INOVANCE

Advanced User Guide

ES510 Series Servo Drive

User Guide

A01
Data code 19011047

Preface

Thank you for purchasing the ES510 series servo drive developed and manufactured by Inovance.

The ES510 is a servo drive specially developed for implementing the high-performance vector control of the permanent magnet synchronous motor (PMSM). It features abundant functions, including:

- process control of the injection molding machine, including accurate control on injection speed and pressure holding
- stability control when working with the injection molding machine controller
- software monitoring
- support of communication bus
- support of multiple types of encoders

Inovance dedicates to continuous product upgrade. The software and user guide will be updated with the product. You can download the latest software and user guide from Inovance's official website (www.inovance.com).

Introduction

§ Functions and Features

The ES510 has the following functions and features:

1) Compatible with 23-bit encoder, supporting "auto-tuning free" function

The ES510 is compatible with Weton 23-bit photoelectric encoder, with a resolution of up to 8 million pulses per revolution (PPR). The servo drive also supports motor parameter packing, accomplishing "auto-tuning free" function and improving the simplicity of servo drive.

NOTE

◆ The "auto-tuning free" function is only applicable to servo systems configured with ESMG1-xxxxxxx-A3xxxx series motor with 23-bit encoder.

2) Built-in braking unit and braking protection functions

The built-in braking unit is a standard configuration of the ES510. The braking circuit is provided with multiple protections, including regenerative resistor short circuit, braking circuit overcurrent, braking transistor working overtime, and braking transistor short circuit.

3) Optimized EMC solution

A complete set of solution is provided based on actual application requirements and certification requirements.

§ Unpacking

Upon unpacking, check the following items:

- Whether the nameplate model and the servo drive ratings are consistent with your order. The packaging box contains the servo drive (with certificate of conformity) and the warranty card.
- Whether the product is damaged during transportation. If you find anything omission or damage, contact Inovance or your supplier immediately.

§ First-time Use

For users who use this product for the first time, read the user guide carefully. If you have any problem concerning the functions or performance, contact the technical support personnel of Inovance to ensure correct use.

§ Standards Compliance

The following table lists the 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	Servo drive	EN 61800-3
			Servo motor	EN 60034-1
	Low Voltage Directive	2014/35/EU	Servo drive	EN 61800-5-1
			Servo motor	EN 60034-1
	RoHS Directive	2011/65/EU	EN 50581	
TUV	-			EN 61800-5-1
UL	-			UL61800-5-1 C22.2 No.14-13

Safety Information and Precautions

§ Before Use

Thank you for purchasing the ES510 series servo drive developed by Inovance. This user guide describes the correct use of the ES510. Read this guide carefully and fully understand the safety precautions before using the product (installation, wiring, running, maintenance, and inspection).

§ About the User Guide

The related user guide is listed as follows. See the guide according to your needs.

<table>
<tr><td rowspan="3">  </td><td>◆ ES510 Series Servo Drive Advanced User Guide
◆ Data code: 19011047</td></tr>
<tr><td>◆ This user guide describes the features and correct use of the ES510, including model selection, parameter setting, commissioning, maintenance, and inspection. Read this guide carefully before using the product. For equipment integrators, deliver the user guide together with the product to end-users for further reference.</td></tr>
<tr><td>◆ For illustration purpose, the drawings in the user guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified before using the product, and operate the product in accordance with the instructions.
◆ The drawings in the user guide are for illustration only. Actual products may vary.
◆ The instructions are subject to change, without notice, due to the product upgrade, specification modification as well as efforts to increase the accuracy and convenience of the user guide. Download the latest user guide from Inovance's official website (www.inovance.com).
◆ Contact the regional agent or customer service center of Inovance if you have problems during use. The data code is required.
◆ Email: UM@inovance.com</td></tr>
</table>

Safety Precautions

1) Before installing, using, and maintaining this equipment, read the safety information and precautions thoroughly, and comply with them during operations.
2) To ensure the safety of humans and equipment, follow the signs on the equipment and all the safety instructions in this user guide.
3) "CAUTION", "WARNING", and "DANGER" items in this user guide do not indicate all safety precautions that need to be followed; instead, they just supplement the safety precautions.
4) Use this equipment according to the designated environment requirements. Damage caused by improper usage is not covered by warranty.
5) Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.

Safety Levels and Definitions

DANGER	indicates that failure to comply with the notice will result in severe personal injuries or even death.
WARNING	indicates that failure to comply with the notice may result in severe personal injuries or even death.
CAUTION	indicates that failure to comply with the notice may result in minor personal injuries or damage to the equipment.

Safety Instructions

Unpacking
CAUTION ◆ Check whether the packing is intact and whether there is damage, water seepage, damp, and deformation. ◆ Unpack the package by following the package sequence. Do not hit the package with force. ◆ Check whether there are damage, rust, or injuries on the surface of the equipment or equipment accessories. ◆ Check whether the number of packing materials is consistent with the packing list.
WARNING ◆ Do not install the equipment if you find damage, rust, or indications of use on the equipment or accessories. ◆ Do not install the equipment if you find water seepage, component missing or damage upon unpacking. ◆ Do not install the equipment if you find the packing list does not conform to the equipment you received.

Storage and Transportation

- Store and transport this equipment based on the storage and transportation requirements for humidity and temperature.
- Avoid transporting the equipment in environments such as water splashing, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing this equipment for more than three months. Long-term storage requires stricter protection and necessary inspections.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport this equipment with other equipment or materials that may harm or have negative impacts on this equipment.

- Use professional loading and unloading equipment to carry large-scale or heavy equipment.
- When carrying this equipment with bare hands, hold the equipment casing firmly with care to prevent parts falling. Failure to comply may result in personal injuries.
- Handle the equipment with care during transportation and mind your step to prevent personal injuries or equipment damage.
- Never stand or stay below the equipment when the equipment is lifted by hoisting equipment.

Installation

- Thoroughly read the safety instructions and the user guide before installation.
- Do not modify this equipment.
- Do not rotate the equipment components or loosen retaining bolts (especially those marked in red) on equipment components.
- Do not install this equipment in places with strong electric or magnetic fields.
- When this product is mounted in a cabinet or terminal device, protection measures such as a fireproofing shell, electric protection shell, or mechanical protection shell must be provided for the cabinet or terminal device. The IP level must meet IEC standards and local laws and regulations.

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals.
- Installation, wiring, maintenance, inspection, or parts replacement must be performed by only experienced personnel who have been trained with necessary electrical information.
- Installation personnel must be familiar with equipment installation requirements and relevant technical materials.
- Before installing equipment with strong electromagnetic interference, such as a transformer, install an electromagnetic shielding device for this equipment to prevent malfunctions.

Wiring

DANGER

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals.
- Never perform wiring at power-on. Failure to comply will result in an electric shock.
- Before wiring, cut off all equipment power supplies. Before wiring, cut off all equipment power supplies. Wait at least 10 minutes before further operations because residual voltage exists after power-off.
- Make sure that the equipment is well grounded. Failure to comply will result in an electric shock.
- During wiring, follow the proper electrostatic discharge (ESD) procedures, and wear an anti-static wrist strap. Failure to comply will result in damage to internal equipment circuits.

WARNING

- Never connect the power cable to output terminals of the equipment. 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.
- Wiring cables must meet diameter and shielding requirements. The shielding layer of the shielded cable must be reliably grounded at one end.
- After wiring, make sure that no screws are fallen and cables are exposed in the drive and other related devices.

Power-on

DANGER

- Before power-on, make sure 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.
- At power-on, unexpected operations may be triggered on the equipment. Therefore, stay away from the equipment.
- After power-on, do not open the cabinet door and protective cover of the equipment. Failure to comply will result in an electric shock.
- Do not touch any wiring terminals at power-on. Failure to comply will result in an electric shock.
- Do not remove any part of the equipment at power-on. Failure to comply will result in an electric shock.

Operation
DANGER ◆ Do not touch any wiring terminals at power-on.Failure to comply will result in an electric shock. ◆ Do not remove any part of the equipment during operation. Failure to comply will result in an electric shock. ◆ Do not touch the equipment shell, fan, or resistor for temperature detection. Failure to comply will result in heat injuries. ◆ Signal detection must be performed by only professionals during operation. Failure to comply will result in personal injuries or equipment damage.
WARNING ◆ Prevent metal or other objects from falling into the device during operation. Failure to comply may result in equipment damage. ◆ Do not start or stop the equipment using the contactor. Failure to comply may result in equipment damage.
Maintenance
DANGER ◆ Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals. ◆ Do not maintain the equipment at power-on. Failure to comply will result in an electric shock. ◆ Before maintenance, cut off all equipment power supplies and wait at least 10 minutes.
WARNING ◆ Perform daily and periodic inspection and maintenance for the equipment according to maintenance requirements and keep a maintenance record.
Repair
DANGER ◆ Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals. ◆ Do not repair the equipment at power-on. Failure to comply will result in an electric shock. ◆ Before inspection and repair, cut off all equipment power supplies and wait at least 10 minutes.

WARNING

- Require repair services according to the product warranty agreement.
- When the equipment is faulty or damaged, require professionals to perform troubleshooting and repair by following repair instructions and keep a repair record.
- Replace quick-wear parts of the equipment according to the replacement guide.
- Do not operate damaged equipment. Failure to comply may result in worse damage.
- After the equipment is replaced, perform wiring inspection and parameter settings again.

Disposal

WARNING

- Dispose of retired equipment by following local regulations or standards. Failure to comply may result in property damage or personal injuries.
- Recycle retired equipment by following industry waste disposal standards to avoid environmental pollution.

Safety Signs

For safe equipment operation and maintenance, comply with the safety signs on the equipment, and do not damage or remove the safety labels. The following table describes the safety signs.

Safety Sign	Description
	◆ Read this user guide before installation and operation. Failure to comply will result in an electric shock. ◆ Do not remove the cover at power-on or within 10 minutes after power-off. ◆ Before maintenance, inspection, and wiring, cut off input and output power, and wait at least 10 minutes until the power indicator is off.

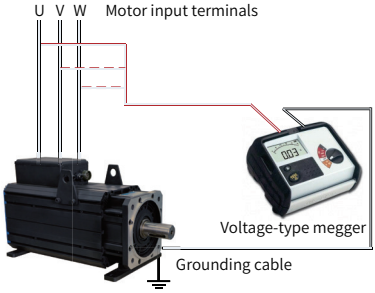
General Precautions

1) Requirements on the residual current device (RCD)

The servo drive generates high leakage current during running, which flows through the protective earthing conductor. Install a type B RCD at the primary side of the power supply. When selecting the RCD, you should consider the transient and steady-state leakage current to ground that may be generated at startup and during running of the servo drive. You can select a specialized RCD with the function of suppressing high harmonics or a general-purpose RCD with 300 mA residual current (two to four times of the protective conductor current).

2) Motor insulation test

Perform the insulation test when the motor is used for the first time, when it is reused after long-term storage, or in a regular inspection, to prevent the poor insulation of motor windings from damaging the servo drive. The motor must be disconnected from the servo drive during the insulation test. A 500-volt megger is recommended for the test. Ensure that the insulation resistance is not less than 5 MΩ.



3) Thermal protection of the motor

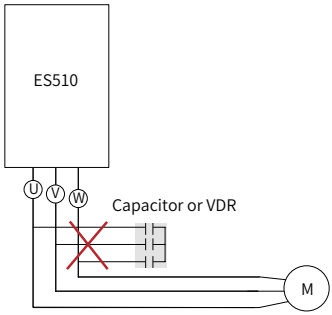
If the rated capacity of the selected motor does not match that of the servo drive, especially when the rated power of the servo drive is greater than that of the motor, adjust the motor protection parameters or install a thermal relay for the motor for protection.

4) Motor heating and noise

The output of the servo drive is pulse width modulation (PWM) wave with certain harmonic wave. Therefore, the motor temperature rise, noise, and vibration are slightly greater than those during running at the mains frequency.

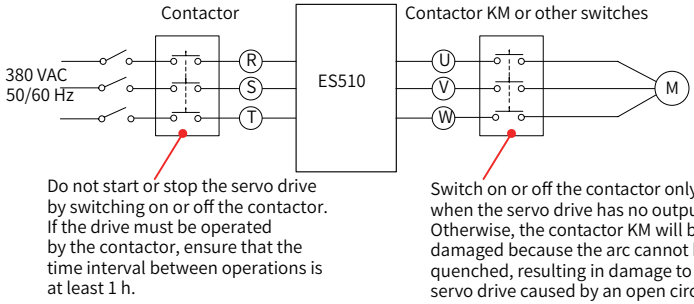
5) Voltage dependent resistor (VDR) or capacitor for improving the power factor on the output side

The output of the servo drive is PWM wave. Do not install a capacitor for the improving power factor or a lightning protection VDR on the output side of the servo drive. Otherwise, transient overcurrent or even damage to the servo drive may occur.



6) Contactors on the input and output sides of the servo drive

When a contactor is installed between the input side of the servo drive and the power supply, do not start or stop the servo drive by switching on or off the contactor. If the servo drive has to be operated by the contactor, ensure that the time interval between switching is at least 1 h because frequent charging and discharging reduce the service life of the capacitor inside the servo drive. When a contactor is installed between the output side of the servo drive and the motor, do not switch on or off the contactor when the servo drive has an output. Otherwise, modules inside the servo drive may be damaged.



7) Use outside the rated voltage

The servo drive must be used within the allowable voltage range specified in this guide. Otherwise, components inside the servo drive may be damaged. If required, use a corresponding voltage step-up or step-down device.

8) Prohibition of three-phase input changed into two-phase input

Do not change the three-phase input of the servo drive into two-phase input. Failure to comply will result in faults or damage to the servo drive.

9) Surge protection device (SPD)

The servo drive has a built-in VDR for suppressing the surge voltage generated when the inductive loads around the servo drive are switched on or off. If the inductive loads generate very high surge voltage, use an SPD for the inductive load or use an SPD together with a diode.

NOTE

◆ Do not connect the SPD to the output side of the servo drive.

10) Altitude and de-rating

In places where the altitude is above 1000 m, it is necessary to de-rate the servo drive because the cooling effect reduces due to thin air. (The servo drive must be de-rated by 1% for each 100 m higher, with the maximum altitude being 3000 m. When the ambient temperature is above 40°C, the servo drive must be de-rated by 1.5% for each 1°C higher. The maximum operating temperature is 50°C.)

For de-reating, contact Inovance for technical support.

11) Special needs

If the wiring that is not described in this user guide (such as common DC bus) needs to be used, contact Inovance for technical support.

12) Disposal

The electrolytic capacitors on the main circuit and PCB may explode when they are burnt. Poisonous gas is generated when the plastic parts are burnt. Treat them as ordinary industrial waste.

13) Compatible motor

- The standard compatible motor is PMSM. If the motor is non-PMSM, replace it with a proper synchronous motor according to the rated current of the servo drive.
- The cooling fan and rotor shaft of the non-variable-frequency motor are coaxial, which results in reduced cooling effect when the motor speed reduces. Therefore, add a more powerful cooling fan or replace the motor with a variable-frequency motor in scenarios where the motor overheats easily.
- Although the standard parameters of the compatible motor have been configured inside the servo drive, it is still necessary to perform motor auto-tuning or modify the default values based on actual conditions. Otherwise, the running effect and protection performance will be affected.
- The servo drive may alarm or even be burnt out when a short circuit exists on cables or inside the motor. Therefore, perform the insulation short circuit test when the motor and cables are newly installed or during routine maintenance. During the test, ensure that the servo drive is completely disconnected from testing parts.

Revision History

Date	Version	Change Description
September 2019	A00	First release.
November 2020	A01	Minor modifications.

§ **Guide Obtaining:**

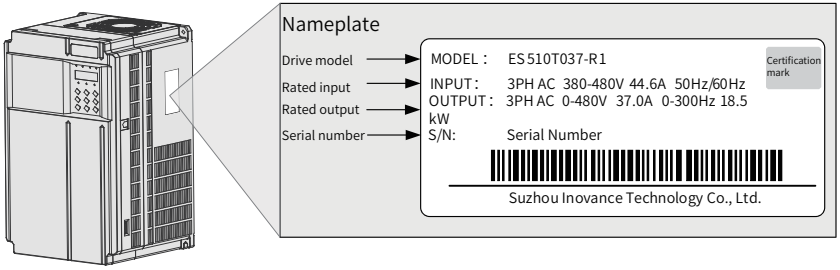
Download the latest user guide from Inovance's official website (www.inovance.com).

Contents

1 Product Information

Safety Instruction
CAUTION ◆ Never hold the front cover or terminal cover to handle the servo drive. If only the front cover is held, the drive body will fall off, which may result in personal injury. ◆ Follow the proper ESD procedures when operating the servo drive. Failure to comply will result in damage to internal circuits of the servo drive.

1.1 Nameplate and Model Number



Model number

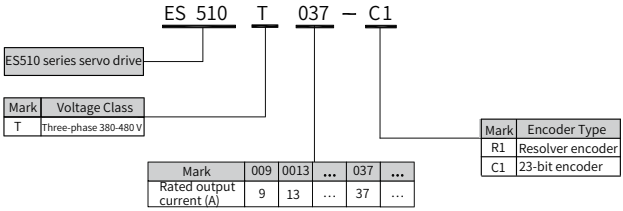


Figure 1-1 Nameplate and model number

1.2 Components

Based on different voltage class and power rating, the ES510 can be divided into two types of structure: plastic structure and sheet metal structure. The following figure shows the components of the ES510.

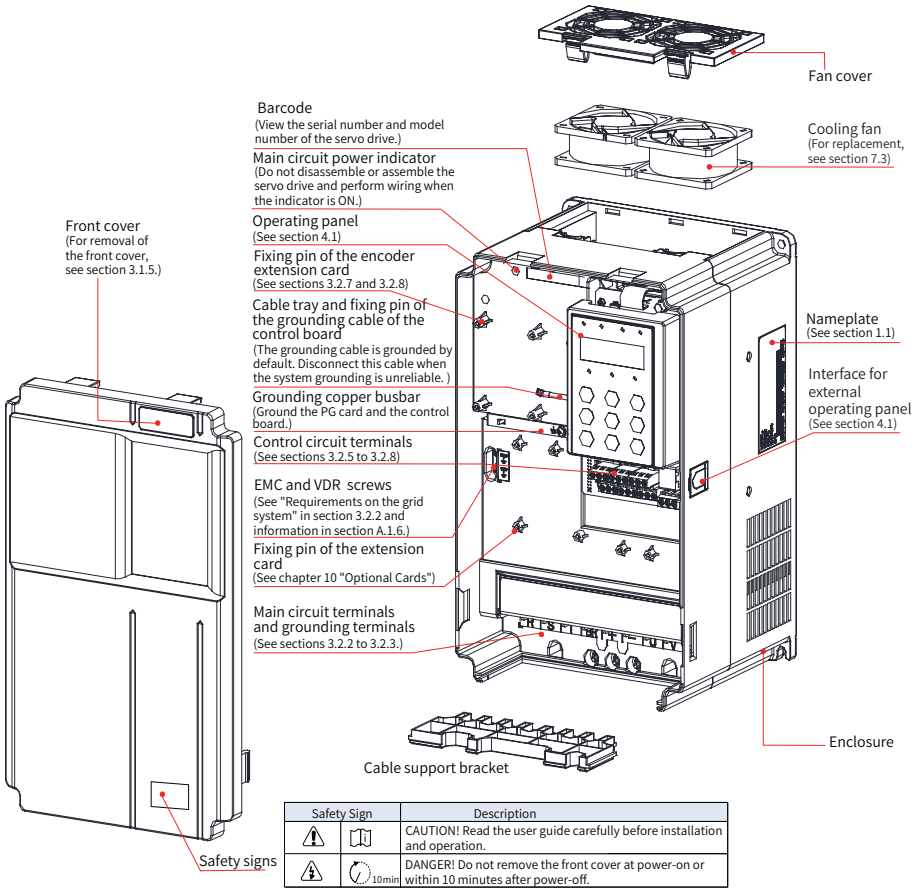


Figure 1-2 Component diagram

2 System Connection

Safety Instruction
DANGER ◆ Never perform wiring at power-on. Failure to comply will result in an electric shock. Always keep the circuit breaker in OFF state.
WARNING ◆ When installing the servo drive in an enclosed cabinet or casing box, use the cooling fan or air conditioner to keep the air inlet temperature below 50°C. Failure to comply will result in overheating or even a fire.
CAUTION ◆ During installation, use a paper or cloth to cover the upper part of the servo drive to prevent metal filings, oil, and water from entering into the servo drive when drilling holes. ◆ If foreign matters enter into the servo drive, the servo drive may get faulty. ◆ After the installation is completed, remove the paper or cloth. Otherwise, the ventilation will get poor and the drive will overheat abnormally. ◆ Follow the proper ESD procedures when operating the servo drive. Failure to comply will result in damage to internal circuits of the servo drive. ◆ When operating the motor out of the speed range, contact the motor manufacturer. ◆ Confirm the load torque characteristics of the machine to be connected because the torque characteristics are different when the machine is driven by the drive and by the mains power. Pay attention to this point when selecting the capacity of the servo drive. In addition, when the distance between the motor and the servo drive exceeds 100 m, the motor torque decreases with the decrease of the voltage. In this case, use a cable thick enough to connect the motor and the drive or contact Inovance's technical personnel. ◆ Never lift the drive when the cover is removed. Failure to comply will result in damage to the PCB and the terminal block.

2.1 Connection of Peripheral Devices

When the ES510 is used to control the hydraulic system with PMSM, install peripheral devices on both input and output sides of the servo drive to ensure system's safety and stability. The system components are shown in the following figure.

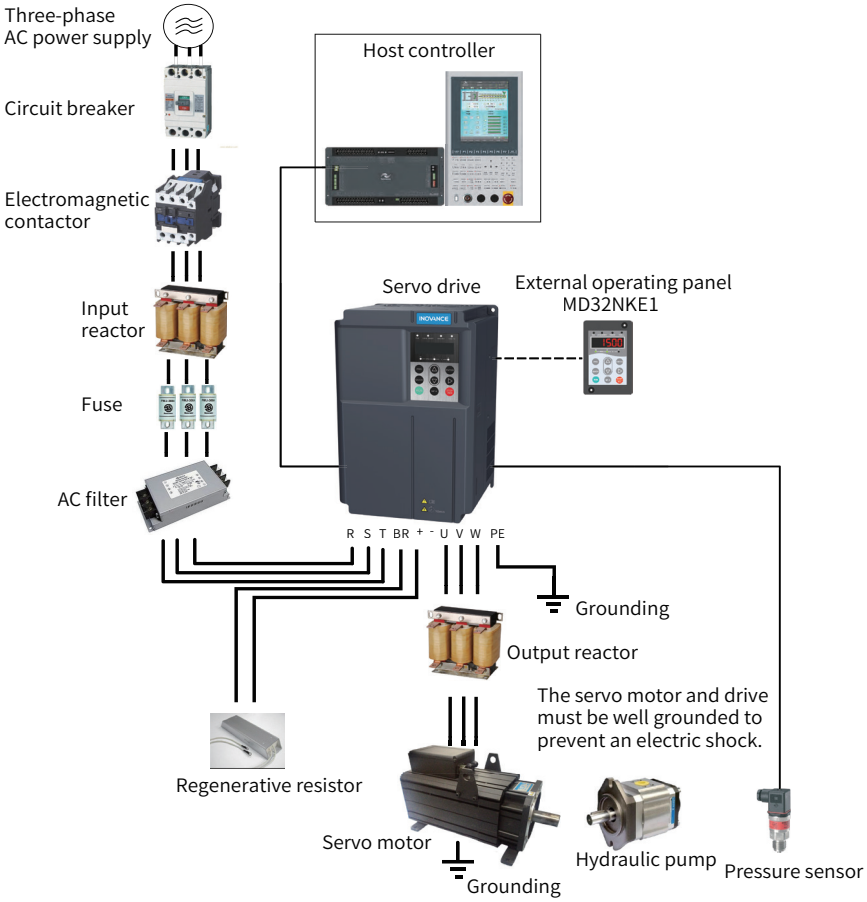


Figure 2-1 Electrical system configuration with ES510

NOTE

- The preceding figure is just a connection diagram of peripheral devices and cannot be used as a guide for peripheral device selection. For the selection of peripheral devices, see *"8 Technical Data and Model Selection" on page 102*.

2.2 Use of Peripheral Devices

Table 2-1 Usage description of peripheral electrical devices for the ES510

Name	Mounting Location	Function Description
Circuit breaker	Between the power supply and the drive input side	Short circuit breaker: Cuts off the power supply when an overcurrent occurs on downstream devices to prevent accidents.
		RCD: Provides protection against potential high leakage current during running of the drive to prevent an electric shock or even a fire. Select a proper RCD according to the field situation.
(Electromagnetic) Contactor	Between the air switch and the drive input side	◆ Do not power on or power off the drive frequently by switching the contactor on and off (the time interval cannot be less than 1 h). ◆ Do not use the contactor to directly start/ stop the drive.
Input reactor	On the drive input side	◆ Improves the power factor of the input side. ◆ Eliminates high harmonics of the input side effectively to prevent other devices from being damaged due to the distortion of the voltage waveform. ◆ Eliminates the input current unbalance caused by inter-phase unbalance.
Fuse	Between the power supply and the drive input side	Prvents accidents in case of short circuit and protect downstream semiconductor components.
AC filter	On the drive input side	◆ Reduces the external conduction and radiation interference generated by the drive. ◆ Decreases the conduction interference flowing from the power supply to the drive and improves the anti-interference capacity of the drive.
Regenerative resistor	All drives	Absorbs regenerative energy during motor deceleration.
Output reactor (du/dt filter)	Between the drive output side and the motor (close to the drive side)	The output side of the servo drive usually has many high harmonics. When the distance between the motor and the drive is too long, large distributed capacitance exists in the circuit. Certain harmonics may cause resonance in the circuit, which will: ◆ degrade the motor insulation performance, causing damage to the motor in the long run. ◆ generate large leakage current, causing frequent drive protection trips. If the distance between the drive and the motor is greater than 50 m, install an AC output reactor.

Name	Mounting Location	Function Description
Output ferrite core	On the drive output side (close to the drive side)	Reduces the bearing current.
Host controller	Part of control signals from the host controller is connected to the drive	◆ Controls the drive. ◆ Sends various references to the drive. ◆ Exchanges information with the drive.
Servo motor	On the drive output side	Selects an appropriate motor according to the recommendation.
Servo pump	Connected to the servo motor	Provides the hydraulic system with flow and pressure.
Pressure sensor	Installed in the oil outlet circuit, with feedback signals connected to the drive	Provides hydraulic circuits with pressure feedback analog signals.

NOTE

◆ Do not install the capacitor or SPD on the drive output side. Failure to comply will cause faults of the drive or damage to the capacitor and SPD.
◆ Harmonics exist in the input/output (main circuits) of the drive, which may interfere with the communication device connected to the drive. Therefore, install an AC input filter to minimize the interference.

3 Installation and Wiring

3.1 Installation

3.1.1 Installation Environment

1) Ambient temperature: The ambient temperature substantially affects the service life of the servo drive. Do not operate the servo drive outside the allowable ambient temperature (-10°C to +55°C).

2) Install the servo drive on the surface of a nonflammable object. Ensure that there is sufficient space around for heat dissipation because a large amount of heat will be generated during the operation of the servo drive. Install the servo drive vertically on the support by using the screws.

3) Install the servo drive in a place without strong vibration. The vibration cannot exceed 1 g. Keep the servo drive away from devices such as punch presses.

4) Install the servo drive in a place free from direct sunlight, high humidity, and condensation.

5) Install the servo drive in a place free from corrosive, flammable and explosive gases.

6) Install the servo drive in a place free from oil dirt and dust.

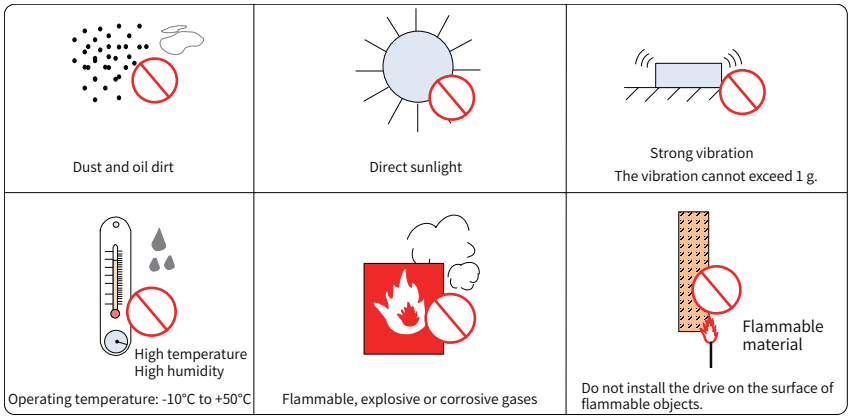


Figure 3-1 Requirements on the installation environment

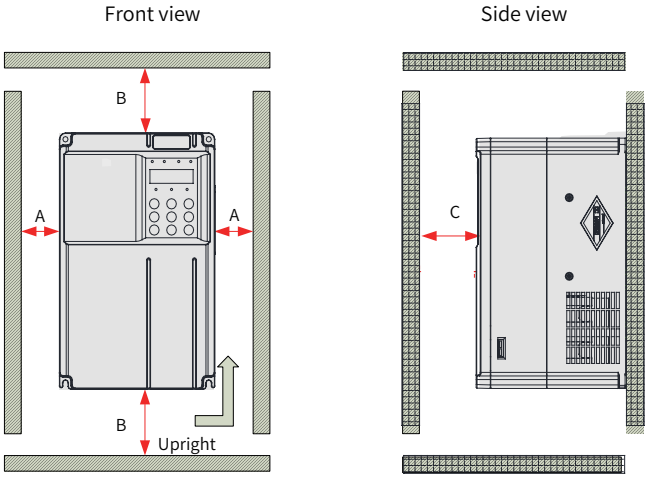
7) The servo drive must be installed in a cabinet which is used in a final system with a fireproof enclosure providing both electrical and mechanical protections. The installation must conform to local laws and regulations and related IEC requirements.

3.1.2 Mounting Clearance and Direction

1) Mounting clearance

The clearance that needs to be reserved varies with the power rating of the ES510.

■ Mounting of a single drive

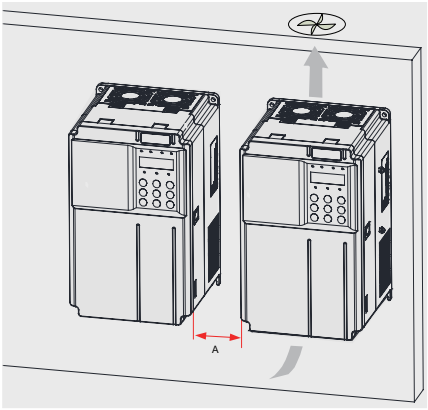


Power Rating	Clearance Requirement (unit: mm)		
3.7–18.5 kW	A ⩾ 10	B ⩾ 100	C ⩾ 40

Figure 3-2 Mounting clearance for a single drive

■ Multi-drive mounting

The ES510 dissipates heat from bottom to top. If multiple servo drives are connected together, install them side by side.



Power Rating	Clearance Requirement (unit: mm)
3.7–18.5 kW	A ⩾ 10

Figure 3-3 Clearance for multi-drive mounting

For applications where a servo drive needs to be installed above another servo drive, install an air guide plate to divert the air from the lower servo drive away from the upper one. Otherwise, an overheating or overload fault will occur.

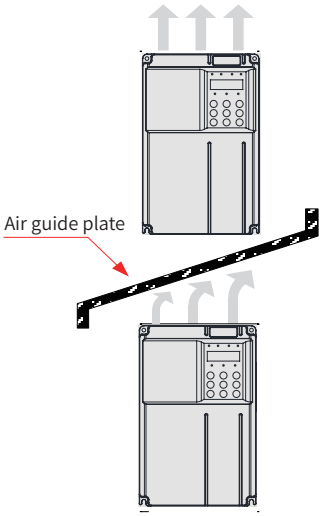


Figure 3-4 Mounting of a servo drive above another servo drive

2) Mounting direction

Install the servo drive in an upright direction. Never install the drive in horizontal, side, upside-down or other directions.

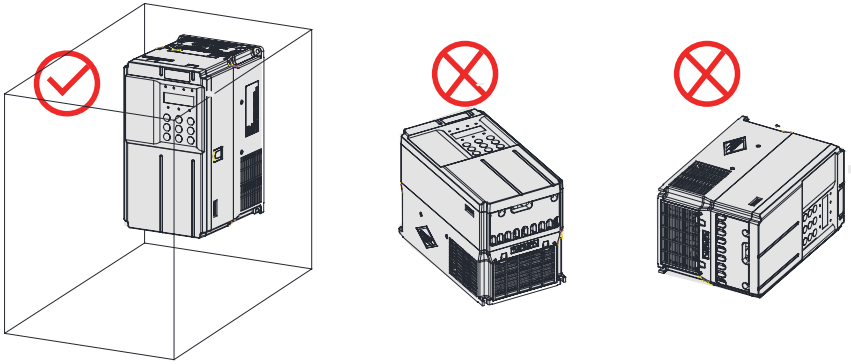


Figure 3-5 Mounting direction diagram

3.1.3 Installation Methods

The ES510 has a plastic structure. According to the applications, the ES510 can be installed in the method of backplate mounting or through hole mounting.

1) Backplate mounting

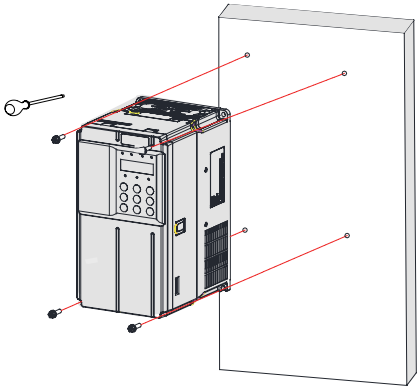


Figure 3-6 Backplate mounting diagram

NOTE

- It is forbidden to fasten only the top two retaining nuts of the servo drive because the servo drive may fall and be damaged due to uneven force after long-time running.

2) Through hole mounting

■ Through hole mounting

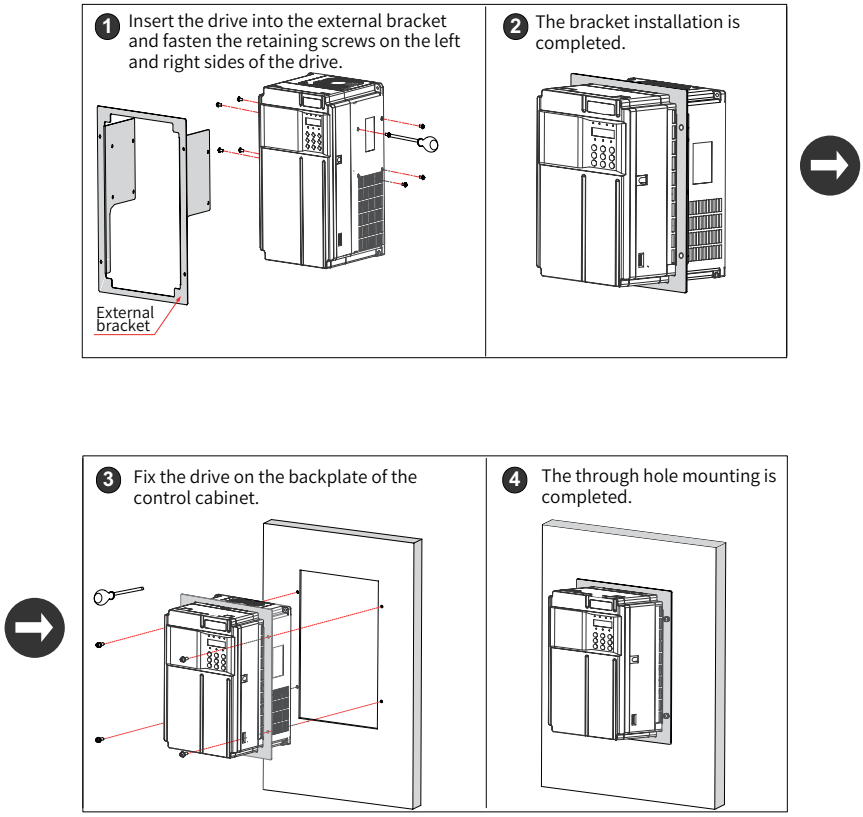


Figure 3-7 Through hole mounting diagram

3) Bracket models used for through hole mounting

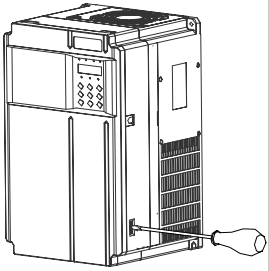
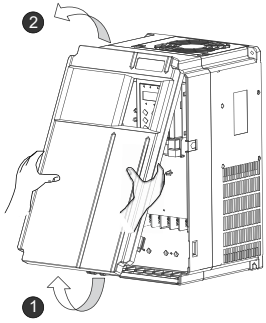
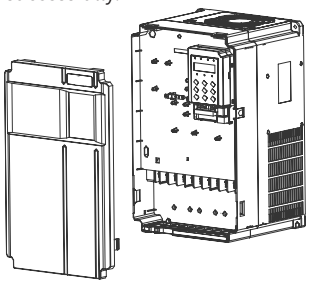
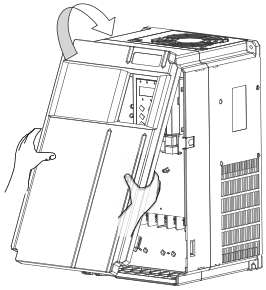
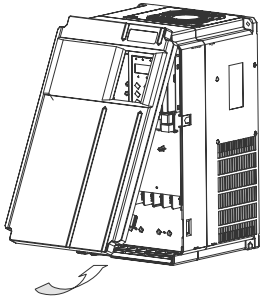
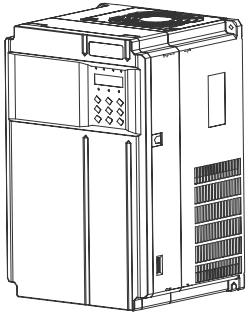
Table 3-1 List of bracket models used for through hole mounting

Bracket Model	Applicable Drive	
MD500-AZJ-A1T2	ES510T009-C1	ES510T009-R1
	ES510T013-C1	ES510T013-R1
MD500-AZJ-A1T3	ES510T017-C1	ES510T017-R1
MD500-AZJ-A1T4	ES510T025-C1	ES510T025-R1
	ES510T032-C1	ES510T032-R1
	ES510T037-C1	ES510T037-R1

3.1.4 Removing and Installing the Front Cover

Remove the front cover before wiring the main circuit and the control circuit.

Removing and Installing the Front Cover

<table>
<tr><th colspan="3">Removing the Front Cover</th></tr>
<tr>
<td>Use a tool to push the snap-fit joints inwards (perform this operation simultaneously on both sides of the drive).
 
Hold the the cover with both hands</td>
<td>Hold the the cover with both hands.
① Lift the lower part of the cover.
② Push the cover upwards and lift the upper part of the cover.
  </td>
<td>The cover is removed successfully.
  </td>
</tr>
<tr><th colspan="3">Installing the Front Cover</th></tr>
<tr>
<td>Hold the front cover with both hands and insert the snap-fit joints on the top of the front cover into the fixing holes.
  </td>
<td>Align the front cover to the drive and push the bottom edge of the cover in the arrow direction shown in the figure.
  </td>
<td>The cover is installed successfully.
  </td>
</tr>
</table>

NOTE

- Before removing the cover, wait at least 10 minutes after the drive is powered off.
- Be careful when removing the front cover. Falling off of the cover may cause equipment damage or personal injury.

3.2 Wiring

3.2.1 Standard System Wiring

For the typical system wiring, see *"Figure 3-35 System wiring diagram" on page 55*.

3.2.2 Functions of Main Circuit Terminals and Precautions

1) Functions of main circuit terminals

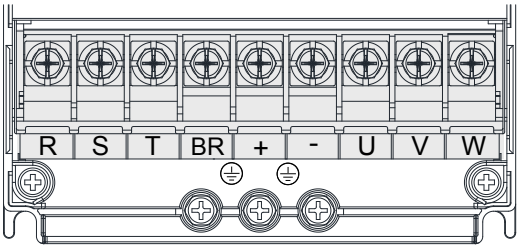


Figure 3-8 Layout of main circuit terminals

Table 3-2 Description of main circuit terminals

Terminal Mark	Terminal Name	Function Description
R, S, T	Three-phase power input terminals	Connected to the three-phase AC power supply
(+), (-)	Positive and negative terminals of the DC bus	Input points of the common DC bus
(+), BR	Terminals connected to the regenerative resistor	Connected to the regenerative resistor
U, V, W	Servo drive output terminals	Connected to the three-phase motor
⏚	Grounding terminal (PE)	Connected to the ground

NOTE

- When the drive is configured with a 23-bit PG card, the UVW cables of the motor must be connected to that of the servo drive correspondingly.

2) Selection of main circuit cables

Symmetrical shielded cables are recommended for input/output cables of the main circuit. Compared with the 4-core cables, the symmetrical shielded cables can reduce the electromagnetic radiation of the entire conductive system.

- Recommended power cables: symmetrical shielded cables

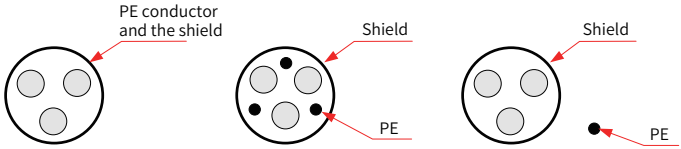


Figure 3-9 Recommended power cables

- Non-recommended power cables:

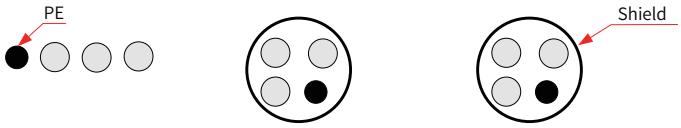


Figure 3-10 Non-recommended power cables

3) Power input terminals R, S, T

- The input wiring of the servo drive has no phase sequence requirement.
- The specification and installation method of external power cables must comply with the local laws and regulations and related IEC standards.
- Select copper conductors of proper size as power cables according to the recommended values in *"3.2.3 Layout and Size of Main Circuit Terminals" on page 35*.
- Install the filter in a place close to the input terminals of the servo drive, and the cable between them must be shorter than 30 cm. Ensure that the grounding terminal of the filter and that of the servo drive are connected together and that both the filter and the servo drive are installed on the same conductive surface that is connected to the main grounding terminal of the cabinet.

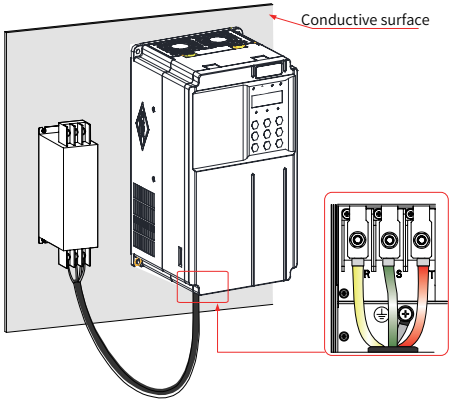


Figure 3-11 Installation diagram of the filter

4) DC bus terminals (+), (-)

- Terminals (+) and (-) of the DC bus carry a residual voltage after the servo drive is switched off. Wait at least 10 minutes and ensure that the CHARGE indicator goes off before performing wiring. Failure to comply will result in an electric shock.
- Do not connect the regenerative resistor directly to the DC bus. Failure to comply may result in damage to the servo drive or even a fire.

5) Terminals (+) and BR connected to the regenerative resistor

- Connect a regenerative resistor of the recommended model, and ensure that the cable between the regenerative resistor and the terminals is shorter than 5 m. Failure to comply will result in damage to the servo drive.
- Do not place any combustible around the regenerative resistor to avoid burning of surrounding components caused by overheating of the regenerative resistor.
- After the regenerative resistor is connected to the servo drive, set a proper braking unit actuation voltage in F9-08 (Braking transistor applied voltage) based on the actual load.

6) Servo drive output terminals U, V, W

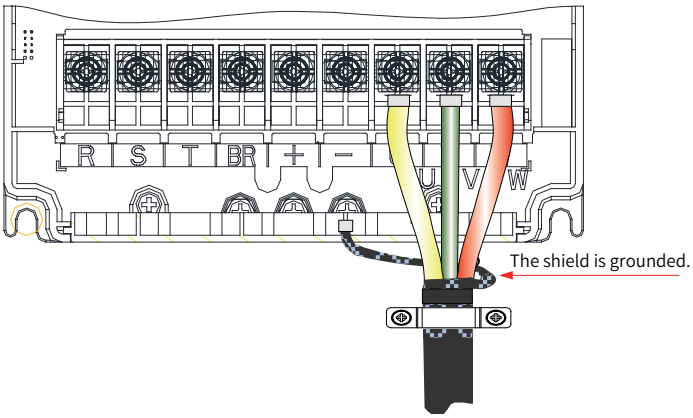


Figure 3-12 Wiring of the shield

- The specification and installation method of external power cables must comply with the local laws and regulations and related IEC standards.
- Select copper conductors of proper size as power cables according to the recommended values in *"Table 8-7 Selection of peripheral electrical devices for the ES510" on page 108*.
- Do not connect a capacitor or an SPD to the output side of the servo drive. Failure to comply will result in frequent drive protection or even damage to the drive.

- If the motor cable is too long, electrical resonance will be generated due to the impact of distributed capacitance. This will damage the motor insulation or generate high leakage current, causing the overcurrent protection of the servo drive. Therefore, install an AC output reactor close to the servo drive if the motor cable is longer than 100 m.
- Shielded cables are recommended for motor output cables. Use the fixing support of power cables to ground the shield 360 degrees, and connect the drain wire of the shield to the PE terminal.
- Ensure that the drain wire of the motor cable shield is as short as possible, and the width is not less than 1/5 of its length.

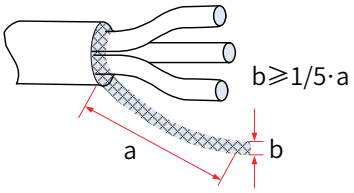


Figure 3-13 Drain wire of the motor cable shield

7) Grounding terminal (PE)

- The grounding terminal must be grounded reliably. The resistance of the grounding cable must be smaller than 10 Ω. Otherwise, the servo drive will be abnormal or damaged.
- Do not connect the grounding terminal of the drive to the neutral conductor of the power supply.
- Select the protective grounding conductor of a proper size according to the recommended values in *"Table 8-7 Selection of peripheral electrical devices for the ES510" on page 108*.
- Use yellow-green cables for the protective grounding conductor.
- It is recommended to install the servo drive on the conductive metal surface. Ensure that the entire conductive bottom of the drive is in good contact with the surface.
- Install the filter and the servo drive on the same surface to ensure the filtering effect of the filter.

8) Requirements on the upstream protection device

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

- When selecting the protection devices, consider the current capacity of the power cable, system overload capacity, and short circuit capacity of upstream power distribution. Generally, make a selection according to the recommended values in "Table 8-7 Selection of peripheral electrical devices for the ES510" on page 108.

9) Requirements on the grid system

- The ES510 is applicable to the grid system with the neutral point grounded. If the drive is used in an IT power system (a system with the neutral ungrounded or high resistance grounding), remove the VDR screw (screw 1 in the following figure). Failure to comply may result in personal injury or damage to the servo drive.
- In applications where an RCD is used, if the RCD trips at startup, remove the EMC screw (screw 2 in the following figure).

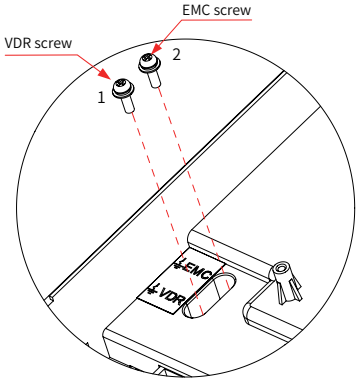


Figure 3-14 VDR and EMC screws

3.2.3 Layout and Size of Main Circuit Terminals

The following figures describe the layout and size of the main circuit terminals of different drive models. For the cable selection, see "8.4 Selection of the Cable, Circuit Breaker and Contactor" on page 108.

