INOVANCE

SV520N Series
Servo Drive User Guide

User Guide

A00
Data code 19011200

Preface

Thank you for purchasing the SV520N series servo drive developed by Inovance.

The SV520N series servo drive is designed to drive linear motors. The network-type SV520N series servo drive supports EtherCAT protocol to achieve a networked operation of multiple servo drives through working with a host controller.

The SV520N series servo drive offers stiffness level setting, inertia auto-tuning and vibration suppression to simplify the operation process and achieve quick and accurate position control, speed control, and torque control.

This user guide contains product safety instructions, mechanical and electrical installations, and basic commissioning and maintenance instructions. First-time users must read through this user guide.

If you have any questions concerning product functions or performance, contact Inovance for technical support.

This user guide is subject to change without notice due to continuous product improvement.

Deliver user guide along with the equipment to the end users.

Notes
◆ The drawings in the user guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions described in the user guide. ◆ The figures in this user guide are for reference only, which may not be exactly the same as the product you ordered. ◆ This user guide is subject to changes due to product upgrade, specification modification as well as efforts to improve the accuracy and convenience of the user guide. ◆ If the user guide is damaged or lost, contact our regional agents or customer service centers to order the user guide. ◆ Contact Inovance customer service center for any concerns during use.

Unpacking Inspection

Check the following items upon unpacking.

Items	Description
Check whether the product delivered is consistent with your order.	The box contains the device you ordered. Check the device model according to the nameplate of the servo drive.
Check whether the product is damaged.	Check whether the overall appearance of the product is intact. If there is any part missing or damaged, contact Inovance or your supplier immediately.

Revision History

Date	Version	Description
December 2019	A00	First release

Safety Instructions

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 the manual 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.

- 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 user guide before installation. ◆ Do not modify this equipment. ◆ Do not rotate the equipment components or loosen fixed bolts (especially those marked in red) on equipment components. ◆ Do not install this equipment in places with strong electric or magnetic fields. ◆ When this equipment is installed in a cabinet or final equipment, protection measures such as a fireproof enclosure, electrical enclosure, or mechanical enclosure must be provided. The IP rating 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
 ◆ 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. Wait at least 15 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 antistatic wrist strap. Failure to comply will result in damage to internal equipment circuits.

- 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 equipment.

Power-on

- 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

- Do not touch any wiring terminals during operation. 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.

- 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

- 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 15 minutes.

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

Repair

- 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 15 minutes.

- Require for 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, personal injuries, or even death. ◆ Recycle retired equipment by following industry waste disposal standards to avoid environmental pollution.

Safety Signs

■ Description of safety signs in the user guide


Read the user guide before installation and operation.


Reliably ground the system and equipment.


Danger!


High temperature!


Prevent personal injuries caused by machines.


High voltage!

Wait 15 minutes before further operations.

■ Description of safety signs on the equipment

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

Safety Sign	Description
	◆ Never fail to connect the Protective Earth(PE) terminal. Read the user guide and follow the safety instructions before use. ◆ To prevent the risk of electric shock, do not touch terminals within 15 minutes after cutting off the power supply. ◆ To prevent the risk of burning, do not touch the heatsink when the power supply is ON.

Contents

1 Product Information

1.1 Nameplate and Model Number

SV520 N S 5R5 I - *

Code	Series No.
SV520	SV520

Code	Type
N	Network

Code	Voltage Class
S	220 V

Code	Rated Output Current			
1R6	2R8	5R5	7R6	012
1.6 A	2.8 A	5.5 A	7.6 A	12 A

Customized function

Code	Installation Mode
I	Baseplate installation (standard)

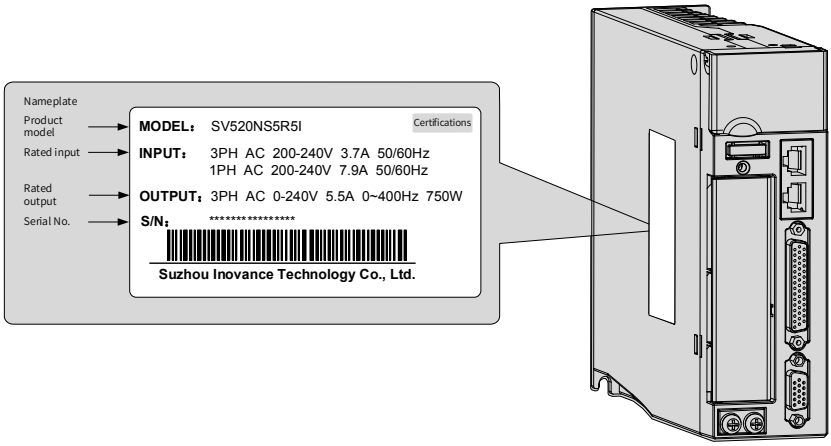


Figure 1-1 Nameplate and model number of SV520N

1.2 Components

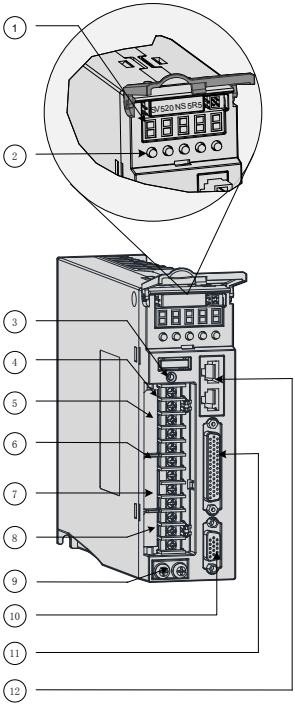


Figure 1-2 Components of SV520N series servo drives

No.	Name	Function
1	LED display (5-digit)	Displays servo drive running status and parameter settings.
2	Buttons	MODE: Used to switch parameters in sequence. ▲ : Used to increase the value of the blinking digit. ▼ : Used to decrease the value of the blinking digit. ◀◀ : Used to shift the blinking digit leftwards. Hold down ◀◀ : Turning to another page when the displayed number exceeds five digits SET: Used to save modifications and enter the next menu.
3	CHARGE indicator (bus voltage indicator)	Used to indicate an electrically-charged bus capacitor. When this indicator lights up, it indicates electric charge may be still present in the internal capacitor of the servo drive even if the main circuit power supply is switched off. To prevent electric shock, do not touch the power terminals with the CHARGE indicator ON.
4	L1C, L2C (control circuit power input terminals)	The control circuit power input must be based on the rated voltage class.

No.	Name	Function
5	R, S, T (main circuit power input terminals)	The main circuit power input must be based on the rated voltage class.
6	$P_{\oplus}$, Θ (DC bus terminals)	Used as the common DC bus for multiple servo drives.
7	$P_{\oplus}$, D, C (terminals for connecting external regenerative resistor)	Terminals $P_{\oplus}$ and D are jumpered by default. To connect an external regenerative resistor, remove the jumper between $P_{\oplus}$ and D and connect the external regenerative resistor between $P_{\oplus}$ and C.
8	U, V, W (motor connecting terminal)	Connected to U, V, and W phases of the servo motor.
9	⏚ PE (grounding terminal)	Connected to the grounding terminals of the power supply and the motor
10	CN2 (encoder connecting terminal)	Connected to motor encoder terminals.
11	CN1 (control terminal)	Used by reference input signals and other I/O signals.
12	CN3, CN4 (EtherCAT communication terminal)	Connected to EtherCAT for communication purposes.

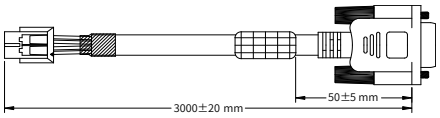
1.3 Cables and Models

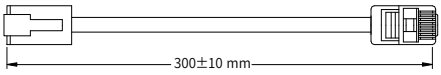
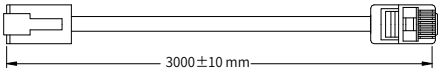
1.3.1 Communication Cable Options

Table 1-1 Communication cable options

Servo Drive Model	Model	Description
SV520N	S6N-L-T00-3.0	Servo drive to PC communication cable
	S6-L-T04-0.3	Cable for multi-drive parallel communication
	S6-L-T03-3.0	Plug for servo drive communication termination resistor

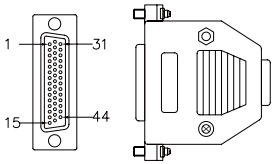
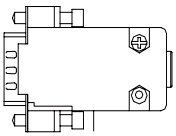
Table 1-2 Outline drawing of communication cables

Name	Cable Model	Length (in mm)	Cable Dimension Drawing
Servo drive to PC communication cable (network-type)	S6N-L-T00-3.0	3000	

Name	Cable Model	Length (in mm)	Cable Dimension Drawing
Cables for multi-drive parallel communication/ PLC to servo drive communication cable (network-type)	S6-L-T04-0.3	300	
	S6-L-T04-3.0	3000	

1.3.2 Encoder Cable Options

Table 1-3 Encoder cable options

Model	Description	Appearance
S6-C8	Encoder cable connector kit (DB44 plug)	
S6-C6	Encoder cable connector kit (DB15 plug)	

1.4 Specifications of the Regenerative Resistor

Table 1-4 Specifications of the regenerative resistor

Servo Drive Model		Specifications of Built-in Regenerative Resistor		Min. Permissible Resistance (Ω)	Max. Braking Energy Absorbed by the Capacitor (J)
		Resistance (Ω)	Capacity (W)		
Single-phase 220 V	SV520NS1R6I	-	-	50	9
	SV520NS2R8I	-	-	45	18
Single-phase/ Three-phase 220 V	SV520NS5R5I	50	50	40	26
Three-phase 220 V	SV520NS7R6I	25	80	20	26
	SV520NS012I	25	80	15	47

1.5 Wiring of Peripheral Devices

SV520N series servo drives in size A and size C (SV520NS1R6I, SV520NS2R8I, SV520NS5R5I, SV520NS7R6I, SV520NS012I) are built-in with dynamic brakes, removing

the need for an external dynamic brake. The dynamic brake is intended to be used in emergency stop upon fault. Do not use it to stop a servo drive in normal state. Failure to comply may damage the servo drive.

The SV520N servo system is comprised of an SV520N servo drive and a DDL motor. The peripheral devices of the servo system are shown in the following figure.

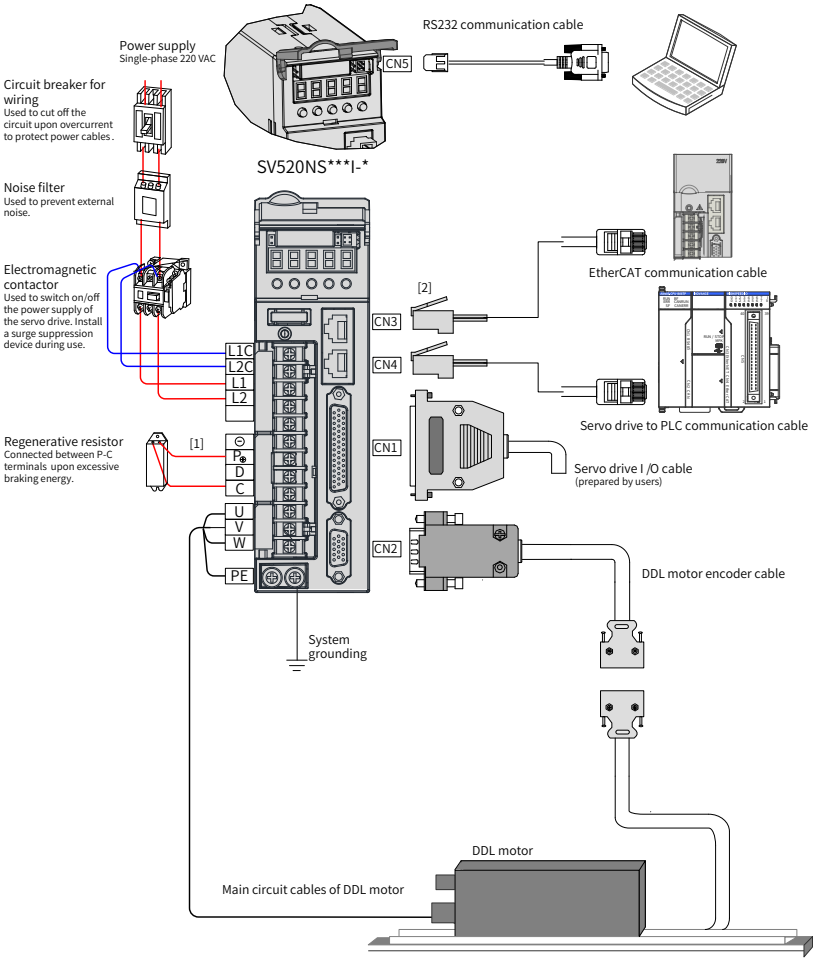


Figure 1-3 Wiring example of single-phase 220 V servo system (network-type)

[1] Remove the jumper between $P_{\oplus}$ and D before connecting an external regenerative resistor.

[2] CN3 is used for communication output. CN4 is used for communication input.

The SV520N series servo drive is directly connected to an industrial power supply, with no isolation such as a transformer. To prevent cross electric shock, install a fuse or circuit breaker on the input power supply. The servo drive is not built-in with a ground protection circuit. For the sake of safety, install a residual current device (RCD) to provide protection against overload and short circuit or install a specialized RCD to protect the grounding cable.

Do not start or stop the motor by using the electromagnetic contactor. As a high-inductance device, the motor may generate instantaneous high voltage and damage the contactor.

Pay attention to the power capacity when connecting an external control power supply or a 24 VDC power supply, especially when the power supply is used to power up multiple servo drives or brakes. Insufficient power supply will lead to insufficient supply current, resulting in failure of the servo drive or brake. The brake must be powered up by a 24 VDC power supply matching the motor model and brake requirements.

NOTE

In a single-phase 220 V servo system, the main circuit terminals are L1 and L2. Do not connect any cables to the reserved terminals.

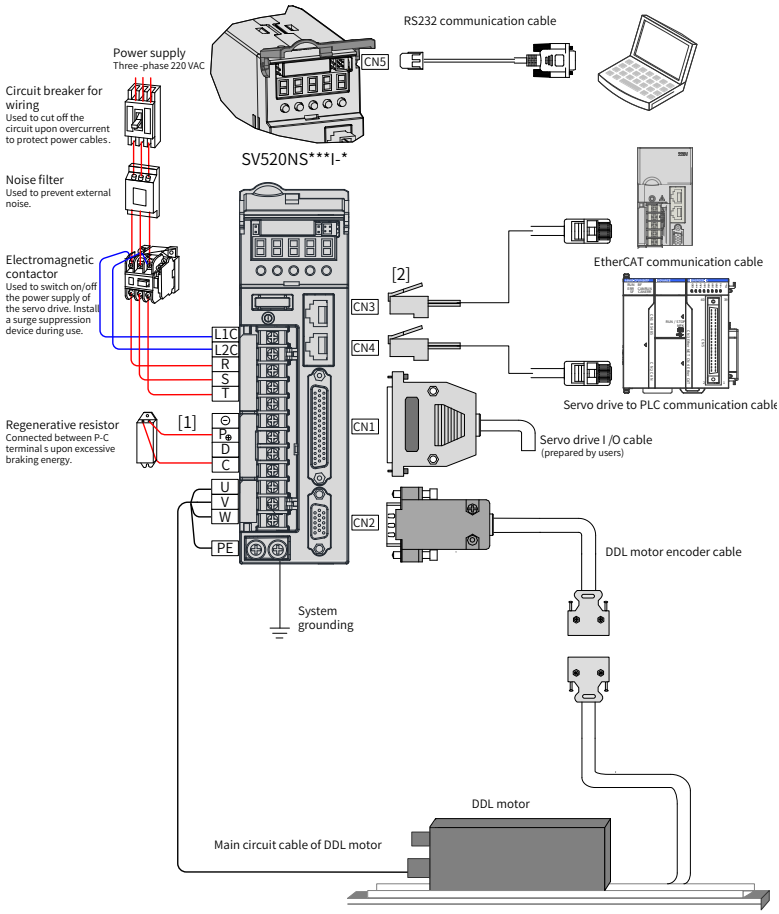


Figure 1-4 Wiring example of three-phase 220 V servo system (network-type)

[1] Remove the jumper between $P_{\oplus}$ and D before connecting an external regenerative resistor.

[2] CN3 is used for communication output. CN4 is used for communication input.

The servo drive is directly connected to an industrial power supply, with no isolation such as a transformer. To prevent cross electric shock, install a fuse or circuit breaker on the input power supply. The servo drive is not built-in with a ground protection circuit. For the sake of safety, install a residual current device (RCD) to provide protection against overload and short circuit or install a specialized RCD to protect the grounding cable.

Do not start or stop the motor by using the electromagnetic contactor. As a high-inductance device, the motor may generate instantaneous high voltage and damage the contactor.

Pay attention to the power capacity when connecting an external control power supply or a 24 VDC power supply, especially when the power supply is used to power up multiple servo drives or brakes. Insufficient power supply will lead to insufficient supply current, resulting in failure of the servo drive or brake. The brake must be powered up by a 24 VDC power supply matching the motor model and brake requirements.

2 Installation

2.1 Installation of Servo Drive

2.1.1 Installation Location

- Install the servo drive inside a cabinet free from sunlight and rain.
- Install the servo drive in a place that meets with the following requirements:
  a) Free from corrosive and inflammable gases and combustible materials, such as the hydrogen sulfide, chlorine, ammonia, sulphur gas, chloridize gas, acid, soda and salt
  b) Free from high temperature, humidity, dust and metal powder
  c) Free from vibration

2.1.2 Installation Environment

Table 2-1 Installation environment

Item	Description
Ambient temperature	0°C to 55°C (average load ratio not exceeding 80% in ambient temperatures between 40° C to 55° C) (non-freezing)
Ambient humidity	Below 90% RH (without condensation)
Storage temperature	–20°C to +85°C (non-freezing)
Storage humidity	Below 90% RH (without condensation)
Vibration	Below 4.9 m/s^2
Shock	Below 19.6 m/s^2
IP rating	IP10
Altitude	Below 1000 m

2.1.3 Installation Precautions

- Installation Method

Install the servo drive vertically to the wall. Cool the servo drive down with natural convection or a cooling fan. Secure the servo drive on the mounting surface through two to four mounting holes (number of mounting holes varying with the servo drive capacity).

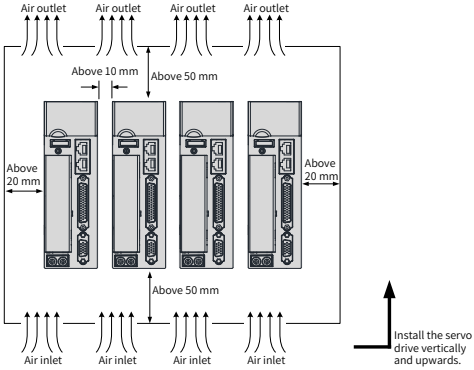


Figure 2-1 Installation of SV520N series servo drives

Install the servo drive vertically to the wall, making its front (actual mounting surface) face the operator.

■ Cooling

As shown in above figure, keep sufficient space around the servo drive to allow cooling through the cooling fan or natural convection. Install the cooling fan on the top of the servo drive to avoid excessive regional temperature rise and maintain an even temperature inside the control cabinet.

■ Side-by-side installation

When installing multiple servo drives side by side, keep a clearance of at least 10 mm between two servo drives (if available) and a clearance of at least 50 mm above and below each servo drive.

■ Grounding

The grounding terminal must be grounded properly. Failure to comply may result in electric shock or malfunction due to interferences.

■ Routing

Route the cables downwards (as shown in the following figure). This is to prevent the liquid from flowing into the servo drive along the cable.

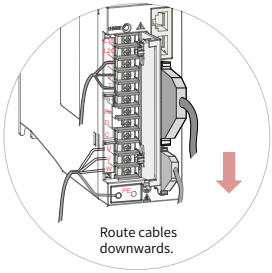


Figure 2-2 Routing of the SV520N series servo drive

2.2 Dimension Drawings

Size A: SV520NS1R6I, SV520NS2R8I, SV520NS5R5I

Size C: SV520NS7R6I, SV520NS012I

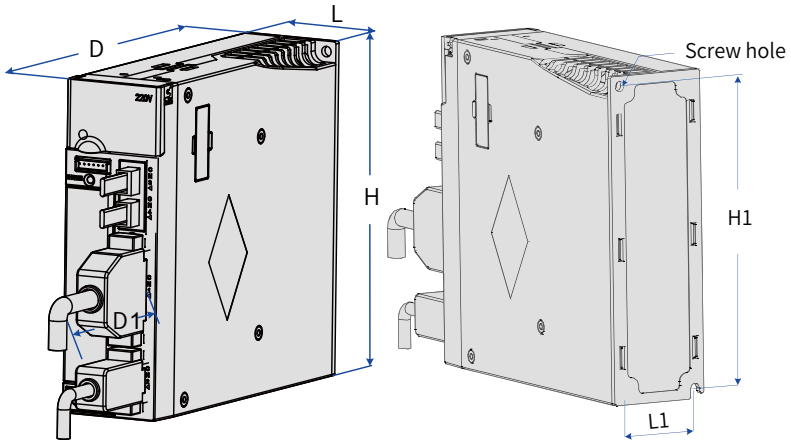


Figure 2-3 Dimensions of the servo drive

Structure	L (mm)	H (mm)	D (mm)	L1 (mm)	H1 (mm)	D1 (mm)	Screw Hole	Tightening Torque (N·m)
Size A	50	160	173	40	150	75	2-M4	0.6 to 1.2
Size C	90	160	183	80	150	75	4-M4	0.6 to 1.2

3 Wiring

3.1 Pin Layout of the Servo Drive

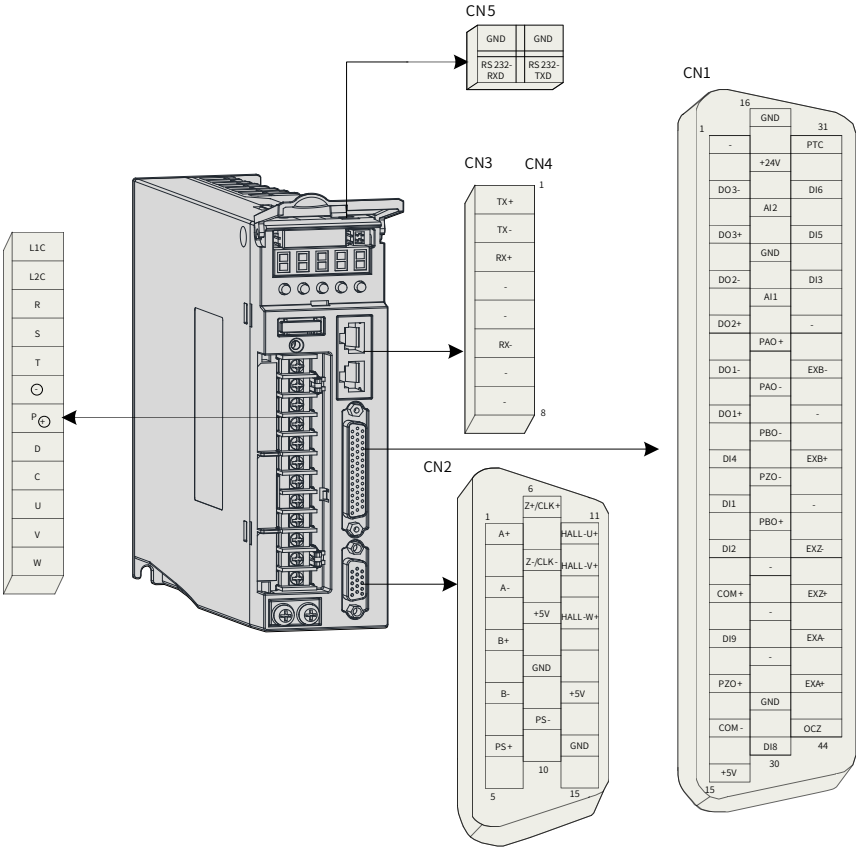


Figure 3-1 Terminal pin layout of SV520N series servo drive (network-type)

The preceding figure shows the terminal pin layout of the servo drive.

3.2 Wiring of the Main Circuit

3.2.1 Introduction to Main Circuit Terminals

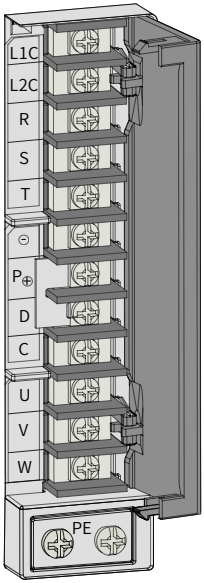


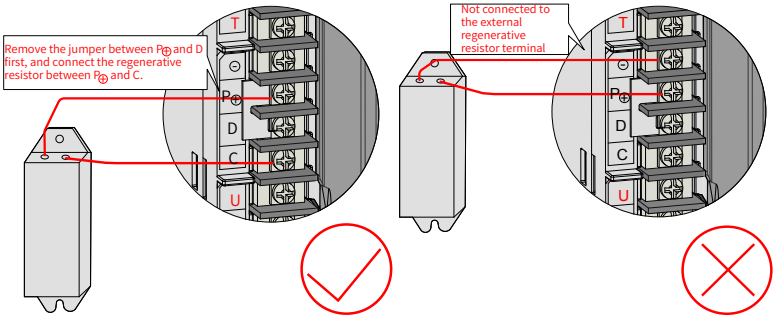
Figure 3-2 Terminal block layout of servo drives in size A (size C)

Table 3-1 Names and functions of main circuit terminals of servo drives in size A (size C)

Symbol	Name	Function	
L1, L2	Main circuit power input terminals	S1R6, S2R8, S5R5	Single-phase main circuit power input, only L1 and L2 terminals available Connect 220 VAC power supply between L1 and L2.
R, S, T		S5R5, S7R6, S012	Three-phase main circuit 220 V power input
L1C, L2C	Control power input terminal	See the rated voltage class on the nameplate.	

Symbol	Name	Function	
$P_{\oplus}$, D, C	Terminals for connecting external regenerative resistor	S1R6, S2R8	Connect the external regenerative resistor between $P_{\oplus}$ and C upon excessive braking energy. The external regenerative resistor needs to be purchased separately.
		S5R5, S7R6, S012	Terminals $P_{\oplus}$ and D are jumpered by default. To install an external regenerative resistor, remove the jumper between $P_{\oplus}$ and D first, and connect the external regenerative resistor between $P_{\oplus}$ and C. The external regenerative resistor needs to be purchased separately.
$P_{\oplus}$, Θ	Common DC bus terminal	Used in common DC bus connection when multiple servo drives are connected in parallel.	
U, V, W	Motor connecting terminal	Connect to U, V and W phases of the DDL motor.	
PE	Grounding terminal	Two PEs connected respectively to the grounding terminals of the power supply and the motor. Ensure the entire system is grounded.	

Connection of the regenerative resistor



Observe the following precautions when connecting the external regenerative resistor:

- Do not connect the external regenerative resistor to terminals $P_{\oplus}$ and Θ directly. Failure to comply may damage the servo drive and cause a fire accident.
- Before connecting the external regenerative resistor, remove the jumper between $P_{\oplus}$ and D first. Failure to comply will cause overcurrent and damage the braking transistor.
- For selection of external regenerative resistors, see "1.4 Specifications of the Regenerative Resistor". Do not select a resistor with resistance lower than the minimum permissible value. Failure to comply will incur Er.201 or damage the servo drive.

- Before operating the servo drive, ensure parameters related to the regenerative resistor (2002-1Ah, 2002-1Bh, and 2002-1Ch) are set properly.
- Install the external regenerative resistor on incombustible objects such as metal.

3.2.2 Recommended Models and Specifications of Main Circuit Cables

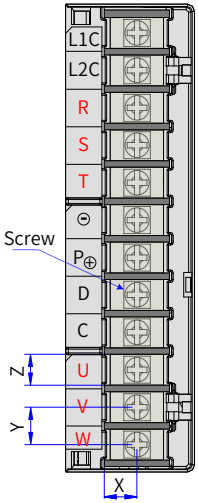


Figure 3-3 Terminal block of SV520N series servo drives

Table 3-2 Specifications and dimensions of the terminal block

Structure	Main Circuit Terminals					PE (Grounding Terminal)	
	X (mm)	Y (mm)	Z (mm)	Screw	Tightening Torque (N·m)	Screw Dimension	Tightening Torque (N·m)
Size A	6.8	7.6	6.3	M3 screw	0.4 to 0.6	M4	0.6 to 1.2
Size C	8	8.2	7	M3 screw	0.4 to 0.6	M4	0.6 to 1.2

Table 3-3 Current specifications of SV520N series servo drives

Servo Drive Model SV520N □□□□ I		Rated Input Current (A)	Rated Output Current (A)	Maximum Output Current (A)
Size A	S1R6	2.3	1.6	5.8
	S2R8	4.0	2.8	10.1
	S5R5	7.9 (single-phase)/3.7 (three-phase)	5.5	16.9
Size C	S7R6	5.1	7.6	17
	S012	8.0	11.6	28

Table 3-4 Recommended main circuit cables and models for SV520N series servo drives

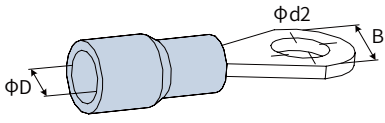
No.	Series	Servo Drive Model	L1C, L2C		R, S, T		$P_{\oplus}$, C		U, V, W		PE	
			mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Single-phase 220 V												
1	Size A	S1R6	2x0.75	18	2x0.75	18	2x0.75	18	3x0.75	18	0.75	18
2		S2R8	2x0.75	18	2x0.75	18	2x0.75	18	3x0.75	18	0.75	18
3		S5R5	2x0.75	18	2x0.75	18	2x0.75	18	3x0.75	18	0.75	18
Three-phase 220 V												
4	Size A	S5R5	2x0.75	18	3x0.75	18	2x0.75	18	3x0.75	18	0.75	18
5	Size C	S7R6	2x0.75	18	3x0.75	18	2x0.75	18	3x0.75	18	0.75	18
6		S012	2x0.75	18	3x1.5	16	2x1.5	16	3x1.5	16	1.5	16

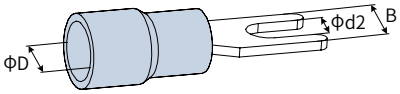
Table 3-5 Recommended cable lugs for the main circuit

Servo Drive Model SV520N □□□□ I		L1C, L2C	R, S, T	$P_{\oplus}$, C	U, V, W	PE
Size A	S1R6	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 2-4
	S2R8	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 2-4
	S5R5	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 2-4
Size C	S7R6	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 1.25-3 TVS 1.25-3	TVR 2-4
	S012	TVR 1.25-3 TVS 1.25-3	TVR 2-3M TVS 2-3W	TVR 2-3M TVS 2-3W	TVR 2-3M TVS 2-3W	TVR 2-4

Reference data for recommended cable lugs (Manufacturer: Suzhou Yuanli Metal Enterprise Co., Ltd)

Table 3-6 Dimension drawings of the cable lug

Cable Lug Model		D (mm)	d2 (mm)	B (mm)	Dimension Drawing
TVR series	1.25-3	4.0	3.7	5.5	
	1.25-4	4.0	4.3	8.0	
	2-3M	4.5	3.7	6.6	
	2-4	4.5	4.3	8.5	
	5.5-3	6.3	3.7	9.5	
	5.5-4	6.3	4.3	9.5	

Cable Lug Model		D (mm)	d2 (mm)	B (mm)	Dimension Drawing
TVS series	1.25-3	4.0	3.2	5.7	
	1.25-4W	4.0	4.3	7.2	
	2-3W	4.5	3.7	6.2	
	5.5-3	6.3	3.2	7.3	
	5.5-4	6.3	4.3	8.2	

■ Use the cables listed in the following table as the main circuit cables.

Table 3-7 Recommended main circuit cables

Cable Type		Allowable Temperature (℃)
Model	Name	
PVC	General PVC cable	-
IV	PVC cable with rated voltage of 600 V	60
HIV	Heat-resistant PVC	75

For three-cable applications, the relation between AWG specifications and the allowable current is shown in the following table. Note that the values listed in the table cannot be exceeded during use.

Table 3-8 Specifications for three-cable applications

AWG Specification	Nominal Cross Sectional Area (mm^2)	Allowable Current in Different Ambient Temperatures (A)		
		30°C	40°C	50°C
20	0.519	8	7	6
19	0.653	9	8	7
18	0.823	13	11	9
16	1.31	18	15	12
14	2.08	26	23	20
12	3.31	32	28	26
10	5.26	48	43	38
8	8.37	70	65	55
6	13.3	95	85	75

3.2.3 Wiring Example of the Power Supply

■ Models using single-phase 220 V power supply: SV520NS1R6I and SV520NS2R8I

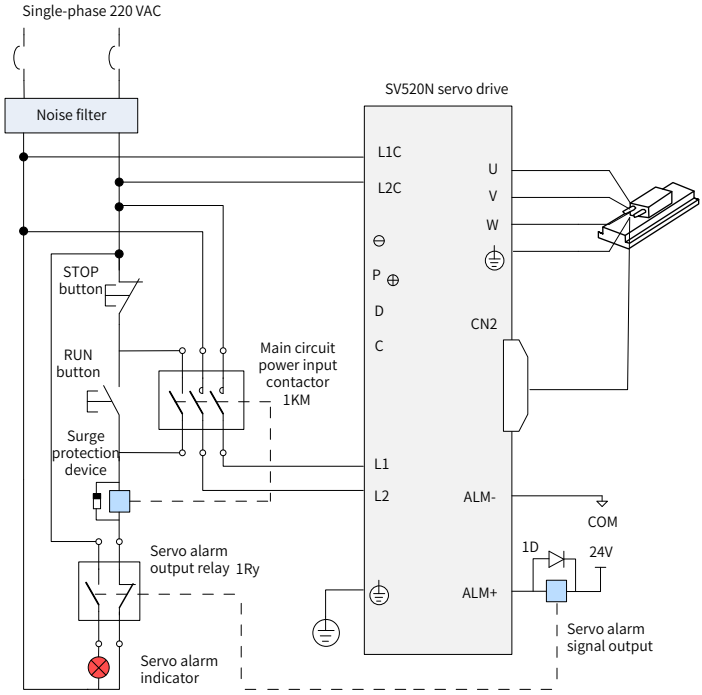


Figure 3-4 Wiring of the main circuit of single-phase 220 V models

NOTE

- 1KM: Electromagnetic contactor; 1Ry: Relay; 1D: Flywheel diode
- The DO is set as alarm output (ALM+/-) to cut off the power supply and turn on the fault indicator when a fault occurs on the servo drive. As models SV520NS1R6 and SV520NS2R8 are not configured with built-in regenerative resistors, there is no need to connect a jumper between terminals P ⊕ and D. Connect an external regenerative resistor between P ⊕ and C as needed.

■ Models using three-phase 220 V power supply: SV520NS5R5I, SV520NS7R6I, and SV520NS012I

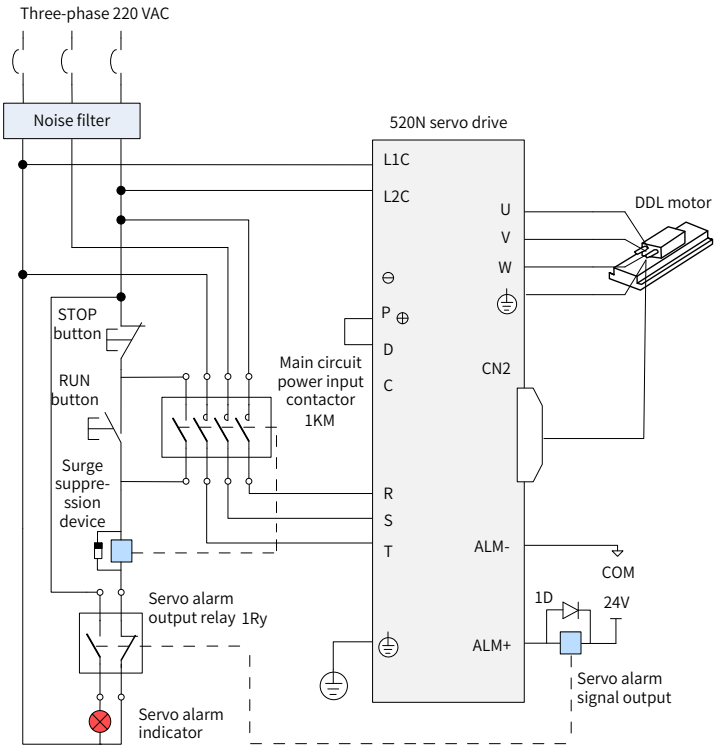


Figure 3-5 Wiring of the main circuit of three-phase 220 V models

NOTE

- 1KM: Electromagnetic contactor; 1Ry: Relay; 1D: Flywheel diode
- The DO is set as alarm output (ALM+/-) to cut off the power supply and turn on the fault indicator when a fault occurs on the servo drive.

Connect the main circuit power supply according to Figure 3-4 and Figure 3-5. The DO is set as alarm output (ALM+/-) to cut off the power supply and turn on the fault indicator when a fault occurs on the servo drive.

Observe the following precautions when wiring the main circuit:

■ Do not connect the input power cables to terminals U, V and W. Failure to comply will damage the servo drive.

■ Pay attention to the allowable current reduction ratio when binding cables together for use in places with adverse cooling conditions such as a duct.

- Use heat-resistant cables in environments with high temperatures. For environments with low temperatures, take heat-preservation measures to prevent the cable surface from being hardened and cracked.
- The bending radius of a cable must be 10 times more than its outer diameter to prevent the internal conductor from breaking due to long-time bending.
- Use cables with a rated voltage above 600 VAC and rated temperature above 75° C. In environments with 30° C ambient temperature and normal cooling conditions, the allowable current density of the cable cannot exceed 8 A/mm^2 when the total current is below 50 A, or 5 A/mm^2 when the total current is above 50 A. This value can be adjusted upon high ambient temperature when cables are bundled together. The allowable current density (A/mm^2) can be calculated based on the following formula:

Allowable current density = 8 x Reduction coefficient of current-carrying density of the conductor x Current correction coefficient

$$\text{Current correction coefficient} = \sqrt{(\text{Nominal max. permissible cable temp.} - \text{Ambient temp.})/30}$$

- Do not connect the regenerative resistor between terminals $P_{\oplus}$ and Θ. Failure to comply may cause a fire accident.
- Do not bundle power cables and signal cables together or route them through the same duct. Power cables and signal cables must be separated by a distance of at least 30 cm to prevent interference.
- High residual voltage may be still present in the servo drive even if the power supply is cut off. Do not touch the power terminals within 5 minutes after power-off.
- Perform inspection after confirming the CHARGE indicator is OFF.
- Do not turn on/off the power supply frequently. If frequent ON/OFF cycles are needed, ensure the interval is at least one minute. The capacitor in the main circuit of the servo drive will be charged with a large current for 0.2s upon power on. Turning on/off the power supply frequently will deteriorate the performance of the main circuit components inside the servo drive.
- Use a grounding cable with the same cross section as the main circuit cable. If the cross section of the main circuit cable is less than 1.6 mm^2, use a grounding cable with a cross section of 2.0 mm^2.
- Ground the SV520N servo drive reliably.
- Do not power on the servo drive when any terminal block screws or cables are loosened. Failure to comply may cause a fire accident.

