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ES680N Series Servo Drive

User Guide

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

Data code PS00014716A04

Legal Information

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Due to continuous updates and improvements of products and technologies, the content of this documentation may not fully match the actual products. In the event of any discrepancies, the actual products shall prevail.

The contents are subject to change without notice due to product upgrade.

Waste Disposal

The storage, use, and disposal of this product (including optional accessories) must comply with local laws and regulations.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel can identify the risks of the product/system and prevent possible dangers.

Proper Use of the Product

Proper transportation, storage, assembly, installation, commissioning, operation, and maintenance are required to ensure the safe operation of the product without any problems. The required ambient conditions must be met. All operations must follow the guidelines provided in this documentation.

Preface

Introduction

The ES680N series servos are high-performance hydraulic servo products. The ES680N series servo drives are developed for high-performance vector control of permanent magnet synchronous motors (PMSMs). They are technical upgrades from the ES650N series and feature the high-speed EtherCAT bus compared with the ES680 series. The tuning-free function is available when an MEG series motor is used together with the drive.

It is mainly applied to industries such as plastic molding, pipe extrusion, shoes making, rubber, and metal injection molding.

This user guide provides information about model selection, installation, wiring, commissioning, function description, communication, troubleshooting, and routine maintenance.

More documents

Document	Code	Description
ES680N Series Servo Drive User Guide	PS00014716	This guide provides information about model selection, installation, wiring, commissioning, functions, communication, fault handling, and routine maintenance.

Revision history

Date	Document version	Software version	Revision
September 2026	A04	Firmware code: 03029858 Version: D01.01 Version label: H01-00 = 4006.3/H01-03 = 0000.0	**Updated content:** • Added precautions for power-on and wiring and added safety compliance icons in *"1.1 Safety Precautions" on page 13*. • Added the information that customers need to purchase DC reactors separately for 160 kW models and above in *"2.1.1 Product Positioning and Features" on page 20*. • Modified the chapter title and separated the model and nameplate descriptions in *"2.1.2 Nameplate and Model" on page 21*. • Updated the product figure and the operating panel figure in *"2.4 System Composition" on page 53*. • Added short circuit ratings in and deleted the description of overload ratios from *"2.1.4 Technical Data" on page 22*. • Added the information that if the motor cable diameter is large and there is no suitable three-conductor shielded cable, a single-conductor shielded cable can be used in *"7.3.2 Dimension and Cable Selection for Main Circuit Terminals" on page 91*. • Updated the wiring length limit of the braking resistor from "not exceeding 5 m" to "not exceeding 10 m", and added the information that if customers have separate protection requirements for the braking circuit, add protective components after evaluation in *"7.3.4 Requirements for Main Circuit Wiring" on page 99*. • Added the minimum required current and added the following descriptions in the function description of power supply input CN4 in *"7.6.1 Descriptions of Control Circuit Terminals" on page 106*: When an external 24 V power supply is connected and the drive is powered at 380 V, the system uses the internal power supply of the drive preferentially. • Added the following check item in *"7.9 Post-wiring Inspection" on page 121*: Avoid cross wiring between the motor and the AC drive. • Updated the values of rated output current and short circuit current in *"8.1.1 Fuse, Contactor, and Circuit Breaker" on page 123*. • Changed SOP-20 to SOP-20-880 and SOP-20-810 and updated the figure of the local operating panel in *"2.5 List of Options" on page 55*, *"8.4 External Operating Panel" on page 151*, and *"10.1 Operating panel" on page 156*. • Updated the figure of the operating panel in *"10.2 Local Operating Panel" on page 156*. • Changed judgment sentences in to declarative sentences in *"14.1.1 Daily Checklist" on page 204* and *"14.2.1 Periodic Checklist" on page 205*. • Added the following instructions in *"15.2 Restart upon Fault Events" on page 222*: When enabling automatic fault reset and automatic restart, ensure that unexpected equipment operation will not cause personal injury or mechanical damage.

Date	Document version	Software version	Revision
September 2026	A04	Firmware code: 03029858 Version: D01.01 Version label: H01-00 = 4006.3/H01-03 = 0000.0	**Updated content:** • Added information about STO certification in *"16.1 Certifications, Directives, and Standards" on page 257*. • Added the following instructions in *"19.3 Motor Parameter Auto-Tuning" on page 286*: After re-installing and re-wiring the synchronous motor on the field, perform motor parameter auto-tuning to prevent abnormal motor control by the drive. • Updated the user guide according to the latest software version and updated the value of H02.05 to 0 in *"20.1 Parameters in Groups H00 to H22" on page 288*. • Updated *"15.4 List of fault codes" on page 230* and *"15.5 List of Alarm Codes" on page 249*. • Updated the parameter name and setting range in *"12.2 Operation Command Setting" on page 170* and *"12.3 Start/Stop Mode Setting" on page 171*. • Updated parameter names in *"11.3.2 Settings of Oil Pressure Function Parameters" on page 164*. • Changed pin 17 from "GND" to "Null" and changed pin 9 from "Null" to "GND" in *"7.5 Connecting the Encoder" on page 105*. **Added content:** • Added *" EtherCAT Hydraulic Pressure Mode" on page 263* and sub-sections. • Added *"16.4 STO Certification" on page 261* • Added *"16.5 KC Certification" on page 262*.
March 2026	A03	–	**Updated content:** • Updated *" Front Cover" on page 1*, *" Preface" on page 1*, *"1.1 Safety Precautions" on page 13*, and *" Back Cover" on page 348*. • Updated *"2.1.4 Technical Data" on page 22*. • Made minor corrections. **Added content:** • Added *" Legal Information" on page 1*. • Added *" Service and Support" on page 347*.
May 2025	A02	–	• Updated *" Front Cover" on page 1*, *" Preface" on page 1*, *"1.1 Safety Precautions" on page 13*, and *" Back Cover" on page 348*. • Updated *"2.2.2.2 Components of the Motor Junction Box" on page 32*, which is to reuse the section "Description of Motor Junction Box" from the MEG Air-cooled Series Servo Motor User Guide. • Updated *"2.2.3.1 Electrical Specifications" on page 32*, which is to reuse the section "Electrical Specifications" from the MEG Air-cooled Series Servo Motor User Guide. • Updated *"2.2.4 Dimensions" on page 40*, which is to reuse the section "Product Dimensions" from the MEG Air-cooled Series Servo Motor User Guide. • Updated *"2.2.5 Torque-Speed Characteristics" on page 44*, which is to reuse the section "Torque and Speed Characteristics" from the MEG Air-cooled Series Servo Motor User Guide. • Updated the servo motor model in *"2.3 Servo System Configurations" on page 50*. • Updated the fault list in *"15.4 List of fault codes" on page 230*. • Updated the alarm list in *"15.5 List of Alarm Codes" on page 249*.

Date	Document version	Software version	Revision
October 2024	A01	–	• Updated *" Front Cover" on page 1*, *" Preface" on page 1*, *"1.1 Safety Precautions" on page 13*, and *" Back Cover" on page 348*. • Added T9 models. • Updated *"2.1.4 Technical Data" on page 22*. ▪ Updated "Allowable frequency fluctuation range" and added the actual allowable range; ▪ Added descriptions of "Overload capacity"; ▪ Updated technical specifications of "Vibration"; ▪ Added cabinet specifications of "Shock". • Updated electrical specifications of the servo motor in *"2.2.3.1 Electrical Specifications" on page 32*. • Updated the servo motor dimensions and weight in *"2.2.4 Dimensions" on page 40*. • Updated information about 1700 rpm rated speed, 2000 rpm rated speed, and 2200 rpm rated speed in *"2.2.5 Torque-Speed Characteristics" on page 44*. • Updated the system composition diagram in *"2.4 System Composition" on page 53*. • Added IP20 in *"4.2.1 Installation Environment" on page 61*. • Updated the main circuit cable specifications in *"7.3.2 Dimension and Cable Selection for Main Circuit Terminals" on page 91*. • Added GTNR, BC, and SQNBS series cable lugs in *"7.3.3 Cable Lug Selection" on page 96*. • Updated the CAN bus connection topology in *"7.7.1 Wiring of CAN Communication" on page 114*. • Updated *"8.1.1 Fuse, Contactor, and Circuit Breaker" on page 123*. ▪ Updated the selection guidance table for the fuse, contactor, and circuit breaker and added T9 models. ▪ Added the selection guidance table for the European standard fuse. • Updated the model of the through-hole mounting bracket for T5 models to ES680-AZJ-T5 and added the model of the through-hole mounting bracket for T9 models in *"8.3 Grounding Bracket of Cable Shield" on page 148*. • Made minor corrections.
November 2023	A00	–	First release.

Access to the guide

This guide is not delivered along with the product. You can obtain the PDF document by one of the following means:

- Visit https://www.inovance.com/global, and choose "Service&Support > Support > Documentation Download".
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install the My Inovance app, and search for the user guide in the app.

Warranty disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. Maintenance will be charged after the warranty expires.

Even within the warranty period, maintenance can be charged for the following product damage:

- Damage caused by operations not following the instructions in the guide
- Damage caused by fire, flood, or abnormal voltage
- Damage caused by using the product for unintended functions
- Damage caused by using the product outside the specified scope
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance fee will be 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 the Warranty Card.

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1 Fundamental Safety Instructions

1.1 Safety Precautions

Safety disclaimer

- This chapter provides essential safety instructions for proper use of the product. Before using this product, read through the guide and comprehend all the safety instructions. Failure to comply with the safety instructions may result in death, severe injury, or equipment damage.
- "DANGER", "WARNING", and "CAUTION" signs in this guide are only supplements to the safety instructions, and do not reflect all safety instructions to be followed.
- Use this product according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
- Inovance shall take no responsibility for any personal injury or property damage caused by improper use.

Safety levels and definitions



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



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



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

Safety Precautions

- Drawings in the user guide are sometimes shown without covers or protective guards. Install the covers or protective guards as specified, 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 protection measures to protect their safety. For example, they must wear safety shoes, safety clothing, safety glasses, protective gloves and sleeves, or other protective equipment.

Unpacking



- Do not install the product in case of any damage, rust, or signs of use on the product or accessories upon unpacking.
- Do not install the product in case of water seepage into the product or missing or damaged components upon unpacking.
- Do not install the product in the case of any discrepancy between the product you received and the product name on the packing list.



- Check whether the packing is intact and whether there is damage, water seepage, dampness, and deformation before unpacking.
- Unpack the package layer by layer. Do not strike the package violently.
- Check for damage, rust, or scratches on the surfaces of the product and accessories upon unpacking.
- Check the number of the equipment, accessories, and paper materials against the packing list carefully upon unpacking.

Storage and transportation



- Large or heavy equipment must be handled by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injury or equipment damage.
- Before hoisting the equipment, ensure that 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 which is being hoisted.
- Hoist the equipment at a constant speed with a steel rope to prevent any vibration or shock to the equipment. Never turn the equipment over or keep it suspended for a long time. Failure to comply may result in personal injury or equipment damage.



- Handle the equipment with care and mind your steps during transportation to prevent personal injury or equipment damage.
- When carrying the equipment with bare hands, hold the enclosure firmly with care to prevent parts from falling. Failure to comply may result in personal injury.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply may result in equipment damage.
- Do not store or transport the equipment in environments where the equipment may be exposed to splashing water or rain, direct sunlight, strong electric field, strong magnetic field, or strong vibration.
- Store the equipment for up to three months. Take stricter protective measures and carry out the necessary inspections for a longer storage time.
- Pack the equipment securely and properly before transportation. Use a fully enclosed container for long-distance transportation.
- Do not transport the equipment with other devices or items that may impact or cause harm to the equipment.

Installation
DANGER • Ensure peripheral power distribution requirements are met, and select circuit breakers, fuses, cables, and cable terminals correctly. • Use standard torque to fasten screws, and use appropriate terminal crimping tools for to crimp terminals. • Ensure heat dissipation requirements are met and design inlet and outlet airflow duct properly. • Avoid environments with dripping water, conductive foreign objects (such as carbon fiber filaments, conductive metal dust, metal chips), and salt spray. **Failure to follow the above instructions will pose a fire risk.** • This equipment must be operated only by trained and qualified electrical personnel. Operations can be performed by professionals only.
WARNING • Read through the guide and safety instructions before installation. • Do not install this equipment in places with strong electric or magnetic field. • Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply may result in mechanical hazards. • Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock. • Before installing the equipment in an enclosed environment (such as a cabinet or case), use a cooling device (such as a fan or air conditioner) to cool the environment 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 terminal device, appropriate guard devices (guards for fire, electrical, and mechanical protection) meeting applicable IEC standards and local laws and regulations must be provided. • Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction. • Install the equipment onto an incombustible object such as a metal. Keep the equipment away from combustible objects. Failure to comply may result in a fire. **The edges of the equipment metal enclosure are sharp. Note the following precautions during installation to avoid personal injury or cable damage:** • When performing installation, handling, or maintenance operations, always wear cut-resistant gloves. • Avoid direct skin contact with enclosure edges and cut surfaces during operation.
Caution • Cover the top of the product 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 product and causing faults. After installation, remove the cloth or paper on top of the product 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, switch off all power supplies of the device. 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 can result in electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board and other exposed live parts with power on. Failure to comply can result in electric shock.
- Make sure that the equipment and product are grounded properly. Failure to comply can result in the risk of electric shock.

WARNING

- Do not connect the power cable to output terminals of the equipment or product. Failure to comply may cause equipment damage or even a fire.
- When connecting a drive with the motor, make sure that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used must comply with corresponding cross-sectional area and shielding requirements. The shield of the shielded cable must be grounded at one end properly.
- Fix the terminal screws with the tightening torque specified in the guide. Improper tightening torque may cause the connecting part over-temperature or damage, resulting in a fire.
- After wiring is done, ensure that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply could result in electric shock or equipment damage.
- Avoid direct skin contact with enclosure edges and cut surfaces during operation.
- Route cables carefully during wiring. Keep them away from sharp edges to prevent squeezing or cutting. It is recommended to use protective sleeves.
- If the enclosure is covered with a protective film, do not remove it until all installation is completed and any further contact with sharp edges is no longer required.

Caution

- During wiring, follow the proper electrostatic discharge (ESD) procedures, and wear an antistatic wrist strap. Failure to comply may result in damage to the equipment or internal circuits.
- Use the shielded twisted pair cable to wire the control circuit, and connect the shield to the grounding terminal of the equipment. Failure to comply may result in equipment malfunction.

Power-on

DANGER

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

WARNING

- Perform a trial run after wiring and parameter setting to ensure that 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. Using an incorrect supply voltage may cause a fire.
- Before power-on, check that no one is near the equipment, motor, or other mechanical parts. Failure to comply may result in personal injury or even death.

Operation
DANGER • The equipment must be operated by professionals. Failure to comply will result in personal injury or even death. • Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply can result in electric shock. **The equipment is equipped with the automatic restart function. After power supply recovery or fault clearance, do not enable this function when the equipment is running, being inspected, or when personnel are in contact with the drive mechanism. Before enabling the automatic restart function, check the following:** • No personnel are working on the load side, and no foreign objects cause blockages. • All safety protection devices (such as safety doors, emergency stop circuits) are properly engaged. • Prominent "Automatic restart" safety warning signs have been posted on the equipment and the site.
WARNING • Do not touch the enclosure, fan, or resistor with bare hands. Failure to comply may result in burns. • Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance
DANGER • Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals. • Do not perform maintenance on the equipment with power-on. Failure to comply may result in an electric shock. • Before maintenance, disconnect all the power supplies of the equipment and wait for at least the time specified on the warning label. • When using a permanent magnet (PM) motor, do not touch the motor terminals while the motor is rotating, because induced voltage may be present at the terminals even after the product is powered off. Failure to comply may result in electric shock.
WARNING • Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair
DANGER • Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals. • Do not repair the equipment with power-on. Failure to comply may result in electric shock. • Before inspection or repair, disconnect all the power supplies of the equipment and wait for at least the time specified on the warning label.
WARNING • Submit a request for repair based on the warranty agreement. • When the fuse is blown or the circuit breaker or earth leakage current breaker (ELCB) trips, wait for at least the time specified on the warning label before power-on or other operations. Failure to comply may result in personal injury or death and equipment damage. • Troubleshooting and repair of a faulty or damaged equipment must be performed by professionals based on the repair instructions, with the repair records kept properly. • Replace quick-wear parts of the equipment according to the replacement instructions. • Never operate the damaged equipment. Failure to comply may result in personal injury or death, or greater equipment damage. • Recheck the wiring and reset the parameters after equipment replacement.

Disposal
WARNING • Dispose of the retired equipment in accordance with applicable national regulations and standards. Failure to comply may result in property damage, personal injury, or death. • Recycle retired equipment in accordance with industry waste disposal standards to avoid environmental pollution.

Safety Label

To ensure safe operation, comply with safety labels on the equipment and do not damage or remove the labels. The following table describes the meanings of the safety labels.

Safety Label	Description
	• Before using the equipment, read the guide and safety precautions carefully. Failure to comply may result in personal injury, death, or equipment damage. • Do not touch the terminals or remove the cover with power-on or within 10 min after power-off. Failure to comply may result in electric shock.

1.2 Industrial Information Security

The product provides interfaces for network connection and data transmission. To protect factories, systems, machines, and networks from cyberattacks, it is essential to implement proper protection mechanism for industrial security.

Customers are responsible for providing and maintaining a secure connection between the product and their network or any other network to protect their factories, systems, machines, and networks from unauthorized access. Such systems or machines can be connected to an enterprise network or

the Internet only when a secure connection is established and appropriate security measures (such as using antivirus software or installing firewalls) are in place.

Inovance continuously develops and improves products and solutions to enhance safety. It is strongly recommended that you update the product promptly and always use the latest version.



Malware (such as viruses, Trojans, and worms) can bring the device into an unsafe operating state, resulting in death, serious injury, and property damage. Observe the following precautions:

- Always use the latest software version. If the product version is no longer supported or the latest version is not used, you will be exposed to increased risk of cyber attacks.
- Develop and maintain appropriate protective measures (including but not limited to antivirus software, firewalls, WAF, IPS/IDS, situational awareness system, identity authentication, and data encryption) to prevent the files in mobile storage devices from being damaged by malware, and to protect the products, networks, systems, and interfaces from unauthorized access, tampering, hacking, data leakage, or information theft.
- Check all safety-related interfaces and settings after commissioning.

2 Product Information

2.1 Introduction to the Servo Drive

2.1.1 Product Positioning and Features

The ES680N series servo drives are developed for high-performance vector control of permanent magnet synchronous motors (PMSMs). They are technical upgrades from the ES650N series and feature the high-speed EtherCAT bus compared with the ES680 series.

It supports high-speed EtherCAT bus and closed-loop oil pressure control through communication, as well as CoE/EoE application layer protocols. The drive adopts high-performance vector control technology and supports monitoring through the software tool and CAN communication bus. It is configured with optimized injection speed and pressure holding precision control and flexible function combination.

The ES680N series servo drive mainly applies to industries including plastic molding, pipe extrusion, shoe-making, rubber, and metal injection molding. It can be used together with a MEG series motor that equipped with 23-bit A3 encoder to achieve the tuning-free function, allowing high precision oil pressure control, low pressure and speed fluctuation, fast response in field weakening range, and high torque output.

Highlights:

1. STO function as standard
   The STO function can be enabled through peripheral devices such as an emergency stop switch, preventing physical injury and device damage during production.

2. FE EtherCAT communication
   The CoE/EoE application layer protocols and closed-loop oil pressure control and be achieved through communication. The control circuit can be connected to an external 24 V power supply to keep EtherCAT communication with the host controller.

3. Small size and high power density
   The overall power density of ES680N series servo drives is improved by 30% compared with ES650N and IS580 series drives.

4. Wide voltage range
   Rated input: Three-phase 380 VAC to 480 VAC; voltage fluctuation range: -15% to +10%

5. Built-in DC reactor
   37 kW to 132 kW models are delivered with DC reactors as standard, which facilitates on-site installation. For 160 kW models and above, you need to purchase DC reactors separately.

6. Comprehensive built-in braking unit and protective functions
   The built-in braking unit is available in models of 132 kW and below. The braking circuit is configured with protective functions and corresponding fault indications for short circuit and overcurrent of the braking resistor.

7. Long service life
   Long service life of the bus capacitor owing to high standard of configurations

8. Protection of the fan drive circuit
   The fan drive circuit comes into rescue when the fan is short-circuited due to blockage or damage.

9. Comprehensive protective functions
   Protections against output short-circuited to ground and pre-charge relay (contactor) close fault are available in all series of ES680 servo drives.

10. EMC solution optimization
    A whole set of solutions based on actual application needs and certification needs are available.

11. High-performance (23-bit) encoder
    The drive comes standard with Inovance 23-bit A3 encoders with a resolution of up to 8 million PPR. It also supports motor parameter packaging for tuning-free operation, improving software usability. Moreover, the drive supports PT1000 and KTY for motor temperature detection.

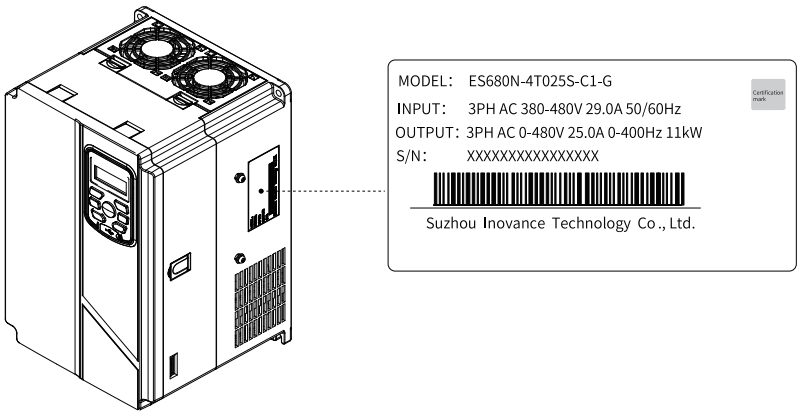
2.1.2 Nameplate and Model

Model

ES680 ① N ② - 4T ③ 025 ④ S ⑤ - C1 ⑥ - G ⑦

① **Product series** ES680: 680 series hydraulic servo drive	⑤ **Functional safety** S: With STO function
② **Product category** N: EtherCAT version	⑥ **Encoder type** C1: Weton 23-bit encoder
③ **Voltage class** 4T: Three-phase 380 V to 480 V	⑦ **Motor type** G: Dedicated high-speed model
④ **Rated output current** 025: 25 A	-

Nameplate description



Note

The preceding nameplate is for reference only. Actual nameplates may vary.

2.1.3 Product Model

The drive model is consistent with the model indicated by the nameplate of the drive. The T model is dependent on the drive structures. The relationship between the drive model and T model is shown in the following table.

Table 2–1 Relationship between the drive model and T model

Product model	Power (kW)	T model	Structure
ES680N-4T025S-C1	11	T4	Plastic structure
ES680N-4T032S-C1	15		
ES680N-4T037S-C1	18.5		
ES680N-4T044S-C1	22		
ES680N-4T060S-C1	30	T5	
ES680N-4T075S-C1	37	T6	
ES680N-4T091S-C1	45		
ES680N-4T112S-C1	55	T7	Sheet metal structure
ES680N-4T150S-C1	75		
ES680N-4T176S-C1	90	T8	Sheet metal structure
ES680N-4T210S-C1	110		
ES680N-4T253S-C1	132		
ES680N-4T312S-C1	160	T9	Sheet metal structure
ES680N-4T395S-C1	200		
ES680N-4T426S-C1	220		
ES680N-4T480S-C1	250		
ES680N-4T525S-C1	280		
ES680N-4T600S-C1	315		
ES680N-4T650S-C1	355		

2.1.4 Technical Data

Electrical Specifications

Table 2–2 Electrical specifications (11 kW to 75 kW)

Item		Specifications (Model: ES680N-4TXXXS-C1)								
		025	032	037	044	060	075	091	112	150
Applicable motor capacity (kW)		11	15	18.5	22	30	37	45	55	75
Input	Rated input current (A)	29	36	42	48	57	69	89	106	139

Item		Specifications (Model: ES680N-4TXXXS-C1)								
		025	032	037	044	060	075	091	112	150
Output	Rated output current (A)	25	32	37	44	60	75	91	112	150
	Output voltage	Three-phase 0 V to 480 V (≤ input voltage)								
	Maximum output frequency	400 Hz								
	Carrier frequency	2.0 kHz to 8.0 kHz								
Power supply	Rated voltage and frequency	Three-phase 380 VAC to 480 VAC, 50 Hz/60 Hz								
	Allowable voltage fluctuation range	–15% to +10%; allowed voltage range: 323 VAC to 528 VAC								
	Allowable frequency fluctuation range	±5%; actual allowed range: 47.5 Hz to 63 Hz								
	Power supply capacity (kVA)	30	39	45	54	52	62	81	97	127
Power dissipation (kW)		0.45	0.55	0.65	0.81	1.01	1.20	1.51	1.80	1.84
Standard short-circuit current rating (standard fault SCCR)		5 kA						10 kA		
High short-circuit current rating (high fault SCCR)		100 kA								

Table 2–3 Electrical specifications (90 kW to 355 kW)

Item		Specifications (Model: ES680N-4TXXXS-C1)									
		176	210	253	312	395	426	480	525	600	650
Applicable motor capacity (kW)		90	110	132	160	200	220	250	280	315	355
Input	Rated input current (A)	164	196	240	287	365	410	441	495	565	617
Output	Rated output current (A)	176	210	253	312	395	426	480	525	600	650
	Output voltage	Three-phase 0 V to 480 V (≤ input voltage)									
	Maximum output frequency	400 Hz									
	Carrier frequency	2.0 kHz to 8.0 kHz									

Item		Specifications (Model: ES680N-4TXXXS-C1)									
		176	210	253	312	395	426	480	525	600	650
Power supply	Rated voltage and frequency	Three-phase 380 VAC to 480 VAC, 50 Hz/60 Hz									
	Allowable voltage fluctuation range	–15% to +10%; allowed voltage range: 323 VAC to 528 VAC									
	Allowable frequency fluctuation range	±5%; actual allowed range: 47.5 Hz to 63 Hz									
	Power supply capacity (kVA)	150	179	220	263	334	334	375	404	453	517
Power dissipation (kW)		2.14	2.85	3.56	4.15	4.15	4.15	4.55	5.06	5.33	5.69
Standard short-circuit current rating (standard fault SCCR)		10 kA			18 kA					30 kA	
High short-circuit current rating (high fault SCCR)		100 kA									

Technical Specifications

Table 2–4 Technical Specifications

Item		Technical Specifications
Basic functions	Resolution of input frequency	Digital setting: 0.01 Hz; Analog setting: maximum frequency x 0.025%
	Control mode	Feedback vector control (FVC)
	Starting torque	0 Hz/180% (FVC)
	Speed regulation range	1:1000 (FVC)
	Stable and accurate speed	±0.02% (FVC)
	Torque control accuracy	FVC: ±3%
	Torque boost	Automatic torque boost; Customized torque boost: 0.1% to 30.0%
	Acceleration/Deceleration curve	Straight-line acceleration/deceleration S-curve acceleration/deceleration Four groups of acceleration/deceleration time ranging from 0.0 to 6500.0s
	DC braking	Starting frequency of DC braking: 0.00 Hz to maximum frequency; braking time: 0.0s to 36.0s Injection action current value: 0.0%–100.0%
	Built-in PID	Implements a closed-loop process control system.
	Auto voltage regulation (AVR)	Keeps constant output voltage automatically when the mains voltage changes.
	Overvoltage/Overcurrent stall control	Limits the current and voltage automatically during operation to prevent frequent tripping caused by overvoltage/overcurrent.
Custom functions	Supported field buses	Supports multiple field buses: EtherCAT, CAN (for oil pressure)
	STO function	Carries STO function as standard to comply with SIL3.
	Encoders supported	C1 models come standard with Inovance 23-bit A3 encoder, and support PT1000 and KTY for temperature detection.
	Advanced software tool	Supports parameter settings and virtual oscilloscope. Internal drive status can be monitored through the virtual oscilloscope.
Operation	Operation command	Three command sources available: operating panel, terminal, and communication You can perform switch the command source in multiple ways.
	Frequency source	There are ten frequency sources in total, including digital setting (retentive/non-retentive at power failure), analog setting (AI1, AI2, or AI3), pulse input (DI5), multi-reference, simple PLC, PID, and communication setting. The sources can be switched in various ways.
	Input terminal	Five DIs and three AIs as standard Among the three AI terminals, two of which support -10 V to +10 V voltage input, one of which supports 0 V to 10 V voltage input or 0 mA to 20 mA current input (defined by parameter).
	Output terminals	Standard: Two DOs
Display and operation on the operation panel	Display	Displays parameters.
	LCD display	Optional; displays operation prompts in Chinese or English
	Parameter clone	Allows quick parameter copy through the external operating panel (LCD).

Item		Technical Specifications
Protective functions	Open-phase protection	Input and output phase loss protection
	Overcurrent protection	Stops the drive upon overcurrent (with current exceeding 2.5 x rated current).
	Overvoltage protection	Stops the drive when the DC voltage of the main circuit is above 820 V.
	Undervoltage protection	Stops the drive when the DC voltage of the main circuit is lower than 350 V.
	Over-temperature protection	Triggers protection when the inverter bridge overheats
	Brake protection	Provides protection in case of short circuit of the braking resistor and long-term operation of the braking transistor.
	Short-circuit protection	Protection against output interphase short circuit and output short circuit to ground
	Motor over-temperature protection	Provides protection when the motor stator temperature exceeds the setpoint.
Environment	Applicable scenarios	Indoors and free from direct sunlight, dusts, corrosive gases, combustible gases, oil mists, vapors, water drips, and salty elements.
	Altitude	For altitudes below 1000 m, derating is not required. For altitudes above 1000 m, derate 1% for every additional 100 m. For altitudes above 3000 m, contact Inovance.
	Ambient temperature	-10℃ to +50℃(For temperatures between -10℃ to +40℃, derating is not required. For temperatures above 40℃, derate 1.5% for every additional 1℃.)
	Humidity	5% to 95% RH (without condensation)
	Vibration	Operation scenario: Tested according to IEC 60068-2-6. Vibration amplitude at 5 Hz to 8.4 Hz: 3.5 mm; gravitational acceleration at 8.4 Hz to 200 Hz: 1 g; 10 cycles in each of X/Y/Z-axis direction Transportation scenario: Tested 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 environment: Tested according to IEC 60068-2-27. Acceleration: 15 g; pulse width; 11 ms; 18 times in directions of three axes
	Storage temperature	-20℃ to +60℃ (temperature change: < 1℃/min)
IP rating	IP20 (open type, for IEC-certified products)	
Protection class	Class I	

2.1.5 Components

Components of T4 to T6 models

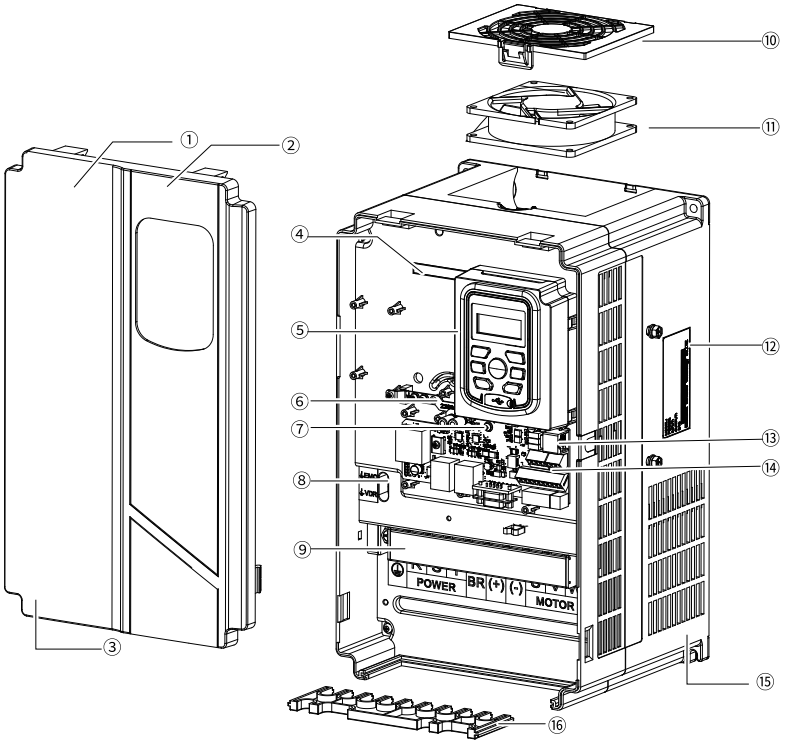


Figure 2-1 Components of T4 to T6 models

No.	Name	Description
①	Logo	-
②	Top cover	-
③	Equipment label	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	Bar code	Indicates the code and model of the equipment.
⑤	Operating Panel	-
⑥	Grounding bar	Grounds the control board and the shield of the encoder cable.
⑦	Grounding screw of the control board	The control board is not grounded by default. When the control board needs to be grounded, tighten an M3×8 SEMS screw on the grounding threaded hole of the control board.
⑧	Grounding screw	Grounding screws for EMC capacitor and voltage dependent resistor.
⑨	Main circuit terminal and grounding terminal	-
⑩	Fan cover	-
⑪	Cooling fan	-
⑫	Nameplate	-
⑬	External operating panel interface	-
⑭	Control circuit terminal	-

No.	Name	Description
⑮	Enclosure	-
⑯	Comb-type wiring cover	-

Note

- Each T4 model has two cooling fans on the top.
- Each T5 or T6 model has one cooling fan on the top.

Components of T7 and T8 models

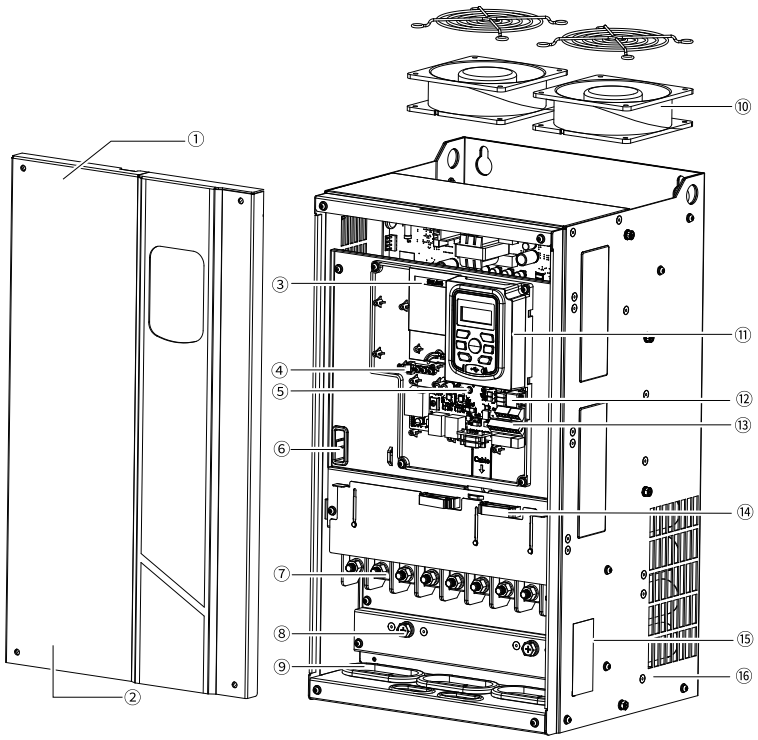
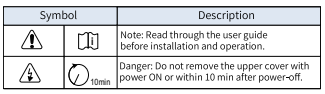


Figure 2-2 Components of T7 and T8 models

No.	Name	Description
①	Top cover	-
②	Equipment label	
③	Bar code	Indicates the code and model of the equipment.
④	Grounding bar	Grounds the control board and the shield of the encoder cable.
⑤	Grounding screw of the control board	The control board is not grounded by default. When the control board needs to be grounded, tighten an M3×8 SEMS screw on the grounding threaded hole of the control board.
⑥	Grounding screw	Grounding screws for safety capacitor and voltage dependent resistor
⑦	Main circuit terminals	-

No.	Name	Description
⑧	Grounding terminal	-
⑨	Protective ring	-
⑩	Cooling fan	-
⑪	Operating Panel	-
⑫	External operating panel interface	-
⑬	Control circuit terminal	-
⑭	Cable tie	-
⑮	Nameplate	-
⑯	Enclosure	-

Note

The number of cooling fans on top of T7 models is shown as follows:

- 55 kW: One cooling fan
- 75 kW: Two cooling fans

There are two cooling fans on top of T8 models.

Components of T9 models

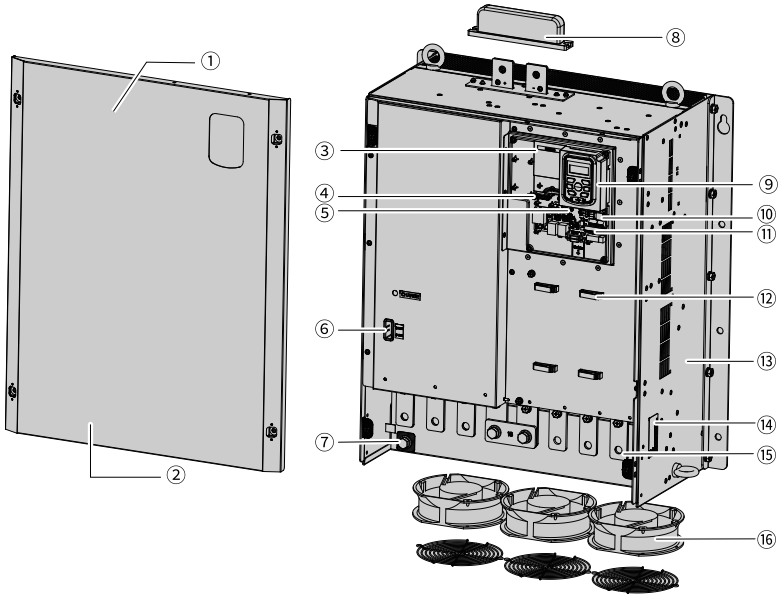
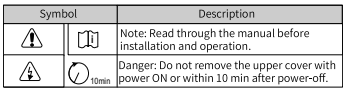


Figure 2-3 Components of T9 models

No.	Name	Description
①	Top cover	-
②	Equipment label	
③	Bar code	Indicates the code and model of the equipment.
④	Grounding bar	Grounds the control board and the shield of the encoder cable.

No.	Name	Description
⑤	Grounding screw of the control board	The control board is not grounded by default. If grounding is needed, tighten an M3x8 SEMS screw on the grounding threaded hole of the control board.
⑥	Grounding screw	Grounding screws for safety capacitor and voltage dependent resistor
⑦	Grounding terminal	-
⑧	Busbar protective cover	-
⑨	Operating Panel	-
⑩	External operating panel interface	-
⑪	Control circuit terminal	-
⑫	Cable tie	-
⑬	Enclosure	-
⑭	Nameplate	-
⑮	Main circuit wiring block	-
⑯	Cooling fan	-

2.2 Introduction to the Servo Motor

2.2.1 Model and Nameplate

Model

MEG ① 20 ② - 13D ③ 22C ④ D ⑤ - ** ⑥ * ⑦ * ⑧ * ⑨ - * ⑩

① **Product series**

MEG: Servo motor for hydraulic servo drives

② **Frame size**

20: 200 x 200

23: 266 x 266

③ **Rated power**

(comprised of two digits and a letter)

A: x 1

B: × 10

C: × 100

D: x 1000

E: x 10000

Example: 13D: 13000 W

④ **Rated speed**

(comprised of two digits and a letter)

A: x 1

B: × 10

C: × 100

D: x 1000

E: x 10000

Example: 22C: 2,200 rpm

⑤ **Voltage class**

D: 380 V

⑥ **Encoder type**

(comprised of a letter and a digit)

A3: 23-bit high performance encoder

⑦ **Shaft connection mode**

1: Plain shaft

2: Hollow cone shaft

3: Solid, with key and tapped hole

A: Solid, with key and threaded hole, built-in rotor

⑧ **Brake, reducer and oil seal**

0: None

1: Oil seal

⑨ **Cooling method**

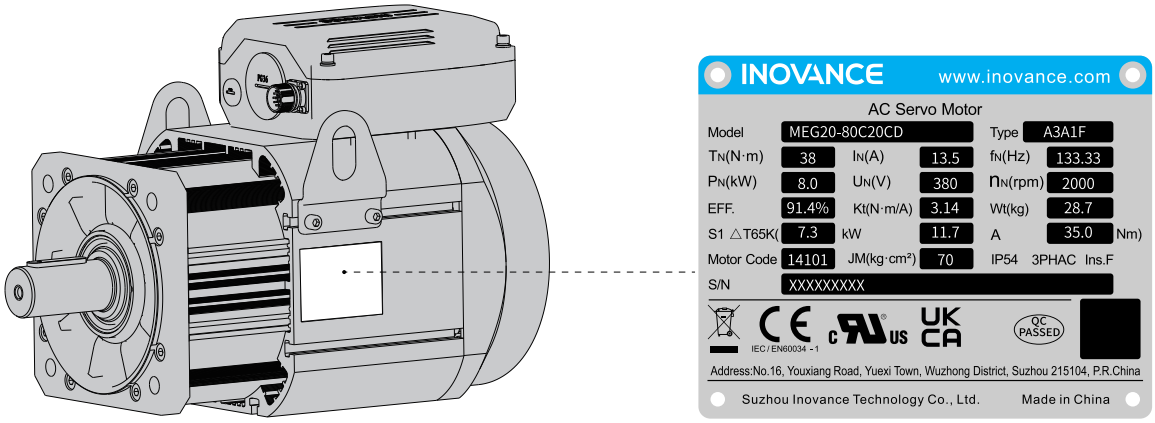
F: Forced air cooling

⑩ **Customized**

_: Standard

K: Narrow foot

Description of nameplate



2.2.2 Component Description

2.2.2.1 Motor Components

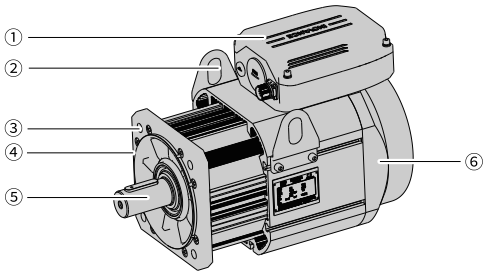


Figure 2-4 Components of the motor

No.	Part name	Description
①	Junction box	Used to connect motor drive cables and protect cables.
②	Eyebolt	Used to lift the motor to help move the motor.
③	Mounting screw on the user side	Used to fix the motor.
④	Mounting flange face on the user side	Used to support motors, and fix and protect the bearing.
⑤	Shaft extension (keyed)	Used to connect the driven parts.
⑥	Rear cover of the fan	Used to protect the fan and avoid safety accidents.

2.2.2.2 Components of the Motor Junction Box

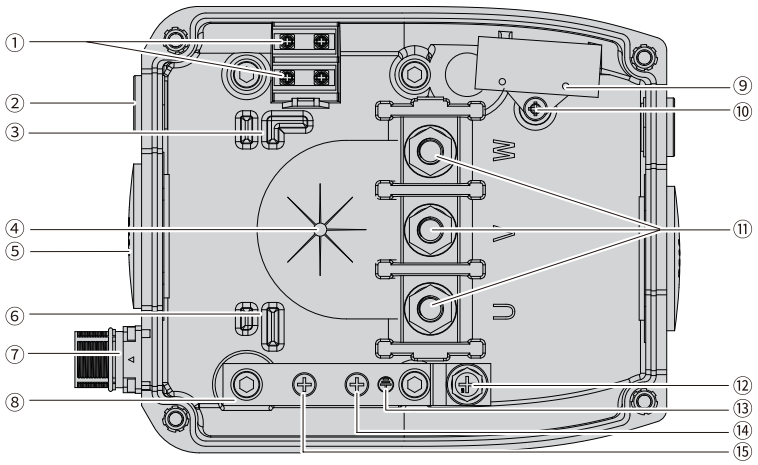


Figure 2-5 Internal structure of the motor junction box

No.	Component	No.	Component	No.	Component
①	220 V fan, 2 x M4 cross recessed screw	⑥	Routing sealing duct	⑪	M10 bolt for U, V, and W power cables Applicable to standard M10 nuts
②	2 x PG11 sealing plug	⑦	M23 aviation connector	⑫	M8 grounding screw
③	Routing sealing duct	⑧	4-M6 spring/flat washer screw that connected to the junction box and enclosure	⑬	Grounding mark
④	Motor cable outlet (Take measures to prevent falling of small components.)	⑨	Fan capacitor	⑭	Internal grounding screw of the fan
⑤	2 x PG36 sealing cap	⑩	M4 screw	⑮	Grounding screw of the fan power supply cable (customer side)

2.2.3 Technical Specifications

2.2.3.1 Electrical Specifications

Table 2–5 Motor performance (flange size 200 x200 at 2200 rpm)

Item		Unit	Model: MEG20-XXXXXX-A3A1F								
			85C22 CD	13D22 CD	20D22 CD	23D22 CD	27D22 CD	31D22 CD	33D22 CD	39D22 CD	42D22 CD
Rated voltage	U_N	V	380								
Rated current	I_N	A	15.7	21.6	33.8	38.9	45.8	54.8	57.3	65.8	71.0
Rated speed	n_N	rpm	2200								
Rated frequency	f_N	Hz	146.67								
Rated torque	T_N	N·m	37	58	83	96	116	135	142	165	178
Rated power	P_N	kW	8.5	13.4	19.1	22.1	26.7	31.1	32.7	38.0	41.2

Item		Unit	Model: MEG20-XXXXXX-A3A1F								
			85C22 CD	13D22 CD	20D22 CD	23D22 CD	27D22 CD	31D22 CD	33D22 CD	39D22 CD	42D22 CD
Rated point efficiency	η	%	91.6	92.3	93.1	93.2	93.6	93.7	94.3	95.1	95.2
65 K power	P (65 K)	kW	7.8	10.7	13.0	16.4	21.0	23.0	23.5	27.6	30.2
65 k torque	T (65 K)	N·m	34.0	46.5	56.5	71.0	91.0	100.0	105.0	125.0	130.0
65 k current	I (65 k)	A	13.6	16.9	21.7	27.7	35.4	38.9	42.4	49.8	52.6
Maximum current	I_{max}	A	48.0	48.0	55.5	66	84.0	84.0	112.5	135.0	138
Maximum speed	$_{N·max}$	rpm	3000								
Torque corresponding to max. speed	$T_{N·max}$	N·m	54.3	72.9	108.5	138.0	154.7	157.4	215.0	263.6	262.7
Peak current at rated speed	$I_{N·max}$	A	48	48	55.5	66	84	84	112.5	135	138
Peak torque at rated speed	$T_{N·max}$	N·m	77	101.7	138.5	173.7	199.9	203	284	334.5	339.5
D-axis incremental inductance	L_d	mH	6.301	4.901	2.633	2.042	1.79	1.481	1.786	1.2	1.032
Q-axis incremental inductance	L_q	mH	13.3	11.12	6.134	4.551	4.254	3.483	4.063	2.863	2.664
Line resistance (Ω) at 20℃	R_w	Ω	1.1330	0.6811	0.3764	0.2724	0.2072	0.1728	0.1897	0.1296	0.1308
Electromagnet torque constant at 20℃	K_t	N·m/A	2.7	2.88	2.7	2.62	2.65	2.61	2.93	2.61	2.72
Axis torque constant at 20℃	K_t	N·m/A	2.36	2.68	2.45	2.47	2.53	2.46	2.47	2.50	2.51
Back EMF constant at 20℃	K_e	V/krpm	163.0	174.0	163.0	158	161	158.0	177.0	158.0	165
Back EMF temperature coefficient	dK_e/dT	%/℃	-0.1								
Stall current	I_o	A	19.6	26.2	42.5	46.0	55.0	63.0	68.0	79.3	82.9
Stall torque	T_o	N·m	46.3	70.4	104.4	114.2	139.1	155.3	168.9	199	208
Rotor moment of inertia	J_m	$kg·cm^2$	70.0	90.0	111.0	132.0	152.0	173.0	194.0	215.0	221

Table 2–6 Motor performance (flange size 200 x200 at 2000 rpm)

Item		Unit	Model: MEG20-XXXXXX-A3A1F								
			80C20 CD	13D20 CD	18D20 CD	22D20 CD	25D20 CD	30D20 CD	32D20 CD	35D20 CD	38D20 CD
Rated voltage	U_N	V	380								
Rated current	I_N	A	13.5	21.1	28.5	32.2	41.1	49.0	52.8	56.6	63.5

Item		Unit	Model: MEG20-XXXXXX-A3A1F								
			80C20 CD	13D20 CD	18D20 CD	22D20 CD	25D20 CD	30D20 CD	32D20 CD	35D20 CD	38D20 CD
Rated speed	n_N	rpm	2000								
Rated frequency	f_N	Hz	133.33								
Rated torque	T_N	N·m	38	59	85	102	120	140	149	168	181
Rated power	P_N	kW	8.0	12.4	17.8	21.4	25.1	29.3	31.2	35.2	37.9
Rated point efficiency	η	%	91.4	92.1	93.1	93.2	93.4	93.6	94.3	95.1	95.2
65 K power	P (65 K)	kW	7.3	10.1	11.3	15.7	19.9	20.3	20.9	25.1	27.3
65 k torque	T (65 K)	N·m	35	48	54	75	95	102	110	125	130
65 k current	I (65 k)	A	11.7	16.4	16.3	24.1	32.0	35.7	38.9	42.1	46.5
Maximum current	I_{max}	A	48.0	48.0	55.5	66	84.0	84.0	112.5	135	138
Maximum speed	N_{max}	rpm	3000								
Torque corresponding to max. speed	$T_{N·max}$	N·m	48	74.4	89.9	127.6	156.5	165.5	220.5	233.1	246.9
Peak current at rated speed	$I_{N·max}$	A	48	48	55.5	66	84	84	112.5	135	138
Peak torque at rated speed	$T_{N·max}$	N·m	74.9	115.2	136	185.6	226	225	307.3	352.9	357.9
D-axis incremental inductance	L_d	mH	7.554	5.258	4.236	2.832	2.454	2.03	1.696	1.64	1.384
Q-axis incremental inductance	L_q	mH	16.14	11.53	8.864	7.014	5.776	4.748	3.92	4.19	3.532
Line resistance (Ω) at 20℃	R_w	Ω	1.5560	0.8909	0.6313	0.4407	0.2901	0.2432	0.1897	0.2000	0.1730
Electromagnet torque constant at 20℃	K_t	N·m/A	3.14	3.09	3.18	3.32	3.10	3.02	2.94	3.27	3.10
Axis torque constant at 20℃	K_t	N·m/A	2.81	2.79	2.98	3.16	2.91	2.85	2.82	2.96	2.85
Back EMF constant at 20℃	K_e	V/krpm	190	187	192	201	187	183	177	198	187
Back EMF temperature coefficient	dK_e/dT	%/℃	-0.1								
Stall current	I_o	A	15.8	25.3	34.6	39.5	50.6	59.0	64.4	72.4	81.4
Stall torque	T_o	N·m	44.6	70.7	103.2	125	147.9	169.6	181.8	215	232
Rotor moment of inertia	J_m	$kg·cm^2$	70.0	90.0	111.0	132.0	152.0	173.0	194.0	215.0	221

Table 2–7 Motor performance (frame size 200 x 200 (1700 rpm))

Item		Unit	Model: MEG20-XXXXXX-A3A1F								
			71C17 CD	11D17 CD	17D17 CD	19D17 CD	23D17 CD	27D17 CD	29D17 CD	32D17 CD	35D17 CD
Rated voltage	U_N	V	380								
Rated current	I_N	A	13.0	19.5	27.4	30.0	36.8	43.0	45.5	48.8	56.5
Rated speed	n_N	rpm	1700								
Rated frequency	f_N	Hz	113.33								
Rated torque	T_N	N·m	40	61	93	107	125	150	158	178	191
Rated power	P_N	kW	7.1	10.9	16.6	19.0	22.3	26.7	28.1	31.7	34.1
Rated point efficiency	η	%	91.4	92.1	93.1	93.2	93.4	93.6	94.2	95.1	95.2
65 K power	P (65 K)	kW	6.6	8.7	10.9	14.1	17.6	23.0	16.9	19.6	25.1
65 k torque	T (65 K)	N·m	37	49	70	79	90	110	114	130	140
65 k current	I (65 k)	A	11.5	15.0	21.4	22.3	28.7	31.5	32.8	35.6	42.5
Maximum current	I_{max}	A	48.0	48.0	55.5	66	84.0	84.0	112.5	135	138
Maximum speed	$N_{\cdot max}$	rpm	3000								
Torque corresponding to max. speed	$T_{N\cdot max}$	N·m	43.7	63	92.6	109.4	136.4	152.2	175.3	184.1	226.9
Peak current at rated speed	$I_{N\cdot max}$	A	48	48	55.5	66	84	84	112.5	135	138
Peak torque at rated speed	$T_{N\cdot max}$	N·m	81.4	121.4	163.7	191.2	240.1	257.1	320.3	348.1	402.3
D-axis incremental inductance	L_d	mH	10.44	7.3	4.997	4.477	3.199	3.018	2.391	2.908	1.946
Q-axis incremental inductance	L_q	mH	21.37	16.08	11.15	9.883	7.538	6.939	5.416	6.69	4.918
Line resistance (Ω) at 20℃	R_w	Ω	1.7040	1.1280	0.6590	0.5837	0.3825	0.3310	0.2813	0.2974	0.2326
Electromagnet torque constant at 20℃	K_t	N·m/A	3.44	3.54	3.54	3.74	3.54	3.61	3.52	3.92	3.61
Axis torque constant at 20℃	K_t	N·m/A	3.07	3.12	3.39	3.56	3.39	3.48	3.46	3.64	3.38
Back EMF constant at 20℃	K_e	V/krpm	208	214	214	226	214	219	213	237	219
Back EMF temperature coefficient	dK_e/dT	%/°C	-0.1								
Stall current	I_o	A	15.4	22.5	30.6	36.7	42.6	50.6	54.3	58.7	68.3
Stall torque	T_o	N·m	47.6	70.7	103.9	131.2	145	176.8	188.9	214.3	231
Rotor moment of inertia	J_m	$kg\cdot cm^2$	70	90	111	132	152	173	194	215	221

Table 2–8 Motor performance (flange size 266 x 266 at 2200 rpm)

Item		Unit	Model: MEG23-XXXXXX-A3A1F				
			51D22CD	55D22CD	63D22CD	75D22CD	79D22CD
Rated voltage	U_N	V	380				
Rated current	I_N	A	88.0	92.5	112.5	125.2	134.5
Rated speed	n_N	rpm	2200				
Rated frequency	f_N	Hz	146.67				
Rated torque	T_N	N·m	220	240	270	323	341
Rated power	P_N	kW	50.7	55.3	62.2	74.4	78.6
Rated point efficiency	η	%	95.2	95.4	95.5	95.6	95.7
65 K power	P (65 K)	kW	36.9	40.3	50.7	55.3	57.8
65 k torque	T (65 K)	N·m	160	175	220	240	250
65 k current	I (65 k)	A	70.4	74.2	100.8	102.3	99.8
Maximum current	I_{max}	A	135	168	202.5	202.5	202.5
Maximum speed	$_{N·max}$	rpm	3000				
Torque corresponding to max. speed	$T_{N·max}$	N·m	244.1	276.5	353.9	359.2	398.81
Peak current at rated speed	$I_{N·max}$	A	135	168	202.5	202.5	202.5
Peak torque at rated speed	$T_{N·max}$	N·m	311.4	372.1	464	469.5	491.5
D-axis incremental inductance	L_d	mH	1.54	1.458	1.066	1.056	0.976
Q-axis incremental inductance	L_q	mH	2.729	2.48	1.86	1.83	1.707
Line resistance (Ω) at 20℃	R_w	Ω	0.1098	0.0994	0.0709	0.0664	0.0642
Electromagnet torque constant at 20℃	K_t	N·m/A	2.72	2.76	2.68	2.72	2.87
Axis torque constant at 20℃	K_t	N·m/A	2.5	2.59	2.4	2.58	2.53
Back EMF constant at 20℃	K_e	V/krpm	164	167	162	164	173
Back EMF temperature coefficient	dK_e/dT	%/℃	-0.1				
Stall current	I_o	A	98.0	109.0	121.5	147.5	158.1
Stall torque	T_o	N·m	248	283	324	381.5	401
Rotor moment of inertia	J_m	kg·cm ^{2}	375	427	479	531	605

Table 2–9 Motor performance (frame size 266 x 266 at 2000 rpm)

Item		Unit	Model: MEG23-XXXXXX-A3A1F				
			48D20CD	52D20CD	59D20CD	67D20CD	72D20CD
Rated voltage	U_N	V	380				
Rated current	I_N	A	81.7	87.0	98.8	117.4	126.5
Rated speed	n_N	rpm	2000				
Rated frequency	f_N	Hz	133.33				
Rated torque	T_N	N·m	227	245	280	322	348
Rated power	P_N	kW	47.5	51.3	58.6	67.4	72.8
Rated point efficiency	η	%	95.2	95.4	95.5	95.6	95.7
65 K power	P (65 K)	kW	35.6	37.7	41.9	48.2	54.7
65 k torque	T (65 K)	N·m	170	180	200	230	260
65 k current	I (65 k)	A	67.3	70.3	77.6	92.2	96.5
Maximum current	I_{max}	A	135	168	202.5	202.5	202.5
Maximum speed	$_{N·max}$	rpm	3000				
Torque corresponding to max. speed	$T_{N·max}$	N·m	244.1	269.8	327.5	359.2	385.6
Peak current at rated speed	$I_{N·max}$	A	135	168	202.5	202.5	202.5
Peak torque at rated speed	$T_{N·max}$	N·m	344.4	422.1	504	523.5	553.2
D-axis incremental inductance	L_d	mH	1.917	1.853	1.37	1.105	1.181
Q-axis incremental inductance	L_q	mH	3.284	3.332	2.543	2.006	2.056
Line resistance (Ω) at 20℃	R_w	Ω	0.1403	0.1246	0.0997	0.0791	0.0765
Electromagnet torque constant at 20℃	K_t	N·m/A	3.04	3.16	3.11	2.96	3.16
Axis torque constant at 20℃	K_t	N·m/A	2.77	2.81	2.83	2.74	2.75
Back EMF constant at 20℃	K_e	V/krpm	183.5	190.79	188	179	192
Back EMF temperature coefficient	dK_e/dT	%/℃	-0.1				
Stall current	I_o	A	97.0	105.5	120.5	148.0	161.7
Stall torque	T_o	N·m	269.6	297.2	341.6	406	445
Rotor moment of inertia	J_m	$kg·cm^2$	375	427	479	531	605

Table 2–10 Motor performance (frame size 266 x 266 at 1700 rpm)

Item		Unit	Model: MEG23-XXXXXX-A3A1F				
			41D17CD	48D17CD	55D17CD	59D17CD	63D17CD
Rated voltage	U_N	V	380				
Rated current	I_N	A	70.8	79.5	88.4	99.7	111.5
Rated speed	n_N	rpm	1700				
Rated frequency	f_N	Hz	113.33				
Rated torque	T_N	N·m	233	268	305	325	357
Rated power	P_N	kW	41.4	47.7	54.3	57.8	63.7
Rated point efficiency	η	%	95.2	95.4	95.5	95.6	95.7
65 K power	P (65 K)	kW	31.2	35.6	39.2	42.7	46.5
65 k torque	T (65 K)	N·m	175	200	220	240	260
65 k current	I (65 k)	A	58.5	65.3	70.2	81.0	82.5
Maximum current	I_{max}	A	135	168	202.5	202.5	202.5
Maximum speed	$_{N·max}$	rpm	3000				
Torque corresponding to max. speed	$T_{N·max}$	N·m	190.6	237.4	264.4	297.4	332.7
Peak current at rated speed	$I_{N·max}$	A	135	168	202.5	202.5	202.5
Peak torque at rated speed	$T_{N·max}$	N·m	357.8	410.8	480.1	560	587
D-axis incremental inductance	L_d	mH	2.585	2.31	2.234	1.723	1.648
Q-axis incremental inductance	L_q	mH	4.419	3.901	3.899	2.978	2.849
Line resistance (Ω) at 20℃	R_w	Ω	0.1895	0.1619	0.1380	0.1128	0.1064
Electromagnet torque constant at 20℃	K_t	N·m/A	3.51	3.51	3.80	3.46	3.44
Axis torque constant at 20℃	K_t	N·m/A	3.29	3.37	3.45	3.25	3.2
Back EMF constant at 20℃	K_e	V/krpm	212.5	212	229.9	209.2	227
Back EMF temperature coefficient	dK_e/dT	%/℃	-0.1				
Stall current	I_o	A	85.1	95.5	106.5	117.6	132.7
Stall torque	T_o	N·m	279.9	322.2	367.6	383.5	425
Rotor moment of inertia	J_m	$kg·cm^2$	375	427	479	531	605

2.2.3.2 Mechanical Characteristics

Table 2–11 Motor specifications

Item	Specification				
Degree of protection	IP54				
Voltage withstanding level	2160 VAC for 1s (380 V class)				
Insulation resistance 500 VDC	≥ 20 MΩ				
Max. vibration acceleration	Peak acceleration 50 m/s^2; duration: 30 ms				
Max. vibration in radial direction	Acceleration 25 m/s^2; vibration duration: 30 min				
Insulation class	155 (F)				
Cooling method	IC 416				
Type of construction	IM B35/IM V1				
Duty cycle	S1				
PT1000 alarm threshold	130℃				
Resistance of PT1000 at 10℃ to 30℃	1039 Ω to 1118 Ω				
Ambient temperature	-20℃ to +40℃ (non-frozen)				
Ambient humidity	20% to 90% RH (without condensation)				
Storage temperature	-20℃ to +60℃ (non-frozen)				
Storage humidity	20% RH to 90% RH (without condensation)				
Rated altitude	Below 1000 m (derating required for altitudes above 1000 m)				
Altitude-based derating	1000 m	2000 m	3000 m	4000 m	5000 m
	1	0.947	0.887	0.824	0.645
Ambient temperature-based derating	40℃	45℃	50℃	55℃	60℃
	1	0.952	0.901	0.855	0.781
Operating location	• Install the drive in a place free from corrosive and inflammable gases and combustible materials, such as the hydrogen sulfide, chlorine, ammonia, sulphur gas, chloridize gas, acid, soda and salt. • Use the motor with oil seal in places with grinding fluid, oil mist, iron powders or cuttings. • Install the motor away from heating sources such as a heating stove. • Do not use the motor in an enclosed environment. Running in an enclosed environment can lead to motor overtemperature, which shortens its service life.				

Table 2–12 Fan specifications

Item	G23-SC225A1-068-00M	G20-SC175A1-068-000
Rated voltage	230 VAC	
Rated voltage range	207 VAC to 253 VAC	
Capacitance (±5%)	4 μF/450 V	1.5 μF/450 V
Current (±10%)	0.62 A/0.87 A	0.23 A/0.24 A
Input power (±10%)	140 W/198 W	48 W/55 W
Noise (-7/+3)	71 dB/73 dB	61 dB/64 dB
Degree of protection	IP54	IP54 (for horizontal shaft installation)
Insulation class	F	

2.2.4 Dimensions

Dimensions of MEG20-*******-A3A1F servo motors

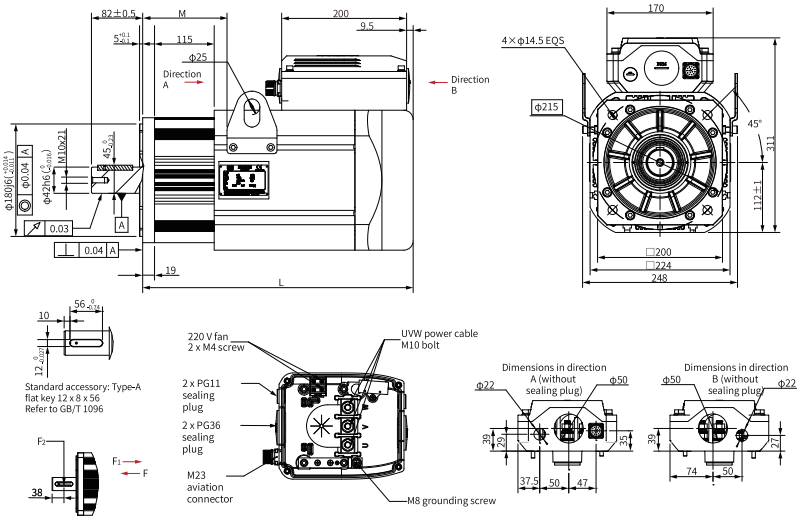


Figure 2-6 Dimensions of MEG20-*******-A3A1F servo motors (unit: mm)

Note

- Technical requirements: The tolerance of unmarked dimensions is compliant with GB/T 1804-2000 Class c.
- Foot mounting is available. Contact Inovance for details.
- It is recommended to use M12 socket head cap screws to install the motor flange.

Table 2–13 Dimensions and weight of MEG20-*******-A3A1F servo motors

Model MEG20-*******-A3A1F	M (mm)	L (mm)	Net weight (kg)	Gross weight (kg)
71C17CD 80C20CD 85C22CD	134	320	30	35
11D17CD 13D20CD 13D22CD	134	348	35	40
17D17CD 18D20CD 20D22CD	134	377	40	50
19D17CD 22D20CD 23D22CD	134	405	45	50
23D17CD 25D20CD 27D22CD	135	434	50	55
27D17CD 30D20CD 31D22CD	148	462	55	60

Model MEG20-*******-A3A1F	M (mm)	L (mm)	Net weight (kg)	Gross weight (kg)
29D17CD 32D20CD 33D22CD	162	491	60	70
32D17CD 35D20CD 39D22CD	180	519	70	75
35D17CD 38D20CD 42D22CD	200	549	75	80

MEG20-*******-A3A1F-K

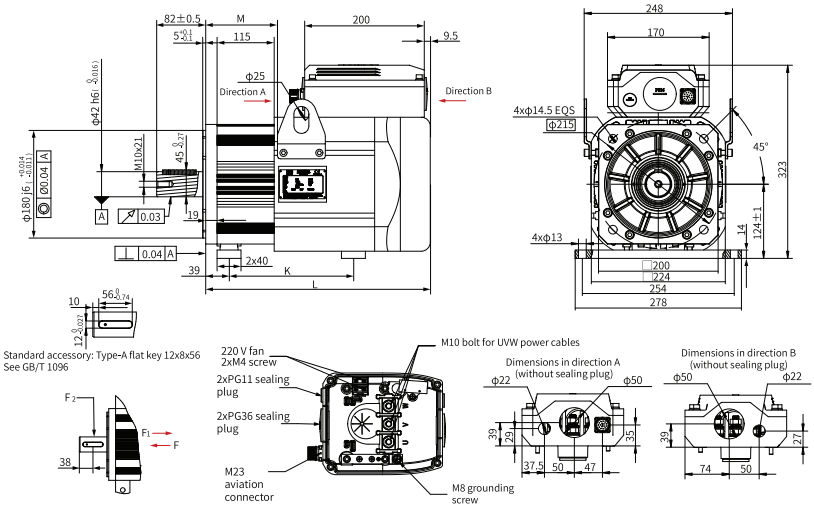


Figure 2-7 Dimensions of MEG20-*******-A3A1F-K servo motors (unit: mm)

Note

- Technical requirements: The tolerance of unmarked dimensions is compliant with GB/T 1804-2000 Class c.
- Foot mounting is available. Contact Inovance for details.
- It is recommended to use M12 socket head cap screws to install the motor flange.

Table 2–14 Dimensions and weight of MEG20-*******-A3A1F-K servo motors

Model MEG20-*******-A3A1F	M (mm)	L (mm)	K (mm)	Net weight (kg)	Gross weight (kg)
71C17CD 80C20CD 85C22CD	134	320	151	35	40
11D17CD 13D20CD 13D22CD	134	348	180	40	45
17D17CD 18D20CD 20D22CD	134	377	208	45	50

Model MEG20-*******-A3A1F	M (mm)	L (mm)	K (mm)	Net weight (kg)	Gross weight (kg)
19D17CD 22D20CD 23D22CD	134	405	237	50	55
23D17CD 25D20CD 27D22CD	135	434	265	55	60
27D17CD 30D20CD 31D22CD	148	462	294	60	70
29D17CD 32D20CD 33D22CD	162	491	322	65	75
32D17CD 35D20CD 39D22CD	180	519	351	75	80
35D17CD 38D20CD 42D22CD	200	549	380	80	85

Dimensions of MEG23-*******-A3A1F servo motors

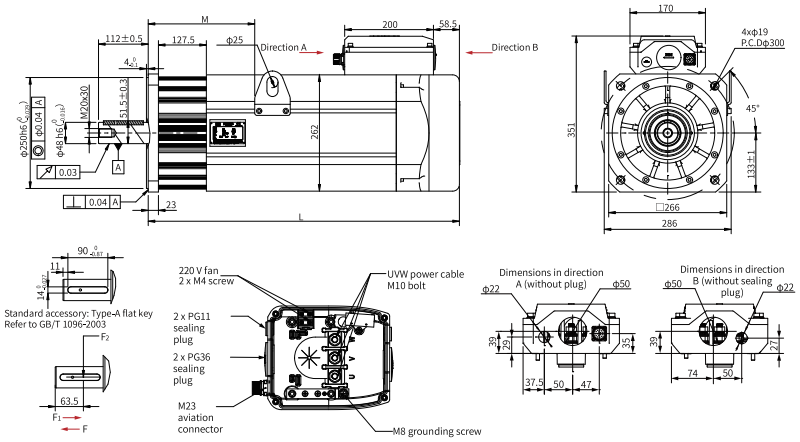


Figure 2-8 Dimensions of MEG23-*******-A3A1F servo motors (unit: mm)

Note

- Technical requirements: The tolerance of unmarked dimensions is compliant with GB/T 1804-2000 Class c.
- Foot mounting is available. Contact Inovance for details.
- It is recommended to use M16 socket head cap screws to install the motor flange.

Table 2–15 Dimensions and weight of MEG23-*******-A3A1F servo motors

Model MEG23-*******-A3A1F	M (mm)	L (mm)	Net weight (kg)	Gross weight (kg)
41D17CD 48D20CD 51D22CD	188	568	90	100
48D17CD 52D20CD 55D22CD	205	611.5	105	110
55D17CD 59D20CD 63D22CD	223	657	115	125
59D17CD 67D20CD 75D22CD	240	701.5	125	135
63D17CD 72D20CD 79D22CD	260	746	135	140

MEG23-*******-A3A1F-K

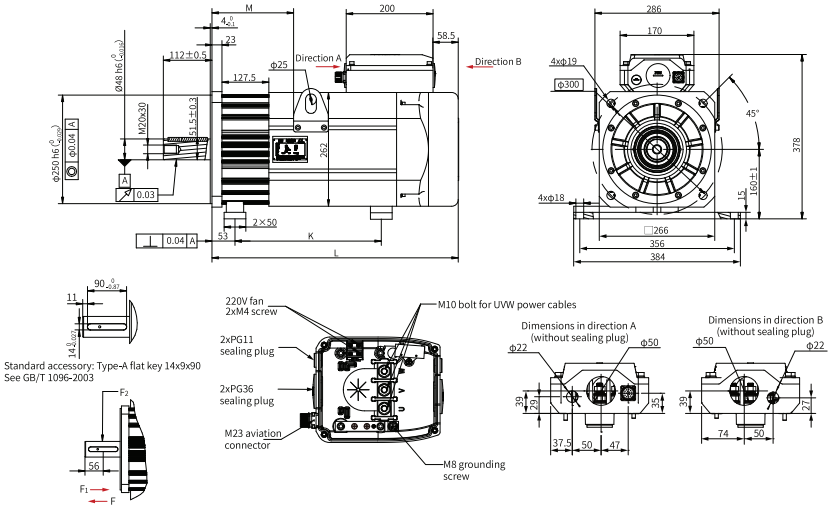


Figure 2-9 Dimensions of MEG23-*******-A3A1F-K servo motors (unit: mm)

Note

- Technical requirements: The tolerance of unmarked dimensions is compliant with GB/T 1804-2000 Class c.
- Foot mounting is available. Contact Inovance for details.
- It is recommended to use M16 socket head cap screws to install the motor flange.