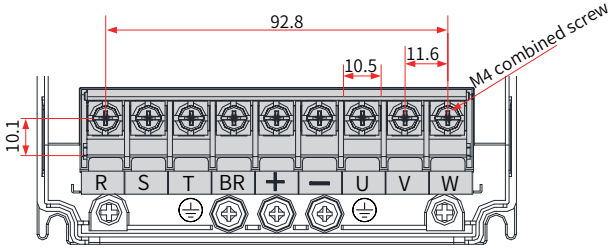


Figure 3-15 Size of main circuit terminals (ES510T009 to ES510T013)

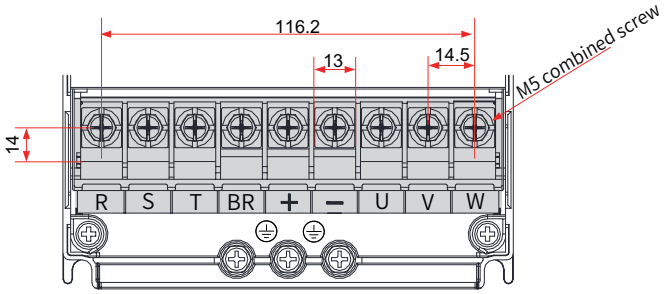


Figure 3-16 Size of main circuit terminals (ES510T017)

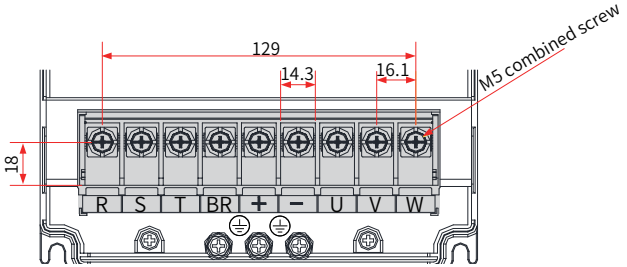


Figure 3-17 Size of main circuit terminals (ES510T025 to ES510T037)

Table 3-3 Selection of main circuit cables

Model	Rated Input Current (A)	Recommended Input/Output Power Cable (mm^2)	Recommended Cable Lug Model	Recommended Grounding Cable (mm^2)	Recommended Grounding Cable Lug Model	Tightening Torque (N·m)
ES510T009-C1, ES510T009-R1	10.9	3 x 2.5	TNR2-4	2.5	TNR2-4	1.2
ES510T013-C1, ES510T013-R1	15.8					
ES510T017-C1, ES510T017-R1	20.6	3 x 4	TNR3.5-5	4	TNR3.5-5	2.8
ES510T025-C1, ES510T025-R1	30.2	3 x 10	TNR8-5	10	TNR8-5	2.8
ES510T032-C1, ES510T032-R1	38.7					
ES510T037-C1, ES510T037-R1	44.6					

3.2.4 Layout of the Control Board

If the jumper operation, PG card connection, and extension card connection are required during wiring the control circuit, remove the front cover of the servo drive before wiring (For the removal of the front cover, see "3.1.4 Removing and Installing the Front Cover" on page 30). The following figure shows the location of the control board, jumpers, and various extension cards (For the installation of optional cards, see "10 Optional Cards" on page 137).

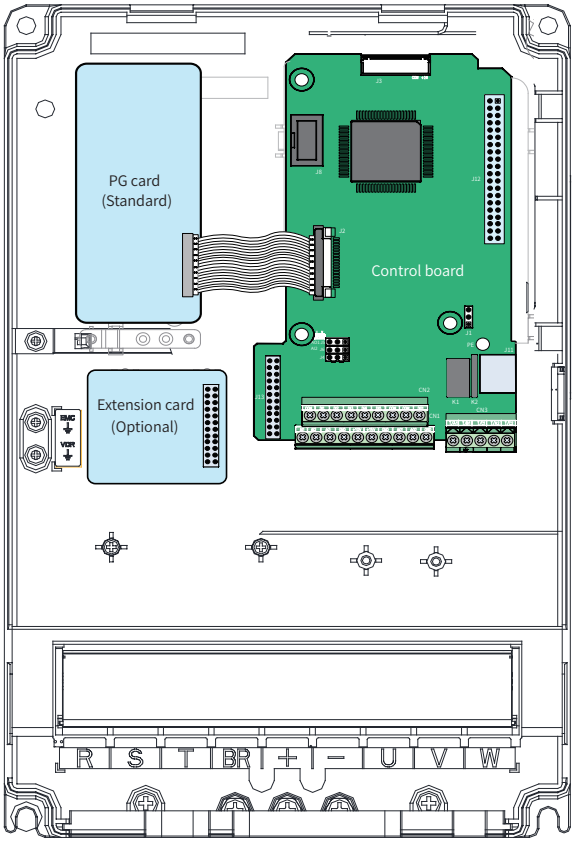


Figure 3-18 Layout of the control board

3.2.5 Layout of the Control Circuit Terminals

■ Layout of the control board terminals

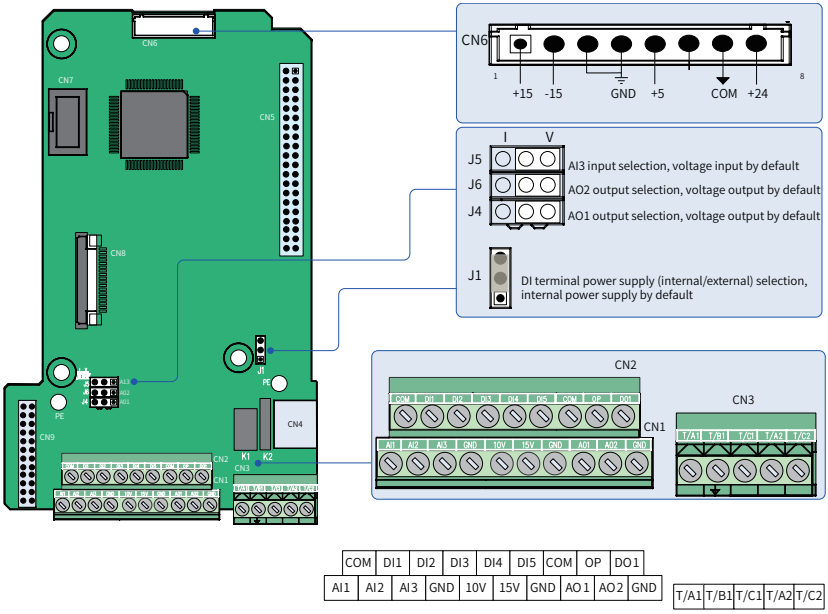


Figure 3-19 Layout of the control board terminals

Table 3-4 Function description of the control board terminals

Type	Terminal Mark	Terminal Name	Function Description
Power supply	10V-GND	External 10 V power supply	Provides 10 V power supply to an external unit (max. output current: 10 mA) Used as the power supply for the external potentiometer, with a resistance range of 1–5 kΩ.
	15V-GND	External 15V power supply	Provides 15 V power supply to an external unit (generally the pressure sensor) Max. output current: 10 mA

Type	Terminal Mark	Terminal Name	Function Description
Analog input (AI)	AI1-GND	AI terminal 1	1) Input voltage: 0–10 VDC 2) Input impedance: 22 kΩ
	AI2-GND	AI terminal 2	1) Input voltage: 0–10 VDC 2) Input impedance: 22 kΩ
	AI3-GND	AI terminal 3	1) Input range: 0–10 VDC/0–20 mA, determined by jumper J5 on the control board 2) Input impedance: 22 kΩ (voltage input), 500 Ω (current input)
Digital input (DI)	DI1-COM	DI terminal 1	1) Photocoupler isolation input, with the input frequency less than 100 Hz; The power supply (external/internal) is determined by jumper J1 on the control board. 2) Input impedance: 1.39 kΩ 3) Voltage range (level input): 9–30 V
	DI2-COM	DI terminal 2	
	DI3-COM	DI terminal 3	
	DI4-COM	DI terminal 4	
	DI5-COM	DI terminal 5	
	OP	External 24 V power supply for DI	Use the jumper cap to select an external 24 V power supply to power the DI circuit.
Analog output (AO)	AO1-GND	AO terminal 1	Voltage/Current output is determined by jumper J4 on the control board, with a load resistance less than 500 Ω. Output voltage: 0–10 V Output current: 0–20 mA
	AO2-GND	AO terminal 2	Voltage/Current output is determined by jumper J6 on the control board, with a load resistance less than 500 Ω. Output voltage: 0–10 V Output current: 0–20 mA
Digital output (DO)	DO1-COM	DO terminal 1	Photocoupler isolation and bipolar open collector output Output voltage: 0–24 V Output current: 0–50 mA Note: DO1 only supports the external power supply. When the external power supply is used, check whether the power ground can be connected to the COM terminal.
Relay output	T/A1-T/B1	Normally closed (NC) terminal	Contact driving capacity: 250 VAC, 3 A, COSØ = 0.4 30 VDC, 1 A
	T/A1-T/C1	Normally open (NO) terminal	
	T/A2-T/C2	NO terminal	

Type	Terminal Mark	Terminal Name	Function Description
Auxiliary interface	CN9	Extension card interface	28-core terminal, used for connection with various optional cards such as bus cards
	CN8	PG card interface	Supports the resolver, 23-bit encoder, and ABZ encoder
	CN14	External operating panel interface	Connected to the external operating panel
Jumper[1]	J1	DI signal drive selection terminal	Used to select the power supply (internal/external) to drive DI signals (internal 24 V power supply by default)
	J4	AO1 output selection terminal	Used to select voltage/current output (voltage output by default)
	J6	AO2 output selection terminal	Used to select voltage/current output (voltage output by default)
	J5	AI3 input selection terminal	Used to select voltage/current input (voltage input by default)

[1] The location of jumpers J1, J4, J5, and J6 on the control board is shown in *"Figure 3-19 Layout of the control board terminals" on page 38*.

3.2.6 Wiring of the Control Circuit Terminals

1) Selection of control circuit cables

All control cables must be shielded cables.

Use a separate shielded cable for each analog signal, and do not use a common return cable for these signal cables.

Shielded twisted pairs (STPs) are recommended for digital signal cables.

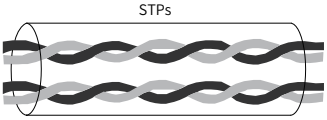


Figure 3-20 STPs diagram

2) Wiring requirements on the control circuit

- The motor cables must be laid far away from all control cables.
- It is recommended that the motor cables, input power cables, and control circuit cables be laid in different cable trays. To avoid electromagnetic interference caused by coupling, the motor cables and control circuit cables cannot be laid in parallel for a long distance.
- If the control circuit cables must run across the drive cables, make sure the angle between them is close to 90 degrees.

The recommended wiring is as follows:

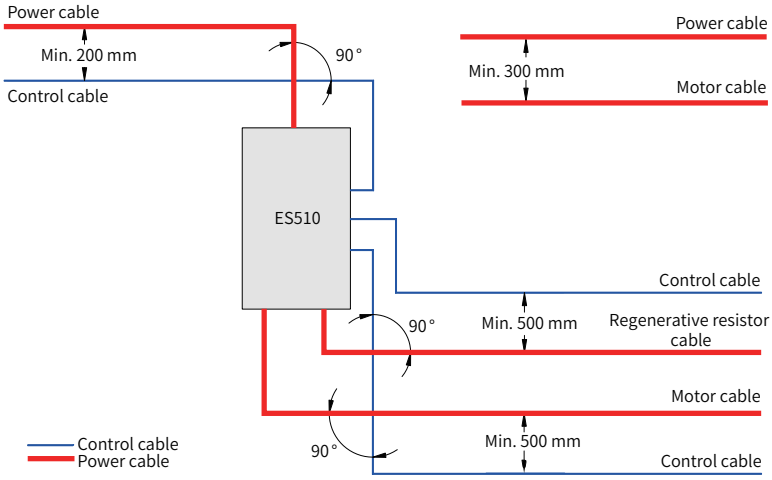


Figure 3-21 Wiring diagram

3) AI1 and AI2 terminals

Weak analog voltage signals are easy to suffer external interference. Therefore, the shielded cable must be used and the cable length must be less than 20 m, as shown in "Figure 3-22 Wiring diagram of AI terminals" on page 42. In applications where analog signals suffer severe interference, install a filter capacitor or ferrite core on the analog signal source side, as shown in "Figure 3-24 Wiring of the AI3 terminal" on page 43.

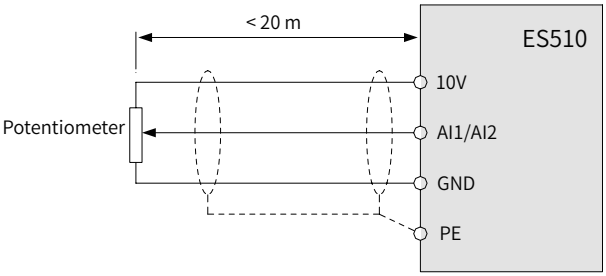


Figure 3-22 Wiring diagram of AI terminals

The drain wire of the shield of AI terminals must be connected to the PE terminal on the drive side.

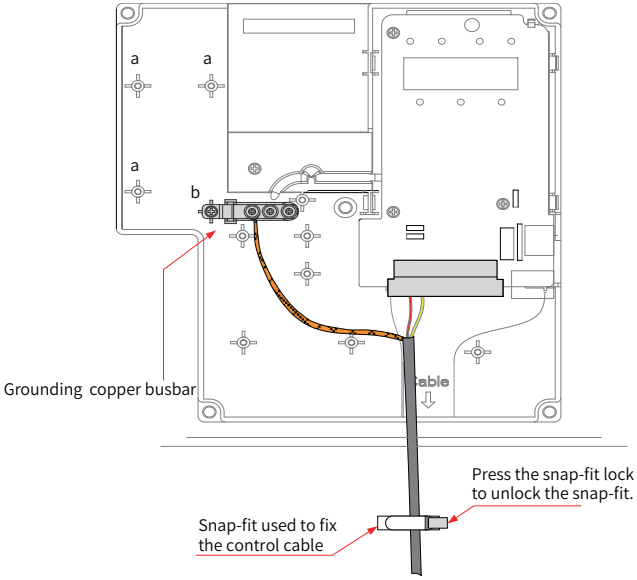


Figure 3-23 Grounding of the shield of AI terminals

4) AI3 terminal

When the voltage signal input is used, the AI3 terminal is wired in the same method as the AI1 terminal.

When the current signal input is used, the AI3 terminal is used for current input, GND terminal is used for current output, and jumper J5 jumps to "I" side.

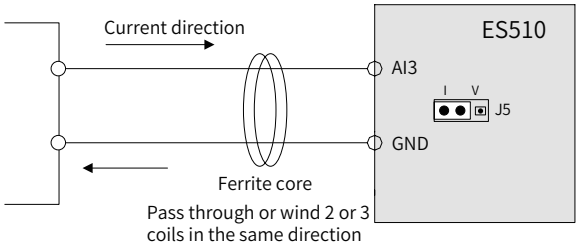


Figure 3-24 Wiring of the AI3 terminal

5) DI terminals (DI1 to DI5)

■ Sink wiring

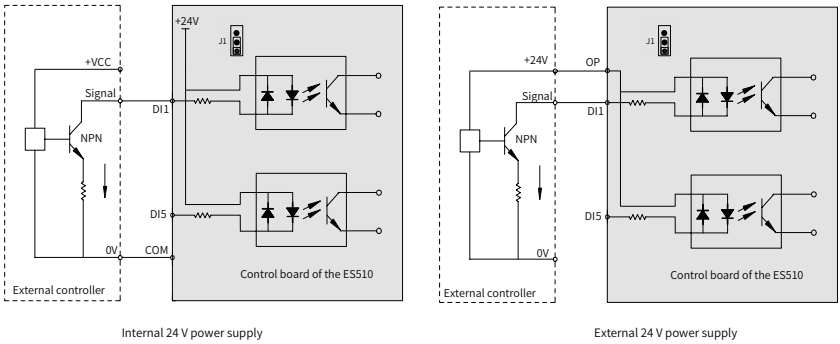


Figure 3-25 Sink wiring

The internal 24 V power supply is mostly used for wiring. When the internal power supply is used, short pins 1 and 2 of jumper J1 on the control board (see "Figure 3-25 Sink wiring" on page 43), and connect the COM terminal of the servo drive to the 0V of the external controller.

If an external 24 V power supply is used, short pins 2 and 3 of jumper J1 on the control board (see "Figure 3-25 Sink wiring" on page 43), connect the 24V of the power supply to the OP terminal of the servo drive and connect the 0V to a corresponding DI terminal through the controller contact.

NOTE

◆ In such a wiring mode, the DI terminals of different servo drives cannot be connected in parallel. Otherwise, DI malfunction may occur. If parallel connection of DI terminals (between different servo drives) is required, connect a diode in series on the DI terminal side (the anode of the diode is connected to the DI terminal), as shown in "Figure 3-26 Parallel sink wiring of DI terminals for multiple servo drives" on page 44. The diode needs to meet the following requirements: IF > 40 mA, VR > 40 V.

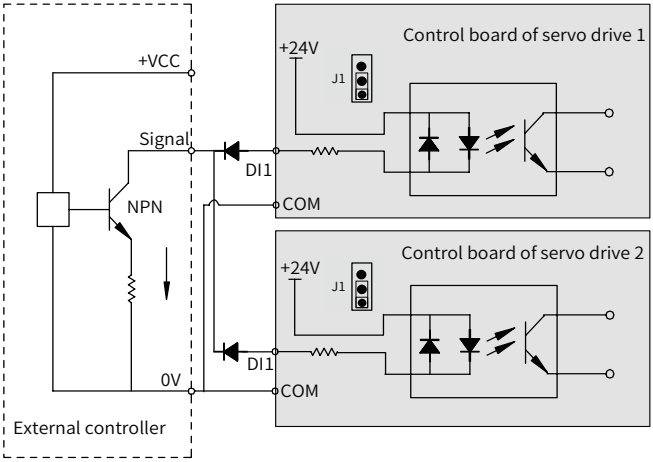
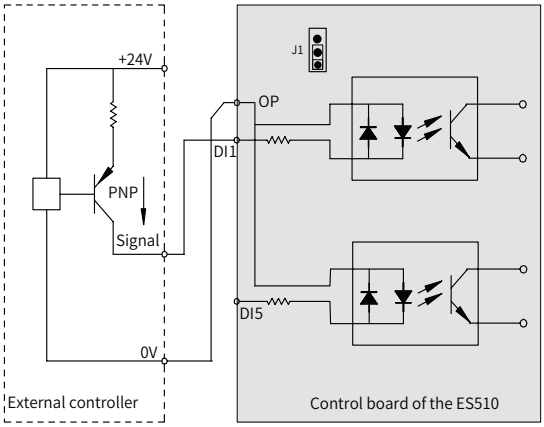


Figure 3-26 Parallel sink wiring of DI terminals for multiple servo drives

■ Source wiring



External 24 V power supply

Figure 3-27 Source wiring

In source mode, an external 24 V power supply must be used. Short pins 2 and 3 of jumper J1 as shown in *"Figure 3-27 Source wiring" on page 44*, and connect the 0V of the external controller to the OP terminal of the servo drive.

6) DO terminal

When the DO terminal drives the relay, install a snubber diode on both sides of the relay coil. Otherwise, it may cause damage to the 24 VDC power supply. The driving capacity is not more than 50 mA.

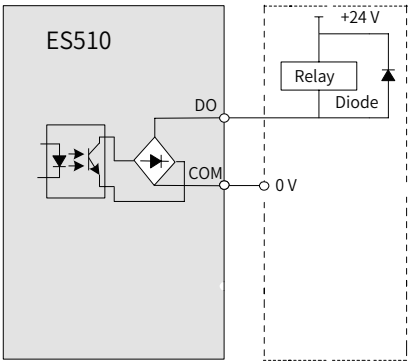


Figure 3-28 Wiring of the DO terminal

NOTE

- Install the polarity of the snubber diode correctly, as shown in "Figure 3-28 Wiring of the DO terminal" on page 45. Otherwise, the 24 VDC power supply will be burnt out immediately once there is a digital output.
- The DO terminal can be driven only by the external 24 V power supply. When DO1 is driven by the external power supply, check whether the external 24 V power ground can be connected to the grounding terminal of the control board.

7) Relay output terminals

The inductive load (relay, contactor, and motor) causes voltage spike when the current is cut off. Use a VDR for protection at the relay contact, and install an absorption circuit (VDR, RC absorption circuit or diode) on the inductive load to minimize the interference when cutting off the current.

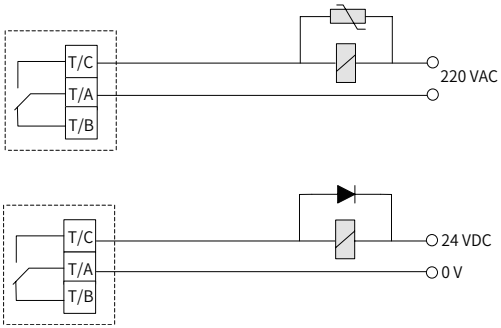


Figure 3-29 Anti-interference processing of relay output terminals

3.2.7 Description of the PG Card

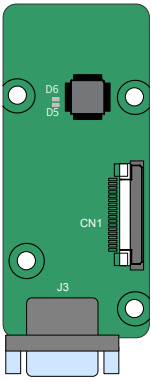
The ES510 is equipped with a built-in PG card, with the resolver PG card for the ES510TXXX-R1 and 23-bit PG card for the ES510TXXX-C1.

Table 3-5 Configuration table of the motor, drive, cables and PG card

Motor Type	Drive	Cable Type	Cable[2]	PG Card
ESMGX-XXXXXXX-R1A1FA	ES510TXXX-R1	Resolver PG card with the aviation plug	S58-L-P31-XX (XX can be 3.0, 6.0, 8.0, 12.0, 15.0, 20.0, and 25.0)	S58-PG-B1
ESMGX-XXXXXXX-A3A1FA	ES510TXXX-C1	23-bit PG card with the aviation plug	S58-L-P10-XX (XX can be 3.0, 6.0, 7.0, 8.0, 12.0, 15.0, and 25.0)	ES510-PG-CT1
Third-party or Inovance motors without the aviation plug	ES510TXXX-R1	Resolver PG card without the aviation plug	S58-L-P30-XX (XX can be 3.0, 6.0, and 15.0)	S58-PG-B1

[2] XX is the cable length (unit: m).

1) Resolver PG card (S58-PG-B1)



Specifications of the S58-PG-B1	
User Interface	DB9 Female
Cable specification	> 22AWG
Resolution	12-bit
Excitation frequency	10 kHz
VRMS	7 V
VP-P	3.15±27%
Range of frequency-division	Without frequency-division function
Load capacity	175 mA
Input impedance	0.5 transformation ratio: 5.9 kΩ 0.286 transformation ratio: 9.4 kΩ

Table 3-6 Function description of S58-PG-B1 terminals

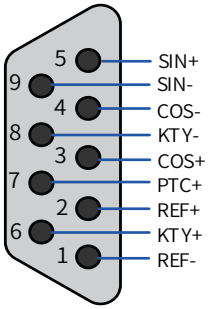
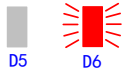
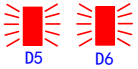
Terminal Mark	Pin No.	Pin Definition	Function Description	Terminal Arrangement
J3	1	REF-	Resolver excitation negative	
	2	REF+	Resolver excitation positive	
	3	COS+	Resolver feedback COS positive	
	4	COS-	Resolver feedback COS negative	
	5	SIN+	Resolver feedback SIN positive	
	6	KTY+	KTY resistance positive	
	7	PTC+	PTC resistance positive	
	8	KTY-	KTY/PTC resistance negative	
	9	SIN-	Resolver feedback SIN negative	
CN1	18-pin flexible flat cable (FFC) interface, connected to J2 on the control board of the servo drive			

Table 3-7 Status Description of S58-PG-B1 indicators

Fault Indicator	Fault Status	Possible Cause and Solution
	Normal	No
	Phase-locked loop (PLL) unlocked	The phase lag of the resolver is too large.
	Value of signal SIN/ COS exceeds the upper limit	D6 flashes due to interference. Solution: Ground the motor well and connect the grounding point of the PG card to the PE terminal of the drive.
	Value of signal SIN/ COS is too small.	The DB9 connector is not connected or incorrectly connected, or the cable is disconnected. Solution: If the preceding situation does not occur, check whether the resolver matches the S58-PG-B1.
◆ Note: For certain PG cards, D3 is the same as D5 and D2 is the same as D6.		

NOTE

- ◆ The resolver must meet the parameter requirements of the S58-PG-B1, whose excited input DC resistance must be larger than 17 Ω (measured by a multimeter). Otherwise, the S58-PG-B1 cannot work properly.
- ◆ Do not select a resolver with more than four pole-pairs. Otherwise, the S58-PG-B1 will be overloaded.

2) 23-bit PG card (ES510-PG-CT1)

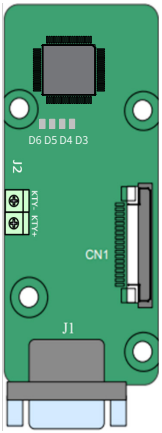


Figure 3-30 Layout of 23-bit PG card terminals

Table 3-8 Function description of ES510-PG-RT1 terminals

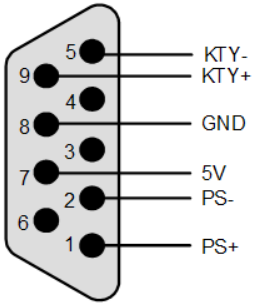
Terminal Mark	Pin No.	Pin Definition	Function Description	Terminal Arrangement
J1	1	PS+	485+	
	2	PS-	485-	
	3	NC	Not connected	
	4	NC	Not connected	
	5	KTY-	KTY thermistor negative	
	6	NC	Not connected	
	7	5 V	5 V power supply for the encoder	
	8	GND	Reference ground of 5 V power supply	
	9	KTY+	KTY thermistor positive	
J2	1	KTY-	KTY thermistor negative	 Reserved for the motor
	2	KTY+	KTY thermistor positive	
CN1	18-pin FFC interface, connected to J2 on the control board of the servo drive			

Table 3-9 Status description of indicators

Indicator	Indicator Mark	Normal State	Fault State	Fault Cause	Solution
D3 (red)	I-NOSIE	Steady OFF	Flashing or steady ON	The communication between the PG card and 23-bit encoder suffers an interference, or the communication cable between them is disconnected.	Ground the motor well and connect the grounding point of the PG card to the PE terminal of the drive.
D4 (red)	O-NIOSE	Steady OFF	Flashing or steady ON	The communication between the PG card and the control board suffers an interference, or the communication cable between them is disconnected.	Ground the motor well and connect the grounding point of the PG card to the PE terminal of the drive.
D5 (green)	LATCH	◆ Slow flashing: Read motor angle ◆ Rapid flashing: Read motor parameter	Steady OFF	The communication between the PG card and the control board suffers an interference, or the communication cable between them is disconnected.	Check whether the FFC between the PG card and the control board is connected correctly.
D6 (green)	DL	Steady OFF	Steady ON	The DB9 connector is disconnected or connected incorrectly, or the cable is disconnected.	Check whether DB9 connector of the encoder cable is connected correctly.

3.2.8 Wiring of the PG Card

■ Wiring method

1) Wiring of the PG card with aviation plug (applicable to the ESMG series motor)

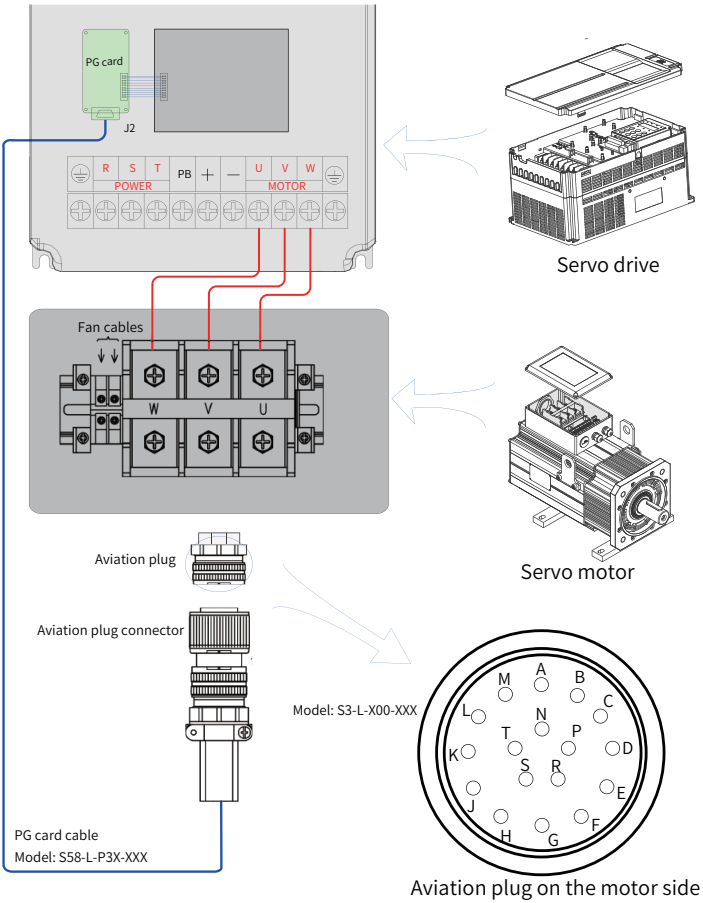


Figure 3-31 Wiring between the PG card and the motor (applicable to the ESMG series motor)

The following table shows the color of cable cores for the resolver PG card with aviation plug (applicable to the ESMG series motor).

17-pin Aviation Plug	A	B	C	D	E	F	G	H	L	K	J
Resolver PG Card (DB9 Male)	1	2	3	4	5	9	7	8		6	Housing
Definition of Signal	REF-	REF+	Cos+	Cos-	Sin+	Sin-	PTC+	KTY-	PTC-	KTY+	Shield
Color of Cable Core	Yellow/ White	Red/ White	Red	Black	Yellow	Blue	Orange	Brown		Gray	Shield
Remarks	One pair		One pair		One pair			Common point of KTY and PTC			

The following table shows the color of cable cores for the 23-bit PG card with aviation plug (applicable to the ESMG series motor).

17-pin Aviation Plug	A	B	L	M	G	H	J
23-bit PG Card (DB9 Male)	1	2	5	9	7	8	Housing
Definition of Signal	PS+	PS-	KTY-	KTY+	+5V	GND	Shield
Color of Cable Core	Yellow	Yellow/Black	Green	White	Red	Black	Shield
Remarks	Twisted pair		Twisted pair		Twisted pair		
Note: When the drive is configured with a 23-bit PG card, the UVW cables of the motor must be connected to those of the servo drive correspondingly so that the motor can be free from auto-tuning.							

2) Wiring of the PG card without aviation plug (applicable to the ESMG-****-F series motor)

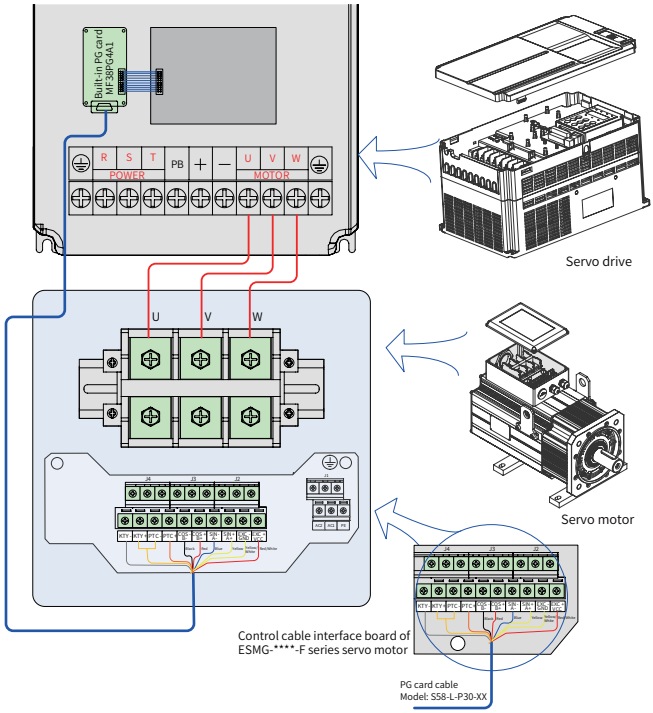


Figure 3-32 Wiring between the resolver PG card and the motor (applicable to the third-party or Inovance motors without the aviation connector)

The following table shows the color of cable cores for the resolver PG card without aviation plug (applicable to the third-party or Inovance motors without the aviation plug).

Resolver PG Card (DB9 Male)	1	2	3	4	5	9	7	8	6
Color of Cable Core	REF-	REF+	Cos+	Cos-	Sin+	Sin-	PTC+	KTY-/ PTC-	KTY+
Definition of Signal	Yellow/ White	Red/ White	Red	Black	Yellow	Blue	Orange	Brown	Gray
Remarks	One pair		One pair		One pair		/	Common point of KTY and PTC	/

■ Shield grounding of the PG card

When the parameters of the servo drive are set properly, the PG card suffers electromagnetic interference if the feedback speed or position of the PG card is instable. In this case, ground the shield of encoder signal cables to suppress the interference.

A grounding PE terminal is provided for the ES510. After the PG card is installed, connect the shield of encoder signal cable to the PE terminal of the PG card to achieve the connection between the signal cable shield and the PE terminal of the drive, ensuring that the signal cable shield is grounded.

Installation of the PG card: Before installation, remove the screws in the amplified position in the following figure, align the mounting holes of the PG card to the three fixing pins (on the upper left of the amplified position), and fix the PG card with M3x8 screws.

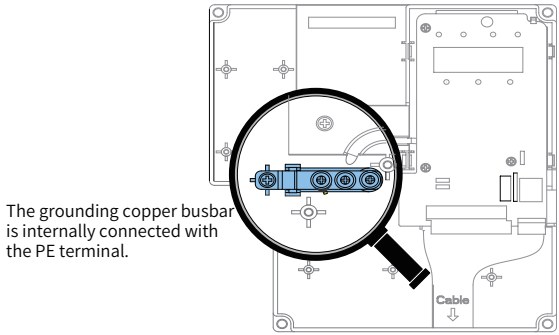


Figure 3-33 PE point design for the servo drive (grounding copper busbar)

■ EMC guidelines

For details, see *"10.2.5 EMC Guidance" on page 149*.

3.2.9 Tightening Torque of Control Circuit Terminals and Cable Selection

■ Tubular terminal

Use the tubular terminal with the insulation sleeve.

When the single cable or twisted pair cable is used, the cable core must be exposed by 6 mm.

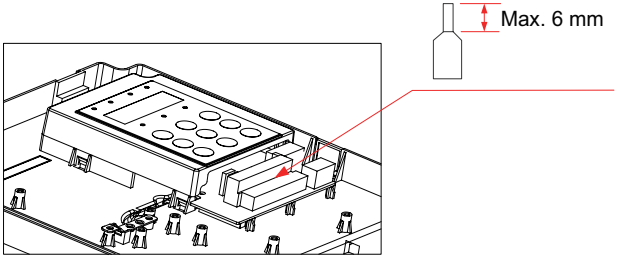


Figure 3-34 Requirement on the tubular terminal of control cables

Table 3-10 Specifications of control cables

Control Circuit Terminal Block	Single Cable(mm^2, AWG)	Twisted Pair Cable (mm^2, AWG)	Tightening Torque (N·m)
	0.2–0.75 (24AWG to 18AWG)		0.565

3.2.10 Wiring Checklist

Table 3-11 Wiring checklist

☐√	No.	Item
☐	1	Check whether the drive model is consistent with your order.
☐	2	Check whether peripheral devices (regenerative resistor, braking unit, AC reactor, filter, and circuit breaker) meet the design requirements.
☐	3	Check whether the optional card model is consistent with your order.
☐	4	Check whether the installation method and location of the servo drive meet the requirements.
☐	5	Check whether the input voltage of the servo drive is within 323–528 V.
☐	6	Check whether the rated motor voltage is consistent with the output specification of the servo drive.
☐	7	Check whether the power input cables are connected to R, S, T terminals of the servo drive correctly.
☐	8	Check whether the motor cables are connected to U, V, W terminals of the servo drive correctly.
☐	9	Check whether the diameter of main circuit cables meets the requirements.
☐	10	Check whether the motor output cable exceeds 50 m. If so, reduce the carrier frequency (F0-15).
☐	11	Check whether the grounding cable is connected properly.
☐	12	Check whether the servo drive output terminals and control signal terminals are connected securely.
☐	13	Check whether the regenerative resistor and braking unit are wired correctly and whether their resistance is proper.
☐	14	Check whether the control circuit cables of the servo drive are STPs.
☐	15	Check whether the optional cards are wired correctly.
☐	16	Check whether the control circuit cables are separated from the main circuit power cables during cabling.

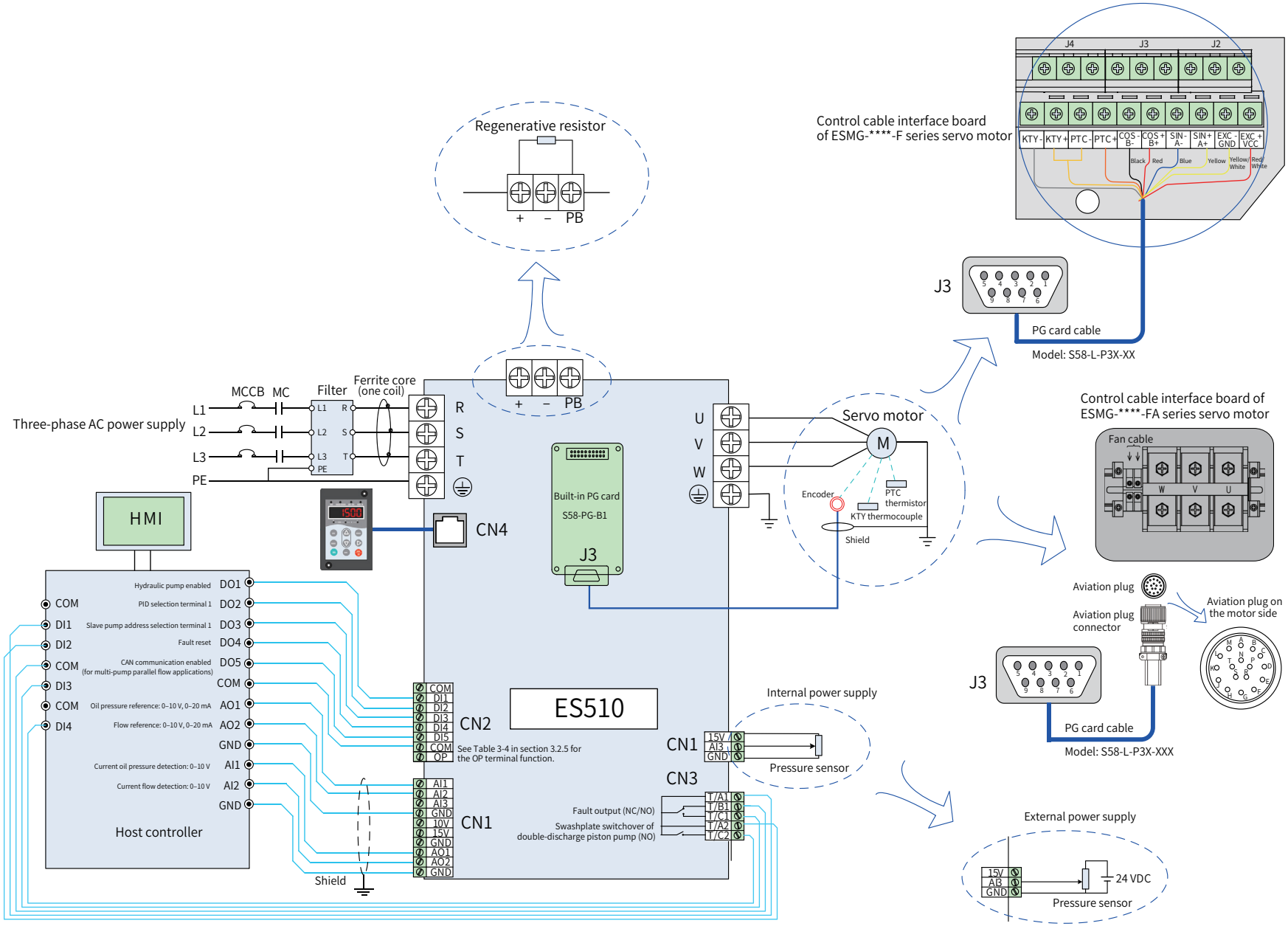


Figure 3-35 System wiring diagram

4 Panel Operation

4.1 Description of the Operating Panel

You can set or modify the parameters, monitor the drive status and start or stop the servo drive by operating the operating panel. The following figure shows the appearance and keys of the operating panel.

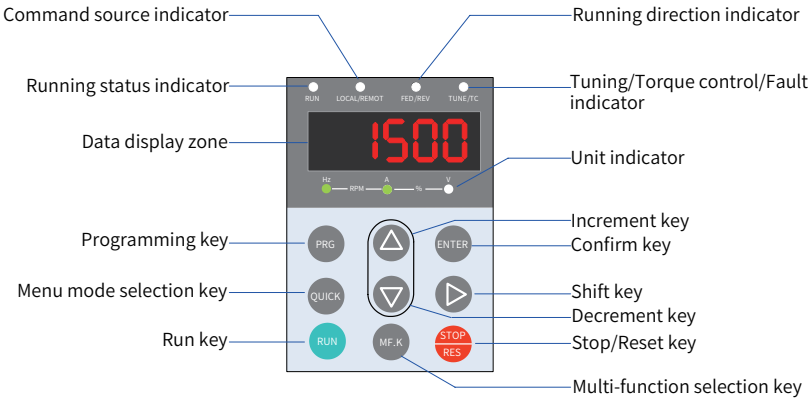
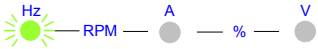
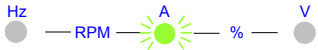
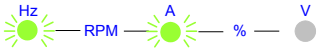


Figure 4-1 Operating panel

1) Indicators

Table 4-1 Description of indicators on the operating panel

Indicator Status		Status Description
RUN Running status indicator	RUN	OFF: Stop status
	RUN	ON: Running status
LOCAL/REMOT Command source indicator	LOCAL/ REMOT	OFF: Operating panel control
	LOCAL/ REMOT	ON: Terminal control
	LOCAL/ REMOT	Flashing: Communication control
FWD/REV Running direction indicator	FED/REV	OFF: Forward running
	FED/REV	ON: Reverse running

Indicator Status		Status Description
TUNE/TC Tuning/Torque control/Fault indicator		OFF: Normal running
		ON: Torque control mode
		Slow flashing: Tuning state (once per second)
		Quick flashing: Fault state (four times per second)
		Hz: unit of frequency
		A: unit of current
		V: unit of voltage
		RPM: unit of rotational speed
		%: percentage

2) LED display area

The 5-digit LEDs on the operating panel are able to display the set frequency, output frequency, various monitoring data, and fault codes.

Table 4-2 LED display and actual data

LED Display	Actual Data	LED Display	Actual Data	LED Display	Actual Data	LED Display	Actual Data
0	0	6	6	C	C	n	N
1	1	7	7	c	c	P	P
2	2	8	8	d	D	r	R
3	3	9	9	E	E	t	T
4	4	A	A	F	F	U	U
5	5, S	b	B	L	L	u	u

3) Functions of keys on the operating panel

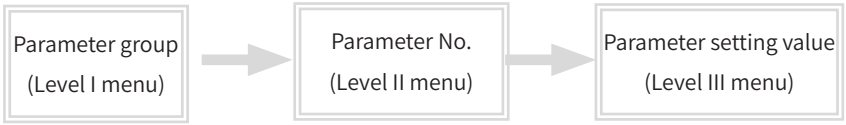
Table 4-3 Function of keys on the operating panel

Key	Name	Function
PRG	Programming	Enter or exit Level I menu.
ENTER	Confirm	Enter the menu interfaces level by level, and confirm parameter settings.
△	Increment	Increase data or parameter.
▽	Decrement	Decrease data or parameter.
▷	Shift	Select the displayed parameter in the stop or running state. Select the digit to be modified when modifying a parameter value.
RUN	Run	Start the servo drive in the operating panel control mode.
STOP RES	Stop/Reset	Stop the servo drive when the drive is in the running state and perform the reset operation when the drive is in the fault state. The functions of this key can be restricted by F7-02 (STOP function).
MF.K	Multi-function selection	Perform function switchover according to the setting of F7-01 (MF.K function selection). For details, see "3) Operations of the multi-function selection key" on page 61.
QUICK	Menu mode selection	Perform switchover between different menu modes.

4.2 Viewing and Modifying Parameters

1) Operation instructions

The operating panel adopts a three-level menu to perform operations such as parameter settings. It consists of:



After entering each level of menu, if the LED flashes, you can press , or to modify the flashing value. Figure 4-2 shows the operation procedure.

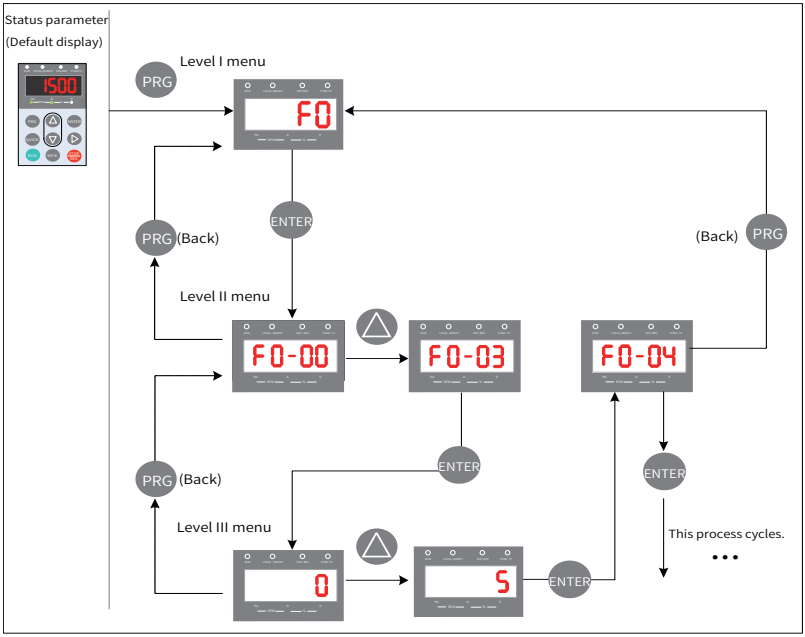


Figure 4-2 Operation procedure of the three-level menu

The following example shows how to modify the value of F3-02 (Cut-off frequency of torque boost) from 10.00 Hz to 15.00 Hz.

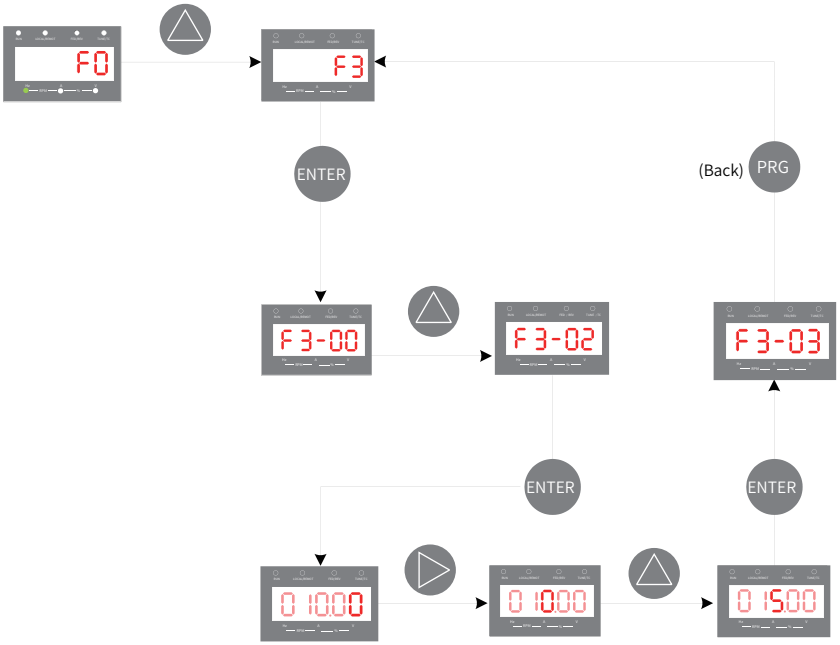


Figure 4-3 Parameter modification flowchart

NOTE

- You can return to Level II menu from Level III menu by pressing PRG or ENTER. The difference between the two is as follows:

  After you press ENTER, the system saves the parameter setting, goes back to Level II menu and automatically shifts to the next parameter.

