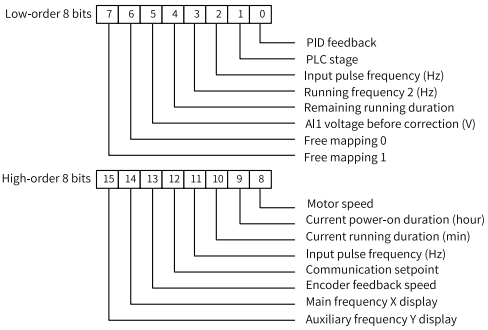
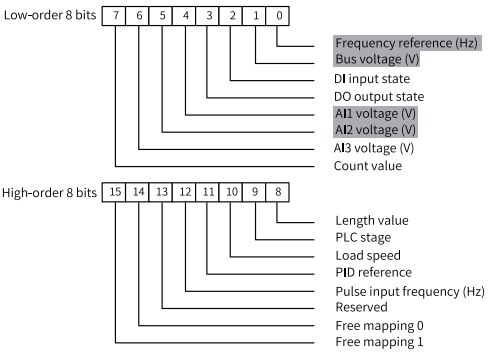
   Each bit of F7-03 (Parameter 1 displayed on led operating panel during operation) corresponds to one parameter. Set the corresponding bit to 1. Convert the binary value to a hexadecimal value and set F7-03 to this hexadecimal value. For specific conversion methods, see *“Table 29–38 Converting a*

binary number into the hexadecimal equivalent" on page 826. You can view related parameter values by switching every bit of F7-03 through the keys on the operating panel.

Other monitoring parameters are viewed in the same way as F7-03. The corresponding relationship between the monitoring parameters and every bit of F7-03, F7-04, and F7-05 is as follows.

Table 29–37 Corresponding relationship between the monitoring parameters and every bit of F7-03, F7-04, and F7-05

Parameter Code	Parameter Name	Default	Value Range	Description
F7-03	Parameter 1 displayed on LED operating panel during operation	0x1F	0000–0xFFFF	If a parameter needs to be displayed during running, set its corresponding bit to 1. After converting the binary number to a hexadecimal number, set F7-03 to the hexadecimal number. Note: The shaded parameters are displayed by default. 

Parameter Code	Parameter Name	Default	Value Range	Description
F7-04	Parameter 2 displayed on LED operating panel during operation	0	0000–0xFFFF	This parameter defines the parameters displayed on the LED operating panel when the AC drive is running. You can view the parameters corresponding to each bit by pressing the left and right shift keys. The value 1 of a bit indicates that the parameter is displayed, and the value 0 of the bit indicates that the parameter is hidden. Each parameter is displayed in the hexadecimal format. 
F7-05	Parameter displayed on the LED operating panel upon stop	0x33	0000–0xFFFF	This parameter defines the parameters displayed on the LED operating panel when the AC drive is in stop state. You can view the parameters corresponding to each bit by pressing the left and right shift keys. The value 1 of a bit indicates that the parameter is displayed, and the value 0 of the bit indicates that the parameter is hidden. Each parameter is displayed in the hexadecimal format.  Note: The shaded parameters are displayed by default.

Note

When the AC drive is powered off and on again, the parameters that are selected before power-off are displayed.

The monitoring parameters corresponding to each bit of F7-03, F7-04, and F7-05 do not completely correspond to all the monitoring parameters in group U0. If the parameter to be monitored cannot be found by F7-03, F7-04, and F7-05, search it in group U0 through the key by using method 2.

To convert a binary number into a hexadecimal equivalent, do as follows:

From right to left, every four binary digits correspond to one hexadecimal digit. If there are less than four binary digits left, fill in with 0 to make the number of left binary digits to be four. Then, convert every four binary digits into a decimal number. 0000 to 1111 in the binary format correspond to 0 to 15 in the decimal format and 0 to F in the hexadecimal format. Convert the decimal number into a hexadecimal equivalent according to the corresponding relationship between decimal and hexadecimal numbers. See the following table for details.

For example, the binary number is 011 1101 1111 1001. After adding 0 to the highest place, the binary number changes to 0011 1101 1111 1001. According to the preceding table, the hexadecimal equivalent is 3DF9.

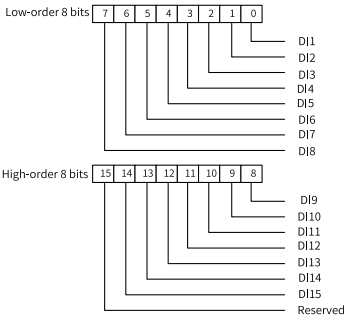
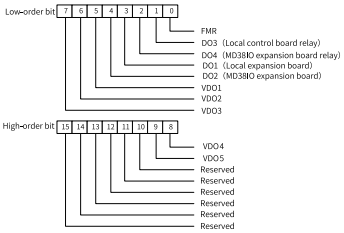
Table 29–38 Converting a binary number into the hexadecimal equivalent

Binary	1111	1110	1101	1100	1011	1010	1001	1000	0111	0110	0101	0100	0011	0010	0001	0000
Decimal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Hexadecimal	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0

2. Use the operating panel to enter group U0 and view the monitoring parameters. *“Table 29–39 Monitoring parameters in group U0” on page 826*The monitoring parameters are only readable.

Table 29–39 Monitoring parameters in group U0

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-00	Operating frequency	0.01 Hz	0.00 Hz to 655.35 Hz	It displays the absolute value of the AC drive operating frequency. See *“Figure 29–81” on page 834* .
U0-01	Frequency reference	0.01 Hz	0.00 Hz to 655.35 Hz	It displays the absolute value of the AC drive frequency reference. See *“Figure 29–81” on page 834* .
U0-02	Bus voltage	0.1 V	0.00 V to 6553.5 V	It displays the AC drive bus voltage.
U0-03	Output voltage	1 V	0 V to 65535 V	It displays the output current of the AC drive in the running state.
U0-04	Output current	0.01 A	0.00 A to 655.35 A	It displays the output current of the AC drive in the running state.
U0-05	Output power	0.1 kW	-3276.8 kW to 3276.7 kW	It displays the output power of the AC drive in the running state.
U0-06	Output torque	0.10%	-3276.8% to 3276.7%	It displays the output torque of the AC drive in the running state. This percentage takes the rated motor torque as the basis.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-07	DI input state	1	0x0000 to 0xFFFF	It displays the state value of the DI. After it is converted to binary data, each bit corresponds to one DI signal. The value 1 indicates high level input, and the value 0 indicates low level input. The corresponding relationship between bits and DIs is as follows. 
U0-08	DO output state	1	0x0000 to 0xFFFF	It displays the state value of the DO. After the value is converted to a binary number, every bit of the binary number corresponds to one DO signal. The value 1 indicates high level output, and the value 0 indicates low level output. The relationship between bits and DOs is as follows. 
U0-09	AI1 voltage	0.01 V	-10.57 V to 10.57 V	It displays AI1 voltage.
U0-10	AI2 voltage	0.01 V	-10.57 V to 10.57 V	It displays AI2 voltage. Note: When AI2 inputs current signals, AI2 supports the current range from 0 mA to 20 mA When the impedance is selected to be 500 Ω, the corresponding voltage range of U0-10 is 0 V to 10 V. When the impedance is selected to be 250 Ω, the corresponding voltage range of U0-10 is 0 V to 5 V.
U0-11	AI3 voltage	0.01 V	-10.57 V to 10.57 V	It displays AI3 voltage.
U0-12	Count value	1	0 to 65535	It displays the value in the counting function.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-13	Length	1	0 to 65535	It displays the value in the fixed length function.
U0-14	Load speed display	1 rpm	0 rpm to 65535 rpm	It displays the load target speed, which is affected by F7-06 (U0-14 = U0-14 x F7-06).
U0-15	PID reference	1	0 to 65535	PID reference = PID reference (percentage) x FA-04 (PID reference feedback range)
U0-16	PID feedback	1	0 to 65535	PID feedback = PID feedback (percentage) x FA-04 (PID reference feedback range)
U0-17	PLC stage	1	0 to 15	It displays current simple PLC stage, which supports 16 speeds. Note: The PLC supports a total of 16 speeds from speed 0 to speed 15.
U0-18	Pulse input frequency	0.01 kHz	0.00 kHz to 655.35 kHz	It displays the high-speed pulse sampling frequency of DI5.
U0-19	Feedback speed	0.01 Hz	-327.68 Hz to 327.67 Hz	It displays the feedback speed (Hz). See *"Figure 29–81" on page 834* .
U0-20	Remaining running time	0.1 min	0.0 min to 6553.5 min	It displays the remaining running time when the timing function is enabled.
U0-21	AI1 voltage before calibration	0.001 V	-32.768 V to 32.767 V	It displays the actual value of analog input sampling voltage/ current. The voltage/current used has been corrected linearly to reduce the deviation between the sampling voltage/current and the actual input voltage/current. You can check U0-09 for the corrected voltage/current.
U0-22	AI2 voltage before calibration	0.001 V	-32.768 V to 32.767 V	It displays the actual value of analog input sampling voltage/ current. The voltage/current used has been corrected linearly to reduce the deviation between the sampling voltage/current and the actual input voltage/current. You can check U0-10 for the corrected voltage/current.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-23	AI3 voltage before calibration	0.001 V	-32.768 V to 32.767 V	It displays the actual value of analog input sampling voltage/ current. The voltage/current used has been corrected linearly to reduce the deviation between the sampling voltage/current and the actual input voltage/current. You can check U0-11 for the corrected voltage/current.
U0-24	Motor speed	1 rpm	0 rpm to 65535 rpm	It displays the motor feedback speed (rpm).
U0-25	Current power-on time	1 min	0 min to 65535 min	-
U0-26	Current operating time	0.1 min	0.0 min to 6553.5 min	-
U0-27	Pulse input frequency	1 Hz	0 Hz to 65535 Hz	It displays DI5 high-speed pulse sampling frequency. It is the same as U0-18 but in different units.
U0-28	Communication setpoint	0.01%	-100.00% to 100.00%	It displays data written by means of the communication address 0x1000. The setpoint of address 0x1000 determines the base of this percentage.
U0-29	Encoder feedback speed	0.01 Hz	-599.00 Hz to 599.00 Hz	It displays the motor running frequency (Hz) measured by the encoder. For details, see *"Figure 29–81" on page 834* .
U0-30	Display of main frequency X	0.01 Hz	-599.00 Hz to 599.00 Hz	It displays the main frequency X (Hz).
U0-31	Display of auxiliary frequency Y	0.01 Hz	-599.00 Hz to 599.00 Hz	It displays the auxiliary frequency Y (Hz).
U0-32	Memory address view	1	0 to 65535	-
U0-33	Synchronous motor rotor position	0.1°	0.0° to 360.0°	-
U0-34	AI3 temperature mode - motor temperature value	1°C	-50°C to 300°C	It indicates the motor temperature sampled through AI3. For motor temperature detection, see F9-57 (Type of motor temperature sensor).
U0-35	Target torque	0.1%	-600.0% to 600.0%	This parameter indicates the current torque upper limit reference, which is a percentage of the rated motor torque.
U0-36	Resolver position	1	0 to 360	-
U0-37	Power factor angle	0.1°	-3276.8° to 3276.7°	This parameter indicates the current power factor angle.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-38	ABZ position	1	0 to 360	This parameter displays the number of phase-A and phase-B pulses of the ABZ encoder. This value is four times the number of pulses that the encoder runs. For example, if 4000 is displayed, the actual number of pulses that the encoder runs is 4000/4 = 1000. The value increases when the encoder rotates in the forward direction and decreases when the encoder rotates in the reverse direction. After increasing to 65535, the value will be set to 0 and increase from 0 again. After decreasing to 0, the value be set to 65535 and decrease from 65535 again. You can check whether installation of the encoder is normal by viewing U0-38.
U0-39	Target voltage upon V/f separation	1 V	0 V to F1-02	This parameter displays the target output voltage in V/f separation status.
U0-40	Output voltage upon V/f separation	1 V	0 V to F1-02	This parameter displays the actual output voltage in the V/f separation state.
U0-45	Fault subcode	1	0 to 9	It displays the fault subcode.
U0-46	Minor fault code	0.1	0 to 6553.5	–
U0–47	Encoder position feedback (high-order 16 bits)	1	0 to 65535	It displays the high-order 16 bits of the encoder position feedback.
U0–48	Encoder position feedback (low-order 16 bits)	1	0 to 65535	It displays the low-order 16 bits of the encoder position feedback. Note: It displays the low-order 16 bits of the ABZ pulse. The parameter value is four times the number of actual encoder pulses. For example, if 4000 is displayed, the number of actual encoder pulses is 1000 (4000/4). The value increases when the encoder rotates in the forward direction and decreases when the encoder rotates in the reverse direction. After increasing to 65535, the value will be set to 0 and increase from 0 again. After decreasing to 0, the value be set to 65535 and decrease from 65535 again. You can check whether installation of the encoder is normal by viewing U0-48.

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-58	Number of motor revolutions	1	0 to 65535	It displays the number of phase Z pulses of the ABZ or UVW encoder. The parameter value increases or decreases by 1 every time the encoder rotates one revolution forward or reversely. You can check whether the encoder is installed properly through U0-58.
U0-59	Frequency reference	0.01%	-100.00% to 100.00%	It displays the current frequency reference. The parameter value takes the maximum frequency of the drive (F0-10) as the base.
U0-60	Operating frequency	0.01%	-100.00% to 100.00%	It displays the current operating frequency. The parameter value takes the maximum frequency of the drive (F0-10) as the base.
U0-61	AC drive state	1	Bit 1, bit 0	0: Stop; 1: Forward running; 2: Reverse running
			Bit 3, bit 2	0: Constant speed; 1: Acceleration; 2: Deceleration
			Bit 4	0: Bus voltage normal; 1: Undervoltage
U0-62	Current fault code	1	0 to 65535	It displays the current fault master code. For example, if the fault E015.1 (external terminal NO fault) is reported, this parameter displays 15.
U0-63	Torque sent in point-to-point communication	0.01%	-327.68% to 327.67%	-
U0-64	Number of slaves in master-slave control	1	0 to 65535	-
U0-65	Torque upper limit	0.1%	-600.0% to 600.0%	It displays the torque upper limit. The parameter value takes the rated motor torque as the base.
U0-66	Model of communication expansion card	1	0 to 65535	It displays the model of the communication expansion card. 100: CANopen 200: PROFIBUS DP 300: CANlink 400: PROFINET 500: EtherCAT 600: EtherNet/IP
U0-67	Software version of communication expansion card.	1	0 to 65535	-

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-68	AC drive state read through DP card	1	0 to 65535	bit 0: 0: Stop 1: Run Bit 1: 0: Forward run 1: Reverse run Bit 2: Whether the AC drive has a fault 0: Normal 1: Faulty Bit 3: Whether the frequency reaches the pre-set value 0: No 1: Yes Bit 4: Whether communication is normal 0: Abnormal 1: Normal Bit 5 to bit 7: Reserved Bits 8-15: Fault master code. For details, see specific fault descriptions.
U0-69	Frequency read through communication expansion card	0.01 Hz	-327.68 Hz to 327.67 Hz	-
U0-70	Speed read through communication expansion card	1 rpm	-32768 rpm to +32767 rpm	-
U0-71	Current read through communication expansion card	0.1 A	0.0 A to 6553.5 A	It displays the current read through the communication expansion card.
U0-73	Motor SN	1	0 to 65535	-
U0-76	Low-order bits of cumulative power consumption	0.1 kWh	0 kWh to 6553.5 kWh	It displays high-order/low-order bits of cumulative power consumption. Calculation formula: Total power consumption = U0-77 x 10000 + U0-76.
U0-77	High-order bits of cumulative power consumption	1 kWh	0 kWh to 65535 kWh	
U0-80	EtherCAT slave name	1	0 to 65535	-
U0-81	EtherCAT slave alias	1	0 to 65535	-
U0-83	EtherCAT XML file version	1	0 to 65535	-
U0-84	Number of lost EtherCAT synchronization frames	1	0 to 65535	-

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-85	Maximum number of error frames and invalid frames over EtherCAT port 0 per unit time	1	0 to 65535	-
U0-86	Maximum number of error frames and invalid frames of EtherCAT port 1 per unit time	1	0 to 65535	-
U0-87	Maximum number of error frames forwarded by EtherCAT port per unit time	1	0 to 65535	-
U0-88	Maximum number of error frames processed by EtherCAT data frame processing unit per unit time	1	0 to 65535	-
U0-89	Maximum number of lost links over the EtherCAT port per unit time	1	0 to 65535	-
U0-90	AI2 temperature mode - motor temperature value	1°C	-50°C to 300°C	It indicates the motor temperature sampled through AI2. For motor temperature detection, see F9-75 (Type of motor temperature sensor).
U0-91	AC drive running frequency (unsigned)	0.01 Hz	0.00 Hz to 655.35 Hz	It displays the AC drive running frequency (unsigned).
U0-92	AI2 temperature mode - motor temperature value	0.1°C	-50.0°C to 300.0°C	It indicates the motor temperature sampled through AI2. For motor temperature detection, see F9-75 (Type of motor temperature sensor).
U0-95	STO initialization flag	1	0 to 65535	-
U0-96	STO status word monitoring	1	0 to 65535	It displays the monitored STO status word. Bit 0: STO1 disconnection flag 1: STO1 disconnected; 0: STO1 connected Bit 1: STO2 disconnection flag 1: STO2 disconnected; 0: STO2 connected Bit 2: DO output selection (valid when function 42 is allocated to DO) 1: DO output; 0: DO not output Bit 3: STO status (if active, the operating panel displays STO status). 1: STO activated; 0: STO deactivated
U0-97	STO model	1	0 to 65535	-

Parameter Code	Parameter Name	Minimum Unit	Value Range	Description
U0-98	STO AD sampling value (1.2 V)	1	0 to 65535	-
U0-99	STO AD sampling value (5 V)	1	0 to 65535	-

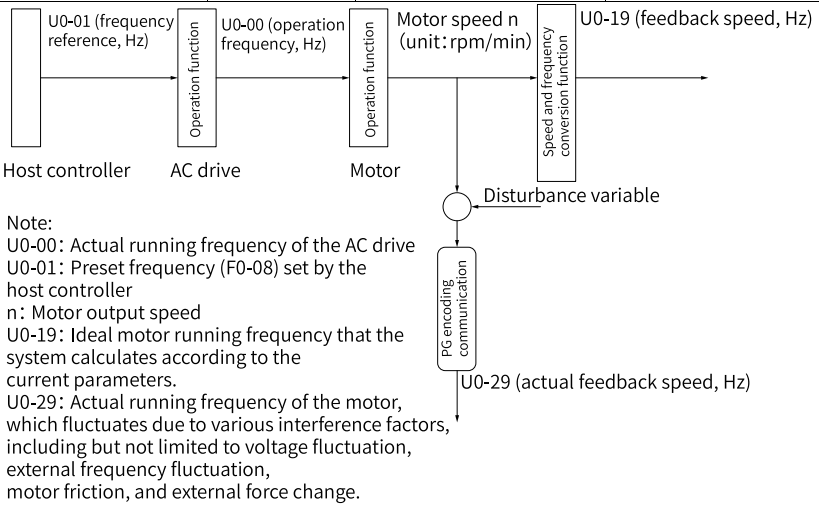


Figure 29-81 Relationship among U0-00, U0-01, U0-19, and U0-29

30 Process Functions

30.1 Wobble Function

With the wobble function, the output frequency of the AC drive wobbles up and down around the frequency reference (F0-07). This function is applicable to industries such as textile and chemical fiber, and reciprocating motion, and winding/unwinding applications.

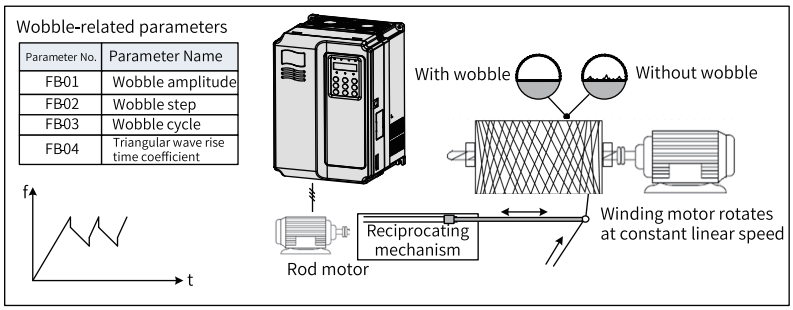


Figure 30-1 Application scenario of the wobble function

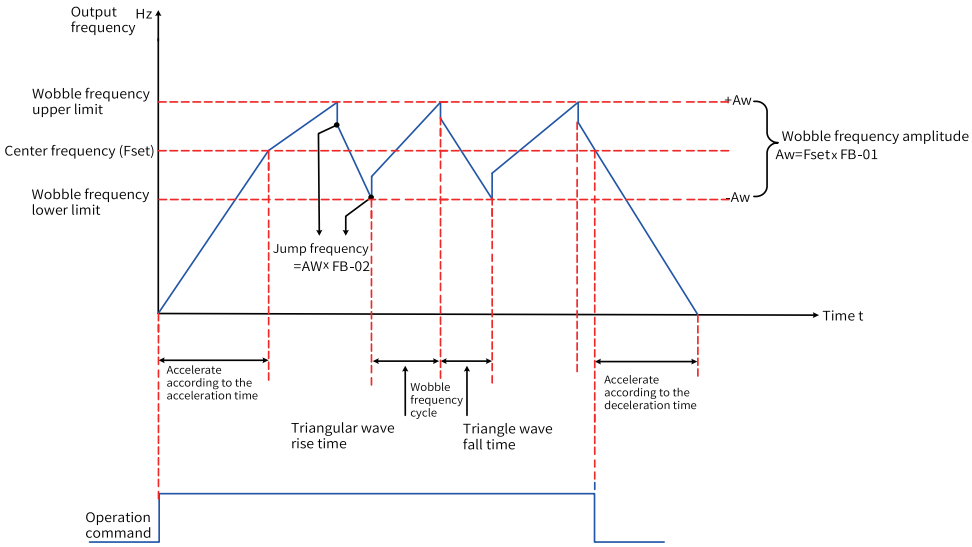


Figure 30-2 Working principle of the wobble function

Parameter Code	Parameter Name	Default	Value Range	Description
FB-00	Wobble setting mode	0	0: Relative to the center frequency 1: Relative to the maximum frequency	0: Relative to the center frequency (F0-07, frequency source superposition selection). This mode is a variable wobble system, in which the wobble changes with the center frequency. 1: Relative to the maximum frequency (F0-10). This mode is a fixed wobble system, in which the wobble amplitude is fixed. Note: For detailed instructions on using this function, refer to section Wobble Control Function in the MD520 Series General-Purpose AC Drive Function Guide.
FB-01	Wobble amplitude	0.0%	0.0% to 100.0%	When FB-01 is set to 0, the wobble function is disabled.

Parameter Code	Parameter Name	Default	Value Range	Description
FB-02	Jump frequency amplitude	0.0%	0.0% to 50.0%	This parameter defines the wobble amplitude and jump frequency amplitude. The wobble frequency is limited by the frequency upper limit and frequency lower limit.
FB-03	Wobble cycle	10.0s	0.1s to 3000.0s	This parameter defines the time of a complete wobble cycle.
FB-04	Wobble triangular wave rise time coefficient	50.0%	0.1% to 100.0%	This parameter indicates the percentage of triangular wave rising time to FB-03 (wobble cycle).

1. **Wobble calculation**
   When FB-00 is set to 0 (relative to the center frequency), wobble frequency (AW) = F0-07 (frequency source superposition selection) x FB-01 (wobble amplitude).

   When FB-00 is set to 1 (relative to the maximum frequency), wobble frequency (AW) = F0-10 (maximum frequency) x FB-01 (wobble amplitude).

2. **Jump frequency calculation**
   During wobble, jump frequency = wobble frequency (AW) x FB-02 (jump frequency amplitude).

   When FB-00 is set to 0 (relative to the center frequency), the jump frequency is a variable.

   When FB-00 is set to 1 (relative to the maximum frequency), the jump frequency is a fixed value.

3. **Calculation of the triangular wave rise/fall time**
   Triangular wave rise time (unit: s) = FB-03 (wobble cycle) x FB-04 (triangular wave rise time coefficient)

   Triangular wave fall time (unit: s) = FB-03 (wobble cycle) x (1 – FB-04 (triangular wave rise time coefficient))

   (Wobble cycle = Triangular wave rise time + Triangular wave fall time)

30.2 Fixed Length Control Function

The AC drive supports fixed length control in which the length pulses can be collected only by DI5. To use this function, allocate function 27 (length count input) to DI5.

Parameter Code	Parameter Name	Default	Value Range	Description
FB-05	Length reference	1000 m	0 m to 65535 m	This parameter specifies the length value to be controlled in fixed length control mode.
FB-06	Actual length	0 m	0 m to 65535 m	The actual length is a monitored value. Actual length (FB-06) = Number of pulses sampled by terminal/Number of pulses per meter (FB-07).
FB-07	Number of pulses per meter	100.0	0.1 to 6553.5	This parameter indicates the number of pulses outputted per meter. The length pulse is collected by DI5, which must be assigned with the length count input function (F4-04 = 27).

In the following figure, the actual length is the monitored value. Actual length (FB-06) = Number of pulses sampled by terminal/Number of pulses per meter (FB-07) When the actual length (FB-06)

exceeds or equals the length reference (FB-05), the relay or DO allocated with function 10 (Length reached) outputs an active signal. During fixed length control, length reset can be implemented by a multi-function DI with function 28 assigned. For details, see the following figure.

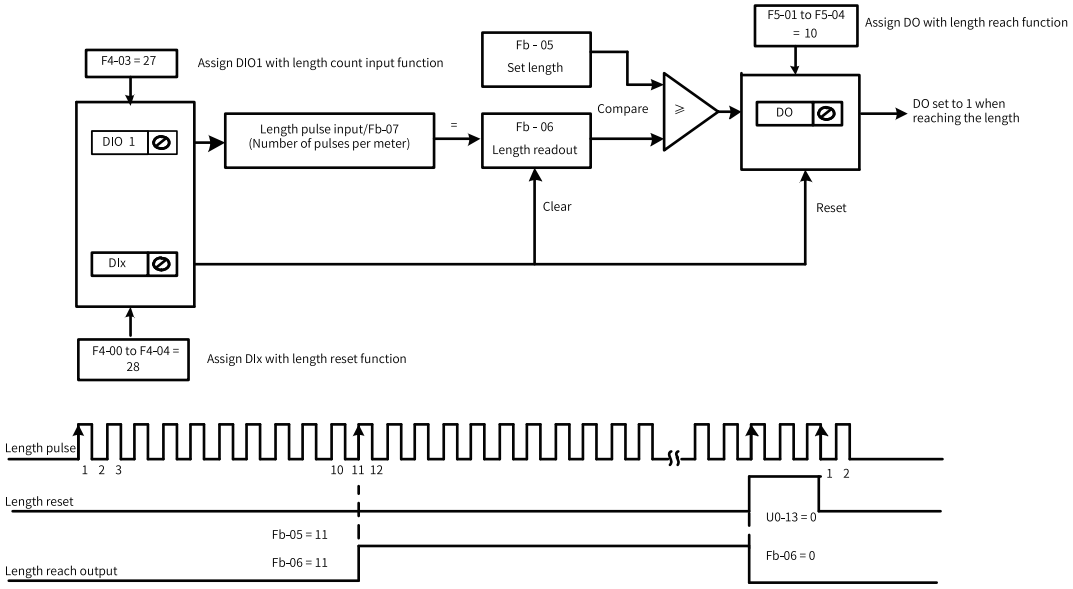


Figure 30-3 Fixed length control

Parameter Code	Parameter Name	Value Range	Description
F4-04	DI5 function selection	27	Length counting input
F4-00 to F4-09 (any one)	DI1 to DI10 function selection (any one)	28	Length reset
F5-01 to F5-05 (any one)	Terminal output function selection (any one)	10	Length reached

Under the fixed length control mode, the length can be calculated only through the number of pulses because the direction cannot be identified. When the T/A-T/B signal output by the relay with the length reach function allocated is fed to the stop input terminal of the AC drive, the AC drive stops automatically.