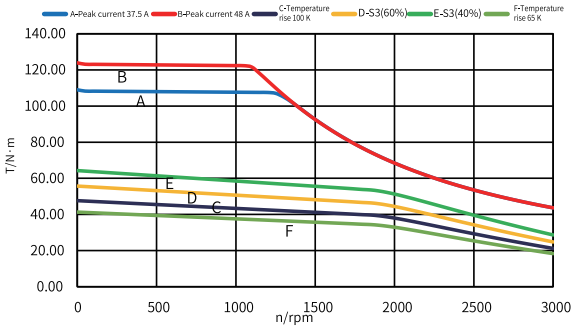
Table 2–16 Dimensions and weight of MEG23-*******-A3A1F-K servo motors

Model MEG23-*******-A3A1F	M (mm)	L (mm)	K (mm)	Net weight (kg)	Gross weight (kg)
41D17CD 48D20CD 51D22CD	188	568	337	90	100
48D17CD 52D20CD 55D22CD	205	611.5	380	110	120
55D17CD 59D20CD 63D22CD	223	657	426	125	130
59D17CD 67D20CD 75D22CD	240	701.5	470	135	140
63D17CD 72D20CD 79D22CD	260	746	514	140	145

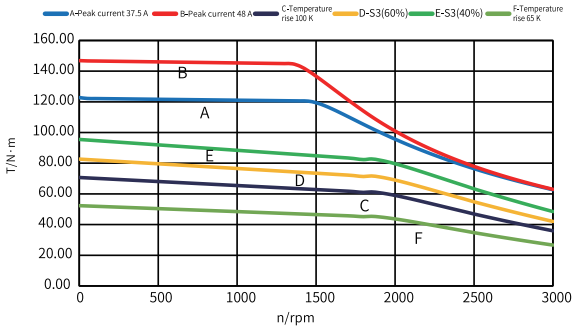
2.2.5 Torque-Speed Characteristics

Table 2–17 Rated speed at 1700 rpm

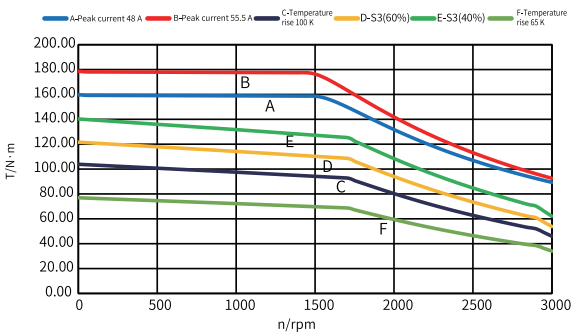
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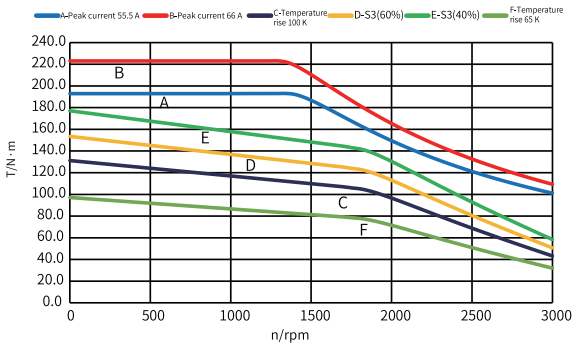
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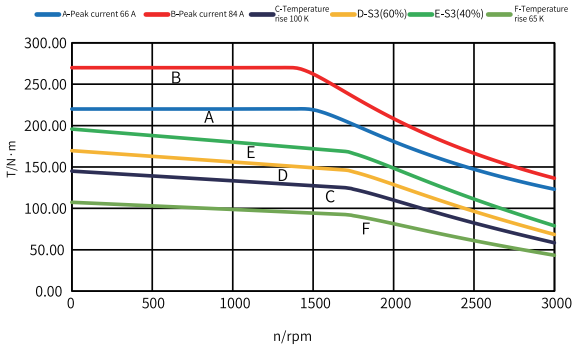
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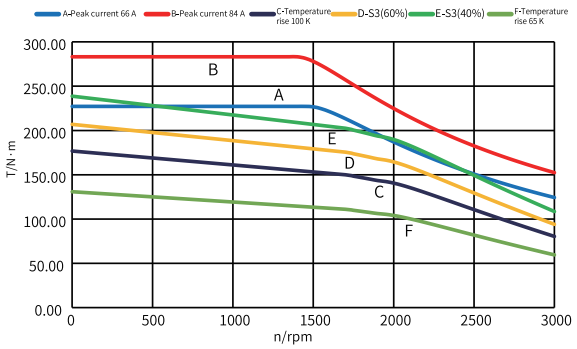
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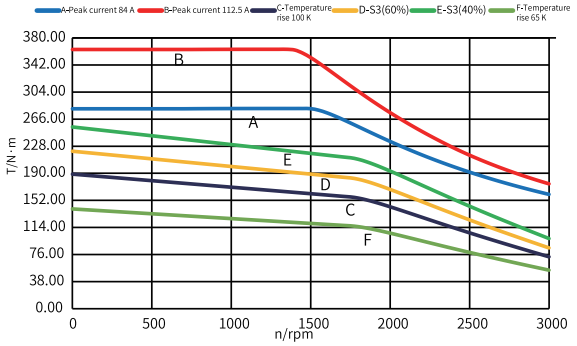
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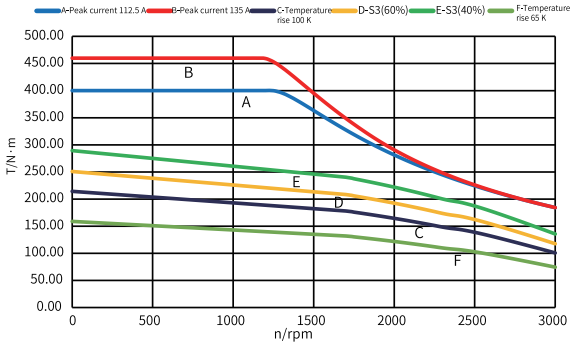
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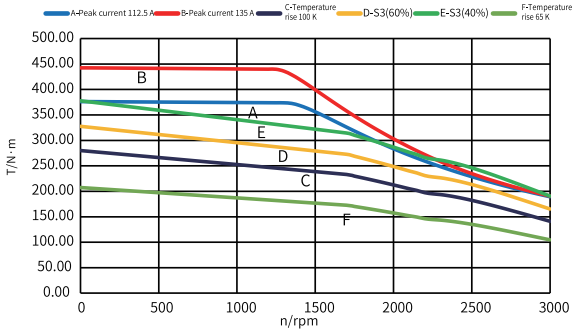
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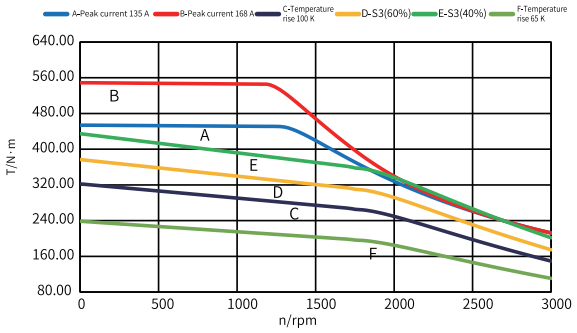
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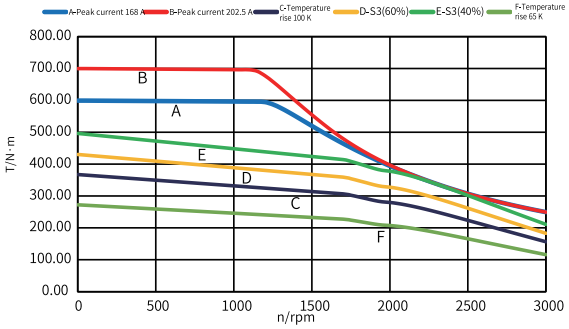
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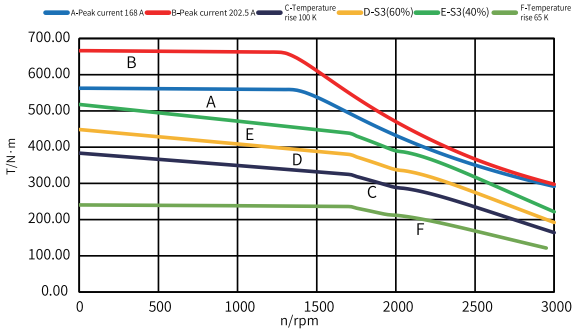
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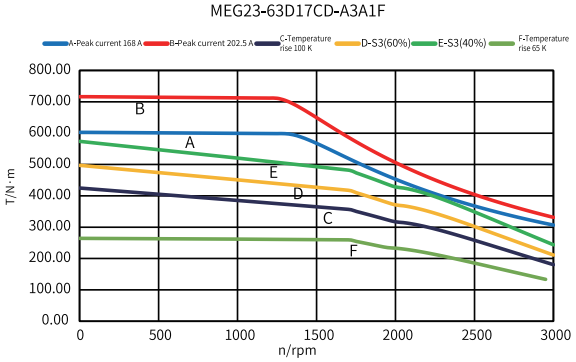
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MEG23-59D17CD-A3A1F



MEG23-63D17CD-A3A1F



MEG20-35D17CD-A3A1F

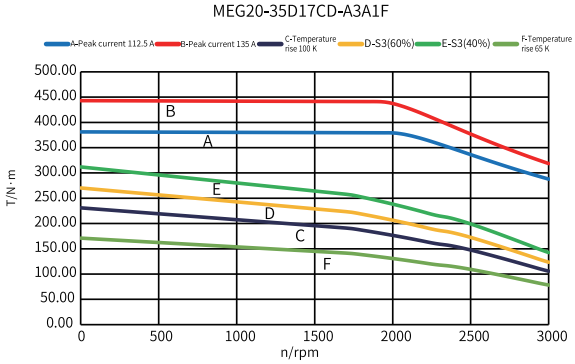
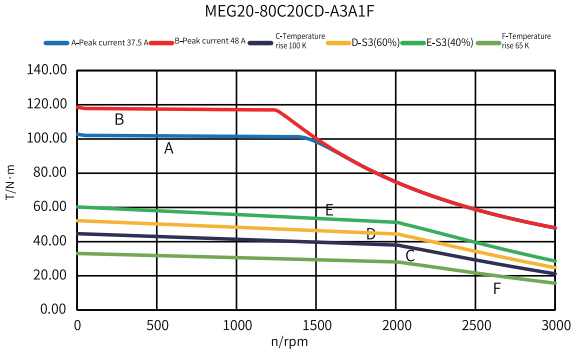
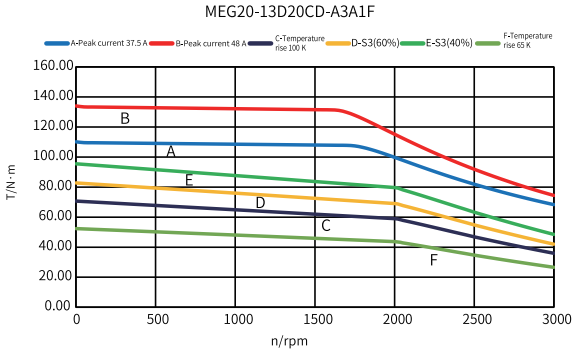


Table 2–18 Rated speed at 2000 rpm

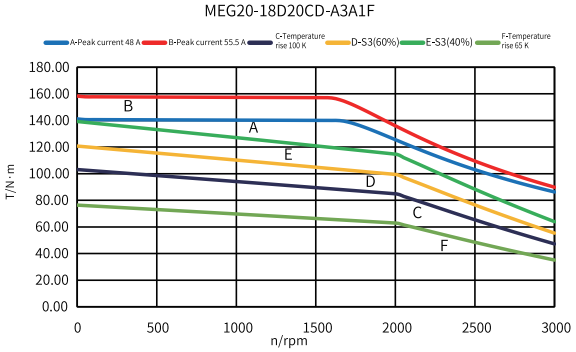
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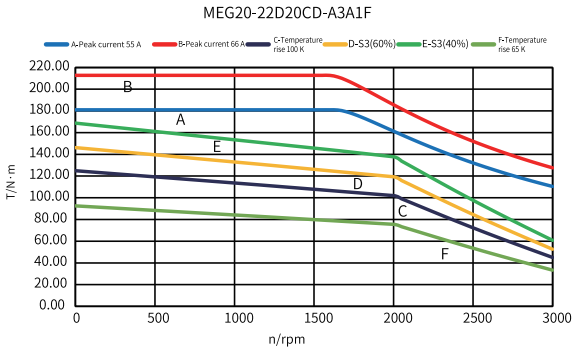
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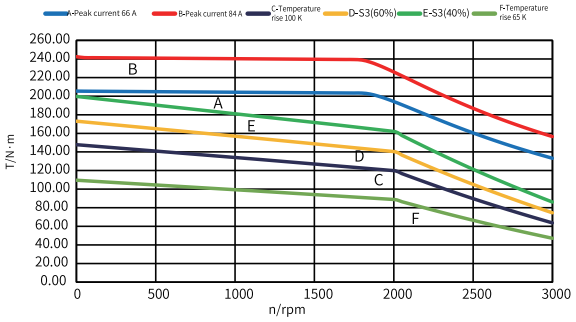
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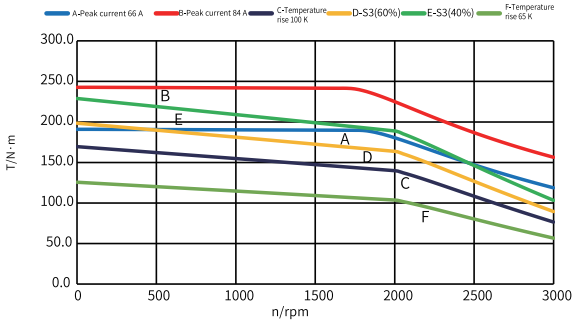
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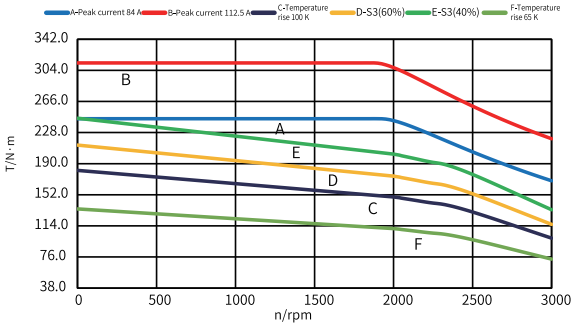
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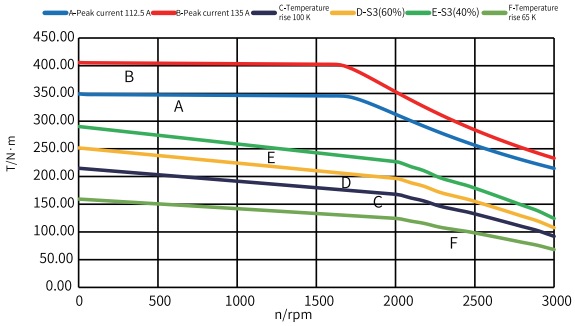
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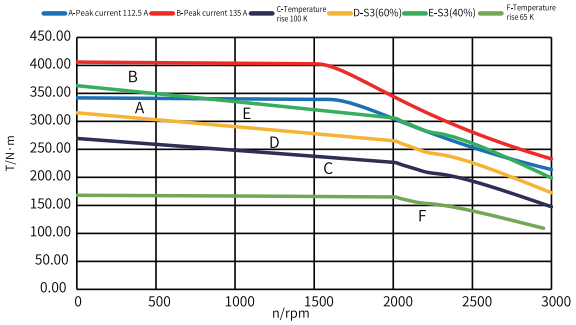
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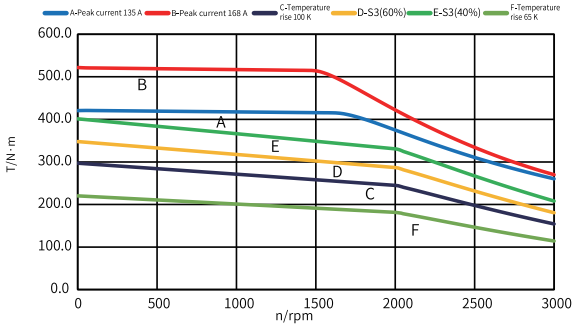
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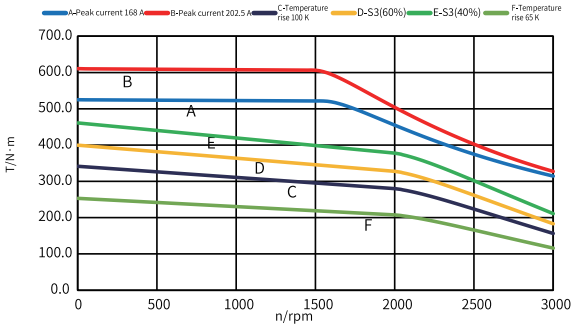
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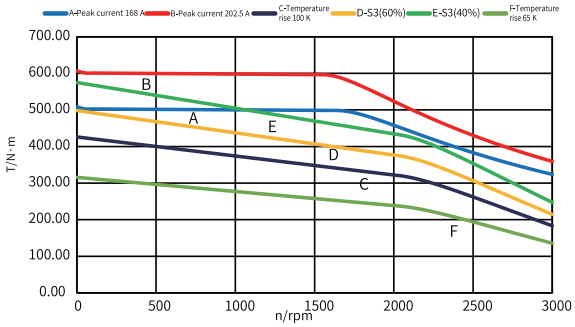
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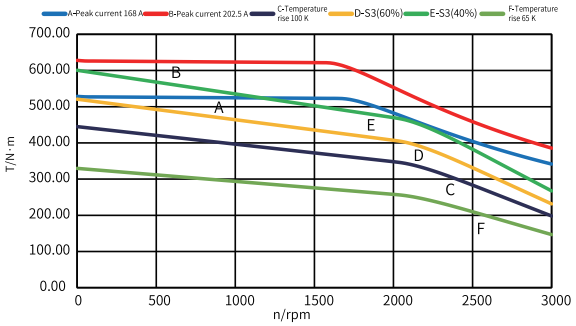
MEG23-59D20CD-A3A1F



MEG23-67D20CD-A3A1F



MEG23-72D20CD-A3A1F



MEG20-38D20CD-A3A1F

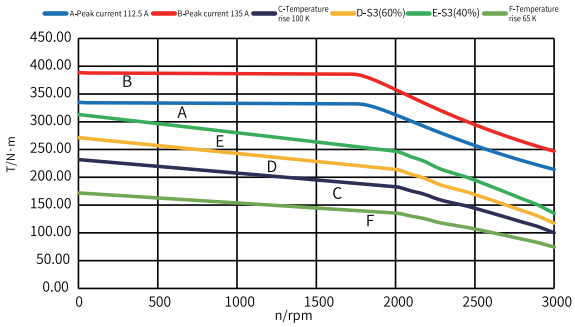
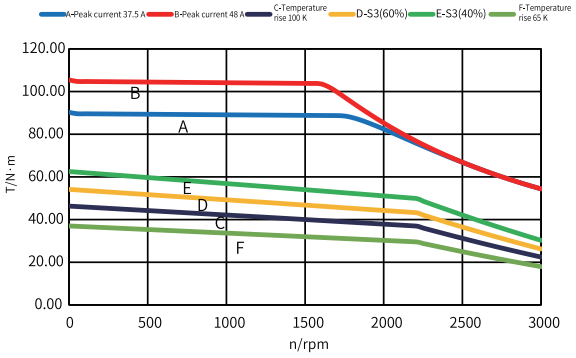
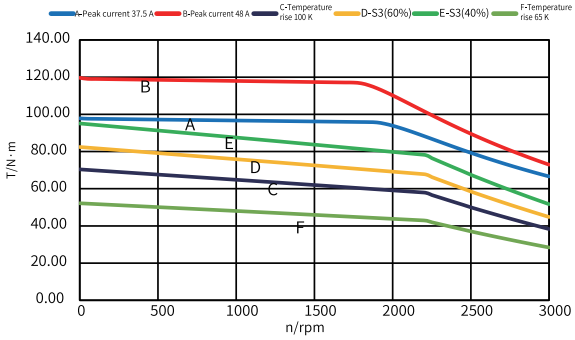


Table 2–19 Rated speed at 2200 rpm

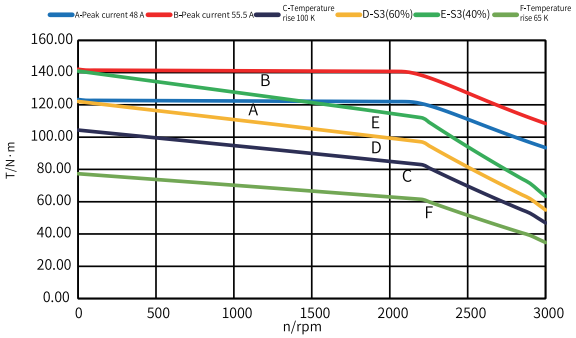
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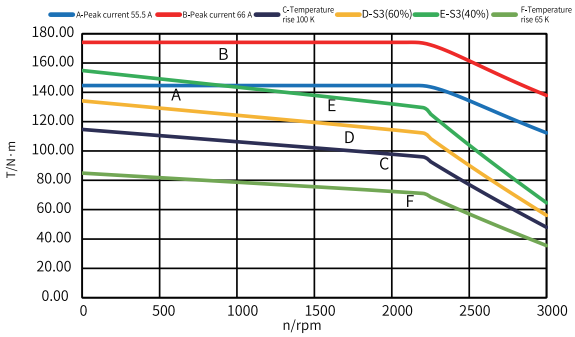
MEG20-13D22CD-A3A1F



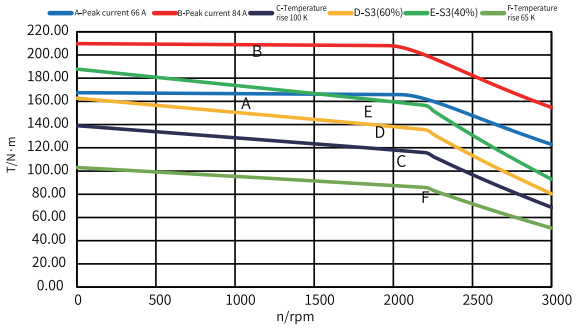
MEG20-20D22CD-A3A1F



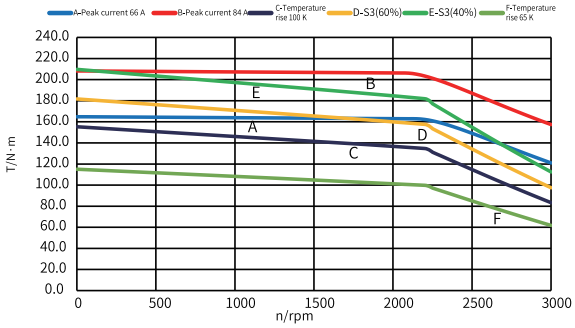
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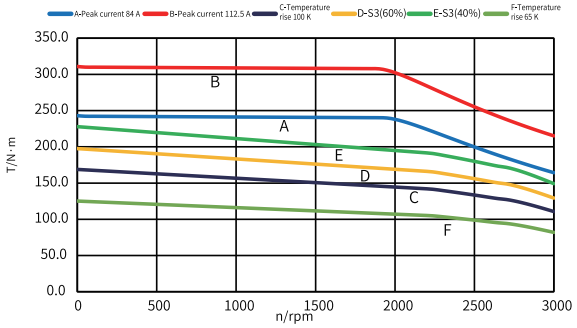
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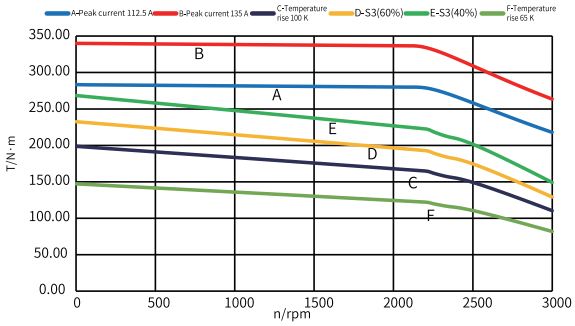
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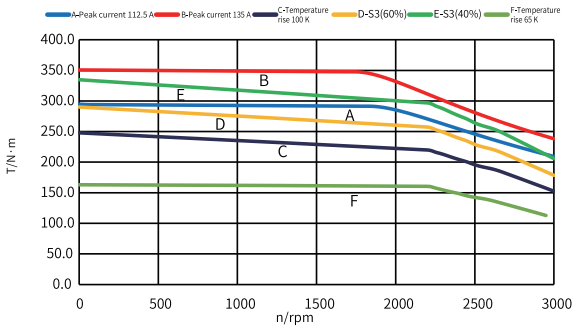
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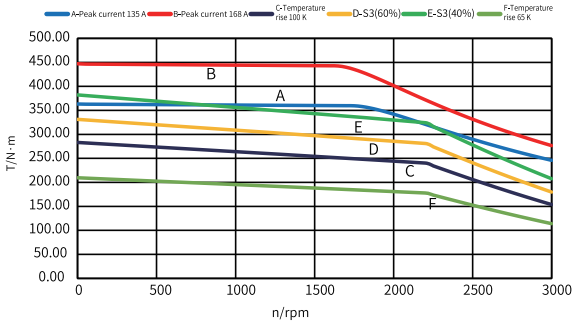
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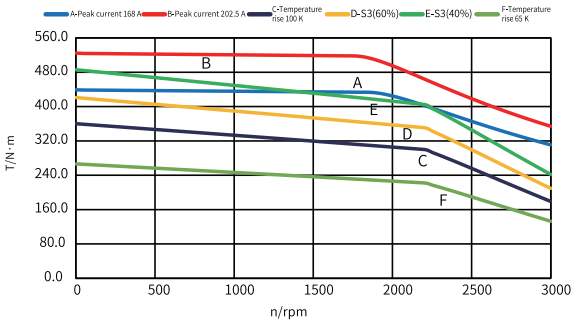
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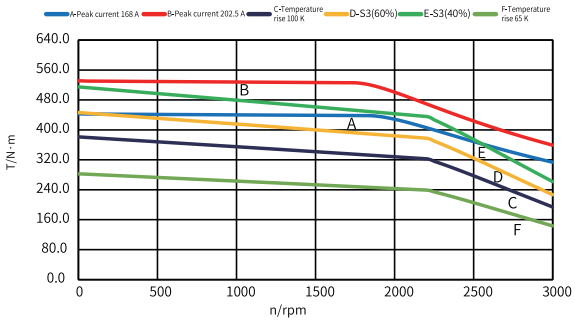
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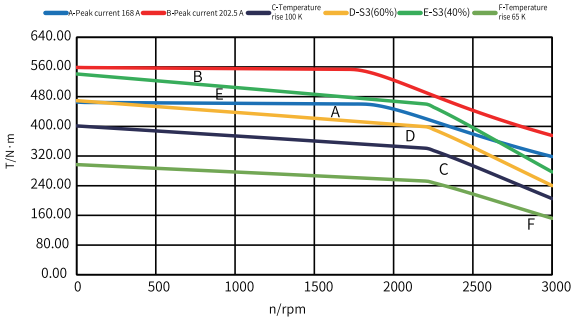
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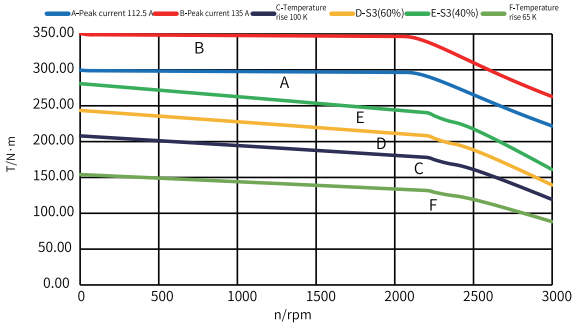
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MEG23-79D22CD-A3A1F



MEG20-42D22CD-A3A1F



2.3 Servo System Configurations

Table 2–20 Relationship between the servo drive and motor

Servo drive model	Servo motor model
ES680N-4T025S-C1	MEG20-71C17CD-A3A1F MEG20-80C20CD-A3A1F MEG20-85C22CD-A3A1F MEG20-11D17CD-A3A1F MEG20-13D20CD-A3A1F MEG20-13D22CD-A3A1F
ES680N-4T032S-C1	MEG20-71C17CD-A3A1F MEG20-80C20CD-A3A1F MEG20-85C22CD-A3A1F MEG20-11D17CD-A3A1F MEG20-13D20CD-A3A1F MEG20-13D22CD-A3A1F MEG20-17D17CD-A3A1F MEG20-18D20CD-A3A1F MEG20-20D22CD-A3A1F

Servo drive model	Servo motor model
ES680N-4T037S-C1	MEG20-17D17CD-A3A1F MEG20-18D20CD-A3A1F MEG20-20D22CD-A3A1F MEG20-19D17CD-A3A1F MEG20-22D20CD-A3A1F MEG20-23D22CD-A3A1F
ES680N-4T044S-C1	MEG20-19D17CD-A3A1F MEG20-22D20CD-A3A1F MEG20-23D22CD-A3A1F MEG20-23D17CD-A3A1F MEG20-25D20CD-A3A1F MEG20-27D22CD-A3A1F MEG20-23D17CD-A3A1F MEG20-30D20CD-A3A1F MEG20-31D22CD-A3A1F
ES680N-4T060S-C1	MEG20-23D17CD-A3A1F MEG20-25D20CD-A3A1F MEG20-27D22CD-A3A1F MEG20-23D17CD-A3A1F MEG20-30D20CD-A3A1F MEG20-31D22CD-A3A1F MEG20-29D17CD-A3A1F MEG20-32D20CD-A3A1F MEG20-33D22CD-A3A1F

Servo drive model	Servo motor model
ES680N-4T075S-C1	MEG20-29D17CD-A3A1F MEG20-32D20CD-A3A1F MEG20-33D22CD-A3A1F MEG20-20D17CD-A3A1F MEG20-35D20CD-A3A1F MEG20-39D22CD-A3A1F MEG20-35D17CD-A3A1F MEG20-38D20CD-A3A1F MEG20-42D22CD-A3A1F MEG23-41D17CD-A3A1F MEG23-48D20CD-A3A1F MEG23-51D22CD-A3A1F
ES680N-4T091S-C1	MEG20-32D17CD-A3A1F MEG20-35D20CD-A3A1F MEG20-39D22CD-A3A1F MEG23-41D17CD-A3A1F MEG23-48D20CD-A3A1F MEG23-51D22CD-A3A1F MEG23-48D17CD-A3A1F MEG23-52D20CD-A3A1F MEG23-55D22CD-A3A1F
ES680N-4T112S-C1	MEG23-55D17CD-A3A1F MEG23-52D20CD-A3A1F MEG23-63D22CD-A3A1F MEG23-59D17CD-A3A1F MEG23-67D20CD-A3A1F MEG23-75D22CD-A3A1F
ES680N-4T150S-C1	MEG23-55D17CD-A3A1F MEG23-59D20CD-A3A1F MEG23-63D22CD-A3A1F MEG23-59D17CD-A3A1F MEG23-67D20CD-A3A1F MEG23-75D22CD-A3A1F MEG23-63D17CD-A3A1F MEG23-72D20CD-A3A1F MEG23-79D22CD-A3A1F
ES680N-4T176S-C1	Under development
ES680N-4T210S-C1	MEG26-33B25CD-A3A1L
ES680N-4T253S-C1	Under development
ES680N-4T312S-C1	Under development
ES680N-4T395S-C1	Under development
ES680N-4T426S-C1	MEG26-51B30CD-A3A1L
ES680N-4T480S-C1	Under development
ES680N-4T525S-C1	Under development
ES680N-4T600S-C1	Under development

Table 2–21 Connection between the servo drive and the encoder cable

Servo drive model	Encoder cable model
ES680N-4T025S-C1	ES680-P10-3.0 ES680-P10-6.0 ES680-P10-8.0 ES680-P10-12.0 ES680-P10-15.0 ES680-P10-25.0 ES680-P10-30.0
ES680N-4T032S-C1	
ES680N-4T037S-C1	
ES680N-4T044S-C1	
ES680N-4T060S-C1	
ES680N-4T075S-C1	
ES680N-4T091S-C1	
ES680N-4T112S-C1	
ES680N-4T150S-C1	
ES680N-4T176S-C1	
ES680N-4T210S-C1	
ES680N-4T253S-C1	
ES680N-4T312S-C1	
ES680N-4T395S-C1	
ES680N-4T426S-C1	
ES680N-4T480S-C1	
ES680N-4T525S-C1	
ES680N-4T600S-C1	
ES680N-4T650S-C1	

2.4 System Composition

Install necessary peripheral components on the input/output side of the drive to ensure safety and stability of the hydraulic system used to control permanent magnet synchronous motors. The system components are as shown in the following figure.

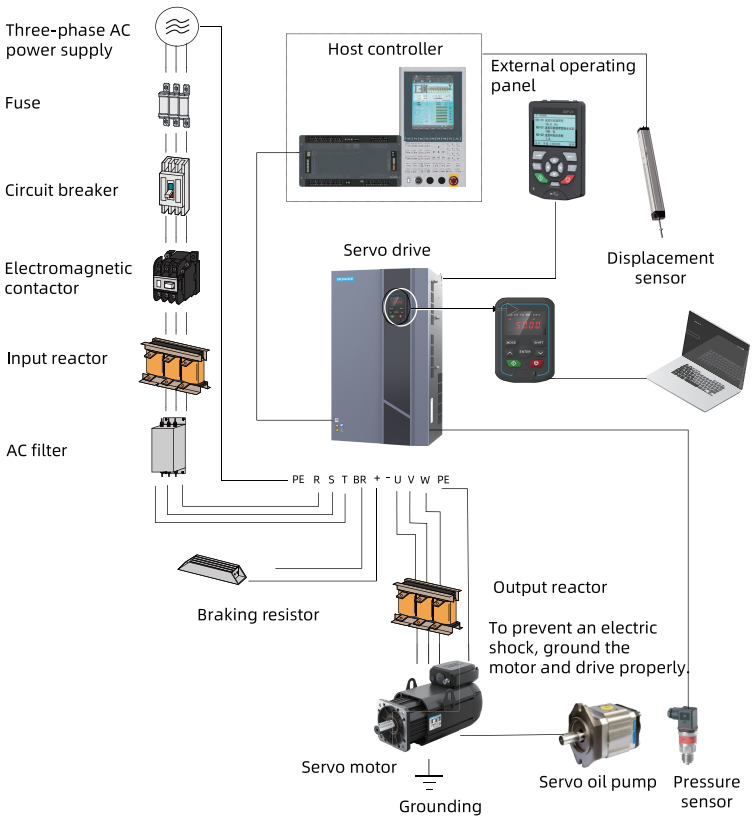


Figure 2-10 System components

Component	Installation position	Applicable model	Description
Fuse	Input side of the drive	All models	Prevents accidents caused by short circuit.
Circuit breaker	Input side of the drive	All models	Between the power supply and the input side of the drive Circuit breaker: When overcurrent occurs on downstream devices, it cuts off the power supply to prevent accidents. Residual current device (RCD): The drive may generate high-frequency leakage current during operation. To prevent electric shock which may cause a fire, select a proper RCD based on actual applications.
Contactor	Input side of the drive	All models	Used to power on or off the drive. Do not use the contactor to power on/off the drive frequently (interval time between ON/OFF operations shorter than 1 hour) or start the drive directly through the contactor.
AC Input Reactor	Input side of the drive	All models	Eliminates harmonics and improves the power factor on the input side.
AC filter	Input side of the drive	All models	Reduces the conduction and radiation interference generated by the AC drive to external devices.
Braking resistor	Input side of the drive	Models of 132 kW and below	Consumes the regenerative energy generated during deceleration.
Output reactors	Output side of the drive	All models	It ensures motor insulation and prolongs the service life of the motor.

Component	Installation position	Applicable model	Description
Output magnetic ring	Output side of the drive	All models	Reduces bearing current.
Host controller	Some control signals are connected to the drive.	-	Used to control the overall operations, sen commands to the drive, and exchange data with the drive.
Servo motor	Output side of the drive	-	Use a proper motor.
Servo oil pump	Connected to the servo motor	-	Provides flow and pressure for the hydraulic system.
Pressure sensor	Oil outlet on the oil circuit (with feedback signals connected to the drive)	-	Provides pressure feedback of the hydraulic circuit in analog signals.
Displacement sensor	Template of the injection molding machine	-	Provides position feedback analog signals for closed-loop position control.
External Operating Panel	CN7 interface	All models	Used for commissioning and parameter settings.

2.5 List of Options

Name	Model	Applicable model	Description
Input reactor	For applicable models, see *"8.1.2 AC Input Reactor" on page 125*.		-
EMC Filter	For applicable models, see *"8.1.3 EMC Filter" on page 131*.		-
Output reactors	For applicable models, see *"8.1.6 Output Reactor" on page 138*.		-
Ferrite Ring and Ferrite Clamp	For product models, see *"8.1.7 Ferrite Ring and Ferrite Clamp" on page 142*.	All models	-
External Operating Panel	SOP-20-880 and SOP-20-810	All models	Equipped with LCD and operating panel to support parameter copy/ modification.
Extension cable	MDCAB	All models	Standard 8-core cable with a length of 3 m as standard Used to connect SOP-20 operating panel.
Through-hole mounting bracket	MD500-AZJ- A1T*	For applicable models, see *"8.2 Through-hole Mounting Bracket" on page 143*.	Fulfills the through-hole mounting demands of the customer.
Grounding Bracket for Cable Shield	For applicable models, see *"8.3 Grounding Bracket of Cable Shield" on page 148*.		Supports repetitive power cable fixation and 360° grounding of the shield.

3 Unpacking and Handling

3.1 Handling Before Unpacking

3.1.1 Packing Dimensions and Weight (with Package)

T model	Drive model	Package type	Exterior package dimensions (mm) L x W x H	Net weight (kg)	Gross weight (kg)
T4	ES680N-4T025S-C1 ES680N-4T032S-C1 ES680N-4T037S-C1 ES680N-4T044S-C1	Carton box + Expanded polyethylene	420 x 270 x 265	4.3	4.7
T5	ES680N-4T060S-C1	Carton box + Expanded polyethylene	465 x 352 x 322	7.6	8.6
T6	ES680N-4T075S-C1 ES680N-4T091S-C1	Carton box + Expanded polyethylene	530 x 386 x 367	17.7	19.1
T7	ES680N-4T112S-C1 ES680N-4T150S-C1	Carton box + Expanded polyethylene + Plywood pallet	715 x 435 x 427	34.5	42
T8	ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	Carton box + Expanded polyethylene + Plywood pallet	742 x 480 x 467	51	59
T9	ES680N-4T312S-C1 ES680N-4T395S-C1 ES680N-4T426S-C1	Pearl cotton + Plywood stack + Plywood wooden box	880 x 670 x 505	89	113
	ES680N-4T480S-C1 ES680N-4T525S-C1	Pearl cotton + Plywood stack + Plywood wooden box		95	113
	ES680N-4T600S-C1 ES680N-4T650S-C1	Pearl cotton + Plywood stack + Plywood wooden box		102	126

3.1.2 Handling Requirements

- T4 to T6 models are small and light and therefore can be handled manually. T7 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 a pallet and lift them together, as shown in the following figure.

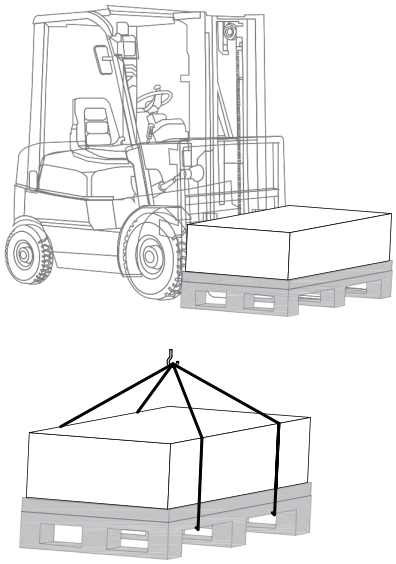


Figure 3-1 Lifting the drive

- Transport the AC drive in the upright position indicated on the packing box. Never turn it upside down or place it on its side, as shown in the following figure.

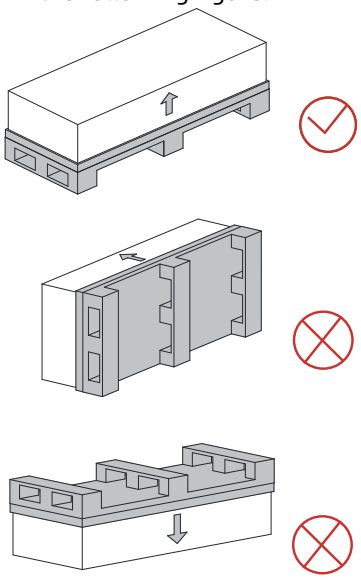


Figure 3-2 Placing the drive

3.2 Unpacking Inspection

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. If necessary, contact Inovance or the local agent for technical support.

Caution

The electrical safety performance of the drive may be affected if it is damaged during transportation. Perform professional high-voltage test on the drive before connection.

Packing methods and components vary with models due to difference in structural dimensions and weight.

- T4 to T6 models are packed using cartons.
- T7 to T8 models are packed using cartons and plywood pallets.
- T9 models are packed using wooden crates.

The following figure shows the packing list.

- **Packing list for T4 to T6 models**

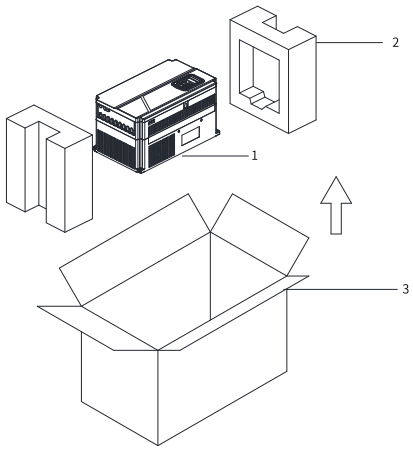


Figure 3-3 Packing list for T4 to T6 models

No.	Name
1	Drive
2	Cushion
3	Carton

- **Packing list of T7 to T8 models**

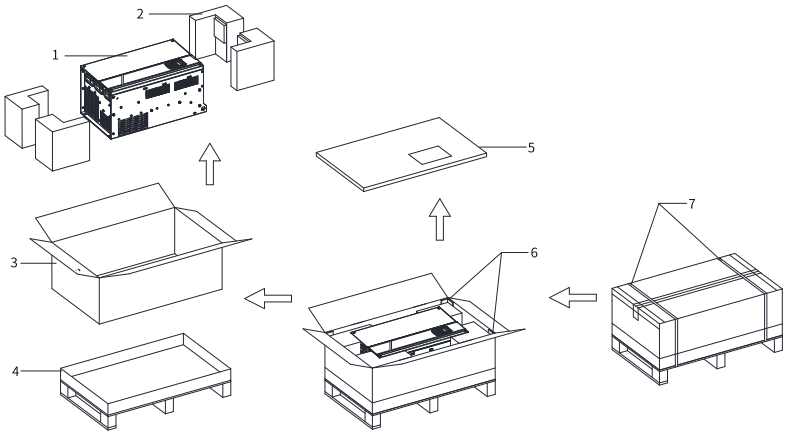


Figure 3-4 Packing list of T7 to T8 models

No.	Name
1	Drive
2	Cushion
3	Carton
4	Plywood pallet
5	Honeycomb cardboard

No.	Name
6	Paper corner protector
7	Packing strap

- **Packing list of T9 model**

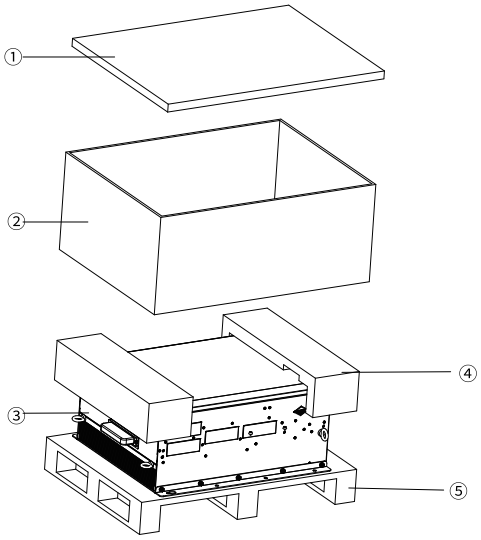


Figure 3-5 Packing list of T9 model

No.	Name
□	Wooden box cover
□	Side plate of wooden box
□	Drive
□	Cushion
□	Wooden box base

Note

Dispose of the packaging materials in accordance with applicable local regulations.

3.3 Handling and Hoisting After Unpacking

T4 to T6 models can be handled manually. T7 models must be hoisted with a proper hoisting device.

Precautions for handling and hoisting:

- Comply with local regulations when handling the AC drive.
- To prevent physical injury, do not grab the drive by the top cover or external cover only during handling. Ensure that all the screws are tightened before handling. Failure to comply may cause the main body of the drive to fall, leading to physical injury.
- 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 all the drive components are tightened properly with screws before hoisting. Failure to comply may result in physical injury due to fall-off of the drive.
- Do not subject the drive to excessive vibration or shock when hoisting the drive with a sling. Failure to comply may result in physical injury due to fall-off of the drive.

- When hoisting the drive with a sling, do not turn the drive over or let the drive hang in the air for too long. Failure to comply may result in physical injury due to fall-off of the drive.

Hoisting procedure:

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.

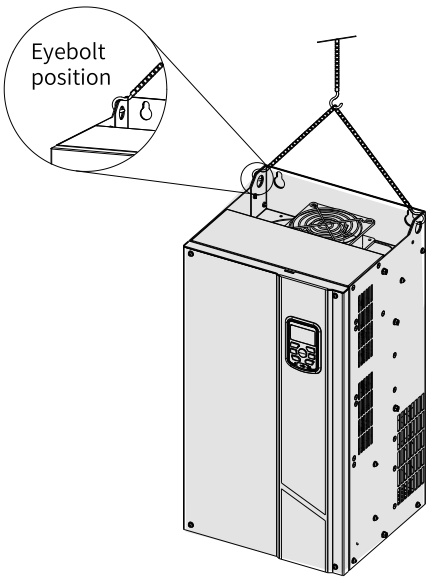


Figure 3-6 Lifting the AC drive

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.

3.4 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 up or take similar measures to prevent the drive from being polluted or affected by the surrounding environment.
- Try to store the system with the original packing carton box.
- Do not expose the equipment to environments with moisture, high temperatures, or direct sunlight for a long time.
- The electrolytic capacitor can deteriorate after long-term storage. Therefore, switch on the drive once for at least 5 hours every 6 months. After switch-on, increase the input voltage slowly to the rated value by using a voltage regulator. Contact Inovance for technical support if necessary.

4 Installation Requirements

4.1 Installation Flowchart

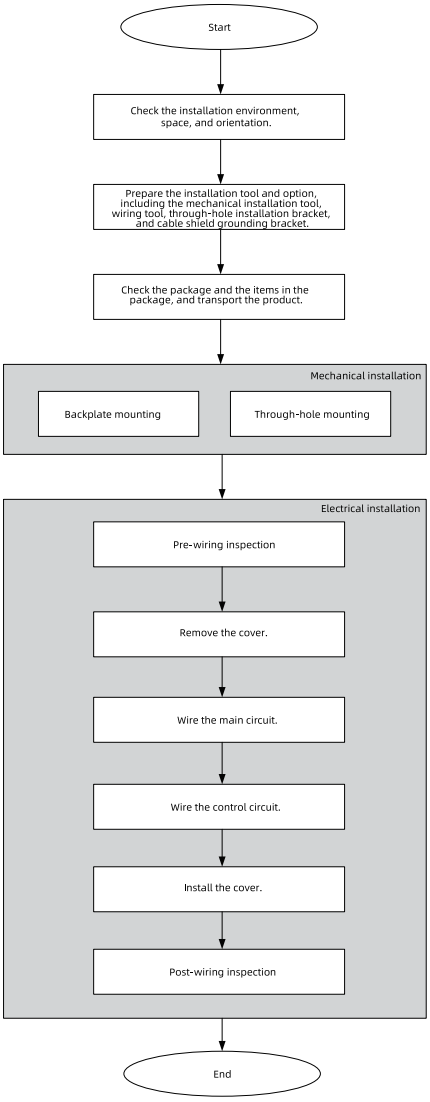


Figure 4-1 Installation flowchart

4.2 Installation Site Inspection

4.2.1 Installation Environment

Install the drive in environments that meet the following requirements.

Table 4-1 Environmental requirements

Environment	Condition
Installation location	Indoor
Grid overvoltage category	OVCIII
IP rating	IP20
Temperature	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 temperature: -20°C to +60°C (air temperature change rate less than 1°C/min) • To improve the reliability of the drive, use the drive in environments without dramatic temperature change. • When installing the cabinet unit into an enclosed environment, use a cooling fan or air conditioner to keep the temperature of the inlet air below 50°C. Failure to comply can result in overtemperature or fire. • The drive generates a large amount of heat during operation. Install the drive on the surface of an incombustible object therefore, with sufficient surrounding space reserved for heat dissipation. • Take measures to prevent the drive from being frozen.
Relative humidity	5% to 95% RH (without condensation)
Environment	• Pollution degree: PD2 or below • It is recommended to install the drive in a place meeting the following conditions: a. Free from direct sunlight, dust, corrosive gas, combustible or explosive gas, oil mist, water vapor, drip, or salt • b. Away from vibration sources c. Away from devices such as a punch press • Do not install any device that may generate electromagnetic waves or interference, such as transformers, around the drive. If such a device is required, install a shielding plate between the device and the drive. Otherwise, the drive can malfunction. • The drive must be installed in a fireproof cabinet with doors that provide effective electrical and mechanical protection. The installation must conform to local and regional laws and regulations, and to relevant IEC requirements.
Altitude	For altitudes below 1000 m, derating is not required. For altitudes above 1000 m, derate 1% for every additional 100 m. For altitudes above 3000 m, contact Inovance.
Vibration resistance	Vibration should be lower than 9.8 m/s^2(1 g).

4.2.2 Installation Direction

Install the drive vertically upward only, as shown in *"Figure 4-2" on page 63* . Do not lie down the drive horizontally or by its side, or install it in the upside-down direction.

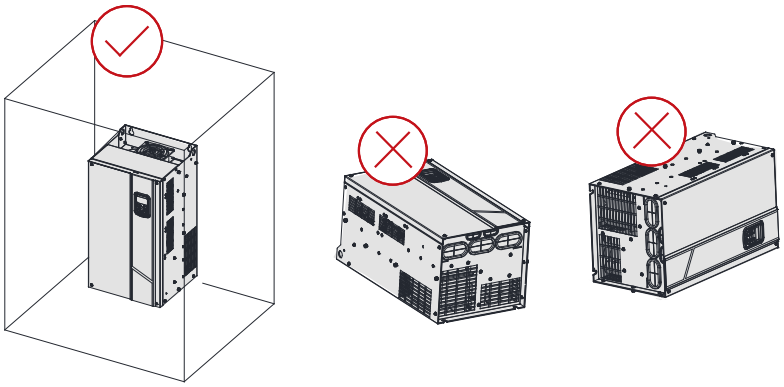


Figure 4-2 Installation direction

4.3 Installation Tools

4.3.1 Mechanical Installation Tools

"Table 4-2" on page 63 lists the tools for mechanical installation.

Table 4–2 Tools for mechanical installation

Tool name	Description
Electric drill and appropriate drilling bits	Used to drill mounting holes on the mounting surface.
Nut wrench or socket wrench	Used to tighten or loosen screws during mechanical installation. The following specifications are required: #13, #16, and #18.
Phillips screwdriver and straight screwdriver (2.5 mm to 6 mm)	Used to tighten or loosen screws during mechanical installation.
Torque wrench	Used to tighten or loosen screws during mechanical installation.
Crowbar	It is used to pry off the top cover or cover of the drive.
Hoisting machine	It is used to lift the equipment.
Tape measure	Used to measure the mounting dimensions of the equipment.
Gloves	Used to prevent static electricity during mechanical installation.
Screw	Used to fix the drive to the mounting surface.

For screw specifications and quantity, see *"Table 4-3" on page 63*.

Table 4–3 Specifications and quantity of screws

Installation method	T model	Screw specification	Tightening torque (Unit: N·m)	Quantity (Unit: PCS)	Description
Backplate Mounting	T4 to T5	M5	5.39± 0.54	4	Used to fix the drive to the wall.
	T6	M6	0.9± 0.09		
	T7 to T8	M8	2.0± 0.2		
Through-hole Mounting	T4	M4	2.85± 0.285	4	Used to fix the drive to the backplate of the control cabinet.
	T5	M5	5.39± 0.54		
	T6	M6	0.9± 0.09		
	T7 to T8	M8	1.96± 0.196		

4.3.2 Wiring Tools

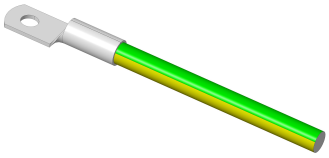
When wiring the main circuit terminal, select an appropriate installation tool based on the terminal size. Requirements on the main circuit wiring tools are shown in *"Table 4-4" on page 64*.

Table 4–4 Requirements on the main circuit wiring tools

T model	Recommended fastener	Tool
T4	M5 SEMS screw	Phillips screwdriver (#3 slot)
T5 to T6	M6 SEMS screw	Phillips screwdriver (#3 slot)
T7	M8 nut, spring washer	Socket wrench (#13 socket wrench)
T8	M12 nut, spring/flat washer	Socket wrench (#19 socket wrench)

4.3.3 Preparing Cables

Table 4–5 Cable

<table>
<tr><th>Type</th><th>Name</th><th>Drawing</th><th>Type</th><th>Name</th><th>Drawing</th></tr>
<tr><td rowspan="2">Main circuit cable</td><td>Power cable</td><td></td><td rowspan="2">Control circuit cable</td><td>Signal cable</td><td></td></tr>
<tr><td>Grounding cable</td><td></td><td>Network cable (with metal shield)</td><td></td></tr>
</table>

5 Mechanical Installation

5.1 Precautions for Installing the Drive

- Ensure the installation location is sturdy enough to bear the mechanical strength of the drive.
- Cover the top of the device 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 device. After installation is done, remove the cloth or paper. Failure to comply may affect ventilation and result in unexpected overtemperature.
- Reserve sufficient clearance for heat dissipation, including heat dissipation of other components in the cabinet. For details, see "Installing one drive" in *“6.2.1 Installation Space” on page 80*.
- 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 “Dual-row Installation” in *“6.2.1 Installation Space” on page 80*.
- 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 properly with specified tightening torque. Failure to comply may result in electric shock or fire.
- Keep combustibles and explosives away from the device.

5.2 Drive Installation Method

5.2.1 Backplate Mounting

During backplate mounting, do not fasten the drive with two fixing nuts on the top only. Failure to comply will lead to an uneven distribution of stress, causing the drive to fall after long-term operation.

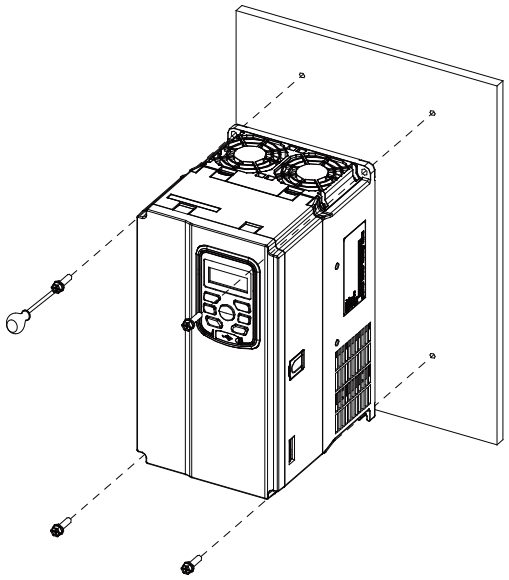


Figure 5-1 Backplate mounting of T4 to T6 models

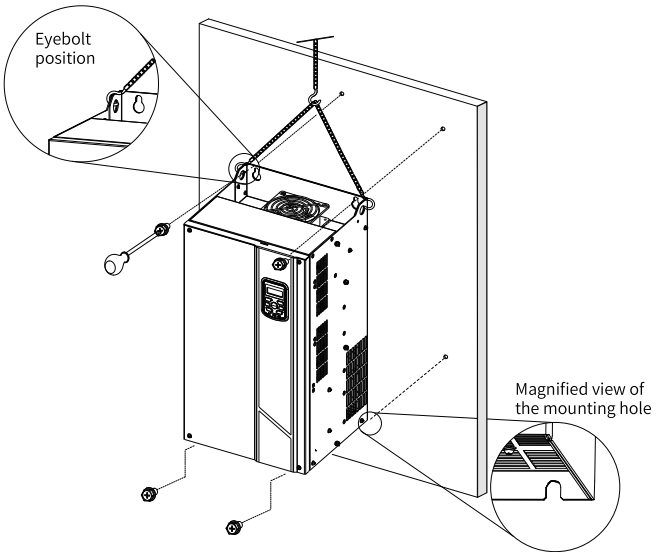


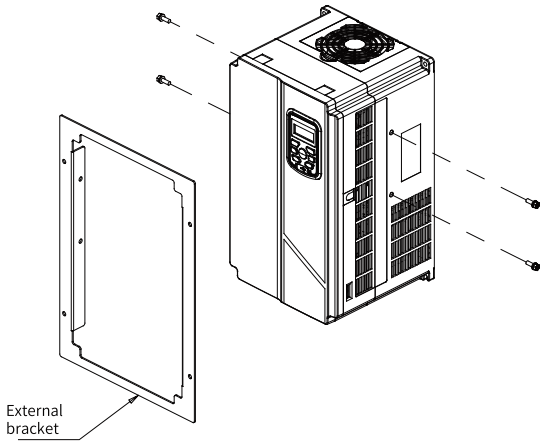
Figure 5-2 Backplate mounting of T7 to T8 models

5.2.2 Through-Hole Mounting

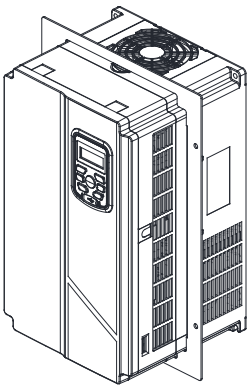
The through-hole mounting bracket is required for through-hole mounting. The bracket is optional and needs to be purchased separately.

1. T4 to T6 models

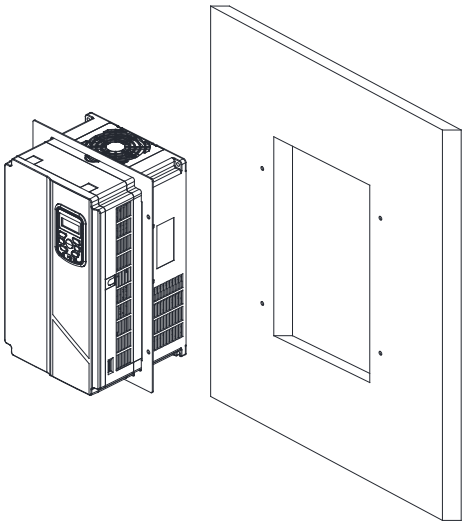
   a. Insert the through-hole mounting bracket into the enclosure and tighten the mounting screws on the left and right sides of the drive.



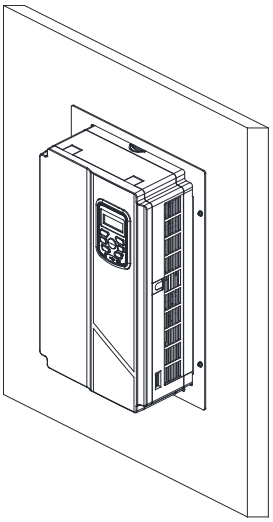
The following figure shows the drive with through-hole mounting bracket installed.



b. Fix the drive with through-hole mounting bracket to the back of the control cabinet.

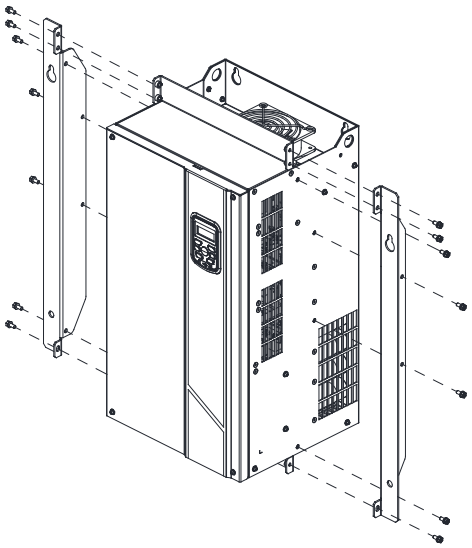


The following figure shows the drive that installed properly.

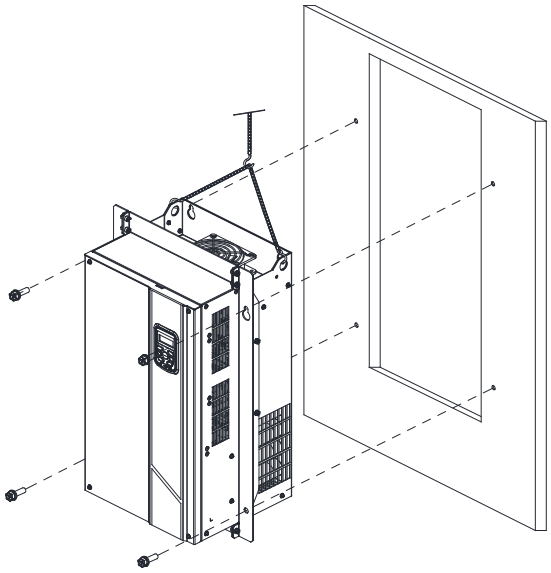


2. T7 to T8 models

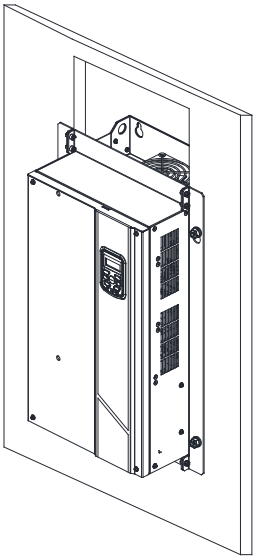
a. Fix the through-hole mounting bracket from both sides of the enclosure.



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



The following figure shows what it looks like when through-hole mounting is done.



5.3 Drive Cover Removal and Installation

5.3.1 Removing the Cover

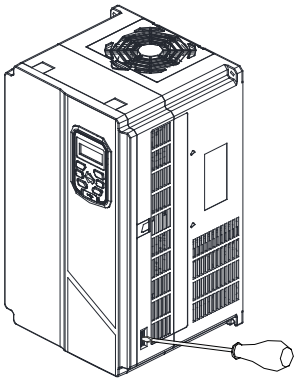
During control circuit wiring, if the jumper or function extension card is involved, remove the cover first. When removing the cover, hold the cover with your hands and carefully lift the lower part of the cover to prevent it from falling off. Failure to comply can result in equipment damage or personal injury.

Prerequisites

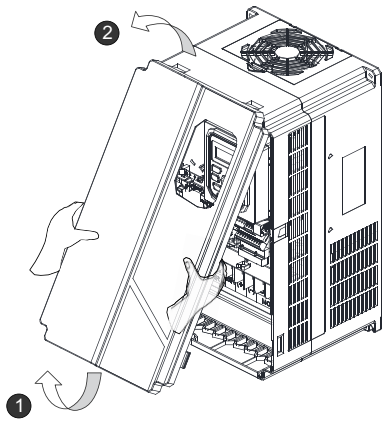
Before removing the cover, ensure that the device has been powered off for more than 10 minutes.

1. To remove the cover of T4 to T6 models, do the following:

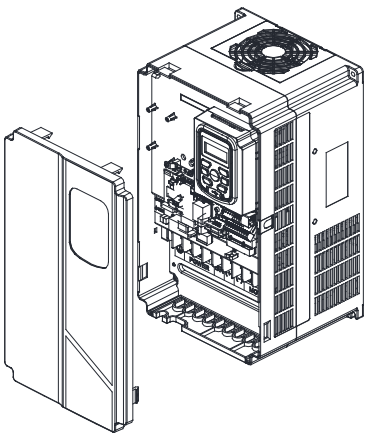
a. Use a tool to push the snap-fit joints inwards at both sides of the drive to release the cover.



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).

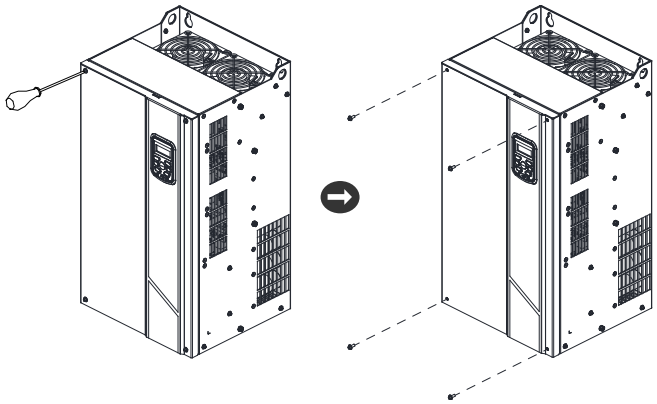


The drive without cover is shown below.

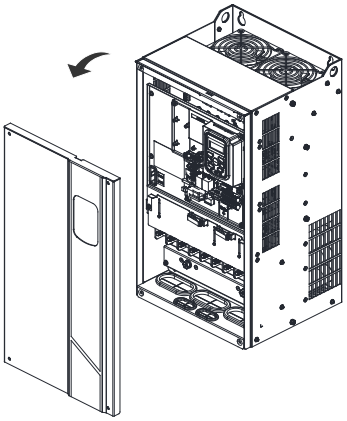


2. Remove the cover for T7 to T8 models.

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

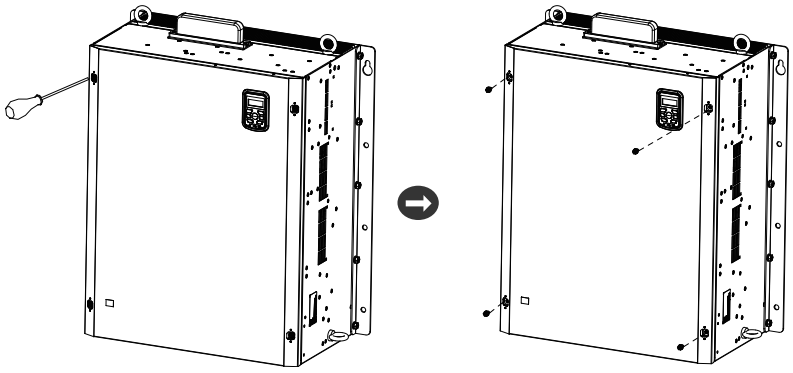


b. Hold the cover with both hands and lift it up in the direction indicated by the arrow.

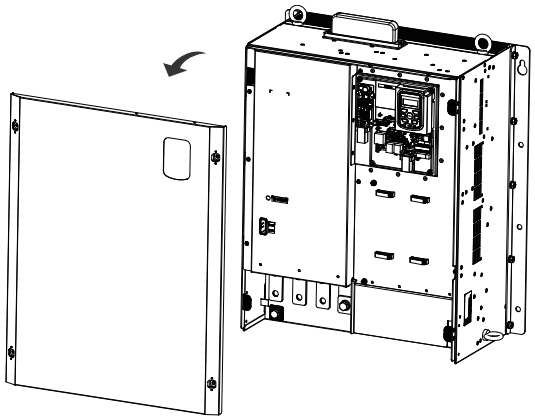


3. Removing the cover of T9 model

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



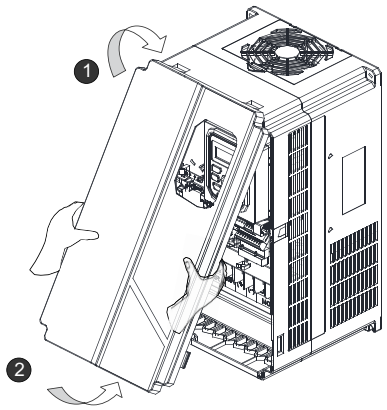
b. Hold the cover with both hands and lift it up in the direction indicated by the arrow.



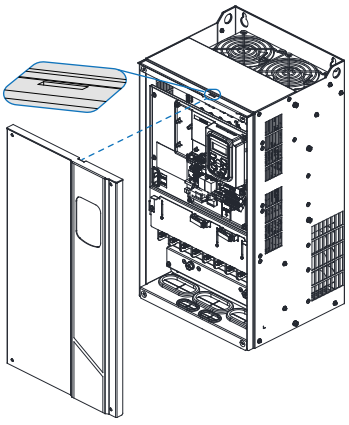
5.3.2 Installing the Cover

Remove the cover before wiring the main circuit and control circuit. After wiring is done, re-install the cover.

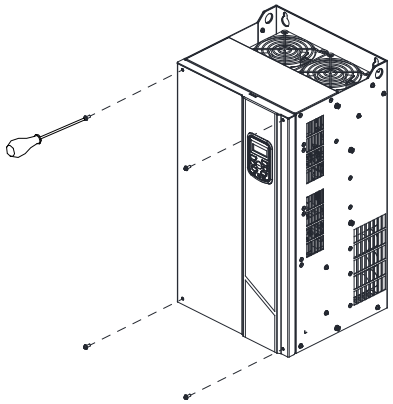
1. Install the cover for T4 to T6 models.
   a. Hold the cover with both hands and insert the upper edge snap-fit joint of the cover into the hole on the drive.
   b. Then, press down the cover in the direction indicated by the arrow, as shown in ②.



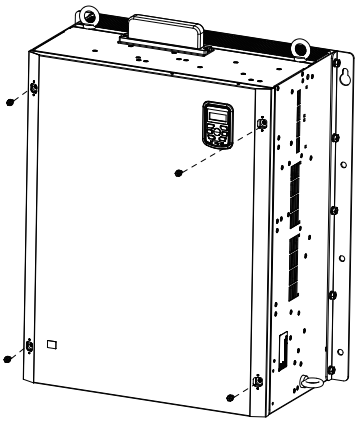
2. Install the cover for T7 to T8 models.
   a. Hold the cover with both hands, align the cover with the upper edge snap-fit joint on the chassis and push it in place as shown in the following figure.



b. Install the four fixing screws with a screwdriver.

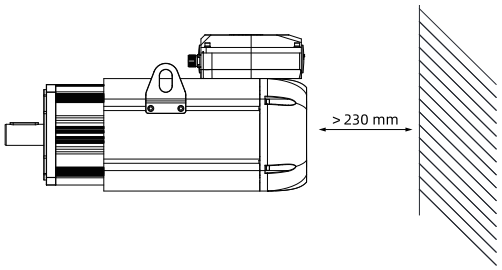


3. To install the cover of T9 models, do the following.
   a. Install the four fixing screws with a screwdriver.



5.4 Installing the Motor

- Use shrinkage fitting for transition fit or interference fit when installing parts (such as the coupler or timing pulley) to the motor shaft extension. Do not strike the shaft extension during assembly or disassembly. Failure to comply may damage the bearing or incur shaft movement, affecting normal operation of the motor.
- Keep the motor flange clean during installation. To prevent verticality or concentricity error, ensure there are no unwanted objects or scratches in the flange.
- If the load is connected with a bracket or similar, take the motor shaft as the basis to measure the verticality and coaxiality of the spigot and the end face on the load side after motor installation is completed.
  Recommended specifications: Coaxiality: < 0.1 mm; Verticality: < 0.1 mm.
- During installation, keep the motor rear exposed with a clearance of at least 230 mm for heat dissipation.



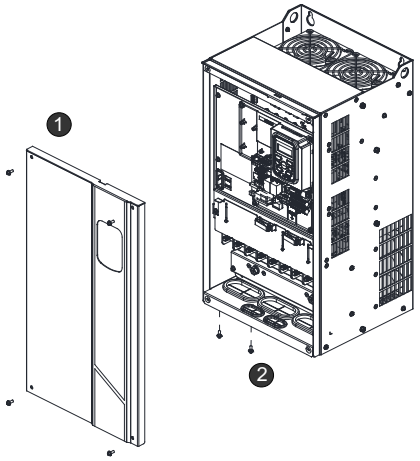
- Ensure the ambient temperature of the motor is below 40℃ during installation. If the ambient temperature exceeds 40℃, check the motor model based on the derating standards.
- To prevent short circuit, ensure that no unwanted objects fall into the junction box during U/V/W cable connection.

5.5 Option Installation

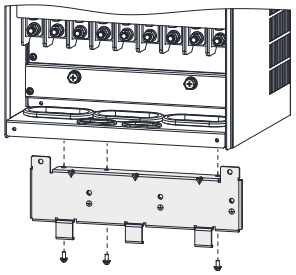
5.5.1 Grounding Bracket for Cable Shield

The cable shield grounding bracket is optional and needs to be purchased separately. Procedure of installing the grounding bracket of cable shield:

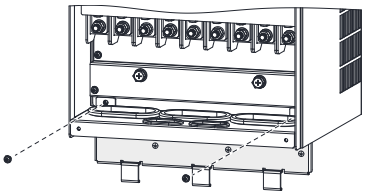
1. Remove the cover, as shown in ❶. Remove the two M4x12 SEMS screws on the air inlet plate, as shown in ❷.



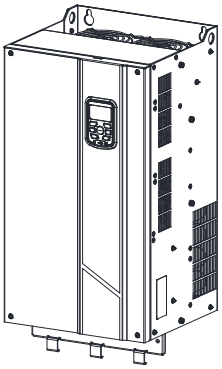
2. Place the grounding bracket of the cable shield on the chassis, and fasten the bracket with three M4×12 SEMS screws at the positions shown in the following figure.



3. Tighten the two M4×12 SEMS screws at the positions shown in the following figure.



4. Install the cover.



5.5.2 EMC Filter

- Install the filter near the input terminals of the drive. The cable between the filter and the drive must be shorter than 30 cm.
- Connect the grounding terminals of the filter and the grounding terminal of the drive together, and install the filter and drive on the same conductive surface that is connected to the main grounding terminal of the cabinet.
- Connect the LINE terminal of the EMC filter to the power grid, and the LOAD terminal to the drive.

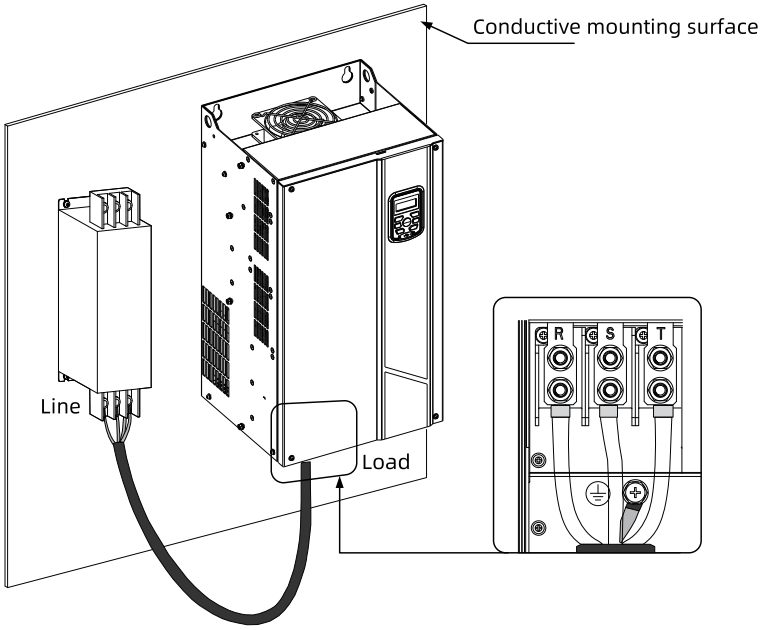


Figure 5-3 EMC filter installation

5.5.3 Ferrite Ring

The magnetic ring can be installed on the input or output side of the drive. Install the magnetic ring as close to the drive as possible.

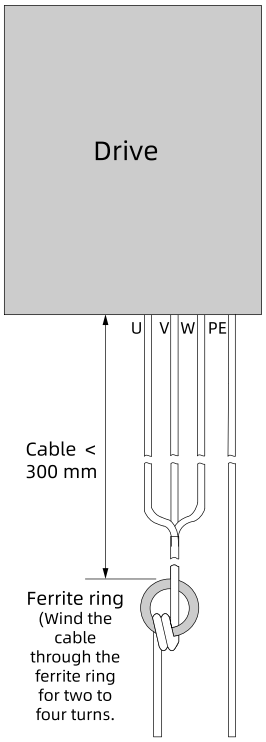


Figure 5-4 Installing the magnetic ring

Note

The R/S/T or U/V/W cables must pass through the same magnetic ring to suppress the common mode noise.

5.5.4 Simple Filter

The simple filter must be grounded securely, and the cable between the filter and the drive must be shorter than 300 mm.

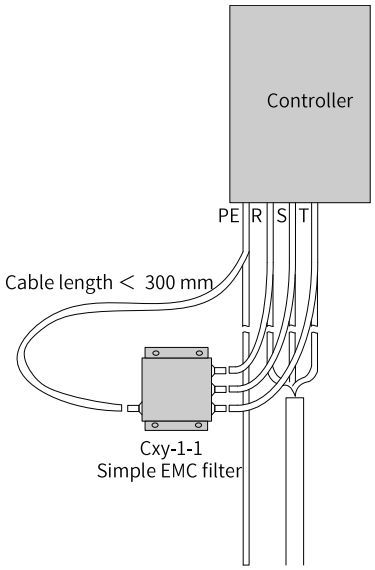


Figure 5-5 Simple filter installation

6 Mechanical Design

6.1 Dimensions and Weight of the Drive

Dimensions of the drive and mounting (backplate mounting) dimensions are shown as follows. The through-hole mounting requires an optional through-hole mounting bracket. See the mounting dimensions in *"8.2 Through-hole Mounting Bracket" on page 143*.

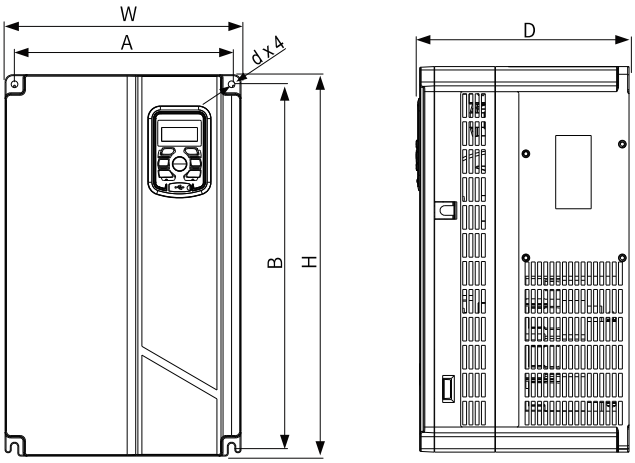


Figure 6-1 Outline and mounting dimensions of T4 and T6 models

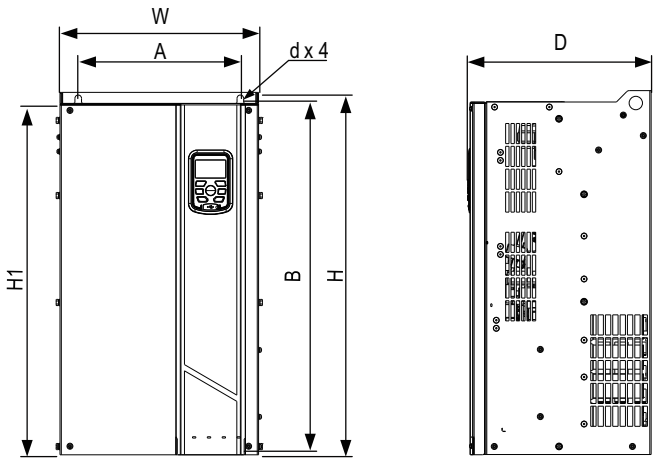


Figure 6-2 Outline and mounting dimensions of T7 and T8 models

Table 6–1 Dimensions, mounting holes, and weight of the drive

T model	Drive model	Mounting hole dimension (mm)		Outline dimension (mm)				Mounting hole diameter (mm)	Net weight (kg)	Gross weight (kg)
		A	B	H	H1	W	D	d		
T4	ES680N-4T025S-C1 ES680N-4T032S-C1 ES680N-4T037S-C1 ES680N-4T044S-C1	166	266	280	-	180	170	Φ6	4.3	4.7
T5	ES680N-4T060S-C1	195	335	350	-	210	195	Φ6	7.6	8.6
T6	ES680N-4T075S-C1 ES680N-4T091S-C1	230	380	400	-	250	222.5	Φ7	17.7	19.1
T7	ES680N-4T112S-C1 ES680N-4T150S-C1	245	523	542	525	300	278	Φ10	34.5	42
T8	ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	270	560	554	-	338	315	Φ10	51	59

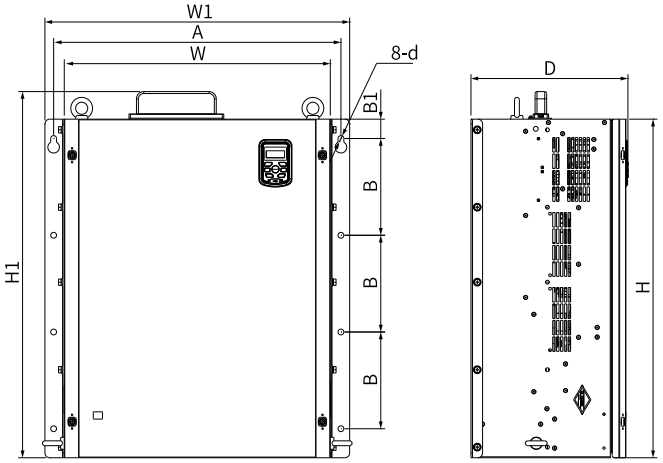


Figure 6-3 Outline dimensions and mounting dimensions of T9 models

Table 6–2 Dimensions, mounting holes, and weight of the T9 drive

T model	Drive model	Mounting hole dimension (mm)			Outline dimension (mm)					Mounting hole diameter (mm)	Net weight (kg)	Gross weight (kg)
		A	B	B1	H	H1	W	W1	D	d		
T9	ES680N-4T312S-C1	594	200	40	700	757	550	630	325	Φ12	89	113
	ES680N-4T395S-C1											
	ES680N-4T426S-C1											
	ES680N-4T480S-C1	594	200	40	700	757	550	630	325	Φ12	95	119
	ES680N-4T525S-C1											
	ES680N-4T600S-C1	594	200	40	700	757	550	630	325	Φ12	102	126
	ES680N-4T650S-C1											

6.2 Cabinet Design

6.2.1 Installation Space

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

Note

Install the fan in the correct air exhaust direction to ensure that air flows from inside to outside of the cabinet. Otherwise, if hot air cannot be exhausted, the drive will be overheated or damaged.

1. **Installing one drive**

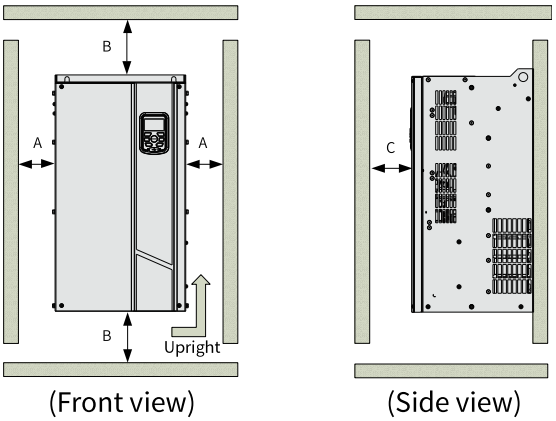


Figure 6-4 Clearance for installing one drive

T model	Drive model	Power rating	Dimensions (mm)		
T4	ES680N-4T025S-C1 ES680N-4T032S-C1 ES680N-4T037S-C1 ES680N-4T044S-C1	11 kW to 22 kW	A ≥ 10	B ≥ 200	C ≥ 40
T5	ES680N-4T060S-C1	30 kW	A ≥ 10		
T6	ES680N-4T075S-C1 ES680N-4T091S-C1	37 kW to 45 kW	A ≥ 50		
T7	ES680N-4T112S-C1 ES680N-4T150S-C1	55 kW to 75 kW	A ≥ 50	B ≥ 300	
T8	ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	90 kW to 132 kW	A ≥ 50		
T9	ES680N-4T312S-C1 ES680N-4T395S-C1 ES680N-4T426S-C1 ES680N-4T480S-C1 ES680N-4T525S-C1 ES680N-4T600S-C1 ES680N-4T650S-C1	160 kW to 355 kW			

2. **Installing multiple drives**

- **Side-by-side installation**
  The drive dissipates heat from bottom to top. When multiple drives are required to work together, install them side by side. Keep their tops level with each other, especially for those of different sizes.

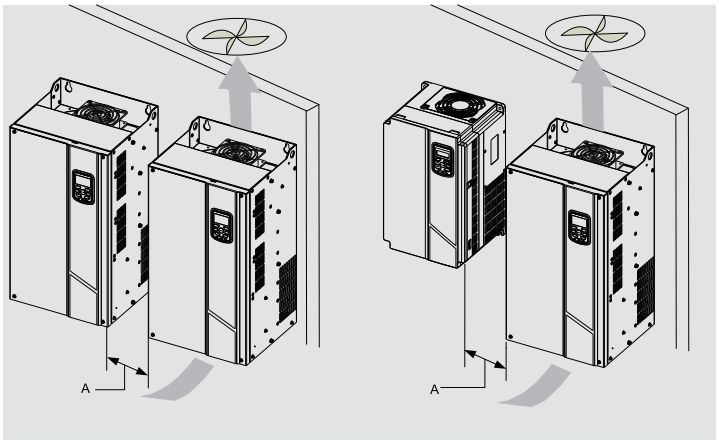


Figure 6-5 Installing multiple drives side by side

T model	Drive model	Power rating	Dimensions (mm)
T4	ES680N-4T025S-C1 ES680N-4T032S-C1 ES680N-4T037S-C1 ES680N-4T044S-C1	11 kW to 22 kW	A ≥ 10
T5	ES680N-4T060S-C1	30 kW	
T6	ES680N-4T075S-C1 ES680N-4T091S-C1	37 kW to 45 kW	A ≥ 50
T7	ES680N-4T112S-C1 ES680N-4T150S-C1	55 kW to 75 kW	
T8	ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	90 kW to 132 kW	
T9	ES680N-4T312S-C1 ES680N-4T395S-C1 ES680N-4T426S-C1 ES680N-4T480S-C1 ES680N-4T525S-C1 ES680N-4T600S-C1 ES680N-4T650S-C1	160 kW to 355 kW	

- **Dual-row installation**

  In applications requiring drives to be installed in two rows, install an air guide plate to prevent overtemperature/overload fault that may occur due to heat dissipated from the lower row to the upper row, as shown in *"Figure 6-6" on page 82* .

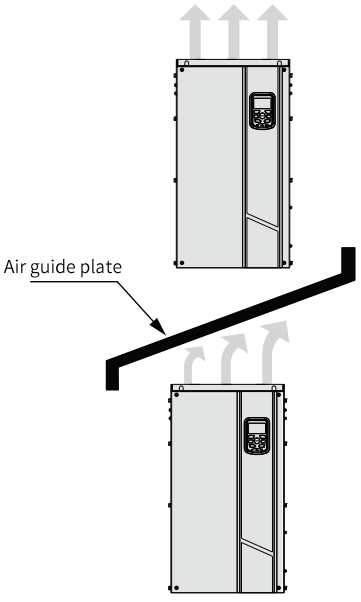


Figure 6-6 Dual-row installation

6.2.2 Mounting Backplate Requirements

Requirements of backplate thickness, dimensions, and stiffness

To prevent damage to the drive during transportation and ensure proper operation of the drive, use a mounting plate with sufficient stiffness, strength, and thickness (≥ 2 mm). Take enhancement measures on the backplate if necessary. It is recommended to weld a horizontal reinforced beam to the back of the backplate, as shown below.

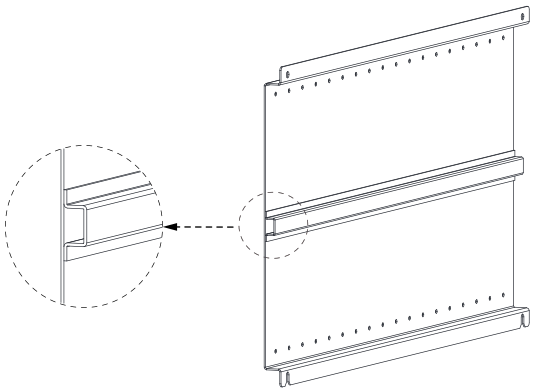


Figure 6-7 Welding a lateral reinforcing beam on the back of the backplate

Requirement on the mounting holes

- You can drill mounting holes on the backplate in advance. For detailed mounting hole dimensions, see *"6.1 Dimensions and Weight of the Drive" on page 78*.
- To prevent damage to the drive during delivery, fix not only the mounting screws to the mounting backplate but also self-clinching nuts or independent nuts to enhance robustness and strength.

6.2.3 Cabinet Heat Dissipation

Heat dissipation design of the cabinet door

As the drive dissipates heat through the fan, the air inlet on the cabinet door must be wide enough to allow the cooling air to enter the cabinet.

Ensure the air inlet of the cabinet is lower than that of the drive by more than 50 mm to allow the cooling air to flow upwards after being heated, as shown in the following figure.

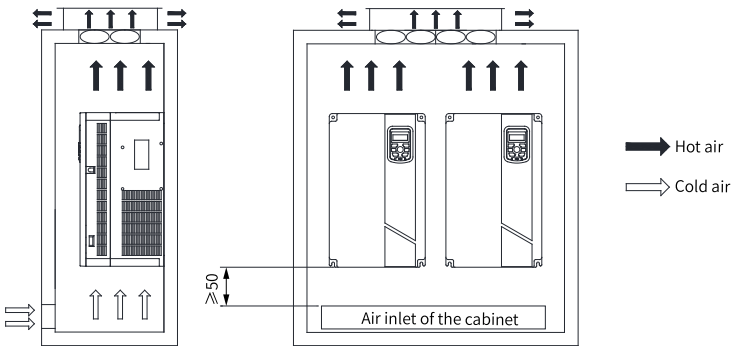


Figure 6-8 Position of the cabinet air inlet

Note

In cases whether multiple drives are installed inside the cabinet, if the fan blows air from external to internal, the air flow inside the cabinet will be disturbed, affecting the overall cooling effect. Therefore, do not install a fan at the air inlet of the cabinet to blow air into the cabinet.

When the drive is placed into the cabinet, the minimum effective area of the air inlet is shown in *"Table 6-3" on page 84*.

Table 6–3 Minimum effective ventilation area of the cabinet air inlet

Drive	Minimum effective area of the cabinet air inlet (cm^2)
T4	50
T5	60
T6 to T7	102
T8	204
T9	636

The preceding table only applies to an individual drive. When multiple drives are placed inside the cabinet, add up the preceding air inlet area to obtain the total air inlet area. For example, if two T5 and one T7 drives are placed inside the cabinet, the minimum effective area of the cabinet air inlet is 2 x 60 + 1 x 102 = 222 cm^2.

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

The ventilation area in the preceding table refers to the actual through-hole area of an opening. The ventilation area is calculated opening area x opening rate.

Top air outlet

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

1. Passive exhaust (self-ventilated)

   As the hot air flows upwards, the forcible air flow guides the air inside the drive to flow to the outside from the top air outlet of the cabinet.

   Passive air exhaust can easily cause hot air to accumulate on the upper part of the cabinet, causing the air pressure in this area to rise. The air pressure in the air inlet of the cabinet is low due to the suction action of the fan of 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. This air flow forces the hot air at the air outlet to flow towards the air inlet so that it is absorbed into the drive again, causing a significant temperature rise and an adverse effect on the performance of the drive.