  After you press PRG, the system does not save the parameter setting, but directly goes back to Level II menu and remains at the current parameter.

- In Level III menu, if a parameter has no blinking digit, it means that the parameter cannot be modified. This may be because:

1) Such a parameter is read-only, such as drive type, actually detected parameters and running record parameters.
2) Such a parameter cannot be modified when the servo drive is in the running state. It can be modified only when the drive is in the stop state.

2) Parameter groups

Table 4-4 Parameter groups

Parameter Group	Function Description	Remarks
Group F0 to Group FP	Basic parameters	Including running reference parameters, frequency reference parameters, motor parameters, control mode parameters, AI/AO characteristic correction parameters, and optimized control parameters.
Group A0 to Group AF		
Groups U0 and U1	Monitoring parameters	Display of basic monitoring parameters

3) Operations of the multi-function selection key

The function of multi-function selection key MF.K can be set in F7-01 (MF.K function selection) . You can use this key to switch the running command or the rotational direction of the drive or perform forward/reverse jog in either the stop or running state.

Parameter No.	Function	Default	Setting Range	Parameter Description
F7-01	MF.K function selection	0	0: MF.K invalid	The key has no function.
			1: Switchover between operating panel control mode and terminal/ communication control mode	When F0-02 (Command source) is set to 0 (Operating panel control mode), the command source remains unchanged after you press MF.K key. When F0-02 (Command source) is set to 1 (Terminal control mode), the command source switches from the operating panel control to the terminal control after you press MF.K key. When F0-02 (Command source) is set to 2 (Communication control mode), the command source switches from the operating panel control to the communication control after you press MF.K key.
			2: Switchover between forward running and reverse running	You can use this key to change the direction of the frequency reference. This function is valid only when the command source is the operating panel.
			3: Forward jog	Use MF.K key to implement forward jog.

5 Basic Operations and Trial Run

This chapter describes the basic commissioning procedure of the servo drive, including the frequency reference setting, startup control, and stop control. By following the instructions, you can perform the motor trial run under the control of the servo drive.

5.1 Commissioning Flowchart of the Servo Drive

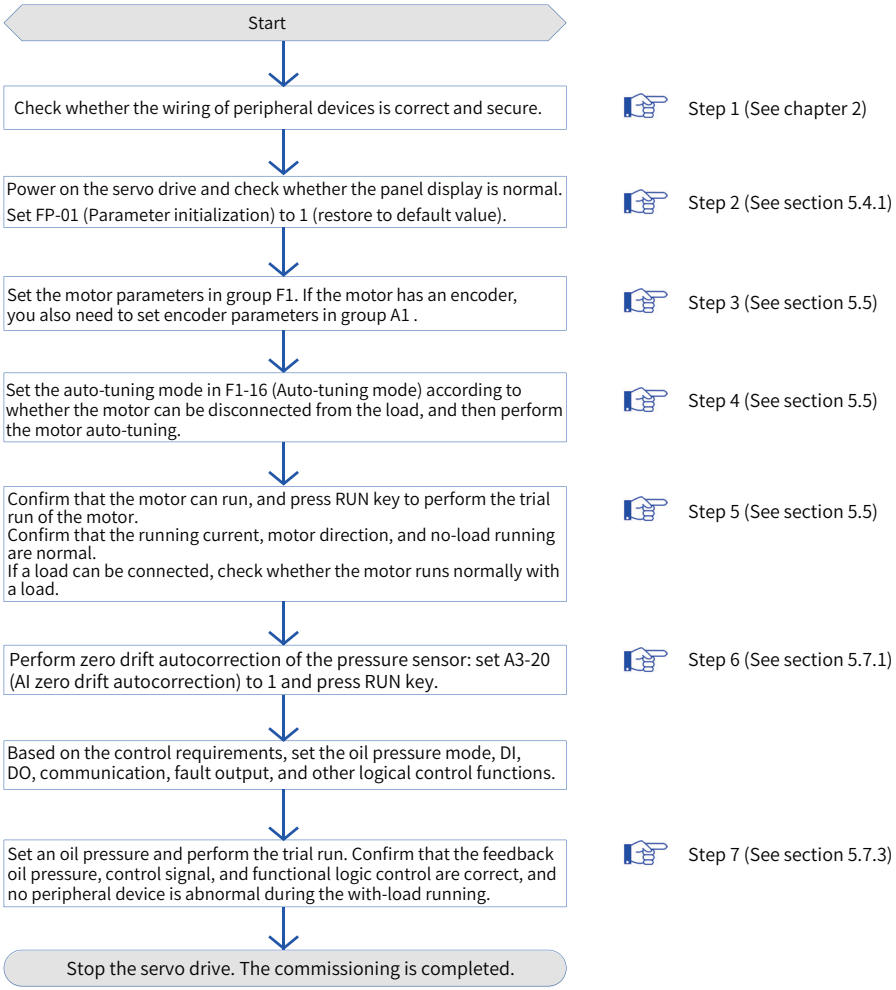


Figure 5-1 Quick commissioning steps

5.2 Inspection Before Power-on

Before power-on, ensure that the following items are checked.

Item	Description
The power voltage	Check whether the power voltage is 380–480 VAC, 50/60 Hz.
	Ground the power input terminals (R, S, T) reliably.
	Check whether the servo drive and the motor are properly grounded.
The connection between the servo drive output terminals and the motor terminals	Check whether the connection between the servo drive output terminals (U, V, W) and the motor terminals is secure.
The connection between the servo drive control circuit terminals and other control devices	Check whether the connection between the servo drive control circuit terminals and other control devices is secure.
The state of the servo drive control circuit terminals	Check whether all servo drive control circuit terminals are OFF (the servo drive is not in the running state).
The motor load	Check whether the motor is in the no-load state (not connected with the mechanical system).

5.3 Panel Display After Power-on

After power-on, the normal display on the operating panel is as follows:

State	Display	Description
Normal state		Digital setting "1500" is displayed by default.
Fault state		When a fault occurs, the servo drive stops. The fault type is displayed.

5.4 Parameter Settings

5.4.1 Parameter Initialization

You can initialize the servo drive. After initialization, FP-01 (Parameter initialization) automatically restores to 0.

Parameter No.	Parameter Name	Setting Range	Default
FP-01	Parameter initialization	0: No operation 1: Restore default parameters (excluding motor parameters) 2: Clear fault records 3: Restore user backup parameters 4: Restore factory system parameters (excluding A2-01) 5: Restore all parameters (excluding groups FF, FP, and FA). Remember to back up parameters.	0

1: Restore factory parameters (excluding motor parameters)

After FP-01 (Parameter initialization) is set to 1, most parameters of the servo drive are restored to default settings, excluding motor parameters, fault records, timed business running time (parameters in group FA), AI/AO correction parameters (F4-43 to F4-54), and heatsink temperature (F7-07).

2: Clear fault records

Clear the fault records and accumulative running time (F7-09).

3: Restore user backup parameters

Restore the user parameters that are backed up by setting FP-05 (User parameter storage) to 1.

4: Restore factory system parameters (excluding A2-01)

After FP-01 (Parameter initialization) is set to 4, most parameters of the servo drive are restored to default settings, excluding A2-01 (CAN ommunication address), motor parameters, fault records, timed business running time (parameters in group FA), AI/AO correction parameters (F4-43 to F4-54), and heatsink temperature (F7-07).

5: Restore all parameters

After FP-01 (Parameter initialization) is set to 5, most parameters of the servo drive are restored to default settings, excluding timed business running time (parameters in group FA), accumulative running time (F7-09), and factory parameters (group FF).

5.4.2 Startup and Stop Commands

Parameter No.	Parameter Name	Setting Range	Default
F0-02	Command source	0: Operating panel control (LOCAL/REMOT indicator OFF) 1: Terminal control (LOCAL/REMOT indicator ON) 2: Communication control (LOCAL/REMOT indicator flashing)	0

It is used to select the input channel of the servo drive control commands, such as start, stop, forward running, reverse running, and jog.

0: Operating panel control (LOCAL/REMOT indicator OFF)

Commands are given by 

and 

keys on the operating panel.

1: Terminal control (LOCAL/REMOT indicator ON)

Commands are given by multifunctional input terminals such as FWD, REV, JOGF, and JOGR.

2: Communication control (LOCAL/REMOT indicator flashing)

5.4.3 Motor Control Mode Selection

Parameter No.	Parameter Name	Setting Range	Application
F0-01	Motor control mode	0: Sensorless vector control (SVC)	Refers to open-loop vector control.
		1: Feedback vector control (FVC)	Refers to closed-loop vector control. The motor must be configured with an encoder and the PG card (optional) of the servo drive must match the encoder type.
		2: Variable/ Frequency (V/F) control (speed open-loop control)	Applicable to applications with low load requirements or applications where one servo drive drives multiple motors of such loads as fan and pump.

5.5 Auto-Tuning: Motor Type Selection

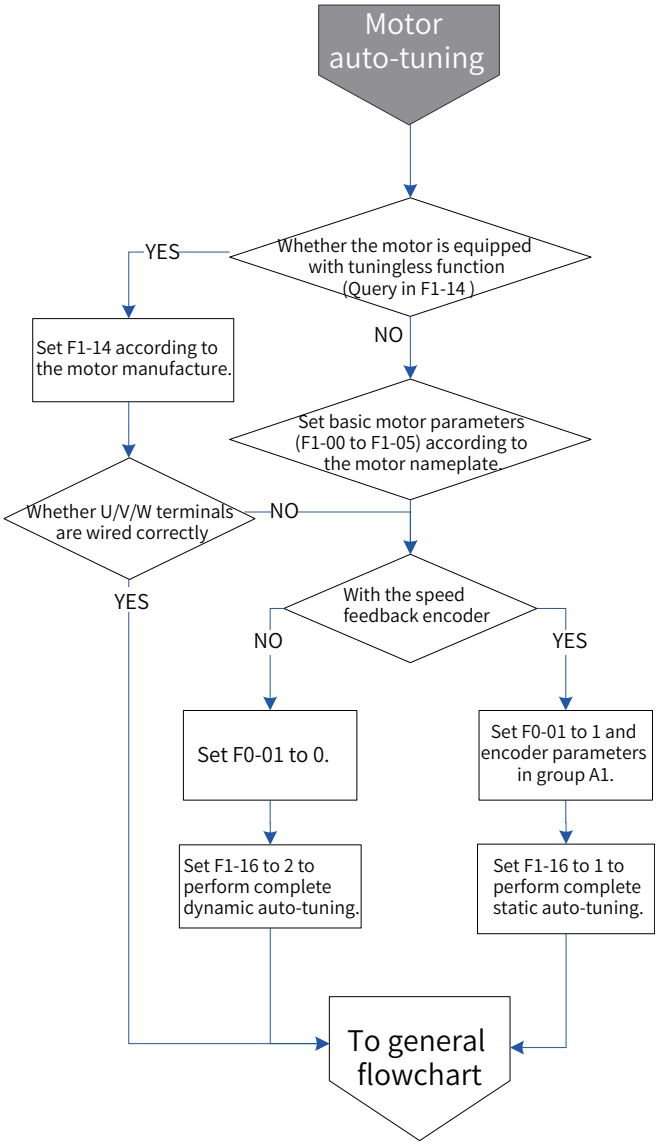


Figure 5-2 Motor auto-tuning procedure (vector control)

NOTE

◆ The "auto-tuning free" function is only applicable to servo systems configured with ESMG1-xxxxxxx-A3xxxx series motor with 23-bit encoder.

Motor Type Selection

Parameter No.	Parameter Name	Setting Range
F1-00	Motor type selection	0: Asynchronous motor
		1: Variable frequency asynchronous motor
		2: Synchronous motor

The methods for the servo drive to obtain the internal electrical parameters of the controlled motor are static auto-tuning 1, no-load dynamic auto-tuning, static auto-tuning 2, and manual input of motor parameters.

If an Inovance motor is used, you can run the motor directly after inputting the motor ID in FP-02 (Motor model).

Auto-Tuning Mode	Applicable Scenario	Auto-Tuning Effect
Static auto-tuning 1 (F1-16 = 1)	Applied to scenarios where the motor back EMF is known. The motor runs at a low speed during auto-tuning. You can perform auto-tuning without turning on the overflow valve.	Best
No-load dynamic auto-tuning (F1-16 = 2)	Applied to scenarios where the motor back EMF is unknown. The motor runs at a high speed during auto-tuning; therefore, the overflow valve must be turned on. With-load auto-tuning will affect the precision of motor auto-tuning and the control effect of the servo system.	Ordinary
Static auto-tuning 2 (F1-16 = 3)	Applied to scenarios where the motor back EMF is known and where there is a heavy load. The motor runs at a low speed during auto-tuning. You can perform auto-tuning without turning on the overflow valve. Note: When the resolver and the motor are wired correctly, adopt this mode if error E43.02 is reported during static auto-tuning 1 or dynamic auto-tuning.	Good
Manual input of motor parameters	Applied to scenarios where the motor can be hardly disconnected from the application system. Input the parameters of the motor with the same model that have implemented auto-tuning successfully into corresponding parameters (F1-00 to F1-06 and F1-11 to F1-15).	Good

The motor auto-tuning procedure is as follows:

Step 1: If the motor can be completely disconnected from the load, disconnect the motor from the load after power-off so that the motor can rotate without load.

Step 2: After power-on, set F0-02 (Command source) to 0 (Operating panel control).

Step 3: Input the parameters (such as F1-00 to F1-05) on the motor nameplate correctly.

If there is an encoder, input the encoder parameters (A1-00 and A1-04)

Step 4: Set F1-16 (Auto-tuning mode) to 1 (Static auto-tuning 1), and press ENTER .

Then, "TUNE" is displayed on the operating panel, as shown in the following figure.

After RUN key on the operating panel is pressed, the servo drive will drive the motor to accelerate/decelerate and run in the forward/reverse direction. The RUN indicator is ON and the auto-tuning lasts for approximately 2 min. When the preceding display disappears and the operating panel returns to the normal parameter display, the auto-tuning is completed.

The servo drive will automatically calculate the following motor parameters after the complete auto-tuning.

Parameter No.	Parameter Name
F1-11	Shaft D inductance (synchronous motor)
F1-12	Shaft Q inductance (synchronous motor)
F1-13	Stator resistance (synchronous motor)

If the motor cannot be completely disconnected from the load, set F1-16 (Auto-tuning mode) to 3 (Static auto-tuning 2) and press RUN key on the operating panel to start the motor auto-tuning.

5.6 Observation of Running Status

1) After auto-tuning is completed, set F0-08 (Preset frequency) to 5 to perform a trial run at a low speed and observe whether the running current of the servo drive is small and stable.

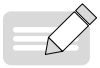
2) If the running current is large, check whether the motor parameters (Group F1) and the number of rotary encoder pole pairs (A1-04) are set correctly. If the parameters need to be modified, perform auto-tuning again, run the servo drive at a low speed, and observe whether the running is normal.

3) When motor auto-tuning becomes normal, check whether the servo drive runs in correct direction. If incorrect, exchange any two phases of the motor UVW cables and perform motor auto-tuning again.

4) If an oscillation or a low sound occurs during motor running, reduce the speed loop properly by decreasing the value of F2-00 (Speed loop proportional gain 1) and F2-

03 (Speed loop proportional gain 2) or increasing the value of F2-01 (Speed loop integral time 1) and F2-04 (Speed loop integral time 2).

5) If the motor speed is unstable, increase the speed loop properly by increasing the value of F2-00 (Speed loop proportional gain 1) and F2-03 (Speed loop proportional gain 2) or decreasing the value of F2-01 (Speed loop integral time 1) and F2-04 (Speed loop integral time 2).



NOTE

- The overflow valve must be turned on to ensure that there is no load during the trial run.
- The speed/current loop parameters are set in group F2.
- The speed/current loop response will affect pressure stability. If conditions permit, set a strong speed/current loop response as possible as it can.

5.7 Commissioning of the Servo Hydraulic Pump

5.7.1 Oil Pressure Mode Selection

Parameter No.	Parameter Name	Setting Range	Application
A3-00	Oil pressure mode	0: Speed mode	Applied in non-oil pressure mode.
		2: References given by AI terminals	During the oil pressure control by the servo drive, AI1 gives the oil pressure reference, AI2 gives the flow reference, and AI3 gives the oil pressure feedback reference.
		5: References given by EST host controller through CAN communication	During the oil pressure control by the servo drive, the EST host controller gives the oil pressure and flow references through CAN communication, and AI3 gives the oil pressure feedback reference.
		6: References given by CANopen communication	During the oil pressure control by the servo drive, CANopen communication gives the oil pressure and flow references, and AI3 gives the oil pressure feedback reference.

When the non-oil pressure mode (A3-00 = 0) switches to the oil pressure mode (A3-00 ≠ 0), the relevant parameters will be set automatically. The following table shows the details.

If you modify the following parameters in the oil pressure mode, the parameters will be restored to the automatically set values when the servo drive is powered on again after power failure. If the oil pressure mode switches to the non-oil pressure mode, the parameters will be restored to the values set before the oil pressure mode.

Parameter No.	Parameter Name	Setting Range
F0-01	Control mode	1: Vector control
F0-02	Command source	1: Terminal control
F0-17	Acceleration time	0.0s

Parameter No.	Parameter Name	Setting Range
F0-18	Deceleration time	0.0s
F1-00	Motor type	2: Synchronous motor

5.7.2 AI Zero Drift Autocorrection

Step	Parameter Setting	Description
Command source setting	F0-02 = 0	Operating panel control mode LOCAL/REMOT indicator on the operating panel is OFF.
AI zero drift autocorrection	A3-20 = 1	AI zero drift autocorrection When AI cod is displayed, press RUN key on the operating panel and AI zero drift will be autocorrected.

NOTE

- Manual AI zero drift correction: When the servo drive is disabled, view the values of U1-04, U1-05, and U1-06. The max. value of the three parameters plus 10 mV is assigned to F4-18, F4-23, and F4-28 respectively.
- After AI zero drift autocorrection is completed, the value of A3-20 will be automatically restored to 0.

5.7.3 Oil Pressure Parameter Settings

1) Setting of parameters related to system pressure and flow

■ Setting of system flow and pressure parameters

Parameter No.	Parameter Name	Setting Range
A3-01	Max. motor speed	It is used to set max. motor speed (motor speed corresponding to 100% of the flow reference)
A3-02	System pressure	It is used to set max. system pressure. Range: 0 to A3-03 (Max. oil pressure).
A3-03	Max. oil pressure	It is used to set the measuring range of the output type pressure sensor with a voltage of 0–10 VDC.

■ Setting of AI1 oil pressure reference parameters

Parameter No.	Parameter Name	Setting Range
F4-18	Min. AI1 input	Min. voltage input of oil pressure reference, corresponding to AI1 zero drift
F4-19	Corresponding value of min. AI1 input	Min. oil pressure reference Default: 0.0% (zero pressure)
F4-20	Max. AI1 input	Max. voltage input of oil pressure reference Max. value: 10 V
F4-21	Corresponding value of max. AI1 input	Max. oil pressure reference, 100% corresponding to system pressure (A3-02)

These parameters are used to set the AI1 oil pressure reference (0–10 V or other

measuring range) corresponding to different oil pressure (0 kg/cm^2 to A3-02).

■ Setting of AI2 flow reference parameters

Parameter No.	Parameter Name	Setting Range
F4-23	Min. AI2 input	Min. voltage input of flow reference, corresponding to AI2 zero drift
F4-24	Corresponding value of min. AI2 input	Min. flow reference Default: 0.0% (zero flow)
F4-25	Max. AI2 input	Max. voltage input of flow reference Max. voltage input: 10 V
F4-26	Corresponding value of max. AI2 input	Max. flow reference, 100% corresponding to max. motor speed (A3-01) by default

These parameters are used to set the AI2 flow reference (0–10 V or other measuring range) corresponding to different motor speed (0 rpm to A3-01).

■ Setting of AI3 oil pressure feedback parameters

Parameter No.	Parameter Name	Setting Range
F4-28	Min. AI3 input	Min. voltage input of oil pressure feedback, corresponding to AI3 zero drift
F4-29	Corresponding value of min. AI3 input	Min. oil pressure feedback Default: 0.0% (zero pressure)
F4-30	Max. AI3 input	Max. voltage input of oil pressure feedback Max. value: 10 V
F4-31	Corresponding value of max. AI3 input	Max. oil pressure feedback, 100% corresponding to max. oil pressure (A3-03) by default

These parameters are used to set the AI3 oil pressure feedback (0–10 V or other measuring range) corresponding to different pressure sensor measuring range (0 kg/cm^2 to A3-03).

2) Setting of pressure relief parameter

Parameter No.	Parameter Name	Setting Range
A3-08	Max. reverse motor speed	It is used to set the maximum reverse motor speed during pressure relief, corresponding to the percentage setting of max. motor speed (A3-01) A larger value indicates a faster pressure relief, and a smaller value indicates a slower pressure relief. Noise will occur during reverse running of the hydraulic pump if the value of A3-08 is too large.

3) Setting of base flow and base pressure

Due to the existence of internal leakage in the hydraulic pump, the hydraulic oil in the oil circuit will flow back to the oil tank when there are no flow and pressure references, causing the air to enter the oil circuit. This will result in system running noise and instability. Therefore, certain base flow and pressure must be provided.

Parameter No.	Parameter Name	Setting Range
A3-09	Base flow	0.0% to 50.0%, corresponding to the percentage setting of max. motor speed (A3-01)
A3-10	Base pressure	0.0–50.0 kg/cm^2

4) Filter time of oil pressure and flow references

■ Oil pressure reference filter time

Parameter No.	Parameter Name	Setting Range
F4-22	AI1 input sampling filter	0.000s to 10.000s
A3-04	Rising time of 1st group of oil pressure references	0.000s to 2.000s
A4-02	Falling time of 1st group of oil pressure references	0.000s to 2.000s
A3-25	Rising S-curve filter time of 1st group of oil pressure references	0.000s to 1.000s
A3-26	Falling S-curve filter time of 1st group of oil pressure references	0.000s to 1.000s
A4-10	Rising S-curve filter time of 2nd group of oil pressure references	1s to 1.000s
A4-11	Falling S-curve filter time of 2nd group of oil pressure references	1s to 1.000s
A4-14	Rising time of 2nd group of oil pressure references	0s to 2.000s
A4-15	Falling time of 2nd group of oil pressure references	0s to 2.000s

A smaller filter time generates quicker oil pressure response and larger overshoot. Conversely, a larger filter time generates slower oil pressure response and smaller overshoot.

■ Flow reference filter time

Parameter No.	Parameter Name	Setting Range
F4-27	AI2 input sampling filter	0.000s to 10.000s
A4-03	Rising time of 1st group of flow references	0s to 1.000s
A4-04	Falling time of 1st group of flow references	0s to 1.000s
A4-12	Rising time of 2nd group of flow references	0.001s to 5.000s
A4-13	Falling time of 2nd group of flow references	0.001s to 5.000s

A smaller filter time generates quicker oil pressure response and larger running impact.

Conversely, a larger filter time generates slower oil pressure response and smoother running.

5.7.4 Adjustment of Oil Pressure PID

1) Oil pressure PID modes

■ Oil pressure PID mode 1: PID groups selected by DI terminals

The ES510 has four groups of PID parameters which can be selected using different combinations of terminals terminals DI2 allocated with function 48 and DI3 allocated with function 49. They are:

DI3 (Function 49)	DI2 (Function 48)	PID Group
0	0	1st group: A3-05, A3-06, A3-07
0	1	2nd group: A3-11, A3-12, A3-13
1	0	3rd group: A3-14, A3-15, A3-16
1	1	4th group: A3-17, A3-18, A3-19

A larger proportional gain (Kp), smaller integral time (Ki) and larger differential time (Kd) generate a faster response. An overshoot will occur if the response is too fast, causing the system oscillation and instability.

A smaller proportional gain (Kp), larger integral time (Ki) and smaller differential time (Kd) generate a slower response. If the response is too slow, the efficiency will decrease and the manufactured product will become unstable.

■ Oil pressure PID proportional gain (parameters: A3-05, A3-11, A3-14, and A3-17)

The larger the proportional gain is, the quicker the pressure response will be. However, a system oscillation will occur if the proportional gain is too large.
The smaller the proportional gain is, the slower the pressure response will be. The following figure shows the details.

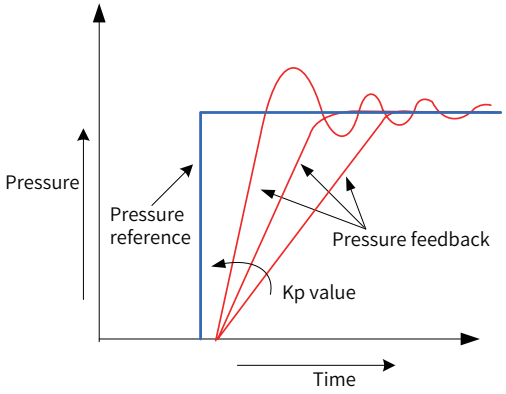


Figure 5-3 Oil pressure PID proportional gain

■ Oil pressure PID integral time (parameters: A3-06, A3-12, A3-15, and A3-18)

The smaller the integral time is, the quicker the pressure response will be. However, an overshoot or even a system oscillation will occur if the response is too quick.
The larger the integral time is, the slower the pressure response will be. The pressure will become unstable if the response is too slow. The following figure shows the details.

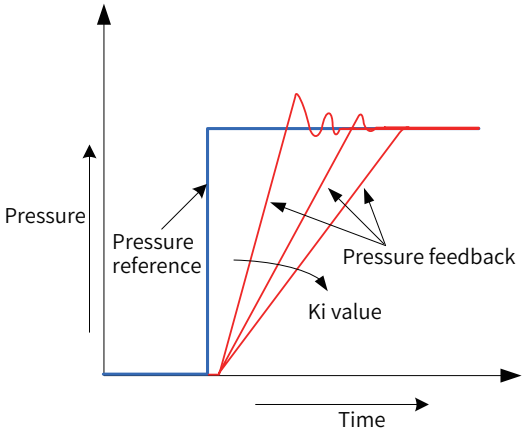


Figure 5-4 Oil pressure PID integral time

2) Oil pressure loop PID response gain (parameter: A3-29)

A3-29 (Oil pressure loop gain) is used to adjust the response of the entire oil pressure loop control circuit. The larger the oil pressure loop gain is, the quicker the response will be. However, a system oscillation will occur if the response is too quick.

The smaller the oil pressure loop gain is, the slower the response will be.

In applications where the oil pressure system has very large inertia or where the oil tube is long and thin, reduce the oil pressure loop gain.

5.7.5 Commissioning of Pressure Holding Stability

If the pressure fluctuation of pressure holding is too large during commissioning, increase the speed loop response at low speed to enhance the pressure stability. That is, increase the value of F2-00 (Speed loop proportional gain 1) and reduce the value of F2-01 (Speed loop integral time 1) properly. The motor will have an oscillation if the value adjustment is improper.

6 Troubleshooting

6.1 Safety Information

Safety Instruction
 DANGER ◆ Do not perform wiring when the power is on, and keep all circuit breakers in OFF state. Failure to comply will result in an electric shock.
 WARNING ◆ Ensure that the servo drive is grounded according to local laws and regulations. Failure to comply will result in an electric shock or even a fire. ◆ Do not remove the enclosure or touch the internal circuit of the servo drive when the power is on. Failure to comply will result in an electric shock. ◆ Inspection, maintenance, and repair can be performed only by qualified personnel. Failure to comply will result in an electric shock or even a fire. ◆ When installing the servo drive in an enclosed cabinet or a casing box, use the cooling fan or air conditioner to keep the air inlet temperature below 50°C. Failure to comply will result in overheating or even a fire. ◆ Tighten all screws based on the specified torque. Failure to comply may result in an electric shock or even a fire. ◆ Ensure that the input voltage of the servo drive is within the range specified on the nameplate. Failure to comply will result in an electric shock or even a fire. ◆ Never place flammable and explosive objects around the drive.
 CAUTION ◆ During installation, use a paper or cloth to cover the upper part of the servo drive to prevent metal filings, oil, and water from entering into the servo drive when drilling holes. If foreign matters enter into the servo drive, the servo drive may get faulty. ◆ After the installation is completed, remove the paper or cloth. Otherwise, the ventilation will get poor, causing abnormal overheating of the drive. ◆ Follow proper ESD procedures when operating the servo drive. Failure to comply will result in damage to internal circuits of the servo drive.

6.2 Alarms and Fault Display

When the servo drive has a fault, it stops output immediately, the fault indicator 

flashes, and the contact of the fault relay acts. The operating panel will display the fault code, such as 

. The fault types and solutions for corresponding fault codes are shown in *"Table 6-2 Fault list" on page 78*. The solutions listed in Table 6-2 are for reference only. Do not repair or modify the drive by yourself without permission. If the fault cannot be eliminated, contact the technical personnel of Inovance.

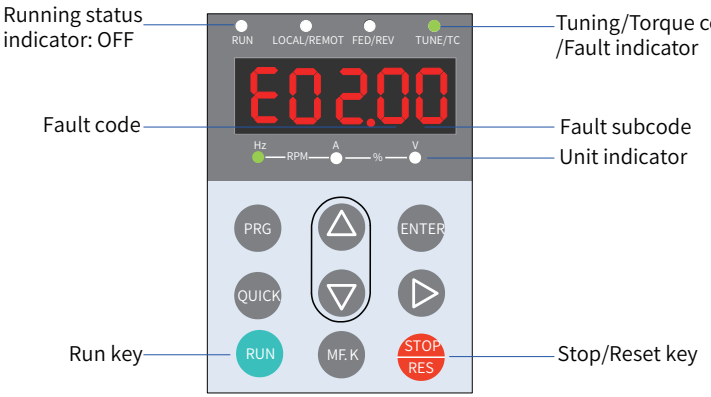
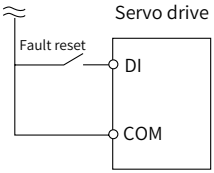
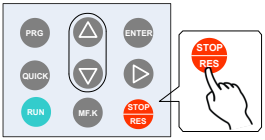
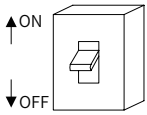
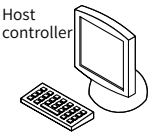


Figure 6-1 Fault display on the operating panel

6.3 Restart After Fault

Table 6-1 Methods of restarting the servo drive after fault

Stage	Solution	Remarks
In the fault state	View the detailed information of recent three faults using the operating panel, including fault time, fault type, and frequency/ current/bus voltage/DI or DO status/power-on time/running time at the occurrence of the fault.	View the fault information in parameters F9-18 to F9-44. 
Before fault reset	Find the fault cause according to the fault type displayed on the operating panel and eliminate the fault by following the solutions. Then, reset the servo drive.	Troubleshoot the fault according to "6.4 Fault Alarms and Solutions" on page 78.
Methods of resetting the fault	1) Allocate a DI terminal with function 9 (Fault reset) by setting any of F4-00 (DI1 terminal function selection) to F4-04 (DI5 terminal function selection) to 9.	
	2) Confirm the value of F7-02 (STOP/ RESEY key function) is 2 (default value), indicating that STOP RES key can be used to reset the fault in all operation modes.	Press STOP RES key on the operating panel. 
	3) The fault can be reset automatically after the servo drive is powered on again. Cut off the main circuit power supply, and re-power on the main circuit after the display on the operating panel disappears.	
	4) Reset the fault using the communication of the host controller. Write "7" (Fault reset) into the communication address 2000H using the host controller so that the servo drive can be reset after the fault is eliminated.	

6.4 Fault Alarms and Solutions

The following faults may occur during the use of the servo drive. Perform simple fault analyses according to the following solutions. (If the fault subcode is not provided, it means that you need not pay attention to the fault subcode.)

Table 6-2 Fault list

Fault	Panel Display	Possible Cause	Solution
Detection circuit fault		The current detection circuit is damaged, causing too large current zero-drift at stop.	Check the current detection circuit.
Overcurrent during acceleration		The drive output circuit is grounded or short-circuited.	Eliminate external faults, and check whether the motor is short-circuited or open-circuited.
		The braking transistor is short-circuited.	Power off the servo drive, remove the regenerative resistor, and power on the servo drive again. ◆ If no fault is reported, it indicates that the braking circuit is abnormal. The reason may be that the resistance between the regenerative resistor cable and the enclosure of the servo drive is too small (short circuit). In this case, replace the regenerative resistor. ◆ If the fault persists, it indicates that the braking transistor circuit is normal but the motor control loop has a fault. Check whether the overcurrent is caused by other reasons.
		The control mode is SVC or FVC, and motor auto-tuning is not performed.	Set motor parameters according to the nameplate and perform motor auto-tuning.
		The acceleration time is too short.	Increase the acceleration time.
		The rotating motor is started.	Select the motor speed tracking restart or start the motor after it stops.
		The servo drive suffers external interference.	View historical fault records. If the current is far from the overcurrent level, find the interference source. If no external interference exists, the drive board, Hall sensor, hall cables or the control board may be faulty.

Fault	Panel Display	Possible Cause	Solution
Overcurrent during deceleration		The drive output circuit is grounded or short-circuited.	Eliminate external faults. Check whether the motor is short-circuited or open-circuited.
		The braking transistor is short-circuited.	Power off the servo drive, remove the regenerative resistor, and power on the servo drive again. ◆ If no fault is reported, it indicates that the braking circuit is abnormal. The reason may be that the resistance between the regenerative resistor cable and the enclosure of the servo drive is too small (short circuit). In this case, replace the regenerative resistor. ◆ If there is still a fault, it indicates that the braking transistor circuit is normal but the motor control loop has a fault. Check whether the overcurrent is caused by other reasons.
		The control mode is SVC or FVC, and motor auto-tuning is not performed.	Set motor parameters according to the nameplate and perform motor auto-tuning.
		The deceleration time is too short.	Increase the deceleration time.
		The servo drive suffers external interference.	View historical fault records. If the current is far from the overcurrent level, find the interference source. If no external interference exists, the drive board, Hall sensor, hall cables or the control board may be faulty.

Fault	Panel Display	Possible Cause	Solution
Overcurrent at constant speed	E04.00	The drive output circuit is grounded or short-circuited.	Eliminate external faults. Check whether the motor is short-circuited or open-circuited.
		The braking transistor is short-circuited.	Power off the servo drive, remove the regenerative resistor, and power on the servo drive again. ◆ If no fault is reported, it indicates that the braking circuit is abnormal. The reason may be that the resistance between the regenerative resistor cable and the enclosure of the servo drive is too small (short circuit). In this case, replace the regenerative resistor. ◆ If there is still a fault, it indicates that the braking transistor circuit is normal but the motor control loop has a fault. Check whether the overcurrent is caused by other reasons.
		The control mode is SVC or FVC, but motor auto-tuning is not performed.	Set motor parameters according to the nameplate and perform motor auto-tuning.
		The deceleration time is too short.	If the running current exceeds the rated motor current or rated output current of the servo drive during stable running, select a drive of larger power class.
		The servo drive suffers external interference.	View historical fault records. If the current value is far from the overcurrent level, find the interference source. If no external interference exists, the drive board, Hall sensor, hall cables or the control board may be faulty.
Overvoltage during acceleration	E05.00	The input voltage is too high.	Adjust the input voltage to the normal range.
		An external force drives the motor during acceleration.	Cancel the external force or install a regenerative resistor.
		The braking unit and regenerative resistor are not installed.	Install the braking unit and regenerative resistor.
		The acceleration time is too short.	Increase the acceleration time.

Fault	Panel Display	Possible Cause	Solution
Overvoltage during deceleration	E06.00	The input voltage is too high.	Adjust the input voltage to the normal range.
		An external force drives the motor during deceleration.	Cancel the external force or install a regenerative resistor.
		The deceleration time is too short.	Increase the deceleration time.
		The braking unit and regenerative resistor are not installed.	Install the braking unit and regenerative resistor.
		The motor is short-circuited to ground.	The short circuit to ground causes a booster circuit, which may result in overvoltage. Check whether the drive output cables or the motor is short-circuited to ground.
Overvoltage at constant speed	E07.00	The input voltage is too high.	Adjust the input voltage to the normal range.
		An external force drives the motor during running at a constant speed.	Cancel the external force or install a regenerative resistor.
Pre-charge resistor fault	E08.00	The pre-charge resistor is frequently off and on in a short period of time.	Power off the servo drive and consult the technical personnel of Inovance.
Undervoltage	E09.01	The input voltage of the servo drive is not within the specified range.	Adjust the voltage to the normal range.
		The bus voltage is abnormal.	Consult the technical personnel of Inovance.
		The rectifier bridge, pre-charge resistor, drive board or control board is abnormal.	Consult the technical personnel of Inovance.
	E09.09	The program cannot run for a long time after power-on.	Check the input voltage and bus voltage, or consult the technical personnel of Inovance.
Drive overload	E10.00	The load is too heavy or locked-rotor occurs on the motor.	Reduce the load and check the motor and mechanical conditions.
		The power class of the servo drive is too small.	Select a drive of larger power class.
	E10.01	The encoder is faulty.	Set A1-05 (Detection time of the PG card cable disconnection protection) to a proper value (2s) to enable the encoder check.

Fault	Panel Display	Possible Cause	Solution
Input phase loss	E12.00	Three-phase power input phase loss exists.	Check and eliminate external faults.
		The drive board, lightning protection board, main control board (MCB) or rectifier bridge is abnormal.	Consult the technical personnel of Inovance.
Output phase loss	E13.00	The motor is faulty.	Check whether the motor is open-circuited.
		The cable connecting the drive and the motor is abnormal.	Eliminate external faults.
		The three-phase output of the servo drive is unbalanced during motor running.	Check whether the motor three-phase winding is normal. If abnormal, eliminate the fault.
		The drive board or IGBT module is abnormal.	Consult the technical personnel of Inovance.
IGBT overheating	E14.00	The ambient temperature is too high	Reduce the ambient temperature.
		The air filter is blocked.	Clean the air filter.
		The fan is damaged.	Replace the damaged fan.
		The thermistor is damaged.	Replace the damaged thermistor.
		The IGBT is damaged.	Replace the damaged IGBT.
External input fault	E15.00	Input the external fault signal using the DI terminal.	Eliminate external faults and confirm whether the load can be restarted (set F8-18 properly). Reset and run the servo drive.
		The STOP key is pressed in the terminal/ communication control mode or in a stall condition.	Reset and run the servo drive.
Communication fault	E16.03	The host controller does not work properly.	Check the wiring of the host controller.
		The communication cable is abnormal.	Check the connection of communication cables.
		The communication extension card type (F0-28) is set incorrectly.	Set the communication extension card type correctly.
		The communication parameters in group FD are set incorrectly.	Set the communication parameters correctly.
		If the fault still exists after all preceding solutions have been done, restore the default settings.	

Fault	Panel Display	Possible Cause	Solution
Contactor fault	E17.00	The drive board or power supply board is abnormal.	Replace the drive board or power supply board.
		The contactor is faulty.	Replace the contactor.
		The lightning protection board is abnormal.	Replace the lightning protection board.
		The servo drive suffers external interference.	Eliminate external interference.
Current detection fault	E18.00	The zero drift or temperature drift of UVW current detection circuit is too large.	Consult the technical personnel of Inovance. (The Hall sensor, hall cables, the drive board, the wiring between the drive board and the control board, or the control board is abnormal.)
Motor auto-tuning fault	E19.02	The initial magnetic pole position angle auto-tuning of the synchronous motor is abnormal.	The motor inductance is too large, or the motor is disconnected.
	E19.23	The magnetic pole position auto-tuning of the synchronous motor is abnormal.	Check the current detection circuit or the motor winding.
Encoder fault	E20.03	The encoder direction detection is incorrect.	Check the pulse signal and motor parameter settings.
	E20.08	The encoder angle verification is incorrect.	Check the encoder PPR and motor parameters settings.
EEPROM reading/writing fault	E21.01	Parameter writing error	◆ Decrease the parameter modification frequency if the EEPROM reading/writing is too frequent. ◆ Replace the PCB if the board is damaged.
	E21.02	Parameter reading error	
	E21.03	Parameter writing/reading delay error	
	E21.04	The quantity of parameters to be stored is out of range.	
	E21.05	Parameter writing error occurs at power-on.	
	E21.06	Parameter reading error occurs at power-on.	
	E21.07	At power-on, the quantity of parameters to be stored is out of range.	

Fault	Panel Display	Possible Cause	Solution
Motor short circuit to ground		The motor is short-circuited to ground.	Check whether the motor is short-circuited to ground. If yes, replace motor cables or the motor. If the fault still exists, consult the technical personnel of Inovance.
		Before the servo drive is powered on, the motor is rotating under the drive of an external force.	Power on the servo drive after the motor stops.
Output inter-phase short circuit		There is an output inter-phase short circuit.	Check whether the UVW three-phase output of the servo drive is short-circuited.
EEPROM address incorrect		The EEPROM address is out of the specified range, or identical physical addresses occur.	Power off the servo drive and consult the technical personnel of Inovance.
Accumulative running time reached		The accumulative running time reaches the set value.	◆ Set F8-17 (Set running time) to a non-zero value. ◆ Set F7-09 (Accumulative running time) to a value larger than F8-17 (Set running time). ◆ Set F8-23 (Action selection when accumulative running time is reached) to 1. (For the selection of stop mode when the accumulative running time is reached, see *"Figure 6-3 Running time reached (E26.00)" on page 91*.)

Fault	Panel Display	Possible Cause	Solution
Business running time reached		The business running time is reached.	Check if FA-08 [Accumulative business running time (hour)] is equal to or larger than any of FA-01 (Timed running time for first running), FA-03 (Timed running time for second running), FA-05 (Timed running time for third running), and FA-07 (Timed running time for fourth running). If yes, require the running time protection password (FA-00, FA-02, FA-04, FA-06) from the manufacturer, and increase the value of FA-01 (Timed running time for first running), FA-03 (Timed running time for second running), FA-05 (Timed running time for third running), and FA-07 (Timed running time for fourth running).
Output load loss		There is an output load loss.	Check the working condition of the load.
Pulse-by-pulse current limit fault		The drive output circuit is grounded or short-circuited.	Eliminate the external faults.
		The load is too heavy or locked-rotor occurs on the motor.	Reduce the load, and check the motor and mechanical conditions.
		The power class of the servo drive is too small.	Select a drive of larger power class.

Fault	Panel Display	Possible Cause	Solution
CAN communication fault		The communication cable is disconnected.	◆ Check whether the communication cable is in good contact. ◆ Check whether the cable shield is connected properly and whether the communication cable is too long. ◆ Check the load rate of the CAN bus.
		The communication suffers severe interference (receiving error)	
		The communication is never online after power-on.	◆ Check whether CANH and CANL are connected reversely. ◆ Check whether parameters (A2-00 and A2-01) are set incorrectly and whether the fault occurs on the communication cable. Eliminate these problems first.
		There is an extension card fault (extensible protocol card not supported temporarily).	Power off the servo drive, consult the technical personnel of Inovance, and replace the extension card.
		CANopen protocol abnormal	Power off the servo drive and consult the technical personnel of Inovance.
		CANopen communication timeout	Power off the servo drive and consult the technical personnel of Inovance.
		PDO length does not match the mapping.	Power off the servo drive and consult the technical personnel of Inovance.
Encoder fault during motor auto-tuning		The encoder parameters are set incorrectly.	Set the encoder parameters again.
		The motor auto-tuning is not performed.	Perform the motor auto-tuning.
		Motor overspeed detection parameters (F9-67 and F9-68) are set incorrectly.	Set F9-67 and F9-68 again according to actual conditions.

Fault	Panel Display	Possible Cause	Solution
Excessive speed deviation	E44.00	The speed deviation is too large.	Check whether the installation and wiring of the encoder and the motor power cable are loose. Check whether the servo drive works normally after the PG card is replaced.
	E44.01	Parameter setting of the servo drive is incorrect.	Increase the value of F2-10 (Upper torque limit).
	E44.02	The encoder is faulty.	◆ Power off the servo drive and replace the PG card. ◆ Consult the technical personnel of Inovance.
	E44.03	The drive parameters are set incorrectly or the encoder is faulty.	◆ Power off the servo drive and replace the PG card. ◆ Increase the value of F2-10 (Upper torque limit). ◆ Consult the technical personnel of Inovance.
Motor temperature fault	E45.00	The PTC protection is enabled when the motor overheats.	Handle this problem according to "Figure 6-2 Motor overheating fault (E45.00)" on page 91.
	E45.01	The temperature sensor cable is disconnected or not connected.	Check whether the motor temperature sensor cable is disconnected.
	E45.02	The wiring of the PG card is faulty.	◆ Check whether the wiring of the PG card is proper. ◆ Check whether the motor temperature sensor is short-circuited.
	E45.03	The KTY protection is enabled when the motor overheats.	Handle this problem according to "Figure 6-2 Motor overheating fault (E45.00)" on page 91.
	E45.04	The PTC cable is disconnected.	Set F9-16 (Motor overtemperature protection) to 2 and enable both PTC and KTY protections. Check whether the PTC cable is disconnected.
	E45.05	The KTY cable is disconnected.	Set F9-16 (Motor overtemperature protection) to 2 and and enable both PTC and KTY protections. Check whether the KTY cable is disconnected.

Fault	Panel Display	Possible Cause	Solution
Pressure sensor fault		The pressure sensor is faulty.	Check whether the connection of the pressure sensor is loose and the power supply and the output are normal.
		The load is too heavy (the motor or hydraulic pump is stuck).	◆ Stop the servo drive and rotate the motor manually to check whether the motor can rotate. ◆ Check whether F2-10 (Upper torque limit) is set to a proper value. ◆ Check whether dynamic motor auto-tuning is normal.
		The zero drift of the pressure sensor is faulty.	◆ Ensure that the pressure measured by the pressure sensor is zero. ◆ Ensure that the pressure sensor is wired correctly (whether the value of AI3 measured by the multimeter and U0-32 are consistent). ◆ Ensure that parameters F4-28 (Min. AI3 input) to F4-31 (Corresponding value of max. AI3 input) are set correctly.
		The measuring range of the pressure sensor exceeds the upper and lower limits.	Check whether the measuring range of the pressure sensor is smaller than A3-55 (Lower pressure deviation limit during pressure relief when the valve is closing) or larger than A3-56 (Upper torque limit in zero torque mode).
Slave pump fault in multi-pump confluence mode		The slave pump is faulty in multi-pump confluence mode.	See "Appendix B Multi-Pump Mode of the Injection Molding Machine" on page 157.
Station number conflict		There is a conflict between different station numbers.	See "Appendix B Multi-Pump Mode of the Injection Molding Machine" on page 157.

Fault	Panel Display	Possible Cause	Solution
Encoder fault		◆ The encoder cable is disconnected or not connected. ◆ The encoder type is set incorrectly.	◆ Check whether the connector between the PG card and the resolver becomes loose. ◆ Check whether the cable between the resolver and the PG card is wired correctly. ◆ Check whether the resolver, PG card, and the encoder type are correct, and whether A1-00 (PG card type) is set properly.
		Encoder interference exists.	Use the shielded cable as the encoder cable, and separate the encoder cable from the power cable. Ground the PG card and connect and disconnect it for several times.
Multi-master fault in multi-pump mode		Multiple masters are used together in multi-pump mode.	See "Appendix B Multi-Pump Mode of the Injection Molding Machine" on page 157.
Parameter restoring fault		Parameters are not stored before restoring.	Set the parameters correctly, and then store them. (Input the password set in FP-04 and set FP-05 to 1 to store parameters.)
Back EMF fault during auto-tuning		The motor back EMF is too low during dynamic auto-tuning.	Check whether parameters in group F1 are set correctly, and replace the motor with a new one of the same type to test whether the motor is demagnetized.
Braking transistor working overtime		The braking transistor works overtime.	Check whether the bus voltage is higher than the braking voltage for a long time and whether the braking protection time set previously is too short.
Reverse running time reached		In the oil pressure mode, the accumulative reverse running time exceeds the value set in A4-09 (Long-time running protection time for reverse pressure relief).	Check whether the flow falling time and oil cooling reference falling time set previously are too short.
Parameter initialization abnormal		Parameter initialization is abnormal at power-on.	Power off the servo drive and consult the technical personnel of Inovance.