3.2.4 Connection of the DDL Motor

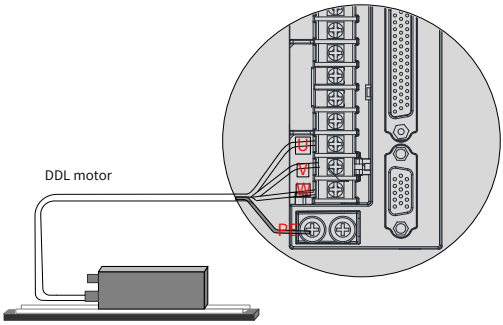


Figure 3-6 Connection between the servo drive and DDL motor

■ Connection of the encoder signal

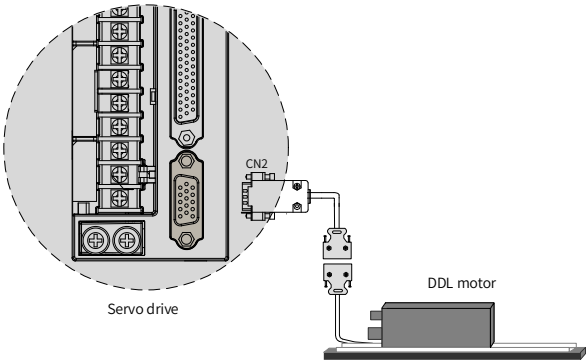


Figure 3-7 Connection between the servo drive and DDL motor encoder signal

3.2.5 Connection of the DDL Motor Encoder

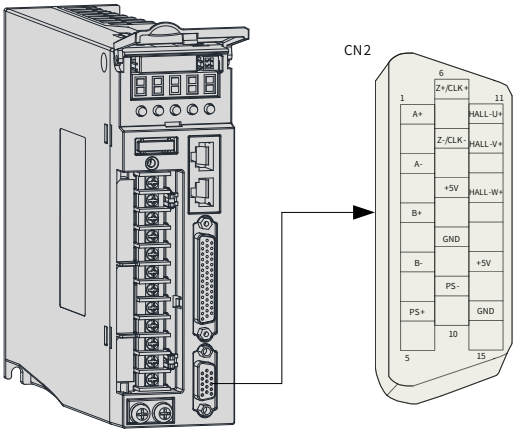


Figure 3-8 Pin layout of CN2 terminal of SV520N series servo drives

Table 3-9 Pin definition of CN2 terminal of SV520N series servo drives

Pin	Definition	Description
1	A+	Encoder phase A input (+)
2	A-	Encoder phase A input (-)
3	B+	Encoder phase B input (+)
4	B-	Encoder phase B input (-)
5	PS+	Serial communication signal (+)
6	Z+/CLK+	Encoder phase Z input (+)/Serial communication clock (+)
7	Z-/CLK-	Encoder phase Z input (-)/Serial communication clock (-)
8	+5V	Encoder 5 V power supply (load current less than 200 mA)
9	GND	Reference ground of the power supply
10	PS-	Serial Data (-)
11	HALL-U+	Hall signal U
12	HALL-V+	Hall signal U
13	HALL-W+	Hall signal W
14	+5V	Hall 5 V power supply (load current less than 100 mA)
15	GND	Reference ground of the power supply
Enclosure	PE	Shield

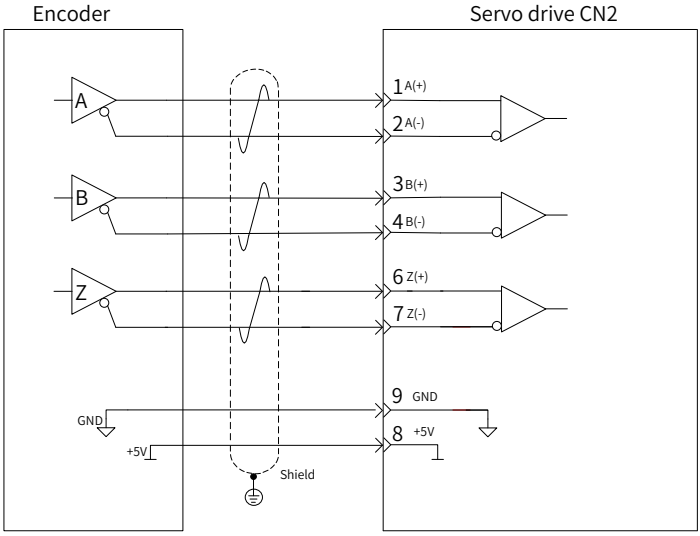
NOTE

- SV520N series servo drives do not support serial motor encoders.
- PIN6 and PIN7 are pins for multiplexing functions of "Encoder phase Z input" and "Serial communication clock". Only the phase Z input function is supported.

■ Wiring diagram

Encoder pulse input (use shielded twisted pair cables given the high input frequency)

Encoder pulse input
Max. input frequency: 4 Mpps

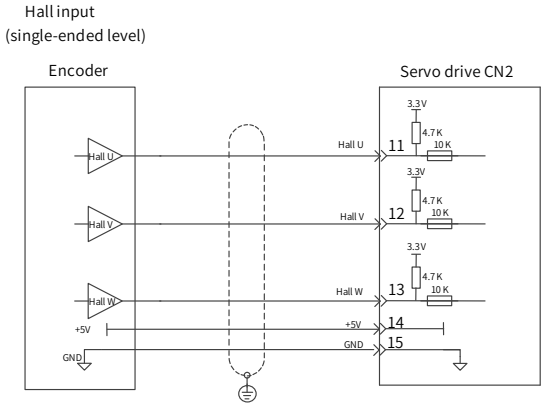


NOTE

- The maximum pulse frequency in the case of a phase A/B linear encoder is 4 Mpps.
- The pulse input interface of phase A/B encoder supports cable disconnection detection.

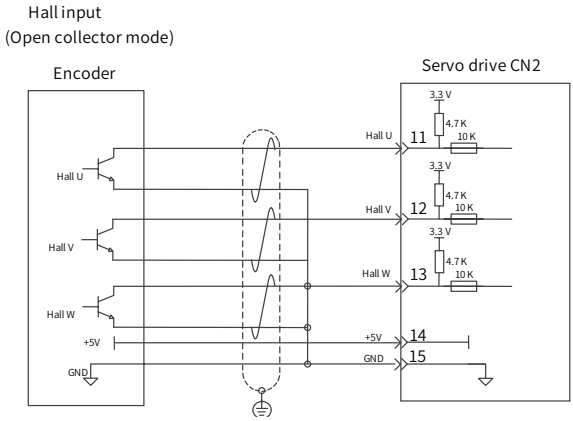
The Hall input interface supports single-ended level signals and open collector output.

1) In the case of single-ended level input



Note that the single-ended level input supports 5 V TTL signals only.

2) In the case of open collector input



CAUTION	
	Precautions for wiring: ◆ Ground the shield of the servo drive and DDL motor properly. Failure to comply will result in a false warning. ◆ Ground the encoder cable shield and connect the differential signals to the two conductors of the twisted pair cable. ◆ It is recommended to use shielded twisted pair cables of AWG16 to AWG26, with length not exceeding 10 m. ◆ Take the current consumed by the cable resistance and the encoder into account during cable selection.

■ Values listed in the following table are based on consumption that the current consumed by the encoder is 200 mA.

Table 3-10 Specifications of the encoder cable

Cable Diameter	Ω/km	Allowable Cable Length (in m)
26AWG (0.13 mm^2)	143	8.0
25AWG (0.15 mm^2)	89.4	14.0
24AWG (0.21 mm^2)	79.6	15.0
23AWG (0.26 mm^2)	68.5	18.0
22AWG (0.32 mm^2)	54.3	23.0
21AWG (0.41 mm^2)	42.7	29.0

You can also calculate the specifications of the encoder cable based on the following formula if the current consumed by the encoder is larger than 200 mA.

$$L2 = \frac{\triangle U_{max2}}{I_{encoder} \times 2R_{unit}}$$

In the above formula, △ U represents 0.5 V, $I_{encoder}$ represents the current consumed by the encoder, and R_{unit} represents the unit resistance of the cable (in Ω/km).

3.3 Connection of Control Signal Terminals

3.3.1 Terminal Layout

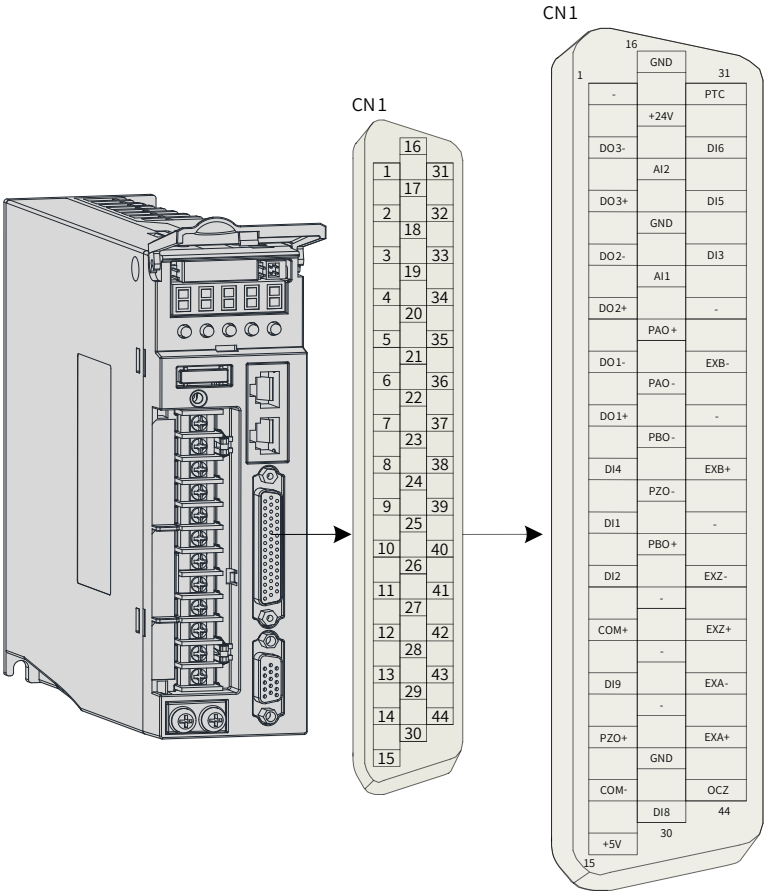


Figure 3-9 Pin layout of control circuit terminal connector of the pulse-type servo drive

CN1: Plastic housing of the plug on the cable side: DB44P (SZTDK), black

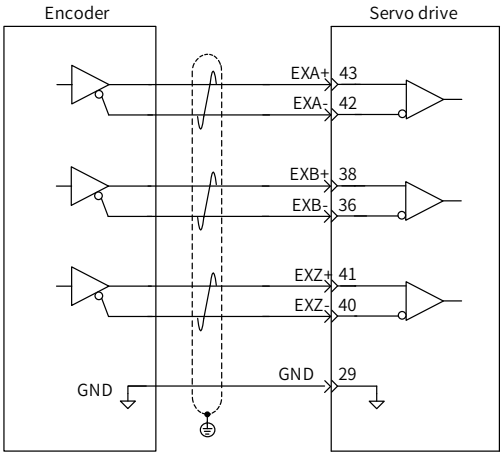
Core: HDB44P (SZTDK)

3.3.2 Second Encoder Feedback Signal

This section describes the input interfaces of the second encoder (external) of the user interface connector.

Table 3-11 Description of the second encoder feedback signal

Signal Name		Pin No.	Description
External encoder	EXA+ EXA-	43 42	Input interface of the second encoder (external)
	EXB+ EXB-	38 36	
	EXZ+ EXZ-	41 40	



To reduce noise interference, connect the reference ground of the external encoder to the GND of the servo drive. Use shielded twisted pair cables and connect the cable shield to the enclosure of CN1.

The following table lists the maximum input frequency and minimum pulse width of the input mode (differential) of the external encoder.

Table 3-12 Relation between pulse input frequency and pulse width

Pulse Mode		Max. Frequency (pps)	Min. Pulse Width (μs)
Regular	Differential	4 M	0.125

NOTE

The pulse received by the servo drive may be wrong if the pulse width output by the host controller is smaller than the minimum pulse width.

3.3.3 AI Signals

Table 3-13 Description of AI signals

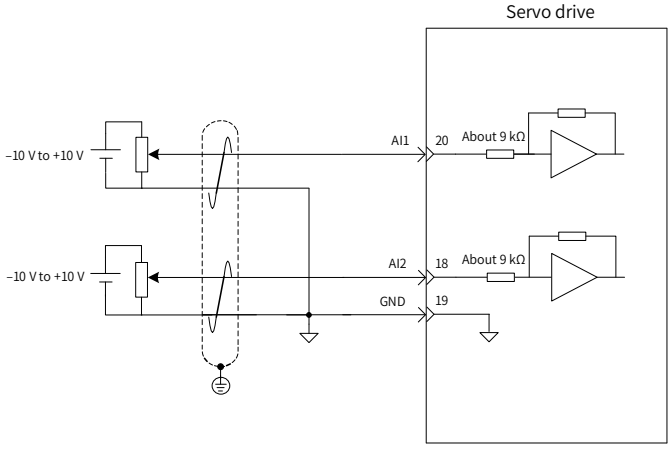
Signal Name	Function	Pin No.	Description
Analog	AI2	18	Regular analog input signals with a resolution of 12 bits Maximum input voltage allowed by the hardware: ±12 V
	AI1	20	
	GND	19	Analog input signal ground

The input terminals for analog speed and torque signals are AI1 and AI2 with a resolution of 12 bits. The voltage references are set in group H03.

Effective voltage input range: –10 V to + 10 V

Maximum allowable voltage: ±12 V

Input impedance: about 9 kΩ



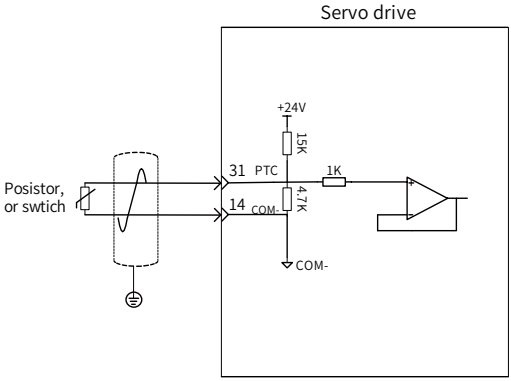
3.3.4 PTC Interface

The PTC model supported by SV520N series servo drives is MZ6-150-DS, manufactured by Dandong Keliang and Nanjing Huaju.

Table 3-14 Description of PTC input signals

Signal Name	Function	Pin No.	Description
PTC	PTC	31	Motor temperature PTC signal (see COM-)
	COM-	14	24 V reference ground of internal power supply

Wiring diagram



The servo drive supports switched-mode thermistors by default. Connect the shielded cable between the servo drive and DDL motor during wiring.

3.3.5 DI/DO Signals

Table 3-15 Description of DI/DO signals

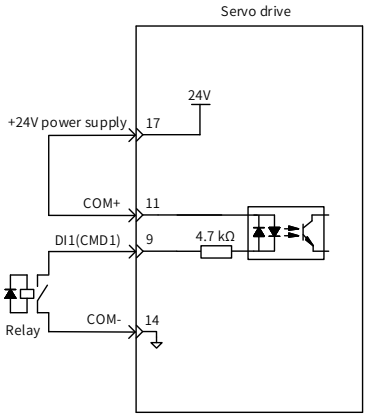
Signal Name		Function	Pin No.	Description
General	DI1	P-OT	9	Positive limit switch
	DI2	N-OT	10	Negative limit switch
	DI3	INHIBIT	34	Pulse input prohibited
	DI4	ALM-RST	8	Alarm reset (edge-triggered)
	DI5	S-ON	33	Servo ON
	DI6	ZCLAMP	32	Zero clamp
	DI8	HomeSwitch	30	Home switch
	DI9	Reserved	12	-
	+24V		17	24 V internal power supply, voltage range: 20 V to 28 V, maximum output current: 200 mA
	COM-		14	
	COM+		11	Power input terminal (12 V to 24 V)
	DO1+	S-RDY+	7	Servo ready
	DO1-	S-RDY-	6	
	DO2+	COIN+	5	Positioning completed
	DO2-	COIN-	4	
	DO3+	ZERO+	3	Zero speed signal
	DO3-	ZERO-	2	

1) DI Circuit (DI1 as an example)

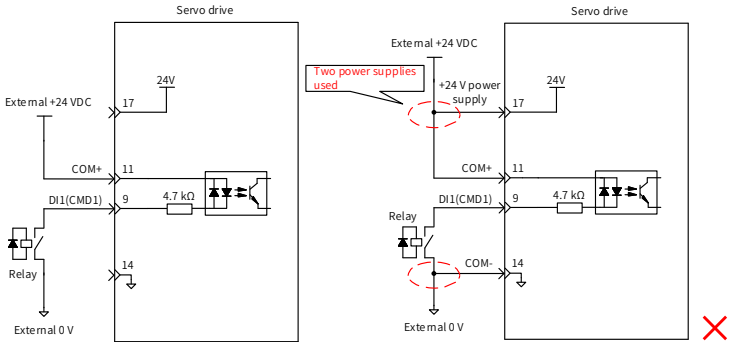
The interface circuits of DI1 to DI6, DI8, and DI9 are the same.

a) When the host controller provides relay output:

① For use of the internal 24 V power supply of the servo drive

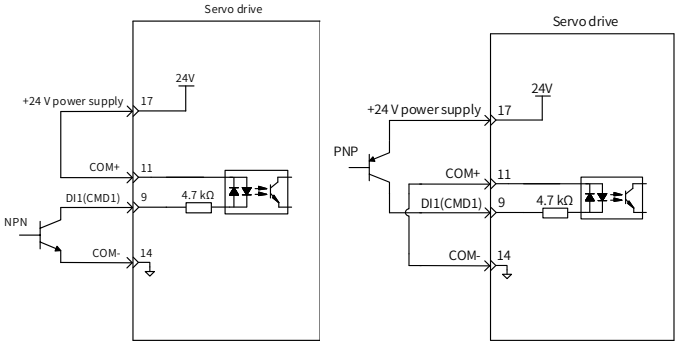


② For use of an external power supply

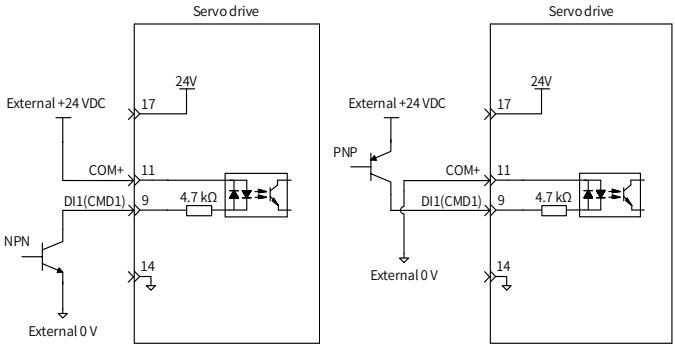


b) When the host controller provides open-collector output:

① For use of the internal 24 V power supply of the servo drive



② For use of an external power supply

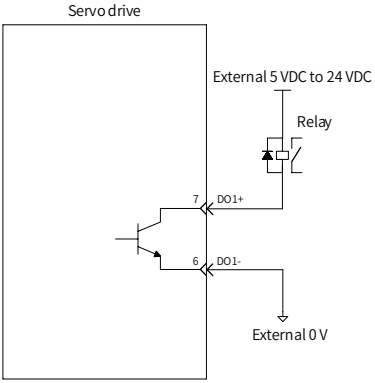


PNP and NPN input cannot be applied in the same circuit.

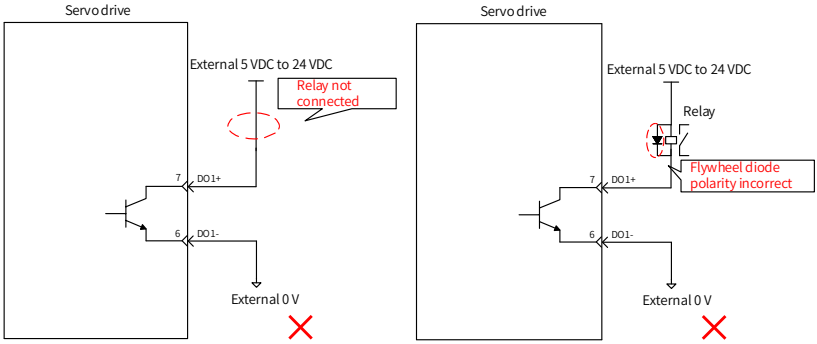
2) DO circuit (DO1 as an example)

DO1 to DO3 circuits are the same.

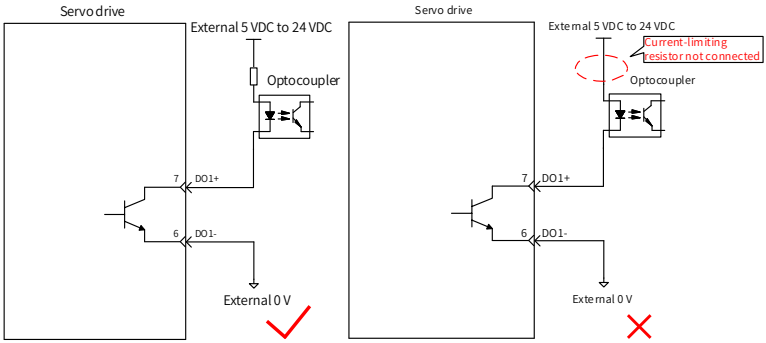
a) When the host controller provides relay input:



In this case, install a flywheel diode to prevent the DO terminal from being damaged.



b) When the host controller provides optocoupler input:



The maximum allowable voltage and current capacity of the optocoupler output circuit inside the servo drive are as follows:

Maximum voltage: 30 VDC

Maximum current: DC 50 mA

3.4 Encoder Frequency-Division Output Circuit

Table 3-16 Description of encoder frequency-division output signals

Signal Name	Function	Pin No.	Description	
General	PAO+ PAO-	21 22	Phase A frequency-division output signal	Phases A/B quadrature frequency-division pulse output signal
	PBO+ PBO-	25 23	Phase B frequency-division output signal	
	PZO+ PZO-	13 24	Phase Z frequency-division output signal	Home pulse output signal
	PZ-OUT	44	Phase Z frequency-division output signal	Home pulse open-collector output signal
	GND	29	Home pulse open-collector output signal ground	
General	+5V	15	5 V internal power supply. The maximum output current is 200 mA.	
	GND	16		
	PE	Enclosure	-	

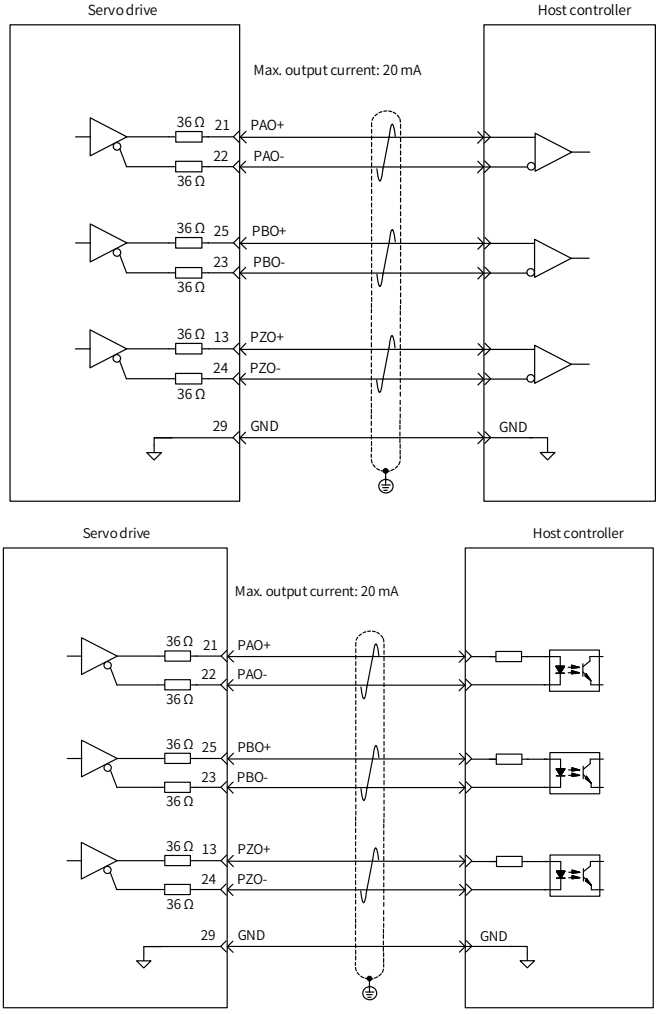
The encoder frequency-division output circuit outputs differential signals through the differential drive. Generally, it provides feedback signals to the host controller in a closed-loop position control system. A differential or optocoupler circuit must be used on the host controller side to receive feedback signals. The maximum output current is 20 mA.

Phase A pulse: PAO+, PAO-, differential output. The maximum output pulse frequency is 4 Mpps.

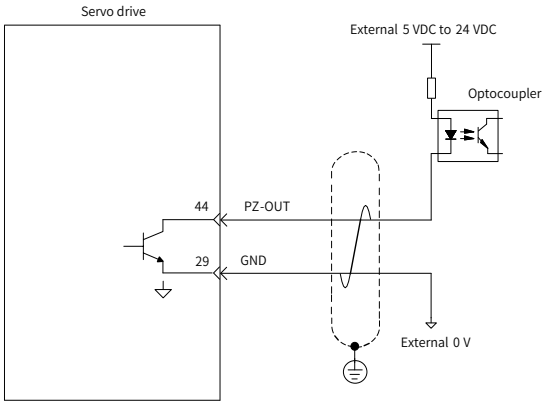
Phase B pulse: PBO+, PBO-, differential output, The maximum output pulse frequency is 4 Mpps

Phase Z pulse: PZO+, PZO-, differential output. The maximum output pulse frequency is 4 Mpps.

PZ-OUT, GND, open-collector output. The maximum output pulse frequency is 100 kpps.



The encoder phase Z frequency-division output circuit outputs open-collector signals. Generally, it provides feedback signals to the host controller in a closed-loop position control system. An optocoupler circuit, relay circuit, or bus receiver circuit must be used on the host controller side to receive feedback signals.



NOTE

- To reduce noise interference, connect the 5V ground of the host controller to the GND terminal of the servo drive and use shielded twisted pair cables.
- The maximum permissible voltage and current capacity of the optocoupler output circuit inside the servo drive are as follows:

  Maximum voltage: 30 VDC
  Maximum current: DC 50 mA

3.5 Wiring of Communication Signals CN3/CN4

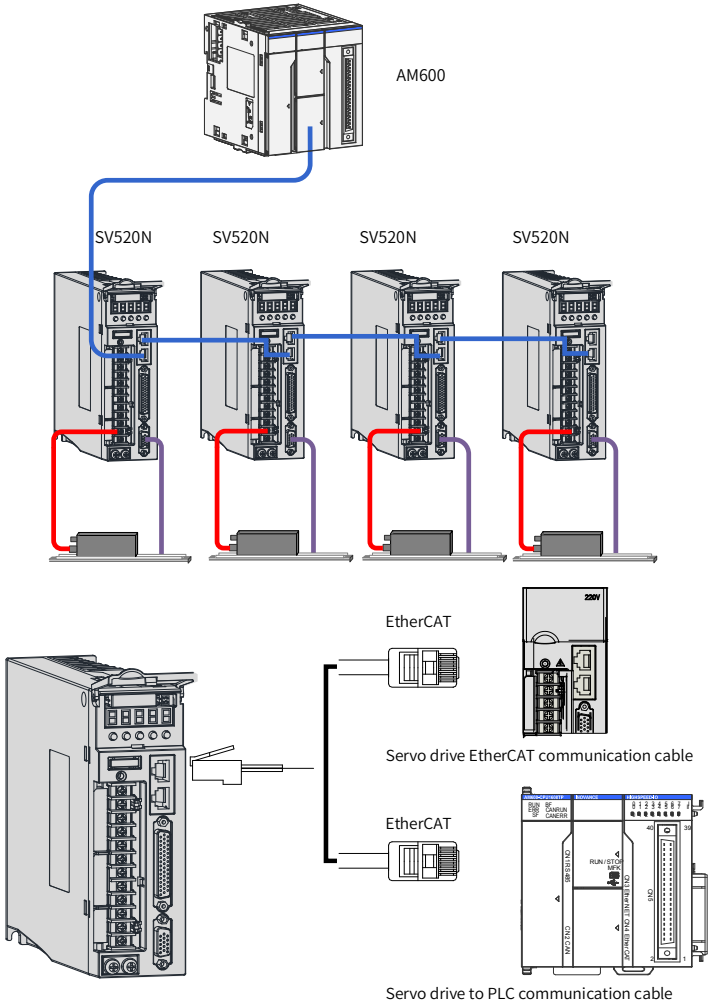
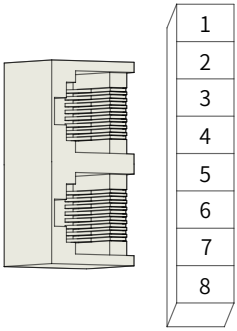


Figure 3-10 Wiring of communication signals

3.5.1 Pin Definition of Communication Signal Connector

The CN3/CN4 terminal on the servo drive is used for communication connection among the servo drive and the PC, PLC, and other servo drives. The pin definitions for CN3 and CN4 are shown in the following table.

Table 3-17 Pin definition of communication signal connector

Pin No.	Definition	Description	Terminal Pin Layout
1	TX+	Data transmitting (+)	
2	TX-	Data transmitting (-)	
3	RX+	Data receiving (+)	
4	-	-	
5	-	-	
6	RX-	Data receiving (-)	
7	-	-	
8	-	-	
Enclosure	PE	Shield	

3.5.2 Selection of Communication Cables

■ Selection Principle

Cable Specification	Supplier	Price
0.2 m to 10 m	Inovance	See the cable ordering information.
More than 10 m	Haituo	The cable price is added by RMB 5 for every additional 1 m based on the price of S6-L-T04-10.0. The cable price is also dependent on the magnitude of the order.

Basic information of Inovance EtherCAT communication cables

■ Cable models

S6-L-T04-3.0

Code	Product Series
S6	S6 series

Code	Meaning
L	Line

Code	Meaning
T	Communication cable

Cable Length (Unit: m)			
Code	Length	Code	Length
0.2	0.2	2.0	2.0
0.3	0.3	3.0	3.0
0.5	0.5	5.0	5.0
1.0	1.0	10.0	10.0

Code	Meaning
04	EtherCAT multi-drive communication cable

■ Cable ordering information

Material Code	Cable Model	Length (m)
15040261	S6-L-T04-0.3	0.3
15040262	S6-L-T04-3.0	3.0
15041960	S6-L-T04-0.2	0.2
15041961	S6-L-T04-0.5	0.5
15041962	S6-L-T04-1.0	1.0
15041963	S6-L-T04-2.0	2.0
15041964	S6-L-T04-5.0	5.0
15041965	S6-L-T04-10.0	10.0

Cables of 10 m and below must be purchased from Inovance.

Cables of above 10 m are preferred to be purchased from Haituo. The cable price is added by RMB 5 for every additional 1 m based on the price of S6-L-T04-10.0. The cable price is also dependent on the magnitude of the order.

■ Specifications:

Item	Description
UL certification	Complies with UL certification.
Cat 5e cable	Cat 5e cable
Double shielded	Braided shield (coverage: 85%), aluminum foil shield (coverage: 100%)
Environment adaptability	Ambient temperature: –30°C to +60°C , resistant to industrial oil, corrosive acid and alkali
EMC test standard	GB/T 24808-2009

■ Picture

Cable	Connection
	

3.6 Wiring of Software Tool Communication and Online Upgrade Signals (CN5)

Terminal layout of RS232 (CN5):

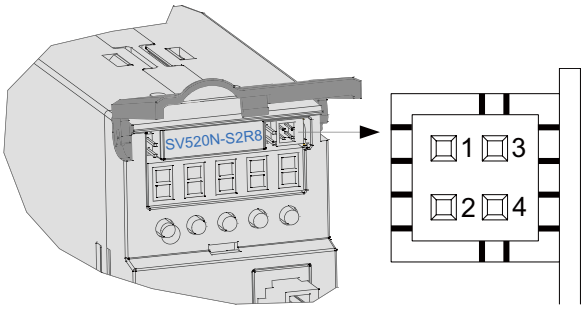


Figure 3-11 RS232 connector terminal

Table 3-18 Definition of RS232 connector terminals

Pin	Definition	Description
1	GND	Reference ground
2	RS232-RXD	Receiving end of RS232 signal
3	GND	Reference ground
4	RS232-TXD	Transmitting end of RS232 signal

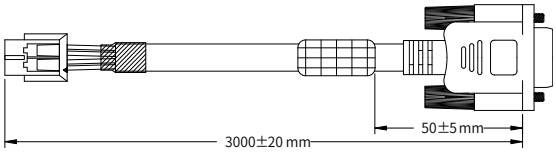


Figure 3-12 Dimension drawing of PC communication cable

Table 3-19 Pin connection relation of PC communication cable

4 Pins on the Servo Drive Side (A)		DB9 on PC side (B)	
Signal Name	Pin No.	Signal Name	Pin No.
GND	1, 3	GND	5
RS232-TXD	4	PC-RXD	2
RS232-RXD	2	PC-TXD	3
PE (shielded)	Null	PE (shielded)	Enclosure

If the host controller provides only the USB interface, use the serial-to-USB cable for conversion.

Recommendations:
Manufacture: Z-TEK
Model: ZE551A, with a 0.8 m USB extension cable
Chip model: FT232

3.7 Anti-interference Measures for Electrical Wiring

Take the following measures to suppress interference:

- Use cables as short as possible for reference input and encoder connection.
- Use a thick cable (above 2.0 mm^2) as the grounding cable.
- D class (or higher class) grounding is recommended (grounding resistance below 100 Ω).
- Use single-point grounding.
- Use a noise filter to prevent radio frequency interference. In domestic applications or applications with noise interference, install the noise filter on the input side of the power cable.
- To prevent malfunction caused by electromagnetic interference, take the following measures:

1) Install the host controller and noise filter near the servo drive.

2) Install a surge protection device on the relay, solenoid and electromagnetic contactor coils.

3) The distance between high-voltage cables and low-voltage cables must be at least 30 cm. Do not put these cables in the same duct or bundle them together.

4) Do not share the same power supply with an electric welding machine or an electric discharge machining device. When the servo drive is placed near a high-frequency generator, install a noise filter on the input side of the power cable.

3.7.1 Anti-interference Wiring Example and Grounding

The servo drive uses high-speed switch elements in the main circuit. The noise of such switches may affect the normal operation of the system due to improper wiring or grounding. Therefore, the servo drive must be properly wired and grounded. A noise filter can be added if necessary.

Anti-interference wiring example

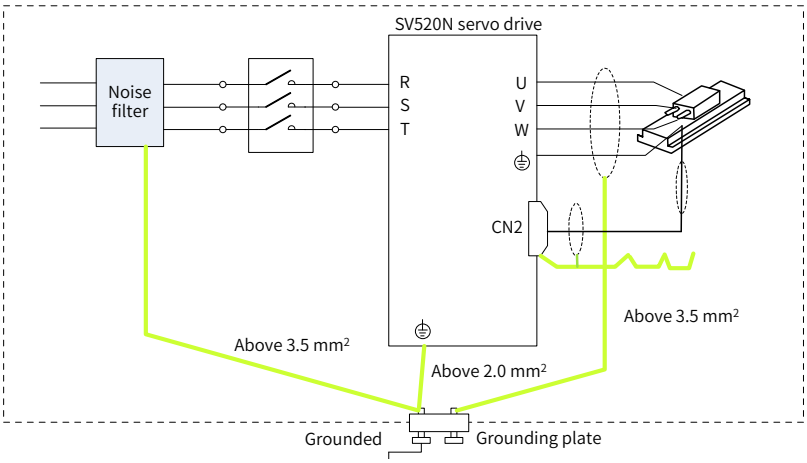


Figure 3-13 Anti-interference wiring example

■ Grounding

To prevent potential electromagnetic interference, perform grounding properly according to the following instructions.

■ Grounding the DDL motor enclosure

Connect the grounding terminal of the DDL motor to the PE terminal of the servo drive, and ground the PE terminal properly to reduce potential electromagnetic interference.

■ Grounding the power cable shield

Ground both ends of the shield or metal conduit in the main circuit of the DDL motor. Crimping is preferred to ensure good contact.

■ Grounding the servo drive

Ground the PE terminal of the servo drive properly and tighten the retaining screws to ensure good contact.

3.7.2 Instructions for Use of the Noise Filter

To prevent interferences from the power cable and the servo drive, install a noise filter on the input side of the power supply according to the magnitude of the input current. In addition, install a noise filter on power cables of peripheral devices as needed. Observe the following requirements when installing and wiring the noise filter.

Do not put the input and output cables of the noise filter in the same duct or bundle them together.

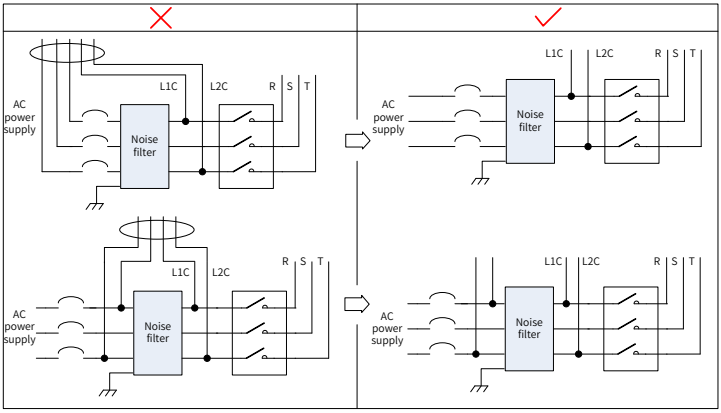


Figure 3-14 Separate routing of I/O cables of the noise filter

Route the grounding cable and the output cable of the noise filter through different routes.

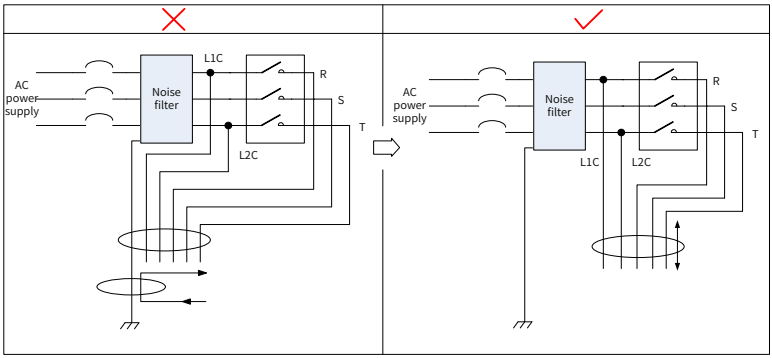


Figure 3-15 Separate routing of the grounding cable and output cable

Use a separate grounding cable as short and thick as possible for the noise filter. Do not share the same grounding cable with other grounding devices.

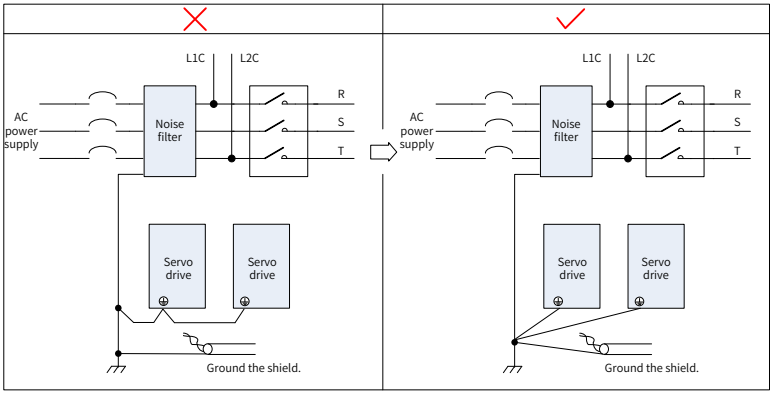


Figure 3-16 Single-point grounding

If the noise filter and the servo drive are installed in the same control cabinet, fix the noise filter and the servo drive to the same metal plate. Make sure the contact part is in good conductive condition and ground the metal plate properly.

You can also ground the noise filter separately.

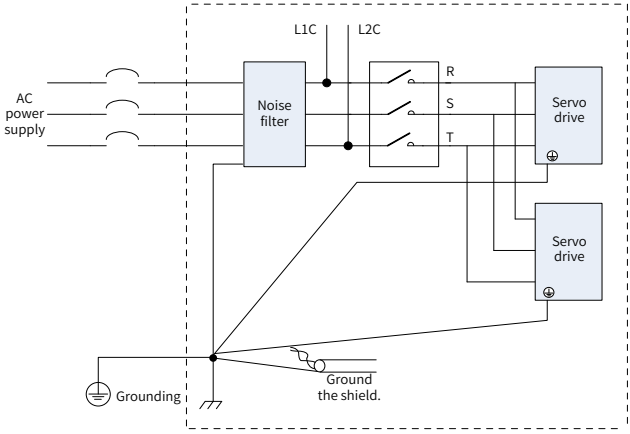


Figure 3-17 Grounding of the Noise filter

3.8 Precautions for Use of Cables

Do not bend or apply any tension to cables. The conductor of a signal cable is only 0.2 mm or 0.3 mm in diameter. Handle the cables carefully to prevent fracture.

In cases where cables need to be moved, use flexible cables. Regular cables may be easily damaged after bending for a long time. Cables configured together with low-power DDL motors do not fit for drag chains.

If a cable drag chain is used, make sure the following requirements are fulfilled:

- The bending radius of the cable is at least 10 times more than its outer diameter.
- Do not fix or bundle the cables inside the cable drag chain. The cables can be bundled and fixed only at two unmovable ends of the cable drag chain.
- Do not twist or distort the cables.
- The space factor inside the cable drag chain cannot exceed 60%.
- Do not use cables of different sizes together. This is to prevent thin cables from being crushed by thick cables. If thick and thin cables need to be used together, use a spacer plate to separate them.