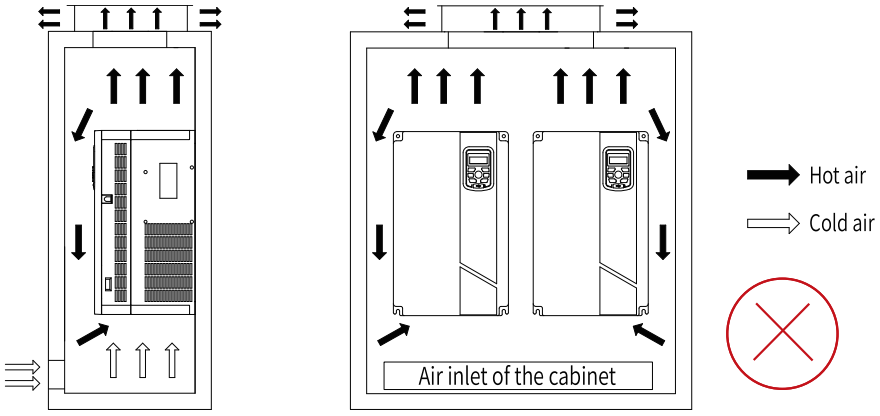


Figure 6-9 Hot air backflow in the passive exhaust mode (without isolation devices)

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

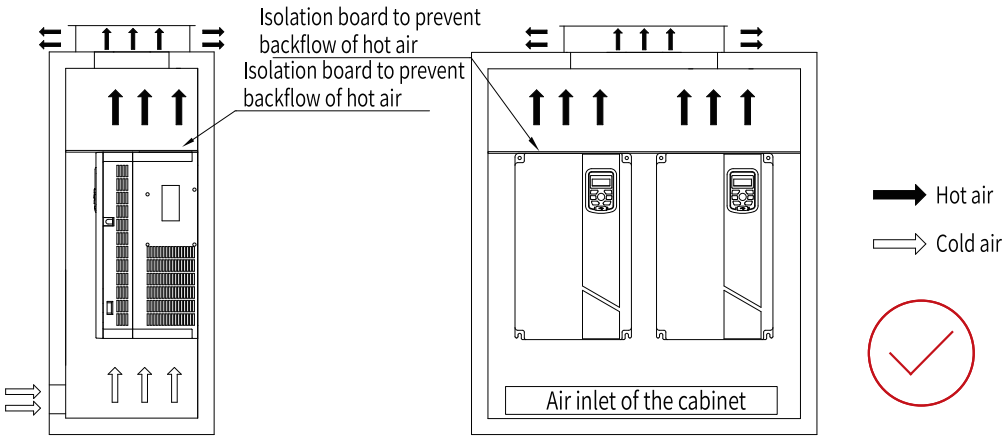


Figure 6-10 Hot air backflow in the passive exhaust mode (with isolation devices)

The temperature of the air outlet of the drive is high, which features a lower density compared with that of the air inlet. To allow the hot air inside the cabinet to flow to the outside, ensure the minimum effective area of the cabinet air outlet listed in *"Table 6-4" on page 85* is reserved in the passive exhaust mode.

Table 6–4 Minimum effective area of the cabinet air outlet in passive exhaust mode

Drive	Minimum effective area (cm^2)
T4	80
T5	96
T6 to T7	163
T8	326
T9	954

Values listed in the preceding table only apply to an individual drive. When multiple drives are inside the cabinet, add up the preceding air outlet area to get the total air outlet area.

If the air outlet is installed with a filter screen, the air outlet resistance increases substantially. In this case, the minimum effective area of the air inlet is 1.2...1.5 x values listed in the preceding table.

The effective area in the preceding tables refers to the actual through-hole area of the opening. The effective area is calculated by the following formula: opening area x opening rate.

2. Active exhaust

In the active 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.

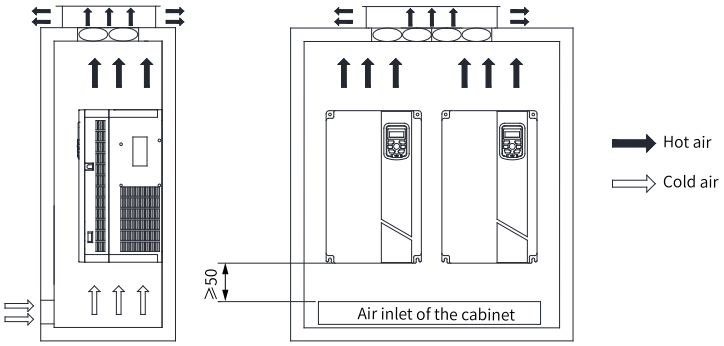


Figure 6-11 Cabinet ventilation system

To ensure that the hot air can be exhausted to the outside, the total air volume of the fan cannot be lower than that of all drives in the cabinet. The cooling air needed by the drive is shown in *"Table 6-5" on page 86*.

Table 6–5 Cooling air volume of the drive

Power of the drive (kW)	Cooling air of the drive (CFM)
11	42
15	42
18.5	64
22	54
30	70
37	106
45	102
55	122
75	122
90	287
110	354.2
132	354.2
160	400
200	400
220	400
250	400
280	500
315	510
355	510
Note: 1 CFM = 0.02832 m^3/min	

Cabinet fan design

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

1. Calculate the total cooling air needed by the drive based on *"Table 6-5" on page 86*.
2. Determine the maximum air volume (Qmax).
3. Determine the specification and quantity of the fan based on the maximum air volume (Qmax).

In which:

Maximum air volume of the cabinet = 1.3 to 1.5 x Sum of the cooling air volume

Maximum air volume of the cabinet = (1.6...2.2) x Total air volume (when the air outlet of the cabinet is installed with a filtering net, shutter, or similar)

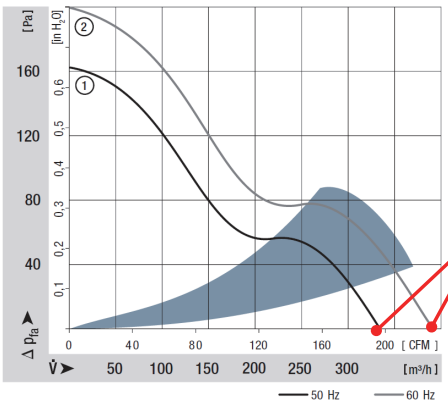
Note

The air volume of the selected fan cannot be lower than the maximum air volume Qmax. When an individual fan cannot deliver the required air volume, connect multiple fans in parallel.

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 air flow of the fan (Qmax)



Maximum air flow of the fan (Qmax)

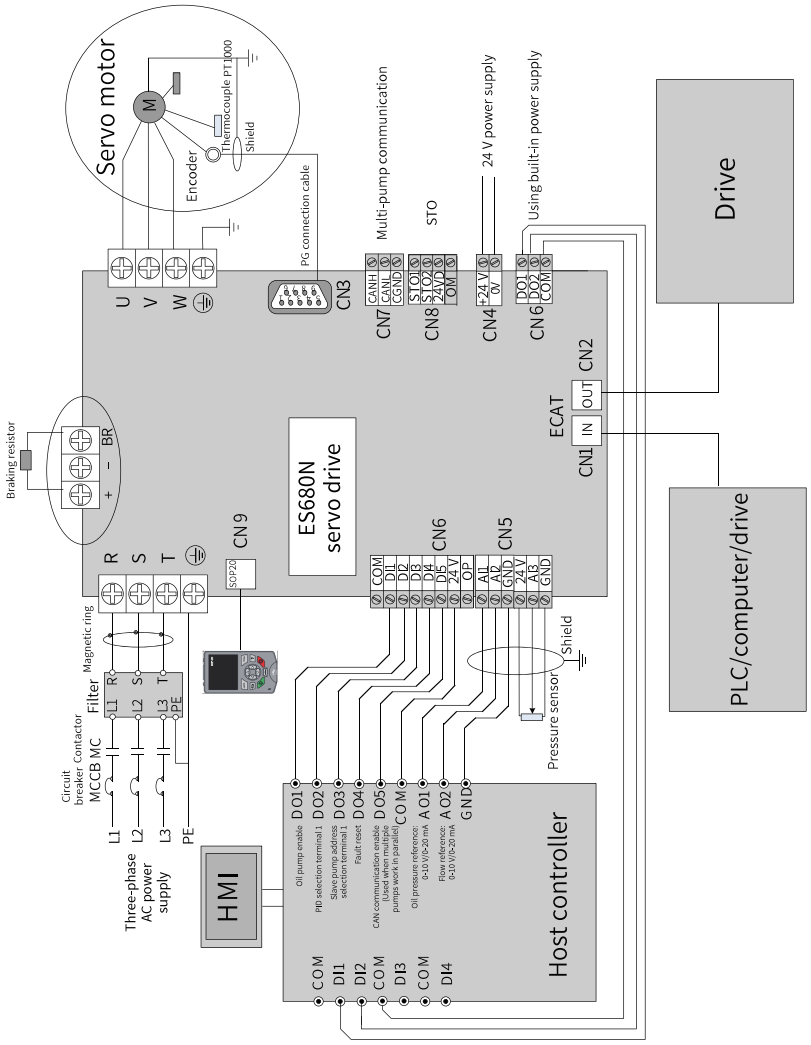
Figure 6-12 Q_{max} of a system fan

Note

Install the fan in the correct air exhaust direction to ensure that air flows from inside to outside of the cabinet. Otherwise, if hot air cannot be exhausted, the drive will be overheated or damaged.

7 Wiring

7.1 Electrical Wiring



7.2 Inspection Before Wiring

- Do not wire the drive with power on. Keep all circuit breakers in the OFF state. Failure to comply will result in an electric shock.
- Before operation, cut off the input and output power, and wait at least 10 minutes until the power indicator is off.
- 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 concerning cable dimensions, fuses, grounding, open circuit, 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. If any fuse trips, find out the cause and rectify the fault.

7.3 Main Circuit Wiring

7.3.1 Descriptions of Main Circuit Terminals

Terminal layout of T4 to T8 models

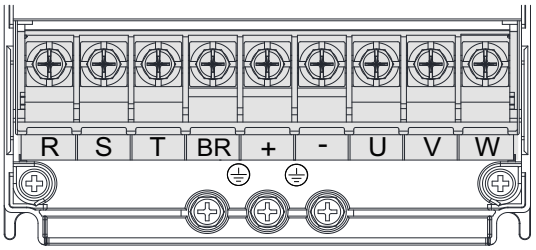


Figure 7-1 Main circuit terminals of T4 models

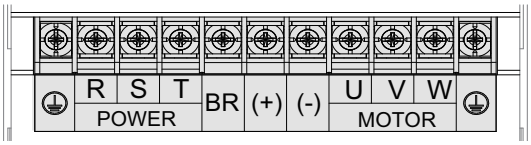


Figure 7-2 Main circuit terminal layout of T5 and T6 models

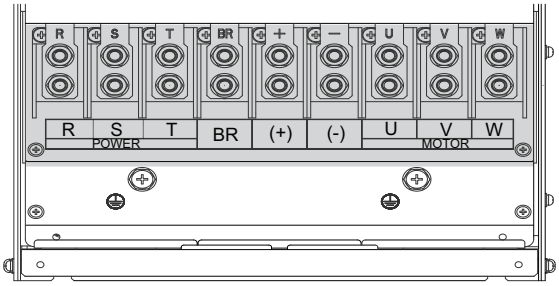


Figure 7-3 Main circuit terminals of T7 models

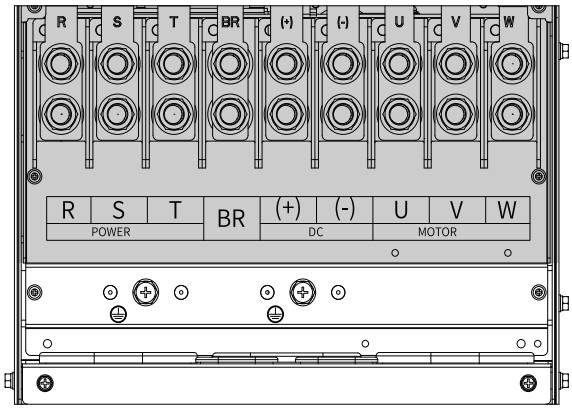


Figure 7-4 Main circuit terminals of T8 models

Descriptions of T4 to T8 model terminals

Table 7–1 Main circuit terminals of T4 to T8 models

Symbol	Name	Description
R, S, T	Three-phase power input terminals	Used to connect to the three-phase AC power supply
(+), (-)	Positive and negative terminals of the DC bus	Used to connect the common DC bus.
(+), BR	Terminals for connecting the braking resistor	Used to connect the braking resistor.
U, V, W	Output terminals	Connected to a three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

Layout and description of T9 model terminals

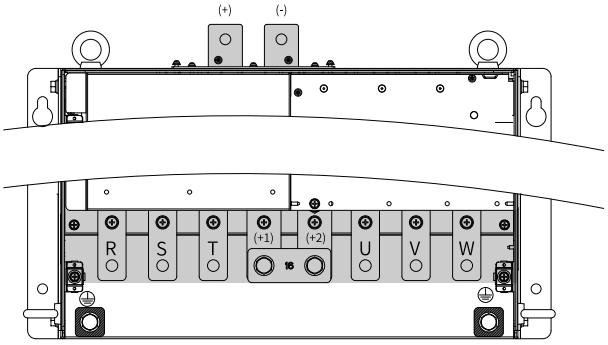


Figure 7-5 Main circuit terminal layout of T9 model

Table 7–2 Main circuit terminals of T9 models

Symbol	Name	Description
R, S, T	Three-phase power input terminals	Used to connect to the three-phase AC power supply
(+), (-)	Positive and negative terminals of the DC bus	Used to connect the common DC bus.
(+1), (+2)	DC reactor connection	DC reactor connection
U, V, W	Output terminals	Connected to a three-phase motor.
⏚	Grounding terminal (PE)	Used for protective grounding.

7.3.2 Dimension and Cable Selection for Main Circuit Terminals

Terminal dimensions

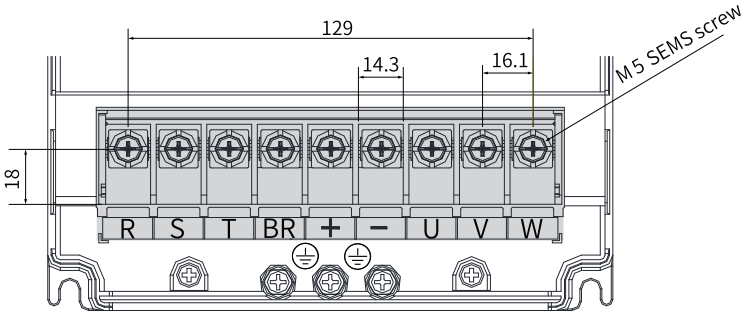


Figure 7-6 Dimensions of main circuit terminals of T4 models

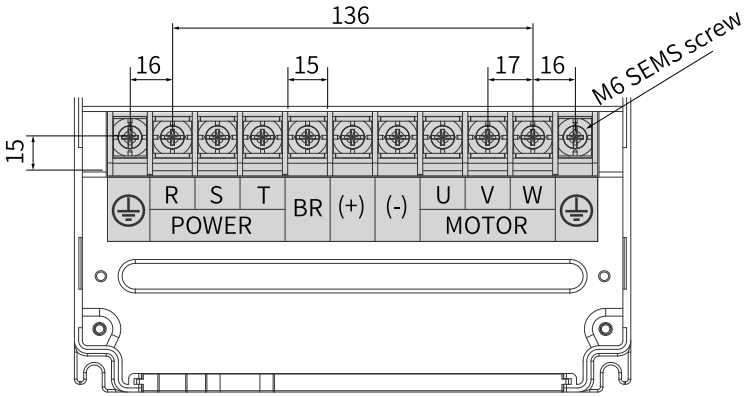


Figure 7-7 Dimensions of main circuit terminals for T5 models

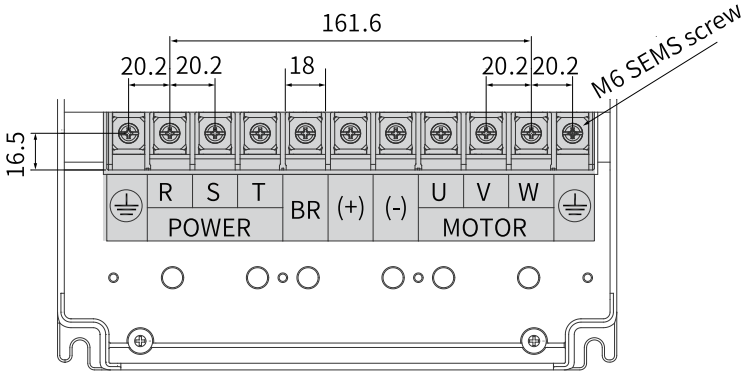


Figure 7-8 Dimensions of main circuit terminals of T6 models

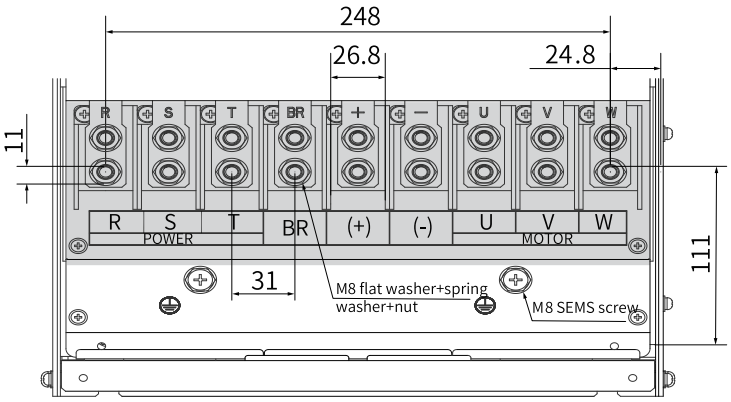


Figure 7-9 Dimensions of main circuit terminals of T7 models

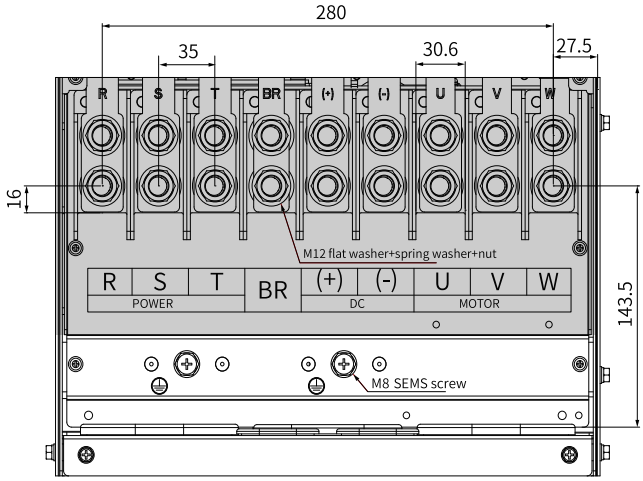


Figure 7-10 Dimensions of main circuit terminals of T8 models

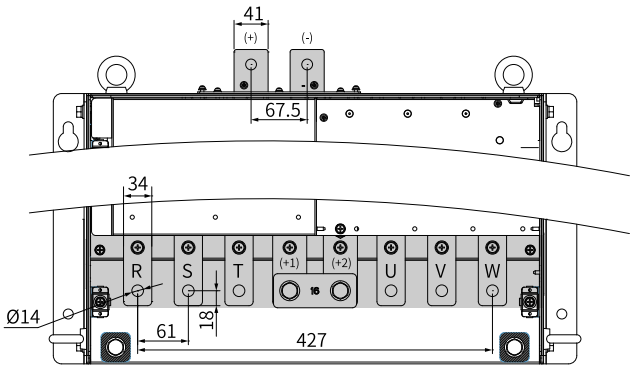


Figure 7-11 Dimensions of main circuit terminals of T9 models

Power cable selection

Observe national or regional regulations when selecting power cables. Select IEC cables according to the following requirements:

- Compliant with EN 60204-1 and IEC 60364-5-52 standards
- PVC insulated cables with copper conductors
- Heat resistance: maximum cable surface temperature not exceeding 70°C at an ambient temperature of 40°C (Note: Contact the manufacturer if the ambient temperature exceeds 40°C.)
- Symmetric cable with copper-braided shield

Note

- If the recommended cables for peripheral equipment or options are not suitable for the product, contact Inovance.
- If the motor cable has a large diameter and there is no suitable three-conductor shielded cable, a single-conductor shielded cable can be used.

To comply with the EMC standards, use shielded cables. You can select the single-conductor shielded cable, three-conductor shielded cable, or four-conductor shielded cable. The three-conductor shielded cable and four-conductor shielded cable are shown in the following figure.

If the conductivity of the three-conductor shielded cable does not meet the requirements, use an additional PE grounding cable. Alternatively, use a four-conductor shielded cable, with one conductor used as the PE cable.

For single-conductor, three-conductor, or four-conductor shielded cables, the shield must be made of coaxial copper braid with a braided density of over 90%. This ensures shielding performance and conductivity and suppresses radio-frequency interference.

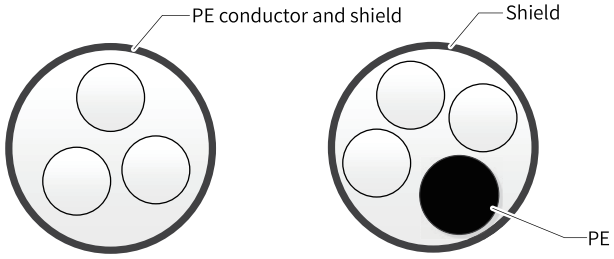


Figure 7-12 Recommended power cable types

Specifications of recommended main circuit cables

Table 7–3 Specifications of recommended main circuit cables

T model	Drive model	Power	Rated input current	RST/UVW		Grounding cable		RST/UVW cable lug width (mm)	Width of the drive terminal (mm)	RST/UVW screw specifications	Tightening torque (N·m) (lb.in)
				Recommended cable (mm^2) <1>	Cable lug model	Cross-sectional area (mm^2) <1>	Cable lug model				
T4	ES680N-4T025S-C1	11	29	3x6	GTNR6-5	6	GTNR6-5	10	14.3	M5	2.8 (24.8)
	ES680N-4T032S-C1	15	36	3 x 10	GTNR10-5	10	GTNR10-5	12.4	15	M5	2.8 (24.8)
	ES680N-4T037S-C1	18.5	42	3 x 10	GTNR10-5	10	GTNR10-5	12.4	15	M5	2.8 (24.8)
	ES680N-4T044S-C1	22	48	3 x 10	GTNR10-5	10	GTNR10-5	12.4	15	M5	2.8 (24.8)
T5	ES680N-4T060S-C1	30	57	3 x 16	GTNR16-6	16	GTNR16-6	12.4	15	M6	4.8 (42.5)

T model	Drive model	Power	Rated input current	RST/UVW		Grounding cable		RST/ UVW cable lug width (mm)	Width of the drive terminal (mm)	RST/ UVW screw specifications	Tightening torque (N·m) (lb.in)
				Recommended cable (mm^2) <1>	Cable lug model	Cross-sectional area (mm^2) <1>	Cable lug model				
T6	ES680N-4T075S-C1	37	69	3 x 25	GTNR25-6	16	GTNR16-6	14	18	M6	4.8 (42.5)
	ES680N-4T091S-C1	45	89	3x35	GTNR35-6	25	GTNR25-6	16.5	18	M6	4.8 (42.5)
T7	ES680N-4T112S-C1	55	106	3 x 50	GTNR50-8	35	GTNR35-8	18	26.8	M8	13.0 (115.2)
	ES680N-4T150S-C1	75	139	3 x 70	GTNR70-8	50	GTNR50-8	21.8	26.8	M8	13.0 (115.2)
T8	ES680N-4T176S-C1	90	164	3x95	GTNR95-12	70	GTNR70-8	25	30.6	M12	35.0 (310.1)
	ES680N-4T210S-C1	110	196	3x120	GTNR120-12	95	GTNR95-8	28.4	30.6	M12	35.0 (310.1)
	ES680N-4T253S-C1	132	240	3x150	BC150-12	95	GTNR95-8	30	30.6	M12	35.0 (310.1)
T9	ES680N-4T312S-C1	160	287	3x185	BC185-12	120	GTNR120-12	33.5	34	M12	35.0 (310.1)
	ES680N-4T395S-C1	200	365	2 x (3 x 95)	GTNR95-12	120	GTNR120-12	25	34	M12	35.0 (310.1)
	ES680N-4T426S-C1	220	410	2 x (3 x 120)	GTNR120-12	150	BC150-12	28.4	34	M12	35.0 (310.1)
	ES680N-4T480S-C1	250	441	2 x (3 x 150)	BC150-12	185	BC185-12	30	34	M12	35.0 (310.1)
	ES680N-4T525S-C1	280	495	2 x (3 x 185)	BC185-12	240	BC240-12	33.5	34	M12	35.0 (310.1)
	ES680N-4T600S-C1	315	565	2 x (3 x 185)	BC185-12	240	BC240-12	33.5	34	M12	35.0 (310.1)
	ES680N-4T650S-C1	355	617	2 x (3 x 240)	BC240-12	300	BC300-12	37.7	34	M12	35.0 (310.1)

Note

<1>: Applicable to GB standards in China. For example, 3 x 10 indicates one 3-conductor 10 mm² cable; 2 x (3 x 95) indicates two 3-conductor 95 mm² cables.

The preceding recommended lugs are the GTNR and BC series from Suzhou Yuanli, and TLK and SQNBS series from KST.

Note:

- Observe national or regional regulations during selection. The preceding table is based on:
  - Cables with PVC insulation and copper conductor
  - Cables with maximum surface temperature not exceeding 75°C at an ambient temperature of 40°C (Remark: When the ambient temperature exceeds 40°C, contact Inovance.)
  - Cable installation type E applied (See IEC60204-1.)
- If the conditions are different, you need to select the model according to actual conditions.

Table 7–4 Specifications of recommended main circuit cables (UL-compliant)

T model	Drive model	RST/UVW		Grounding cable		RST/UVW cable lug width (mm)	Width of the drive terminal (mm)	RST/UVW screw specifications	Tightening torque (N·m) (lb.in)
		Cable (AWG/ kcmil)<2>	Cable lug model	Cable (AWG/ kcmil)<2>	Cable lug model				
T4	ES680N-4T025S-C1	8	TLK10-5	8	TLK10-5	12	14.3	M5	2.8 (24.8)
	ES680N-4T032S-C1	8	TLK10-5	8	TLK10-5	12	15	M5	2.8 (24.8)
	ES680N-4T037S-C1	6	TLK16-5	6	TLK16-5	12	15	M5	2.8 (24.8)
	ES680N-4T044S-C1	6	TLK16-5	6	TLK16-5	12	15	M5	2.8 (24.8)
T5	ES680N-4T060S-C1	4	TLK25-6	4	TLK25-6	14	15	M6	4.8 (42.5)
T6	ES680N-4T075S-C1	2	TLK35-6	4	TLK25-6	17	18	M6	4.8 (42.5)
	ES680N-4T091S-C1	2	TLK35-6	4	TLK25-6	17	18	M6	4.8 (42.5)
T7	ES680N-4T112S-C1	1/0	TLK50-8	2	TLK35-8	20	26.8	M8	13.0 (115.2)
	ES680N-4T150S-C1	3/0	TLK95-8	1/0	TLK50-8	26	26.8	M8	13.0 (115.2)
T8	ES680N-4T176S-C1	4/0	TLK120-12	2/0	TLK70-8	28	30.6	M12	35.0 (310.1)
	ES680N-4T210S-C1	300 kcmil	SQNBS150-12	3/0	TLK95-8	22	30.6	M12	35.0 (310.1)
	ES680N-4T253S-C1	350 kcmil	SQNBS180-12	4/0	TLK120-8	30	30.6	M12	35.0 (310.1)

T model	Drive model	RST/UVW		Grounding cable		RST/UVW cable lug width (mm)	Width of the drive terminal (mm)	RST/UVW screw specifications	Tightening torque (N·m) (lb.in)
		Cable (AWG/ kcmil)<2>	Cable lug model	Cable (AWG/ kcmil)<2>	Cable lug model				
T9	ES680N-4T312S-C1	2x4/0	TLK120-12	250 kcmil	SQNBS150-12	28	34	M12	35.0 (310.1)
	ES680N-4T395S-C1	2 x 300 kcmil	SQNBS180-12	300 kcmil	SQNBS150-12	30	34	M12	35.0 (310.1)
	ES680N-4T426S-C1	2 x 350 kcmil	SQNBS180-12	350 kcmil	SQNBS180-12	30	34	M12	35.0 (310.1)
	ES680N-4T480S-C1	2 x 500 kcmil	SQNBS250-12	500 kcmil	SQNBS250-12	36	34	M12	35.0 (310.1)
	ES680N-4T525S-C1	2 x 500 kcmil	SQNBS250-12	500 kcmil	SQNBS250-12	36	34	M12	35.0 (310.1)
	ES680N-4T600S-C1※	2 x 500 kcmil	SQNBS250-12	600 kcmil	SQNBS325-12	36	34	M12	35.0 (310.1)
	ES680N-4T650S-C1※	2 x 500 kcmil	SQNBS250-12	600 kcmil	SQNBS325-12	36	34	M12	35.0 (310.1)

Note

<1> applies to US standards. The value "8" indicates 8AWG, "1/0" indicates 0AWG, "2/0" indicates 00AWG, "3/0" indicates 000AWG, "4/0" indicates 0000AWG, and "2 x 300 kcmil" indicates two 300 kcmil cables.

The preceding recommended cable lugs are TLK and SQNBS series lugs from KST.

Note:

- Observe national or regional regulations. The cables recommended in the preceding table meet the following conditions:
  - PVC insulation and copper conductor.
  - Heat resistance: maximum cable surface temperature not exceeding 75°C at an ambient temperature of 40°C. (Note: When the ambient temperature exceeds 40°C, contact Inovance.)
  - Cable layout type E is adopted (see IEC60204-1).
- The recommended cables must meet requirements for 125% overload. When local regulations allow, the cross-sectional area of the copper conductor can be reduced if the cable's temperature resistance exceeds 75°C.
- Cables recommended for ES680N-4T600S-C1 and ES680N-4T650S-C1 (with the symbol ※) are based on temperature resistance of 105°C.
- If the conditions vary, select the model according to actual conditions.

7.3.3 Cable Lug Selection

GTNR series cable lugs

The appearance, model, and dimensions (mm) of GTNR series lugs are shown below.



Figure 7-13 Appearance of GTNR series cable lugs

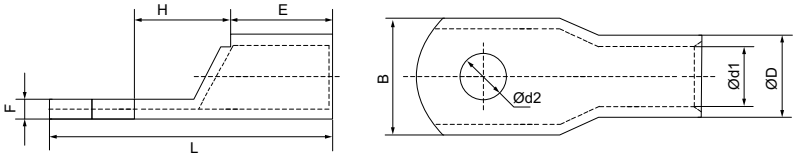


Figure 7-14 Dimensions of GTNR series cable lugs

Model	Dimensions								
	D	d1	E	H	B	d2	F	L	Crimping pliers
GTNR6-5	6	4.2	9	9	10	5.3	1.4	23.8	RYO-8 YYT-8 RYO-14
GTNR10-5	7	5	9	11.5	12.4	5.3	1.45	27.5	
GTNR16-6	7.8	5.8	12	12	12.4	6.4	1.7	31	CT-38 CT-100
GTNR25-6	9.5	7.5	12	12.5	14	6.4	1.9	32	
GTNR35-6	11.4	8.6	15	14	16.5	6.4	2.7	38	
GTNR35-8	11.4	8.6	15	14	16.5	8.4	2.7	38	
GTNR50-8	12.6	9.6	16	17	18	8.4	2.8	43.5	CT-100
GTNR70-8	15	12	18	20	21.8	8.4	2.8	50	
GTNR95-8	17.4	13.5	20	22	25	8.4	3.9	55	
GTNR95-12	17.4	13.5	20	22	25	13	3.9	55	
GTNR120-12	19.8	15	22	24	28.4	13	4.7	60	RYC-150

BC series cable lugs

The appearance, model, and dimensions (mm) of BC series lugs are shown below.



Figure 7-15 Appearance of BC series cable lugs

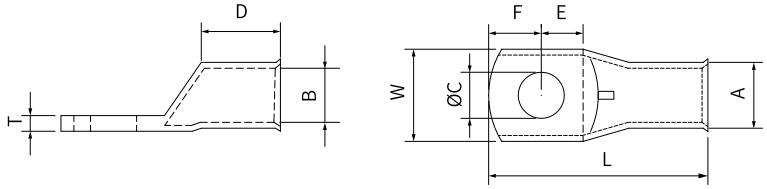


Figure 7-16 Dimensions of BC series cable lugs

Model	Dimension								
	A	B	W	E	D	L	T	C	F
BC150-12	21	16.5	30	16.5	27	78	4.5	12.8	16.5
BC185-12	23	18.5	33.5	16.5	30	82	4.5	12.8	16.5
BC185-16	23	18.5	33.5	16.5	30	82	4.5	16.7	16.5
BC240-12	26	21	37.7	18	32	88	5	12.8	17
BC240-16	26	21	37.7	18	32	88	5	16.7	17
BC300-12	28	23	41	18	37	97	5	12.8	17
BC300-16	28	23	41	18	37	97	5	16.7	17

TLK series cable lugs

The appearance, model, and dimensions (mm) of TLK series lugs from KST are shown below.



Figure 7-17 Appearance of TLK series cable lugs

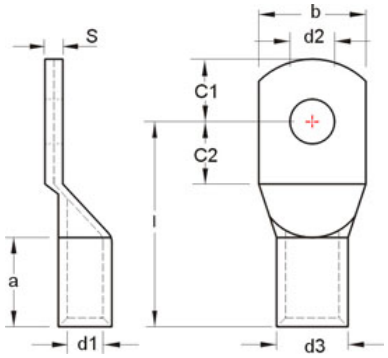


Figure 7-18 Dimensions of TLK series cable lugs

Model	Dimension								
	S	a	b	C1	C2	d1	d2	d3	I
TLK6-5	2.4	9	10	6.5	7.5	3.5	5.5	6.5	21
TLK10-5	1.8	10	12	6.5	7.5	4.6	5.5	7	22
TLK16-5	2.8	13	12	5.5	6.5	5.5	5.5	8.5	26
TLK16-6	2.8	13	12	6.25	7.5	5.5	6.5	8.5	27
TLK25-6	2.8	15	14	7.5	7.5	7	6.4	10	30
TLK35-6	3.2	17	17	7.5	7.5	8.5	6.4	12	32
TLK35-8	3.2	17	17	10	10	8.5	8.4	12	34
TLK50-8	3.7	19	20	10	10	10	8.4	14	37
TLK70-8	4.3	21	23	10	10	12	8.4	16.5	43

Model	Dimension								
	S	a	b	C1	C2	d1	d2	d3	I
TLK95-8	4.2	25	26	12	12	13.5	8.4	18	48
TLK120-12	4.3	26	28	14	14	15	13	19.5	51

SQNBS series cable lugs

The appearances, models, and dimensions (unit: mm) of SQNBS series lugs from KST are shown below.

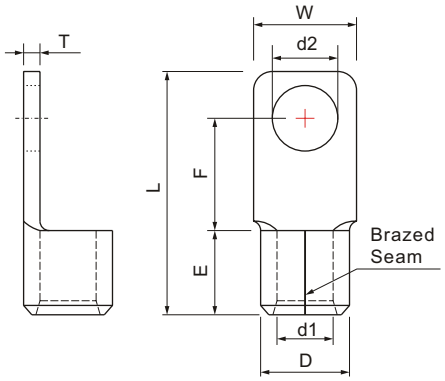


Figure 7-19 Dimensions of SQNBS series cable lugs

Model	Dimension							
	d2	W	F	L	E	D	d1	T
SQNBS150-12	13.0	22	22.3	61	26.5	26.5	19.5	3.2
SQNBS180-12	13.0	30	22.3	68	28.5	28.6	20.6	3.5
SQNBS250-12	13.0	36	22.3	72.5	31	32.7	24	4
SQNBS325-12	13.0	37.2	32	87.7	35.5	37.6	28	4.3

7.3.4 Requirements for Main Circuit Wiring

Requirements for Main Circuit Wiring

- The specifications and installation method of external main circuit cables must comply with local regulations and related IEC standards. For main circuit cables, select copper conductors of appropriate size according to the recommended specifications.
- No specific sequence is required for wiring of RST on the input side of the drive.
- To protect the main circuit, isolate and cover it from surfaces that may come into contact.
- 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 twisted conductors (if used).
- 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.
- Terminals BR, (-), and (+) are used to connect optional parts. Do not connect these terminals to an AC power supply.
- Wiring requirements for DC bus (+) and (-) terminals
  - Power off and wait for at least 10 min until the power indicator is off before wiring because residual voltage still exists in the DC bus terminals (+ and -) immediately after power-off. Failure to comply can result in the risk of electric shock.
  - The cable length of the braking unit must not be longer than 10 m. Use the twisted pair cables or closely-paired cables for parallel connection.
  - Do not connect the braking resistor directly to the DC bus. Failure to comply may result in damage to the drive and even fire.
- Wiring requirements for (+) and BR terminals
  - Connect a braking resistor of the recommended model, and ensure that the cable length of the braking resistor is shorter than 10 m. Failure to comply may damage the drive.
  - Keep the braking resistor away from combustibles. Avoid igniting the surrounding components due to overheating of the braking resistor.
  - After the brake resistor is connected, set H01.41 based on the actual load.

Note

If customers have independent protection requirements for the braking circuit, add external protection components as needed based on an evaluation of operating conditions.

Main circuit cabling requirements

Power supply cables and motor cables may generate strong electromagnetic interference. To prevent electromagnetic interference generated by long-distance parallel routing and coupling between disturbing cables and control cables, keep a clearance of at least 30 cm between main circuit cables and signal cables. Common main circuit cables include input R/S/T cables, output U/V/W cables, DC bus, and brake cables. Signal cables include I/O signal cables, communication cables, and encoder cables.

Cable ducts must be connected and grounded properly. Aluminum cable ducts can be used to ensure equipotentiality of the device. The filter, drive, and motor must be properly connected to systems (machines or devices), with spraying protection applied at the installation part and the conductive metal kept in full contact.

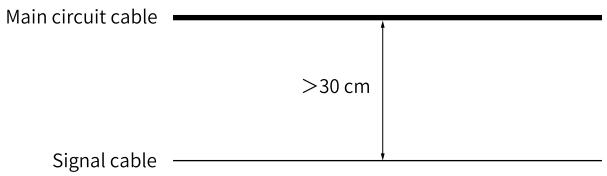


Figure 7-20 Cabling diagram

Wiring in an IT or angular grid system

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

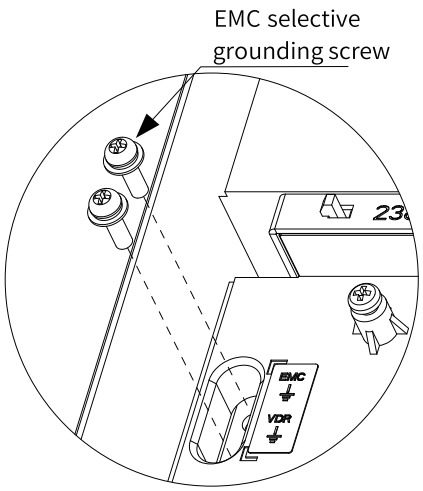


Figure 7-21 Disconnect the EMC selective grounding screw.

Note

For power systems except the IT and delta types, fixed optional EMC and VDR grounding screws are provided. Disconnect the VDR screw before any withstand voltage tests. Failure to comply may cause the servo to fail the tests.

7.3.5 Protection Requirements

Requirements for protection of main circuit cables

Apply heat-shrink tubing to the copper lug and conductors of the cable, and ensure all conducting parts of the cable are properly wrapped, as shown in *"Figure 7-22" on page 101* .

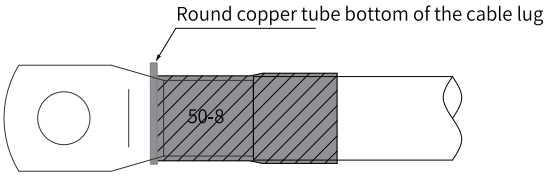


Figure 7-22 Cable conductor with the heat-shrink tube

Requirements on upstream protection device

- Install a proper protection device on the power input side to provide protections on overcurrent, short-circuit and electrical isolation.
- 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 applications.

Application in IT system

- The drive is applicable to a power grid system with neural points grounded. If the drive is used in an IT power grid system (where the neural point is not grounded), remove the grounding jumpers from the voltage dependent resistor (VDR) and safety capacitor (EMC). That is, remove the No. 1 and No. 2 screws shown in the following figure. Do not install a filter. Failure to comply may result in damage to the drive or even personal injury.
- If a residual current device used trips during power-on, compliance with EMI requirements of IEC 61800-3 Category C3 cannot be guaranteed. In this case, you can remove the EMC grounding jumper, as shown by No. 2 screw in *"Figure 7-23" on page 102* .

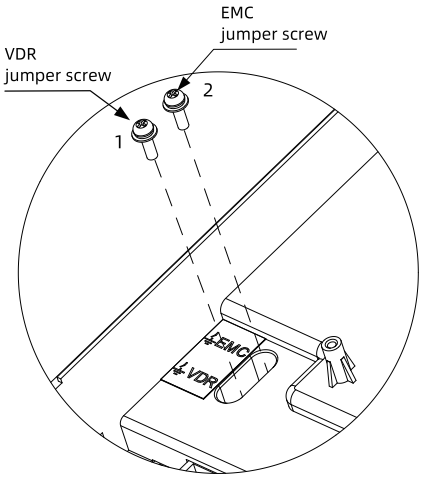


Figure 7-23 Positions of VDR and EMC grounding jumpers

7.4 Connecting the Motor

Motor cable shield requirements

It is recommended to use the shielded cable as the motor output cable. Perform a 360° connection on the shield structure by using the shield grounding bracket, and crimp the drain wire of the shield to the PE terminal. The following figure shows wiring of the shield.

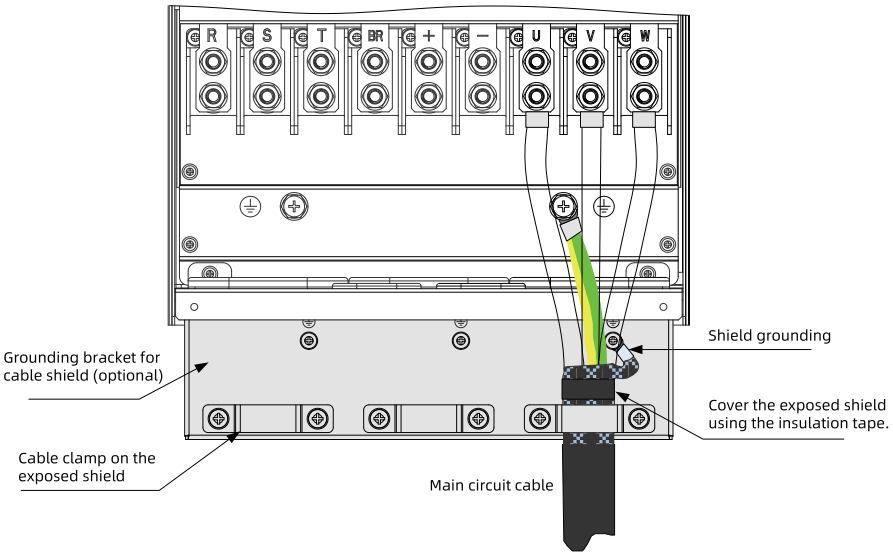


Figure 7-24 Wiring of the shield

Keep the lead wire of the motor cable shield as short as possible, with its width (b in the following figure) not shorter than 1/5 of its length (a in the following figure).

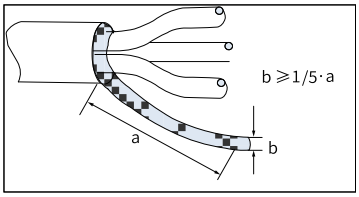


Figure 7-25 Drain wire of the motor cable shield

Length of motor cables

When the drive is working, the quick on-off of its power switching transistor can lead to excessively high dU/dt at the output side. If the motor cable is too long, the motor winding can be subject to 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, which can easily incur high harmonic current.

The cable connecting the drive and the motor cannot be excessively long. An excessively long cable can result in large distributed capacitance and high harmonic current. When the length of the output cable is equal to or higher than the value listed in the following table, install an output reactor near the drive.

Table 7–5 Minimum length of the cable for output reactor

T model	Drive model	Rated voltage (V)	Min. cable length threshold for installing an output reactor (m)
T4	ES680N-4T025S-C1	200 to 500	110
	ES680N-4T032S-C1	200 to 500	125
	ES680N-4T037S-C1	200 to 500	135
	ES680N-4T044S-C1	200 to 500	150
T5 to T8	ES680N-4T060S-C1 ES680N-4T075S-C1 ES680N-4T091S-C1 ES680N-4T112S-C1 ES680N-4T150S-C1 ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	280 to 690	150
T9	ES680N-4T312S-C1 ES680N-4T395S-C1 ES680N-4T426S-C1 ES680N-4T480S-C1 ES680N-4T525S-C1	280 to 690	150

Wiring of the motor

Connect the motor to the drive with U, V, and W phases connected in the correct sequence.

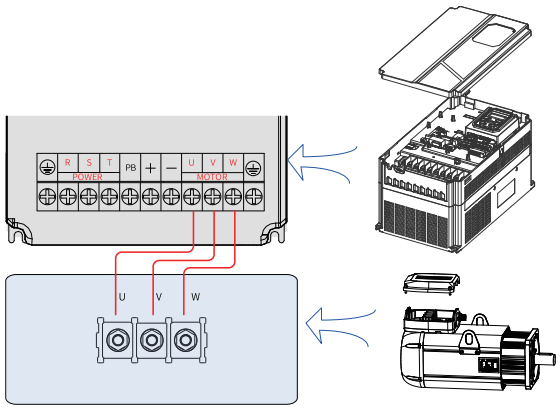


Figure 7-26 Wiring diagram

7.5 Connecting the Encoder

Caution

- During on-site installation and commissioning, route the signal cables (such as encoder cables) and power cables through different routes. Never bundle the signal cables and power cables together to prevent interference to the encoder.
- The motor enclosure must be connected to the PE terminal of the servo drive. Meanwhile, the grounding cable on the motor enclosure side must be connected properly. Failure to comply will result in poor grounding effect.
- Is recommended to use the shielded twisted pair cable as the encoder cable. The shielded twisted pair cable is above 26AWG. The shield of the shielded twisted pair cable is grounded at both ends, with one end connected to the grounding terminal (PE) of the drive and the other connected to the motor enclosure.
- For some large equipment, if the drive is far away from the motor, the motor cable may be excessively long resulting (≥ 10 m). The grounding performance can be affected by the inductance of the cable. In this case, the encoder shield can be ungrounded (by disconnecting the grounding cable of the control board from the grounding copper busbar).

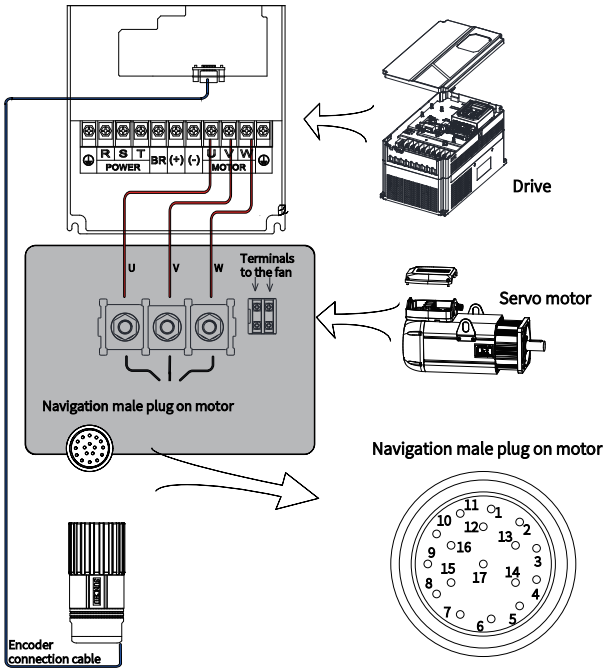


Figure 7-27 Wiring between the encoder and motor

Table 7–6 Encoder cable signals and colors

Drive end (DB9 male)	1	2	3	4	5	9	7	8		6	Enclosure
Motor end (17-pin aviation connector)	10	7	5	6	4	14	16	17	9	8	15
Signal assignment	PS+	PS-	-	-	PT1000-	PT1000+	+5V	-	GND	-	Shield

Conductor color	Yellow	Yellow/ Black	Gray	Orange	White	Green	Red	Black	Blue	Purple	Shield
Remarks	Twisted pair		Twisted pair		Twisted pair		Twisted pair		Twisted pair		-

7.6 Control Circuit Wiring

7.6.1 Descriptions of Control Circuit Terminals

Layout of control circuit terminals is shown in *"Figure 7-28" on page 106* .

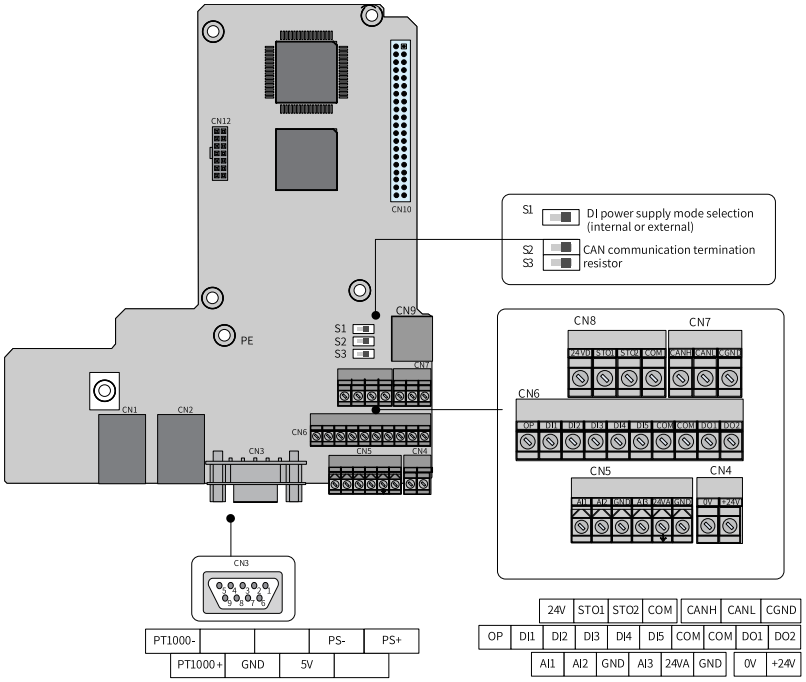


Figure 7-28 Layout of control terminals

Table 7–7 Descriptions of Control Circuit Terminals

Type	Symbol	Name	Description
Power supply input (CN4)	+24 V to 0 V	External 24 V power supply input	Used for the control circuit on the control board, with an input range of 24V±10%. Maximum input current: 1 A Minimum required current: 0.6 A ***Note*** When an external 24 V power supply is connected and the drive is powered at 380 V, the system uses the internal power supply of the drive preferentially.
Power output (CN5)	24VA-GND	24VA analog signal source	24 V ± 10%; maximum output current: 30 mA Generally used to power the pressure sensor

Type	Symbol	Name	Description
Analog input (CN5)	AI1-GND	AI1	• Input voltage range: -10 VDC to +10 VDC • Input impedance: 52 kΩ • 12-bit resolution, calibrated precision: 0.5%
	AI2-GND	AI2	
	AI3-GND	Analog input terminal 3	• Input range: 0 V DC to 10 V DC or 0 mA to 20 mA, as defined by the panel setting parameter • Input impedance: 52 kΩ for voltage input or 500 Ω for current input • 12-bit resolution, calibrated precision: 0.5%
Digital input (CN6)	DI1-COM	Digital input 1	• Optocoupler isolation, input frequency lower than 100 Hz, driven by external or internal power supply as defined by S1 on the control board • Input impedance: 1.98 kΩ • Operating voltage range: 9 V to 30 V
	DI2-COM	DI2	
	DI3-COM	DI3	
	DI4-COM	DI4	
	DI5-COM	DI5	
	OP	External 24 V power supply for digital input	The DI circuit can be powered up by an external 24 V power supply, as selected by the DIP switch.
Digital output. (CN4)	DO1-COM	DO1	Optocoupler isolation; dual-polarity open collector output Output voltage range: 0 V to 24 V Output current range: 0 mA to 50 mA Note: DO can be driven by external power supplies only. Check whether the power supply GND can be connected to COM when using the external power supply.
	DO2-COM	DO2	
CAN communication (CN7)	CANH	CAN input (+)	One isolation CAN communication as standard, used for communication between the host controller or PLC and the drive • Max. communication speed: 1 Mbps • Max. number of nodes: 64
	CANL	CAN input (-)	
	CGND	Power ground	
STO (CN8)	24VD	24VD power supply output	Compliant with SIL3 Short STO1, STO2 and 24VD when STO is not used. When using STO, remove the short circuit jumper.
	STO1	STO1 input	
	STO2	STO2 input	
	COM	Power supply reference ground	
Auxiliary interface	CN1 and CN2	EtherCAT communication network port	Supports FE EtherCAT standard functions to achieve protocols in the CoE and EoE application layer. CN1 (incoming) and CN2 (outgoing)
	CN3	23-bit motor encoder interface	PT1000 motor temperature detection as standard, compatible with KTY temperature detection
	CN9	External operating panel interface	External Operating Panel
DIP switch	S1	DI signal power supply switch	Used to switch between the internal and external power supplies for DI signals. By default, the internal 24 V power supply is used.
	S2, S3	DIP switch for CAN termination resistor setting	You can choose whether to match the termination resistor. The termination resistor is matched by default.

7.6.2 Wiring Requirements of Control Circuit

Cable selection requirements for the control circuit

To reduce interference suffered by the control circuit, shielded cables are recommended for the control circuit. Use separate shielded cables for different analog signals. It is recommended to use shielded twisted pairs for digital signals.

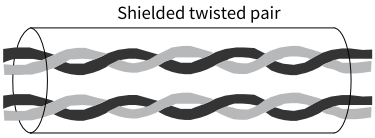


Figure 7-29 Shielded twisted pair cable

Grounding requirement on the control circuit cable shield

- It is recommended to use the grounding bracket (optional part) together with the shield. In this way, the cable shield can be grounded at 360°.
- Keep the drain wire of the shield as short as possible, as shown in the following figure. Fix the shield to the grounding sheet metal of the drive with screws.

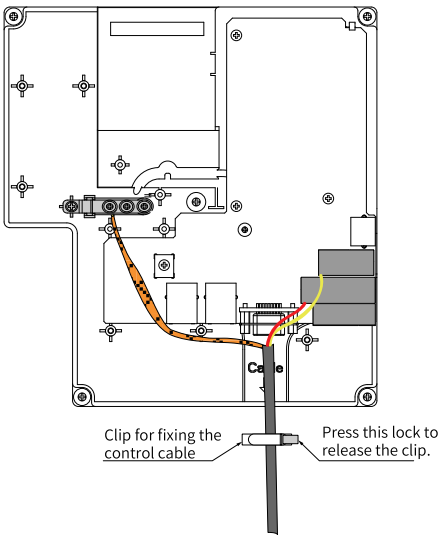


Figure 7-30 Grounding of the control circuit cable shield

Requirements on control circuit routing

- To prevent interference, route the control circuit cables and main circuit cables through different routes and keep the control circuit cables away from the main circuit cables.
- If the control cable must run across the power cable, make sure they are cross-connected at an angle of 90°.

The recommended routing diagram is shown as follows.

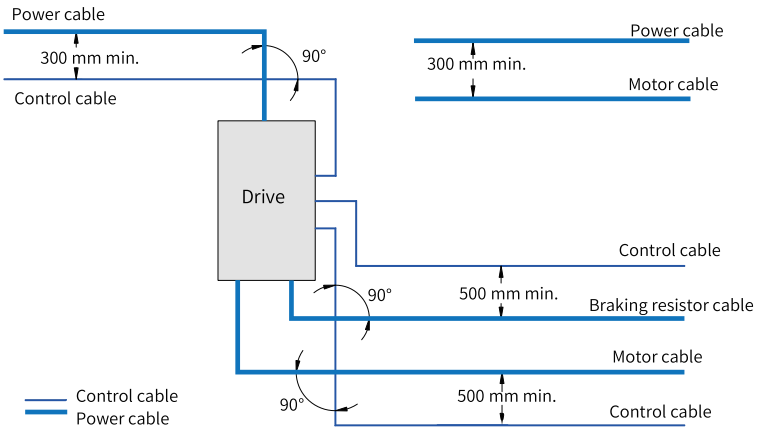


Figure 7-31 Recommended routing

Requirements on tubular terminals of the control circuit

Use tubular terminals with insulation sheath. Keep the exposed conductor of a single or twisted cable no longer than 6 mm, as shown in the following figure.

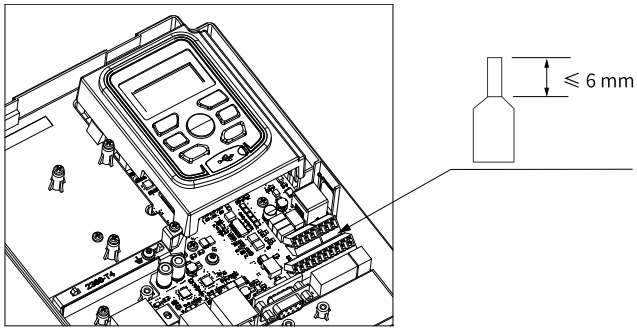


Figure 7-32 Requirements on tubular terminals of the control circuit

Single conductor mm² (AWG)	Twisted pair cable mm² (AWG)	Tightening torque (N•m)
0.2 to 0.75 (18AWG to 24AWG)		0.565

7.6.3 Wiring of Control Circuit Terminals

Wiring of AI1/AI2

Weak analog voltage signals are susceptible to external interference. Therefore, a shielded cable is required, and the wiring distance must be as short as possible (not longer than 20 m), as shown in *"Figure 7-33" on page 110* . In scenarios where analog signals experience severe external interference, install a filter capacitor or a ferrite core on the analog signal source side, as shown in *"Figure 7-34" on page 110* . Connect the drain wire of the analog terminal shield to the PE terminal.

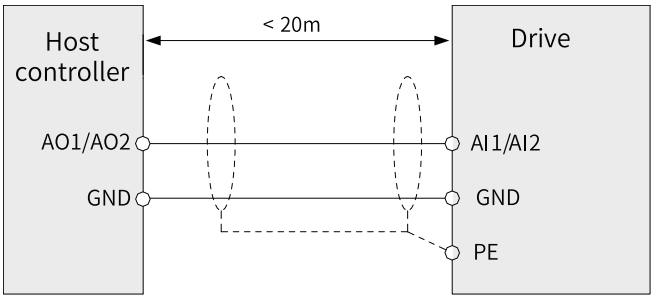


Figure 7-33 Wiring of AI terminals

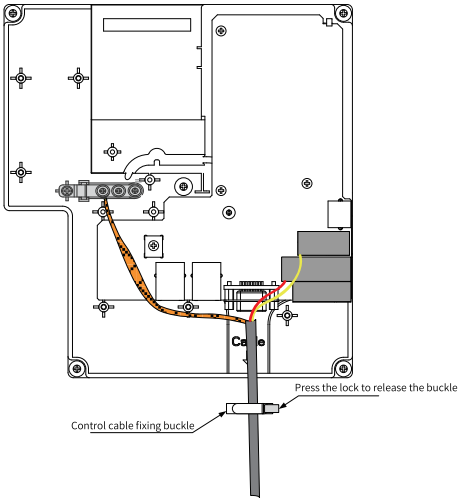


Figure 7-34 Grounding of the control circuit cable shield

Wiring of AI3

- If AI3 is to be used for voltage signal input, wire it in the same way as AI1.
- When AI3 uses current signal input, AI3 is the current inflow direction and 24VA is the current outflow direction (The input mode of AI3 is set by parameters.)

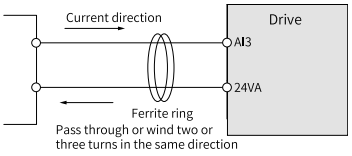


Figure 7-35 Wiring of AI3 terminal

Wiring of DI1 to DI5

- Sink wiring mode

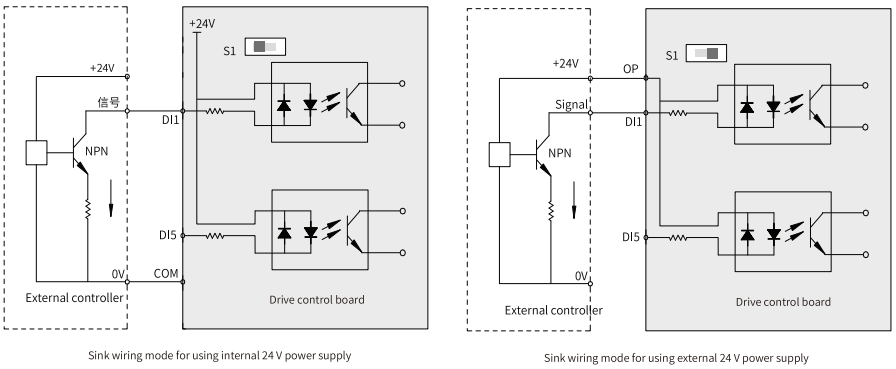


Figure 7-36 Sink wiring mode

- When using the internal 24 V power supply of the drive, which is also the most popular wiring mode, set S1 (downwards) based on the sequence shown in the internal 24 V wiring diagram, and connect COM terminal on the drive to 0V of the external controller.
- When using the external 24 V power supply, set S1 (upwards) based on the sequence shown in the preceding figure on the right. Then connect 24V+ of the external power supply to the OP terminal and connect 0V of the external power supply to the corresponding DI terminal after passing the contact of the controller.

Note

In this wiring mode, the DI terminals of different drives cannot be connected in parallel. Otherwise, DI malfunction may result. If parallel connection (among different drives) is required, connect a diode in series at the DI and the diode needs to satisfy the requirement: IF > 40 mA, VR > 40 V, as shown by *"Figure 7-37" on page 111* .

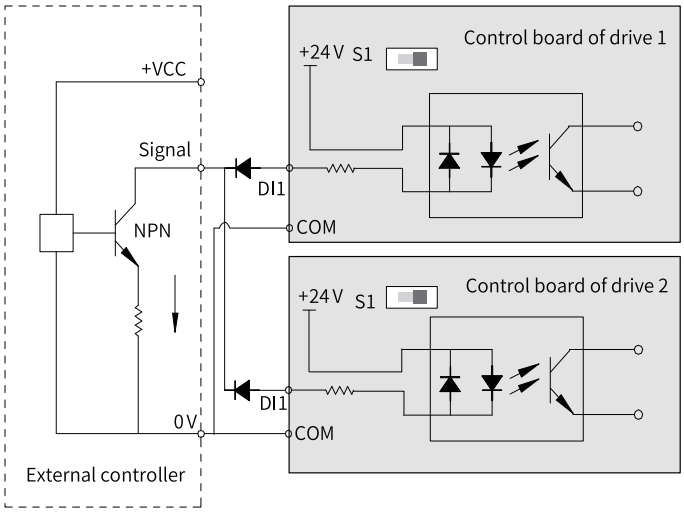
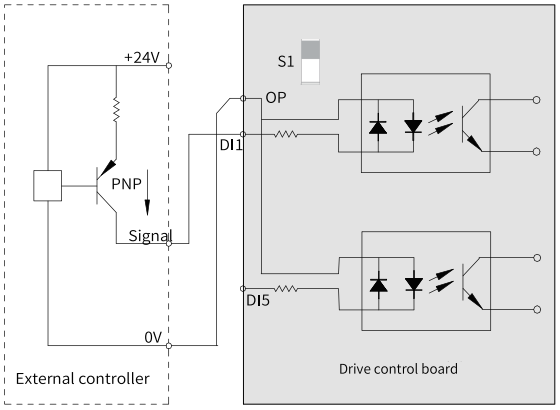


Figure 7-37 Parallel connection of DI terminals of multiple drives in the sink mode

- Source wiring mode



Source wiring for use of external 24 V power supply

Figure 7-38 Source wiring mode

To use the source wiring mode, use the external 24 V power supply and set S1 (rightwards) as shown in *"Figure 7-38" on page 112* . Then connect 0V of the external power supply to OP.

DO wiring

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

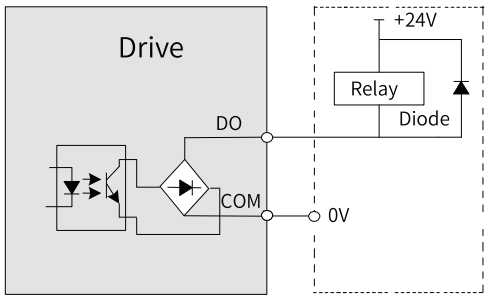


Figure 7-39 Wiring of DO terminals

Caution

- Be sure to correctly install the polarity of the snubber diode; otherwise, the 24 VDC power supply will be damaged immediately upon the DO output.
- The DO terminals can be driven by external +24 V power supplies only. When DO1 is driven by an external power supply, ensure that the GND of the external +24 V power supply can be connected to the GND of the drive control board.

Wiring of STO terminals

Electrical specifications and connection of the input circuit

Table 7–8 Specifications

Signal	Input state	Description
STO1	"1" or "H"	The input signal is normal.
	"0" or "L"	Activate STO
STO2	"1" or "H"	The input signal is normal.
	"0" or "L"	Activate STO

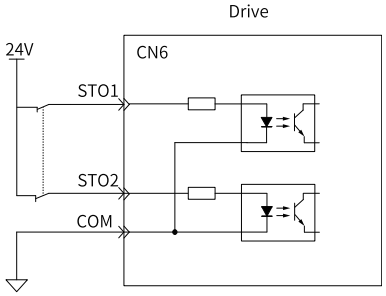
The following table describes the electrical characteristics of the safety request input signal.

Table 7–9 Electrical characteristics of safety input signals

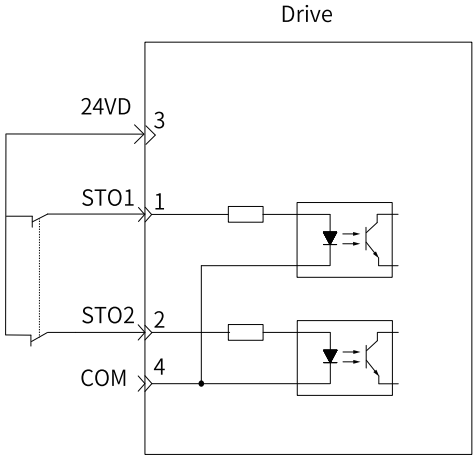
Item	Characteristics	Description
Voltage range	24 VDC (±15%)	-
Input current	3 mA (Typ.)	Value of each channel
Standards of logic levels	"0" < 5 V, "1" > 15 V	-
Digital input impedance	7.88 kΩ	-

The following figure describes the STO terminal wiring.

1. Wiring example of external 24 V



2. Wiring example of internal 24 V



EMC Requirements

1. To avoid short circuit between two adjacent conductors, shielded cables can be used with shield connected to the protective ground, or flat cables can be used with a grounding wire inserted between every two signal conductors.
2. Double-shield or single-shield twisted pair cables are recommended.
3. Fix and ground the cable protective cover using a piece of conductive metal.

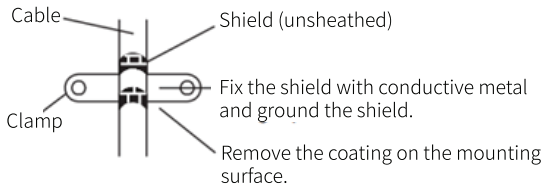


Figure 7-40 Cable clamp

4. The maximum cable length allowed between the drive and the safety switch is 30 m.

Other requirements

- All wiring must be well protected, routed and clamped where practicable.
- Ensure that the cables are not pulled or pinched during installation.
- When using external 24V power, to avoid common faults in the cable, the two channels must pass through two separate lines, otherwise the cable must be protected by double shields.

Cable	Remark
Category	Low voltage, double-shielded or single-shielded twisted multi-pair cable
Maximum size	0.8 mm^2 (18 AWG)
Minimum size	0.3 mm^2 (28 AWG)
Maximum length	The maximum length between the STO input terminal and the operation contact is 30 m.

7.7 Communication Connection

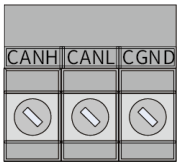
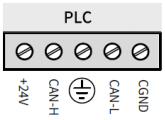
7.7.1 Wiring of CAN Communication

CAN communication connection

Use a three-conductor shielded cable for the CAN bus to connect to the CANH, CANL, and CGND terminals of the drive. Use one 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 describes the pin connection between CN5 and PLC when CN5 on the control board is used to achieve CAN communication networking.

Table 7–10 Pin connection between the drive and PLC communication cable

CN5 (A) of the control board on the drive side			PLC side (B)		
Communication type	Signal Name	Layout	Communication type	Signal Name	Layout
CAN	CANH		CAN	CAN-H	
	CANL			CAN-L	
	CGND			CGND	
	-			+24 V	
-	Shield	CGND	-	Shield	CGND

The following figure shows how to connect the shield.

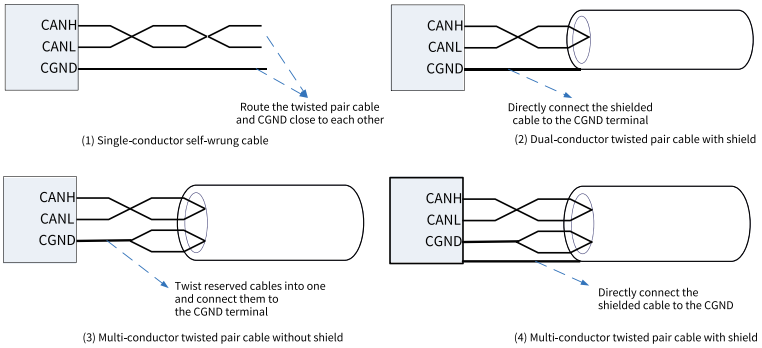


Figure 7-41 Recommended connection mode for the shield

Connect the shield of the CAN communication cable between cabinets to CGND. Given the potential interference generated by the grounding cable (PE), do not connect the shield of the CAN communication cable to the grounding cable (PE).

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. Ensure the distance of each node branch is lower than 0.3 m.

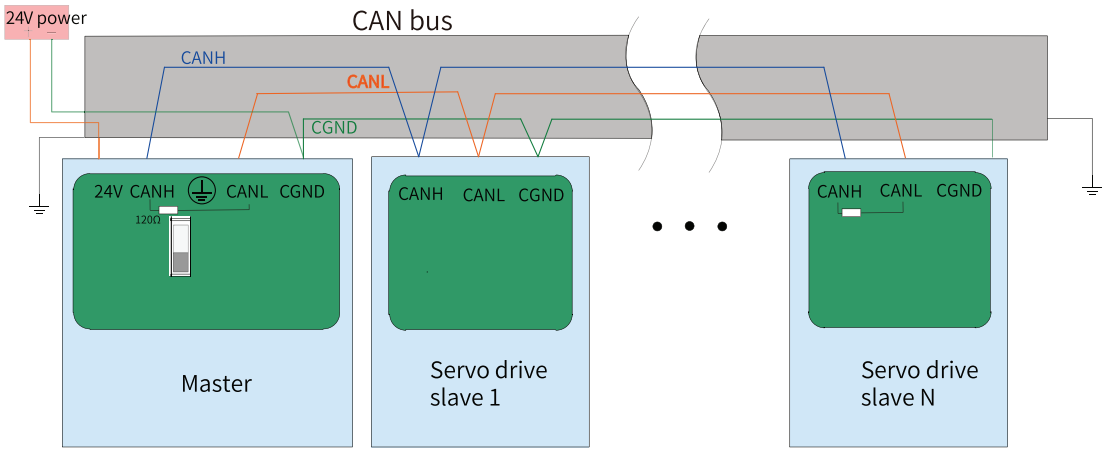


Figure 7-42 CAN bus topology

Transmission distance

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 7–11 Transmission distance and baud rate

Baud rate (kbps)	Cross sectional area	Transmission distance (m)	Number of nodes
1024	0.205 mm^2	25	64
500	0.34 mm^2	95	64
100	0.5 mm^2	560	64
50	0.75 mm^2	1100	64

Termination resistor setting

Table 7–12 Termination resistor setting

Terminal symbol (control board of the drive)	Name	Function	Jumper/DIP switch position	Remark
S2, S3	DIP switch for CAN termination resistor setting	The termination resistor is connected.		The states of S2 and S3 must be consistent.
		The termination resistor is not connected.		

7.7.2 Wiring of EtherCAT Communication

Communication networking

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

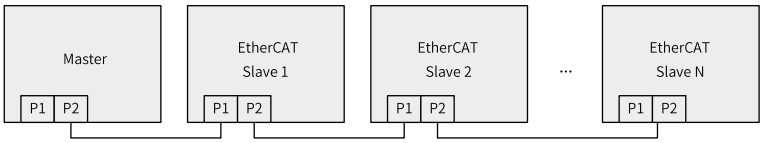


Figure 7-43 Bus topology

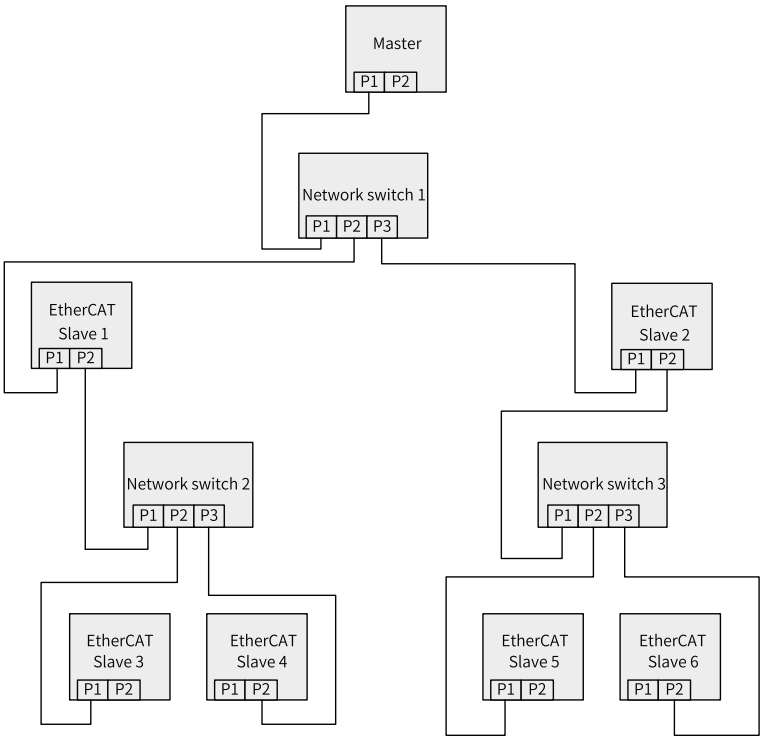


Figure 7-44 Tree topology

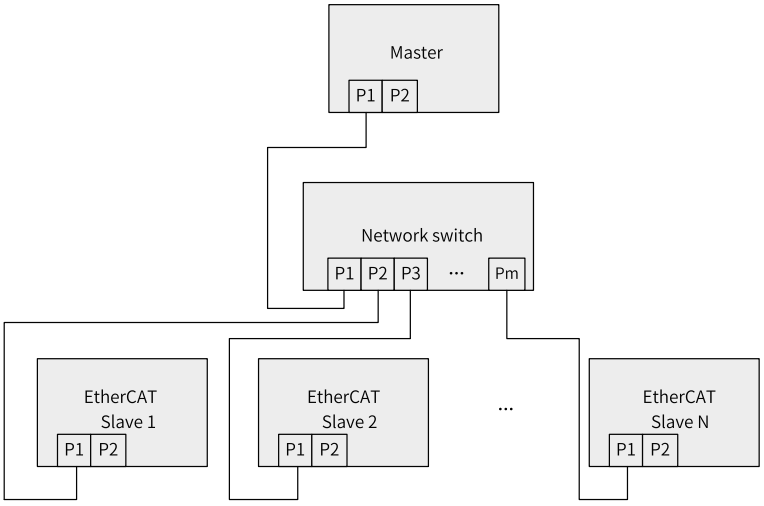


Figure 7-45 Star topology

7.8 Grounding

7.8.1 Main Circuit Grounding Requirements

Caution

- Ground the grounding terminal to avoid electric shocks. Follow the relevant electrical regulations of specific countries or regions on the grounding method.
- 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.
- Grounding cables (except for motors) shall meet requirements of GB/T 12668.501 and EN 61800-5-1. 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.
- 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.
- If the leakage current exceeds 3.5 mA, use the protective grounding conductor with the cross-sectional area of at least 10 mm^2 according to EN 61800-5-1, or connect with two protective grounding conductors of the same specifications.
- Observe the grounding requirements of all the devices as improper grounding can lead to malfunction.

Main circuit wiring requirements:

- The protective grounding conductor must be a yellow-green cable comprised of copper conductors. Do not connect the protective grounding conductor to a switching device (such as a circuit breaker) in series.
- Ground the grounding terminal properly. Improper grounding can result in device malfunction or damage.
- The grounding terminal cannot be shared with the neutral terminal (N) of the power supply.
- It is recommended to install the drive to a conductive metal mounting surface. Ensure the whole conductive bottom of the drive is connected properly to the mounting surface.
- Tighten the grounding screw with specified tightening torque to prevent the protective grounding conductor from being secured improperly.
- Install the filter and drive on the same mounting surface to ensure a proper filtering effect of the filter.

The drive can be installed individually or side by side with other drives. The grounding diagrams for different installation methods are shown below.

Installation of an individual drive

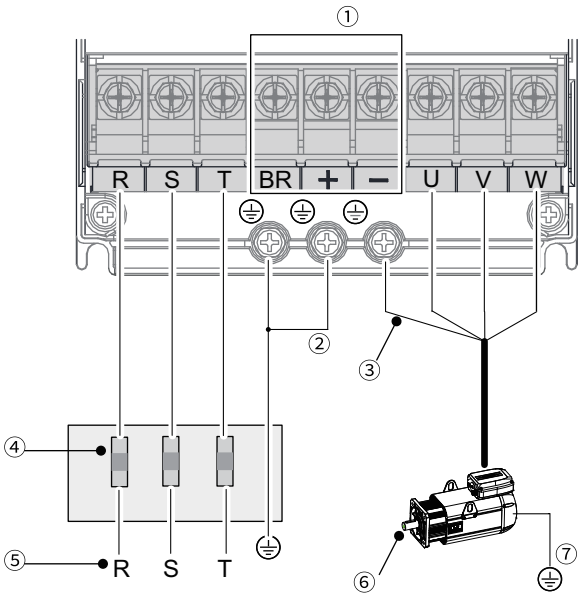


Figure 7-46 Grounding of the main circuit

Table 7–13 Grounding of the main circuit

No.	Wiring description
①	Do not ground the DC bus terminal or the braking resistor terminal.
②	Connect the PE on the input power supply end to the input PE terminal of the drive.
③	Connect the output PE of the drive to the motor cable shield.
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.

Side-by-side installation of multiple drives

The following figure shows the grounding of multiple paralleled drives installed in the cabinet.

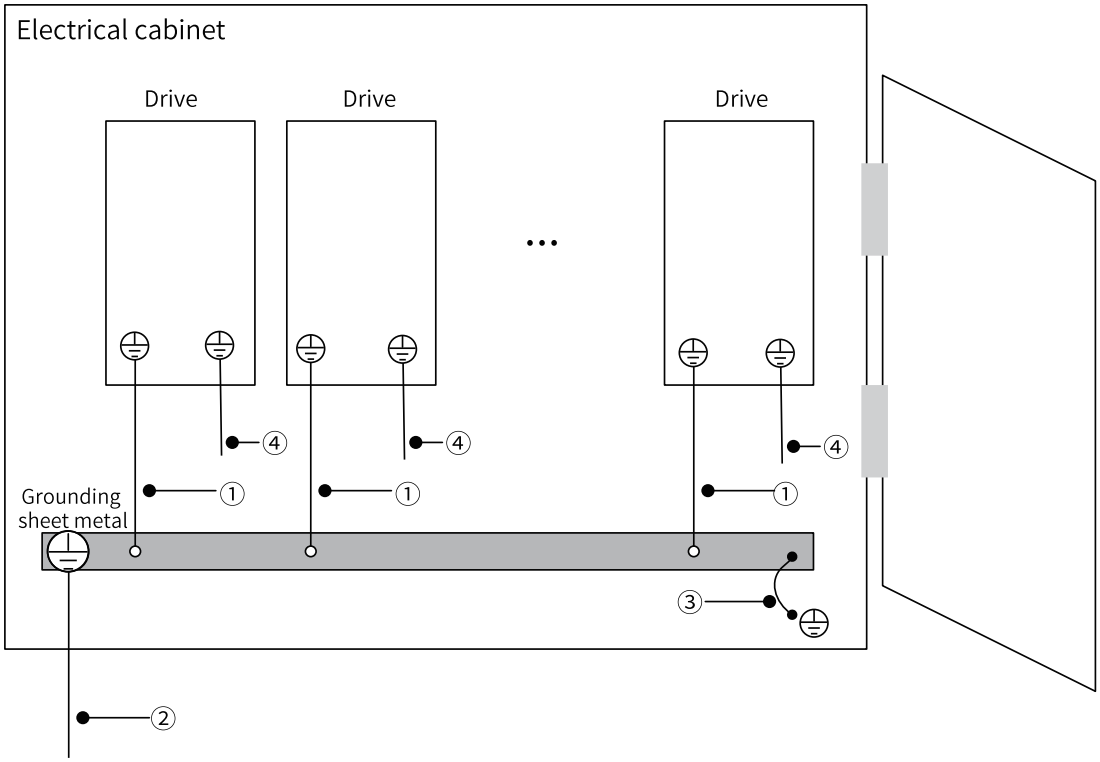


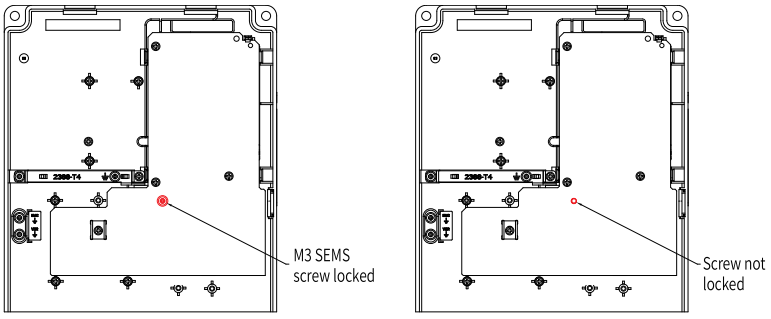
Figure 7-47 Side-by-side installation of multiple drives

Table 7–14 Grounding multiple servo drives installed side by side

No.	Wiring 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.

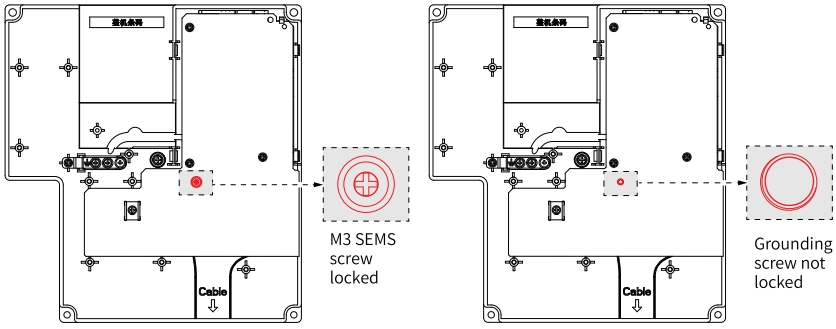
7.8.2 Grounding Requirements for the Control Circuit

The control board is not grounded by default. When the control board needs to be grounded, tighten an M3 x 8 SEMS screw on the grounding threaded hole of the control board. The following figure shows grounded/ungrounded control boards.