Fault	Panel Display	Possible Cause	Solution
Motor rotor locked	E69.00	The UVW wiring is incorrect.	◆ After power-off, adjust the motor cables to ensure that UVW cables of the servo drive are connected to UVW cables of the motor correspondingly. ◆ Set A1-09 ("Auto-tuning free" function) to 0 to disable the "auto-tuning free" function and perform auto-tuning again.
"Auto-tuning free" fault	E70.00	Parameters related to "auto-tuning free" function are set incorrectly.	Check whether A1-09 ("Auto-tuning free" function) is set correctly, whether the motor is a synchronous motor, whether the encoder is a 23-bit encoder, and whether the control mode is FVC.
	E70.01	SPI communication cable used for "auto-tuning free" function is disconnected.	Check whether the communication cable of the PG card is connected incompletely or disconnected.
	E70.02	485 communication cable used for "auto-tuning free" function is disconnected.	Check whether the encoder cable is connected incompletely or disconnected.
	E70.03	Motor parameters are set incorrectly.	Set A1-09 ("Auto-tuning free" function) to 0 to disable the "auto-tuning free" function and perform auto-tuning again. If the fault still exists, consult the technical personnel of Inovance.
	E70.05	The "auto-tuning free" function is disabled.	Set A1-09 ("Auto-tuning free" function) to 1 to enable the "auto-tuning free" function. Then, set A1-10 to a proper value.
Feedback speed abnormal	E71.00	There is an alarm when the frequency deviation exceeds the rated motor frequency.	The solutions are the same as those of E69.00.
Encoder direction abnormal in the "auto-tuning free" mode	E73.00	In the "auto-tuning free" mode, a fault occurs on auto-tuning due to abnormal UVW wiring, or the encoder direction is manually modified to the reverse direction (A1-03 is set to 1).	Wire the UVW cables correctly or prohibit the modification of the encoder direction in the "auto-tuning free" mode.

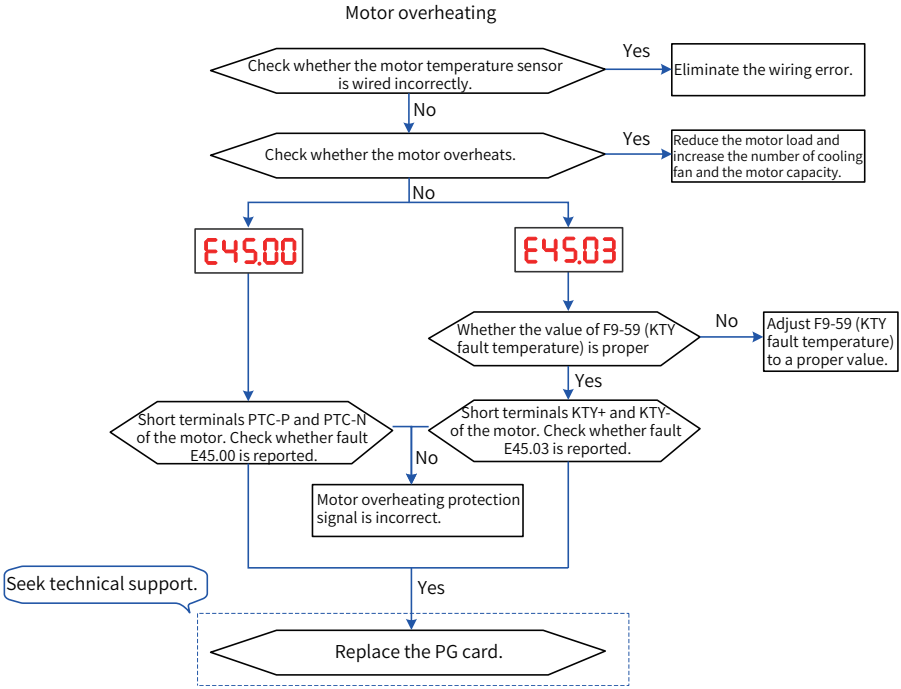


Figure 6-2 Motor overheating fault (E45.00)

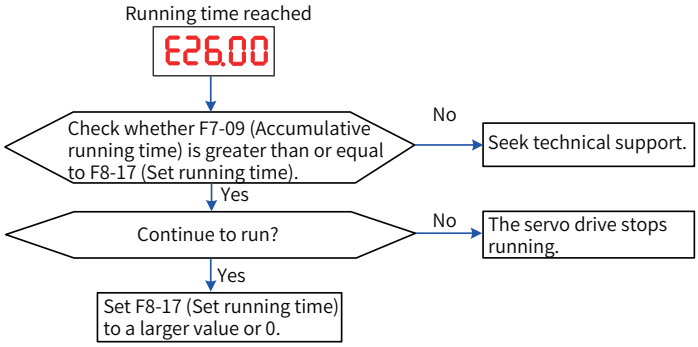


Figure 6-3 Running time reached (E26.00)

6.5 Common Faults and Solutions

No.	Fault Symptom	Possible Cause	Solution
1	There is no display at power-on. 	There is no mains voltage or the mains voltage is too low.	◆ Check the power supply.
		The switched-mode power supply on the drive board of the servo drive is faulty.	◆ Check the bus voltage.
		The cable between the control board and the drive board and between the control board and the operating panel is broken.	◆ Re-connect the 8-core cable and 40-core cable.
		The pre-charge resistor of the servo drive is damaged.	◆ Consult the technical personnel of Inovance.
		The control board or operating panel is faulty.	
		The rectifier bridge is damaged.	
2	"HC" is displayed at power-on. 	The cable between the drive board and the control board is in poor contact.	◆ Re-connect the 8-core cable and 40-core cable.
		Components on the control board are damaged.	◆ Consult the technical personnel of Inovance.
		The motor or motor cable is short-circuited to the ground.	
		The Hall sensor is damaged.	
		The mains voltage is too low.	
3	The display is normal at power-on. But after the running starts, "HC" is displayed and the drive stops running immediately. 	The cooling fan is damaged or blocked.	◆ Replace the fan.
		The cable of external control terminals is short-circuited.	◆ Eliminate the external short circuit fault.

No.	Fault Symptom	Possible Cause	Solution
4	The motor does not rotate after the servo drive starts to run.	The motor wiring is abnormal.	◆ Check whether the wiring between the servo drive and the motor is normal.
		The motor parameters are set incorrectly.	◆ Restore the factory parameters and reset parameter groups properly. ◆ Check whether the encoder parameters and rated motor parameters (such as rate motor frequency and rated motor speed) are set correctly. ◆ Check whether F0-01 (Control mode) and F0-02 (Command source) are set correctly. ◆ Modify F3-01 (Torque boost) in V/F control mode under heavy-load start.
		The cable connecting the drive board and the control board is in poor contact.	◆ Re-connect the cable connecting the drive board and the control board and ensure a secure connection.
		The drive board is faulty.	◆ Consult the technical personnel of Inovance.
5	DI terminals are disabled.	The parameters are set incorrectly.	◆ Check and reset parameters in group F4.
		The external signal is incorrect.	◆ Re-connect the external signal cable.
		Jumper J1 is connected incorrectly.	◆ Check whether jumper J1 is wired correctly according to the wiring diagram.
		The control board is faulty.	◆ Consult the technical personnel of Inovance.
6	The motor speed cannot rise in FVC mode.	The encoder is faulty.	◆ Replace the encoder and check the wiring.
		The encoder is wired incorrectly or in poor contact.	◆ Replace the PG card.
		The PG card is faulty.	◆ Consult the technical personnel of Inovance.
		The drive board is faulty.	

No.	Fault Symptom	Possible Cause	Solution
7	The servo drive reports overcurrent and overvoltage frequently.	The motor parameters are set improperly.	◆ Reset the motor parameters or perform the motor auto-tuning again.
		The acceleration/deceleration time is improper.	◆ Set proper acceleration/ deceleration time.
		The load fluctuates.	◆ Consult the technical personnel of Inovance.
8	The motor coasts to stop or the braking is disabled during deceleration or deceleration to stop.	The encoder cable is disconnected, or the overvoltage stall protection is enabled.	◆ Check the encoder wiring in FVC mode (F0-01 = 1). ◆ If the regenerative resistor is configured, disable the overvoltage stall protection function by setting F3-23 (Overvoltage stall protection in V/F mode) to 0.
9	Pre-charge resistor burnout	◆ The drain wire of the regenerative resistor is connected to the metal enclosure (that is, short-circuited to the ground). ◆ The braking transistor is damaged. ◆ The short circuit occurs due to the damage of the bus capacitor. ◆ The negative bus is short-circuited to the ground.	◆ Increase the insulation of the drain wire of the regenerative resistor by taking such measures as winding the electric tape cloth. ◆ Replace the braking transistor. ◆ Replace the bus capacitor. ◆ Eliminate the short circuit fault.

7 Maintenance

7.1 Daily Inspection

Safety Instruction
 ◆ Never perform wiring at power-on. Failure to comply will result in an electric shock. ◆ Before inspection, cut off the power supply of all devices. After the power supply of the servo drive is cut off, wait for several minutes before the next operation until the power indicator is OFF because there is residual voltage in the DC capacitor of the servo drive. Before next power-on, wait for an interval specified by the drive. ◆ Do not modify the wiring, disconnect the cable, remove the optional card and replace the cooling fan during running. Failure to comply will result in an electric shock. ◆ The motor grounding terminal must be grounded. Failure to comply will result in an electric shock due to the contact between the grounding terminal and the motor housing. ◆ Maintenance and repair can only be performed by qualified electrical personnel. ◆ Installation, wiring, commissioning, repair, inspection, and component replacement must be performed only by qualified technicians.
 ◆ Do not run the servo drive with the front cover removed. ◆ For illustration purpose, the drawings in this user guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified before using the product, and perform operations in accordance with the instructions. ◆ Tighten all terminal screws based on the specified tightening torque. This is to prevent a fire caused by overheating of the loose cable connection. ◆ Ensure that the input voltage of the main circuit is within the allowable range. Incorrect input voltage will result in abnormal running of the servo drive. ◆ Keep flammable materials far away from the servo drive and do not install the servo drive on flammable surfaces such as metal.
 ◆ Replace the cooling fan according to the instructions in this user guide. Ensure correct air outlet direction of the fan. Incorrect air direction will weaken the cooling effect. ◆ Do not install or remove the motor when the servo driver is running. Failure to comply will result in an electric shock and damage to the servo drive. ◆ Use shielded cables for control circuit wiring. ◆ Prevent the drive malfunction and ground the shield at one end reliably. ◆ Do not modify the drive circuits. Failure to comply will result in damage to the servo drive. ◆ Connect the output circuit terminals of the servo drive and the motor terminals correctly. ◆ If it is necessary to change the motor running direction, exchange any two of output terminals of the servo drive. ◆ Do not operate the damaged servo drive to prevent other devices from being damaged.

Daily inspection items

The influence of the ambient temperature, humidity, dust, and vibration will cause the aging of the components in the servo drive, which may result in potential faults or reduce the service life of the servo drive. Therefore, it is necessary to carry out daily and periodic maintenance for the servo drive. More frequent periodic inspection is required if the servo drive is used in the following situations:

- High ambient temperature
- Frequent start and stop
- Fluctuations in the AC power supply or load
- Strong vibration or impact
- Dust and hydrochloric acid

Check the following items daily to avoid performance deterioration and product damage. Copy this checklist and sign the "Checked" column after each inspection.

Item	Inspection	Solution	Checked
Motor	Whether abnormal sound or vibration exists	◆ Check whether the mechanical connection of the motor is abnormal. ◆ Check whether there is motor phase loss. ◆ Check whether the retaining screws of the motor are secure.	
Fan	Whether the cooling fan of the servo drive and motor work abnormally	◆ Check whether the cooling fan of the servo drive is running. ◆ Check whether the cooling fan of the motor is abnormal. ◆ Check whether the air filter is clogged. ◆ Check whether the ambient temperature is within the allowable range.	
Installation environment	Whether the electric cabinet and the cable tray are abnormal	◆ Check whether the insulation of input and output cables of the servo drive is damaged. ◆ Check whether the mounting bracket vibrates. ◆ Check whether the copper busbar and cable terminals become loose or get corroded.	
Load	Whether the running current of the drive exceeds the rated current of the drive and motor for a period of time.	◆ Check whether the motor parameters are set properly. ◆ Check whether the motor is overloaded. ◆ Check whether the mechanical vibration is too large (less than 1 g on normal condition).	

Item	Inspection	Solution	Checked
Input voltage	Whether the power voltage between the main circuit and the control circuit is within the allowable range.	◆ Check whether the input voltage is within the allowable range. ◆ Check whether the start of heavy load exists around the servo drive.	

7.2 Periodic Inspection

7.2.1 Periodic Inspection Items

Periodically inspect the components that can be hardly checked during running. Keep the servo drive clean all the time. Remove the dust on the surface of the servo drive, especially the metal dust, to prevent it from entering into the drive. Clear the oil stain from the cooling fan of the servo drive.

Safety Instruction
 DANGER ◆ Do not perform inspection at power-on. Failure to comply will result in an electric shock. ◆ Cut off all power supplies before inspection, and wait for at least 10 minutes before further operations to avoid risks caused by the residual voltage in the capacitor of the drive.

Item	Inspection	Solution	Checked
Servo drive	Whether there are wastes, dirt, and dust on the surface of the servo drive	◆ Check whether the servo drive cabinet is powered off. ◆ Use a vacuum cleaner to clean wastes and dust to prevent direct contact with components. ◆ Wipe the surface dirt that is difficult to clean with ethyl alcohol and wait until the surface becomes dry.	
Cables	◆ Whether the power cables and connections discolor ◆ Whether the insulation layer is aged or cracked	◆ Replace the cracked cables. ◆ Replace the damaged terminals.	
Peripheral devices, such as the electromagnetic contactor	◆ Check whether the contactor cannot be closed completely or has an abnormal sound when it acts ◆ Check whether the short circuit, water stain, expansion or cracking occurs on any peripheral device	◆ Replace the abnormal peripheral devices.	

Item	Inspection	Solution	Checked
Air vent	◆ Whether the air filter and heatsink are clogged ◆ Whether the fan is damaged	◆ Clean the are filter. ◆ Replace the fan.	
Control circuit	◆ Whether any control component is in poor contact ◆ Whether terminal screws are loose ◆ Whether the insulation layer of control cables is cracked	◆ Clear away foreign matters on the surface of control cables and terminals. ◆ Replace the damaged or corroded control cables.	

7.2.2 Insulation Test on the Main Circuit

NOTE

◆ Before measuring the insulation resistance with a megger (500 VDC megger recommended), disconnect the main circuit from the servo drive. Do not use the insulation resistance meter to test the insulation of the main circuit (see *"Figure 7-1 Insulation test on the main circuit"*). The high voltage test (> 500 V) need not be performed again because it has been done before delivery.

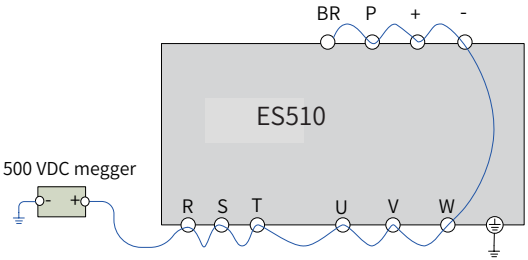


Figure 7-1 Insulation test on the main circuit

The measured insulation resistance must be greater than 5 MΩ. Before the test, remove the VDR screws and disconnect the VDR.

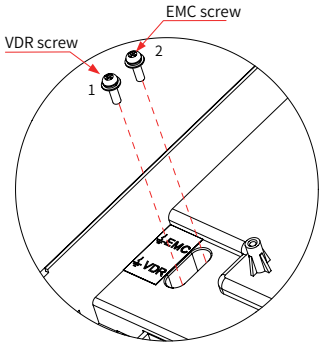


Figure 7-2 Positions of VDR and EMC grounding jumpers

7.3 Replacement of Quick-Wear Parts

7.3.1 Service Life of Quick-Wear Parts

The quick-wear parts of the servo drive include the cooling fan and the filter electrolytic capacitor. Their service life is closely related to the operating environment and maintenance. The general service life of the two components is listed in the following table.

Component	Service Life
Cooling fan	⩾ 5 years
Electrolytic capacitor	⩾ 5 years

NOTE

The standard service life indicates the time duration when the components are used in the following conditions. You can determine when to replace these components according to the actual running time.

- Ambient temperature: 40°C
- Load rate: 80%
- Operating rate: 24 hours per day

7.3.2 Number of the Cooling Fan

Model	Number
ES510T009-C1, ES510T009-R1	1
ES510T013-C1, ES510T013-R1	1
ES510T017-C1, ES510T017-R1	1
ES510T025-C1, ES510T025-R1	2
ES510T032-C1, ES510T032-R1	2
ES510T037-C1, ES510T037-R1	2

7.3.3 Replacing the Cooling Fan

■ Possible damage causes: bearing worn and blade aging

■ Judging criteria:

1) Whether there is crack on the blade

2) Whether there is abnormal vibration noise at startup

3) Whether the blade runs abnormally

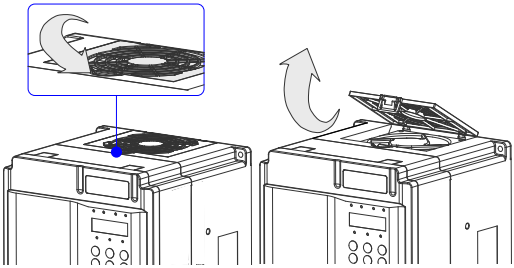
■ Methods to replace the cooling fan:

1) Press the snap-fit joint on the protective cover and pull the cover out.

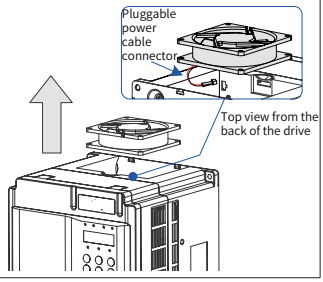
2) After the replacement is completed, ensure that the airflow direction is upward.

Removing the Cooling Fan

Press the snap-fit joint on the protective cover slightly and remove the fan cover.



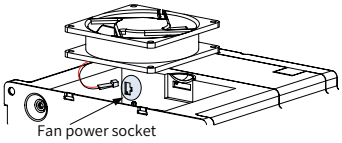
Pull the fan upward and disconnect the pluggable power cable connector from the socket.



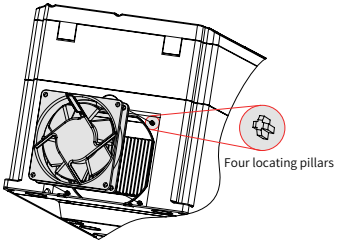
Installing the Cooling Fan

① Install the fan in a reverse procedure to removal. Pay attention to the direction of the fan.

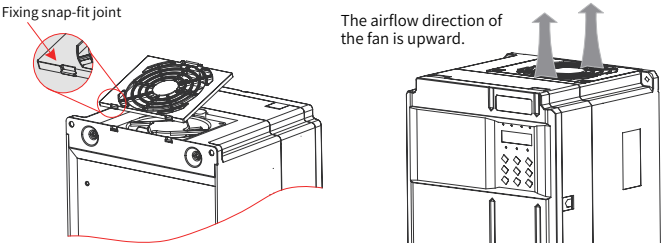
② Insert the pluggable power cable connector into the power socket in the drive, as shown in the following figure.



③ Put the fan into the location to be installed and ensure that the four fixing holes on the bottom of the fan are aligned with the four locating pillars in the servo drive.



④ Insert the two snap-fit joints into the grooves and then push down the snap-fit joints slightly.



7.3.4 Filter Electrolytic Capacitor

- Possible damage causes: input power supply in poor quality, high ambient temperature, frequent load jumping, and electrolytic aging.
- Judging criteria: whether there is liquid leakage, whether the safety valve has projected, the value of the electrostatic capacitance, and the value of the insulation resistance.
- Replacement of the filter electrolytic capacitor: Because the electrolytic capacitor will influence internal components of the servo drive, do not replace the electrolytic capacitor yourself. Contact Inovance if there is a requirement for replacement.

7.4 Storage

For temporary and long-term storage of the servo drive, pay attention to the following aspects:

1) Pack the servo drive with the original packing box provided by Inovance.
2) Do not expose the servo drive in the environment with high humidity or temperature, or in an outdoor place with strong sunlight for a long time.
3) Long-term storage degrades the electrolytic capacitor. Thus, the servo drive must be energized once every six months, and each time lasts at least 5 hours. The input voltage must be increased slowly to the rated value with the regulator, or consult a professional servo drive personnel for technical support.

8 Technical Data and Model Selection

8.1 Technical Data of the Servo Drive

Table 8-1 Drive model and technical data

Item		Specification					
Model: ES510TXXX-R1, ES510TXXX-C1		009	013	017	025	032	037
Compatible motor capacity (kW)		3.7	5.5	7.5	11	15	18.5
Input	Rated input current (A)	10.9	15.8	20.6	30.2	38.7	44.6
Output	Rated output current (A)	9.0	13.0	17.0	25.0	32.0	37.0
	Output voltage	0 to Input voltage					
	Max. output frequency	300 Hz (You can change the value by setting the parameter.)					
	Carrier frequency	2.0–8.0 kHz (adjusted automatically based on the load features)					
	Overload	60s for 150% of the rated current					
Power supply	Rated voltage & Rated frequency	Three-phase 380–480 VAC, 50/60 Hz					
	Allowable voltage fluctuation range	-15% to 10%, 323–528 VAC					
	Allowable frequency fluctuation range	±5%					
	Power capacity (kVA)	12	17.5	22.8	33.4	42.8	45
Heat dissipation	Thermal power (kW)	0.138	0.201	0.240	0.355	0.454	0.478
	Exhaust air volume (CFM)	20	24	30	40	42	51.9

Table 8-2 Technical specifications of the ES510

Item		Specification	
Basic functions	Input frequency resolution	Digital setting: 0.01 Hz Analog setting: max. frequency x 0.025%	
	Control mode	SVC, FVC, and V/F control	
	Startup torque	0.25 Hz/150% (SVC); 0 Hz/180% (FVC)	
	Speed adjustment range	1:200 (SVC)	1:1000 (FVC)
	Speed stability accuracy	±0.5% (SVC)	±0.02% (FVC)
	Torque control accuracy	FVC: ±3%; SVC: ±5% (above 10 Hz)	
	Torque boost	Automatic torque boost; manual torque boost: 0.1% to 30.0%	
	V/F curve	Linear	
	Acceleration/ Deceleration curve	Linear or S curve Four groups of acceleration/deceleration time ranging from 0.0s to 6500.0s	
	DC injection braking	Braking start frequency: 0.00 Hz to max. frequency Braking time: 0.0s to 36.0s Braking current value: 0.0% to 100.0%	
	Built-in PID	Implements the process control in the closed-loop control system.	
	Automatic voltage regulation (AVR)	Automatically maintains a constant output voltage when the grid voltage changes.	
	Overvoltage/ Overcurrent stall control	Automatically limits the current and voltage during running to avoid frequent tripping caused by overvoltage or overcurrent.	
Customized features	Rapid current limiting function	Avoids frequent overcurrent of the servo drive.	
	Multiple field buses	Supports three kinds of field buses: Modbus-RTU, CANopen, and PROFIBUS-DP.	
	Motor overheating protection	Provides motor overheating protection by using the PTC thermistor and KTY sensor.	
	Multiple encoder types	Supports a variety of encoders: resolver, 23-bit encoder, and ABZ encoder.	
	Software tool	Supports the operations of drive parameters and the virtual oscilloscope function. You can monitor the drive states using the virtual oscilloscope.	

Item		Specification
Running	RUN command source	Command source: operating panel, control terminals, and serial communication Allows different methods of switchover between various RUN command sources.
	Frequency reference setting channel	Supports 10 frequency reference setting channels: digital setting, analog voltage setting, analog current setting, pulse setting, and serial communication setting. Allows different methods of switchover between various frequency reference setting channels.
	Input terminals	Standard input terminals include: ◆ Five DI terminals ◆ Three AI terminals, two of which only supports 0–10 V voltage input and one of which supports 0–10 V voltage input or 0–20 mA current input
	Output terminals	Standard output terminals include: ◆ One DO terminal ◆ Two relay output terminals; ◆ Two AO terminals that supports 0–20 mA current output or 0–10 V voltage output
Display and panel operations	LED Display	Displays the parameters.
	LCD display	Optional, displayed in English or Chinese.
	Parameter copy	Allows quick parameter copy using the LCD operating panel.
Protection functions	Phase loss protection	Input/Output phase loss protection
	Transient overcurrent protection	The drive stops when the transient current exceeds 250% of the rated output current.
	Overvoltage protection	The drive stops when the DC voltage of the main circuit is higher than 820 V.
	Undervoltage	The drive stops when the DC voltage of the main circuit is lower than 350 V.
	Overheating protection	Protection triggered when the inverter bridge overheats.
	Overload protection	The drive stops after running at 150% of the rated current for 60s.
	Overcurrent protection	The drive stops when the current exceeds 2.5 times rated current.
	Braking protection	Braking transistor working overtime Regenerative resistor short circuit protection
	Short circuit protection	Output phase-to-phase short circuit protection Output phase-to-ground short circuit protection

Item		Specification
Environment	Operating location	Indoor, free from direct sunlight, dust, corrosive gas, flammable gas, oil mist, water vapor, drip, or salt.
	Altitude	Below 1000 m (de-rated by 1% for each 100 m higher if the altitude is above 1000 m) Max. altitude: 3000 m
	Ambient temperature	-10°C to +40°C (de-rated by 1.5% for each 1°C higher if the ambient temperature is above 40°C) Max. temperature: 50°C
	Humidity	Less than 95%RH, non-condensing
	Vibration	Less than 5.9 m/s^2 (1 g)
	Storage temperature	-20°C to +60°C

8.2 Outline and Dimensions of the Servo Drive

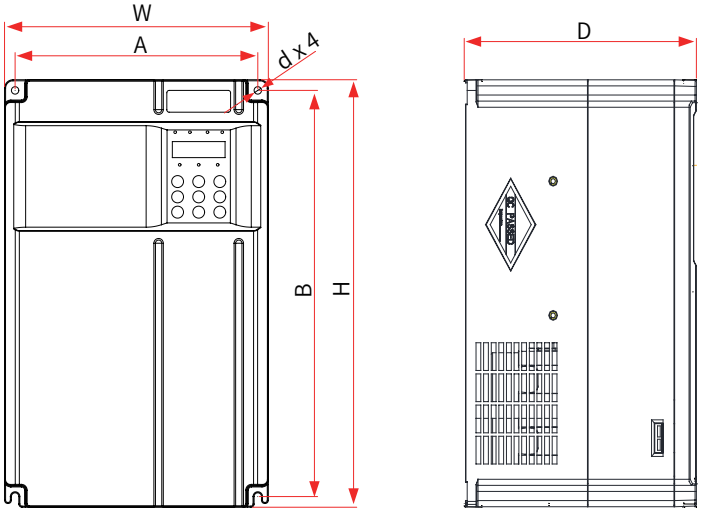


Figure 8-1 Overall and mounting dimensions of the ES510

Table 8-3 Overall and mounting hole dimensions of the ES510

Model	Mounting Hole (mm)		Overall Dimensions (mm)			Mounting Hole Diameter (mm)	Weight (kg)
	A	B	H	W	D	d	
ES510T009-C1, ES510T009-R1	119	189	200	130	162	Ø5	2.0
ES510T013-C1, ES510T013-R1							2.2
ES510T017-C1, ES510T017-R1	128	238	250	140	170	Ø6	3.3
ES510T025-C1, ES510T025-R1	166	266	280	180	170	Ø6	4.5
ES510T032-C1, ES510T032-R1							4.7
ES510T037-C1, ES510T037-R1							4.8

8.3 List of Options

Peripheral options include the braking unit, various extension cards, and external operating panel, as listed in the following table. For details about their usage, see the instructions of each option. If any optional part is required, specify it in your order.

Table 8-4 Options of the ES510

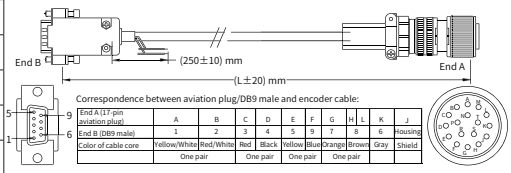
Component	Model	Function	Remarks
Built-in braking unit	-	Standard built-in braking unit	-
RS485 communication card	MD38TX1	Supports Modbus communication card with photocoupler isolation	Available for all models
CANopen communication extension card	MD38CAN1	Supports CANopen communication	Available for all models
Multi-functional PG card	MD38PGMD	Supports differential input, collector input, push-pull input, differential output, and collector output.	Available for all models
Resolver PG card	S58-PG-B1	For use with a resolver that has an excitation frequency of 10 kHz. The card has a DB9 interface.	Available for all models
23-bit PG card	ES510-PG-CT1	For use with Weton 23-bit encoder. The card has a DB9 interface.	Available for all models
LED operating panel	MD32NKE1	LED display and operating panel	Available for MD series Provides RJ45 interface

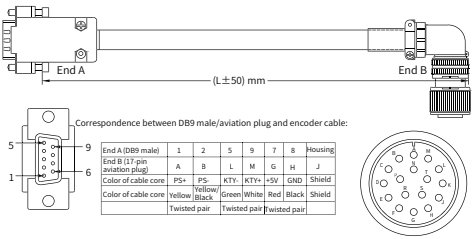
Component	Model	Function	Remarks
External LCD operating panel	SOP-20-810	External LCD display and operating panel	It can be used to copy and modify parameters.
Extension cable	MDCAB	Standard 8-core cable Connected to MD32NKE1, MD32KC, MDCP, or SOP-20-810	Standard length: 3 m
Through hole mounting bracket	MD500-AZJ-A1T*	Meets the requirements of middle through hole mounting	Each model has corresponding mounting bracket. For details, see "Table 3-1 List of bracket models used for through hole mounting" on page 29.
Cable fixation bracket	MD500-AZJ-A2T*	Meets the requirements of secondary fixation of power cables and 360 degree grounding of the shield	Each model has its own bracket. For details, see "Table 3-1 List of bracket models used for through hole mounting" on page 29.

Table 8-5 List of the motor, drive, cable, and PG card

Model or Series of the Servo Motor	Base	Drive	Resolver Cable (** Indicates Cable Length)	PG Card
ESMG1-XXXXXXX-R1A1FA	100	ES510TXXX-R1	S58-L-P31-**	S58-PG-B1
ESMG1-XXXXXXX-A3A1FA	100	ES510TXXX-C1	S58-P10-**	ES510-PG-CT1

Table 8-6 Encoder cables

Cable Name	Cable Model	Cable Length (m)	Cable Appearance
Resolver cables for the ES510 with aviation plug	S58-L-P31-3.0	3	
	S58-L-P31-6.0	6	
	S58-L-P31-8.0	8	
	S58-L-P31-12.0	12	
	S58-L-P31-15.0	15	
	S58-L-P31-20.0	20	
	S58-L-P31-25.0	25	

Cable Name	Cable Model	Cable Length (m)	Cable Appearance
23-bit encoder cables for the ES510 with aviation plug	S58-P10-3.0	3	
	S58-P10-6.0	6	
	S58-P10-7.0	7	
	S58-P10-8.0	8	
	S58-P10-12.0	12	
	S58-P10-15.0	15	
	S58-P10-25.0	25	

End A (DB9 male)	1	2	5	9	7	8	Housing
End B (17-pin aviation plug)	A	B	L	M	G	H	J
Color of cable core	PS+	PS-	KTY-	KTY+	+5V	GND	Shield
Color of cable core	Yellow	Yellow/ Black	Green	White	Red	Black	Shield
	Twisted pair		Twisted pair		Twisted pair		

8.4 Selection of the Cable, Circuit Breaker and Contactor

Table 8-7 Selection of peripheral electrical devices for the ES510

Model	Recommended Input IEC Cable (mm^2) [1]	Recommended IEC Ground Cable (mm^2)	Recommended Output IEC Cable (mm^2)	Terminal Width (mm)	Screw Specification	Recommended Fuse Bussmann (Pass UL Certification)		Recommended Contactor Specification	Recommended Circuit Breaker Specification
						Rated Current (A)	Model	Rated Current (A)	Rated Current (A)
ES510T009-C1, ES510T009-R1	3 x 1.5	TNR2-4	2.5	10.2	M4	20	FWP-20B	16	16
ES510T013-C1, ES510T013-R1	3 x 2.5			10.2	M4	30	FWP-30B	26	25
ES510T017-C1, ES510T017-R1	3 x 4	TNR3.5-5	4	13.0	M5	40	FWP-40B	26	32
ES510T025-C1, ES510T025-R1	3 x 10	TNR8-5	10	13.0	M5	60	FWP-60B	38	50
ES510T032-C1, ES510T032-R1				14.3	M5	70	FWH-70B	50	63
ES510T037-C1, ES510T037-R1				15.0	M5	80	FWH-80B	65	63

[1] Compliant with Chinese standard. "3 x 10" indicates a three-core cable, and "2 x (3 x 95)" indicates two 3-core cables.

■ Recommended cable lug (Suzhou Yuanli Metal Enterprise Co., Ltd)

GTNR series TNR series BC series

Figure 8-2 Cable lugs

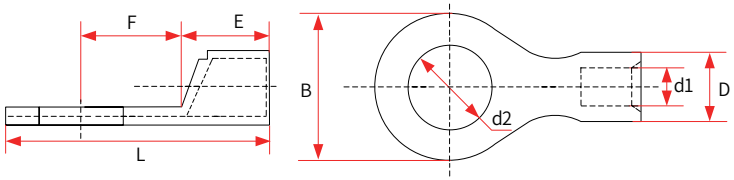


Figure 8-3 Dimensions of the TNR series cable lug

Table 8-8 Model and size of the TNR series cable lug

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

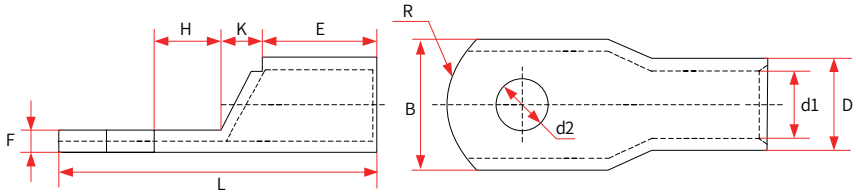


Figure 8-4 Dimensions of the GTNR series cable lug

Table 8-9 Model and size of the GTNR series cable lug (unit: mm)

Model	D	d1	E	H	K	B	d2	F	L	R	Crimping Tool
GTNR1.5-5	4.0	2.2	5.0	5.0	2.0	8.0	5.3	1.0	16.0	5	RYO-8 YYT-8 RYO-14
GTNR2.5-4	4.5	2.9	7.0	5.0	2.0	8.0	4.3	1.0	18.0		
GTNR2.5-5				6.0			5.3		20.0	7	
GTNR2.5-6						10.2	6.4	0.8			
GTNR4-5	5.2	3.6	7.0	6.0	2.0	10.0	5.3	1.0	20.0		
GTNR4-6							6.4				
GTNR6-5	6.0	4.2	9.0	6.0	3.0	10.0	5.3	1.2	23.0		
GTNR6-6				7.5			6.4		26.0		
GTNR6-8						12.0	8.4	1.0			
GTNR10-6	7.0	5.0	9.0	8.0	3.5	12.4	6.4	1.3	26.5		
GTNR10-8							8.4		27.5		
GTNR16-6	7.8	5.8	12.0	8.0	4.0	12.4	6.4	1.3	31.0		CT-38 CT-100
GTNR16-8							8.4				

■ RCD selection

1) Each the earth leakage current of the servo drive is greater than 3.5 mA. Therefore, the servo drive must be grounded.
2) The servo drive generates DC leakage current inside protective conductors. Therefore, a type B RCD (time-delayed) must be used.
3) Use a time-delay RCD to reduce the carrier frequency of the servo drive.
4) Replace a RCD with higher rated operating current if the RCD malfunctions.
5) Shorten the length of the motor drive cable.
6) Take more leakage current suppression measures.
7) Recommended RCD manufacturers are CHINT and Schneider.

8.5 Selection of the AC Input Reactor

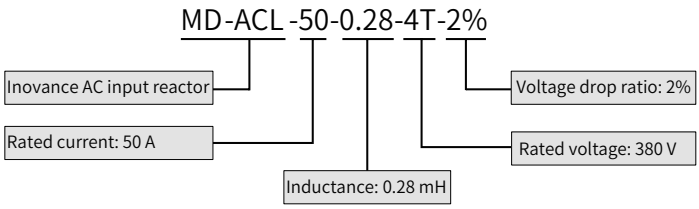
The AC input reactor is an option used to suppress the harmonics in the input current. In applications where strong suppression of harmonics is required, install an external AC input reactor. The following table lists the recommended manufacturer and models of the AC input reactor.

1) Recommended AC input reactor models

Table 8-10 Recommended AC input reactor models

Drive Model	AC Input Reactor Model (Inovance)
ES510T009-C1, ES510T009-R1	MD-ACL-15-3-4T
ES510T013-C1, ES510T013-R1	MD-ACL-15-3-4T
ES510T017-C1, ES510T017-R1	MD-ACL-40-1.45-4T
ES510T025-C1, ES510T025-R1	MD-ACL-40-1.45-4T
ES510T032-C1, ES510T032-R1	MD-ACL-50-1.2-4T
ES510T037-C1, ES510T037-R1	MD-ACL-50-0.28-4T-2%

2) Model number of the AC input reactor



3) Overall dimensions of the AC input reactor

■ Dimensions of 10/15 A AC input reactor

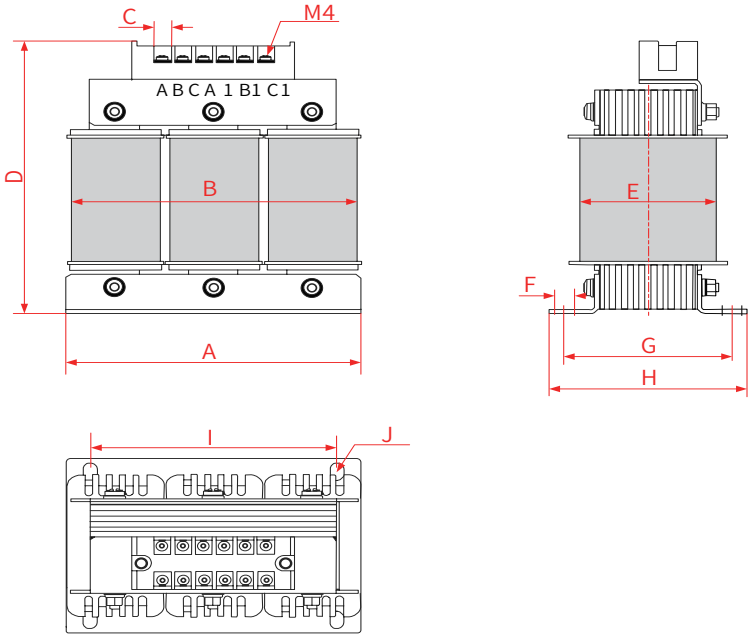


Figure 8-5 Dimension diagram of 10/15 A AC input reactor

Table 8-11 Dimensions of 10/15 A AC input reactor (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	Φ7*10
15	150 ± 2	155	8	160	80	10	85 ± 2	100 ± 2	125 ± 1	Φ7*10

■ Dimensions of 40/50 A (1.2 mH) AC input reactor

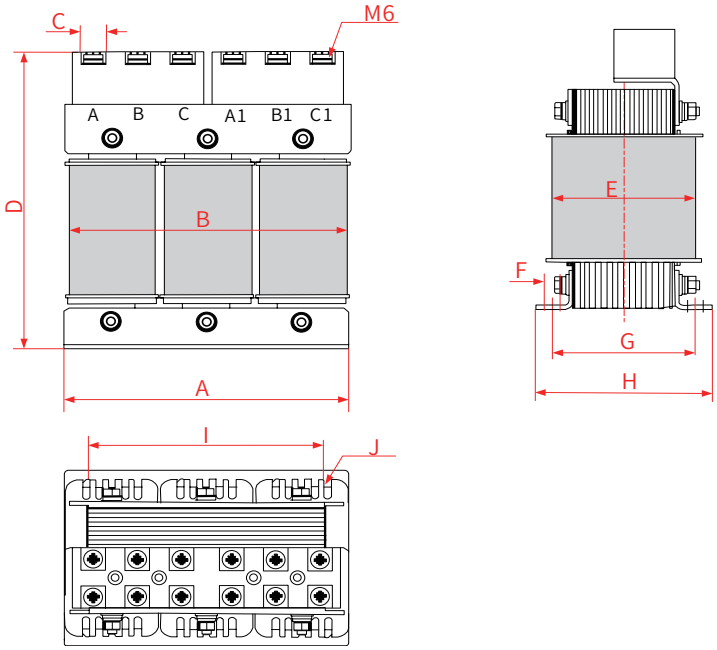


Figure 8-6 Dimension diagram of 40/50 A(1.2 mH) AC input reactor

Table 8-12 Dimensions of 40/50 A (1.2 mH) AC input reactor (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	Φ7*10
50	200 ± 2	210	16	230	110	10	115 ± 2	130 ± 2	170 ± 1	Φ7*10

■ Dimensions of 50 A (0.28 mH) AC input reactor

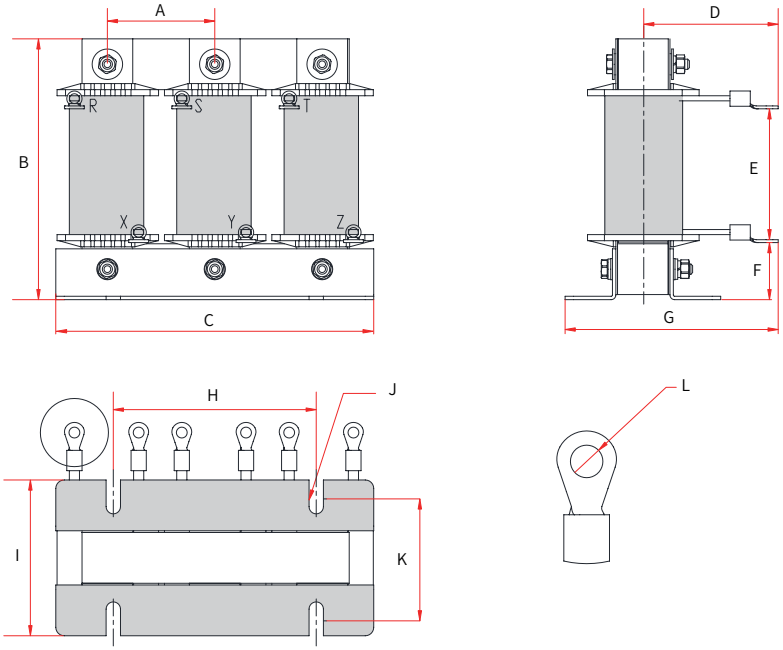


Figure 8-7 Dimension diagram of 50 A (0.28 mH) AC input reactor

Table 8-13 Dimensions of 50 A (0.28 mH) AC input reactor

Rated Current (A)	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	I (mm)	J (mm)	K (mm)	L (mm)
50	64	160	195	80 ± 10	75 ± 5	35 ± 5	135	120 ± 1	92 ± 2	Φ8.5*20	72 ± 2	Φ6.4

NOTE

- The preceding figure is a typical connection diagram of peripheral devices and cannot be used as a guide for peripheral device selection.
- The dimensions of the AC input reactor provided here are for reference only. The actual dimensions are subject to the real product.

8.6 Selection of the EMC Filter

8.6.1 Standard EMC Filter

The following filters meet the emission requirements of category C2 specified in the EN 61800-3 standard. The filter must be grounded securely and the cable between the filter and the servo drive must be less than 30 cm. For the cable selection, see *"Table 8-7 Selection of peripheral electrical devices for the ES510" on page 108*.

1) Appearance

Schaffner FN3258 series filter

Schaffner FN3359 series filter

Jianli EBK5 series filter

Figure 8-8 Appearance of standard EMC filter

NOTE

- The cable between the filter and the servo drive must be as short as possible (within 30 cm). Make sure to connect the filter and the servo drive to the same grounding reference surface to enable reliable grounding of the filter. Otherwise, desired filtering effect will not be achieved.

2) Recommended EMC filter models

Schaffner and Jianli filters are recommended, as listed in the following table.

Table 8-14 Recommended manufacturers and models of the EMC input filter

Drive Model	AC Input Filter Model (Schaffner)	AC Input Filter Model (Changzhou Jianli)
ES510T009-C1, ES510T009-R1	FN3258-16-33	DL-16EBK5
ES510T013-C1, ES510T013-R1	FN3258-30-33	DL-25EBK5
ES510T017-C1, ES510T017-R1	FN3258-30-33	DL-25EBK5
ES510T025-C1, ES510T025-R1	FN3258-42-33	DL-35EBK5
ES510T032-C1, ES510T032-R1	FN3258-42-33	DL-50EBK5
ES510T037-C1, ES510T037-R1	FN3258-55-34	DL-50EBK5

3) Mounting dimensions

■ Dimensions of Schaffner FN3258 series 7-55 A filter

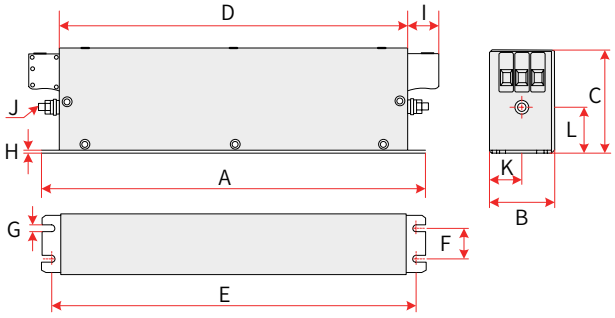


Figure 8-9 Dimension diagram of Schaffner FN3258 series 7-55A filter (unit: mm)

Table 8-15 Dimensions of Schaffner FN3258 series 7-55A filter (mm)

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

8.6.2 Simple EMC Input Filter

The simple EMC input filter can efficiently suppress the field interference and the interference generated by the servo drive during running.

Ground the simple EMC input filter securely and ensure that the cable between the filter and the servo drive is less than 30 cm.

Table 8-16 Recommended simple EMC input filter models

Drive Model	Simple EMC AC Input Filter Model
ES510T009-C1, ES510T009-R1	DL-35EB1/10
ES510T013-C1, ES510T013-R1	
ES510T017-C1, ES510T017-R1	
ES510T025-C1, ES510T025-R1	DL65EB1/10
ES510T032-C1, ES510T032-R1	
ES510T037-C1, ES510T037-R1	

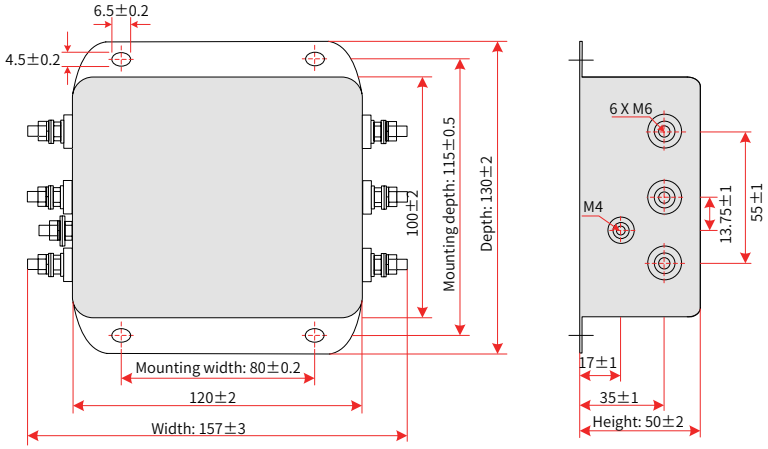


Figure 8-10 Mounting dimensions of the simple EMC filter (unit: mm)

Table 8-17 Overall and mounting dimensions of the simple EMC filter

Filter Model	Overall Dimensions (Width x Depth x Height, unit: mm)	Mounting Dimensions (Width x Depth) (unit: mm)
DL-15EB1/10	157 × 130 × 50	80 × 115
DL-35EB1/10	218 × 140 × 80	184 × 112
DL-65EB1/10	218 × 140 × 80	184 × 112

8.7 Selection of Braking Components

When an external braking unit is used, the cables between the servo drive and the braking unit cannot be too long (recommended length: less than 3 m) because an over-long cable will cause large stray inductance and therefore voltage spike. Additionally, fix the cables with cable ties to ensure cabling in parallel.