30.3 Counting Function

The DI allocated with function 25 (counter input) is used to collect the count value (when the pulse frequency is high, the DI5 must be used).

Parameter Code	Parameter Name	Default	Value Range	Description
FB-08	Count value reference	1000	0 to 65535	When the count value reaches FB-08, the DO outputs an active signal indicating that the count value reference has reached. Note 1: For detailed instructions on using this function, refer to the section "Counting Function" in the MD520 Series General-Purpose AC Drive Function Guide.
FB-09	Designated count value	1000	0 to 65535	When the counting value reaches FB-09, the DO outputs an active signal indicating that the designated counting value has reached. The value of FB-09 must be lower than or equal to the value of FB-08.

When the count value reaches the value of FB-08, the DO outputs an active signal indicating that the count value reference has reached. When the count value reaches FB-09, the DO outputs an active signal indicating that the designated count value has reached.

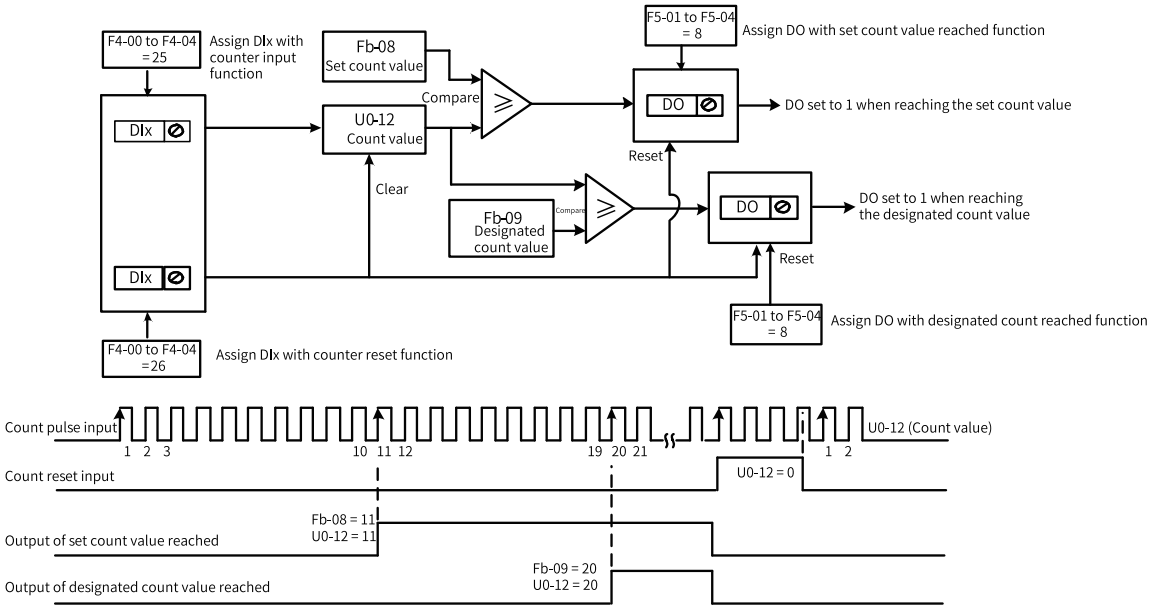


Figure 30-4 Schematic diagram of the counting function

Parameter Code	Parameter Name	Value Range	Description
F4-00 to F4-09 (any one)	DI1 to DI10 function selection (any one)	25	Counter input
F4-00 to F4-09 (any one)	DI1 to DI10 function selection (any one)	26	Counting reset
F5-01 to F5-04 (any one)	Terminal output function selection (any one)	8	Counting value reference reached
F5-01 to F5-04 (any one)	Terminal output function selection (any one)	9	Designated counting value reached

- DI5 must be used when the pulse frequency is high.
- One DO can be assigned with either the "count value reference reach" function or the "designated count value reach" function.
- The counter keeps counting when the AC drive is running or stops until the count value reference is reached.

- The count value is retentive at a power failure.
- When the count value reach signal of the DO is fed to the AC drive stop input terminal, the AC drive stops automatically.

30.4 Simple PLC Function

The simple PLC function is different from the user programmable function of the MD500. Simple PLC can only complete simple combination of multi-reference. For details on the user programmable function, see the descriptions of group FC.

Parameter Code	Parameter Name	Default	Value Range	Description
FC-16	Simple PLC running mode	0	0: Stop after running one cycle 1: Keep final values after running for one cycle 2: Repeat after running one cycle	When using the simple PLC to set the main frequency (F0-03 = 7), set FC-00 to FC-15 to select the simple PLC frequency, set FC-16 to select the operation mode of the simple PLC, and set FC-17 to select whether to retain the operating stage and frequency of the simple PLC after power failure or stop. 0: Stop after running one cycle The AC drive stops after running for one cycle, and will not start up until receiving a running command. 1: Keep final values after running for one cycle The AC drive automatically retains the final running frequency and direction after running for one cycle. When the drive is started again, it runs from the initial PLC state. 2: Repeat after running one cycle The AC drive automatically starts another cycle after running for one cycle, and will not stop until receiving a stop command. Note that the AC drive will stop according to the stop mode set by F6-10

Simple PLC can be the frequency source or V/f separation voltage source. The following figure describes the simple PLC used as the frequency source. When the simple PLC is used as the frequency source, the positive or negative values of FC-00 to FC-15 determines the running direction. If the parameter values are negative, the AC drive runs in the reverse direction.

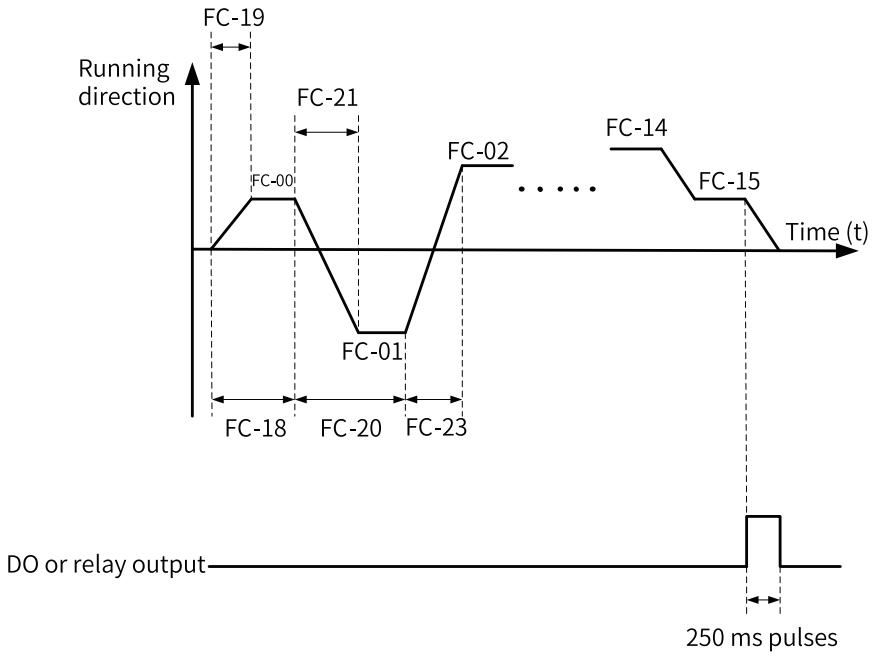


Figure 30-5 Simple PLC

When used as the frequency source, the PLC supports the following three running modes. When used as the V/f separated voltage source, the modes are not supported. Where:

- 0: Stop after running one cycle. The AC drive stops after running for one cycle, and starts after receiving another running command.
- 1: Keep the final value after running one cycle. The AC drive keeps the final running frequency and direction after running one cycle.
- 2: Repeat after running one cycle. The AC drive automatically starts another cycle after running one cycle, and stops only when receiving a stop command.

PLC retention upon power failure indicates that the AC drive memorizes the PLC running phase and running frequency before power failure and will continue to run from the memorized values after it is powered on again. If "Non-retentive upon power failure" is selected, the AC drive restarts the PLC process after it is powered on again. PLC retention upon stop indicates that the AC drive memorizes the PLC running phase and running frequency upon stop and will continue to run from the memorized values after it operates again. If "Non-retentive upon stop" is selected, the AC drive restarts the PLC process after it operates again.

Parameter Code	Parameter Name	Value Range	Description
FC-17	Simple PLC retention selection upon power failure	Ones: Retention selection upon power failure 0: Non-retentive upon power failure 1: Retentive upon power failure Tens: Retention selection upon stop 0: Non-retentive upon stop 1: Retentive upon stop	The running mode of the simple PLC is set by FC-16. FC-17 is used to determine whether the running stage and running frequency of the PLC before power failure are memorized upon power failure or shutdown. Ones: Retention selection upon power failure The AC drive restarts the simple PLC process upon power-on each time. When it is set to 1, the AC drive retains the PLC operation stage and operating frequency upon power failure and continues to run from the retained values after the drive is powered on again. Tens: Retention selection upon stop The AC drive restarts the simple PLC process upon power-on each time. When it is set to 1, the AC drive retains the PLC operation stage and operating frequency upon stop and continues to run from the retained values after the drive is started again.
FC-18	Running time of multi-reference 1 set by simple PLC	0.0s (h) to 6553.5s (h)	This parameter indicates the running time of multi-reference x (x = 1 to 16) set by simple PLC The operating time is the sum of acceleration or deceleration time and operating time at constant speed and target frequency.
FC-19	Acceleration/ Deceleration time of multi-reference 1 set by simple PLC	0 to 3	0: Group 1 acceleration/deceleration time (F0-17 and F0-18) 1: Group 2 acceleration/deceleration time (F8-03 and F8-04) 2: Group 3 acceleration/deceleration time (F8-05 and F8-06) 3: Group 4 acceleration/deceleration time (F8-07 and F8-08)
FC-20	Running time of multi-reference 2 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-18
FC-21	Acceleration/ Deceleration time of multi-reference 2 set by simple PLC	0 to 3	Same as FC-19
FC-22	Running time of multi-reference 3 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-18

Parameter Code	Parameter Name	Value Range	Description
FC-23	Acceleration/ Deceleration time of multi-reference 3 set by simple PLC	0 to 3	Same as FC-19
FC-24	Running time of multi-reference 4 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-18
FC-25	Acceleration/ Deceleration time of multi-reference 4 set by simple PLC	0 to 3	Same as FC-19
FC-26	Running time of multi-reference 5 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-27	Acceleration/ Deceleration time of multi-reference 5 set by simple PLC	0 to 3	Same as FC-18
FC-28	Running time of multi-reference 6 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-29	Acceleration/ Deceleration time of multi-reference 6 set by simple PLC	0 to 3	Same as FC-18
FC-30	Running time of multi-reference 7 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19

Parameter Code	Parameter Name	Value Range	Description
FC-31	Acceleration/ Deceleration time of multi-reference 7 set by simple PLC	0 to 3	Same as FC-18
FC-32	Running time of multi-reference 8 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-33	Acceleration/ Deceleration time of multi-reference 8 set by simple PLC	0 to 3	Same as FC-18
FC-34	Running time of multi-reference 9 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-35	Acceleration/ Deceleration time of multi-reference 9 set by simple PLC	0 to 3	Same as FC-18
FC-36	Running time of multi-reference 10 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-37	Acceleration/ Deceleration time of multi-reference 10 set by simple PLC	0 to 3	Same as FC-18
FC-38	Running time of multi-reference 11 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19

Parameter Code	Parameter Name	Value Range	Description
FC-39	Acceleration/ Deceleration time of multi-reference 11 set by simple PLC	0 to 3	Same as FC-18
FC-40	Running time of multi-reference 12 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-41	Acceleration/ Deceleration time of multi-reference 12 set by simple PLC	0 to 3	Same as FC-18
FC-42	Running time of multi-reference 13 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-43	Acceleration/ Deceleration time of multi-reference 13 set by simple PLC	0 to 3	Same as FC-18
FC-44	Running time of multi-reference 14 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-45	Acceleration/ Deceleration time of multi-reference 14 set by simple PLC	0 to 3	Same as FC-18
FC-46	Running time of multi-reference 15 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19

Parameter Code	Parameter Name	Value Range	Description
FC-47	Acceleration/ Deceleration time of multi-reference 15 set by simple PLC	0 to 3	Same as FC-18
FC-48	Running time of multi-reference 16 set by simple PLC	0.0s (h) to 6553.5s (h)	Same as FC-19
FC-49	Acceleration/ Deceleration time of multi-reference 16 set by simple PLC	0 to 3	Same as FC-18
FC-50	Time unit of simple PLC operation	0: s (second) 1: h (hour)	This parameter defines the unit of the simple PLC running time for each speed.
FC-51	Multi-reference 1 source	0: FC-00 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: PID 6: Preset frequency (F0-08) Others: F connector	The frequency reference of multi-reference 1 can be selected through seven ways, including digital setting, analog input, pulse frequency, PID, and preset frequency. 0: FC-00 The frequency reference is set by FC-00. 1: AI1 The frequency reference is set by AI1. 2: AI2 The frequency reference is set by AI2. 3: AI3 The frequency reference is set by AI3. 4: Pulse reference The frequency reference is set by pulse frequency. 5: PID The frequency reference is set by PID. 6: Preset frequency (F0-08) The frequency reference is set by F0-08 Others: F connector The frequency reference is set by connector.

30.5 Master/Slave Control Function

Rigid connection and flexible connection

The master/slave control function is designed for multi-drive applications, in which the system is driven by multiple AC drives and motor shafts are coupled by gears, chains, or conveyor belts. Master/Slave control enables even distribution of loads among the drive units. The external control signals are connected only to the master that controls the slaves through serial communication.

The master works in the typical speed control mode and the slaves follow the torque or speed reference of the master. There are two types of master/slave control connection modes: rigid connection and flexible connection, as shown in the following figure.

- When motor shafts of the master and slaves are connected rigidly by chains or gears, the slaves must work in the torque control mode to avoid speed difference among drive units.
- When motor shafts of the master and slaves are connected flexibly, the slaves must work in the speed control because slight speed difference among drive units is allowed. When the master and slaves are in the speed control mode, the droop rate must be used.

Note

Only CANlink communication is supported.

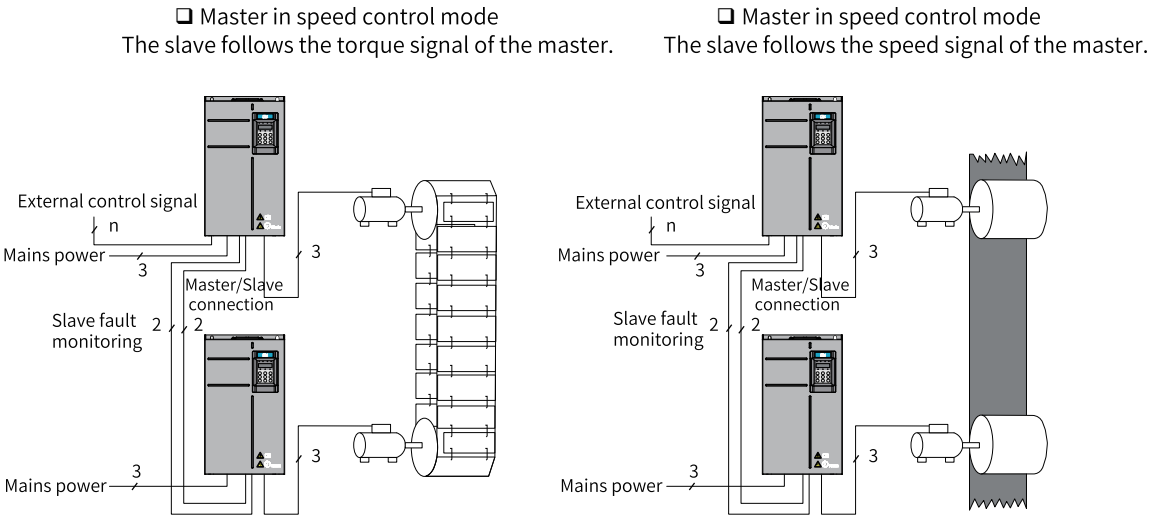


Figure 30-6 Rigid/Flexible connection

Master/slave connection

To avoid control conflict, all drive units connected to the same machinery must receive the external control signals only through the master. When wiring the master and slaves, connect all external control signal cables only to the master, and never using the operating panel or fieldbus system to control the slaves, as shown below.

If the DI needs to connect to the 24 V power supply, see wiring methods of connection to the internal or external 24 V power supply in the sink wiring method or source wiring method in MD520 Series General-Purpose AC Drive Manual Package or the MD520 Series General-Purpose AC Drive Installation Guide.

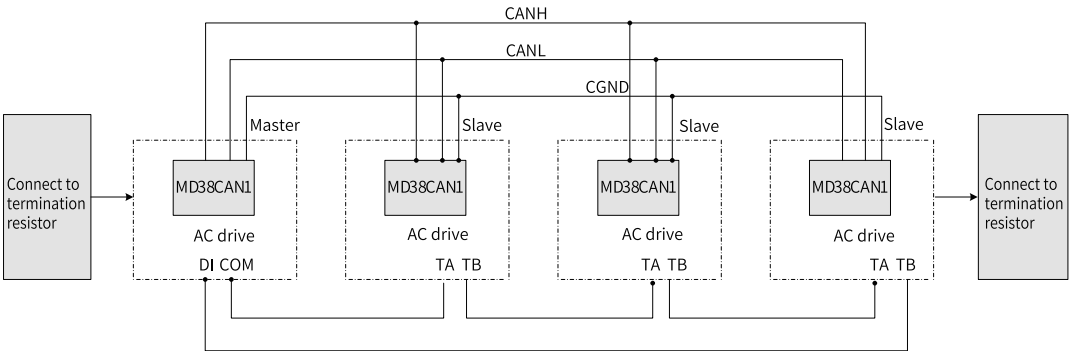


Figure 30-7 Connections between the master and slaves

When a slave becomes faulty, the fault information is sent to the master in one of the following ways. When the slave stops due to a fault, the master stops running.

1. The relay is used for slave fault feedback.
2. The faulty slave sends the fault information to the master through communication after the tens place of A8-02 is set to 1.

Droop control

F8-15 is used for droop control. The droop control function allows slight speed difference between the master and slaves to avoid conflict between them. Only when the master and slaves are in the speed control mode, the droop rate needs to be adjusted. A proper droop rate is gradually obtained during drive running. Do not set F8-15 to a very large value. Otherwise, steady speed will decline obviously when the load is large. You must set F8-15 for both the master and the slave.

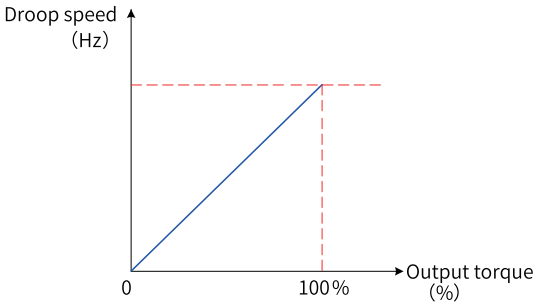


Figure 30-8 Relationship between droop rate and output torque

Droop speed = Synchronous frequency x output torque x (F8-15/10)

For example, if F8-15 is set to 1.00, the synchronous frequency is 50 Hz, and the output torque is 50%, the actual frequency of the AC drive is 47.5 Hz, which is calculated by 50 Hz - 50 Hz x 50% x (1.00/10).

Related parameters

A8-00 to A8-07

Example

The following tables describe parameter settings for rigid connection and flexible connection.

- Rigid connection

Table 30–1 Parameter settings for the master in the speed control mode (A0-00 = 0)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	0	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F2-10	Torque upper limit in speed control mode	0.0% to 600.0%	150.0%	Yes

Table 30–2 Parameter settings for the slave in the torque control mode (A0-00 = 1)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	1	No

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
A8-02	Slave following master's command	Ones: Whether to follow master's command 0: Not following master's running command 1: Following master's running command Tens: Transmitting slave fault information 0: Not transmitting slave fault information 1: Transmitting slave fault information Hundreds: Whether to display alarm when slave becomes offline 0: Not displaying alarm when slave becomes offline 1: Displaying alarm when slave becomes offline	Ones: 1 Tens: 1	No
A8-03	Function selection for data received by the slave	0: Operating frequency 1: Target frequency	0	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F8-07	Acceleration time 4 (Frequency acceleration time in torque control)	0.0s to 6500.0s	0.0s	No
F8-08	Deceleration time 4 (Frequency deceleration time in torque control)	0.0s to 6500.0s	0.0s	No
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	No
FD-02	Local address	1 to 247	1	No
A0-00	Speed/Torque control mode selection	0: Speed control 1: Torque control	1	No

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
A0-01	Mode A - Torque reference source in torque control (drive torque upper limit source)	0: A0-03 1: AI1 2: AI2 3: AI3 4: Pulse reference 5: Communication 6: Min. (AI1, AI2) 7: Max. (AI1, AI2) Others: F connector	0	No
A0-03	Mode A - Torque digital setting in torque control	-200.0% to 200.0%	130.0%	Same as the setting of F2-10 of the master
A0-07	Mode A - Torque rise filter time	0.00s to 650.00s	0.00s	No
A0-08	Mode A - Torque drop filter time	0.00s to 650.00s	0.00s	No

Do not set the startup frequency in the torque control mode. Otherwise, the startup shock current will be large.

- Flexible connection

Table 30–3 Parameter settings for the master in the speed control mode (A0-00 = 0)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens position: Reserved Hundreds position: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	0	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F8-15	Droop control	0.00% to 10.00%	1.00 Hz	Yes
F0-17	Acceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No
F0-18	Deceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No

Table 30–4 Parameter settings for the slave in the speed control mode (A0-00 = 0)

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
FD-00	Baud rate	Ones: Modbus 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps Tens: Reserved Hundreds: Reserved Thousands: CANlink/ CANopen baud rate 0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	The values of the thousands place for the master and slave are the same.	No
A8-00	Master-slave control function	0: Inactive 1: Valid	1	No
A8-01	Master/Slave selection	0: Master 1: Slave	1	No

Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
A8-02	Slave following master's command	Ones: Whether to follow master's command 0: Not following master's running command 1: Following master's running command Tens: Transmitting slave fault information 0: Not transmitting slave fault information 1: Transmitting slave fault information Hundreds: Whether to display alarm when slave becomes offline 0: Not displaying alarm when slave becomes offline 1: Displaying alarm when slave becomes offline	11	No
A8-03	Function selection for data received by the slave	0: Operating frequency 1: Target frequency	0	No
F0-02	Operation command source selection	0: Operating panel 1: Terminal 2: Communication 3: User-defined	2	No

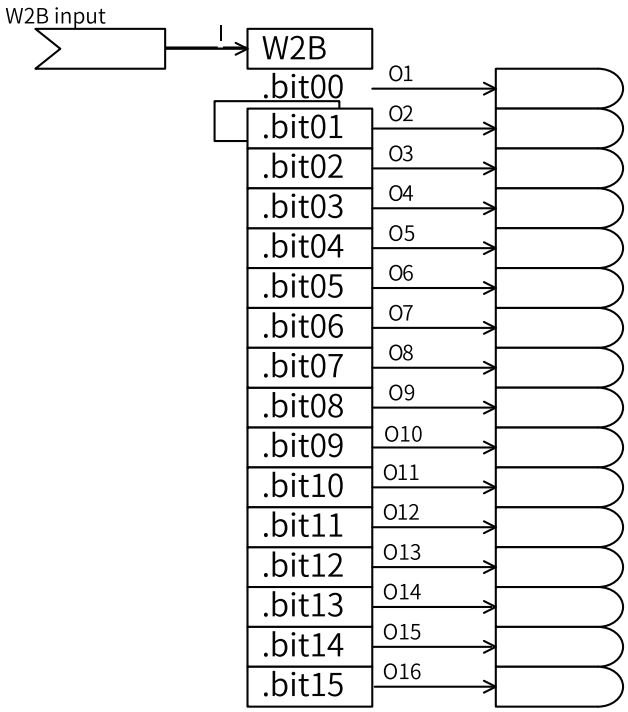
Parameter Code	Parameter Name	Value Range	Value	Adjustment Required
F0-03	Main frequency source	0: Digital setting (non-retentive upon power failure) 1: Digital setting (retentive upon power failure) 2: AI1 3: AI2 4: AI3 5: Pulse reference (DI5) 6: Multi-reference 7: Simple PLC 8: PID 9: Communication Others: F connector	9	No
F0-10	Maximum frequency	5.00 Hz to 599.00 Hz	50.00 Hz (Same value for the master and slave)	No
F0-17	Acceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No
F0-18	Deceleration time 1	0.0s to 6500.0s	Same value for the master and slave	No
F8-15	Droop control	0.00% to 10.00%	1.00 Hz	Yes
FD-02	Local address	1 to 247	1	No
A0-00	Speed/Torque control mode selection	0: Speed control 1: Torque control	0	No

30.6 Programming Module

30.6.1 Word-to-Bit Conversion

Word-to-bit conversion module (A to H)

1. **Diagram**



2. **Operation**

   When the input I is a single word, the output O1 to O16 correspond to bit 00 to bit 15 of the input I.

   When the input I is a double word, the output O1 to O16 correspond to high-order 16 bits (bit 00 to bit 15) of the input I.