Control board grounded　　Control board not grounded

Figure 7-48 T4 and T6 control boards (grounded and ungrounded)



Control board grounded　　Control board not grounded

Figure 7-49 T7 and T9 control boards (grounded and ungrounded)

7.9 Post-wiring Inspection

Check the following items after wiring. If the check item meets the requirements, check the "Tick" box.

Table 7–15 Wiring checklist

No.	Item	Compliance
1	The drive model is consistent with the model described in the order.	☐
2	The peripheral devices (braking resistor, braking unit, AC reactor, filter, and circuit breaker) meet the design requirements.	☐
3	The installation method and location of the drive meet requirements.	☐
4	The voltage on the input side of the drive is between 323 V to 528 V.	☐
5	The rated voltage of the motor is consistent with the output specifications of the drive.	☐
6	The power input cables are connected to R, S, and T terminals.	☐
7	The motor input cables are connected to the U, V, and W terminals.	☐
8	The cross sectional area of the main circuit cable meets the requirements.	☐
9	The motor output cable does not exceed 50 m. (If exceeded, reduce the carrier frequency (F0-15).)	☐
10	The grounding cable is connected properly.	☐
11	The output terminals and control signal cable terminals of the drive are connected properly.	☐

No.	Item	Compliance
12	The braking resistor and braking unit are wired properly and carry proper resistance.	□
13	The control circuit signal cables of the drive are shielded twisted pairs.	□
14	The control circuit cables and main circuit power cables are routed through different routes.	□
15	The encoder cable is connected securely.	□
16	When wiring multiple motors, ensure the connections are correct and avoid cross-wiring between the motors and the drive. Cross-wring may cause abnormal motor operation.	□

8 Selection of Options

8.1 Peripheral Electrical Component

8.1.1 Fuse, Contactor, and Circuit Breaker

The earth leakage current of the drive is higher than 3.5 mA, which requires proper grounding protection.

Caution

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.

Use a Type B (time-delayed) RCD because the drive may generate DC leakage current in the protective conductor. When the RCD malfunctions, do as follows:

- Use an RCD of higher rated action current or use a time-delayed RCD.
- Reduce the carrier frequency of the drive.
- Shorten the length between the motor and the drive.
- Take additional measures to suppress the leakage current.

The following table describes the recommended brands of the residual current device.

Table 8–1 Recommended fuses and circuit breakers (compliance with UL certification)

T model	Drive model	Recommended fuses (FWH series of Bussmann)			ABB Tmax series inverse time circuit breaker
		Recommended fuse current (A) (UL248 certified)	Fuse ultimate breaking capacity Icu (kA)	Model	Rated current (A) (UL489 certified)
T4	ES680N-4T025S-C1	40	200	FWH-40C	40
	ES680N-4T032S-C1	50		FWH-50C	70
	ES680N-4T037S-C1	60		FWH-60C	70
	ES680N-4T044S-C1	70		FWH-70C	70
T5	ES680N-4T060S-C1	80		FWH-80C	100
T6	ES680N-4T075S-C1	100		FWH-100C	125
	ES680N-4T091S-C1	125		FWH-125C	125
T7	ES680N-4T112S-C1	150		FWH-150C	200
	ES680N-4T150S-C1	200		FWH-200C	200
T8	ES680N-4T176S-C1	225		FWH-225C	225
	ES680N-4T210S-C1	275		FWH-275C	250
	ES680N-4T253S-C1	325		FWH-325C	300
T9	ES680N-4T312S-C1	400		FWH-400C	400
	ES680N-4T395S-C1	500		FWH-500C	500
	ES680N-4T426S-C1	600		FWH-600C	600
	ES680N-4T480S-C1	600		FWH-600C	600
	ES680N-4T525S-C1	700		FWH-700C	700
	ES680N-4T600S-C1	800		FWH-800C	800
	ES680N-4T650S-C1	1000		FWH-100A	800

Table 8–2 Fuse selection (CE certified)

T model	Drive model	Recommended fuse		
		Recommended fuse current (A) (UL248 certified)	Fuse ultimate breaking capacity Icu (kA)	Model
T4	ES680N-4T025S-C1	32	200	170M2609
	ES680N-4T032S-C1	40		170M2610
	ES680N-4T037S-C1	50		170M2611
	ES680N-4T044S-C1	63		170M2612
T5	ES680N-4T060S-C1	80		170M2613
T6	ES680N-4T075S-C1	100		170M2614
	ES680N-4T091S-C1	125		170M2615
T7	ES680N-4T112S-C1	160		170M2616
	ES680N-4T150S-C1	200		170M2617
T8	ES680N-4T176S-C1	250		170M2618
	ES680N-4T210S-C1	315		170M2619
	ES680N-4T253S-C1	315		170M2620
T9	ES680N-4T312S-C1	400		170M4012
	ES680N-4T395S-C1	500		170M4014
	ES680N-4T426S-C1	550		170M4015
	ES680N-4T480S-C1	550		170M4015
	ES680N-4T525S-C1	630		170M4016
	ES680N-4T600S-C1	700		170M4017
	ES680N-4T650S-C1	800		170M4018

Note

The recommended values in the preceding table are 40℃ at an altitude lower than 2000 m, and are installed on the front end of the drive. The current carrying density of the conductor does not exceed 1.3 AMP/mm². The fuse is a ceramic package. The rated carrier current is the rated drive line value.

8.1.2 AC Input Reactor

Installing the input reactor on the input side of the drive can improve the input power factor, suppress the high harmonics of the input current of the drive, and reduce external conduction and radiation interference.

Model

The following table lists the recommended manufacturers and models of input reactors.

MD-ACL -50-0.28-4T-2%
① ② ③ ④ ⑤

① **Internal code** Inovance AC input reactor	④ **Rated voltage** 4T: 380 V
② **Rated current** 50: 50 A	⑤ **Voltage drop percentage** 2%: 2%
③ **Inductance** 0.28: 0.28 mH	-

Figure 8-1 AC input reactor model

Table 8–3 Recommended AC input reactor models

T model	Drive model	Inovance AC input reactor model
T4	ES680N-4T025S-C1	MD-ACL-40-1.45-4T
	ES680N-4T032S-C1	MD-ACL-50-1.2-4T
	ES680N-4T037S-C1	MD-ACL-50-0.28-4T-2%
	ES680N-4T044S-C1	MD-ACL-60-0.24-4T-2%
T5	ES680N-4T060S-C1	MD-ACL-80-0.17-4T-2%
T6	ES680N-4T075S-C1	MD-ACL-90-0.16-4T-2%
	ES680N-4T091S-C1	MD-ACL-120-0.12-4T-2%
T7	ES680N-4T112S-C1	MD-ACL-150-0.095-4T-2%
	ES680N-4T150S-C1	MD-ACL-200-0.07-4T-2%
T8	ES680N-4T176S-C1	MD-ACL-250-0.056-4T-2%
	ES680N-4T210S-C1	MD-ACL-250-0.056-4T-2%
	ES680N-4T253S-C1	MD-ACL-330-0.042-4T-2%
T9	ES680N-4T312S-C1	MD-ACL-330-0.042-4T-2%
	ES680N-4T395S-C1	MD-ACL-490-0.028-4T-2%
	ES680N-4T426S-C1	MD-ACL-490-0.028-4T-2%
	ES680N-4T480S-C1	MD-ACL-490-0.028-4T-2%
	ES680N-4T525S-C1	MD-ACL-660-0.021-4T-2%
	ES680N-4T600S-C1	MD-ACL-660-0.021-4T-2%
	ES680N-4T650S-C1	MD-ACL-660-0.021-4T-2%

Dimensions

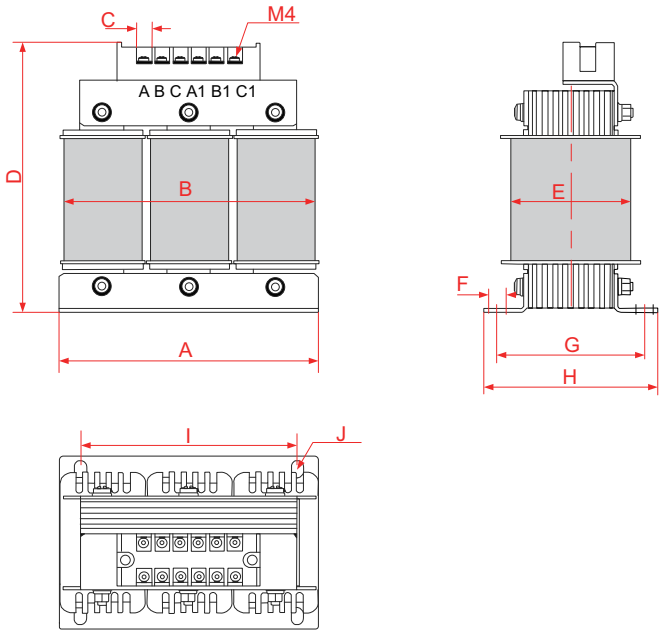


Figure 8-2 Dimensions of AC input reactors (10 A/15 A)

Table 8–4 Dimensions of AC input reactors (10 A to 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

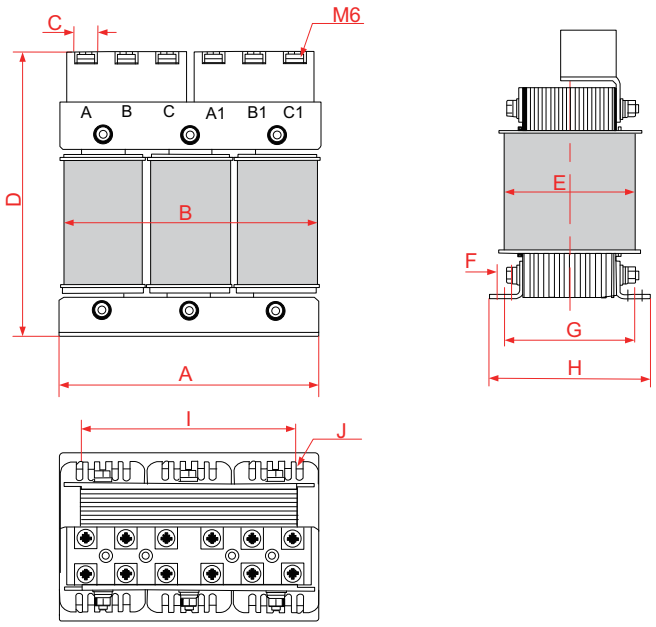


Figure 8-3 Dimensions of AC input reactors (40 A to 50 A, 1.2 mH)

Table 8–5 Dimensions of AC input reactors (40 A to 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

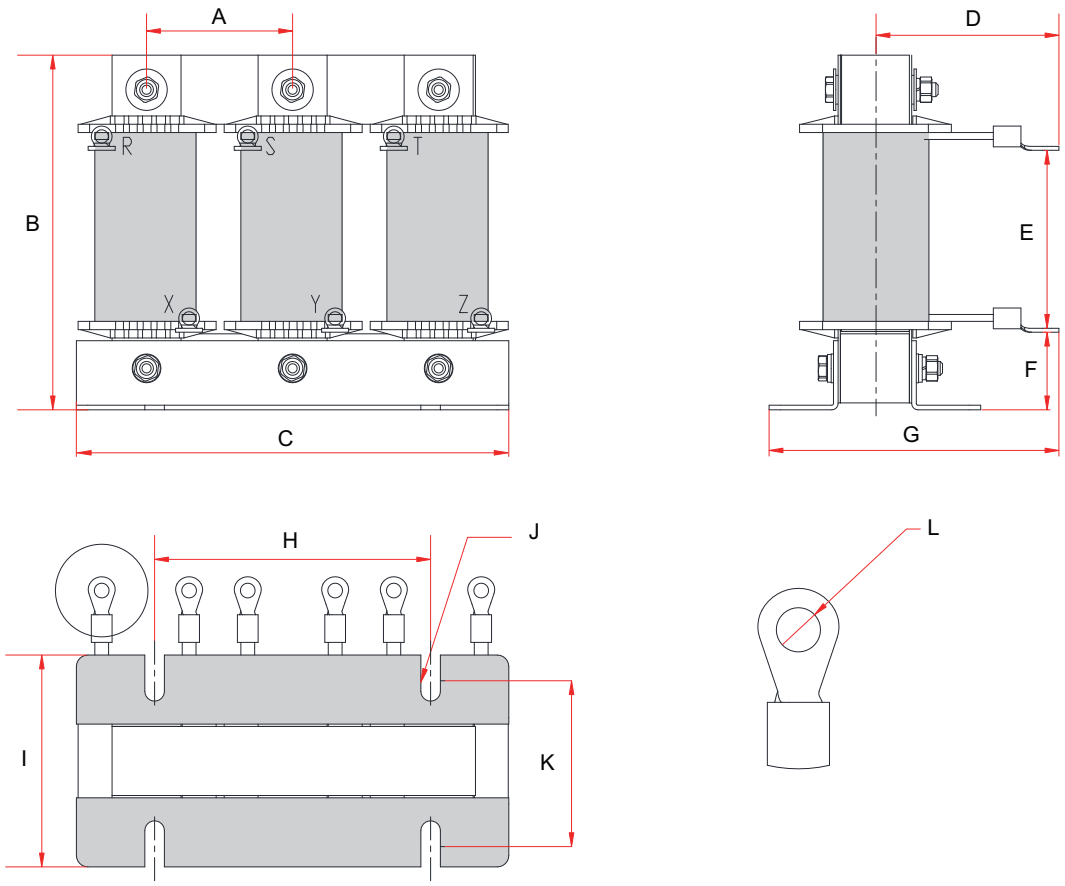


Figure 8-4 Dimensions of AC input reactors (50 A to 60 A, 0.28 mH)

Table 8–6 Dimensions of AC input reactors (50 A to 60 A, 0.28 mH, 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

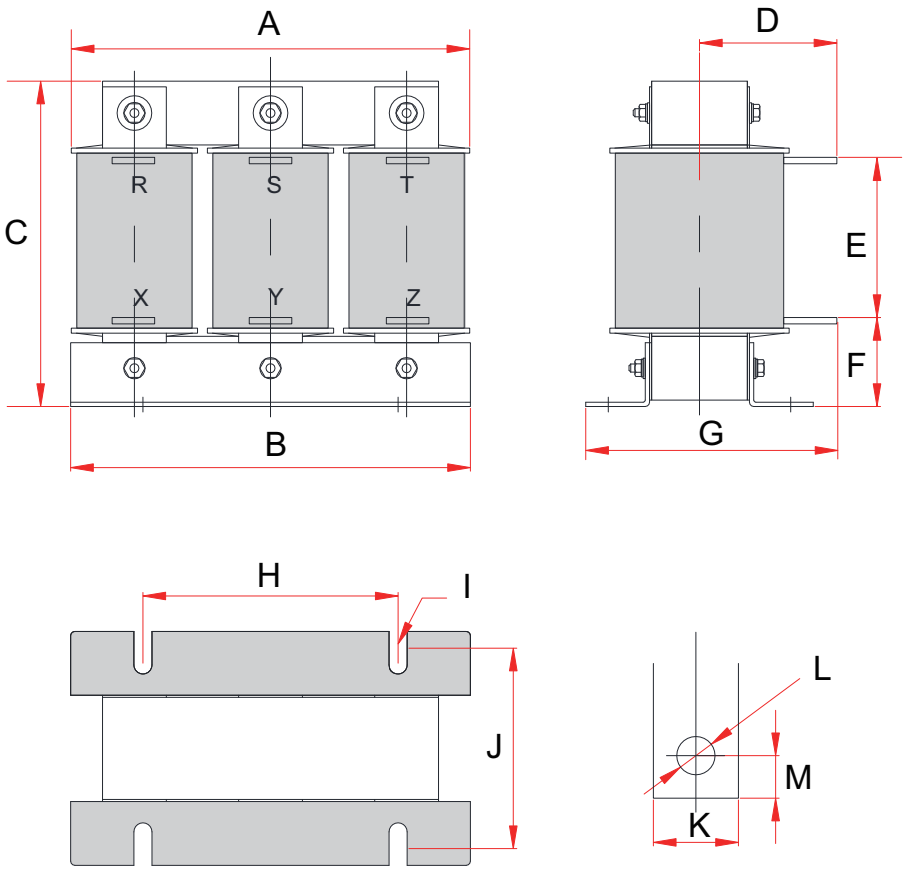


Figure 8-5 Dimensions of AC input reactors (90 A to 120 A)

Table 8–7 Dimensions of AC input reactors (90 A to 120 A, unit: mm)

Rated current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M
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

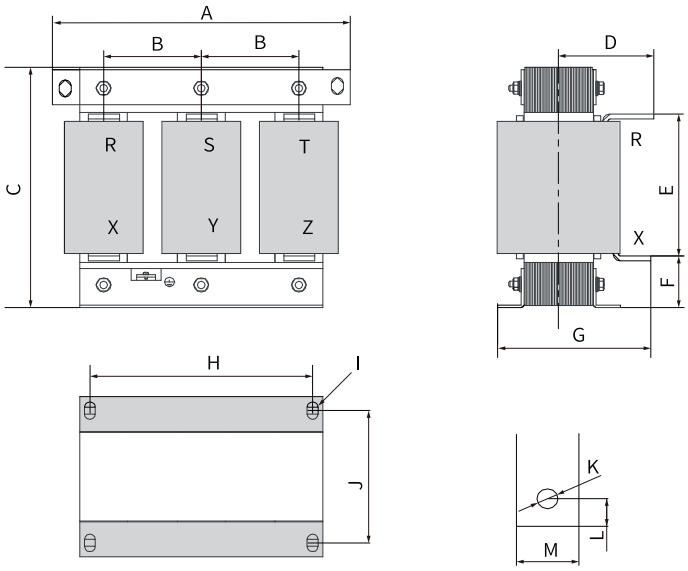


Figure 8-6 Dimensions of AC input reactors (150 A to 200 A)

Table 8–8 Dimensions of AC input reactors (150 A to 200 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

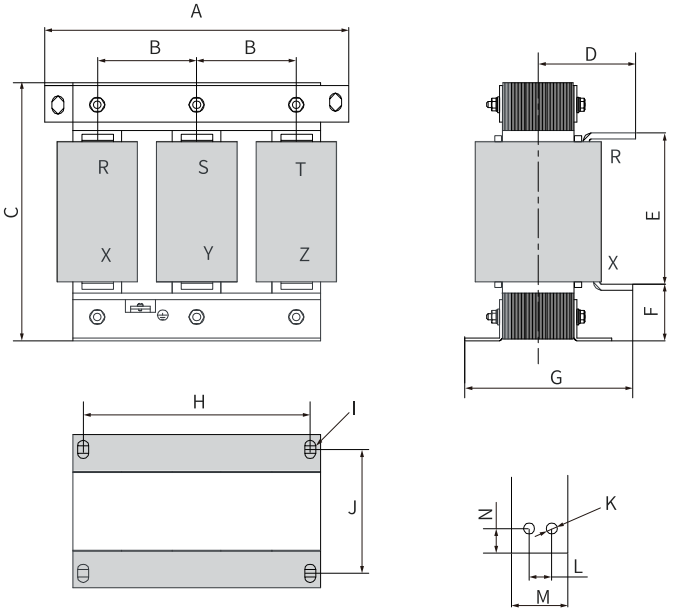


Figure 8-7 Dimensions of AC input reactors (490 A to 660 A)

Table 8–9 Dimensions of AC input reactors (490 A to 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

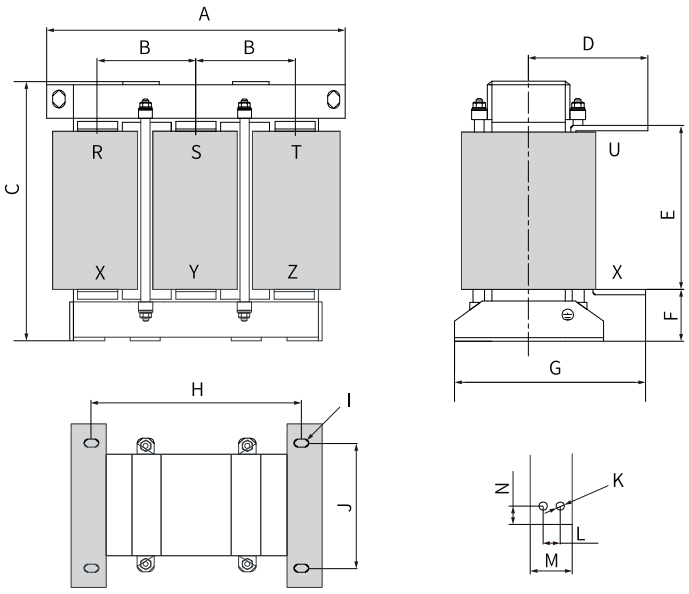


Figure 8-8 Dimensions of AC input reactors (800 A to 1000 A)

Table 8–10 Dimensions of AC input reactors (800 A to 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 AC input reactors provided here are for reference only. Actual dimensions may vary with models.

8.1.3 EMC Filter

Model

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.

Table 8–11 Standard EMC filter model and appearance

Filter model		Appearance
Schaffner	FN3258 series filter	
	FN3359 series filter	

Table 8–12 Recommended manufacturers and models of EMC input filter (three-phase 380–480 V)

T model	Drive model	AC input filter model (Schaffner)
T4	ES680N-4T025S-C1	FN 3258-42-33
	ES680N-4T032S-C1	FN 3258-42-33
	ES680N-4T037S-C1	EN 3258-55-34
	ES680N-4T044S-C1	FN 3258-75-34
T5	ES680N-4T060S-C1	FN 3258-75-34
T6	ES680N-4T075S-C1	EN 3258-100-35
	ES680N-4T091S-C1	EN 3258-100-35
T7	ES680N-4T112S-C1	FN 3258-130-35
	ES680N-4T150S-C1	FN 3258-180-40
T8	ES680N-4T176S-C1	FN 3258-180-40
	ES680N-4T210S-C1	FN 3359-250-28
	ES680N-4T253S-C1	FN 3359-250-28
T9	ES680N-4T312S-C1	IEC 3359-320-99
	ES680N-4T395S-C1	FN 3359-400-99
	ES680N-4T426S-C1	FN 3359-400-99
	ES680N-4T480S-C1	FN 3359-600-99
	ES680N-4T525S-C1	FN 3359-600-99
	ES680N-4T600S-C1	FN 3359-600-99
	ES680N-4T650S-C1	FN 3359-800-99

Dimension

Dimensions of Schaffner FN 3258 series filters (50–180 A)

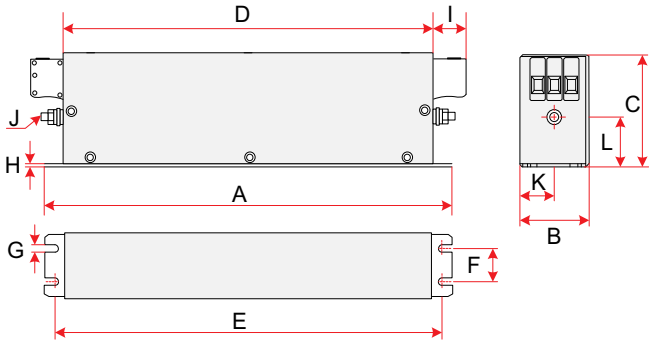


Figure 8-9 Dimensions of FN 3258 series filters (50 A to 180 A, unit: mm)

Table 8–13 Dimensions of FN 3258 series filter (50 A to 180 A)

Rated current (A)	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	I (mm)	J	K (mm)	L (mm)
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
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

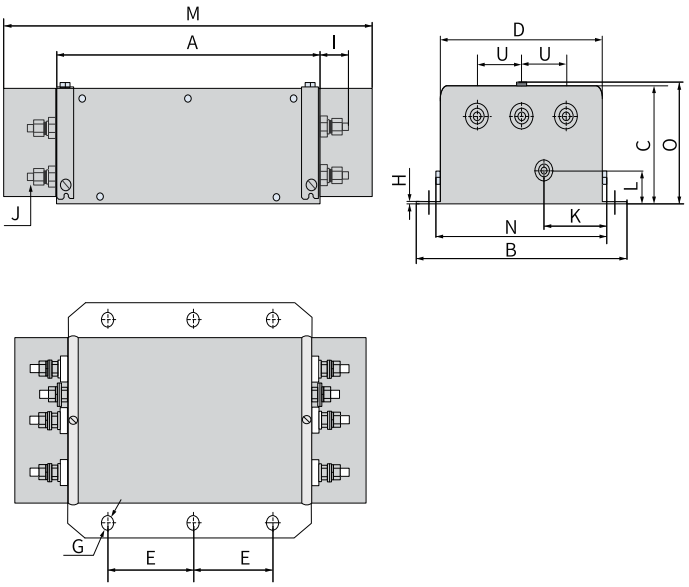


Figure 8-10 Dimension drawing of FN 3359 series filters (150 A to 250 A)

Table 8–14 Dimensions of FN 3359 series filters (150 A to 250 A, unit: mm)

Symbol	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	-	-	-

Symbol	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).

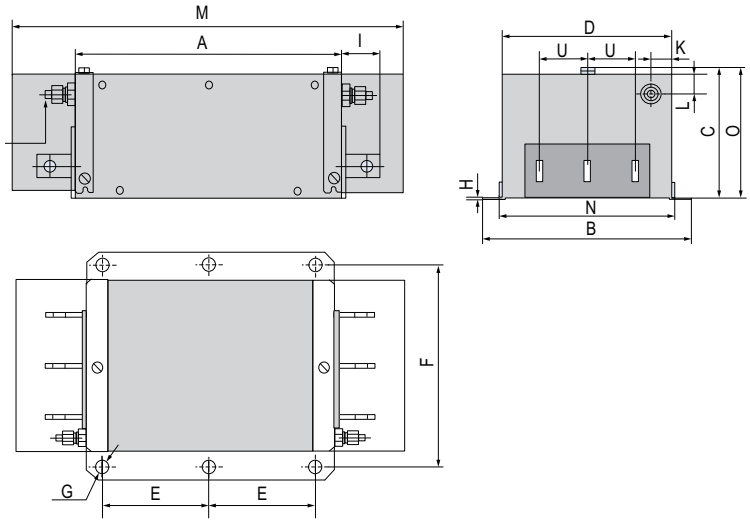


Figure 8-11 Dimension drawing of FN 3359 series filters (320 A to 2500 A)

The following figure shows dimensions of the sheet metal.

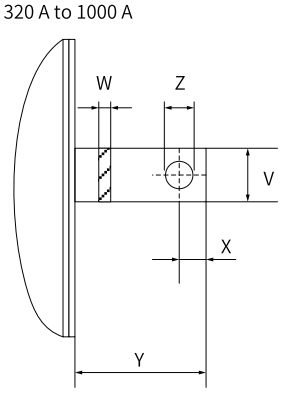


Figure 8-12 Dimensions of the sheet metal

Table 8–15 Dimensions of FN 3359 series filters (320 A to 2500 A, unit: mm)

Symbol	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

Symbol	Rated current						
	320 A	400 A	600 A	800 A	1000 A	1600 A	2500 A
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

8.1.4 Simple Filter

The simple filter can be used to suppress the radio frequency electromagnetic noise generated from the power grid and that escaped from the drive to the outside. 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 the grounding terminal of the drive, and the grounding cable must be as short as possible (shorter than 30 cm).

Models

The following table lists the simple filter model which applies to all models of the drive.

Filter manufacturer	Filter model
(JIANLI)	Cxy-1-1

Dimensions

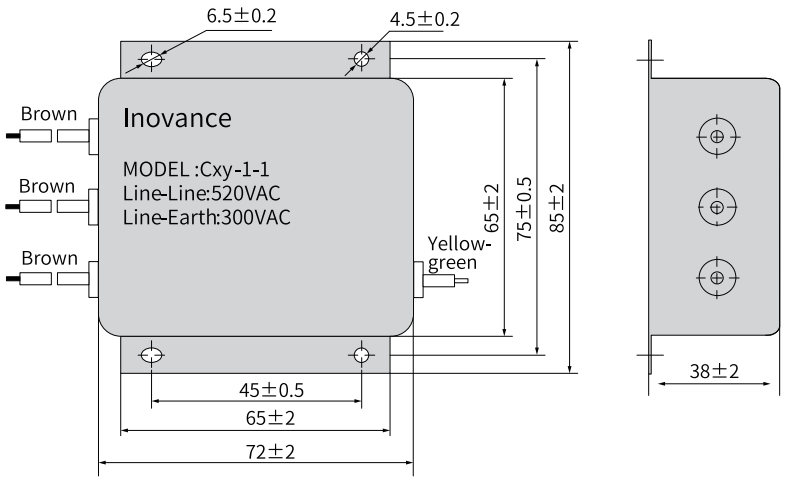


Figure 8-13 Dimensions of the simple filter

8.1.5 Braking Component

Caution

The cable connecting the braking resistor and the drive cannot exceed 10 m.

Model

Table 8–16 Model selection of braking components

Model	Drive model	Braking unit		Recommended braking resistor power (kW)	Recommended resistance of the braking resistor (Ω)	Min. resistance of the braking resistor (Ω)
		Model	Quantity			
T4	ES680N-4T025S-C1	Built-in		1.5	≥ 32	28
	ES680N-4T032S-C1	Built-in		1.5	≥ 32	20
	ES680N-4T037S-C1	Built-in		2.5	≥ 22	20
	ES680N-4T044S-C1	Built-in		3.2	≥ 22	18
T5	ES680N-4T060S-C1	Built-in		4.2	≥ 20	12
T6	ES680N-4T075S-C1	Built-in		5.5	≥ 16	12
	ES680N-4T091S-C1	Built-in		6	≥ 16	12
T7	ES680N-4T112S-C1	Built-in		6	≥ 16	9
	ES680N-4T150S-C1	Built-in		8	≥ 12	9
T8	ES680N-4T176S-C1	Built-in		10	≥ 8	6
	ES680N-4T210S-C1	Built-in		10	≥ 8	6
	ES680N-4T253S-C1	Built-in		12	≥ 6	4
T9	ES680N-4T312S-C1	MDBUN-200-T	2	21	≥ 6	3.4
	ES680N-4T395S-C1	MDBUN-200-T	2	21	≥ 6	3.4
	ES680N-4T426S-C1	MDBUN-200-T	2	21	≥ 6	3.4
	ES680N-4T480S-C1	MDBUN-200-T	2	21	≥ 6	3.4
	ES680N-4T525S-C1	MDBUN-200-T	2	27	≥ 3.2	2.5
	ES680N-4T600S-C1	MDBUN-200-T	2	27	≥ 3.2	2.5
	ES680N-4T650S-C1	MDBUN-200-T	2	27	≥ 2.5	1.6

Note

- The braking voltage of the built-in braking unit is set to 760 V (H01.41), which is applicable to 380 V power grid. If the drive is used in 480 V power grid, increase the value of H01.41 to prevent the braking transistor from being switched on in advance, and set the braking voltage of the built-in braking unit to a value between 760 V and 780 V.
- The values in the preceding table are for reference only. You can select different resistance and power based on actual conditions. Note that the resistance cannot be lower than the minimum braking resistance listed in the table. The power may be higher than the recommended value in the table. The braking resistor model is dependent on the generating power of the motor in the actual system and is also related to the system inertia, deceleration time and potential energy load. You should select the braking resistor according to actual conditions.
- For systems featuring large inertia and requiring short deceleration time and frequent braking, select a braking resistor with high power and low resistance.
- T9 models are not equipped with the built-in braking unit.

Selecting the Braking Resistor

Selecting the braking power

The braking power (Pb) can be calculated using the following formula:

$$Pb = P \times Td \times K$$

P: Motor power

K: Mechanical energy conversion efficiency (typically K = 0.7)

Td: Ratio of braking torque to rated motor torque

The value of Td varies with the system, as shown in the following table.

Common application	Elevators, hoists, and cranes	Winding and unwinding	Large-Inertia Device requiring Quick Stop	Regular-inertia loads
Td value	100%	120%	120%	80%

Selecting the Resistance of the Braking Resistor

During braking, almost all regenerative energy of the motor is consumed by the braking resistor. The resistance (R) can be calculated using the following formula:

$$R = U^2/Pb$$

U refers to the braking voltage upon stable braking of the system.

The value of U varies with the system:

- The value of U in 380 VAC system: 700 V
- The value of U in 480 VDC system: 800 V

Braking Resistor Power Selection

In theory, the power of the braking resistor is consistent with the braking power. However the power of the braking resistor is derated by 70% during actual application. You can calculate the power of the braking resistor according to the following formula:

$$Pr = Pb \times ED \div 0.7$$

In this formula, ED indicates the braking proportion, that is, the percentage of braking time in the whole operation cycle.

Common application	Elevator	Winding and unwinding	Cranes and centrifuges	Load that needs braking occasionally Load	Injection molding machines	General application
ED value	20% to 30%	20% to 30%	50% to 60%	5%	5% to 10%	10%

8.1.6 Output Reactor

Installing an output reactor on the output side of the drive helps reduce excessive dV/dt and voltage stress on the motor winding, protecting the motor winding from insulation breakdown, lowering the motor temperature, and prolonging the service life of the motor as well as reducing interference to neighboring devices.

The cable connecting the drive and the motor cannot be excessively long. An excessively long cable can result in large distributed capacitance and high harmonic current. When the length of the output cable is equal to or higher than the value listed in the following table, install an output reactor near the drive.

Table 8–17 Minimum length of the cable for output reactor

T model	Drive model	Rated voltage (V)	Min. cable length for optional output reactor (m)
T4	ES680N-4T025S-C1	200 to 500	110
	ES680N-4T032S-C1	200 to 500	125
	ES680N-4T037S-C1	200 to 500	135
	ES680N-4T044S-C1	200 to 500	150
T5 to T8	ES680N-4T060S-C1 ES680N-4T075S-C1 ES680N-4T091S-C1 ES680N-4T112S-C1 ES680N-4T150S-C1 ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	280 to 690	150
T9	ES680N-4T312S-C1 ES680N-4T395S-C1 ES680N-4T426S-C1 ES680N-4T480S-C1 ES680N-4T525S-C1	280 to 690	150

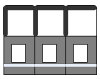
Model

Recommended manufacturers and models of the output reactor are shown in the following table.

Table 8–18 Output reactor model (Schaffner)

T model	Drive model	Reactor	Rated current at 40℃ (A)	Typical rated power of the motor (kW)	Rated inductance (mH)	Loss (W)	I/O selection terminal	Total (kg)
T4	ES680N-4T025S-C1	RWK 305-32-KL	32	15	0.184	55	KL	3.9
	ES680N-4T032S-C1	RWK 305-32-KL	32	15	0.184	55	KL	3.9
	ES680N-4T037S-C1	RWK 305-45-KL	45	18.5	0.131	60	KL	6.1
	ES680N-4T044S-C1	RWK 305-45-KL	45	22	0.131	60	KL	6.1
T5	ES680N-4T060S-C1	RWK 305-60-KL	60	30	0.098	65	KL	6.1
T6	ES680N-4T075S-C1	RWK 305-72-KL	72	37	0.082	70	KL	6.1
	ES680N-4T091S-C1	RWK 305-90-KL	90	45	0.065	75	KL	7.4
T7	ES680N-4T112S-C1	RWK 305-110-KL	110	55	0.053	90	KL	8.2
	ES680N-4T150S-C1	RWK 305-156-KS	156	75	0.038	120	KS	10.7
T8	ES680N-4T176S-C1	RWK 305-182-KS	182	90	0.032	140	KS	16
	ES680N-4T210S-C1	RWK 305-230-KS	230	132	0.026	180	KS	22
	ES680N-4T253S-C1	RWK 305-280-KS	280	160	0.021	220	KS	29
T9	ES680N-4T312S-C1	RWK 305-330-KS	330	160	0.018	240	KS	32
	ES680N-4T395S-C1	RWK 305-400-S	400	200	0.015	330	S	34
	ES680N-4T426S-C1	RWK 305-400-S	400	200	0.015	330	S	34
	ES680N-4T480S-C1	RWK 305-500-S	500	250	0.012	340	S	35
	ES680N-4T525S-C1	RWK 305-600-S	600	355	0.01	380	S	37
	ES680N-4T600S-C1	RWK 305-600-S	600	355	0.01	380	S	37
	ES680N-4T650S-C1	RWK 305-680-S	680	400	0.009	410	S	38

Table 8–19 I/O selection terminal corresponding to the reactor

Reactor model	******-KL	******-KS	******-S
I/O selection terminal			

Dimensions

Dimensions of the output reactor are shown in the following table.

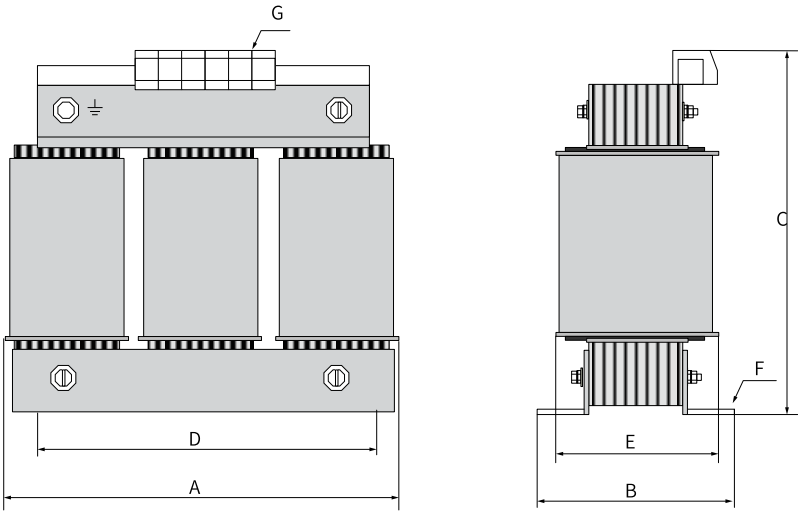


Figure 8-14 Dimensions of output reactors (4 A to 45 A)

Table 8–20 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

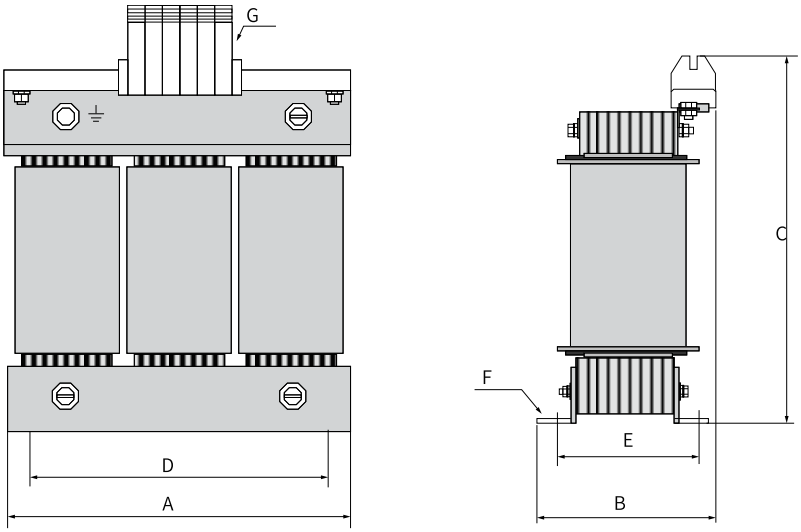


Figure 8-15 Dimensions of output reactors (60–110 A)

Table 8–21 Dimensions of output reactors (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

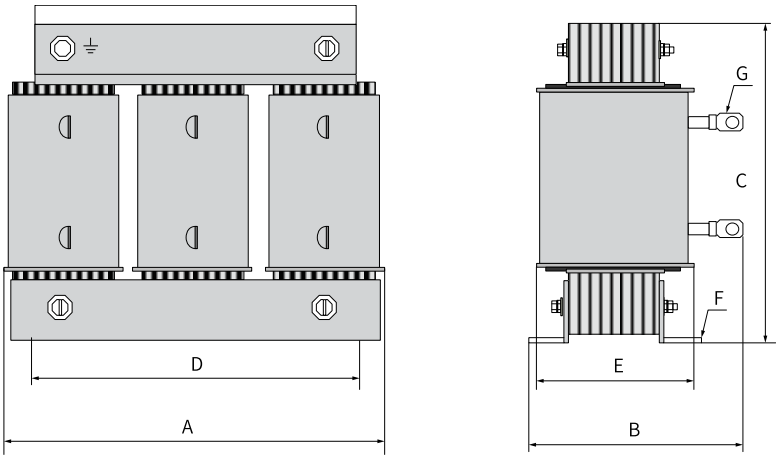


Figure 8-16 Dimensions of output reactors (124–1100 A)

Table 8–22 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

Series	A	B	C	D	E	F	G
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

8.1.7 Ferrite Ring and Ferrite Clamp

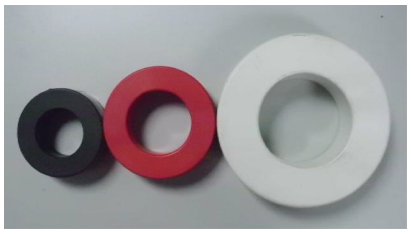
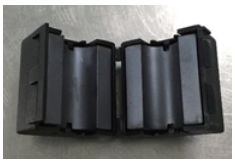
Model

The magnetic ring can be installed on the input or output side of the drive. Install the magnetic ring as close to the drive as possible. Installing the magnetic ring on the input side can suppress the noise in the input power supply system of the drive. A magnetic ring on the output side is mainly used to reduce the external interference of the drive 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 8–23 Appearance and model of the magnetic ring and ferrite clamp

Category	Model	Appearance
Ferrite Ring	DY644020H	
	DY805020H	
	DY1207030H	
Ferrite clamp	DYR-130-B	

Dimension

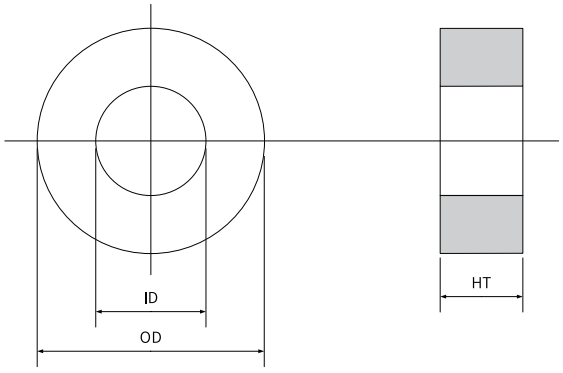


Figure 8-17 Dimensions of the magnetic ring

Table 8–24 Dimensions of the magnetic ring

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

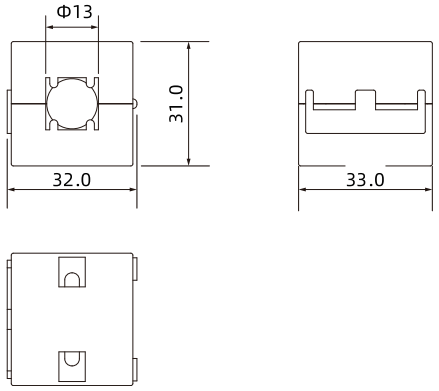


Figure 8-18 Dimensions of the ferrite clamp (unit: mm)

8.2 Through-hole Mounting Bracket

The through-hole mounting bracket is optional, which should be purchased separately as needed.

Applicable model

Table 8–25 Models of through-hole mounting brackets

T model	Drive model	Through-hole mounting bracket model
T4	ES680N-4T025S-C1 ES680N-4T032S-C1 ES680N-4T037S-C1 ES680N-4T044S-C1	MD500-AZJ-A1T4
T5	ES680N-4T060S-C1	MD500-AZJ-A1T5
T6	ES680N-4T075S-C1 ES680N-4T091S-C1	MD500-AZJ-A1T6

T model	Drive model	Through-hole mounting bracket model
T7	ES680N-4T112S-C1 ES680N-4T150S-C1	MD500-AZJ-A1T7
T8	ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	MD500-AZJ-A1T8
T9	ES680N-4T312S-C1 ES680N-4T395S-C1 ES680N-4T426S-C1 ES680N-4T480S-C1 ES680N-4T525S-C1 ES680N-4T600S-C1 ES680N-4T650S-C1	-

Hole dimensions

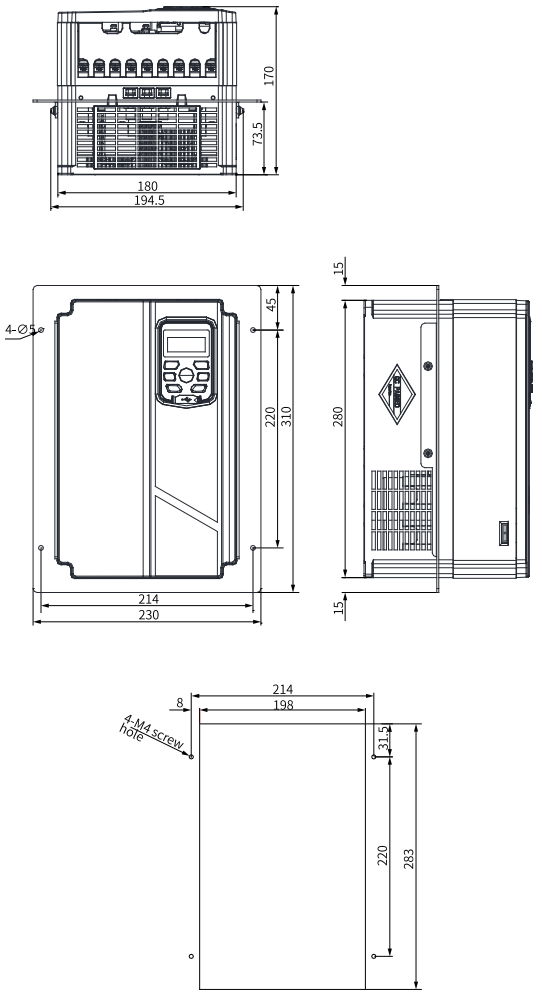


Figure 8-19 MD500-AZJ-A1T4 through-hole mounting bracket and mounting hole dimensions (unit: mm)

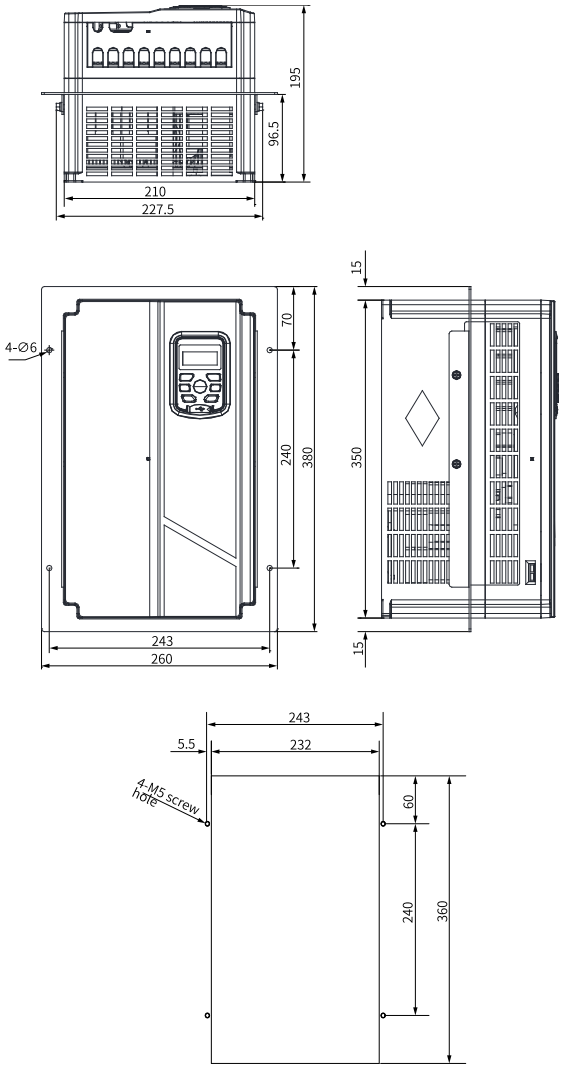


Figure 8-20 MD500-AZJ-A1T5 through-hole mounting bracket and mounting hole dimensions (unit: mm)

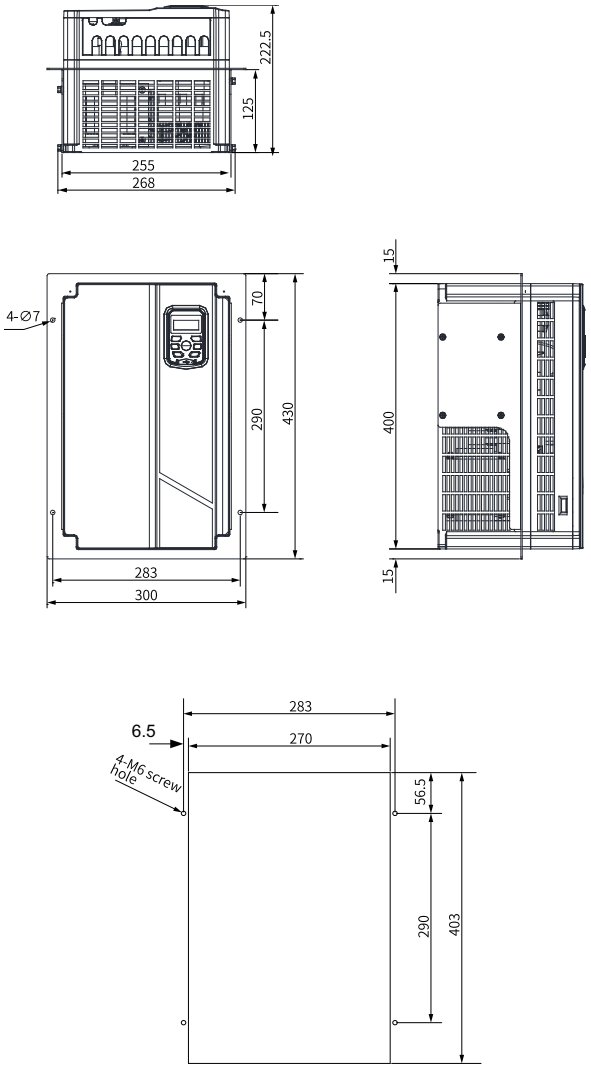


Figure 8-21 MD500-AZJ-A1T6 through-hole mounting bracket and mounting hole dimensions (unit: mm)

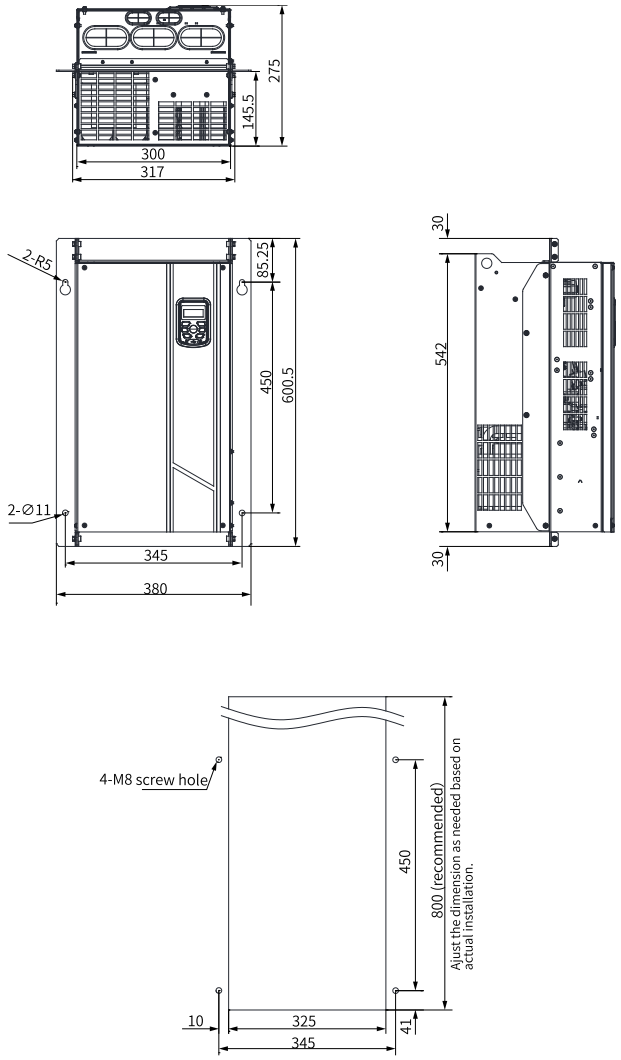


Figure 8-22 MD500-AZJ-A1T7 through-hole mounting bracket and mounting hole dimensions (unit: mm)

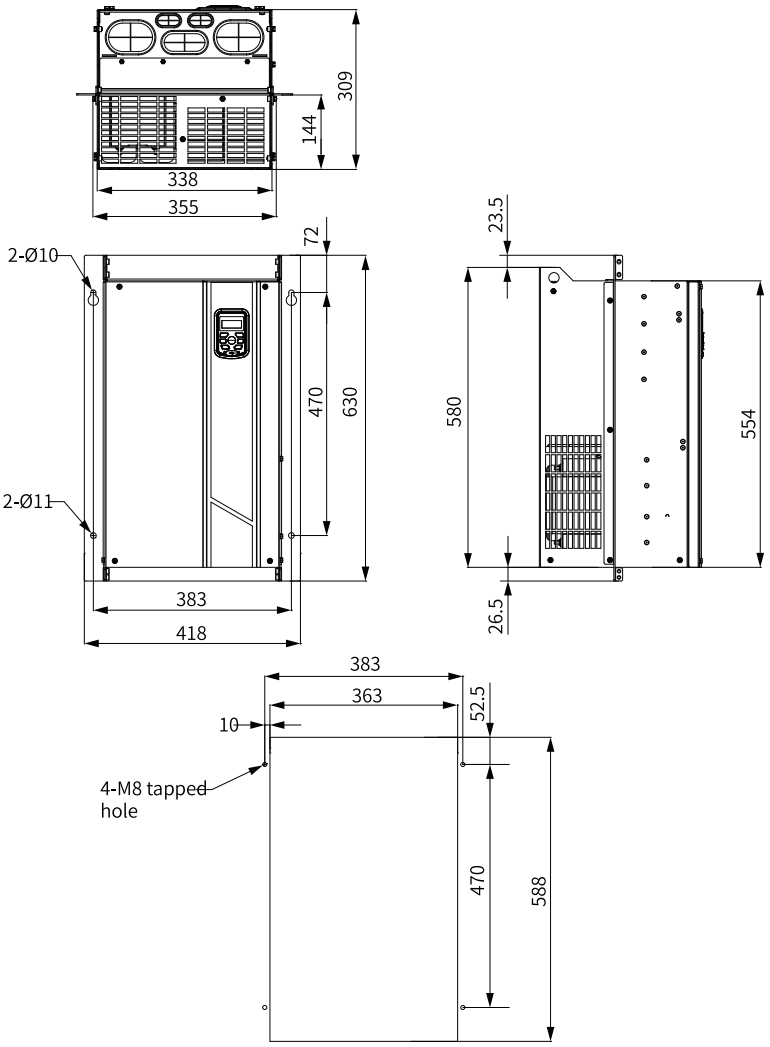


Figure 8-23 MD500-AZJ-A1T8 through-hole mounting bracket and mounting hole dimensions (unit: mm)

8.3 Grounding Bracket of Cable Shield

Table 8–26 Grounding bracket models of the cable shield

T model	Drive model	Through-hole mounting bracket model
T4	ES680N-4T025S-C1 ES680N-4T032S-C1 ES680N-4T037S-C1 ES680N-4T044S-C1	ES680-AZJ-T4
T5	ES680N-4T060S-C1	ES680-AZJ-T5
T6	ES680N-4T075S-C1 ES680N-4T091S-C1	MD500-AZJ-A2T6
T7	ES680N-4T112S-C1 ES680N-4T150S-C1	MD500-AZJ-A2T7

T model	Drive model	Through-hole mounting bracket model
T8	ES680N-4T176S-C1 ES680N-4T210S-C1 ES680N-4T253S-C1	MD500-AZJ-A2T8
T9	ES680N-4T312S-C1 ES680N-4T395S-C1 ES680N-4T426S-C1 ES680N-4T480S-C1 ES680N-4T525S-C1 ES680N-4T600S-C1 ES680N-4T650S-C1	-

Dimensions

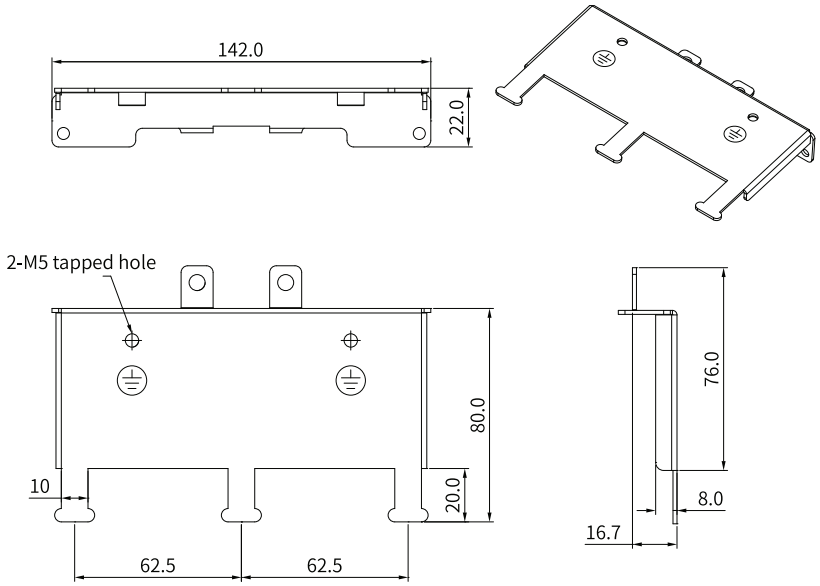


Figure 8-24 ES680-AZJ-T4 dimensions (unit:mm)

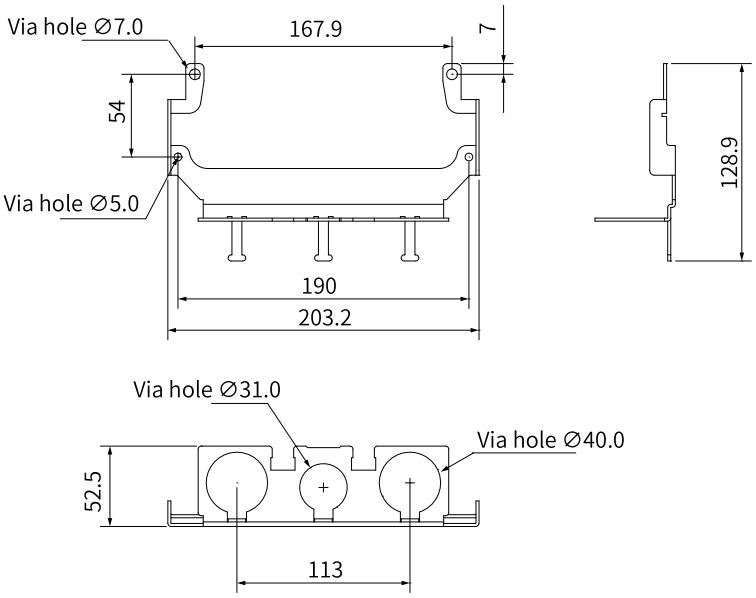


Figure 8-25 ES680-AZJ-A2T5 dimensions (unit:mm)

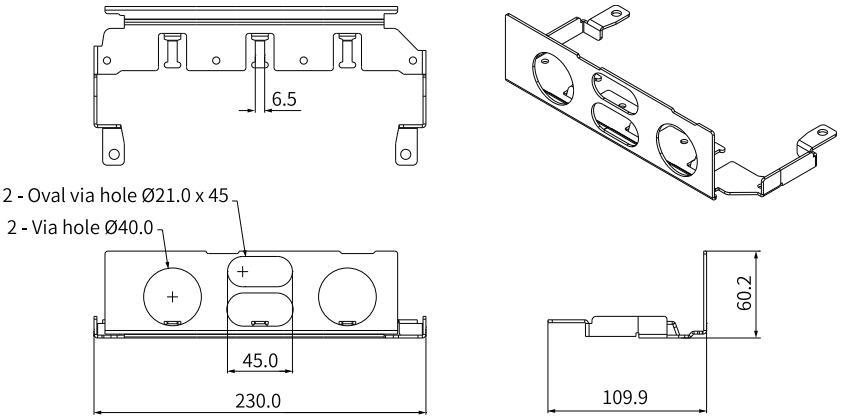


Figure 8-26 MD500-AZJ-A2T6 dimensions (unit:mm)

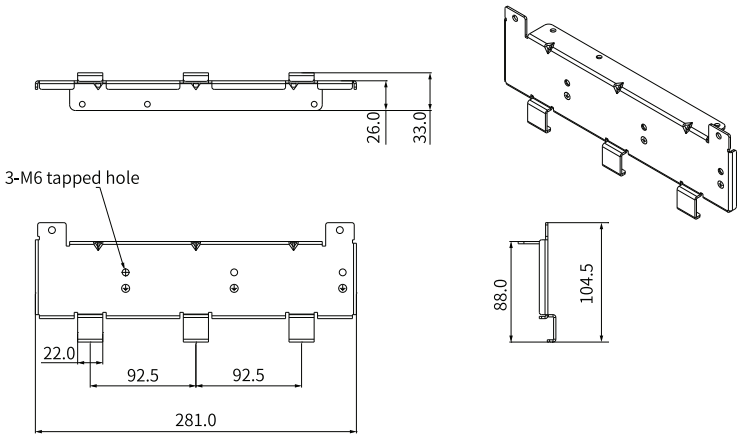


Figure 8-27 MD500-AZJ-A2T7 dimensions (unit:mm)

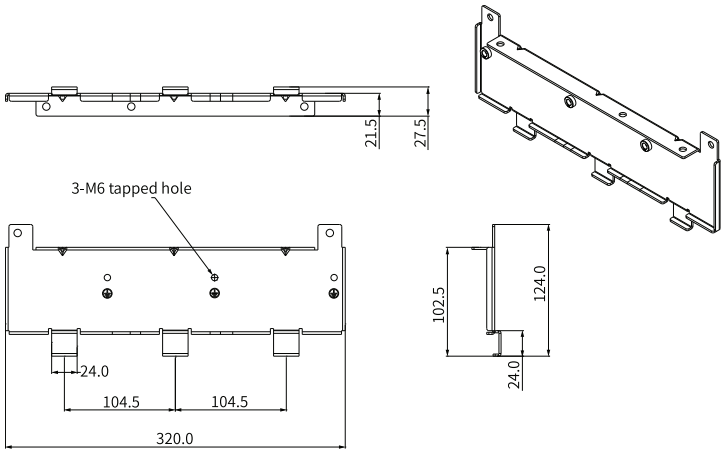


Figure 8-28 MD500-AZJ-A2T8 dimensions (unit:mm)

8.4 External Operating Panel

The external LCD operating panel SOP-20-880 or SOP-20-810 enables you to modify parameters and flash programs. The following figure describes the appearance and dimensions of the panel.

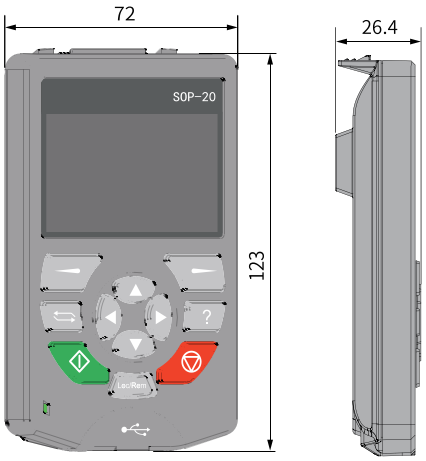


Figure 8-29 Appearance and dimensions of the external operating panel (unit: mm)

9 Solutions to Common EMC Problems

9.1 Leakage Current Suppression

The drive outputs high-speed pulse voltage, which may easily incur high-frequency leakage current. The leakage current generated by the drive can exceed 100 mA. Therefore, the rated action current of the residual current device must be above 100 mA. Use a B-type (delay-time) RCD because the drive may generate DC leakage current in the protective conductor.

If multiple drives are required, each drive must be installed with a residual current device. The factors that affect the leakage current are as follows:

- Capacity of the drive
- Carrier frequency
- Type and length of motor cable
- EMI filter

When the leakage current causes the residual current device to act, you must:

- Increase rated action current of the residual current device.
- Replace the residual current device with a new one that carries high-frequency suppression function and is B-type (delay-time).
- Reduce the carrier frequency.
- Shorten the length of the drive output cable.
- Install a leakage current suppression device.
- Recommended ELCB manufacturers are Siemens and Schneider.

9.2 Residual Current Device (RCD)

When the earth leakage circuit breaker (ELCB) malfunctions, perform troubleshooting according to the following table.

Table 9–1 Solution for leakage current

Trip	Possible cause	Solution
Tripped upon power-on	The anti-interference performance of the ELCB is poor.	1. Use a RCD of a recommended brand. 2. Use a RCD with a higher action current. 3. Move the unbalanced load to the front end of the ELCB. 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 ELCB is too low.	
	Unbalanced load is connected to the back end of the ELCB.	
	The capacitance of the front end of the servo drive is too high.	
Tripped during operation.	The anti-interference performance of the ELCB is weak.	1. Use a RCD of a recommended brand. 2. For an individual drive, ensure the EMC screw has been screwed down. For multiple drives, disconnect the selective EMC grounding screw, as shown in *"Figure 9-1" on page 153* . 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 9-2" on page 154* . 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 ELCB is too low.	
	Unbalanced load is connected to the back end of the ELCB.	
	For motor cables and the motor, the distributed capacitance to ground is too high.	

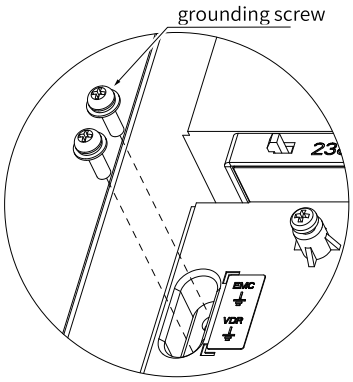


Figure 9-1 Disconnecting the selective EMC grounding screw

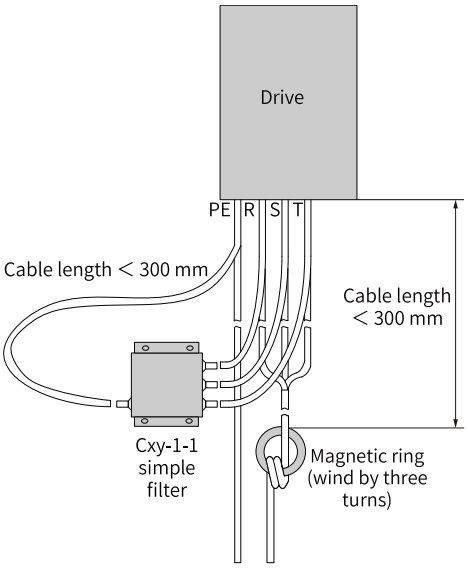


Figure 9-2 Installing a simple filter and magnetic ring on the input side

9.3 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 drive to meet standard requirements.

9.4 Control Circuit Interference

The drive generates strong interference during operation, which may interfere with other devices due to improper cabling or grounding. When the drive disturbs or is disturbed by other devices, adopt the following measures.

Step	Solution
1	Use shielded I/O signal cables with the shield connected to the PE terminal.
2	Connect the PE terminal of the motor to the PE terminal of the drive, and connect the PE terminal of the drive to the PE terminal of the power grid.
3	Add an equipotential bonding grounding cable between the host controller and the drive.
4	Wind the magnetic ring around UVW cables of the drive by two to four turns.
5	Increase the capacitor filtering of the low-speed DI, with a recommended maximum value of 0.1 μF.
6	Increase the filtering capacitance of the AI. The recommended maximum value is 0.22 uF.
7	Wind the signal cable around a ferrite clamp or magnetic ring by one or two turns.
8	Use shielded power cables with the shield grounded properly.

9.5 Communication Interference

9.5.1 CAN Communication Interference

Observe the following steps for troubleshooting.

No.	Step
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	Install ferrite clamps on both sides of the communication cable or wind the magnetic ring around the communication cable by one or two turns.
7	Wind the magnetic ring around UVW cables of the drive by two to four turns.
8	Use shielded power cables and ground the shield properly.

9.5.2 EtherCAT Communication Interference

Observe the following steps for troubleshooting.

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 connected properly 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	Wind the magnetic ring around UVW cables of the drive by two to four turns.
8	Use shielded power cables and ground the shield properly.

9.6 Encoder Feedback Signal Error

In the case of interference, take the following rectification measures.

No.	Step
1	Route encoder cables and power cables through different routes.
2	When the drive is routed far away from the motor (motor cable of 10 m), disconnect the selective grounding screw of the control board.
3	Install the magnetic ring or ferrite clamp near the encoder signal cable.
4	Wind the magnetic ring around UVW cables of the drive by two to four turns.
5	Use a shielded power cable and properly ground its shield.

10 Introduction to Commissioning Tools

10.1 Operating panel

Name	Model	Description	Appearance
Local operating panel	-	The LED operating panel that comes with the drive is used to monitor and modify parameters and start/stop the drive. Note: The backend software is connected via a Type-C data cable.	
External Operating Panel	SOP-20-880 and SOP-20-810	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. For more information, see the user guide of the operating panel.	

10.2 Local Operating Panel

Component Description

The local operating panel can be used to view the operating status, set parameters, and view the fault information. The following figure shows the operating panel.



Figure 10-1 Operating panel components

Key descriptions

Table 10–1 Key descriptions

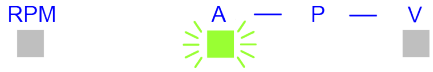
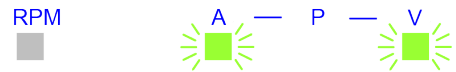
Key		Name	Function
	MODE	Mode key	Used to enter or exit from Level I menus. Press and hold this key under level 0 menu to enter the user-defined parameter password input interface.
	SHIFT	Shift key	Used to select the displayed parameters cyclically in the stop or running interfaces. Select the digit to be modified when modifying a parameter value. Press and hold this key under level 0 menus to enter the user-defined parameter group (group B).
	△	Increment key	Used to increase the data or parameter.
	▽	Decrement key	Used to decrease the data or parameter.
	ENTER	OK key	Used to access different levels of menus and confirm parameter setting.
	RUN	Run key	Used to operate the device in operating panel control mode.
	STOP	Stop key	Used to stop operations. Keep this key pressed down under level 0 menu to reset the software.

Status indicator

In the following table, the color green indicates that the LED turns on, gray indicates that the LED turns off, and red indicates that the LED flashes.

Table 10–2 Indicators on the operating panel

Indicator status		Description
RUN Operation indicator		Off: shut down
		ON: Running
F/R FWD/REV indicator		Off: Forward running
		On: Reverse running
T/E Auto-tuning/Fault indicator		OFF: Normal running
		Flashing green once per second: Auto-tuning state
		Quick flashing (red): Fault state (flashing 4 times/s)
		Speed unit (rpm)

Indicator status	Description
	A: unit of current
	V: unit of voltage
	Pressure unit (Bar)

LED display

The operating panel provides 5-digit LED display to indicate the speed reference, output speed, various monitoring data, and alarm codes.

Table 10–3 LED display and actual data

Display	Actual data	Display	Actual data	Display	Actual data	Display	Actual data
0	0	9	9	h	h	r	r
1	1	A	A	c	c	t	t
2	2	b	B	J	J	U	U
3	3	C	C	L	L	y	y
4	4	d	D	n	n	T	T
5	5	E	E	N	N	u	u
6	6	F	F	o	o	-	-
7	7	H	H	P	P	-	-
8	8	G	G	q	q	-	-

10.3 Parameter Setting

The operating panel provides three levels of menus for parameter setting. Upon entering the menu, you can press  and  to perform setting when the displayed bit blinks. The three levels of menus are described as follows:

- Level-1 menu: parameter groups
- Level-2 menu: parameters
- Level-3 menu: parameter values

The following figure shows an example for how to change the value of H06.03 from 1000 to 1500.

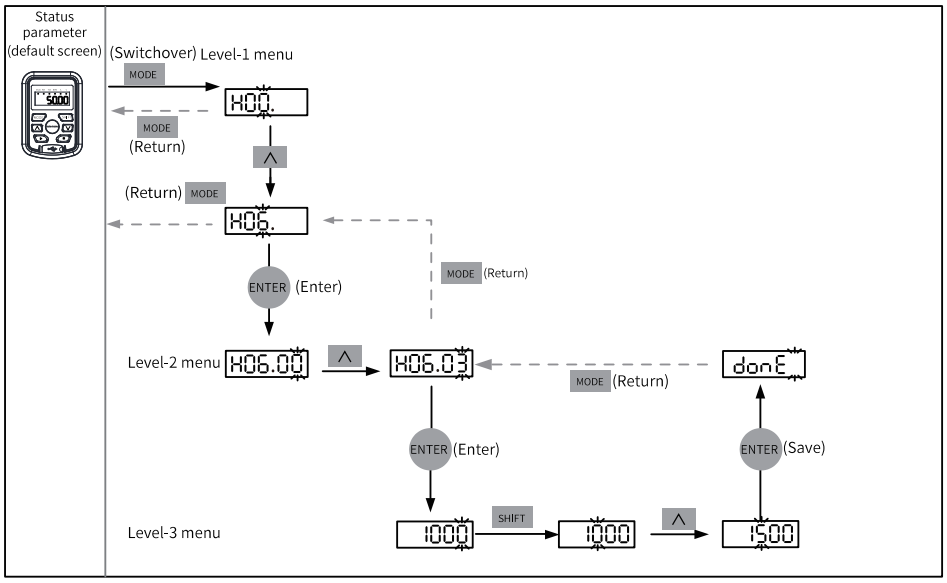


Figure 10-2 Modifying a parameter

Press MODE or ENTER to return to a level II menu when operating on a level III menu. The difference between the two is as follows:

1. ENTER: Used to save the parameter setting and switch to the next parameter automatically.
2. After you press MODE, the system does not save the parameter setting, but directly returns to level-2 menu and remains at the current parameter.

If a parameter does not include a blinking digit in the level-3 menu, the parameter cannot be modified. This may be because:

1. The parameter is an unmodifiable parameter, such as the product type, actual measurement, and operation log.
2. This parameter can be modified only after the drive stops.

10.4 Parameter View

You can view all the parameters through the operating panel. The following figure shows the operation procedure.

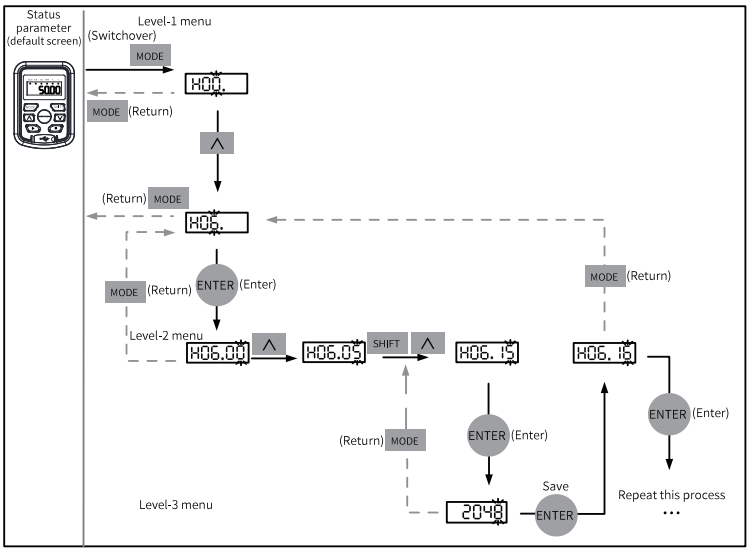


Figure 10-3 Parameter view example

11 Quick Commissioning Guide

11.1 Commissioning Preparation

Power-on inspection

Check the following items before switching on the power supply.

Item	Description
Power supply voltage	Check that the power supply voltage is proper. (3PH 380 VAC to 480 VAC 50/60 Hz)
	Confirm the power input terminals R, S, T are connected reliably.
	Check that the drive and the motor are grounded properly.
Connection between the drive output terminals and motor terminals	Check that the output terminals (U/V/W) of the drive are connected to the motor terminals in the correct phase sequence.
Connection of control circuit terminals	Check whether the drive control circuit terminals are connected to other control devices properly.
Control terminal status	Check that all the control circuit terminals of the drive are off (not ready to run).
Load	Confirm whether the motor is in the no-load status and not connected to the mechanical system.
Encoder terminal connection	Check whether the encoder terminals are connected properly.

Power-on

After power-on, the operating panel displays the following information.

Status	Corresponding display (example)	Description
Normal state		Default display state State: 10RY/18RY
Upon fault		The fault type is displayed when the drive is in the stopped state. The fault code format is Exxx.y. E: Fault state xxx: Fault code y: Fault subcode

11.2 Quick Commissioning Flowchart

This product supports motor tuning-free function for quick commissioning. For quick commissioning process, see *"Figure 11-1" on page 162* and *"Figure 11-2" on page 163* .

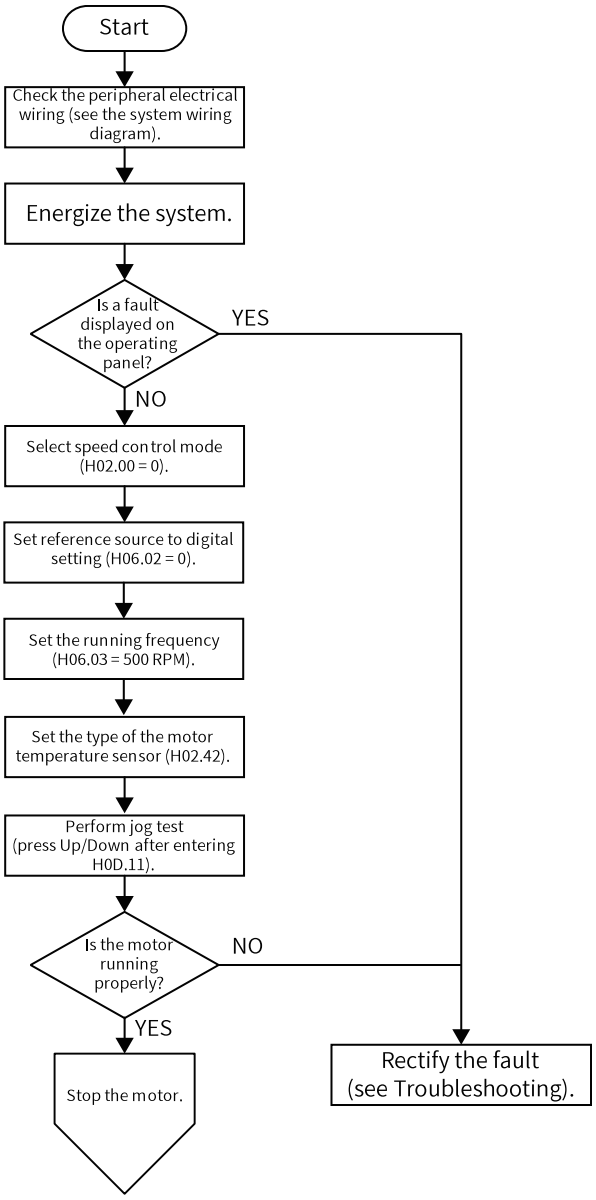


Figure 11-1 Commissioning in speed control mode

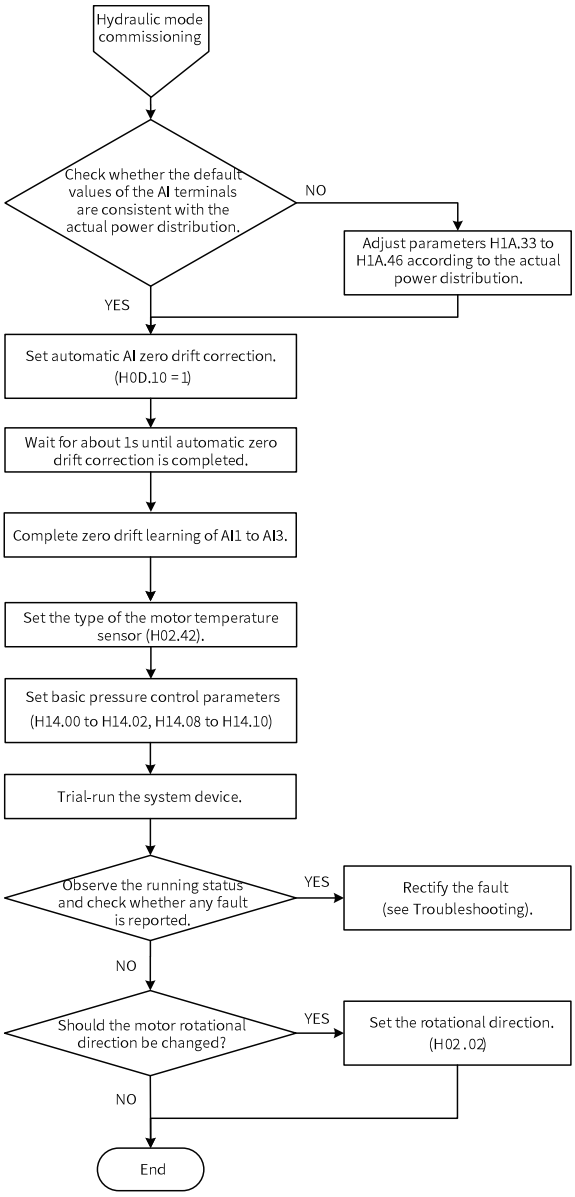


Figure 11-2 Commissioning in oil pressure mode

11.3 Commissioning for Hydraulic Servo Applications

11.3.1 Automatic AI Zero Drift Calibration

Setting procedure	Related parameters	Description
Automatic AI zero drift calibration	H0D.10 = 1	Automatic AI zero drift calibration Wait for 1s for the AI zero drift calibration to be done.

Note

Manual correction: Disable the drive, and check the values of parameters H0B.92, H0B.93, and H0B.94 representing the three AIs. Add 0.08 V to the maximum value and write the result to parameters H1A.33, H1A.38, and H1A.43, respectively.

After automatic AI zero drift correction is completed, the value of parameter H0D-10 is automatically restored to 0.

11.3.2 Settings of Oil Pressure Function Parameters

Mapping between system pressure and flow

Table 11–1 System flow and pressure

Parameter	Parameter name	Value	Description
H14.00	Hydraulic pressure control mode	0: Hydraulic pressure mode not enabled 2: Analog flow pressure reference 8: EtherCAT hydraulic pressure mode	Defines the hydraulic pressure control mode. 0: Hydraulic pressure mode not enabled 2: Analog flow pressure reference 8: EtherCAT hydraulic pressure mode
H14.01	Maximum speed	0 to 6000	Specifies the maximum speed of the motor, which is also the speed corresponding to 100% of the flow reference.
H14.02	System hydraulic pressure	0.0 to 500.0	Defines the maximum pressure of the system in the range of zero to the value of H14.03.
H14.03	Maximum hydraulic pressure	10.0 bar to 500.0 bar	Specifies the range of the pressure sensor, which corresponds to 0 VDC to 10 VDC output-type pressure sensor.