Table 8-18 Selection of braking components for the ES510

Drive Model	Drive Power (kW)	Braking Unit	Recommended Regenerative Resistor Power (W)	Recommended Braking Resistance (Ω)	Min. Braking Resistance (Ω)
ES510T009-C1, ES510T009-R1	3.7	Standard: built-in braking unit	800	⩾ 50	39
ES510T013-C1, ES510T013-R1	5.5				
ES510T017-C1, ES510T017-R1	7.5				
ES510T025-C1, ES510T025-R1	11		1500	⩾ 32	28
ES510T032-C1, ES510T032-R1	15				20
ES510T037-C1, ES510T037-R1	18.5		2500	⩾ 22	
Note: Increase the power or improve the heat dissipation of the regenerative resistor when the regenerative resistor overheats.					

NOTE

- The braking voltage of the built-in braking unit is 760 V (F9-08) by default, which is applicable to 380 V power system. If the drive is used in a 480 V power system and the regenerative resistor overheats severely, increase the braking voltage in F9-08 (recommended: 760–780 V) to avoid premature running of the braking transistor.
- The data in Table 8-18 is for reference only. You can select the resistance and power of the regenerative resistor as required. It should be noted that the braking resistance cannot be lower than the recommended minimum value, but the power can exceed the recommended value. The regenerative resistor model depends on the generation power of the motor in the actual system and is also related to system inertia, deceleration time, and potential energy load. Select a proper regenerative resistor as required. Larger system inertia requires shorter deceleration time and more frequent braking. In this case, you need to select a regenerative resistor with larger power and smaller resistance.

8.8 Selection of the AC Output Reactor (du/dt filter)

Whether to install an AC output reactor (du/dt filter) on the servo drive output side is dependent on the actual situation. The cables between the servo drive and the motor cannot be too long because an over-long cable will cause large distributed capacitance and therefore high reflect voltage on motor terminal.

Install an AC output reactor when the cables are too long. When the cable length is equal to or greater than the value shown in the following table, install an AC output reactor (du/dt filter) on the servo drive output side.

8.8.1 Recommended Models (Inovance)

Table 8-19 Min. cable length when an AC output reactor is recommended

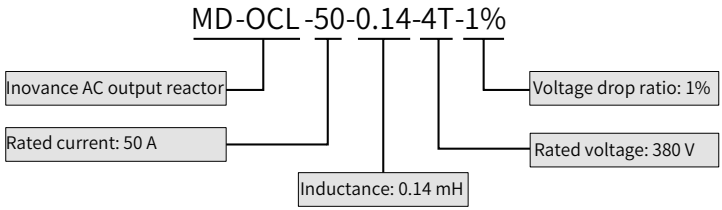
Power (kW)	Rated Voltage (V)	Min. Cable Length when an AC Output Reactor is Recommended (Unit: m)
3.7	200–500	60
5.5	200–500	70
7.5	200–500	100
11	200–500	110
15	200–500	125
18.5	200–500	135

1) Recommended AC output reactor models

Table 8-20 Recommended manufacturer and models of the AC output reactor

Drive Model	AC Output Reactor Model (Inovance)
ES510T009-C1, ES510T009-R1	MD-OCL-10-0.7-4T-1%
ES510T013-C1, ES510T013-R1	MD-OCL-15-0.47-4T-1%
ES510T017-C1, ES510T017-R1	MD-OCL-20-0.35-4T-1%
ES510T025-C1, ES510T025-R1	MD-OCL-30-0.23-4T-1%
ES510T032-C1、ES510T032-R1	MD-OCL-40-0.18-4T-1%
ES510T037-C1, ES510T037-R1	MD-OCL-50-0.14-4T-1%

2) Model number of the AC output reactor



3) Dimensions of the AC output reactor

■ Dimensions of 5–10 A AC output reactor

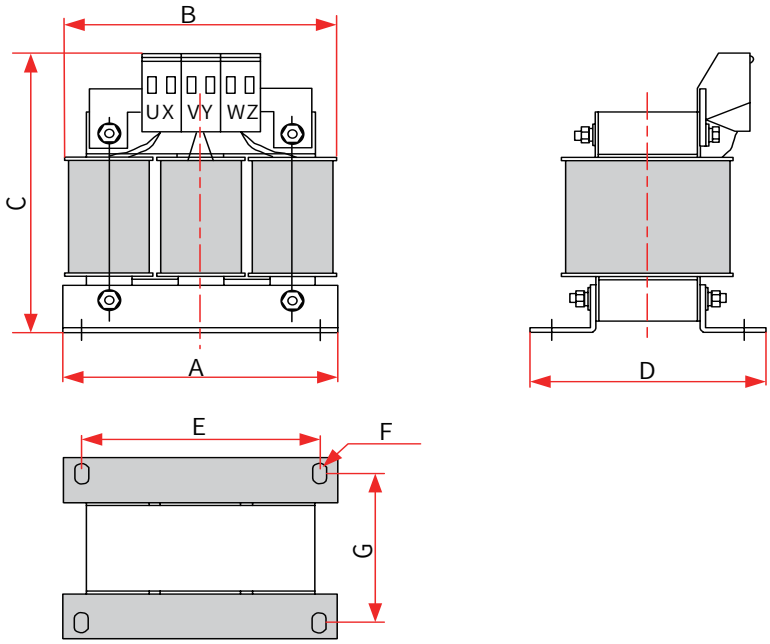


Figure 8-11 Dimension diagram of 5–10 A AC output reactor

Table 8-21 Dimensions of 5–10 A AC output reactor (unit: mm)

Rated Current (A)	A	B	C	D	E	F	G
5	105 ± 1	110	130	84 ± 2	91 ± 1	Φ6*11	65 ± 2
7	105 ± 1	110	130	84 ± 2	91 ± 1	Φ6*11	65 ± 2
10	105 ± 1	110	130	84 ± 2	91 ± 1	Φ6*11	65 ± 2

■ Dimensions of 15 A AC output reactor

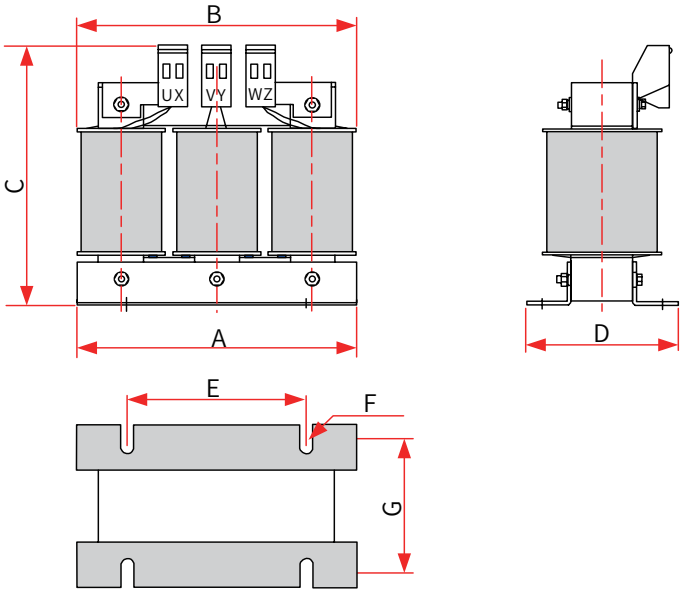


Figure 8-12 Dimension diagram of 15 A AC output reactor

Table 8-22 Dimensions of 15 A AC output reactor (unit: mm)

Rated Current (A)	A	B	C	D	E	F	G
15	148 ± 1	155	140	76 ± 2	95 ± 1	Φ6*15	61 ± 2

■ Dimensions of 20 A AC output reactor

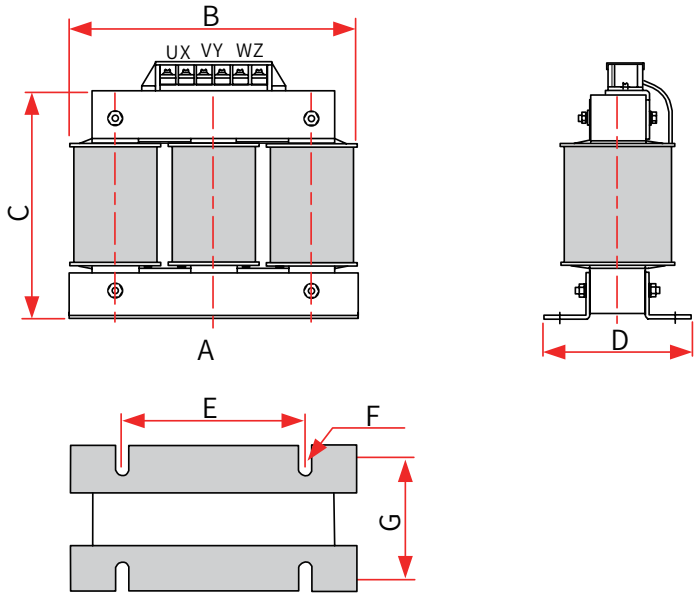


Figure 8-13 Dimension diagram of 20 A AC output reactor

Table 8-23 Dimensions of 20 A AC output reactor (unit: mm)

Rated Current (A)	A	B	C	D	E	F	G
20	148 ± 1	155	165	76 ± 2	95 ± 1	Φ6*15	61 ± 2

■ Dimensions of 30-50 A AC output reactor

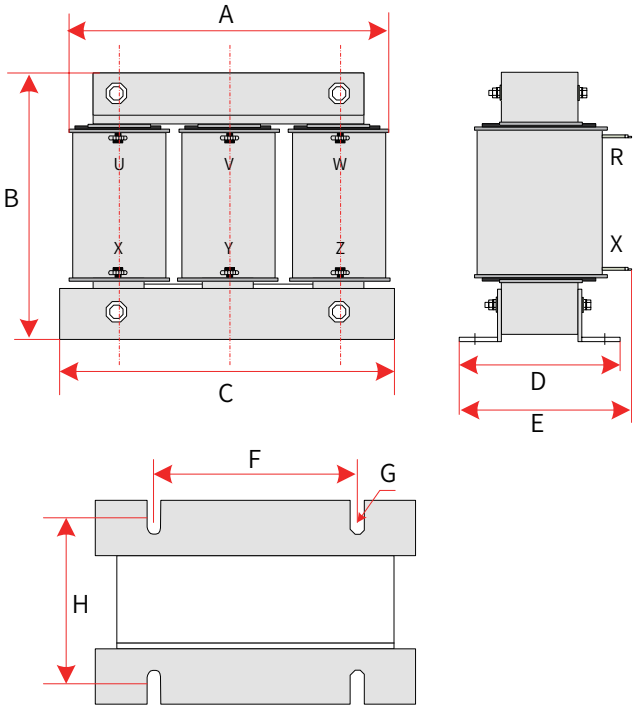


Figure 8-14 Dimension diagram of 30-50 A AC output reactor

Table 8-24 Dimensions of 30-50 A AC output reactor (unit: mm)

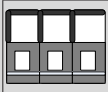
Rated Current (A)	A	B	C	D	E	F	G	H
30	155	130	148 ± 1	95 ± 2	135	95 ± 1	Φ6*15	80 ± 2
40	155	130	148 ± 1	95 ± 2	135	9 5 ± 1	Φ6*15	80 ± 2
50	155	130	148 ± 1	95 ± 2	135	95 ± 1	Φ6*15	80 ± 2

NOTE

◆ The dimensions of the reactor provided here are for reference only. The actual dimensions are subject to the real product.

8.8.2 Recommended Models (Schaffner)

Table 8-25 Recommended AC output reactor models (Schaffner)

Drive Model	Reactor	Rated Current at 40°C (A)	Rated Power of Standard Motor (kW)	Rated Inductance (mH)	Power Consumption (W)	I/O Terminal			Total (kg)
									
ES510T009-C1, ES510T009-R1	RWK 305-10-KL	10	3.7	0.588	30	KL	-	-	1.8
ES510T013-C1, ES510T013-R1	RWK 305-14-KL	13	5.5	0.42	34	KL	-	-	2.2
ES510T017-C1, ES510T017-R1	RWK 305-17-KL	17	7.5	0.364	38	KL	-	-	2.5
ES510T025-C1, ES510T025-R1	RWK 305-32-KL	32	11	0.184	55	KL	-	-	3.9
ES510T032-C1, ES510T032-R1	RWK 305-32-KL	32	15	0.184	55	KL	-	-	3.9
ES510T037-C1, ES510T037-R1	RWK 305-45-KL	45	18.5	0.131	60	KL	-	-	6.1

1) Appearance and mounting dimensions of the AC output reactor

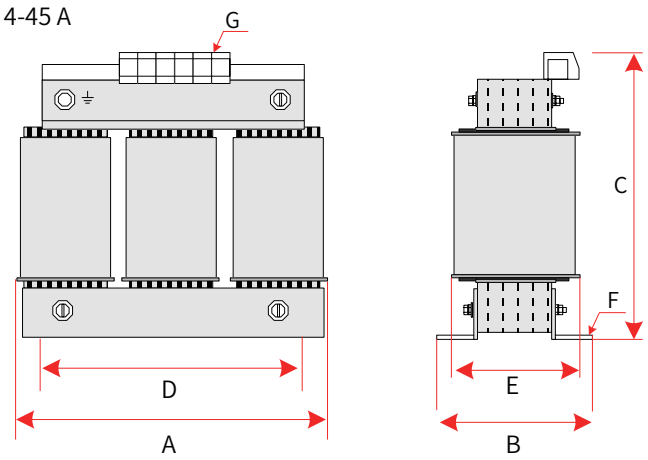


Figure 8-15 Dimension diagram of the AC output reactor

Table 8-26 Mounting dimensions of the AC output reactor (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 × 9	2.5 mm^2
10 A	100	max.70	max.115	56	43	4.8 × 9	2.5 mm^2
14 A	125	max.70	mx.135	100	45	5 × 8	2.5 mm^2
17 A	125	max.75	max.135	100	55	5 × 8	2.5 mm^2

Series	A	B	C	D	E	F	G
24 A	125	max.75	max.135	100	55	5 × 8	4 mm^2
32 A	155	max.95	max.170	130	56	8 × 12	10 mm^2
45 A	155	max.110	max.190	130	72	8 × 12	10 mm^2

8.9 Selection of the Output Ferrite Core

The output ferrite core is used to reduce the bearing current and the interference on surrounding devices. Install an output ferrite core on the servo drive output side (close to the servo drive), as shown in the following figure.

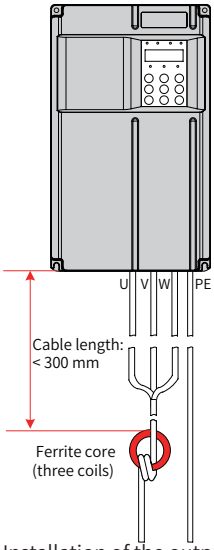


Figure 8-16 Installation of the output ferrite core

Figure 8-17 Appearance of the output ferrite core

Table 8-27 Models of the output ferrite core

Model	Product Code	Dimensions (Outer Diameter x Inner Diameter x Thickness) (unit: mm)
DY644020H	11013031	64 × 40 × 20
DY805020H	11013032	80 × 50 × 20
DY1207030H	11013033	120 × 70 × 30

8.10 Selection of Compatible Motors

Table 8-28 Models of compatible motors

Drive Model	Power Capacity (kVA)	Input Current (A)	Output Current (A)	Compatible Motor Power (kW)	Thermal Power (kW)
ES510T009-C1, ES510T009-R1	12	10.9	9.0	3.7	0.138
ES510T013-C1, ES510T013-R1	17.5	15.8	13.0	5.5	0.201
ES510T017-C1, ES510T017-R1	22.8	20.6	17.0	7.5	0.240
ES510T025-C1, ES510T025-R1	33.4	30.2	25.0	11	0.355
ES510T032-C1, ES510T032-R1	42.8	38.7	32.0	15	0.454
ES510T037-C1, ES510T037-R1	45	44.6	37.0	18.5	0.478

8.11 Panel Dimensions

1) LED operating panel

MD32NKE1 is the external operating panel with LED display used for the ES510. It is operated in the same way as the built-in operating panel and is more convenient for customers to use. The dimensions of MD32NKE1 is as follows.

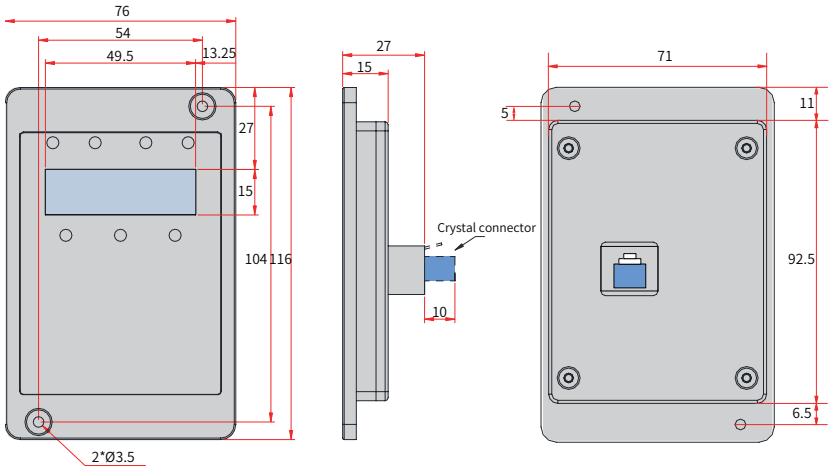


Figure 8-18 Dimensions of the external MD32NKE1 operating panel

2) External LCD operating panel

SOP-20-810 is the external operating panel with LCD display used for the ES510. You can use it to implement parameter copy, parameter modification, and programming. The appearance and dimensions of SOP-20-810 are shown as follows.

Figure 8-19 Overall dimensions of SOP-20-810 (unit: mm)

9 Selection and Use of the Servo Motor

9.1 Model Number

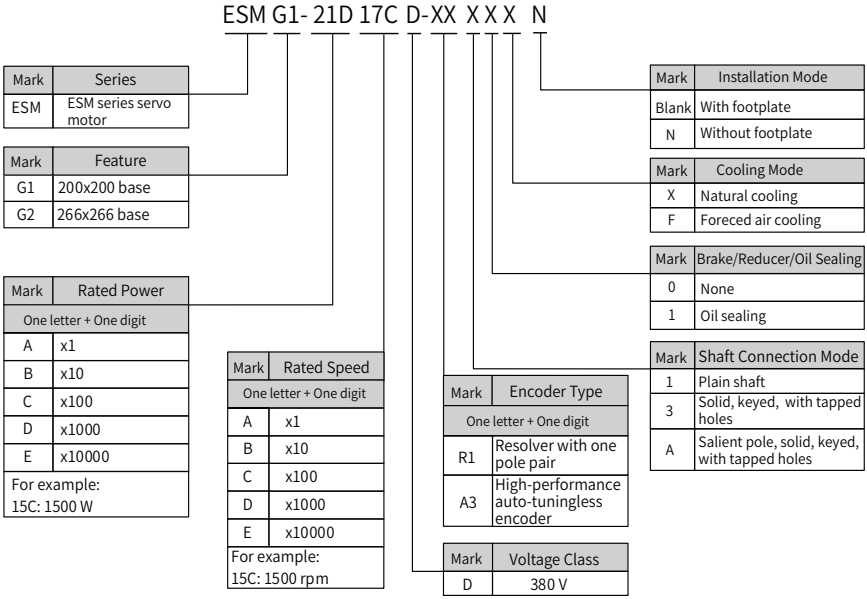


Figure 9-1 Model number of the ESMG series servo motor

NOTE

- Motor duty cycles describe the load supported by the motor. It specifies the duration time and sequence of the following periods: starting period, electric braking period, no-load period, and rest period.
- S1 duty (IEC 60034-1 standard) is continuous duty, in which the motor runs at a constant load for sufficient time to enable the motor to reach thermal equilibrium.
- S4 duty (IEC 60034-1 standard) is intermittent periodic duty with starting, in which the motor runs in a series of identical duty cycles, with each cycle including a significant starting time, a constant load period, and a rest period.

9.2 Selection of the ESMG1 Series Servo Motor

■ Technical specifications

Model: ESMG1-XXXXXXX-XXA1F			67C17CD	89C17CD	13D17CD	17D17CD	21D17CD	27D17CD
Rated speed	n_N	rpm	1700					
Rated frequency	f_N	Hz	113.33					
Voltage class	U_N	V	380					
Rated power	P_N	kW	6.7	8.9	13.4	16.4	20.5	26.7
Rated torque	T_N	N·m	37.5	50	75	92	115	150
Rated current	I_N	A	11.5	15.3	24.1	29.5	35.1	48.2
Rated efficiency	η	%	93.8%	94.2%	94.8%	95.2%	95.4%	95.7%
Peak torque at rated speed	T_{max}	N·m	86	123	170	225	263	373
Peak current at rated speed	I_{max}	A	30.2	43.30	58.30	80.50	88.60	124.10
Angular acceleration at peak torque	a_{pk}	rad/s^2	14333	16400	18889	21429	21917	24867
Max. speed	nmax	rpm	2500					
Peak torque at max. speed	Tmax	N·m	56	80	110	145	172	212
Peak current at max. speed	Imax	A	25.6	36.2	49.4	66	76.4	90.4
Torque at low speed	T_N=0	N·m	47	63	94	115	144	188
Current at low speed	I_N=0	N·m	14	19	30	37	44	60
Number of magnetic poles	2P	-	8					
D-axis inductance	L_d	mH	16.55	11	7.48	5.99	5.5	3.74
Q-axis inductance	L_q	mH	32.4	21.5	14.63	11.7	10.75	7.31
Phase resistance at 20°C	R_{phi}	mΩ	826.7	480	282.8	200.35	171.9	108.1
Torque constant at 20°C	K_T	N·m/A	3.60	3.60	3.43	3.43	3.60	3.43
Temperature coefficient of back EMF	dK_e/dT	%/°C	-0.09					
Rotor inertia	J_m	mkg·m^2	6	7.5	9	10.5	12	15
Insulation class	-	-	CLASS-F					
Cooling	-	-	IC 416					
IP rating	-	-	IP 54					
Mounting	-	-	IM B35					
Max. shock on motor	S	m/s^2	200					
Max. vibration (radial)	V_r	m/s^2	200					
Max. vibration (axial)	V_a	m/s^2	50	45	40	35	30	20
Insulation resistance at 500 VDC	R_{ins}	MΩ	⩾ 20 MΩ					
Withstanding voltage (1 min)	-	-	1800 VAC					
Net weight	G.W	kg	37.2	45.2	51.9	59	66	79.8
Fan type	-	-	Single-phase capacitor-run centrifugal fan					

Model：ESMG1-XXXXXXX-XXA1F				67C17CD	89C17CD	13D17CD	17D17CD	21D17CD	27D17CD
Fan power		-	W	41					
Fan voltage		-	VAC	220/230					
Fan frequency		-	-	50/60					
Threshold of built-in PTC		PTCt	ºC	130					
KTY resistance (10ºC to 30ºC)		R-KTY	Ω	514-652					
Operating ambient temperature		-	ºC	-20ºC to +40ºC (no freezing)					
Operating ambient humidity		-	-	20%RH to 90%RH (no condensation)					
Storage temperature		-	ºC	-20ºC to +60ºC (no freezing)					
Storage humidity		-	-	20%RH to 90%RH (no condensation)					
Altitude		-	-	Below 1000 m, derating is required when the altitude is above 1000 m					
De-rating	Altitude	-	-	-	1000 m	2000 m	3000 m	4000 m	5000 m
	Correction factor	-	-	-	1	0.947	0.887	0.824	0.645
	Ambient temperature	-	-	-	40°C	45°C	50°C	55°C	60°C
	Correction factor	-	-	-	1	0.952	0.901	0.855	0.781

Model：ESMG1-XXXXXXX-XXA1F			79C20CD	11D20CD	15D20CD	19D20CD	25D20CD	31D20CD
Rated speed	n_N	rpm	2000					
Rated frequency	f_N	Hz	133.33					
Voltage class	U_N	V	380					
Rated power	P_N	kW	7.9	10.5	15.7	19.3	24.1	31.4
Rated torque	T_N	N·m	37.5	50	75	92	115	150
Rated current	I_N	A	13.8	17.5	26.2	33	40.2	52.4
Rated efficiency	η	%	93.4%	94.0%	94.4%	94.9%	95.2%	95.5%
Peak torque at rated speed	T_{max}	N·m	86	123	170	225	263	373
Peak current at rated speed	I_{max}	A	35.2	49.20	67.00	90.00	101.30	150.00
Angular acceleration at peak torque	a_{pk}	rad/s^2	14333	16400	18889	21429	21917	24867
Max. speed	nmax	rpm	2500					
Peak torque at max. speed	Tmax	N·m	70	97.9	131	170	195	285
Peak current at max. speed	Imax	A	31.8	43.6	60	79.2	87	130.3
Torque at low speed	T_N=0	N·m	47	63	94	115	144	188
Current at low speed	I_N=0	N·m	17	22	33	41	50	66
Number of magnetic poles	2P	-	8					
D-axis inductance	L_d	mH	11.5	5.95	4.74	3.46	2.98	2.37
Q-axis inductance	L_q	mH	22.5	9.63	7.67	5.61	4.82	3.84

Model：ESMG1-XXXXXXX-XXA1F				79C20CD	11D20CD	15D20CD	19D20CD	25D20CD	31D20CD
Phase resistance at 20°C		R_{phi}	mΩ	574.1	360.00	231.40	151.80	130.00	92.85
Torque constant at 20°C		K_T	N·m/A	3.00	3.08	3.08	3.00	3.08	3.08
Temperature coefficient of back EMF		dK_e/dT	%/°C	-0.09					
Rotor inertia		J_m	mkg·m^2	6	7.5	9	10.5	12	15
Insulation class		-	-	CLASS-F					
Cooling		-	-	IC 416					
IP rating		-	-	IP 54					
Mounting		-	-	IM B35					
Max. shock on motor		S	m/s^2	200					
Max. vibration (radial)		V_r	m/s^2	200					
Max. vibration (axial)		V_a	m/s^2	50	45	40	35	30	20
Insulation resistance at 500 VDC		R_{ins}	MΩ	⩾ 20 MΩ					
Withstanding voltage (1 min)		-	-	AC 1800 V					
Net weight		G.W	kg	37.2	45.2	51.9	59	66	79.8
Fan type		-	-	Single-phase capacitor-run centrifugal fan					
Fan power		-	W	41					
Fan voltage		-	VAC	220/230					
Fan frequency		-	-	50/60					
Threshold of built-in PTC		PTCt	°C	130					
KTY resistance (10°C to 30°C)		R-KTY	Ω	514-652					
Operating ambient temperature		-	°C	-20°C to +40°C (no freezing)					
Operating ambient humidity		-	-	20%RH to 90%RH (no condensation)					
Storage temperature		-	°C	-20°C to +60°C (no freezing)					
Storage humidity		-	-	20%RH to 90%RH (no condensation)					
Altitude		-	-	Below 1000 m, derating is required when the altitude is above 1000 m					
De-rating	Altitude	-	-	-	1000 m	2000 m	3000 m	4000 m	5000 m
	Correction factor	-	-	-	1	0.947	0.887	0.824	0.645
	Ambient temperature	-	-	-	40°C	45°C	50°C	55°C	60°C
	Correction factor	-	-	-	1	0.952	0.901	0.855	0.781

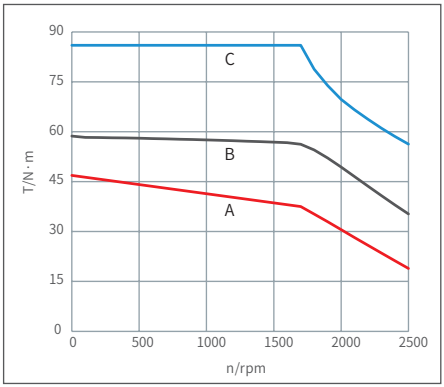
■ Motor curves

A Continuous working area

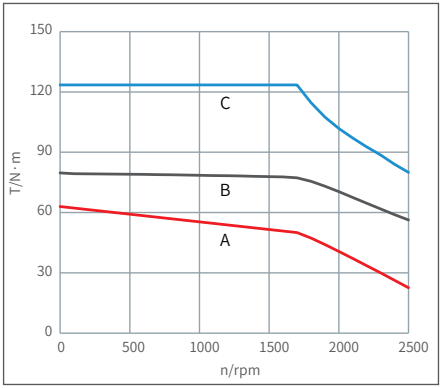
B 100 K temperature rise working area

C Short-term working area

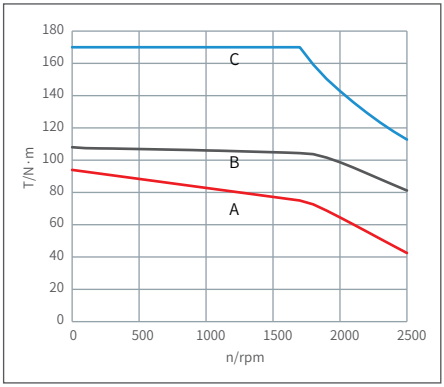
67C17CD



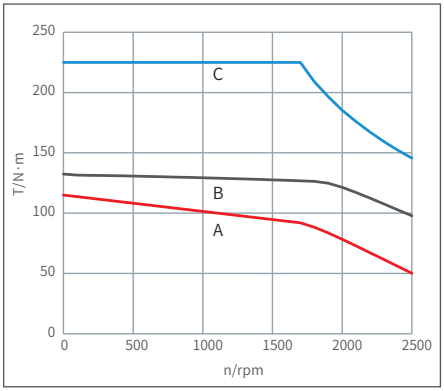
89C17CD



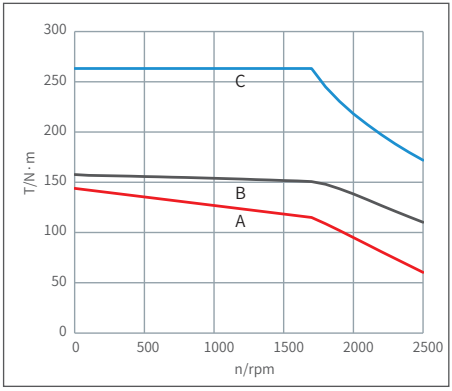
13D17CD



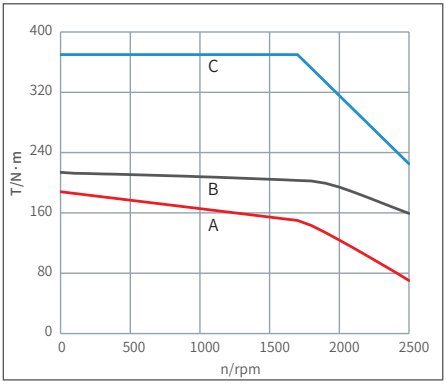
17D17CD



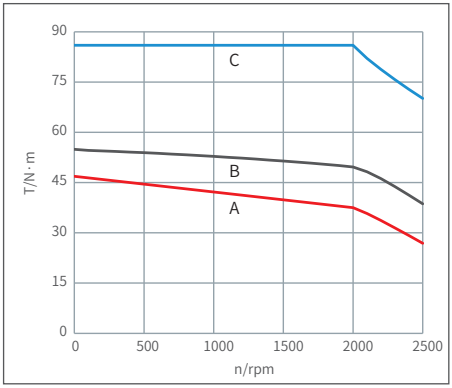
21D17CD



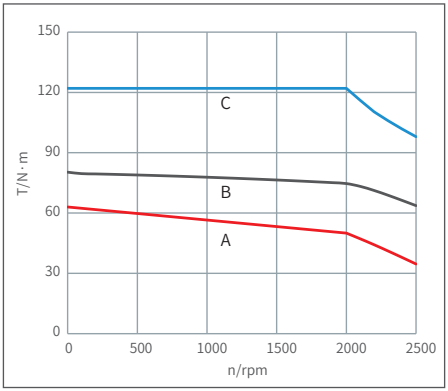
27D17CD



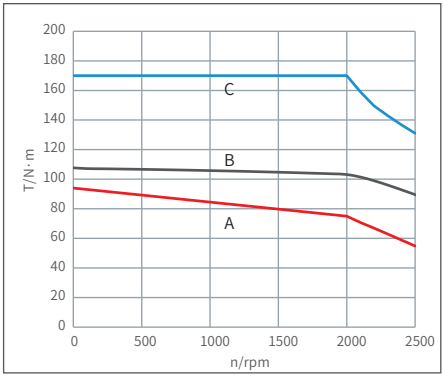
79C20CD



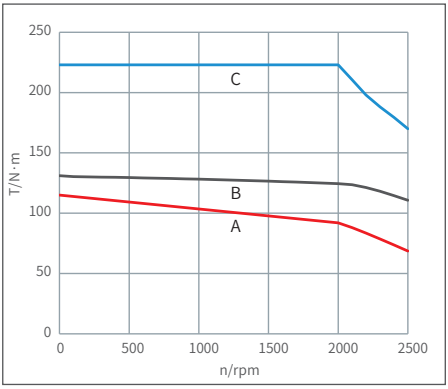
11D20CD



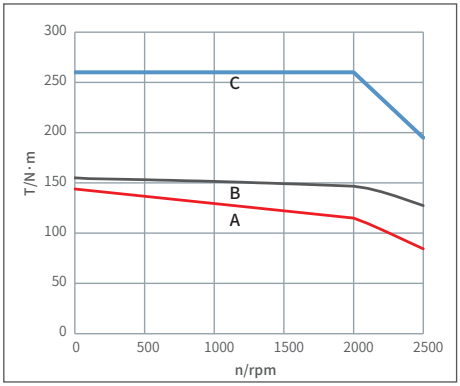
15D20CD



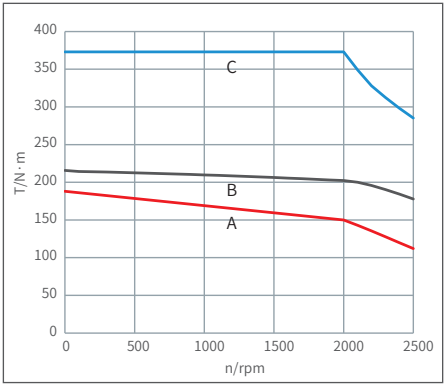
19D20CD



25D20CD

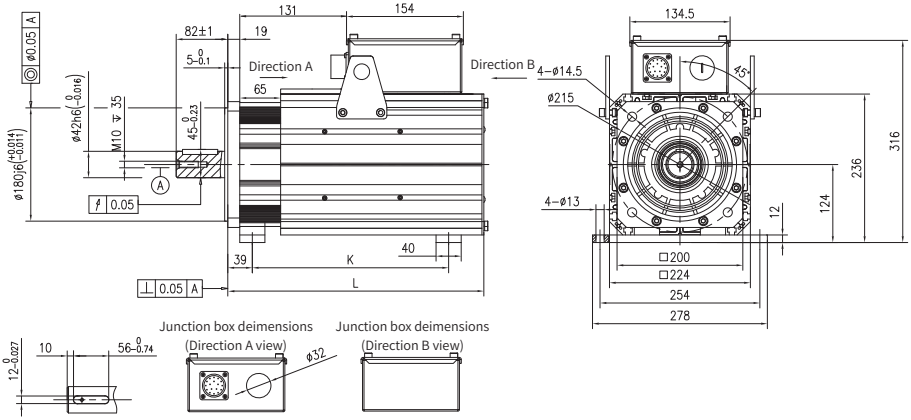


31D20CD



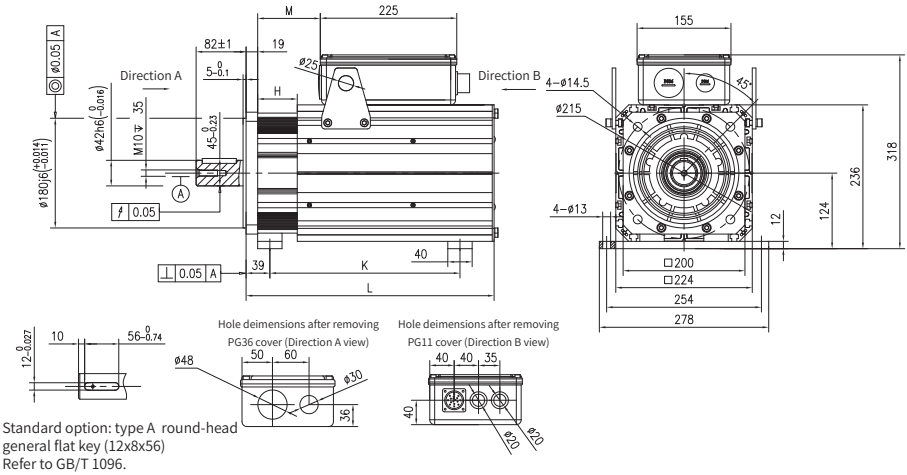
9.3 Outline and Dimensions of the ESMG1 Series Servo Motor

The following figure shows the dimensions of the ESMG1 series servo motor (200x200 base).



Standard option: type A round-head general flat key (12x8x56)
Refer to GB/T 1096.

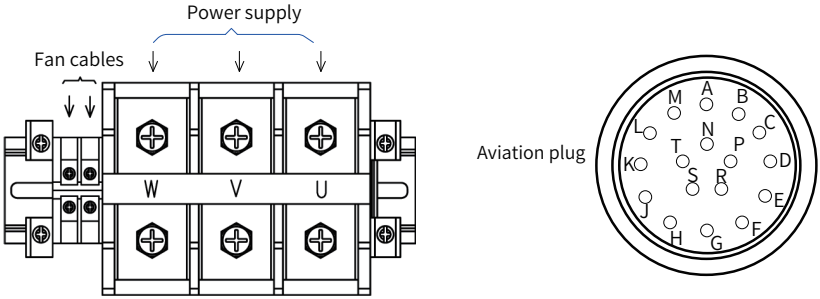
Model	L (mm)	K (mm)	Weighet (kg)
ESMG1-67C17CD-XXA1F	341	258	37.2
ESMG1-79C20CD-XXA1F			



Model	L (mm)	K (mm)	H (mm)	M (mm)	Weighet (kg)
ESMG1-89C17CD-XXA1F	375	285	65	74	45.2
ESMG1-11D20CD-XXA1F					
ESMG1-13D17CD-XXA1F	409	312	115	112	51.9
ESMG1-15D20CD-XXA1F					
ESMG1-17D17CD-XXA1F	444	354	115	147	59
ESMG1-19D20CD-XXA1F					
ESMG1-21D17CD-XXA1F	481	396	115	184	66
ESMG1-25D20CD-XXA1F					
ESMG1-27D17CD-XXA1F	552	471	115	254	79.8
ESMG1-31D20CD-XXA1F					

9.4 Wiring of the Servo Motor

9.4.1 Layout and Wiring of the Junction Box



Main circuit terminal diagram　　Aviation plug interface diagram

Figure 9-2 Wiring diagram of the junction box

Definition of the ES510 signal cables and the motor aviation plug signal cables (for reference only):

Aviation plug (17-pin)	A	B	C	D	E	F	G	H	L	K	J
D-type connector (9-pin)	1	2	3	4	5	9	7	8		6	Housing
Definition of signal	REF+	REF-	Cos+	Cos-	Sin+	Sin-	PTC+	KTY-	PTC-	KTY+	Shield
Color of the cable core	Yellow/ White	Red/ White	Red	Black	Yellow	Blue	Orange	Brown		Gray	Shield
Remarks	One pair		One pair		One pair			Common point of KTY and PTC			

9.4.2 Precautions for Using Motor Main Circuit Terminals

When wiring the main circuit, make sure that phase sequences are consistent with terminal marks. Connect the PE terminal to the retaining screw in the junction box.

NOTE

- For the position of jumpers, see the PCB silkscreen. Never connect signal cables of the PTC, KTY, and resolver to 220 V power supply. Failure to comply will damage the motor.
- The motor has been tested by IP54 experiment. Before wiring, however, protective treatment must be given to the cable outlet hole to prevent foreign objects from entering into the motor.
- If there is adhesive dust in the operating environment, the dust will be stuck on the surface of the motor, affecting the heat dissipation of the motor. Clean the fan according to section "9.5 Cleaning the Motor Fan" on page 135.

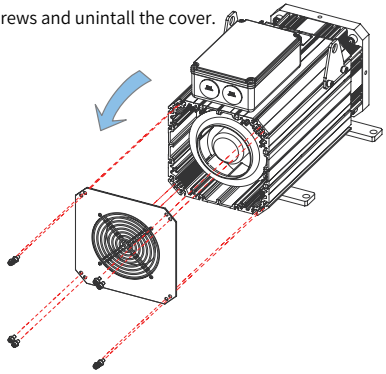
9.5 Cleaning the Motor Fan

The service life of the fan is estimated to be 40,000 h when it keeps full-speed running at the rated voltage at 40°C. Foreign objects stuck on the fan will degrade the fan performance and reduce the airflow. The air resistance will increase and the airflow will decrease after the air filter is blocked, thereby affecting the heat dissipation of the motor. The servo drive reports Err45 if the motor winding temperature exceeds the motor protection temperature.

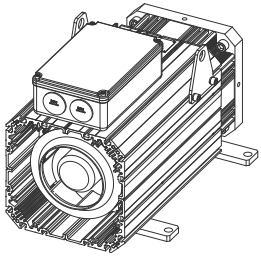
Clean the fan as follows:

1) Remove the eight screws (G1 are M4 hexagon socket screws and G2 are M5 hexagon socket screws) on the air filter cover at the end of the motor and uninstall the cover.

Remove the screws and unintall the cover.



2) Use a straight screwdriver to completely remove the foreign objects on the surface of the FAN and in the air filter, and ensure that no foreign object obstructs the air path. Then, blow the fan again with a high-pressure air gun.



3) Install the cover and fasten the removed screws to complete the cleaning.

NOTE

- Determine the cleaning frequency of the fan according to the actual working conditions.

10 Optional Cards

The ES510 supports various fieldbuses by connecting with external extension cards and supports different types of encoders. This chapter describes the installation and use of extension cards.

10.1 Installation and Functions of the Extension Cards

10.1.1 Installation

The ES510 is equipped with three PG cards (resolver PG card, 23-bit PG card, and multi-functional PG card) and three fieldbus cards (Modbus-RTU, CANopen, and PROFIBUS-DP). For the details of the resolver and 23-bit PG cards, see *"3.2.7 Description of the PG Card" on page 46*. For the installation position of extension cards, see section *"3.2.4 Layout of the Control Board" on page 37*.

10.1.2 Functions

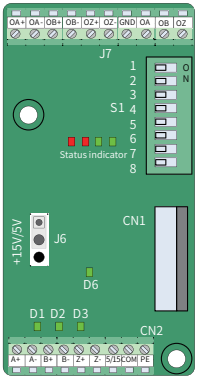
Table 10-1 Function description of the extension cards

Model	Name	Function and Specification	Applicable Model
S58-PG-B1	Resolver PG card	Applicable to resolvers with an excitation frequency of 10 kHz. The card has a DB9 interface.	All models
ES510-PG-CT1	23-bit PG card	Applicable to Weton 23-bit encoder. The card has a DB9 interface.	All models
MD38PGMD	Multi-functional PG card	Supports differential input, collector input, push-pull input, differential output, and collector output.	All models
MD38CAN1	CAN communication extension card	Supports CANopen	All models
MD38TX1	RS485 communication extension card	Supports Modbus-RTU	All models
MD38DP2	PROFIBUS-DP fieldbus card	Supports PROFIBUS-DP communication	All models

10.2 Using the Extension Cards

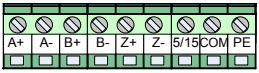
10.2.1 Layout and Functions of Terminals of Multi-Functional PG Card (MD38PGMD)

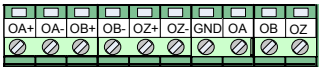
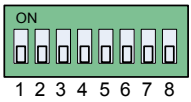
MD38PGMD



MD38PGMD	
User interface	Inclined terminal block
Clearance	3.5 mm
Screw	Flathead
Pluggable	No
Cable specification	16AWG to 26AWG
Max. rate	Differential: 500 kHz; Collector: 100 kHz
Type of encoder interface	Differential, collector, or push-pull
Type of frequency division interface	Differential or collector

Table 10-2 Function description of MD38PGMD terminals

Terminal Mark		Description	Terminal Layout
CN1		Interface connecting the PG card and the control board of the servo drive	
CN2	A+	Encoder output signal A positive	
	A-	Encoder output signal A negative	
	B+	Encoder output signal B positive	
	B-	Encoder output signal B negative	
	Z+	Encoder output signal Z positive	
	Z-	Encoder output signal Z negative	
	5/15	5 V or 10 V power supply for the encoder	
	COM	Encoder power ground	
	PE	Shield wiring terminal	

Terminal Mark		Description	Terminal Layout
J7	OA+	Differential frequency division output signal A positive	
	OA-	Differential frequency division output signal A negative	
	OB+	Differential frequency division output signal B positive	
	OB-	Differential frequency division output signal B negative	
	OZ+	Differential frequency division output signal Z positive	
	OZ-	Differential frequency division output signal Z negative	
	GND	Frequency division output reference ground	
	OA	Collector frequency division output signal A	
	OB	Collector frequency division output signal B	
	OZ	Collector frequency division output signal Z	
S1		DIP switch used to set the frequency division coefficient and the filtering function.	
J6		Jumper used to select the encoder power supply (5 V or 15 V output)	
Status indicators	LED1	Encoder input signal indicator	
	LED2	PG card signal processing indicator	
	LED3	Inter-lock status indicator	
	LED4	System status indicator	
Encoder input signal indicators	D1	The indicators flash or remain steady on when the encoder has an input signal. Indicator D1 corresponds to signals A+ and A-, indicator D2 corresponds to signals B+ and B-, and indicator D3 corresponds to signals Z+ and Z-.	
	D2		
	D3		
D6		Power indicator	

10.2.2 Layout and Functions of Terminals of CAN Communication Extension Card (MD38CAN1)

1) Layout and functions of MD38CAN1 terminals

MD38CAN1 is a communication extension card used for CAN communication of the ES510. It enables the servo drive to access the high-speed CANopen communication network to implement the fieldbus control.

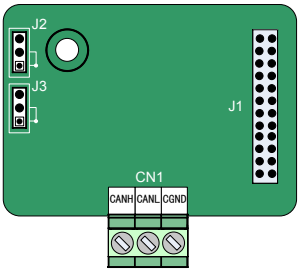


Figure 10-1 Layout of MD38CAN1 terminals

Table 10-3 Function description of MD38CAN1 terminals

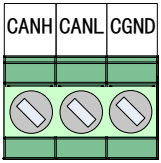
Terminal Mark		Terminal Name	Function Description	Terminal Layout
CN1	CANH	CAN input positive	Connected to the positive pole of the CAN bus.	
	CANL	CAN input negative	Connected to the negative pole of the CAN bus.	
	CGND	Power ground	Connected to the reference ground of all CAN nodes.	

Table 10-4 Jumper description of the MD38CAN1 extension card

Terminal Mark	Terminal Name	Location of the Jumper/DIP Switch	Function Description	Remarks
J2, J3	Jumper used to set the CAN terminating resistor		Use the terminating resistor.	The status of jumpers J2 and J3 must be consistent.
			Do not use the terminating resistor.	

NOTE

◆ For the position of jumpers, see the PCB silkscreen.

2) Use of CAN bus

■ CAN connection mode

The CAN bus topology is shown in the following figure. It is recommended to use STPs as the CAN bus and use twisted pair cables to for all CANH connections and all CANL connections. Install a 120 Ω terminating resistor at both ends of the CAN bus to prevent signal reflection. Connect the reference ground of CAN signal of all nodes together. A maximum of 64 nodes are supported and the distance of each node branch must be smaller than 0.3 m.