3. **Connection**

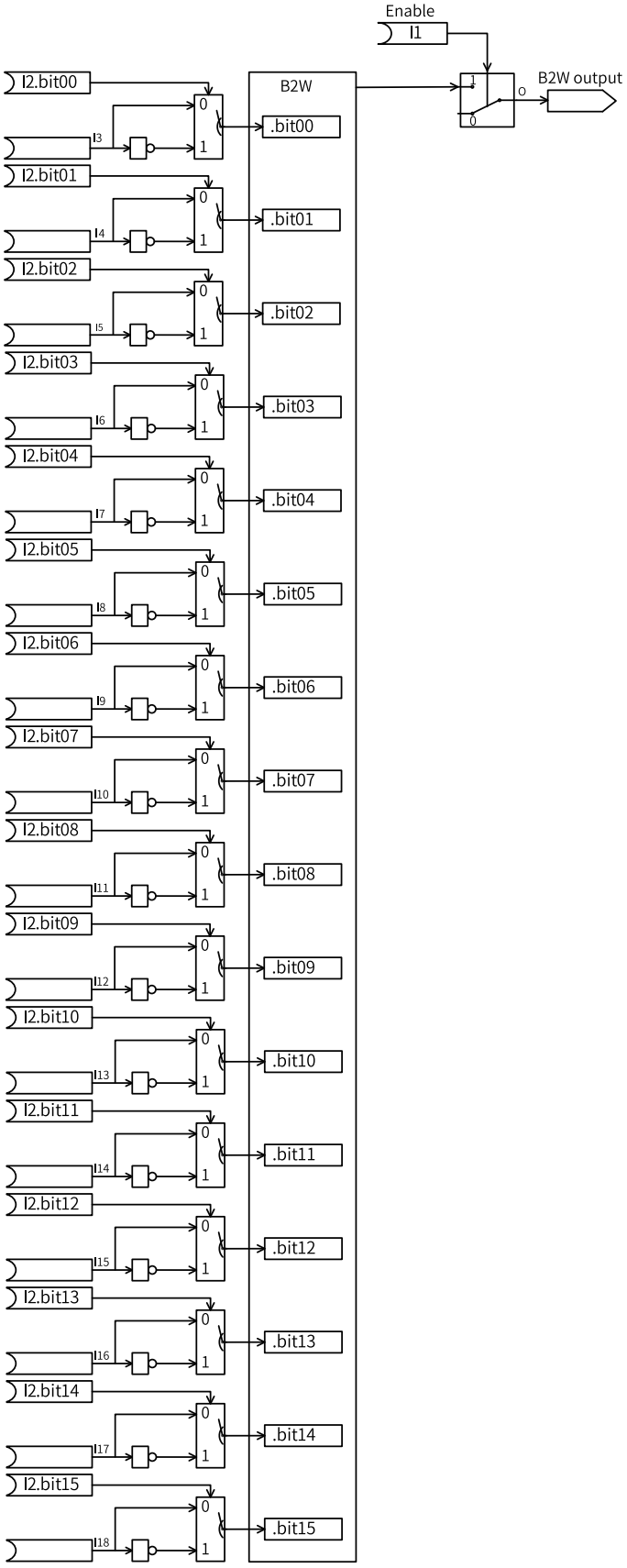
   Input I: Single word connector and double word connector

   Output O1 to O16: Bit connector

Word-to-Bit Conversion Module		A	B	C	D	E	F	G	H
Input	I	C1-00	C1-01	C1-02	C1-03	C1-04	C1-05	C1-06	C1-07
Output	O1 (bit 00)	L1-76	L1-92	L2-08	L2-24	L2-40	L2-56	L2-72	L2-88
	O2 (bit 01)	L1-77	L1-93	L2-09	L2-25	L2-41	L2-57	L2-73	L2-89
	O3 (bit 02)	L1-78	L1-94	L2-10	L2-26	L2-42	L2-58	L2-74	L2-90
	O4 (bit 03)	L1-79	L1-95	L2-11	L2-27	L2-43	L2-59	L2-75	L2-91
	O5 (bit 04)	L1-80	L1-96	L2-12	L2-28	L2-44	L2-60	L2-76	L2-92
	O6 (bit 05)	L1-81	L1-97	L2-13	L2-29	L2-45	L2-61	L2-77	L2-93
	O7 (bit 06)	L1-82	L1-98	L2-14	L2-30	L2-46	L2-62	L2-78	L2-94
	O8 (bit 07)	L1-83	L1-99	L2-15	L2-31	L2-47	L2-63	L2-79	L2-95
	O9 (bit 08)	L1-84	L2-00	L2-16	L2-32	L2-48	L2-64	L2-80	L2-96
	O10 (bit 09)	L1-85	L2-01	L2-17	L2-33	L2-49	L2-65	L2-81	L2-97
	O11 (bit 10)	L1-86	L2-02	L2-18	L2-34	L2-50	L2-66	L2-82	L2-98
	O12 (bit 11)	L1-87	L2-03	L2-19	L2-35	L2-51	L2-67	L2-83	L2-99
	O13 (bit 12)	L1-88	L2-04	L2-20	L2-36	L2-52	L2-68	L2-84	L3-00
	O14 (bit 13)	L1-89	L2-05	L2-21	L2-37	L2-53	L2-69	L2-85	L3-01
	O15 (bit 14)	L1-90	L2-06	L2-22	L2-38	L2-54	L2-70	L2-86	L3-02
	O16 (bit 15)	L1-91	L2-07	L2-23	L2-39	L2-55	L2-71	L2-87	L3-03

Bit-to-word module (A to D)

1. **Diagram**



2. **Operation**

When the input I1 is set to 0, the module is disabled and the output O equals to 0.

The bit 00 to bit 15 of the inverse flag input I2 correspond to the inverse flags of I3 to I18. When the bit is 1, the inputs I3 to I18 are reversed. Use the reversed I3 to I18 as bit 00 to bit 15 of the hexadecimal number and output to O.

3. **Connection**

Input I1: 0: Disable; 1: Enable

Input I2: 16-bit unsigned number

Input I3 to I18: 0, 1, DI input, and bit connector input

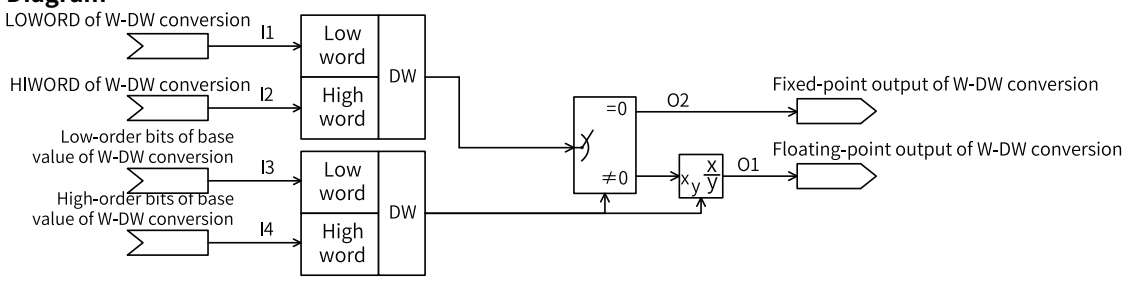
Output O: word connector

Word-to-Bit Module		A	B	C	D
Input	I1	C1-12	C1-30	C1-48	C1-66
	I2	C1-13	C1-31	C1-49	C1-67
	I3 (bit 00)	C1-14	C1-32	C1-50	C1-68
	I4 (bit 01)	C1-15	C1-33	C1-51	C1-69
	I5 (bit 02)	C1-16	C1-34	C1-52	C1-70
	I6 (bit 03)	C1-17	C1-35	C1-53	C1-71
	I7 (bit 04)	C1-18	C1-36	C1-54	C1-72
	I8 (bit 05)	C1-19	C1-37	C1-55	C1-73
	I9 (bit 06)	C1-20	C1-38	C1-56	C1-74
	I10 (bit 07)	C1-21	C1-39	C1-57	C1-75
	I11 (bit 08)	C1-22	C1-40	C1-58	C1-76
	I12 (bit 09)	C1-23	C1-41	C1-59	C1-77
	I13 (bit 10)	C1-24	C1-42	C1-60	C1-78
	I14 (bit 11)	C1-25	C1-43	C1-61	C1-79
	I15 (bit 12)	C1-26	C1-44	C1-62	C1-80
	I16 (bit 13)	C1-27	C1-45	C1-63	C1-81
	I17 (bit 14)	C1-28	C1-46	C1-64	C1-82
	I18 (bit 15)	C1-29	C1-47	C1-65	C1-83
Output	O	L7-21	L7-22	L7-23	L7-24

30.6.2 Word-to-Double Word Conversion

Word-to-double word conversion module (A to D)

1. **Diagram**



2. **Operation**

$$O=\begin{cases} O1:\dfrac{I1\times 65535+I2}{I3\times 65535+I4}, I3\times 65535+I4\neq 0 \\ O2:I1\times 65535+I2, I3\times 65535+I4=0 \end{cases}$$

When the base value with I3 as the high-order 16 bits and I4 used as the low-order 16 bit is not zero, the output equals the double word with I1 as the high-order 16 bits and I2 as the low-order 16 bits divided by the base value. The result is output to O1.

When the base value with I3 as the high-order 16 bits and I4 used as the low-order 16 bit is zero, the output equals the double word with I1 as the high-order 16 bits and I2 as the low-order 16 bits. The double word is output directly to O2 without base value conversion.

3. **Connection**

Input I1 and I2: Word connector and double word connector

Input I3 and I4: 16-bit unsigned number

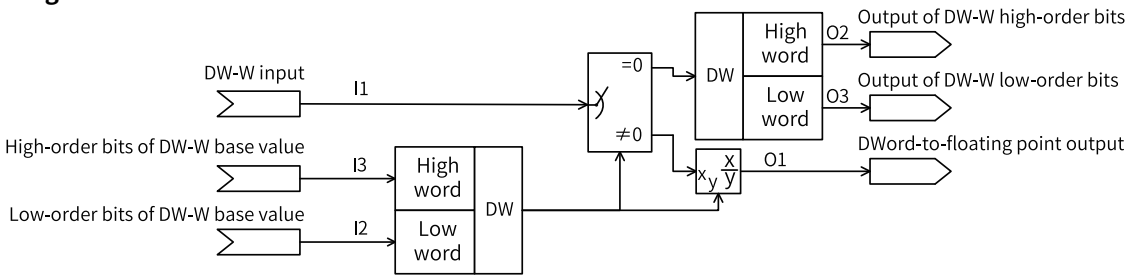
Output O1: Floating point connector

Output O2: Double word connector

Word-to-Double Word Conversion Module	Input				Output	
	I1	I2	I3	I4	O1	O2
A	C2-00	C2-01	C2-02	C2-03	LD-31	L9-00
B	C2-04	C2-05	C2-06	C2-07	LD-32	L9-01
C	C2-08	C2-09	C2-10	C2-11	LD-33	L9-02
D	C2-12	C2-13	C2-14	C2-15	LD-34	L9-03

Double word-to-word conversion module (A to D)

1. **Diagram**



2. **Operation**

$$O=\begin{cases} O1:\dfrac{I1}{I2\times 65535+I3}, & I2\times 65535+I3\neq 0 \\ \begin{cases} O2:(I1>>16)\&0xFFFF \\ O3:I1\&0xFFFF \end{cases}, & I2\times 65535+I3=0 \end{cases}$$

When the base value with I2 as the high-order 16 bits and I3 as the low-order 16 bits is not zero, the output equals the value of I1 divided by the base value. The result is output is to O1.

When the base value with I2 as the high-order 16 bits and I3 as the low-order 16 bits is zero, the output O2 is the high-order 16 bits of I1 and the output O3 is the low-order 16 bits of I1.

3. **Connection**

Input I1: Double word connector

Input I2 and I3: unsigned number

Output O1: Floating point connector

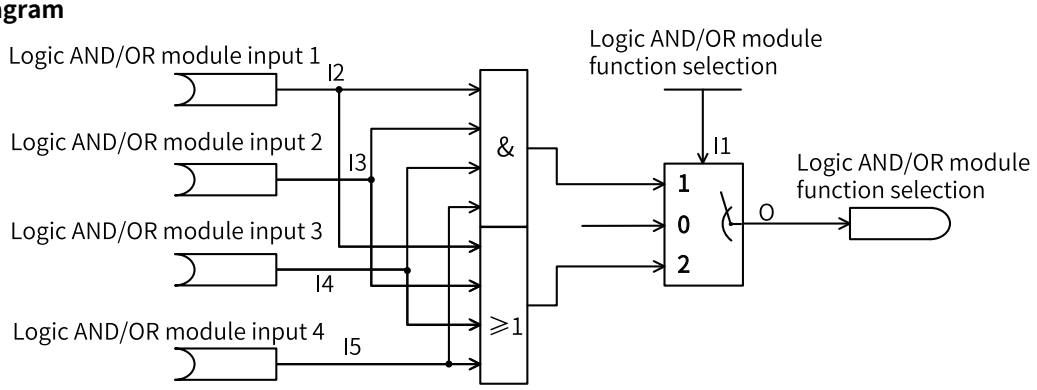
Output O2 and O3: Word connector

DW-W Conversion	Input			Output		
	I1	I2	I3	O1	O2	O3
A	C2-32	C2-33	C2-34	LD-35	L7-25	L7-26
B	C2-35	C2-36	C2-37	LD-36	L7-27	L7-28
C	C2-38	C2-39	C2-40	LD-37	L7-29	L7-30
D	C2-41	C2-42	C2-43	LD-38	L7-31	L7-32

30.6.3 Logic Operation

Logic AND/OR Module (A to L)

1. **Diagram**



2. **Operation**

When I1 for enabling logic AND/OR module is set to 0, the module is inactive, and the output (O) is 0.

When I1 for enabling logic AND/OR module is set to 1, the logic AND module is valid and the output (O) is I2 & I3 & I4 & I5.

Only when I2, I3, I4, and I5 are all true, the output (O) will be true; Otherwise, the output (O) is false. The truth table is as follows.

Input				Output
I2	I3	I4	I5	O
0	X	X	X	0
X	0	X	X	0
X	X	0	X	0
X	X	X	0	0
1	1	1	1	1

When I1 for enabling logic AND/OR module is set to 2, logic OR is valid and the output (O) is I2 | I3 | I4 | I5.

Only when I2, I3, I4 and I5 are false, the output (O) is false; otherwise, the output (O) is true. The truth table is as follows.

Input				Output
I2	I3	I4	I5	O
1	X	X	X	1
X	1	X	X	1
X	X	1	X	1
X	X	X	1	1
0	0	0	0	0

3. **Connection**

Input I1: 0: module disabled; 1: logic AND module; 2: logic OR module

Input I2, I3, I4, and I5: 0, 1, DI input, and bit connector input

Output (O): Bit connector

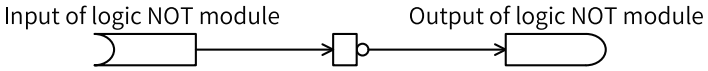
Logic AND/OR Module	Input					Output
	I1	I2	I3	I4	I5	O
A	C3-00	C3-01	C3-02	C3-03	C3-04	L3-36
B	C3-05	C3-06	C3-07	C3-08	C3-09	L3-37
C	C3-10	C3-11	C3-12	C3-13	C3-14	L3-38
D	C3-15	C3-16	C3-17	C3-18	C3-19	L3-39
E	C3-20	C3-21	C3-22	C3-23	-	L3-40
F	C3-24	C3-25	C3-26	C3-27	-	L3-41
G	C3-28	C3-29	C3-30	C3-31	-	L3-42
H	C3-32	C3-33	C3-34	C3-35	-	L3-43
I	C3-36	C3-37	C3-38	C3-39	-	L3-44
J	C3-40	C3-41	C3-42	C3-43	-	L3-45
K	C3-44	C3-45	C3-46	C3-47	-	L3-46
L	C3-48	C3-49	C3-50	C3-51	-	L3-47

Note

Logic AND/OR modules A to D support four input terminals, and Logic AND/OR modules E to L support three input terminals.

Logic NOT Module (A to P)

1. **Diagram**



2. **Operation**

- When the input (I) is set to 0, the module is disabled and the output is 0
  O = 0
- When the input (I) is not 0, the output is opposite to the input I.
  O = $\overline{I}$

Output of logic NOT module

Input	Output
I	O
0	1
1	0

3. **Connection**

Input I: 0, 1, DI input, and bit connector input

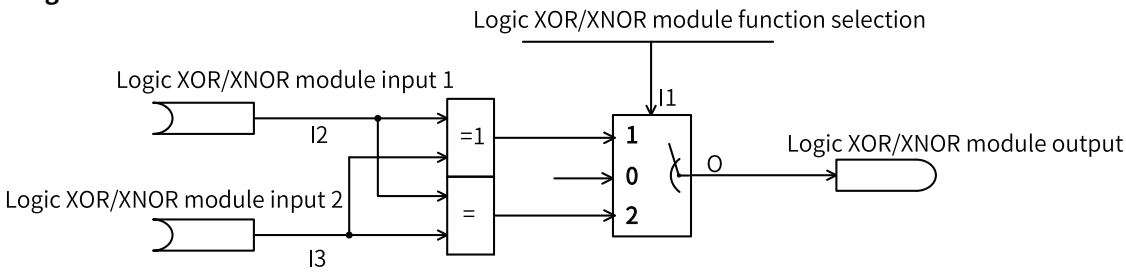
Output (O): Bit connector

Logic NOT Module	Input	Output
	I	O
A	C3-56	L3-52
B	C3-57	L3-53
C	C3-58	L3-54

Logic NOT Module	Input	Output
	I	O
D	C3-59	L3-55
E	C3-60	L3-56
F	C3-61	L3-57
G	C3-62	L3-58
H	C3-63	L3-59
I	C3-64	L3-60
J	C3-65	L3-61
K	C3-66	L3-62
L	C3-67	L3-63
M	C3-68	L3-64
N	C3-69	L3-65
O	C3-70	L3-66
P	C3-71	L3-67

Logic XOR/XNOR Module (A to H)

1. **Diagram**



2. **Operation**

When I1 for enabling the logic XOR/XNOR module is set to 0, the module is disabled, and the output (O) is 0. O = 0

When I1 for enabling the logic XOR/XNOR module is set to 1, the module is enabled. O = (!I2 & I3) | (I2 & !I3)

When I2 and I3 are the same, the output (O) is 0. When I2 and I3 are different, the output (O) is 1. The truth table is as follows.

Input		Output
I2	I3	O
0	0	0
1	0	1
0	1	1
1	1	0

When I1 for enabling the logic XOR/XNOR module is set to 2, the logic XNOR module is enabled. O = (I2 & I3) | (!I2 & !I3)

When I2 and I3 are the same, the output (O) is 1. When I2 and I3 are different, the output (O) is 0. The truth table is as follows.

Input		Output
I2	I3	O
0	0	1
1	0	0

Input		Output
0	1	0
1	1	1

3. **Connection**

Input I1: 0: module disabled; 1: logic XOR module; 2: logic XNOR module

Input I2 and I3: 0, 1, DI input, and bit connector input

Output (O): Bit connector

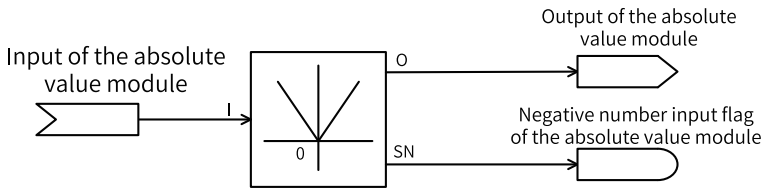
Table 30–5

Logic XOR/XNOR Module	Input			Output
	I1	I2	I3	O
A	C3-72	C3-73	C3-74	L3-68
B	C3-75	C3-76	C3-77	L3-69
C	C3-78	C3-79	C3-80	L3-70
D	C3-81	C3-82	C3-83	L3-71
E	C3-84	C3-85	C3-86	L3-72
F	C3-87	C3-88	C3-89	L3-73
G	C3-90	C3-91	C3-92	L3-74
H	C3-93	C3-94	C3-95	L3-75

30.6.4 Mathematical Operation

Absolute value module (A to H)

1. **Diagram**



2. **Operation**

$$O=|I|$$

$$SN=\begin{cases}1, I<0\\0, I\geqslant 0\end{cases}$$

The output O equals the absolute value of the input I. When the input value is negative, the SN is 1; otherwise, the SN is 0.

3. **Connection**

Input I: AI, HDI, Aim, motorized potentiometer, PID, word connector, double word connector, and floating point connector

Output O: Word connector, double word connector, and floating point connector

Output SN: bit connector

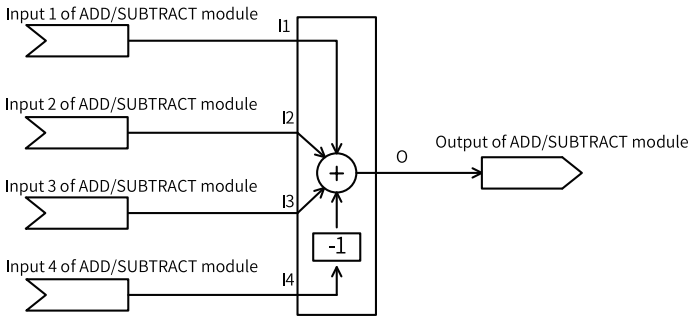
Absolute Value Module	Input	Output	
	I	O	SN
A	C4-00	LD-08	L4-16
B	C4-01	LD-09	L4-17

Absolute Value Module	Input	Output	
	I	O	SN
C	C4-02	LD-10	L4-18
D	C4-03	LD-11	L4-19
E	C4-04	LD-12	L4-20
F	C4-05	L9-08	L4-21
G	C4-06	L9-09	L4-22
H	C4-07	L9-10	L4-23

Note The modules A–E are floating-point absolute value modules, and the modules F–G are fixed-point absolute value modules.

Addition and subtraction module (A to H)

1. **Diagram**



2. **Operation**

   O=I1+I2+I3-I4

   The output O equals the sum of I1, I2, and I3 minus I4.

3. **Connection**

   Input I1, I2, I3, and I4: AI, HDI, Aim, motorized potentiometer, PID, word connector input, and float connector input

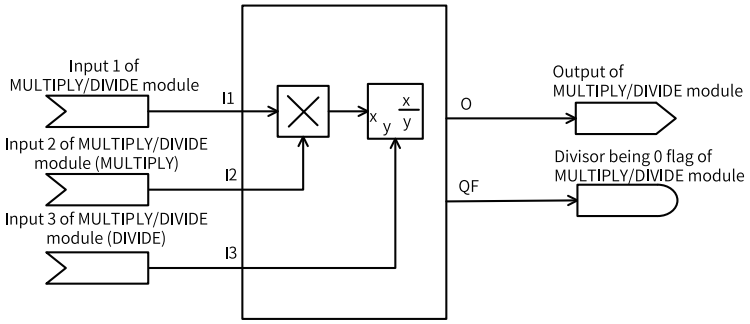
   Output O: Double word connector and floating point connector

Addition and Subtraction Module	Input				Output
	I1	I2	I3	I4	O
A	C4-08	C4-09	C4-10	C4-11	LD-13
B	C4-12	C4-13	C4-14	C4-15	LD-14
C	C4-16	C4-17	C4-18	C4-19	LD-15
D	C4-20	C4-21	C4-22	C4-23	LD-16
E	C4-24	C4-25	C4-26	C4-27	LD-17
F	C4-28	C4-29	C4-30	C4-31	L9-11
G	C4-32	C4-33	C4-34	C4-35	L9-12
H	C4-36	C4-37	C4-38	C4-39	L9-13

Note The modules A–E are floating-point ADD/SUBTRACT modules, and the modules F–H are fixed-point ADD/SUBTRACT modules.

Multiplication and division module (A to H)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I1 \times I2, I3 = 0 \\ \frac{I1 \times I2}{I3}, I3 \neq 0 \\ 0 \quad , I3 = 0 \end{cases}$$

$$QF = \begin{cases} 1 \ , I3 = 0 \\ 0 \ , I3 \neq 0 \end{cases}$$

When I3 is set to 0, the output is the product of I1 multiplied by I2.

When I3 is set to other options, if the input value I3 is 0, the output is 0 and the divisor is the zero flag bit which is 1; if the input value I3 is not 0, the output is the product of (I1 x I2)/I3, and the divisor is the zero flag bit which is 0.

3. **Connection**

Input I1, I2, and I3: AI, HDI, Aim, motorized potentiometer, PID, word connector input, double word connector, and floating point connector input

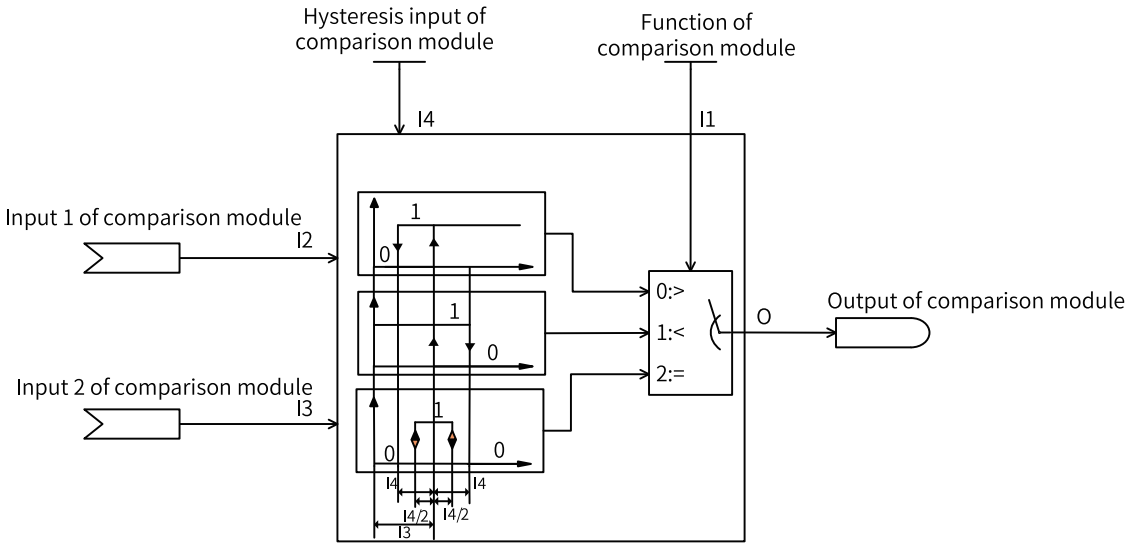
Output O: Double word connector and floating point connector

Multiplication and Division Module	Input			Output
	I1	I2	I3	O
A	C4-40	C4-41	C4-42	LD-18
B	C4-43	C4-44	C4-45	LD-19
C	C4-46	C4-47	C4-48	LD-20
D	C4-49	C4-50	C4-51	LD-21
E	C4-52	C4-53	C4-54	LD-22
F	C4-55	C4-56	C4-57	L9-14
G	C4-58	C4-59	C4-60	L9-15
H	C4-61	C4-62	C4-63	L9-16

Note The modules A–E are floating-point MULTIPLY/DIVIDE modules, and the modules F–H are byte MULTIPLY/DIVIDE modules.

Comparison module (A to H)

1. **Diagram**



2. **Operation**

Hysteresis input I4 suppresses frequent connection and disconnection.