Table 11–2 Settings for AI1 oil pressure references

Parameter	Parameter name	Value	Description
H1A.33	AI1 minimum input	0: Non-hydraulic pressure mode 2: Oil pressure 2 mode 3: Reserved 4: Reserved 5: Oil pressure 5 mode	Defines the minimum voltage input of hydraulic pressure references, which corresponds to AI1 zero drift.
H1A.34	Corresponding setting of AI1 minimum input	0 to 6000	Defines the minimum hydraulic pressure reference, which is 0.0% (zero pressure) by default.
H1A.35	Maximum input of AI1	0.0 to 500.0	Defines the maximum voltage input of oil pressure references, which is normally 10 V.
H1A.36	Corresponding setting of AI1 maximum input	10.0 bar to 500.0 bar	Specifies the maximum pressure reference. The value of 100.0% corresponds to the system pressure (H14.02).

These parameters are used to define how to match 0 V to 10 V (or other ranges) of AI1 oil pressure references to 0 kg/cm^2 to the system pressure defined by H0B.02.

Table 11–3 Settings for AI2 flow references

Parameter	Parameter name	Value	Description
H1A.38	Minimum input of AI2	-11.00 to +11.00	Defines the minimum voltage input of flow references, which corresponds to AI1 zero drift.
H1A.39	Corresponding setting of AI2 minimum input	-100.0 to +100.0	Defines the minimum flow reference, which is 0.0% (zero flow) by default.
H1A.40	Maximum input of AI2	-11.00 to +11.00	Defines the maximum voltage input of flow references, which is normally 10 V.
H1A.41	Corresponding setting of AI2 maximum input	-100.0 to +100.0	Defines the maximum flow reference. The default value 100.0% corresponds to the maximum speed (H14.01).

These parameters are used to define how to match 0 V to 10 V (or other ranges) of AI2 flow references to 0 rpm to H14.01 (Maximum speed).

Table 11–4 Settings for AI3 oil pressure feedback

Parameter	Parameter name	Value	Description
H1A.43	Minimum input of AI3	-11.00 to +11.00	Defines the minimum voltage input of hydraulic pressure feedback, which corresponds to AI3 zero drift.
H1A.44	Corresponding setting of AI3 minimum input	-100.0 to +100.0	Defines the minimum hydraulic pressure feedback, which is 0.0% (zero pressure) by default.
H1A.45	Maximum input of AI3	-11.00 to +11.00	Defines the maximum voltage input of hydraulic pressure feedback, which is normally 10 V.
H1A.46	Corresponding setting of AI3 maximum input	-100.0 to +100.0	Specifies the maximum pressure feedback. The value of 100.0% corresponds to the maximum pressure (H14.03).

These parameters are used to define how to match 0 V to 10 V (or other ranges) of AI3 pressure feedback to 0 kg/cm^2 to the maximum pressure of the pressure sensor defined by H14.03.

Pressure relief setting

Parameter	Parameter name	Value	Description
H14.08	Upper limit of maximum negative speed	0.0% to 6553.5%	Defines the maximum negative speed during pressure relief, which is a percentage to the maximum speed (H14-01). This parameter is used to set the maximum negative speed of the motor. A higher value indicates faster pressure relief but louder oil pump noise during reverse operation. A lower value indicates slower pressure relief.

Base flow and base pressure setting

If flow and pressure references are not available, the hydraulic fluid will flow back into the tank due to internal leakage in the pump. This can cause system running noise and instability. Therefore, the base flow and base pressure must be set.

Parameter	Parameter name	Value	Description
H14.09	Bottom flow	0.0 to 50.0	When there is no flow reference, the bottom flow applies for operation. This parameter is a percentage to the maximum speed (H14-01).
H14.10	Bottom pressure	0.0 kg/cm^2 to 50.0 kg/cm^2	When there is no pressure reference, the bottom pressure applies for operation.

Filter time of pressure and flow references

- Oil pressure reference filter time

Parameter	Parameter name	Value	Description
H1A.37	AI1 filter time	0.000s to 9.999s	Defines the AI1 filter time.
H14.04	Rise time of the first hydraulic pressure group	0.000s to 2.000s	Defines the rise time of the first hydraulic pressure group.
H15.02	1st group of oil pressure ramp-down time	0.000s to 2.000s	Defines the 1st group of oil pressure ramp-down time.
H14.25	1st group of hydraulic pressure ramp-up S-curve filter time	0.001 to 10.000	Defines the 1st group of hydraulic pressure ramp-up S-curve filter time.
H14.26	1st group of hydraulic pressure ramp-down S-curve filter time	0.001 to 1.000	Defines the 1st group of hydraulic pressure ramp-up S-curve filter time.

Shorter filter time indicates faster hydraulic response and larger overshoot. Longer filter time indicates slower hydraulic response and smaller overshoot.

- Flow reference filter time

Parameter	Parameter name	Value	Description
H1A.42	AI2 filter time	0.000s to 9.999s	Defines the AI2 filter time.
H15.03	Rise time of 1st group of flow references	0.000 to 5.000	Defines the 1st group of flow ramp-up time.
H15.04	Fall time of 1st group of flow references	0.000 to 5.000	Defines the 1st group of flow ramp-down time.

Shorter filter time indicates faster hydraulic response and larger operation impact. Longer filter time indicates slower hydraulic response and smoother operation.

11.3.3 Oil Pressure Loop PID Response Adjustment

Oil pressure loop PID mode

- **Oil pressure loop PID mode 1: PID group mode defined by DI**
  The drive provides four groups of PID, which can be selected by DI functions 48 (PID selection terminal 2) and 49 (PID selection terminal 3), as shown below.

DI3 (DI function 49)	DI2 (DI function 48)	PID group
0	0	First group of PID: H14.05, H14.06, H14.07
0	1	Second group of PID: H14.11, H14.12, H14.13

DI3 (DI function 49)	DI2 (DI function 48)	PID group
1	0	Third group of PID: H14.14, H14.15, H14.16
1	1	Fourth group of PID: H14.17, H14.18, H14.19

The higher the value of the proportional gain (Kp), the shorter the integral time (Ki), and the longer the derivative time (Kd) and the faster the response will be. Note that excessively fast response may easily incur overshoot, leading to system oscillation during operation.

On the contrary, the lower the value of proportional gain (Kp), the longer the integral time (Ki), the shorter the derivative time (Kd) and the slower the response will be. Note that excessively slow response can result in efficiency reduction and unstable manufacturing quality.

- Oil pressure loop PID proportional gain (H14.05, H14.11, H14.14, H14.17)
  The higher the proportional gain, the faster the pressure response. Note that excessively high proportional gain may lead to system oscillation, as shown below.

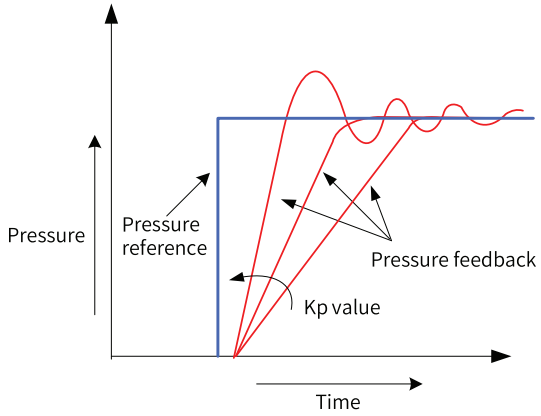


Figure 11-3 Oil pressure loop PID proportional gain

- Oil pressure loop PID integral time (H14.06, H14.12, H14.15, H14.18)
  The shorter the integral time, the faster the pressure response. Note that excessively fast response may lead to overshoot and system oscillation. On the contrary, excessively slow response may lead to unstable pressure, as shown below.

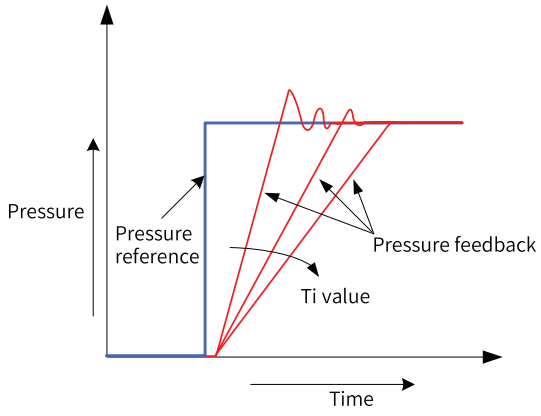


Figure 11-4 Oil pressure loop PID integral time

Oil pressure loop PID response gain (H14.29)

This parameter is used to adjust the responsiveness of the whole oil pressure loop. The higher the oil pressure loop gain, the faster the response will be. However, excessively fast response can lead to system oscillation. On the contrary, the lower the oil pressure loop gain, the slower the oil pressure loop response will be.

Reduce the value of this parameter in the case of large oil pressure system inertia or long and thin oil pipes.

Param.	Name	Value range	Unit	Default	Change
H14.29	Oil pressure loop gain coefficient	0.2 to 5.00	%	1.00	Real time

11.3.4 Pressure Holding Stability Commissioning

If the holding pressure fluctuates violently during commissioning, improve the responsiveness of the low-speed speed loop (1st group) to enhance pressure stability, which is to adjust the value of H09.01 properly. Note that an excessively high setpoint can lead to motor oscillation.

Param.	Name	Setpoint	Default	Unit	Change
H09.01	Stiffness level of the 1st gain set	0 to 31	12	-	Real time

Switching pressure loop PI control parameters based on the set pressure

Param.	Name	Setpoint	Default	Unit	Change
H14.63	High-voltage/Low-voltage PI parameter switchover Kp	0 to 1	0	-	Real time
H14.64	1st group of low pressure control Kp	0.0 to 800.0	210	-	Real time
H14.65	1st group of low pressure control Ti	0.001 to 10.000	0.5	-	Real time
H14.66	1st group of high pressure control Kp	0.0 to 800.0	260	-	Real time
H14.67	1st group high pressure control Ti	0.001 to 10.000	0.02	-	Real time
H14.68	Low pressure threshold	0.0 to [H14.69]	50	-	Real time
H14.69	High pressure threshold	[H14.68] to [H14.02]	100	-	Real time

When H14.63 is set to 1, high-pressure/low-pressure PI parameter switchover function is enabled. In this case, the values of H14.05 and H14.06 change automatically based on the set pressure.

- When the set pressure is higher than the value of H14.69, use H14.66 and H14.67 for pressure loop control.
- When the set pressure is lower than the value of H14.68, use H14.64 and H14.65 for pressure loop control.
- When the set pressure is between H14.68 and H14.69, the corresponding pressure loop IP parameter is calculated through linear interpolation.

Note

The high-/low-pressure PI parameter switchover is available only when the first group of PID parameters are used (that is, the 49# DI function and 48# DI function are both set to 0).

12 Function Description

12.1 Parameter Initialization

You can restore drive setting to default. After initialization is done, H02.31 is set to 0 automatically.

Param.	Name	Value range	Min. unit	Default	Change
H02.31	System parameter initialization	0: No action 1: Restore system default parameters 2: Clear fault records	1	0	At stop

- 1: Restore default setting except motor parameters
  After setting H02.31 to 1, all the parameters, except parameter groups H00, H01, and AI correction parameters, are restored to default.
- 2: Clear fault records
  Used to clear drive fault log and cumulative operating time (low bit of H0b.19 and high bit of H0b.20).

12.2 Operation Command Setting

Operation commands are used to control the start, stop, forward and reverse running of the drive. Three operation command sources are available: iPanel/software tool, terminal, and communication. Select an input mode of operation commands through parameter H02.00.

Param.	Name	Value range	Default value	Change method
H02.00	Control mode selection	0: Speed control mode 1: Position control mode 2: Torque control mode 9: EtherCAT mode	9	At stop

Setting operating commands through the operating panel

Set H2.00 to 0 and press  and  on the operating panel to start and stop the drive.

Press  to start the drive. The RUN indicator turns on. When the drive is running, press  to stop the drive. The RUN indicator turns off.

Setting operation commands through terminals

Set the parameter for H03 terminal selection to 1 to control the start and stop of the drive (only one terminal in DI1 to DI5 can be set to 1).

Setting operation commands through communication

Set H02.00 to 9 to use communication as the operation command source. You can start and stop the drive. Access different communication addresses according to different communication protocols, as described in the Communication section.

12.3 Start/Stop Mode Setting

The drive adopts direct start, as shown in the following table.

Param.	Name	Value range	Default value	Change mode
H02.05	Stop mode at S-OFF	-3: Stop at zero speed, keeping dynamic braking state -2: Ramp to stop as defined by 6084h/609Ah, keeping dynamic braking state -1: Dynamic braking stop, keeping dynamic braking state 0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/609Ah, keeping de-energized state	0	Real time

Coast to stop

Set H02.05 to 0 to select the coast-to-stop mode. Once the stop command takes effect, the drive immediately stops output, and the motor coasts to stop according to mechanical inertia.

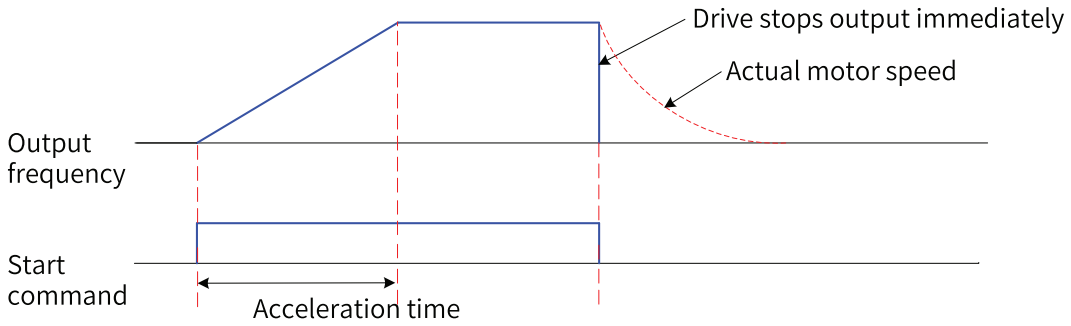


Figure 12-1 Sequence diagram for coast-to-stop

Acceleration/Deceleration Time Setting

The acceleration time refers to the time required by the drive to accelerate from zero frequency to the speed reference value (H06.03). The deceleration time refers to the time required by the drive to decelerate from the speed reference value (H06.03) to zero frequency.

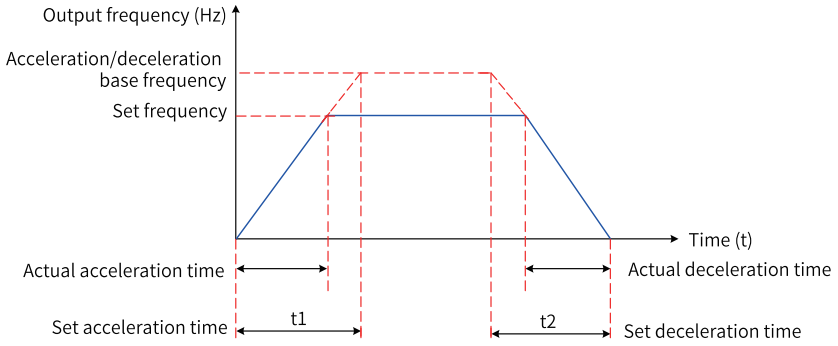


Figure 12-2 Acceleration/Deceleration time

Param.	Name	Value range	Default value	Change mode
H06.03	Speed reference value	-6000 to +6000	200 RPM	Real time
H06.05	Acceleration ramp time of speed reference	0 to 65535	0 ms	Real time
H06.06	Deceleration ramp time of speed reference	0 to 65535	0 ms	Real time

12.4 Control Interface

12.4.1 Digital Input (DI) Terminal Functions

The drive is equipped with five multi-functional DI terminals by default. You can assign any one of the DI functions to a DI terminal.

Param.	Name	Value range	Default	Unit	Change
H03.02	DI1 function selection	0: Not assigned 1: S-ON 2: Fault reset 3 to 51: Reserved 52: PID selection, such as injection, pressure holding, and mold open/close state 53: PID selection, such as injection, pressure holding, and mold open/close state 54: Master/Slave pump switchover in AI mode 55: Slave pump master terminal enabled 56: Switching from pressure mode to speed mode 57: CAN multi-pump control terminal 1 58: CAN multi-pump control terminal 2 59: Action upon switchover from injection to pressure holding in multi-pump mode 61: Terminal 2 for switching from pressure mode to speed mode 62: Reserved	1	-	Real time
H03.04	DI2 function selection		52	-	Real time
H03.06	DI3 function selection		57	-	Real time
H03.08	DI4 function selection		2	-	Real time
H03.10	DI5 function selection		54	-	Real time
H03.50	AI1 offset	-5000 mV to +5000 mV	0 mV	1 mV	Real time
H03.51	AI1 filter time Constant	0 ms to 65535 ms	200 ms	0.01 ms	Real time
H03.52	AI1 median filter selection	0 to 1	1	-	Real time
H03.53	AI1 dead zone	0 mV to 10000 mV	100 mV	0.1 mV	Real time
H03.54	AI1 zero drift	-1000 mV to +1000 mV	0 mV	0.1 mV	Real time
H03.55	AI2 offset	-5000 mV to +5000 mV	0 mV	1 mV	Real time
H03.56	AI2 filter time Constant	0 ms to 65535 ms	200 ms	0.1 ms	Real time
H03.57	AI2 median filter selection	0 to 1	1	-	Real time
H03.58	AI2 dead zone	0 mV to 10000 mV	100 mV	0.1 mV	Real time
H03.59	AI2 zero drift	-10000 mV to +10000 mV	0 mV	0.1 mV	Real time
H03.60	AI3 offset	-5000 mV to +5000 mV	0 mV	1 mV	Real time
H03.61	AI3 filter time Constant	0 ms to 65535 ms	200 ms	0.1 ms	Real time
H03.62	AI3 median filter selection	0 to 1	1	-	Real time
H03.63	AI3 dead zone	0 mV to 10000 mV	0 mV	0.1 mV	Real time
H03.64	AI3 zero drift	-1000 mV to +1000 mV	0 mV	0.1 mV	Real time
H03.65	AI3 input source	0: Current type 1: Voltage type	1	0	At stop

12.4.2 Digital Output (DO) Terminal Function

Param.	Name	Setpoint	Default	Unit	Change
H04.00	DO1 output selection	0: No function	2	-	Real time
H04.02	DO2 output selection	1: Drive in operation 2: Fault output 3 to 6: Reserved 7: Drive overload pre-alarm 8 to 15: Reserved 16: User-corrected absolute value AI1 > AI2 17 to 22: Reserved 23: Swashplate switchover 1 24: CAN OFF signal (pressure control status output) 25: Slave fault signal output 26: Injection swashplate switchover signal 27: Bus voltage established 28 to 31: Reserved 32: Motor temperature reached	23	-	Real time

Table 12–1 Description of the output terminal function

Setpoint	Function	Description
0	No function	The output terminal is not assigned with any function.
1	Drive in operation	When the drive is operating and frequency (can be zero) is output, the terminal outputs an active signal.
2	Fault (coast to stop)	An “active” signal can be outputted when the drive stops upon fault.
7	Drive overload pre-warning	The terminal outputs an active signal 10s before overload protection for the drive applies.
16	AI1>AI2	The terminal outputs an active signal when the value of AI1 is greater than that of AI2.
23	Swashplate switchover 1	This signal can be outputted when the pressure is higher than H14.23 and the flow is lower than H14.22.
24	Pressure control state output	This signal is outputted when the feedback pressure is lower than 90% of the setpoint of H14.23 or 90% of the feedback flow is higher than H14.22.
25	Slave fault signal output	This signal can be outputted when the master pump receives alarm information from the slave pump.
26	Injection swashplate switchover signal	Reserved
27	Bus voltage establishment	-
32	Digital output when motor temperature reached	-

12.5 Speed Control Mode

Note

The ES680N series servo drive supports speed control, position control, and torque control modes.

For details about the position control and torque control modes, see the SV660N Series Servo Drive Function Guide with the document code PS00001781.

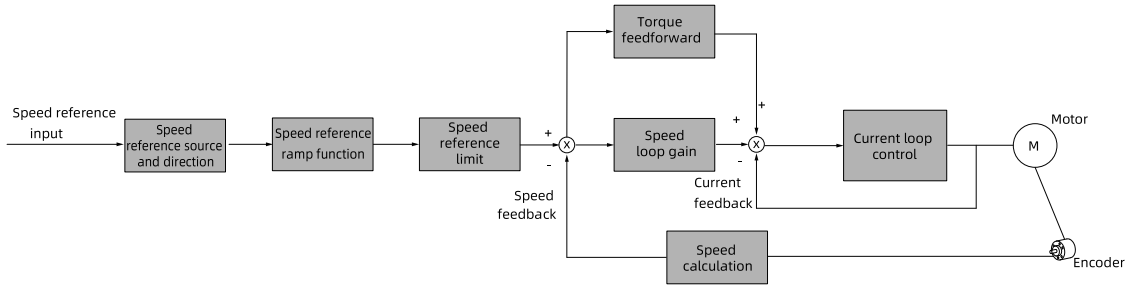


Figure 12-3 Block diagram of speed control

Set H02.00 (Control mode selection) to 0 (Speed control mode) through the operating panel or Inovance software tool to make the servo drive operate in the speed control mode. Set the drive parameters based on the mechanical structure and technical indicators. The following part uses the basic parameter setting to describe the speed control mode.

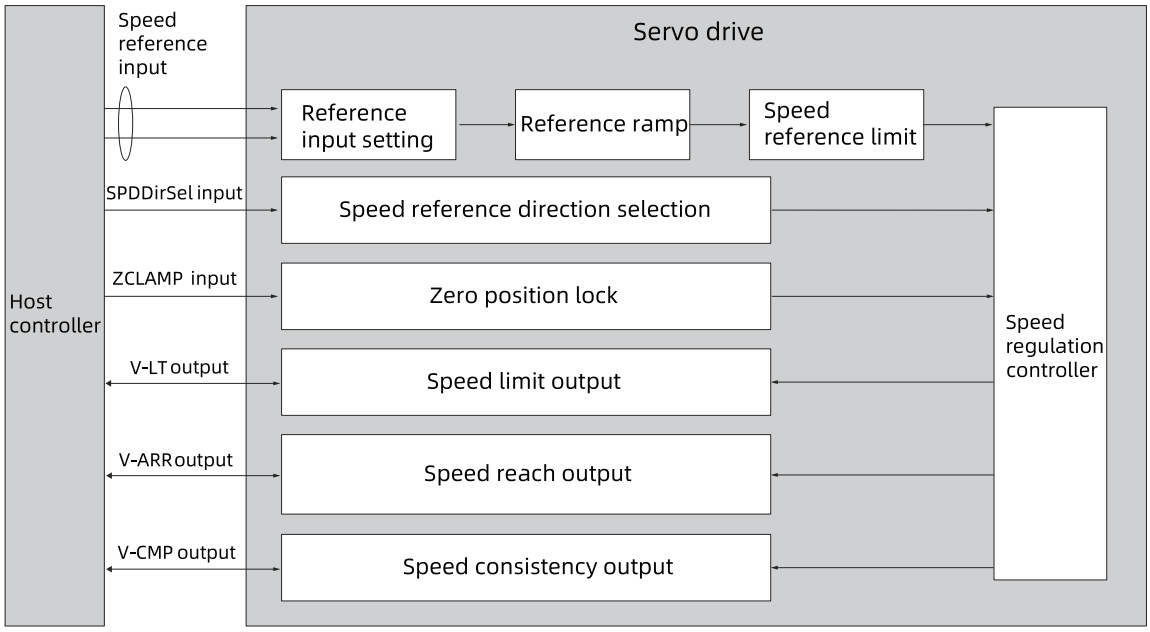


Figure 12-4 Signal exchange between the drive and the host controller

12.5.1 Block diagram of speed control parameters

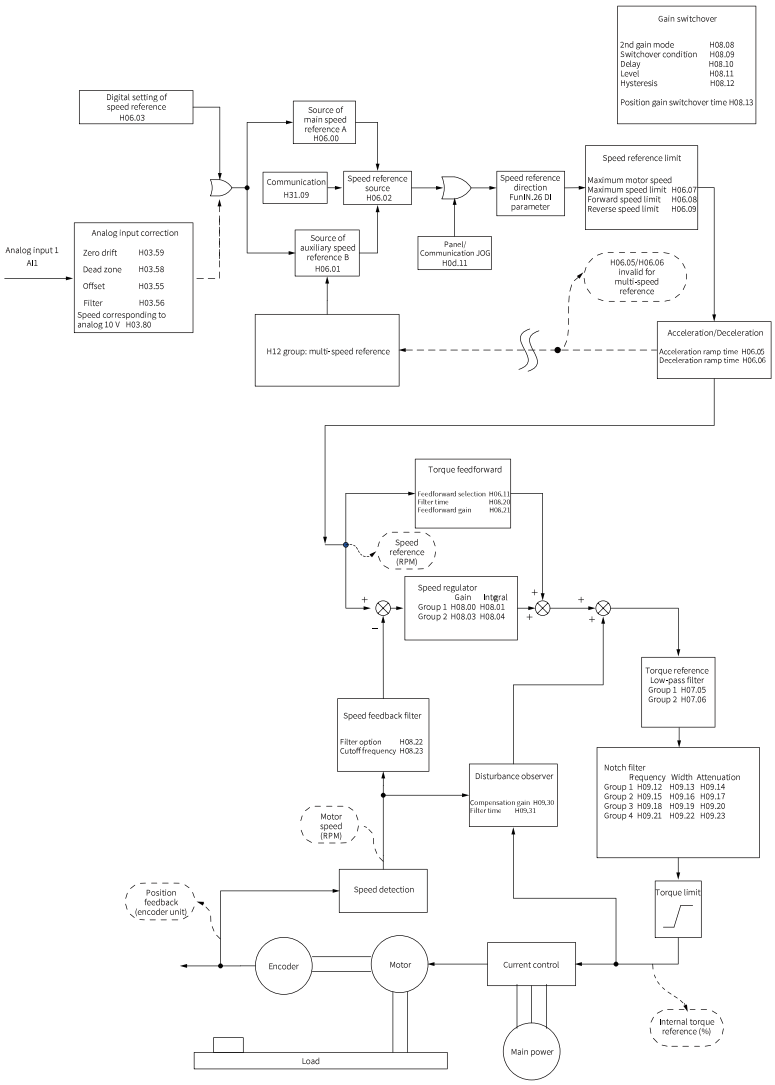


Figure 12-5 Block diagram of speed control parameters

12.5.2 Speed Reference Input Setting

Speed reference direction setting

To switch the speed reference direction through DI, assign FunIN.26 to the corresponding DI. The input signal of this DI determines the speed reference direction.

☆ Related functions:

Code	Name	Function	Description
FunIN.26 DI function code	SPDDirSel	Speed reference direction	Inactive: Forward Active: Reverse

The actual direction of rotation is related to the setting of H02.02 (Direction of rotation), the sign (+/-) of the speed reference value, and the logic of FunIN.26.

Table 12–2 Actual direction of rotation in the speed control mode

H02.02	Sign of speed reference	FunIN.26	Direction of rotation
0	+	Inactive	CCW
0	+	Active	CW
0	-	Inactive	CW
0	-	Active	CCW
1	+	Inactive	CW
1	+	Active	CCW
1	-	Inactive	CCW
1	-	Active	CW

12.5.3 Ramp Function Setting

The ramp function is used to smooth the acceleration rate of speed references through acceleration/deceleration time setting.

In the speed control mode, a high acceleration rate easily leads to motor jerk or intense vibration. In this case, increasing the acceleration/deceleration time smoothens the motor speed change, preventing mechanical damage caused by jerk or vibration.

Caution

- When the speed reference source is digital setting or jog speed, the acceleration time and deceleration time are set in H06.05 and H06.06.
- When the speed reference source is multi-speed reference, the acceleration time and deceleration time are set in parameter group H12. For details, see section "Description of Parameters".

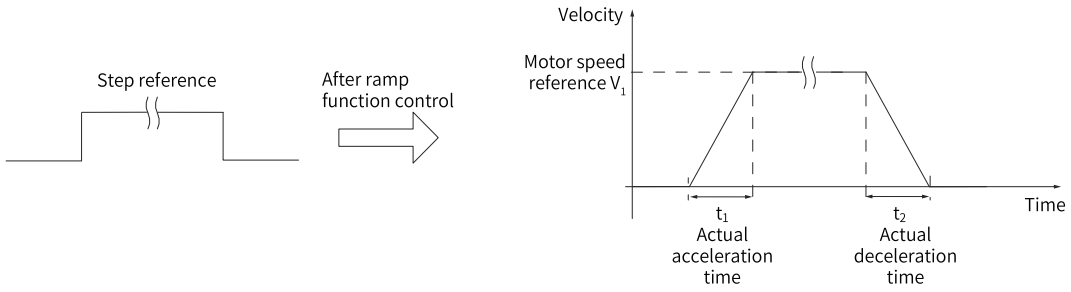


Figure 12-6 Ramp function definition

- H06.05: Time for the speed reference to accelerate from 0 rpm to 1000 rpm
- H06.06: Time for the speed reference to decelerate from 1000 rpm to 0 rpm.

The formula for calculating the actual acceleration/deceleration time is as follows.

$$\text{Actual acceleration time } t_1 = \frac{\text{Speed reference}}{1000} \times \text{Speed reference acceleration ramp time}$$

$$\text{Actual deceleration time } t_2 = \frac{\text{Speed reference}}{1000} \times \text{Speed reference deceleration ramp time}$$

12.5.4 Speed Reference Limit

Caution

When the actual speed of the motor exceeds H0A.08 (Overspeed threshold), E500 (Motor overspeed) occurs. For details of H0A.08, see Chapter "Parameter List". The speed reference limit must be lower than H0A.08.

In speed control mode, the speed reference can be limited. The sources of speed reference limit include:

- H06.08 specifies the forward speed limit. If the forward speed reference exceeds this value, it is limited to this value.
- H06.09 specifies the reverse speed limit. If the reverse speed reference exceeds this value, it is limited to this value.
- The maximum motor speed varies with the actual motor model.

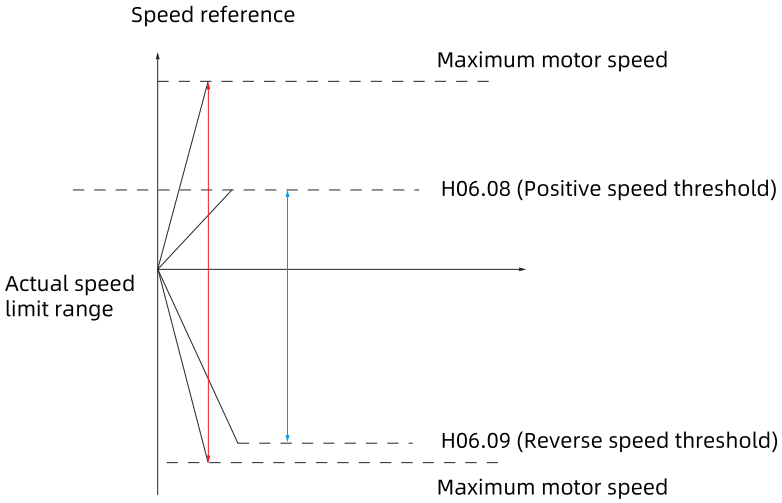


Figure 12-7 Example of speed reference limit

The actual motor rotational speed amplitude meets the following requirements:

- |Forward speed reference amplitude| ≤ min. {maximum motor speed, H06.08}
- |Reverse speed reference amplitude| ≤ min. {maximum motor speed, H06.09}

☆ Related parameters:

Parameter	Name	Value range	Unit	Description	Setting mode	Effective time	Default setting
H06.08	Positive speed limit	0 to 6000	rpm	This parameter limits the forward speed reference in the local speed mode and inactive in the EtherCAT mode.	During operation	Real time	6000
H06.09	Negative speed limit	0 to 6000	rpm	This parameter limits the reverse speed reference in the local speed mode and inactive in the EtherCAT mode.	During operation	Real time	6000

12.6 STO

12.6.1 Terms and Abbreviations

Terms/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 a dangerous Failure per Hour
PL	Performance level
SC	Systematic capability
SIL	Safety integrity level
T_1	Test interval
DI	Digital input (DI)
DO	Digital output
MTTFd	Mean time to dangerous failure

12.6.2 Standards Compliance

Standards compliance

- EU directives and standards
  Low Voltage Directive 2014/35/EU, EN 61800-5-1

  EMC Directive 2014/30/EU Standard EN 61800-3

  Machinery Directive 2006/42/EC (Functional safety) Standard IEC 61800-5-2
- Safety standard

Model	Safety standard	Reference standard
ES680N-4T****-C1	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 performance

Item	Standard	Performance Indicator
Safety integrity level (SIL)	IEC 61508 IEC 62061	SIL3 SILCL3
Performance level (PL)	ISO 13849-1	PL e (CAT.3)

- Technical data
  - The electrical safety complies with overvoltage category III of EN 61800-5-1.
  - The environment test requirements comply with EN 61800-5-1 and EN 61800-5-2.
  -

Item	Technical data
Ambient temperature	-10℃ to +50℃ (For temperatures above 40℃, derate 1.5% for every additional 1℃.)
Storage/Transport temperature	-20℃ to +60℃
Ambient/Storage humidity	5% to 95% RH (without condensation)

<table>
<tr><th>Item</th><th>Technical data</th></tr>
<tr><td>Vibration</td><td>
<table>
<tr><th>Item</th><th>Test condition</th></tr>
<tr><td>Test reference</td><td>Test Fc of IEC 60068-2-6 4.6</td></tr>
<tr><td>Condition</td><td>The EUT has been powered on and operating normally.</td></tr>
<tr><td>Motion</td><td>Sinusoidal</td></tr>
<tr><td>Vibration amplitude/ Acceleration</td><td>Amplitude: 3.5 mm (5 Hz ≤ f ≤ 8.4 Hz)
1 g (8.4 Hz ≤ f ≤ 200 Hz)</td></tr>
<tr><td>Vibration duration</td><td>10 sweep cycles per axis on each of three mutually perpendicular axes</td></tr>
<tr><td>Axis</td><td>X, Y, Z</td></tr>
<tr><td>Mounting details</td><td>According to the manufacturer's specifications</td></tr>
</table>
</td></tr>
<tr><td>Shock resistance</td><td>
<table>
<tr><th>Item</th><th>Test condition</th></tr>
<tr><td>Test reference</td><td>Test Ea of IEC 60068-2-27:2008 Table 20</td></tr>
<tr><td>Condition</td><td>The EUT has been powered on and operating normally.</td></tr>
<tr><td>Motion</td><td>Semi-sinusoidal</td></tr>
<tr><td>Shock amplitude/ Time</td><td>50 m/s ^{2} (5 g)/30 ms</td></tr>
<tr><td>Number of shocks</td><td>3 sweep cycles per axis on each of three mutually perpendicular axes</td></tr>
<tr><td>Axis</td><td>±X, ±Y, ±Z</td></tr>
<tr><td>Mounting details</td><td>According to the manufacturer's specifications</td></tr>
</table>
</td></tr>
<tr><td>IP rating (IP)/Pollution degree (PD)</td><td>IP20
PD2: free from corrosive or explosive gases, water, oil, chemicals, dust, salty elements, or metallic dust</td></tr>
<tr><td>Overvoltage category</td><td>OVC III</td></tr>
<tr><td>Altitude</td><td>≤ 3000 m
(For altitudes above 1000 m, derate 1% for every additional 100 m.)</td></tr>
<tr><td>Cooling method</td><td>Air-cooled</td></tr>
<tr><td>Others</td><td>Free from static electricity, electromagnetic field, magnetic field, and radioactive substances</td></tr>
</table>

12.6.3 Overview

Safety function

Safety torque off (Safe Torque Off) is a safety function that complies with IEC 61800-5-2:2016. This product is 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 + 24VDC 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.

Table 12–3 STO function

STO1 input	STO2 Input	PWM signal
H	H	Normal
L	H	Inhibited
H	L	Inhibited
L	L	Inhibited

Table 12–4 STO description

Item	Description
Definition	Cuts off the power of the motor.
Description	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start. When the STO function is activated, if the motor is running, the drive immediately blocks the output and the motor enters the de-energized state.
Safety state	Disables the PWM gating signal of the drive.
Operation mode	High demand or continuous mode

12.6.4 Installation

Note

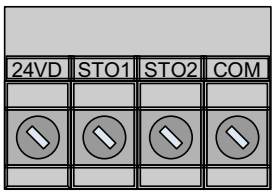
Designers and installation personnel must be trained to understand safety requirements related to design and installation.

Before use, configure the two independent inputs STO1/STO2 as two-channel inputs for the STO function.

For devices with the STO function, if the STO function is not required, STO1/STO2 can be connected to 24 VDC at the same time to ensure normal operation of the devices.

12.6.5 Terminals and Connection

Terminal layout and assignment

Layout	Mark	Name	Function
	24VD	24VD digital signal power output	Compliant with SIL3 Short STO1, STO2, and 24VD when STO is not used. Remove the jumper bar when using STO.
	STO1	STO1 input	
	STO2	STO2 input	
	COM	Power supply reference GND of 24VD	

Specification

The drive operates normally only when the input states of STO1 and STO2 are both "High" ("1" or "H"). The servo drive does not operate when the input states of STO1 or STO2 are different or are both "Low" ("0" or "L").

Electrical characteristics

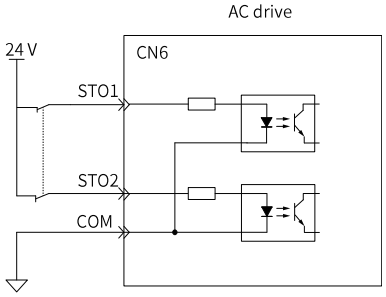
The following table describes the electrical characteristics of the safety request input signal.

Item	Characteristics	Description
Voltage range	24 VDC (±15%)	-
Input current	3 mA (Typ.)	This is the value per channel.
Standards of logic levels	"0" < 5 V; "1" > 15 V	-
Digital input impedance	7.88 kΩ	-

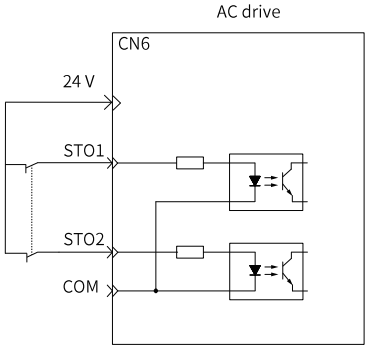
Connection example

The following figure describes the wiring of STO terminals.

1. Wiring example when the external 24 V is used



2. Wiring example when the internal 24 V is used



EMC Requirements

1. To avoid short circuit between two adjacent conductors, shielded cables can be used with shield connected to the protective ground, or flat cables can be used with a grounding wire inserted between every two signal conductors.
2. Double-shield or single-shield twisted pair cables are recommended.
3. Fix and ground the cable protective cover using a piece of conductive metal.

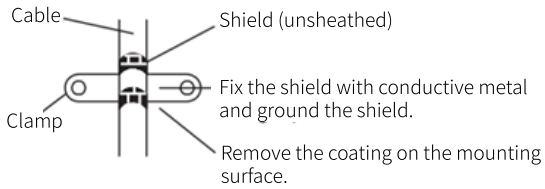
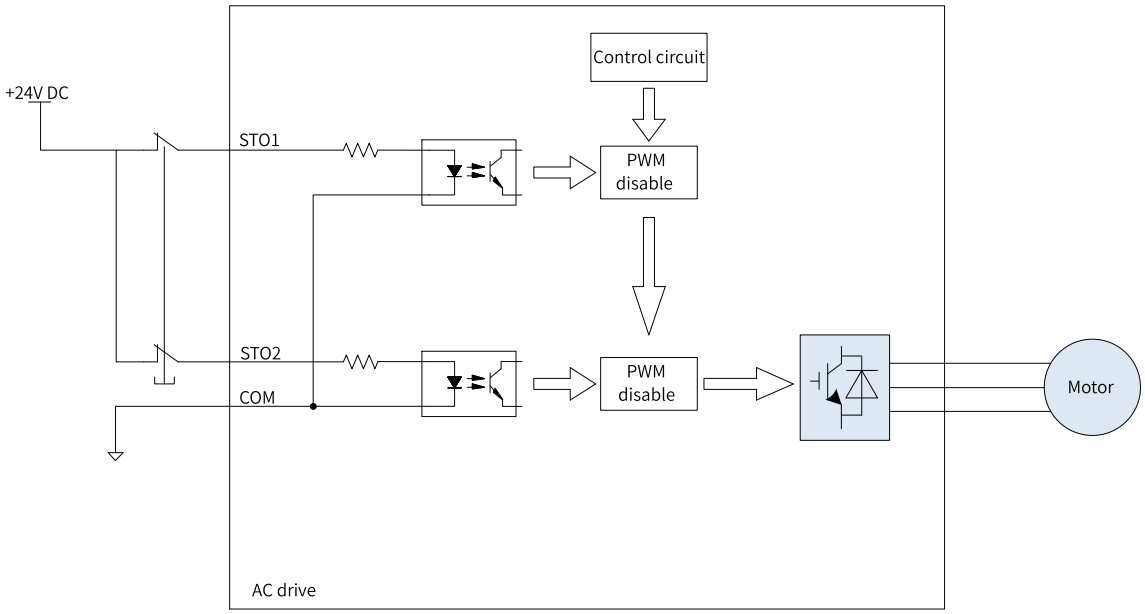


Figure 12-8 Cable clamp

4. The maximum cable length allowed between the AC drive and safety switch is 30 m.

12.6.6 Functional Safety Wiring

The following figure shows the electrical wiring of the drive with safety function.



12.6.7 Troubleshooting

See the following table for the causes and solutions of faults. If the problem cannot be solved through the solutions in the following table, contact Inovance for technical support.

Table 12–5 Fault codes related to the STO function

Code	Status	Cause	Solution
STO/E150.0	STO activated by external request	STO1/STO2 are all in the "Low" state.	Connect STO1 and STO2 to the 24V voltage signal.
E150.1	Input states of STO1 and STO2 inconsistent	The input states of STO1 and STO2 are inconsistent.	1 .Ensure that STO1 and STO2 voltage disconnection requests are triggered at the same time. 2 .The input circuit is abnormal. After disconnecting the 24 V signal, an STO input signal is still in "High" state. In this case, contact the agent or Inovance for technical support.

Code	Status	Cause	Solution
E150.2	STO activated	OV/UV of 5 V power supply is detected.	Contact Inovance for technical support.
E150.3	Status of STO1 and STO2 inconsistent	Only one of STO1 and STO2 is in 'Low' state. The states of STO1 and STO2 are inconsistent.	Contact Inovance for technical support.
E150.4	STO activated	The input circuit of STO works improperly.	Contact Inovance for technical support.
E150.5	STO activated	The STO blocking output chip is abnormal.	Contact Inovance for technical support.

12.6.8 Precautions for Use

General safety instructions

The chapter contains the warning symbols used in this guide and the safety instructions with which you must comply when you install or maintain safety modules of a drive or an inverter. If you ignore the safety instructions, injury, death or damage can occur. Read this chapter before you start the installation.

Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.

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 12–6 Warning labels

Label	Indication	Description	Consequence of negligence
Example:  General hazards  Special hazards Electric shock	DANGER	Critical 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.

Caution

- 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:

- The STO function is not a substitute for the emergency stop (E-stop) function. If only the STO function is triggered, with no extra measures taken, the power supply cannot be cut off in emergencies and high-current parts of the motor and drive are still energized, incurring the risk of electric shock or other risks result in electric energy. Therefore maintenance work on electrical parts of the drive or motor can only be carried out after isolating the drive system from the main 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 the safety of the entire control system, it is necessary to design the entire system according to recognized safety rules. An individual subsystem with the STO function, although intentionally designed for safety-related applications, cannot ensure the safety of the entire system.
- In emergency stop situations, the STO function can be used to stop the drive.
- In processes without personnel protection, do not to use the STO function to stop the drive. If the STO function is used to stop a running drive, the drive will coast to stop. If this is unacceptable, stop the system using a proper mode instead of the STO function.
- This publication provides a guide on the application of Inovance STO function and also on the design of safety-related systems for machinery control.
- It is the responsibility of the designer of the end product or application to ensure safety and compliance with relevant regulations.

Risk assessment

- Before using the safety function, perform risk assessment on the 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 faults occur on the IGBT power transistor, the drive will produce an aligning torque regardless of whether the STO function is used. This torque may drive the motor shaft to rotate to a maximum angle of (180 ÷ p).
- p indicates the number of motor pole pairs.

To ensure safety, users should decide all the risk assessments and residual risks in the entire machine equipment. Companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning. 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 drive. Cut off the power supply of the drive to make sure the drive is powered off before maintenance.

Note

Trigger the STO function for the AC drive at least once every three months.

13 Communication

13.1 Technical Data of EtherCAT Communication

Item		Specification
EtherCAT Basic performance of the slave	Communication protocol	EtherCAT protocol
	Services available	CoE (PDO, SDO), EoE
	Synchronization mode	DC - Distributed clock
	Physical layer	100BASE-TX
	Baud rate	100 Mbps (100Base-TX)
	Duplex mode	Full duplex
	Topology	Ring and linear
	Transmission medium	Shielded cables of Cat 5e or higher
	Transmission distance	Shorter than 100 m between two nodes (with proper environment and cables)
	Number of slaves	Up to 65535 by protocol, not exceeding 100 in actual use
	EtherCAT frame length	44 bytes to 1498 bytes
	Process data	Max. 1486 bytes per Ethernet frame
	Synchronous jitter of two slaves	< 1 μs
	Refresh time	About 30 μs for 1000 digital inputs and outputs About 100 us for 100 servo axes Define different refresh time for different interfaces.
	Bit error rate	10^{-10} Ethernet standard
EtherCAT Configuration unit	Number of FMMU units	8
	Number of storage synchronization management units	8
	Process data RAM	8kB
	Distributed clock	64-bit
	EEPROM capacity	32-kbit

13.2 Status Indication

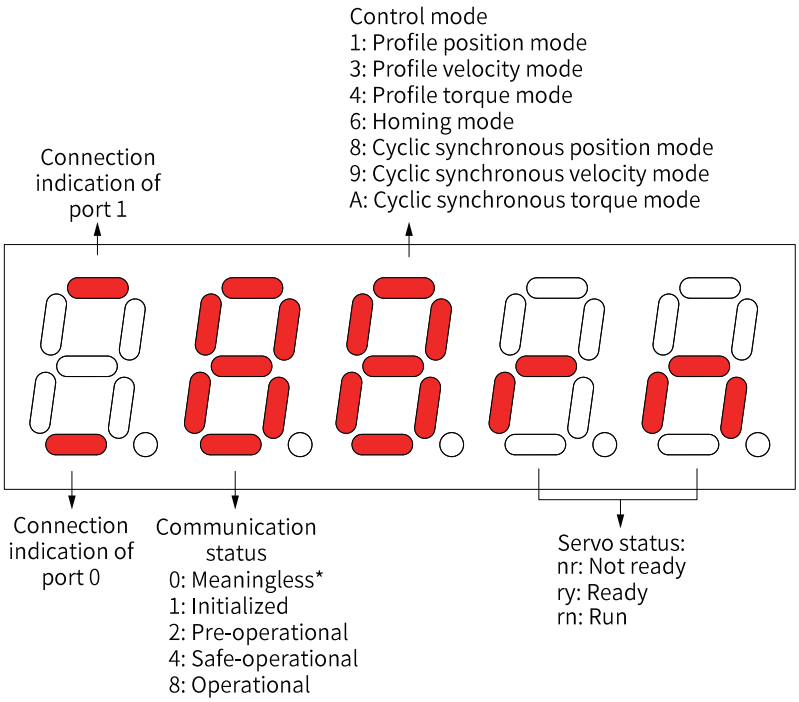


Figure 13-1 Status indication diagram

If the value 0 is displayed, it indicates no value is written or the value 0 is written to 0x6060h, or H02.00 is set to 0, 1, or 2.

Communication connection

The connection status of the two RJ45 ports are indicated by "-" on the upper and lower part of the first LED on the operating panel. The upper "-" indicates the status of PORT1, and the lower "-" indicates the status of PORT0.

Solid OFF: No communication connection is detected in the physical layer.

Solid on: Communication connection is detected in the physical layer.

Communication status

The 2nd LED indicates the status of the EtherCAT state machine of the slave in the form of characters, as described in the following table.

State of EtherCAT state machine:

State	SDO	RPDO	TPDO	Description	Display
Initializing	No	No	No	Communication initialization	1: Solid ON
Pre-operational	Yes	No	No	Initializing network configuration SDO available	2: Blinking at an interval of 400 ms
Safe-operational	Yes	Yes	No	SDO, TPDO, and distributed clock modes available	4: Blinking at an interval of 1200 ms (ON for 200ms and OFF for 1000 ms)
Operational	Yes	Yes	Yes	Regular operational state	8: Solid ON

Display of operation modes

The 3rd LED indicates the operation mode of the servo drive in the form of hexadecimal without blinking, as described in the following table.

The operation modes include the following:

Modes of operation (6060h)	Display
1: Profile position mode	1
3: Profile velocity mode	3
4: Profile torque mode	4
6: Homing mode	6
8: Cyclic synchronous position mode	8
9: Cyclic synchronous speed mode	9
10: Cyclic synchronous torque mode	A

Display of servo status

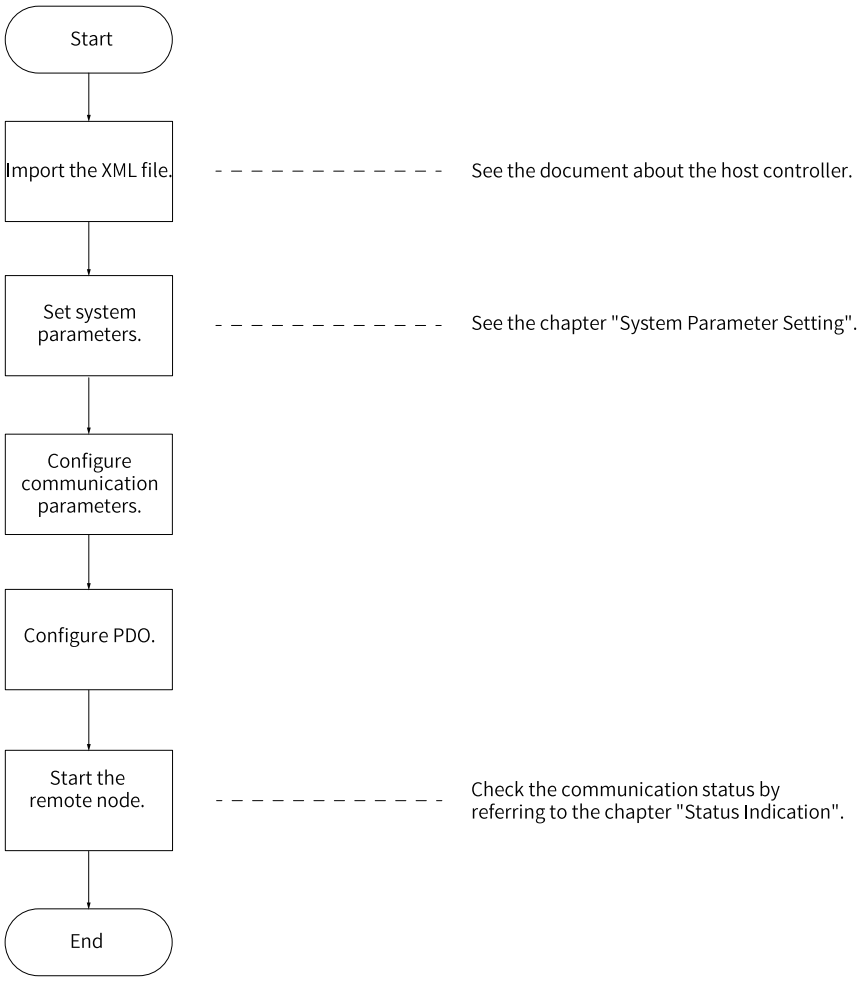
The 4th and 5th LEDs indicate the slave (servo) status.

The following servo states are displayed.

State	Description	Display
Reset	Initialization	reset
Not ready	Initialization is done. The control circuit is switched on but the main circuit is not switched on. Not ready	nr
Ready	The main circuit is switched on, but the S-ON signal is inactive. Ready	ry The character "y" blinks when the motor speed is not 0 rpm. When the communication layer is in the pre-operational or safe-operational state, the blinking frequency is the same as that of characters "2" or "4" (see "communication status" in the previous page for details). When the communication layer is in Init or Operational state, the blinking frequency is 2 Hz.
Operational	The S-ON signal is active and the motor is energized. Run	rn The character "n" blinks when the motor speed is not 0. When the communication layer is in the pre-operational or safe-operational state, the blinking frequency is the same as that of characters "2" or "4" (see "communication status" in the previous page for details). When the communication layer is in Init or Operational state, the blinking frequency is 2 Hz.

13.3 Overview of the EtherCAT Protocol

EtherCAT is an industrial Ethernet-based fieldbus system that features high performance, low cost, easy use and flexible topology. It is applicable to industrial applications requiring ultra-high speed I/O network. EtherCAT adopts standard Ethernet physical layer with twisted pairs or optical fibers (100Base-TX or 100Base-FX) used as the transmission media.



An EtherCAT system includes the master and the slave. The master requires a common network adapter, and the slaves require a special slave control chip, such as ET1100, ET1200, and FPGA.

EtherCAT can process data at the I/O layer:

- No lower-layer sub-bus required
- Or gateway delay
- One system covers all devices, including input/output devices, sensors, actuators, drives, and displays.
- Transmission rate: 2 x 100 Mbit/s (high-speed Ethernet, full duplex mode).
- Synchronization: synchronization jitter < 1 μs (number of nodes up to 300, cable length within 120 m)
- Refresh time:

256 digital I/Os: 11 μs

1000 digital I/Os distributed in 100 nodes: 30 μs = 0.03 ms

200 analog I/Os (16-bit): 50 μs, sampling rate 20 kHz

100 servo axes (8 bytes IN + 8 bytes OUT for each): 100 μs = 0.1 ms

12000 DI/DOs: 350 μs

To support devices of various types and wider applications, EtherCAT-based application protocols are established:

- CANopen over EtherCAT (CoE)
- Ethernet over EtherCAT (EoE)

The slave device only needs to support the suitable application protocol.

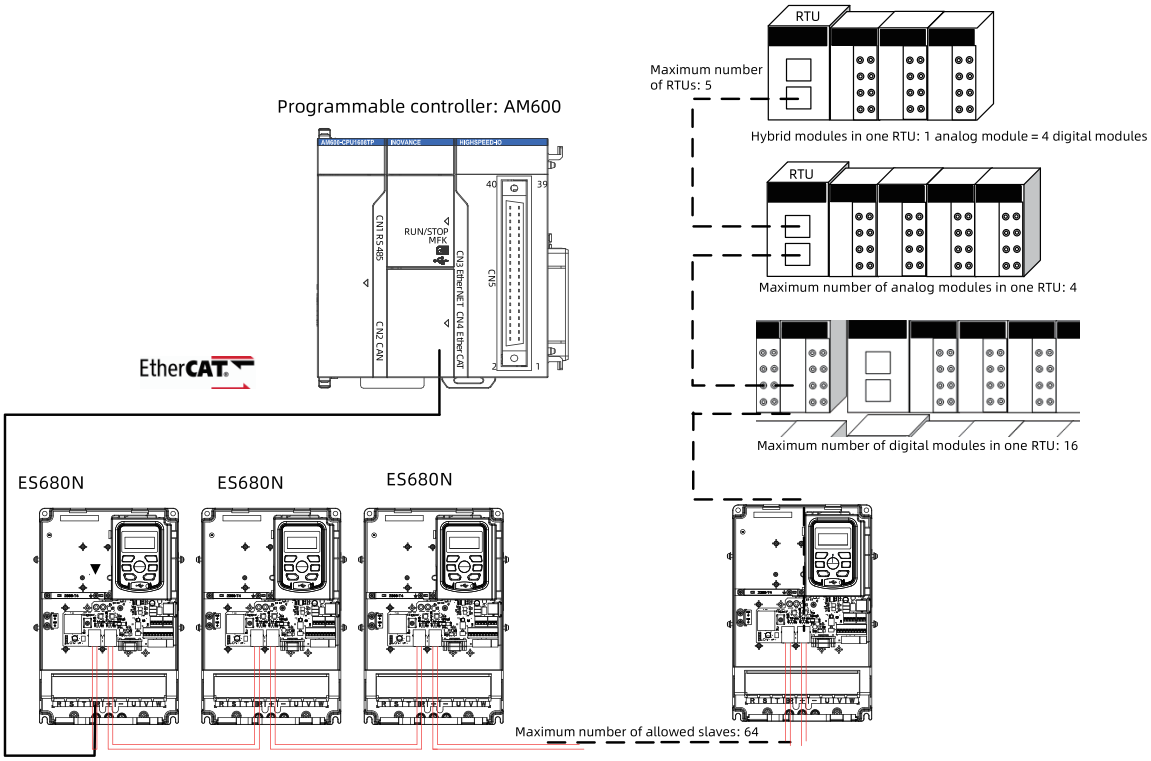


Figure 13-2 EtherCAT networking

Note

EtherCAT® is a registered trademark and patented technology licensed by Beckhoff Automation GmbH, Germany.

13.4 System Parameter Setting

Parameter address structure

Parameter access address: index+subindex, both of which are in hexadecimal

CiA402 protocol establishes the following restrictions on the parameter address:

Index (Hex)	Description
0000-0FFF	Data type
2000-5FFF	Manufacturer-specific object

Index (Hex)	Description
6000-9FFF	Profile object
A000-FFFF	Reserved

System parameter setting

Necessary parameter settings are required for the ES680N series servo drive to be connected to the EtherCAT fieldbus network.

Index	Sub-index	Name	Value range	Default
2002	01h	Control mode selection	0: Speed control mode 1: Position control mode 2: Torque control mode 9: EtherCAT mode	9
200E	02h	Saving objects written through communication to EEPROM	0: Neither parameters nor object dictionaries written through communication saved to EEPROM 1: Only parameters written through communication saved to EEPROM 2: Only object dictionaries written through communication saved to EEPROM 3: Both parameters and object dictionaries written through communication saved to EEPROM	3
200E	16h	EtherCAT slave alias	0 to 65535	0

Note

Set H0E.01h properly if parameters are to be stored in EEPROM. Otherwise, these parameters restore to the default settings after power-on again. After parameter setting, set H0E.01 to 0 to prevent long-time data writing to EEPROM, which may cause damage to the EEPROM device.

13.5 Specifications of EtherCAT Communication

Item		Specification
Communication protocol		IEC 61158 Type 12, IEC 61800-7 CiA 402 Drive Profile
Application layer	SDO	SDO request, SDO response
	PDO	Variable PDO mapping, fixed PDO mapping
	CiA 402	Profile position (PP) mode
		Profile velocity (PV) mode
		Profile torque (PT) mode
		Homing (HM) mode
		Cyclic synchronous position (CSP) mode
		Cyclic synchronous velocity (CSV) mode
		Cyclic synchronous torque (CST) mode

Item		Specification
Physical layer	Transmission protocol	100BASE-TX (IEEE802.3)
	Maximum distance	100 m
	Interface	RJ45 x 2 (INT, OUT)

13.6 Structure of EtherCAT Communication

Multiple kinds of application protocols are available for EtherCAT communication. The IEC 61800-7 (CiA 402)-CANopen motion control profile is used for the drive. The following figure shows the EtherCAT communication structure at the CANopen application layer.

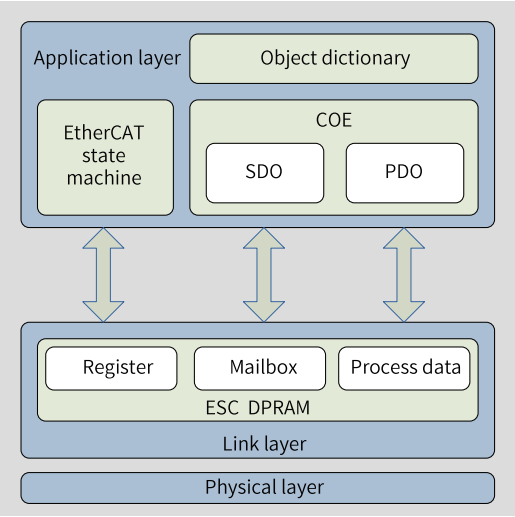
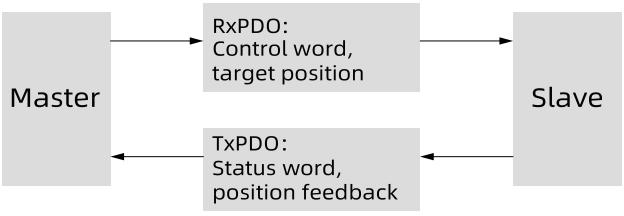


Figure 13-3 EtherCAT communication structure at CANopen application layer

The object dictionary in the application layer contains communication parameters, application data, and PDO mapping data. The process data object (PDO) includes the real-time data generated during operation, which is read and written cyclically. In the SDO mailbox communication, communication parameter objects and PDO process data objects are aperiodically accessed and modified.

13.7 Process Data

The real-time data transmission of EtherCAT is achieved through PDO. PDOs can be divided into RPDOs (Receive PDO) and TPDOs (Transmit PDO) based on the data transmission direction. RPDOs transmit the master data to the slave, and TPDOs returns the slave data to the master.



The ES680N series servo drive allows users to assign the PDO list and define the PDO mapped objects.

PDO mapped

The PDO mapped is used to establish the mapped relation between the object dictionary and the PDO. 1600h to 17FFh are RPDOs, and 1A00h to 1BFFh are TPDOs. The ES680N series servo drive provides 6 RPDOs and 5 TPDOs, as listed in the following table.

RPDO (6)	1600h	Mutable mapped
	1701h to 1705h	Fixed mapped
TPDO (5)	1A00h	Mutable mapped
	1B01h to 0x1B04h	Fixed mapped

a. Fixed PDO mapped

ES680N provides 5 fixed RPDOs and 4 fixed TPDOs.

The following table lists the typical instances of RPDOs and TPDOs.

Modes of operation available	PP/CSP
1701h (Outputs)	Mapped objects (4 mapped objects, 12 bytes)
	6040h (Control word) 607Ah (Target position) 60B8h (Touch probe function) 60FEh sub-index 1 (Forced physical outputs)
1B01h (Inputs)	Mapped objects (9 mapped objects, 28 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 60F4 (Following error actual value) 60B9 (Touch probe status) 60BA (Probe 1 rising edge position feedback) 60BC (Probe 2 rising edge position feedback) 60FD (Digital inputs)

Modes of operation available	PP/PV/PT/CSP/CSV/CST
1702h (Outputs)	Mapped objects (7 mapped objects, 19 bytes)
	6040h (Control word) 607Ah (Target position) 60FFh (Target velocity) 6071h (Target torque) 6060h (Modes of operation) 60B8h (Touch probe function) 607Fh (Max. profile velocity)

1B02h (Inputs)	Mapped objects (9 mapped objects, 25 bytes)
	603Fh (Error code)
	6041h (Status word)
	6064h (Position actual value)
	6077h (Torque actual value)
	6061h (Modes of operation display)
	60B9 (Touch probe status)
	60BA (Probe 1 rising edge position feedback)
	60BC (Probe 2 rising edge position feedback)
	60FD (Digital inputs)

Modes of operation available	PP/PV/CSP/CSV
1703h (Outputs)	Mapped objects (7 mapped objects, 17 bytes)
	6040h (Control word)
	607Ah (Target position)
	60FFh (Target velocity)
	6060h (Modes of operation)
	60B8h (Touch probe function)
	60E0h (Positive torque limit value)
	60E1h (Negative torque limit value)
1B03h (Inputs)	Mapped objects (10 mapped objects, 29 bytes)
	603Fh (Error code)
	6041h (Status word)
	6064h (Position actual value)
	6077h (Torque actual value)
	60F4 (Following error actual value)
	6061h (Modes of operation display)
	60B9 (Touch probe status)
	60BA (Probe 1 rising edge position feedback)
	60BC (Probe 2 rising edge position feedback)
	60FD (Digital inputs)

Modes of operation available	PP/PV/PT/CSP/CSV/CST
1704h (Outputs)	Mapped objects (9 mapped objects, 23 bytes)
	6040h (Control word)
	607Ah (Target position)
	60FFh (Target velocity)
	6071h (Target torque)
	6060h (Modes of operation)
	60B8h (Touch probe function)
	607Fh (Max. profile velocity)
	60E0h (Positive torque limit value)
	60E1h (Negative torque limit value)

1B02h (Inputs)	Mapped objects (9 mapped objects, 25 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 6061h (Modes of operation display) 60B9 (Touch probe status) 60BA (Probe 1 rising edge position feedback) 60BC (Probe 2 rising edge position feedback) 60FD (Digital inputs)

Modes of operation available	PP/PV/CSP/CSV
1705h (Outputs)	Mapped objects (8 mapped objects, 19 bytes)
	6040h (Control word) 607Ah (Target position) 60FFh (Target velocity) 6060h (Modes of operation) 60B8h (Touch probe function) 60E0h (Positive torque limit value) 60E1h (Negative torque limit value) 60B2h (Torque offset)
1B04h (Inputs)	Mapped objects (10 mapped objects, 29 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 6061h (Modes of operation display) 60F4 (Following error actual value) 60B9 (Touch probe status) 60BA (Probe 1 rising edge position feedback) 60BC (Probe 2 rising edge position feedback) 606C (Velocity actual value)

Variable PDO mapped

The ES680N provides one fixed RPDO and one fixed TPDO.

Variable PDO	Index	Max. number of mapped objects	Max. length of the byte	Default mapped object
RPDO1	1600h	10	40	6040h (Control word) 607Ah (Target position) 60B8 (Touch probe function)
TPDO1	1A00h	10	40	603F (Error code) 6041 (Status word) 6064 (Position actual value) 60BC (Probe 2 rising edge position feedback) 60B9 (Touch probe status) 60BA (Probe 1 rising edge position feedback) 60FD (Digital inputs)

Sync manager PDO assignment

The process data can contain multiple PDO mapped data objects during cyclic EtherCAT data communication. The CoE protocol defines the PDO mapped object list of the Sync Manager using data objects 0x1C10 to 0x1C2F. Multiple PDOs can be mapped to different sub-indexes. The ES680N series servo drive supports assignment of one RPDO and one TPDO, as described in the following table.

Index	Sub-index	Description
0x1C12	01h	One of 0x1600 and 0x1701...0x1705 selected as the RPDO to be used
0x1C13	01h	One of 0x1A00 and 0x1B01...0x1B04 selected as the TPDO to be used

Configuring PDO

PDO mapped parameters include pointers of process data that corresponds to PDO and that is to be sent or received by PDO, including index, sub-index, and mapped object length. The sub-index 0 indicates the number (N) of mapped objects in the PDO, and the maximum length of each PDO is 4 x N bytes. One or multiple objects can be mapped simultaneously. Sub-indexes 1 to N indicate the mapped content. The following defines mapped parameters.

bit	31	...	16	15	...	8	7	...	0
Descrip-tion	Index			Sub-index			Object length		

The index and sub-index together define the position of an object in the object dictionary. The object length indicates the bit length of the object in hexadecimal, as shown below.

Object length	Bit length
08h	8-bit
10h	16-bit
20h	32-bit

For example, the mapped parameter of the 16-bit control word 6040h-00 is 60400010h.

- Observe the following procedure for PDO configuration:
  Follow the following PDO mapped configuration:

  1. Configure the mapped group of PDO. Write 0 to sub-index 00h of 1C12h (or 1C13h).

a. Clear the original mapped group. Write 0 to sub-index 00h of 1C12h (or 1C13h) to clear the original mapped group.
b. Write the PDO mapped group. Write the mapped group according to application needs. Pre-write values of 1600h/1701h...1705h to 1C12h and values of 1A00h/1B01h...1B04h to 1C13h. Note: Only 1600h and 1A00h are configurable mapped groups.
c. Write the total number of this PDO mapped group to sub-index 0 of 1C12h (or 0x1C13h).

2. Configure the mapped objects of PDO. Write 0 in sub-index 00h of 1600h (or 1A00h).

a. Clear the original mapped objects. Write 0 to sub-index 00h of 1600h (or 1A00h) to clear the original mapped objects.
b. Write the PDO mapped content. Write the mapped content to sub-index 1...10 of the mapped parameter based on object parameter definitions in XML file. Only mappable objects can be configured as PDO mapped content.
c. Write the total number of mapped objects. Write the number of mapped objects in step b to sub-index 0.

Note

- Configure the PDO only when the EtherCAT state machine is in Pre-operational state ("2" displayed on the operating panel). Otherwise, an error is reported.
- PDO configuration parameters cannot be saved to EEPROM. Configure the mapped objects again each time after power-on. Otherwise, the mapped objects are default parameters of the drive.

An SDO fault code will be returned when the following operations are under execution:

- Modify PDO parameters in status other than pre-operational.
- Write a value outside the range of 1600h/1701h...1705h to 1C12. Write a value outside the range of 1A00h/1B01h...1B04h to 1C13.

13.8 Communication State Machine

- Introduction to CiA402 control

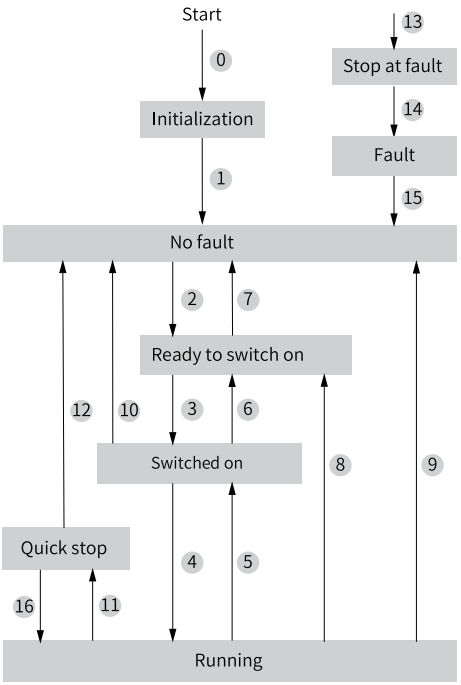


Figure 13-4 Switchover of the CiA402 state machine

To make the servo drive run in the designated state, observe the process stipulated in the standard 402 protocol when operating the ES680N servo drive.

See the following table for descriptions of different status.

Status	Description
Initializing	Initialization of the servo drive and internal self-inspection are done. Parameters cannot be set. Drive functions cannot be executed.
No fault	No fault exists in the servo drive or the fault has been cleared. Parameters can be set.
Ready to switch on	The servo drive is ready to run. Parameters can be set.
Wait for the S-ON signal	The servo drive is waiting for the S-ON signal. Parameters can be set.
Servo running	The servo drive is running properly and a certain operation mode is enabled. The motor is energized and starts rotating when the speed reference is not 0. Only parameters whose "Effective time" is "During running" can be set.
Quick stop	Quick stop is activated and the servo drive is in the process of quick stop. Only parameters whose "Effective time" is "During running" can be set.
Stop at fault	A fault occurs and the servo drive is in the process of stop. Only parameters whose "Effective time" is "During running" can be set.
Fault	The stop process is done and all the drive functions are disabled. Parameters can be modified for troubleshooting purpose.

- The following figure shows the status transition diagram of EtherCAT state machine.

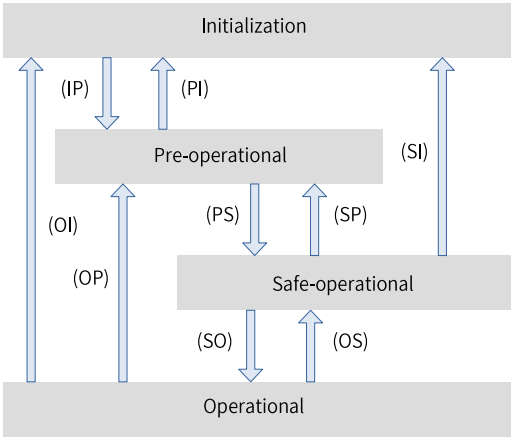


Figure 13-5 EtherCAT state machine

The EtherCAT state machine must support the following four states and coordinate the states between the master and slave application program during initialization and operation.

- Init: initialization, shortened as I
- Pre-Operational: pre-operational, shortened as P
- Safe-Operational: safe-operational, shortened as S
- Operational: operational, shortened as O

Transition from Init state to Operational state must be in the sequence of Init→Pre-Operational→Safe→Operational, and then Operational step by step. In transition from the Operational state to the Init state, certain steps can be skipped. The following table lists the state transition and the initialization process.

Status	SDO	RPDO	TPDO	Description
Init (I)	No	No	No	Communication initialization No communication available in the application layer, EtherCAT slave controller (ESC) register can only be read/ written by the master
IP	No	No	No	The master configures the slave addresses, mailboxes, and distributed clocks (DCs). Request for the Pre-Operational state.
Pre-Operational (P)	Yes	No	No	Mailbox data communication in the application layer (SDO)
PS	Yes	No	No	The master uses process data mapping of SDO initialization. The master configures the Sync Manager channel used during process data communication. The master configures the FMMU. Request for the Safe-Operational state.
Safe-Operational (S)	Yes	No	Yes	SDO, TPDO, and distributed clock mode can be used.
SO	Yes	No	Yes	The master sends valid output data to request the Operational state.

Status	SDO	RPDO	TPDO	Description
Operational (O)	Yes	Yes	Yes	Normal operational state Both the input and output are active. Mailbox communication can still be used.

13.9 Service Data Object (SDO)

The EtherCAT SDO is used to transfer non-cyclic data, such as communication parameter configuration and servo drive parameter configuration. The CoE service types of EtherCAT include:

- Emergency message
- SDO request:
- SDO response:
- TxPDO
- RxPDO
- Remote TxPDO transmission request
- Remote RxPDO transmission request
- SDO information.

The drive supports SDO request and SDO response.

13.10 Distributed Clock

The distributed clock (DC) enables all EtherCAT devices to use the same system time and allows synchronous execution of slave tasks. A slave can generate synchronous signals according to the synchronized system time. The ES680N series servo drive supports the DC synchronization mode only. The synchronization cycle is determined by SYNC0. The cycle range varies with the operation mode.

Note

- The SYNC signal can be used to synchronize all the salves with an error less than 1 μs. The master must synchronize all the slaves to the same clock and continues doing so during operation to prevent clock skew caused by the difference in the crystal oscillator. This parameter is used to synchronize the 0x910 register of the ESC.
- SYNC startup time = 0x990 register (with ESC) - 0x920 Note that the DC mode (0x981 = 0x03) can be enabled only after 0x910 reaches the startup time. If the startup time of SYNC is set improperly, the 0x134 status register of ESC reports error code 0x2D.

14 Maintenance and Repair

14.1 Daily Maintenance

14.1.1 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 product. It is recommended to make a copy of this checklist and sign the "Checked" column after each inspection.

Item	Description	Solution	Result
Motor	The motor encounters unusual vibration and noise.	• Ensure mechanical connections are normal. • Ensure no phase loss occurs on the motor. • Check whether motor screws are tightened.	□
Cooling fan	Check whether the fans of the drive and the motor work properly.	• Ensure the fan on the device side operates normally. • Ensure the fan on the device side operates normally. • Ensure the ventilation channel is not blocked. • Ensure that the ambient temperature is within the allowable range.	□
Installation Environment	The control cabinet and cable ducts are abnormal.	• Check that the insulation of the inlet/outlet cable is intact. • Check that the mounting bracket does not vibrate. • Check that the copper busbar and cable terminals are connected properly or are not corroded.	□
Load	The operating current of the drive exceeds the rated current of the drive and motor.	• Ensure motor parameters are set properly. • Ensure motor overload does not occur. • Ensure that the mechanical vibration is below 1 g.	□
Input voltage	The supply voltage between the main circuit and control circuit is abnormal.	• Ensure that the input voltage is within the allowable range. • Check that no heavy loads are starting nearby.	□

14.1.2 Daily Cleaning Items

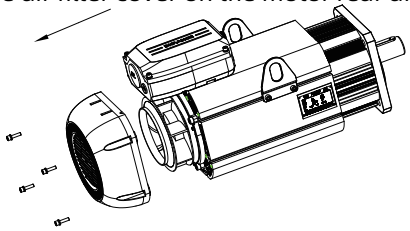
Perform routine cleaning according to the following table.

Table 14–1 Routine cleaning list

No.	Daily Cleaning Items	Tick
1	Clean the dust on the equipment surface, especially the metallic dust.	☐
2	Clean the air filter and the fan blades.	☐
3	Keep the front end of the servo drive and the connectors clean.	☐

The following takes the motor as an example to describe how to clean the air filter and fan blades.

- Remove the bolts used to fix the air filter cover on the motor rear and take off the cover.



- Use a piece of cloth dipped with alcohol to wipe the fan blades. Use an air gun to blow off the dust inside the air filter on the front cover side. After clean-up, re-install the air filter cover.

Note

- Cut off the power supply before cleaning. Clean the equipment with an air gun or a piece of dry cloth.
- Do not use the gasoline, diluent, alcohol, acidic or alkaline detergent during cleaning to prevent enclosure discoloration or damage.
- In application sites where cotton fibers and objects with high absorptivity can be easily attracted to the drive, such as shoe machineries and textile machineries, clean the air filter at least once every 31 days.

14.2 Periodic Maintenance

14.2.1 Periodic Checklist

Perform periodic inspection on items that are difficult to check during operation. Clear the dust especially metal powders on the surface of the drive to prevent the dust from entering the drive. Clear the greasy dirt from the cooling fan of the drive.

Caution

- To prevent electric shock, never perform inspection at power-on.
- Before inspection, disconnect all the power supplies and wait for at least 10 minutes to avoid risks caused by the residual voltage in the capacitor of the drive.

Item	Description	Precautions	Checked
Drive	There are waste, dirt, or dust on the surface.	• Ensure the controller cabinet is powered off. • Use a vacuum cleaner to suck up waste and dust to prevent direct contact with the parts. • For stubborn surface dirt, wipe up the dirt with a piece of soft cloth immersed in alcohol.	☐
Cable	• Power cables and connections are discolored. • The insulation is aged or cracked.	• Replace the cracked cables. • Replace the damaged terminal.	☐
Peripheral components of the electromagnetic contactor	• The contactor cannot be closed tightly or generates unexpected noise during operation. • Short circuit, water stain, expansion or cracking occurs on any peripheral device.	Replace such defective components.	☐
Air duct	• The air duct and heatsink are clogged. • The fan is damaged.	• Clean the air duct. • Replace the fan.	☐
Control circuit	• Control components are in poor contact. • Terminal screws are loose. • The insulation of the control cable is cracked.	• Clean the surface of control circuit cables and terminals. • Replace control circuit cables that are damaged or corroded.	☐

14.2.2 Regular Maintenance

The electrical and electronic parts inside the drive may be mechanically worn out and degraded. To keep the drive and servo motor in good condition, perform parts replacement based on the following table. Contact Inovance or Inovance agent before replacement to double check whether the part needs to be replaced.

Target	Category	Standard replacement interval	Remarks
Drive	Bus filter capacitor	About five years	The standard replacement cycle is for reference only. If any device/component works improperly before the replacement cycle expires, replace it immediately.
	Cooling fan	2 to 3 years (10,000 h to 30,000 h)	
	Aluminum electrolytic capacitor on the PCB	About five years	
	Pre-charge relay	100,000 operations (depending on the operating conditions)	
	Pre-charge resistor	20,000 operations (depending on the operating conditions)	
Motor	Bearing	3 to 5 years (20,000 h to 30,000 h)	
	Cooling fan	30000 h	
	Oil seal	5000 h	
	Encoder	3 to 5 years (20,000 h to 30,000 h)	

14.3 Component Replacement

14.3.1 Replacing the Cooling Fan

- Possible causes of fan 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.

Fan quantity

Table 14–2 Number of fans (three-phase 380 V to 480 V)

Type	Model	Number of fans
Drive	T4	2
	T5, T6	1
	T7-55 kW	1
	T7-75 kW	2
	T8	2
	T9	3
Motor	MEG20, MEG23	1

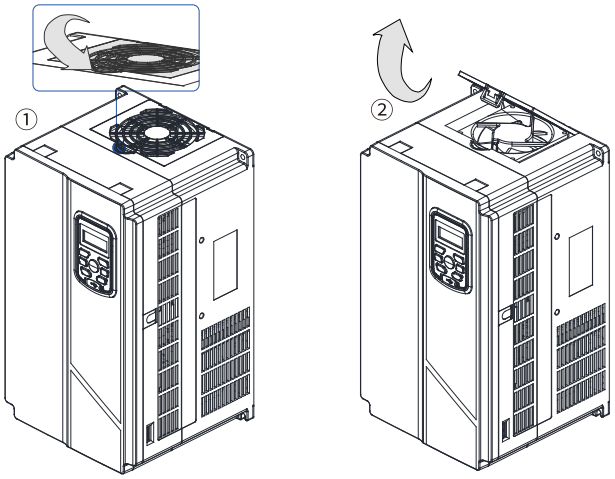
Note

The number and location of cooling fans vary with product models, but the fans are removed and installed in the same way.

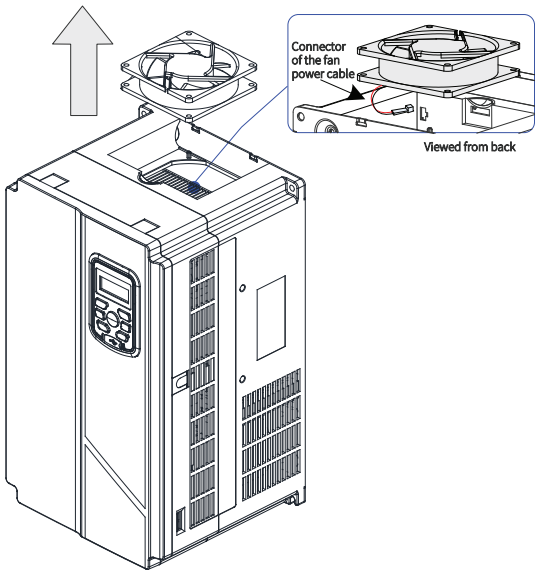
Removing and installing the fan of T4 to T6 models

Removing the fan (T6 as an example)

Step 1. Press the snap-fit joint on the fan cover gently and remove the cover.