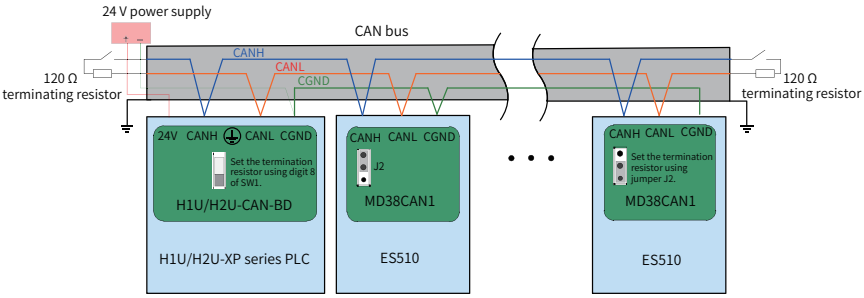
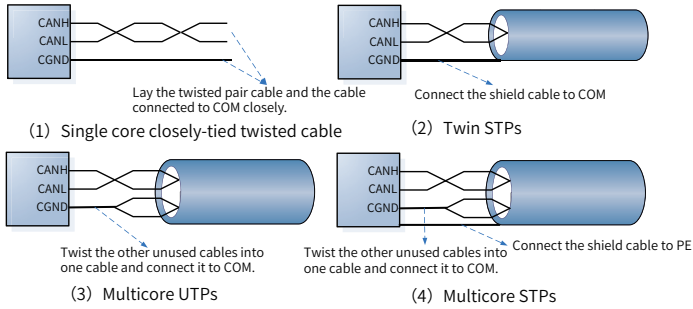


Figure 10-2 CAN bus topology

■ Recommended usage of different field cables:



■ Transmission distance of CAN bus

The transmission distance of the CAN bus is related to the baud rate and communication cable. The relationship between the maximum bus length and the baud rate is shown in the following table.

No.	Transmission Distance	Baud Rate	Number of Nodes	Cable Diameter
1	25 m	1 Mbps	64	0.205 mm^2
2	95 m	500 kbps	64	0.34 mm^2
3	560 m	100 kbps	64	0 5 mm^2
4	1100 m	50 kbps	64	0.75 mm^2

10.2.3 Layout and Functions of Terminals of RS485 Communication Extension Card (MD38TX1)

1) Layout and functions of MD38TX1 terminals

MD38TX1 communication card, which is specially designed for RS485 communication function of the ES510, adopts an isolation scheme. Its electrical parameters conform to international standard, and it can be used to implement the running control of servo drive and parameter setting through the remote serial communication. Use this card according to actual requirements.

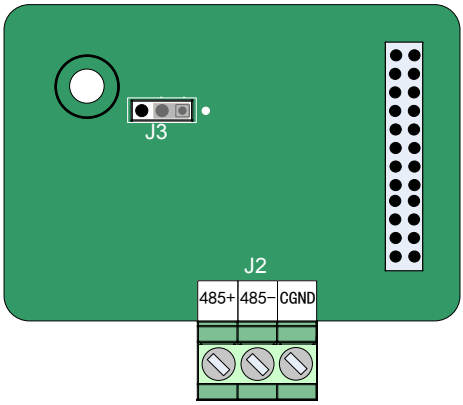


Figure 10-3 Layout of MD38TX1 terminals

Table 10-5 Function description of MD38TX1 terminals

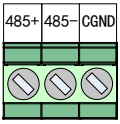
Terminal Mark		Terminal Name	Function Description	Terminal Layout
J2	485+	RS485 communication signal positive	RS485 communication input terminal (isolated)	
	485-	RS485 communication signal negative	RS485 communication input terminal (isolated)	
	CGND	Reference ground of RS485 communication signal	The power supply is isolated.	

Table 10-6 Jumper description of the MD38TX1 extension card

Terminal Mark	Terminal Name	Function Description	Location of the Jumper/DIP Switch
J3	Jumper used to set the RS485 communication terminating resistor	Use the terminating resistor.	
		Do not use the terminating resistor.	

NOTE

◆ For the position of jumpers, see the PCB silkscreen.

2) Use of RS485 communication bus

■ RS485 bus topology

The RS485 bus topology is shown in the following figure. It is recommended to use STPs as the RS485 bus and use the twisted pair cables to connect 485+ and 485-. Install a 120 Ω terminating resistor at both ends of the bus to prevent signal reflection. Connect the reference ground of RS485 signal of all nodes together. A maximum of 128 nodes are supported and the distance of each node branch must be smaller than 3 m.

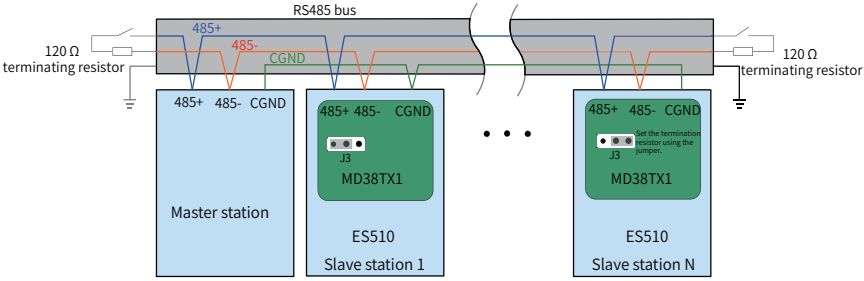
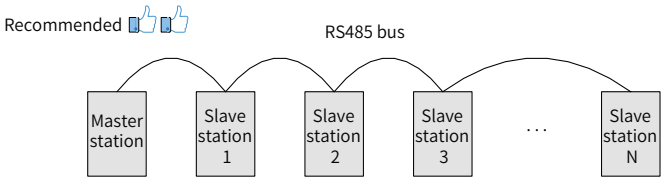


Figure 10-4 RS485 bus topology

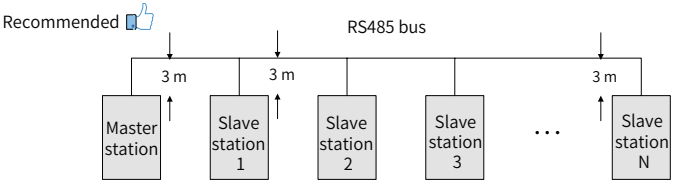
■ Multi-node connection mode

When the number of nodes is large, the RS485 bus must be daisy-chained. If branch connection is required, the cable between the bus and the node must be as short as possible. The recommended length is not greater than 3 m. The following figure shows the common bus structure.

♦ Daisy chain connection mode

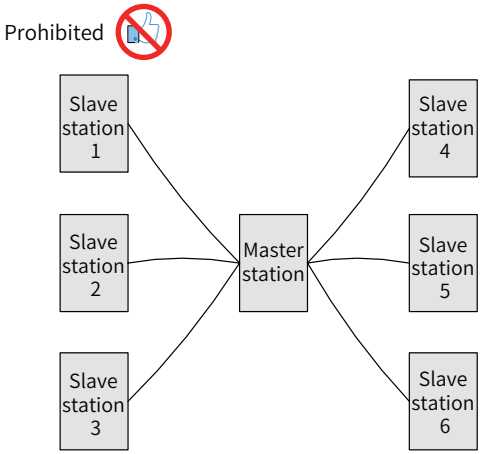


♦ Branch connection mode



Note: The branch cable between the bus and the node cannot exceed 3 m.

♦ Star connection mode (prohibited)

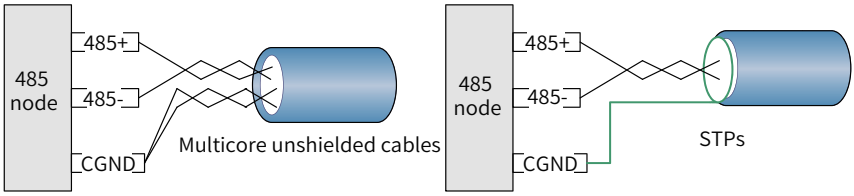


3) Terminal wiring

■ Terminal wiring for nodes with CGND

MD38TX1 has three cables used to connect terminals 485+, 485-, and CGND respectively. Check whether the RS485 bus has the three cables and terminals are not connected reversely or incorrectly. If a shielded cable is used, the shield must be connected to CGND. In any node, only connect the shield to CGND. Never connect the shield to any other position, including the drive enclosure and grounding terminal.

Due to the cable attenuation, use AGW26 or thicker cables if the cable length is greater than 3 m. Always use twisted pair cables to connect 485+ and 485-.



a. Multicore unshielded cables b. STPs

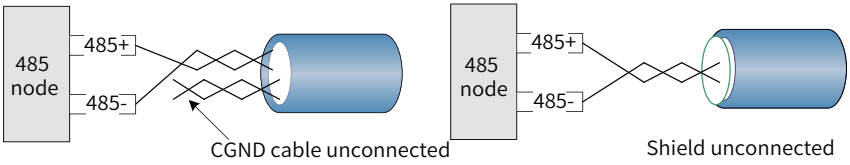
Recommended cable 1: Multicore twisted pair cables
Use one twisted pair to connect 485+ and 485- and twist the remaining pairs into one and connect it to CGND.

Recommended cable 2: STPs
Connect the twisted pair to 485+ and 485- and the shield to CGND.

In applications where STPs are used, the shield can be connected to CGND only. Never connect the shield to the ground.

■ Terminal wiring for nodes without CGND

For nodes without CGND, do not connect CGND or the shield to the PE terminal of nodes directly. Connect CGND or the shield by as follows.



a. Multicore unshielded cables b. STPs

Method 1: Check whether there is a reference ground used by the RS485 circuit exists on other terminals of this node. If yes, connect the CGND cable (the shield) to the pin.

Method 2: Find the reference ground used by the RS485 circuit on the board of this node and connect the drain wire to CGND or the shield.

Method 3: If the reference ground of the RS485 circuit cannot be found, keep the CGND cable or the shield unconnected and use an extra grounding cable to connect this node to the PE terminal of other nodes.

4) Transmission distance and number of nodes

The maximum number of nodes and transmission distance of standard RS485 circuit (Inovance) vary with the baud rate, as listed in the following figure:

No.	Baud Rate	Transmission Distance	Number of Nodes	Cable Diameter
1	115.2 kbps	100 m	128	26AWG
2	19.2 kbps	1000 m	128	26AWG

10.2.4 Layout and Functions of Terminals of PROFIBUS-DP Fieldbus Card (MD38DP2)

Use of the fieldbus adapter card: Before installation, cut off the power supply of the servo drive and wait about 10 minutes until the charging indicator becomes completely OFF. Insert the MD38DP2 in the required position and fix the screws to prevent the connector from being damaged by the external signal cable tension.

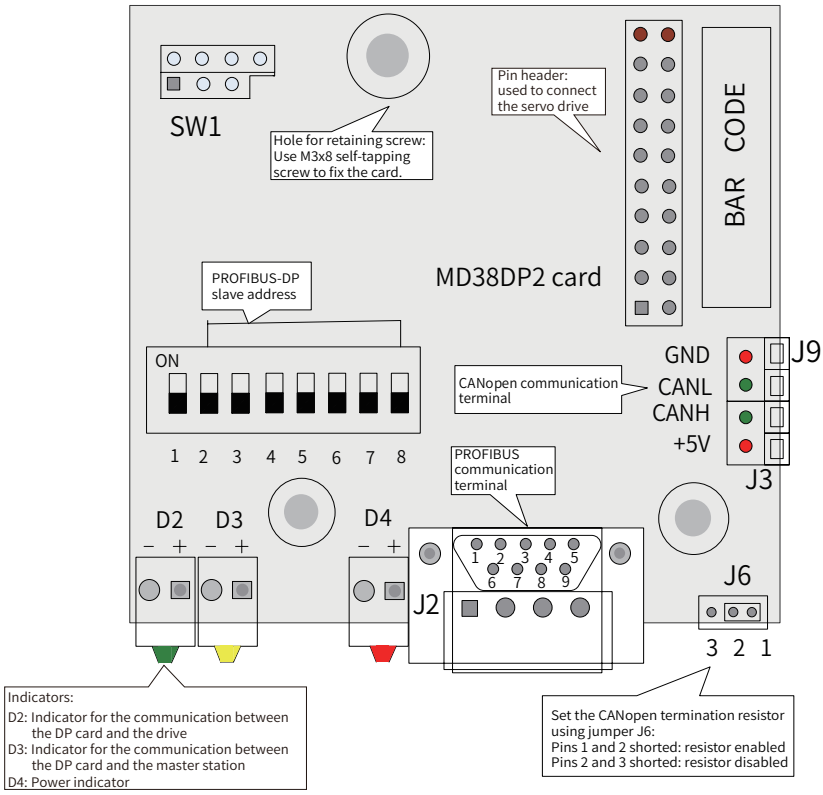


Figure 10-5 Layout of MD38DP2 terminals

1) DIP switch

Digit	Function	Description
1	DP card type switchover	OFF: MD38DP2 (default) ON: MD38DP1
2 to 8	PROFIBUS-DP slave address	The address of station 0 to station 125 can be set using the 7-digit binary DIP switch. For example: Address Switch setting 0 000 0000 7 000 0111 20 001 0100 125 111 1101

NOTE

- The change of digit 1 is valid only after power-on again. The change of digits used to set the slave address takes effect immediately after setting.

2) Description of the DB9 connector

MD38DP2 is connected to the PROFIBUS master station using the standard DB9 connector. The pins of the DB9 connector are defined in the same way as those of Siemens DB9 connector, as shown in the following figure.

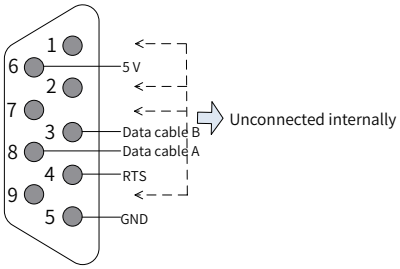


Figure 10-6 DB9 connector pins

3) Function description of control terminals

Category	Terminal Mark	Terminal Name	Function Description
PROFIBUS communication terminal (J2)	1, 2, 7, 9	NC	Unconnected internally
	3	Data cable B	Positive pole of the data cable
	4	RTS	Request for sending signal
	5	GND	Isolated 5 V power ground
	6	5 V	Isolated 5 V power supply
	8	Data cable A	Negative pole of the data cable
CANopen communication terminal (J3, J9)	CANH	CAN input positive	Positive pole of the data cable
	CANL	CAN input negative	Negative pole of the data cable
	GND	Power ground	Isolated 5 V power ground
Programming	SW1	Programming	Interface for production and commissioning. Do not use it.
Jumper	J6	CAN terminating resistor selection	Pins 1 and 2 shorted: resistor enabled Pins 2 and 3 shorted: resistor disabled
Indicators	D4 (red)	Power indicator	Steady ON: The drive is energized. OFF: The drive is not connected with the power supply or the DP card is installed incorrectly.
	D3 (yellow)	Indicator for the communication between the DP card and the master station	Steady ON: The communication between the DP card and the PROFIBUS master station is normal. OFF: There is no communication between the DP card and the PROFIBUS master station (check the connection of PROFIBUS cables and the setting of station number). Flashing: The master station does not run or a fault occurs on the communication between the DP card and the PROFIBUS master station.
	D2 (green)	Indicator for the communication between the DP card and the drive	Steady ON: The communication between the DP card and the drive is normal. OFF: The communication between the DP card and the drive is unsuccessful (check whether the baud rate is set correctly). Flashing: Interference exists on the communication between the DP card and the drive, or the extension card address is beyond the range of 1 to 125.

NOTE

- For some products, the indicator color may be inconsistent with the number. The number is preferred. The indicators are D2, D3, and D4 from left to right. See *"Figure 10-5 Layout of MD38DP2 terminals" on page 146* for details.

10.2.5 EMC Guidance

1) During on-site installation and commissioning, the signal cables (such as encoder cables) and power cables must be laid in different cable trays. Never bundle the encoder cables and power cables together to prevent the encoder interference.
2) The motor housing must be connected to the PE terminal of the servo drive. Meanwhile, the grounding cable on the motor housing side must be connected properly. Failure to comply will result in poor grounding effect.
3) STPs are recommended. For the differential encoder, wire the twisted pair cable according to the differential pair and connect the cable shield to the PE terminal of the servo drive.
4) For some large-scale equipment, the long motor cable (>10 m) determined by the long distance between the servo drive and the motor can result in high inductance and weaken the grounding effect. In this case, the encoder shield need not be connected to the PE terminal of the servo drive.

Appendix A Standards Compliance

A.1 CE Standard Compliance

A.1.1 CE Certification

Figure A-1 CE mark

1) The CE mark indicates compliance with European safety and environmental regulations. The European Norm includes the Machinery Directive for machinery manufacturers, the Low Voltage Directive for electronics manufacturers, and EMC Directive for electromagnetic interference control.

2) The CE mark is required for engaging in commercial business (production, importation, and distribution) in Europe.

3) This drive carries the CE mark and complies with the following directives:

- Low Voltage Directive: 2006/95/EC
- EMC Directive: 2004/108/EC

4) Machines and devices integrating this drive must also be CE certified and marked.

5) 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 standards and the European Norm.

A.1.2 Low Voltage Directive Compliance

This drive has been tested according to EN61800-5-1 and complies with the Low Voltage Directive.

To enable machines and devices integrating this drive to comply with the Low Voltage Directive, be sure to meet the following conditions:

1) Mounting location

Mount the servo drive in places with overvoltage and pollution respectively not higher than category 3 and degree 2 in accordance with IEC60664.

2) Installing fuse on the input side (primary side)

To prevent accidents caused by a short circuit, install a fuse that complies with UL standards on the input side.

For the input/output current of the servo drive, see *"8 Technical Data and Model Selection" on page 102*. For the fuse selection, see *"Table 8-7 Selection of peripheral electrical devices for the ES510" on page 108*.

3) Preventing entry of foreign objects

The servo drive must be installed in a cabinet which is used in a final system with a fireproof enclosure providing both electrical and mechanical protections. The installation must conform to local laws and regulations and related IEC requirements.

4) Grounding

For a drive of 400 V class, connect the neutral point of the drive power supply to ground.

5) Wiring

See "3 Installation and Wiring" on page 25 for the wiring diagram which complies with the Low Voltage Directive.

A.1.3 EMC Directive Compliance

EMC describes the ability of electrical and electronic devices or systems to work properly in the electromagnetic environment without introducing electromagnetic interferences that disturb the operation of other local devices or systems. In other words, EMC includes two aspects: 1) The electromagnetic interference generated by a device or system during normal running must be within a certain limit; 2) Each device or system must have sufficient immunity to the electromagnetic interference in the environment in which it is meant to function.

The ES510 complies with the European EMC directive 2004/108/EC and category C2 of standard EN 61800-3:2004+A1:2012. It is applicable to both the first environment and the second environment.

Safety Instruction
DANGER ◆ When applied in the first environment, the drive may generate radio interference. In addition to the CE compliance requirements described in this chapter, take measures to prevent radio interference if necessary.

To satisfy EMC directive and requirements of related standards, install the recommended external EMC filter on the drive's input side and the shielded cable on the output side, and ensure that the filter is reliably grounded and the shield of output cables is grounded 360 degrees with a cable gland. For the selection of the EMC filter, see "8 Technical Data and Model Selection" on page 102. For the selection and installation of drive cables on the output side, see "3 Installation and Wiring" on page 25.

The manufacturer of the system integrating this drive is responsible for compliance of the system with the European EMC directive and requirements of category C2, C3 and C4 of standard EN 61800-3:2004+A1:2012 according to the system application environment.

A.1.4 Introduction to EMC Standard

First environment: Environment that includes domestic premises. It also includes establishments directly connected to a low-voltage power supply network (without intermediate transformers) 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.

Category C1 drive: Power drive system (PDS) with rated voltage less than 1000 V, intended for use in the first environment.

Category C2 drive: 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.

Category C3 drive: PDS with rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment

Category C4 drive: PDS with rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment

A.1.5 Cable Requirements and Wiring

1) To fulfill the EMC requirements of CE mark, use shielded cables. Shielded cables are classified into three-conductor cables and four-conductor cables. If the conductivity of the cable shield cannot meet the requirement, add a separate PE cable, or use a four-conductor shielded cable, of which one phase conductor is PE cable. The cable shield, which serves to suppress the emission and conduction of the radio frequency interference, must be made of co-axial copper braids with a weaving density larger than 90% to enhance shielding effectiveness and conductivity performance. For the selection and grounding of shielded cables, see *"3 Installation and Wiring" on page 25*.
2) The motor cables and PE shielded conductor (twisted) must be as short as possible to reduce the electromagnetic radiation and external stray current and capacitive current of the cable. For motor cables over 100 m, install an output filter or a dv/dt reactor.
3) It is recommended to adopt shielded cables as control cables.
4) The motor cables must be laid away from other cables. The motor cables of several drives can be laid in parallel.
5) It is recommended that motor cables, power input cables, and control cables be laid in different cable trays. The motor cables and other cables cannot be laid in parallel for a long distance to prevent the electromagnetic interference caused by rapid change of the drive output voltage.
6) If the control cable must run across the power cable, make sure the angle between

them is close to 90 degrees. Other cables cannot run across the drive.

7) Power input and output cables and low-voltage signal cables such as control cables of the drive should, if possible, be laid vertically rather than in parallel.
8) Cable trays must be in good connection and well-grounded. Aluminum cable trays can be used to improve equal potential.
9) 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.
10) For detailed wiring requirements, see *"3 Installation and Wiring" on page 25*.

A.1.6 Solutions to Leakage Current

The drive outputs high-speed pulse voltage, generating high-frequency leakage current. Each drive produces more than 100 mA leakage current. Therefore, the rated trip current of the RCD must be larger than 100 mA. The drive outputs DC leakage current in the protective conductor. In this case, a type B RCD (time-delayed) must be used.

Install an RCD for each drive in multi-drive applications.

1) Factors that influence the leakage current are listed as follows:

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

2) When the leakage current generated by the drive triggers the RCD to act, take the following measures:

- Increase the rated trip current of the RCD.
- Replace the original RCD with a time-delay type B RCD with high-frequency suppression function.
- Reduce the carrier frequency.
- Shorten the length of the output drive cables.
- Install a leakage current suppression device.
- Recommended RCD brands are Chint and Schneider.

A.1.7 Solutions to Common EMC Interference Problems

The drive generates strong interference. Although EMC measures are taken, interference may still exist due to improper wiring or grounding during use. When the drive interferes with other devices, adopt the following solutions.

Table A-1 Solutions to common EMC interference problems

Interference Type	Solution
ELCB tripping	◆ Reduce the carrier frequency. ◆ Shorten the drive cable length. ◆ Wind the ferrite core around the input drive cables except the PE cable. ◆ For tripping at the moment of power-on, cut off the large capacitor to ground on the power input side by disconnecting the grounding terminal of the external or built-in filter and disconnecting the grounding terminal of Y capacitor to ground of the input ports. ◆ For tripping during drive running or when the drive is enabled, take leakage current suppression measures (install a leakage current filter, install safety capacitor + wind ferrite core, or wind ferrite core).
Interference generated during running	◆ Connect the motor housing to the PE terminal of the drive. ◆ Connect the PE terminal of the drive to that of the mains power supply. ◆ Wind the power input cables with the ferrite core. ◆ Add a capacitor or ferrite core to the interfered signal port. ◆ Apply additional common-ground connection between devices.
Communication interference	◆ Connect the motor housing to the PE terminal of the drive. ◆ Connect the PE terminal of the drive to that of the mains power supply. ◆ Wind the power input cables with the ferrite core. ◆ Add a terminating resistor between the communication cable source and the load. ◆ Add an auxiliary reference ground wire if the differential cable pair is used for external communication. ◆ Adopt shielded communication cables, and connect the cable shield to the common ground of communication. ◆ Adopt daisy chain wiring mode for multi-node communication, with the branch length less than 30 cm.
I/O interference	◆ Enlarge the capacitance filter of low-speed DI terminals. The recommended maximum value is 0.1 μF. ◆ Enlarge the capacitance filter of AI terminals. The recommended maximum value is 0.22 μF.

A.2 UL Standard Compliance

The UL/cUL mark indicates that UL has performed product tests and evaluation, and determined that their stringent standards for product safety have been met.

The ES510 has been tested in accordance with UL standard UL508C and complies with UL standards. Abide by the following requirements to maintain compliance with UL standards when integrating this drive into other machines and devices.

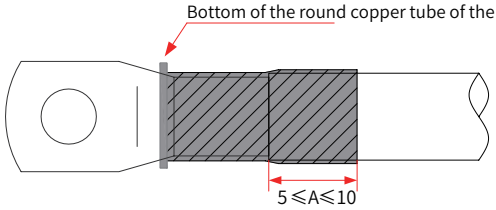
1) Mounting location

Mount the drive in a place with pollution degree 1 or 2 (UL standard).

2) Wiring of the main circuit terminals

To meet UL standards, use crimping terminals that fulfill UL standards to connect the cables to the main circuit terminals. The recommended terminals are listed in *"Table 8-7 Selection of peripheral electrical devices for the ES510" on page 108*. Use tools recommended by manufactures to crimp the terminals. Insulate the crimping terminals by using the heat-shrinkable sleeve with insulated cladding or UL certification. Use UL certified insulated cables with vinyl resin coating. The continuous maximum allowable temperature and maximum voltage of the cables are 75°C and 600 V respectively. Select the insulated cables under the condition where the ambient temperature is 40°C.

The heat-shrinkable sleeve is installed as follows:



A: overlap between the sleeve and the cable jacket (unit: mm)

Before ordering, contact the agent or sales representative of Inovance.

3) Fuse on the input side

To meet UL standards, install a fuse recommended in *"Table 8-7 Selection of peripheral electrical devices for the ES510" on page 108* on the drive's input side.

4) Low-voltage wiring of the control circuit terminals

Connect the low-voltage cables to the circuit cables of NEC division 1. Follow the regulations on wiring in your country or region. For the control circuit terminals, use class 2 (UL standard) power supply.

Table A-2 Power supply for the control circuit terminals

Input/Output	Terminal Mark	Power Supply Specification
Multi-functional DI	DI1, DI2, DI3, DI4, DI5, COM	Use the internal LVLC power supply of the servo drive. If the external power supply is used, it must be of class 2.
Multi-functional AI	AI1, AI2, AI3, GND	Use the internal LVLC power supply of the servo drive. If the external power supply is used, it must be of class 2.
Multi-functional DO	DO1, COM	Use the internal LVLC power supply of the servo drive. If the external power supply is used, it must be of class 2.
Multi-functional AO	AO1, AO2, GND	Use the internal LVLC power supply of the servo drive. If the external power supply is used, it must be of class 2.

5) Short circuit capacity

The ES510 has been short circuit tested using a power supply with a current below 100000 A and a voltage below 480 V.

During wiring, use the circuit breaker (MCCB) and the fuse on the input side used for short circuit protection. Use a drive with a short circuit capacity not lower than that of the power supply.

6) Overheating protection

The motor overheating protection is not tested during UL certification. Therefore, contact the agent or sales representative of Inovance for details about this function.

Appendix B Multi-Pump Mode of the Injection Molding Machine

B.1 Parallel Pump Control Mode of the Servo Hydraulic Pump

The parallel pump control mode for the servo hydraulic pump includes multi-pump convergent flow and multi-pump distributed flow.

Multi-pump convergent flow: One servo drive works as the main drive and other drives connected in parallel work as slave drives. The host controller outputs a group of flow and pressure analog signals.

- In the flow control state (the feedback pressure is smaller than the reference pressure), the master drive and the slave drives run at the same speed.
- In the pressure control state (the feedback pressure is greater than or equal to the reference pressure), the slave drives automatically stop working and the main drive controls the pumps.

Multi-pump distributed flow: Multiple servo drives may work in multi-pump convergent flow mode or multi-pump distributed flow mode (independent oil pressure PID control for each pump). The host controller outputs multiple groups of flow and pressure analog signals.

1) Multi-pump convergent flow diagram

The following is a multi-pump convergent flow control diagram.

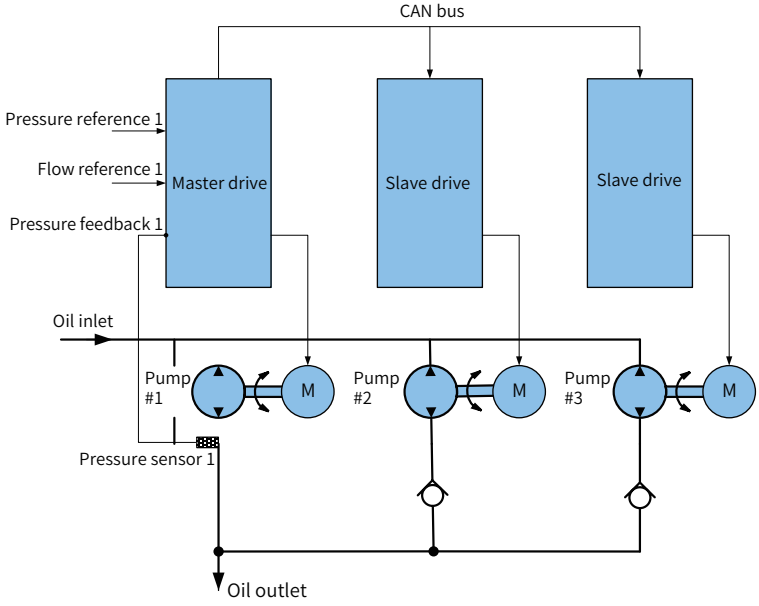


Figure B-1 Multi-pump convergent flow diagram

NOTE

- For detailed wiring and CAN communication wiring, see "1) Wiring (parallel pump running)" on page 159. For the setting of parameters, see "2) Parameter setting for slave pump response to master pump references" on page 160.

Set the same speed for motors through communication.

2) Multi-pump distributed flow diagram

The following is a multi-pump distributed flow control diagram.

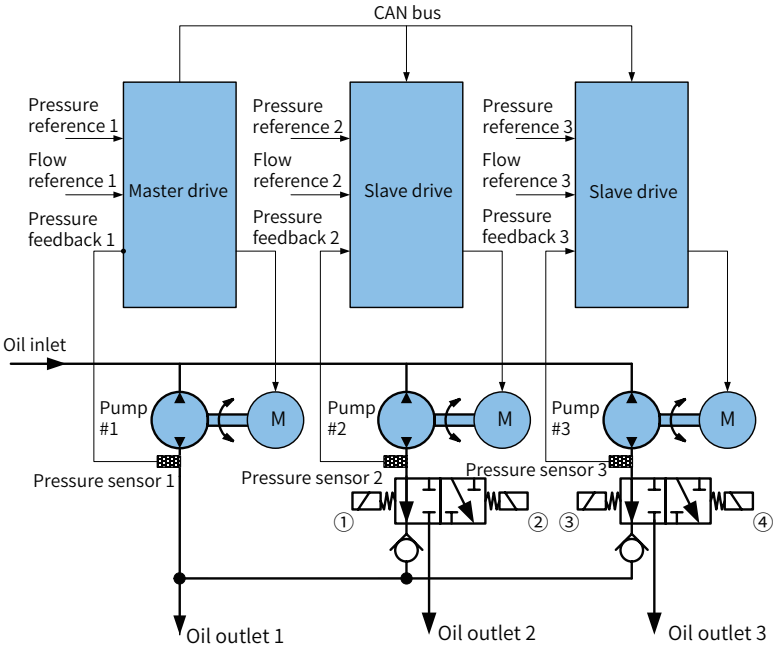


Figure B-2 Multi-pump distributed flow diagram

NOTE

- For detailed wiring and CAN communication wiring, see "1) Wiring (parallel pump running)" on page 159. For the setting of parameters, see "2) Parameter setting for slave pump response to master pump references" on page 160.

Set the same speed for motors through communication.

Control the convergent/distributed flow of pumps 2 and 3 by powering on and off the solenoid valves (① , ② , ③ , and ④).

In convergent flow control, the pressure and flow references and pressure feedback signal received by slave drives are invalid.

In distributed flow control, CAN communication references received by slave drives are invalid.

B.2 Multi-Pump Control Modes

Parameter No.	Parameter Name	Setting Range
A2-03	Multi-pump mode selection in CAN communication	0: Multi-pump mode 1 (broadcasting mode) 1: Multi-pump mode 2 (multi-master mode)

The ES510 supports both multi-pump mode 1 and multi-pump mode 2.

Multi-pump mode 1

Multi-pump mode 1 is the broadcasting mode applicable to simple multi-pump control.

The drive cannot control the slave pump when the slave pump switches to the master pump.

Enable the multi-pump mode using the 50# DI terminal.

If you disconnect the 50# DI terminal of the slave pump, the slave pump mode will switch to the master pump mode.

Multi-pump mode 2

Multi-pump mode 2 is the multi-master mode. To meet the requirements of more complex multi-pump convergent flow and multi-pump distributed flow modes, a maximum of four multi-pump distributed flow control combinations is supported.

The detailed wiring and application of multi-pump mode 1 and multi-pump mode 2 are described as follows.

1) Wiring (parallel pump running)

Multi-pump convergent flow

See *Figure B-19* and *Figure B-20* for detailed wiring. In this mode, connect the slave pump alarm output signal (set F5-02 to 25) to the host controller for alarm display.

NOTE

High pressure occurs without cause on the oil circuit of the slave pump in the pressure control state when the leakage of the check valve is large while the internal leakage of the slave pump is small. To relieve the high pressure of the oil circuit, take the following measures:

- Reduce the discharge of the slave pump to a reasonable range.
- Decrease the upper torque limit of the slave drive to a reasonable range.
- Set the speed response curve of the slave drive according to the maximum leakage speed of the master pump, ensuring that the slave drive implements automatic pressure relief in low-speed pressure holding state. For detailed parameter setting, see *"2) Parameter setting for slave pump response to master pump references" on page 160*.

Multi-pump distributed flow

See *Figure B-21* and *Figure B-22* for detailed wiring. Connect the slave alarm output signal (set F5-02 to 25) to the host controller for alarm display. In this control mode, the slave drive receives the pressure feedback 2 from the pressure sensor installed in the oil circuit of the slave pump. Therefore, the high pressure without cause will never occur in the oil circuit of the slave pump in the pressure control state.

■ Communication connection: connect the CAN bus of all pumps together, as shown in the following figure.

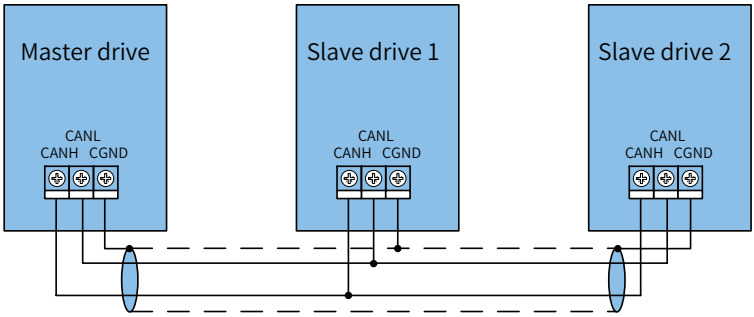


Figure B-3 CAN bus connection diagram

Note: Use STPs for the CAN bus connection. Connect the CANH and CANL terminals on the control board of all drives together, and connect all CGND terminals together using the shield. The CAN communication terminating resistor of the front drive and the end drive at the CAN bus must be connected using jumper J4.

2) Parameter setting for slave pump response to master pump references

Parameter No.	Parameter Name	Default	Description
A3-32	Min. slave pump speed reference input	0.0%	Drive setting for the slave pump
A3-33	Corresponding value of min. slave pump speed reference input	0.0%	
A3-34	Middle point of slave pump speed reference input	0.0%	
A3-35	Corresponding value of middle point of slave pump speed reference input	0.0%	
A3-36	Max. slave pump speed reference input	100.0%	
A3-37	Corresponding value of max. slave pump speed reference input	100.0%	

By setting parameters A3-32 to A3-37 to proper values, the slave pump can implement automatic pressure relief when the master pump is in the low-speed pressure holding

state, avoiding the occurrence of high-pressure holding of the slave pump and ensuring the system's flow linearity.

Example:

Condition 1: The maximum pressure holding speed of the master pump is 50 rpm, and the maximum speed of the master pump and the slave pump are both 2000 rpm.

Condition 2: During pressure holding, the master pump works and the slave pump stops.

Condition 3: To ensure the flow linearity, the slave pump runs at the same speed as the master pump when the speed of the master pump exceeds 100 rpm.

It means that when the master pump speed is less than 50 rpm, the slave pump does not work. When the master pump speed is greater than 100 rpm, the master pump and the slave pump run at the same speed. The speed reference of the master pump is 0% to 100%. The three-point curve showing the slave pump response to the master pump speed reference is as follows:

(A3-32, A3-33) = (Slave pump input reference: 50 rpm, slave response reference: 0 rpm) = (2.5%, 0.0%)

(A3-34, A3-35) = (Slave pump input reference: 100 rpm, slave response reference: 100 rpm) = (5.0%, 5.0%)

(A3-36, A3-37) = (Slave pump input reference: 2000 rpm, slave response reference: 2000 rpm) = (100%, 100%)

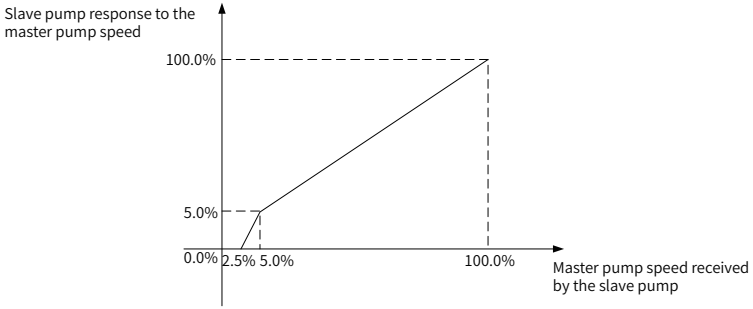


Figure B-4 Slave pump response to THE master pump speed reference

NOTE

- The two multi-pump modes have identical settings for the slave pump response to the master pump speed reference.

B.3 Parameter Settings of the Master Drive

■ Multi-pump mode 1 (A2-03 = 0)

The parameter setting is simple. Enable the 50# DI terminal of all servo drives.

Parameter No.	Parameter Name	Value	Description
A2-01	CAN communication address	1	
A2-03	Multi-pump mode 1	0	
F4-**	Multi-pump control enabling	50	Short DI5 to COM directly.
F5-02	Output selection of the relay (T/A2-T/C2) on the control board	25	Slave alarm output (NO)

■ Multi-pump mode 2 (A2-03 = 1)

The 1# servo drive must be the master pump. A maximum of four combined distributed flow control can be implemented. The related parameter settings are as follows:

Parameter No.	Parameter Name	Value	Description
F4-**	Slave pump address selection input terminal 1	53	In multi-pump distributed flow control, the two parameters are used to set the slave pumps to be controlled by the master pump for convergent flow.
F4-**	Slave pump address selection input terminal 2	54	
F5-02	Output selection of the relay (T/A2-T/C2) on the control board	25	Slave alarm output (NO)
A2-01	CAN communication address	1	
A2-03	Multi-pump mode 2	1	
A2-04	CAN slave address 1	0	Working with the 53# and 54# input terminals, these parameters are used to implement the four combined convergent/distributed flow control.
A2-05	CAN slave address 2	0	
A2-06	CAN slave address 3	0	
A2-07	CAN slave address 4	0	

■ Slave pump address DI input selection

54# DI Terminal Input	53# DI Terminal Input	Selection of CAN Slave Address
0	0	A2-04: CAN slave address 1
0	1	A2-05: CAN slave address 2
1	0	A2-06: CAN slave address 3
1	1	A2-07: CAN slave address 4

■ Salve pump address setting

The LED display of the slave pump address setting is as follows:

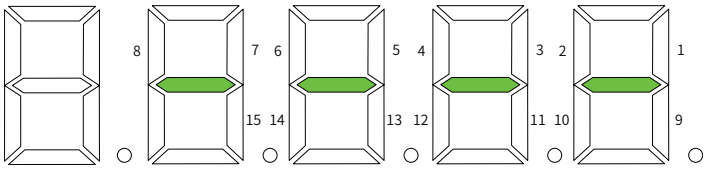


Figure B-5 Initial display of the slave pump address setting

- The numbers indicate the station number of the slave pump address.
- If the LED corresponding to a number is ON, it indicates that the slave pump with that station number is controlled.
- The ES510 supports the setting of a maximum of 15 slave pump addresses.

For example, the 1# pump is the master pump, and the slave pump addresses set in A2-04 (CAN slave address 1) are shown in the following figure. It indicates that the 1# pump serves as the master pump and works with slave pumps 2#, 3# and 4# in convergent flow mode.

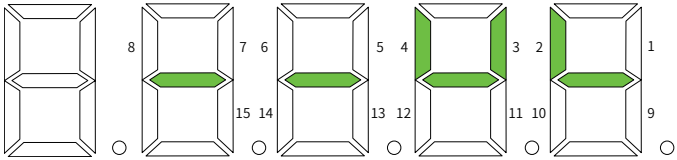


Figure B-6 Slave address setting

The key operations to set the slave pump address are as follows:

Set the address of pumps 1# to 8# by using △ and ▷.

Set the address of pumps 9# to 15# by using ▽ and ▷.

B.4 Parameter Setting of the Slave Drive

■ Multi-pump mode 1 (A2-03 = 0)

The following table lists the parameter setting of the slave drive. Set the other parameters according to the general method used for the servo hydraulic pump.

Parameter No.	Parameter Name	Value	Description
A2-01	CAN communication address	> 1	Slave drive
F4-**	Multi-pump control enabling	50	The slave pump may switch to the master pump.

If the slave pump needs to switch to the master pump, disconnect the 50# DI terminal of the slave pump.

■ Multi-pump mode 2 (A2-03 = 1)

The following table lists the parameter setting of the slave drive. Set the other parameters according to the general method used for the servo hydraulic pump.

Parameter No.	Parameter Name	Value	Description
A2-01	CAN communication address	> 1	Slave drive
F4-**	Slave pump address selection input terminal 1	53	When the slave pump is used as the master pump, it need to be triggered by the terminal. For the slave pump address setting, see "B.3 Parameter Settings of the Master Drive" on page 162.
F4-**	Slave pump address selection input terminal 2	54	

B.5 Applications of the Multi-Pump Convergent/Distributed Flow

■ Multi-pump mode 1 (A2-03 = 0)

For example, the hydraulic pump system of the injection molding machine consists of three pumps with their addresses set as 1#, 2# and 3#. In the multi-pump mode 1, a slave pump cannot control the other slave pumps. Therefore, there are two combinations as follows:

1) Combination 1: 3-pump convergent flow

2) Combination 2: distributed flow of (2 + 1) pumps, with the 2# slave pump controlled by the 1# master pump and the 3# slave pump switching to the master pump.

The following section describes the wiring of the two combinations.

1) Combination 1: 3-pump convergent flow

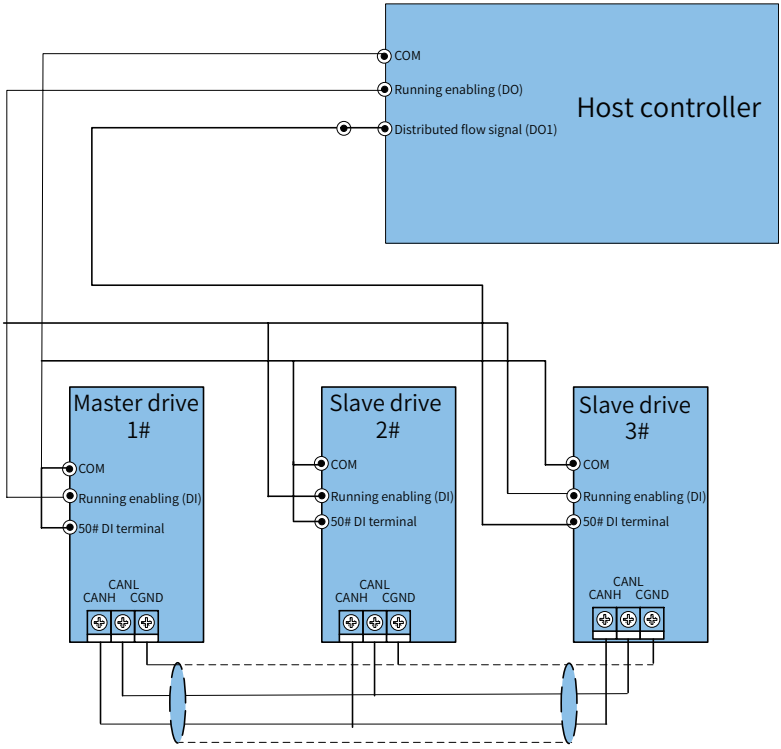


Figure B-7 Wiring of 3-pump convergent flow

Wiring description:

Because the 1# pump is always the master pump and the 2# pump is always the slave pump, short the 50# DI terminal directly.

The 3# pump switches to the master pump in combination 2, which requires an external switchover signal. When the host controller sends a closing signal, the 50# DI terminal of the 3# slave pump becomes off to enter the multi-pump convergent flow state.

2) Combination 2: distributed flow of (2 + 1) pumps, with the 2# slave pump controlled by the 1# master pump and the 3# pump switching to the master pump.

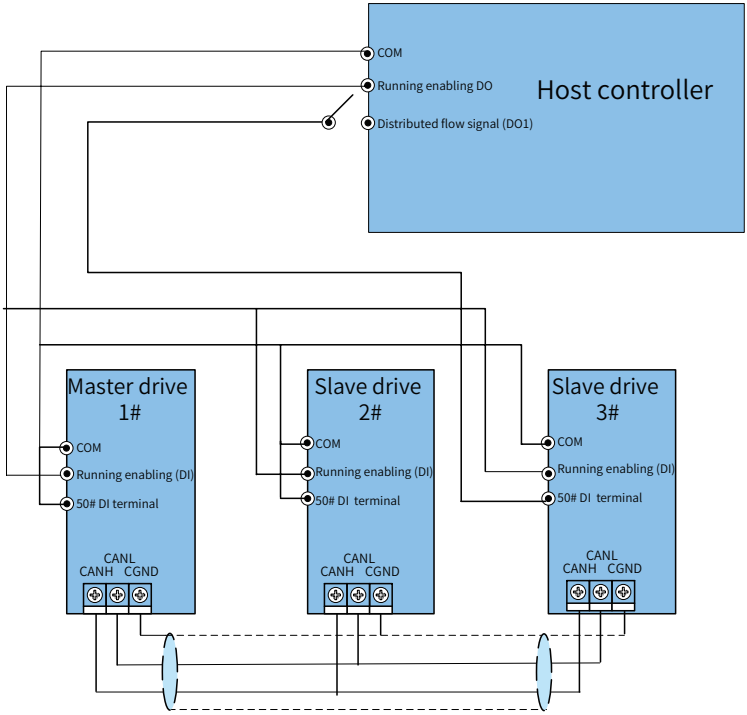


Figure B-8 Distributed flow of (2 + 1) pumps

The 1# master pump controls the 2# slave pump, and the 3# pump can switch from the slave pump to the master pump by disconnecting the 50# DI terminal. The same rule applies to other pumps.

■ Multi-pump mode 2 (A2-03 = 1)

For example, the hydraulic pump system of the injection molding machine consists of four pumps with their addresses set as 1#, 2#, 3#, and 4#. There are three combinations as follows:

1) Combination 1: 4-pump convergent flow

2) Combination 2: distributed flow of (2 + 2) pumps, with the 2# slave pump controlled by the 1# master pump and the 4# slave pump controlled by the 3# master pump.

3) Combination 3: distributed flow of (3 + 1) pumps, with the 2# and 3# slave pumps controlled by the 1# master pump and the 4# slave pump switching to the master pump.

The following section describes the wiring and parameter setting of the above three combinations.

The CAN communication address (A2-01) of the four pumps are set as 1#, 2#, 3#, and 4#, respectively. Set the address of the pump used as the master pump in the three combinations to 1#.

1) Combination 1: 4-pump convergent flow

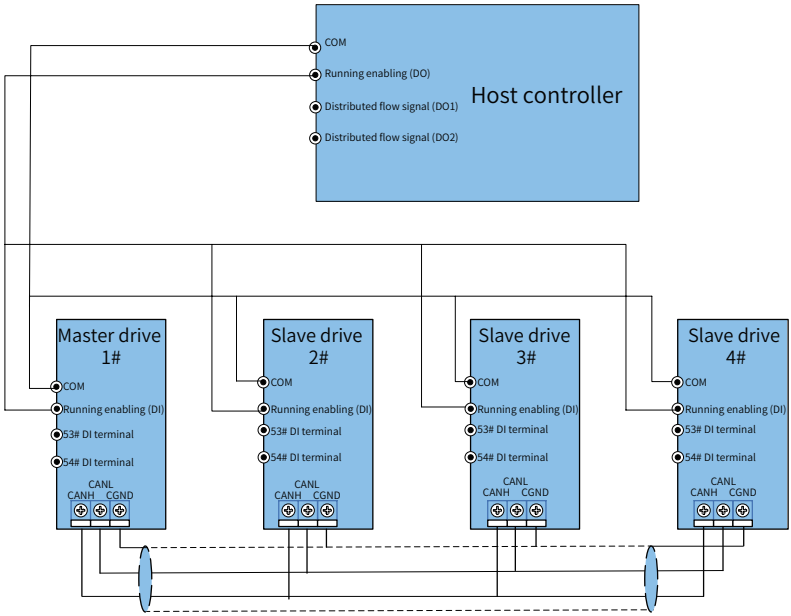


Figure B-9 Wiring of 4-pump convergent flow

- Wiring description: The convergent flow control requires very simple wiring. You just need to connect all CAN buses and running enabling DI terminals.
- Parameter setting: The 1# pump is the master pump, and the 2#, 3# and 4# pumps are slave pumps. Set the slave pump addresses in A2-04 (CAN slave address 1) as follows:

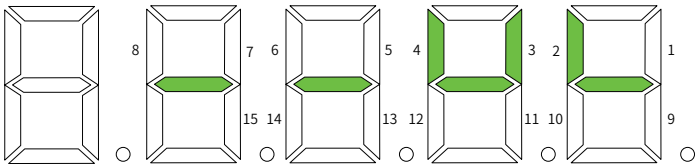


Figure B-10 Slave pump address setting

2) Combination 2: distributed flow of (2 + 2) pumps, with the 2# slave pump controlled by the 1# master pump and the 4# slave pump controlled by the 3# master pump.