- When l1 (comparison module function) is set to 0, before I2 increases from 0 to I3 in the forward direction, the output O keeps low level. When I2 increases to a value higher than I3, the output O changes from low level to high level. When I2 keeps increasing, the output O keeps high level. If I2 decreases but keeps higher than I3 - l4, the output O keeps high level. Only when I2 is lower than I3 - l4, the output O changes from high level to low level.
- When l1 (comparison module function) is set to 1, before I2 increases from 0 to I3+I4 in the forward direction, the output O keeps high level. When I2 increases to a value higher than I3+I4, the output O changes from high level to low level. When I2 keeps increasing, the output O keeps low level. If I2 decreases but keeps higher than I3, the output O keeps low level. Only when I2 is lower than I3, the output O changes from low level to high level.
- When l1 (comparison module function) is set to 2, the output keeps high level if I2 is within the range of I3-I4/2 to I3+I4/2; otherwise, the output is low level.

3. **Connection**

Input l1: 0 (module disabled);1: Input 1 > Input 2; 2: Input 1 < Input 2; 3: Input 1 = Input 2

Input I2 and I3: AI, HDI, Aim, motorized potentiometer, PID, word connector input, double word connector, and floating point connector input

Input I4: Floating point number with two decimal places

Output O: Bit connector

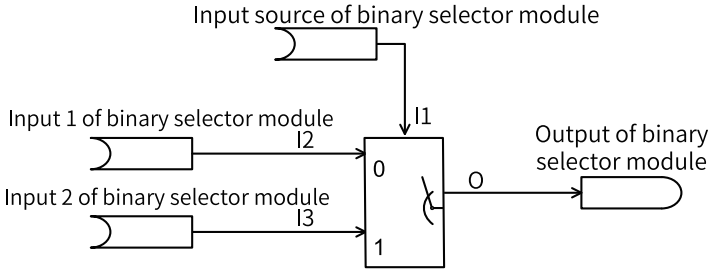
Comparison Module	Input				Output
	I1	I2	I3	I4	O
A	C4-64	C4-65	C4-66	C4-67	L4-00
B	C4-68	C4-69	C4-70	C4-71	L4-01
C	C4-72	C4-73	C4-74	C4-75	L4-02
D	C4-76	C4-77	C4-78	C4-79	L4-03
E	C4-80	C4-81	C4-82	C4-83	L4-04
F	C4-84	C4-85	C4-86	C4-87	L4-05
G	C4-88	C4-89	C4-90	C4-91	L4-06
H	C4-92	C4-93	C4-94	C4-95	L4-07

Note The modules A–E are floating-point comparison modules, and the modules F–H are fixed-point comparison modules.

30.6.5 Switch Function

Binary selector module (A to H)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

When I1 (binary selector module) is set to 0, the output O equals I2. When I1 (binary selector module) is set to 1, the output O equals I3.

3. **Connection**

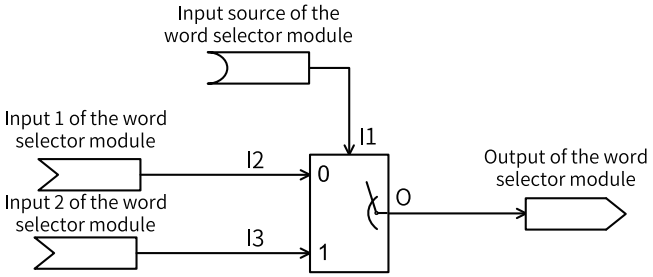
Input I1, I2, and I3: 0, 1, DI input, double word connector, or bit connector

Output (O): Bit connector

Binary Selector Module	Input			Output
	I1	I2	I3	O
A	C5-00	C5-01	C5-02	L3-04
B	C5-03	C5-04	C5-05	L3-05
C	C5-06	C5-07	C5-08	L3-06
D	C5-09	C5-10	C5-11	L3-07
E	C5-12	C5-13	C5-14	L3-08
F	C5-15	C5-16	C5-17	L3-09
G	C5-18	C5-19	C5-20	L3-10
H	C5-21	C5-22	C5-23	L3-11

Word selector module (A to D)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

When I1 (word selector module) is set to 0, the output O equals I2. When I1 (digital selector module) is set to 1, the output O equals I3.

3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

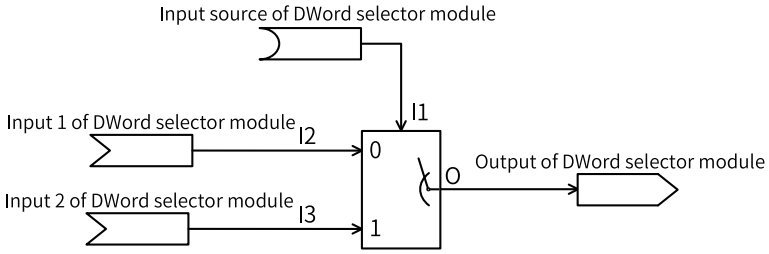
Input I2 and I3: Word connector and double word connector

Output O: Word connector

Word Selector Module	Input			Output
	I1	I2	I3	O
A	C5-24	C5-25	C5-26	L7-41
B	C5-27	C5-28	C5-29	L7-42
C	C5-30	C5-31	C5-32	L7-43
D	C5-33	C5-34	C5-35	L7-44

Double word selector module (A to D)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

When I1 (double word selector module) is set to 0, the output O equals I2. When I1 (double word selector module) is set to 1, the output O equals I3.

3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

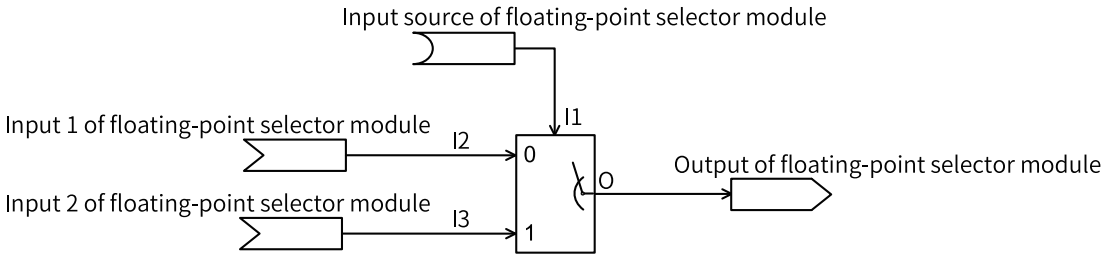
Input I2 and I3: Word connector, word connector, and double word connector

Output O: Double word connector

Double Word Connector	Input			Output
	I1	I2	I3	O
A	C5-36	C5-37	C5-38	L9-04
B	C5-39	C5-40	C5-41	L9-05
C	C5-42	C5-43	C5-44	L9-06
D	C5-45	C5-46	C5-47	L9-07

Floating point selector module (A to H)

1. **Diagram**



2. **Operation**

$$O = \begin{cases} I2, I1=0 \\ I3, I1=1 \end{cases}$$

3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

Input I2, I3: AI, HDI, Aim, motorized potentiometer, PID, and floating point connector input

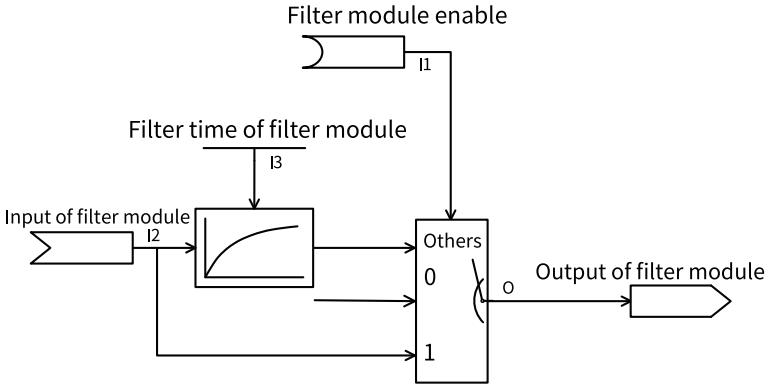
Output O: Floating point connector

Floating Point Selector Module	Input			Output
	I1	I2	I3	O
A	C5-48	C5-49	C5-50	LD-00
B	C5-51	C5-52	C5-53	LD-01
C	C5-54	C5-55	C5-56	LD-02
D	C5-57	C5-58	C5-59	LD-03
E	C5-60	C5-61	C5-62	LD-04
F	C5-63	C5-64	C5-65	LD-05
G	C5-66	C5-67	C5-68	LD-06
H	C5-69	C5-70	C5-71	LD-07

30.6.6 Control Function

Filter module (A to F)

1. **Diagram**



2. **Operation**

When I1 is set to 0, the filter module is disabled and the output O is 0.

Set I1 to a non-zero value. If the input value is 1, the filter module is disabled and the output O equals I2. If the input value is 0, the output O equals the filter value of the input I.

3. **Connection**

Input I1: 0 (filter module disabled), 1 (filter module enabled, but filtering disabled), 2 (filter module and filtering enabled, DI input, or bit connector input

Input I2: AI, HDI, Aim, motorized potentiometer, PID, word connector input, and floating point connector input

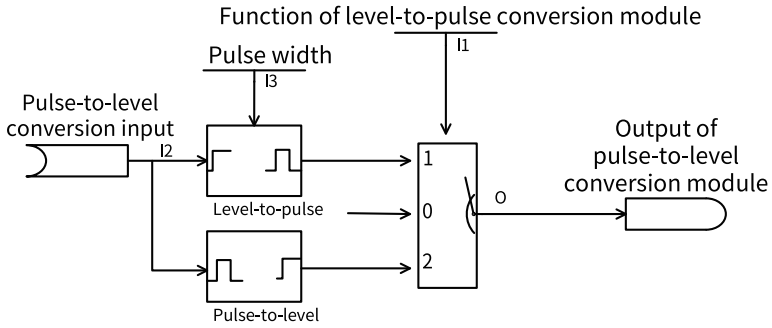
Input I3: Floating point number with three decimal places

Output O: Double word connector and floating point connector

Filter module	Input			Output
	I1	I2	I3	O
A	C6-00	C6-01	C6-02	LD-23
B	C6-03	C6-04	C6-05	LD-24
C	C6-06	C6-07	C6-08	LD-25
D	C6-09	C6-10	C6-11	LD-26
E	C6-12	C6-13	C6-14	L9-17
F	C6-15	C6-16	C6-17	L9-18

Level-to-pulse conversion module (A to D)

1. **Diagram**

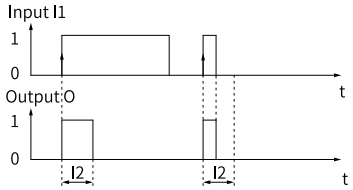


2. **Operation**

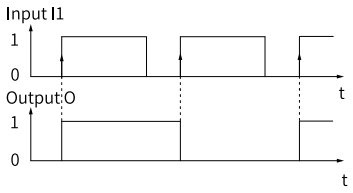
When I1 is set to 0, the module is disabled and the output is 0.

When I1 is set to 1, level-to-pulse conversion is valid, and the output is set to 1 within the pulse time I3 on the rising edge of input I2.

If input I1 is 0, the output is 0 immediately regardless of whether the pulse duration is reached.



When I1 is set to 2, pulse-to-level conversion is valid. In this case, the output is set to 1 on the first rising edge of input I2, and set to 0 on the second rising edge of input I2, and so on. That is, the output is set to 1 on each odd rising edge of input I2, and set to 0 on each even rising edge of input I2.



3. **Connection**

Input l1: 0: Module disabled; 1: Level-to-pulse conversion; 2: Pulse-to-level conversion

Input I2: 0, 1, DI input, and bit connector input

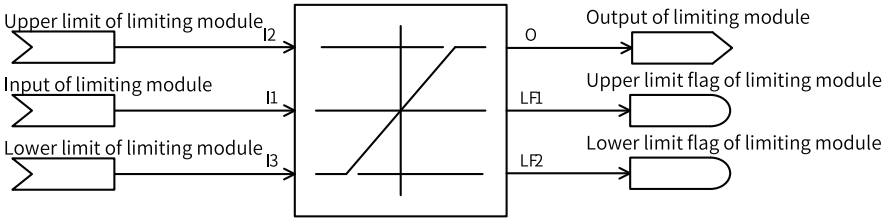
Input I3: Floating point number with two decimal places

Output O: Bit connector

Level-to-pulse Conversion Module	Input			Output
	I1	I2	I3	O
A	C6-24	C6-25	C6-26	L3-84
B	C6-27	C6-28	C6-29	L3-85
C	C6-30	C6-31	C6-32	L3-86
D	C6-33	C6-34	C6-35	L3-87

Limiting module (A to F)

1. **Diagram**



2. **Operation**

$$O=\begin{cases} I1, I3 \le I1 \le I2 \\ I2, I1 \ge I2 \\ I3, I1 \le I3 \end{cases}$$

$$LF1=\begin{cases} 0, I3 \le I1 \le I2 \\ 1, I1 \ge I2 \end{cases}$$

$$LF1=\begin{cases} 0, I3 \le I1 \le I2 \\ 1, I1 \le I3 \end{cases} \quad LF1=\begin{cases} 0, I3 \le I1 \le I2 \\ 1, I1 \le I3 \end{cases}$$

When the input I1 is higher than the upper limit I2, the output O is equal to I2, and the upper limit flag position LF1 is set to 1. When the input I1 is lower than the lower limit I3, the output O is equal to I3, and the lower limit flag position LF2 is set to 1. When the input l1 is within the range of the lower limit to the upper limit, the output is equal to the input.

3. **Connection**

Input I1, I2, and I3: AI, HDI, Aim, motorized potentiometer, PID, word connector input, and floating point connector input.

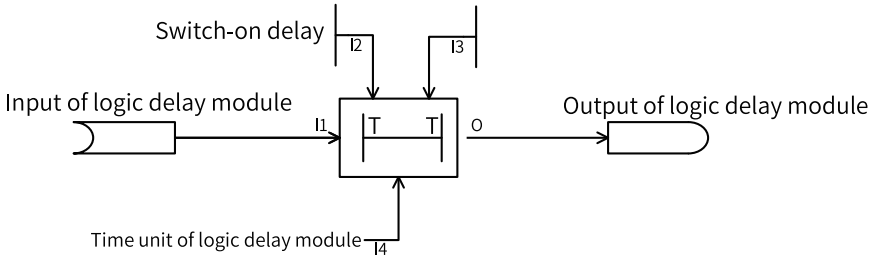
Output O: Double word connector and floating point connector

Output LF1 and LF2: Bit connector

Limiting Module	Input			Output		
	I1	I2	I3	O	LF1	LF2
A	C6-36	C6-37	C6-38	LD-27	L4-48	L4-49
B	C6-39	C6-40	C6-41	LD-28	L4-50	L4-51
C	C6-42	C6-43	C6-44	LD-29	L4-52	L4-53
D	C6-45	C6-46	C6-47	LD-30	L4-54	L4-55
E	C6-48	C6-49	C6-50	L9-19	L4-56	L4-57
F	C6-51	C6-52	C6-53	L9-20	L4-58	L4-59

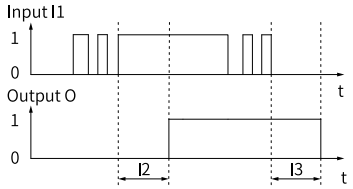
Logic delay module (A to H)

1. **Diagram**



2. **Operation**

The output O will delay for switch-on when the input I1 changes from low level to high level, and the delay time is determined by the I2 switch-on delay time and the I4 time unit. The output O will also delay for switch-off when the input I1 changes from high level to low level, and the delay time is determined by the I3 switch-off delay time and the I4 time unit. Pulse signals shorter than the delay time are filtered out during delay, as shown in the following figure.



3. **Connection**

Input I1: 0, 1, DI input, and bit connector input

Input I2 and I3: unsigned number

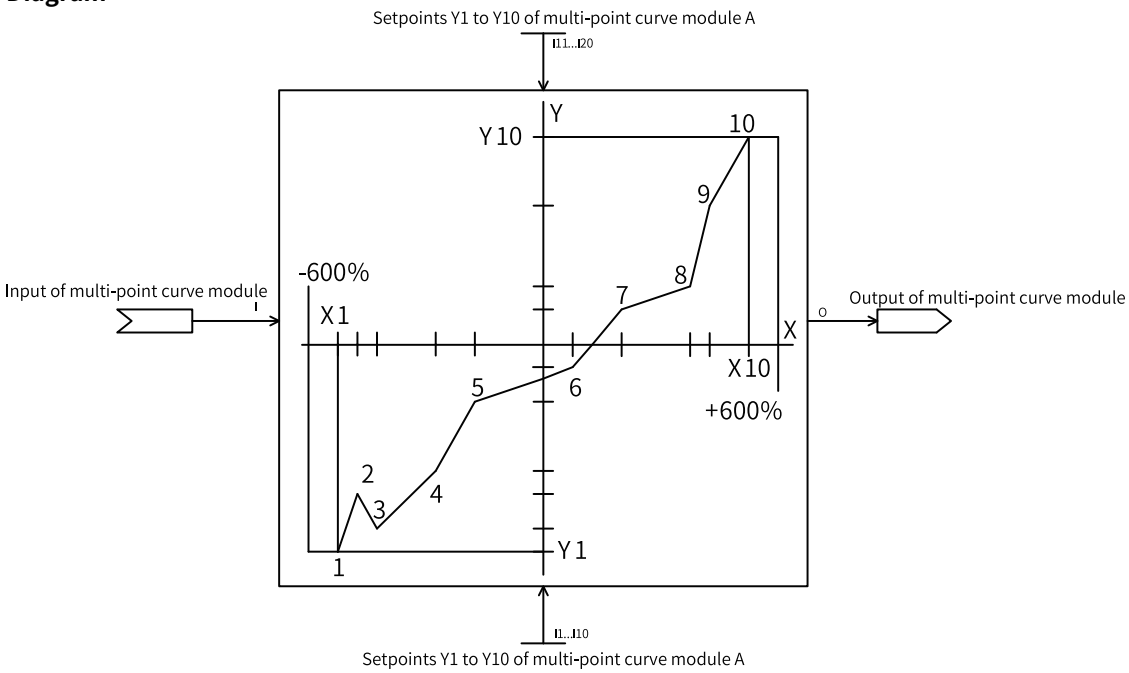
Input I4: 0: No delay: 1: 10 ms: 10: 100 ms; 100: 1s; 1000: 10s; 6000: 1 min; 12000: 2 min

Output (O): Bit connector

Logic Delay Module	Input				Output
	I1	I2	I3	I4	O
A	C6-54	C6-55	C6-56	C6-57	L3-20
B	C6-58	C6-59	C6-60	C6-61	L3-21
C	C6-62	C6-63	C6-64	C6-65	L3-22
D	C6-66	C6-67	C6-68	C6-69	L3-23
E	C6-70	C6-71	C6-72	C6-73	L3-24
F	C6-74	C6-75	C6-76	C6-77	L3-25
G	C6-78	C6-79	C6-80	C6-81	L3-26
H	C6-82	C6-83	C6-84	C6-85	L3-27

30.6.7 Multi-point curve

1. **Diagram**



2. **Operation**

The coordinate is valid only when X1 ⩽ X2 ⩽ · · · ⩽ X10 is satisfied. When the input is outside the active coordinate point, the output is equal to the ordinate value of adjacent valid coordinate point. When the input is within the valid coordinate point, the corresponding ordinate value is calculated based on the curve.

Assume that the coordinate is valid and number of coordinates inputted is lower than 10. If the last abscissa inputted is negative, the abscissa and the following abscissa whose value is 0 are kept, and the subsequent coordinate values are discarded. If the last abscissa inputted is positive, the abscissa is kept, and the subsequent coordinate values are discarded.

If the conditions of X1 ⩽ X2 ⩽ · · · ⩽ X10 is not satisfied, the drive reports L32.4 (limit-type fault). If two X coordinates are the same but the Y coordinates are different, the drive also reports L32.4 (limit-type fault).

3. **Connection**

Input I: Float point connector

Input I1 to I20: One decimal floating point number

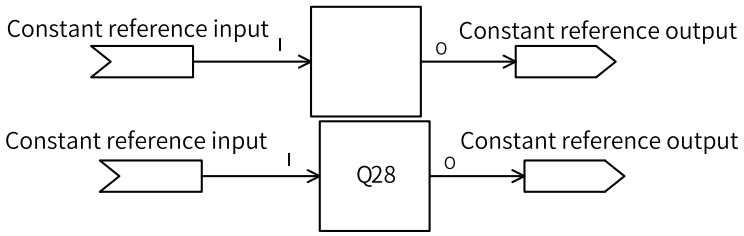
Output O: Floating point connector

Multi-point Curve Module		A	B
Input	I	C7-00	C7-21
	I1 (X1)	C7-01	C7-22
	I2 (X2)	C7-02	C7-23
	I3 (X3)	C7-03	C7-24
	I4 (X4)	C7-04	C7-25
	I5 (X5)	C7-05	C7-26
	I6 (X6)	C7-06	C7-27
	I7 (X7)	C7-07	C7-28
	I8 (X8)	C7-08	C7-29
	I9 (X9)	C7-09	C7-30
	I10 (X10)	C7-10	C7-31
	I11 (Y1)	C7-11	C7-32
	I12 (Y2)	C7-12	C7-33
	I13 (Y3)	C7-13	C7-34
	I14 (Y4)	C7-14	C7-35
	I15 (Y5)	C7-15	C7-36
	I16 (Y6)	C7-16	C7-37
	I17 (Y7)	C7-17	C7-38
	I18 (Y8)	C7-18	C7-39
	I19 (Y9)	C7-19	C7-40
	I20 (Y10)	C7-20	C7-41
Output	O	LD-46	LD-47

30.6.8 Constant Value

Constant value setting (1 to 42)

1. **Diagram**



2. **Operation**

O = I.

The output O equals the input I.

Constant value setting modules 1 to 5 are used to set floating point numbers with two decimal places. The setting range is -300.00 to +300.00.

Constant value setting modules 6 to 21 are used to set floating point numbers with one decimal place. The setting range is -3000.0 to +3000.0.

Constant value setting modules 22 to 26 are used to convert the input floating point number with two decimal places to the fixed point number for output through Q28. The setting range is -300.00 to +300.00.

Constant value setting modules 27 to 42 are used to set fixed point numbers. The setting range is 0 to 65535.

3. **Connection**

Input I: Unsigned number, floating point number with one decimal place, and floating point number with two decimal places

Output O: Word connector and floating-point connector

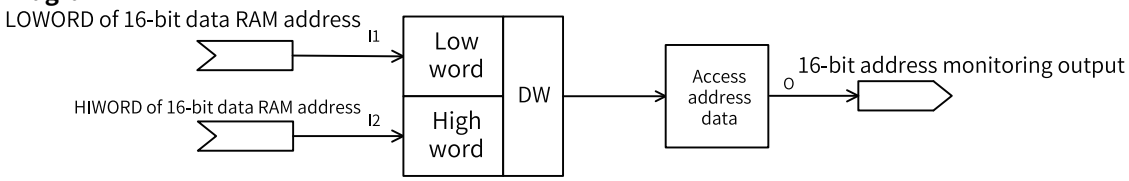
Constant Value Setting Module	Input	Output	Remarks
	I	O	
1	C8-00	LD-65	Floating point number with two decimal places
2	C8-01	LD-66	Floating point number with two decimal places
3	C8-02	LD-67	Floating point number with two decimal places
4	C8-03	LD-68	Floating point number with two decimal places
5	C8-04	LD-69	Floating point number with two decimal places
6	C8-05	LD-70	Floating point number with one decimal place
7	C8-06	LD-71	Floating point number with one decimal place
8	C8-07	LD-72	Floating point number with one decimal place
9	C8-08	LD-73	Floating point number with one decimal place
10	C8-09	LD-74	Floating point number with one decimal place
11	C8-10	LD-75	Floating point number with one decimal place
12	C8-11	LD-76	Floating point number with one decimal place
13	C8-12	LD-77	Floating point number with one decimal place
14	C8-13	LD-78	Floating point number with one decimal place
15	C8-14	LD-79	Floating point number with one decimal place
16	C8-15	LD-80	Floating point number with one decimal place
17	C8-16	LD-81	Floating point number with one decimal place
18	C8-17	LD-82	Floating point number with one decimal place
19	C8-18	LD-83	Floating point number with one decimal place
20	C8-19	LD-84	Floating point number with one decimal place

Constant Value Setting Module	Input	Output	Remarks
	I	O	
21	C8-20	LD-85	Floating point number with one decimal place
22	C8-21	L7-00	Floating point number conversion to fixed point number through Q28
23	C8-22	L7-01	Floating point number conversion to fixed point number through Q28
24	C8-23	L7-02	Floating point number conversion to fixed point number through Q28
25	C8-24	L7-03	Floating point number conversion to fixed point number through Q28
26	C8-25	L7-04	Floating point number conversion to fixed point number through Q28
27	C8-26	L7-05	Fixed point number
28	C8-27	L7-06	Fixed point number
29	C8-28	L7-07	Fixed point number
30	C8-29	L7-08	Fixed point number
31	C8-30	L7-09	Fixed point number
32	C8-31	L7-10	Fixed point number
33	C8-32	L7-11	Fixed point number
34	C8-33	L7-12	Fixed point number
35	C8-34	L7-13	Fixed point number
36	C8-35	L7-14	Fixed point number
37	C8-36	L7-15	Fixed point number
38	C8-37	L7-16	Fixed point number
39	C8-38	L7-17	Fixed point number
40	C8-39	L7-18	Fixed point number
41	C8-40	L7-19	Fixed point number
42	C8-41	L7-20	Fixed point number

30.6.9 Any Parameter Control

Any 16-bit data address monitoring (1–5)

1. **Diagram**



2. **Operation**

Enter I1 as the low word and I2 as the high word. Find the corresponding data through the 32-bit address and output it to O.

The address range allowed for monitoring is as follows:

0x20000000 to 0x2001FFFE

0x24000000 to 0x2404FFFE

3. **Connection**

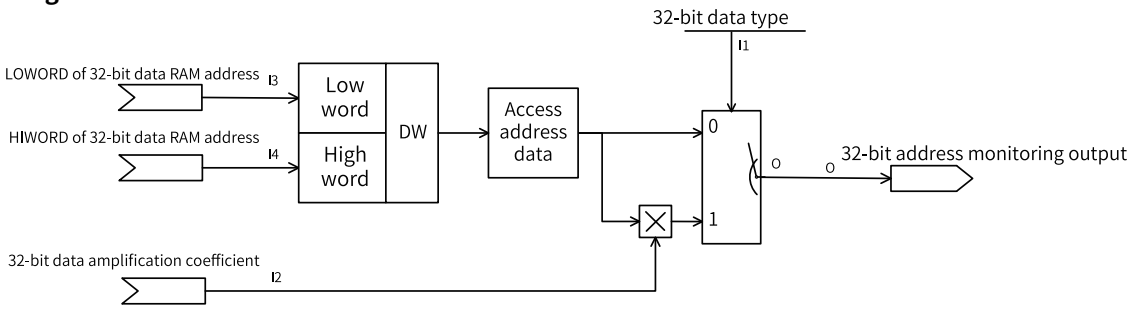
Input I1 and I2: hexadecimal unsigned number

Output O: word connector

16-bit Data Address Monitoring	Input		Output
	I1	I2	O
1	C9-00	C9-01	L7-36
2	C9-02	C9-03	L7-37
3	C9-04	C9-05	L7-38
4	C9-06	C9-07	L7-39
5	C9-08	C9-09	L7-40

Any 32-bit data address monitoring (1–5)

1. **Diagram**



2. **Operation**

Enter I1 as the low word and I2 as the high word. Find the corresponding data through the 32-bit address. If data type selection I3 is set to 0, the data is output directly to O. If data type selection I3 is set to 1, the data is output to O after being multiplied by the magnification factor I4.