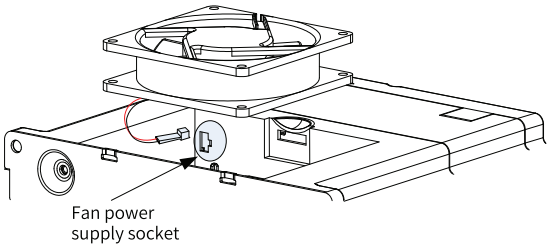
Step 2. Pull the fan upwards and unplug the power cable connector from the socket.



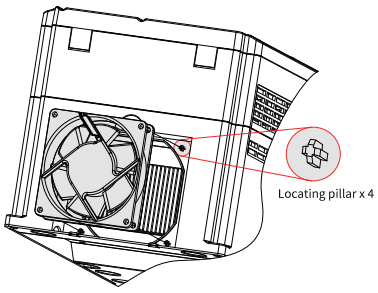
Installing the fan (T6 as an example)

- 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.

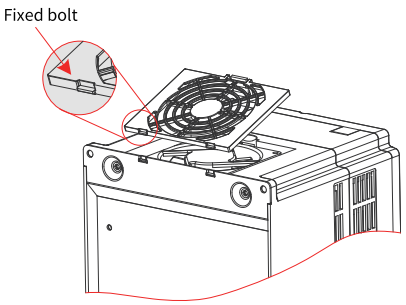
Step 1. Plug the fan power cable connector to the socket.



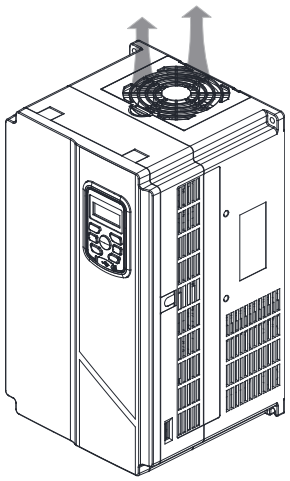
Step 2. Install the fan into the drive, with the four fixing holes at the bottom of the fan aligned with the positioning pins.



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.



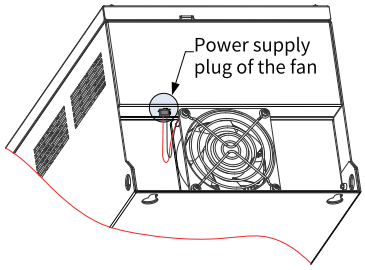
Step 4. After replacing the fan, ensure the fan blows the air upwards.



Removing and installing the fan of T7 to T8 models

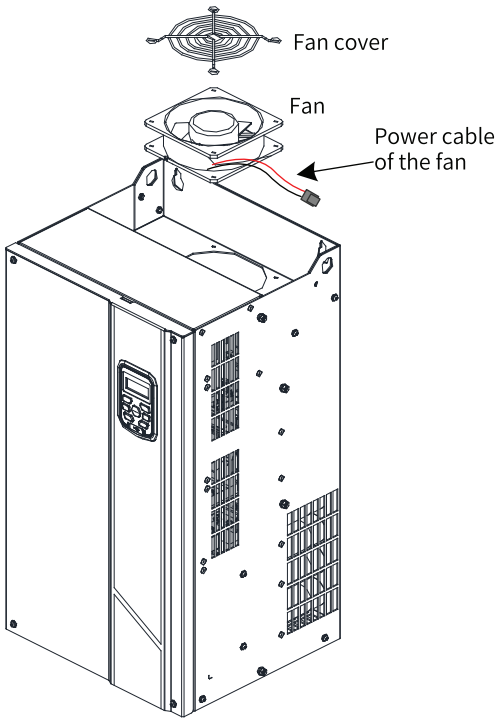
Removing the fan (T7 as an example)

Step 1. Unplug the fan power cable plug from the socket (top view).



Step 2. Remove the four fixing screws from the fan cover with a screwdriver.

Step 3. Remove the fan and fan cover from the drive.



Installing the fan (T7 as an example)

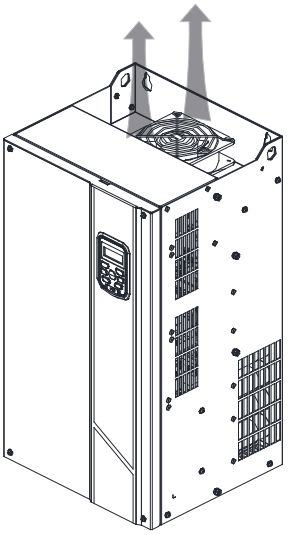
Note

- Install the fan in reverse order of removal and ensure the correct direction of the fan.
- Viewed from the rear fan cover, the fan rotates clockwise to blow air into the motor air filter.

Step 1. Install the fan and fan cover on the drive. Note that the fixed holes are aligned.

Step 2. Plug in the fan power cable plug into the socket.

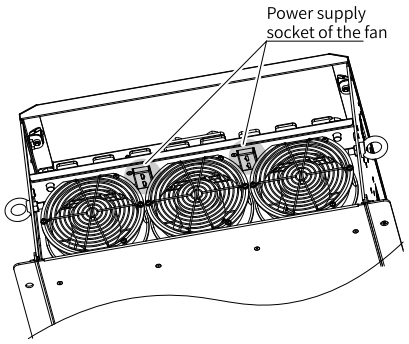
Step 3. After replacing the fan, ensure the fan blows the air upwards.



Removing and installing the fan of T9 models

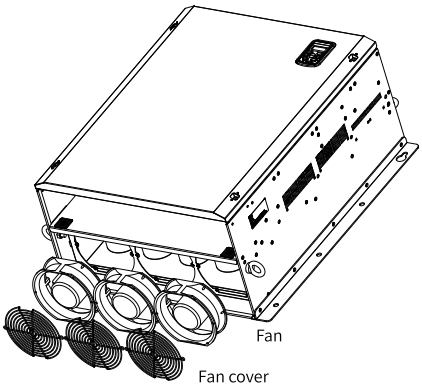
Removing the fan

Step 1. Unplug the fan power cable plug from the socket (top view).



Step 2. Remove the four fixing screws from the fan cover with a screwdriver.

Step 3. Remove the fan and fan cover from the drive.



Installing the fan

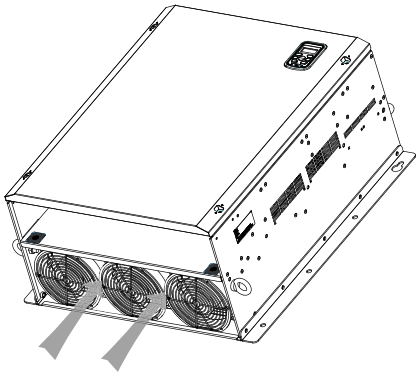
Note

- Install the fan by following the same steps, but in the reverse order. Pay attention to the 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. Install the fan and fan cover on the drive. Note that the fixed holes are aligned.

Step 2. Plug in the fan power cable plug into the socket.

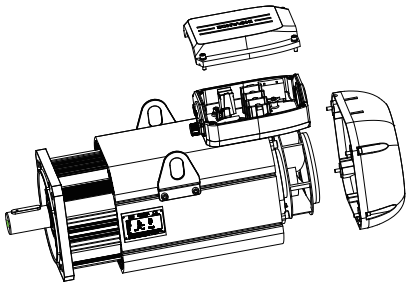
Step 3. After replacing the fan, ensure the fan blows the air upwards.



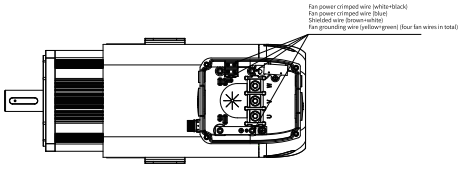
Removing and installing the MEG motor fan

Removing the fan

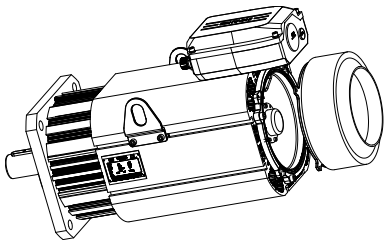
Step 1. Remove the cover of the junction box and the rear cover of the fan with a hexagon wrench.



Step 2. Remove the power crimping cables (white+black/blue), shielded cable (brown+white), and grounding cable (yellow-green) of the fan.



Step 3. Remove the cover of the fan with a hexagon wrench.



Step 4. Remove the fan with a hexagon wrench and pull the fan cable out through the cable outlet hole.

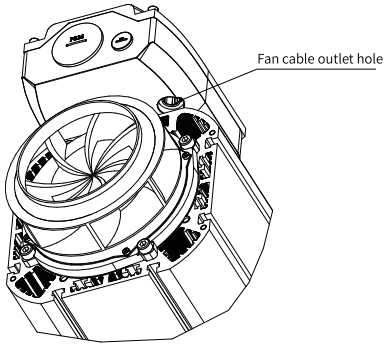
Installing the fan

Note

- Install the fan in reverse order of removal and ensure the correct direction of the fan.
- Viewed from the rear fan cover, the fan rotates clockwise to blow air into the motor air filter.

Step 1. Install the fan to the fan cover.

Step 2. Pass the fan cable through the fan cable outlet hole of the junction box, and then install the fan cover to the rear end cover.



Step 3. Lock the power crimping cables (white+black/blue) to the power terminals of the fan. Crimp the shielded cable (brown+white) and lock the shielded cable and the grounding cable (yellow-green) of the fan to the grounding plate.

Step 4. Finally, lock the junction box cover and the rear cover of the fan.

14.3.2 Replacing the Electrolytic Capacitor

Category	Remark
Possible cause	Input power supply unstable, high ambient temperature, frequent load fluctuations and electrolyte aging
Judging criteria	Check whether there is liquid leakage. Check whether the safety valve has projected. Measure the static capacitance. Measure the insulating resistance.
Replacement	To avoid damage to other components, contact Inovance for replacing the electrolytic capacitor.

14.3.3 Replacing the Motor Flat Key

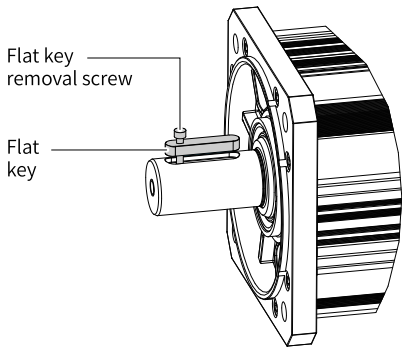
The motor flat key is equipped with the disassembly hole. See the following table for specifications of the disassembly bolt.

Motor specifications	Dimensions of the flat key (mm x mm x mm x mm)	Specifications of the disassembly bolt (inner hexagon bolt) (inner hexagon bolt)	Property class
MEG20	Type-A flat key - 8 x 12 x 56	M5 x 10 and above	8.8 and above
MEG23	Type-A flat key - 9 x 14 x 90	M5 x 10 and above	8.8 and above

Removing the flat key

Step 1. Use an Allen wrench to screw down the disassembly bolt into the disassembly hole to push the flat key out.

Step 2. Disassemble the flat key.



Installing the flat key

1. Align the flat key to the recess.

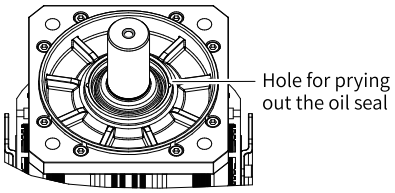
2. Tap the flat key into the recess with a rubber mallet to install the flat key.

14.3.4 Replacing the Motor Oil Seal

Removing the oil seal

Step 1. When removing the oil seal, put a piece of cloth near the hole where the oil seal is pried out. This is to prevent the end cover from being scratched.

Step 2. Secure the motor properly and hold the outer lip of the oil seal with either end of the needle-nose pliers. Then pry out either or both holes to remove the oil seal, as shown below.



Step 3. Pry out the oil seal slowly.

Installing the oil seal

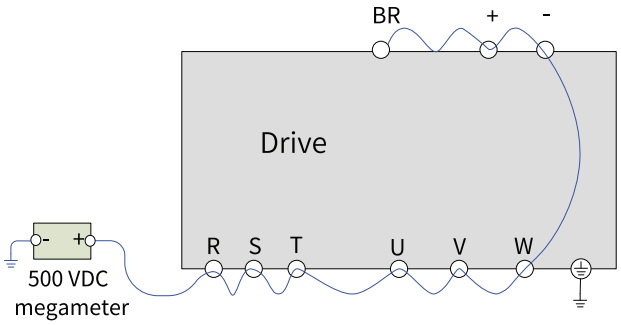
Reinstall the fan based on the same procedure, but in the reverse order.

14.4 Main Circuit Insulation Test

Danger

Do not perform high voltage test (> 500 V) again because it has been done before delivery.

- Remove the voltage dependent resistor screw before test and disconnect the voltage dependent resistor.
- Before measuring the insulation resistance with a megameter (500 VDC megameter recommended), disconnect the main circuit from the drive. Do not test the main circuit insulation with the insulation resistance meter, as shown below.



- The measured insulation resistance must be greater than 5 MΩ.

14.5 Storage and Warranty

Storage

For storage of the product, observe the following requirements.

- Try to store the product with the original packing box provided by Inovance.
- Do not expose the product 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 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 disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. Maintenance will be charged after the warranty expires.

Within the warranty period, maintenance 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.

15 Troubleshooting

15.1 Fault Levels

Fault and alarm levels

Faults and alarms of the drive are divided into three levels based on severity: No. 1 > No. 2 > No. 3, as shown below.

- No. 1 non-resettable fault
- No. 1 resettable fault
- No. 2 resettable fault
- No. 3 resettable alarm

"Reset" means the operating panel stops displaying the fault/alarm status once a "Reset signal" is input.

To stop the operating panel from displaying the fault/alarm, set H0d.01 to 1 (Fault reset enabled) or activate the logic of the DI assigned with FunIN.2 (ALM-RST, fault and alarm reset).

- To reset No. 1 and No. 2 resettable faults, switch off the S-ON signal first and then set H0d.01 to 1 or use FunIN.2 (ALM-RST).
- To reset No. 3 alarms, set H0d.01 to 1 or activate the DI terminal allocated with DI function 9.

Note

- Some faults/alarms can only be reset after the fault causes are rectified through setting modifications. However, a reset operation does not activate modifications.
- If the modification can be effective only after power-on, reconnect the control power.
- If the modification can be effective only after stop, turn off the S-ON signal. The servo drive can operate properly only after modifications are activated.

☆Related parameters:

Param.	Name	Value range	Name	Setting mode	Effective time	Default
H0d.01	Fault reset	0 - No action 1 - Reset the fault and alarm	Used to stop the operating panel from displaying the fault/alarm when a resettable fault/alarm occurs. This parameter is set to 0 immediately after fault reset.	At stop	Real time	0

☆Related function No.:

Code	Name	Description	Name
FunIN.2	ALM-RST	Fault/Alarm reset signal	The drive may, depending on the alarm type, continue operating after reset. When FunIN.2 is assigned to a low-speed DI, the effective level change of this DI must be kept for more than 3 ms. Otherwise, fault reset will be inactive. Do not assign FunIN.2 to a high-speed DI. Otherwise, fault/alarm reset will be inactive. • Inactive: Not resetting the fault/alarm • Valid: Fault/alarm reset

Fault and alarm Log

The servo drive can record the latest 10 faults and alarms and values of status parameters upon fault/alarm. Among the latest 5 faults/alarms, if a fault/alarm occurs repetitively, the servo drive records the fault/alarm code and the drive status only once.

After fault/alarm reset is successful, servo drive still records the fault/alarm. To remove the fault/alarm from the fault log, set H02-31 (System parameter initialization) to 1 or 2.

You can select the specific fault/alarm in H0b.33, view the corresponding fault/alarm code in H0b.34 and the values of status parameters in H0b.35...H0b.42. For details of these parameters, see Chapter "Parameter List". If no fault occurs, the operating panel displays "E000" in H0b.34.

The operating panel displays "Exxx" when you view H0b.34 (Fault code of the selected fault) through the panel. In "Exxx", "xxx" is the fault/alarm code. The value of H0b.34 read through the software tool or communication is a decimal, which needs to be converted to a hexadecimal equivalent to indicate the actual fault/alarm code. The following table gives examples of such conversion.

Exxx	H0b.34 (Decimal)	H0b.34 (Hexadecimal)	Remarks
E101.0	257	0101	0: No. 1 non-resettable fault 101: Fault code
E130.0	8496	2130	2: No. 1 resettable fault 130: Fault code
E121.0	24865	6121	6: No.2 resettable fault 121: Fault code
E110.0	57616	E110	E: No. 3 resettable alarm 110: Alarm code

Fault and alarm List

- No. 1 non-resettable faults:

Table 15–1 List of No. 1 non-resettable faults

Display	Name	Type	Reset
E101.0	Internal parameter error	No. 1	No
E101.1	Abnormal parameters in group H00/H01	No. 1	No
E102.0	FPGA communication initialization error	No. 1	No
E102.8	FPGA and MCU version mismatch	No. 1	No
E104.1	MCU operation timeout (MCU crashed)	No. 1	No

Display	Name	Type	Reset
E104.2	FPGA operation timeout (FPGA crashed)	No. 1	No
E104.4	MCU command update timeout	No. 1	No
E120.0	Unknown encoder model	No. 1	No
E120.1	Unknown motor model	No. 1	No
E120.2	Unknown drive model	No. 1	No
E120.6	Model mismatch	No. 1	No
E136.0	Encoder ROM motor parameter check error	No. 1	No
E136.1	Encoder ROM motor parameter read error	No. 1	No
E140.0	Encryption integrated circuit check error	No. 1	No
E140.1	Encryption integrated circuit check failure	No. 1	No
E140.2	Encryption integrated circuit version error	No. 1	No
E140.3	Encrypted integrated circuit damaged	No. 1	No
E201.1	Phase-U overcurrent	No. 1	No
E201.2	Phase-V overcurrent	No. 1	No
E201.3	Hardware overcurrent	No. 1	No
E210.0	Ground fault detection error	No. 1	No
E234.0	Runaway protection	No. 1	No
E740.2	Absolute encoder communication fault	No. 1	No
E740.3	Absolute encoder single-turn calculation error	No. 1	No
E740.6	Encoder write fault	No. 1	No
EA33.0	Encoder data error	No. 1	No
EA34	Encoder echo check error	No. 1	No
E750.2	Encoder parity error	No. 1	No
E750.3	Encoder data error	No. 1	No
E750.4	Encoder DosFlagError	No. 1	No
E750.5	Encoder LotFlagError	No. 1	No
E750.6	Encoder AbsCntError	No. 1	No
EE12.0	ECAT initialization failure	No. 1	No

Note

The value "1" indicates valid and "0" indicates invalid. "1" and "0" do not indicate high and low levels of DO terminals.

- No. 1 resettable faults

Table 15–2 List of No. 1 resettable faults

Display	Name	Type	Reset
E150.0	STO safety state applied	No. 1	Yes
E150.1	STO input state error	No. 1	Yes
E150.2	Buffer5V voltage error	No. 1	Yes
E150.3	STO upstream optocoupler short-circuited	No. 1	Yes
E150.4	Buffer power-on detection error	No. 1	Yes
E206.0	Switching frequency error	No. 1	Yes
E208.0	MCU position reference updated frequently	No. 1	Yes

Display	Name	Type	Reset
E208.2	Encoder communication timeout	No. 1	Yes
E208.3	Current sampling fault	No. 1	Yes
E208.4	FPGA current loop operation timeout	No. 1	Yes
E234.1	Torque reference too low	No. 1	Yes
E234.2	Excessive speed deviation	No. 1	Yes
E400.0	Main circuit overvoltage	No. 1	Yes
E410.0	Main circuit undervoltage	No. 1	Yes
E500.0	Motor overspeed	No. 1	Yes
E500.1	Speed feedback overflow	No. 1	Yes
E500.2	FPGA position feedback overspeed	No. 1	Yes
E602.0	Angle auto-tuning stall	No. 1	Yes
E602.2	Reverse U/V/W phase sequence detected in angle auto-tuning	No. 1	Yes
E605.0	Bootstrap speed too fast	No. 1	Yes
E606.0	Pre-charge resistor overload	No. 1	Yes
E607.0	ON-time of braking resistor too long	No. 1	Yes
E610.0	OEM overload	No. 1	Yes
E620.0	Fan fault detection	No. 1	Yes
E630.0	Motor stall	No. 1	Yes
E630.1	Motor stall	No. 1	Yes
E650.0	Heatsink overtemperature	No. 1	Yes
E660.0	Motor overtemperature	No. 1	Yes
E660.1	PT1000 short-circuited	No. 1	Yes
E660.2	PT1000 open circuit	No. 1	Yes
E770.0	External encoder scale fault	No. 1	Yes
E770.1	External encoder scale fault	No. 1	Yes
E770.2	External encoder scale fault	No. 1	Yes

- No. 2 resettable faults

Table 15–3 List of No. 2 resettable faults

Display	Name	Type	Reset
E122.0	Multi-turn absolute encoder setting error	No. 2	Yes
E122.1	DI function assignment fault	No. 2	Yes
E122.2	DO function assignment fault	No. 2	Yes
E122.3	Upper limit in rotation mode too high	No. 2	Yes
E420.0	Main circuit phase loss	No. 2	Yes

Display	Name	Type	Reset
E440.0	Output phase loss	No. 2	Yes
E661.0	Gain values generated in one-key tuning too low	No. 2	Yes
E731.0	Encoder battery failure	No. 2	Yes
E733.0	Encoder multi-turn counting error	No. 2	Yes
E735.0	Encoder multi-turn counting overflow	No. 2	Yes
E760.0	Encoder overtemperature	No. 2	Yes
EB00.0	Excessive position deviation	No. 2	Yes
EB00.1	Position deviation overflow	No. 2	Yes
EB01.0	Position reference incremental error	No. 2	Yes
EB01.1	Individual position reference increment being excessive	No. 2	Yes
EB01.2	Position reference increment being excessive continuously	No. 2	Yes
EB01.3	Target position overflow near the upper/lower limit of the signed 32-bit number	No. 2	Yes
EB01.4	Target position exceeding the max. value of mechanical single-turn position	No. 2	Yes
ED07.6	Bus disconnection error	No. 2	Yes
ED08.6	Bus PDO transmission length error	No. 2	Yes
ED09.6	Lower limit of software position higher than the upper limit	No. 2	Yes
ED10.6	Home offset outside the software position limit	No. 2	Yes
ED11.6	Synchronization frame error exceeding 1/4 of the synchronization cycle	No. 2	Yes
EE08.0	Synchronization loss	No. 2	Yes
EE08.1	Network status switchover error	No. 2	Yes
EE08.2	IRQ loss	No. 2	Yes
EE08.3	E08 caused by link loss	No. 2	Yes
EE08.4	RxErr incurred by Port0 link interference	No. 2	Yes
EE08.5	Transfer error	No. 2	Yes
EE08.6	No data received	No. 2	Yes
EE09.0	Software position limit setting error	No. 2	Yes
EE09.1	Home setting error	No. 2	Yes

Display	Name	Type	Reset
EE09.2	Bus gear ratio beyond the limit	No. 2	Yes
EE09.3	No synchronization signal	No. 2	Yes
EE09.5	Number of PDO mapped objects exceeding 10	No. 2	Yes
EE11.0	ESI check error	No. 2	Yes
EE11.1	EEPROM read failure	No. 2	Yes
EE11.2	EEPROM update failure	No. 2	Yes
EE13.0	EtherCAT synchronization cycle setting error	No. 2	Yes
EE15.0	Excessive EtherCAT synchronization cycle error	No. 2	Yes

- No. 3 resettable alarms

Table 15–4 List of resettable alarms

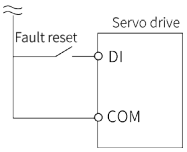
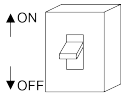
Display	Name	Type	Reset
E108.0	Parameter write fault	No. 2	Yes
E108.1	Parameter read fault	No. 2	Yes
E108.2	Invalid check on data written in EEPROM	No. 2	Yes
E108.3	Invalid check on data read in EEPROM	No. 2	Yes
E121.0	S-ON command invalid	No. 2	Yes
E600.0	Alarm for inertia auto-tuning failure	No. 2	Yes
E601.0	Homing timeout alarm	No. 2	Yes
E601.1	Homing switch error	No. 2	Yes
E601.2	Homing mode setting error	No. 2	Yes
E640.0	EEPROM parameter configuration error	No. 2	Yes
E640.2	New driver board	No. 2	Yes
E640.3	Old driver board model read error	No. 2	Yes
E640.4	Inconsistent with main control board parameters	No. 2	Yes
E640.6	Main control board parameter exceeding the limit	No. 2	Yes
E730.0	Encoder battery alarm	No. 2	Yes
E900.0	Emergency stop alarm	No. 2	Yes
E902.2	Invalid setting for torque reach	No. 2	Yes
E904.0	Cyclic monitoring alarm	No. 2	Yes
E909.0	Motor overload alarm	No. 2	Yes
E910.0	Control circuit overvoltage	No. 2	Yes
E920.0	Braking resistor overload	No. 2	Yes

Display	Name	Type	Reset
E922.0	Resistance of the external braking resistor too low	No. 2	Yes
E924.0	Braking transistor overload alarm	No. 2	Yes
E941.0	Parameters changed can be activated at next power-on only	No. 2	Yes
E942.0	Frequent parameter storage	No. 2	Yes
E950.0	Forward overtravel alarm	No. 2	Yes
E952.0	Reverse overtravel alarm	No. 2	Yes
EA41.0	Torque ripple compensation failure	No. 2	Yes
E831.1	Excessive AI zero offset	No. 2	Yes
E834.1	AD sampling overvoltage alarm of MCU	No. 2	Yes
E831.2	Excessive AI zero offset	No. 2	Yes
E834.2	AD sampling overvoltage alarm of MCU	No. 2	Yes
E831.3	Excessive AI zero offset	No. 2	Yes
E834.3	AD sampling overvoltage alarm of MCU	No. 2	Yes

15.2 Restart upon Fault Events

Table 15–5 Restart methods upon fault events

Stage	Solution	Remarks
Upon occurrence of fault	View the operating panel for detailed information of the latest five faults, including the time, fault type, speed, current, bus voltage and DI/DO state upon occurrence of the fault.	Check the information through H0B.34 to H0B.43.
Before fault reset	Find and rectify the fault cause according to the fault type displayed on the operating panel.	Rectify the fault according to *"15.4 List of fault codes" on page 230*.

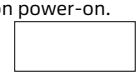
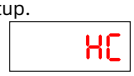
Stage	Solution	Remarks
Fault reset methods	1. Assign the DI with function 2 (Fault reset) by setting any of H03.02 to H03.10 to 2.	
	2. Check that H0D.01 is set to 1, indicating the fault can be reset by pressing  in any operation mode.	Hold the STOP/RES key down for 2s on the operating panel.
	(3) Power off and then power on the drive, so that the drive is reset automatically. 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. Write "7" (Fault reset) to the communication address 2000H through the host controller.	

Note

When automatic fault reset and automatic restart are enabled, ensure that unexpected equipment operation will not cause personal injury or mechanical damage. This function is strictly prohibited for vertical lifting applications; otherwise, heavy loads may fall out of control.

15.3 Troubleshooting

15.3.1 Troubleshooting

No.	Fault 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 input power supply.
		The switched-mode power supply on the driver board of the drive is faulty.	Check the bus voltage.
		The control board is disconnected from the driver board and operating panel.	Re-connect the 40-pin flat cable.
		The buffer resistor of the drive is damaged.	Contact Inovance for technical support.
		The control board or the operating panel is faulty.	
		The rectifier bridge is damaged.	
		The cable connecting the driver board and the control board is in poor contact.	Re-connect the 40-pin flat cable.
		Related components on the control board are damaged.	Contact Inovance for technical support.
		The motor or the motor cable is short-circuited to ground.	
		The Hall device is faulty.	
		The grid voltage is excessively low.	
2	The display is normal upon power-on, but "HC" is displayed and the drive stops immediately after startup. 	The fan is damaged or does not rotate.	Replace the fan.
		The cable of the external control terminal is short-circuited.	Rectify peripheral short circuit fault.
3	The motor does not rotate after the drive runs.	Check whether the motor cables are connected properly.	Check whether the drive and motor are connected properly.
		Drive parameters are set improperly (motor parameters).	Restore parameters to default settings and reset related parameters. Check whether encoder parameters and rated motor specifications (such as rated motor frequency and rated motor speed) are set properly. Check whether H02-00 (Control mode) is set properly.
		The cable connecting the drive 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 Inovance for technical support.

No.	Fault symptom	Possible cause	Solution
4	The DI is inactive.	The related parameters are set incorrectly.	Check and reset the parameters in group F4 again.
		The external signal is incorrect.	Reconnect the external signal cable.
		Check whether the S1 DIP switch is set properly.	Check whether the S1 DIP switch is consistent with the actual wiring mode.
		The control board is faulty.	Contact Inovance for technical support.
5	Overcurrent and overvoltage is reported by the drive frequently.	Motor parameters are set incorrectly.	Reset motor parameters or perform motor parameter auto-tuning.
		The acceleration/deceleration time is improper.	Set the acceleration/deceleration time properly.
		The load fluctuates.	Contact Inovance for technical support.
6	Pre-charge resistor damaged	Check whether the drain wire of the braking resistor is bonded with the metal enclosure (short-circuited to PE).	Enhance the insulation of the drain wire of the braking resistor, such as winding the electric tape around the drain wire.
		Check whether the braking transistor is damaged.	Replace the braking transistor.
		Check whether the bus capacitor is damaged and short-circuited.	Replace the bus capacitor.
		The negative bus is short-circuited to ground.	Rectify the fault.

15.3.2 Troubleshooting During Trial Run in Speed Control Mode

Startup process	Fault symptom	Cause	Verification method
Turn on the control power (24 V and 0 V) Main power supply (R/S/T terminals)	The LED neither lights up nor displays "ry".	1. The voltage of the control circuit power supply is abnormal.	The fault persists though CN1, CN2, CN3, and CN4 are disconnected. Measure the voltage between terminals 24V and 0V.
		2. The input voltage is abnormal.	For three-phase 380 V models, measure the AC voltage among R, S, and T. When the DC bus voltage amplitude (voltage between (+) and (-)) is lower than 350 V, "nr" is displayed.
		3. The programming terminal is shorted.	Check whether the programming terminal is shorted.
		4. The servo drive is faulty.	-
	The panel displays "Exxx.y".	See *"15.4 List of fault codes" on page 230Fault List* and *"15.5 List of Alarm Codes" on page 249Alarm List* to find the cause and rectify the fault.	
	The keypad displays "ry" after preceding faults are cleared.		
Switching on the S-ON signal (S-ON signal switched on)	The panel displays "Exxx.y".	See *"15.4 List of fault codes" on page 230Fault List* and *"15.5 List of Alarm Codes" on page 249Alarm List* to find the cause and rectify the fault.	
	The servo motor shaft is in the free running state.	1. The S-ON signal is inactive.	Switch the keypad display to the servo status interface and view whether the keypad displays "ry" instead of "rn". • Check parameters in groups H03 or H17 to see whether FunIN.1 (S-ON) is assigned to a DI. If FunIN.1 is assigned, check whether the corresponding DI logic is active. If FunIN.1 is not assigned, assign FunIN.1 to a DI and activate the logic of this DI. For details about the setting method, see *"20.1 Parameters in Groups H00 to H22" on page 288* and *"20.1 Parameters in Groups H00 to H22" on page 288*. • If the S-ON signal has been set through parameters in group H03 or H17 and the corresponding DI logic is active, but the operating panel still displays "ry", check whether the DI is connected correctly. For details, see *"7.6.3 Wiring of Control Circuit Terminals" on page 109*.
		2. The control mode is wrong.	Check whether H02.00 (Control mode selection) is set to 0 (Position control mode). If it is set to 2 (Torque control mode), the motor shaft will be in the de-energized state because the default torque reference is 0.
	The keypad should display "rn" after preceding faults are cleared.		

Startup process	Fault symptom	Cause	Verification method
Inputting speed references	The servo motor does not rotate or the motor speed is incorrect.	The speed reference (H0b-01) is 0.	• The speed reference selected is wrong. Check whether H06.02 is set correctly. • No speed reference is inputted or the speed reference is abnormal. • When digital setting is used to set the speed reference, check whether H06-03 is set correctly. • When the speed reference is set through multi-speed references, check whether parameters in group H12 are set correctly. • When communication is used to set the speed reference, check whether H31.09 is set correctly. • When jog speed reference is used to set the speed reference, check whether H06.04 is set correctly, whether DI functions are set to 18 and 19, and whether the logic of corresponding DI is valid. • Check whether the acceleration time and deceleration time (H06.05 and H06.06) are set correctly. • Check whether the FunIN.12 (ZCLAMP, zero clamp) is misaligned and whether the active logic of the corresponding DI is correct.
Inputting speed references	The servo motor rotates in the reverse direction.	The value of the speed reference (H0b-01) is negative.	• When digital setting is used to set the speed reference, check whether H06.03 is less than 0. • When the speed reference is set through multi-speed references, check the sign (+/-) of each speed reference value in group H12. • When the torque reference is set through communication, check whether the value of H31.09 is lower than 0. • When jog speed reference is used to set the speed reference, check the value of H06.04 and whether the valid logic of DI functions 18 and 19 matches the predicted rotating direction. • Check whether FunIN.26 (SpdDirSel, speed reference direction selection) is assigned to a DI and whether the logic of the DI is active. • Check whether H02.02 (Direction of rotation) is set properly.
	The servo motor can rotate after preceding faults are cleared.		
Rotating unstably at low speed	The motor speed is unstable during low-speed operation.	Gains are set improperly.	Perform gain auto-tuning.
	Side-to-side vibrations occur on the motor shaft.	The load moment of inertia ratio (H08-15) is too large.	If the servo motor can operate safely, perform inertia auto-tuning again. Perform gain auto-tuning.

15.3.3 Troubleshooting During Trial Run in Torque Control Mode

<table>
<tr><th>Startup process</th><th>Fault symptom</th><th>Cause</th><th>Verification method</th></tr>
<tr><td rowspan="5">Connection of control power (+24V and 0V terminals) and
Main power supply
(R, S, T)</td><td rowspan="4">The LED neither lights up nor displays "rdy".</td><td>1. The voltage of the control circuit power supply is abnormal.</td><td>The fault persists though CN1, CN2, CN3, and CN4 are disconnected.
Measure the AC voltage between terminal 24V and 0V.</td></tr>
<tr><td>2. The voltage of the main circuit power supply is abnormal.</td><td>For three-phase 380 V models, measure the AC voltage among R, S, and T. When the DC bus voltage amplitude (voltage between + and -) is lower than 460 V, "nrd" is displayed.</td></tr>
<tr><td>3. The programming terminal is shorted.</td><td>Check whether the programming terminal is shorted.</td></tr>
<tr><td>4. The servo drive is faulty.</td><td>-</td></tr>
<tr><td>The panel displays "Exxx.y".</td><td colspan="2">See “15.4 List of fault codes” on page 230Fault List and “15.5 List of Alarm Codes” on page 249Alarm List to find the cause and rectify the fault.</td></tr>
<tr><td colspan="3">The keypad displays "rdy" after preceding faults are cleared.</td></tr>
<tr><td rowspan="3">Switching on the S-ON signal
(S-ON signal switched on)</td><td>The panel displays "Exxx.y".</td><td colspan="2">See “15.4 List of fault codes” on page 230Fault List and “15.5 List of Alarm Codes” on page 249Alarm List to find the cause and rectify the fault.</td></tr>
<tr><td>The servo motor shaft is in the free running state.</td><td>The S-ON signal is inactive.</td><td>• Switch the keypad display to the servo status interface and view whether the keypad displays "rdy" instead of "run".
• Check parameters in groups H03 or H17 to see whether FunIN.1 (S-ON) is assigned to a DI. If FunIN.1 is assigned, check whether the corresponding DI logic is active. If FunIN.1 is not assigned, assign FunIN.1 to a DI and activate the logic of this DI. For details about the setting method, see “20.1 Parameters in Groups H00 to H22” on page 288 and “20.1 Parameters in Groups H00 to H22” on page 288.
• If the S-ON signal has been set through parameters in group H03 or H17 and the corresponding DI logic is active, but the operating panel still displays "rdy", check whether the DI is connected correctly. For details, see “7.6.3 Wiring of Control Circuit Terminals” on page 109.</td></tr>
<tr><td colspan="3">The keypad displays "run" after preceding faults are cleared.</td></tr>
</table>

Startup process	Fault symptom	Cause	Verification method
Input torque reference	The servo motor does not rotate.	The internal torque reference (H0b.02) is 0.	The torque reference selected is wrong. Check whether H07.02 (Torque reference source) is set correctly. No torque reference is inputted. • In digital setting mode, check whether H07.03 is set to 0. • In communication setting mode, check whether H31.11 is set to 0.
	The servo motor rotates in the reverse direction.	The value of internal torque reference (H0b.02) is a negative number.	• In digital setting mode, check whether H07.03 is set to a value smaller than 0. • When the torque reference is set through communication, check whether the value of H31.11 (Torque reference set through communication) is lower than 0. • Check whether FunIN.25 (ToqDirSel, speed reference direction selection) is assigned and whether the corresponding DI logic is active. • Check whether H02.02 (Direction of rotation) is set properly.
	The servo motor can rotate after preceding faults are cleared.		
Rotating unstably at low speed	The motor speed is unstable during low-speed operation.	Gains are set improperly.	Perform gain auto-tuning.
	Side-to-side vibrations occur on the motor shaft.	The load moment of inertia ratio (H08.15) is too high.	If the servo motor can operate safely, perform inertia auto-tuning again. Perform gain auto-tuning.

15.4 List of fault codes

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E101.0	Abnormal parameters in groups H02 and above	The total number of parameters changes, which generally occurs after software update. Values of parameters in groups H02 and above exceed the limit, which generally occurs after software update.	The voltage of the control circuit power supply drops instantaneously.	1 .Check whether the control power (L1C, L2C) is cut off or whether an instantaneous power failure occurs. 2 .Measure whether the input voltage on the non-drive side of the control cable during operation is within the following specifications: a. 220 V servo drive: effective value: 220 V to 240 V; permissible deviation: -10% to +10% (198 V to 264 V). b. 380 V servo drive: effective value: 380 V to 440 V permissible deviation: -10% to +10% (342 V to 484 V)	1. Restore system parameters to default settings (2002-20h = 1), and write parameters again. 2. Increase the power capacity or replace the power supply with one of higher capacity. The restore system parameters to default settings (2002-20h = 1) and write the parameters again.
			Instantaneous power failure occurs during saving parameters.	Check whether instantaneous power failure occurs when saving parameters.	Power on the system again, restore the default setting (2002-20h = 1), and write the parameters again.
			The number of write operations within a certain period of time exceeds the limit.	1 .Check whether instantaneous power failure occurs when saving parameters. 2 .Check whether parameters are updated frequently through the host controller.	1. Power on the system again, restore system parameters to default settings (2002-20h = 1), and write the parameters again. 2. Change the way of writing and write parameters again. If the servo drive is faulty, replace it.
			The software is updated.	Check whether values of parameters in group H02 and above exceed the upper/lower limit due to software update.	Set the drive model and motor model again, and restore system parameters to default setting (2002-20h = 1).
			The drive is faulty.	If the fault persists though parameters are restored to default settings after repeated power cycling, the drive is faulty.	Replace the drive.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E101.1	Abnormal parameters in group H00/H01	The total number of parameters changes, which generally occurs after software update. Values of parameters in groups H00 or H01 exceed the limit, which generally occurs after software update.	The drive detects whether parameter values in groups H00 and H01 exceed the upper/lower limit range during initialization upon power-on. If yes, the operating panel displays E101.1. Motor parameters in group H00 are read from the encoder. Drive parameters in group H01 are mapped based on the drive model defined by H01-10.	Check which parameter in group H00 and H01 exceeds the limit. Confirm whether this parameter range is abnormal.	Replace the motor or drive.
E101.2	Address error in read/write after total number of parameters changes	Address error in read/write operation after the number of parameters changes.	The total number of parameters changes after software update, leading to address error in read/write operations.	Check whether the parameter access address exceeds the limit.	Restore default settings.
E102.0	FPGA communication initialization errors occur.	The communication between MCU and FPGA cannot be established.	1. The FPGA is faulty. 2. The communication between MCU and FPGA cannot be established.	The fault persists after repeated power cycling.	Replace the drive.
E102.8	Software versions of MCU and FPGA mismatch	FPGA and MCU software versions do not match.	The core software versions of MCU and FPGA do not match.	View the FPGA software version (2001-02h), MCU software version (2001-04h) and CPU1 software version (2001-01h) through the keypad or Inovance software tool. Check whether the non-zero values of the most significant bit of these software version numbers are consistent.	Contact Inovance for technical support. Update the FPGA or MCU software to make them match.
E104.1	MCU operation times out (MCU crashed).	The access to MCU times out.	Prevent FPGA from operating after MCU crashes.	The fault persists after repeated power cycling.	Replace the drive.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E104.2	FPGA operation timeout (FPGA crashed)	The MCU torque interrupt scheduling time is abnormal. This fault is reported only in the commissioning phase.	• The FPGA is faulty. • Prevent the MCU from reporting an alarm and switching the state after the FPGA crashes. • The communication handshake between FPGA and MCU is abnormal.	The fault persists after repeated power cycling.	Replace the drive.
E104.4	MCU reference update timeout	Take the moment when interrupt starts as the start time, an alarm can be triggered if the time taken for the command to be written to the MCU is longer than the time taken for FPGA to start the position and speed regulator.	The system reports that the encoder communication time is set improperly, or the command calculation time is excessively long.	The fault persists after repeated power cycling.	Replace the drive.
E120.0	Unknown encoder type	The servo drive detects the encoder model during initialization upon power-on. If the encoder model does not comply with the requirement, E120.0 occurs.	The FPGA software does not support the motor code. The encoder is not matched.	Check whether the encoder model is correct.	2001-03 = 0: motor code (2000-01h) 14000/14101 supported; 2001-03 = 1: motor code (2000-01h) 14120 supported; Other motor codes are not supported.
E120.1	No corresponding motor model	The drive detects the motor model defined by H00.00 during initialization upon power-on. If the motor model does not exist, E120.1 occurs.	The motor model defined by H00-00 is abnormal.	200B-2Eh (Internal fault code) = 1120. Check whether the servo drive model (2001-0Bh) and the bus motor model (2000-06h) match according to sections "Servo Drive Model and Nameplate" and "Servo Motor Specifications".	Set a correct motor model (H0-00).
E120.2	No corresponding drive model	The servo drive detects the drive model defined by H01.10 during initialization upon power-on. If the servo drive model does not exist, E120.2 occurs.	The drive model (H01.10) is set incorrectly.	Check whether the value of H01.10 is abnormal.	Disable the drive model auto-tuning function and set H01.10 to a proper value manually.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E120.5	Motor and drive current mismatch	The rated output of the drive is much higher than the rated current of the motor. Use a servo drive of lower rated output or a motor with higher rated current.	The internal scale value is abnormal.	Check whether the drive model is correct. If the set current sampling coefficient is excessively high, calculation overflow can occur.	Replacing the Drive
E120.6	FPGA and motor model mismatch	1. The motor model is set improperly, causing mismatch and malfunction of the drive. 2. The motor model is set properly, but the motor encoder is not supported by the drive.	FPGA software version not matching the motor model defined by H00-00	Check whether the FPGA software version (H01-01) supports the motor model set by H00-00.	Update the FPGA software to support the motor model defined by H00-00.
E122.0	Multi-turn absolute encoder setting error	In the absolute position mode, the motor is incompatible, or the motor code is set improperly.	In the absolute position mode, the motor is incompatible or the motor code is set improperly.	Check the motor nameplate to see whether the motor is configured with a multi-turn absolute encoder. Check whether 200D-01h (Motor SN) is correct.	Set 200D-01h (Motor code) correctly according to the motor nameplate or replace with a matching motor.
E122.1	DI function allocation error	1. The same function is assigned to different DIs. 2. The DI function No. exceeds the maximum number allowed for DI functions.	1. Two or more DIs are assigned with the same function No. 2. The DI function No. exceeds the maximum number allowed for DI functions.	1. Check whether DI function numbers defined by 2003-03, 2003-05, 2003-07, 2003-09, and 2003-0B are repetitive. 2. Check whether the MCU program is updated.	1. Ensure each DI is assigned with a unique function No. 2. Restore system parameters to default values (2002-20h = 1) and power on the drive again.
E122.2	DO function assignment fault	The DO function No. exceeds the number of DO functions.	The DO function No. exceeds the maximum number allowed for DO functions.	Check whether DO function numbers defined by 2004-01, 2004-03, and 2004-05 are abnormal.	Set the correct DO function No.
E122.3	Excessively high upper limit in rotation mode	The upper limit of mechanical single-turn position exceeds 2^{31} in the absolute rotation mode.	The upper limit of the mechanical single-turn position exceeds 231 in the absolute position rotation mode.	When the drive operates in the absolute rotation mode (H0201 = 2), check the setting of mechanical gear ratio/ mechanical single-turn position upper limit/electronic gear ratio.	Reset the mechanical gear ratio/ mechanical single-turn position upper limit/electronic gear ratio to ensure that the mechanical single-turn position upper limit (reference range) does not exceed 2^{31}.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E136.0	Encoder ROM motor parameter verification error	When reading parameters from the encoder ROM, the drive detects that no parameters are saved or parameter values are inconsistent with the setpoints.	A parameter verification error occurs, or no parameter is saved in the ROM of the bus incremental encoder.	Check whether the encoder cable included in the standard configuration is used. The cable must be connected securely without scratching, breaking or poor contact on both ends. Measure signals PS+, PS-, +5V and GND at both ends of the encoder cable and observe whether signals at both ends are consistent. For the signal definition, see hardware connections.	Use the encoder cable provided by Inovance. Ensure motor terminals and servo drive screws are connected securely. Use a new encoder cable if necessary. Route encoder cables and power cables (RST, UVW) through different routes.
E136.1	Encoder ROM motor parameter read error	The encoder cable is connected improperly. A communication error occurs on the encoder due to interference.	The encoder cable is connected improperly.	Check the encoder cable connection. Check whether ambient vibration is too strong, which loosens the encoder cable and even damages the encoder.	Connect the cables again according to the correct wiring diagram. Connect the cables again and ensure encoder terminals are connected securely.
E136.2	Torque fluctuation compensation data verification error	When the drive reads torque fluctuation compensation data, check whether the check data is consistent with the conventional value.	Contact the technical support of the manufacturer.	Contact the technical support of the manufacturer.	Contact the technical support of the manufacturer.
E140.0	Encryption integrated circuit verification error	Encryption integrated circuit verification failure	The encryption integrated circuit cannot communicate with Renesas integrated circuit or get the secret key.	1. Check the software version. Check whether the encryption program is programmed in the servo drive. 2. Check whether the encryption integrated circuit is abnormal.	Power off and on the drive again, if the fault persists, contact Inovance for maintenance.
E140.1	Encryption integrated circuit verification failure	The encryption integrated circuit version is not correct.	The key of the encryption integrated circuit is not correct, causing failure in decrypting the Renesas integrated circuit.	1. Check the software version. Check whether the encryption program is programmed in the servo drive. 2. Check whether the encryption integrated circuit is abnormal.	Power off and on the drive again, if the fault persists, contact Inovance for maintenance.
E140.2	Encryption integrated circuit version error	Communication between the MCU and encryption integrated circuit is abnormal.	The key of the encryption integrated circuit is not correct, causing failure in decrypting the Renesas integrated circuit.	1. Check the software version. Check whether the encryption program is programmed in the servo drive. 2. Check whether the encryption integrated circuit is abnormal.	Power off and on the drive again, if the fault persists, contact Inovance for maintenance.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E140.3	Encryption integrated circuit damaged	The MCU does not establish communication with the encryption integrated circuit.	The key of the encryption integrated circuit is not correct, causing failure in decrypting the Renesas integrated circuit.	1. Check the software version. Check whether the encryption program is programmed in the servo drive. 2. Check whether the encryption integrated circuit is abnormal.	Power off and on the drive again, if the fault persists, contact Inovance for maintenance.
E150.0	STO safety state applied	The STO input protection applies (safety state).	Two 24 V inputs are disconnected simultaneously, triggering the STO function.	Check whether the external 24 V power signal is normal.	When the external 24 V signal is cut off, the drive enters STO safety state and the motor coasts to stop.
E150.1	STO input state abnormal	The single-channel input of STO is inactive.	The 24 V input signal of STO1 or STO2 is abnormal. Only one STO input signal is disconnected.	Check whether the external 24 V power signal is normal.	The 24 V input signal is normal, but the drive reports E150.1 after restart. This may be caused by an abnormal 24 V input circuit. It is recommended to replace the drive.
E150.2	Buffer 5 V supply error	The MCU monitors the 5 V power supply of the PWM Buffer to detect whether overvoltage or undervoltage occurs. If the voltage is abnormal, this fault code will be displayed.	The 5 V voltage supplied to the STO Buffer is abnormal due to undervoltage or overvoltage.	Check whether the fault can be removed by a restart. If not, the 5 V voltage supplied to the Buffer is abnormal.	Replace the drive.
E150.3	STO upstream optocoupler short-circuited	Short circuit occurs on the optocoupler of the upstream hardware circuit of STO. In this case, the drive displays E150.3.	Short circuit occurs on the upstream optocoupler of STO.	Check whether the fault persists and the operating panel displays E150.3 after restart.	If yes, replace the drive.
E150.4	Buffer power-on detection error	An error occurs on the PWM buffer integrated circuit during initialization detection upon power-on (the PWM signal cannot be blocked). The drive displays E150.4.	An error occurs on the STO buffer during detection upon power-on.	The fault persists and the operating panel displays E150.4 after restart.	Replace the drive.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
0201H	Phase U overcurrent	A current higher than the detection threshold is sampled in the phase U current.	Motor cables are in poor contact.	Check whether the drive power cables and motor UVW cables are loose.	Tighten the cables that are loose or disconnected.
	Phase V overcurrent	A current higher than the threshold is collected in the phase V current.	Motor cables are in poor contact.	Check whether the drive power cables and motor UVW cables are loose.	Tighten the cables that are loose or disconnected.
	Phase N overcurrent	An excessively high current flows through the negative pole of the DC-AC circuit.	The gain is set improperly and the motor oscillates.	Check whether vibration or sharp noise occurs during start and operation of the motor.	Perform gain tuning.
E208.2	Encoder communication timeout	The attempt to receive the data fed back by the encoder fails.	The drive fails to receive the data fed back by the encoder in three consecutive cycles.	Check bit12 of H0B-30. The encoder cable is wired incorrectly or loosened. The encoder cable is too long. The encoder communication suffers from interference. The encoder is faulty.	1. Check whether the motor model is correct. 2. Check whether the encoder cable is proper. 3. Check whether the encoder version (H00.04) is proper. 4. If servo drive operates improperly, replace it.
E208.3	Current sampling fault	Current sampling errors occur.	Phase U and phase V current sampling is abnormal.	1. Check whether large devices on site generate interference, or whether the cabinet contains multiple interference sources such as variable-frequency devices. 2. The internal current sampling chip is damaged.	1. Check whether the drive and motor are grounded and shielded properly. 2. Install the ferrite ring on the motor power cables and encoder cables. 3. Replace the drive.
E208.4	FPGA current loop operation timeout	The operating time of the current loop exceeds the interval threshold.	FPGA operation timeout	Internal fault code 200B-2Eh = 4208: Current loop operation timeout	Disable unnecessary functions to extend the operation time of the current loop.
E210.0	Ground fault detection errors occur.	The drive detects an abnormal motor phase current or bus voltage during self-test upon power-on. 1. The bus voltage exceeds the discharge threshold. 2. The phase U current exceeds 1/4 of the value of H01.16.	The servo drive power cables (UVW) are short-circuited to ground.	Disconnect the motor cables, and measure whether the servo drive power cables (U/V/W) are short-circuited to ground (PE).	Re-connect the cables or replace the drive power cables.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E234.0	Runaway	The torque reference direction is opposite to the speed feedback direction in the torque control mode. The speed feedback direction is opposite to the speed reference direction in the position or speed control mode.	The UVW phase sequence is incorrect.	Check whether the UVW phase sequence on the servo drive side is consistent with that on the motor side.	Connect the U/V/W cables according to correct phase sequence.
E234.1	Excessively low torque reference	The speed deviation keeps exceeding H1B-11 (Speed threshold for runaway fault) for the time defined by H1B-10. In this case, the synthesized current reference is lower than 120%.	Excessively low torque upper limit	-	Adjust the speed loop gain or mechanical operating conditions.
E234.2	Excessive speed deviation	The speed deviation keeps exceeding H1B-11 (Speed threshold for runaway fault) for the time defined by H1B-10. In this case, the synthesized current reference is higher than 120%.	Excessive speed deviation	-	Check current torque upper limit source of the drive and increase the torque upper limit.
E400.0	Main circuit overvoltage	The DC bus voltage between P⊕ and N⊖ exceeds the overvoltage threshold. For 380 V servo drive, the normal value is 540 V, and the overvoltage threshold is 820 V (default value of H01-40).	The voltage input to the main circuit is too high.	Check the input power supply specifications of the drive. Measure whether the input voltage of the main circuit cable on the drive side (RST) meets the following specifications: effective value for 220 V drive: 220 V to 240 V; allowable deviation: -10% to +10% (198 V to 264 V).	Replace or adjust the power supply according to the specified range.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E410.0	Main circuit undervoltage	The DC bus voltage between P⊕ and N⊖ is lower than the undervoltage threshold. For 380 V servo drive, the normal value is 540 V, and the undervoltage threshold is 350 V (default value of H01-42).	1. The main circuit power supply is unstable or power failure occurs. 2. An instantaneous power failure occurs.	Check the input power supply specifications of the drive. Measure whether the input voltage of the main circuit cable on the non-drive side and drive side (RST) meets the following specifications. For 220 V drive, the effective value ranges from 220 V to 240 V with the allowable deviation range of -10% to +10% (198 V to 264 V). All three phases need to be measured.	Increase the power capacity.
E420.0	Main circuit phase loss	One or two phases missing on the three-phase drive	The three-phase input cables are connected improperly.	Check whether the power cables (R/S/T) on servo drive side and non-servo drive side are in good condition and connected securely.	Replace the cables and connect the main circuit cables correctly.
E430.0	Control power supply undervoltage	The control voltage of the drive is lower than the undervoltage threshold.	The control circuit voltage of drives in size C/D/E is lower than the undervoltage threshold.	1. The control power supply of servo drives in size C/D/E are unstable or fails. 2. The control power supply of drives in size C/D/E is in poor contact.	1. Check the specifications of the power supply and measure whether the input voltage of the main circuit is within the following range: • Effective value range of 220 V servo drive: 220 V to 240 V• Allowable deviation: -10% to +10% (198 V to 264 V) • Effective value range of 380 V servo drive: 380 V to 440 V• Allowed error: -10% to 10% (342 to 484 V). All three phases need to be measured. 2. Check whether control circuit cables are connected properly and whether the voltage of control circuit cables (L1C, L2C) on the drive side is within the specified range.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E440.0	Output phase loss	One or two phases missing on three-phase output	1. The motor is faulty. 2. The drain wire between the drive and motor is improper. 3. The three-phase output of the drive is unbalanced during operation of the motor.	1. Check the circuit. 2. Check whether the motor vibrates during running.	1. Increase the capacity of the power supply. 2. Increase the capacity of the power supply. 3. Increase the capacity of the power supply. 4. Replace the cables and connect the main circuit cables properly (three-phase: R/S/T; single-phase: L1/L2). 5. Replace the drive.
E450.0	Contactor fault	The pre-charge resistor operates improperly.	1. The driver board or the power supply board is abnormal. 2. The contactor is abnormal. 3. The lightening protection board is faulty. 4. The drive suffers external interference.	Circuit inspection	1. Replace the driver board or power supply board. 2. Replace the contactor. 3. Replace the lightning protection board. 4. Remove external interference.
E500.0	Motor overspeed	The actual speed of the motor exceeds the overspeed threshold.	The U/V/W phase sequence of motor cables is wrong.	Check whether the U, V, W terminals of the drive match those of the motor.	Connect the U/V/W cables according to the correct sequence.
E500.1	Speed feedback overflow	The FPGA speed measurement overflows.	FPGA internal speed overflow	Check whether the U, V, W terminals of the drive match those of the motor.	Connect the U/V/W cables according to the correct sequence.
E500.2	FPGA position feedback pulse overspeed	The MCU has detected that the position feedback increment fed back by the FPGA is excessive.	The MCU has detected that the position feedback increment fed back by the FPGA is excessive.	1. Check whether the value of H0B-17 changes abruptly. 2. Check whether the communication between the servo drive and the encoder is disturbed.	1. Check the encoder wiring. 2. Replace the drive.
E602.0	Angle auto-tuning failure	Abnormal jitter occurs on the encoder feedback during angle auto-tuning.	The data fed back by the encoder is abnormal.	Check whether the encoder communication is disturbed.	Check the hardware wiring of the encoder.
E602.2	The U, V, W phase sequence is incorrect.	An incorrect U/V/W phase sequence is detected during angle auto-tuning.	The drive indicates the U/V/W cables are wired improperly, preventing the motor from getting out of control.	Check whether U/V/W phases of the motor are wired correctly.	Exchange cables of any two phases among U/V/W and perform auto-tuning again.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E605.0	Overspeed upon S-ON	The motor speed exceeds the rated speed when the drive is enabled.	The feedback speed is higher than the rated speed.	Contact Inovance for technical support.	Contact Inovance for technical support.
E606.0	Pre-charge resistor overload fault	1. The count variable is incremented by 30000 upon each closure of the pre-charge resistor with power on. 2. The count variable decreases by 5 every 10 ms. 3. When the count variable reaches 150000, a pre-charge resistor fault can be reported.	The pre-charge resistor is opened and closed frequently within a short period of time.	Contact Inovance for technical support.	Contact Inovance for technical support.
E607.0	The on-time of the braking resistor is excessively long.	The on-time of the braking resistor exceeds the value of H1B-48 (Permissible on-time of the braking unit).	The braking transistor is in the braking protection state for a long time.	1. Check whether the bus voltage keeps higher than the braking voltage for a long time. 2. Check whether the set braking protection time is excessively low.	1. Limit the braking torque. 2. Set the braking protection time to a high value.
E610.0	OEM overload	Overload alarm timer value (No. 60 oscilloscope channel), perform addition and subtraction operations based on the overload table and overload deactivation table. When the overload alarm timer value exceeds 36000, an OEM overload fault is reported.	The load is excessive.	Monitor whether the feedback current value is excessively high.	Reduce the load and check the motor and mechanical conditions.
E620.0	Fan fault	Heat accumulation of the motor reaches the fault threshold.	Fan fault	Contact Inovance for technical support.	Contact Inovance for technical support.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E630.0	Motor stall over-temperature protection	The actual motor speed is lower than 10 rpm but the torque reference reaches the limit, and such status lasts for the time defined by H0A-32.	U/V/W phase loss or incorrect phase sequence occurs on the drive.	Perform a no-load trial run on the motor and check the wiring.	Connect cables again according to the correct wiring diagram or replace the cables.
E630.1	Motor stall 2	1. The actual motor speed is lower than 0.5 Hz. 2. The current reference exceeds the maximum output current of the drive. 3. Conditions 1 and 2 are met, and the duration exceeds the value defined by H1B-47.	The motor phase sequence is wrong.	-	Change the motor phase sequence after power off to ensure U/V/W phase sequence on the drive side is consistent with that on the motor side.
E631.0	Brake fault	When angle auto-tuning is not enabled, the synthesized current keeps exceeding the value of H07-41 for a period longer than 1s.	Contact Inovance for technical support.	Contact Inovance for technical support.	Contact Inovance for technical support.
E650.0	Heatsink temperature excessively high	The temperature of the drive power module is higher than the overtemperature threshold.	The ambient temperature is too high.	Measure the ambient temperature.	Improve the cooling conditions for the servo drive to reduce the ambient temperature
E660.0	Motor temperature excessively high	The motor temperature exceeds the temperature alarm upper limit value (H02-43), which lasts for 1.5s.	Air-cooled motor over-temperature	Observe whether the temperature of the air-cooled motor is excessively high.	Cool the motor down.
E660.1	PT1000 short-circuited	Check whether short circuit occurs based on the AD sampling value of PT1000.	PT1000 short-circuited or connected reversely	-	Check whether the motor temperature sensor is short-circuited.
E660.2	PT1000 disconnected	Check whether open circuit occurs based on the AD sampling value of PT1000.	PT1000 disconnected	-	Check whether the temperature sensor is disconnected.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E661.0	Gain values generated in one-button tuning too low	The gain drops to the low limit during tuning.	1. The one-button tuning value is incorrect. 2. The internal gain is adjusted to the lower limit with the position loop 5 and the speed loop 10.	-	Set the notch manually when vibration cannot be suppressed automatically. Check whether the positioning threshold is excessively low and increase the acceleration/deceleration time. Modify the electronic gear ratio to improve the reference resolution, or increase the reference filter time constant in the "Parameter configuration" interface. Check whether the machine is subject to cyclic fluctuation.
E731.0	Encoder battery failure	The battery voltage of the absolute encoder is lower than 2.9 V.	The battery is not connected during power-off.	Check whether the battery is connected during power-off.	Set 200D-15h to 1 to clear the fault.
E733.0	Encoder multi-turn counting error	Encoder multi-turn counting error	The encoder is faulty.	Set 200D-15h to 2 to clear the fault. E1.733 persists after power cycling.	Replace the motor.
E735.0	Encoder multi-turn counting overflow	Multi-turn counting overflow occurs on the absolute encoder.	The absolute encoder rotates more than 32767 turns in one direction in linear mode.	View the value of H0B-70 and check whether the operating direction is unchanged after H0B-70 reaches 32767.	View the operating instructions for the absolute encoder. This fault can be hidden in cases where no multi-turn absolute position is needed but the absolute position during running needs to be recorded. The rotation mode applies to occasions where only single-turn absolute position needs to be recorded.
E740.2	Absolute encoder error	A communication fault occurs on the RX side of the encoder.	Encoder wiring is incorrect.	Check the wiring of the encoder.	Connect the encoder cables according to the correct wiring diagram.
E740.3	Absolute encoder single-turn calculation error	An internal fault occurs on the encoder.	The encoder is faulty.	Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates the original encoder cable is damaged. Keep the motor in a fixed position, power on and off the motor repeatedly and observe the change of 200B-12h (Electrical angle). The electrical angle deviation should be within ±30°.	Use a new encoder cable. If the fault persists after the encoder cable is replaced, the encoder may be faulty. In this case, replace the servo motor.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E740.6	Encoder write error	The attempt to write the encoder data failed.	An error occurs when writing the position offset after angle auto-tuning.	Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates the original encoder cable is damaged. Keep the motor in a fixed position, power on and off the motor repeatedly and observe the change of 200B-12h (Electrical angle). The electrical angle deviation should be within ±30°.	Use a new encoder cable. If the fault persists after the encoder cable is replaced, the encoder may be faulty. In this case, replace the servo motor.
E750.2	Encoder ParityError	The number of resolver errors exceeds H02-36.	Resolver parity check error	Contact Inovance technical support.	Contact Inovance technical support.
E750.3	Encoder DataError	The number of resolver errors exceeds H02-36.	Resolver data type error	Contact Inovance technical support.	Contact Inovance technical support.
E750.4	Encoder LotFlagError	Resolver RDC signal distortion	Resolver RDC signal distortion	Contact Inovance technical support.	Contact Inovance technical support.
E750.5	Encoder LotFlagError	Resolver RDC tracking failure	Resolver RDC tracking failure	Contact Inovance technical support.	Contact Inovance technical support.
E750.6	Encoder AbsCntError	A resolver counting increment error occurs.	A resolver counting increment error occurs.	Contact Inovance technical support.	Contact Inovance technical support.
E755.0	Nikon encoder communication error	Nikon encoder communication fault	Nikon encoder communication fault	Contact Inovance technical support.	Contact Inovance technical support.
E760.0	Encoder over-temperature	The temperature of the absolute encoder is excessively high.	The temperature of the absolute encoder is excessively high.	Measure the encoder or motor temperature.	Switch off the S-ON signal to wait for the encoder to cool down.
EA33.0	Encoder data read/ write error	Internal parameters of the encoder are abnormal.	The serial incremental encoder cable is disconnected or loose.	Check the wiring.	Check whether the encoder cable is connected improperly, disconnected, or in poor contact. If the motor cables and encoder cable are bundled together, separate them.
EB00.0	Excessive position deviation	The position deviation is higher than the value of 6065h in position control mode.	U/V/W phase loss or incorrect phase sequence occurs on the drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
EB00.1	Position deviation overflow	The position deviation calculated by the drive is excessively high.	U/V/W phase loss or incorrect phase sequence occurs on the drive.	Perform a no-load trial run on the motor and check the wiring.	Re-connect the cables according to the wiring diagram or replace the cables.
EB01.1	Individual position reference increment excessively high	The target position increment is excessively high.	The target position increment is excessively high.	Check the variation between two adjacent target positions using the software tool.	1. Check whether the maximum motor speed meets the application requirement. If yes, reduce the target position reference increment to lower the profiled reference speed. If not, replace the servo motor. 2. Before switching the mode or enabling the servo drive, check whether the target position is consistent with the current position feedback. 3. The communication time sequence of the host controller is abnormal, leading to a slave data receiving error. Check the communication time sequence of the host controller.
EB01.2	Position reference increment remains excessively high	The target position increment is excessively high.	The target position increment is excessively high.	Check the variation between two adjacent target positions using the software tool.	1. Check whether the maximum motor speed meets the application requirement. If yes, reduce the target position reference increment to lower the profiled reference speed. If not, replace the servo motor. 2. Before switching the mode or enabling the servo drive, check whether the target position is consistent with the current position feedback. 3. The communication time sequence of the host controller is abnormal, leading to a slave data receiving error. Check the communication time sequence of the host controller.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
EB01.3	Reference overflow	The target position is still in the process of transmission when the servo limit or software position limit signal is activated and the 32-bit upper/ lower limit is reached.	The target position is still in the process of transmission when the servo limit or software position limit signal is activated and the 32-bit upper/lower limit is reached.	Check whether the host controller keeps sending commands after the overtravel alarm is reported by the servo drive.	1. The host controller detects servo drive limit signals (bit0 and bit1 of 60FD recommended). 2. The host controller stops transmitting the limit direction command after detecting active servo drive limit signals.
EB01.4	Single-turn position limit violated in singlet-turn absolute mode	The target position in single-turn absolute mode exceeds the upper/lower limit of the single-turn position.	The target position exceeds the upper/ lower limit of the unit position in the single-turn absolute mode.	Check whether the set target position is within the single-turn upper/lower limit.	Set the target position to a value within the upper/lower limit.
EB46.0	The pressure sensor does not generate feedback.	When the feedback oil pressure is lower than 2.5 KG and the speed is lower than H14-21 (Upper limit for pressure sensor fault detection speed), if the speed deviation is greater than 15 rpm and the speed feedback is lower than 8 rpm, EB46.1 is reported. Otherwise, EB46.0 is reported.	1. The sensor is wired improperly. 2. The sensor is damaged.	Check whether the sensor is wired properly and whether the sensor can be used.	1. Perform wiring properly. 2. Replace the sensor.
EB46.1	Pressure sensor stall flag detected	When the feedback oil pressure is lower than 2.5 KG and the speed is lower than H14-21 (Upper limit for pressure sensor fault detection speed), if the speed deviation is greater than 15 rpm and the speed feedback is lower than 8 rpm, EB46.1 is reported. Otherwise, EB46.0 is reported.	1. Eliminate mechanical problems. 2. Check whether control commands are incorrect.	1 .Check whether the motor can be operated without load. 2 .Eliminate mechanical faults. 3 .Check whether control instructions are correct.	1. Rectify mechanical problems. 2. Set the control command correctly.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
EB46.2	Reverse operation applies for a long time.	The oil pressure relief time exceeds H15-09 during reverse run.	1. Check whether the control commands sent from the host controller are incorrect. 2. The oil pressure loop parameters are set improperly.	1. Check whether the control instructions sent from the host controller are incorrect. 2. The oil pressure loop parameters are set improperly.	1. Send host controller commands correctly. 2. Set oil pressure loop parameters properly.
EB46.3	The feedback value of the pressure sensor exceeds the maximum/ minimum oil pressure limit.	If the calibrated oil pressure feedback voltage keeps lower than H14-58 (Lower limit of No. 46 fault detection voltage) or greater than H14-57 (Upper limit of No. 46 fault detection voltage) for a period longer than H14-59, this fault is reported.	1. Parameters are set improperly. 2. The sensor is damaged.	1. Check whether parameters are set properly. 2: Check whether the sensor is damaged.	1. Set the parameters correctly. 2. Replace the sensor.
EC42.0	CAN communication disconnected	CAN communication disconnected	The wiring is incorrect or interference exists.	Check physical wiring or disturbance source.	Connect the cables properly and take anti-interference measures.
EC42.2	The data received during communication is incorrect.	CAN communication information reception error	Interference	Check whether disturbance exists.	Take anti-interference measures.
EC42.3	CAN communication is not connected.	CAN communication is not connected.	Check whether wiring is correct. If yes, contact Inovance technical support.	Check whether wiring is correct. If yes, contact Inovance technical support.	Check whether wiring is correct. If yes, contact Inovance technical support.
EC47.0	The slave pump is faulty.	One of the slave pumps is faulty and cannot operate normally.	The slave pump is faulty.	Check whether the slave pump is faulty.	Rectify the slave pump fault.
EC48.0	The same address exists in the drive address H0C-00.	The CAN addresses of two drives are the same.	The drive address is repetitive.	Check the addresses of each drive.	Ensure that the address of each drive is unique.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
EC52.0	Multi-master fault in multi-pump confluence	The master is repetitive. A slave pump is controlled by different master pumps.	A slave pump is controlled by multiple master pumps.	Check the slave pumps controlled by each master pump.	Change the selection of slave pumps controlled by the master pump.
EE08.0	Synchronization signal loss	The sync signal is turned off when the EtherCAT network is in the OP state.	The data received by the slave is abnormal during synchronous communication.	Check whether the communication cable is shielded twisted pairs. Check whether the drive is grounded properly. Check whether the network port of the drive is damaged.	Use shielded twisted pair cables. Connect cables according to wiring instructions. Check the network connection status through the first LED.
EE08.1	Status switchover error	When the servo drive is enabled, the EtherCAT network status switches from OP state to other status.	The data received by the slave is abnormal during synchronous communication.	Check whether the communication cable is shielded twisted pairs. Check whether the drive is grounded properly. Check whether the network port of the drive is damaged.	Use shielded twisted pair cables. Connect cables according to wiring instructions. Check the network connection status through the first LED.
EE08.2	IRQ loss	The IRQ signal is lost.	The data received by the slave is abnormal during synchronous communication.	Check whether the communication cable is shielded twisted pairs. Check whether the drive is grounded properly. Check whether the network port of the drive is damaged.	Use shielded twisted pair cables. Connect cables according to wiring instructions. Check the network connection status through the first LED.
EE08.3	Unstable network connection	The network cable of the drive is connected improperly. (The low-order 16 bits of H0E.29 represents the IN port loss count. The high-order 16 bits of H0E.29 represents the OUT port loss count.)	The link is lost during synchronous communication.	Check whether the link loss value changes upon fault (E08). If yes, E08.3 can be reported.	Use shielded twisted pair cables. Connect cables according to the standard wiring instructions.
EE08.4	Data frame loss protection error	The PDO data is corrupted due to EMC interference or improper network cables.	Rx_ERR occurs on Port0 during synchronous communication.	At the time the fault (E08) occurs, check whether Rx_ERR occurs on Port0 and the link does not change.	Use shielded twisted pair cables. Connect cables according to the standard wiring instructions.
EE08.5	Data frame transfer error	Incorrect data frames are generated from the upstream slave, and invalid data frames are transferred to the downstream slave.	Transfer errors or invalid frames lead to processing unit error during synchronous communication.	At the time the fault occurs (E08), check whether a processing unit error caused by transfer errors (H0E-27) or invalid frames (H0E-28) occurs, and whether RX_ERR on Port0 is not counted.	Use shielded twisted pair cables. Connect cables according to the standard wiring instructions.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
EE08.6	Data update timeout	The slave is in the OP status and does not receive the data frame for a long time.	The slave fails to receive data during synchronous communication.	Check for IRQ loss via SYNC interrupt. The error counter increments by 1 each time an IRQ is lost, and resets to 0 each time an IRQ is received. When the error count value exceeds the value of H0E-22, E08.6 can be reported when causes for E08.3, E08.4, and E08.5 do not exist.	Use shielded twisted pair cables. Connect cables according to the standard wiring instructions.
EE09.0	Software position limit setting error	The software lower limit is equal to or higher than the software upper limit.	The software lower limit is equal to or higher than the software upper limit.	Check the values of 607D-01 and 607D-02.	Reset the values of 607D-01 and 607D-02 and ensure the former is lower than the latter.
EE09.1	Home setting error	The home offset exceeds the upper/ lower limit.	The home offset is outside the soft limit.	The home offset is outside the software position limit when the encoder works in the incremental mode, absolute linear mode, and single-turn absolute mode.	Set the home offset to a value between the software limits.
EE09.2	Gear ratio overlimit	The electronic gear ratio exceeds the limit: (0.001, 4000 x Encoder resolution/ 10000).	The electronic gear ratio exceeds the limit: (0.001 x Encoder resolution/10000, 4000 x Encoder resolution/ 10000). The set electronic gear ratio exceeds the preceding range.	1. The numerator or denominator of the gear ratio is 0. 2. The gear ratio 6091.01h/ 6091.02h exceeds [0.001 x Encoder resolution/10000, 4000 x Encoder resolution/ 10000].	Contact Inovance to replace the MCU integrated circuit.
EE09.4	No sync signal	The MCU does not receive the synchronization signal when the servo communication is switched to OP status.	The communication synchronization clock is configured improperly.	Use another master (such as Beckhoff or Omron PLC) and perform tests to compare between different masters.	Set the gear ratio according to the preceding range.
EE09.5	PDO mapping overlimit	The number of mapped objects of TPDO or RPDO exceeds 20 or the number of bytes exceeds 42.	The number of mapping objects in TPDO or RPDO exceeds 10.	Check the number of self-indexes configured in 1600h or 1A00h.	The number of mapping objects in TPDO or RPDO cannot exceed 10.
EE11.1	ESI validation error	The attempt to load the XML file fails during EtherCAT communication.	The XML configuration file is not programmed.	When the host controller scans the slave, its ID is null.	Program the XML file.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
EE11.2	Attempt to read EEPROM failed	The EEPROM communication of external EtherCAT devices failed.	The attempt to read EtherCAT data in the EEPROM failed.	This fault persists after the drive is powered off and on several times.	Replace the drive.
EE12.0	EEPROM update failure	The communication is normal but the message in the EEPROM is incorrect or lost.	The EtherCAT data in the EEPROM cannot be updated.	This fault persists after the drive is powered off and on several times.	Replace the drive.
EE12.0	EtherCAT initialization failure	EtherCAT peripheral initialization failed after power-on.	The device configuration file is not programmed.	When the host controller scans the slave, its ID is null.	Program the device configuration file.
EE13.0	EtherCAT synchronization cycle setting error	After the network switches to the operation mode, the synchronization cycle is not an integer multiple of 125 us or 250 us.	After the network switches to the operation mode, the synchronization cycle is not an integer multiple of 125 us or 250 us.	Check the synchronization cycle set on the host controller.	Set the value of the synchronization cycle to an integral multiple of 125 us or 250 us. Note: The reference scheduling cycle can be calculated through parameters H01-60 and H01-61.
EE15.0	Excessive EtherCAT synchronization cycle error	The synchronization cycle error exceeds the threshold.	The synchronization cycle error of the controller is excessive.	Measure the synchronization cycle of the controller through the digital oscilloscope or the oscilloscope function of the Inovance drive commissioning software.	Increase the value of 200E-21h.

15.5 List of Alarm Codes

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E108.0	Storage parameter write error	Parameter values cannot be written to EEPROM.	A fault occurs when writing parameters.	Modify a certain parameter, power cycle the drive, and check whether the modified value is saved.	If the modified value is not saved and the fault persists after the drive is powered off and on several times, replace the drive.
E108.1	Storage parameter read error	Parameter values cannot be read from EEPROM.	The parameter-read operation is abnormal, and the system indicates an EEPROM read failure.	The keypad displays E108.1 when the attempt to read parameters from EEPROM fails.	If the fault persists after the drive is powered off and on several times, replace the drive.
E108.2	Verification error on the data written to EEPROM	The check on the data written to EEPROM fails.	Parameter writing fails the check.	Modify a certain parameter, power cycle the drive, and check whether the modified value is saved.	If the modified value is not saved and the fault persists after the drive is powered off and on several times, replace the drive.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E108.3	Verification error on data read from EEPROM	The check on the data read from EEPROM failed.	The check on the data read from EEPROM failed.	Modify a certain parameter, power cycle the drive, and check whether the modified value is saved.	If the modified value is not saved and the fault persists after the drive is powered off and on several times, replace the drive.
E121.0	Duplicate S-ON command	A redundant S-ON signal is sent when some auxiliary functions are used.	1. The S-ON signal is activated through communication when the servo drive is already enabled internally.	Check whether an S-ON signal is sent from the host controller when auxiliary functions (200D-03h, 200D-04h, 200D-0Ch) are used.	Switch off the S-ON signal sent from the host controller.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E600.0	Inertia auto-tuning failure	Vibration cannot be suppressed. You can set notch parameters (H09.12 to H09.23) manually to suppress vibration. The auto-tuned values fluctuate dramatically. Increase the maximum operating speed, reduce the acceleration/ deceleration time, and shorten the stroke of the lead screw during ETune operation. Mechanical couplings of the load are loose, or the mechanism is eccentric. Rectify mechanical faults. An alarm occurs during auto-tuning and causes interruption. Clear the alarm and perform auto-tuning again. The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/ deceleration time to ensure the motor current is not saturated.	1. Continuous vibration occurs during auto-tuning. 2. The auto-tuned values fluctuate dramatically. 3. Mechanical couplings of the load are loose, or the mechanism is eccentric. 4. An alarm occurs during auto-tuning, interrupting the operation. 5. The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/ deceleration time to ensure the motor current is not saturated.	During internal detection shutdown, the torque fluctuation exceeds the threshold. Under conditions where the load-to-inertia ratio is less than 5, the auto-tuned value (B) differs from the last auto-tuned value (A) by more than A ± 3 times the load-to-inertia ratio. Under conditions where the load-to-inertia ratio is greater than 5, the auto-tuned value (B) differs from the last auto-tuned value (A) by more than ±0.5 x A times the load-to-inertia ratio.	1. Rectify the fault and perform inertia auto-tuning again. 2. For vibration that cannot be suppressed, enable the vibration suppression function. 3. Ensure mechanical couplings are connected securely. 4. Increase the maximum operating speed, reduce the acceleration/deceleration time, and shorten the stroke of the lead screw during ETune operation.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E601.0	Homing alarm	When using the homing function, the home is not found within the time defined by H05.35.	1. The home switch is faulty.	During homing, the system continuously searches for the home at high speed. After high-speed searching, low-speed searching at reverse speed applies.	If a hardware DI is used, check whether the corresponding DI function is assigned to a certain DI in group 2003h and check the wiring of this DI. Change the DI logic manually and observe the value of 200B-04h (Monitored DI status) to monitor whether the drive receives corresponding DI level changes. If the home signal is Z signal but it cannot be found, check the condition of the Z signal.
E601.1	Homing switch error	The home switch is set improperly.	1. The home switch is faulty.	During homing, the system continuously searches for the home at high speed. After high-speed searching, low-speed searching at reverse speed applies.	If a hardware DI is used, check whether the corresponding DI function is assigned to a certain DI in group 2003h and check the wiring of this DI. Change the DI logic manually and observe the value of 200B-04h (Monitored DI status) to monitor whether the drive receives corresponding DI level changes. If the home signal is Z signal but it cannot be found, check the condition of the Z signal.
E601.2	Homing mode setting error	The homing mode value exceeds the existing homing mode value.	The homing mode value exceeds the existing homing mode value.	Check whether the homing mode value exceeds the existing homing mode value (object dictionary 6098h).	Change the value of 6098h.
E640.0	EEPROM parameter configuration error	EEPROM parameter configuration error	Contact Inovance for technical support.	Contact Inovance for technical support.	Contact Inovance for technical support.
E640.2	The driver board is new.	A conflict occurs when reading EEPROM with new and legacy driver boards.	Contact Inovance for technical support.	Contact Inovance for technical support.	Contact Inovance for technical support.
E640.3	The legacy development board model being read is wrong.	A conflict occurs when reading EEPROM with new and legacy driver boards.	Contact Inovance for technical support.	Contact Inovance for technical support.	Contact Inovance for technical support.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E640.4	The legacy development board is inconsistent with the main control board parameter.	A conflict occurs when reading EEPROM with new and legacy driver boards.	Contact Inovance for technical support.	Contact Inovance for technical support.	Contact Inovance for technical support.
E640.6	Main control board parameter exceeding the upper/ lower limit	Main control board parameter exceeding the upper/lower limit	Contact Inovance for technical support.	Contact Inovance for technical support.	Contact Inovance for technical support.
E730.0	Encoder battery alarm	The battery voltage of the absolute encoder is lower than 3.0 V.	The battery voltage of the absolute encoder is lower than 3.0 V.	Measure the battery voltage.	Use a new battery of matching voltage.
E831.1	Excessive AI1 zero offset	Excessive AI1 zero offset	Interference exists.	#	Check the grounding cable of the device to remove the interference.
E831.2	Excessive AI2 zero offset	Excessive AI2 zero offset	Interference exists.	#	Check the grounding cable of the device to remove the interference.
E831.3	AI3 zero offset is excessively high.	AI3 zero offset is excessively high.	Interference exists.	#	Check the grounding cable of the device to remove the interference.
E834.1	MCU AD1 sampling overvoltage alarm	MCU AD1 sampling overvoltage alarm	1. The AI1 input voltage is too high. 2. The AI1 wiring is incorrect or interference exists.	#	1. Adjust the AI input voltage and observe the sampling voltage until the sampling voltage falls below 11.5 V. 2. Use shielded twisted pair cables and shorten the cable length. Increase the AI filter time constant. Specifically, increase H03-51, H03-56, and H03-61 for AI1, AI2, and AI3, respectively.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E834.2	MCU AI2 sampling overvolt age alarm	MCU AI2 sampling overvoltage alarm	1. The AI2 input voltage is too high. 2. The AI2 wiring is incorrect or interference exists.	#	1. Adjust the AI input voltage and observe the sampling voltage until the sampling voltage falls below 11.5 V. 2. Use shielded twisted pair cables and shorten the cable length. Increase the AI filter time constant. Specifically, increase H03-51, H03-56, and H03-61 for AI1, AI2, and AI3, respectively.
E834.3	MCU AI3 sampling overvolt age alarm	MCU AI3 sampling overvoltage alarm	1. The AI3 voltage is too high. 2. The AI3 wiring is incorrect or interference exists.	#	1. Adjust the AI input voltage and observe the sampling voltage until the sampling voltage falls below 11.5 V. 2. Use shielded twisted pair cables and shorten the cable length. Increase the AI filter time constant. Specifically, increase H03-51, H03-56, and H03-61 for AI1, AI2, and AI3, respectively.
E900.0	DI emergency braking	The logic of the DI (including the hardware DI and virtual DI) assigned with DI function 34 (FunIN.34) is active.	The logic of the DI (including the hardware DI and virtual DI) assigned with DI function 34 (FunIN.34) is active.	Check whether the logic of DI assigned with FunIN.34: Emergency stop is active.	Check the operation mode and deactivate the DI braking signal without affecting the safety performance.
E902.0	DI setting invalid	DI function parameters are set to invalid values.	The DI function setting is inactive.	H0B45 = 0x0902 Check whether 2003-03h, 2003-05h, and 2003-07h to 2003-11h are assigned with invalid DI function numbers.	Set the DI function No. correctly.
E902.1	DO setting invalid	DO function parameters are set to invalid values.	The DO function setting is invalid.	H0B45 = 0x1902 Check whether 2004-00h, 2004-02h, and 2004-04h are assigned with invalid DO function numbers.	Ensure the DO function No. is valid.
E902.2	Invalid torque arrival setting	The DO parameters set for torque arrival in torque control mode are invalid.	The DO parameters set for torque reach in torque control mode are inactive.	Check whether the value of 2007-17h is lower than or equal to the value of 2007-18h (unit: 0.1%).	Set 2007-17h to a value higher than that of 2007-18h.
E908.0	Model ID checksum failure	The first two check words for model identification are incorrect, indicating a failure to read the model identification parameters.	1. The model ID check word saved in EEPROM is incorrect. 2. The model parameters are not written in the drive before delivery.	1. Check whether the warning persists after restart. 2. Check whether parameters can be saved to EEPROM.	Set H01-72 to 1 to disable model identification function temporarily.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E909.0	Motor overload alarm	The cumulative heat of the motor reaches the alarm threshold.	The motor and encoder cables are connected improperly or in poor contact.	Check the wiring among the servo drive, servo motor and the encoder according to the correct wiring diagram.	Connect the cables according to the correct wiring diagram. Prefer to use the cables delivered as standard. When self-made cables are used, prepare and connect the cables according to the hardware wiring instructions.
E920.0	Braking resistor overloaded	The accumulative heat of the braking resistor exceeds the set value.	The cable of the external braking resistor is connected improperly.	Remove the external braking resistor and measure whether its resistance is "∞" (infinite). Measure whether the resistance between P and C is "∞" (infinite).	Use a new external braking resistor. If the resistance measured is the same as the nominal value, connect the resistor between P and C. Connect the external braking resistor between P and C with a new cable.
E922.0	Excessively low resistance of the external braking resistor	The value of H02.27 (Resistance of external braking resistor) is lower than the value of H02.21 (Permissible minimum resistance of external braking resistor).	When an external braking resistor is used (H02-25 = 1 or 2), the resistance of this resistor is lower than the minimum allowable value.	1. Check whether the external braking resistor between P and C is the same as the value of H02-27. 2. Check whether the resistance of the external braking resistor set in H2-27 is smaller than the value set in H02-21.	If yes, connect an external braking resistor that matches the servo drive between terminals P and C and set H02-27 according to the resistance of the resistor selected. If not, set H02-27 according to the resistance of the resistor used.
E924.0	Braking transistor over-tempera ture	The estimated temperature of the braking transistor is higher than H0A.18 (IGBT overtemperature threshold).	1. The junction temperature of the braking transistor is too high. 2. The braking transistor will be turned off automatically after overload occurs.	The braking transistor temperature exceeds the threshold defined by H0A-49.	Adjust the working conditions and reduce the usage of the braking transistor.
E941.0	Modified parameters activated at next power-on	This alarm is reported if the parameters modified are those whose "Effective time" is "Next power-on".	Parameters whose modification is activated at next power-on have been updated.	Check whether parameters you modified are designed to be activated at next power-on.	Power off and on the servo drive again.
E942.0	Parameter stored too frequently	The number of parameters modified at a time exceeds 200.	Too many parameters are modified and saved to EEPROM (200C-0Eh = 1) at a brief interval.	Check whether parameters are modified frequently through the host controller.	Check the operation mode. For parameters that need not be saved in EEPROM, set 200C-0Eh to 0 before the host controller writes parameters.