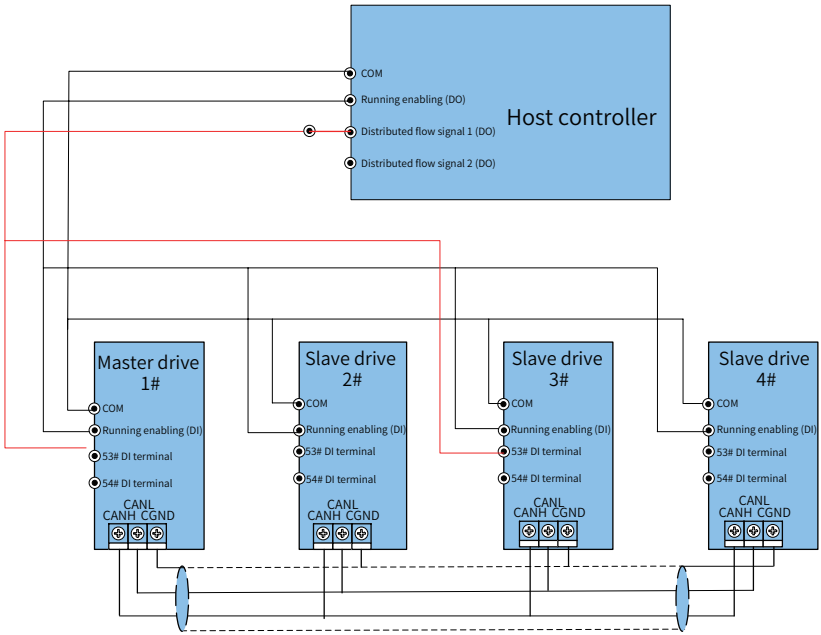


Figure B-11 Wiring of distributed flow of (2 + 2) pumps

♦ Wiring description

The host controller that provides the distributed flow signal is connected to the 53# DI terminal of the drive driving the master pump. Using the 53# DI signal, the master pump identifies the slave pump address, and the slave pump switches to the master pump and identifies the slave pump address.

♦ Parameter setting

In this combination, the 1# pump and 3# pump are both used as the master pump. The slave pump changes and the address of the slave pumps need to be set again. The 2# pump works as the slave pump controlled by the 1# master pump. Set the slave pump address in A2-05 (CAN slave address 2) as follows:

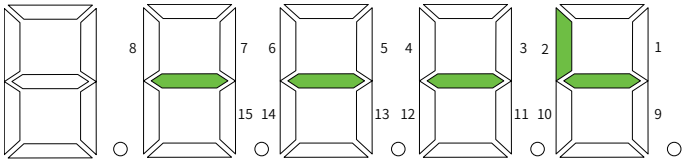


Figure B-12 Setting of the slave pump address in A2-05 (CAN slave address 2)

The 4# pump works as the slave pump controlled by the 3# master pump. Set the slave pump address in A2-05 (CAN slave address 2) as follows:

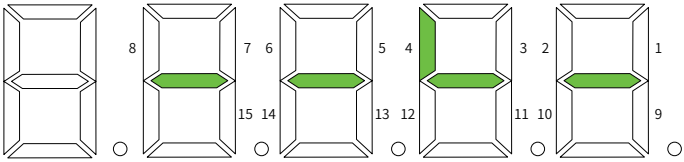


Figure B-13 Setting of the slave pump address in A2-05 (CAN slave address 2)

3) Combination 3: distributed flow of (3 + 1) pumps, with the 2# and 3# slave pumps controlled by the 1# master pump and the 4# pump switching to the master pump.

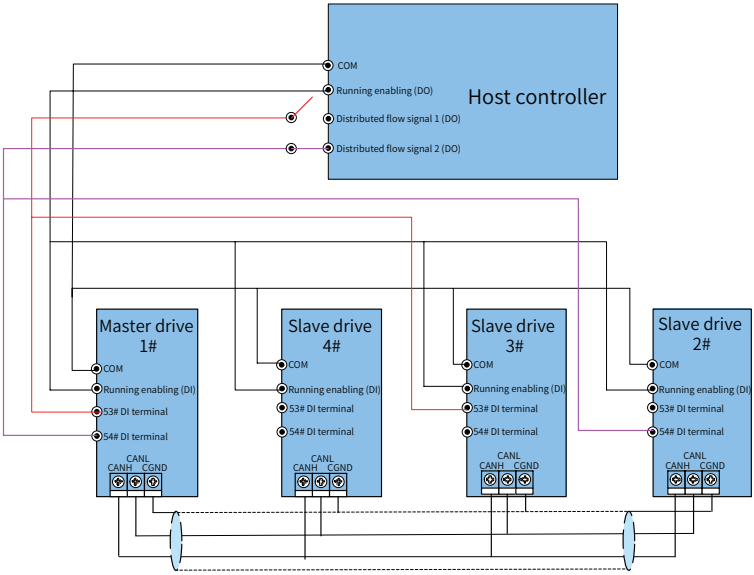


Figure B-14 Distributed flow of (3 + 1) pumps

♦ Wiring description

The host controller that provides the distributed flow signal is connected to the 54# DI terminal of the drive driving the master pump. Using the 54# DI signal, the master pump identifies the slave pump address, and the slave pump switches to the master pump and identifies the slave pump address. The 53# DI terminal in combination 2 is disconnected.

♦ Parameter setting

In this combination, the 1# pump and 4# pump are both used as the master pump. The slave pump changes and the address of the slave pumps need to be set again. The slave pumps controlled by the 1# master pump are the 2# and 3# pumps. Set the slave pump address in A2-06 (CAN slave address 3) as follows:

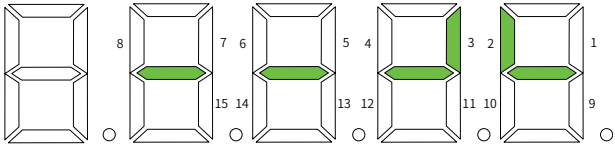


Figure B-15 Setting of the slave pump address in A2-06 (CAN slave address 3)

After the 4# slave pump switches to the master pump, no slave pump is controlled by it. Therefore, you need not to set A2-06 (CAN slave address 3).

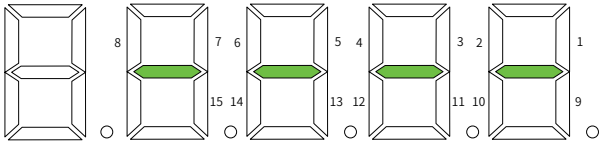


Figure B-16 Setting of the slave pump address in A2-06 (CAN slave address 3)

B.6 Fault Alarms

The following figures describe the faults specific to the multi-pump control.

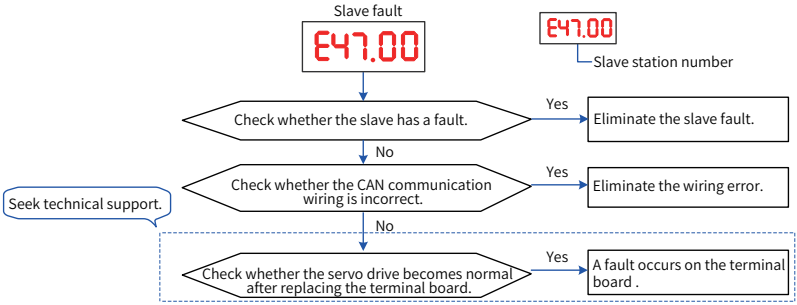


Figure B-17 Slave pump fault alarm (E47.00)

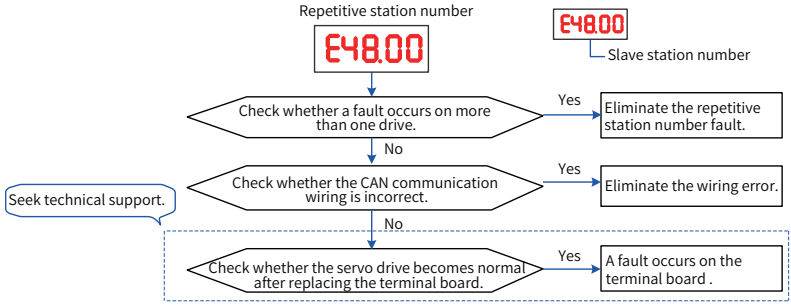


Figure B-18 CAN address conflict (E48.00)

Wiring of the main circuit and control terminals:

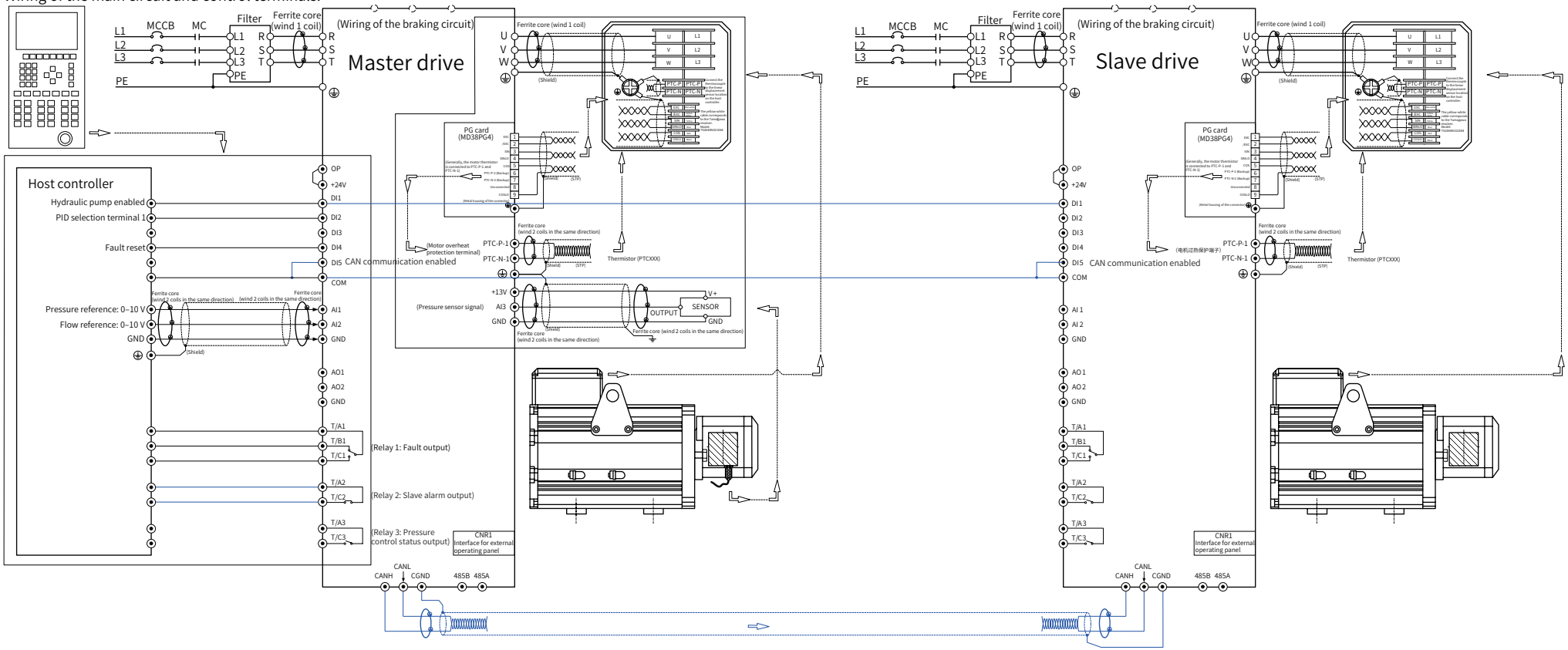


Figure B-19 Wiring diagram for multi-pump convergent flow in multi-pump mode 1

NOTE

◆ In multi-pump mode 1, the 50# DI terminal of slave and master pumps must be ON to enable the multi-pump convergent flow control.

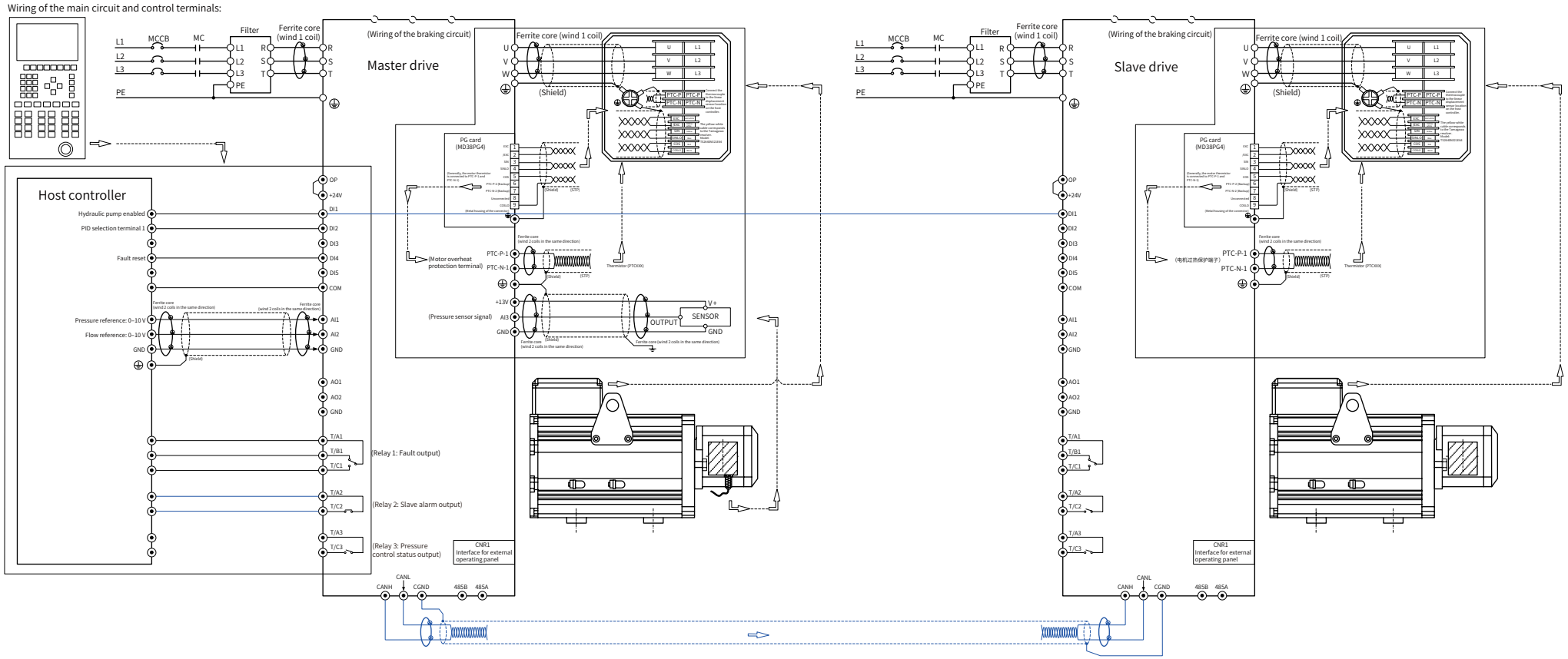


Figure B-20 Wiring diagram for multi-pump convergent flow in multi-pump mode 2

NOTE

◆ In multi-pump mode 2, connect the CAN bus correctly and set the correct address for the slave pump responding to the flow reference from the master pump. For detailed parameter setting, see "B.3 Parameter Settings of the Master Drive" on page 162.

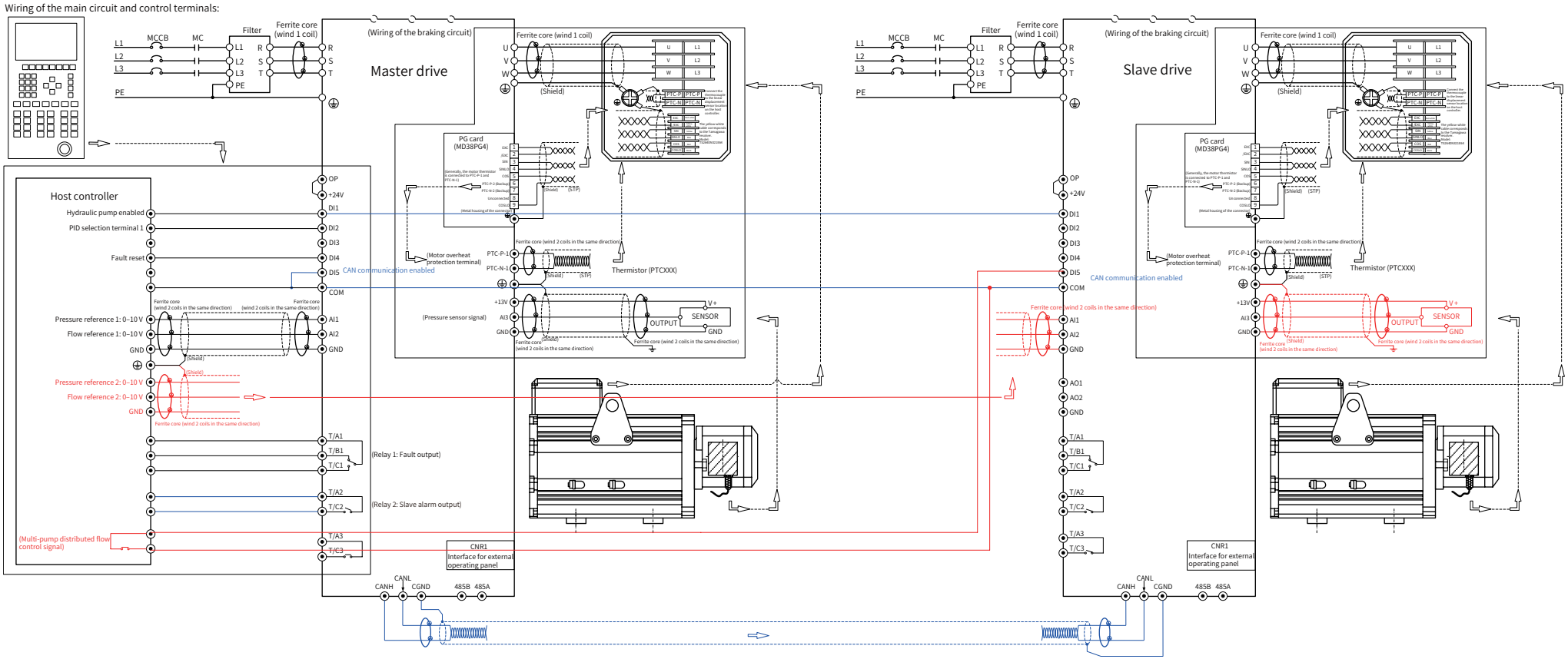


Figure B-21 Wiring diagram for multi-pump distributed flow in multi-pump mode 1

NOTE

◆ Disconnect the 50# DI terminal of the slave drive by using the identifiable divergent flow signal sent by the host controller. The drive then receives the pressure reference 2, flow reference 2, and pressure feedback 2 from the host controller and enters the oil pressure PID control state.

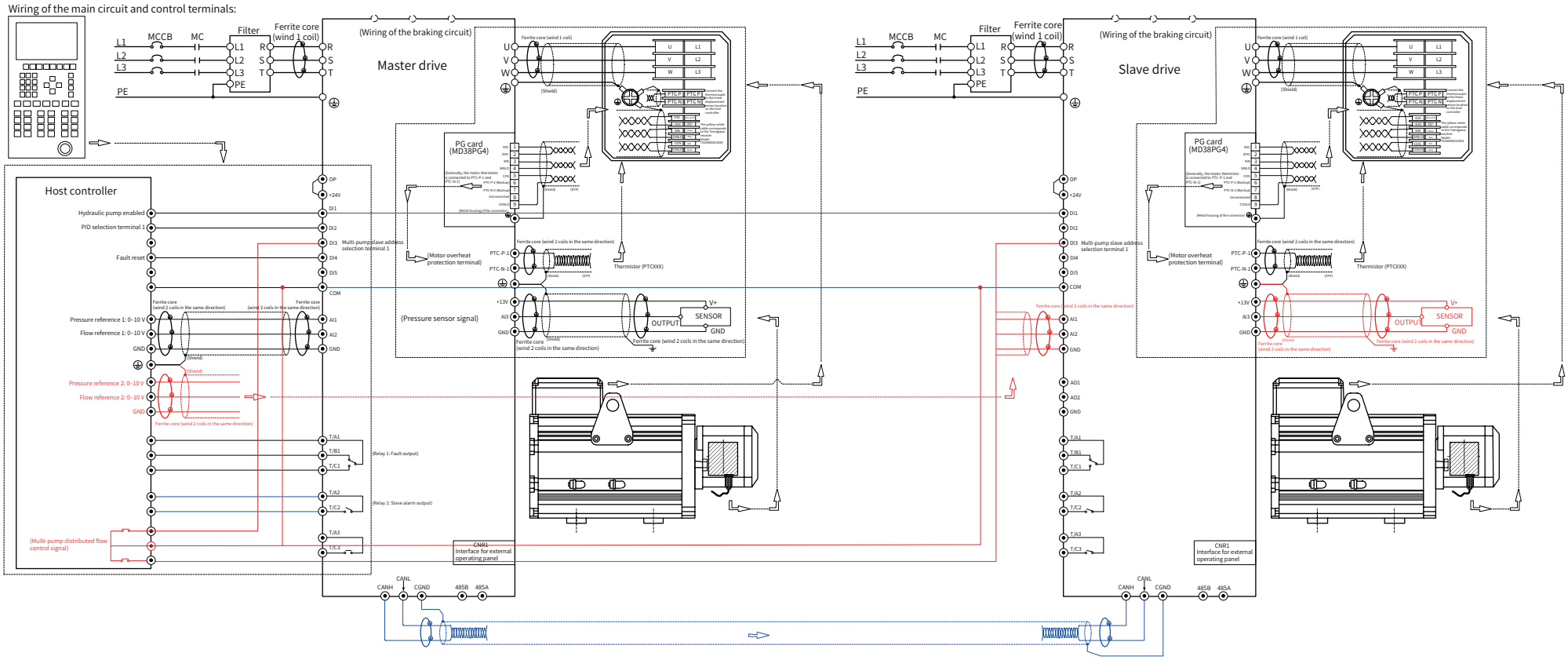


Figure B-22 Wiring diagram for multi-pump distributed flow in multi-pump mode 2

NOTE

- Connect the slave pump alarm output signal (set F5-02 to 25) to the host controller for alarm display.
- In this control mode, the slave drive independently receives the pressure feedback 2 from the pressure sensor installed in the oil circuit of the slave pump. Therefore, high pressure without cause will never occur in the oil circuit of the slave pump in the pressure control state.

Appendix C Parameter Table

If FP-00 (User password) is set to a non-zero value, the password protection is enabled. The parameter menu is accessible in parameter mode and user-modified mode only after the correct password is entered. To disable the password protection, set FP-00 (User password) to 0.

The user password is only used for locking the operating panel. If the password protection is enabled, you must enter the correct password to read or write parameters using the operating panel. However, you need to enter the password again to get access if you want to operate the operating panel one hour later. Reading and writing of parameters (except parameters in group FP) are allowed without the password during communication.

Groups F and A include basic function parameters, and group U includes the monitoring function parameters. The symbols in the following parameter table are described as follows:

☆ : The parameter can be modified when the drive is in stop or running state;

★ : The parameter cannot be modified when the drive is in running state;

● : The parameter value is the actual measured value and cannot be modified;

*: The parameter is a factory parameter and can be set only by the manufacturer.

C.1 Basic Parameters

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
Group A0: Flux-Weakening Control Parameters					
A0-00	Flux-weakening control mode for synchronous motor	0: Direct computing 1: Automatic adjustment	1	1	★
A0-01	Flux-weakening current coefficient	0–500	1	5	☆
A0-02	Flux-weakening depth for synchronous motor	0% to 50%	1%	5%	☆
A0-03	Max. force gain of synchronous motor	20% to 300%	1%	100%	☆
A0-04	Excitation current gain of synchronous motor	40% to 200%	1%	100%	☆
Group A1: PG Card Parameters					
A1-00	Type of PG card	0: Resolver PG card 1: 23-bit PG card 2: Standard ABZ encoder	1	1	★
A1-02	Encoder installation angle	0.0° to 359.9°	0.1°	0.0	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A1-03	Speed feedback direction	0: Same as the reference direction 1: In reverse to the reference direction	1	—	★
A1-04	Number of pole pairs of the resolver	1–50	1	Model dependent	★
A1-05	Detection time of the PG card cable disconnection protection	0.000s to 00.050s	0.001s	0.020s	☆
A1-06	Encoder PPR	3–65535	1	1024	★
A1-07	23-bit encoder cable disconnection detection	0: Disabled 1: Enabled	1	1	★
A1-08	Quantity of encoder interference detection	0–60000	1	0	☆
A1-09	"Auto-tuning free" function	0: Disabled 1: Enabled	1	0	★
Group A2: CAN Communication Parameters					
A2-00	Baud rate	0: 20 K 1: 50 K 2: 125 K 3: 250 K 4: 500 K 5: 1 M	1	4	☆
A2-01	CAN communication address	1–64	1	1	☆
A2-02	Communication cable disconnection detection time	0.1s to 600.0s	0.1s	0.3s	☆
A2-03	Multi-pump mode selection in CAN communication	0: Broadcasting mode 1: Multi-master mode	1	0	☆
A2-04	CAN slave pump address 1	0–65535	1	0	☆
A2-05	CAN slave pump address 2	0–65535	1	0	☆
A2-06	CAN slave pump address 3	0–65535	1	0	☆
A2-07	CAN slave pump address 4	0–65535	1	0	☆
A2-09	CAN protocol in speed mode	0: Reserved 1: CANopen 2: Reserved	1	0	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A2-10	CANopen expert mode	0: Disabled 1: Enabled	1	0	★
A2-11	PDO disabling time in CANopen mode	0–65535	1	0	★
A2-12	CANopen event triggering time	0–65535	1 ms	2 ms	★
Group A3: Basic Oil Pressure Parameters					
A3-00	Oil pressure control mode	0: Non-oil pressure control mode 1: Oil pressure control mode 1 (CAN channel setting) 2: Oil pressure control mode 2 (Analog channel setting) 3: EST mode 1 4: EST mode 2 5: EST mode 3 6: CANopen mode (See appendix E for details about CANopen communication protocol) 7: Reserved	1	0	★
A3-01	Max. motor speed	1–30000 rpm	1 rpm	2000 rpm	★
A3-02	System pressure	0.0 kg/cm^2 to A3-03	0.1 kg/cm^2	175.0 kg/cm^2	☆
A3-03	Max. oil pressure	A3-02 to 500.0 kg/cm^2	0.1 kg/cm^2	250.0 kg/cm^2	☆
A3-04	Rising time of 1st group of oil pressure references	0.000s to 2.000s	0.001s	0.125s	☆
A3-05	1st group of oil pressure control K_p	0.0–800.0	0.1	210.0	☆
A3-06	1st group of oil pressure control T_i	0.001s to 10.000s	0.001s	0.040s	☆
A3-07	1st group of oil pressure control T_d	0.000s to 1.000s	0.001s	0.000s	☆
A3-08	Max. reverse motor speed	0.0% to 100.0%	0.1%	10.0%	☆
A3-09	Base flow	0.0% to 50.0%	0.1%	0.5%	☆
A3-10	Base pressure	0.0–50.0 kg/cm^2	0.1 kg/cm^2	0.5 kg/cm^2	☆
A3-11	2nd group of oil pressure control K_p	0.0–800.0	0.1	210.0	☆
A3-12	2nd group of oil pressure control T_i	0.001s to 10.000s	0.001s	0.040s	☆
A3-13	2nd group of oil pressure control T_d	0.000s to 1.000s	0.001s	0.000s	☆
A3-14	3rd group of oil pressure control K_p	0.0–800.0	0.1	210.0	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A3-15	3rd group of oil pressure control T_i	0.001s to 10.000s	0.001s	0.100s	☆
A3-16	3rd group of oil pressure control T_d	0.000s to 1.000s	0.001s	0.000s	☆
A3-17	4th group of oil pressure control K_p	0.0–800.0	0.1	210.0	☆
A3-18	4th group of oil pressure control T_i	0.001s to 10.000s	0.001s	0.100s	☆
A3-19	4th group of oil pressure control T_d	0.000s to 1.000s	0.001s	0.000s	☆
A3-20	Analog channel zero drift auto-tuning	0: Disabled 1: Enabled	1	0	★
A3-21	Pressure sensor cable disconnection detection time	0.001s to 60.000s	0.001s	0.500s	☆
A3-22	Max. motor speed output in pressure control state	0.0% to 100.0%	0.1%	10.0%	☆
A3-23	Min. oil pressure output in pressure control state	0.0% to 100.0%	0.1%	60.0%	☆
A3-24	Output delay time in pressure control state	0.001s to 10.000s	0.001s	0.100s	☆
A3-25	Rising S-curve filter time of 1st group of oil pressure references	0.001s to 1.000s	0.001s	0.030s	☆
A3-26	Falling S-curve filter time of 1st group of oil pressure references	0.001s to 1.000s	0.001s	0.030s	☆
A3-27	Overshoot suppression detection level of 1st group of oil pressure	0–2000	1	80	☆
A3-28	Overshoot suppression coefficient of 1st group of oil pressure	0–3.000	0.001	0.200	☆
A3-29	Oil pressure loop gain coefficient	0.20–5.00	0.01	1.00	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A3-30	Upper torque limit from pressure mode switching to speed mode	50.0% to 250.0%	0.1%	160.0%	☆
A3-31	Delay time of 1st group of oil pressure reference	0.000s to 0.500s	0.001s	0.000s	☆
A3-32	Min. slave pump speed reference input	0.0% to A3-34	0.1%	0.0%	☆
A3-33	Corresponding value of min. slave pump speed reference input	-100.0% to +100.0%	0.1%	0.0%	☆
A3-34	Middle point of slave pump speed reference input	A3-32 to A3-36	0.1%	0.0%	☆
A3-35	Corresponding value of middle point of slave pump speed reference input	-100.0% to +100.0%	0.1%	0.0%	☆
A3-36	Max. slave pump speed reference input	A3-34 to 100.0%	0.1%	100.0%	☆
A3-37	Corresponding value of max. slave pump speed reference input	-100.0% to +100.0%	0.1%	100.0%	☆
A3-38	Whether enable the slave pump speed be consistent with the master pump in multi-pump mode	0: Disabled 1: Enabled	1	0	☆
A3-39	Pressure holding gain in multi-pump confluence mode	20–800	1	100	☆
A3-40	Pressure deviation of jitter elimination by decreasing PI in multi-pump injection state	0.0–50.0 kg	0.1 kg	5.0 kg	☆
A3-41	Lower limit of flow jitter elimination by decreasing PI in multi-pump injection state	0–30000 rpm	1 rpm	0 rpm	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A3-42	Detection time of flow jitter elimination by decreasing PI in multi-pump injection state	0.200s to 2.000s	0.001s	0.400s	☆
A3-43	Pressure deviation when the slave pump does not run in multi-pump CAN communication mode	0–50.0 kg	0.1 kg	5.0kg	☆
A3-44	Lower flow limit when the slave pump does not run in multi-pump CAN communication mode	-100.0% to +100.0%	0.1%	0.0%	☆
A3-45	Stop judging delay in the case of no speed reference from the slave pump	0.100s to 5.000s	0.001s	1.000s	☆
A3-46	Deceleration time before stop when the slave pump receives no speed reference	0.001s to 5.000s	0.001s	0.200s	☆
A3-47	Pressure relief delay when the valve is opening	0.001s to 5.000s	0.001s	0.100s	☆
A3-48	Pressure relief delay when the valve is closing	0.001s to 5.000s	0.001s	0.100s	☆
A3-49	Lower pressure deviation limit during pressure relief when the valve is opening	0.0 to A3-02	0.1 kg	0.0 kg	☆
A3-50	Lower pressure setting limit during pressure relief when the valve is opening	0.0 to A3-02	0.1 kg	0.0 kg	☆
A3-51	Lower current limit of pressure sensor fault detection	20% to 300%	1%	100%	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A3-52	Upper speed limit of pressure sensor fault detection	20% to 100%	1%	50.0%	☆
A3-53	Falling time of 2nd group of high-speed flow	0.000s to 5.000s	0.001s	0.100s	☆
A3-54	Judging value of 2nd group of high-speed flow	0 to 100.0%	0.1%	100.0%	☆
A3-55	Pressure deviation during pressure relief when the valve is closing	0.0 kg/cm^2 to A3-02	0.1 kg/cm^2	0.0 kg/cm^2	☆
A3-56	Upper torque limit in zero torque mode	0.0% to 250.0%	0.1%	0.00%	☆
A3-57	Upper limit of pressure sensor fault detection (E65.00)	A3-58 to 11.000 V	0.001 V	10.000 V	☆
A3-58	Lower limit of pressure sensor fault detection (E65.00)	0.000 V to A3-57	0.001 V	0 V	☆
A3-59	Pressure sensor fault detection time (E65.00)	0.000s to 60.000s	0.001s	0.000s	☆
A3-60	Pressure sensor signal output mode	0: 0–10 V output (4–20 mA, jumper is required) 1: 1–5 V output 2: 1–6 V output 3: 1–10 V output 4: 0.25–10.25 V output	1	0	☆
A3-61	Update cycle of multi-master pump reference in EST mode 3	10–30 ms	1 ms	10 ms	☆
A3-63	High-voltage/ Low-voltage PI parameter switchover	0: High-voltage/Low-voltage PI parameter switchover disabled 1: High-voltage/Low-voltage PI parameter switchover enabled	1	0	☆
A3-64	1st group of low-voltage control K_p	0.0–800.0	0.1	210.0	☆
A3-65	1st group of low-voltage control T_i	0.001–10.000	0.001	0.500	☆
A3-66	1st group of high-voltage control K_p	0.0–800.0	0.1	260.0	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A3-67	1st group of high-voltage control T_i	0.001–10.000	0.001	0.020	☆
A3-68	Lower-voltage threshold	0.0 to A3-69	0.1 bar	50.0 bar	☆
A3-69	High-voltage threshold	A3-69 to A3-02	0.1 bar	100.0 bar	☆
A3-70	Lower-voltage threshold at stop of the salve pump	A3-71 to A3-02	0.1 bar	0.0 bar	☆
A3-71	Allowable range of oil pressure threshold at stop of the salve pump	0 to A3-70	0.1 bar	0.0 bar	☆
A3-72	Delay of switchover from DI52 function to DI57 function	0.000s to 0.500s	0.001s	0.000s	☆
A3-73	Automatic exit time of DI52 function	0.000s to 0.500s	0.001s	0.000s	☆
Group A4: Optimized Oil Pressure Parameters					
A4-00	Display current filter time	0.000s to 5.000s	0.001s	0.005s	☆
A4-01	Motor speed display filter time	0.000s to 5.000s	0.001s	0.010s	☆
A4-02	Falling time of 1st group of oil pressure references	0.001s to 2.000s	0.001s	0.020s	☆
A4-03	Rising time of 1st group of flow references	0s to 5.000s	0.001s	0.080s	☆
A4-04	Falling time of 1st group of flow references	0s to 5.000s	0.001s	0.080s	☆
A4-05	Reserved	Reserved	-	-	-
A4-06	Flow leakage compensation	0.0% to 50.0%	0.1%	0.0%	☆
A4-08	Min. reverse relief pressure	0.0 kg/cm^2 to A3-02	0.1 kg/cm^2	0.0 kg/cm^2	☆
A4-09	Long-time running protection time for reverse pressure relief	0.0s to 500.0s	0.1s	0.000s	☆
A4-10	Rising S-curve filter time of 2nd group of oil pressure references	0.001s to 1.000s	0.001s	0.030s	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A4-11	Falling S-curve filter time of 2nd group of oil pressure reference	0.001s to 1.000s	0.001s	0.030s	☆
A4-12	Rising time of 2nd group of flow references	0.001s to 5.000s	0.001s	0.080s	☆
A4-13	Falling time of 2nd group of flow references	0.001s to 5.000s	0.001s	0.080s	☆
A4-14	Rising time of 2nd group of oil pressure references	0.001s to 2.000s	0.001s	0.125s	☆
A4-15	Falling time of 2nd group of oil pressure references	0.001s to 2.000s	0.001s	0.150s	☆
A4-16	Overshoot suppression detection level of 2nd group of oil pressure	1–2000	1	80	☆
A4-17	Overshoot suppression coefficient of 2nd group of oil pressure	0.001s to 3.000s	0.001s	0.200s	☆
A4-18	Delay time of 2nd group of oil pressure reference	0.000s to 0.500s	0.001s	0.000s	☆
A4-22	Oil pressure deviation threshold of oil pressure suppression canceling	0 to A3-02	0.1 kg	10.0 kg	☆
A4-23	Max. integral limit deviation	0 to A3-02	0.1 kg	45.0 kg	☆
A4-24	Integral limit mode selection	0–1	1	0	☆
A4-25	Upper increase limit of pressure loop output	0–50.0	0.1s	2.0	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A4-26	Oil pressure PID algorithm selection	0: Standard oil pressure algorithm 1: Specialized algorithm 1 2: Specialized algorithm 2 3: Specialized algorithm 3	1	3	★
A4-29	Overshoot suppression pressure threshold of 1st group of oil pressure impact	0 to 100.0% (Perform overshoot suppression when A4-29 exceeds 100%)	0.1%	70.0%	☆
A4-30	Overshoot suppression coefficient K_d of 1st group of oil pressure impact	0–1.00 (A larger value indicates a stronger suppression)	0.01	0.4	☆
A4-31	Overshoot suppression pressure threshold of 2nd group of oil pressure impact	0 to 100.0% (Perform overshoot suppression when A4-31 exceeds 100%)	0.1%	70.0%	☆
A4-32	Overshoot suppression coefficient K_d of 2nd group of oil pressure impact	0–1.00 (A larger value indicates a stronger suppression)	0.01	0.4	☆
A4-33	Integral regulation coefficient 1 of algorithm 3	0–1.00	0.01	0.08	☆
A4-34	Integral regulation coefficient 2 of algorithm 3	0–1.00	0.01	0.08	☆
A4-35	Integral regulation coefficient 3 of algorithm 3	0–1.00	0.01	0.08	☆
A4-36	Integral regulation coefficient 4 of algorithm 3	0–1.00	0.01	0.08	☆

<table>
<tr><th>Param. No.</th><th>Parameter Name</th><th>Setting Range</th><th>Min. Unit</th><th>Default</th><th>Property</th></tr>
<tr><td colspan="6">Group A6: Multi-Speed Parameters</td></tr>
<tr><td>A6-00</td><td>Speed change point 1 in multi-speed mode</td><td rowspan="16">Set F0-03 (Main frequency source) to 6 (Multi-speed), and set the speed by using DI terminals 12#, 13#, 14#, and 15#. By taking terminals DI1 to DI4 as an example, the following table describes the relationship between terminals and speed segments:
<table><tr><th rowspan="2">Speed Segment</th><th colspan="4">Terminal Status</th></tr><tr><th>DI4
15#</th><th>DI3
14#</th><th>DI2
13#</th><th>DI1
12#</th></tr><tr><td>A6-00</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>A6-01</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>A6-02</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>A6-03</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>A6-04</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>A6-05</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>A6-06</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>A6-07</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>A6-08</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>A6-09</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>A6-10</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>A6-11</td><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>A6-12</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>A6-13</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>A6-14</td><td>1</td><td>1</td><td>1</td><td>0</td></tr><tr><td>A6-15</td><td>1</td><td>1</td><td>1</td><td>1</td></tr></table>Setting range: 1 to A6-16</td><td rowspan="16">1 rpm</td><td rowspan="16">100 rpm</td><td rowspan="16">☆</td></tr>
<tr><td>A6-01</td><td>Speed change point 2 in multi-speed mode</td></tr>
<tr><td>A6-02</td><td>Speed change point 3 in multi-speed mode</td></tr>
<tr><td>A6-03</td><td>Speed change point 4 in multi-speed mode</td></tr>
<tr><td>A6-04</td><td>Speed change point 5 in multi-speed mode</td></tr>
<tr><td>A6-05</td><td>Speed change point 6 in multi-speed mode</td></tr>
<tr><td>A6-06</td><td>Speed change point 7 in multi-speed mode</td></tr>
<tr><td>A6-07</td><td>Speed change point 8 in multi-speed mode</td></tr>
<tr><td>A6-08</td><td>Speed change point 9 in multi-speed mode</td></tr>
<tr><td>A6-09</td><td>Speed change point 10 in multi-speed mode</td></tr>
<tr><td>A6-10</td><td>Speed change point 11 in multi-speed mode</td></tr>
<tr><td>A6-11</td><td>Speed change point 12 in multi-speed mode</td></tr>
<tr><td>A6-12</td><td>Speed change point 13 in multi-speed mode</td></tr>
<tr><td>A6-13</td><td>Speed change point 14 in multi-speed mode</td></tr>
<tr><td>A6-14</td><td>Speed change point 15 in multi-speed mode</td></tr>
<tr><td>A6-15</td><td>Speed change point 16 in multi-speed mode</td></tr>
</table>