The address range allowed for monitoring is as follows:

0x20000000 to 0x2001FFFC

0x24000000 to 0x2404FFFC

3. **Connection**

Enter I1 and I2, which are unsigned numbers.

Input I3 and I4: hexadecimal unsigned number

Output O: word connector

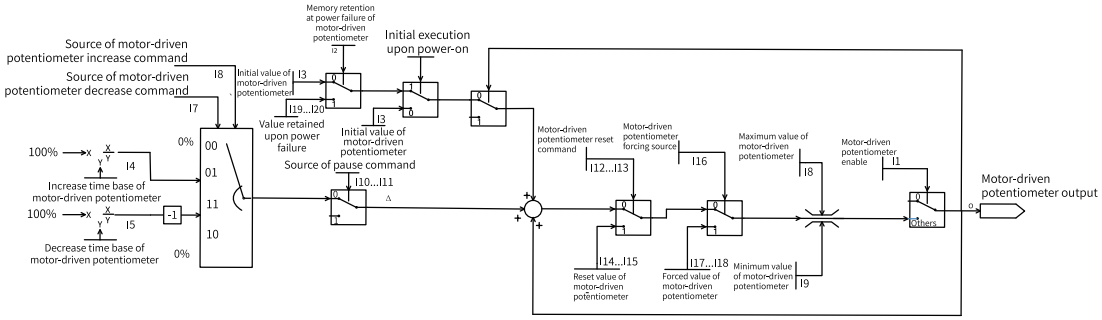
32-bit Data Address Monitoring	Input				Output
	I1	I2	I3	I4	O
1	C9-10	C9-11	C9-12	C9-13	L9-21
2	C9-14	C9-15	C9-16	C9-17	L9-22

32-bit Data Address Monitoring	Input				Output
	I1	I2	I3	I4	O
3	C9-18	C9-19	C9-20	C9-21	L9-23
4	C9-22	C9-23	C9-24	C9-25	L9-24
5	C9-26	C9-27	C9-28	C9-29	L9-25

30.6.10 Motorized Potentiometer

Constant value setting (1 to 42)

1. **Diagram**



2. **Operation**

- When I1 is 0, the motorized potentiometer is disabled and the output O is 0. When I1 is 1, the motorized potentiometer is enabled.
- When I2 is 1, the motorized potentiometer restores the values of I19 and I20 before power-off upon power-on for the first time. When I2 is 0, the motorized potentiometer restores the initial value of I3 upon power-on for the first time.
- When I1 is enabled and the value is not restored to the value memorized before power-off, the output O of the motorized potentiometer is the initial value of I3.
- When I6 is set to 1, the motorized potentiometer increases the output O based on the increasing time base set by I4. When I7 is set to 1, the motorized potentiometer decreases the output O based on the increasing time base set by I5.
- When the motorized potentiometer increases, the maximum value of the output O is I8. When the motorized potentiometer decreases, the minimum value of the output O is I9.
- When I10 and I11 are 1, the output O change pauses. When I10 and I11 become 0, the output O continues to change.
- When I12 and I13 are 1, the output O is reset to the specified value. If the reset value source I14 is 0, the output O is reset to the value specified by I15, which is the digital setting of the reset value. If the reset value source I14 is other values, the output O is reset to the value specified by I14.
- When I16 is 1, the output O is forced to the specified value. If the forced value source I17 is 0, the output O is forced to the value specified by I18, which is the digital setting of the force value. If the forced value source I17 is other values, the output O is forced to the value specified by I17.
- I19 and I20 are per unit values after the motor potentiometer output memory value is converted by Q28.

3. **Connection**

Input I: Unsigned number, floating point number with one decimal place, and floating point number with two decimal places

Output O: Word connector and floating-point connector

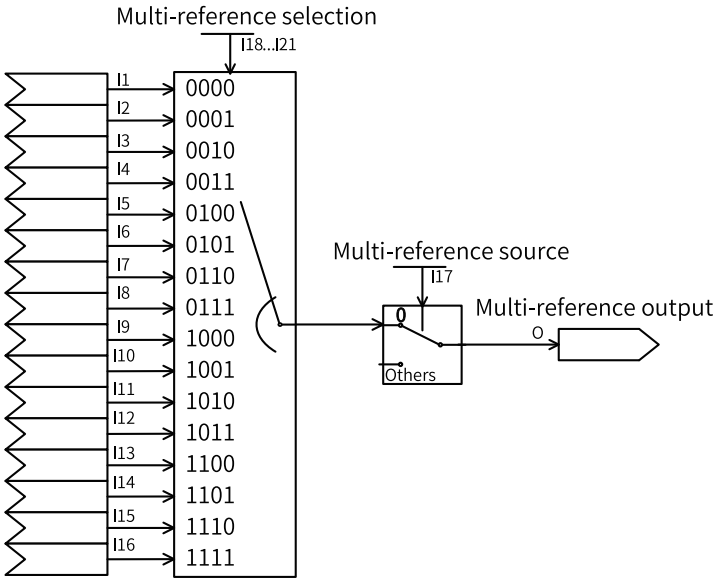
Motorized Potentiometer			Remarks
Input	I1	FB-20	Motorized potentiometer enable
	I2	FB-21	Retention at power failure of motorized potentiometer
	I3	FB-22	Initial value of motorized potentiometer
	I4	FB-23	Increasing time base of motorized potentiometer
	I5	FB-24	Decreasing time base of motorized potentiometer
	I6	FB-25	Source of motorized potentiometer increasing command
	I7	FB-26	Source of motorized potentiometer decreasing command
	I8	FB-27	Maximum value of motorized potentiometer output
	I9	FB-28	Minimum value of motorized potentiometer output
	I10	FB-29	Source 1 of motorized potentiometer pause command
	I11	FB-30	Source 2 of motorized potentiometer pause command
	I12	FB-31	Source 1 of motorized potentiometer reset command
	I13	FB-32	Source 2 of motorized potentiometer reset command
	I14	FB-33	Source of motorized potentiometer reset value
	I15	FB-34	Reset value digital setting of motorized potentiometer
	I16	FB-35	Source of motorized potentiometer force command
	I17	FB-36	Source of motorized potentiometer force value
	I18	FB-37	Force value digital setting of motorized potentiometer
	I19	FB-38	High-order bits of motorized potentiometer storage
	I20	FB-39	Low-order bits of motorized potentiometer storage

Motorized Potentiometer			Remarks
Output	O	LD-45	Final output value of motorized potentiometer
	ForceVal	LD-39	Force value of motorized potentiometer
	ResetVal	LD-40	Reset value of motorized potentiometer
	MaxVal	LD-41	Maximum value of motorized potentiometer
	MinVal	LD-42	Minimum value of motorized potentiometer
	InitVal	LD-43	Initial value of motorized potentiometer
	ProcessOutput	LD-44	Process operation output value of motorized potentiometer

30.6.11 Multi-reference

Multi-reference module

1. **Diagram**



2. **Operation**

When I17 for setting the multi-reference source is set to 0, combinations of bit values for I18 to I21 are used to set multi-reference 1 (I1) to multi-reference 16 (I16), and the corresponding multi-reference is output to O.

When I17 is set to a value other than 0, the corresponding value is output to O.

Multi-reference	I21 (bit 3)	I20 (bit 2)	I19 (bit 1)	I18 (bit 0)	Effective Value
Multi-reference 1	0	0	0	0	I1
Multi-reference 2	0	0	0	1	I2
Multi-reference 3	0	0	1	0	I3
Multi-reference 4	0	0	1	1	I4
Multi-reference 5	0	1	0	0	I5

Multi-reference	I21 (bit 3)	I20 (bit 2)	I19 (bit 1)	I18 (bit 0)	Effective Value
Multi-reference 6	0	1	0	1	I6
Multi-reference 7	0	1	1	0	I7
Multi-reference 8	0	1	1	1	I8
Multi-reference 9	1	0	0	0	I9
Multi-reference 10	1	0	0	1	I10
Multi-reference 11	1	0	1	0	I11
Multi-reference 12	1	0	1	1	I12
Multi-reference 13	1	1	0	0	I13
Multi-reference 14	1	1	0	1	I14
Multi-reference 15	1	1	1	0	I15
Multi-reference 16	1	1	1	1	I16

3. **Connection**

I1 to I16: One decimal floating-point number

I17: AI, pulse, PID, preset frequency, or floating point connector

I18 to I21: 0, 1, DI input value, or bit connector input value

Output O: Floating point connector or system information

Multi-reference			Output Connector	
Input	I1	FC-00	SetVal1	LD-49
	I2	FC-01	SetVal2	LD-50
	I3	FC-02	SetVal3	LD-51
	I4	FC-03	SetVal4	LD-52
	I5	FC-04	SetVal5	LD-53
	I6	FC-05	SetVal6	LD-54
	I7	FC-06	SetVal7	LD-55
	I8	FC-07	SetVal8	LD-56
	I9	FC-08	SetVal9	LD-57
	I10	FC-09	SetVal10	LD-58
	I11	FC-10	SetVal11	LD-59
	I12	FC-11	SetVal12	LD-60
	I13	FC-12	SetVal13	LD-61
	I14	FC-13	SetVal14	LD-62
	I15	FC-14	SetVal15	LD-63
	I16	FC-15	SetVal16	LD-64
	I17	FC-51	-	-
	I18	FC-55	-	-
	I19	FC-56	-	-
	I20	FC-57	-	-
	I21	FC-58	CurSel	FC-52/U2-05
Output	O	LD-48/FC-53/U2-06	-	-

30.7 Brake Control

Before the drive runs, the mechanical brake is used to block the motor and the driven device in the zero speed state.

The brake control logic conditions can be set through parameters in group A7. You can determine whether to enable brake control and whether feedback detection is enabled for brake through A7-00. When brake control is enabled, set relevant parameters based on the actual working conditions of equipment and load for effective control by the brake logic to achieve operation safety.

- If A7-00 is set to 2, the brake with feedback is selected and the system detects the brake feedback status set by A7-03. If the brake release feedback signal is not obtained within the time set by A7-04, a fault is reported, indicating that brake release fails.
- If A7-00 is set to 1, the brake is controlled by the time reference and the actual status is not detected.

A7-17, A7-18, and A7-19 can be used to set the brake release conditions. For example, you can set the brake to be released only when the output torque is greater than a specified value. This ensures that the gravity load does not slip at the moment of brake release. In particular, the system speed loop does not act and no torque is output before the brake release. Therefore, after setting the brake release conditions, set the starting torque through A7-06 to meet the brake release conditions.

30.7.1 Typical Brake Configuration

When using the brake, you can refer to the following typical configurations. The default values of parameters in group A7 are not listed in the following table.

1. Simple brake configuration

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information

2. The brake has no feedback and only has the start torque to avoid shorting stator during brake release.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-06	Start torque source in the vector control mode	2: Digital setting of start speed
A7-07	Digital setting of start torque	Set the parameter according to the estimated load weight.

3. The brake has no feedback and only has the start torque to avoid shorting stator during brake release.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.

Parameter Code	Parameter Name	Value Range
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-09	Start speed source	1: Digital setting of start speed
A7-10	Digital setting of start speed	Set the parameter according to the estimated load weight.

4. The brake has no feedback. The retentive torque is used as the start torque.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	1: With brake but without detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-06	Start torque source in the vector control mode	1: Retentive torque
A7-07	Digital setting of start torque	Use the torque set by A7-7 as the retentive torque when the motor is started for the first time. You can set the parameter according to the estimated load weight.
A7-08	Retentive start torque gain coefficient	Set it to 100% in normal scenarios. To adjust the proportion of the retentive torque, set this parameter.
A7-16	Brake release command source	This parameter specifies an external brake control condition. When it is set to 0, the brake cannot be released. When the brake is released, setting A7-16 to 0 will not close the brake.
A7-17	Comparison value source for brake release	This parameter specifies an additional condition for determining brake release. If A7-17 is set to 0, the condition is invalid. After A7-17 is set to a connector, the brake release condition is met, and the connector value is greater than the value of A7-18 for a duration set by A7-19, the brake will be released.
A7-18	Comparison threshold for brake release	
A7-19	Brake release delay	

5. The brake can be released only when the brake has feedback and the output torque is higher than 35% of the rated torque.

Parameter Code	Parameter Name	Value Range
A7-00	Brake function selection	2: With brake and detection information
A7-01	Brake release time	Set the parameter according to the actual brake release time.
A7-02	Brake close time	Set the parameter according to the actual brake close time.
A7-03	Brake feedback source	4: DI3. When the brake feedback source is set to DI3, the value 1 indicates brake release and 0 indicates brake close.
A7-06	Start torque source in the vector control mode	2: A7-07
A7-07	Digital setting of start torque	40% (the value must be greater than 35%)
A7-17	Comparison value source for brake release	LC-12 (output torque)

Parameter Code	Parameter Name	Value Range
A7-18	Comparison threshold for brake release	35%
A7-19	Brake release delay	0.2s (You can decrease this value to avoid fluctuation of measured value and to accelerate brake release.)

Note

If the brake release comparison condition is not set, the brake can be released after the set start torque is reached. However, the actual torque may be deviated.

6. Typical settings and problem handling

Brake release time setting:

- Short brake release time will cause severe brake wear, and overshooting may occur during brake release.
- Long brake release time will cause slow command response and shorting stator during the brake release.
- Set a short brake duration. Observe the output torque using an oscilloscope. When the torque drops significantly, the time when the brake release command is received to the time when the torque drops is the actual brake release time.

Brake close time setting:

- If the brake close time is too short, the torque will be canceled when the brake is not fully applied, causing the heavy load to slip.
- If the brake close time is too long, which may result in unstable control when the device runs at zero speed in the SVC speed.
- Set the brake close time to the brake release time. When the shorting stator braking mode occurs upon brake close, slowly increase the brake close time.

When the load slips upon brake release, do as follows:

- Increase the value of the speed loop gain by increasing the value of F2-00 and decreasing the value of F2-01 properly.
- Set A7-09 to 2 to set the brake start speed direction the same as the motor running direction, and set the brake start frequency through A7-10.
- Set the brake start torque through A7-06, A7-07, and A7-08, and adjust the brake start torque properly [Note 1].



- [Note 1]: The fixed brake starting torque is not suitable for machines with counterweight. Load changes may reverse the brake release speed.
- The brake feedback source is set to parameter interconnection, which can be any DI or bit connector.
- If the brake feedback source is the DI, check that the DI command from the feedback point source will not cause the AC drive to run or get faulty and ensure that the brake function is normal.

30.7.2 Time Sequence Diagram

- Vector control

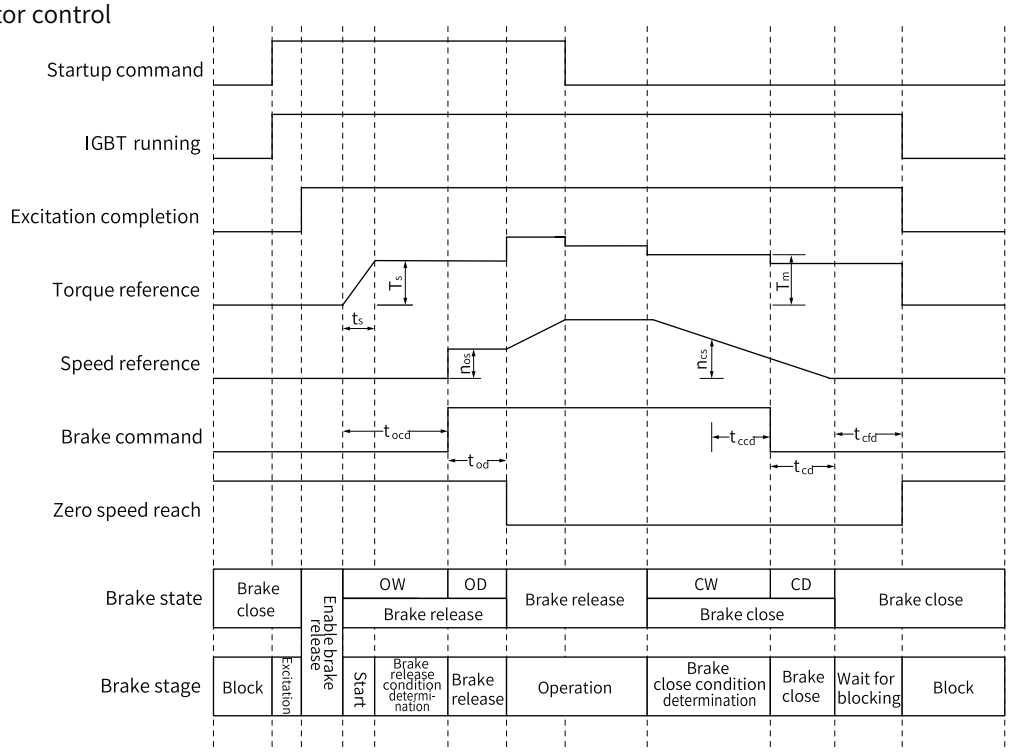


Figure 30-9 Brake time sequence

Abbreviation	Description	Abbreviation	Description
T_s	Starting torque upon brake release	T_m	Retentive torque upon brake close
n_{os}	Starting speed upon brake release	n_s	Speed threshold upon brake close
t_s	Acceleration time for brake starting torque	t_{ocd}	Comparison delay upon brake release
t_{od}	Brake release time	t_{ccd}	Brake close delay time
t_{cd}	Brake close time	t_{cfd}	Brake feedback fault delay time
OW	Brake release waiting time	OD	Brake release delay time
CW	Brake close waiting time	CD	Brake close delay time

- V/f control

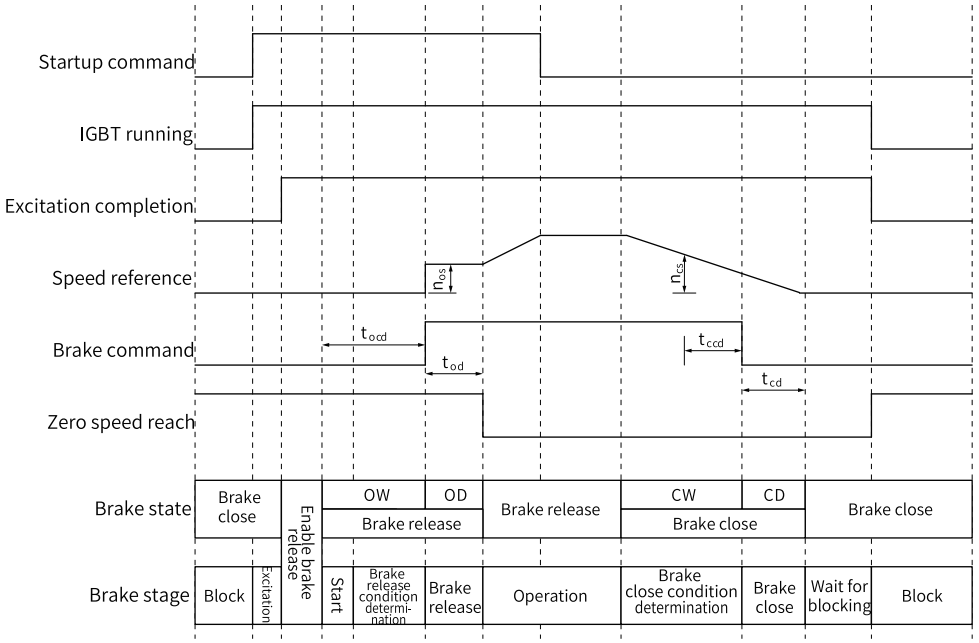


Figure 30-10 Brake time sequence

Abbreviation	Description	Abbreviation	Description
n_{os}	Starting speed upon brake release	n_{cs}	Speed threshold upon brake close
t_{ocd}	Comparison delay upon brake release	t_{od}	Brake release time
t_{ccd}	Brake close delay time	t_{cd}	Brake close time
OW	Brake release waiting time	OD	Brake release delay time
CW	Brake close waiting time	CD	Brake close delay time

30.7.3 Overview of Brake Stages

All brake actions can be performed only after the operating command is received and the motor is prepared. For asynchronous motors, brake starts after motor pre-excitation. For synchronous motors, brake starts after the motor magnetic pole angle is obtained.

In case of a fault or an emergency stop command, a brake that is being released immediately enters the closed stage and the brake close command is output.

Brake release and close are generally triggered by operating commands.

In case of OFF2 emergency stop, coast to stop, or that A7-11 is set to 1 at any time, the brake module immediately outputs the close signal (L4-76 = 0).

Parameter Code	Parameter Name	Description
A7-11	Forced brake close command source	0: Inactive 1: Immediately output brake close signal (L4-76 = 0)

Note

The brake force command is to forcibly close the brake. In this case, the device does not exit the running state and may output torque.

This function is generally used for brake force test. You can use the forced brake close command to test whether the brake mechanism meets the brake force requirements during high-speed operation.

It is recommended to use a customized fault when emergency stop is configured. In the emergency stop state, the brake module immediately outputs a close signal by reporting the fault and outputting the OFF2 emergency stop command. At the same time, the AC drive enters the stop state.

Brake release permission

The brake can proceed with the next stage only after the brake release permission command (A7-16) is activated. Brake release permission is enabled by default.

Brake release preparation stage

Brake release preparation stages include start torque establishment, brake release condition determination, and brake release.

1. Start torque establishment:
   This function is only valid in the vector control mode. To prevent shorting stator braking mode (for PMSM) upon brake release due to gravity load, sufficient torque is output based on the setting of A7-06. If A7-06 is set to 0, no torque is output before brake release.
2. Brake release condition determination:
   After the start torque is established, you can set A7-17 to A7-19 to add additional start conditions. By default, there is no additional condition. After the start torque is established, the brake release acts.
3. Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient)
   The start torque retentive value is the output torque upon previous braking.

   Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient)

   The start torque retentive value is the output torque upon previous braking.

   Set the start speed source.

   0: The start speed is disabled.

   1: The start speed is enabled. When the start speed is set to a positive value, the start speed direction is forward (positive frequency). When the start speed is set to a negative value, the start speed direction is reverse (negative frequency).

   2: The start speed is enabled. The absolute value of the start speed is that of A7-10 (digital setting of start speed). When the value of A7-10 (digital setting of start speed) is positive, the start speed direction is the same as the final operating direction of the motor. When the value of A7-10 (digital setting of start speed) is negative, the start speed direction is opposite to the final operating direction of the motor.

   Brake release:

   The brake release signal (L4-76 = 1) is output in this stage. In addition, the ramp function generator (RFG) is enabled. If A7-09 is valid, the RFG starts to accelerate from the speed indicated by A7-10. If A7-09 is invalid, the RFG starts to accelerate from 0.

Parameter Code	Parameter Name	Description	
A7-06	Start torque source in vector control mode	This parameter is used to set the start torque source in the vector control mode. 0: The start torque is disabled. 1: The start torque is enabled. The start torque is equal to the retentive torque (LC-69) multiplied by the retentive gain factor (A7-08). If no torque value is recorded, the function of option 1 equals that of option 2. 2: The start torque is enabled. The start torque value is determined by A7-07 (Digital setting of start torque).	
A7-07	Digital setting of start torque	When A7-06 (Start torque source in vector control mode) is set to 2, the start torque is the value of A7-07.	
A7-08	Retentive start torque gain coefficient	Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient) The start torque retentive value is the output torque upon previous braking.	
A7-09	Start speed source	This parameter is used to set the start speed source. 0: The start speed is disabled. 1: The start speed is enabled. When the start speed is set to a positive value, the start speed direction is forward (positive frequency). When the start speed is set to a negative value, the start speed direction is reverse (negative frequency). 2: The start speed is enabled. The absolute value of the start speed is that of A7-10 (digital setting of start speed). When the value of A7-10 (digital setting of start speed) is positive, the start speed direction is the same as the final operating direction of the motor. When the value of A7-10 (digital setting of start speed) is negative, the start speed direction is opposite to the final operating direction of the motor.	
A7-10	Digital setting of start speed	The starting speed value is the speed value corresponding to current per-unit parameter.	
A7-16	Brake release permission source	0: Inactive 1: Valid 2: Disable 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7	10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector

Parameter Code	Parameter Name	Description
A7-17	Comparison value source for brake release	If the value of A7-17 is higher than the value of A7-18 for the time longer than the value set by A7-19, the brake release applies.
A7-18	Comparison threshold for brake release	This parameter sets the comparison threshold for brake release.
A7-19	Brake release delay	This parameter sets the brake release delay time.

Note

Different values of A7-20 and A7-21 indicate different start torque during forward and reverse rotation, which meets different application requirements.

Brake release action stage

Brake release includes the brake detection stage and brake release completion stage.

- Brake detection stage: When receiving the brake release command, the device maintains the RFG output and waits for the completion of brake release.
  - If A7-00 is set to 1, the device waits for the duration set by A7-01 and exits this stage after the duration expires.
  - When A7-00 is set to 2 and the duration set by A7-01 expires, the feedback point of A7-03 is detected. If the feedback point is detected as low level, the device exits the state. If the feedback point detected keeps as high level for the duration longer that the value of A7-04, a fault will be triggered and the brake cannot be released.
- Brake release completion state: The RFG is enabled and the RFG output speed is allowed to increase based on the time reference. The brake output state remains unchanged unless the stop or brake closing command is received. If A7-00 is set to 2, whether the feedback point of A7-03 is at a low level will be always detected.

Brake close preparation stage

When the brake close command is received, the brake output is not immediately closed but enters the closing preparation stage.

- Brake close determination conditions: When the actual speed keeps lower than the value of A7-12 for the duration longer than the value of A7-13, or the ramp output speed keeps lower than the value of A7-14 for the duration longer than the value of A7-15 (0 indicates invalid condition), the brake closing conditions are met, and the retentive torque and brake output closing stage starts.

- Retentive torque: When A7-06 is set to 1, the torque before brake closing is memorized as the torque output for the next startup.
- Brake close: After the stage starts, the brake close signal (L4-76 = 0) is output and then the brake close action stage starts.

Brake close action stage

Brake close includes the brake close detection stage and brake close completion stage.

- Brake close detection stage: After the brake close command is received, the device waits for the completion of brake release. Before the brake is closed, the device keeps the current output to prevent the shorting stator braking mode.
  - If A7-00 is set to 1, the device waits for the duration set by A7-02 and exits this stage after the duration expires.
  - When A7-00 is set to 2 and the duration set by A7-02 expires, the feedback point of A7-03 is detected. If the feedback point is detected as high level, the device exits the state. If the feedback point detected keeps as low level for the duration longer than the value of A7-04, a fault will be triggered and the brake cannot be closed.
- Brake close completion: When the brake close is completed, the ramp output speed is forced to 0. The brake output remains at the closed state unless the operation or brake release command is received.