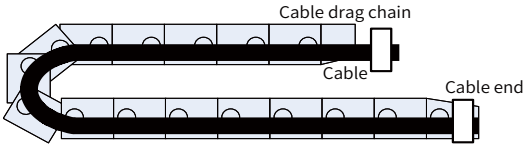


Figure 3-18 Cable drag chain

4 Commissioning

4.1 Commissioning Objects

The DDL motor types supported are as follows:

Linear Servo Parts	Type		Supported or Not	Characteristics	Notes
Position feedback device	Optical (magnetic) scale	Pulse type	Supported	5 V RS422 differential pulse signal, supporting up to 20 MHz frequency (quadrupled)	Select the encoder type in H00-26.
		With or without Z Signal	Supported	-	
	Hall devices	Switched-mode Hall	Hall auto-tuning supported	OC-type signal	Hall auto-tuning (H0A-51 = 1), auto-tuning in static Hall mode (H0A-13 = 6)

Linear Servo Parts	Type		Supported or Not	Characteristics	Notes
Linear motor	Iron core excitation	With or without iron core	Unilateral/ Bilateral excitation supported	U-type, barrel-shape, tablet-type	The magnetic pole auto-tuning requires the motor rotor to move. Select the magnetic pole auto-tuning mode as needed (H0A-13 = 0 to 9). The magnetic pole auto-tuning is performed through the jog mode by default (H0A-13 = 1)
	PTC	With or without PTC	PTC device supported	-	Switch-type PTC supported only
	Magnetic rail length	Long magnetic pole, short magnetic pole	DDL motors with fixed rotor or long rotor supported	The magnetic rail length can be smaller than one electric cycle.	For the DDL motor with short magnetic pole (the magnetic rail length equals one electric cycle), use pre-positioning mode (H0A-13 = 0) for magnetic pole auto-tuning. The electrical angle of pre-positioning can be set in H0A-50.

4.2 Basic Commissioning Process

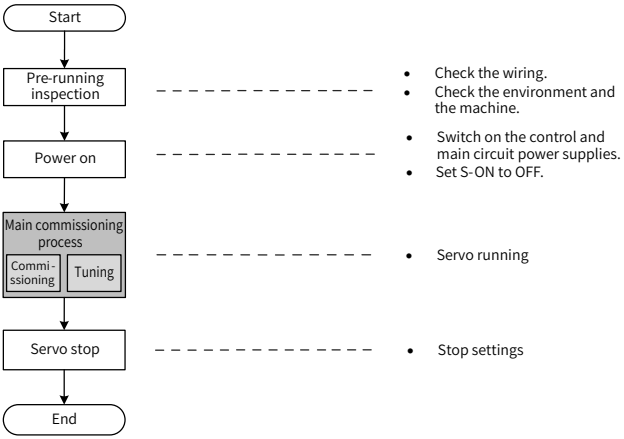


Figure 4-1 Process of servo drive settings

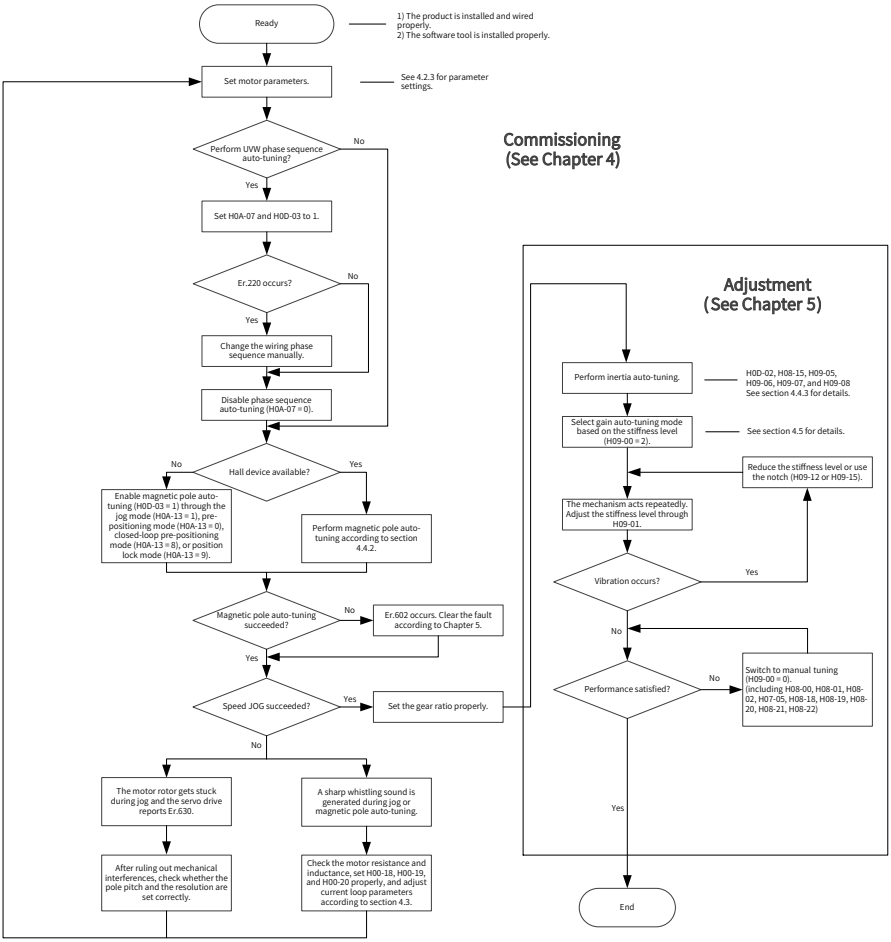


Figure 4-2 Main commissioning process of the servo drive

4.2.1 Pre-running Inspection

Check the following items before operating the servo drive and servo motor.

Table 4-1 Pre-running checklist

Checked	No.	Description
Wiring		
☐	1	Power input terminals of the control circuit (L1C, L2C) and main circuit (R, S, T) of the servo drive are connected properly.

Checked	No.	Description
☐	2	The main circuit output terminals (U, V, W) of the servo drive are connected to the motor power cables in the correct phase sequence. If you are uncertain whether these cables are connected in the correct phase sequence, check and adjust the phase sequence according to section 5.4.
☐	3	No short circuit exists in power input terminals (R, S, T) or power output terminals (U, V, W) of the main circuit.
☐	4	The control signal cables such as the brake and overtravel protection signal cables are connected properly.
☐	5	The servo drive and the servo motor are grounded reliably.
☐	6	Remove the jumper between terminals $P_{\oplus}$ and D when an external regenerative resistor is used.
☐	7	The cable tension is within the specified range.
☐	8	The connecting terminals are well insulated.
Environment and Mechanical Conditions		
☐	1	No foreign objects, such as the cable end or metal filings which may cause short circuit in the signal cables and power cables, exist inside or outside the servo drive.
☐	2	The servo drive or external regenerative resistor is placed on incombustible objects.
☐	3	The servo motor installation and the shaft and mechanical connections are reliable.
☐	4	The servo motor and the machine that the servo motor is connected to are ready to run.

4.2.2 Power Supply Connection

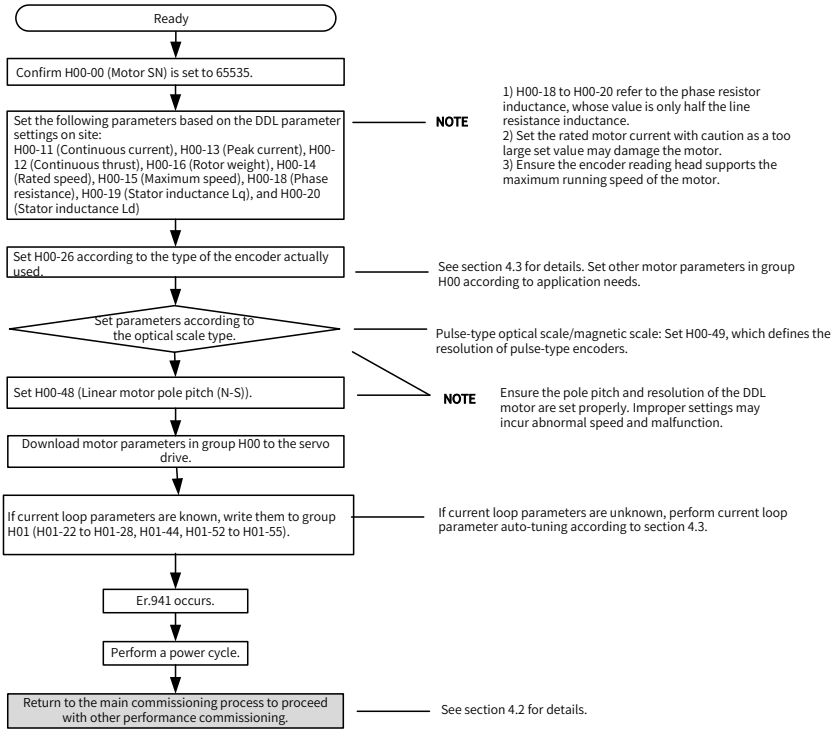
■ Powering on the control circuit and main circuit

Switch on the power supplies of the control circuit (L1C, L2C) and the main circuit.

The main circuit power terminals of single-phase 220 V models are L1 and L2. The main circuit power terminals of three-phase 220 V/380 V models are R, S, and T.

After powering on the control circuit and main circuit, if the bus voltage indicator is in normal status and the keypad displays "reset" → "nr" → "ry" in sequence, it indicates the servo drive is ready to run and waiting for the S-ON signal.

4.2.3 Parameter Setting

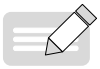


Enter the correct factory password before parameter settings (2002-2A (H02-41) = 1430). Otherwise, parameters cannot be read or written. If you perform parameter settings through the software tool wizard, there is no need to enter the password. See details in "4.3 Quick Commissioning Guide to the Software Tool".

1 Motor parameter settings

Parameters related to motor settings are listed in the following table.

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2000	01h	H00-00	Motor SN	Set the motor SN to 65535.	0 to 65535	65535	1	16 bits	At stop	Next power-on
	0Ch	H00-11	Continuous current	-	1 to 65535	230	0.01 A	16 bits	At stop	Next power-on
	0Dh	H00-12	Continuous thrust	-	10 to 65535	375	0.1 N	16 bits	At stop	Next power-on
2000	0Eh	H00-13	Peak Current	-	1 to 65535	690	0.01 A	16 bits	At stop	Next power-on
	0Fh	H00-14	Rated speed	-	100 to 30000	1900	mm/s	16 bits	At stop	Next power-on
	10h	H00-15	Max. speed	-	100 to 60000	3000	mm/s	16 bits	At stop	Next power-on
	11h	H00-16	Rotor weight	-	1 to 65535	290	g	16 bits	At stop	Next power-on
	13h	H00-18	Stator resistance	Phase resistance value	1 to 65535	4000	0.001 Ω	16 bits	At stop	Next power-on
	14h	H00-19	Stator inductance Lq	Phase inductance value	1 to 65535	100	0.01 mH	16 bits	At stop	Next power-on
	15h	H00-20	Stator inductance Ld	Phase inductance value	1 to 65535	100	0.01 mH	16 bits	At stop	Next power-on
	31h	H00-48	Pole pitch (N-S)	-	1 to 65535	160	0.1 mm	16 bits	At stop	Next power-on


NOTE

- Motor parameters can be set only when 2000-01h (H00-00) is set to 65535. Do not change the default value 65535.
- Set H00-11 to a too large value may damage the motor.
- The phase resistance (phase inductance) equals to half the line resistance (line inductance). If you are uncertain of the phase resistance, see "4.2.4 Motor Parameter Auto-tuning".
- Ensure the pole pitch of the DDL motor is set properly. A wrong pitch may incur abnormal speed or malfunction.
- Ensure the encoder reading head supports the maximum running speed of the motor. This is to prevent runaway accidents caused by excessive speed feedback upon maximum running speed. If the data on the reading head is unavailable or the range of the reading head is unclear, push the motor manually and observe the speed feedback through the oscilloscope of the software tool to determine the range of the reading head.

2 Encoder parameter settings

Parameters related to encoder settings are listed in the following table.

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2000	1Bh	H00-26	Encoder type	0x00: AB analog with Z signal but without Hall, encoder counting direction unchanged 0x02: AB analog without Z signal or Hall, encoder counting direction unchanged 0x03: AB pulse with Z signal but without Hall, encoder counting direction unchanged 0x04: AB pulse without Z signal or Hall, encoder counting direction unchanged 0x08: AB analog with Z signal and Hall, encoder counting direction unchanged 0x0A: AB analog without Z signal but with Hall, encoder counting direction unchanged 0x0B: AB pulse with Z signal and Hall, encoder counting direction unchanged 0x0C: AB pulse without Z signal but with Hall, encoder counting direction unchanged 0x10: AB analog with Z signal but without Hall, encoder counting direction reversed 0x12: AB analog without Z signal or Hall, encoder counting direction reversed 0x13: AB pulse with Z signal but without Hall, encoder counting direction reversed 0x14: AB pulse without Z signal or Hall, encoder counting direction reversed 0x18: AB analog with Z signal and Hall, encoder counting direction reversed 0x1A: AB analog without Z signal but with Hall, encoder counting direction reversed 0x1B: AB pulse with Z signal and Hall, encoder counting direction reversed 0x1C: AB pulse without Z signal but with Hall, encoder counting direction reversed	0 to 65535	4	1	16 bits	At stop	Immediately

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2000	2Fh	H00-46	Magnetic scale pitch	Used in a magnetic scale encoder to suppress the feedback noise of the magnetic scale.	1 to 65535	10	0.1 mm	16 bits	At stop	Next power-on
	30h	H00-47	Encoder type	0: Optical scale 1: Magnetic scale	0 to 1	0	1	16 bits	At stop	Next power-on
	32h	H00-49	Resolution	Indicates the minimum resolution of the encoder.	1 to 10000	100	0.01 um/p	16 bits	At stop	Next power-on

NOTE

- For a pulse-type optical scale/magnetic scale, set H00-49 (Resolution) properly.
- Ensure the encoder resolution is set properly to prevent abnormal speed or malfunction caused by a wrong encoder resolution.

3 Current loop parameter settings

After motor parameters are set properly, the servo drive calculates a group of default current loop parameters based on motor parameter characteristics. Such parameters need no adjustment.

Parameters related to current loop settings are listed in the following table.

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2001	19h	H01-24	D-axis current loop gain	-	1 to 65535	200	1	16 bits	At stop	Immed-iately
	1Ah	H01-25	D-axis current loop integral compensation factor	-	0 to 65535	100	1	16 bits	At stop	Immed-iately
	1Ch	H01-27	Q-axis current loop gain	-	1 to 65535	1000	1	16 bits	At stop	Immed-iately
	1Dh	H01-28	Q-axis current loop integral compensation factor	-	0 to 65535	100	1	16 bits	At stop	Immed-iately
	35h	H01-52	D-axis proportional gain in performance priority mode	-	0 to 65535	800	1	16 bits	At stop	Immed-iately
	36h	H01-53	D-axis integral gain in performance priority mode	-	0 to 65535	200	0.01	16 bits	At stop	Immed-iately
	37h	H01-54	Q-axis proportional gain in performance priority mode	-	0 to 65535	100	1	16 bits	At stop	Immed-iately

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2001	38h	H01-55	Q-axis integral gain in performance priority mode	-	0 to 65535	100	0.01	16 bits	At stop	Immed-iately
	39h	H01-56	2nd proportional gain coefficient in performance priority mode	-	0 to 10000	1000	0.1%	16 bits	At stop	Immed-iately
	3Ah	H01-57	3rd proportional gain coefficient in performance priority mode	-	0 to 10000	1000	0.1%	16 bits	At stop	Immed-iately
	3Bh	H01-58	1st gain switchover threshold in performance priority mode	-	0 to 3000	10	0.1%	16 bits	At stop	Immed-iately
	3Ch	H01-59	2nd gain switchover threshold in performance priority mode	-	0 to 3000	20	0.1%	16 bits	At stop	Immed-iately
	3Dh	H01-60	3rd gain switchover threshold in performance priority mode	-	0 to 3000	1000	0.1%	16 bits	At stop	Immed-iately
	3Eh	H01-61	4th gain switchover threshold in performance priority mode	-	0 to 3000	2000	0.1%	16 bits	At stop	Immed-iately

NOTE

- When the default current loop parameters cannot fulfill the performance requirements, perform current loop auto-tuning to obtain a group of appropriate current loop parameters or use the software tool to perform current loop auto-tuning. See details in "4.3 Quick Commissioning Guide to the Software Tool".
- If the auto-tuned current loop parameters fail to meet the requirements, adjust current loop parameters manually. Contact Inovance technical support for detailed operation methods.

4.2.4 Motor Parameter Auto-tuning

When the resistance or inductance of the motor is unclear, use the motor parameter auto-tuning function to obtain the resistance and inductance of the motor. To enable motor parameter auto-tuning, make the servo drive stay in "Rdy" state first, and then set 200D-09h (H0D-08) to a proper value. Related parameters are listed in the following table.

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200D	09h	H0D-08	Motor parameter auto-tuning	0: No operation 1: Enabled	0 to 6	0	1	16 bits	At stop	Immed-iately
200A	0Fh	H0A-14	Search for duty cycle during motor parameter auto-tuning	0: Disabled 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately

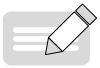
NOTE

- Motor parameter auto-tuning can be done without magnetic pole auto-tuning.
- During parameter auto-tuning, you may hear noises generated during current transition, which is quite normal. The duration of such noise is determined by the motor characteristics. The auto-tuning process of motors with large inductance takes a longer time than those with small inductance. After auto-tuning is done, 200A-0Fh (H0A-14) and 200D-09h (H0D-08) are set to 0 automatically. The auto-tuned resistance and inductance will be written automatically.
- You can also perform motor parameter auto-tuning through the software tool. See details in "4.3 Quick Commissioning Guide to the Software Tool".

4.2.5 Phase Sequence Auto-tuning

Phase sequence auto-tuning helps users to determine whether the motor drive cables are connected in the correct sequence so that the servo drive can run properly. To enable phase sequence auto-tuning, make the servo drive stay in "Rdy" status first, and then set 200A-08h (H0A-07) to 1 and 200D-04h (H0D-03) to 1. The related parameters are listed in the following table.

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	08h	H0A-07	Phase sequence auto-tuning	0: Disabled during angle auto-tuning 1: Enabled during angle auto-tuning	0 to 1	0	1	16 bits	At stop	Immed-iately
200D	04h	H0D-03	Initial angle auto-tuning	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately


NOTE

- If Er.220 (Wrong phase sequence) occurs during manual phase sequence tuning, exchange any two motor drive cables to adjust the phase sequence.
- After phase sequence auto-tuning is done, 200D-04h (H0D-03) is set to 0 automatically, and the value of 200A-08h (H0A-07) remains unchanged. It is recommended to disable phase sequence auto-tuning (H0A-07 = 0) when no warning occurs after manual tuning. Otherwise, phase sequence auto-tuning will be performed by default every time upon receiving the first S-ON signal.
- You can also perform phase sequence auto-tuning through the software tool. See details in "4.3 Quick Commissioning Guide to the Software Tool". If an error occurs during auto-tuning, the phase sequence will be switched automatically, removing the need for manual switchover.

Troubleshooting:

If the motor shakes leftwards and rightwards irregularly during phase sequence auto-tuning, stop phase sequence auto-tuning immediately. This is usually caused by an improper setting of 2008-10h (Load moment of inertia ratio), which means 2008-10h is set to a value much smaller than the actual load moment of inertia ratio (smaller than 1/5 of the actual ratio). Estimate a proper inertia ratio and perform phase sequence auto-tuning again.

If the motor generates strong vibration noise during phase sequence auto-tuning, stop phase sequence auto-tuning immediately. This is usually caused by improper setting of 2008-10h (Load moment of inertia ratio) or 200A-4Bh (H0A-74), which means 2008-10h or 200A-4Bh is set to a too large value. Estimate a proper inertia ratio or reduce the closed-loop pre-positioning gain and perform phase sequence auto-tuning again.

4.2.6 Magnetic Pole Auto-tuning

Magnetic pole auto-tuning (initial electric auto-tuning) is required before linear motor control. This is to determine the electrical control basis to allow proper control over motor operations.

The SV520N series servo drive offers five kinds of magnetic pole auto-tuning modes. See the following table for details.

Auto-tuning Mode	Scope of Action	Applicable Motor	Applicable Encoder	Load-carrying Capacity
Pre-positioning mode	Large	Barrel-type/U-type	All	Weak
Jog mode	Small	All	Optical scale	Medium
Hall auto-tuning	Null	High power	All	Strong
Position lock mode	Very small	All	All	Strong
Closed-loop pre-positioning mode	Large	All	All	Strong

Type	Mode	Applicable Occasion	Advantage & Disadvantage
Dynamic auto-tuning	Pre-positioning mode	Applicable to occasions where the rotor is allowed to move between the pole pitch (H00-48)	Advantage: wide scope of application
			Disadvantage: unstable rotor movement (overshoot within the range of stroke) Disturbance not allowed
	Closed-loop pre-positioning mode	Applicable to occasions where the rotor is allowed to move between the pole pitch (H00-48) and auto-tuning is allowed at the hardware limit	Advantage: wide scope of application
			Disadvantage: large range of movement
	Jog mode	Applicable to occasions with a light load (within half the rated load) or no load	Advantage: small range of movement (within hundreds of pulses, dependent on the value of H0A-15), rotor movement invisible
			Disadvantage: not recommended in the four occasions described in the NOTE on page 73. Disturbance not allowed
Quasi-static auto-tuning	Position lock mode	Applicable to occasions with load, Z axis and external interface, in which movement within 100P (encoder unit) is allowed during auto-tuning	Advantage: invisible rotor movement and strong anti-interference capacity, warning triggered for mechanical interference during auto-tuning
			Disadvantage: applicable to specific DDL motors or applications, requiring auto-tuned parameters to be fine-tuned manually to improve the auto-tuning performance
Static auto-tuning	Hall auto-tuning	Applicable to occasions where the motor rotor cannot move	Advantage: initial angle auto-tuning not required upon power-on
			Disadvantage: high cost (This mode is recommended for static auto-tuning.)

NOTE

If the rotor is of small inertia, select dynamic auto-tuning in applications requiring movement. If the motor is of large inertia, select static auto-tuning in applications where the rotor cannot move easily.

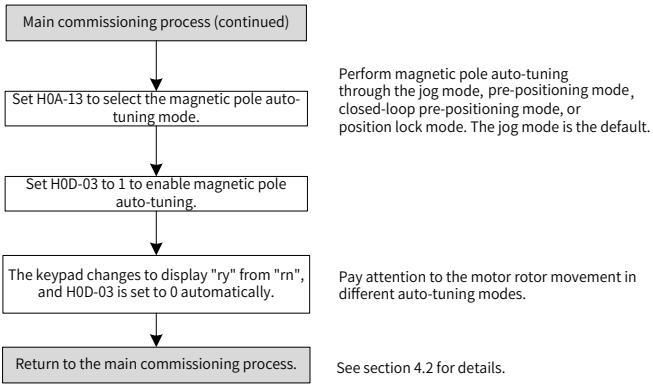
1 Auto-tuning process

The magnetic pole auto-tuning can be divided into "magnetic pole auto-tuning without Hall device" and "magnetic pole auto-tuning with Hall device" based on whether the linear motor carries a Hall device.

1) Magnetic pole auto-tuning without Hall device

Scope of application: Pre-positioning mode, jog mode, closed-loop pre-positioning mode, position lock mode

The starting process is as follows.



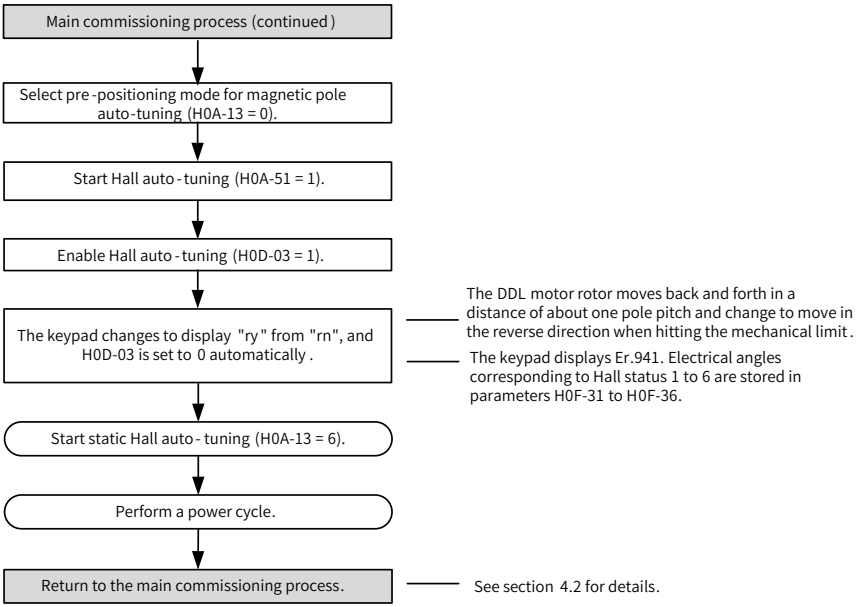
NOTE

During initial power-on, the angle auto-tuning completed flag can also be output through the DO terminal (H04-00 = 20). In EtherCAT communication control, you can also obtain the magnetic pole auto-tuning state through bit14 of status word 6041h.

2) Magnetic pole auto-tuning with Hall device

Scope of application: Hall auto-tuning

The starting process is as follows.



2 Auto-tuning through pre-positioning mode

See "Magnetic pole auto-tuning without Hall device" for details on pre-positioning mode.

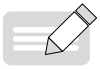
Set H0A-50 to position the rotor to different electric angles during auto-tuning through pre-positioning mode.

Features of pre-positioning auto-tuning are shown in the following table.

Rotor Actions	Max. Amplitude of Motion	Auto-tuning Completed
The motor rotor moves immediately to the set position from the power-on position, and then tries to move within a small range. Note that mechanical interference must be avoided.	The motor may move violently within a large range. The maximum amplitude of motion is the distance between N-S. If phase sequence auto-tuning is enabled, the maximum amplitude of motion is the distance between N-N.	When the keypad display changes from "rn" to "ry", it indicates auto-tuning is completed. The auto-tuning process takes about 8s.

Related Parameters

Para. group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	0Eh	H0A-13	Initial angle auto-tuning mode	0: Pre-positioning mode 1: Jog mode 6: Static Hall mode 8: Closed-loop pre-positioning mode 9: Position lock mode	0 to 9	1	1	16 bits	At stop	Immed-iately
200D	04h	H0D-03	Initial angle auto-tuning	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
200A	33h	H0A-50	Pre-positioning electrical angle		0 to 359	90	1°	16 bits	At stop	Immed-iately
200C	07h	H0C-06	Return to the starting position after pre-positioning auto-tuning completed	0: Disabled 1: Enabled	0 to 1	1	1	16 bits	At stop	Immed-iately



NOTE

200C-07h (H0C-06) is used to set whether to return to the starting position of auto-tuning after pre-positioning auto-tuning is done. If this function is enabled, the motor will not stop at the electric angle of pre-positioning after auto-tuning is done.

3 Auto-tuning through jog mode

See "Magnetic pole auto-tuning without Hall device" for details.

The set value of 200A-0Fh (H0A-15) acts as the threshold for judging motor movement. This parameter is used in adjustment of electrical angle reference of internal magnetic pole auto-tuning after motor movement. If the motor moves the stroke defined by 2000-31h x 200A-0Fh/1000 (H00-48 x H0A-15/1000), it indicates the motor moves. In this case, you can fine-tune the set value of 200A-0Fh (H0A-15). During magnetic pole auto-tuning through jogging, the motor rotor may move leftwards and rightwards within a small range and generate current noise. If the keypad display changes from "rn" to "ry", it indicates the auto-tuning is done and you can proceed to the next commissioning process. If the keypad displays "Er.602", it indicates the auto-tuning fails.

Related Parameters

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	0Eh	H0A-13	Initial angle auto-tuning mode	0: Pre-positioning mode 1: Jog mode 6: Static Hall mode 8: Closed-loop pre-positioning mode 9: Position lock mode	0 to 9	1	1	16 bits	At stop	Immed-iately
200D	04h	H0D-03	Initial angle auto-tuning selection	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
200A	10h	H0A-15	Motor running threshold in jog auto-tuning	-	1 to 1000	100	0.01% pole pitch	16 bits	At stop	Immed-iately
200A	2Eh	H0A-45	Injection current rising slope in jog auto-tuning	-	1 to 255	5	1	16 bits	At stop	Immed-iately
200A	32h	H0A-49	Motor standstill threshold in jog auto-tuning	-	2 to 999	2	1p	16 bits	At stop	Immed-iately

NOTE

Causes for jog auto-tuning failure:
- Large friction during motor rotor movement
- Loose cooperation between the rotor and motor track
  Rotor tilted during auto-tuning, leading to mechanical stuck
- Rotor locked due to mechanical limit during auto-tuning
- Rotor suffering from external interference during auto-tuning

If preceding factors affect magnetic pole auto-tuning, you can select other auto-tuning modes. The auto-tuning process takes about 5s.

4 Auto-tuning through closed-loop pre-positioning mode

See "Magnetic pole auto-tuning without Hall device" for details on pre-positioning auto-tuning.

The closed-loop pre-positioning mode adopts closed-loop speed with a large motion range. This mode features strong load-carrying capacity and high auto-tuning precision. It is immune from the motor and encoder characteristics and free from warnings and runaway accidents. The program is built-in with mechanical limit auto-tuning mode, including soft cushion, mechanical limit, and spring damping buffer limit. If the rotor hits the mechanical limit during auto-tuning, it will return automatically and finish auto-tuning. Note that the rotor will move in the distance of one pole pitch in this mode, take measures to prevent the rotor from disturbing the machinery of other axes. Reducing the value of H0A-79 (Damping of closed-loop pre-positioning auto-tuning) can increase the auto-tuning speed.

Related Parameters

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	0Eh	H0A-13	Initial angle auto-tuning mode	0: Pre-positioning mode 1: Jog mode 6: Static Hall mode 8: Closed-loop pre-positioning mode 9: Position lock mode	0 to 9	1	1	16 bits	At stop	Immed-iately
200D	04h	H0D-03	Initial angle auto-tuning selection	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
200A	4Bh	H0A-74	Gain in closed-loop pre-positioning auto-tuning	-	0 to 20000	50	0.1 Hz	16 bits	At stop	Immed-iately
200A	4Ch	H0A-75	Injection current rising slope in closed-loop pre-positioning auto-tuning	-	1 to 4096	50	1	16 bits	At stop	Immed-iately
200A	50h	H0A-79	Damping of closed-loop pre-positioning auto-tuning	-	1 to 1000	50	1%	16 bits	At stop	Immed-iately

5 Auto-tuning through position lock mode

See "Magnetic pole auto-tuning without Hall device" for details.

This auto-tuning mode features a strong anti-interference capacity in which the motor movement is almost invisible and mechanical interference will not affect the magnetic pole auto-tuning.

Related Parameters

Para. group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	0Eh	H0A-13	Initial angle auto-tuning mode	0: Pre-positioning mode 1: Jogging mode 6: Static Hall mode 8: Closed-loop pre-positioning mode 9: Position lock mode	0 to 9	1	1	16 bits	At stop	Immed-iately
200D	04h	H0D-03	Initial angle auto-tuning selection	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
200A	40h	H0A-63	Current amplitude of position lock auto-tuning	-	0 to 300	200	1%	16 bits	At stop	Immed-iately
200A	43h	H0A-66	Acceleration feedback threshold in position lock auto-tuning	-	0 to 1000	100	0.1%	16 bits	At stop	Immed-iately
200A	45h	H0A-68	Gain in position lock auto-tuning	-	0 to 65535	200	1 Hz	16 bits	At stop	Immed-iately

NOTE

- This mode applies to most of applications except for some special applications (such as DDL motors) in which auto-tuning may fail. If auto-tuning fails, perform auto-tuning again. If the problem persists, contact our technical support.
- A certain range of movement is allowed during auto-tuning in applications with load or where Z-axis suffers from external interference. You can set the motion range through H0A-69. If the set range is exceeded during auto-tuning, Er.602 (Magnetic pole auto-tuning failure) will be reported. Set H0A-69 according to actual working conditions.
- For settings of H0A-63 and H0A-68, a too small set value ensures mild motor vibration but prolongs the auto-tuning duration and may incur auto-tuning failure (Er.602). On the contrary, a too large set value shortens the auto-tuning duration but may incur strong motor vibration. Set the values of H0A-63 and H0A-68 according to actual needs.

6 Auto-tuning through Hall signal

See "Magnetic pole auto-tuning with Hall device" for details.

Magnetic pole auto-tuning through the Hall signal requires the Hall device to be installed properly and the corresponding Hall data to be stored in parameters H0F-31 to H0F-36. The Hall data can be set manually through parameters or through triggering the automatic Hall data detection.

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	0Eh	H0A-13	Initial angle auto-tuning mode	0: Pre-positioning mode 1: Jog mode 6: Static Hall mode 8: Closed-loop pre-positioning mode 9: Position lock mode	0 to 9	1	1	16 bits	At stop	Immed-iately
200D	04h	H0D-03	Initial angle auto-tuning	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
200A	34h	H0A-51	Hall auto-tuning selection	-	0 to 1	0	1	16 bits	At stop	Immed-iately
200F	20h	H0F-31	Electrical angle corresponding to Hall status 1	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
200F	21h	H0F-32	Electrical angle corresponding to Hall status 2	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
200F	22h	H0F-33	Electrical angle corresponding to Hall status 3	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
200F	23h	H0F-34	Electrical angle corresponding to Hall status 4	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
200F	24h	H0F-35	Electrical angle corresponding to Hall status 5	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
200F	25h	H0F-36	Electrical angle corresponding to Hall status 6	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on

4.2.7 Current Loop Auto-tuning

When the default current loop parameters cannot fulfill the performance requirement, you can perform current loop parameter auto-tuning to obtain the current loop parameters. To enable current loop auto-tuning, make the servo drive stay in "Ry" status after finishing magnetic pole auto-tuning, and then start auto-tuning by setting 200D-07h (H0D-06). The related parameters are listed in the following table.

Para. Group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200D	07h	H0D-06	Current loop parameter auto-tuning	0: No operation 3: Enable static auto-tuning	0 to 6	0	1	16 bits	At stop	Immed-iately
	0Eh	H0D-13	Rise time of current loop auto-tuning		0 to 99	0	62.5 μs	16 bits	At stop	Immed-iately
	0Fh	H0D-14	Steady-state error in current loop auto-tuning		10 to 500	10	0.1%	16 bits	At stop	Immed-iately
	10h	H0D-15	Overshoot in current loop auto-tuning		0 to 500	10	0.1%	16 bits	At stop	Immed-iately

NOTE

- Perform magnetic pole auto-tuning before current loop auto-tuning. Otherwise, the servo drive does not respond to the auto-tuning command. See "4.2.6 Magnetic Pole Auto-tuning" for details.
- Set parameters 200D-0Eh to 200D-10h (H0D-13 to H0D-15) to proper values before auto-tuning. These parameters are the indicators for current loop auto-tuning.
- After auto-tuning is done, 200D-07h (H0D-06) will be set to 0 automatically, and the values of 200D-0Eh to 200D-10h (H0D-13 to H0D-15) will be changed to reflect the auto-tuned results.

Note: The auto-tuned results are determined by motor characteristics, which are different from the set indicators.

- You can also start current loop parameter auto-tuning through the software tool. See details in "4.3 Quick Commissioning Guide to the Software Tool".
- If the auto-tuned current loop parameters fail to meet the requirement, adjust current loop parameters manually. Contact Inovance technical support for detailed operation methods.

4.2.8 Jog

After commissioning procedures mentioned in section 4.2.1 to 4.2.6 are done, the servo drive will be able to make the DDL motor run in different modes. It is recommended to perform a jog test before running to prevent unexpected accidents.

The SV520N series servo drive offers two jog modes: speed jog through the keypad and speed jog through the software tool.

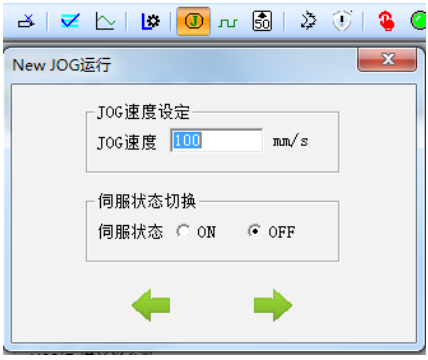
■ Speed jog through the keypad

Enter the speed jog mode by setting H0D-11 (200D-0Ch) through the keypad. The keypad displays the default jog speed, which can be modified by pressing the ▲ / ▼ button. Press the SET button to enter the jog state, and the keypad displays "JOG". Power on the servo motor and hold down the ▲ / ▼ button to switch between forward and reverse jog. Press the MODE button to exit from the speed jog mode.

■ Speed jog through software tool

Open the software tool (Inovance servo commissioning software), click " 试运行 (Trial run) -> JOG)" in the menu bar or click the symbol "J" (the highlighted icon in the following figure) to open the speed JOG interface.

Set the jog speed and switch on the servo drive. Press the forward/reverse arrow displayed on the interface to switch between forward and reverse jog.



NOTE

Further adjustment and improvement on performance and application designs can be done only if the servo drive functions properly after the jog test.

4.3 Quick Commissioning Guide to the Software Tool

4.3.1 Introduction to the Software Tool

1 Overview

The software tool InoServoShop can be downloaded for free on www.inovance.cn. Use the PC communication cable (S6-L-T00-3.0) provided by Inovance to achieve communication between the PC and the servo drive. You can also make the communication cable by yourself, and connect the cable according to the instructions in "3 Wiring".

InoServoShop features the following functions:

- Oscilloscope: Detects and saves the transient data during running
- Electronic cam: Used to set electronic cam parameters in the form of graphics. (not supported by SV520N series servo drives)
- Parameter management: Reads and downloads parameters in batches.
- Database: Identifies parameters of customized software.
- Inertia auto-tuning: Achieves auto-tuning on the load inertia ratio through a series of actions.
- Mechanical characteristics analysis: Analyzes the resonance frequency of the mechanical system.
- Motion JOG: Profiles a position reference to make the motor run repeatedly.
- Gain tuning: Adjusts the stiffness level of the servo drive and monitors motion information.

InoServoShop can run in WindowsXP and Windows7. For details on how to use the InoServoShop, see the InoServoShop help files.

InoServoShop4.10 offers SV520N commissioning wizard to assist users in on-site commissioning. See "4.3.2 Commissioning Process" for the commissioning process.

2 Instructions for use

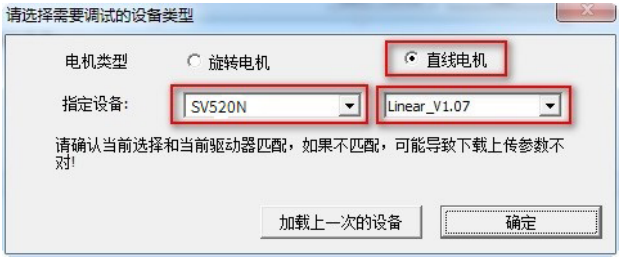
1) Connecting the servo drive

Ensure the servo drive is connected properly to the host controller through the serial ports after InoServoShop4.10 is installed.

2) Searching for serial devices

Double click 

on the desktop icon. For initial device loading, select " 直线电机 " (Linear motor) in " 电机类型 " (Motor type) and select "SV520N" in " 指定设备 " (Designated device). Select "Linear_Vx.xx" as the database and click " 确定 " (OK). If you have performed preceding settings previously, click " 加载上一次的设备 " (Loading the last settings) directly.



The software will search for the serial device automatically.

4.3.2 Commissioning Process

You can perform DDL motor parameter settings and auto-tuning with the software tool through the motor installation wizard and adjustment wizard of the DDL commissioning assistant. Motor parameters, initial angle auto-tuning, curve trajectories and response parameters can be set through the wizard. The servo drive generates the optimal gain parameters automatically. You can save these parameters after auto-tuning is done or export parameters as a recipe for use in other devices of the same model. The commissioning process through the software tool is as follows.

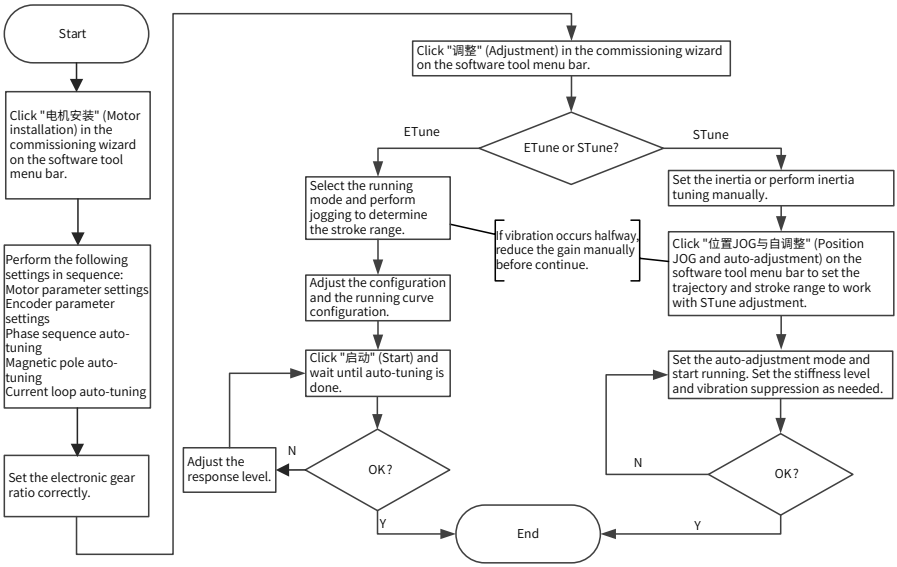


Figure 4-3 Commissioning process

The commissioning process of the software tool mainly involves "Motor installation wizard" and "Adjustment wizard". The function descriptions are as follows.