Fault code	Fault Subcode Name	Fault description	Possible cause	Verification method	Solution
E950.0	Forward overtravel	The logic of the DI assigned with FunIN.14: P-OT (Positive limit switch) is active.	The logic of the DI assigned with FunIN.14: P-OT (Positive limit switch) is active.	Check whether a certain DI terminal in group 2003h is allocated with function 14 and whether the DI logic of the corresponding bit of 200B-04h (Monitored DI status) is active.	Check the operation mode. On the prerequisite of safety, send a reverse run command or rotate the motor to deactivate the DI function 14.
E952.0	Reverse overtravel	The logic of the DI assigned with FunIN.15: N-OT (Negative limit switch) is active.	The negative limit switch has been hit, or the position feedback exceeds the software lower limit.	Check whether a certain DI terminal in group 2003h is allocated with function 15 and whether the DI logic of the corresponding bit of 200B-04h (Monitored DI status) is active.	Check the operation mode. Send a forward run command or rotate the motor to deactivate the logic of DI assigned with FunIN.15 without affecting the safety performance.

16 Certification and Standard Compliance

16.1 Certifications, Directives, and Standards

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	Directive		Standard
CE	EMC directive	2014/30/EU	EN IEC 61800-3
	LVD directive	2014/35/EU	EN 61800-5-1
	RoHS directive	2011/65/EU 2015/863/EU	-
UL/cUL Certification	-		UL61800-5-1 CSA C22.2 No.274
STO	Functional safety command	2006/42/EC	IEC 61800-5-2

Note

The product meets the requirements of the latest instructions and standards of the CE, UL&cUL, and STO.

16.2 CE Certification

16.2.1 Introduction to CE Certification



Figure 16-1 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 the EU.
- The CE mark is mandatory for engaging in commercial business (production, importation, and distribution) in the EU.
- The drive complies with LVD, EMC, and RoHS directives and carries the CE mark.
- Machines and devices integrated with this drive must also comply with CE requirements for distribution in EU.
- The integrator who integrates this drive into other products and attaches CE mark to the final assembly has the responsibility of ensuring compliance with CE certification.

16.2.2 Requirements for Compliance with EMC

- This product 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, radio interference may be generated. In addition to CE compliance requirements, measures should be taken to prevent interference when necessary.

- To allow the product 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 integrated with this drive is responsible for ensuring compliance with EMC directives and EN IEC 61800-3 based on the application environment of the system.

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: Environment that 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.

- Category C1 equipment: Power drive system (PDS) with the rated voltage lower than 1000 V, which is intended for use in the first environment
- Category C2 equipment: PDS with rated voltage less than 1000 V, which is neither a plug-in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by professionals.
- 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

16.2.3 Requirements for Compliance with LVD

The product has been tested in accordance with EN61800-5-1 and complies with the Low Voltage Directive. Observe the following requirements to enable machines and devices integrated with this drive to comply with the LVD.

Installation location

Install the product in a place with overvoltage category III and pollution degree 1 or 2 as specified by IEC 60664-1.

Installation environment

For requirements on installation environments, see *"4.2.1 Installation Environment" on page 61*.

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.
- Drives (IP20) intended to be installed inside the cabinet must be installed in a structure that prevents intrusion of unwanted objects from the top and the front.

Wiring requirements for main circuit terminals

For details about the main circuit terminal wiring requirements, see *"7.3.4 Requirements for Main Circuit Wiring" on page 99*.

Main circuit cable selection

For details about main circuit cable selection requirements, see *"7.3.2 Dimension and Cable Selection for Main Circuit Terminals" on page 91*.

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. See *"8.1.1 Fuse, Contactor, and Circuit Breaker" on page 123* for recommended fuse/circuit breaker models.

16.3 UL and cUL Certification



Figure 16-2 UL/cUL mark

- The UL/cUL mark commonly applies 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 to determine compliance with UL/cUL standards. Observe the following requirements to enable machines and devices integrated with this drive to comply with UL/cUL standards.

Installation 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:

The open-type T4 to T8 models support an ambient temperature range of -10℃ to +50℃. The maximum ambient temperature for T4 to T7 is 50℃ and for T8 is 40℃. Derate by 1.5% for every additional 1℃.

Installation requirements

- T4 to T8 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 doors that provide effective electrical and mechanical protection. The installation must conform to local and regional laws and regulations and relevant NEC standards.
- Solid state motor overload protection: 115% of rated operating current of the motor
- The integrated solid state short circuit protection does not cover the branch circuit. The branch circuit must be protected based on national and regional electrical standards.
- Motor overtemperature protection is not available.
- The rated value of short circuit current is 100,000 Arms (maximum).

Requirements for Main Circuit Wiring



Field installation is not allowed for output terminals BR, (-), and (+).

- Terminals BR, (-), and (+) are used to connect optional parts. Do not connect these terminals to an AC power supply.
- To protect the main circuit, separate and cover the surface that may come into contact with the main circuit.
- 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 twisted conductors (if used).
- 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 with an angle not higher than 5°. Failure to comply may damage the terminal screws.

Requirements for Control Circuit Wiring

Observe the requirements in UL508 during wiring.

Main circuit cable selection requirement

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 a maximum temperature of 75°C (167°F) continuously. The following conditions are used as premises:

  1. Ambient temperature: Below 40°C (104°F)
  2. Normal operating ratings

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

For details about main circuit cable selection requirements, see *"7.3.2 Dimension and Cable Selection for Main Circuit Terminals" on page 91*.

Requirements for protective devices

- To comply with UL61800-5-1, 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. See *"8.1.1 Fuse, Contactor, and Circuit Breaker" on page 123* for recommended fuse/circuit breaker models.

16.4 STO Certification



Figure 16-3 Safe Torque Off (STO) Functional Safety Certification Mark

Machinery Directive 2006/42/EC (Functional Safety) under IEC 61800-5-2

16.5 KC Certification



Figure 16-4 KC mark

Drives with the KC mark on the nameplate comply with electromagnetic compatibility standards of South Korea. Applicable models: T4 to T8

이 기기는 업무용(A 급) 전자파적합기기로서 판매자 또는사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

For sellers or other users, please bear in mind that this device is an A-grade electromagnetic wave device.
This device is intended to be used in areas other than at home.

17 Appendix A: Hydraulic Pressure Mode

17.1 EtherCAT Hydraulic Pressure Mode

17.1.1 Control Block Diagram

The hydraulic pressure mode is used in hydraulic drive systems such as injection molding machines. The hydraulic pressure mode is an algorithm that makes adjustment on the basis of speed control mode. The control box diagram is shown in the following figure.

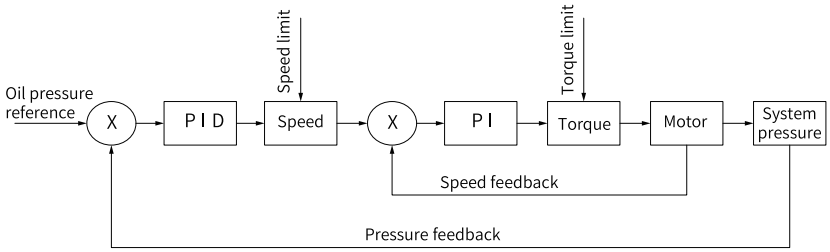


Figure 17-1 Block diagram of the hydraulic pressure control algorithm

17.1.2 Control Solutions

The parallel servo pump control scheme is divided into "multi-pump convergent flow" and "multi-pump divergent flow".

- Multi-pump convergent flow: One servo drive acts as the master, while the other drives act as slaves operating in parallel. The controller sets the pump control word and pressure over EtherCAT and the slave pump sets the following speed percentage.
  - In the flow control state (feedback pressure lower than the reference pressure), the speed of the master and slave drives can be consistent.
  - In the pressure control state (feedback pressure greater than or equal to the reference pressure), the slave pump automatically stops working and is independently controlled by the master drive.
- Multi-pump divergent flow: Multiple sets of/single set of servo drives can operate in multi-pump divergent flow (independent oil pressure PID control) mode. The controller sets all pumps to be master pumps, with the flow and pressure references set separately and oil pressure PID control performed independently.

Multi-pump convergent flow

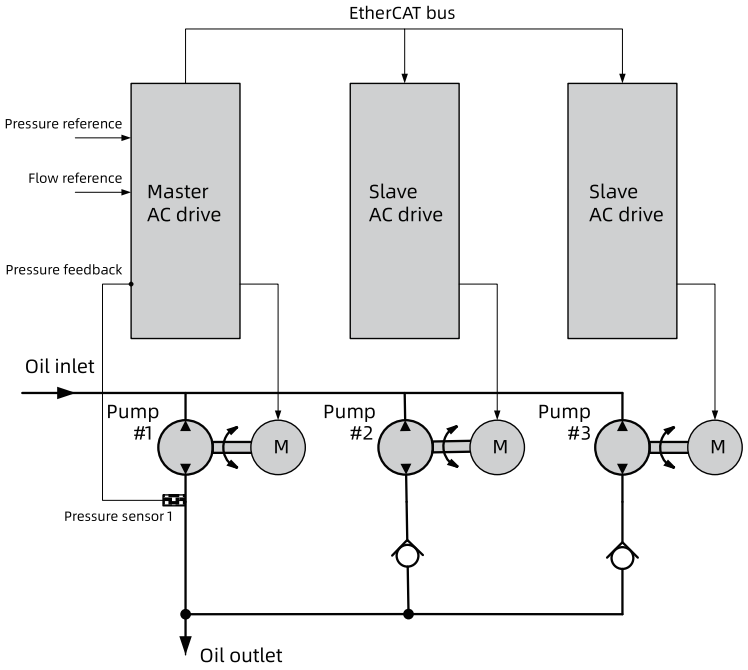


Figure 17-2 Structure of multi-pump convergent flow

Note

- For multi-pump convergent flow wiring, see *"17.1.3.1 Wiring" on page 265*. For EtherCAT communication wiring, see the relevant content in *" Communication" on page 189*.
- Ensure that the motor speed is the same by means of communication.

Multi-pump divergent flow

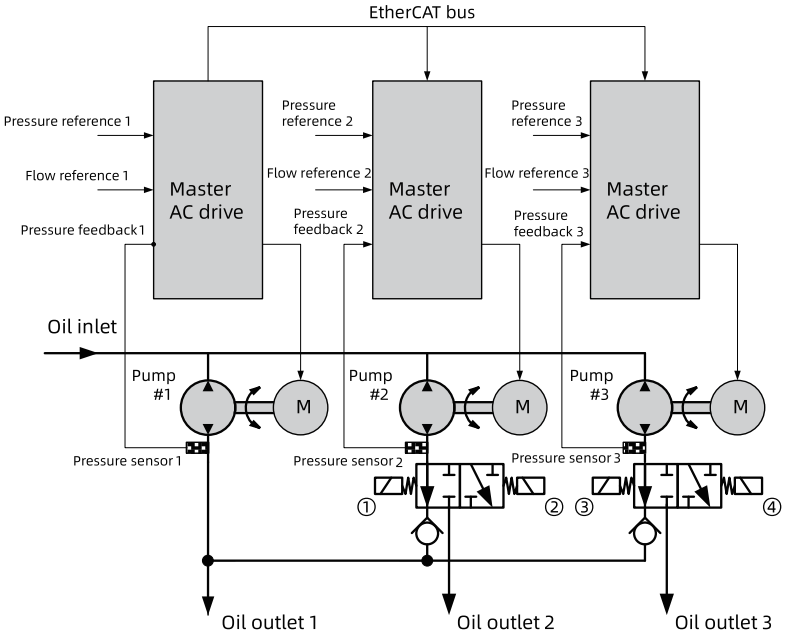


Figure 17-3 Structure of multi-pump divergent flow

- For multi-pump divergent flow wiring, see section 17.1.4.1 Wiring. For EtherCAT communication wiring, see section 13 Communication.
- Ensure that the motor speed is the same by means of communication. Control convergent flow and divergent flow of pumps 2 and 3 through solenoid valves ①, ②, ③, and ④, respectively.
- For convergent flow control, pressure and flow references and pressure feedback signals received by the slave drive are invalid. For divergent flow control, EtherCAT communication references received by the slave drive are invalid.

17.1.3 Multi-pump Convergent Flow

17.1.3.1 Wiring

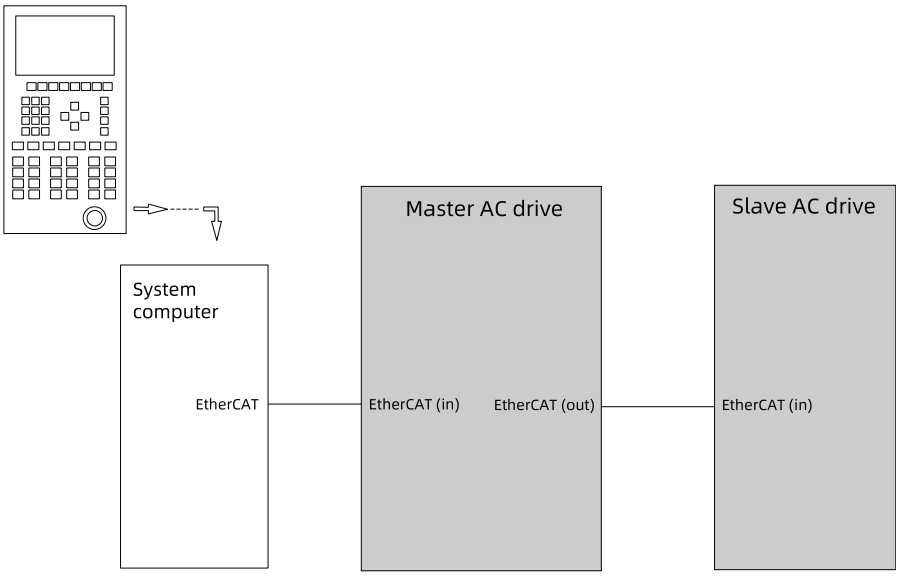


Figure 17-4 Wiring of multi-pump convergent flow mode

To understand the alarm condition of the drive during multi-pump convergent flow mode, you can perform the following operations (take the slave drive and DO2 (alarm signal) as an example).

1. When H04.02 is set to 25, DO2 is assigned with slave fault signal.
2. Connect the slave drive DO2 to the system computer. When an alarm occurs on the drive, the alarm condition can be displayed in the system computer.

Note

In the pressure control state, unexpected high pressure may occur on the oil circuit of slave pump when the check valve leakage is high but the internal leakage of the slave pump is low. In this case, do the following to relieve the high pressure.

- Reduce the upper limit of the slave drive torque properly by setting object dictionary entries 60E0 and 60E1 through the host controller. If the internal torque limit (torque limit source set in H07-07) applies, set H07-09 and H07-10.
- Set the slave speed response curve based on the maximum leakage speed of the master pump, achieving automatic pressure relief of the slave drive under low-speed pressure holding. For details on parameter settings, see *"17.1.3.3 Response to Master Pump Commands" on page 266*.

17.1.3.2 Master and Slave Settings

The master and slave pump are set through H0C.00. The setpoint 1 indicates the master pump and others represent the slave pump. Only one master and multiple slave are supported, not multiple masters and multiple slaves.

Parameter	Hex.	Parameter name	Value	Default value	Change mode
H0C.00	200C-01h	CAN communication station No.	1 to 247	1	Real time

17.1.3.3 Response to Master Pump Commands

Parameter	Hex.	Parameter name	Value	Default value	Change mode
H14.32	2014-21h	Minimum input of slave injection molding machine	-100.0 to +100.0	0.0	Real time
H14.33	2014-22h	Corresponding setting of minimum input of slave injection molding machine	-100.0 to +100.0	0.0	Real time
H14.34	2014-23h	Input at the common point of the slave injection molding machine	-100.0 to +100.0	0.0	Real time
H14.35	2014-24h	Corresponding setting of the common point of the slave injection molding machine	-100.0 to +100.0	0.0	Real time
H14.36	2014-25h	Maximum input of slave injection molding machine	-100.0 to +100.0	100.0	Real time
H14.37	2014-26h	Corresponding setting of the maximum input of slave injection molding machine	-100.0 to +100.0	100.0	Real time

H14.32 to H14.37 are used to ensure the linear flow of the whole system through preventing high pressure holding of the slave during automatic pressure relief when the master pump operates at low speed in pressure holding mode.

Example:

- Condition 1: Assume that the maximum holding speed of the master is 50 rpm, the maximum speed is 2000 rpm, and the maximum speed of the slave is also 2000 rpm.
- Condition 2: During pressure holding, only the master pump is involved, the slave pump stops completely.
- Condition 3: To ensure linear flow, the speed of the slave pump speed must be the same as the master pump when the master pump operates at a speed higher than 100 rpm.

That is, if the master pump is below 50 rpm, the slave pump stops working. When the master pump is above 100 rpm, the slave pump and the master pump run at the same speed. The speed reference of the master pump is 0% to 100%. The slave pump is set through a 3-point curve to respond to the speed reference of the master pump as follows:

(H14.32, H14.33) = (Slave pump input reference: 50 rpm, slave pump response reference: 0 rpm) = (2.5%, 0.0%)

(H14.34, H14.35) = (Slave pump input reference: 100 rpm, slave pump response reference: 100 rpm) = (5.0%, 5.0%)

(H14.36, H14.37) = (Slave pump input reference: 2000 rpm, slave pump response reference: 2000 rpm) = (100%, 100%)

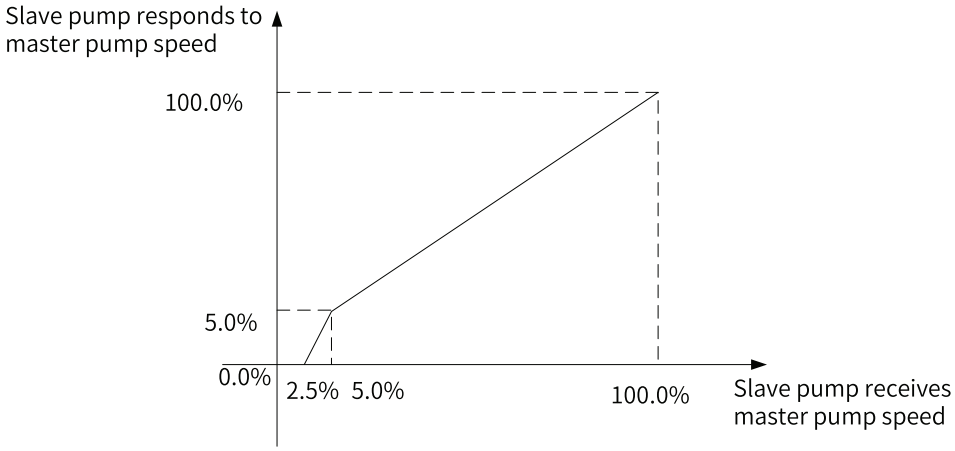


Figure 17-5 Response to master pump commands

17.1.3.4 Reference Setting

Set the master pump and slave pump in multi-pump convergent flow control mode. The master pump receives flow pressure references, and the slave pump follows the master pump speed based on the speed response setting. The calculated following speed for the slave pump is transmitted to the host controller through object dictionary 201C-01. The host controller then sends this value to object dictionary 201B-04h of the corresponding slave pump drive, so that it obtains the value of the speed for following the master pump. The pressure sensor is connected to the master pump. The master/slave pump is set as follows:

Master pump setting

1. When H14.00 is set to 8, the oil pressure reference is obtained through EtherCAT communication.
2. The host controller sets the master/slave pump through 201B-03. If 201B-03 is set 0, it indicates the master pump.
3. When H02.00 is set to 9, the EtherCAT communication mode applies.
4. Send pressure references (201B-01) and flow references (201B-02) through PLC.
5. Set the PLC operation mode to CSV (object dictionary 6060 = 9).
6. The oil pressure feedback value can be viewed in object dictionary 201C-02.
7. Start or stop the drive through the control word 6040.

Slave pump setting

1. When H14.00 to 8, the oil pressure reference is obtained through EtherCAT communication.
2. The host controller sets the master/slave pump through 201B-03. If 201B-03 is set 1, it indicates the slave pump.
3. When H02.00 is set to 9, the EtherCAT communication mode applies.

4. Map the speed for the slave pump to follow the master pump (201C-01h) to the slave pump speed reference 201B-04 on the host controller.
5. Write control word to the PLC to control drive operations.

Related parameters

Parameter	Hex.	Parameter name	Value	Default value	Unit	Change mode
H02-00	2002-01h	Control mode selection	0: Speed mode 1: Position mode 2: Torque mode 9: EtherCAT mode	9	-	At stop
H14-00	2014-01h	Hydraulic pressure control mode	0: Non-hydraulic pressure mode 1: Reserved 2: Hydraulic pressure mode 2 3: Reserved 4: Reserved 5: Hydraulic pressure mode 5	0	-	At stop
H1B-00	201B-01h	Pressure reference sent over EtherCAT	0.0 to 500.0	0.0	-	Real time
H1B-01	201B-02h	Flow reference sent over EtherCAT	0.00 to 655.35	0.00	-	Real time
H1B-02	201B-03h	EtherCAT single/ multi-pump control word	0 to 1	0	-	Real time
H1B-03	201B-04h	Slave pump rotation speed reference	-100 to +100.00	0.00	-	Real time
H1C-00	201C-01h	Slave pump speed reference sent by master pump	-100.0 to +100.0	0.0	-	Read-only
H1C-01	201C-02h	Oil pressure feedback	0.0 to 500.0	0.0	-	Real time

17.1.4 Multi-pump Divergent Flow

17.1.4.1 Wiring

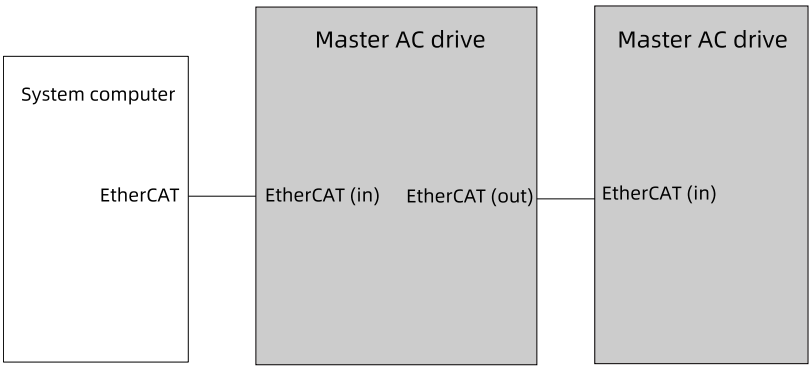


Figure 17-6 Wiring of multi-pump divergent flow mode

17.1.4.2 Reference Setting

In multi-pump divergent flow control mode, each pump is the master pump that obtains pressure and flow references from the PLC. For details on communication PDOs, see EtherCAT section. You can control drive operations through the PLC. The setting procedure for each master pump is shown below.

1. When H14.00 is set to 8, the oil pressure reference is obtained through EtherCAT communication.
2. Set 201B-03 to 0 (Master pump).
3. When H02.00 is set to 9, the EtherCAT communication mode applies.
4. Set the PLC operation mode to CSV (object dictionary 6060 = 9).
5. Send pressure references (201B-01) and flow references (201B-02) through PLC.
6. Control the drive through the control word.

Parameter	Hex.	Parameter name	Value	Default value	Unit	Change mode
H02.00	2002-01h	Control mode selection	0: Speed mode 1: Position mode 2: Torque mode 9: EtherCAT mode	9	-	At stop
H14.00	2014-01h	Hydraulic pressure control mode	0: Non-hydraulic pressure mode 1: Reserved 2: Hydraulic pressure mode 2 3: Reserved 4: Reserved 5: Hydraulic pressure mode 5	0	-	At stop

17.2 Multi-pump Mode of Injection Molding Machine

17.2.1 Parallel Servo Oil Pump Control Solution

The parallel servo pump control scheme is divided into "multi-pump flow convergence" and "multi-pump flow divergence".

- Multi-pump flow convergence: A set of servo drives act as the master drive, while the other drives act as slave drives that operate in parallel. The controller outputs a set of analog flow signals and pressure analogs.
  - In the flow control state (feedback pressure lower than the reference pressure), the speed of the master and slave drives can be consistent.
  - In the pressure control state (feedback pressure greater than or equal to the reference pressure), the slave pump automatically stops and is independently controlled by the master drive.
- Multi-pump flow divergence: Multiple sets of servo drives can operate in the multi-pump flow convergence mode and flow divergence mode (independent oil pressure loop PID control). The controller outputs multiple sets of analog flow signals and pressure signals.

Multi-pump flow convergence

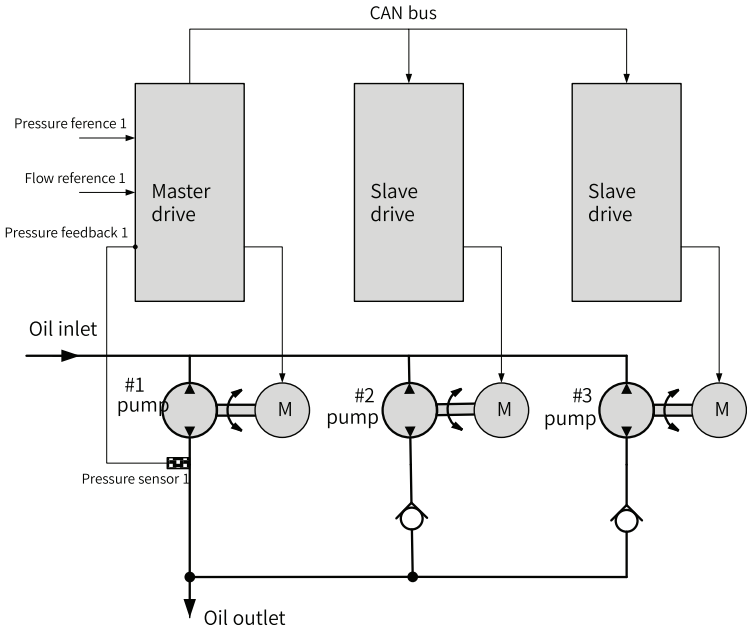


Figure 17-7 Structure of multi-pump flow convergence

Description: For details on wiring and CAN communication wiring, see *"17.2.2.2 Wiring" on page 272*.

The motor speed can be kept the same through communication.

Multi-pump flow divergence

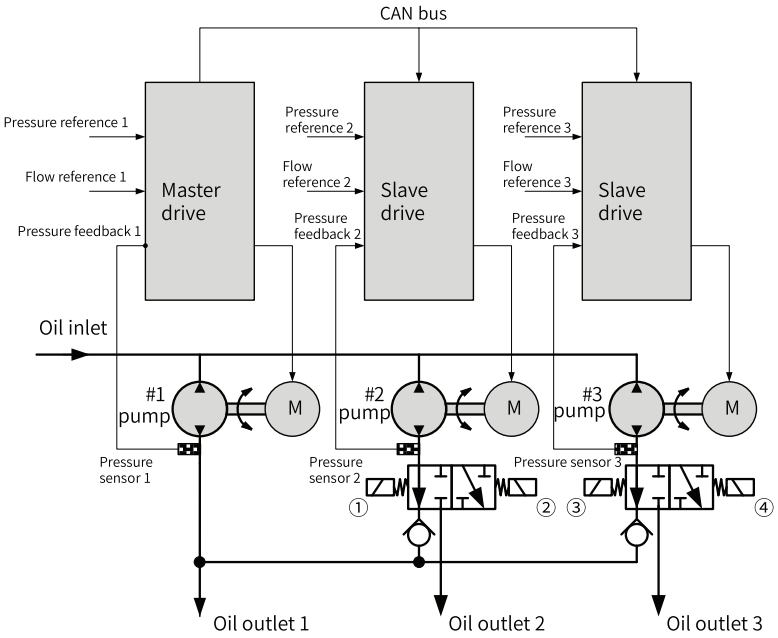


Figure 17-8 Structure of multi-pump flow divergence

Description: For detailed wiring and CAN communication connection, see *"17.2.2.2 Wiring" on page 272*.

The motor speed can be kept the same through communication.

The ON state of solenoid valves ①, ②, ③, and ④ can be used to control flow convergence/ divergence of pumps 2 and 3.

During flow convergence control, the pressure and flow references and pressure feedback signals received from the drive are invalid.

During flow divergence control, the CAN communication references received from the drive are invalid.

17.2.2 Multi-pump Control Mode

17.2.2.1 Description of Multi-Pump Mode

Param.	Name	Setpoint	Description
H0C-11	CAN multi-pump mode	0	Multi-pump mode 1 (Broadcast mode)
		1	Multi-pump mode 2 (Multi-master mode)
H14-00	Oil pressure mode	2	Oil pressure control mode 2 (set through analog channels)

The drive supports two multi-pump modes, including:

- Multi-pump mode 1: This mode is broadcast mode, which is applicable to simple multi-pump control. The slave pump cannot be controlled when the slave pump is switched to the master

pump. The #54 DI terminal is used to enable the multi-pump mode. When #54 DI terminal is disconnected, the slave pump switches to the master pump.

- Multi-pump mode 2: This mode applies to complicated multi-pump flow convergence/ divergence control with up to four types of combination supported. The following describes the wiring and application differences between the two modes.

17.2.2.2 Wiring

Multi-pump flow convergence

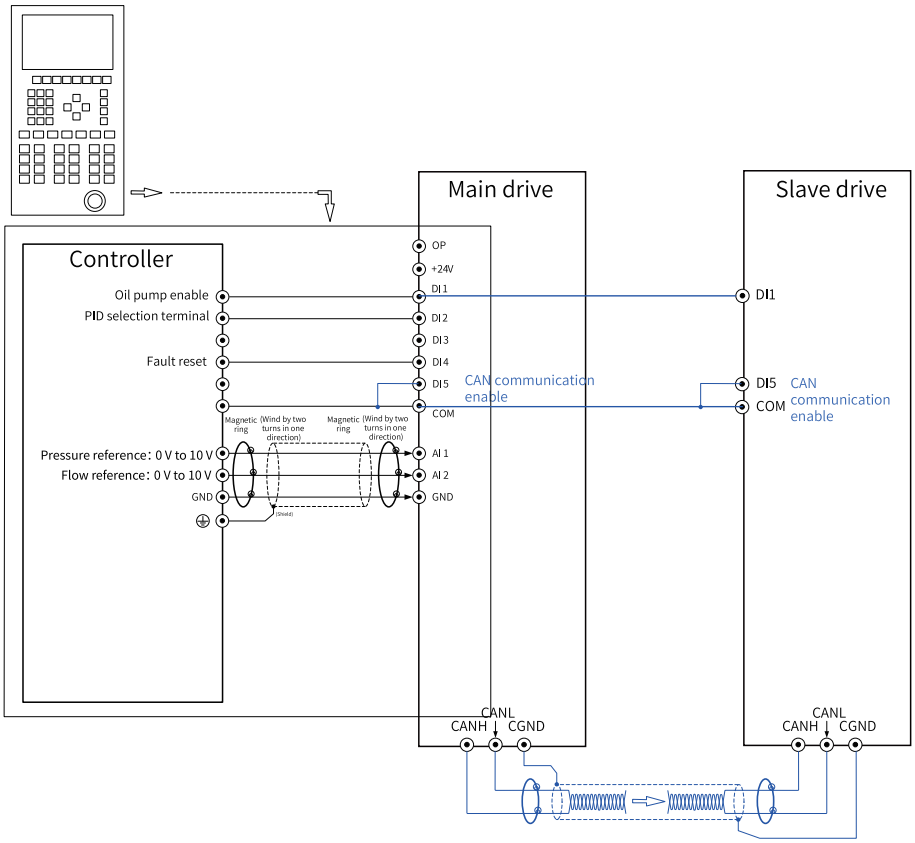


Figure 17-9 Wiring of multi-pump flow convergence mode 1

Note

In multi-pump mode 1, No. 50 DI terminals of the master and slave drives must be closed to enable the multi-pump convergent flow control mode.

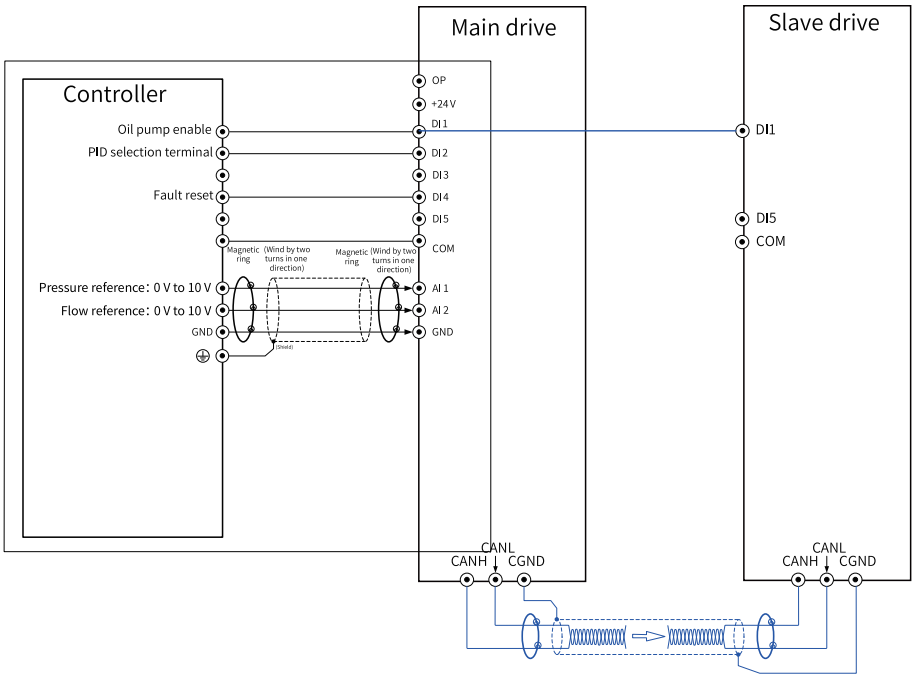


Figure 17-10 Wiring of multi-pump flow convergence mode 2

Note

After two CAN buses are connected properly in multi-pump mode, set the slave pump address responding to the master pump flow references. For details about how to set relevant parameters, see the Section "Master Drive Settings".

During multi-pump flow convergence, the "slave alarm output" signal (H04-02 = 5) is connected to the controller to display alarms.

Note

In the pressure control state, unexpected high pressure may occur on the oil circuit of slave pump when the check valve leakage is high but the internal leakage of the slave pump is low. In this case, do the following to relieve the high pressure.

- Reduce the pumpage of the slave pump properly through H14.47.
- Reduce the upper limit of the drive torque properly through 2007-34 in the host controller.
- Set the slave speed response curve based on the maximum leakage speed of the master pump, achieving automatic pressure relief of the slave drive under low-speed pressure holding. For parameter setting, see *"17.2.2.3 Response to Master Pump Commands" on page 276*.

Multi-pump flow divergence

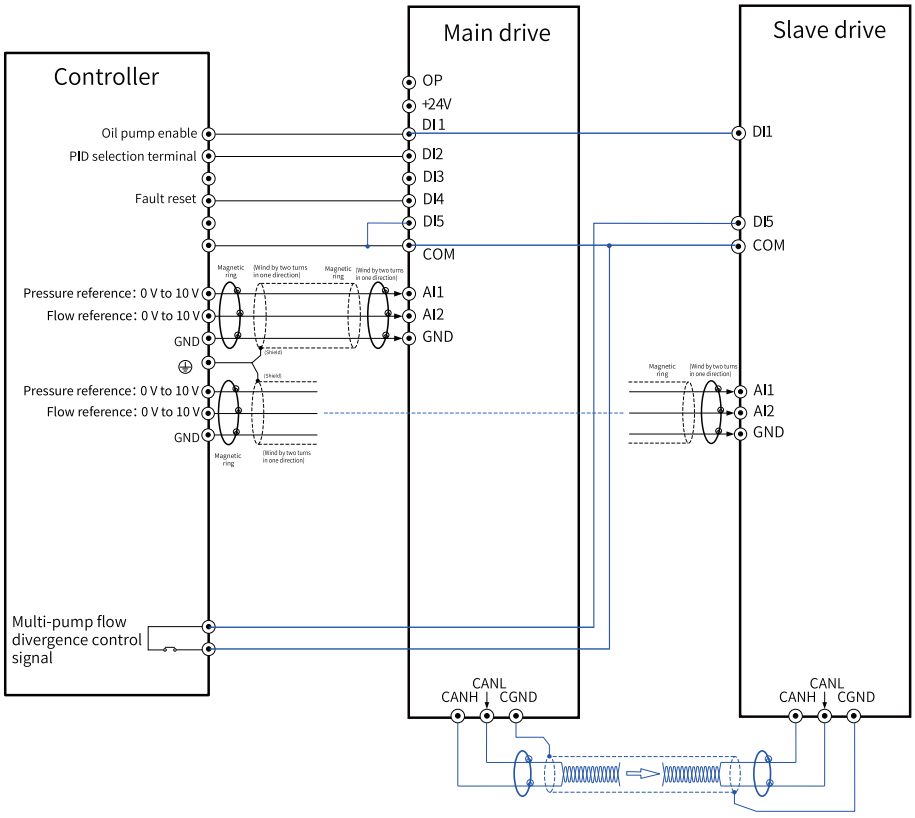


Figure 17-11 Wiring of multi-pump flow divergence mode 1

Note

Use the flow divergence signal sent by the host controller to disconnect #54 DI terminal. After receiving the pressure, flow reference 2 and pressure feedback 2 from the controller, the master drive (switched from the slave drive) enters the oil pressure loop PID control state.

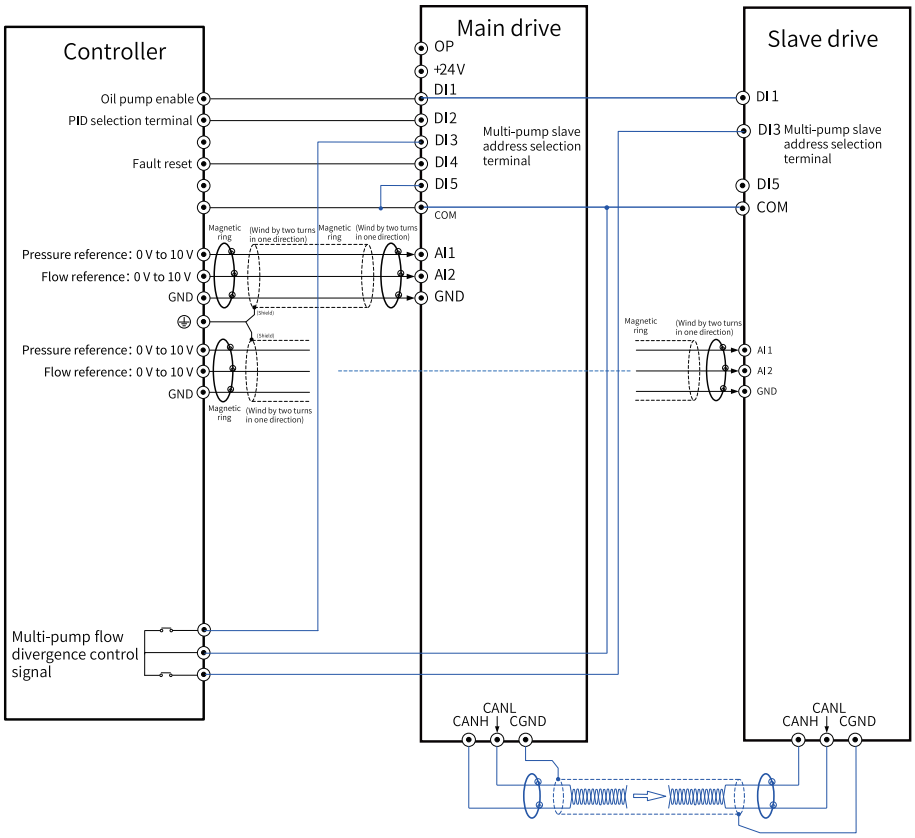


Figure 17-12 Wiring of multi-pump flow divergence mode 2

Note

Set F5-02 to 25 to connect the slave alarm output signal to the controller for alarm display.

In the pressure control mode, the slave drive receives pressure feedback 2 independently from the pressure sensor on the slave drive oil circuit. Therefore, unexpected high pressure will not occur on the oil circuit of slave drive in this mode.

Communication wiring

The following figure describes the CAN bus connections of all pumps.

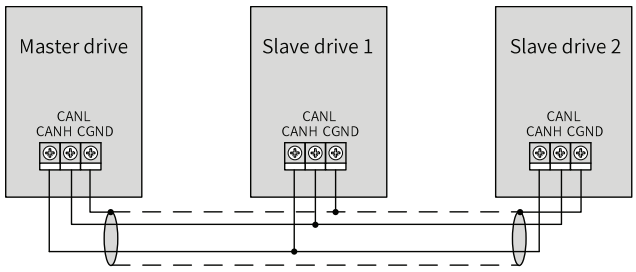


Figure 17-13 CAN bus connection

Note

Use shielded twisted pairs. Connect the CANH/CANL terminals on the control boards of all the drives together, respectively. Connect all the CGND terminals together using the shield. Termination resistors must be connected to the front drive and the end drive (S2/S3 DIP switches as termination resistors).

17.2.2.3 Response to Master Pump Commands

Table 17–1 Slave drive setting

Param.	Name	Default
H14.32	Minimum input of slave speed reference	0.0%
H14.33	Corresponding setting of the minimum input of slave speed reference	0.0%
H14.34	2nd point input of slave speed reference	0.0%
H14.35	Corresponding setting of the 2nd point input of slave speed reference	0.0%
H14.36	Maximum input of slave speed reference	100.0%
H14.37	Corresponding setting of the maximum input of slave speed reference	100.0%

H14.32 to H14.37 are used to ensure the linear flow of the whole system through preventing high pressure holding of the slave during automatic pressure relief when the master pump operates at low speed in the pressure holding mode.

Example:

- Condition 1: Assume that the maximum holding speed of the master is 50 rpm, the maximum speed is 2000 rpm, and the maximum speed of the slave is also 2000 rpm.
- Condition 2: During pressure holding, only the master pump is involved, the slave pump stops completely.
- Condition 3: To ensure linear flow, the speed of the slave pump speed must be the same as the master pump when the master pump operates at a speed higher than 100 rpm.

That is, if the master pump is below 50 rpm, the slave pump stops working. When the master pump is above 100 rpm, the slave pump and the master pump run at the same speed. The speed reference of the master pump is 0% to 100%. The slave pump is set through a 3-point curve to respond to the speed reference of the master pump as follows:

(H14.32, H14.33) = (Slave pump input reference: 50 rpm, slave pump response reference: 0 rpm) = (2.5%, 0.0%)

(H14.34, H14.35) = (Slave pump input reference: 100 rpm, slave pump response reference: 100 rpm) = (5.0%, 5.0%)

(H14.36, H14.37) = (Slave pump input reference: 2000 rpm, slave pump response reference: 2000 rpm) = (100%, 100%)

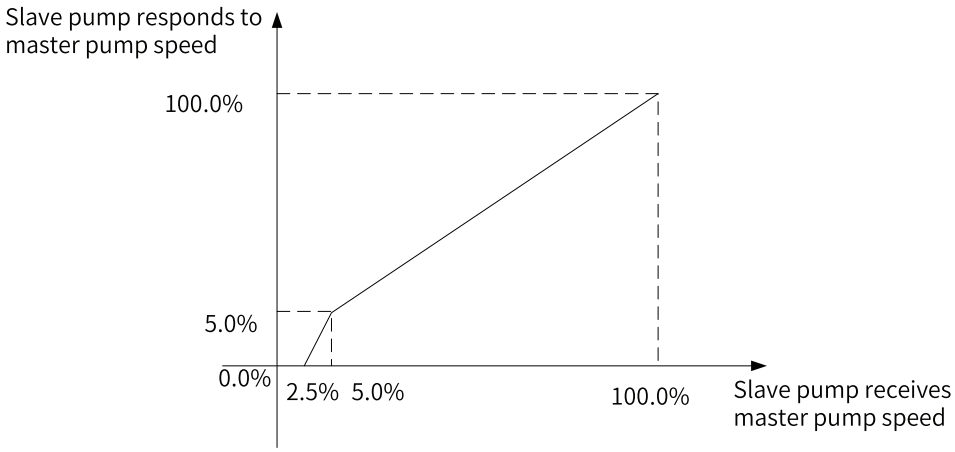


Figure 17-14 Response to master pump commands

Note

The slave drive responses to the speed reference of the master pump are set in the same way for the two multi-pump modes.

17.2.3 Master Drive Setting

Multi-pump mode 1 (H0C-11 = 0)

Enable #50 multi-pump control enable DI terminal on all the drives.

Param.	Name	Value range	Remarks
H0C-00	Communication address	1 to 15	The station number cannot exceed 15. At least one station number is set to 1.
H0C-11	CAN multi-pump mode	0	Multi-pump mode 1 (Broadcast mode)
H03-**	Multi-pump control enable	54	DI5 shorted with COM directly
H04-02	D02 output mode selection	25	Slave pump alarm output

Multi-pump mode 2 (H0C-11 = 1)

Ensure that a drive with No. 1 address must be available for parameter setting. A drive with No. 1 address must act as the master pump only. Up to four combinations are supported for flow divergence control, as shown in the following table.

Param.	Name	Setpoint	Description
H03-**	Slave pump address selection input terminal 1	57	Used to set which slave pumps are selected for flow convergence by the master pump.
H03-**	Slave pump address selection input terminal 2	58	
H04-02	D02 output mode selection	25	Slave pump alarm output
H0C-00	Communication address	1 to 15	The station number cannot exceed 15. At least one station number is set to 1.
H0C-11	CAN multi-pump mode	1	Multi-pump mode 2 (Multi-master mode)

Param.	Name	Setpoint	Description
H0C-15	CAN slave pump address 1	0	Used together with #57 and #58 input terminals to implement four types of flow convergence/ divergence control.
H0C-16	CAN slave pump address 2	0	
H0C-17	CAN slave pump address 3	0	
H0C-18	CAN slave pump address 4	0	

Slave pump address DI input selection

#58 DI input	#57 DI input	CAN slave address selection
0	0	H0C-15: CAN slave pump address 1
0	1	H0C-16: CAN slave pump address 2
1	0	H0C-17: CAN slave pump address 3
1	1	H0C-18: CAN slave pump address 4

17.2.4 Slave Drive Setting

Multi-pump mode 1 (H0C-11 = 0)

The following figure shows the parameter setting of the slave drive. Set other parameters according to general setting methods of servo oil pump.

Param.	Name	Value range	Description
H0C-00	CAN communication address	2 to 15	The station number of the slave drive ranges from 2 to 15.
H03-**	Multi-pump control enable	54	Switch to master pump control

To switch from the slave pump to the master pump, disconnect the #50 DI terminal of the slave pump.

Multi-pump mode 2 (H0C-11 = 1)

The following figure shows the parameter setting of the slave drive. Set other parameters according to general setting methods of servo oil pump.

Param.	Name	Value range	Description
H0C-00	CAN communication address	2 to 15	The station number of the slave drive ranges from 2 to 15.
H03-**	Slave pump address selection input terminal 1	57	When a slave pump is used as the master pump, the terminal must be triggered.
H03-**	Slave pump address selection input terminal 2	58	

17.2.5 Multi-pump Flow Convergence/Divergence Control

Multi-pump mode 1 (H0C-11 = 0)

Example: The oil pump system of the injection molding machine carries three pumps in total, with addresses set to #1, #2, and #3 respectively. As slave pump is not available in multi-pump mode 1, the following two combinations can be used.

- Combination 1: Flow convergence of three pumps
- Combination 2: 2+1 for flow divergence control, where #1 pump used as the master pump to drive #2 slave pump, and #3 pump switched to the master pump

The following describes the wiring for the preceding two combinations.

- **Combination 1: Flow convergence of three pumps**

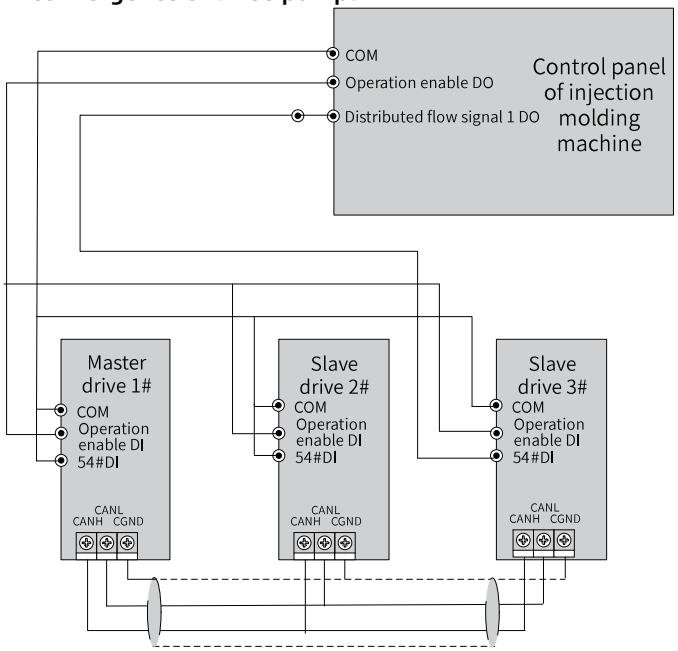


Figure 17-15 Wiring of pump flow convergence

Description:

As #1 master pump keeps being the master pump and #2 master pump keeps being the slave pump, the #54 DI terminal is shorted directly.

In combination 2, #3 slave pump will be switched to the master pump. In this case, the host controller sends a close signal to disconnect #54 DI terminal of #3 slave pump.

- **Combination 2: 2+1 for flow divergence control, where #1 pump used as master pump to drive #2 slave pump, and #3 pump switched to the master pump**

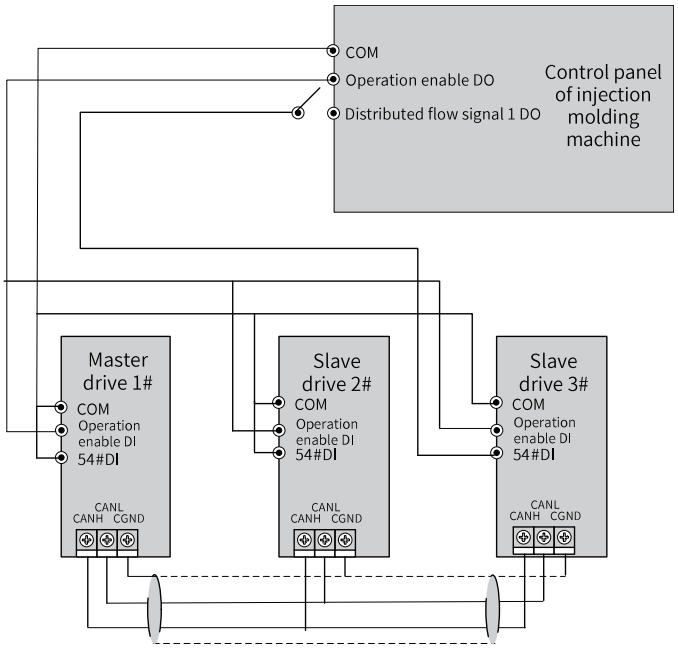


Figure 17-16 2+1 for flow divergence control

The #1 master pump drives the #2 slave pump and #3 pump switches to the master pump. You can switch #3 pump to the master pump by disconnecting #54 DI terminal of #3 slave pump.

Multi-pump mode 2 (H0C-11 = 1)

Example: The oil pump drive system of the injection molding machine carries four oil pumps in total, with addresses being #1, #2, #3, and #4 respectively. Then the following four combinations are available.

- Combination 1: Flow convergence of four pumps
- Combination 2: 2+2 for flow divergence control, where #1 pump used as the master pump to drive #2 slave pump, and #3 pump used as the master pump to drive #4 slave pump
- Combination 3: 3+1 for flow divergence control, where #1 pump used as the master pump to drive #2 and #3 slave pumps, and #4 slave pump switched to the master pump

The following describes the wiring and setting for preceding three combinations.

The CAN communication addresses (H0C-00) of the four pumps are set to #1, #2, #3, and #4 respectively. For pumps which are used as a master pump in every of the preceding three combinations, the communication address must be set to #1.

- **Combination 1: Flow convergence control of four pumps**

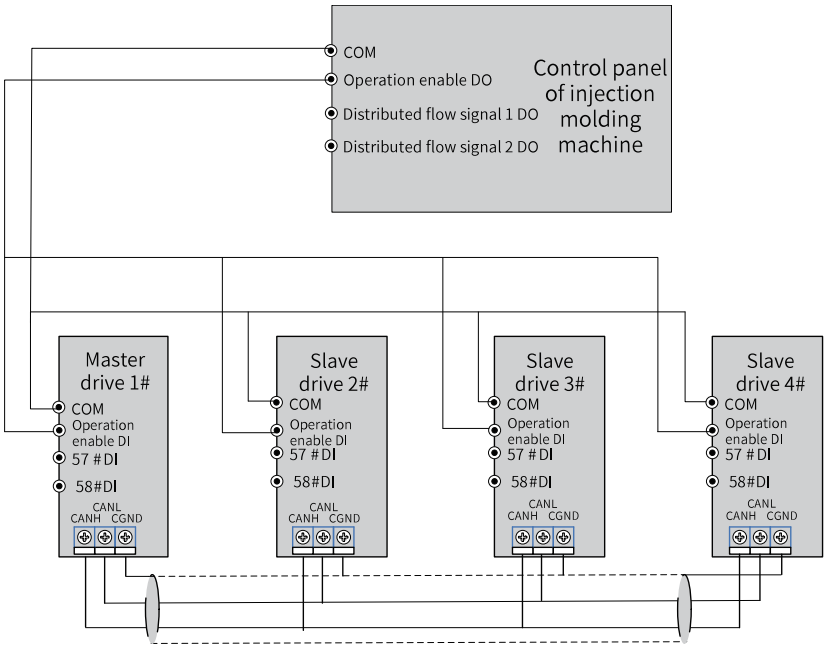


Figure 17-17 Pump flow convergence control

Wiring description: In case of flow convergence only, connect all the CAN cables properly, including the operation enable DI terminal.

Parameter setting: The slave pump address can be set through H0C-15 (CAN slave pump address 1). Each bit of H0C-15 represents a slave pump, and bit0 to bit15 correspond to slave pump #1 to slave pump #16 respectively. For example, if #1 pump is the master pump, the slave pump can be #2, #3, and #4, and bit1, bit2, and bit3 must be set to 1. In this case, set H0C-15 (CAN slave pump address 1) to 1110 (binary) or 14 (decimal).

- **Combination 2: 2+2 for flow divergence control, where #1 pump used as the master pump to drive #2 slave pump, and #3 pump used as the master pump to drive #4 slave pump**

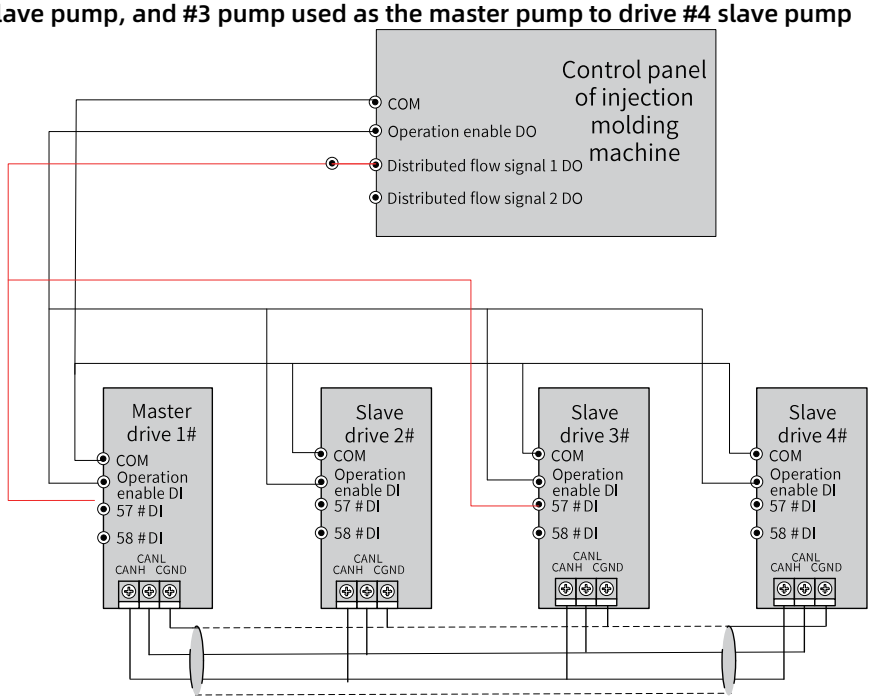


Figure 17-18 2+2 for flow divergence control

Wiring description: The host controller provides flow divergence signal to be connected to #57 DI terminal of the drive that used as the master pump. The master pump uses the #57 signal to identify the slave address, while the slave pump uses the #57 signal to switch to the master pump to identify the slave pump address.

Parameter setting: You can set the slave pump address through H0C-16 (CAN slave pump address 2). Each bit of H0C-16 represents a slave pump, and bit0 to bit15 correspond to #1 slave pump to #16 slave pump respectively. This combination mode involves #1 and #3 master pumps, which drive different slaves. The slave address needs to be set.

- #2 pump is used as the slave pump of #1 master pump. In this case, bit1 needs to be set to 1 and H0C-16 needs to be set to 0010 (binary) or 2 (decimal).
- #4 pump is used as the slave pump of #3 master pump. In this case, bit3 needs to be set to 1 and H0C-16 needs to be set to 1000 (binary) or 8 (decimal).

- **Combination 3: 3+1 for flow divergence control, where #1 pump used as the master pump to drive #2 and #3 slave pumps, and slave pump 4 switched to master pump**

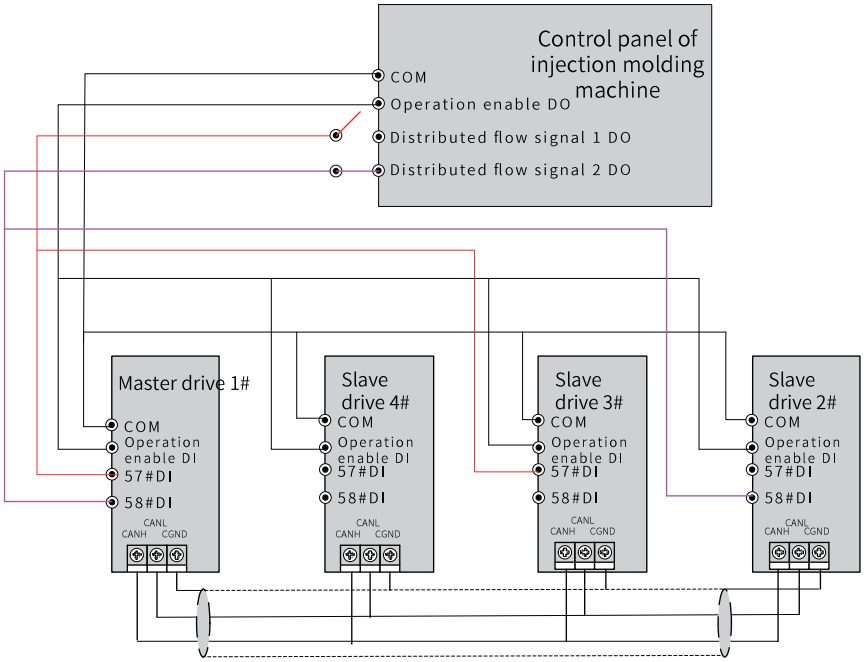


Figure 17-19 3+1 for flow divergence control

Wiring description: The host controller provides flow divergence signal to be connected to #58 DI terminal of the drive that used as the master pump. The master pump uses the #58 signal to identify the slave address, while the slave pump uses the #54 signal to switch to the master pump to identify the slave pump address. The #57 signal in combination 2 is disconnected.

Parameter setting: The slave pump address can be set through H0C-17 (CAN slave pump address 3). Each bit of H0C-17 represents a slave pump, and bit0 to bit15 correspond to #1 slave pump to #16 slave pump respectively. Parameter setting: This combination mode involves #1 and #4 master pumps, which drive different slaves. The slave address needs to be set.

- #2 and #3 pumps are used as the slave pump of #1 master pump. In this case, bit1 and bit2 need to be set to 1 and H0C-17 needs to be set to 0110 (binary) or 6 (decimal).
- After switching to the master pump, #4 pump does not drive any slave pump, so H0C-17 does not need to be set.

17.2.6 Description of Faults and Alarms

The following describes the faults and alarms specific to multi-pump control.

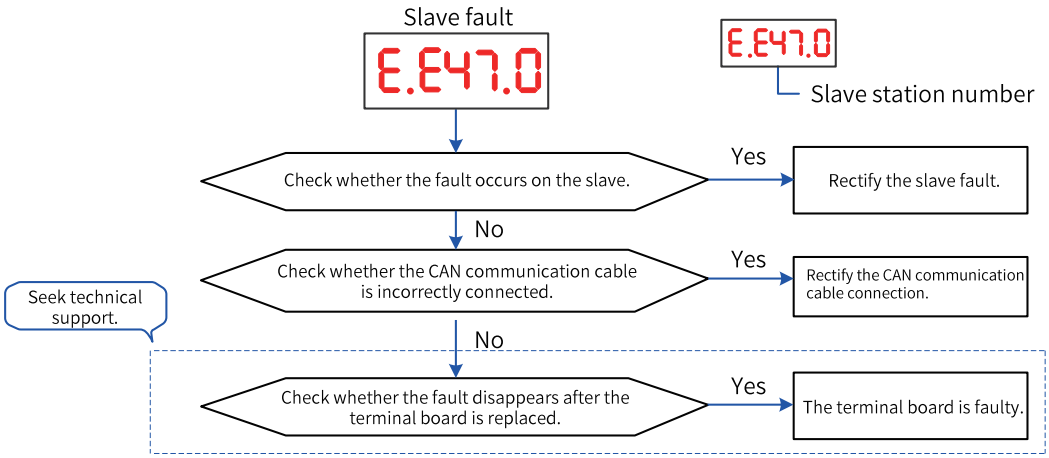


Figure 17-20 Slave fault (E.E47.0)

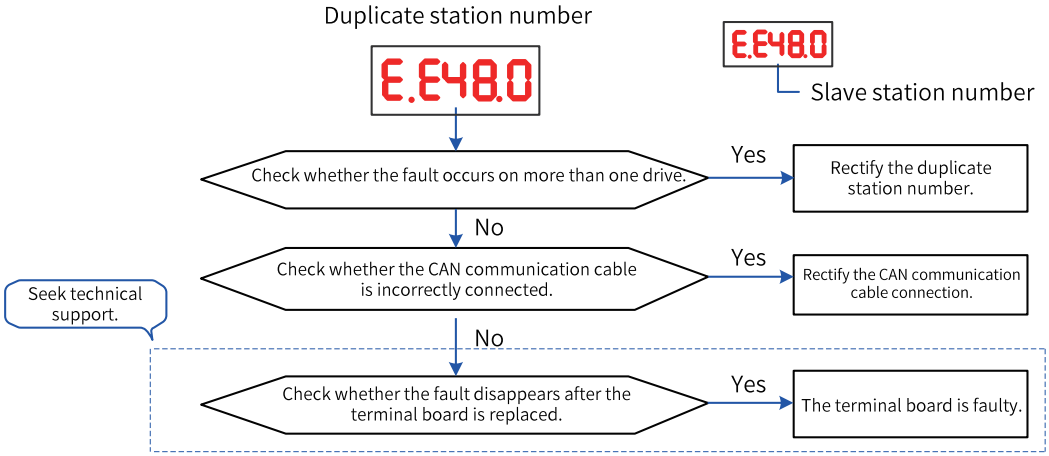


Figure 17-21 CAN address conflict (E.E48.0)

18 Appendix B: Motor Codes and Models

Motor series	Motor model	Remarks
MEG20-A3A1F	MEG20-85C22CD-A3A1F MEG20-80C20CD-A3A1F MEG20-71C17CD-A3A1F	Standard: Tuning-free
	MEG20-13D22CD-A3A1F MEG20-13D20CD-A3A1F MEG20-11D17CD-A3A1F	
	MEG20-20D22CD-A3A1F MEG20-18D20CD-A3A1F MEG20-17D17CD-A3A1F	
	MEG20-23D22CD-A3A1F MEG20-22D20CD-A3A1F MEG20-23D22CD-A3A1F	
	MEG20-27D22CD-A3A1F MEG20-25D20CD-A3A1F MEG20-23D17CD-A3A1F	
	MEG20-31D22CD-A3A1F MEG20-30D20CD-A3A1F MEG20-27D17CD-A3A1F	
	MEG20-33D22CD-A3A1F MEG20-32D20CD-A3A1F MEG20-29D17CD-A3A1F	
	MEG20-39D22CD-A3A1F MEG20-35D20CD-A3A1F MEG20-32D17CD-A3A1F	
MEG23-A3A1F	MEG23-51D22CD-A3A1F MEG23-48D20CD-A3A1F MEG23-41D17CD-A3A1F	Standard: Tuning-free
	MEG23-55D22CD-A3A1F MEG23-52D20CD-A3A1F MEG23-48D17CD-A3A1F	
	MEG23-63D22CD-A3A1F MEG23-59D20CD-A3A1F MEG23-55D17CD-A3A1F	
	MEG23-75D22CD-A3A1F MEG23-67D20CD-A3A1F MEG23-59D17CD-A3A1F	

19 Appendix C: Motor Configuration and Parameter Auto-tuning

19.1 Overview

This product supports motor tuning-free function. You can perform motor parameter auto-tuning as needed based on this section.

19.2 Motor Parameters

Param.	Name	Value	Default value	Unit	Change mode
H00.09	Rated voltage	0: 0 V to 220 V 1: 1 V to 380 V	0	-	At stop
H00.10	Rated power	0.01 to 655.35	0.75	kW	At stop
H00.11	Rated current	0.01 to 655.35	4.70	A	At stop
H00.12	Rated torque	0.10 to 655.35	2.39	N·m	At stop
H00.13	Maximum torque	0.10 to 655.35	7.16	N·m	At stop
H00.14	Rated speed	100 to 6000	3000	rpm	At stop
H00.15	Maximum speed	100 to 6000	6000	rpm	At stop
H00.16	Moment of inertia	0.01 kg·cm^2 to 655.35 kg·cm^2	1.30	kg·cm^2	At stop
H00.17	Number of PMSM pole pairs	2 to 65535	4	-	At stop
H00.18	Stator resistance	0.001 to 65.535	0.500	Ω	At stop
H00.19	Stator inductance L^q	0.01 to 655.35	3.27	mH	At stop
H00.20	Stator inductance L^d	0.01 to 655.35	3.87	mH	At stop
H00.21	Linear back EMF factor	0.01 to 655.35	33.30	mV/rpm	At stop
H00.22	Torque coefficient K^t	0.01 to 655.35	0.51	N·m/A	At stop
H00.24	Mechanical constant T^m	0.01 to 655.35	0.24	ms	At stop
H00.30	Encoder selection (HEX)	19: 0x13 - Inovance encoder	19	-	At stop
H00.31	Encoder pulses per revolution	1 p/Rev to 1.073741824E9 p/Rev	8388608	PPR	At stop
H01-22	d-axis coupling voltage compensation coefficient	0.0% to 1000.0%	100.0	%	Real time
H01-23	q-axis back EMF compensation factor	0.0% to 1000.0%	100.0	%	Real time
H01-24	d-axis current loop gain	0 to 65535	900	Hz	Real time
H01-25	d-axis current loop integral compensation factor	0.01 to 655.35	1.00	-	Real time

Param.	Name	Value	Default value	Unit	Change mode
H01-27	q-axis current loop gain	0 to 65535	900	Hz	Real time
H01-28	q-axis current loop integral compensation factor	0.01 to 655.35	1.00	-	Real time
H01-39	Current loop version	0x0 to 0xFFFF	0x0	-	At stop
H01-52	d-axis proportional gain in performance priority mode	0 to 65535	2200	Hz	Real time
H01-53	d-axis integral gain in performance priority mode	0.01 to 655.35	1.50	-	Real time
H01-54	q-axis proportional gain in performance priority mode	0 to 65535	2200	Hz	Real time
H01-55	q-axis integral gain in performance priority mode	0.01 to 655.35	1.50	-	Real time

19.3 Motor Parameter Auto-Tuning

Internal electrical parameters of the controlled motor can be obtained through auto-tuning, as shown in the following table.

Param.	Name	Value range	Default value	Change mode
H0D.03	Encoder initial angle auto-tuning	0: Disable 1: Enabled	0	At stop

Note

- The ES680 series servo drive supports the tuning-free function when working with an Inovance motor equipped with A3 series high performance encoder. It also supports motor auto-tuning function.
- After re-installing and re-wiring the synchronous motor on the field, perform motor parameter auto-tuning to prevent abnormal motor operation.

Static parameter auto-tuning

Perform motor auto-tuning as follows:

- If the motor can be disconnected from the load, disconnect the power supply, and then disconnect the load from the motor to let the motor rotate without load.

Step	Process
Step 1	After power-on, check whether parameters in groups H00 and H01, drive parameters, and motor parameters are correct.
Step 2	H0D.03 is set to 1 (Angle auto-tuning). Press ENTER to confirm. After the keypad displays Done, the system will prompt E941.0. You need to power up and down again to execute the auto-tuning process.

The motor resistance, inductance, and initial angle are auto-tuned.