Blocking waiting stage

The blocking waiting stage starts from the time when the brake close command takes effect to the time when the motor speed reaches zero.

When the motor feedback speed keeps lower than the zero speed set by AA-14 for the time set by AA-15, the system determines that the motor reaches zero speed and the PWM output is blocked.

30.7.4 Common Function Descriptions

Start torque and start speed selection

The start torque is valid only in the vector control mode. Generally, different configurations can be selected based on the control mode, as shown below.

Control Mode	Start torque	Start Speed
FVC	Supported	Not supported
SVC	Supported	Supported and configurable
V/f	Supported	Not supported

For details on start torque automatic memory, see the section of "Automatic memory of start torque". Functions of parameters for start torque are the same as those for start torque, expect that start torque and start speed are used in different brake stages. Enable the start torque first and then the start speed. Assume that when the drive outputs a positive speed, the motor rotates in the forward direction. When the drive outputs a negative speed, the motor rotates in the reverse direction. The details are as follows:

- Digital setting: The motor start direction can only be set through related parameters and cannot be set through the forward/reverse rotation commands. If the digital setting value is positive, the motor rotates in the forward direction. If the digital setting value is negative, the motor rotates in the reverse direction.
- Determined by digital setting and motor running direction: When the digital setting value is positive, the motor rotation direction (start torque/speed phase) is consistent with the target speed direction. When the digital setting value is negative, the motor rotation direction (start torque/ speed phase) is opposite to the target speed direction. When the target speed is 0, the final stable running direction is determined by the running direction of the last non-zero speed. The speed direction of the first operation upon power-on is positive by default. For details, refer to the following table.

Digital Setting Value	Target Speed (Final Stable Running Direction)	Motor Running Direction (Start Torque/Speed Phase)
Positive	Positive	Forward
Positive	Negative	Reverse
Negative	Positive	Reverse
Negative	Negative	Forward run

Automatic memory of start torque

When A7-06 is set to 1, the internal torque memory function of the AC drive is activated. Upon each stop, the torque before brake closing is recorded and will be used as the start torque output upon the next startup. This reduces load drop during brake release. The automatic torque memory function can well adapt to load changes during operation.

When the function is used, a torque fault may occur during the stop process due to external brake faults.

When the automatic memory of start torque function is activated for the first time, the initial value of the torque is the value of A7-07.

The A7-08 parameter can be set to adjust the coefficient for automatic torque memory. If A7-08 is set to 80% and the retentive torque during the stop process is 50%, the start torque will be 40%.

Excitation disabling delay

To improve the working efficiency of asynchronous motors, users may want to keep continuous output of motor exciting current for a period even if the brake is closed during the stop process. In this way, when users start motors again within a short period, the brake can directly run without need of motor excitation (excitation time for some motors may take 3s to 5s).

When the motor feedback speed keeps lower than the zero speed set by AA-14 for the time set by AA-15, the motor reaches zero speed, and PWM output is blocked. Therefore, if the value of AA-15 increases, excitation can last longer after the motor reaches the zero speed, eliminating the need for excitation upon next brake release.

In addition, if the brake close action time set by A7-02 is increased, the brake module can force the brake to output current, keeping excitation for a period after stop.

Parameter Code	Parameter Name	Description
AA-14	Zero-speed threshold	This parameter defines the threshold for motor zero speed during deceleration to stop. An excessively low setpoint may cause the motor stop failure when the motor speed is near zero but exceeds this threshold. An excessively high setpoint may cause the motor to rotate when the drive output has been blocked. Set this parameter based on the actual stop performance. 100.0% corresponds to rated motor frequency.
AA-15	Zero speed determination time	The drive blocks output when the motor actual speed keeps lower than the zero speed threshold during deceleration to stop after the period defined by this parameter elapses.

Start torque restriction

In some lifting load scenarios, the brake can be released only when the load torque is greater than the threshold for security reasons. The speed loop does not act before the brake release. Therefore, the torque cannot be output even if the speed is specified. In this case, set A7-06 for the start torque. The torque can be measured by using two methods:

1. Use the comparison function of A7-17 for AC drive detection. Set A7-06 to a start torque value higher than the threshold, set A7-17 to the output torque indicated by LC-12, set A7-18 to the comparison threshold, and set A7-19 to the delay time. When the absolute value of A7-17 keeps greater than the value of A7-18 for the time longer that the value of A7-19, the AC drive enters the brake release state.
2. The torque is detected on the PLC. After the conditions are met, the PLC transmits a status bit to the AC drive through communication. Set A7-06 to a start torque value higher than the threshold, and then set A7-16 to the received PLC status bit. After the operating command is received, the AC drive does not enter the brake release state until the bit is set to 1. When the brake is released, setting A7-16 to 0 will not close the brake.

Note

When torque detection is not configured, the system enters the next stage when the set starting torque reaches the target value. In this case, the actual output torque may be slightly deviated.

30.7.5 Related Parameters

Parameter Code	Parameter Name	Value Range	Description
A7-00	Brake function selection	0: Disable brake 1: Enable brake without detection information 2: Enable brake with detection information	This parameter is used to set the brake function. 0: Disable brake 1: Enable brake without detection information 2: Enable brake with detection information
A7-01	Brake release time	0.00s to 30.00s	This parameter specifies the duration from brake close to brake release, that is, the action time of the brake mechanism. As the brake mechanism ages, the action time increases. In this case, adjust this parameter according to the actual mechanism response speed.

Parameter Code	Parameter Name	Value Range	Description
A7-02	Brake close time	0.00s to 30.00s	This parameter specifies the duration from brake release to brake close, that is, the action time of the brake mechanism. As the brake mechanism ages, the action time increases. In this case, adjust this parameter according to the actual mechanism response speed.
A7-03	Brake feedback source	0: Invalid 1: Valid 2: Invalid 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7 10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector	When there is brake feedback, you need to set the brake feedback source, which can be the DI or bit connector.
A7-04	Brake feedback fault delay time	0.00s to 30.00s	After the brake acts and the AC drive does not receive feedback within the time set by this parameter, the AC drive considers that the brake mechanism is abnormal and reports a brake fault.
A7-05	Start torque direction	0: Digital setting 1: Determined by digital setting and motor operating direction	This parameter is used to set the start torque direction. 0: The start torque is determined by the value of A7-07 (digital setting of start torque). A positive value indicates positive torque and a negative value indicates negative torque. 1: The absolute value of the start torque is that of A7-07 (digital setting of start torque). When the value of A7-07 is positive, the start torque direction is consistent with the final operating direction of the motor. When the value of A7-07 is negative, the start torque direction is opposite to the final operating direction of the motor.

Parameter Code	Parameter Name	Value Range	Description
A7-06	Start torque source in the vector control mode	0: Disable 1: Retentive torque 2: Digital setting Others: F connector	This parameter is used to set the start torque source in the vector control mode. 0: The start torque is disabled. 1: The start torque is enabled. The start torque is equal to the retentive torque (LC-69) multiplied by the retentive gain factor (A7-08). If no torque value is recorded, the function of option 1 equals to that of option 2. 2: The start torque is enabled. The start torque value is determined by A7-07 (Digital setting of start torque).
A7-07	Digital setting of start torque	-200.0% to 200.0%	When A7-06 (Start torque source in the vector control mode) is set to 2, the start torque is the value of A7-07.
A7-08	Retentive start torque gain coefficient	0.0% to 300.0%	Start torque = LC-69 (Start torque retentive value) x A7-08 (Start torque retentive gain coefficient) The start torque retentive value is the output torque upon previous braking.
A7-09	Start speed source	0: Disable 1: Digital setting of start speed 2: Determined by digital setting of start speed and motor operating direction	This parameter is used to set the start speed source. 0: Disable 1: The start speed is enabled. When the start speed is set to a positive value, the start speed direction is forward (positive frequency). When the start speed is set to a negative value, the start speed direction is reverse (negative frequency). 2: The start speed is enabled. The absolute value of the start speed is that of A7-10 (digital setting of start speed). When the value of A7-10 (digital setting of start speed) is positive, the start speed direction is the same as the final operating direction of the motor. When the value of A7-10 (digital setting of start speed) is negative, the start speed direction is opposite to the final operating direction of the motor.
A7-10	Digital setting of start speed	-30.0% to 30.0%	The start speed is the speed corresponding to the current per-unit value parameter.

Parameter Code	Parameter Name	Value Range	Description
A7-11	Forced brake close command source	0: Invalid 1: Valid 2: Invalid 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7 10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector	This parameter is used to set the forced brake close command source to force brake close. The brake closes forcibly when a forced brake command is sent in any stage. 0: Disable forced brake close 1: Enable forced brake close 2: Disable forced brake close 3 to 18: The DI is used to set whether to enable forced brake close. If the terminal is active, the forced brake command takes effect. Otherwise, the forced brake command is invalid. Others: The parameter connected to B connector is used to set whether to enable forced brake close.
A7-12	Actual speed monitoring threshold for brake close	0.0% to 100.0%	When the feedback speed reaches the value of A7-12 (Actual speed monitoring threshold for brake close) for the duration set by A7-13 (Actual speed monitoring time for brake close), the brake close starts.
A7-13	Actual speed monitoring time for brake close	0.00s to 300.00s	
A7-14	Set speed monitoring threshold for brake close	0.0% to 100.0%	When the set speed reaches the value of A7-14 (Set speed monitoring threshold for brake close) for the duration of A7-13+A7-15, the brake close starts.
A7-15	Set speed monitoring time for brake close	0.00s to 60.00s	

Parameter Code	Parameter Name	Value Range	Description
A7-16	Brake release permission source	0: Invalid 1: Valid 2: Invalid 3: DI1 4: DI2 5: DI3 6: DI4 7: DI5 8: DI6 9: DI7 10: DI8 11: DI9 12: DI10 13: DI11 14: DI12 15: DI13 16: DI14 17: DI15 18: DI16 Others: B connector	This parameter is used to set the source for brake release permission commands.
A7-17	Comparison value source for brake release	0: Disable 1: AI1 2: AI2 3: AI3 4: HDI 5: Aim 6: Multi-reference output 7: Motorized potentiometer output 8: PID Others: F connector	If the value of A7-17 is higher than the value of A7-18 for the time longer than the value set by A7-19, the brake release applies.
A7-18	Comparison threshold for brake release	0.0% to 300.0%	This parameter sets the comparison threshold for the brake release delay time.
A7-19	Brake release delay	0.00s to 30.00s	This parameter defines the brake release delay time.

31 Parameter List

For complete information on parameters and fault codes, see *MD520 Series General-Purpose AC Drive Parameter Guide.*

32 Routine Maintenance

32.1 Routine Check

32.1.1 Daily Checklist

The ambient temperature, humidity, dust, and vibration will cause aging of components inside the drive, which leads to potential faults and shortens the service life of the drive. Therefore, routine maintenance on the device is required. The maintenance interval must be shortened when the drive is used in environments suffering from high ambient temperature, frequent startup and stop, violent fluctuation in the AC power supply and the load, strong vibration or shock, and intrusive and corrosive substances such as dust, metal dust, and hydrochloric acid.

Check the following items daily to ensure a proper operation of the device. It is recommended to make a copy of this checklist and sign the "Checked" column after each inspection.

Item	Content	Solution	Checked
Motor	Check for unusual vibration or noise.	• Check whether the mechanical connection is normal. • Check whether phase loss occurs on the motor. • Check whether motor screws are tightened.	
Fan	Check whether the fan of the AC drive and motor operates normally.	• Check whether the fan of the AC drive operates properly. • Check whether the fan of the motor operates properly. • Check whether the air duct is blocked. • Check whether the ambient temperature is within the permissible range.	
Installation environment	Check whether the control cabinet and cable ducts are normal.	• Check for insulation damage of input and output cables. • Check the mounting bracket for vibration. • Check whether copper bars and terminals become loose or get corroded.	
Load	Check whether the operating current of the drive exceeds the rated current of the drive and motor.	• Check for settings of motor parameters. • Check whether the motor is overloaded. • Check whether the mechanical vibration is severe (normal condition: < 0.6 g).	
Input voltage	Check whether the power supply voltage between the main circuit and control circuit is normal.	• Check whether the input voltage is within the permissible range. • Check whether heavy load starts around.	

32.1.2 Regular Checklist

The following shows items to be checked every one or two years. Determine the actual inspection cycle based on actual application and operating environment. Regular maintenance helps detect product function deterioration and damage.

Make a copy of the following checklist and sign the "Checked" column after each inspection.

Caution

Do not perform inspection or connection work with power on. Failure to do so may result in an electric shock. Cut off the power supplies of all equipment before wiring or repair. Wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safety voltage range. Failure to do so may result in an electric shock.

Item	Content	Solution	Checked
AC drive	Check for waste, dirt and dust on the surface of the drive.	• Check whether the controller cabinet has been powered off. • Use a vacuum cleaner to suck up waste and dust to prevent direct contact with the components. • Wipe the surface dirt that is difficult to clean with alcohol and wait until the surface becomes dry.	
Cable	• Check power cables and connections for discoloration. • Check whether the insulation is aged or cracked.	• Replace the cracked cable. • Replace the damaged terminals.	
Peripherals of the electromagnetic contactor	• Check whether the contactor closes tightly or generates unusual noise during closing. • Check whether short circuit, water seepage, swelling, or cracking occurs on any peripheral device.	Replace the abnormal components.	
Air duct	• Check whether the air duct and heatsink are blocked. • Check whether the fan is damaged.	• Clean the air duct. • Replace the fan.	
Control circuit	• Check whether control components are in poor contact. • Check whether terminal screws are loose. • Check whether the insulation of the control cable is cracked.	• Remove foreign objects on the surface of control cables and terminals. • Replace the damaged or corroded control cables.	

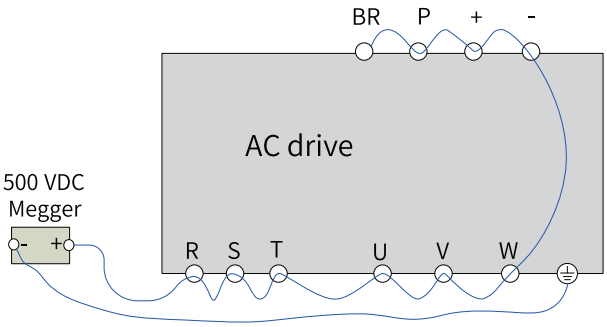
32.2 Main Circuit Insulation Test

Danger

The high voltage (> 500 V) test need not be performed again because it has been completed before delivery.

Remove the voltage dependent resistor screw before test and disconnect the voltage dependent resistor.

Before measuring insulation resistance with a megameter (500 VDC megameter recommended), disconnect the main circuit from the AC drive. Do not use the insulation resistance meter to test the insulation of the control circuit. See the following figure.



The measured insulation resistance must be greater than 5 MΩ.

Caution

Disconnect the optional grounding screw of VDR before performing a voltage resistance test. Otherwise, the test may fail.

32.3 Quick-Wear Parts Replacement

32.3.1 Service Life of Quick-Wear Parts

The quick-wear parts of the AC drive include the cooling fan and filter electrolytic capacitor. The service life of such devices is closely related to the operating environment and maintenance conditions. Generally, the service life is as follows.

Name	Service Life [Note]
Fan	⩾ 5 years
Filter electrolytic Capacitor	⩾ 5 years
Note: The service life indicates the time when the part is used in the following conditions. You can determine when to replace the part according to the actual operating time. Ambient temperature: 40°C Load rate: 80% Operating rate: 24 hours per day	

32.3.2 Replacing the Cooling Fan

Cooling fans

- Possible causes of damage: bearing wear or blade aging
- Criteria for determining the fan damage: cracks on the blade, unusual vibration noise upon start, and improper operation of fan blades
- Replacement of the fan: Press the snap-fit joint on the fan plastic cover and pull the fan outward. After replacing the fan, ensure the fan blows the air upwards.

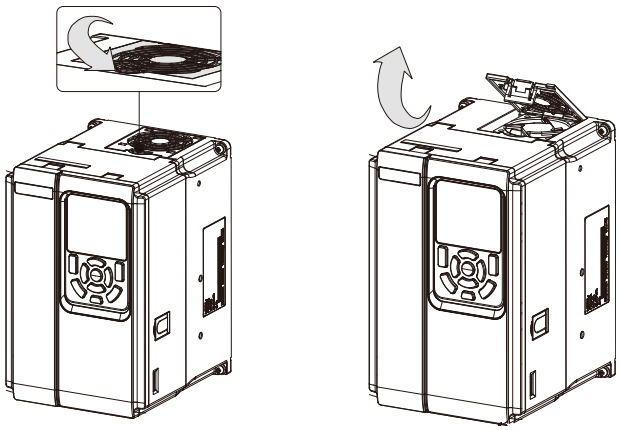
Table 32–1 Number of cooling fans

Structure	Number of Cooling Fans
T1 (0.4 kW to 1.1 kW)	-
T1 (1.5 kW to 3.0 kW) T2 T3 (7.5 kW) T5 to T7	1
T3 (11 kW) T4 T8 to T10	2
T11 to T12	3
T13	2

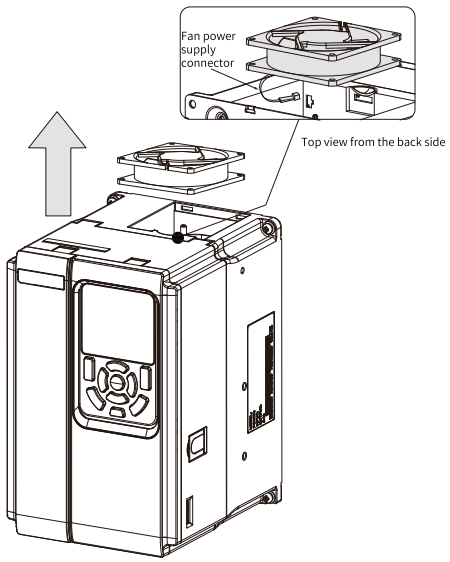
Removing and installing the fan of T1 to T6 models

Removing the fan

Step 1. Press the snap-fit joint on the fan cover and remove the cover.



Step 2. Pull the fan upwards and unplug the power cable connector from the socket.

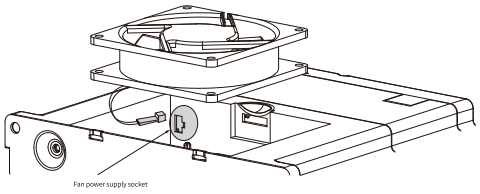


Installing the fan

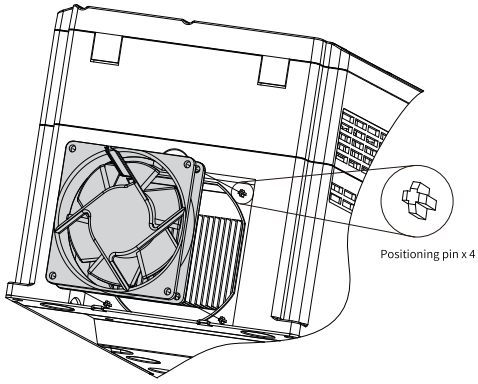
Note

- Install the fan in the reverse order of removal and ensure the correct direction of the fan.
- The fan should rotate clockwise to blow air into the motor air duct when viewed from the rear cover of the fan.

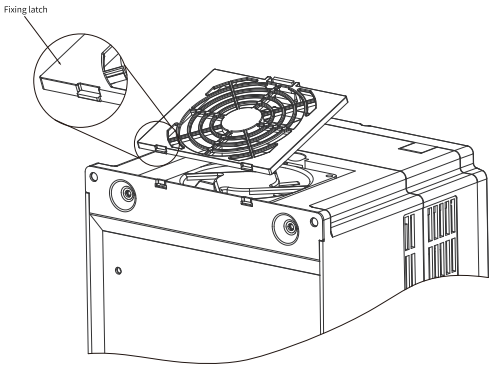
Step 1. Plug the fan power cable connector to the socket.



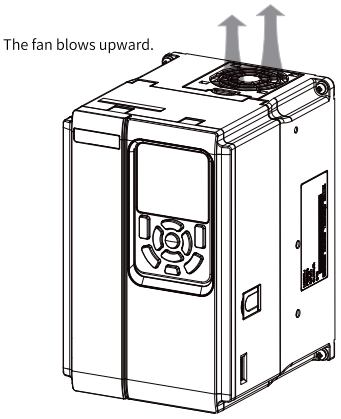
Step 2. Install the fan into the drive, with the four fixing holes at the bottom of the fan aligned with the positioning pins.



Step 3. Insert the two small snap-fit joints on the fan cover into the slot and then press down to fix the snap-fit joints.



Step 4. After replacing the fan, ensure the fan blows the air upwards.



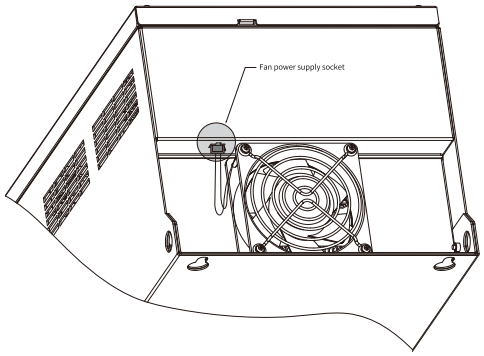
Removing and installing the fan of T7 to T9 models

Note

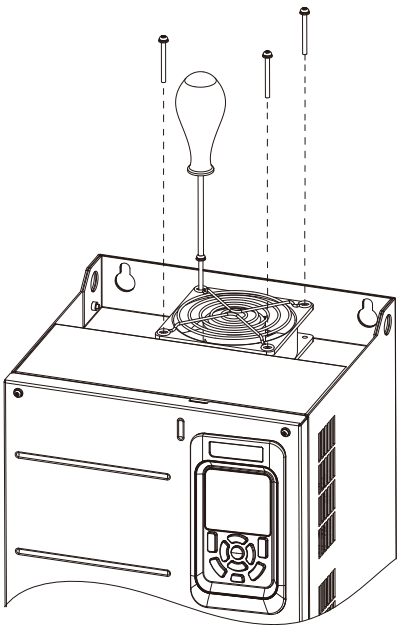
The number and location of cooling fans vary with product models, but the fans are removed and installed in the same way.

Removing the fan

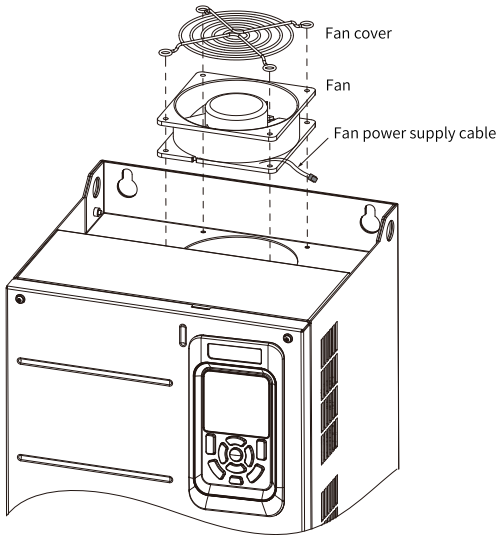
Step 1. Disconnect the power cable connector of the fan (top view).



Step 2. Remove the four fixing screws on the fan cover with a screwdriver.



Step 3. Remove the fan and fan cover from the drive.

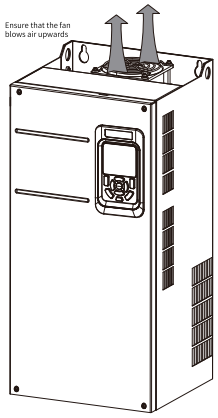


Installing the fan

Step 1. Install the fan in the reverse order of removal and ensure the correct direction of the fan.

Step 2. Align the fixing holes of the fan cover and the fan with those on the drive during installation.

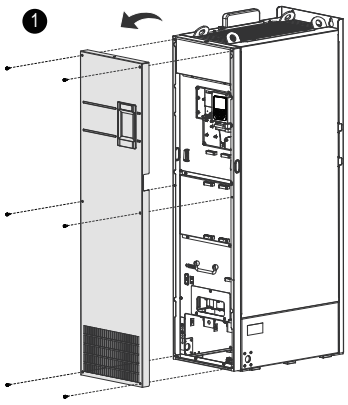
Step 3. After replacing the fan, ensure the fan blows the air upwards.



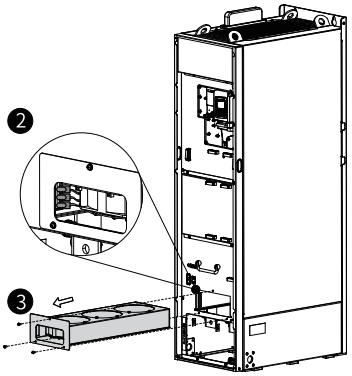
Removing and installing the fan of T10 to T12 models

Removing the fan

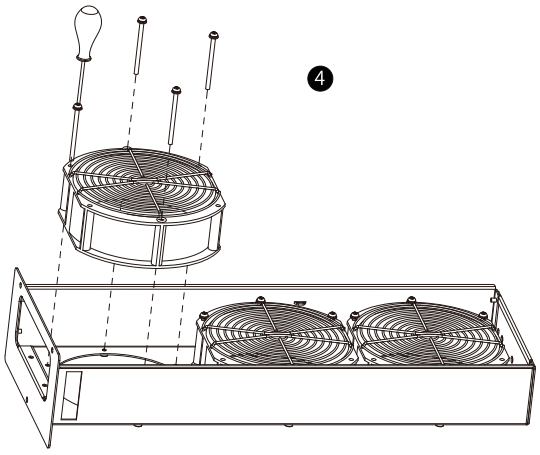
Step 1. Remove the six fixing screws on the cover. Then, hold the cover with both hands and lift it up in the direction indicated by the arrow to remove the cover.



Step 2. Disconnect the power cable connectors of all fans. Remove the three fixing screws from the fan box and pull out the fan box in the direction indicated by the arrow.



Step 3. Remove the four fixing screws from each fan cover and remove the fan.

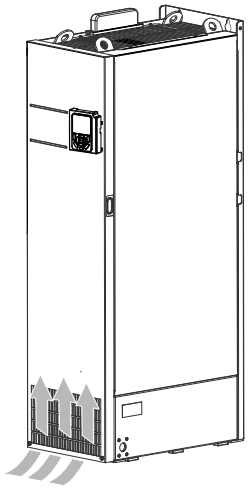


Installing the fan

Step 1. Install the fan in the reverse order of removal and ensure the correct direction of the fan.

Step 2. Align the fan box with the rail and push it into the drive.

Step 3. Connect the fan power cable connector first and then fix the fan box. After replacing the fan, ensure the fan blows the air upwards.