Interface	Description
Motor installation wizard	Used to perform: 1) Parameter settings (motor parameters, encoder parameters, and current loop parameters) 2) Motor parameter auto-tuning 3) Phase sequence auto-tuning 4) Magnetic pole auto-tuning 5) Current loop auto-tuning (current loop adjustment)
Adjustment wizard	Used to perform: 1) Jog test 2) Gain tuning (speed loop and position loop)

1 Motor installation wizard

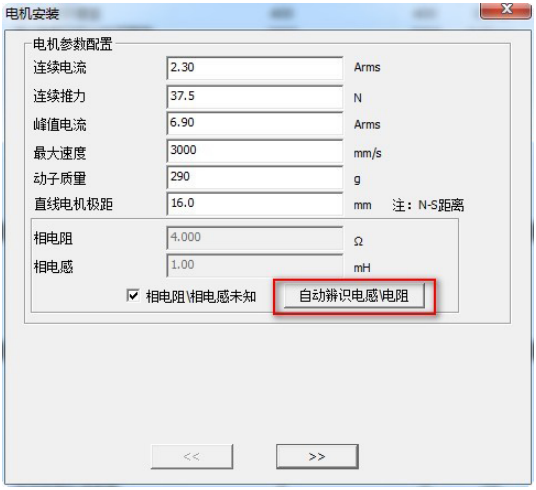
The motor installation wizard is used to perform parameter settings, motor parameter auto-tuning, phase sequence auto-tuning, magnetic pole auto-tuning and current loop auto-tuning. See the detailed process below.

1) Motor parameter configuration and auto-tuning

a) Search for the drive device through the software tool. After the drive device is found, the motor installation interface appears automatically.

You can also click " 调试向导 " (Commissioning wizard) to enter " 电机安装 " (Motor installation) interface.

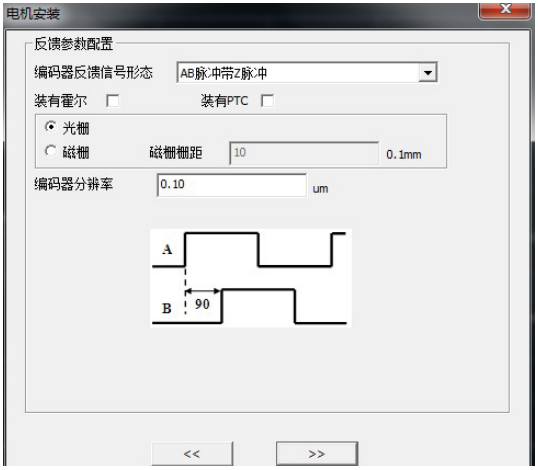
b) Perform auto-tuning if the motor resistance or inductance is still unknown after motor configuration is done according to the motor parameters provided by the motor manufacturer. Select " 相电阻 / 相电感未知 " (Phase resistance/inductance unknown)" to display " 自动辨识电感 / 电阻 " (Auto-tuning of inductance/resistance) button. Click this button to auto-tune the resistance/inductance parameters. During initial auto-tuning, the motor generates noises with pitch changing from high to low, which is quite normal. Click this button again, you will hear no noise this time. Perform auto-tuning two or three times. When the displayed phase inductance/resistance becomes stable, the auto-tuning is done.



2) Encoder parameter settings

a) After motor parameter configuration is done, click ">>" on the interface to enter the encoder feedback setting interface.

Set the encoder feedback type and encoder resolution. If the Hall device or PTC is installed, check related options.

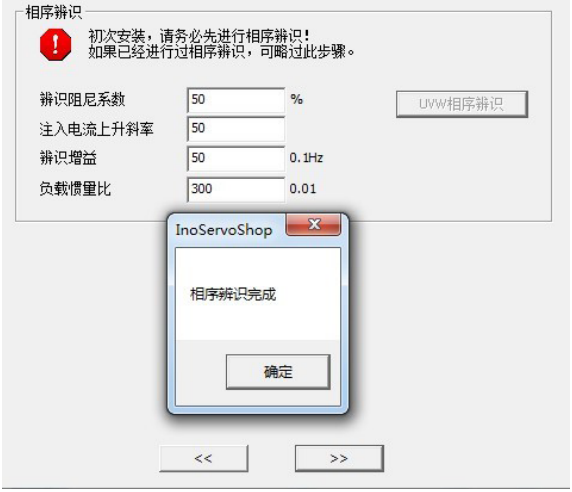


b) After setting, click ">>" on the interface to enter motor configuration acknowledge interface.

- After the configuration is acknowledged, click " 下载 " (Download) to download the set parameters to the servo drive. If the servo drive detects a change in the configuration, the keypad displays "RESET" and the software tool tells you the download is done. If motor parameters are set improperly, you can make necessary changes in this interface. Other available operations on motor parameters include " 保存 " (Save), " 打开 " (Open), and " 上传 " (Upload). " 保存 " (Save) is used to save the current configuration into local PC memory as a .txt file. " 打开 " (Open) is used to open the motor configuration files (.txt) in the local PC. " 上传 " (Upload) is used to save the current servo drive configuration to the software tool of the PC.

3) Phase sequence auto-tuning

After setting, click ">>" on the interface to enter the phase sequence auto-tuning interface.



For initial configuration of the motor and the servo drive, as it is unclear whether the nominal phase sequence of motor power cables complies with the default phase sequence of the servo drive, you need to select "UVW 相序辨识使能 " (UVW phase sequence auto-tuning enable) and click " 开始辨识 " (Start auto-tuning) to make the motor run. The motor phase sequence is auto-tuned during running and related configurations are performed automatically. After phase sequence auto-tuning is done, a dialog box named " 相序辨识完成 " (Phase sequence auto-tuning completed) pops out.

NOTE

During phase sequence auto-tuning through the software tool, if incorrect phase sequence is detected, the software tool will correct the phase sequence and make the servo drive enter "RESET" to perform configuration, removing the need for manual phase sequence switchover. In manual phase sequence auto-tuning, you need to switch the phase sequence manually.

4) Magnetic pole auto-tuning

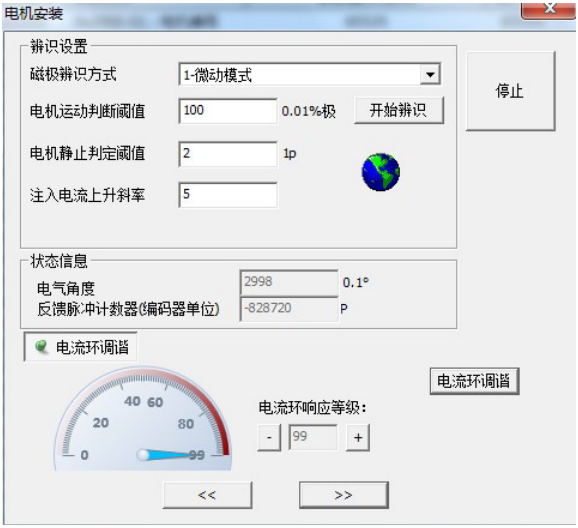
After setting, click ">>" on the interface to enter the magnetic pole auto-tuning interface. This interface is divided into two columns: " 辨识设置 " (Auto-tuning setting) and " 状态信息 " (Status information). " 辨识设置 " (Auto-tuning setting) contains configurations related to magnetic pole auto-tuning. " 状态信息 " (Status information) contains electrical information generated during auto-tuning. In initial power-on, magnetic pole auto-tuning can be performed only after initial angle auto-tuning is done (models with Hall excluded).

5) Current loop auto-tuning

a) After magnetic pole auto-tuning is done, " 电流环调谐 " (Current loop auto-tuning) column appears at the lower part of the interface, displaying configurations related to current loop auto-tuning. You can set the current loop response level as needed and start current loop auto-tuning.

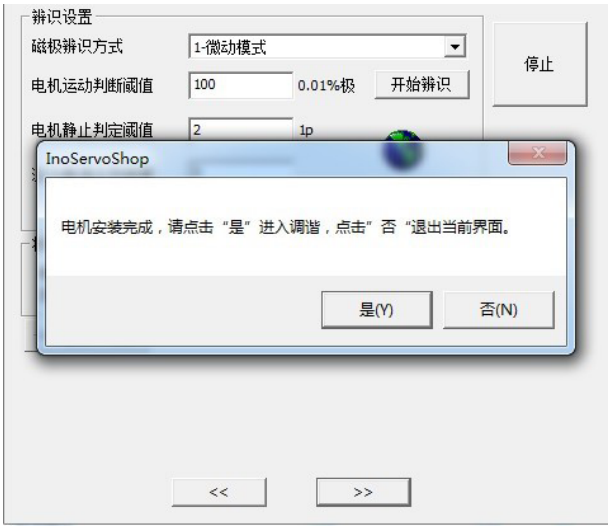
NOTE

The current loop response level displayed on this interface is a desired value. The final response effect after auto-tuning is determined by the motor characteristics. The actual response effect cannot exceed the desired response level. In addition, the duration of auto-tuning is in positive correlation with the response level.



b) After current loop auto-tuning is done, a dialog box pops out. Click " 确定 " (OK) to save the auto-tuned results.

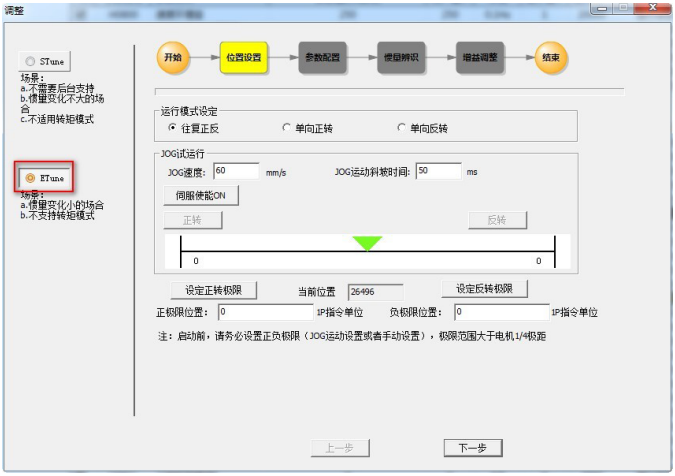
c) After magnetic pole auto-tuning and current loop auto-tuning are done, click ">>" on the interface to finish motor installation. In the pop-up dialog box asking whether to enter " 调整 " (Adjustment), click " 是 " (Yes). You can also click " 调试向导 " (Commissioning wizard) to enter " 调整 " (Adjustment) interface.



2 Adjustment wizard: ETune commissioning

1) Setting the running mode and stroke

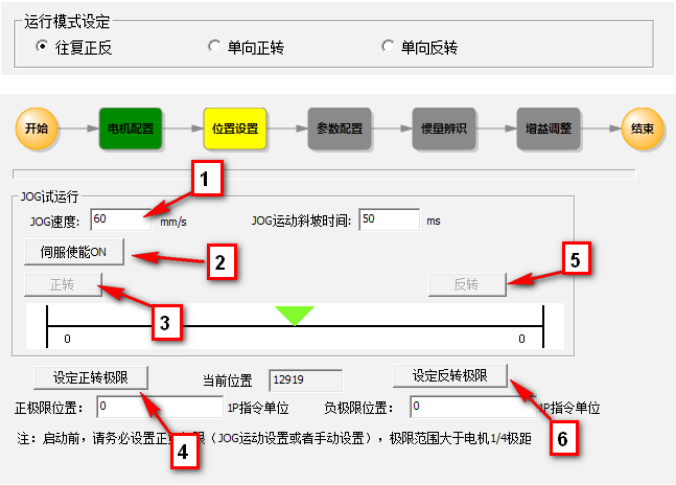
a) Click "ETune" to enter the speed loop position auto-tuning interface.



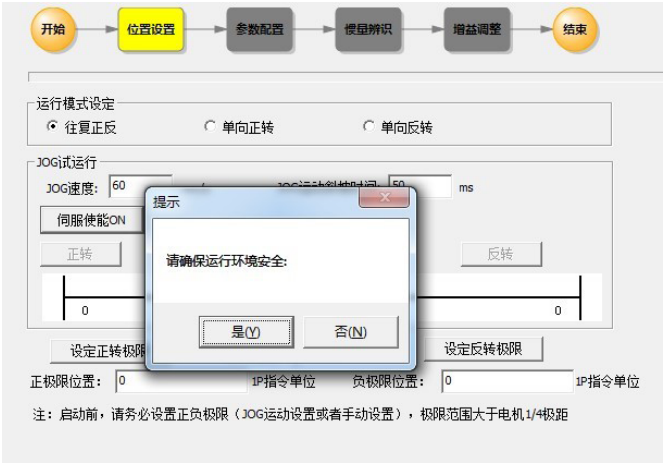
b) Set the running mode and motion range needed in motor auto-tuning. The setting interface is as follows.

NOTE

For linear motors, it is recommended to adopt the default mode " 往复正反 " (Reciprocating between FWD/REV) as the running mode during auto-tuning. This is to prevent dangers caused by motor overtravel.



c) Check whether the jog speed and ramp time fulfill the requirement. Keep them to default values. Click " 伺服使能 ON" (Servo ON) and a dialog box used to confirm whether the running environment is safe pops out.



d) If the running environment is safe, clicking " 是 " (Yes) to enable the servo drive and the " 正转 " (Forward) and " 反转 " (Reverse) buttons. The " 伺服使能 ON" (Servo ON)

button changes to " 伺服使能 OFF" (Servo OFF).

e) Hold down the " 正转 " (Forward) button and observe the motor rotor movement. When the motor rotor moves to the forward limit, release the button, and the green triangle icon on the software tool interface will be shifted to the forward limit position to display the absolute position fed back by the encoder. Click " 设定正转极限 " (Set forward limit) to input this absolute position to the box named" 正极限位置 " (Forward limit position). Similarly, click " 反转 " (Reverse) to set the reverse limit. The final interface is as follows.

2) Adjustment mode and running curve configuration

a) Click " 下一步 " (Next) to switch off the S-ON signal, and the software tool enters the auto-tuning parameter configuration interface.

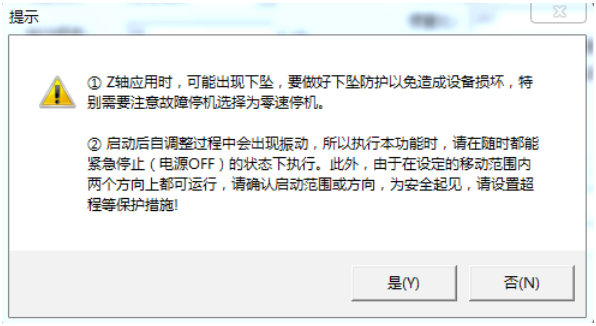
The auto-tuning parameter configuration interface is divided into two columns: " 模式配置 " (Mode configuration) and " 曲线配置 " (Curve configuration).

- In " 模式配置 " (Mode configuration), the first option " 调整模式 " (Adjustment mode) is divided into " 定位模式 " (Positioning mode) and " 轨迹模式 " (Trajectory mode), selectable based on actual applications. You can keep the other options to their default values. The vibration threshold refers to the magnitude of vibration. Response level refers to the percentage of the final effective gain to the gain limit, the larger the percentage, the smaller the margin. The inertia ratio auto-tuning is optional and the auto-tuned inertia ratio can be modified directly.
- In the " 曲线配置 " (Curve configuration) column, set the " 最大速度 " (Maximum speed) according to the actual maximum running speed and adjust the " 加减速时间 " (Acceleration/Deceleration time) as needed. Note that a short acceleration/deceleration time not necessarily brings a quicker positioning process. Keep the acceleration/deceleration ramp as large as possible. " 等待时间 " (Interval) refers to the running curve interval between two adjacent cycles. " 运行模式 " (Running mode) refers to the running direction (bidirectional or unidirectional). For linear motors, select " 正负 " (Forward-Reverse) or " 负正 " (Reverse-Forward) in the " 运行模式 " (Running mode). In this mode, the motor reciprocates within the set motion range and auto-tune the loop gain and suppress mechanical vibrations that may occur during running automatically.

b) After parameter configuration is done, click " 启动 " (Start) and a dialog box displaying the following safety instructions pops out:

① Take measures to prevent possible falling accidents when applying Z-axis. Set the

stop mode upon fault to "Stop at zero speed".
② Vibration may occur during auto-tuning. This function must be executed in cases where an emergency stop (power OFF) can be triggered at any time. As the motor can run in both directions, check the starting range or direction and take protective measures against possible accidents such as overtravel.

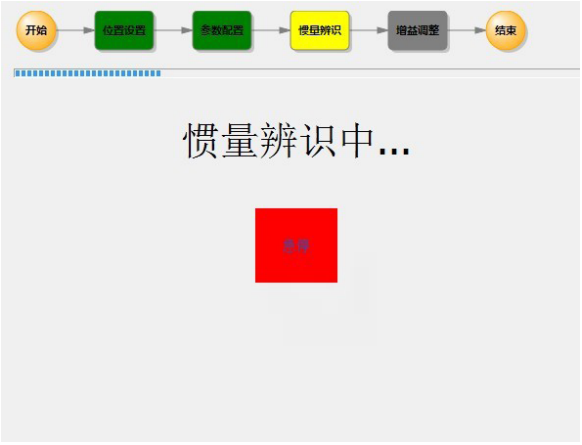


3) Auto-tuning through ETune

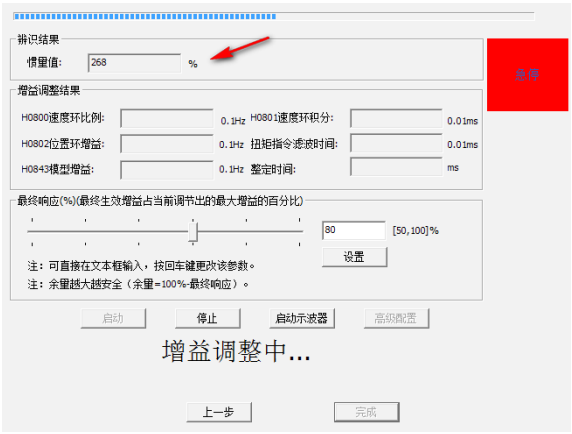
a) After you click " 是 " (Yes), the motor starts running and enters speed loop/position loop parameter auto-tuning state. If you choose to perform inertia auto-tuning, an inertia auto-tuning will be performed at:
1) 25 Hz speed loop gain
2) Three times the initial inertia ratio
3) Maximum set speed (limited to 100 to 2000 mm/s internally)
4) Set acceleration/deceleration time

If you choose not to perform inertia auto-tuning on the Start Page, the servo drive starts gain tuning directly after start.

b) The software tool interface switches to " 惯量辨识 " (Inertia auto-tuning) during inertia auto-tuning, as shown below.

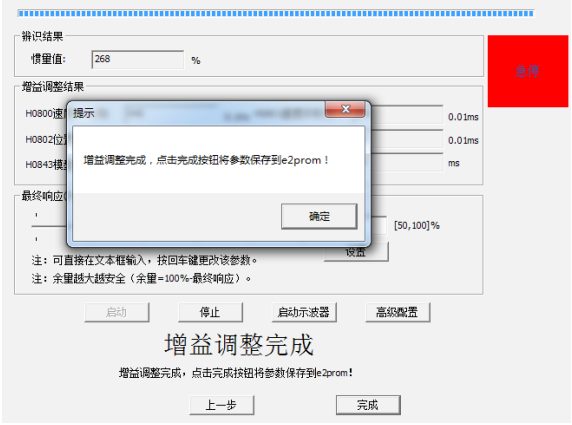


c) After inertia auto-tuning is done, the software tool interface switches to the gain tuning interface and displays the inertia auto-tuning results in the first column. The progress bar displays the auto-tuning progress.



- The auto-tuning process may take 3 to 5 min based on the load conditions and settings in the " 模式设定 " (Mode setting) and " 曲线设定 " (Curve setting). The servo drive will detect and suppress strong vibration that may occur during auto-tuning. If the settings in " 模式设定 " (Mode setting) are demanding or mechanical characteristics are unsatisfactory, vibration may persist, leading to Er.661. In this case, check the mechanical connections of the load, the retaining screws on the guide rail, and installation of the magnetic rail, or you can perform auxiliary analysis based on the mechanical characteristics described in section "5.7 Mechanical Characteristics Analysis". Contact the service personnel of Inovance if necessary.

d) After auto-tuning is done, a dialog box indicating gain auto-tuning completed pops out. Click " 确定 " (OK).

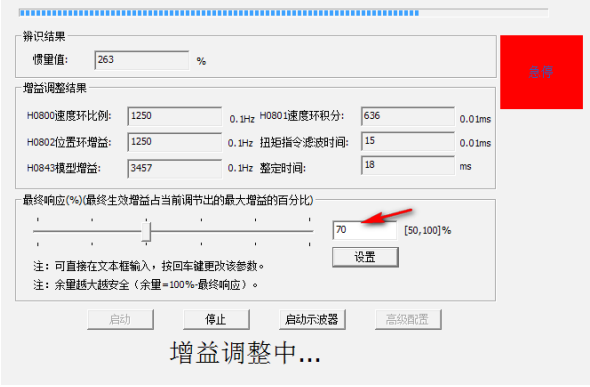


The auto-tuned gain values will be displayed in the second column.

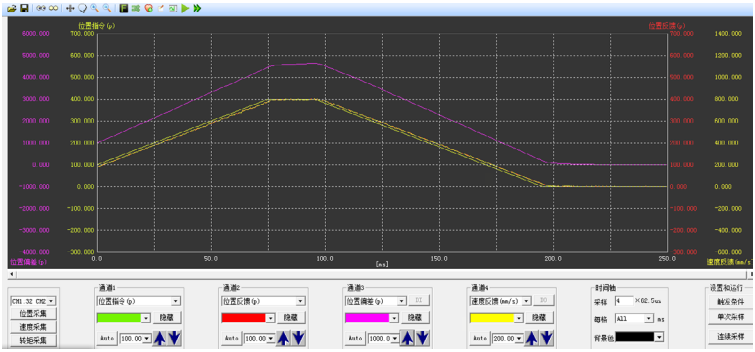
4) Response adjustment based on actual needs

a) If high-frequency noises generated during motor reciprocating is too loud, reduce the percentage of " 最终响应 " (Final response) properly.

b) After the percentage of final response is set, the servo drive performs gain tuning again based on the settings.



c) Click " 确认 " (OK) in the dialog box which pops out after gain tuning is done. Click " 启动示波器 " (Start oscilloscope) and capture the positioning waveform to check whether the actual running waveform meets the requirement.



d) After the waveform is confirmed, return to the gain tuning interface and click " 完成 " (Done). The motor stops accordingly and the software tool displays a dialog box named " 参数写入成功 " (Parameter written succeeded).

5) Parameter export based on actual needs

Click " 确定 " (OK) and the interface skip to the next step automatically.

The final auto-tuned result will be displayed on this interface. You can click " 导出 " (Export) to save the auto-tuned results to the PC or select " 重新开始 " (Restart). If the motor runs properly and fulfills the requirement, you can close the auto-tuning interface to proceed to other configurations.

3 Adjustment wizard: STune commissioning

1) STune commissioning

a) Click "STune" to enter STune commissioning interface, as shown below.

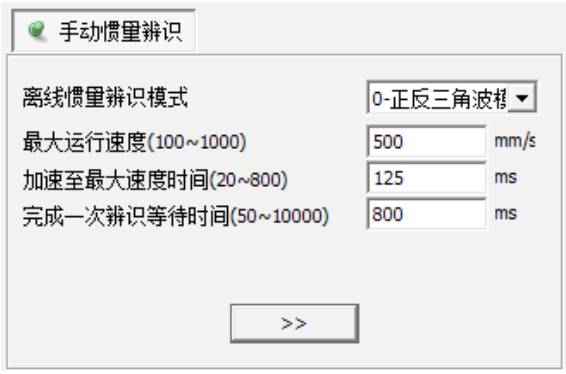
Select " 自调整模式 " (Gain auto-tuning mode). The default mode is standard stiffness level. If you choose STune mode, check " 标准模式 + 手动惯量 " (Standard mode+Manual inertia) or " 定位模式 + 手动惯量 " (Positioning mode+Manual inertia). Set the threshold for automatic vibration suppression through " 振动阈值 " (Vibration threshold).

The stiffness level can be reduced or increased through a mouse click on  or  . The higher the stiffness level is, the stronger the gain is, and the faster the response will be. Note that a too high stiffness level will incur vibration.


NOTE

Model tracking will be started automatically after you check " 定位模式 + 手动惯量 " (Positioning mode+Manual inertia). See details in "5.4.8 Model Tracking". Parameters related to model tracking (H08-42/H08-43/H08-46) will change with the stiffness level. After you check " 标准模式 + 手动惯量 " (Standard mode+Manual inertia), parameters related to model tracking will also change with the stiffness level, but model tracking will not be started automatically.

b) Click " 手动惯量辨识按钮 " (Manual inertia tuning) to enter the following interface.



Select " 离线惯量辨识模式 " (Offline inertia auto-tuning mode), " 最大运行速度 " (Maximum running speed), " 加速时间 " (Acceleration time), and " 完成一次辨识等待时间 " (Tuning interval).

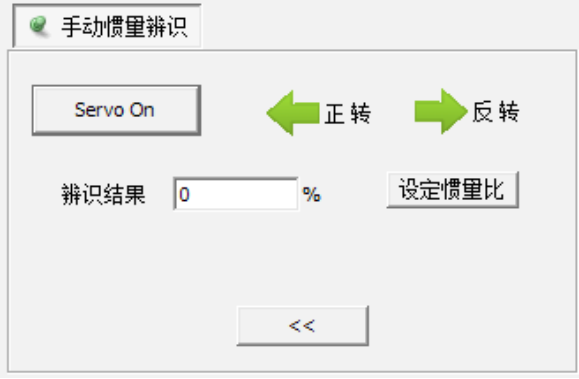
NOTE

Do not set the maximum running speed or the time for accelerating to the maximum speed to a too large value in the case of a small stroke. Failure to comply may incur overtravel caused by a too long running distance of inertia tuning.

c) Click >> to enter the inertia tuning interface. Click "Servo ON" and hold down the " 正转 " (Forward) or " 反转 " (Reverse) arrow to perform inertia tuning.

The motor rotor reciprocates and the tuned results will be displayed in the column named " 辨识结果 " (Tuned results). After the tuned results are stabilized, release the " 正转 " (Forward) or " 反转 " (Reverse) arrow and click " 设定惯量比 " (Set inertia ratio) to activate the tuned results.

Note: Hold only the " 正转 " (Forward) or " 反转 " (Reverse) arrow down to trigger inertia tuning. Holding down the " 正转 " (Forward) arrow makes the motor run forwardly first. Holding down the " 反转 " (Reverse) arrow makes the motor run reversely first.



NOTE

During STune adjustment, you can set the motion trajectory and stroke range through the software tool (" 菜单栏 -> 辅助功能 -> 位置 JOG 与自调整 " (Menu bar -> Auxiliary functions -> Position JOG and auto-tuning)) or through the external host controller (communication setting).

2) Position JOG and auto-tuning

Click " 辅助功能 -> 位置 JOG 与自调整 " (Auxiliary function -> Position JOG and auto-tuning) in the menu bar to open the interface.

Step 1: Set the stroke range of position JOG.

Step 2: Profile the motion curve as needed.

4 Notes

- Setting H00-11 (Continuous current) to a too large value may damage the motor.
- Set H00-48 (Pole pitch) to a proper value (in 0.1 mm). The value of H00-48 represents the distance between N-S on the magnetic rail of the linear motor.
- Confirm the specifications of the optical scale. H00-49 represents the resolution of a pulse-type optical scale in 0.01 μm.
- If the motor pole pitch or optical scale specifications are set improperly, the motor will get stuck, leading to Er.630 (Motor rotor locked). In this case, check settings of

preceding parameters.

- Note that the motor may move the distance within the range of N-N during commissioning through the software tool.
- Set the electronic gear ratio based on actual applications before performing ETune.
- The maximum speed and acceleration/deceleration time of the auto-tuning curve can be adjusted based on actual conditions. You can increase the acceleration/deceleration time because the positioning process may be quickened after auto-tuning.
- If the acceleration/deceleration time is set to a too small value, overload may occur. In this case, increase the acceleration/deceleration time properly.

5 Solutions to common faults

Fault Symptom	Fault Cause	Solution
Er.661: Gain too low	1) The vibration cannot be suppressed.	1) Enable the vibration suppression function manually to suppress vibration.
	2) The positioning overshoot is too large.	2) Check whether the positioning threshold is too low. Increase the acceleration/deceleration time and reduce the response level.
	3) The reference suffers from noises.	3) Modify the electronic gear ratio to improve the reference resolution, or increase the reference filter time in the " 参数配置 " (Parameter configuration) interface.
	4) The current fluctuates.	4) Check whether the machine suffers from periodic fluctuation.
Er.600: Angle auto-tuning failure	1) The vibration cannot be suppressed.	1) Enable vibration suppression manually and perform ETune.
	2) The auto-tuned values fluctuate dramatically.	2) Increase the maximum running speed or reduce the acceleration/deceleration time. Shorten the stroke of screws.
	3) Mechanical connections of the load are loosened or offset occurs to the machine.	3) Check for mechanical faults.
	4) Interruption occurs due to the fault that occurs during auto-tuning.	4) Clear the fault and perform ETune adjustment again.

NOTE

If strong vibration or error occurs during initial adjustment, write the auto-tuned inertia values manually and perform ETune again without inertia auto-tuning.

4.4 Run and Stop

4.4.1 Running Sequence

■ Setting S-ON signal to ON

The servo drive is ready to run and the keypad displays "rn". As there is no reference input, the servo motor stays standstill. If 6060h (Modes of operation) is not set or the servo torque and speed limit are 0, the servo axis will stay in the free-running state. Otherwise, it stays in locked state.

After a reference is input, the servo motor starts running.

Table 4-2 Operation of the servo drive

Record	No.	Description
☐	1	During initial running, set a proper reference to make the motor run at a low speed and check whether the motor rotates properly.
☐	2	Observe whether the motor runs in the correct direction. If the motor runs in a direction opposite to the reference direction, check the input reference and reference direction signal.
☐	3	If the motor runs in the correct direction, observe the actual motor speed (200B-01h) and average load rate (200B-0Dh) through the keypad or the software tool.
☐	4	After checking the preceding running conditions, set related parameters to enable the motor to work in desired conditions.
☐	5	See "5 Adjustment" for details on commissioning of the servo drive.

■ Power-on sequence diagram

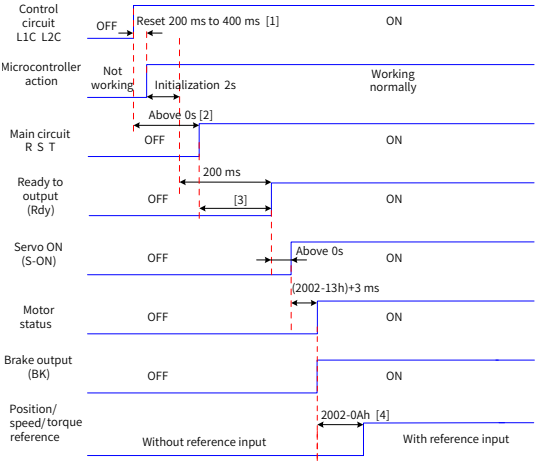


Figure 4-4 Power-on sequence

[1] Reset time: Determined by the +5V power supply of the micro-processor.

[2] Above 0s: The time is determined by the moment when the main power supply is switched on.

[3] When the control power and main power are switched on at the same time, the time is the same as that from micro-processor initialization completed to Rdy signal active.

[4] When DO function 9 (FunOUT.9: BK, brake output) is not used, 2002-0Ah (Delay from brake output ON to command received) is invalid.

■ Stop sequence at warning or fault

1) No. 1 fault: Coast to stop, keeping de-energized state

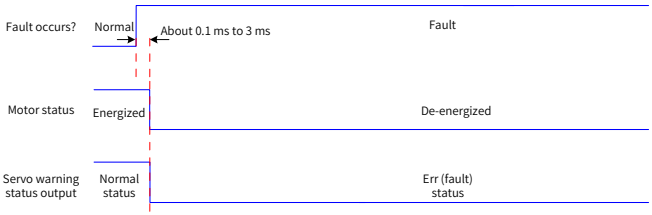


Figure 4-5 Sequence for "coast to stop, keeping de-energized status" at No. 1 fault

2) No. 2 fault (without brake): Coast to stop, keeping de-energized state

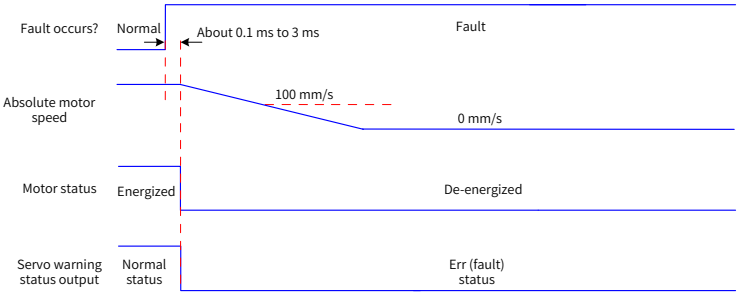


Figure 4-6 Sequence of "coast to stop, keeping de-energized status" at No. 2 fault

3) No. 2 fault (without brake): Stop at zero speed, keeping de-energized state

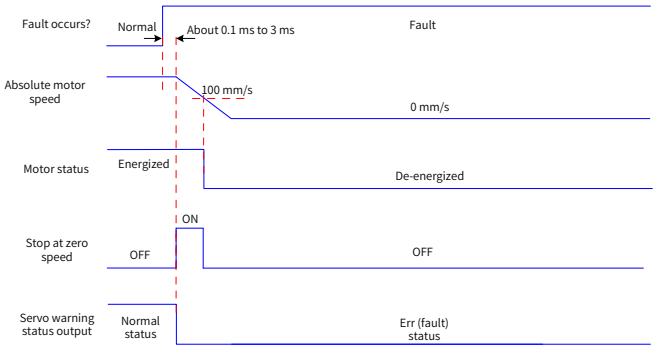


Figure 4-7 Sequence of "stop at zero speed, keeping de-energized state" at No. 2 fault (without brake)

When Er.900 (DI emergency braking), Er.950 (Forward overtravel warning), or Er.952 (Reverse overtravel warning) occurs, the servo drive stops according to the following sequence.

■ Stop at overtravel/braking: stop at zero speed, keeping position lock state

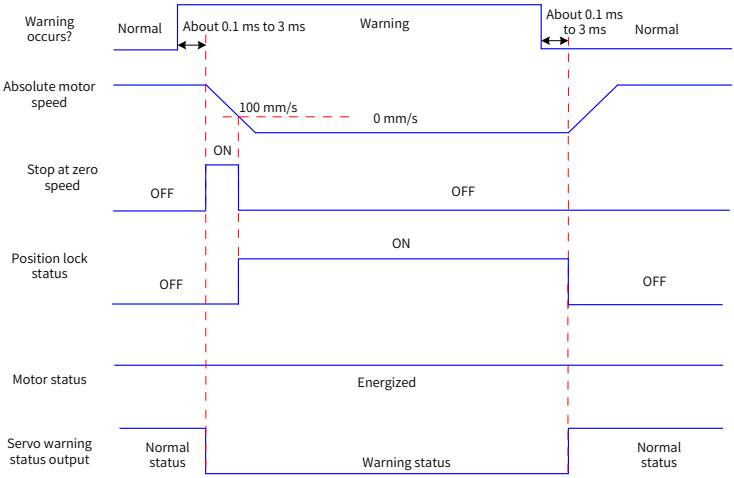


Figure 4-8 Sequence of warnings that cause stop

Only the preceding three warnings will affect the running state of the servo drive, the other warnings, as shown below, will not affect the running state of the servo drive.

■ Warnings that do not cause stop

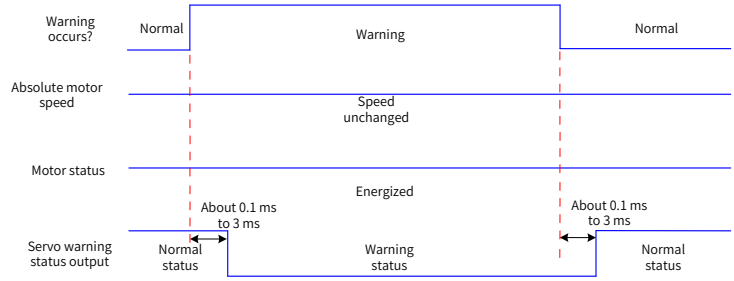


Figure 4-9 Sequence of warnings that do not cause stop

■ Fault reset

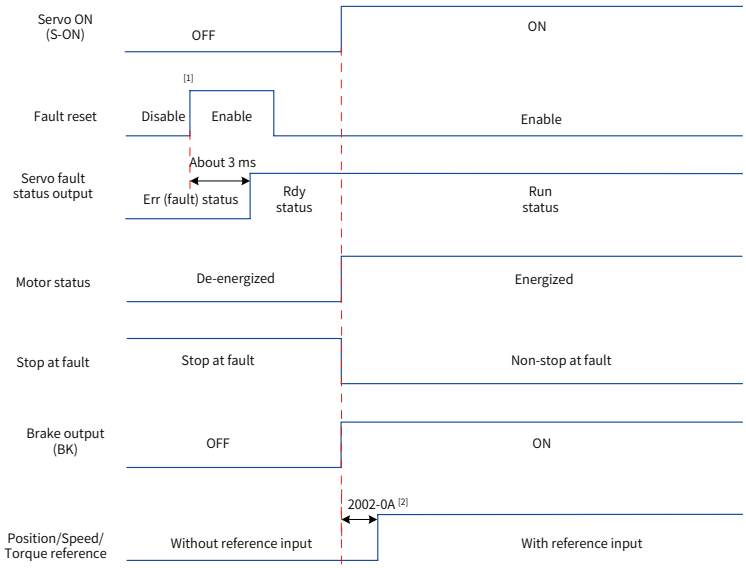


Figure 4-10 Sequence of fault reset

[1] The DI fault reset signal (FunIN.2: ALM-RST) is triggered at edge change.

[2] When DO function 9 (FunOUT.9: BK, brake output) is not used, 2002-0Ah (Delay from brake output ON to command received) is invalid.

4.4.2 Stop Settings

The stop modes can be coast to stop and stop at zero speed. The stop status can be de-energized status and position lock status. See the following table for details.

Table 4-3 Comparison of the two stop modes

Stop Mode	Coast to Stop	Stop at Zero Speed
Description	The servo motor is de-energized and decelerates to 0 gradually. The deceleration time is affected by the mechanical inertia and friction.	The servo drive outputs the reverse braking torque and the motor decelerates to 0 quickly.
Feature	This mode features smooth deceleration and small mechanical shock, but the deceleration process is long.	This mode features quick and fast deceleration, but the mechanical shock is strong.

Table 4-4 Comparison of the two stop status

De-energized	Position lock
The motor is not energized after stop, and the motor shaft can be rotated freely.	The motor shaft is locked and cannot be rotated freely after the motor stops.

The servo drive stops due to the following causes:

■ Stop at S-ON signal off:

Switch off the S-ON signal through communication, and the servo drive stops according to the preset stop mode.

Related index codes

<table>
<tr><td rowspan="2">2002-06h</td><td>Name</td><td colspan="3">Stop mode at S-ON OFF</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 1</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the deceleration mode of the servo motor from running to stop and the servo motor state after stop when the S-ON signal is switched off.
<table><tr><th>Value</th><th>Stop Mode</th></tr><tr><td>0</td><td>Coast to stop, keeping de-energized state</td></tr><tr><td>1</td><td>Stop at zero speed, keeping de-energized state</td></tr></table>Set the proper stop mode according to the mechanical status and running requirement.</td></tr>
</table>

■ Stop at fault

The stop mode varies with the fault type. For fault classifications, see "6 Troubleshooting".

☆ Related index codes

<table>
<tr><td rowspan="2">2002-09h</td><td>Name</td><td colspan="3">Stop mode at No. 1 fault</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the deceleration mode of the servo motor from running to stop and the servo motor state after stop when a No. 1 fault occurs.
<table><tr><td>Value</td><td>Stop Mode</td></tr><tr><td>0</td><td>Coast to stop, keeping de-energized state</td></tr></table>For details on No .1 faults, see "6 Troubleshooting".</td></tr>
<tr><td rowspan="2">2002-07h</td><td>Name</td><td colspan="3">Stop mode at No. 2 fault</td><td>Setting Condition & Effective Time</td><td>At stop Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the deceleration mode of the servo motor from running to stop and the servo motor state after stop when a No. 2 fault occurs.
<table><tr><td>Value</td><td>Stop Mode</td></tr><tr><td>0</td><td>Coast to stop, keeping de-energized state</td></tr><tr><td>1</td><td>Stop at zero speed, keeping de-energized state</td></tr></table>For details on No .2 faults, see "6 Troubleshooting".</td></tr>
</table>

■ Stop at overtravel:

★ Definitions of terms:

"Overtravel": The mechanical motion exceeds the designed range of safe motion.

"Stop at overtravel": When the moving part moves beyond the range of safe motion, the limit switch outputs a level change to make the servo drive force the motor to stop.