20 Appendix D: Parameter List

20.1 Parameters in Groups H00 to H22

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H00-00	0x0000	Motor code	0 to 65535	14101	-	At stop
H00-02	0x0002	Custom code	0.00 to 4294967295.00	0.00	-	Read-only
H00-04	0x0004	Encoder version	0.0 to 6553.5	0.0	-	Read-only
H00-05	0x0005	Bus motor code	0 to 65535	0	-	Read-only
H00-06	0x0006	Non-standard FPGA code	0.00 to 655.35	0.00	-	Read-only
H00-07	0x0007	STO version	0.00 to 655.35	0.00	-	Read-only
H00-08	0x0008	Bus encoder type	0 to 65535	0	-	Read-only
H00-09	0x0009	Rated voltage	0: 220 V 1: 380 V	0	-	At stop
H00-10	0x000A	Rated power	0.01 to 655.35	0.75	kW	At stop
H00-11	0x000B	Rated current	0.01 to 655.35	4.70	A	At stop
H00-12	0x000C	Rated torque	0.10 to 655.35	2.39	N/m	At stop
H00-13	0x000D	Maximum torque	0.10 to 655.35	7.16	N/m	At stop
H00-14	0x000E	Rated speed	100 to 6000	3000	rpm	At stop
H00-15	0x000F	Maximum speed	100 to 6000	6000	rpm	At stop
H00-16	0x0010	Moment of inertia	0.01 to 655.35	1.30	kg·cm²	At stop
H00-17	0x0011	Number of PMSM pole pairs	2 to 65535	4	-	At stop
H00-18	0x0012	Stator resistance	0.001 to 65.535	0.500	Ω	At stop
H00-19	0x0013	Stator inductance Lq	0.01 to 655.35	3.27	mH	At stop
H00-20	0x0014	Stator inductance Ld	0.01 to 655.35	3.87	mH	At stop
H00-21	0x0015	Linear back EMF factor	0.01 to 655.35	33.30	mV/rpm	At stop
H00-22	0x0016	Torque coefficient Kt	0.01 to 655.35	0.51	N·m/Arms	At stop
H00-23	0x0017	Electrical constant Te	0.01 to 655.35	6.54	ms	At stop
H00-24	0x0018	Mechanical constant Tm	0.01 to 655.35	0.24	ms	At stop
H00-28	0x001C	Absolute encoder position offset	0 to 4294967295	8192	-	At stop
H00-30	0x001E	Encoder selection (HEX)	19: 0x13 - Inovance encoder	0x13	-	At stop
H00-31	0x001F	Encoder pulses per revolution	1 to 1073741824	8388608	PPR	At stop
H00-35	0x0023	Model of the bus encoder motor	0 to 65535	0	-	At stop

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H01-00	0x0100	MCU software version	0.0 to 6553.5	0.0	-	Read-only
H01-01	0x0101	FPGA software version	0.0 to 6553.5	0.0	-	Read-only
H01-07	0x0107	Software test version	0.00 to 655.35	0.00	-	Read-only
H01-08	0x0108	Model parameter version	0.00 to 655.35	0.00	-	Read-only
H01-10	0x010A	Drive series No.	14: 11 kW 15: 15 kW 16: 18.5 kW 17: 22 kW 18: 30 kW 19: 37 kW 20: 45 kW 21: 55 kW 22: 75 kW 23: 90 kW 24: 110 kW 25: 132 kW 26: 160 kW 27: 200 kW 28: 220 kW 29: 250 kW 30: 280 kW 31: 315 kW 32: 355 kW	14	-	At stop
H01-11	0x010B	DC-AC voltage level	0 to 65535	380	V	Read-only
H01-12	0x010C	Rated power of the drive	0.00 kW to 655.35 kW	11.00	kW	Read-only
H01-14	0x010E	Maximum output power of the drive	0.00 kW to 655.35 kW	11.00	kW	Read-only
H01-16	0x0110	Rated output current of the drive	0.00 A to 655.35 A	25.00	A	Read-only
H01-18	0x0112	Maximum output current of the drive	0.00 A to 655.35 A	42.50	A	Read-only
H01-20	0x0114	Carrier frequency	2000 to 20000	5000	Hz	At stop
H01-21	0x0115	Dead zone time	0.01 to 20.00	3.00	μs	At stop
H01-22	0x0116	d-axis coupling voltage compensation coefficient	0.0% to 1000.0%	100.0	%	Real time
H01-23	0x0117	q-axis back EMF compensation factor	0.0% to 1000.0%	100.0	%	Real time
H01-24	0x0118	d-axis current loop gain	0 to 65535	900	Hz	Real time
H01-25	0x0119	d-axis current loop integral compensation factor	0.01 to 655.35	1.00	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H01-26	0x011A	Sinc3 filter data extraction rate in current sampling	0: Extraction rate 32 1: Extraction rate 64 2: Extraction rate 128 3: Extraction rate 256	0	-	At stop
H01-27	0x011B	q-axis current loop gain	0 to 65535	900	Hz	Real time
H01-28	0x011C	q-axis current loop integral compensation factor	0.01 to 655.35	1.00	-	Real time
H01-29	0x011D	q-axis coupling voltage compensation coefficient	0.0% to 6553.5%	6553.5	%	Real time
H01-30	0x011E	Bus voltage gain tuning	50.0% to 150.0%	100.0	%	At stop
H01-32	0x0120	Relative gain of UV sampling	1 to 65535	32768	-	At stop
H01-34	0x0122	Drive overtemperature threshold	0 to 150	100	℃	Real time
H01-36	0x0124	Current sensor range	0.00 to 169.59	21.33	A	At stop
H01-38	0x0126	FPGA phase current protection threshold	0.0% to 100.0%	41.3	%	At stop
H01-39	0x0127	Current loop version	0x0 to 0xFFFF	0x0	-	At stop
H01-40	0x0128	DC bus overvoltage protection threshold	600 to 820	820	V	Read-only
H01-41	0x0129	DC bus voltage discharge threshold	600 to 820	760	V	At stop
H01-42	0x012A	DC bus undervoltage threshold	300 to 440	350	V	Real time
H01-52	0x0134	d-axis proportional gain in performance priority mode	0 to 65535	2200	Hz	Real time
H01-53	0x0135	d-axis integral gain in performance priority mode	0.01 to 655.35	1.50	-	Real time
H01-54	0x0136	q-axis proportional gain in performance priority mode	0 to 65535	2200	Hz	Real time
H01-55	0x0137	q-axis integral gain in performance priority mode	0.01 to 655.35	1.50	-	Real time
H01-56	0x0138	Current loop low-pass cutoff frequency	0 to 65535	11000	Hz	At stop
H01-59	0x013B	Bus encoder data transmission compensation time	0.000 to 65.535	0.000	μs	At stop
H01-60	0x013C	FPGA scheduling frequency selection	1: 16 kHz 2: 8 kHz	2	-	At stop

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H01-61	0x013D	Reference scheduling frequency	0: 4 kHz 1: 2 kHz 2: 1 kHz 3: 8 kHz	0	-	At stop
H01-62	0x013E	Auto-tuned drive model	0 to 65535	0	-	Read-only
H01-66	0x0142	Current loop configuration	0 to 31	12	kHz	Real time
H01-67	0x0143	Dead zone compensation coefficient	0.00 to 2.00	1.00	-	Real time
H01-68	0x0144	Current observer cutoff frequency	200 to 5000	2000	-	Real time
H01-69	0x0145	Current observer calibration coefficient	0.00 to 9.00	1.00	-	Real time
H01-72	0x0148	Disable drive model auto-tuning function	0: Inactive 1: Active	1	-	Real time
H01-73	0x0149	Sigma-delta signal phase compensation time	0 to 65535	1	-	Real time
H02-00	0x0200	Control mode selection	0: Speed control mode 1: Position control mode 2: Torque control mode 9: EtherCAT mode	9	-	At stop
H02-01	0x0201	Absolute system selection	0: Incremental mode 1: Absolute position linear mode 2: Absolute position rotation mode 3: Absolute position linear mode (no encoder overflow alarm) 4: Absolute position single-turn mode	0	-	At stop
H02-02	0x0202	Direction of rotation	0: CCW as the forward direction 1: CW as the forward direction	0	-	At stop

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H02-05	0x0205	Stop mode at S-OFF	-3: Stop at zero speed, keeping dynamic braking state -2: Ramp to stop as defined by 6084h/609Ah, keeping dynamic braking state -1: Dynamic braking stop, keeping dynamic braking state 0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/609Ah, keeping de-energized state	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H02-06	0x0206	Stop mode at No. 2 fault	-5: Stop at zero speed, keeping dynamic braking state -4: Stop at emergency-stop torque, keeping dynamic braking state -3: Ramp to stop as defined by 6085h, keeping dynamic braking state -2: Ramp to stop as defined by 6084h/609Ah, keeping dynamic braking state -1: Dynamic braking stop, keeping dynamic braking state 0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/609Ah, keeping de-energized state 2: Ramp to stop as defined by 6085h, keeping de-energized state 3: Stop at emergency stop torque, keeping de-energized state	2	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H02-07	0x0207	Stop mode at overtravel	0: Coast to stop, keeping de-energized state 1: Stop at zero speed, keeping position lock state 2: Stop at zero speed, keeping de-energized state 3: Ramp to stop as defined by 6085h, keeping de-energized status 4: Ramp to stop as defined by 6085h, keeping position lock status 5: Dynamic braking stop, keeping de-energized state 6: Dynamic braking stop, keeping dynamic braking state 7: Not responding to overtravel	1	-	At stop
H02-08	0x0208	Stop mode at No. 1 fault	0: Coast to stop, keeping de-energized state 1: Dynamic braking stop; keeping de-energized state 2: Dynamic braking stop, keeping dynamic braking state	2	-	At stop
H02-09	0x0209	Delay from brake output ON to command received	0 to 500	250	ms	Real time
H02-10	0x020A	Delay from brake output OFF to motor de-energized	50 to 1000	150	ms	Real time
H02-11	0x020B	Motor speed threshold at brake output OFF in rotary state	20 to 3000	30	rpm	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H02-12	0x020C	Delay from S-ON off to brake output off in the rotary state	1 to 1000	500	ms	Real time
H02-15	0x020F	Alarm display on the LED	0: Output alarm information immediately 1: Not output alarm information	0	-	Real time
H02-20	0x0214	Dynamic brake relay coil on-delay	30 ms to 30000 ms	30	ms	Real time
H02-21	0x0215	Minimum allowable resistance of braking resistor	1 to 1000	40	Ω	Read-only
H02-24	0x0218	Resistor heat dissipation coefficient	10 to 100	30	%	Real time
H02-25	0x0219	Braking resistor type	0: Reserved 1: External, natural cooling 2: External, forced air cooling 3: No braking resistor, energy absorbed only by the internal capacitor	1	-	Read-only
H02-26	0x021A	Power of external braking resistor	1 to 65535	40	W	Real time
H02-27	0x021B	Resistance of external braking resistor	15 to 1000	50	Ω	Real time
H02-30	0x021E	User password	0 to 65535	0	-	Real time
H02-31	0x021F	System parameter initialization	0: Inactive 1: Restore default values 2: Clear fault log	0	-	At stop
H02-32	0x0220	Parameter selection in group H0B	0 to 99	50	-	Real time
H02-33	0x0221	Tooling current reference	1.0 to 150.0	10.0	-	Real time
H02-34	0x0222	Tooling frequency reference	0 to 50	50	-	Real time
H02-35	0x0223	Keypad data refresh frequency	0 to 20	0	Hz	Real time
H02-39	0x0227	Phase W overcurrent selection	0 to 1	0	-	Real time
H02-41	0x0229	Manufacturer password	0 to 65535	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H02-42	0x022A	Motor temperature sensor selection	0: Off 1: KTY 2: PT1000 3: PT100	2	-	Real time
H02-43	0x022B	Motor temperature alarm upper limit	-40°C to +200°C	130	°C	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H03-02	0x0302	DI1 function selection	0: Not assigned 1: S-ON 2: Fault reset 14: Positive limit switch 15: Negative limit switch 31: Home switch 34: Emergency stop 52: PID selection 1, such as injection, pressure holding, and mold open/close state 53: PID selection 2, such as injection, pressure holding, and mold open/close state 54: CAN communication enable 55: Slave used as master 56: Terminal for switchover from pressure mode to speed mode 57: Slave pump address selection terminal 1 58: Slave pump address selection terminal 2 59: Switching from injection mode to pressure holding mode 61: Terminal 2 for switching from pressure mode to speed mode	1	-	Real time
H03-03	0x0303	DI1 logic selection	0: Normally closed 1: Normally open	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H03-04	0x0304	DI2 function selection	0: Not assigned 1: S-ON 2: Fault reset 14: Positive limit switch 15: Negative limit switch 31: Home switch 34: Emergency stop 52: PID selection, such as injection, pressure holding, and mold open/ close state 53: PID selection, such as injection, pressure holding, and mold open/ close state 54: CAN communication enable 55: Slave used as master 56: Switching from pressure mode to speed mode 57: Slave pump address selection terminal 1 58: Slave pump address selection terminal 2 59: Switching from injection mode to pressure holding mode 61: Terminal 2 for switching from pressure mode to speed mode	52	-	Real time
H03-05	0x0305	DI2 logic selection	0: Normally closed 1: Normally open	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H03-06	0x0306	DI3 function selection	0: Not assigned 1: S-ON 2: Fault reset 14: Positive limit switch 15: Negative limit switch 31: Home switch 34: Emergency stop 52: PID selection, such as injection, pressure holding, and mold open/ close state 53: PID selection, such as injection, pressure holding, and mold open/ close state 54: CAN communication enable 55: Slave used as master 56: Terminal for switchover from pressure mode to speed mode 57: Slave pump address selection terminal 1 58: Slave pump address selection terminal 2 59: Switching from injection mode to pressure holding mode 61: Terminal 2 for switching from pressure mode to speed mode	57	-	Real time
H03-07	0x0307	DI3 logic selection	0: Normally closed 1: Normally open	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H03-08	0x0308	DI4 function selection	0: Not assigned 1: S-ON 2: Fault reset 14: Positive limit switch 15: Negative limit switch 31: Home switch 34: Emergency stop 52: PID selection, such as injection, pressure holding, and mold open/ close state 53: PID selection, such as injection, pressure holding, and mold open/ close state 54: CAN communication enable 55: Slave used as master 56: Terminal for switchover from pressure mode to speed mode 57: Slave pump address selection terminal 1 58: Slave pump address selection terminal 2 59: Switching from injection mode to pressure holding mode 61: Terminal 2 for switching from pressure mode to speed mode	2	-	Real time
H03-09	0x0309	DI4 logic selection	0: Normally closed 1: Normally open	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H03-10	0x030A	DI5 function selection	0: Not assigned 1: S-ON 2: Fault reset 14: Positive limit switch 15: Negative limit switch 31: Home switch 34: Emergency stop 52: PID selection, such as injection, pressure holding, and mold open/ close state 53: PID selection, such as injection, pressure holding, and mold open/ close state 54: CAN communication enable 55: Slave used as master 56: Terminal for switchover from pressure mode to speed mode 57: Slave pump address selection terminal 1 58: Slave pump address selection terminal 2 59: Switching from injection mode to pressure holding mode 61: Terminal 2 for switching from pressure mode to speed mode	54	-	Real time
H03-11	0x030B	DI5 logic selection	0: Normally closed 1: Normally open	0	-	Real time
H03-50	0x0332	AI1 offset	-5000 to +5000	0	mV	Real time
H03-51	0x0333	AI1 input filter time constant	0.00 to 655.35	2.00	ms	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H03-53	0x0335	AI1 dead zone	0.0 to 1000.0	10.0	mV	Real time
H03-54	0x0336	AI1 zero drift	-1000.0 to +1000.0	0.0	mV	Real time
H03-55	0x0337	AI2 offset	-5000 to +5000	0	mV	Real time
H03-56	0x0338	AI2 input filter time constant	0.00 to 655.35	2.00	ms	Real time
H03-58	0x033A	AI2 dead zone	0.0 to 1000.0	10.0	mV	Real time
H03-59	0x033B	AI2 zero drift	-1000.0 to +1000.0	0.0	mV	Real time
H03-60	0x033C	AI3 offset	-5000 to +5000	0	mV	Real time
H03-61	0x033D	AI3 input filter time constant	0.00 to 655.35	2.00	ms	Real time
H03-63	0x033F	AI3 dead zone	0.0 to 1000.0	0.0	mV	Real time
H03-64	0x0340	AI3 zero drift	-1000.0 to +1000.0	0.0	mV	Real time
H03-65	0x0341	AI3 input source	0: Current type 1: Voltage type	1	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H04-00	0x0400	DO1 function selection	0: Not assigned 1: Drive running 2: Fault output 3: Reserved 6: Reserved 7: Drive overload pre-alarm 8: Reserved 12: Reserved 13: Reserved 15: Ready to run 16: User-calibrated absolute value AI1 > AI2 18: Reserved 20: Reserved 22: Reserved 23: Swash plate switchover 1 24: CAN enable off signal (pressure control status output) 25: Slave fault signal output 26: Reserved 27: Establish bus voltage 28: Reserved 29: Reserved 30: Reserved 31: Reserved 32: Temperature arrival	2	-	Real time
H04-01	0x0401	DO1 logic selection	0: 0 - Normally closed 1: 1 - Normally open	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H04-02	0x0402	DO2 function selection	0: Not assigned 1: Drive running 2: Fault output 3: Reserved 6: Reserved 7: Drive overload pre-alarm 8: Reserved 12: Reserved 13: Reserved 15: Ready to run 16: User-calibrated absolute value AI1 > AI2 18: Reserved 20: Reserved 22: Reserved 23: Swash plate switchover 1 24: CAN enable off signal (pressure control status output) 25: Slave fault signal output 26: Reserved 27: Bus voltage 28: Reserved 29: Reserved 30: Reserved 31: Reserved 32: Temperature arrival	23	-	Real time
H04-03	0x0403	DO2 logic selection	0: 0 - Normally closed 1: 1 - Normally open	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H04-23	0x0417	DO logic upon EtherCAT communication disconnection	0: DO1 to DO3 hold the last output state. 1: DO1 is forced off and DO2 to DO3 hold the last output state. 2: DO2 is forced off and DO1 to DO3 hold the last output state. 3: DO1 and DO2 are forced off and DO3 holds the last output state. 4: DO3 is forced off and DO1 to DO2 hold the last output state. 5: DO1 and DO3 are forced off and DO2 holds the last output state. 6: DO2 and DO3 are forced off and DO1 holds the last output state. 7: DO1 to DO3 are forced off.	0	-	Real time
H04-28	0x041C	DO for motor temperature arrival	0.0 to 300.0	0.0	-	Real time
H05-04	0x0504	First-order low-pass filter time constant	0.0 to 6553.5	0.0	ms	At stop
H05-05	0x0505	Moving average filter time constant 1	0.0 to 1000.0	0.0	ms	At stop
H05-06	0x0506	Moving average filter time constant 2	0.0 to 128.0	0.0	ms	At stop
H05-07	0x0507	Numerator of electronic gear ratio	0 to 4294967295	1	-	Real time
H05-09	0x0509	Denominator of electronic gear ratio	0 to 4294967295	1	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H05-19	0x0513	Speed feedforward control	0: No speed feedforward 1: Internal speed feedforward 2: 60B1 used as speed feedforward 3: Zero phase control	1	-	At stop
H05-20	0x0514	Condition for positioning completion signal output	0: Position deviation = Filtered position reference - Position feedback 1: 1 2: 2 3: 3	0	-	At stop
H05-35	0x0523	Home search time limit	0.0s to 6553.5s	5000.0	s	Real time
H05-46	0x052E	Position offset in absolute position linear mode (low-order 32 bits)	-2147483648 to +2147483647	0	-	At stop
H05-48	0x0530	Position offset in absolute position linear mode (high-order 32 bits)	-2147483648 to +2147483647	0	-	At stop
H05-50	0x0532	Numerator of mechanical gear ratio	1 to 65535	1	-	At stop
H05-51	0x0533	Denominator of mechanical gear ratio	1 to 65535	1	-	At stop
H05-52	0x0534	Pulses per load revolution in absolute position rotation mode (low-order 32 bits)	0 to 4294967295	0	p	At stop
H05-54	0x0536	Pulses per load revolution in absolute position rotation mode (high-order 32 bits)	0 to 4294967295	0	p	At stop
H05-64	0x0540	Probe level selection	0: The internal optocoupler corresponding to probe rising edge changes from ON to OFF. 1: The internal optocoupler corresponding to probe rising edge changes from OFF to ON.	0	-	At stop

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H06-02	0x0602	Speed reference selection	0: Source of main speed reference A 1: Source of auxiliary speed reference B	0	-	At stop
H06-03	0x0603	Speed reference	-6000 to +6000	200	rpm	Real time
H06-05	0x0605	Acceleration ramp time of speed reference	0 to 65535	0	ms	Real time
H06-06	0x0606	Deceleration ramp time of speed reference	0 to 65535	0	ms	Real time
H06-08	0x0608	Positive speed limit	0 to 6000	6000	rpm	Real time
H06-09	0x0609	Negative speed limit	0 to 6000	6000	rpm	Real time
H06-10	0x060A	Deceleration unit in emergency stop	0: x 1 1: x 10 2: x 100	0	-	At stop
H06-11	0x060B	Torque feedforward control	0: No torque feedforward 1: Internal torque feedforward 2: 60B2 used as external torque feedforward	1	-	Real time
H06-12	0x060C	Ramp-up time of jog speed	0 to 65535	10	ms	Real time
H06-13	0x060D	Speed feedforward smoothing filter	0 to 2000	0	μs	Real time
H06-16	0x0610	Threshold of motor rotation speed	0 to 1000	20	rpm	Real time
H06-28	0x061C	Cogging torque compensation enable	0: Inactive 1: Active	1	-	At stop
H06-29	0x061D	Zero speed threshold source switchover	0 to 1	0	-	At stop
H06-36	0x0624	E500.1 Overspeed error single-turn pulse compare threshold	0 to 3000	1200	-	At stop
H06-37	0x0625	E500.1 Overspeed error speed mask switch	0 to 2	1	-	At stop
H07-03	0x0703	Torque reference set through keypad	-400.0 to +400.0	0.0	%	Real time
H07-05	0x0705	Torque reference filter time constant 1	0.00 to 30.00	0.20	ms	Real time
H07-06	0x0706	Torque reference filter time constant 2	0.00 to 30.00	0.27	ms	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H07-07	0x0707	Torque limit source	0: CiA 402 1: Internal torque limit	0	-	Real time
H07-09	0x0709	Positive internal torque limit	0.0 to 250.0	180.0	%	Real time
H07-10	0x070A	Negative internal torque limit	0.0 to 250.0	180.0	%	Real time
H07-15	0x070F	Emergency-stop torque	0.0 to 400.0	100.0	%	Real time
H07-19	0x0713	Internal speed limit in torque control	0 to 6000	3000	rpm	Real time
H07-20	0x0714	Negative internal speed limit in torque control	0 to 6000	3000	rpm	Real time
H07-21	0x0715	Base value for torque arrival	0.0 to 400.0	0.0	%	Real time
H07-22	0x0716	Output torque upon torque arrival DO signal activation	0.0 to 400.0	20.0	%	Real time
H07-23	0x0717	Output torque upon torque arrival DO signal deactivation	0.0 to 400.0	10.0	%	Real time
H07-24	0x0718	Field weakening depth of the drive	60 to 135	115	-	Real time
H07-25	0x0719	Maximum allowable demagnetizing current of the drive	0 to 200	150	-	Real time
H07-26	0x071A	Field weakening enable of the drive	0: Inactive 1: Active	0	-	At stop
H07-27	0x071B	Field weakening gain of the drive	0.000 to 1.000	0.030	-	Real time
H07-28	0x071C	Speed of the field weakening point of the drive	0 to 65535	0	-	Read-only
H07-29	0x071D	Current limit circle coefficient	0 to 150	100	-	At stop
H07-31	0x071F	MTPA enable of the drive	0 to 1	0	-	At stop
H07-32	0x0720	Electro-hydraulic MTPA enable	0: Inactive 1: Active	1	-	At stop
H07-33	0x0721	Field weakening integral gain coefficient	0–10	4	-	Real time
H07-36	0x0724	Torque reference 2 filtering time	0.00 to 10.00	0.00	ms	Real time
H07-37	0x0725	Torque reference filter selection	0: First-order filter 1: Second-order filter	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H07-38	0x0726	Attenuation ratio of biquad low-pass filter	0 to 50	16	-	At stop
H07-40	0x0728	Waiting time for speed limit violation judgment	0 to 300	10	-	Real time
H07-41	0x0729	Brake protection torque limit	0.0 to 400.0	400.0	-	Real time
H07-42	0x072A	Maximum current lead angle	140 to 175	155	-	Real time
H07-43	0x072B	Voltage feedback mean filter	0 to 5	4	-	Real time
H07-44	0x072C	MTPA coefficient	0% to 65535%	100	%	Real time
H07-45	0x072D	Fluctuation suppression coefficient	0 to 1000	0	-	Real time
H07-59	0x073B	Speed limit of active braking torque	0 to 2000	0	-	Real time
H07-60	0x073C	DERATECH 60E0 positive/ negative torque limit switch	0 to 1	0	-	Real time
H07-69	0x0745	Salient-pole motor torque limit	0 to 1	1	-	Real time
H07-70	0x0746	Regenerative power limit percentage	0 to 100	100	-	Real time
H07-71	0x0747	Electro-hydraulic field weakening enable	0: Inactive 1: Active	1	-	At stop
H07-72	0x0748	Threshold for changing electro-magnetic field weakening integral to gain	0 to 65535	1000	-	Real time
H07-73	0x0749	Threshold for reverting to electro-magnetic field weakening integral from gain	0 to 65535	3000	-	Real time
H07-74	0x074A	Electro-magnetic field weakening integral gain	0 to 5000	100	-	Real time
H07-75	0x074B	Electro-magnetic anti-saturation integral gain	0 to 8000	100	-	Real time
H07-76	0x074C	Electro-hydraulic field weakening depth	80% to 125%	115	%	Real time
H08-00	0x0800	Speed loop gain	0.1 to 2000.0	39.0	Hz	Real time
H08-01	0x0801	Speed loop integral time constant	0.15 to 512.00	20.51	ms	Real time
H08-02	0x0802	Position loop gain	0.1 to 2000.0	55.7	Hz	Real time
H08-03	0x0803	2nd speed loop gain	0.1 to 2000.0	75.0	Hz	Real time
H08-04	0x0804	2nd speed loop integral time constant	0.15 to 512.00	10.61	ms	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H08-05	0x0805	2nd position loop gain	0.1 to 2000.0	120.0	Hz	Real time
H08-06	0x0806	Current loop gain	0: Mode 0 1: Mode 1 2: Mode 2 3: Mode 3	0	-	Real time
H08-08	0x0808	2nd gain mode setting	0: Fixed to the 1st gain, P/PI switched by bit26 of external 60FE 1: 1st and 2nd gain set switched based on H0809	1	-	Real time
H08-09	0x0809	Gain switchover condition selection	0: Fixed to the 1st gain set (PS) 1: Switched by bit26 of 60FE 2: Torque reference exceeds the threshold (PS) 3: Speed reference exceeds the threshold (PS) 4: Speed reference change rate exceeds the threshold (PS) 5: Speed reference high-speed/low-speed thresholds (PS) 6: Position deviation too large (P) 7: Position reference available (P) 8: Positioning not completed (P) 9: Actual speed reaches the threshold (P) 10: Position reference generated + Actual speed reaches the threshold (P)	0	-	Real time
H08-10	0x080A	Gain switchover delay	0.0 to 1000.0	5.0	ms	Real time
H08-11	0x080B	Gain switchover level	0 to 20000	50	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H08-12	0x080C	Gain switchover time lag	0 to 20000	30	-	Real time
H08-13	0x080D	Position gain switchover time	0.0 to 1000.0	3.0	ms	Real time
H08-15	0x080F	Load moment of inertia ratio	0.00 to 120.00	1.00	-	Real time
H08-17	0x0811	Zero phase delay	0.0 to 4.0	0.0	ms	Real time
H08-18	0x0812	Speed feedforward filter time constant	0.00 to 64.00	0.50	ms	Real time
H08-19	0x0813	Speed feedforward gain	0.0% to 100.0%	0.0	%	Real time
H08-20	0x0814	Torque feedforward filter time constant	0.00 to 64.00	0.50	ms	Real time
H08-21	0x0815	Torque feedforward gain	0.0 to 300.0	0.0	%	Real time
H08-22	0x0816	Speed feedback filter option	0: Disable 1: 2 times 2: 4 times 3: 8 times 4: 16 times	4	-	At stop
H08-23	0x0817	Cutoff frequency of speed feedback low-pass filter	100 to 8000	8000	Hz	Real time
H08-24	0x0818	Pseudo differential feedforward control coefficient	0.0 to 200.0	100.0	%	Real time
H08-27	0x081B	Cutoff frequency of speed observer	50 to 600	170	Hz	Real time
H08-28	0x081C	Speed observer inertia calibration coefficient	1 to 1600	100	%	Real time
H08-29	0x081D	Speed observer filter time	0.00 to 10.00	0.80	ms	Real time
H08-31	0x081F	Disturbance cutoff frequency	10 to 4000	600	Hz	Real time
H08-32	0x0820	Disturbance compensation gain	0 to 100	0	%	Real time
H08-33	0x0821	Disturbance observer inertia calibration coefficient	1 to 1600	100	%	Real time
H08-37	0x0825	Phase modulation for medium-frequency jitter suppression 2	-90 to +90	0	-	Real time
H08-38	0x0826	Frequency for medium-frequency jitter suppression 2	0 to 1200	0	Hz	Real time
H08-39	0x0827	Compensation gain for medium-frequency jitter suppression 2	0 to 300	0	%	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H08-40	0x0828	Speed observer enable	0: Inactive 1: Active	0	-	Real time
H08-42	0x082A	Model control enable	0: Inactive 1: Active	0	-	Real time
H08-43	0x082B	Model gain	0.1 to 2000.0	40.0	-	Real time
H08-46	0x082E	Feedforward value	0.0 to 102.4	95.0	-	Real time
H08-53	0x0835	Medium- and low-frequency jitter suppression frequency 3	0.0 to 300.0	0.0	Hz	Real time
H08-54	0x0836	Medium- and low-frequency jitter suppression compensation 3	0 to 200	0	%	Real time
H08-56	0x0838	Medium- and low-frequency jitter suppression phase modulation 3	0 to 600	100	%	Real time
H08-59	0x083B	Medium- and low-frequency jitter suppression frequency 4	0.0 to 300.0	0.0	Hz	Real time
H08-60	0x083C	Medium- and low-frequency jitter suppression compensation 4	0 to 200	0	%	Real time
H08-61	0x083D	Medium- and low-frequency jitter suppression phase modulation 4	0 to 600	100	%	Real time
H08-62	0x083E	Position loop integral time constant	0.15 to 512.00	512.00	-	Real time
H08-63	0x083F	2nd position loop integral time constant	0.15 to 512.00	512.00	-	Real time
H08-64	0x0840	Speed observer feedback source	0: Inactive 1: Active	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H09-00	0x0900	Auto-tuning mode selection	0: Inactive, gain parameters tuned manually 1: Active, gain parameters tuned automatically based on the stiffness level 2: Positioning mode, gain parameters tuned automatically based on the stiffness level 3: Interpolation mode + Inertia auto-tuning 4: Normal mode + Inertia auto-tuning 6: Quick positioning mode + Inertia auto-tuning	0	-	Real time
H09-01	0x0901	Stiffness level selection	0 to 41	12	-	Real time
H09-02	0x0902	Adaptive notch mode	0: Adaptive notch not updated 1: One adaptive filter (3rd notch) activated 2: Two adaptive filters (3rd and 4th notches) activated 3: Test only resonance point (displayed in H09-24) 4: Adaptive notch cleared and the 3rd and 4th notches restored to default values	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H09-03	0x0903	Online inertia auto-tuning mode	0: Disabled 1: Enabled, inertia ratio changing slowly 2: Enabled, inertia ratio changing normally 3: Enabled, inertia ratio changing quickly	0	-	Real time
H09-05	0x0905	Offline inertia auto-tuning mode	0: Bidirectional 1: Unidirectional	0	-	At stop
H09-06	0x0906	Maximum speed of inertia auto-tuning	100 to 1000	500	rpm	At stop
H09-07	0x0907	Time constant for accelerating to maximum speed during inertia auto-tuning	20 to 800	125	ms	At stop
H09-08	0x0908	Interval time upon completion of inertia auto-tuning	50 to 10000	800	ms	At stop
H09-09	0x0909	Number of motor revolutions per inertia auto-tuning	0.00 to 100.00	1.00	-	Real time
H09-11	0x090B	Vibration threshold	0.0% to 100.0%	5.0	%	Real time
H09-12	0x090C	Frequency of the 1st notch	50 to 8000	8000	Hz	Real time
H09-13	0x090D	Bandwidth level of the 1st notch	0 to 20	2	-	Real time
H09-14	0x090E	Depth level of the 1st notch	0 to 99	0	-	Real time
H09-15	0x090F	Frequency of the 2nd notch	50 to 8000	8000	Hz	Real time
H09-16	0x0910	Bandwidth level of the 2nd notch	0 to 20	2	-	Real time
H09-17	0x0911	Depth level of the 2nd notch	0 to 99	0	-	Real time
H09-18	0x0912	Frequency of the 3rd notch	50 to 8000	8000	Hz	Real time
H09-19	0x0913	Bandwidth level of the 3rd notch	0 to 20	2	-	Real time
H09-20	0x0914	Depth level of the 3rd notch	0 to 99	0	-	Real time
H09-21	0x0915	Frequency of the 4th notch	50 to 8000	8000	Hz	Real time
H09-22	0x0916	Bandwidth level of the 4th notch	0 to 20	2	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H09-23	0x0917	Depth level of the 4th notch	0 to 99	0	-	Real time
H09-24	0x0918	Auto-tuned resonance frequency	0 to 5000	0	Hz	Read-only
H09-30	0x091E	Tension fluctuation compensation gain	-100.0 to +100.0	0.0	-	Real time
H09-31	0x091F	Tension fluctuation compensation filter time	0.00 to 25.00	0.50	-	Real time
H09-32	0x0920	Gravity compensation value	0.0% to 100.0%	0.0	%	Real time
H09-33	0x0921	Forward friction compensation value	0.0% to 100.0%	0.0	%	Real time
H09-34	0x0922	Negative friction compensation value	-100.0 to 0.0	0.0	%	Real time
H09-35	0x0923	Friction compensation speed	0.0 to 20.0	2.0	-	Real time
H09-36	0x0924	Friction compensation speed selection	0: Slow mode + Speed reference 1: Slow mode + Model speed 2: Slow mode + Speed feedback 3: Slow mode + Observed speed 16: Fast mode + Speed reference 17: Fast mode + Model speed 18: Fast mode + Speed feedback 19: Fast mode + Observed speed	0x0	-	Real time
H09-37	0x0925	Vibration monitoring time	0 to 65535	300	-	Real time
H09-38	0x0926	Frequency of low-frequency resonance suppression 1 at the mechanical end	1.0 to 100.0	100.0	Hz	Real time
H09-39	0x0927	Low-frequency suppression 1 at the mechanical end	0 to 3	2	-	At stop
H09-41	0x0929	Frequency of the 5th notch	50 to 8000	8000	Hz	Real time
H09-42	0x092A	Bandwidth level of the 5th notch	0 to 20	2	-	At stop
H09-43	0x092B	Depth level of the 5th notch	0 to 99	0	-	At stop

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H09-44	0x092C	Frequency of low-frequency suppression 2 at the mechanical end	0.0 to 200.0	0.0	-	Real time
H09-45	0x092D	Response of low-frequency resonance suppression 2 at mechanical end	0.01 to 10.00	1.00	-	Real time
H09-47	0x092F	Bandwidth of low-frequency resonance suppression 2 at mechanical end	0.00 to 2.00	1.00	-	Real time
H09-49	0x0931	Frequency of low-frequency resonance suppression 3 at the mechanical end	0.0 to 200.0	0.0	-	Real time
H09-50	0x0932	Response of low-frequency resonance suppression 3 at the mechanical end	0.01 to 10.00	1.00	-	Real time
H09-52	0x0934	Bandwidth of low-frequency resonance suppression 3 at the mechanical end	0.00 to 2.00	1.00	-	Real time
H09-56	0x0938	STune mode	0 to 6	4	-	Real time
H09-57	0x0939	STune resonance suppression switchover frequency	0 to 4000	900	Hz	Real time
H09-58	0x093A	STune resonance suppression reset enable	0: Inactive 1: Active	0	-	Real time
H0A-00	0x0A00	Power input phase loss protection	0: Active 1: Phase loss not detected 3: Power loss detected	0	-	Real time
H0A-01	0x0A01	Absolute position limit	0: Disable 1: Enable 2: Enabled after homing	0	-	Real time
H0A-08	0x0A08	Overspeed threshold	0 to 20000	0	rpm	Real time
H0A-12	0x0A0C	Runaway protection enable	0: Inactive 1: Active	1	-	Real time
H0A-18	0x0A12	IGBT overtemperature threshold	120 to 175	135	℃	Real time
H0A-19	0x0A13	Filter time of probe 1	0.00 to 6.30	2.00	μs	Real time
H0A-20	0x0A14	Filter time of probe 2	0.00 to 6.30	2.00	μs	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0A-21	0x0A15	STO function display	0: STO status display 1: STO fault display	0	-	Real time
H0A-23	0x0A17	TZ signal filter time	0 to 31	15	25 ns	At stop
H0A-25	0x0A19	Filter time constant of speed feedback display values	0 to 5000	50	ms	Real time
H0A-26	0x0A1A	Mask motor overload alarm/fault	0: Inactive 1: Mask motor overload alarm (Er.909) and motor overload fault (Er.620)	0	-	Real time
H0A-27	0x0A1B	Motor rotation DO speed filter time	0 to 5000	50	ms	Real time
H0A-32	0x0A20	Over-temperature protection time window upon stall	10 to 65535	200	ms	Real time
H0A-33	0x0A21	Overtemperature protection enable upon stall	0: Inactive 1: Active	1	-	Real time
H0A-36	0x0A24	Mask encoder multi-turn overflow fault	0: Inactive 1: Active	0	-	Real time
H0A-40	0x0A28	Overtravel compensation disable	0: Enable 1: Disable	0	-	At stop
H0A-41	0x0A29	STO function switchover	0 to 1	0	-	Real time
H0A-42	0x0A2A	YIZUMI STO status word non-standard function switch	0 to 1	0	-	Real time
H0A-50	0x0A32	Encoder communication fault tolerance threshold	0 to 31	5	-	Real time
H0A-51	0x0A33	Phase loss detection filtering count	3 to 36	20	55 ms	Real time
H0A-52	0x0A34	Encoder temperature protection threshold	0 to 175	0	℃	Real time
H0A-55	0x0A37	Runaway current threshold	100.0 to 400.0	200.0	%	Real time
H0A-56	0x0A38	Reset delay	0 to 60000	10000	ms	Real time
H0A-57	0x0A39	Runaway speed threshold	1 to 1000	50	rpm	Real time
H0A-58	0x0A3A	Runaway speed filter time	0.1 to 100.0	2.0	ms	Real time
H0A-59	0x0A3B	Runaway protection detection time	10 to 1000	30	ms	Real time
H0A-70	0x0A46	Overspeed threshold 2	0 to 20000	0	rpm	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0A-72	0x0A48	Maximum stop time in ramp-to-stop	0 to 65535	10000	ms	At stop
H0A-73	0x0A49	STO 24 V disconnection filter time	0 to 5	5	ms	Real time
H0A-74	0x0A4A	Fault tolerance filter time of two STO channels	0 to 10	10	ms	Real time
H0A-75	0x0A4B	Servo OFF delay after STO triggered	0 to 25	20	ms	Real time
H0A-77	0x0A4D	Output phase loss detection enable	0 to 1	1	-	Real time
H0A-78	0x0A4E	Output phase loss detection enable	0 to 1	1	-	Real time
H0A-79	0x0A4F	Output phase loss detection enable	0 to 1	1	-	Real time
H0A-80	0x0A50	Low frequency overload protection	0 to 1	1	-	Real time
H0A-81	0x0A51	Statistical Period	1 to 60	10	-	Real time
H0A-82	0x0A52	Low frequency alarm count	0 to 65535	0	-	Read-only
H0A-83	0x0A53	Fault tolerance count for low frequency overload	0 to 288	144	-	Real time
H0A-84	0x0A54	Carrier frequency switch	0 to 1	1	-	At stop
H0A-86	0x0A56	Low frequency alarm clear time	0 to 65535	0	-	Read-only
H0A-87	0x0A57	High bit of cumulative count of low frequency sub-alarm	0 to 65535	0	-	Read-only
H0A-89	0x0A59	Cumulative operating time (seconds)	0 to 65535	0	-	Read-only
H0A-90	0x0A5A	Cumulative operating time (hours)	0 to 65535	0	-	Read-only
H0B-00	0x0B00	Actual motor speed	-32767 to +32767	0	rpm	Read-only
H0B-01	0x0B01	Speed reference	-32767 to +32767	0	rpm	Read-only
H0B-02	0x0B02	Internal torque reference	-500.0 % to +500.0%	0.0	%	Read-only
H0B-03	0x0B03	Monitored DI states	0x0 to 0xFFFF	0x0	-	Read-only
H0B-04	0x0B04	Hydraulic pressure feedback	0.0 p to 6553.5 p	0.0	p	Read-only
H0B-05	0x0B05	Monitored DO states	0x0 to 0xFFFF	0x0	-	Read-only
H0B-06	0x0B06	Oil pressure reference	0.0 p to 6553.5 p	0.0	p	Read-only
H0B-07	0x0B07	Absolute position counter	-2147483648 to +2147483647	0	p	Read-only
H0B-09	0x0B09	Mechanical angle	0.0 to 360.0	0.0	°	Read-only

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0B-10	0x0B0A	Electrical angle	0.0 to 360.0	0.0	°	Read-only
H0B-12	0x0B0C	Average load rate	0.0 to 800.0	0.0	%	Read-only
H0B-15	0x0B0F	Position following error (encoder unit)	-2147483648 to +2147483647	0	p	Read-only
H0B-17	0x0B11	Feedback pulse counter	-2147483648 to +2147483647	0	p	Read-only
H0B-19	0x0B13	Total power-on time	0.0 to 429496729.5	0.0	s	Read-only
H0B-21	0x0B15	AI1 sampling voltage (calibrated)	-32.767 V to +32.767 V	0.000	V	Read-only
H0B-22	0x0B16	AI2 sampling voltage (calibrated)	-32.767 V to +32.767 V	0.000	V	Read-only
H0B-23	0x0B17	AI3 sampling voltage (calibrated)	-32.767 V to +32.767 V	0.000	V	Read-only
H0B-24	0x0B18	RMS value of phase current	0.0 to 6553.5	0.0	A	Read-only
H0B-26	0x0B1A	Bus voltage	0.0 to 6553.5	0.0	V	Read-only
H0B-27	0x0B1B	Module temperature	-20 to +200	0	°C	Read-only
H0B-28	0x0B1C	Absolute encoder fault information generated by FPGA	0x0 to 0xFFFF	0x0	-	Read-only
H0B-29	0x0B1D	Axis status information generated by FPGA	0x0 to 0xFFFF	0x0	-	Read-only
H0B-30	0x0B1E	Axis fault information generated by FPGA	0x0 to 0xFFFF	0x0	-	Read-only
H0B-31	0x0B1F	Encoder fault information	0x0 to 0xFFFF	0x0	-	Read-only
H0B-33	0x0B21	Fault log	0: Active fault 1: Last fault 2: 2nd to last fault 3: 3rd to last fault 4: 4th to last fault 5: 5th to last fault 6: 6th to last fault 7: 7th to last fault 8: 8th to last fault 9: 9th to last fault	0	-	Real time
H0B-34	0x0B22	Fault code of the selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-35	0x0B23	Time stamp of the selected fault	0.0 to 429496729.5	0.0	s	Read-only
H0B-37	0x0B25	Motor speed upon the selected fault	-32767 to +32767	0	rpm	Read-only
H0B-38	0x0B26	Motor phase U current upon selected fault	-3276.7 to +3276.7	0.0	A	Read-only

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0B-39	0x0B27	Motor phase V current upon selected fault	-3276.7 to +3276.7	0.0	A	Read-only
H0B-40	0x0B28	Bus voltage upon selected fault	0.0 to 6553.5	0.0	V	Read-only
H0B-41	0x0B29	Input terminal state upon selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-43	0x0B2B	Output terminal status upon selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-45	0x0B2D	Internal fault code	0x0 to 0xFFFF	0x0	-	Read-only
H0B-46	0x0B2E	Absolute encoder fault information generated by FPGA upon selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-47	0x0B2F	System status information generated by FPGA upon selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-48	0x0B30	System fault information generated by FPGA upon selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-49	0x0B31	Encoder fault information upon the selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-51	0x0B33	Internal fault code upon the selected fault	0x0 to 0xFFFF	0x0	-	Read-only
H0B-53	0x0B35	Position following error (reference unit)	-2147483648 to +2147483647	0	p	Read-only
H0B-55	0x0B37	Actual motor speed	-6000.0 to +6000.0	0.0	rpm	Read-only
H0B-57	0x0B39	Control circuit bus voltage	0.0 to 6553.5	0.0	V	Read-only
H0B-58	0x0B3A	Mechanical absolute position (low-order 32 bits)	-2147483648 to +2147483647	0	p	Read-only
H0B-60	0x0B3C	Mechanical absolute position (32 high-order bits)	-2147483648 to +2147483647	0	p	Read-only

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0B-63	0x0B3F	NotRdy state	0: None 1: Control circuit power supply error (H0B-57) 2: Phase loss detection error 3: Main circuit power supply detection error (including ground fault) 4: Other servo faults 5: Ground fault detection not completed	0	-	Read-only
H0B-66	0x0B42	Encoder temperature	-100°C to +200°C	0	°C	Read-only
H0B-67	0x0B43	Discharge load factor	0.0 to 200.0	0.0	%	Read-only
H0B-70	0x0B46	Number of the absolute encoder revolutions	0 and 65535	0	Rev	Read-only
H0B-71	0x0B47	Position of absolute encoder within one turn	0 to 2147483647	0	p	Read-only
H0B-74	0x0B4A	System fault information generated by FPGA	0x0 to 0xFFFF	0x0	-	Read-only
H0B-77	0x0B4D	Encoder position (32 low-order bits)	-2147483648 to +2147483647	0	p	Read-only
H0B-79	0x0B4F	Encoder position (32 high-order bits)	-2147483648 to +2147483647	0	p	Read-only
H0B-81	0x0B51	Single-turn position of the rotary load (32 low-order bits)	-2147483648 to +2147483647	0	p	Read-only
H0B-83	0x0B53	Single-turn position of the rotating load (32 high-order bits)	-2147483648 to +2147483647	0	p	Read-only
H0B-85	0x0B55	Single-turn position of the rotary load (reference unit)	-2147483648 to +2147483647	0	p	Read-only
H0B-87	0x0B57	Motor temperature	-49.0°C to +300.0 °C	0.0	°C	Read-only
H0B-88	0x0B58	IGBT temperature	-49.0°C to +300.0 °C	0.0	°C	Read-only
H0B-90	0x0B5A	Number of the group with abnormal parameters	0x0 to 0xFFFF	0x0	-	Read-only
H0B-91	0x0B5B	Offset in the group with abnormal parameters	0 to 65535	0	-	Read-only

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0B-92	0x0B5C	Uncalibrated AI1 voltage	-32.767 V to +32.767 V	0.000	V	Read-only
H0B-93	0x0B5D	Uncalibrated AI2 voltage	-32.767 V to +32.767 V	0.000	V	Read-only
H0B-94	0x0B5E	AI3 voltage before correction	-32.767 V to +32.767 V	0.000	V	Read-only
H0B-95	0x0B5F	RS line voltage	-1000 V to +1000 V	0	V	Read-only
H0B-96	0x0B60	ST line voltage	-1000 V to +1000 V	0	V	Read-only
H0B-97	0x0B61	TR line voltage	-1000 V to +1000 V	0	V	Read-only
H0B-98	0x0B62	Fault code	0x0 to 0xFFFF	0x0	-	Read-only
H0B-99	0x0B63	Subcode	0x0 to 0xFFFF	0x0	-	Read-only
H0C-00	0x0C00	CAN communication station No.	1 to 247	1	-	Real time
H0C-02	0x0C02	CAN baud rate	0: 20 kbps 1: 50 kbps 2: 100 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 1 Mbps	5	-	Real time
H0C-03	0x0C03	Odd/Even parity setting	0 to 3	0	-	Real time
H0C-11	0x0C0B	CAN multi-pump mode	0 to 1	0	-	Real time
H0C-15	0x0C0F	CAN slave pump address 1	0x0 to 0xFFFF	0xFFFE	-	Real time
H0C-16	0x0C10	CAN slave pump address 2	0x0 to 0xFFFF	0x0	-	Real time
H0C-17	0x0C11	CAN slave pump address 3	0x0 to 0xFFFF	0x0	-	Real time
H0C-18	0x0C12	CAN slave pump address 4	0x0 to 0xFFFF	0x0	-	Real time
H0C-21	0x0C15	Expansion frame enable of oil pressure 5 mode	0 to 1	1	-	Real time
H0C-22	0x0C16	CAN communication disconnection detection time	0.0 to 60.0	0.3	-	Real time
H0C-23	0x0C17	Slave pump fault not detected at stop	0 to 1	0	-	Real time
H0C-24	0x0C18	Time threshold for clearing stale CANopen commands	0 to 1000	30	-	Real time
H0C-25	0x0C19	CANlink disconnection detection time	0 to 65535	500	-	Real time
H0C-26	0x0C1A	CANopen expert mode	0 to 1	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0C-27	0x0C1B	PDO inhibit time in CANopen mode (expert mode)	0 to 65535	20	-	Real time
H0C-28	0x0C1C	CANopen event time	0 to 65535	10	-	Real time
H0D-00	0x0D00	Software reset	0: Inactive 1: Active	0	-	At stop
H0D-01	0x0D01	Fault reset	0: Inactive 1: Active	0	-	At stop
H0D-03	0x0D03	Encoder initial angle auto-tuning	0: Inactive 1: Active	0	-	At stop
H0D-04	0x0D04	Read/Write in encoder ROM	0: Inactive 1: Write ROM 2: Read ROM 3: ROM failed	0	-	At stop
H0D-05	0x0D05	Emergency stop	0: Inactive 1: Active	0	-	Real time
H0D-10	0x0D0A	Zero drift detection with one key	0 to 2	0	-	Real time
H0D-12	0x0D0C	Phase U/V current balance calibration	0: Inactive 1: Active	0	-	At stop
H0D-17	0x0D11	DI/DO force enable switch	0: Inactive 1: DI force enabled, and DO force disabled 2: DI force disabled, and DO force enabled 3: DI and DO force enabled	0	-	Real time
H0D-18	0x0D12	Forced DI value	0x0 to 0x1F	0x1F	-	Real time
H0D-19	0x0D13	Setpoint of forced DO value	0x0 to 0x7	0x0	-	Real time
H0D-20	0x0D14	Absolute encoder reset enable	0: Inactive 1: Reset encoder fault 2: Reset encoder fault and multi-turn data	0	-	At stop
H0E-00	0x0E00	Node address	1 to 127	1	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0E-01	0x0E01	Saving objects written through communication to EEPROM	0: Neither parameters nor object dictionaries written through communication saved to EEPROM 1: Only parameters written through communication saved to EEPROM 2: Only object dictionaries written through communication saved to EEPROM 3: Both parameters and object dictionaries written through communication saved to EEPROM	3	-	Real time
H0E-20	0x0E14	EtherCAT slave name	0 to 65535	0	-	Read-only
H0E-21	0x0E15	EtherCAT slave alias	0 to 65535	0	-	At stop
H0E-22	0x0E16	Synchronous loss count allowed by EtherCAT	1 to 20	8	-	Real time
H0E-23	0x0E17	EtherCAT synchronization detection mode	0 to 65535	0	-	Read-only
H0E-24	0x0E18	Synchronous loss count	0 to 65535	0	-	Read-only
H0E-25	0x0E19	Maximum invalid frame and error count of EtherCAT port 0 per unit time	0x0 to 0xFFFF	0x0	-	Read-only
H0E-26	0x0E1A	Maximum invalid frame and error count of EtherCAT port 1 per unit time	0x0 to 0xFFFF	0x0	-	Read-only
H0E-27	0x0E1B	Maximum error count transferred by EtherCAT port per unit time	0x0 to 0xFFFF	0x0	-	Read-only
H0E-28	0x0E1C	Max. EtherCAT data frame processing unit error per unit time	0x0 to 0xFF	0x0	-	Read-only
H0E-29	0x0E1D	Maximum link loss count of EtherCAT port 0 per unit time	0x0 to 0xFFFF	0x0	-	Read-only

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H0E-31	0x0E1F	EtherCAT synchronous mode setting	0 to 2	1	-	At stop
H0E-32	0x0E20	EtherCAT synchronous error threshold	100 to 4000	3000	ns	At stop
H0E-33	0x0E21	EtherCAT state machine state and port connection state	0 to 65535	0	-	Read-only
H0E-34	0x0E22	Excessive CSP position reference increment count	1 to 30	20	-	Real time
H0E-35	0x0E23	AL fault code	0x0 to 0xFFFF	0x0	-	Read-only
H0E-36	0x0E24	EtherCAT enhanced link enable	0: Inactive 1: Active	0	-	Real time
H0E-37	0x0E25	EtherCAT XML reset enable	0: Inactive 1: Active	0	-	Real time
H0E-80	0x0E50	Modbus baud rate	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 10: 230400 bps	9	-	Real time
H0E-81	0x0E51	Modbus data format	0: No parity, 2 stop bits (8-N-2) 1: Even parity, 1 stop bit (8-E-1) 2: Odd parity, 1 stop bit (8-O-1) 3: No parity, 1 stop bit (8-N-1)	3	-	Real time
H0E-82	0x0E52	Modbus response delay	0 to 20	0	ms	Real time
H0E-83	0x0E53	Modbus communication timeout period	0 to 600	0	ms	Real time
H0E-90	0x0E5A	Modbus version	0.00 to 655.35	0.00	-	Read-only
H0E-93	0x0E5D	EtherCAT COE version	0.00 to 655.35	0.00	-	Read-only
H0E-96	0x0E60	XML version information	0.00 to 655.35	0.00	-	Read-only
H10-27	0x101B	Enable non-standard functions related to DERATECH	0 to 1	0	-	Real time
H10-28	0x101C	Enable non-standard functions related to DERATECH position loop	0 to 1	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H10-29	0x101D	DERATECH analog output torque switch	0 to 1	0	-	Real time
H10-30	0x101E	E101 Fault production line tracing	0 to 65535	0	-	Read-only
H10-40	0x1028	Speed feedback value displayed by oscilloscope 6 channel	-32767 to +32767	0	-	Read-only
H14-00	0x1400	Hydraulic pressure control mode	0: Non-hydraulic pressure mode 1: Reserved 2: Oil pressure 2 mode 3: Reserved 4: Reserved 5: Oil pressure 5 mode	0	-	At stop
H14-01	0x1401	Maximum speed	0 to 6000	2000	rpm	At stop
H14-02	0x1402	System hydraulic pressure	0.0 to 500.0	175.0	bar	At stop
H14-03	0x1403	Maximum hydraulic pressure	10.0 bar to 500.0 bar	250.0	bar	At stop
H14-04	0x1404	Rise time of the first hydraulic pressure group	0.000s to 2.000s	0.125	s	Real time
H14-05	0x1405	1st group of hydraulic pressure control Kp	0.0 to 800.0	210.0	-	Real time
H14-06	0x1406	1st group of hydraulic pressure control Ti	0.001 to 10.000	0.040	-	Real time
H14-07	0x1407	1st group of hydraulic pressure control Td	0.000 to 1.000	0.000	-	Real time
H14-08	0x1408	Upper limit of maximum negative speed	0.0% to 6553.5%	10.0	%	Real time
H14-09	0x1409	Bottom flow	0.0 to 50.0	0.5	%	Real time
H14-10	0x140A	Bottom pressure	0.0 to 50.0	0.5	bar	Real time
H14-11	0x140B	2nd group of hydraulic pressure control Kp	0.0 to 800.0	210.0	-	Real time
H14-12	0x140C	2nd group of hydraulic pressure control Ti	0.001 to 10.000	0.040	-	Real time
H14-13	0x140D	2nd group of hydraulic pressure control Td	0.000 to 1.000	0.000	-	Real time
H14-14	0x140E	3rd group of hydraulic pressure control Kp	0.0 to 800.0	210.0	-	Real time
H14-15	0x140F	3rd group of hydraulic pressure control Ti	0.001 to 10.000	0.100	-	Real time
H14-16	0x1410	3rd group of hydraulic pressure control Td	0.000 to 1.000	0.000	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H14-17	0x1411	4th group of hydraulic pressure control Kp	0.0 to 800.0	210.0	-	Real time
H14-18	0x1412	4th group of hydraulic pressure control Ti	0.001 to 10.000	0.100	-	Real time
H14-19	0x1413	4th group of hydraulic pressure control Td	0.000 to 1.000	0.000	-	Real time
H14-21	0x1415	Hydraulic pressure sensor pressure signal fault detection time	0.000 to 60.000	0.500	-	Real time
H14-22	0x1416	Swash plate switchover flow reference in percentages	0.0 to 100.0	10.0	-	At stop
H14-23	0x1417	Oil pressure reference in percentages for swash plate switching	0.0 to 100.0	60.0	-	At stop
H14-24	0x1418	Swash plate switchover delay	0.000s to 10.000s	0.100	s	Real time
H14-25	0x1419	1st group of hydraulic pressure ramp-up S-curve filter time	0.001 to 10.000	0.001	s	Real time
H14-26	0x141A	1st group of hydraulic pressure ramp-down S-curve filter time	0.001 to 1.000	0.001	s	Real time
H14-27	0x141B	1st group of hydraulic pressure overshoot suppression detection level	0 to 2000	200	-	Real time
H14-28	0x141C	1st group of hydraulic pressure overshoot suppression coefficient	0 to 3000	200	-	Real time
H14-29	0x141D	Hydraulic pressure loop gain factor of injection molding machine	2.0% to 50.0%	10.0	%	Real time
H14-30	0x141E	Torque upper limit for switching from hydraulic pressure mode to speed mode	50.0 to 250.0	160.0	-	Real time
H14-31	0x141F	Delay of 1st group of hydraulic pressure references	0.000 to 0.500	0.000	-	Real time
H14-32	0x1420	Minimum input of slave injection molding machine	-100.0 to +100.0	0.0	-	Real time
H14-33	0x1421	Corresponding setting of minimum input of slave injection molding machine	-100.0 to +100.0	0.0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H14-34	0x1422	Input at the common point of the slave injection molding machine	-100.0 to +100.0	0.0	-	Real time
H14-35	0x1423	Corresponding setting of the common point of the slave injection molding machine	-100.0 to +100.0	0.0	-	Real time
H14-36	0x1424	Maximum input of slave injection molding machine	-100.0 to +100.0	100.0	-	Real time
H14-37	0x1425	Corresponding setting of the maximum input of slave injection molding machine	-100.0 to +100.0	100.0	-	Real time
H14-38	0x1426	Whether the slave speed consistent with master speed in multi-pump mode	0 to 1	0	-	Real time
H14-39	0x1427	Single pump pressure holding gain of injection molding machine	20 to 800	100	-	Real time
H14-40	0x1428	Pressure deviation of flow jitter elimination by decreasing PI during multi-pump injection	0.0 to 50.0	5.0	-	Real time
H14-41	0x1429	Lower limit of flow jitter elimination by decreasing PI during multi-pump injection	0 to 30000	0	-	Real time
H14-42	0x142A	Monitoring time of flow jitter elimination by decreasing PI during multi-pump injection	0.200 to 2.000	0.400	-	Real time
H14-43	0x142B	Pressure deviation of a non-operating slave pump in multi-pump CAN communication mode	0.0 to 50.0	5.0	-	Real time
H14-44	0x142C	Flow lower limit of a non-operating slave pump in multi-pump CAN communication mode	-100.0 to +100.0	10.0	-	Real time
H14-45	0x142D	Stop delay when the slave pump receives no speed reference	0.010 to 5.000	1.000	-	Real time
H14-46	0x142E	Time for decelerating to stop when the slave pump receives no speed reference	0.001 to 5.000	0.200	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H14-47	0x142F	Pressure deviation of a non-operating slave pump in multi-pump ETC mode	0.0 to 50.0	5.0	-	Real time
H14-51	0x1433	Current lower limit of pressure sensor fault detection	20 to 300	100	-	Real time
H14-52	0x1434	Speed upper limit of pressure sensor fault detection	20 to 100	50	-	Real time
H14-53	0x1435	1st group of high-speed flow ramp-down time	0.000 to 5.000	0.100	-	Real time
H14-54	0x1436	1st group of high-speed flow threshold	0.0 to 100.0	100.0	-	Real time
H14-55	0x1437	Pressure relief deviation when stopping the valve	0.0 to 500.0	0.0	-	Real time
H14-56	0x1438	Torque lower limit in zero torque mode	0.0 to 250.0	20.0	-	Real time
H14-57	0x1439	Voltage upper limit of No. 46 fault detection	-1.000 to 11.000	10.000	-	Real time
H14-58	0x143A	Voltage lower limit of No. 46 fault detection	-1.000 to 11.000	-0.100	-	Real time
H14-59	0x143B	No. 46 fault detection time	0.000 to 60.000	0.000	-	Real time
H14-60	0x143C	Pressure sensor type	0 to 4	0	-	Real time
H14-61	0x143D	Communication data volume reduction upon prolonged multi-pump data update cycle in mode 5	10 to 30	10	-	Real time
H14-63	0x143F	High/Low-voltage PI parameter switchover enable	0 to 1	0	-	Real time
H14-64	0x1440	1st group of bottom pressure control Kp	0.0 to 800.0	210.0	-	Real time
H14-65	0x1441	1st group of low pressure control Ti	0.001 to 10.000	0.500	-	Real time
H14-66	0x1442	1st group of high pressure control Kp	0.0 to 800.0	260.0	-	Real time
H14-67	0x1443	1st group high pressure control Ti	0.000 to 10.000	0.020	-	Real time
H14-68	0x1444	Low pressure threshold	0.0 to 500.0	50.0	-	Real time
H14-69	0x1445	High pressure threshold	0.0 to 500.0	100.0	-	Real time
H14-70	0x1446	Hydraulic pressure threshold upon stop of slave pump	0.0 to 500.0	0.0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H14-71	0x1447	Allowable fluctuation of hydraulic pressure threshold upon stop of slave pump	0.0 to 500.0	0.0	-	Real time
H15-02	0x1502	1st group of oil pressure ramp-down time	0.000s to 2.000s	0.150	s	Real time
H15-03	0x1503	1st group of flow ramp-up time	0.000 to 5.000	0.030	s	Real time
H15-04	0x1504	1st group of flow ramp-down time	0.000 to 5.000	0.100	s	Real time
H15-05	0x1505	Multi-PID selection	0 to 3	0	-	Real time
H15-06	0x1506	Pump flow compensation	0 to 500	0	-	Real time
H15-08	0x1508	Minimum relief pressure in reverse run (zero speed applied for pressure lower than this setpoint)	0.0 to 500.0	0.0	-	Real time
H15-09	0x1509	Maximum allowable time of pressure relief in reverse run (EB46 reported if timeout)	0.000 to 5.000	0.000	-	Real time
H15-10	0x150A	Allowable time of 2nd group hydraulic pressure reference ramp-up S-curve	0.001 to 1.000	0.001	-	Real time
H15-11	0x150B	Allowable time of 2nd group hydraulic pressure reference ramp-down S-curve	0.001 to 1.000	0.001	-	Real time
H15-12	0x150C	2nd group of flow reference ramp-up time	0.001 to 5.000	0.030	-	Real time
H15-13	0x150D	2nd group of flow reference ramp-down time	0.001 to 5.000	0.100	-	Real time
H15-14	0x150E	2nd group of hydraulic pressure reference ramp-up time	0.000 to 2.000	0.125	-	Real time
H15-15	0x150F	2nd group of hydraulic pressure reference ramp-down time	0.000 to 2.000	0.150	-	Real time
H15-16	0x1510	2nd group of hydraulic pressure overshoot suppression detection level	0 to 2000	200	-	Real time
H15-17	0x1511	2nd group of hydraulic pressure overshoot suppression coefficient	0 to 3000	50	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H15-18	0x1512	Delay of 2nd group of hydraulic pressure references	0.000 to 0.500	0.000	-	Real time
H15-22	0x1516	Oil pressure deviation threshold for deactivating oil pressure suppression	0.0 to 500.0	10.0	-	Real time
H15-23	0x1517	Maximum value of integral limit deviation	0.0 to 500.0	45.0	-	Real time
H15-24	0x1518	Integral limit mode selection	0 to 1	0	-	Real time
H15-25	0x1519	Pressure loop output upper limit increment	0 to 500	20	-	Real time
H15-26	0x151A	Hydraulic pressure PID algorithm selection	0 to 3	0	-	At stop
H15-29	0x151D	1st group of impact overshoot suppression pressure feedback and reference percentage threshold	0.0 to 100.0	70.0	-	Real time
H15-30	0x151E	1st group of impact overshoot suppression factor Kd	0 to 100	40	-	Real time
H15-31	0x151F	2nd group of impact overshoot suppression pressure feedback and reference percentage threshold	0.0 to 100.0	70.0	-	Real time
H15-32	0x1520	2nd group of impact overshoot suppression factor Kd	0 to 100	40	-	Real time
H15-84	0x1554	Resistance of braking resistor	0.0 to 300.0	0.0	-	Real time
H15-85	0x1555	Real-time energy consumption monitoring	-327.67 to +327.67	0.00	-	Read-only
H15-86	0x1556	Per-unit value of the maximum voltage value	0 to 1	0	-	Real time
H15-91	0x155B	Low-order bit of inverter energy consumption	0.0 to 65535.0	0.0	-	Read-only
H15-92	0x155C	High-order bit of inverter energy consumption	0 to 65535	0	-	Read-only
H15-93	0x155D	Braking power	0.0 to 65535.0	0.0	-	Real time
H15-94	0x155E	Power consumption clear	0 to 1	0	-	Real time
H15-95	0x155F	Hardware loss calculation test subscript	0 to 65535	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H15-96	0x1560	Hardware loss calculation test (num)	0 to 65535	0	-	Real time
H15-97	0x1561	Low-order 16 bits of inverter energy consumption	0.0000 to 65535.0000	0.0000	-	Read-only
H15-98	0x1562	High-order 16 bits of inverter energy consumption	0 to 65535	0	-	Read-only
H18-00	0x1800	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-02	0x1802	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-04	0x1804	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-06	0x1806	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-08	0x1808	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-10	0x180A	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-12	0x180C	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-14	0x180E	Monitoring parameter used for EtherCAT monitoring purpose	-2147483648 to +2147483647	0	-	Real time
H18-16	0x1810	Ejection multi-position 2	0.00 to 655.35	0.00	-	Real time
H18-17	0x1811	Ejection multi-position 3	0.00 to 655.35	0.00	-	Real time
H18-18	0x1812	Initial ejection multi-position 1	0.00 to 655.35	0.00	-	Real time
H18-19	0x1813	Initial ejection multi-position 2	0.00 to 655.35	0.00	-	Real time
H18-20	0x1814	Injection multi-speed 1	0.0 to 65535.0	0.0	-	Real time
H18-21	0x1815	Injection multi-speed 2	0.0 to 65535.0	0.0	-	Real time
H18-22	0x1816	Injection multi-speed 3	0.0 to 65535.0	0.0	-	Real time
H18-23	0x1817	Initial ejection multi-speed 1	0.0 to 65535.0	0.0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H18-24	0x1818	Initial ejection multi-speed 2	0.0 to 65535.0	0.0	-	Real time
H18-25	0x1819	Ejection multi-position reference ramp-up time	0.000 to 65535.000	150.000	-	Real time
H18-26	0x181A	Ejection multi-position reference switchover time	0.000 to 65535.000	150.000	-	Real time
H18-27	0x181B	Ejection multi-position reference ramp-down time	0.000 to 65535.000	150.000	-	Real time
H18-28	0x181C	Ejection retract delay mode	0 to 9	0	-	Real time
H18-29	0x181D	Ejection retract delay time	0.000 to 65535.000	0.000	-	Real time
H18-30	0x181E	Ejection retract multi-position 1	0.00 to 655.35	0.00	mm	Real time
H18-31	0x181F	Ejection retract multi-position 2	0.00 to 655.35	0.00	mm	Real time
H18-32	0x1820	Ejection retract multi-position 3	0.00 to 655.35	0.00	mm	Real time
H18-33	0x1821	Initial ejection retract multi-position 1	0.00 to 655.35	0.00	mm	Real time
H18-34	0x1822	Initial ejection retract multi-position 2	0.00 to 655.35	0.00	mm	Real time
H18-35	0x1823	Ejection retract multi-speed 1	0.0 to 65535.0	0.0	mm/s	Real time
H18-36	0x1824	Ejection retract multi-speed 2	0.0 to 65535.0	0.0	mm/s	Real time
H18-37	0x1825	Ejection retract multi-speed 3	0.0 to 65535.0	0.0	mm/s	Real time
H18-38	0x1826	Initial ejection retract multi-speed 1	0.0 to 65535.0	0.0	mm/s	Real time
H18-39	0x1827	Initial ejection retract multi-speed 2	0.0 to 65535.0	0.0	mm/s	Real time
H18-40	0x1828	Ejection retract multi-position reference ramp-up time	0.000 to 65535.000	150.000	s	Real time
H18-41	0x1829	Ejection retract multi-position reference switchover time	0.000 to 65535.000	150.000	s	Real time
H18-42	0x182A	Ejection retract multi-position reference ramp-down time	0.000 to 65535.000	150.000	s	Real time
H18-43	0x182B	Ejector pin vibration reference ramp-up time	0.000 to 65535.000	3.000	s	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H18-44	0x182C	Ejector pin vibration reference ramp-down time	0.000 to 65535.000	3.000	s	Real time
H18-45	0x182D	Ejector pin action time	0.000 to 65535.000	0.000	s	Real time
H19-00	0x1900	Target value of position compare 1	-2147483648 to +2147483647	0	-	Real time
H19-02	0x1902	Attribute value of position comparison 1	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H19-03	0x1903	Target value of position compare 2	-2147483648 to +2147483647	0	-	Real time
H19-05	0x1905	Property value of position compare 2	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H19-06	0x1906	Target value of position compare 3	-2147483648 to +2147483647	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H19-08	0x1908	Property value of position compare 3	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H19-09	0x1909	Target value of position compare 4	-2147483648 to +2147483647	0	-	Real time
H19-11	0x190B	Property value of position compare 4	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H19-12	0x190C	Target value of position compare 5	-2147483648 to +2147483647	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H19-14	0x190E	Property value of position compare 5	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H19-15	0x190F	Target value of position compare 6	-2147483648 to +2147483647	0	-	Real time
H19-17	0x1911	Property value of position compare 6	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H19-18	0x1912	Target value of position compare 7	-2147483648 to +2147483647	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H19-20	0x1914	Property value of position compare 7	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H19-21	0x1915	Target value of position compare 8	-2147483648 to +2147483647	0	-	Real time
H19-23	0x1917	Property value of position compare 8	0: Skip this point 1: Output DO active signal if current position changes from "less than" to "more than" the comparison point 2: Output DO active signal if current position changes from "more than" to "less than" the comparison point 3: Output DO active signal in both situations	0	-	Real time
H1A-33	0x1A21	AI1 minimum input	-11.00 to +11.00	0.02	-	Real time
H1A-34	0x1A22	Corresponding setting of AI1 minimum input	-100.0 to +100.0	0.0	-	Real time
H1A-35	0x1A23	Maximum input of AI1	-11.00 to +11.00	10.00	-	Real time
H1A-36	0x1A24	Corresponding setting of AI1 maximum input	-100.0 to +100.0	100.0	-	Real time
H1A-37	0x1A25	AI1 filter time	0.000 to 9.999	0.010	-	Real time
H1A-38	0x1A26	Minimum input of AI2	-11.00 to +11.00	0.02	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H1A-39	0x1A27	Corresponding setting of AI2 minimum input	-100.0 to +100.0	0.0	-	Real time
H1A-40	0x1A28	Maximum input of AI2	-11.00 to +11.00	10.00	-	Real time
H1A-41	0x1A29	Settings corresponding to AI2 maximum input	-100.0 to +100.0	100.0	-	Real time
H1A-42	0x1A2A	AI2 filter time	0.000 to 9.999	0.005	-	Real time
H1A-43	0x1A2B	Minimum input of AI3	-11.00 to +11.00	0.02	-	Real time
H1A-44	0x1A2C	Corresponding setting of AI3 minimum input	-100.0 to +100.0	0.0	-	Real time
H1A-45	0x1A2D	Maximum input of AI3	-11.00 to +11.00	10.00	-	Real time
H1A-46	0x1A2E	Settings corresponding to AI3 maximum input	-100.0 to +100.0	100.0	-	Real time
H1A-47	0x1A2F	AI3 filter time	0.000 to 9.999	0.000	-	Real time
H1B-00	0x1B00	Pressure reference sent over EtherCAT	0.0 to 500.0	0.0	-	Real time
H1B-01	0x1B01	Flow reference sent over EtherCAT	0.00 to 655.35	0.00	-	Real time
H1B-02	0x1B02	EtherCAT single/multi-pump control word	0 to 1	0	-	Real time
H1B-03	0x1B03	Slave pump rotation speed reference	-100.00 to +100.00	0.00	-	Real time
H1B-06	0x1B06	Switching from pressure mode to speed mode in EtherCAT mode (DI#56, AI1 voltage reference torque upper limit)	0 to 1	0	-	Real time
H1B-07	0x1B07	Switching from pressure mode to speed mode in EtherCAT mode (DI#61, H07-09 torque upper limit)	0 to 1	0	-	Real time
H1B-10	0x1B0A	Runaway fault judgment time	0.0 to 40.0	10.0	s	Real time
H1B-11	0x1B0B	Runaway speed deviation setting	0.50 to 50.00	10.00	Hz	Real time
H1B-46	0x1B2E	Runaway protection judgment time for incorrect phase sequence	0.00 to 5000.00	30	-	At stop
H1B-47	0x1B2F	Motor stall protection judgment time	0.000 to 65.535	0.050	-	At stop
H1B-48	0x1B30	Allowable braking unit enable time	0.0 to 3600.0	5.0	-	At stop
H1C-00	0x1C00	Slave pump speed reference sent by master pump	-100.0 to +100.0	0.0	-	Read-only

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H1C-01	0x1C01	Oil pressure feedback	0.0 to 500.0	0.0	bar	Real time
H1E-00	0x1E00	Oscilloscope sampling clock	0 to 65535	0	-	Real time
H1E-01	0x1E01	Frequency-division coefficient of oscilloscope sampling clock	0 to 65535	0	-	Real time
H1E-02	0x1E02	Oscilloscope sampling state	0 to 65535	0	-	Real time
H1E-03	0x1E03	Oscilloscope trigger variable setting A	0 to 65535	0	-	Real time
H1E-04	0x1E04	Oscilloscope trigger edge setting A	0 to 65535	0	-	Real time
H1E-05	0x1E05	Oscilloscope trigger level A (low-order bit)	0 to 65535	0	-	Real time
H1E-06	0x1E06	Oscilloscope trigger level A (high-order bit)	0 to 65535	0	-	Real time
H1E-07	0x1E07	Oscilloscope trigger variable setting B	0 to 65535	0	-	Real time
H1E-08	0x1E08	Oscilloscope trigger edge setting B	0 to 65535	0	-	Real time
H1E-09	0x1E09	Oscilloscope trigger level B (low-order bit)	0 to 65535	0	-	Real time
H1E-10	0x1E0A	Oscilloscope trigger level B (high-order bit)	0 to 65535	0	-	Real time
H1E-11	0x1E0B	Oscilloscope trigger setting	0 to 65535	0	-	Real time
H1E-12	0x1E0C	Oscilloscope trigger position setting (low-order bit)	0 to 65535	0	-	Real time
H1E-13	0x1E0D	Oscilloscope trigger position setting (high-order bit)	0 to 65535	0	-	Real time
H1E-14	0x1E0E	Oscilloscope sampling enable	0 to 65535	0	-	Real time
H1E-15	0x1E0F	Oscilloscope 1 channel variable selection	0 to 65535	0	-	Real time
H1E-16	0x1E10	Oscilloscope 2 channel variable selection	0 to 65535	0	-	Real time
H1E-17	0x1E11	Oscilloscope 3 channel variable selection	0 to 65535	0	-	Real time
H1E-18	0x1E12	Oscilloscope 4 channel variable selection	0 to 65535	0	-	Real time
H1E-19	0x1E13	Oscilloscope 5 channel variable selection	0 to 65535	0	-	Real time

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H1F-90	0x1F5A	DI function state 1 read via communication	0 to 65535	0	-	Read-only
H1F-91	0x1F5B	DI function state 2 read via communication	0 to 65535	0	-	Read-only
H1F-92	0x1F5C	DI function state 3 read via communication	0 to 65535	0	-	Read-only
H1F-93	0x1F5D	DI function state 4 read via communication	0 to 65535	0	-	Read-only
H1F-94	0x1F5E	DO function state 1 read via communication	0 to 65535	0	-	Read-only
H1F-95	0x1F5F	DO function state 2 read via communication	0 to 65535	0	-	Read-only
H22-00	0x2200	Error code	0 to 65535	0	-	Read-only
H22-01	0x2201	Control word	0 to 65535	0	-	Read-only
H22-02	0x2202	Status word	0 to 65535	0	-	Read-only
H22-03	0x2203	Operation mode	0–10	0	-	Read-only
H22-04	0x2204	Modes of operation display	0–10	0	-	Read-only
H22-05	0x2205	Low-order bit of position feedback	-2147483648 to +2147483647	0	-	Read-only
H22-06	0x2206	High-order bit of position feedback	-2147483648 to +2147483647	0	-	Read-only
H22-07	0x2207	Low-order bit of position feedback in reference unit	-2147483648 to +2147483647	0	-	Read-only
H22-08	0x2208	High-order bit of position feedback in reference unit	-2147483648 to +2147483647	0	-	Read-only
H22-09	0x2209	Low-order bit of actual speed	-2147483648 to +2147483647	0	-	Read-only
H22-10	0x220A	High-order bit of actual speed	-2147483648 to +2147483647	0	-	Read-only
H22-11	0x220B	Torque actual value	-5000 to +5000	0	-	Read-only
H22-12	0x220C	Low-order bit of maximum speed	0 to 4294967295	0	-	Read-only
H22-13	0x220D	High-order bit of maximum speed	0 to 4294967295	0	-	Read-only
H22-14	0x220E	Low-order bit of acceleration	0 to 4294967295	0	-	Read-only
H22-15	0x220F	High-order bit of acceleration	0 to 4294967295	0	-	Read-only
H22-16	0x2210	Low-order bit of deceleration	0 to 4294967295	0	-	Read-only
H22-17	0x2211	High-order bit of deceleration	0 to 4294967295	0	-	Read-only

Parameter	Comm. address	Parameter name	Range	Default value	Unit	Change mode
H22-18	0x2212	Low-order bit of speed offset	-2147483648 to +2147483647	0	-	Read-only
H22-19	0x2213	High-order bit of speed offset	-2147483648 to +2147483647	0	-	Read-only
H22-20	0x2214	Low-order bit of torque offset	-2147483648 to +2147483647	0	-	Read-only
H22-22	0x2216	Positive torque limit	0 to 65535	0	-	Read-only
H22-23	0x2217	Negative torque limit	0 to 65535	0	-	Read-only
H22-24	0x2218	Low-order bit of target speed	-2147483648 to +2147483647	0	-	Read-only
H22-25	0x2219	High-order bit of target speed	-2147483648 to +2147483647	0	-	Read-only

20.2 Parameters in Group 6000

Param.	Hex.	Name	Value range	Default	Unit	Change
603Fh	603Fh	Error code	0 to 65535	0	-	N/A
6040h	6040h	Control word	0 to 65535	0	-	Real time
6041h	6041h	Status word	0 to 65535	0	-	N/A
605Ah	605Ah	Quick stop mode	0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/ 609Ah (HM), keeping de-energized state 2: Ramp to stop as defined by 6085h, keeping de-energized state 3: Stop at emergency stop torque, keeping de-energized state 5: Ramp to stop as defined by 6084h/ 609Ah (HM), keeping position lock state 6: Ramp to stop as defined by 6085h, keeping position lock state 7: Stop at emergency stop torque, keeping position lock state	2	-	At stop

Param.	Hex.	Name	Value range	Default	Unit	Change
605Ch	605Ch	Stop mode at S-OFF	-4: Ramp to stop as defined by 6085h, keeping dynamic braking state -3: at zero speed, keeping dynamic braking state -2: Ramp to stop as defined by 6084h/ 609Ah (HM), keeping dynamic braking state -1: Dynamic braking stop, keeping dynamic braking state 0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/ 609Ah (HM), keeping de-energized state 2: Dynamic braking stop, keeping de-energized state	0	-	At stop
605Dh	605Dh	Halt mode	1: Ramp to stop as defined by 6084h/ 609Ah (HM), keeping position lock state 2: Ramp to stop as defined by 6085h, keeping position lock state 3: Stop at emergency stop torque, keeping position lock state	1	-	At stop
605Eh	605Eh	Stop mode at No. 2 fault	-5: Stop at zero speed, keeping dynamic braking state -4: Stop at emergency stop torque, keeping dynamic braking state -3: Ramp to stop as defined by 6085h, keeping dynamic braking state -2: Ramp to stop as defined by 6084h/ 609Ah (HM), keeping dynamic braking state -1: Dynamic braking stop, keeping dynamic braking state 0: Coast to stop, keeping de-energized state 1: Ramp to stop as defined by 6084h/ 609Ah (HM), keeping de-energized state 2: Ramp to stop as defined by 6085h, keeping de-energized state 3: Stop at emergency stop torque, keeping de-energized state 4: Dynamic braking stop, keeping de-energized state	2	-	At stop
6060h	6060h	Modes of operation	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	Real time

Param.	Hex.	Name	Value range	Default	Unit	Change
6061h	6061h	Operation mode display	1: Profile position (PP) mode 3: Profile velocity (PV) mode 4: Profile torque (PT) mode 6: Homing (HM) mode 8: CSP mode 9: CSV mode 10: CST mode	0	-	N/A
6062h	6062h	Position demand value	-2147483648 to +2147483647	0	Reference unit	N/A
6063h	6063h	Position actual value	-2147483648 to +2147483647	0	Encoder unit	N/A
6064h	6064h	Position actual value	-2147483648 to +2147483647	0	Reference unit	N/A
6065h	6065h	Following error window	0 to 4294967295	27486951	Reference unit	Real time
6066h	6066h	Excessive position deviation timeout	0 to 65535	0	ms	Real time
6067h	6067h	Position window	0 to 4294967295	5872	Reference unit	Real time
6068h	6068h	Position window time	0 to 65535	0	ms	Real time
606Ch	606Ch	Velocity actual value	-2147483648 to +2147483647	0	Reference unit/s	N/A
606Dh	606Dh	Velocity window	0 to 65535	10	rpm	Real time
606Eh	606Eh	Velocity window time	0 to 65535	0	ms	Real time
606Fh	606Fh	Zero speed signal threshold	0 to 65535	10	rpm	Real time
6070h	6070h	Velocity threshold time	0 to 65535	0	ms	Real time
6071h	6071h	Target torque	-4000 to +4000	0	-	Real time
6072h	6072h	Maximum torque reference	0 to 4000	3500	-	Real time
6074h	6074h	Torque reference	-4000 to +4000	0	-	N/A
6077h	6077h	Torque actual value	-4000 to +4000	0	-	N/A
607Ah	607Ah	Target position	-2147483648 to +2147483647	0	Reference unit	Real time
607Ch	607Ch	Home offset	-2147483648 to +2147483647	0	Reference unit	Real time
607D.01h	607D-01h	Min. position limit	-2147483648 to +2147483647	-2147483648	Reference unit	Real time
607D.02h	607D-02h	Max. position limit	-2147483648 to +2147483647	2147483647	Reference unit	Real time
607Eh	607Eh	Polarity	0 to 127	0	-	Real time
607Fh	607Fh	Max. speed	0 to 4294967295	838860800	Reference unit/s	Real time

Param.	Hex.	Name	Value range	Default	Unit	Change
6081h	6081h	Profile velocity	0 to 4294967295	13981013	Reference unit/s	Real time
6083h	6083h	Profile acceleration	0 to 4294967295	1398101333	Reference unit/s^2	Real time
6084h	6084h	Profile deceleration	0 to 4294967295	1398101333	Reference unit/s^2	Real time
6085h	6085h	Quick stop deceleration	0 to 4294967295	2147483647	Reference unit/s^2	Real time
6087h	6087h	Torque slope	0.0 to 429496729.5	429496729.5	%/s	Real time
6091.01h	6091-01h	Motor resolution	1 to 4294967295	1	-	At stop
6091.02h	6091-02h	Shaft resolution	1 to 4294967295	1	-	At stop
6098h	6098h	Homing method	-3 to +35	1	-	Real time
6099.01h	6099-01h	Speed during search for switch	0 to 4294967295	13981013	Reference unit/s	At stop
6099.02h	6099-02h	Speed during search for zero	0 to 4294967295	1398101	Reference unit/s	At stop
609Ah	609Ah	Homing acceleration	0 to 4294967295	1398101333	Reference unit/s^2	Real time
60B0h	60B0h	Position offset	-2147483648 to +2147483647	0	Reference unit	Real time
60B1h	60B1h	Velocity offset	-2147483648 to +2147483647	0	Reference unit/s	Real time
60B2h	60B2h	Torque offset	-4.000 to +4.000	0.000	-	Real time
60B8h	60B8h	Touch probe function	0 to 65535	0	-	Real time
60B9h	60B9h	Touch probe status	0 to 65535	0	-	N/A
60BAh	60BAh	Touch probe 1 rising edge	-2147483648 to +2147483647	0	Reference unit	N/A
60BBh	60BBh	Touch probe 1 falling edge	-2147483648 to +2147483647	0	Reference unit	N/A
60BCh	60BCh	Touch probe 2 rising edge	-2147483648 to +2147483647	0	Reference unit	N/A
60BDh	60BDh	Touch probe 2 falling edge	-2147483648 to +2147483647	0	Reference unit	N/A
60C5h	60C5h	Maximum acceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real time
60C6h	60C6h	Maximum deceleration	0 to 4294967295	4294967295	Reference unit/s^2	Real time
60D5h	60D5h	Touch probe 1 rising edge counter	0 to 65535	0	-	N/A
60D6h	60D6h	Touch probe 1 falling edge counter	0 to 65535	0	-	N/A
60D7h	60D7h	Touch probe 2 rising edge counter	0 to 65535	0	-	N/A

Param.	Hex.	Name	Value range	Default	Unit	Change
60D8h	60D8h	Touch probe 2 falling edge counter	0 to 65535	0	-	N/A
60E0h	60E0h	Positive torque limit	0.000 to 4.000	3.500	-	Real time
60E1h	60E1h	Negative torque limit	0.000 to 4.000	3.500	-	Real time
60E3.01h	60E3-01h	Supported homing method 1	0 to 65535	1	-	N/A
60E3.02h	60E3-02h	Supported homing method 2	0 to 65535	2	-	N/A
60E3.03h	60E3-03h	Supported homing method 3	0 to 65535	3	-	N/A
60E3.04h	60E3-04h	Supported homing method 4	0 to 65535	4	-	N/A
60E3.05h	60E3-05h	Supported homing method 5	0 to 65535	5	-	N/A
60E3.06h	60E3-06h	Supported homing method 6	0 to 65535	6	-	N/A
60E3.07h	60E3-07h	Supported homing method 7	0 to 65535	7	-	N/A
60E3.08h	60E3-08h	Supported homing method 8	0 to 65535	8	-	N/A
60E3.09h	60E3-09h	Supported homing method 9	0 to 65535	9	-	N/A
60E3.10h	60E3-10h	Supported homing method 10	0 to 65535	10	-	N/A
60E3.11h	60E3-11h	Supported homing method 11	0 to 65535	11	-	N/A
60E3.12h	60E3-12h	Supported homing method 12	0 to 65535	12	-	N/A
60E3.13h	60E3-13h	Supported homing method 13	0 to 65535	13	-	N/A
60E3.14h	60E3-14h	Supported homing method 14	0 to 65535	14	-	N/A
60E3.15h	60E3-15h	Supported homing method 17	0 to 65535	17	-	N/A
60E3.16h	60E3-16h	Supported homing method 18	0 to 65535	18	-	N/A
60E3.17h	60E3-17h	Supported homing method 19	0 to 65535	19	-	N/A
60E3.18h	60E3-18h	Supported homing method 20	0 to 65535	20	-	N/A
60E3.19h	60E3-19h	Supported homing method 21	0 to 65535	21	-	N/A
60E3.20h	60E3-20h	Supported homing method 22	0 to 65535	22	-	N/A

Param.	Hex.	Name	Value range	Default	Unit	Change
60E3.21h	60E3-21h	Supported homing method 23	0 to 65535	23	-	N/A
60E3.22h	60E3-22h	Supported homing method 24	0 to 65535	24	-	N/A
60E3.23h	60E3-23h	Supported homing method 25	0 to 65535	25	-	N/A
60E3.24h	60E3-24h	Supported homing method 26	0 to 65535	26	-	N/A
60E3.25h	60E3-25h	Supported homing method 27	0 to 65535	27	-	N/A
60E3.26h	60E3-26h	Supported homing method 28	0 to 65535	28	-	N/A
60E3.27h	60E3-27h	Supported homing method 29	0 to 65535	29	-	N/A
60E3.28h	60E3-28h	Supported homing method 30	0 to 65535	30	-	N/A
60E3.29h	60E3-29h	Supported homing method 33	0 to 65535	33	-	N/A
60E3.30h	60E3-30h	Supported homing method 34	0 to 65535	34	-	N/A
60E3.31h	60E3-31h	Supported homing method 35	0 to 65535	35	-	N/A
60E3.32h	60E3-32h	Supported homing method -1	0 to 65535	-1	-	N/A
60E3.33h	60E3-33h	Supported homing method -2	0 to 65535	-2	-	N/A
60E3.34h	60E3-34h	Supported homing method -3	0 to 65535	-3	-	N/A
60E6h	60E6h	Actual position calculation method	0 to 1	0	-	Real time
60F4h	60F4h	Following error actual value	-2147483648 to +2147483647	0	Reference unit	N/A
60FCh	60FCh	Position demand value	-2147483648 to +2147483647	0	Encoder unit	N/A
60FDh	60FDh	DI state	0 to 4294967295	0	-	N/A
60FE.01h	60FE-01h	Physical output	0 to 4294967295	0	-	Real time
60FE.02h	60FE-02h	Bit mask	0 to 4294967295	0	-	Real time
60FFh	60FFh	Target velocity	-2147483648 to +2147483647	0	Reference unit/s	Real time
6502h	6502h	Supported drive mode	0 to 4294967295	941	-	N/A

Service and Support

Should you encounter a safety accident during the use or operation of the product, or face challenges in operating and maintaining the equipment, which remain unresolved after the relevant documentation is consulted, we provide multiple channels to ensure prompt resolution:

- Channel #1: Contact service@inovance.com.
- Channel #2: Visit https://www.inovance.com/global to access document downloads, after-sales support, spare parts ordering, repair applications, and authenticity verification services.
- Channel #3: Download My Inovance app (https://zshc-eu.inovance.com/download-pc/) where you can access products info and documentation, and query product parameters.

We are committed to providing you with quick and professional technical support, and we look forward to your satisfaction and trust.

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