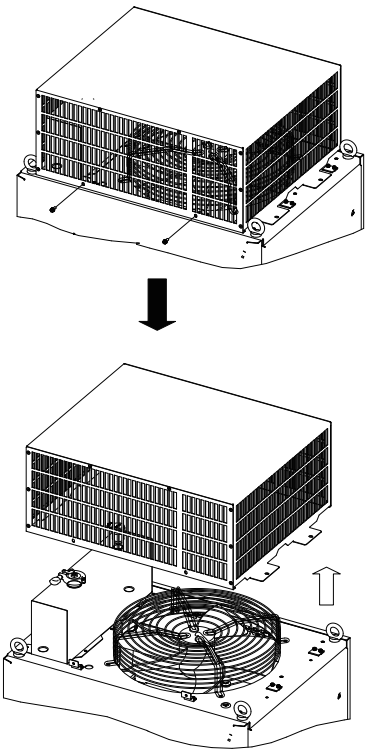
Removing and installing the fan of T13 models

Note

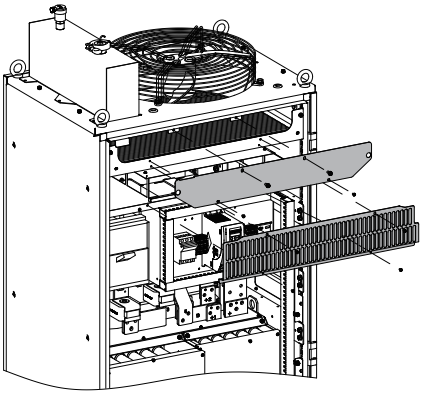
T13 models have a top-mounted fan and a cabinet-mounted AC drive fan. Their removal and installation are described below.

Removing the fan on the top

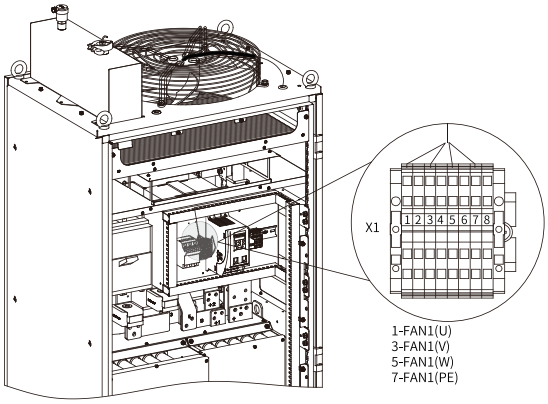
Step 1. Remove the two fixing screws from the top cover at the front, slide forward the protective cover with two hands along the guide for about 20 mm, and lift it up to remove the protective cover.



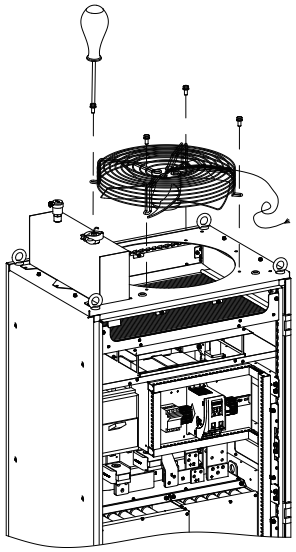
Step 2. Remove the baffle plate as shown in the figure.



Step 3. Disconnect the cables connecting the X1 terminal block to the top-mounted fan and pull out the cables from the wiring tray. Remove cables of terminals 1, 3, 5, and 7 only.



Step 4. Remove the four fixing screws from the top-mounted fan and take out the fan from the AC drive.



Installing the fan on the top

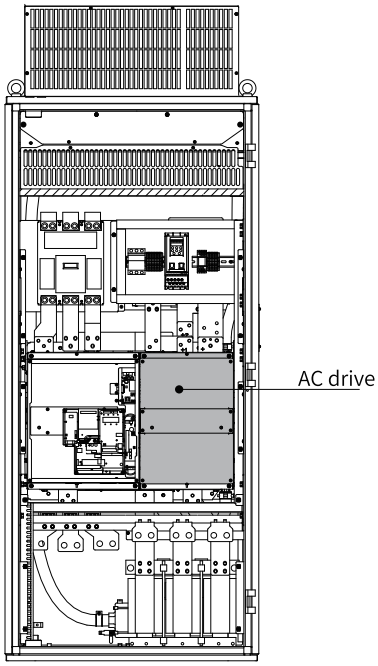
1. Reinstall the fan in the reverse order of removal.

2. Route fan cables according to the wiring diagram.

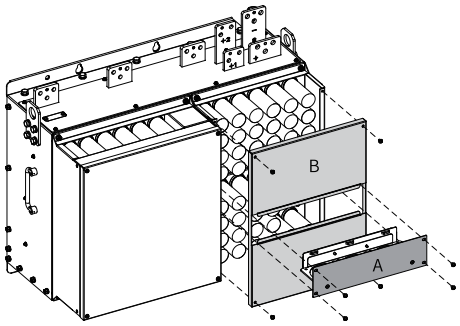
3. Connect the cables to terminals 1, 3, 5, and 7 of the X1 terminal block.

Removing the AC drive fan in the cabinet

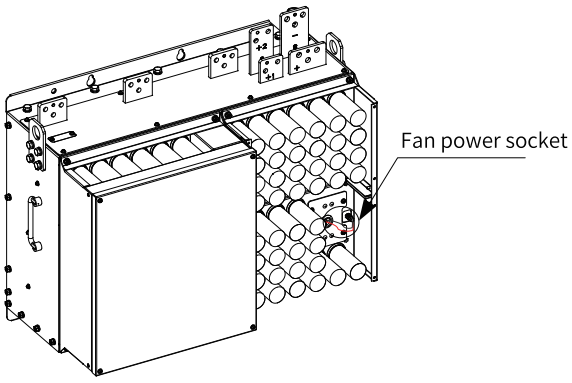
Step 1. Open the cabinet door to locate the AC drive, which is shown in the following figure.



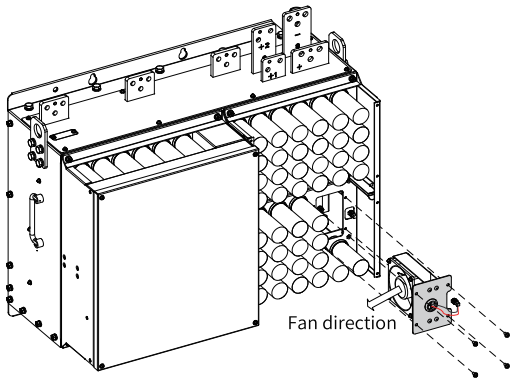
Step 2. Remove baffle plates A and B in sequence from the AC drive.



Step 3. Unplug the fan power cable connector from the socket.



Step 4. Remove the four fixing screws from the fan and take out the fan from the AC drive. Note that the fan direction is from right to left.



Installing the AC drive fan in the cabinet

1. Install the fan in the reverse order of removal. Pay attention to the direction of the fan.

2. When installing the fan to the AC drive, align the mounting holes as indicated by the dotted lines in removal step 4.

3. After replacement, check the air flow direction.

32.3.3 Replacing the Filter Electrolytic Capacitor

- Possible damage causes: input power supply in poor quality, high ambient temperature, frequent load jumping, and electrolytic aging
- Condition to determine whether the capacitor needs to be replaced: 1) Check whether there is liquid leakage. 2) Check whether the safety valve has protruded. 3) Measure the static capacitance and the insulation resistance.
- Replacement: As the capacitor involves the internal parts, never replace the capacitor by yourself. Contact Inovance for replacement.

32.4 Storage and Warranty

Storage

To store the AC drive properly, observe the following:

- Store the AC drive with the original packing carton provided by Inovance.
- Do not expose the AC drive to environments with moisture, high temperatures, or direct sunlight for a long time.

- The electrolytic capacitor will deteriorate after long-term storage. Therefore, switch on the AC drive once for at least 5 hours every 6 months. Increase the input voltage slowly to the rated value by using a voltage regulator. Contact Inovance for technical support if necessary.

Warranty

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

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

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

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

For details, see Product Warranty Card.

33 Solutions to Common EMC Problems

33.1 Residual Current Device Malfunction

When the residual current device (RCD) malfunctions, perform troubleshooting according to the following table.

Table 33–1 Solution for leakage current

Tripping	Possible Cause	Solution
Trip upon power-on	The anti-interference performance of the RCD is poor.	1 Use a RCD of a recommended brand. 2 Use a RCD with a higher tripping current. 3 Move the unbalanced load to the front end of the RCD. 4 Remove the EMC screw or disconnect the grounding terminal of the external EMC filter to reduce the capacitance of the input end to the ground.
	The action current of the RCD is too low.	
	Unbalanced load is connected to the rear end of the RCD.	
	The capacitance to the ground at the front end of the AC drive is large.	
Trip during operation	The anti-interference performance of the RCD is poor.	1 Use a RCD of a recommended brand. 2 For an individual AC drive, tighten the EMC screw. For multiple AC drives, disconnect the optional EMC grounding screw, as shown in *"Figure 33–1 Disconnecting the optional EMC grounding screw" on page 913*. 3 Install a simple filter on the input side of the drive, and wind the LN/RST cables through a magnetic ring near the RCD, as shown in *"Figure 33–2 Installing a simple filter and magnetic ring on the input side" on page 914*. 4 Use a RCD with a higher rated tripping current. 5 Reduce the carrier frequency while ensuring performance. 6 Use shorter motor cables.
	The action current of the RCD is too low.	
	Unbalanced load is connected to the rear end of the RCD.	
	For motor cables and the motor, the distributed capacitance to ground is too high.	

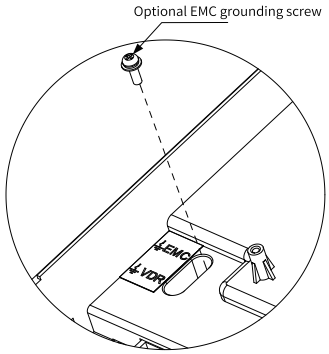


Figure 33-1 Disconnecting the optional EMC grounding screw

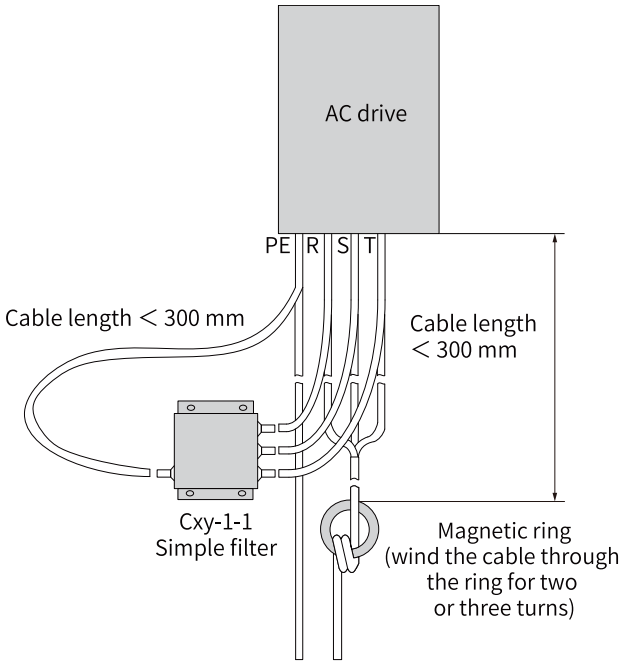


Figure 33-2 Installing a simple filter and magnetic ring on the input side

33.2 Harmonic Suppression

To suppress high-order harmonics of the drive and improve the power factor, install an AC input reactor on the input side of the equipment to meet standard requirements.

33.3 I/O Signal Interference

33.3.1 High-Speed Pulse Interference

In the case of interference, take the following rectification measures.

Step	Solution
1	Use shielded twisted pair cables and ground the cables at both ends.
2	Connect the PE terminal of the AC drive to the motor housing.
3	Connect the PE terminal of the AC drive to that of the power grid.
4	Add an equipotential bonding grounding cable between the host controller and the AC drive.
5	Separate signal cables from power cables with a distance of at least 30 cm.
6	Add a ferrite clamp to the signal cable, or add a magnetic ring and wind the signal cable through the magnetic ring for one to two turns.
7	Install a magnetic ring to the U, V, and W output cables at the drive side and wind the cables through the magnetic ring for two to four turns.
8	Use a shielded power cable and properly ground its shield.

33.3.2 Common I/O Signal Interference

The drive generates strong interference during operation, which may interfere with other devices due to improper wiring or grounding. When the drive interferes with or is interfered by other devices, adopt the following measures.

Procedure	Solution
1	Use shielded cables as I/O signal cables and connect the shield to the PE terminal.
2	Connect the PE terminal of the motor to that of the drive, and connect the PE terminal of the drive to that of the power grid.
3	Add an equipotential bonding grounding cable between the host controller and the AC drive.
4	Install a magnetic ring to the U, V, and W output cables at the drive side and wind the cables through the magnetic ring for two to four turns.
5	Increase the filtering capacitance of the low-speed DI. The recommended maximum value is 0.1 uF.
6	Increase the filtering capacitance of the AI. The recommended maximum value is 0.22 uF.
7	Install a ferrite clamp or a magnetic ring to the signal cable and wind the signal cable through the magnetic ring for one to two turns.
8	Use a shielded power cable and properly ground its shield.

33.4 Communication Interference

33.4.1 RS485 and CAN Communication Interference

In the case of interference, take the following rectification measures.

Step	Solution
1	Install a 120 Ω termination resistor at both ends of the bus.
2	Use multi-conductor shielded twisted pair cables and ground the shield at both ends.
3	Separate communication cables from power cables with a distance of at least 30 cm.
4	Adopt the daisy chain mode for multi-node communication.
5	For multi-node communication, add an equipotential bonding grounding cable between nodes.
6	Add a ferrite clamp at both ends of the communication cable or add a magnetic ring at both ends of the communication cable and wind the communication cable through the magnetic ring for one to two turns.
7	Install a magnetic ring to the U, V, and W output cables at the drive side and wind the cables through the magnetic ring for two to four turns.
8	Use a shielded power cable and properly ground its shield.

33.4.2 EtherCAT and PROFINET Communication Interference

In the case of interference, take the following rectification measures.

No.	Step
1	Check that the communication network cables meet the specification requirements for shielded Cat 5e cables.
2	Check that the communication port is secure and in good contact.
3	Separate communication cables from power cables with a distance of at least 30 cm.
4	For multi-node communication, add an equipotential bonding grounding cable between nodes.
5	Check that the cable between two nodes is no longer than 100 m in length.
6	Install the ferrite clamp on both sides of the communication cable and wind the cable around the ferrite clamp by one or two turns.
7	Install a magnetic ring to the U, V, and W output cables at the drive side and wind the cables through the magnetic ring for two to four turns.
8	Use a shielded power cable and properly ground its shield.

33.5 Encoder Feedback Signal Errors

Take the measures listed in the following table.

No.	Step
1	Route encoder cables and power cables through different routes.
2	When the AC drive is far away from the motor (the motor cable is 10 m), disconnect the grounding terminal (PE) of the encoder shield on the AC drive side.
3	Install a magnetic ring or ferrite clamp to the encoder signal cable near the AC drive.
4	Install a magnetic ring to the U, V, and W output cables at the drive side and wind the cables through the magnetic ring for two to four turns.
5	Use a shielded power cable and properly ground its shield.

34 Troubleshooting

34.1 Common Faults and Diagnosis

34.1.1 Alarm and Fault Display

Upon exceptions, the AC drive stops output immediately, the fault indicator blinks, and the contact of the fault relay acts. The operating panel of the AC drive displays a fault code (example: E002.1), as shown in the following figure.

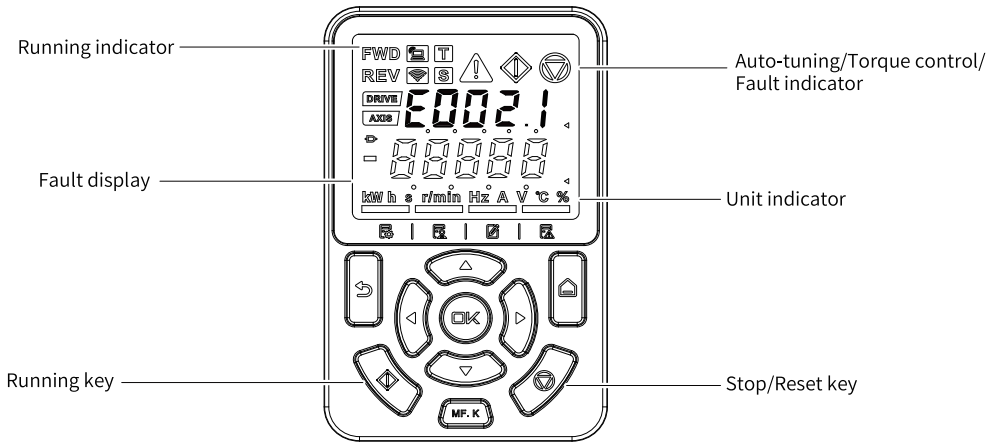


Figure 34-1 Display of faults

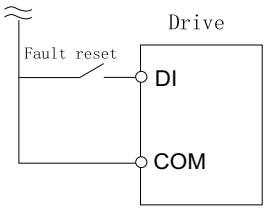
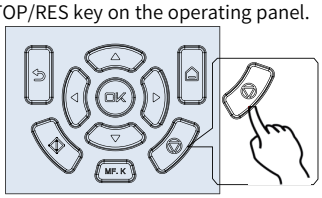
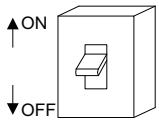
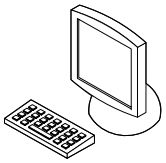
Caution

Do not repair or modify the AC drive by yourself. In case of any fault that cannot be rectified, contact the agent or Inovance for technical support.

34.1.2 Restart After Fault Occurrence

View the current fault code, fault subcode, fault information, minor fault code, minor fault subcode, minor fault information, warning code, warning subcode, warning information through the operating panel.

Table 34–1 Fault view and start method after fault occurrence

Stage	Solution	Description
Upon fault	Fault record 1: View the current fault code, fault subcode, fault information, minor fault code, minor fault subcode, minor fault information, warning code, warning subcode, warning information through the operating panel.	View the record through H0-00 to H0-53.
	Fault record 2: View the frequency, current, bus voltage, input terminal status, output terminal status, AC drive status, power-on time, running time, status word A, status word B, and command word of the last three faults through the operating panel.	View the record through F9-14 and F9-44.
	Fault record 3: View the fault code, fault subcode, fault information, frequency, current, bus voltage, input terminal status, output terminal status, AC drive status, power-on time, running time, status word A, status word B, and command word of the last six faults through the operating panel.	View the record through parameters in groups H3 to H8.
Before fault reset	Before fault reset, find the fault cause and remove the fault according to the fault type displayed on the operating panel.	-
Reset mode to clear faults	1. Allocate function 9 (fault reset) to the DI by setting any of F4-00 to F4-09 to 9.	
	2. Check that F7-02 is set to 1 (default value), indicating that the STOP/RES key is available in any operating mode.	Press the STOP/RES key on the operating panel. 
	3. Power off and then power on the AC drive for automatic reset. Disconnect the main circuit power supply. Wait until the fault code disappears, and then connect the power supply again.	
	4. Reset the drive through communication. When F0-02 (Command source) is set to 2 (Communication control), write "7" (Fault reset) to communication address 2000H using the host controller to reset the AC drive after the fault is cleared.	

34.1.3 Common Troubleshooting

Table 34–2 Common faults and solutions

No.	Symptom	Possible Cause	Solution
1	There is no display upon power-on. 	The drive is not connected to the grid or the grid voltage is too low.	Check the power supply.
		The switched-mode power supply (SMPS) on the driver board of the AC drive is faulty.	Check whether the 24 V output voltage and 10 V output voltage on the control board are normal.
		The control board is disconnected from the driver board and operating panel.	Disconnect the main circuit from the power supply, and then re-connect the 8-pin and 40-pin flat cables.
		The pre-charge resistor of the AC drive is damaged.	Contact the agent or Inovance for technical support.
		The control board or the operating panel is faulty.	
		The rectifier bridge is damaged.	
2	"-H-C" is displayed after power-on. 	The cable connecting the driver board and the control board is in poor contact.	Re-connect the 8-pin and 28-pin flat cables.
		Related components on the control board are damaged.	Contact the agent or Inovance for technical support.
		The motor or the motor cable is short circuited to the ground.	
		The Hall sensor is faulty.	
		The mains voltage is too low.	
3	"E023.1" is displayed upon power-on. 	The motor or the motor cable is short circuited to ground.	Check the insulation status of the motor and the output cable with a megger.
		The AC drive is damaged.	Contact the agent or Inovance for technical support.
4	The display is normal upon power-on. However, after the drive starts to run, "-H-C-" is displayed and the drive stops immediately. 	The fan is damaged or does not rotate.	Replace the fan.
		The cable of the external control terminal is short circuited.	Eliminate external short circuit.
5	E014.1 (module overtemperature) is reported frequently.	The carrier frequency is set too high.	Reduce the carrier frequency (F0-15).
		The cooling fan is damaged, or the air duct is blocked.	Replace the cooling fan or clean the air duct.
		Devices (thermistor or other devices) inside the AC drive are damaged.	Contact the agent or Inovance for technical support.

No.	Symptom	Possible Cause	Solution
6	The motor does not rotate when the AC drive is running.	The wiring between the AC drive and the motor is abnormal.	Check that the wiring between the AC drive and the motor is correct.
		Motor parameters of the AC drive are set incorrectly.	Restore parameters to default settings and reset related parameters.
			Ensure encoder parameters and motor rated parameters are set properly, such as rated frequency and rated speed of the motor.
			Check that F0-01 (control mode) and F0-02 (operation mode) are set properly.
			Modify F3-01 (Torque boost) in the V/f control mode during start with heavy load.
		The cable connecting the driver board and the control board is in poor contact.	Re-connect the cable to ensure it is connected securely.
		The driver board is faulty.	Contact the agent or Inovance for technical support.
7	DI inactive	The related parameters are set incorrectly.	Check and set the parameters in group F4 again.
		The external signal is incorrect.	Re-connect the external signal cable.
		The jumper between OP and +24V becomes loose.	Secure the jumper between OP and +24V.
		The control board is faulty.	Contact the agent or Inovance for technical support.
8	The motor speed cannot be increased in the FVC mode.	The encoder is faulty.	Replace the encoder disk and double check the cable connection.
		The encoder cable is connected improperly or in poor contact.	Reconnect the encoder to ensure good contact.
		The PG card is faulty.	Replace the PG card.
		The driver board is faulty.	Contact the agent or Inovance for technical support.
9	Frequent overcurrent and overvoltage faults	Motor parameters are set incorrectly.	Set the motor parameters again or perform motor parameter auto-tuning.
		The acceleration/deceleration time is improper.	Set proper acceleration/deceleration time.
		The load fluctuates.	Contact the agent or Inovance for technical support.
10	"E017.1" is detected upon power-on or running.	The soft startup contactor is not closed.	Check whether the contactor cable is loose.
			Check whether the contactor is faulty.
			Check whether 24 V power supply of the contactor is faulty.
			Contact the agent or Inovance for technical support.
11	The motor coasts to stop or the brake fails during deceleration or decelerating-to-stop.	The encoder is disconnected, or overvoltage stall suppression protection is enabled.	If the AC drive is in the FVC mode (F0-01 = 1), check the encoder cable connection.
			If a braking resistor is configured, disable the overvoltage stall suppression protection function by setting F3-23 to 0.

34.1.4 Troubleshooting During Trial Run in Different Control Modes

- SVC mode (F0-01= 0; default: 0)
  In this mode, the drive controls the motor speed and torque in a scenario without an encoder for speed feedback. Auto-tuning on motor parameters is required to obtain the motor parameters.

Table 34–3 Troubleshooting in SVC mode

Problem	Solution
Overload or overcurrent during motor start	Set motor parameters F1-01 to F1-05 according to the motor nameplate. Perform auto-tuning (F1-37) on motor parameters. If possible, select dynamic complete auto-tuning.
Slow torque/speed response and motor oscillation occur at a frequency below 5 Hz.	Increase the value of F2-00 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-01 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-00 and increase the value of F2-01.
Slow torque/speed response and motor oscillation occur at a frequency above 5 Hz.	Increase the value of F2-03 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-04 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-03 and increase the value of F2-04.
Low speed accuracy	If the speed deviation is too large when the motor runs with load, increase the value of F2-06 (Vector control slip compensation gain) by the step value of 10%.
Obvious speed fluctuation	Increase the value of A9-05 (Speed filter time) by the step value of 0.001s when motor speed fluctuates abnormally.
Loud motor noise	Increase the value of F0-15 (Carrier frequency) by the step value of 1.0 kHz. Note that increasing the carrier frequency will lead to an increase in the motor leakage current.
Insufficient motor torque or force	Check whether the torque upper limit is too low. If yes, increase the value of F2-10 (Torque upper limit in speed control mode) in the speed control mode or the value of the torque reference in the torque control mode.

- FVC mode (F0-01 = 1)
  This mode is applicable to scenarios with an encoder for speed feedback. In this mode, you need to set the encoder pulses per revolution, encoder type, and encoder direction correctly and perform auto-tuning on motor parameters.

Table 34–4 Troubleshooting in FVC mode

Problem	Solution
Overload or overcurrent fault during start	Set the encoder pulses per revolution, encoder type, and encoder direction correctly.
Overload or overcurrent is detected during motor running.	Set motor parameters F1-01 to F1-05 according to the motor nameplate. Perform auto-tuning (F1-37) on motor parameters. If possible, select dynamic complete auto-tuning.
Slow torque/speed response and motor oscillation occur at a frequency below 5 Hz.	Increase the value of F2-00 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-01 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-00 and F2-01.

Problem	Solution
Slow torque/speed response and motor oscillation occur at a frequency above 5 Hz.	Increase the value of F2-03 (Speed loop proportional gain) by the step value of 10 or decrease the value of F2-04 (Speed loop integral time) by the step value of 0.05 to improve the torque/speed response. If oscillation occurs, decrease the value of F2-03 and F2-04.
Obvious speed fluctuation	Increase the value of F2-07 (Speed filter time) by the step value of 0.001s when motor speed fluctuates abnormally.
Loud motor noise	Increase the value of F0-15 (Carrier frequency) by the step value of 1.0 kHz. Note that increasing the carrier frequency will lead to an increase in the motor leakage current.
Insufficient motor torque or force	Check whether the torque upper limit is too low. If yes, increase the value of F2-10 (Torque upper limit in speed control mode) in the speed control mode or the value of the torque reference in the torque control mode.

- V/f control mode (F0-01 = 2)
  This mode applies to applications without an encoder for speed feedback. You only need to set the rated motor voltage and rated motor frequency correctly.