Related index codes

<table>
<tr><td rowspan="2">2002-08h</td><td>Name</td><td colspan="3">Stop mode at overtravel</td><td>Setting Condition & Effective Time</td><td>At stop & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0 to 2</td><td>Default</td><td>1</td></tr>
<tr><td colspan="11">Defines the deceleration mode of the servo motor from running to stop and the servo motor state after stop at overtravel.
<table><tr><th>Value</th><th>Stop Mode</th></tr><tr><td>0</td><td>Coast to stop, keeping de-energized state</td></tr><tr><td>1</td><td>Stop at zero speed, keeping position lock status</td></tr><tr><td>2</td><td>Stop at zero speed, keeping de-energized state</td></tr></table>When the servo motor is used to drive a vertical axis, set 2002-08h to 1 to lock the motor shaft position after overtravel occurs.</td></tr>
</table>

If the servo motor enters the overtravel state when driving a vertical axis, the workpiece may fall. To prevent such risks, set 2002-08h (Stop mode at overtravel) to 1 (Stop at zero speed, keeping position lock status). When the workpiece moves linearly, install limit switches to prevent mechanical damage. If the limit switch signal is activated, input a reverse RUN command to make the motor (workpiece) run in the reverse direction.

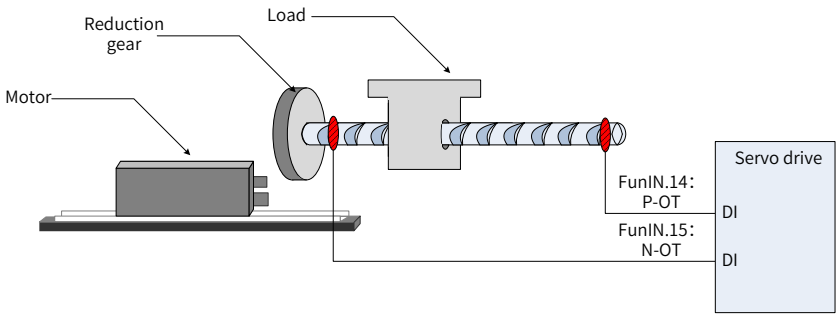


Figure 4-11 Installation of limit switches

To use the limit switch, allocate function 14 (FunIN.14: P-OT, positive limit switch) and function 15 (FunIN.15: N-OT, negative limit switch) to two DIs of the servo drive and set the valid logic of the DI terminal. This is to enable the servo drive to receive the level signals input from the limit switch. The servo drive enables or cancels the stop-at-overtravel status based on the DI level status.

☆ Related parameters

Function No.	Name	Function	Description
FunIN.14	P-OT	Positive limit switch	When the mechanical motion exceeds the forward limit, the overtravel prevention function will be activated. Invalid: Forward drive permitted Valid: Forward drive inhibited
FunIN.15	N-OT	Negative limit switch	When the mechanical motion exceeds the reverse limit, the overtravel prevention function will be activated. Invalid: Reverse drive permitted Valid: Reverse drive inhibited

■ Emergency stop

Two emergency stop modes are supported:

Using DI function 34 (FunIN.34: EmergencyStop)

Using the auxiliary emergency stop function in 200D-06h

☆ Related function No.

Function No.	Name	Function	Description
FunIN.34	EmergencyStop	Braking	Invalid: Current running state unaffected Valid: Position lock after stop at zero speed, Er.900 (DI emergency braking) reported

☆ Related index codes

200D-06h	Name	Emergency stop			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	-	Data Range	0 to 1	Default	0

Value	Description
0	No operation
1	Emergency stop enabled

When emergency stop is enabled, the servo drive immediately stops according to the stop mode defined by 2002-05h.

■ Quick stop

When bit2 (Quick stop) of the control word 6040h is 0 in normal status, the servo drive executes quick stop in the mode defined by 605Ah. Quick stop can be set only in the stop state. After quick stop is done, bit10 of the control word 6041h is set to 1, allowing the servo drive to stay in the stop state.

Index 605Ah	Name	Quick stop option code			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	0 to 7	Default	2

Defines the quick stop mode.

PP:

Value	Stop Mode
0	Coast to stop, keeping de-energized state
1	Ramp to stop as defined by 6084h, keeping de-energized state
2	Ramp to stop as defined by 6085h, keeping de-energized state
3	Stop at the emergency stop torque defined by 2007-10h, keeping de-energized state
4	N/A
5	Ramp to stop as defined by 6084h, keeping position lock state
6	Ramp to stop as defined by 6085h, keeping position lock state
7	Stop at the emergency stop torque defined by 2007-10h, keeping position lock state

CSP:

Value	Stop Mode
0	Coast to stop, keeping de-energized state
1, 2, 3	Stop at the emergency stop torque defined by 2007-10h, keeping de-energized state
4	N/A
5, 6, 7	Stop at the emergency stop torque defined by 2007-10h, keeping position lock state

CSV/PV/HM

Value	Stop Mode
0	Coast to stop, keeping de-energized state
1	Ramp to stop as defined by 6084h (HM: 609Ah), keeping de-energized state
2	Ramp to stop as defined by 6085h, keeping de-energized state
3	Stop at the emergency stop torque, keeping de-energized state
4	N/A
5	Ramp to stop as defined by 6087h, keeping position lock state
6	Ramp to stop as defined by 6085h, keeping position lock state
7	Stop at the emergency stop torque defined by 2007-10h, keeping position lock state

CST/PT:

Value	Stop Mode
0	Coast to stop, keeping de-energized state
1, 2	Ramp to stop as defined by 6087h, keeping de-energized state
3	Coast to stop, keeping de-energized state
4	N/A
5, 6	Ramp to stop as defined by 6087h, keeping position lock state
7	Stop at the emergency stop torque defined by 2007-10h, keeping position lock state

■ Halt

When bit8 of the control word 6040h is set to 1, the servo drive halts as defined by 605Dh. The halt function can be set only in the stop state. If the quick stop command is active during halt, the servo drive immediately switches to the quick stop mode.

Index 605Dh	Name	Stop option code			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	1 to 3	Default	1

Defines the halt mode.

PP:

Value	Stop Mode
1	Ramp to stop as defined by 6084h, keeping position lock state
2	Ramp to stop as defined by 6085h, keeping position lock state
3	Stop at the emergency stop torque defined by 2007-10h, keeping de-energized state

CSP:

Value	Stop Mode
1, 2, 3	Stop at the emergency stop torque defined by 2007-10h, keeping position lock state

PV/CSV/HM:

Value	Stop Mode
1	Ramp to stop as defined by 6084h (HM: 609Ah), keeping position lock state
2	Ramp to stop as defined by 6085h, keeping position lock state
3	Stop at the emergency stop torque defined by 2007-10h, keeping position lock state

PT/CST:

Value	Stop Mode
1, 2	Ramp to stop as defined by 6087h, keeping position lock state
3	Coast to stop, keeping position lock state

4.5 Other Function Settings

4.5.1 Running Direction

Set H02-02 to change the motor direction without changing the polarity of the input reference.

Related index codes

H02-02	Name	Motor direction			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 1	Default	0
Defines the forward running direction of the servo motor when viewing from the motor axis side.										

The change of 2002-03h does not affect the output pulse format and positive/negative attribute of the monitoring parameters.

The "Forward drive" in overtravel prevention shares the same settings as the running direction (2002-03h).

4.5.2 Output Pulse Phase

The servo drive output phase is phase A + phase B quadrature pulse.

The phase relation between phase A and phase B pulses can be changed by setting 2002-04h, without changing the motor running direction.

Related index codes

2002-04h	Name	Output pulse phase			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Data Range	0 to 1	Default	0
Defines the relation between phase A and phase B without changing the motor running direction when pulse output is enabled.										

4.5.3 Brake Settings

When the motor torque direction is opposite to the speed direction, the energy is transmitted from the motor to the servo drive, causing bus voltage rise. When the bus voltage rises to the braking threshold, the energy must be consumed by the regenerative resistor. Otherwise, the servo drive will be damaged. The regenerative resistor can be a built-in or an external one. However, a built-in regenerative resistor cannot be used together with an external regenerative resistor.

The servo motor works in the regenerative state under the following conditions.

- Deceleration stop period during acceleration/deceleration
- Continuous descending in a vertical axis
- Continuous running in negative load state (from the load side)

The regenerative function of the servo drive resistor cannot be used for continuous regenerative purpose. To enable the servo drive to run continuously under negative load state, calculate the resistance of the regenerative resistor needed based on "Figure 4-14 Regenerative resistor selection". If the regenerative energy cannot be consumed properly, the regenerative energy generated from the load may exceed the allowable range and damage the servo drive.

- The following figure is an example of the negative load state.

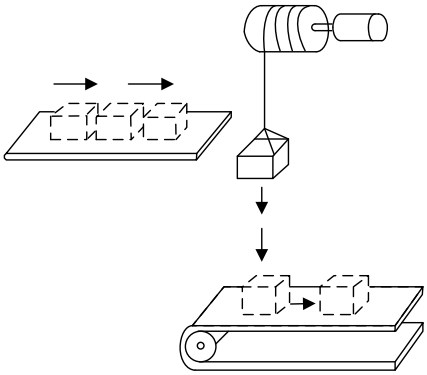


Figure 4-12 Continuous braking force may be generated from a vertical load

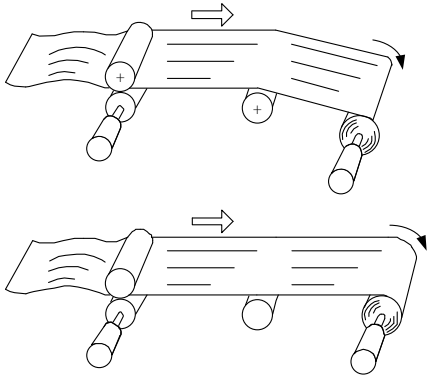


Figure 4-13 Load driven continuously in tension control

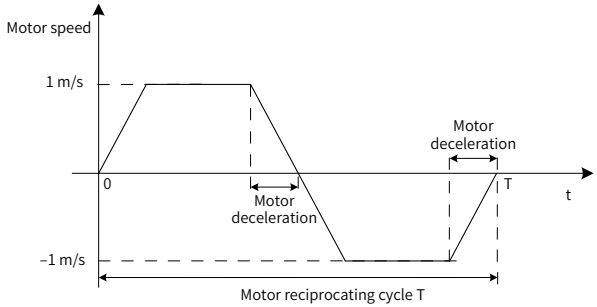
The following table lists the specifications of the regenerative resistor.

Table 4-5 Specifications of the regenerative resistor

Servo Drive Model	Specifications of Built-in Regenerative Resistor		
	Resistance (Ω)	Power (W)	Processing Power (W)
SV520NS1R6I	-	-	-
SV520NS2R8I	-	-	-
SV520NS5R5I	50	50	25
SV520NS7R6I	25	80	40
SV520NS012I			

1 Running with load

The energy at the braking of reciprocating motor movement is converted into electric energy and fed back to the bus capacitor. When the bus voltage rises over the braking voltage threshold, the regenerative resistor will consume the excessive energy. The following figure takes motor no-load running from 1 m/s to standstill as an example to show the motor speed curve.



■ Motor speed curve without external load torque

The formula for calculating the dynamic energy is as follows:

$$E = \frac{1}{2} mv^2$$

In above formula:
E(J) represents the total energy generated from braking.
$m=m_0+m_1$, m represents the sum of the rotor weight and load weight, m_0(kg) represents the motor rotor weight, and m_1(kg) represents the motor load weight.
V(m/s) represents the initial deceleration speed of the motor.

Take a linear motor as an example:
Rotor weight: $m_0 = 1.3$ kg
Load weight: $m_1 = 1$ kg
Energy generated when the speed (V = 1 m/s) reduced to 0:

$$E = \frac{1}{2} mv^2 = 1.15 \text{ J}$$

If the motor carries no load, the braking energy E_0(J) in no-load state is calculated by taking m_1 as 0. Different motor rotors carry different weight and correspond to different values of E_0. In actual applications, take the actual rotor weight into calculation. The following table lists the maximum braking energy absorbed by the capacitor (E_c(J)).

Table 4-6 Maximum braking energy absorbed by the capacitor

Capacity	Servo Drive Model	Max. Braking Energy Absorbed by the Capacitor E_c (J)
200 W	SV520NS1R6I	9
400 W	SV520NS2R8I	18
750 W	SV520NS5R5I	26
1000 W	SV520NS7R6I	26
1500 W	SV520NS012I	47

If the total braking time T is known, you can determine whether an external regenerative resistor is needed and calculate the power of the resistor based on the following flow diagram and formula.

■ Regenerative resistor selection

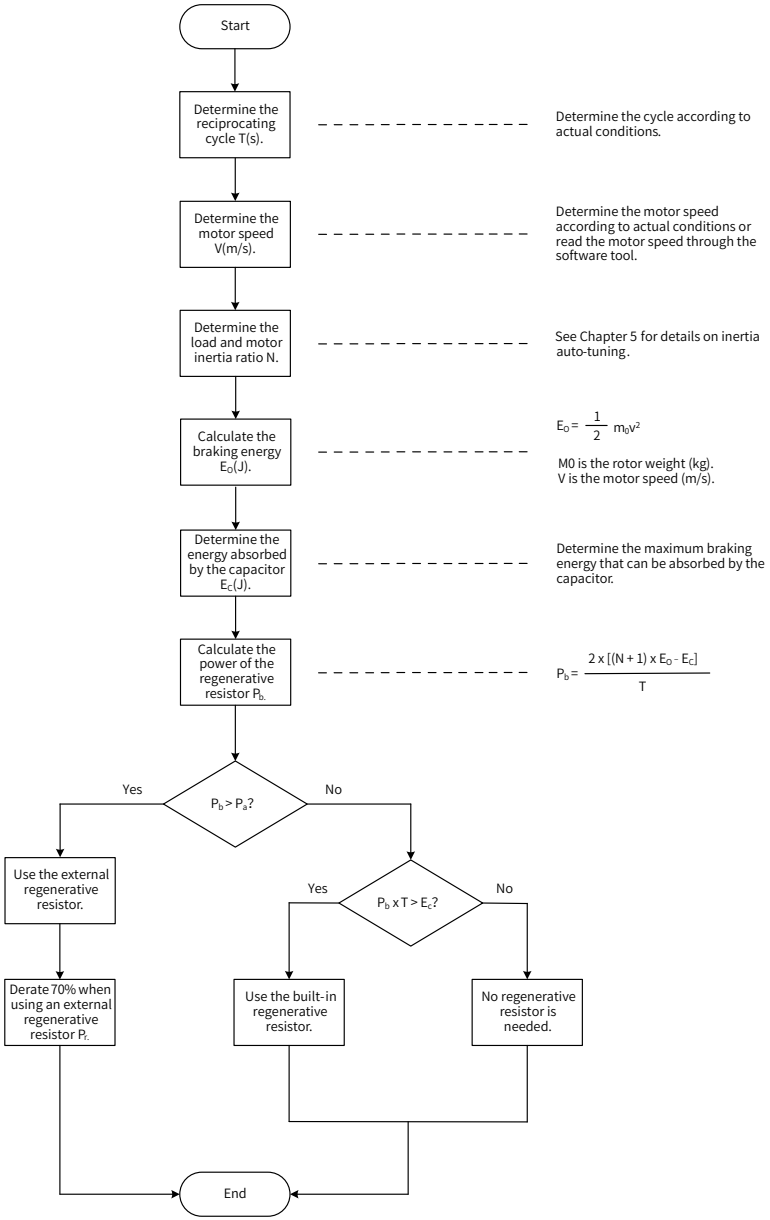


Figure 4-14 Regenerative resistor selection

NOTE

- Take a motor decelerating from 1 m/s to standstill as an example. Assume the load inertia is N times more than the motor inertia, then the braking energy generated during decelerating from 1 m/s to 0 is (N+1) x E_O. The energy needs to be consumed by the regenerative resistor is (N+1) x E_O - E_C (J) after deducting the energy absorbed by the capacitor (E_C). If the reciprocating cycle is T, then the power of the regenerative resistor is 2 x [(N + 1) x E_O - E_C]/T. The motor values are calculated according to the actual motor rotor weight and the running speed. See "Table 4-6 Maximum braking energy absorbed by the capacitor" for the value of E_C.
- Determine whether to use the regenerative resistor and select the built-in or an external one according to the preceding figure, and set H02-25 accordingly.
- Resistors with aluminum enclosures are recommended.

☆ Related parameters

Para. No.	Name	Value Range	Description	Setting Condition	Effective Time	Default
H02-25	Regenerative resistor type	0: Built-in 1: External, natural cooling 2: External, forced air cooling 3: No resistor, using only the capacitor	Defines the regenerative resistor type and the mode of absorbing and releasing the braking energy.	At stop	Immed-iately	0

Take a linear motor as an example. Assume the servo drive is 750 W, the reciprocating cycle T is 2s, the running speed V is 2.5 m/s, the motor rotor weight m_0 is 1.3 kg, and the load inertia is seven times more than the motor inertia, then the braking energy generated during no-load state is as follows:

$$E_O = \frac{1}{2} m_0 v^2 = \frac{1}{2} \times 1.3 \times 2.5^2 = 4.06\ J$$

If the energy that can be absorbed by the capacitor is E_C = 26 J, then the power of the regenerative resistor is as follows:

$$P_b = \frac{2 \times [(N+1) \times E_O - E_C]}{T} = \frac{2 \times [(7+1) \times 4.06 - 26]}{2} = 6.48\ W$$

The calculated value is smaller than the processable power (P_a = 25 W) of the built-in regenerative resistor, so a built-in regenerative resistor is sufficient.

If the inertia ratio is 15 times more than the motor inertia and other conditions are the same, the power of the regenerative resistor needed is as follows:

$$P_b = \frac{2 \times [(N+1) \times E_O - E_C]}{T} = \frac{2 \times [(15+1) \times 4.06 - 26]}{2} = 38.96\ W$$

P_b is larger than the processable power (P_a = 25 W) of the built-in regenerative resistor, so an external regenerative resistor is needed. The recommended power of the external regenerative resistor is $\frac{P_b}{1-70\%} = 129.9\,W$ (given that an external regenerative resistor is derated by 70% during use).

■ Regenerative resistor connection and setting

For use of an external regenerative resistor:

When P_b is larger than P_a, an external regenerative resistor is needed. Set H02-25 to 1 or 2 based on the cooling mode of the regenerative resistor.

Use the external regenerative resistor with 70% derated, that is, Pr = Pb/(1 – 70%), and ensure its resistance is larger than the minimum resistance allowed by the servo drive. Remove the jumper between $P_{\oplus}$ and D, and connect the resistor between $P_{\oplus}$ and C.

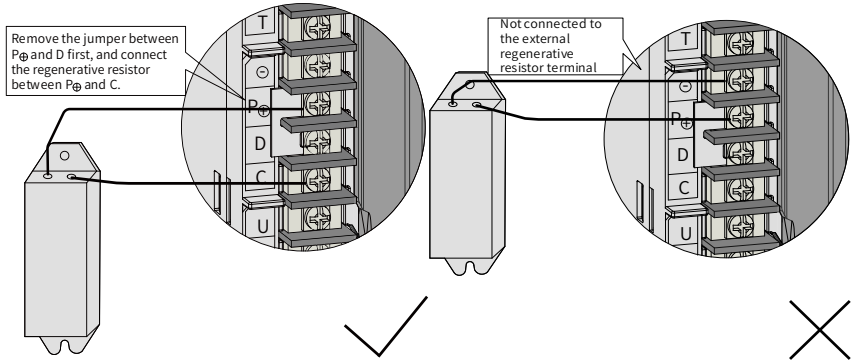


Figure 4-15 Connection of an external regenerative resistor

For the specifications of the lead wire, see "Table 3-4 Recommended main circuit cables and models for SV520N series servo drives".

Set H02-25 to 1 or 2 based on the cooling mode of the regenerative resistor. Set the following parameters properly.

☆ Related parameters

Para. No.	Name	Value Range	Unit	Description	Setting Condition	Effective Time	Default
H02-21	Minimum permissible resistance of regenerative resistor	Model dependent	-	Displays the minimum permissible resistance of the external regenerative resistor.	At display	-	Model dependent
H02-26	Power of external regenerative resistor	1 to 65535	W	Power of the external regenerative resistor actually used Note: The power of the external regenerative resistor actually used cannot be smaller than the calculated value.	At stop	Immed-iately	Model dependent
H02-27	Resistance of external regenerative resistor	1 to 1000	Ω	Defines the resistance of the external regenerative resistor actually used. Note: The resistance of the external regenerative resistor actually used (H02-27) cannot be smaller than the minimum permissible resistance of the regenerative resistor defined by H02-21. Otherwise, Err.922 (External regenerative resistor too small) will occur.	At stop	Immed-iately	Model dependent

CAUTION
◆ Set the power and resistance of the external regenerative resistor in H02-26 and H02-27 correctly. ◆ When an external regenerative resistor is used, ensure the resistance of the external regenerative resistor is larger than the minimum permissible resistance. ◆ In a natural environment, when the processable power (average value) of the regenerative resistor is used at rated capacity, the temperature of the resistor will rise to above 120°C under continuous braking. For the sake of safety, reduce the resistor temperature with forced air cooling, or use a resistor with a thermal switch. For the load characteristics of the regenerative resistor, consult with the manufacturer. ◆ Set the heat dissipation coefficient of the external regenerative resistor based on the heat dissipation conditions.

☆ Related parameters

Para. No.	Name	Value Range	Unit	Description	Setting Condition	Effective Time	Default
H02-24	Heat dissipation coefficient of the resistor	10 to 100	%	Defines the heat dissipation coefficient of the external regenerative resistor. The set value cannot be larger than 30% upon natural ventilation or 50% upon forced air cooling. Note: The larger the heat dissipation coefficient is, the better the braking efficiency will be.	At stop	Immed-iately	30

■ Built-in regenerative resistor

The built-in regenerative resistor is needed in the following conditions:
$P_b < P_a$ and P b x T > E_c

In this case, set H02-25 to 0.

Terminals $P_{\oplus}$ and D must be jumpered for use of the built-in regenerative resistor.

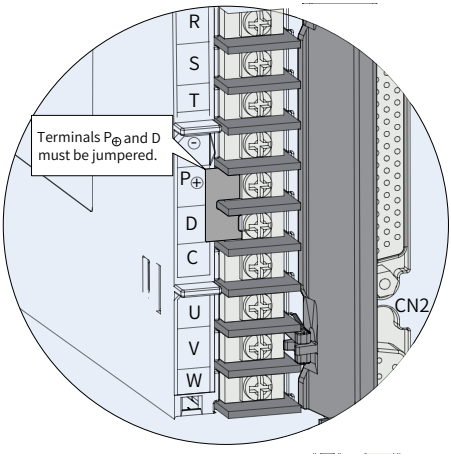


Figure 4-16 Connection of the built-in regenerative resistor

☆ Related parameters

Para. No.	Name	Value Range	Description	Setting Condition	Effective Time	Default
H02-22	Power of built-in regenerative resistor	Model dependent	Displays the power of the built-in regenerative resistor.	At display	-	Model dependent
H02-23	Resistance of built-in regenerative resistor	Model dependent	Displays the resistance of the built-in regenerative resistor.	At display	-	Model dependent

■ Regenerative resistor not needed

No regenerative resistor is needed and the bus capacitor is sufficient to absorb the braking energy in the following condition:

$P_b \times T < E_C$

In this case, set H02-25 to 3.

5 Adjustment

5.1 Overview

A proper gain tuning is required to enable the servo drive to drive the motor with the least delay and error in executing commands sent from the host controller or internal settings.

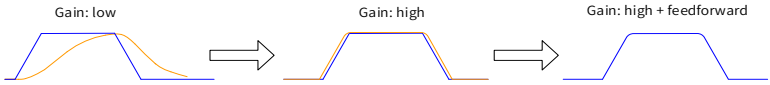


Figure 5-1 Example of gain settings

The gain is defined by multiple mutually-affected parameters (including position loop gain, speed loop gain, filter and load moment of inertia ratio). Set these parameters properly to keep a balanced performance.

CAUTION	
	Before gain tuning, perform a trial run through jogging. This is to check whether the motor runs normally.

The following figure shows the general process of gain tuning.

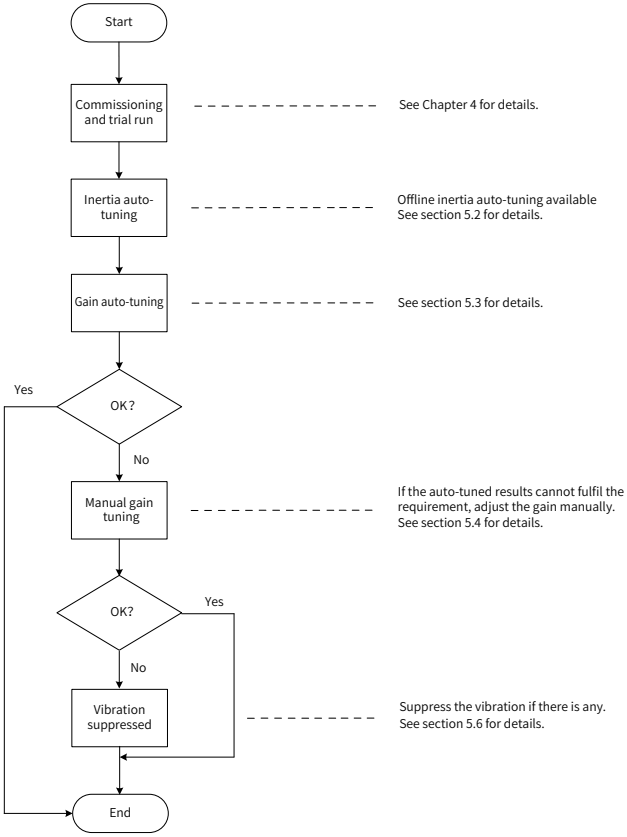


Figure 5-2 Process of gain tuning

Table 5-1 Description of gain tuning process

Process of Gain Tuning			Description	Reference Section
1	Inertia auto-tuning	Offline	The servo drive calculates the load inertia ratio automatically through inertia auto-tuning.	5.2
		Online	Online inertia auto-tuning can be used in ETune adjustment mode only.	-

Process of Gain Tuning			Description	Reference Section
2	Gain auto-tuning		The servo drive automatically generates the values of gain parameters that match the inertia ratio (the inertia ratio must be set correctly).	5.3
3	Manual gain tuning	Basic gain	If gain auto-tuning cannot fulfill the needs, perform manual gain tuning.	5.4
		Reference filter	Filters the position, speed, and torque references.	5.4.4
		Feedforward gain	Improves the following performance.	5.4.3
		Pseudo differential regulator	Adjusts the speed loop control mode to improve the anti-interference capability at low frequency range.	5.4.5
		Torque disturbance observer	Improves the anti-torque disturbance capability.	5.4.6
4	Vibration suppression	Mechanical resonance	Enable the notch function to suppress the mechanical resonance.	5.6.1
		Low-frequency resonance	Activate the filter used to suppress low-frequency resonance.	5.6.2

5.2 Inertia Auto-tuning

The inertia ratio (2008-10h) is calculated through the following formula:

$$\text{Load inertia ratio} = \frac{\text{Total moment of inertia of mechanical load}}{\text{Motor moment of inertia}}$$

The load inertia ratio is a critical parameter of a servo system. A proper inertia ratio helps facilitate the commissioning process.

The load inertia ratio can be set manually or set automatically through inertia auto-tuning.

Online inertia auto-tuning can be used in ETune adjustment mode only. This section only describes offline inertia auto-tuning.

■ Offline inertia auto-tuning

Enable offline inertia auto-tuning (H0D-02), start the motor, and perform inertia auto-tuning. This kind of auto-tuning mode does not involve the host controller.

CAUTION	
	The following requirements must be fulfilled to ensure correct calculation of the load inertia ratio: ◆ Initial position auto-tuning is performed after power-on. ◆ The actual maximum motor speed is larger than 150 mm/s. ◆ The actual acceleration rate during acceleration/deceleration is larger than 3000 mm/s. ◆ The load torque is stable without dramatic changes. ◆ The actual load inertia ratio does not exceed 120. ◆ If the actual load inertia ratio is large but the servo drive gain is low, motor action will be slowed down, failing to meet the requirements on maximum motor speed and acceleration rate. In this case, increase the speed loop gain (H08-00) and perform inertia auto-tuning again. ◆ If vibration occurs during auto-tuning, stop inertia auto-tuning immediately and reduce the gain. ◆ In addition, inertia auto-tuning may fail if the backlash of the transmission mechanism is too large.

5.2.1 Operations

Check the following before performing offline inertia auto-tuning:

1 The motion stroke of the motor meets the following two requirements:

■ Sufficient motion stroke is available between the mechanical limit switches.

Before performing offline inertia auto-tuning, ensure the limit switches are installed properly and sufficient motor motion stroke is reserved to prevent overtravel during inertia auto-tuning.

■ The distance defined by 2009-0Ah (Motor revolutions per inertia auto-tuning) is fulfilled.

View the maximum speed of current inertia auto-tuning (2009-07h), time of accelerating to the maximum speed during inertia auto-tuning (2009-08h), and the motor motion distance needed by inertia auto-tuning (2009-0Ah) to ensure available motor motion stroke is larger than the set value of 2009-0Ah. Otherwise, decrease the value of 2009-07 or 2009-08h until the requirement is met.

2 Estimate the value of 2008-10h (Load moment of inertia ratio).

If the default value (1.00) of 2008-10h is used but the actual inertia ratio is larger than 30.00, the motor may run slowly, resulting in auto-tuning failure. To solve this problem, take the following measures:

Set 2008-10h to a large value first. The recommended setpoint is 5.00. Increase the value of 2008-10h gradually until the value displayed by the keypad changes along with it.

Increase the stiffness level (2009-02h) properly so that the actual motor speed can reach the value defined by 2009-07h.

■ General process for offline auto-tuning

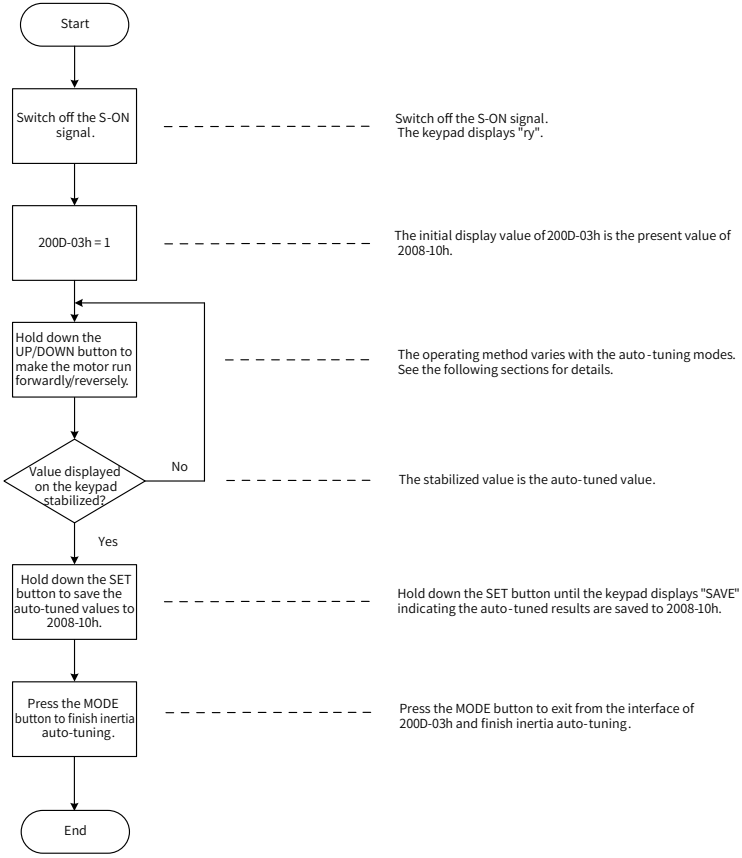
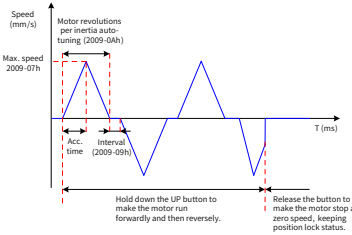
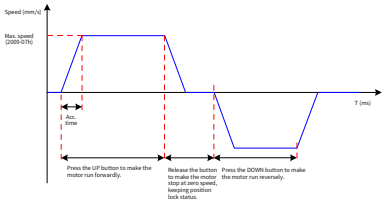
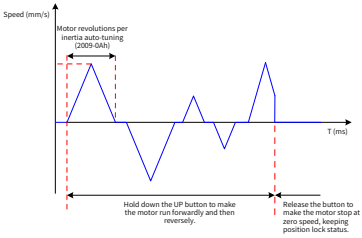
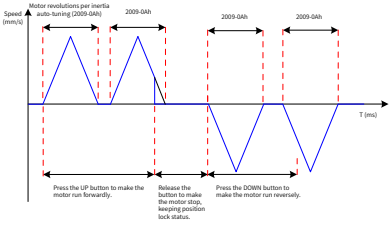


Figure 5-3 Process for offline auto-tuning

Offline inertia auto-tuning includes four modes: positive/negative triangular wave mode, jog mode, bidirectional auto-tuning mode, and unidirectional auto-tuning mode. The commands for these four modes come in different forms.

Table 5-2 Comparison of four offline inertia auto-tuning modes

Item	Positive/Negative Triangular Wave Mode (2009-06h = 0)	Jog Mode (2009-06h = 1)
Command form	Symmetric triangle wave 	Trapezoidal wave 
Maximum speed	2009-07h	2009-07h
Acceleration/ Deceleration time	2009-08h	2009-08h
Description of push buttons on the keypad	Hold down ▲ : The motor runs forwardly and then reversely. Hold down ▼ : The motor runs reversely and then forwardly. Release the button: The motor stops at zero speed and enters the position lock status.	Press ▲ : The motor rotates forwardly. Press ▼ : The motor rotates reversely. Release the button: The motor stops at zero speed and enters the position lock status.
Interval	2009-09h	Interval between adjacent button operations
Motor running distance	2009-0Ah = 2009-07h x 2009-08h	Manual control
Applicable Occasion	Occasions where the motor stroke is short	Occasions where the motor stroke is long and manual control is allowed

Item	Bidirectional auto-tuning mode (2009-06h = 2)	Unidirectional auto-tuning mode (2009-06h = 3)
Command form	Internally-planned trajectory 	Internally-planned trajectory 

Item	Bidirectional auto-tuning mode (2009-06h = 2)	Unidirectional auto-tuning mode (2009-06h = 3)
Maximum speed	Planned internally	Planned internally
Acceleration/ Deceleration time	Planned internally	Planned internally
Description of push buttons on the keypad	Hold down ▲ : The motor rotates forwardly and then reversely. Hold down ▼ : The motor rotates reversely and then forwardly. Release the button: The motor stops at zero speed and enters the position lock status.	Press ▲ : The motor rotates forwardly. Press ▼ : The motor rotates reversely. Release the button: The motor stops at zero speed and enters the position lock status.
Interval	A pause interval existed between forward and reverse running, with pause duration planned internally	A pause interval existed between adjacent auto-tuning, with pause duration planned internally
Motor running distance	Determined by 2009-0Ah	Determined by 2009-0Ah
Applicable Occasion	Occasions where the motor stroke is short	Occasions where the motor stroke is long and manual control is allowed

☆ Related parameters:

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2009	06h	Offline inertia auto-tuning mode	RW	-	Uint16	-	0: Positive/ Negative triangular wave mode 1: Jog mode 2: Bidirectional auto-tuning mode 3: Unidirectional auto-tuning mode	0	At stop	Immed-iately
	07h	Maximum speed of inertia auto-tuning	RW	-	Uint16	mm/s	100 to 1000	500	At stop	Immed-iately
	08h	Time constant for accelerating to the maximum speed during inertia auto-tuning	RW	-	Uint16	ms	20 to 800	125	At stop	Immed-iately
	09h	Inertia auto-tuning interval	RW	-	Uint16	ms	50 to 10000	800	At stop	Immed-iately
	0Ah	Motor revolutions per inertia auto-tuning	RO	-	Uint16	0.01 mm	15 to 10000	2000	At stop	Immed-iately

5.2.2 Solutions to Common Auto-tuning Faults

Er.600: Inertia auto-tuning failure

If the vibration cannot be suppressed automatically, set the vibration suppression function manually.

The auto-tuned inertia values vary with each inertia auto-tuning. It is recommended to increase the maximum running speed, reduce the acceleration/deceleration time, and shorten the action range (H09-09).

5.3 Gain Auto-tuning

In gain auto-tuning, the servo drive automatically generates a group of matching gain parameters based on the setting of 2009-02h (Stiffness level selection) to deliver quick response and stable performance.

NOTE

Ensure the load inertia ratio is accurate before performing gain auto-tuning.

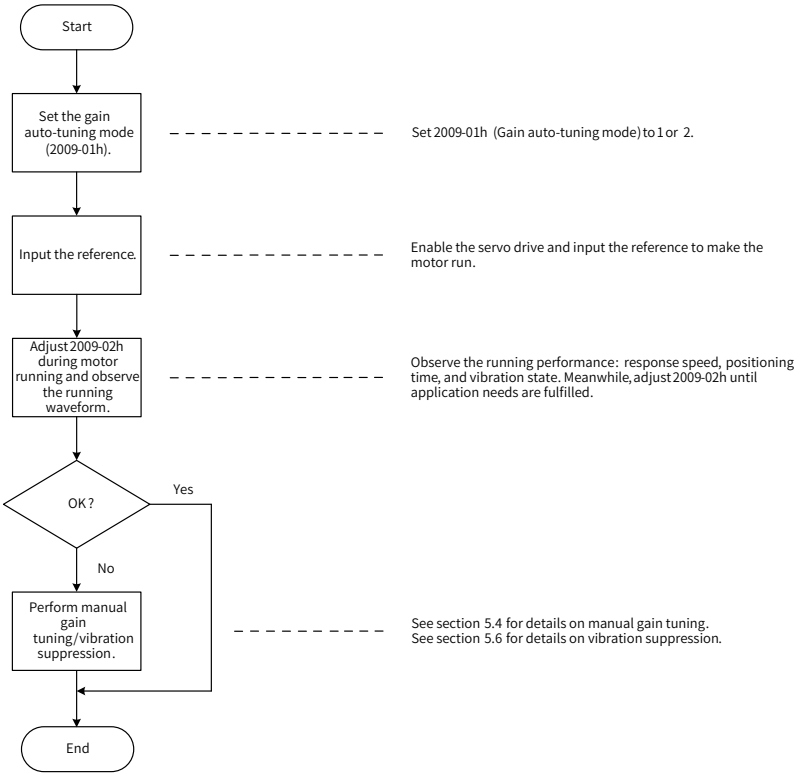


Figure 5-4 Process of gain auto-tuning

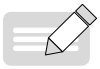
■ Setting the stiffness level (2009-01h = 1)

The setting range of 2009-02h (Stiffness level selection) is 0 to 40. Level 0 indicates the weakest stiffness and lowest gain and level 40 indicates the strongest stiffness and highest gain. The following table lists stiffness levels for different load types for your reference.

Table 5-3 Stiffness level

Recommended Stiffness Level	Type of Load Mechanism
Level 4 to level 8	Large-scale machineries
Level 8 to level 15	Applications with low load stiffness
Level 15 to level 20	Applications with high stiffness

The servo drive provides two kins of gain auto-tuning modes: standard stiffness level mode (2009-01h = 1), which is gain auto-tuning mode, and positioning mode (2009-01h = 2).



NOTE

The gain auto-tuning mode (2009-01h = 1) is applicable to most of applications. In applications requiring quick positioning, use the positioning mode (2009-01h = 2).

5.3.1 Gain Auto-tuning Mode (2009-01h=1)

The first group of gain parameters (2008-01h to 2008-03h, 2007-06h) is updated automatically according to the stiffness level defined by 2009-02h and stored into the corresponding index codes.

Table 5-4 Parameters updated in gain auto-tuning mode

Index Code	Name
2008-01h	Speed loop gain
2008-02h	Speed loop integral time constant
2008-03h	Position loop gain
2007-06h	Torque reference filter time constant

5.3.2 Positioning Mode (2009-01h = 2)

On the basis of Table 5-4, the 2nd group of gain parameters (2008-04h to 2008-06h, 2007-07h) is also automatically updated according to the stiffness level defined by 2009-02h and stored into the corresponding parameters. In addition, the stiffness level of the position loop gain in the 2nd group of gain parameters must be higher than that in the 1st group by one level.

Table 5-5 Parameters updated automatically in positioning mode

Index Code	Name	Description
2008-04h	2nd speed loop gain	-
2008-05h	2nd speed loop integral time constant	If 2008-05h is fixed to 512.00 ms, the 2nd speed loop integral action is invalid, and only proportional control is used in the speed loop.
2008-06h	2nd position loop gain	-
2007-07h	2nd torque reference filter time constant	-

Parameters related to speed feedforward are fixed to certain values.

Table 5-6 Parameters with fixed values in the positioning mode

Index Code	Name	Value
2008-14h	Speed feedforward gain	30.0%
2008-13h	Speed feedforward filter time constant	0.50 ms

Parameters related to gain switchover are fixed to certain values.