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
A6-16	Upper limit of the motor speed	0–65535 rpm	1 rpm	3000 rpm	*
Group F0: Basic Control Parameters					
F0-00	Model selection	1: G type	1	1	●
F0-01	Control mode	0: SVC 1: FVC 2: V/F control	1	1	★
F0-02	Command source	0: Operating panel control 1: Terminal control 2: Communication control	1	0	☆
F0-03	Main frequency source	0: Set by digits, with adjustment using UP or DOWN key (not retentive) 1: Set by digits, with adjustment using UP or DOWN key (retentive) 2: Set by AI1 3: Set by AI2 4: Set by AI3 5 to 8: Reserved 9: Set through Communication	1	0	★
F0-08	Preset frequency	0.00 Hz to Max. frequency (F0-10)	0.01 Hz	100.00 Hz	☆
F0-09	Running direction	0: Run in the default direction 1: Run in the direction reverse to the default direction	1	0	★
F0-10	Max. frequency	50.00–300.00 Hz	0.01 Hz	200.00 Hz	★
F0-11	Setting channel of upper frequency limit	0: Set by F0-12 1: Set by AI1 2: Set by AI2 3: Set by AI3 4: Reserved 5: Set through communication	1	0	★
F0-12	Upper frequency limit	Lower frequency limit (F0-14) to Max. frequency (F0-10)	0.01 Hz	200.00 Hz	☆
F0-13	Offset of upper frequency limit	0.00 Hz to Max. frequency (F0-10)	0.01 Hz	0.00 Hz	☆
F0-14	Lower frequency limit	0.00 Hz to Upper frequency limit (F0-12)	0.01 Hz	0.00 Hz	☆
F0-15	Carrier frequency	2.0–8.0 kHz	0.1 kHz	Model dependent	☆
F0-16	Selection of carrier frequency adjustment with temperature	0: Not adjusted 1: Adjusted	1	1	☆
F0-17	Acceleration time	0.0s to 6500.0s	0.1s	20.0s	☆
F0-18	Deceleration time	0.0s to 6500.0s	0.1s	20.0s	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
Group F1: Motor Parameters					
F1-00	Motor type	0: Asynchronous motor 1: Variable frequency asynchronous motor 2: PMSM	1	2	★
F1-01	Rated power	0.4–1000.0 kW	0.1 kW	Model dependent	★
F1-02	Rated voltage	0–800 V	1 V	Model dependent	★
F1-03	Rated current	0.0–6500.0 A	0.1 A	Model dependent	★
F1-04	Rated frequency	0.00–300.00 Hz	0.01 Hz	Model dependent	★
F1-05	Rated speed	0–30000 rpm	1 rpm	Model dependent	★
F1-11	Shaft D inductance (synchronous motor)	0–65.535 mH	1 mH	Model dependent	★
F1-12	Shaft Q inductance (synchronous motor)	0–65.535 mH	1 mH	Model dependent	★
F1-13	Synchronous motor stator resistance	0–65.535 Ω	1 Ω	Model dependent	★
F1-14	Motor manufacturer selection	0: Disabled 1: Manual input of encoder installation angle (A1-02) 2: Reserved 3: Inovance	1	0	☆
F1-15	Back EMF of synchronous motor	0–65535 V	1 V	Model dependent	★
F1-16	Auto-tuning mode	0: No action 1: No-load static auto-tuning 2: No-load dynamic auto-tuning, high-speed rotation in reverse direction 3: With-load dynamic auto-tuning 4: Rapid no-load dynamic auto-tuning, high-speed rotation in reverse direction 5: No-load dynamic auto-tuning, high-speed rotation in forward direction 6: Rapid no-load dynamic auto-tuning, high-speed rotation in forward direction	1	0	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
Group F2: Vector Control Parameters					
F2-00	Speed loop proportional gain 1	1–400	1	60	☆
F2-01	Speed loop integral time 1	0.01s to 10.00s	0.01s	0.3s	☆
F2-02	Speed loop switchover frequency 1	0.00 Hz to F2-05	0.01 Hz	5.00 Hz	☆
F2-03	Speed loop proportional gain 2	1–400	1	60	☆
F2-04	Speed loop integral time 2	0.01s to 10.00s	0.01s	0.3s	☆
F2-05	Speed loop switchover frequency 2	Speed loop switchover frequency 1 (F2-02) to Max. frequency (F0-10)	0.01 Hz	10.00 Hz	☆
F2-06	Switchover frequency in PWM mode	0.00 Hz to Max. frequency (F0-10)	0.01 Hz	0.00 Hz	☆
F2-07	Speed feedback filter time	0.5–10.0 ms	0.1 ms	1.0 ms	☆
F2-08	Torque control selection	0: Speed control 1: Torque control	0	0	☆
F2-09	Torque source selection	0: Set by parameter F2-10 1: Set by AI1 2: Set by AI2 3: Set by AI3 4: Reserved 5: Set through Communication	0	0	☆
F2-10	Upper torque limit	0.0% to 250.0%	0.1%	200.0%	☆
F2-11	Torque filter bandwidth	0–1500 Hz	1 Hz	500 Hz	☆
F2-12	VC overvoltage suppression	0: Disabled 1: Enabled	1	0	☆
F2-13	Current loop low-speed proportional gain	0.2–5.0	0.1	1.0	★
F2-14	Current loop low-speed integral gain	0.2–5.0	0.1	1.0	★
F2-15	Current loop high-speed proportional gain	0.2–5.0	0.1	1.0	★
F2-16	Current loop high-speed integral gain	0.2–5.0	0.1	1.0	★
F2-17	High-speed adjustment of M-axis current loop	1% to 100%	1%	1%	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F2-18	High-speed adjustment of T-axis current loop	1% to 100%	1%	1%	☆
F2-19	VC excitation boost	0 to 20.0%	0.1%	0.1%	☆
F2-20	ASR position lock switchover frequency	0 Hz to Max. frequency (F0-10)	0.01 Hz	50.00 Hz	★
F2-21	VC slip compensation coefficient	0.5% to 2.00%	0.01%	0.7%	☆
F2-22	VC oscillation suppression mode	0–2	1	0	☆
F2-23	VC oscillation suppression gain	0–100	1	0	☆
F2-24	VC overexcitation gain	0–200	1	0	☆
F2-25	Overvoltage modulation coefficient	100% to 120%	1%	110%	☆
F2-26	Bus voltage filter	0.000–0.100	0.001	0.000	☆
F2-29	Back EMF compensation	0: Disabled 1: Enabled	1	0	★
F2-30	Speed loop parameter enabling	0: Disabled 1: Enabled	1	0	★
F2-31	Expected speed loop bandwidth at high speed	1.0–200.0 Hz	0.1 Hz	10.0 Hz	☆
F2-32	Expected speed loop bandwidth at low speed	1.0–200.0 Hz	0.1 Hz	10.0 Hz	☆
F2-33	Expected speed loop bandwidth at zero speed	1.0–200.0 Hz	0.1 Hz	10.0 Hz	☆
F2-34	Speed loop stiffness level	1–9	1	7	☆
F2-35	System inertia	0.001–50.000	0.001	0.001	★
F2-36	Motor inertia	0.001–50.000	0.001	0.001	★
F2-37	Max. frequency for inertia identification	20% to 100%	1%	80%	★
F2-38	Acceleration/ Deceleration time for inertia identification	1.0s to 50.0s	0.1s	15.0s	★
F2-39	Bandwidth 1 for speed loop dynamic optimization test	1.0–200.0 Hz	0.1 Hz	5.0 Hz	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F2-40	Bandwidth 2 for speed loop dynamic optimization test	1.0–200.0 Hz	0.1 Hz	10.0 Hz	★
F2-41	Bandwidth 3 for speed loop dynamic optimization test	1.0–100.0 Hz	0.1 Hz	15.0 Hz	★
F2-42	Bandwidth 4 for speed loop dynamic optimization test	1.0–200.0 Hz	0.1 Hz	20.0 Hz	★
F2-43	Inertia identification and dynamic set speed	0 to 100%	1%	30%	★
F2-44	Rotor time constant checking	0: Disabled 1: Enabled	1	0	★
F2-45	Rotor time constant checking torque	10% to 100%	1%	30%	★
F2-46	Number of times of rotor time constant checking	1–6	1	3	★
F2-47	Inertia identification	0: Disabled 1: Enabled	1	0	★
F2-48	Setting value of speed loop bandwidth during inertia identification	0.1–100.0 Hz	0.1 Hz	10.0 Hz	★
F2-49	Inertia identification direction	0–1	1	1	★
F2-50	Inertia identification mode	0–1	1	0	★
F2-51	Acceleration/ Deceleration coefficient of inertia identification	0.1–10.0	0.1	1	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
Group F3: V/F Control Parameters					
F3-00	V/F curve selection	0: Linear V/F 1: Multi-point V/F 2: Square V/F 3: 1.2-power V/F 4: 1.4-power V/F 6: 1.6-power V/F 8: 1.8-power V/F 9: Reserved 10: V/F complete separation 11: V/F half separation	0	0	★
F3-01	Torque boost	0.0% to 30.0%	0.1%	1.0%	☆
F3-02	Torque boost cut-off frequency	0.00 Hz to F0-10	0.01 Hz	50.00 Hz	★
F3-03	Multi-point V/F frequency 1	0.00 Hz to F3-05	0.01 Hz	0.00 Hz	★
F3-04	Multi-point V/F voltage 1	0.0% to 100.0%	0.1%	0.0%	★
F3-05	Multi-point V/F frequency 2	0.00 Hz to F3-07	0.01 Hz	0.00 Hz	★
F3-06	Multi-point V/F voltage 2	0.0% to 100.0%	0.1%	0.0%	★
F3-07	Multi-point V/F frequency 3	0.00 Hz to F1-04	0.01 Hz	0.00 Hz	★
F3-08	Multi-point V/F voltage 3	0.0% to 100.0%	0.1%	0.0%	★
F3-09	V/F slip compensation coefficient	0.0% to 200.0%	0.1%	0.0%	☆
F3-10	V/F overexcitation gain	0–200	1	64	☆
F3-11	V/F oscillation suppression gain	0–100	1	0	☆
F3-12	VC oscillation suppression mode	0–3	1	3	★
F3-13	Voltage source for V/F separation	0–8	1	0	☆
F3-14	Digital setting of voltage source for V/F separation	0 to F1-02	0	0	☆
F3-15	Voltage rising time for V/F separation	0–1000.0	0.1	0	☆
F3-16	Voltage deceleration time for V/F separation	0–1000.0	0.1	0	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F3-17	Stop mode selection for V/F separation	0–1	1	0	★
F3-18	V/F overcurrent stall actuating current	0–200	1	130	★
F3-19	V/F overcurrent stall enabling	0–1	1	1	★
F3-20	V/F overcurrent stall suppression gain	0–100	1	20	☆
F3-21	Compensation coefficient of V/F overcurrent stall actuating current	50–200	1	50	★
F3-22	V/F overvoltage stall actuating voltage	650.0–800.0 V	0.1 V	780.0 V	★
F3-23	V/F overvoltage stall enabling	0–1	1	1	★
F3-24	V/F overvoltage stall suppression frequency gain	0–100	1	30	☆
F3-25	V/F overvoltage stall suppression voltage gain	0–100	1	30	☆
F3-26	Max. frequency rise threshold during V/F overvoltage stall	0–50	1	5	★
F3-27	Slip compensation time constant	0.1–10.0	0.1	0.5	☆
F3-28	Automatic frequency rise function	0–1	1	0	★
F3-29	Min. electrical torque current	10–100	1	50	★
F3-30	Max. electrical torque current	10–100	1	20	★
F3-31	Automatic frequency rise K_P	0–100	1	50	☆
F3-32	Automatic frequency rise K_I	0–100	1	50	☆
F3-33	Online torque compensation gain	80–150	1	100	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
Group F4: Input Terminals					
F4-00	DI1 terminal function selection	0: No function 1: Forward running enabled 2: Reverse running enabled 3: Three-wire control 4: Forward jog enabled 5: Reverse jog enabled 6 and 7: Reserved 8: Coast to stop 9: Fault reset 10: Reserved 11: External fault NO input 12: Multi-speed terminal 1 13: Multi-speed terminal 2 14: Multi-speed terminal 3 15: Multi-speed terminal 4 16 and 17: Reserved 18: Frequency source switchover 19 to 32: Reserved 33: External fault NC input 34 to 38: Reserved 39: Switchover between frequency source X and preset frequency 40: Switchover between frequency source Y and preset frequency 41 to 47: Reserved 48: PID selection terminal 1 for servo hydraulic pump 49: PID selection terminal 2for servo hydraulic pump 50: CAN communication enabled 51: Enabling the slave serving as the master 52: Switchover from pressure mode to speed mode (Upper torque limit: AI1/Max. voltage X A3-30) 53: Slave pump address selection terminal 1 54: Slave pump address selection terminal 2 55: Terminal used for switchover from injection to pressure holding 56: Fault reset terminal 2 (The overcurrent fault cannot be reset.) 57: Switchover from pressure mode to speed mode (The upper torque limit is F2-10.)	1	1	★
F4-01	DI2 terminal function selection		1	48	★
F4-02	DI3 terminal function selection		1	53	★
F4-03	DI4 terminal function selection		1	9	★
F4-04	DI5 terminal function selection		1	50	★
F4-05	DI6 terminal function selection (control card)		1	0	★
F4-06	DI7 terminal function selection (control card)		1	0	★
F4-07	DI8 terminal function selection (control card)		1	0	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F4-15	DI terminal input valid filter time	1–10	1	4	☆
F4-18	Min. AI1 input	0–10 V	0.01 V	0.02 V	☆
F4-19	Corresponding value of min. AI1 input	-100.0% to +100.0%	0.1%	0.0%	☆
F4-20	Max. AI1 input	0–10 V	0.01 V	10.00 V	☆
F4-21	Corresponding value of max. AI1 input	-100.0% to +100.0%	0.1%	100.0%	☆
F4-22	AI1 input filter time	0.000s to 10.000s	0.001s	0.01s	☆
F4-23	Min. AI2 input	0–10 V	0.01 V	0.02 V	☆
F4-24	Corresponding value of min. AI2 input	-100.0% to +100.0%	0.1%	0.0%	☆
F4-25	Max. AI2 input	0–10 V	0.01 V	10.00 V	☆
F4-26	Corresponding value of max. AI2 input	-100.0% to +100.0%	0.1%	100.0%	☆
F4-27	AI2 input filter time	0.000s to 10.000s	0.001s	0.005s	☆
F4-28	Min. AI3 input	0–10 V	0.01 V	0.02 V	☆
F4-29	Corresponding value of min. AI3 input	-100.0% to +100.0%	0.1%	0.0%	☆
F4-30	Max. AI3 input	0–10 V	0.01 V	10.00 V	☆
F4-31	Corresponding value of max. AI3 input	-100.0% to +100.0%	0.1%	100.0%	☆
F4-32	AI3 input filter time	0.000s to 10.000s	0.001s	0.000s	☆
F4-43	Displayed AI1 voltage 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F4-44	Measured AI1 voltage 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F4-45	Displayed AI1 voltage 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F4-46	Measured AI1 voltage 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F4-47	Displayed AI2 voltage 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F4-48	Measured AI2 voltage 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F4-49	Displayed AI2 voltage 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F4-50	Measured AI2 voltage 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F4-51	Displayed AI3 voltage 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F4-52	Measured AI3 voltage 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F4-53	Displayed AI3 voltage 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F4-54	Measured AI3 voltage 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
Group F5: Output Terminals					
F5-01	Control board relay (T/A1-T/B1-T/C1) output selection	0: No output 1: Servo drive in running state 2: Fault output 3 to 5: Reserved 6: Motor overload pre-warning 7: Servo drive overload pre-warning 8 to 11: Reserved 12: Accumulative running time reached 13 and 14: Reserved 15: Ready for run 16: AI1 absolute value calibrated by users greater than AI2 absolute value 17 to 19: Reserved 20: Communication setting 21 and 22: Reserved 23: Swashplate switchover 1 of double-discharge piston pump 24: Pressure control status output 25: Slave pump warning output 26: Swashplate switchover 2 of double-discharge piston pump 27: Bus voltage establishment 28: Business running time reached 29: Business running time less than 24 h 30: DO output of max. reverse speed 31: Warning output 32: KTY temperature reached output	1	2	☆
F5-02	Control board relay (T/A2-T/C2) output selection		1	23	☆
F5-03	DO1 output selection		1	24	☆
F5-10	AO1 output selection	0: Running frequency 1: Set frequency 2: Output current 3: Output torque 4: Output power 5: Output voltage 6: Reserved 7: AI1 voltage 8: AI2 voltage 9: AI3 voltage 10: Feedback speed 11: Feedback pressure 14: Communication control 12 to 16: Reserved	1	10	☆
F5-11	AO2 output selection		1	11	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F5-14	AO1 output zero offset coefficient	-100.0% to +100.0%	0.1%	0.0%	☆
F5-15	AO1 gain	-10.00 to +10.00	0.01	1.00	☆
F5-16	AO2 output zero offset coefficient	-100.0% to +100.0%	0.1%	0.0%	☆
F5-17	AO2 gain	-10.00 to +10.00	0.01	1.00	☆
F5-23	Measured AO1 value 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F5-24	Theoretical AO1 output value 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F5-25	Measured AO1 value 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F5-26	Theoretical AO1 output value 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F5-27	Measured AO2 value 1	-9.999 V to+9.999 V	0.001 V	2.000 V	☆
F5-28	Theoretical AO2 output value 1	-9.999 V to +9.999 V	0.001 V	2.000 V	☆
F5-29	Measured AO2 value 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
F5-30	Theoretical AO2 output value 2	-9.999 V to +9.999 V	0.001 V	8.000 V	☆
Group F6: Start/Stop Control Parameters					
F6-10	Stop mode	0: Decelerate to stop 1: Coast to stop	1	0	☆
Group F7: Operating Panel and Display Parameters					
F7-02	STOP/RESET key function	0: STOP/RESET key enabled for both stop and fault reset only in the operating panel control mode 1: STOP/RESET key enabled for stop in terminal control mode 2: STOP/RESET key enabled for fault reset in terminal control mode 3: STOP/RESET key enabled for both stop and fault reset in terminal control mode	1	2	☆
F7-04	LED display of running parameters	H.0000 to H.FFFF	1	H.0270	☆
F7-05	LED display of stop parameters	H.0000 to H.0FFF	1	H.0473	☆
F7-06	Load linear velocity display coefficient	0.0001–6.5000	0.0001	1.0000	☆
F7-07	Heatsink temperature	-1000°C to +1000°C	1°C	-	●
F7-09	Accumulative running time	0–65535 h	1 h	-	●
F7-10	Software version number 1	-	-	-	●
F7-11	Software version number 2	-	-	-	●

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F7-12	Temporary software version number 1	-	-	-	●
F7-13	Temporary software version number 2	-	-	-	●
F7-14	Software version number of 23-bit PG card (The resolver PG card does not have a software version number.)	-	-	-	●
Group F8: Auxiliary Function Parameters					
F8-17	Set running time	0–65000 h	1 h	0 h	☆
F8-18	Startup protection	0: Disabled 1: Enabled	1	0	☆
F8-22	Detection of short circuit to ground at power-on	0: Disabled 1: Enabled	1	1	☆
F8-23	Action selection when the accumulative running time is reached	0: Disabled 1: Enabled	1	0	☆
F8-24	Software undervoltage threshold	148.5–321.7 VAC (AC voltage input, bus voltage = AC voltage input x $\sqrt{2}$)	0.1 V	247.5 V	☆
F8-25	Allowable braking unit enabling time	0.0s to 3600.0s	0.1s	5.0s	☆
F8-27	Short-circuit to ground protection before running	0: Disabled 1: Enabled	1	0	☆
F8-28	Output phase loss protection before running	0: Disabled 1: Enabled	1	0	☆
Group F9: Protection and Fault Parameters					
F9-08	Braking transistor applied voltage	220 V model: 373.2–466.6 V	0.1 V	400.0 V	☆
		380 V model: 644.7–780 V		760.0 V	
F9-12	Input phase loss protection	0: Disabled 1: Enabled	1	1	☆
F9-13	Output phase loss protection	0: Disabled 1: Enabled	1	1	☆
F9-14	Detection value of excessive speed deviation	0.50–50.00 Hz	0.01 Hz	10.00 Hz	☆
F9-15	Detection time of excessive speed deviation	0.0s to 40.0s	0.1s	10.0s	☆
F9-16	Motor overtemperature protection	0: Disabled 1: Enabled	1	1	☆
F9-17	Motor rotor locked judging time	0.000s to 65.535s	0.001s	0.500s	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F9-18	1st fault type	0: No fault 1: Detection circuit fault (E01) 2: Overcurrent during acceleration (E02) 3: Overcurrent during deceleration (E03) 4: Overcurrent at constant speed (E04) 5: Overvoltage during acceleration (E05) 6: Overvoltage during deceleration (E06) 7: Overvoltage at constant speed (E07) 8: Pre-charge resistor fault (E08) 9: Undervoltage (E09) 10: Drive overload (E10) 11: Motor overload (E11) 12: Input phase loss (E12) 13: Output phase loss (E13) 14: IGBT overheating (E14) 15: External input fault (E15) 16: Serial port communication fault (E16) 17: Contactor fault (E17) 18: Current detection fault (E18) 19: Motor auto-tuning fault (E19) 20: Encoder fault (E20) 21: EEPROM reading/writing fault (E21) 22: Reserved (E22) 23: Short circuit to ground (E23) 24: Output inter-phase short circuit (E24) 25: EEPROM address incorrect (E25) 26: Accumulative running time reached (E26) 27: Business running time reached (E27) 30: Output load loss(E30) 40: Pulse-by-pulse current limit fault (E40) 41: Reserved 42: CAN communication fault (E42) 43: Encoder fault during motor auto-tuning (E43) 44: Speed deviation protection fault (E44) 45: Motor overheating (E45) 46: Pressure sensor fault (E46) 47: Salve fault in multi-pump convergent flow mode (E47) 48: Station number conflict (E48) 49: Encoder fault (E49) 52: Multi-master fault in multi-pump convergent flow mode (E52) 58: Parameter restoring fault (E58) 59: Back EMF fault during auto-tuning (E59) 61: Braking transistor working overtime (E61) 62: Braking transistor fault (E62) 63: Reverse running time reached (E63) 66: Regenerative resistor fault (E66) 67: Parameter initialization abnormal (E67)	1	-	●
F9-19	2nd fault type		1	-	●
F9-20	3rd (latest) fault type		1	-	●

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F9-21	Frequency upon 3rd fault	-	-	-	●
F9-22	Current upon 3rd fault	-	-	-	●
F9-23	Bus voltage upon 3rd fault	-	-	-	●
F9-24	Input terminal status upon 3rd fault	-	-	-	●
F9-25	Output terminal status upon 3rd fault	-	-	-	●
F9-26	3rd fault subtype	-	-	-	●
F9-30	Frequency upon 2nd fault	-	-	-	●
F9-31	Current upon 2nd fault	-	-	-	●
F9-32	Bus voltage upon 2nd fault	-	-	-	●
F9-33	Input terminal status upon 2nd fault	-	-	-	●
F9-34	Output terminal status upon 2nd fault	-	-	-	●
F9-35	2nd fault subtype	-	-	-	●
F9-39	Frequency upon 1st fault	-	-	-	●
F9-40	Current upon 1st fault	-	-	-	●
F9-41	Bus voltage upon 1st fault	-	-	-	●
F9-42	Input terminal status upon 1st fault	-	-	-	●
F9-43	Output terminal status upon 1st fault	-	-	-	●
F9-44	1st fault subtype	-	-	-	●
F9-48	Digital output when KTY temperature reached	0–300.0	0.1	0	☆
F9-58	KTY temperature	-40.0°C to +300.0°C	0.1°C	-	●
F9-59	KTY fault temperature threshold	-40.0°C to +300.0°C	0.1°C	130.0	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F9-61	Fault protection action selection	Tens: undervoltage (09) 0: Coast to stop Hundreds: Drive overload (10) 0: Coast to stop 1: Decelerate to stop	1	6000	★
F9-62	Fault protection action selection	Ones: Input phase loss (12) 0: Coast to stop 1: Decelerate to stop Tens: Output phase loss (13) 0: Coast to stop 1: Decelerate to stop Hundreds: Heatsink overheating (14) 0: Coast to stop 1: Decelerate to stop Thousands: External fault (15) 0: Coast to stop 1: Decelerate to stop	1	0	★
F9-63	Fault protection action selection	Ones: 485 communication fault (16) 0: Coast to stop 1: Decelerate to stop	1	0	★
F9-65	Fault protection action selection	Hundreds: Accumulative running time reached (26) 0: Coast to stop 1: Decelerate to stop Thousands: Business running time reached (27) 0: Coast to stop 1: Decelerate to stop	1	0	★
F9-69	Fault protection action selection	Hundreds: CAN communication fault (42) 0: Coast to stop 1: Decelerate to stop Thousands: Auto-tuning fault (43) 0: Coast to stop	1	0	★
F9-70	Fault protection action selection	Ones: runaway (44) 0: Coast to stop 1: Decelerate to stop Tens: Motor temperature fault (45) 0: Coast to stop 1: Decelerate to stop Hundreds: Sensor fault (46) 0: Coast to stop 1: Decelerate to stop	1	0	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
F9-71	Fault protection action selection	Ones: CAN address conflict (48) 0: Coast to stop 1: Decelerate to stop Tens: Resolver PG card cable disconnection (49) 0: Coast to stop 1: Decelerate to stop	1	0	★
F9-72	Fault protection action selection	Ones: Multi-master fault in multi-pump convergent flow mode (52) 0: Coast to stop 1: Decelerate to stop	1	0	★
F9-73	Fault protection action selection	Thousands: Back EMF fault during auto-tuning (59) 0: Coast to stop 1: Decelerate to stop	1	0	★
F9-74	Fault protection action selection	Thousands: Reverse running time reached (63) 0: Coast to stop 1: Decelerate to stop	1	0	★
F9-87	Runaway protection judging time	0.000s to 5.000s	0.001s	0.030s	☆
Group FA: Business Timing Running Parameters					
These parameters cannot be read and written and are not displayed in the software.					
FA-00	First running time protection password	0–65535	1	0	☆
FA-01	Timed first running time	0–65535 h	1 h	0	☆
FA-02	Second running time protection password	0–65535	1	0	☆
FA-03	Timed second running time	0–65535 h	1 h	0:	☆
FA-04	Third running time protection password	0–65535	1	0	☆
FA-05	Timed third running time	0–65535 h	1 h	0:	☆
FA-06	Fourth running time protection password	0–65535	1	0	☆
FA-07	Timed fourth running time	0–65535 h	1 h	0	☆
FA-08	Accumulative business running time (hour)	0–65535 h	1 h	0	●

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
FA-09	Accumulative business running time (second)	0s to 3600s	1s	0	●
Group FB: Optimized Parameter					
FB-04	Pulse-by-pulse current limit function	0: Disabled 1: Enabled	1	1	★
Group FC: Multi-Point AI Check Parameters					
FC-00	Multi-point AI1 check	0: No check 1: Multi-point check of AI1 2: Multi-point check of AI2 3: Multi-point check of AI1 and AI2	0	0	★
FC-01	Min. AI1 input	0–10 V	0.01 V	0.02 V	☆
FC-02	Corresponding value of min. AI1 input	-100.0% to +100.0%	0.1%	0.0%	☆
FC-03	AI1 inflexion point 1 input	0–10 V	0.01 V	1.00 V	☆
FC-04	Corresponding value of AI1 inflexion point 1 input	-100.0% to +100.0%	0.1%	10.0%	☆
FC-05	AI1 inflexion point 2 input	0–10 V	0.01 V	2.00 V	☆
FC-06	Corresponding value of AI1 inflexion point 2 input	-100.0% to +100.0%	0.1%	20.0%	☆
FC-07	AI1 inflexion point 3 input	0–10 V	0.01 V	3.00 V	☆
FC-08	Corresponding value of AI1 inflexion point 3 input	-100.0% to +100.0%	0.1%	30.0%	☆
FC-09	AI1 inflexion point 4 input	0–10 V	0.01 V	4.00 V	☆
FC-10	Corresponding value of AI1 inflexion point 4 input	-100.0% to +100.0%	0.1%	40.0%	☆
FC-11	AI1 inflexion point 5 input	0–10 V	0.01 V	5.00 V	☆
FC-12	Corresponding value of AI1 inflexion point 5 input	-100.0% to +100.0%	0.1%	50.0%	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
FC-13	AI1 inflexion point 6 input	0–10 V	0.01 V	6.00 V	☆
FC-14	Corresponding value of AI1 inflexion point 6 input	-100.0% to +100.0%	0.1%	60.0%	☆
FC-15	AI1 inflexion point 7 input	0–10 V	0.01 V	7.00 V	☆
FC-16	Corresponding value of AI1 inflexion point 7 input	-100.0% to +100.0%	0.1%	70.0%	☆
FC-17	AI1 inflexion point 8 input	0–10 V	0.01 V	8.00 V	☆
FC-18	Corresponding value of AI1 inflexion point 8 input	-100.0% to +100.0%	0.1%	80.0%	☆
FC-19	AI1 inflexion point 9 input	0–10 V	0.01 V	9.00 V	☆
FC-20	Corresponding value of AI1 inflexion point 9 input	-100.0% to +100.0%	0.1%	90.0%	☆
FC-21	AI1 inflexion point 10 input	0–10 V	0.01 V	10.00 V	☆
FC-22	Corresponding value of AI1 inflexion point 10 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-23	AI1 inflexion point 11 input	0–10 V	0.01 V	10.00 V	☆
FC-24	Corresponding value of AI1 inflexion point 11 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-25	AI1 inflexion point 12 input	0–10 V	0.01 V	10.00 V	☆
FC-26	Corresponding value of AI1 inflexion point 12 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-27	AI1 inflexion point 13 input	0–10 V	0.01 V	10.00 V	☆
FC-28	Corresponding value of AI1 inflexion point 13 input	-100.0% to +100.0%	0.1%	100.0%	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
FC-29	AI1 inflexion point 14 input	0–10 V	0.01 V	10.00 V	☆
FC-30	Corresponding value of AI1 inflexion point 14 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-31	AI1 inflexion point 15 input	0–10 V	0.01 V	10.00 V	☆
FC-32	Corresponding value of AI1 inflexion point 15 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-33	AI1 inflexion point 16 input	0–10 V	0.01 V	10.00 V	☆
FC-34	Corresponding value of AI1 inflexion point 16 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-35	AI1 inflexion point 17 input	0–10 V	0.01 V	10.00 V	☆
FC-36	Corresponding value of AI1 inflexion point 17 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-37	Max. AI1 input	0–10 V	0.01 V	10.00 V	☆
FC-38	Corresponding value of max. AI1 input	-100.0% to +100.0%	0.1%	100.0%	☆
FC-39	Min. AI2 input	0–10 V	0.01 V	0.02 V	☆
FC-40	Corresponding value of min. AI2 input	-100.0% to +100.0%	0.1%	0.0%	☆
FC-41	AI2 inflexion point 1 input	0–10 V	0.01 V	1.00 V	☆
FC-42	Corresponding value of AI2 inflexion point 1 input	-100.0% to +100.0%	0.1%	10.0%	☆
FC-43	AI2 inflexion point 2 input	0–10 V	0.01 V	2.00 V	☆
FC-44	Corresponding value of AI2 inflexion point 2 input	-100.0% to +100.0%	0.1%	20.0%	☆
FC-45	AI2 inflexion point 3 input	0–10 V	0.01 V	3.00 V	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
FC-46	Corresponding value of AI2 inflexion point 3 input	-100.0% to +100.0%	0.1%	30.0%	☆
FC-47	AI2 inflexion point 4 input	0–10 V	0.01 V	4.00 V	☆
FC-48	Corresponding value of AI2 inflexion point 4 input	-100.0% to +100.0%	0.1%	40.0%	☆
FC-49	AI2 inflexion point 5 input	0–10 V	0.01 V	5.00 V	☆
FC-50	Corresponding value of AI2 inflexion point 5 input	-100.0% to +100.0%	0.1%	50.0%	☆
FC-51	AI2 inflexion point 6 input	0–10 V	0.01 V	6.00 V	☆
FC-52	Corresponding value of AI2 inflexion point 6 input	-100.0% to +100.0%	0.1%	60.0%	☆
FC-53	AI2 inflexion point 7 input	0–10 V	0.01 V	7.00 V	☆
FC-54	Corresponding value of AI2 inflexion point 7 input	-100.0% to +100.0%	0.1%	70.0%	☆
FC-55	AI2 inflexion point 8 input	0–10 V	0.01 V	8.00 V	☆
FC-56	Corresponding value of AI2 inflexion point 8 input	-100.0% to +100.0%	0.1%	80.0%	☆
FC-57	AI2 inflexion point 9 input	0–10 V	0.01 V	9.00 V	☆
FC-58	Corresponding value of AI2 inflexion point 9 input	-100.0% to +100.0%	0.1%	90.0%	☆
FC-59	Max. AI2 input	0–10 V	0.01 V	10.00 V	☆
FC-60	Corresponding value of max. AI2 input	-100.0% to +100.0%	0.1%	100.0%	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
Group FD: Communication and Oscilloscope Parameters					
FD-00	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	1	5	☆
FD-01	Data format	0: No check (8-N-2) 1: Even parity check 2: Odd parity check 3: No check (8-N-1)	1	0	☆
FD-02	Local address	0–247	1	1	☆
FD-03	Response delay	0–20 ms	1 ms	2 ms	☆
FD-04	Communication timeout	0.0s to 60.0s	0.1s	0.0s	☆
FD-30	software oscilloscope start/ stop	0: Stop 1: Start	1	0.0	☆
FD-31	Channel 1 variable ID	0–999	1	10	☆
FD-32	Channel 2 variable ID	0–999	1	10	☆
FD-33	Channel 3 variable ID	0–999	1	10	☆
FD-34	Channel 4 variable ID	0–999	1	10	☆
FD-35	Sampling interval	0–65535	1	1	☆
FD-36	Triggering object A	0–999	1	1	☆
FD-37	Triggering condition A	0–2	1	0	☆
FD-38	Triggering level A	0–65535	1	0	☆
FD-39	Triggering object B	0–999	1	1	☆
FD-40	Triggering condition B	0–2	1	0	☆
FD-41	Triggering level B	0–65535	1	0	☆
FD-42	Triggering group selection	0: Group A 1: Group B	1	0	☆
FD-43	Carrier frequency cycle of data storage time	0–65535	1	0	★
FD-44	Fault value	0–65535	1	0	★
FD-45	Stored setting value	0–2	1	0	☆
FD-46	Data reading mode for host controller	0: RAM 1: FLASH	1	0	☆
FD-47	Flash rewriting	0–1	1	1	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
Group FE: Use-Defined Parameters					
FE-00	User-defined parameter 0	F0.00 to FP.xx A0.00 to A4.xx U0.00 to U1.xx	-	-	☆
FE-01	User-defined parameter 1		-	-	☆
FE-02	User-defined parameter 2		-	-	☆
FE-03	User-defined parameter 3		-	-	☆
FE-04	User-defined parameter 4		-	-	☆
FE-05	User-defined parameter 5		-	-	☆
FE-06	User-defined parameter 6		-	-	☆
FE-07	User-defined parameter 7		-	-	☆
FE-08	User-defined parameter 8		-	-	☆
FE-09	User-defined parameter 9		-	-	☆
FE-10	User-defined parameter 10		-	-	☆
FE-11	User-defined parameter 11		-	-	☆
FE-12	User-defined parameter 12		-	-	☆
FE-13	User-defined parameter 13		-	-	☆
FE-14	User-defined parameter 14		-	-	☆
FE-15	User-defined parameter 15		-	-	☆
Group FP: User Parameters					
FP-00	User password	0–65535	1	0	☆
FP-01	Parameter initialization	0: No operation 1: Restore factory parameters 2: Clear fault records 3: Restore user-defined parameters 4: Restore factory parameters (excluding A2-01) 5: Restore all parameters to default settings (excluding groups FP and FA, parameter backup is required)	1	0	★

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
FP-02	Motor model	0–65535 If Inovance motor is used, set FP-02 (Motor model) to corresponding motor ID, and parameters in group F1 will be automatically written into the drive. See "Appendix F List of Motor IDs and Motor Models" on page 219 for motor ID and model. Note: When using this function, make sure correct wiring of UVW output. After FP-02 is set properly, it is recommended to input motor parameters manually, set F1-16 to 1, and then perform auto-tuning to avoid wrong wiring.	1	0	★
FP-04	User parameter storage password	0–65535	1	0	☆
FP-05	User parameter storage (Advanced password is required if there is a password)	0: No operation 1: Store user parameters (Advanced password is required if there is a password)	1	0	★
FP-06	LCD panel specification display in both Chinese and English	0–65535	1	0	☆
Group AF: Communication Process Data (only displayed in CANopen mode)					
AF-00	Communication process data	0 to 0xffff	1	0x2010	☆
AF-02	Communication process data	0 to 0xffff	1	0x2020	☆
AF-04	Communication process data	0 to 0xffff	1	0x0000	☆
AF-06	Communication process data	0 to 0xffff	1	0x0000	☆
AF-08	Communication process data	0 to 0xffff	1	0x0000	☆
AF-10	Communication process data	0 to 0xffff	1	0x0000	☆
AF-12	Communication process data	0 to 0xffff	1	0x0000	☆
AF-14	Communication process data	0 to 0xffff	1	0x0000	☆

Param. No.	Parameter Name	Setting Range	Min. Unit	Default	Property
AF-16	Communication process data	0 to 0xffff	1	0x0000	☆
AF-18	Communication process data	0 to 0xffff	1	0x0000	☆
AF-20	Communication process data	0 to 0xffff	1	0x0000	☆
AF-22	Communication process data	0 to 0xffff	1	0x0000	☆
AF-24	Communication process data	0 to 0xffff	1	0x0000	☆
AF-26	Communication process data	0 to 0xffff	1	0x0000	☆
AF-28	Communication process data	0 to 0xffff	1	0x0000	☆
AF-30	Communication process data	0 to 0xffff	1	0x0000	☆
AF-32	Communication process data	0 to 0xffff	1	0x2070	☆
AF-34	Communication process data	0 to 0xffff	1	0x2070	☆
AF-36	Communication process data	0 to 0xffff	1	0x2070	☆
AF-38	Communication process data	0 to 0xffff	1	0x2080	☆
AF-40	Communication process data	0 to 0xffff	1	0x2070	☆
AF-42	Communication process data	0 to 0xffff	1	0x2070	☆
AF-44	Communication process data	0 to 0xffff	1	0x0000	☆
AF-46	Communication process data	0 to 0xffff	1	0x0000	☆
AF-48	Communication process data	0 to 0xffff	1	0x0000	☆
AF-50	Communication process data	0 to 0xffff	1	0x0000	☆
AF-52	Communication process data	0 to 0xffff	1	0x0000	☆
AF-54	Communication process data	0 to 0xffff	1	0x0000	☆
AF-56	Communication process data	0 to 0xffff	1	0x0000	☆
AF-58	Communication process data	0 to 0xffff	1	0x0000	☆
AF-60	Communication process data	0 to 0xffff	1	0x0000	☆
AF-62	Communication process data	0 to 0xffff	1	0x0000	☆

C.2 Monitoring Parameters

Parameter No.	Parameter Name	Setting Range	Min. Unit
Group U0: Running Monitoring Parameters			
U0-00	Running frequency	-650.00 Hz to +650.00 Hz	0.01 Hz
U0-01	Frequency reference	-650.00 Hz to +650.00 Hz	0.01 Hz
U0-02	Bus voltage	0.0–1000.0 V	0.1 V
U0-03	Output voltage	0 V to F02.03	1 V
U0-04	Output current	0.1–6553.5 A	0.1 A
U0-05	Output power	0.4–1000.0 kW	0.1 kW
U0-06	Output torque	0% to 200%	0.1
U0-07	DI status	-	-
U0-08	Output relay status	-	-
U0-09	Voltage after AI1 correction	-10.00 V to +10.000 V	0.001 V
U0-10	Voltage after AI2 correction	-10.00 V to +10.000 V	0.001 V
U0-11	Voltage after AI3 correction	-10.00 V to +10.000 V	0.001 V
U0-12	Mechanical angle of the resolver	1–4096	1
U0-13	Reserved	-	-
U0-14	Motor speed	-9999 rpm to +32767 rpm	1
U0-15 to U0-18	Reserved	-	-
U0-19	Set speed	-9999 rpm to +32767 rpm	1 rpm
U0-20	Motor feedback frequency Q15	0–65535	1
U0-21 to U0-24	Reserved	-	-
U0-25	Accumulative overload value	0–36000	1.0
U0-28	Current at the occurrence of overcurrent	0.01–655.35 A	0.01 A
U0-29	Overcurrent type	1: Hardware overcurrent 2: Software overcurrent	1
U0-30	Voltage before AI1 correction	-10.000 V to +10.000 V	0.001 V
U0-31	Voltage before AI2 correction	-10.000 V to +10.000 V	0.001 V
U0-32	Voltage before AI3 correction	-10.000 V to +10.000 V	0.001 V
U0-33	Reserved	-	-
U0-34	AO1 output voltage	0.000–10.000 V	0.001 V
U0-35	AO2 output voltage	0.000–10.000 V	0.001 V
U0-36	Real-time angle	0.0° to 359.9°	0.1°
U0-37	Set oil pressure	0.0 kg/cm^2 to A3-02	0.1 kg/cm^2
U0-38	Feedback oil pressure	0.0 kg/cm^2 to A3-02	0.1 kg/cm^2
U0-39	Set motor speed	-9999 rpm to +30000 rpm	1 rpm

Parameter No.	Parameter Name	Setting Range	Min. Unit
U0-40	Feedback motor speed	-9999 rpm to +30000 rpm	1 rpm
U0-41	Actual motor speed	0–65535	1
U0-42	Resolver interference status	0–65535	1
U0-43	Reserved	-	-
U0-44	Reserved	-	-
U0-45	Motor KTY temperature	-40.0°C to +200.0°C	-
U0-46	Number of received CAN frames	0–65535	1
U0-47	Number of CAN transmitting error	0–65535	1
U0-48	Number of CAN receiving error	0–65535	1
U0-49	Number of times of CAN bus disconnection	0–65535	1
Group U1: Oil Pressure Monitoring Parameters			
U1-00	Real-time resolver angle	0.0° to 359.9°	0.1°
U1-01	Set oil pressure	0.0 kg/cm^2 to A3-02	0.1 kg/cm^2
U1-02	Feedback oil pressure	0.0 kg/cm^2 to A3-02	0.1 kg/cm^2
U1-03	Feedback flow	-9999 rpm to +30000 rpm	1 rpm
U1-04	AI1 analog voltage	-9.999 V to +9.999 V	0.001 V
U1-05	AI2 analog voltage	-9.999 V to +9.999 V	0.001 V
U1-06	AI3 analog voltage	-9.999 V to +9.999 V	0.001 V
U1-07	AI1 zero drift	-9.99 V to +9.99 V	0.01 V
U1-08	AI2 zero drift	-9.99 V to +9.99 V	0.01 V
U1-09	AI3 zero drift	-9.99 V to +9.99 V	0.01 V
U1-10	Flow set on the host controller	0.00 Hz to F0-10	0.01 Hz
U1-11	Resolver signal interference status	0–1000 (resolver cable disconnected)	1
U1-12	Oil pressure reference from the host controller	0.0 kg/cm^2 to A3-02	0.1 kg/cm^2
U1-13	CAN communication interference status	0–128 (off-line)	1

Appendix D Use of CANopen

D.1 Servo Drive Parameter Settings

Set parameters in the following order.

Table D-1 Parameter setting in CANopen mode

Parameter No.	Setting Range	Description
A2-00	4: 500 Kbps	Baud rate
A2-01	1–8	Drive station number
A3-00	6	CANopen mode
F0-02	2	Command source from communication

D.2 Default RPDO Setting

By default, the ES510 receives references from the host controller through RPDO1. The mapping objects for RPDO1 include PQ control word, multi-pump control word, pressure reference, and flow reference, as shown in the following table.

Table D-2 Default mapping object for RPDO1

RPDO1: 0x20x (x indicates node ID)				
	Mapping object 1	Mapping object 2	Mapping object 3	Mapping object 4
Object Name	PQ control word	Multi-pump control word	Pressure (0.1 bar)	Flow (0.01%)
Object index	0x2073-01	0x2073-02	0x2073-03	0x7303-04

D.2.1 Description of PQ Control Word

PQ control word includes running modes and running command information of the servo drive. As shown in the following table, the value of reserved bits (Bit3, Bit4, Bit5, and Bits 8 to 15) is 0 and the value of Bit6 and Bit7 is fixed to 1. By adjusting the control word of Bit0, Bit1, and Bit2, you can enable, disable or reset the servo drive.

Table D-3 Content definition of PQ control word

Item	Bits 8 to 15	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Bit description	Reserved	1	1	Reserved	Reserved	Reserved	Control word 001: Forward running 010: Reverse running 101: Coast to stop 110: Decelerate to stop 111: Fault reset		
Forward running (H00C1)	H00	1	1	0	0	0	001		
Coast to stop (H00C5)	H00	1	1	0	0	0	101		

Item	Bits 8 to 15	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Fault reset (H00C7)	H00	1	1	0	0	0	111		

D.2.2 Description of Multi-Pump Control Word

The multi-pump control word is used to set the working mode (master pump mode and slave pump mode) of the servo drive. The control word is 16-bit unsigned integers. For the meaning of each bit, see the following table.

Table D-4 Description of multi-pump control word

Example	Multi-Pump Control Word							
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
H0441	0	1	0	0	0	0	0	1
	Master pump	Slave pump	Master pump	Master pump	Master pump	Master pump	Master pump	Slave pump
Example	Multi-Pump Control Word							
	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
H0441	-	0	0	0	0	1	0	0
	-	Master pump	Master pump	Master pump	Master pump	Slave pump	Master pump	Master pump

◆ Note: Bit0 to Bit14 correspond to drives with node IDs 1 to 15. If the bit corresponding to the multi-pump control word received by the drive is 0, the drive runs in master pump mode. Otherwise, the drive runs in slave pump mode.

D.2.3 Description of Pressure References

The pressure reference is 16-bit unsigned integers with min. unit of 0.1 bar. Examples of pressure reference are given in the following table.

Table D-5 Examples of pressure references

Reference Data	Reference Meaning
H01F4 (500)	50.0 bar
H03E8 (1000)	100.0 bar
H07D0 (2000)	200.0 bar

D.2.4 Description of Flow Reference

Table D-6 Examples of flow reference

Reference Data	Reference Meaning
H07D0 (2000)	20.00%
H1388 (5000)	50.00%
H2710 (10000)	100.00%

D.3 Applications

D.3.1 Running in Single-Master Mode

In applications where there is only one servo drive, the drive is used as the independent master pump. If the node ID of the drive is 1, the drive runs in forward direction at a pressure of 70 bar and a flow of 50%. The host controller uses default RPDO1 for communication. The RPDO1 data is shown in the following table.

Table D-7 Example of independent master pump running

COB-ID	PQ Control Word	Multi-Pump Control Word	Pressure (0.1 bar)	Flow (0.01%)
201	H00C1	H0000	H02BC (700)	H1388 (5000)

D.3.2 Running in Single-Master Multi-Slave Mode

If there are three drives whose node ID are 1, 2, and 3 respectively in the network, the drive whose node ID is 1 serves as the master pump, while the drives whose node IDs are 2 and 3 serve as the slave pumps and run following the master pump. If the pressure is 70 bar and the flow is 50%, the RPDO1 data sent by the host controller to each drive is as follows.

Table D-8 Example of single-master multi-slave mode

COB-ID	PQ Control Word	Multi-Pump Control Word	Pressure (0.1 bar)	Flow (0.01%)
201	H00C1	H0006	H02BC (700)	H1388 (5000)
202	H00C1	H0006	H02BC (700)	H1388 (5000)
203	H00C1	H0006	H02BC (700)	H1388 (5000)

D.3.3 Running in Multi-Master Multi-Slave Mode

If there are four drives whose node IDs are 1, 2, 3, and 4 respectively in the network, the drive whose node ID is 2 serves as the slave pump and runs following the drive whose node ID is 1, and the drive whose node ID is 3 serves as the slave pump and runs following the drive whose node ID is 4. If the pressure is 70 bar and the flow is 50%, the RPDO1 data sent by the host controller to the drives whose node ID are 1 and 2 are shown in Table D-9, and the data sent to drives whose node ID are 3 and 4 are shown in Table D-10.

Table D-9 RPDO1 data received by drives whose node ID are 1 and 2

COB-ID	PQ Control Word	Multi-Pump Control Word	Pressure (0.1 bar)	Flow (0.01%)
201	H00C1	H0002	H02BC (700)	H1388 (5000)
202	H00C1	H0002	H02BC (700)	H1388 (5000)

Table D-10 RPDO1 data received by drives whose node ID are 3 and 4

COB-ID	PQ Control Word	Multi-Pump Control Word	Pressure (0.1 bar)	Flow (0.01%)
203	H00C1	H0004	H02BC (700)	H1388 (5000)
204	H00C1	H0004	H02BC (700)	H1388 (5000)

- The references for the master and slave pumps in the same group are identical. The multi-pump control word received by each group of master and slave pumps is different when there are multiple groups of master and slave pumps.

D.4 Transmitting Time of TPDO1 and TPDO2

TPDO1 Triggers 0x1800/TPDO2 Triggers 0x1801			
Sub-index	Description	Default	Unit
3	Disabling time	500 (50 ms)	100 μs
5	Event time	150 (150 ms)	1 ms

D.5 Object Index of Commonly-Used Monitoring Data

Object Index	Description	Min. Unit	Description
0x2071-03	Feedback oil pressure	0.1 kg/cm^2	
0x2071-04	Motor speed	1 rpm	
0x2070-05	Output current	0.1 A	
0x2070-07	Output torque	0.1%	
0x2070-06	Output power	0.1 kW	
0x2070-0E	Output voltage	1 V	
0x2073-0F	Fault code		High 8 bits indicate the fault code and low 8 bits indicate the fault subcode.
0x2070-03	Bus voltage	0.1 V	

D.6. Heartbeat Protection

Heartbeat Consumption Time (0x1016)		
Sub-index	Default	Description
Sub1	0x007F012C	12C indicates 300 ms. If the drive does not receive the heartbeat message from the master station within 300 ms, E42.11 will be reported.

D.7 RPDO1 Communication Time Setting

RPDO1 Time Setting (0x1400)			
Sub-index	Description	Default	Unit
3	Disabling time	30 (3 ms)	100 μs
5	Event time	10 (10 ms)	1 ms

D.8 EDS File

You can ask the technical personnel of Inovance for EDS file.

NOTE

- In the case of low network load rate, you can increase the PDO transmission cycle to 2 ms to improve the drive response.
- RPDO4 is used in the ES510 to support multi-pump function. It cannot be modified externally. Remember to avoid using it.

Appendix E Modbus Communication Protocol

The ES510 provides RS485 communication interface and supports Modbus-RTU communication protocol. Through the Modbus communication protocol, you can implement centralized control of the drive, such as setting the running commands, modifying or reading parameters, and reading the running status and fault information, by using a computer or programmable logic controller (PLC).

This protocol defines the content and format of messages transmitted through serial communication, including master polling (or broadcasting) format and master coding method (parameter No. for the action, transmission data, and error check). The slave uses the same structure in the response, including action confirmation, data returning, and error check. If an error occurs when the slave receives a message, or the slave cannot complete the action required by the master, the slave returns a fault message (response) to the master.

E.1 Application Method

As a slave, the servo drive is connected to a "single-master multi-slave" PC/PLC control network with RS485 bus.

E.2 Bus Structure

1) Hardware interface

An RS485 extension card MD38TX1 must be inserted into the drive.

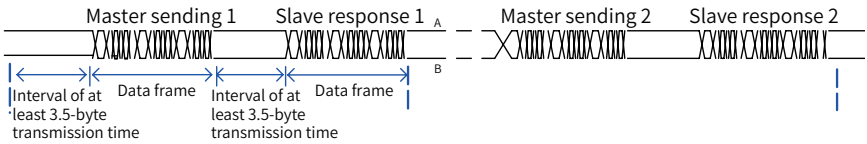
2) Topological structure

The system consists of a single master and multiple slaves. Each device in the network has a unique slave address. Among them, a device (usually a PC, PLC or HMI) serves as the master and initiates communication to read or write parameters of the slaves. The other devices serve as slaves and respond to query or communication operations from the master. Only one device is allowed to transmit data at the same moment, and other devices receive data.

The address range of the slaves is 1 to 247. The value 0 is a broadcasting communication address. A slave must have a unique address in the network.

3) Communication transmission mode

The asynchronous serial and half-duplex transmission mode is used. In the process of asynchronous serial communication, data is sent frame by frame in the form of message. In Modbus-RTU protocol, an interval of at least 3.5-byte transmission time marks the end of the previous message. A new message starts to be sent after this interval.



The built-in communication protocol of the ES510 is the Modbus-RTU slave communication protocol, which allows the drive to provide data to respond to a "query/command" from the master or execute the action according to "query/command" from the master.

The master can be a PC, an industrial control device, or a PLC. It can communicate with a single slave or send broadcast messages to all slaves. When the master communicates with a single slave, the slave needs to return a message (response) to the "query/command" from the master, but it need not return a response to a broadcast message sent by the master.

Appendix F List of Motor IDs and Motor Models

Motor Series	Motor ID	Motor Model
ESMG1	50517	ESMG1-89C17CD-*****
	50717	ESMG1-13D17CD-*****
	50917	ESMG1-17D17CD-*****
	51117	ESMG1-21D17CD-*****
	51517	ESMG1-27D17CD-*****
	50520	ESMG1-11D20CD-*****
	50720	ESMG1-15D20CD-*****
	50920	ESMG1-19D20CD-*****
	51120	ESMG1-25D20CD-*****
	51520	ESMG1-31D20CD-*****

INOVANCE Warranty Agreement

1) Inovance provides an 18-month free warranty to the equipment itself from the date of manufacturing for the failure or damage under normal use conditions.
2) Within the warranty period, maintenance will be charged for the damage caused by the following reasons:
   a. Improper use or repair/modification without prior permission
   b. Fire, flood, abnormal voltage, natural disasters and secondary disasters
   c. Hardware damage caused by dropping or transportation after procurement
   d. Operations not following the user instructions
   e. Damage out of the equipment (for example, external device factors)
3) The maintenance fee is charged according to the latest Maintenance Price List of Inovance.
4) If there is any problem during the service, contact Inovance's agent or Inovance directly.
5) Inovance reserves the rights for explanation of this agreement.

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