Table 34–5 Troubleshooting in V/f control mode

Problem	Solution
Motor oscillation during operation	Decrease the value of F3-11 (Oscillation suppression gain in V/f mode) by the step value of 5. The minimum value is 5.
Overcurrent at startup with high power	Decrease the value of F3-01 (Torque boost) by the step value of 0.5%.
Excessively high current during operation	Set F1-02 (Rated motor voltage) and F1-04 (Rated motor frequency) correctly. Decrease the value of F3-01 (Torque boost) by the step value of 0.5%.
Loud motor noise	Increase the value of F0-15 (Carrier frequency) by the step value of 1.0 kHz. Note that increasing the carrier frequency will lead to an increase in the motor leakage current.
Overvoltage during deceleration or when heavy load is suddenly removed	Set F3-23 Overvoltage stall suppression) to 1 (Enable). Increase the value of F3-24/F3-25 (Frequency gain/Voltage gain for overvoltage stall suppression, 30 by default) by the step value of 10 gradually. The permissible maximum value is 100. Decrease the value of F3-22 (Overvoltage stall suppression action voltage, default: 770 V) by the step value of 10 V. The permissible minimum value is 700 V.
Overcurrent during acceleration or when heavy load is suddenly added	Increase the value of F3-20 (Overcurrent stall suppression gain, default: 20) by the step value of 10. The permissible maximum value is 100. Decrease the value of F3-18 (Overcurrent stall suppression action current, default: 150%) by the step value of 10%. The permissible minimum value is 50%.

34.2 List of Faults and Alarms

For complete information on fault and alarm codes, see *MD520 Series General-Purpose AC Drive Parameter Guide.*

35 Certification and Standard Compliance

35.1 Compliance List

The following table lists the certifications, directives, and standards that the product may comply with. For details about the acquired certificates, see the certification marks on the product nameplate.

Certification Name	Directive Name		Standard Compliance
CE certification	EMC directive	2014/30/EU	EN IEC 61800-3
	LVD	2014/35/EU	EN 61800-5-1
	RoHS directive	2011/65/EU	EN 50581
UL/cUL certification	-		UL61800-5-1
			C22.2 No.274-17
KC certification	Korea radio law		KN 11
Function safety certification (STO)	Machinery directive	2006/42/EC	EN ISO 13849-1:2015 EN 61508: 2010 EN 61800-5-2:2017 EN IEC 62061:2021

Note

The product meets the requirements of the latest instructions and standards of the CE/UL/cUL/KC/STO certification.

35.2 CE Certification

35.2.1 Precautions for Compliance with European Standards



Figure 35-1 CE mark

- The CE mark indicates compliance with the Low Voltage Directive (LVD), Electromagnetic Compatibility (EMC), and Restriction of Hazardous Substances (RoHS) directives for commercial trades (production, import, and sales) in Europe.
- The CE mark is mandatory for engaging in commercial business (production, importation, and distribution) in Europe.
- The product complies with the LVD, EMC, and RoHS directives and is labeled with the CE mark.
- The machinery and devices equipped with this product must also meet CE requirements when sold in Europe.
- The integrator who integrates this drive into other products and attaches the CE mark to the final assembly has the responsibility of ensuring compliance with CE certification.

35.2.2 Requirements for Compliance with EMC Directive

- The drive is applicable to the first environment and second environment and complies with EMC directive 2014/30/EU and standard EN IEC 61800-3.

Caution

If the product is used in the first environment, it may generate radio interference. In addition to CE compliance requirements, measures should be taken to prevent interference when necessary.

- To enable the drive to comply with the EMC directive and standards, install an EMC filter on the input side and use shielded cables on the output side. Ground the filter properly. Ground the shield of the output cable in 360 degrees.

Caution

The manufacturer of the system with the product installed must ensure that the system meets the requirements of the European EMC Directive, and ensure that the system meets the requirements of the standard EN IEC 61800-3 according to the application environment of the system.

EMC specifications

The drive complies with EN IEC 61800-3. The maximum length of the motor cable allowed by the conducted and radiated emission is shown in the following table.

Table 35–1 Maximum motor cable length allowed by conducted and radiated emission

Grid	Structure	Maximum Motor Cable Length Allowed by Conducted Emission				Maximum Motor Cable Length Allowed by Radiated Emission			
		C2 class		C3 class		C2 class		C3 class	
		Built-in Filter	External EMC Filter	Built-in Filter	External EMC Filter	Built-in Filter	External EMC Filter	Built-in Filter	External EMC Filter
Single-phase 200 V to 240 V	T2	-	25 m	25 m[1*]	-	-	25 m	25 m[1*]	-
Three-phase 200 V to 240 V	T1	-	25 m	25 m[1*]	-	-	25 m	25 m[1*]	-
	T2	-	25 m[1*]	25 m[2*]	-	-	25 m[1*]	25 m[2*]	-
	T3	-	25 m	25 m[1*]	-	-	25 m	25 m[1*]	-
	T4		25 m	25 m[3*]			25 m	25 m[3*]	-
	T5	-	25 m	-	-	-	3 m	-	-
	T6	-	25 m	5 m[4*]	-	-	3 m	-	-
	T7 to T8	-	25 m[5*]	5 m	-	-	25 m[5*]	5 m	-
	T9 to T11	-	25 m	5 m	-	-	25 m	5 m	-
	T12	-	25 m[6*]	5 m	-	-	25 m[6*]	5 m	-

Grid	Structure	Maximum Motor Cable Length Allowed by Conducted Emission				Maximum Motor Cable Length Allowed by Radiated Emission			
		C2 class		C3 class		C2 class		C3 class	
		Built-in Filter	External EMC Filter	Built-in Filter	External EMC Filter	Built-in Filter	External EMC Filter	Built-in Filter	External EMC Filter
Three-phase 380 V to 480 V	T1	-	25 m	25 m[1*]	-	-	25 m	25 m[1*]	-
	T2	-	25 m[1*]	25 m[2*]	-	-	25 m[1*]	25 m[2*]	-
	T3	-	25 m	25 m[1*]	-	-	25 m	25 m[1*]	-
	T4	-	25 m	25 m[3*]	-	-	25 m	25 m[3*]	-
	T5	-	25 m	-	-	-	3 m	-	-
	T6	-	25 m	5 m[4*]	-	-	3 m	-	-
	T7 to T8	-	25 m[5*]	5 m	-	-	25 m[5*]	5 m	-
	T9 to T11	-	25 m	5 m	-	-	25 m	5 m	-
	T12	-	25 m[6*]	5 m	-	-	25 m[6*]	5 m	-

Note

- 1*: Add the magnetic ring DY644020H to the input side of the AC drive.
- 2*: Add the magnetic ring DY644020H to the input and outside sides of the AC drive.
- 3*: Add the magnetic ring DY644020H and simple filter Cxy-1-1 to the input side of the AC drive.
- 4*: Add the magnetic ring DY805020H to the input and outside sides of the AC drive.
- 5*: Add the magnetic ring DY1207030H to the outside side of the AC drive.
- 6*: Add the magnetic ring NC-0567-L-b to the outside side of the AC drive.

Introduction to EMC standards

Electromagnetic compatibility (EMC) describes the ability of electronic and electrical devices or systems to work properly in the electromagnetic environment and not to generate electromagnetic interference that influences other local devices or systems. EMC includes the following requirements:

- The electromagnetic interference generated by a device during normal operation must be restricted within a certain limit.
- The device must have sufficient immunity to electromagnetic interference in the environment and can work properly in the environment with electromagnetic interference, which is described as electromagnetic sensitivity.

EN IEC 61800-3 defines the following two environments:

- First environment: It includes domestic premises. It also includes establishments directly connected without intermediate transformer to a low-voltage power supply network which supplies buildings used for domestic purposes.
- Second environment: It includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes.

Devices are divided into the following four categories based on the intended application environment.

- C1 equipment: power drive system (PDS) with the rated voltage lower than 1000 V, which is intended for use in the first environment

- C2 equipment: PDS with the rated voltage lower than 1000 V, which is neither a plug-in device nor a movable device and is intended to be installed and commissioned only by professionals when used in the first environment.
- C3 equipment: PDS with the rated voltage lower than 1000 V, which is intended for use in the second environment and not intended for use in the first environment
- C4 equipment: PDS with the rated voltage equal to or higher than 1000 V or rated current equal to or higher than 400 A, or intended for use in complex systems in the second environment

35.2.3 Requirements for Compliance with the LVD

The drive has been tested in accordance with EN 61800-5-1 and has complied with the LVD. Observe the following requirements to enable machines and devices integrated with this drive to comply with the LVD.

Installation location

Install the drive in a place with overvoltage category III and pollution degree 1 or 2 as specified by IEC 60664-1.

Installation environment

For installation environment requirements, see the section of Installation Environment in *MD520 Series General-Purpose AC Drive Installation Guide*.

Installation protection requirements

- The drive serves as a part of a final system. Install the drive as the system component in a fireproof cabinet that provides effective electrical and mechanical protection, and install it in accordance with local laws and regulations and relevant IEC standards.
- For IP20-certified products, install them in structures where foreign objects cannot enter from the top or front sides.

Wiring of main circuit terminals

For requirements of wiring main circuit terminals, see the related section in the *MD520 Series General-Purpose AC Drive Installation Guide*.

Requirements for protective devices

To comply with EN 61800-5-1 standards, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit. Use a fuse that matches the maximum input current of the AC drive. For selection of fuses, see *"5.4.1 Fuse, Contactor, and Circuit Breaker" on page 91*.

35.3 UL or cUL Certification



Figure 35-2 UL/cUL mark

- The UL/cUL mark is commonly applied to products sold in the United States and Canada. Products with UL/cUL mark have been inspected and assessed by the UL organization. To pass UL/cUL certification, main built-in components of electrical products must also be UL certified.
- The drive has been tested in accordance with UL 61800-5-1 and CSA C22.2 No. 274-17 standards and has complied with UL/cUL standards. Observe the following requirements to enable machines and devices integrated with this drive to comply with UL/cUL standards.

Mounting location

Install the drive in a place with overvoltage category III and pollution degree 1 or 2 as specified by UL61800–5–1.

Ambient temperature

According to the protection level, the ambient temperature must be maintained within the following range:

- T1 to T9 models (Type 1, enclosed type): –10°C to +50°C
- T1 to T12 models (open type): –10°C to +50°C

Installation requirements

- T1 to T9 models are enclosed-type, which must be installed according to the following requirements:
  - The enclosure protection must meet requirements of UL Type 1.
  - Drill the holes according to the mounting dimensions. For details of mounting dimensions, see the section of mounting dimensions in *MD520 Series General-Purpose AC Drive Installation Guide*.
- T1 to T12 models are open-type, which must be installed in a cabinet according to the following requirements:
  The drive must be installed in a fireproof cabinet with the housing that provides effective electrical and mechanical protection. The installation must conform to local and regional laws and regulations and relevant NEC standards.

Main circuit wiring requirements



Field installation is not allowed for output terminals BR, (-), and (+).

- Terminals BR and (+) are used to connect options. Avoid connecting these terminals to an AC power supply.
- To protect the main circuit, separate it from all surfaces that may come into contact with it and provide covers as required.
- The control circuit is the internal safety extra-low voltage (SELV) circuit, which must be insulated and isolated from other circuits. Make sure that the control circuit is connected to the external SELV circuit.
- Prevent foreign matters from entering the wiring part of the terminal block.
- Do not solder the twisted conductors.
- The tightening torque may vary with terminals. Tighten terminal screws with the specified tightening torque. You can use the torque screwdriver, ratchet, or wrench.
- When using an electric screwdriver to tighten terminal screws, set a low speed to prevent damage to the terminal screws.
- Tighten the terminal screws at an angle within 5 degrees. Failure to comply may result in screw damage.

Control circuit wiring requirements

Observe the requirements in UL508 during wiring.

Main circuit cable selection

For the selection of cable dimensions, follow the requirements of US National Electrical Code (NEC) and Part 1 of Canadian Electrical Code (CEC) and relevant local regulations.

- Use cables with copper conductors.
- The recommended cables for the main circuit are 600 V Class 2 heat-resistant indoor PVC cables that can work under temperature of 75°C continuously. The following conditions are used as premises:

  1. Ambient temperature: < 40°C
  2. Normal operating ratings

If recommended cables for peripheral devices or options are not suitable for the product, contact Inovance.

Terminal dimensions and cable selection

For selection of terminals and cables for main circuits, see *"13.3.3 Main Circuit Cables" on page 254*.

Requirements for protective devices

- To meet the requirements of UL standards, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit.
- Install sufficient protective devices against short circuit in branch circuits according to applicable regulations and this guide. The drive is applicable to circuits with the rated breaking capacity lower than 100000 A and the maximum voltage of 480 VAC (class 400 V). For selection of circuit breakers, see *"5.4.1 Fuse, Contactor, and Circuit Breaker" on page 91*.

35.4 KC Certification

Appllicant Suzhou Inovance Technology Co., Ltd.
AC Drive
Model MD520 series
Made In China
Manufacturer
Suzhou Inovance Technology Co.,Ltd.

A 급기기 (업무용 방송통신기자재)
이 기기는 업무용 (A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 ,가정외의 지역에서 사용하는 것을 목적으로 합니다 .

35.5 Functional Safety Certification

EU directives and standards

Low Voltage Directive 2014/35/EU, EN 61800-5-1

EMC Directive 2014/30/ EU, EN 61800-3: 2018

Machinery Directive 2006/42/EC (Function Safety), IEC 61800-5-2

36 Appendix 6000H Group Object Dictionary

36.1 List of Object Dictionary in Group 6000h

Index	Sub-index	Name	Access	SDO	PDO	Data Type	Unit	Value Range	Default
603Fh	-	Error code	RO	YES	YES	Uint16	-	0 to 65535	-
6040h	-	Control word	RW	YES	YES	Uint16	-	0 to 65535	0
6041h	-	Status word	RO	YES	YES	Uint16	-	0 to 65535	-
6042h	-	Target speed	RW	YES	YES	Int16	Determined by FD-09	-32768 to +32767	0
6043h	-	Velocity demand (after acceleration/ deceleration)	RO	YES	YES	Int16	Same as 6042h	-32768 to +32767	-
6044h	-	Output speed	RO	YES	YES	Int16	Same as 6042h	-32768 to +32767	-
6046h	0h	Speed upper and lower limit	RO	YES	NO	Uint8	-	-	2
	1h	Speed lower limit	RW	YES	YES	Uint32	Hz	0 to 65535	0
	2h	Speed upper limit	RW	YES	YES	Uint32	Hz	0 to 65535	5000
6048h	-	Acceleration time (speed control mode)	RO	YES	NO	Uint8	-	-	2
	1h	Speed increment	RW	YES	NO	Uint32	Same as 6042h	1 to 65535	5000
	2h	Time increment	RW	YES	NO	Uint16	Determined by F0-09	0 to 65535	200
6049h	-	Deceleration time (speed control mode)	RO	YES	NO	Uint8	-	-	2
	1h	Speed increment	RW	YES	NO	Uint32	Same as 6042h	1 to 65535	5000
	2h	Time increment	RW	YES	NO	Uint16	Determined by F0-09	0 to 65535	200
605Ah	-	Quick stop mode	RW	YES	NO	Int16	-	0 to 2	1
605Bh	-	Shutdown option code	RW	YES	NO	Int16	-	0 to 1	1
605Ch	-	Disable operation option code	RW	YES	NO	Int16	-	0 to 1	1

Index	Sub-index	Name	Access	SDO	PDO	Data Type	Unit	Value Range	Default
6060h	-	Mode selection	RW	YES	YES	Int8	-	1 to 6	2
6061h	-	Mode display	RO	YES	YES	Int8	-	1 to 6	-
6063h	-	Position feedback	RO	YES	YES	Int32	Encoder unit	-2^{31} to $+(2^{31}-1)$	-
606Ch	-	Speed feedback	RO	YES	YES	Int32	rpm	-2^{31} to $+(2^{31}-1)$	-
6077h	-	Output torque	RO	YES	YES	Int16	-	-32768 to +32767	-
60FDh	-	DI state	RO	YES	YES	Uint32	-	0 to $(2^{32}-1)$	-
6502h	-	Supported mode	RO	YES	YES	Uint32	-	0 to $(2^{32}-1)$	-

36.2 Object Dictionary Descriptions

603Fh: error code

Index 603Fh	Name	Error code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to 65535	Default	-
The error code indicates that the read error code is internally-defined error code and does not comply with the DS402 profile. Example: When the drive encounters an encoder error (E015.1), 603Fh is read and 151 is returned. If 0 is returned, no error occurs on the drive.										

6040h: control word

Index 6040h	Name	Control word			Setting Condition & Effective Time	During operation	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Mode	ALL	Data Range	0 to 65535	Default	0
For details on control commands, see *"Table 36–1" on page 931*.										

Table 36–1 Control command descriptions

Bit	Name	Description
0	Switch on	1: Active; 0: Inactive
1	Enable voltage	1: Active; 0: Inactive
2	Quick stop	0: Active; 1: Inactive

Bit	Name	Description
3	Enable operation	1: Active; 0: Inactive
4 to 6	Operation mode specific	Related to the operation mode
7	Fault reset	The rising edge of bit 7 is used to reset a fault. If the value is always 1, the fault reset is disabled.
8	Reserved	Undefined
9	Reserved	Undefined
10	Reserved	Undefined
11 to 15	Manufacturer specific	Bits 11 to 15 are manufacturer-defined.
Bits 9 to 10 are reserved and must be set to 0. Bits 11 to 15 are manufacturer-defined.		

6041h: status word

Index 6041h	Name	Status word			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to 65535	Default	0
For details on the inverter state, see *"Table 36–2" on page 932*.										

Table 36–2 Descriptions of the inverter state

Bit	Name	Description
0	Ready to switch on	1: Active; 0: Inactive
1	Switch on	1: Active; 0: Inactive
2	Operation enabled	1: Active; 0: Inactive
3	Fault	1: Active; 0: Inactive
4	Voltage enabled	1: Active; 0: Inactive
5	Quick stop	0: Active; 1: Inactive
6	Switch on disabled	1: Active; 0: Inactive
7	-	-
8	Manufacturer specific	-
9	Remote	1: Active; 0: Inactive
10	Target reach	1: Active; 0: Inactive
11 to 15	-	-

Table 36–3 Examples of the inverter state

Value (Binary)	Description
Xxxx xxxx x0xx 0000	Not ready to switch on
Xxxx xxxx x1xx 0000	Switch on disabled
Xxxx xxxx x01x 0001	Ready to switch on
Xxxx xxxx x01x 0011	Switched on
Xxxx xxxx x01x 0111	Operation enabled

Value (Binary)	Description
Xxxx xxxx x00x 0111	Quick stop active
Xxxx xxxx x0xx 1111	Fault reaction active
Xxxx xxxx x0xx 1000	Fault

6042h: vl target velocity

Index 6042h	Name	vl target velocity			Setting Condition & Effective Time	During operation	Data Structure	VAR	Data Type	Int16
	Access	RO	Mapping	RPDO	Mode	vl	Data Range	-32768 to 32767	Default	0

- The unit of the target velocity is determined by FD-09. The value 0 indicates Hz and 1 indicates rpm.
- When the unit is Hz, the association needs to be set according to the frequency unit (F0-22). Assume that F0-22 is set to 2 and the frequency resolution is 0.01 Hz. To set the target frequency to 10.00 Hz, write 1000 through communication. Assume that F0-22 is set to 1 and the frequency resolution is 0.1 Hz. To set the target frequency to 10.0 Hz, write 100 through communication.
- When the unit is rpm, the supported speed ranges from -32768 to 32767. If the speed exceeds this range, use the unit of Hz to support a higher speed.
- The AC drive output frequency is converted to the motor operating frequency (Hz), which can be viewed by U0-01.

6043h: vl velocity demand

Index 6043h	Name	vl velocity demand			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RO	Mapping	TPDO	Mode	vl	Data Range	-32768 to 32767	Default	0

- The vl velocity demand is the instantaneous velocity provided by the ramp function.
- The unit is the same as the unit of the target velocity 6042h.
- When the unit is Hz, the decimal place is set by F0-22. When the unit is rpm, the decimal place is set by the ones place of F7-12.

6044h: vl control effort

Index 6044h	Name	vl control effort			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RO	Mapping	TPDO	Mode	vl	Data Range	-32768 to 32767	Default	0

- The vl control effort indicates the actual running speed of the inverter.
- The unit is the same as the unit of the target velocity 6042h.
- When the unit is Hz, the decimal place is set by the tens place of F7-12. When the unit is rpm, the decimal place is set by the ones place of F7-12.

6046h: vl velocity min max amount

Index 6046h	Name	vl velocity min max amount			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	OD data range	Default	OD default value
It indicates the minimum or maximum running speed (unit: Hz) at which the drive unit is allowed to run. You can define the unit as the DSP 402 protocol does not define.										

Sub-index	Name	Number of entries			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
0h	Access	RO	Mapping	NO	Mode	vl	Data Range	-	Default	2

Sub-index 1h	Name	vl velocity min amount			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65535	Default	0
• It indicates the minimum frequency (unit: Hz) at which the drive unit is allowed to run. The value is limited by the maximum frequency (F0-10) and sub-index 2. You can view the actual value by querying F0-14 (unit: Hz). • The decimal place is set by F0-22.										

Sub-index 2h	Name	vl velocity max amount			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65535	Default	5000
• It indicates the maximum frequency (unit: Hz) at which the drive unit is allowed to run. The value is limited by the maximum frequency (F0-10). • The decimal place is set by F0-22.										

6048h: vl velocity acceleration

Index 6048h	Name	vl velocity acceleration			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	OD data range	Default	OD default value
It is used to set the acceleration time of the inverter.										

Sub-index 0h	Name	Number of entires			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	NO	Mode	vl	Data Range	-	Default	2

Sub-index 1h	Name	Delta speed			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	1 to 65535 (Hz)	Default	5000
• Set F0-25 to 0. If F0-25 is set to other values, the acceleration time will be inaccurate. • The unit is the same as the unit of the target velocity 6042h. • When the unit is Hz, the decimal place is set by F0-22. When the unit is rpm, the value is an integer.										

Sub-index 2h	Name	Delta time			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65536 (s)	Default	20
Set F0-19 to 1 or 2. If F0-19 is set to 0, the acceleration/deceleration time will be inaccurate due to calculation error.										

6049h: vl velocity deceleration

Index 6049h	Name	vl velocity deceleration			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	OD data range	Default	OD default value

Sub-index	Name	Number of entires			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
0h	Access	RO	Mapping	NO	Mode	vl	Data Range	-	Default	2

Sub-index 1 h	Name	Delta speed			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	1 to 65535	Default	5000
• Set F0-25 to 0. If F0-25 is set to other values, the deceleration time will be inaccurate. • The unit is the same as the unit of the target velocity 6042h. • When the unit is Hz, the decimal place is set by F0-22. When the unit is rpm, the value is an integer.										

Sub-index 2h	Name	Delta time			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Mode	vl	Data Range	0 to 65535	Default	20
Set F0-19 to 1 or 2. If F0-19 is set to 0, the acceleration/deceleration time will be inaccurate due to calculation error.										

605Ah: Quick stop option code

In the non-faulty state, when bit 2 (Quick stop) of the control word 6040h is set to 0, the drive implements quick stop in the mode selected by 605Ah.

This function can be set only in the stop state. After quick stop, bit 6 of the control word 6041h is set to 1 and the drive is in the stop state.

Index 605Ah	Name	Quick stop option code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	NO	Mode	ALL	Data Range	0 to 2	Default	1
The values are described as follows: 0: Coast to stop 1: Decelerate to stop. The deceleration time is set by F0-18, namely, the time set by 6049h in vl mode. 2: Emergency stop. The deceleration time is set by F8-55.										

605Bh: Shutdown option code

Index 605Bh	Name	Shutdown option code			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RW	Mapping	NO	Mode	ALL	Data Range	0 to 1	Default	1
For detailed values, see *"Table 36–4" on page 937*.										

Table 36–4 Value descriptions

Value	Stop Mode
-32768 to -1	Manufacturer-defined
0	Coast to stop
1	Decelerate to stop. The deceleration time is set by F0-18, namely, the time set by 6049h in vl mode.
2 to 32767	Reserved

605Ch: Disable operation option code

Index 605Ch	Name	Disable operation option code			Setting Condi-tion & Effective Time	-	Data Struc-ture	VAR	Data Type	Int16
	Access	RW	Mapping	NO	Mode	ALL	Data Range	0 to 1	Default	1
For detailed values, see *"Table 36–5" on page 937*.										

Table 36–5 Value descriptions

Value	Stop Mode
-32768 to -1	Manufacturer-defined
0	Coast to stop
1	1: Decelerate to stop. The deceleration time is set by F0-18, namely, the time set by 6049h in vl mode.
2 to 32767	Reserved

6060H: Modes of operation

Index 6060h	Name	Modes of operation			Setting Condi-tion & Effective Time	-	Data Struc-ture	VAR	Data Type	Int8
	Access	RW	Mapping	RPDO	Mode	ALL	Data Range	0 to 9	Default	2
The values are described as follows: • 0: N/A • 1: N/A • 2: vl (speed mode) • 3: N/A • 4: N/A • 5: N/A • 6: N/A • 7: N/A • 8: N/A • 9: N/A										

6061h: Modes of operation display

Index 6061h	Name	Modes of operation display			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int8
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to 9	Default	2
The values are described as follows: • 0: N/A • 1: N/A • 2: vl (speed mode) • 3: N/A • 4: N/A • 5: N/A • 6: N/A • 7: N/A • 8: N/A • 9: N/A										

6063h: Position actual value*

Index 6063h	Name	Position actual value*			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	-2^{31} to $+(2^{31}-1)$	Default	-
It indicates the motor position in the encoder unit.										

606Ch: Velocity actual value

Index 606Ch	Name	Velocity actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int32
	Access	RO	Mapping	TPDO	Mode	CSV	Data Range	-2^{31} to $+(2^{31}-1)$	Default	-
• It indicates the actual running speed of the inverter. • The unit is rpm. • The decimal place is set by the ones place of F7-12. • Pv supported										

6077h: Torque actual value

Index 6077h	Name	Torque actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Int16
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	Unit: 0.1%	Default	-
The unit uses the rated motor torque as the base value.										

60FDh: Digital inputs

Index 60FDh	Name	Digital inputs			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RO	Mapping	TPDO	Mode	ALL	Data Range	0 to (2^{32} - 1)	Default	-

It indicates the current DI logic of the drive.

- 0: Invalid
- 1: Valid

The DI signal indicated by each bit is described as follows:

- Bits 0 to 26: Reserved
- Bit 27: STO1
- Bit 28: STO2
- Bit 29:EDM
- Bits 30 to 31: Manufacturer-defined

6502h: Supported drive modes

Index 6502h	Name	Supported drive modes			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint32
	Access	RO	Mapping	RO	Mode	ALL	Data Range	0 to 2^{32}	Default	0x0000-0002

Bits are described as below:

- Bit 0: N/A
- Bit 1: available only in speed mode vl
- Bit 2: N/A
- Bit 3: N/A
- Bit 4 N/A
- Bit 5: N/A
- Bit 6: N/A
- Bit 7: N/A
- Bit 8: N/A
- Bits 9 to 31: Reserved

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