The gain switchover function is enabled automatically in the positioning mode.

Index Code	Name	Value	Description
2008-09h	2nd gain mode	1	In the positioning mode, switchover between the 1st (2008-01h to 2008-03h, 2007-06h) and the 2nd group of gain parameters (2008-04h to 2008-06h, 2007-07h) is active. In other modes, the original settings are used.
2008-0Ah	Gain switchover condition	10	In the positioning mode, the gain switchover condition is defined by the value 10 (Position reference available + Actual speed) of 2008-0Ah. In other modes, the original settings are used.
2008-0Bh	Gain switchover delay	5.0 ms	In the positioning mode, the gain switchover delay is 5.0 ms. In other modes, the original settings are used.
2008-0Ch	Gain switchover level	50	In the positioning mode, the gain switchover level is 50. In other modes, the original settings are used.
2008-0Dh	Gain switchover hysteresis	30	In the positioning mode, the gain switchover hysteresis is 30. In other modes, the original settings are used.

NOTE

In the gain auto-tuning mode, parameters updated automatically with 2009-02h and those with fixed values do not allow modification. If you need to modify these parameters, set 2009-01h to 0 to exit from the gain auto-tuning mode.

☆ Related parameters:

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2009	01h	Gain auto-tuning mode	RW	-	Uint16	-	0: Invalid 1: Standard stiffness level 2: Positioning mode 3: Stiffness level + Compensation mode 4: Positioning mode + Compensation mode	0	During running	Immediately
	02h	Stiffness level	RW	-	Uint16	-	0 to 40	12	During running	Immediately

5.4 Manual Gain Tuning

5.4.1 Basic Parameters

When the gain auto-tuning cannot deliver desired performance, adjust the gain parameters based on the auto-tuned values manually to improve the performance.

The servo system consists of three control loops, which are position loop, speed loop, and current loop from external to internal. The block diagram for basic control is shown in the following figure.

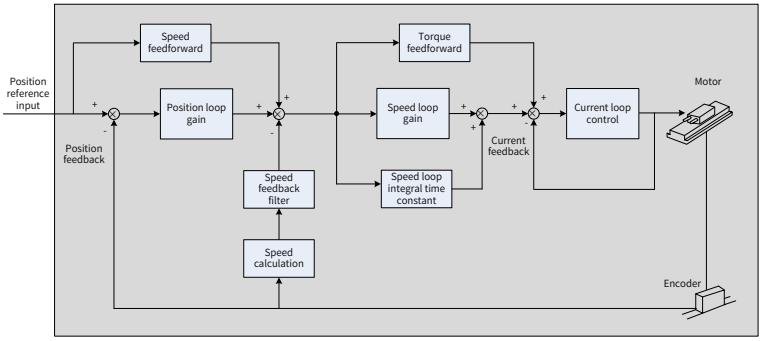


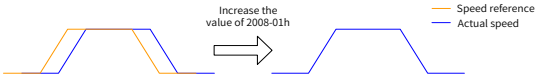
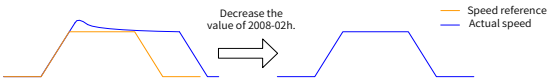
Figure 5-5 Basic block diagram for manual gain tuning

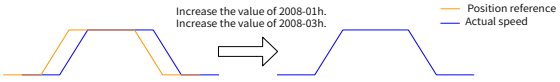
The response level of the inner loop must be higher than that of the outer loop. Otherwise, the system may become unstable.

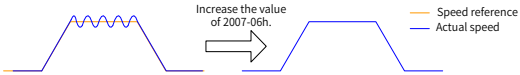
The default gain of the current loop is already designed with the highest level of response, removing the need for adjustment. You only need to adjust the position loop gain, speed loop gain and other auxiliary gains. When executing gain tuning in the position control mode, increase the speed loop gain as well after increasing the position loop gain, and ensure the response level of the position loop is lower than that of the speed loop to keep the system stable.

The following table describes how to adjust the basic gain parameters.

Table 5-7 Adjustment of gain parameters

Step	Para. No.	Name	Description
1	2008-01h	Speed loop gain	Parameter function: Defines the maximum frequency of a varying speed reference that can be followed by the speed loop. When the average load inertia ratio (2008-10h) is set correctly, the following equation applies: Maximum following frequency of the speed loop = 2008-01h  Adjustment method: Increase the value of 2008-01h without incurring noise or vibration. This helps shorten the positioning time and improve speed stability and the following performance. If noise occurs, decrease the value of 2008-01h. If mechanical vibration occurs, enable the resonance suppression function (see "5.6 Vibration Suppression").
2	2008-02h	Speed loop integral time constant	Parameter function: Eliminates the speed loop deviation.  Adjustment method: Select the value according to the following formula: $500 \le 2008\text{-}01h \times 2008\text{-}02h \le 1000$ For example, if 2008-01h is set to 40.0 Hz, 2008-02h must meet the following condition: $12.50\ ms \le 2008\text{-}02h \le 25.00\ ms$ Decreasing the value of 2008-02h strengthens the integral effect and shortens the positioning time, but a too small value may cause mechanical vibration. Do not set 2008-02h to a too large value. Otherwise, the speed loop deviation cannot be cleared to zero. When 2008-02h is set to 512.00 ms, the integral action is invalid.

Step	Para. No.	Name	Description
3	2008-03h	Position loop gain	Parameter function: Defines the maximum frequency of a varying position reference that can be followed by the position loop. Maximum following angular frequency of the position loop = 2008-03h  Adjustment method: To ensure system stability, the maximum following frequency of the speed loop must be 3 to 5 times more than the maximum following frequency of the position loop. $3 \leq \frac{2 \times \pi \times 2008\text{-}01h}{2008\text{-}03h} \leq 5$ For example, when 2008-01h is set to 40.0 Hz, the position loop gain must meet the condition: 50.2 Hz ≤ 2008-03h ≤ 83.7 Hz Adjust 2008-03h based on the positioning time. Increasing the value of 2008-03h shortens the acceleration time and improves the anti-interference capacity of a standstill motor. Do not set 2008-03h to a too large value. Otherwise, system instability and oscillation may occur.

Step	Para. No.	Name	Description
4	2007-06h	Torque reference filter time constant	Parameter function: Eliminates the high-frequency noise and suppresses mechanical resonance.  Adjustment method: Ensure the cutoff frequency of the torque reference low-pass filter is 44 times more than the maximum following frequency of the speed loop. $\frac{1000}{2 \times \pi \times 2007\text{-}06h} \geq (2008\text{-}01h) \times 4$ For example, when 2008-01h is set to 40.0 Hz, 2007-06h must be set to a value smaller than 1.00 ms. If vibration occurs when you increase the value of 2008-01h, adjust the value of 2007-06h to suppress vibration. For details, see "5.6 Vibration Suppression". Do not set 2007-06h to a too large value. Otherwise, the responsiveness of the current loop may be weakened. To suppress vibration at stop, increase the value of 2008-01h and decrease the value of 2007-06h. If excessive vibration occurs on a motor in the stop state, reduce the value of 2007-06h.

☆ Related parameters

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2008	01h	Speed loop gain	RW	-	Uint16	Hz	1 to 20000 (unit: 0.1 Hz)	250	During running	Immediately
	02h	Speed loop integral time constant	RW	-	Uint16	ms	15 to 51200 (unit: 0.01 ms)	3183	During running	Immediately
	03h	Position loop gain	RW	-	Uint16	Hz	1 to 20000 (unit: 0.1 Hz)	400	During running	Immediately

5.4.2 Gain Switchover

Gain switchover can be triggered by the internal state of the servo drive or an external DI to achieve the following functions (supported only in the position control mode and speed control mode):

1) Switching to the lower gain at motor standstill (servo ON) to suppress vibration

2) Switching to the higher gain at motor standstill to shorten the positioning time

3) Switching to the higher gain during motor running to achieve better reference tracking performance

4) Switching between different gain settings through external signals to fit different conditions of the load device

■ 2008-09h = 0

The 1st group of gain parameters (2008-01h to 2008-03h, 2007-06h) are used, but proportional/proportional integral control switchover through DI function 3 (FunIN.3: GAIN_SEL, gain switchover) is supported by the speed loop.

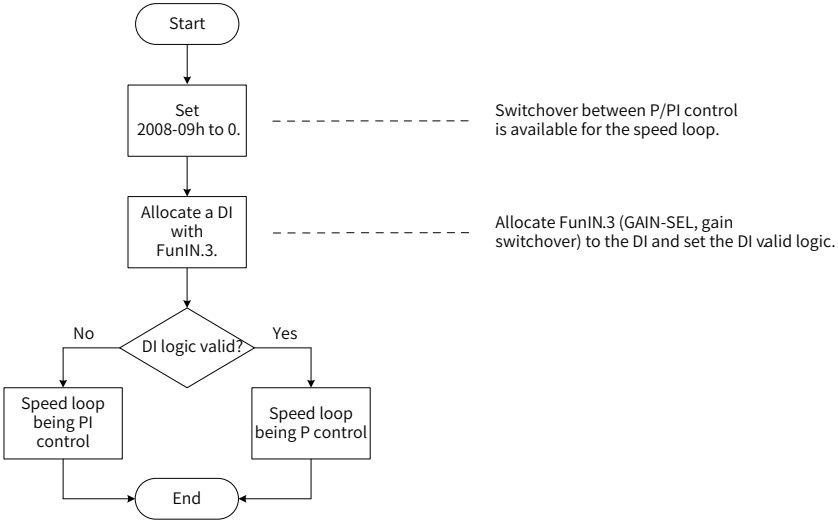


Figure 5-6 Gain switchover process (2008-09h = 0)

■ 2008-09h = 1:

Switchover between the 1st (2008-01h to 2008-03h, 2007-06h) and the 2nd (2008-04h to 2008-06h, 2007-07h) group of gain parameters is achieved based on the setting of 2008-0Ah.

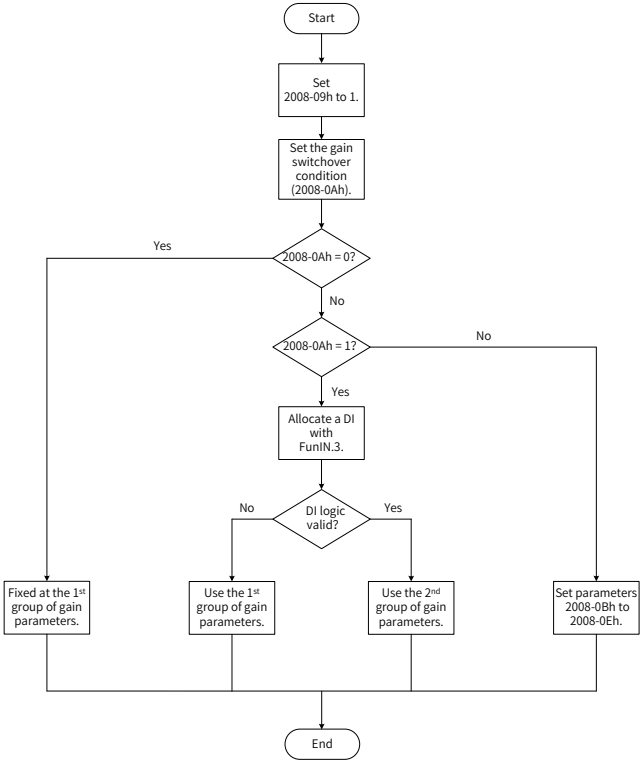
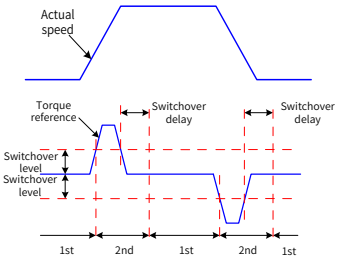
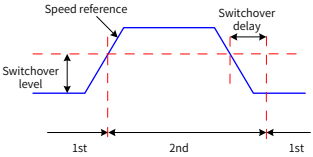
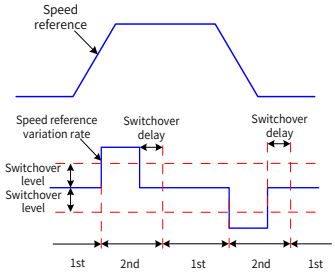
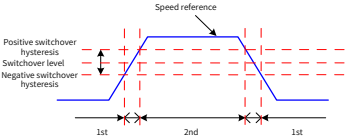


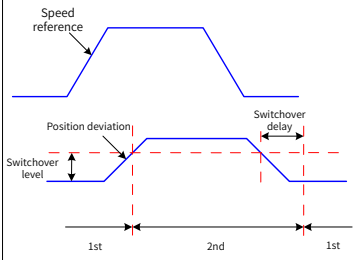
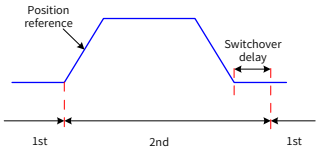
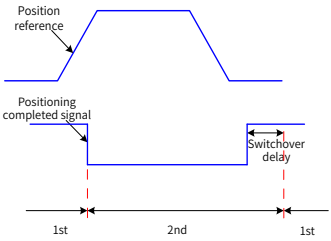
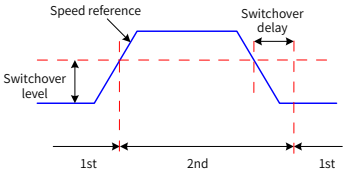
Figure 5-7 Gain switchover process (H08-08 = 1)

There are 11 modes for gain switchover. The following table describes the diagrams and related parameters for different modes.

Table 5-8 Description of gain switchover conditions

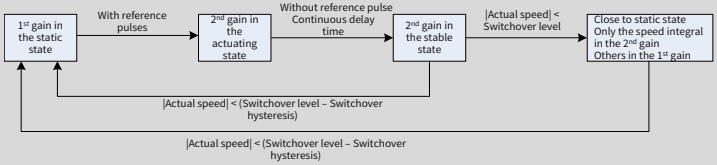
Gain Switchover Condition			Related Parameters		
2008-0Ah	Condition	Diagram	Delay Time (2008-0Bh)	Gain Switchover Level (2008-0Ch)	Gain Switchover Hysteresis (2008-0Dh)
0	Fixed at the 1st gain	-	Invalid	Invalid	Invalid
1	Switchover by external DI	-	Invalid	Invalid	Invalid

Gain Switchover Condition			Related Parameters		
2008-0Ah	Condition	Diagram	Delay Time (2008-0Bh)	Gain Switchover Level (2008-0Ch)	Gain Switchover Hysteresis (2008-0Dh)
2	Torque reference		Valid	Valid (%)	Valid (%)
3	Speed reference		Valid	Valid	Valid
4	Speed reference variation rate		Valid	Valid (10 mm/s/s)	Valid (10 mm/s/s)
5	Speed reference high-speed/ low-speed threshold		Invalid	Valid (mm/s)	Valid (mm/s)

Gain Switchover Condition			Related Parameters		
2008-0Ah	Condition	Diagram	Delay Time (2008-0Bh)	Gain Switchover Level (2008-0Ch)	Gain Switchover Hysteresis (2008-0Dh)
6	Position deviation		Valid	Valid (encoder unit)	Valid (encoder unit)
7	Position reference		Valid	Invalid	Invalid
8	Positioning completed		Valid	Invalid	Invalid
9	Actual speed		Valid	Valid (mm/s)	Valid (mm/s)
10	Position reference + Actual speed	See the following NOTE for details.	Valid	Valid (mm/s)	Valid (mm/s)

NOTE

2008-0Bh (Gain switchover delay) is valid only during switching from the 2nd to the 1st group of gain parameters.



☆ Related parameters

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2008	09h	2nd gain mode	RW	-	Uint16	-	0: Fixed at the 1st gain, P/PI switchover through external DI 1: Gain switchover activated based on the condition defined by H08-09	1	During running	Immediately
	0Ah	Gain switchover condition	RW	-	Uint16	-	0: Fixed at the 1st gain (PS) 1: Switchover through external DI (PS) 2: Torque reference too large (PS) 3: Speed reference too large (PS) 4: Speed reference variation rate too large (PS) 5: Speed reference high speed/low speed threshold (PS) 6: Position deviation too large (P) 7: Position reference available (P) 8: Positioning uncompleted (P) 9: Actual speed (P) 10: Position reference + Actual speed (P)	0	During running	Immediately
	0Bh	Gain switchover delay	RW	-	Uint16	ms	0 to 10000 (unit: 0.1 ms)	50	At stop	Immediately
	0Ch	Gain switchover level	RW	-	Uint16	-	0 to 20000	50	At stop	Immediately

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2008	0Dh	Gain switchover hysteresis	RW	-	Uint16	-	0 to 20000	30	At stop	Immediately
	0Eh	Position gain switchover time	RW	-	Uint16	ms	0 to 10000 (unit: 0.1 ms)	30	At stop	Immediately

5.4.3 Feedforward Gain

1) Speed feedforward

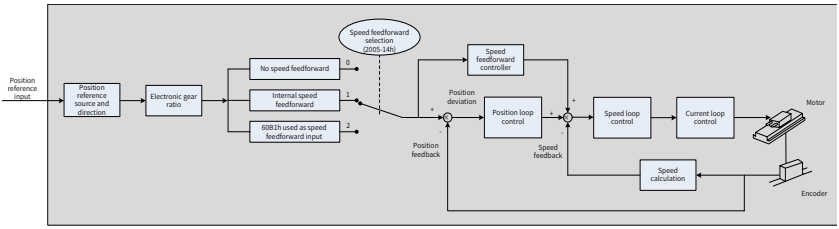


Figure 5-8 Process of speed feedforward control

Speed feedforward can be applied to the position control mode and full-closed loop function to improve speed reference responsiveness and reduce the position deviation at a fixed speed.

Process of speed feedforward

a) Setting the speed feedforward signal source

Set 2005-14h to a non-zero value to enable speed feedforward, and the corresponding signal source will be selected as well.

Index Code	Name	Value	Remarks
2005-14h	Speed feedforward control	0: No speed feedforward	-
		1: Internal speed feedforward	Set the speed information corresponding to the position reference (encoder unit) as the speed feedforward signal source.
		2: 60B1h used as speed feedforward input	Use 60B1h (velocity offset in velocity unit/s) as the source of the speed feedforward signal. The polarity of the speed feedforward signal can be changed by bit6 of 607Eh (Polarity).

b) Setting speed feedforward parameters

Set the speed feedforward gain (2008-14h) and the speed feedforward filter time constant (2008-13h).

Index Code	Name	Description
2008-13h	Speed feedforward filter time constant	 Parameter function: ◆ Increasing 2008-14h improves responsiveness but speed overshoot may occur during acceleration/deceleration. ◆ Decreasing 2008-13h suppresses speed overshoot during acceleration/deceleration. Increasing 2008-13h not only suppresses the noise in the case of a long position reference update cycle, a long drive control cycle and uneven position reference pulse frequencies, but also suppresses the jitter of the positioning completed signal. Adjustment method: ◆ Set 2008-13h to a fixed value, and then gradually increase the value of 2008-14h from 0 to a value at which speed feedforward reaches the required effect. ◆ Adjust 2008-13h and 2008-14h repeatedly to achieve a balanced setting.
2008-14h	Speed feedforward gain	

2) Torque feedforward

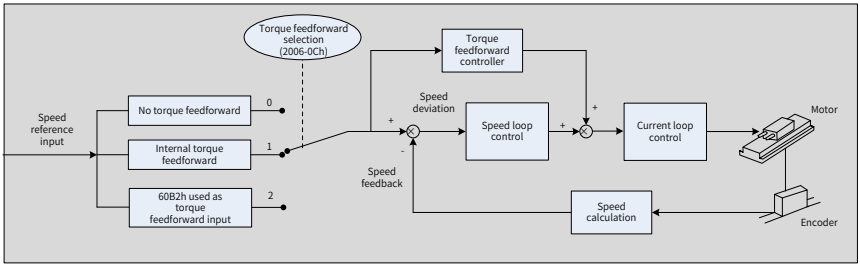


Figure 5-9 Process of torque feedforward control

Torque feedforward used in the position control mode improves torque reference responsiveness and reduces the position deviation at fixed acceleration/deceleration.

Torque feedforward used in the speed control mode improves torque reference responsiveness and reduces the speed deviation at a fixed speed.

Process of torque feedforward

a) Setting the torque feedforward signal source

Set 2006-0Ch to 1 to enable torque feedforward, and the corresponding signal source will be selected as well.

Index Code	Name	Value	Remarks
2006-0Ch	Torque feedforward control	0: No torque feedforward	-
		1: Internal torque feedforward	The speed reference is used as the torque feedforward signal source. In the position control mode, the speed reference is output from the position controller.
		2: 60B2h used as torque feedforward input	60B2h (torque offset in 0.1%) is used as the torque feedforward signal source. The polarity of the torque feedforward signal can be changed by bit5 of 607Eh (Polarity).

b) Setting torque feedforward parameters

Set the torque feedforward gain (2008-16h) and the torque feedforward filter time constant (2008-15h).

Index Code	Name	Description
2008-15h	Torque feedforward filter time constant	◆ Parameter function: Increasing 2008-16h improves responsiveness but may cause overshoot during acceleration/deceleration. Decreasing 2008-15h suppresses overshoot during acceleration/deceleration. Increasing 2008-15h suppresses the noise. ◆ Adjustment method: Keep 2008-15h to the default value, and then gradually increase 2008-16h from 0 to a value at which torque feedforward reaches the required effect. Adjust 2008-15h and 2008-16h repeatedly to achieve a balanced setting.
2008-16h	Torque feedforward gain	For details, see "5.4.4 Speed Feedback Filter Settings".

5.4.4 Speed Feedback Filter Settings

Speed feedback filter settings include moving average filtering of the speed feedback (2008-17h) and the cutoff frequency of speed feedback low pass filter (2008-18h).

Index Code	Name	Description
2008-17h	Moving average filtering of speed feedback	◆ Parameter function: When low-frequency fluctuation is present in the speed detection value, perform moving average filtering on the speed detection value. ◆ Adjustment method: Increasing the value of 2008-17h increases the filtering times and reduces the speed feedback ripple, but it prolongs the feedback delay. Observe the corresponding performance when adjusting the value of 2008-17h.
2008-18h	Cutoff frequency of speed feedback low pass filter	◆ Parameter function: When high-frequency interference is present in the speed detection value, perform low-pass filtering on the speed detection value. ◆ Adjustment method: Decreasing the value of 2008-18h reduces the speed feedback ripple but prolongs the feedback delay. Observe the corresponding performance when adjusting the value of 2008-18h.

When 2008-17h is set to a non-zero value, 2008-18h is invalid.

When 2008-18h is set to 4000, the speed feedback low pass filter is invalid.

5.4.5 Pseudo Derivative Feedback and Feedforward Control

In non-torque control mode, the pseudo derivative feedback and feedforward (PDFF) control can be used to adjust the speed loop control mode.

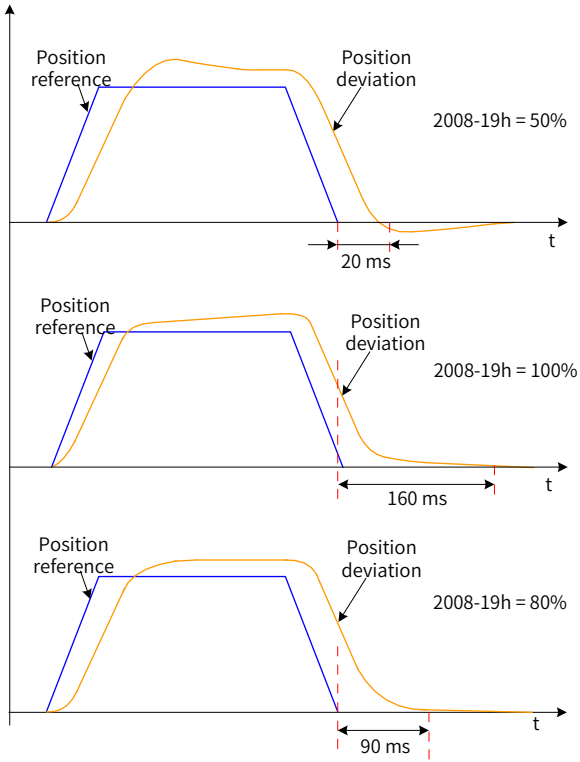


Figure 5-10 Example of PDFF control

PDFF control enhances the anti-interference capacity of the speed loop and improves the performance in following the speed references through speed loop control mode adjustment.

Index Code	Name	Description
2008-19h	PDFF control coefficient	◆ Parameter function: Changes the speed loop control mode in the non-torque control mode. ◆ Adjustment method: Setting 2008-19h to a too small value slows down the responsiveness of the speed loop. When speed feedback overshoot occurs, decrease 2008-19h gradually from 100.0 to a value at which the PDFF effect is achieved. When 2008-19h is set to 100.0, the speed loop control mode does not change, that is, the default proportional integral control is used.

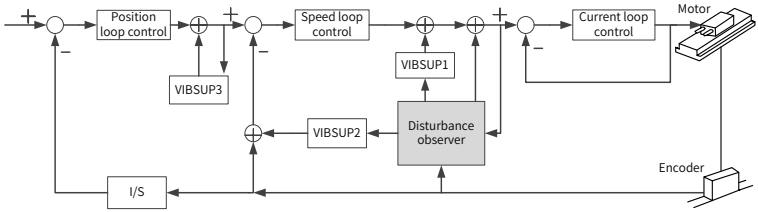
5.4.6 Torque Disturbance Observation

This function is intended to be used in the non-torque control mode.

■ Disturbance observer 1

The disturbance observer is used to observe external disturbance. The disturbance within the frequency range can be observed and suppressed through setting the cutoff frequency and compensation.

The block diagram for disturbance observer 1 is as follows.



1/S: Integral element

Para. No.	Name	Description
H08-31	Disturbance observation cutoff frequency	The higher the cutoff frequency is, the more easily will the vibration occur.
H08-32	Disturbance observation compensation coefficient	Defines the compensation percentage for observation.
H08-33	Disturbance observation inertia correction coefficient	This parameter needs no setting if the set inertia fits the actual conditions. The active inertia is the result of multiplying the value of H08-33 by the set inertia. It is recommended to use the default value of H08-33.

Related parameters

Para. No.	Name	Value Range	Unit	Description	Setting Condition	Effective Time	Default
H08-31	Disturbance observation cutoff frequency	10 to 1700	1 Hz	Defines the cutoff frequency of disturbance observation.	During running	Immed-iately	600
H08-32	Disturbance observation compensation coefficient	0 to 100	1%	Defines the compensation percentage for observation.	During running	Immed-iately	0

Para. No.	Name	Value Range	Unit	Description	Setting Condition	Effective Time	Default
H08-33	Disturbance observation inertia correction coefficient	1 to 10000	1%	Defines the coefficient for correcting the disturbance observation inertia.	During running	Immed-iately	100

■ Disturbance observer 2

The block diagram for disturbance observer 2 is as follows.

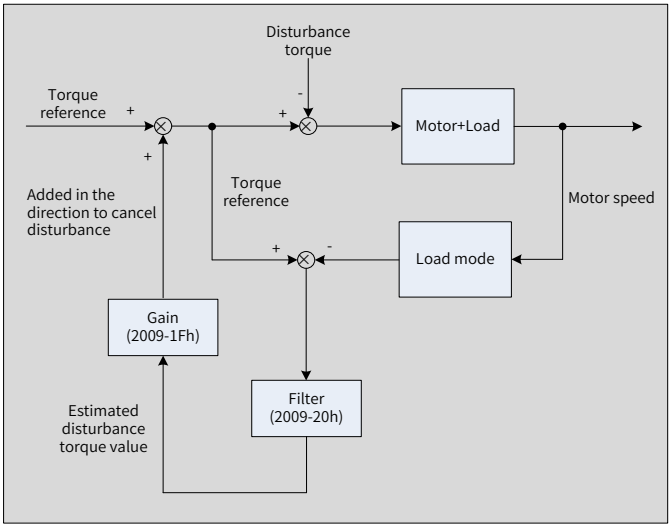


Figure 5-11 Block diagram for disturbance observation

The disturbance observer detects and estimates the external disturbance torque suffered by the system and compensates the torque reference to reduce the effect of external disturbance on the servo system and alleviate the vibration.

Index Code	Name	Description
2009-1Fh	Torque disturbance compensation gain	◆ Parameter function: Increasing the value of 2009-1Fh, which is to increase the proportion of the compensation torque superpositioned to the torque reference, improves the disturbance suppression capacity but increases the noise. Increasing the value of 2009-20h reduces the noise. Decreasing the value of 2009-20h enables detection and estimation on the external disturbance torque with a short delay, improving the anti-interference capacity but strengthening the noise. ◆ Adjustment method: Set 2009-20h to a large value first. Next, increase the value of 2009-1Fh gradually from 0 to a value at which the disturbance observer delivers the desired effect. Finally, decrease the value of 2009-20h gradually with the disturbance observer kept active. Adjust 2009-1Fh and 2009-20h repeatedly to achieve a balanced setting.
2009-20h	Filter time constant of torque disturbance observer	

☆ Related parameters

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2008	13h	Speed feedforward filter time constant	RW	-	Uint16	ms	0 to 6400 (unit: 0.01 ms)	50	During running	Immed-iately
	14h	Speed feedforward gain	RW	-	Uint16	%	0 to 1000 (unit: 0.1%)	0	During running	Immed-iately
	15h	Torque feedforward filter time constant	RW	-	Uint16	ms	0 to 6400 (unit: 0.01 ms)	50	During running	Immed-iately
	16h	Torque feedforward gain	RW	-	Uint16	%	0 to 2000 (unit: 0.1%)	0	During running	Immed-iately
	18h	Cutoff frequency of speed feedback low pass filter	RW	-	Uint16	Hz	0 to 4000	4000	During running	Immed-iately
	19h	PDFF control coefficient	RW	-	Uint16	0.10%	0 to 1000	1000	During running	Immed-iately

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2009	1Fh	Torque disturbance compensation gain	RW	-	Uint16	%	–1000 to +1000 (unit: 0.1%)	0	During running	Immed-iately
	20h	Filter time constant of torque disturbance observer	RW	-	Uint16	ms	0 to 2500 (unit: 0.01 ms)	50	During running	Immed-iately

5.4.7 Speed observer

The speed observer is intended to be used in applications with small load/inertia changes. It helps facilitate quick positioning through improving the responsiveness and filtering high frequencies without incurring high-frequency vibration.

The block diagram for speed observer is as follows.

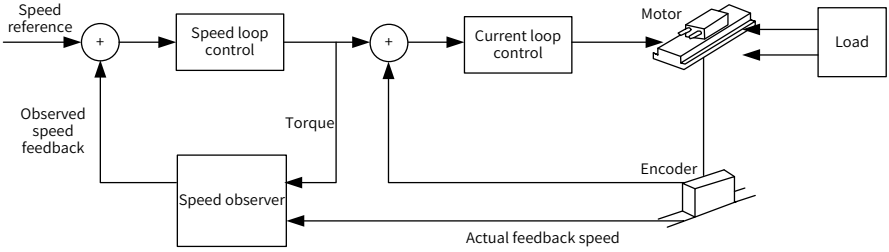
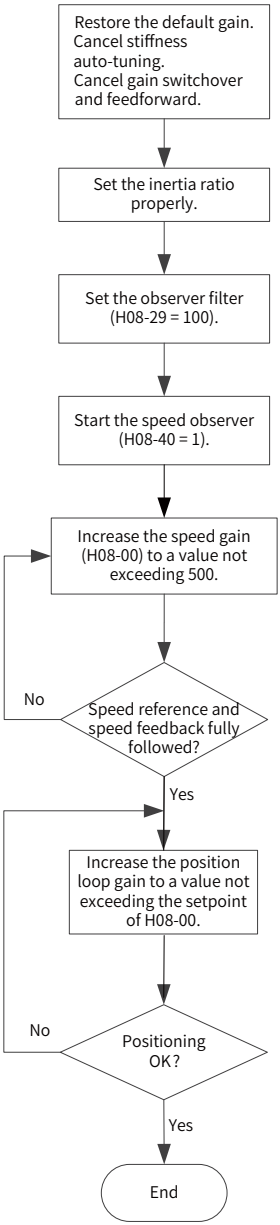


Figure 5-12 Block diagram of speed observer

1 Commissioning procedure



2 Related parameters

Para. No.	Name	Min. Unit	Value Range	Default	Setting Condition	Effective Time
H08-00	Speed loop gain	0.1 Hz	1 to 20000	250	During running	Immediately
H08-27	Speed observation cutoff frequency	1 Hz	10 to 2000	170	During running	Immediately
H08-28	Speed observation inertia correction coefficient	1%	10 to 10000	100	During running	Immediately
H08-29	Speed observation filter time	0.01 ms	0 to 2000	80	During running	Immediately
H08-40	Speed observation selection	1	0 to 1	0	During running	Immediately

5.4.8 Model Tracking

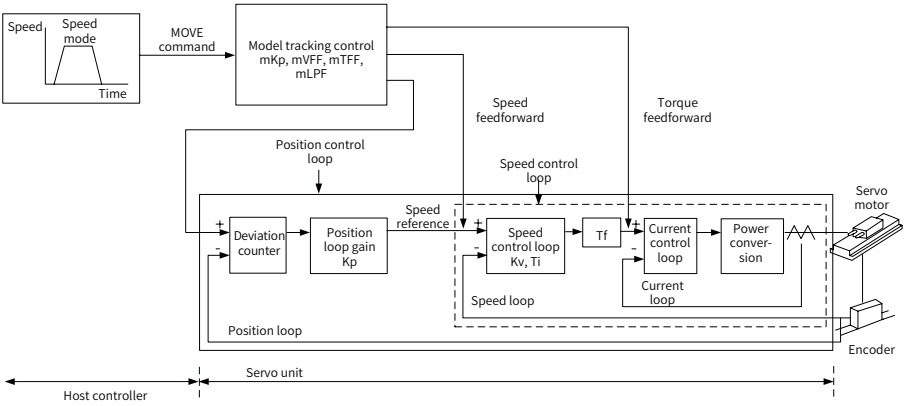
Model tracking control, which is only available in the position control mode, can be used to improve the responsiveness and shorten the positioning time.

Parameters used by model tracking are normally set automatically or along with the gain parameters.

Adjust model tracking parameters manually in the following conditions:

- The auto-tuned results cannot deliver desired performance.
- Improving the responsiveness takes priority over the auto-tuned results.
- Customized parameters are needed in gain or model tracking control.

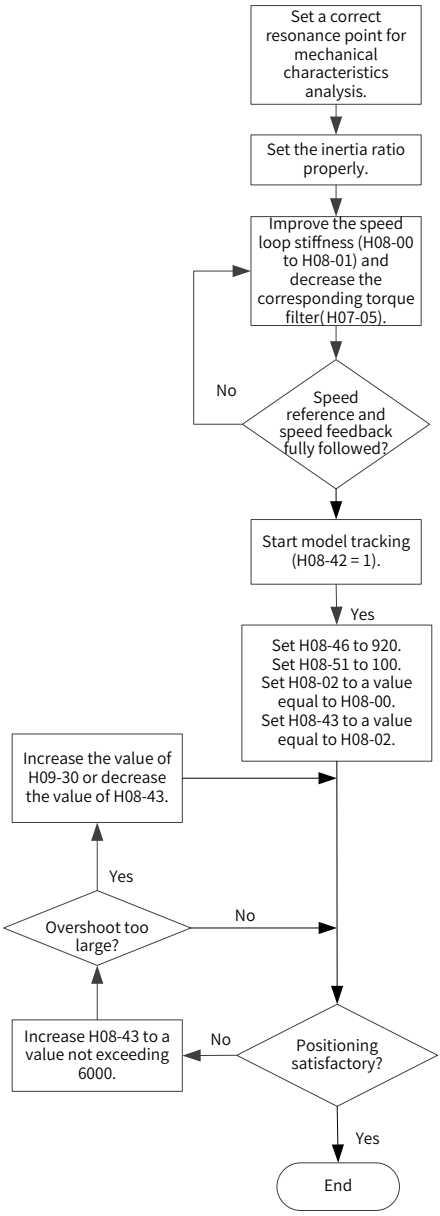
The block diagram for model tracking control is as follows.



Kp: Position loop gain (H08-02)
Kv: Speed loop gain (H08-01)
Ti: Speed loop integral time constant (H0801)
Tf: Torque reference filter time constant (H07-05)
mKp: Model tracking control gain (H08-43)
mTFF: Model tracking control deviation (forward) (H08-48)
Model tracking control deviation (reverse) (H08-49)
mVFF: Model tracking control speed feedforward compensation (H08-46)
mLPF: Model filter time (H08-51)

Figure 5-13 Block diagram of model tracking control

1 Commissioning procedure



2 Related parameters

Para. No.	Name	Min. Unit	Value Range	Default	Setting Condition	Effective Time
H07-05	Torque reference filter time constant	0.01 ms	0 to 3000	79	During running	Immediately
H08-00	Speed loop gain	0.1 Hz	1 to 20000	250	During running	Immediately
H08-01	Speed loop integral time constant	0.01 ms	15 to 51200	3183	During running	Immediately
H08-02	Position loop gain	0.1 Hz	1 to 20000	400	During running	Immediately
H08-42	Model control selection	1	0 to 1	0	At stop	Immediately
H08-43	Model gain	0.1	0 to 10000	400	During running	Immediately
H08-46	Model feedforward	1	0 to 1024	950	During running	Immediately
H08-51	Model filter time 2	0.01 ms	0 to 2000	0	During running	Immediately
H09-30	Torque disturbance compensation gain	0.10%	–1000 to +1000 (unit: 0.1%)	0	During running	Immediately

5.4.9 Friction Compensation

Friction compensation is used to reduce the impact of friction on the running effect during mechanical transmission. Use different positive/negative compensation values according to the running direction.

NOTE

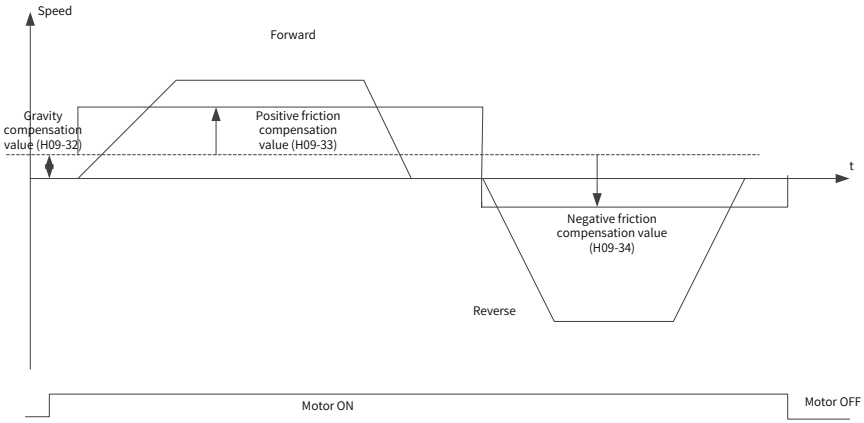
Friction compensation is valid only in the position control mode.

☆ Related parameters

Para. No.	Para. Name	Value Range	Description
H09-32	Gravity compensation value	0 to 500 (min. unit: 0.1)	Defines the constant compensation torque of vertical gravity load.
H09-33	Positive friction compensation	0 to 1000 (min. unit: 0.10%)	Defines the friction compensation for position references in the forward direction.

Para. No.	Para. Name	Value Range	Description
H09-34	Negative friction compensation	–1000 to 0 (min. unit: 0.10%)	Defines the friction compensation for position references in the reverse direction.
H09-35	Friction compensation speed threshold	1 to 300 (min. unit: 1 mm/s)	Defines the running speed after the friction is neutralized.
H09-36	Friction compensation speed selection	0: Speed reference 1: Model speed (valid when the model function is enabled) 2: Speed feedback	Defines the source of the speed threshold.

■ The diagram for friction compensation is as follows.



NOTE

When the speed is less than the speed threshold, static friction applies. When the speed exceeds the speed threshold, dynamic friction applies.
The compensation direction is determined by the actual position reference direction. The forward direction requires a positive compensation value, and the reverse direction requires a negative compensation value.

5.5 Parameter Adjustment in Different Modes

Perform parameter adjustment in the sequence of "Inertia auto-tuning" -> "Gain auto-tuning" -> "Manual gain tuning" in all the control modes.

5.5.1 Parameter Adjustment in the Position Control Mode

Obtain the value of H08-15 (Load moment of inertia ratio) through inertia auto-tuning.

Gain parameters in the position control mode are listed in the following tables.

■ 1st group of gain parameters

Index Code	Name	Description	Default
2007-06h	Torque reference filter time constant	Defines the torque reference filter time constant.	0.79 ms
2008-01h	Speed loop gain	Defines the proportional gain of the speed loop.	25.0 Hz
2008-02h	Speed loop integral time constant	Defines the integral time constant of the speed loop.	31.83 ms
2008-03h	Position loop gain	Defines the proportional gain of the position loop.	40.0 Hz

■ 2nd group of gain parameters

Index Code	Name	Description	Default
2007-07h	2nd torque reference filter time constant	Defines the torque reference filter time constant.	0.79 ms
2008-04h	2nd speed loop gain	Defines the proportional gain of the speed loop.	40.0 Hz
2008-05h	2nd speed loop integral time constant	Defines the integral time constant of the speed loop.	20.00 ms
2008-06h	2nd position loop gain	Defines the proportional gain of the position loop.	64.0 ms
2008-09h	2nd gain mode	Defines the 2nd gain mode.	1
2008-0Ah	Gain switchover condition	Defines the gain switchover condition.	0
2008-0Bh	Gain switchover delay	Defines the gain switchover delay.	5.0 ms
2008-0Ch	Gain switchover level	Defines the gain switchover level.	50
2008-0Dh	Gain switchover hysteresis	Defines the gain switchover hysteresis.	30
2008-0Eh	Position gain switchover time	Defines the gain switchover time of the position loop.	3.0 ms

■ Common gain

Index Code	Name	Description	Default
2008-13h	Speed feedforward filter time constant	Defines the filter time constant of the speed feedforward signal.	0.50 ms

Index Code	Name	Description	Default
2008-14h	Speed feedforward gain	Defines the speed feedforward gain.	0.0%
2008-15h	Torque feedforward filter time constant	Defines the filter time constant of the torque feedforward signal.	0.50 ms
2008-16h	Torque feedforward gain	Defines the torque feedforward gain.	0.0%
2008-17h	Speed feedback filter selection	Defines the speed feedback filter function.	0
2008-18h	Cutoff frequency of speed feedback low pass filter	Defines the cutoff frequency of the first-order low-pass filter for speed feedback.	4000 Hz
2008-19h	PDFF control coefficient	Defines the coefficient of the PDFF controller.	100.0%
2009-1Fh	Torque disturbance compensation gain	Defines the disturbance torque compensation gain.	0.0%
2009-20h	Filter time constant of torque disturbance observer	Defines the filter time constant of the disturbance observer.	0.5 ms
2009-05h	Low-frequency resonance suppression mode	Defines the mode for suppressing low-frequency resonance.	0
2009-27h	Frequency of low-frequency resonance	Defines the frequency of the filter used to suppress low-frequency resonance.	100.0 Hz
2009-28h	Low-frequency resonance frequency filter	Defines the low-frequency resonance filter.	2
200A-11h	Threshold of low-frequency resonance position deviation	Defines the position deviation threshold (in pulses) which can be judged as low-frequency resonance.	0.0005 Rev

Perform gain auto-tuning to obtain the initial values of the 1st or 2nd group of gain parameters and the common gain.

■ Manually adjust the following gain parameters.

Index Code	Name	Description
2007-06h	Torque reference filter time constant	Defines the torque reference filter time constant.
2008-01h	Speed loop gain	Defines the proportional gain of the speed loop.
2008-02h	Speed loop integral time constant	Defines the integral time constant of the speed loop.

2008-03h	Position loop gain	Defines the proportional gain of the position loop.
2008-14h	Speed feedforward gain	Defines the speed feedforward gain.

5.5.2 Parameter Adjustment in the Speed Control Mode

Parameter adjustment in the speed control mode is the same as that in the position control mode except for adjustment of the position loop gain (2008-03h and 2008-06h). See details in "5.5.1 Parameter Adjustment in the Position Control Mode".

5.5.3 Parameter Adjustment in the Torque Control Mode

Parameter adjustment in the torque control mode are differentiated based on the following conditions:

If the actual speed reaches the speed limit, the adjustment method is the same as that described in "5.5.2 Parameter Adjustment in the Speed Control Mode".

If the actual speed does not reach the speed limit, the adjustment method is the same as that described in "5.5.2 Parameter Adjustment in the Speed Control Mode", except for the position/speed loop gain and speed loop integral time constant.

5.6 Vibration Suppression

The block diagram for vibration control is as follows.

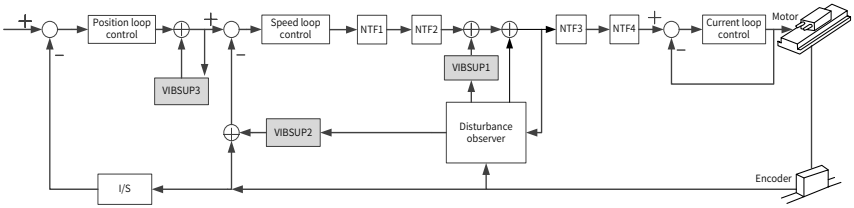


Figure 5-14 Block diagram for vibration control

NTF1 to 4: 1st notch to 4th notch, above 800 Hz

VIBSUP1: Medium- and high-frequency vibration, 500 Hz to 800 Hz

VIBSUP2: Medium- and high-frequency vibration, 300 Hz to 500 Hz

VIBSUP3: Medium- and low-frequency vibration, below 300 Hz

1/S: Integral element

☆ Related parameters

Para. No.	Name	Default	Unit	Min. Value	Max. Value	Setting Condition	Effective Time
H08-34	Medium- and high-frequency vibration suppression phase modulation 1	0	1%	0	1600	During running	Immediately
H08-35	Medium- and high-frequency vibration suppression frequency 1	0	1 Hz	0	1000	During running	Immediately
H08-36	Medium- and high-frequency vibration suppression compensation 1	0	1%	0	100	During running	Immediately
H08-37	Medium-frequency vibration suppression phase modulation 1	0	1%	0	1600	During running	Immediately
H08-38	Medium-frequency vibration suppression frequency 1	0	1 Hz	0	800	During running	Immediately
H08-39	Medium-frequency vibration suppression compensation 1	0	1%	0	100	During running	Immediately
H08-53	Medium- and low-frequency vibration suppression frequency 3	0	0.1 Hz	0	6000	During running	Immediately
H08-54	Medium- and low-frequency vibration suppression compensation 3	0	1%	0	200	During running	Immediately
H08-56	Medium- and low-frequency vibration suppression phase modulation 3	300	1%	0	1600	During running	Immediately

NOTE

- Vibration suppression phase modulation coefficient: Synchronous phase adjustment of the compensation value and vibration. It is recommended to use the default value. Adjustment is needed only when the phase of the compensation value deviates sharply from the vibration phase.
- Vibration suppression frequency: Defines the vibration frequency to be suppressed.
- Vibration suppression compensation coefficient: Defines the magnitude of the suppression compensation.

5.6.1 Suppression of Mechanical Resonance

The resonance frequency is present in the mechanical system. When the gain increases, resonance may occur near the mechanical resonance frequency, disabling further increase in the gain.

Mechanical resonance can be suppressed in the following two methods:

1) Torque reference filter (2007-06h, 2007-07h)

To suppress the mechanical resonance, set the filter time constant to enable the torque reference to be attenuated in the frequency range above the cutoff frequency.

Filter cutoff frequency fc (Hz) = 1/[2π x H07-05 (ms) x 0.001]

1 Notch:

The notch reduces the gain at certain frequencies to suppress the mechanical resonance. After the vibration is suppressed by the notch, you can continue to increase the gain. The operating principle of the notch is shown in the following figure.

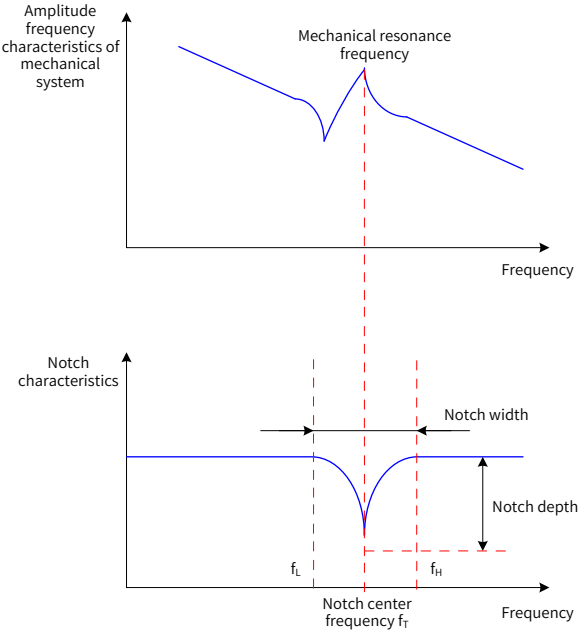


Figure 5-15 Operating principle of the notch

A total of four notches can be used, and each is defined by three parameters: frequency, width level, and depth level. The 1st and 2nd notches are manual ones, and their parameters are set manually by users. The 3rd and 4th notch can be set manually or set as adaptive notches (2009-03h = 1 or 2). When the 3rd and 4th notches are used as adaptive notches, their parameters are set automatically by the servo drive.

Table 5-9 Description of the notch

Item	Manual Notch		Manual/Adaptive Notch	
	1st Notch	2nd Notch	3rd Notch	4th Notch
Frequency	2009-0Dh	2009-10h	2009-13h	2009-16h
Width level	2009-0Eh	2009-11h	2009-14h	2009-17h
Depth level	2009-0Fh	2009-12h	2009-15h	2009-18h

NOTE

- When the "frequency" is the default value (4000 Hz), the notch is invalid.
- The adaptive notch is preferred for resonance suppression. The manual notch can be used in cases where the adaptive notch cannot deliver desired performance.

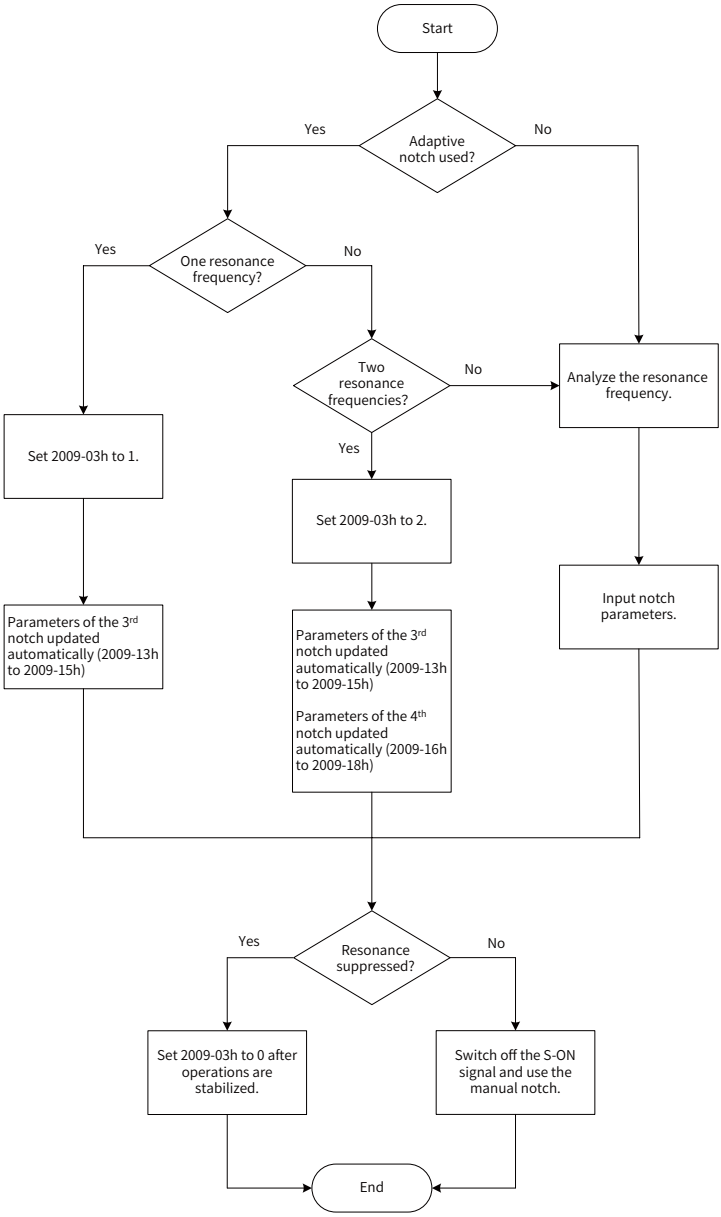


Figure 5-16 Steps for setting the adaptive notch

■ Steps for setting the adaptive notch

1) Set 2009-03h (Adaptive notch mode) to 1 or 2 based on the number of resonance points.

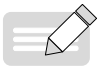
2) When resonance occurs, set 2009-03h to 1 first to enable an adaptive notch. If new resonance occurs after gain tuning, set 2009-03h to 2 to enable both adaptive notches.

3) Parameters of the 3rd or 4th notch are updated automatically during running, and parameter values are automatically stored to the corresponding parameters in group 2009 every 30 minutes.

4) If the resonance is suppressed, it indicates the adaptive notch functions well. After the servo drive remains stable, set 2009-03h to 0, and parameters of the adaptive notch will be fixed at the latest values, preventing notch parameters from being updated to wrong values and causing malfunction of the servo drive and exacerbating the vibration.

5) If the vibration cannot be suppressed, switch off the S-ON signal.

6) If there are more than two resonance frequencies, the problem cannot be solved by using the adaptive notches only, use the manual notch at the same time, or use all the four notches as manual ones (2009-03h = 0).



NOTE

- When the adaptive notch is applied, if the S-OFF signal is activated within 30 min, the notch parameters will not be stored to the corresponding parameters.
- When the resonance frequency is below 300 Hz, the suppression effect of the adaptive notch may be degraded.

■ Steps for using the manual notch

Analyze the resonance frequency.

① When using the manual notch, set the notch frequency to the actual resonance frequency, which is obtained by using the following methods:

Use the "Mechanical characteristics analysis" function in the software tool.

Calculate the resonance frequency based on the motor phase current displayed on the oscilloscope interface of the software tool.

② Set 2009-03h to 3. The servo automatically detects the resonance frequency and stores it in 2009-19h during running.

Input the resonance frequency obtained from step ① into the parameter of the selected notch, and set the width level and depth level of this notch.

If the resonance is suppressed, the notch functions well, and you can continue to adjust the gain. If new resonance occurs, repeat steps ① and ② .

If the vibration cannot be suppressed, switch off the S-ON signal.

■ Width level of the notch

The width level indicates the ratio of the notch width to the center frequency of the notch.

$$\text{Notch width level} = \frac{f_H - f_L}{f_T}$$

In which:

f_T: Center frequency of the notch, which is also the mechanical resonance frequency

f_H-f_L: Notch width, indicating the frequency bandwidth with an amplitude attenuation rate of -3 dB in relative to the notch center frequency

Their relation is shown in the following figure. Use the default value 2.

■ Depth Level of the notch

The notch depth level indicates the ratio of the input to the output at the center frequency.

When the depth level is 0, the input is completely suppressed at the center frequency. When the depth level is 100, the input can be fully received at the center frequency. Therefore, the smaller the depth level is, the larger the notch depth is, and the stronger the suppression effect will be. Note that a too small depth level may lead to system oscillation.

If the amplitude frequency characteristic curve obtained through the mechanical characteristic analysis tool does not have obvious spike but vibration does occur in actual operations, it indicates the gain limit of the servo drive may be reached, which causes the vibration. Such vibration, which may not be mechanical resonance, cannot be suppressed by the notch as it is incurred by the excessive gain. It can be suppressed only by reducing the gain or the filter time of torque reference.

Their relation is shown in the following figure.

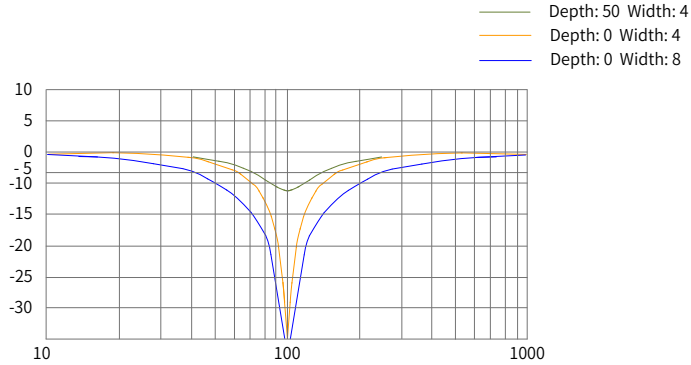


Figure 5-17 Notch frequency characteristics

Related index codes

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2009	03h	Adaptive notch mode	RW	-	Uint16	-	0: Adaptive notch no longer updated 1: One adaptive notch activated (3rd notch) 2: Two adaptive notches activated (3rd and 4th notches) 3: Resonance point tested only (displayed in H09-24) 4: 3rd and 4th notches cleared, with parameters restored to default values	0	During running	Immed-iately

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2009	0Dh	Frequency of the 1st notch	RW	-	Uint16	Hz	50 to 4000	4000	During running	Immed-iately
	0Eh	Width level of the 1st notch	RW	-	Uint16	-	0 to 20	2	During running	Immed-iately
	0Fh	Depth level of the 1st notch	RW	-	Uint16	-	0 to 99	0	During running	Immed-iately
	10h	Frequency of the 2nd notch	RW	-	Uint16	Hz	50 to 4000	4000	During running	Immed-iately
	11h	Width level of the 2nd notch	RW	-	Uint16	-	0 to 20	2	During running	Immed-iately
	12h	Depth level of the 2nd notch	RW	-	Uint16	-	0 to 99	0	During running	Immed-iately
	13h	Frequency of the 3rd notch	RW	-	Uint16	Hz	50 to 4000	4000	During running	Immed-iately
	14h	Width level of the 3rd notch	RW	-	Uint16	-	0 to 20	2	During running	Immed-iately
	15h	Depth level of the 3rd notch	RW	-	Uint16	-	0 to 99	0	During running	Immed-iately

5.6.2 Suppression of Low-frequency Resonance

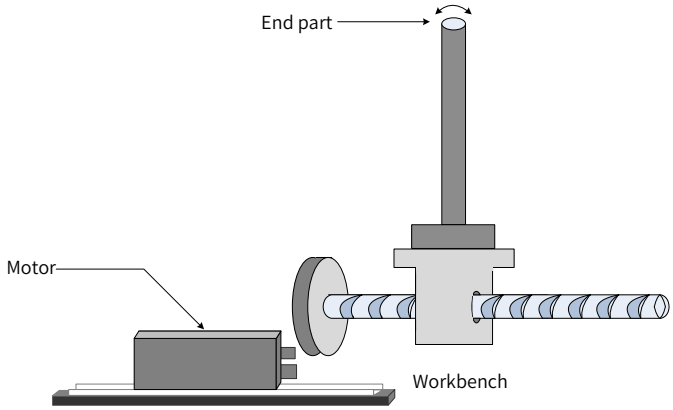


Figure 5-18 Low-frequency resonance

If the mechanical load end is long and heavy, vibration may easily occur on this part upon emergency stop, affecting the positioning effect. Such vibration is called low-frequency resonance as its frequency is generally within 100 Hz, which is smaller than the mechanical resonance frequency. Enable low-frequency resonance suppression to reduce such vibration.

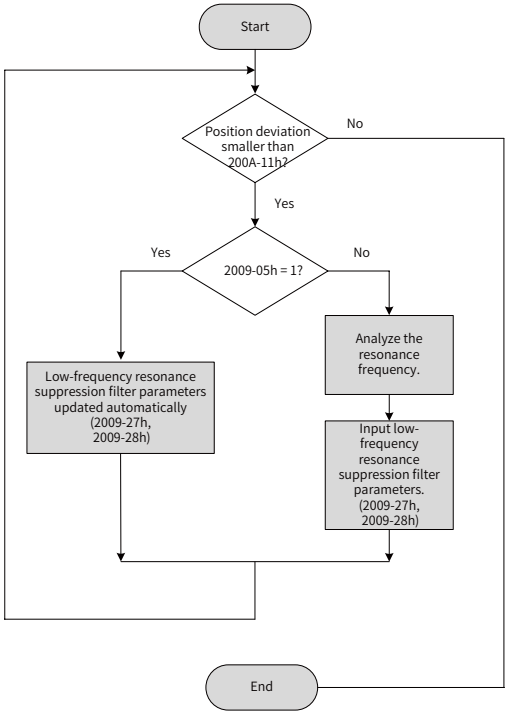


Figure 5-19 Process for setting low-frequency resonance suppression filter

■ Setting 200A-11h (Position deviation threshold in low-frequency resonance)

Low-frequency resonance occurs when the position deviation exceeds the value defined by 200A-11h. Resonance may be easily detected if 200A-11h is set to a small value.

■ Setting 2009-05h (Suppression mode of low-frequency resonance)

The servo drive offers two suppression methods, and automatic suppression is preferred.

When 2009-05h is set to 1, low-frequency resonance suppression filter parameters will be set automatically. The servo drive detects the frequency and amplitude of the low-frequency resonance and sets 2009-27h (Frequency of low-frequency resonance) and 2009-28h (Low-frequency resonance filter setting) automatically.

When 2009-05h is set to 0, low-frequency resonance suppression filter parameters need to be set manually. First, collect the position deviation waveform in the motor positioning state by using the oscilloscope function of the software tool and calculate the position deviation ripple frequency, which is the low-frequency resonance frequency.

Next, manually input the value into 2009-27h, and use the default value of 2009-28h.

Observe whether the position deviation still exceeds 200A-11h after the low-frequency resonance suppression filter is used. If yes, repeat preceding steps. If no, it indicates low-frequency resonance is suppressed.

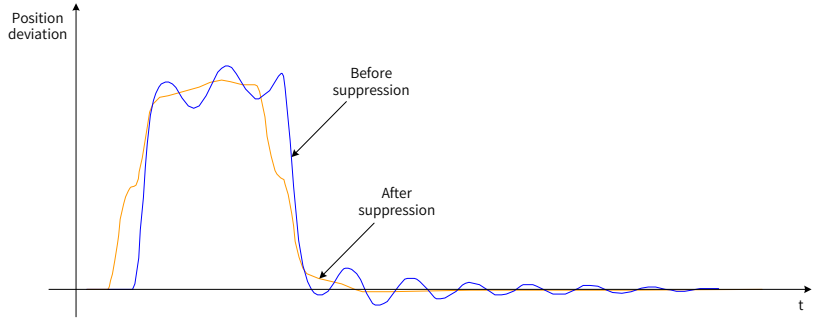


Figure 5-20 Effect of low-frequency resonance suppression

Related index codes

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
2009	05h	Low-frequency resonance suppression mode	RW	-	Uint16	-	0: Set parameters of the low-frequency resonance suppression filter manually. 1: Set parameters of the low-frequency resonance suppression filter automatically.	0	During running	Immed-iately
	27h	Frequency of low-frequency resonance	RW	-	Uint16	Hz	10 to 1000 (unit: 0.1 Hz)	1000	During running	Immed-iately
	28h	Low-frequency resonance frequency filter	RW	-	Uint16	-	0 to 10	2	During running	Immed-iately

Index	Sub-index	Name	Access	Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
200A	11h	Threshold of low-frequency resonance position deviation	RW	-	Uint16	-	1 to 10000	5	During running	Immed-iately

5.7 Mechanical Characteristics Analysis

5.7.1 Overview

The mechanical characteristics analysis is usually performed before the official run to determine the mechanical resonance point and system bandwidth through measuring the frequency response within 0 kHz to 8 kHz.

The servo drive supports mechanical characteristics mode and speed open/closed loop mode and features accurate low-frequency band analysis and small waveform analysis noise. It is intended to be used in combination with InoServoShop_V4.10.0.15 and later version.

5.7.2 Operations

1 Software tool selection

SV520N series servo drives are applicable to InoServoShop_V4.10.0.15 and later versions. See Figure 5-22 for the operation methods.

Mechanical characteristic interface

Figure 5-21 Mechanical characteristic interface

2 Operation process

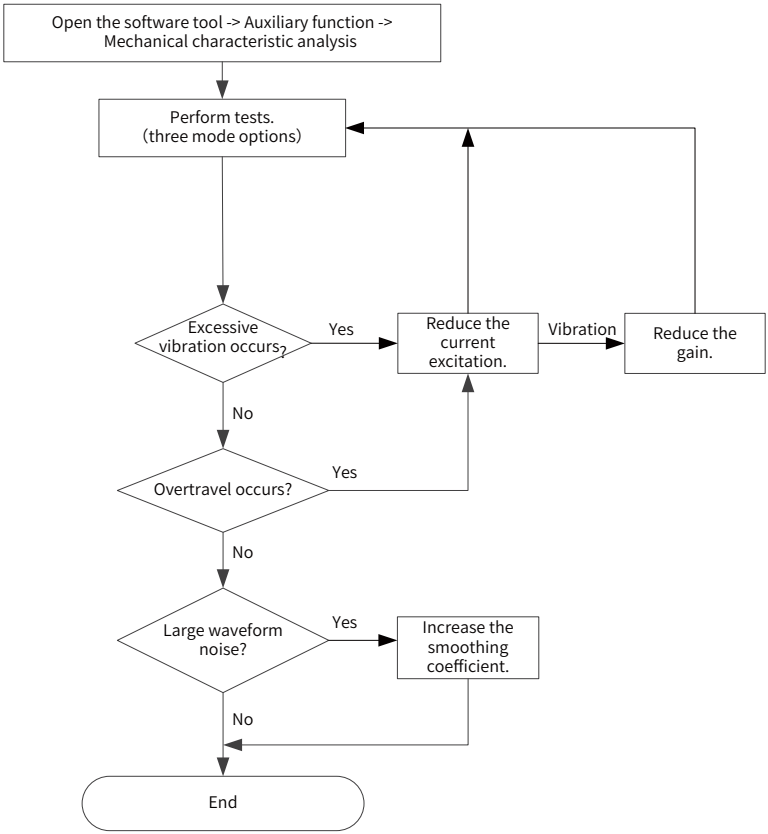


Figure 5-22 Operation process

CAUTION

- To prevent excessive vibration during testing, gradually increase the current excitation from 5% and select " 机械特性 " (Mechanical characteristics) in the " 测试模式 " (Test mode) interface.
- The Bode diagram may be distorted if the current excitation is too small.
- Possible causes and solutions for uncontrollable vibration generated during testing:
  1) Cause: The gain is too high.
     Solution: Reduce the speed gain or set the notch based on the auto-tuned resonance point.
  2) Cause: The inertia is too large.
     Solution: Set a correct inertia.
- The waveform of the resonance point under mechanical characteristic test mode is unaffected after notch settings, but the speed closed loop and speed open loop modes will be attenuated.

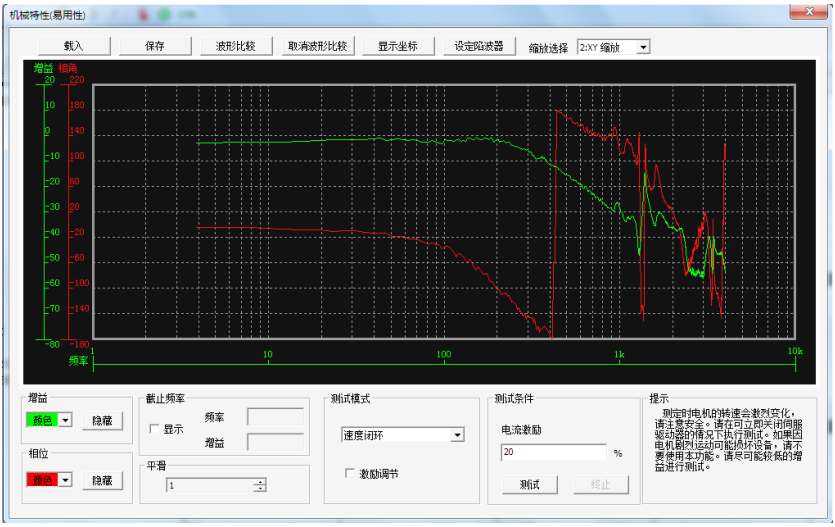


Figure 5-23 Example of the waveform

6 Troubleshooting

6.1 Fault and Warning Codes

■ Fault and warning levels

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

No. 1 non-resettable fault

No. 1 resettable fault

No. 2 resettable fault

No. 3 resettable warning

"Resettable" means the keypad stops displaying the fault/warning once a "Reset signal" is input.

To make the keypad stop displaying the fault/warning, set H0D-01 (Fault reset) to 1 (Enabled) or set the DI terminal allocated with FunIN.2 (ALM-RST) to ON.

To reset a No. 1 or No.2 fault, set S-ON to OFF and then set H0D-01 to 1 or set the DI terminal allocated with FunIN.2 (ALM-RST) to ON.

To reset a No. 3 warning, set H0D-01 to 1 or set the DI terminal allocated with FunIN.2 (ALM-RST) to ON.

☆ Related parameters

Para. No.		Name	Value Range	Description	Remarks
Hexadecimal	Decimal				
200D-02h	H0D-01	Fault reset	0: No operation 1: Fault/Warning reset	Used to make the keypad stop displaying the fault/warning. Such faults/warnings are resettable. Restores to "0: No operation" immediately after fault reset.	See "7 List of Object Groups" for details.

Related function No.

Function No.	Name	Function	Description
FunIN.2	ALM-RST	Fault and warning reset signal	This DI function is edge-triggered. It is invalid when the level is high/low continuously. The servo drive can continue to run after reset of certain warnings. When this function is allocated to a low-speed DI with logic set to level-triggered, the servo drive will forcibly change the DI logic to edge-triggered. The effective level change must last for more than 3 ms. Otherwise, the fault reset is invalid. Do not allocate this function to a high-speed DI. Otherwise, fault/warning reset will be invalid. ◆ Invalid: Fault/Warning not reset ◆ Valid: Fault/Warning reset

■ Fault and warning log

The servo drive offers a fault log to record the latest ten faults/warnings and the status parameter values upon occurrence of the fault/warning. Faults/Warnings that occur repeatedly will be recorded only once.

After fault/warning reset, the servo drive still stores the fault/warning information. To clear the record, set H02-31 (System parameter initialization) to 1 (Restore default values).

You can select the fault/warning record No. in H0B-33, view the corresponding fault/warning code in H0B-34 and the servo drive status parameters in H0B-35 to H0B-42. For details on these parameters, see "Preface". If no fault occurs, the keypad displays "Er.000" in H0B-34.

When viewing H0B-34 from the keypad, the keypad displays "Er.xxx", where "xxx" is the fault/warning code. The data of H0B-34 read through the software tool or communication is a decimal number, which must be converted to a hexadecimal equivalent to indicate the fault or warning code, as shown by the following examples.

"Er.xxx" Displayed on the Keypad	H0B-34 (Decimal)	H0B-34 (Hexadecimal)	Description
Er.101	257	0101	0: No. 1 non-resettable fault 101: Fault code
Er.130	8496	2130	2: No. 1 resettable fault 130: Fault code
Er.121	24865	6121	6: No. 2 resettable fault 121: Fault code

"Er.xxx" Displayed on the Keypad	H0B-34 (Decimal)	H0B-34 (Hexadecimal)	Description
Er.110	57616	E110	E: No. 3 resettable warning 110: Warning code

■ Fault/Warning code output

The servo drive can output the highest-level fault/warning code.

To enable fault/warning output, allocate three DOs with FunOUT.12 (ALMO1, 1st digit of the warning code, AL1), FunOUT.13 (ALMO2, 2nd digit of the warning code, AL2), and FunOUT.14 (ALMO3, 3rd digit of the warning code, AL3), respectively. When different faults/warnings occur, the level of the three DOs changes accordingly.

■ No. 1 non-resettable fault

Display	Fault Name	Fault Type	Resettable or Not	Encoder Output		
				AL3	AL2	AL1
Er.101	Internal parameter error	No. 1	No	1	1	1
Er.102	Programmable logic configuration fault	No. 1	No	1	1	1
Er.104	Programmable logic interrupt	No. 1	No	1	1	1
Er.105	Internal program error	No. 1	No	1	1	1
Er.108	Parameter storage fault	No. 1	No	1	1	1
Er.111	Factory parameter error	No. 1	No	1	1	1
Er.120	Product model mismatch	No. 1	No	1	1	1
Er.201	Overcurrent	No. 1	No	1	1	0
Er.208	FPGA system sampling operation timeout	No. 1	No	1	1	0
Er.210	Output shorted to ground	No. 1	No	1	1	0
Er.220	Phase sequence error	No. 1	No	1	1	0
Er.234	Runaway	No. 1	No	1	1	0
Er.308	Encoder disconnection detection	No. 1	Yes	1	1	0
Er.430	Control power undervoltage	No. 1	No	0	1	1
Er.602	Magnetic pole auto-tuning failure	No.1	No	1	1	1
Er.834	AD sampling overvoltage	No. 1	No	1	1	1
Er.A34	Hall signal error	No. 1	No	0	1	0
Er.E12	EtherCAT initialization failure	No. 1	No	0	1	0

■ No. 1 resettable fault

Display	Fault Name	Fault Type	Resettable or Not	Encoder Output		
				AL3	AL2	AL1
Er.130	Different DIs allocated with the same function	No. 1	Yes	1	1	1
Er.131	Number of DO functions over the limit	No. 1	Yes	1	1	1
Er.207	D-axis/Q-axis current overflow	No. 1	Yes	1	1	0
Er.400	Main circuit overvoltage	No. 1	Yes	0	1	1
Er.410	Main circuit undervoltage	No. 1	Yes	1	1	0
Er.500	Motor overspeed	No. 1	Yes	0	1	0
Er.770	External encoder scale fault	No. 1	Yes	0	1	0

■ No. 2 resettable fault

Display	Fault Name	Fault Type	Resettable or Not	Encoder Output		
				AL3	AL2	AL1
Er.121	Invalid S-ON signal	No. 2	Yes	1	1	1
Er.420	Main circuit phase loss	No. 2	Yes	0	1	1
Er.510	Pulse output overspeed	No. 2	Yes	0	0	0
Er.610	Servo drive overload	No. 2	Yes	0	1	0
Er.620	Motor overload	No. 2	Yes	0	0	0
Er.630	Motor rotor locked	No. 2	Yes	0	0	0
Er.645	Motor PTC protection	No. 2	Yes	0	0	0
Er.650	Heatsink over-temperature	No. 2	Yes	0	0	0
Er.B00	Excessive position deviation	No. 2	Yes	1	0	0
Er.B03	Electronic gear ratio over the limit	No. 2	Yes	1	0	0
Er.D09	Software position upper/lower limit setting error	No. 2	Yes	0	1	1
Er.D10	Home offset setting error	No. 2	Yes	0	1	1
Er.E08	Synchronization loss	No. 2	Yes	0	1	1
Er.E13	Synchronization cycle configuration error	No. 2	Yes	0	1	1
Er.E15	Excessive synchronization cycle error	No. 2	Yes	0	1	1

■ Warning, resettable

Display	Name	Fault Type	Resettable or Not	Encoder Output		
				AL3	AL2	AL1
Er.110	Frequency-division pulse output setting error	No. 3	Yes	1	1	1
Er.601	Homing timeout	No. 3	Yes	0	0	0
Er.900	DI emergency braking	No. 3	Yes	1	1	1
Er.909	Motor overload warning	No. 3	Yes	1	1	0
Er.920	Regenerative resistor overload	No. 3	Yes	1	0	1
Er.922	Resistance of external regenerative resistor too small	No. 3	Yes	1	0	1
Er.939	Motor power cable disconnected	No. 3	Yes	1	0	0
Er.941	Parameter modifications activated at next power-on	No. 3	Yes	0	1	1
Er.942	Frequent parameter storage	No. 3	Yes	0	1	1
Er.950	Forward overtravel warning	No. 3	Yes	0	0	0
Er.952	Reverse overtravel warning	No. 3	Yes	0	0	0
Er.A42	Parameter auto-tuning failure	No. 3	Yes	0	1	0

6.2 Solutions to Faults

■ Er.101: Internal parameter error

Direct cause:

1) The total number of parameters changes, which generally occurs after software update.

2) Parameter values in groups H02 and above exceed the limit, which generally occurs after software update.

Root Cause	Confirming Method	Solution
1) The control power voltage drops instantaneously.	Check whether the voltage drops during control power (L1C, L2C) cutoff or whether instantaneous power failure occurs.	Restore default settings (H02-31 = 1), and write the parameters again.
	Measure whether the input voltage of the control cable on non-drive side complies with the following specifications: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Increase the capacity of the power supply or replace with a power supply of larger capacity, restore default settings (H02-31 = 1), and write the parameters again.
2) Instantaneous power failure occurs during parameter storage.	Check whether instantaneous power failure occurs during parameter storage.	Re-power on the system, restore default settings (H02-31 = 1), and write the parameters again.
3) The number of write operations within a certain period of time exceeds the limit.	Check whether parameters are updated frequently through the host controller.	Change the write mode and write parameters again. If the servo drive is faulty, replace it.
4) The software is updated.	Check whether the software is updated.	Set the servo drive model and servo motor model again, and restore default settings (H02-31 = 1).

Root Cause	Confirming Method	Solution
5) The servo drive is faulty.	If the fault persists after several times of restart and parameter initialization, the servo drive is faulty.	Replace the servo drive.

■ Er.102: Programmable logic configuration fault

Direct cause:

1) The FPGA software version does not match the MCU software version.

2) The FPGA- or MCU-related hardware is damaged, resulting in communication failure between MCU and FPGA.

Root Cause	Confirming Method	Solution
1) The FPGA software version does not match the MCU software version.	View the MCU software version (H01-00) and the FPGA software version (H01-01) through the keypad or the software tool. Check whether the non-zero numbers of the most significant bits of the two software versions are consistent.	Contact Inovance for technical support. Update to the suitable FPGA or MCU software.
2) The FPGA is faulty.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ Er.104: Programmable logic interrupt

To distinguish fault symptoms, the servo drive displays different internal fault codes under the same fault code. You can view these internal fault codes in H0B-45.

Direct cause:

Access to MCU or FPGA times out.

Root Cause	Confirming Method	Solution
1) The FPGA is faulty (Er.0104).	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.
2) The communication between FPGA and MCU is abnormal (Er.1104).		
3) Internal operation timeout (Er.E940) occurs on the servo drive.		

■ Er.105: Internal program error

Direct cause:

1) The total number of parameters is abnormal during EEPROM read/write operations.

2) The parameter value range is abnormal, which generally occurs after software update.

Root Cause	Confirming Method	Solution
1) An EEPROM fault occurs.	Locate the cause according to the descriptions of Er.101.	Restore default settings (H02-31 = 1) and power on the servo drive again.
2) The servo drive is faulty.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ Er.108: Parameter storage fault

Direct cause:

1) Parameter values cannot be written to EEPROM.

2) Parameter values cannot be read from EEPROM.

Root Cause	Confirming Method	Solution
1) The write operation is abnormal.	Modify a parameter, power on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on several times, replace the servo drive.
2) The read operation is abnormal.		

■ Er.111: Factory parameter error

Direct cause:

1) The total number of parameters is abnormal during EEPROM read/write operations.

2) The parameter value range is abnormal, which generally occurs after software update.

Root Cause	Confirming Method	Solution
1) An EEPROM fault occurs.	Locate the cause according to the descriptions of Er.101.	Restore default settings (H02-31 = 1) and power on the servo drive again.
2) The servo drive is faulty.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ Er.120: Product model mismatch

Direct cause:

The motor model does not match the servo drive model or parameter settings are incorrect.

Root Cause	Confirming Method	Solution
1) The product (servo motor or servo drive) SN is unknown.	H0B-45 (Internal fault code) = 3120 Check whether the servo drive SN (H01-02) exists.	If servo drive SN does not exist, set the servo drive SN correctly according to the servo drive nameplate.
2) The rated motor current does not match the rated current of the servo drive.	H0B-45 (Internal fault code) = 4120 The rated current of the servo drive (H01-07) is smaller than that of the servo motor (H00-11).	Check whether the rated motor current (continuous current) input is correct. Replace with a matching servo drive.

■ Er.121: Invalid S-ON signal

Direct cause:

A redundant S-ON signal is sent when some auxiliary functions are used.

Root Cause	Confirming Method	Solution
An external S-ON signal is activated when the servo drive is enabled internally.	Check whether auxiliary functions (H0D-02, H0D-03, H0D-12) are used and whether DI function 1 (FunIN.1: S-ON) is activated.	Set DI function 1 (both hardware DI and virtual DI) to OFF.

■ Er.130: Different DIs allocated with the same function

Cause	Confirming Method	Solution
1) The same function is allocated to different DIs.	Check whether parameters in groups H03 (H03-02/H03-04 to H03-20) and H17 (H17-00/H17-02 to H17-30) are allocated with the same non-zero DI function No..	Allocate different DI functions to the parameters allocated with the same DI function in groups H03 and H17, and switch on the control circuit again or turn off the S-ON signal and send a "RESET" signal to activate such allocations.

2) The DI function No. exceeds the number of DI functions.	Check whether the MCU program is updated.	Restore default settings (H02-31 = 1) and power on the servo drive again.

■ Er.131: Number of DO functions over the limit

Cause	Confirming Method	Solution
The DO function No. exceeds the number of DO functions.	Check whether the MCU program is updated.	Restore default settings (H02-31 = 1) and power on the servo drive again.

■ Er.201: Overcurrent

Direct cause:

Hardware overcurrent is detected.

Root Cause	Confirming Method	Solution
1) The resistance of the regenerative resistor is too small or the resistor is short circuited.	◆ If an internal regenerative resistor is used (H02-25 = 0), check whether $P_{\oplus}$ and D are jumpered properly. If yes, measure the resistance between C and D. ◆ If an external regenerative resistor is used (H02-25 = 1 or 2), measure the resistance between $P_{\oplus}$ and C. ◆ For specifications of the regenerative resistor, see "1.4 Specifications of the Regenerative Resistor".	◆ If an internal regenerative resistor is used and the resistance is 0, use an external regenerative resistor (H02-25 = 1 or 2) and remove the jumper between $P_{\oplus}$ and D. Select an external regenerative resistor of the same resistance and power as the internal one. ◆ If the resistance of the external regenerative resistor used is smaller than H02-21 (Permissible minimum resistance of regenerative resistor), replace with a new regenerative resistor and connect it between $P_{\oplus}$ and C. See details in "1 Product Information". Set H02-26 (Power of external regenerative resistor) and H02-27 (Resistance of external regenerative resistor) to values consistent with the external regenerative resistor specifications.

Root Cause	Confirming Method	Solution
2) The motor cables are in poor contact.	Check whether servo drive power cables and motor cables on U, V, and W sides of the servo drive are loosened.	Tighten the cables that are loosened or disconnected.
3) The motor cables are grounded.	After ensuring the servo drive power cables and motor cables are connected securely, measure whether the insulation resistance between the servo drive UVW sides and the grounding cable (PE) is at MΩ-level.	Replace the motor in the case of poor insulation.
4. The motor UVW cables are short circuited.	Disconnect the motor cables and check whether short circuit occurs among U, V, and W phases and whether burrs exist on the cable connections.	Connect the motor cables properly.
5) The motor is burnt down.	Disconnect the motor cables and measure whether the resistance among U, V, and W phases of the motor cable is abnormal.	If the resistance is abnormal, replace the servo motor.
6) The gain is set improperly and motor oscillation occurs.	Check whether motor oscillates or generates a sharp noise during motor startup and running, or view the current feedback through the software tool.	Adjust the gain.
7) The encoder cable is wired improperly, corroded or connected loosely.	Check whether the encoder cable provided by Inovance is used and whether the cable is aging or corroded, or the connector is loose. Set the S-ON signal to OFF and rotate the motor shaft manually. Check whether H0B-10 (Electrical angle) changes as the motor rotates.	Solder or tighten the encoder cable again or replace the encoder cable.
8) The servo drive is faulty.	The fault persists although motor cables are disconnected and the servo drive is power off and on again.	Replace the servo drive.

■ Er.207: D-axis/Q-axis current overflow

Cause	Confirming Method	Solution
1) Abnormal current feedback results in internal register overflow.	If the fault persists after the servo drive is powered off and on several times, the servo drive is faulty.	Replace the servo drive.
2) Abnormal encoder feedback results in internal register overflow.		

■ Er.208: FPGA sampling operation timeout

Locate the cause through H0B-45 (Internal fault code) when Er.208 occurs.

Cause	Confirming Method	Solution
1) MCU communication times out.	H0B-45 (Internal fault code) = 1208 The internal chip is damaged.	Replace the servo drive.
2) Current sampling times out.	H0B-45 (Internal fault code) = 3208 Check whether a certain device is generating interferences on site and whether there are multiple interference sources in the cabinet. The internal current sampling chip is damaged.	Do not bundle or route high-voltage cables and low-voltage cables together. Replace the servo drive.
3) High-accuracy AD conversion times out.	H0B-45 (Internal fault code) = 4208 Interference exists in high-accuracy AI channels. Check the AI wiring according to the correct wiring diagram.	Use shielded twisted pair cables and shorten the cable length.
4) FPGA operation times out.	H0B-45 (Internal fault code) = 0208 Locate the fault cause according to preceding steps.	Handle the fault according to preceding solutions.

■ Er.210: Output shorted to ground

Direct cause:

The servo drive detects abnormal motor phase current or bus voltage during self-check upon power-on.

Root Cause	Confirming Method	Solution
1) The servo drive power cables (UVW) are shorted to ground.	Disconnect the motor cables, and measure whether the servo drive power cables (UVW) are shorted to ground (PE).	Re-connect or replace the servo drive power cables.
2) The motor is shorted to ground.	After ensuring the servo drive power cables and motor cables are connected securely, measure whether the insulation resistance between the servo drive UVW sides and the grounding cable (PE) is at MΩ-level.	Replace the motor.
3) The servo drive is faulty.	Remove the power cables from the servo drive, but the fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ Er.220: Wrong UVW phase sequence

Direct cause:

A wrong phase sequence of power cables is detected during phase sequence auto-tuning.

Root Cause	Confirming Method	Solution
1) Power cables are connected in the wrong UVW phase sequence.	Exchange the phase sequence of any two power cables and perform phase sequence auto-tuning again until the auto-tuning is succeeded.	Change any two phase sequences and perform phase sequence auto-tuning again.
2) The phase sequence auto-tuning suffers from interference.	Eliminate external factors that limit the rotor motion to ensure the motor motion range is at least one pole pitch.	After eliminating external factors, perform phase sequence auto-tuning again.
3) The phase sequence auto-tuning mode does not match the present application conditions.	Switch the initial angle auto-tuning mode (H0A-13 = 0 or 1).	Switch the auto-tuning mode and perform auto-tuning again.

■ Er.234: Runaway

Direct cause:

1) The torque reference direction is opposite to the speed feedback direction in the torque control mode.

2) The speed feedback direction is opposite to the speed reference direction in the position or speed control mode.

Root Cause	Confirming Method	Solution
1) The UVW phase sequence is incorrect.	Check whether the servo drive power cables are connected in the correct sequence on both sides.	Ensure phase sequence auto-tuning is enabled (H0A-07 = 1) and perform auto-tuning again (H0D-03 = 1). After auto-tuning is done, disable phase sequence auto-tuning (H0A-07 = 0).
2) The set running speed exceeds the maximum speed supported by the encoder reading head.	The maximum speed of some motors may be larger than the maximum speed supported by the reading head. See the related motor manual for the maximum matching speed supported by the reading head.	Replace with a motor and a reading head with higher speed or reduce the running speed.
3) Interference signals cause an error in the initial phase detection of the motor rotor upon power-on.	The UVW phase sequence is correct, but Er.234 occurs when the servo drive is enabled.	Power on the servo drive again.
4) The encoder model is wrong or the cable connection is incorrect.	Ensure the motor SN (H00-00) is set based on the nameplates of the servo drive and the servo motor.	Replace with a matching servo drive and servo motor. Check the motor SN (H00-00) and encoder cable connections again.
5) The gravity load is too heavy in vertical axis applications.	Check whether the load of the vertical axis is too large. Adjust brake parameters H02-09 to H02-12 to see whether the fault can be removed.	Reduce the load of the vertical axis, increase the stiffness level or hide this fault without affecting the safety performance or normal use.

■ Er.308: Encoder disconnection

Direct cause:

The differential signal level of encoder cable phase A/B is abnormal.

Root Cause	Confirming Method	Solution
1) The encoder A/B phase is disconnected.	Check whether the encoder feedback is normal.	Check whether the encoder cables are soldered properly and whether A+, A-. B+, and B- are disconnected.
2) The reading head is damaged.	Check whether the reading head indicator lights up normally and whether the reading head feedback is normal.	Replace the reading head.

■ Er.400: Main circuit overvoltage

Direct cause:

The DC bus voltage between $P_{\oplus}$ and Θ exceeds the overvoltage threshold.

220 V servo drive:
Normal value: 310 V
Overvoltage threshold: 420 V

380 V servo drive:
Normal value: 540 V
Overvoltage threshold: 760 V

Root Cause	Confirming Method	Solution
1) The voltage input to the main circuit is too high.	Measure whether the input voltage on the servo drive main circuit side (RST) complies with the following specifications: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Replace or adjust the power supply according to the specifications.

Root Cause	Confirming Method	Solution
2) The power supply is unstable or affected by lightning.	Check whether the power supply is unstable, affected by lightning or satisfies the preceding specifications.	Connect a surge protection device and then switch on the main circuit and control circuit again. If the fault persists, replace the servo drive.
3) The regenerative resistor fails.	◆ If an internal regenerative resistor is used (H02-25 = 0), check whether $P_{\oplus}$ and D are jumpered properly. If yes, measure the resistance between C and D. ◆ If an external regenerative resistor is used (H02-25 = 1 or 2), measure the resistance between $P_{\oplus}$ and C. ◆ For specifications of the regenerative resistor, see "1.4 Specifications of the Regenerative Resistor".	◆ If the resistance is " ∞ " (infinite), the regenerative resistor is disconnected internally. ◆ If an internal regenerative resistor is used, turn to use an external regenerative resistor (H02-25 = 1 or 2) and remove the jumper between $P_{\oplus}$ and D. The external regenerative resistor must be of the same resistance and power as the internal one. ◆ If an external regenerative resistor is used, replace it with a new external regenerative resistor and connect it between $P_{\oplus}$ and C. ◆ Set H02-26 (Power of external regenerative resistor) and H02-27 (Resistance of external regenerative resistor) according to specifications of the external regenerative resistor.
4) The resistance of the regenerative resistor is too large, and energy absorption during braking is insufficient.	Measure the resistance of the external regenerative resistor between $P_{\oplus}$ and C, and compare the measured value with the recommended value.	Connect a new external regenerative resistor of recommended resistance between $P_{\oplus}$ and C. Set H02-26 (Power of external regenerative resistor) and H02-27 (Resistance of external regenerative resistor) to values consistent with the external regenerative resistor specifications.

Root Cause	Confirming Method	Solution
5) The maximum braking energy exceeds the energy absorption value during abrupt motor acceleration/ deceleration.	Confirm the acceleration/ deceleration time during running and measure whether the DC bus voltage between $P_{\oplus}$ and Θ exceeds the overvoltage threshold during deceleration.	Ensure the input voltage of the main circuit is within the specification and increase the acceleration/deceleration time properly.
6) The bus voltage sampling value deviates greatly from the actual measured value.	Check whether the bus voltage (H0B-26) is within the following range: 220 V servo drive: H0B-26 > 420 V 380 V servo drive: H0B-26 > 760 V Measure whether the DC bus voltage between $P_{\oplus}$ and Θ is smaller than H0B-26.	Contact Inovance for technical support.
7) The servo drive is faulty.	The fault persists after the main circuit is powered off and on several times.	Replace the servo drive.

■ Er.410: Main circuit undervoltage

Direct cause:

The DC bus voltage between $P_{\oplus}$ and Θ is lower than the undervoltage threshold.

220 V servo drive:
Normal value: 310 V
Undervoltage threshold value: 200 V

380 V servo drive:
Normal value: 540 V
Undervoltage threshold: 380 V

Root Cause	Confirming Method	Solution
1) The main circuit power supply is unstable or power failure occurs. 2) Instantaneous power failure occurs.	Measure whether the input voltage of the main circuit cables on the non-drive side and the drive side (RST) complies with the following specifications: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V) The voltages of all the three phases need to be measured.	Increase the capacity of the power supply. See "1 Product Information" for details.
3) The power supply voltage drops during running.	Monitor the input voltage and check whether the main circuit power supply is applied to other devices, resulting in insufficient power capacity and voltage dip.	Increase the capacity of the power supply. See "1 Product Information" for details.
4) Phase loss occurs because a single-phase power supply is used for a three-phase servo drive.	Check whether the main circuit wiring is correct and whether power input phase loss protection (H0A-00) is hidden.	Replace the cables and connect the main circuit cables properly. Three-phase: R, S, T Single-phase: L1, L2
5) The servo drive is faulty.	Check whether the bus voltage (H0B-26) is within the following range: 220 V servo drive: H0B-26 < 200 V 380 V servo drive: H0B-26 < 380 V The fault persists after the main circuit (RST) is powered off and on several times.	Replace the servo drive.

■ Er.420: Main circuit phase loss

Direct cause:

Phase loss occurs on a three-phase servo drive.

Root Cause	Confirming Method	Solution
1) The three-phase input cables are connected improperly.	Check whether RST cables on the drive side and non-drive side are in good condition and connected properly.	Replace the cables and connect the main circuit cables properly.

Root Cause	Confirming Method	Solution
2) A single-phase power supply is used for a three-phase servo drive.	Check the power input specification of the servo drive and the actual input voltage. Measure the main circuit input voltage to check whether it complies with the following specifications: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V) The voltages of all the three phases need to be measured.	Servo drives of 0.75 kW (H01-02 = 5) can be supplied by a single-phase power supply. If the input voltage satisfies the specifications, set H0A-00 (Power input phase loss protection) to 2 (Inhibit phase loss faults and warnings). If the input voltage does not comply with the specifications, replace or adjust the power supply.
3) The three-phase power supply is imbalanced or the voltages of all the three phases are too low.		
4) The servo drive is faulty.	The fault persists after the main circuit is powered off and on several times.	Replace the servo drive.

■ Er.430: Control circuit undervoltage

220 V servo drive:
Normal value: 310 V
Undervoltage threshold: 190 V

380 V servo drive:
Normal value: 540 V
Undervoltage threshold: 350 V

Cause	Confirming Method	Solution
1) The control power supply is unstable or fails.	Check whether the voltage drops during control power supply (L1C, L2C) cutoff or whether instantaneous power failure occurs.	Power on the servo drive again. If the fault is caused by abnormal power failure, stabilize the power supply.
	Check whether the input voltage of control cables complies with the following specification: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Increase the capacity of the power supply.

Cause	Confirming Method	Solution
2) The control circuit cables are in poor contact.	Check whether control circuit cables are well connected and whether voltages of control circuit cables (L1C, L2C) satisfy preceding specifications.	Re-connect or replace the control circuit cables.

■ Er.500: Motor overspeed

Direct cause:

The actual speed of the servo motor exceeds the overspeed threshold.

Root Cause	Confirming Method	Solution
1) The motor pole pitch or resolution is set improperly.	Check the set pole pitch (H00-48). ◆ Check the resolution (H00-49) if a pulse-type encoder is used. ◆ Check the encoder PPR (H00-27) if an analog encoder is used.	Set the corresponding parameters properly.
2) The UVW phase sequence of the motor cables is incorrect.	Check whether the servo drive power cables are connected in the correct sequence on both sides.	Connect the UVW cables according to the correct phase sequence.
3) H0A-08 (Overspeed threshold) is set improperly.	Check whether the overspeed threshold is smaller than the maximum motor speed needed in actual applications. ◆ Overspeed threshold = 1.2 times the maximum motor speed (H0A-08 = 0) ◆ Overspeed threshold = H0A-08 (H0A-08 ≠ 0, and H0A-08 < 1.2 times the maximum motor speed)	Re-set the overspeed threshold according to mechanical requirements.

Root Cause	Confirming Method	Solution
4) The input reference exceeds the overspeed threshold.	Check whether the motor speed corresponding to the input reference exceeds the overspeed threshold. When the reference source is pulse reference in the position control mode: Motor speed (mm/s) = Input pulse frequency (Hz) x Electronic gear ratio x Optical/Magnetic scale resolution (mm)	◆ Position control mode: When the position reference source is pulse reference, reduce the pulse frequency properly without affecting the final positioning accuracy or decrease the electronic gear ratio if allowed. ◆ Speed control mode: Ensure the speed reference and speed limit (H06-06 to H06-09) are within the overspeed threshold. ◆ Torque control mode: Set the speed threshold to a value within the overspeed threshold.
5) The motor speed overshoots.	Check whether the speed feedback exceeds the overspeed threshold through the software tool.	Adjust the gain or mechanical running conditions.
6) The servo drive is faulty.	The fault persists after the servo drive is powered on again.	Replace the servo drive.

■ Er.510: Pulse output overspeed

Cause	Confirming Method	Solution
The output pulse frequency exceeds the upper frequency limit allowed by the hardware (4 MHz).	When H05-38 (Servo pulse output source) is set to 0 (Encoder frequency-division output), calculate the output pulse frequency corresponding to the motor speed upon occurrence of the fault and check whether the pulse frequency exceeds the limit. Output pulse frequency (Hz) = Motor speed (mm/s)/Encoder resolution (mm)	Decrease H05-17 (Encoder frequency-division pulses) to make the output pulse frequency be lower than the upper frequency limit allowed by the hardware within the speed range required by the machine.
	When H05-38 (Servo pulse output source) is set to 1 (Reference pulse synchronous output), the input pulse frequency exceeds 4 MHz or interference exists on pulse input pins. Low-speed pulse input pin: ◆ Differential input terminals: PULSE+, PULSE-, SIGN+, SIGN- (maximum pulse frequency: 500 kpps) ◆ Open-collector input terminals: PULLHI, PULSE+, PULSE-, SIGN+, SIGN- (maximum pulse frequency: 200 kpps) ◆ High-speed pulse input pin ◆ Differential input terminals: HPULSE+, HPULSE-, HSIGN+, HSIGN- (maximum pulse frequency: 4 Mpps)	Decrease the input pulse frequency to a value within the upper frequency limit allowed by the hardware. In this case, if you do not modify the electronic gear ratio, the motor speed will be decreased. If the input pulse frequency is very high but is still within the upper frequency limit allowed by the hardware, take anti-interference measures (use shielded twisted pair cables for pulse input and set pin filter parameters H0A-24 or H0A-30) to prevent interference pulses from being added to actual pulses, leading to a false fault report.

■ Er.610: Servo drive overload

Cause:

The servo drive temperature reaches the fault threshold.

■ Er.620: Motor overload

Direct cause:

The motor temperature reaches the fault threshold.

Root Cause	Confirming Method	Solution
1) The motor and encoder cables are connected improperly or in poor contact.	Check the cable connections among the servo drive, servo motor and encoder according to the correct wiring diagram.	Connect cables based on the correct wiring diagram. It is recommended to use the cables provided by Inovance. When customized cables are used, prepare and connect the cables according to the hardware wiring instructions.
2) The load is too heavy, and the effective torque output by the motor keeps exceeding the rated torque.	Confirm the overload characteristics of the servo drive or motor. Check whether the average load ratio (H0B-12) keeps exceeding 100.0%.	Replace with a servo drive of larger capacity and a matching servo motor, or reduce the load and increase the acceleration/ deceleration time.
3) The acceleration/ deceleration is too frequent or the load inertia is too large.	Calculate the mechanical inertia ratio or perform inertia auto-tuning, and view the inertia ratio (H08-15). Confirm the single running cycle when the servo motor runs cyclically.	Increase the acceleration/ deceleration time during single-cycle running.
4) The gain tuning is improper or the stiffness level is too high.	Check whether the motor vibrates and generates abnormal noise during running.	Adjust the gain again.
5) The model of the servo drive or servo motor is set incorrectly.	For SV520N series servo drives, view the motor model in H00-05 and the servo drive model in H01-02.	View the servo drive nameplate and set the servo drive model in H01-02 and update the motor model to the matching model No..

Root Cause	Confirming Method	Solution
6) Locked-rotor occurs due to mechanical factors, resulting in overload during running.	Check the RUN command and motor speed (H0B-00) through the software tool or the keypad. ◆ RUN command in the position control mode: H0B-13 (Input position reference counter) ◆ RUN command in the speed control mode: H0B-01 (Speed reference) ◆ RUN command in the torque control mode: H0B-02 (Internal torque reference) Check whether the RUN command is not 0 but the motor speed is 0 in the corresponding mode.	Eliminate mechanical factors.
7) The servo drive is faulty.	The fault persists after the servo drive is powered off and on again.	Replace the servo drive.

■ Er.630: Motor rotor locked

Direct cause:

The actual motor speed is lower than 10 mm/s, but the torque reference keeps at the threshold value in the time defined by H0A-32.

Root Cause	Confirming Method	Solution
1) UVW output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a motor trial run without load and check cable connections.	Connect the cables again according to the correct wiring diagram or replace the cables.
2) The servo drive UVW cables or the encoder cables are disconnected.	Check the cable connections.	Connect the cables again according to the correct wiring diagram or replace the cables.

Root Cause	Confirming Method	Solution
3) The rotor is locked due to mechanical factors.	Check the RUN command and motor speed (H0B-00) through the software tool or the keypad. ◆ RUN command in the position control mode: H0B-13 (Input position reference counter) ◆ RUN command in the speed control mode: H0B-01 (Speed reference) ◆ RUN command in the torque control mode: H0B-02 (Internal torque reference) Check whether the RUN command is not 0 but the motor speed is 0 in the corresponding mode.	Eliminate mechanical factors.
4) The motor pole pitch or optical scale resolution (Encoder PPR) is set improperly.	Check whether H00-48 and H00-49 (H00-27) are set according to actual conditions.	Set the motor pole pitch and optical scale resolution (Encoder PPR) properly.

■ Er.645: PTC over-temperature warning

Direct cause:

The PTC warning occurs.

Root Cause	Confirming Method	Solution
1) The PTC is damaged.	Measure whether the PTC resistance and the motor temperature are normal.	Replace the PTC.
2) The motor temperature is too high.	Measure the motor temperature.	Check the causes for motor over-temperature after the motor is cooled down.

■ Er.650: Heatsink over-temperature

Direct cause:

The temperature of the power module is higher than the over-temperature protection threshold.

Root Cause	Confirming Method	Solution
1) The ambient temperature is too high.	Measure the ambient temperature.	Improve the cooling conditions of the servo drive to lower the ambient temperature.
2) The servo drive is switched off and on several times to reset the overload fault.	View the fault records (set H0B-33 and view H0B-34) and check whether overload fault (Er.610, Er.620, Er.630, Er.650, Er.909, Er.920, Er.922) occurs.	Change the fault reset method. After overload occurs, wait for 30s before reset. Increase the capacity of the servo drive and servo motor, increase the acceleration/deceleration time and reduce the load.
3) The fan is damaged.	Observe whether the fan works during running.	Replace the servo drive.
4) The installation direction and the clearance reserved for the servo drive is improper.	Check whether the servo drive is installed properly.	Install the servo drive according to the installation requirements.
5) The servo drive is faulty.	The fault persists even though the servo drive is restarted 5 minutes after power-off.	Replace the servo drive.

■ Er.770: External encoder scale fault

Cause	Confirming Method	Solution
When the fully closed-loop function or customized pulse input function is used, the level difference between any two signals (A+/A-, B+/B-...Z+/Z-) does not meet the requirement. The level difference is equal to or larger than 2 V.	Measure the level difference between A+/A-, B+/B-...Z+/Z-.	Adjust the level until the specifications are fulfilled. Note: When using an external encoder without Z signal, pull up Z+ to above 2 V and ground Z-.

■ Er.834: AD sampling overvoltage

Direct cause:

The AI sampling value is larger than 11.5 V.

Root Cause	Confirming Method	Solution
1) The AI voltage is too high.	Measure the voltage input from AI and check whether AI sampling voltage (H0B-21 or H0B-22) is greater than 11.5 V.	Adjust the AI input voltage until the AI sampling voltage falls below 11.5 V.
2) The AI wiring is incorrect or interference exists.	Check the AI wiring according to the correct wiring diagram.	Use shielded twisted pair cables and shorten the cable length. Increase the AI filter time constant: ◆ AI1 input filter time constant: H03-51 ◆ AI2 input filter time constant: H03-56

■ Er.A33: Encoder data error

Direct cause:

Internal parameters of the encoder are abnormal.

Root Cause	Confirming Method	Solution
1) The serial incremental encoder cable is disconnected or loosened.	Check the cable connections.	Check whether the encoder cables are connected improperly, disconnected, or in poor contact. If the motor cables and encoder cables are bundled together, route them through different routes.
2) An error occurs when reading/writing serial incremental encoder parameters.	If the fault persists after the servo drive is powered off and on several times, the encoder is faulty.	Replace the servo motor.

■ Er.A34: Hall signal error

Direct cause:

The Hall device outputs high/low level continuously.

Root Cause	Confirming Method	Solution
1) The serial incremental encoder cable is disconnected or loosened.	Check the cable connections.	Check whether the encoder cables are connected improperly, disconnected, or in poor contact. If the motor cables and encoder cables are bundled together, route them through different routes.
2) The Hall device is faulty.	If the fault persists after the servo drive is powered off and on several times, the Hall device is faulty.	Replace the Hall device.

■ Er.B00: Excessive position deviation

Direct cause:

The position deviation is larger than the value of 6065h in the position control mode.

Root Cause	Confirming Method	Solution
1) UVW output phase loss or incorrect phase sequence occurs on the servo drive.	Perform a motor trial run without load and check cable connections.	Connect the cables again according to the correct wiring diagram or replace the cables.
2) The servo drive UVW cables or the encoder cables are disconnected.	Check the cable connections.	Connect the cables again. The servo motor power cables must be connected to the servo drive UVW cables correspondingly. Replace with new cables if necessary and ensure all the cables are connected properly.

Root Cause	Confirming Method	Solution
3) The rotor is locked due to mechanical factors.	Check the RUN command and the motor speed (200B-01h) through the software tool or the keypad: ◆ RUN command in the position control mode: 200B-0Eh (Input position reference counter) ◆ RUN command in the speed control mode: 200B-02h (Speed reference) ◆ RUN command in the torque control mode: 200B-03h (Internal torque reference) Check whether the RUN command is not 0 but the motor speed is 0 in the corresponding mode.	Eliminate mechanical factors.
4) The servo drive gain is too low.	Check the position loop gain and speed loop gain of the servo drive. 1st group of gain parameters: 2008-01h to 2008-03h 2nd group of gain parameters: 2008-04h to 2008-06h	Adjust the gain manually or perform gain auto-tuning.

Root Cause	Confirming Method	Solution
5) The position reference increment is too large.	Position control mode: ◆ In CSP mode, view the gear ratio (6091-01h/6091-02h) to check the position reference increment for a single synchronization cycle and convert it to the corresponding speed value. ◆ In PP mode, view the gear ratio (6091-01h/6091-02h) and define the value of 6081h (Profile velocity). ◆ In HM mode, view the gear ratio (6091-01h/6091-02h) and define the value of 6099-01h and 6099-02h.	◆ CSP: Decrease the position reference increment for a single synchronization cycle. The host controller should cover the position ramp when generating references. ◆ PP: Decrease the value of 6081h or increase the acceleration/deceleration ramp (6083h, 6084h). ◆ HM: Decrease the value of 6099-01h and 6099-02h or increase the acceleration/deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions.
6) The value of 6065h (Following error window) is too small in relative to the running condition.	Check whether the set value of 6065h is too small.	Increase the value of 6065h.
7) The servo drive/motor is faulty.	Monitor the running waveform through the oscilloscope function in the software tool: position reference, position feedback, speed reference, torque reference	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or motor.

■ Er.B03: Electronic gear ratio over the limit

Direct cause:

The electronic gear ratio exceeds the limit value (0.001 x (Encoder pulses per motor displacement of 1 mm)/10000, 4000 x (Encoder pulses per motor displacement of 1 mm)/10000).

Encoder pulses per motor displacement of 1 mm = 100000/(Min. linear motor resolution (2000-50h)

Root Cause	Confirming Method	Solution
The set electronic gear ratio exceeds the preceding limit.	Check whether the ratio of 6091-01h to 6091-02h exceeds the preceding limit.	Set the gear ratio according to the preceding limit.

■ Er.D09: Software upper/lower limit setting error

Direct cause:

The lower limit of the software position is larger than the upper limit.

Root Cause	Confirming Method	Solution
The upper limit and lower limit of the software position are set improperly.	Check the settings of 0x607D-01h and 0x607D-02h.	Set 0x607D properly to ensure the value of 607D-1h is smaller than that of 607D-2h.

■ Er.D10: Home offset setting error

Direct cause:

The lower limit of the software position is larger than the upper limit.

Root Cause	Confirming Method	Solution
The home offset is outside the software position upper/lower limit.	Check the settings of 0x607D-01h, 0x607D-02h, and 0x607Ch.	Set 0x607D to a value that complies with the following formula: 0x607D-01h ⩽ 0x607Ch ⩽ 0x607D-02h

■ Er.E08: Synchronization loss

Cause	Confirming Method	Solution
The master synchronization signal is lost during synchronous communication.	Check whether the shielded twisted pair cable is used as the communication cable. Check whether the servo drive is well grounded.	◆ Use the shielded twisted pair cables and connect cables according to the wiring instructions. ◆ Set the synchronization cycle and switch the EtherCAT state machine to the running state. ◆ If there is a large error in the master synchronization cycle, increase the allowable number of EtherCAT synchronization interruptions (200C-24h) of the master or slave.

■ Er.E12: Network initialization failure

Direct cause:

Network initialization fails.

Root Cause	Confirming Method	Solution
1) The FPGA software is not programmed.	Check whether 2001-02h is 01XX.Y.	Program the FPGA software.
2) The device configuration file is not programmed.	After connecting the servo drive to the master, view whether the first left LED on the keypad displays the state of the corresponding network port, and the second LED displays a number among 1, 2, 4, 8.	Program the device configuration file.
3) The servo drive is faulty.	Check whether the servo drive is faulty.	If yes, replace the servo drive.

■ Er.E13: Synchronization cycle configuration error

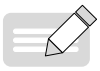
Cause	Confirming Method	Solution
The synchronization cycle is not an integral multiple of 125 μs or 250 μs.	Check the setting of the synchronization cycle in the controller.	Set the value of the synchronization cycle to an integral multiple of 125 μs or 250 μs.

■ Er.E15: Synchronization cycle error too large

Direct cause:

The synchronization cycle error exceeds the threshold.

Root Cause	Confirming Method	Solution
A large synchronization cycle error occurs on the controller.	Measure the synchronization cycle of the controller through the digital oscilloscope or the oscilloscope function in the software tool.	Increase the value of 200C-2Dh and keep testing. If this fault persists, set 200C-2Ch to 2.



NOTE

When any of the following faults occurs, contact Inovance for technical support.

- Er.602: Angle auto-tuning failure
- Er.A40: Motor auto-tuning failure

6.3 Solutions to Warnings

■ Er.110: Frequency-division pulse output setting error

Direct cause:

When using the frequency-division output function of the encoder (H05-38 = 0), the set frequency-division encoder pulses does not match the threshold defined by encoder specifications.

Root Cause	Confirming Method	Solution
The number of frequency-division pulses of the encoder does not conform to the specifications.	Pulse-type encoder: The number of frequency-division pulses cannot exceed the encoder resolution.	Reset the number of encoder frequency-division pulses (H05-17) according to the specifications.

■ Er.601: Homing timeout

Direct cause:

The home is not found within the time defined by H05-35 (Duration limit of homing) during homing.

Root Cause	Confirming Method	Solution
1) The home switch is faulty.	◆ There is only high-speed searching but no low-speed searching during homing. ◆ After high-speed searching, the servo drive keeps low-speed searching in the reverse direction.	If a hardware DI is used, check whether DI function 31 (FunIN.31, homeSwitch) is allocated to a certain DI in group H03 and then check the wiring of the DI. Manually change the DI logic and observe whether the servo drive receives the DI level change through H0B-03. If not, the wiring of the DI is incorrect. If yes, an error occurs during homing. Set the homing function correctly. If a virtual DI is used, check whether the VDI is used correctly.
2) The homing duration is too short.	Check whether the value of H05-35 (Duration limit of homing) is too small.	Increase the value of H05-35.

Root Cause	Confirming Method	Solution
3) The speed in high-speed searching for the home switch is too low.	Check the distance between the initial homing position and the home switch. Then check whether the value of H05-32 is too small, resulting in a prolonged homing process.	Increase the value of H05-32.
4) Both the positive and negative limit switches are activated.	Check DI states of positive and negative limit switches to see whether both DIs are activated.	Replace the limit switch.

■ Er.900: DI emergency braking

Direct cause:

The logic of the DI (including hardware DI and virtual DI) allocated with DI function 34 (FunIN.34: EmergencyStop) is valid.

Root Cause	Confirming Method	Solution
DI function 34 (FunIN.34: Emergency stop) is triggered.	Check whether the logic of the DI allocated with FunIN.34 (EmergencyStop) is valid.	Check the running mode and cancel the DI braking signal without affecting the safety performance.

■ Er.909: Motor overload warning

Direct cause:

The temperature of 60Z series motor (200 W and 400 W) reaches the over-temperature threshold.

Root Cause	Confirming Method	Solution
1) The motor cables and encoder cables are connected improperly or in poor contact.	Check the wiring among the servo drive, servo motor and the encoder according to the correct wiring diagram.	Connect cables based on the correct wiring diagram. It is recommended to use the cables provided by Inovance. When customized cables are used, prepare and connect the cables according to the hardware wiring instructions.
2) The load is too heavy, and the effective torque output by the motor keeps exceeding the rated torque.	Confirm the overload characteristics of the servo drive or motor. Check whether the average load ratio (H0B-12) keeps exceeding 100.0%.	Replace with a servo drive of larger capacity and a matching motor. Reduce the load and increase the acceleration/ deceleration time.
3) The acceleration/ deceleration is too frequent or the load inertia is too large.	Calculate the load inertia ratio or perform load inertia ratio auto-tuning, and view H08-15 (load moment of inertia ratio). Confirm the single running cycle when the servo motor runs cyclically.	Increase the acceleration/ deceleration time.
4) The gain is improper or the stiffness level is too high.	Check whether the motor vibrates and generates abnormal noise during running.	Adjust the gain.
5) The model of the servo drive or servo motor is set incorrectly.	For SV520N series servo drives, view the motor model in H00-05 and the servo drive model in H01-02.	View the servo drive nameplate and set the servo drive model in H01-02 and update the motor model to the matching model No..

Root Cause	Confirming Method	Solution
6) Locked-rotor occurs due to mechanical factors, resulting in overload during running.	Check the RUN command and motor speed (H0B-00) through the software tool or the keypad. RUN command in the position control mode: H0B-13 (Input position reference counter) RUN command in the speed control mode: H0B-01 (Speed reference) RUN command in the torque control mode: H0B-02 (Internal torque reference) Check whether the value of the RUN command is not 0 or is very large but the motor speed is 0 in the corresponding mode.	Eliminate the mechanical factors.
7) The servo drive is faulty.	Power off and on the servo drive again.	Replace the servo drive if the fault persists after the servo drive is powered on again.

■ Er.920: Regenerative resistor overload

Direct cause:

The temperature of the regenerative resistor is greater than the setpoint.

Root Cause	Confirming Method	Solution
1) The external regenerative resistor is connected improperly, disconnected or loosened.	Remove the external regenerative resistor and measure whether the resistance of the resistor is " ∞ " (infinite). Measure whether the resistance between $P_{\oplus}$ and C is " ∞ " (infinite).	Replace with a new external regenerative resistor with resistance consistent with the nominal value. Connect the new resistor between $P_{\oplus}$ and C.
		Select a proper cable and connect the external regenerative resistor between $P_{\oplus}$ and C.
2) The jumper between terminals $P_{\oplus}$ and D is shorted or disconnected when an internal regenerative resistor is used.	Measure whether the resistance between $P_{\oplus}$ and D is " ∞ " (infinite).	Connect terminals $P_{\oplus}$ and D properly with a proper cable.

Root Cause	Confirming Method	Solution
3) H02-25 (Regenerative resistor type) is set improperly when an external regenerative resistor is used.	View the set value of H02-25. Measure the resistance of the external regenerative resistor connected between $P_{\oplus}$ and C. Check whether the resistance is too large by comparing it with the regenerative resistor specifications in "1.4 Specifications of the Regenerative Resistor". Check whether the set value of H02-27 is larger than the resistance of the external regenerative resistor connected between $P_{\oplus}$ and C.	Set H02-25 correctly. ◆ H02-25 = 1 (external, naturally ventilated) ◆ H02-25 = 2 (external, forcible air cooling)
4) The resistance of the external regenerative resistor used is too large.		Select a proper regenerative resistor according to section 1.4.
5) The value of H02-27 (Resistance of external regenerative resistor) is larger than the resistance of the external regenerative resistor in use.		Set H02-27 according to the resistance of the external resistor in use.
6) The main circuit input voltage exceeds the specifications.	Check whether the input voltage of the main circuit on the servo drive side complies with the following specifications: ◆ 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) ◆ 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Replace or adjust the power supply according to the specifications.

Root Cause	Confirming Method	Solution
7) The load moment of inertia is too large.	Perform inertia auto-tuning or calculate the total mechanical inertia according to mechanical parameters. Check whether the actual load inertia ratio exceeds 30.	Select an external regenerative resistor of large resistance and set H02-26 (Power of external regenerative resistor) according to the power of the selected resistor. Select a servo drive with a large capacity. Reduce the load if allowed. Increase the acceleration/deceleration time if allowed. Increase the motor running cycle if allowed.
8) The motor speed is too high, resulting in an incomplete deceleration within the set time. The motor is in continuous deceleration status in cyclic running.	View the motor speed curve during cyclic running and check whether the motor is in the deceleration status for a long time.	
9) The capacity of the servo drive or regenerative resistor is insufficient.	View the motor speed curve in a single cycle and calculate whether the maximum braking energy can be absorbed completely.	
10) The servo drive is faulty.	-	Replace with a new servo drive.

■ Er.922: Resistance of the external regenerative resistor too small

Root Cause	Confirming Method	Solution
When an external regenerative resistor is used (H02-25 = 1 or 2), the resistance of the external regenerative resistor is smaller than the minimum value allowed by the servo drive.	Measure the resistance of the external regenerative resistor between $P_{\oplus}$ and C and check whether it is smaller than H02-21 (Permissible minimum resistance of regenerative resistor).	If yes, replace with a suitable external regenerative and set H02-27 (Resistance of external regenerative resistor) according to the resistance of this resistor, and connect it between $P_{\oplus}$ and C. If not, set H02-27 according to the resistance of the external regenerative resistor in use.

■ Er.939: Motor power cable disconnected

Direct cause:

The actual phase current of the motor is smaller than 10% of the rated current. The actual motor speed is small but the internal torque reference is very large.

Root Cause	Confirming Method	Solution
The motor power cable is disconnected.	Check whether the value of H0B-24 (RMS value of phase current) is five times more than the value of H0B-02 (Internal torque reference) and whether the value of H0B-00 (Actual motor speed) is smaller than one-fourth of the rated motor speed.	Re-connect the motor power cables. Replace with new cables if necessary.

■ Er.941: Parameter modifications activated at next power-on

Direct cause:

Modifications of some parameters are designed to be activated only after the servo drive is powered on again. If these parameters are modified, the servo drive reminds users to power on the servo drive again.

Root Cause	Confirming Method	Solution
The parameters you modified are those whose modifications will be activated at the next power-on.	Check whether parameters you modified are those whose modifications will be activated at the next power-on.	Power on the servo drive again.

■ Er.942: Parameter storage too frequent

Direct cause:

The total number of parameters modified at a time exceeds 200.

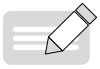
Root Cause	Confirming Method	Solution
A large number of parameters are modified and stored frequently to EEPROM (H0C-13 = 1).	Check whether the host controller executes parameter modifications frequently and quickly.	Check the running mode. For parameters that need not be stored in EEPROM, set H0C-13 to 0 before the write operation of the host controller.

■ Er.950: Forward overtravel warning

Cause	Confirming Method	Solution
The logic of the DI allocated with DI function 14 (FunIN.14: P-OT, positive limit switch) is valid.	Check whether a DI parameter in group H03 is allocated with FunIN.14 (P-OT). Check whether the corresponding DI logic is valid through H0B-03 (Monitored DI states).	Check the running mode. On the prerequisite of ensuring safety, send a reverse RUN command or rotate the motor to deactivate the logic of the DI allocated with FunIN.14 (P-OT).

■ Er.952: Reverse overtravel warning

Cause	Confirming Method	Solution
The logic of the DI allocated with DI function 15 (FunIN.15: N-OT, negative limit switch inhibited) is valid.	Check whether a parameter in group H03 is allocated with FunIN15 (N-OT). Check whether the corresponding DI logic is valid through H0B-03 (Monitored DI states).	Check the running mode. On the prerequisite of ensuring safety, send a reverse RUN command or rotate the motor to deactivate the logic of the DI allocated with FunIN15 (N-OT).



NOTE

When setting H02-02 (Rotation direction) to 1 (CCW as forward direction), exchange the definitions of the positive and negative limit switches (parameters in group H03). Failure to comply will cause motor collision due to overtravel.

7 List of Object Groups

Descriptions of object groups

Parameter access address: index+subindex, both are hexadecimal.

The CiA402 protocol establishes the following restrictions on the parameter address:

Index (Hex)	Description
0000-0FFF	Data type description
1000-1FFF	CoE communication object
2000-5FFF	Manufacturer-specific object
6000-9FFF	Sub-protocol object
A000-FFFF	Reserved

Object Group 1000h

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1000	00	Device Type	RO	No	UINT32	-	-	0x00020192
1008	00	Manufacturer device name	RO	No	-	-	-	SV520N-ECAT
1009	00	Manufacturer hardware version	RO	No	-	-	-	Dependent on the software version
100A	00	Manufacturer software version	RO	No	-	-	-	Dependent on the hardware version
1018	ID object							
	00	Highest sub-index supported	RO	No	UINT8	-	-	0x04
	01	Vendor ID	RO	No	UINT32	-	-	0x00100000
	02	Product code	RO	No	UINT32	-	-	0x000C0108
	03	Revision number	RO	No	UINT32	-	-	0x00010001
1600	RPDO mapping objects in group 1600							
	00	Number of mapping objects supported by group 1600	RW	No	UINT8	-	0 to 0x0A	0x03
	01	1st mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60400010
	02	2nd mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x607A0020
	03	3rd mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60B80010
	04	4th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	-

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1600	05	5th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	-
	06	6th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	-
	07	7th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	-
	08	8th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	-
	09	9th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	-
	0A	10th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	-
1701	RPDO mapping objects in group 1701							
	00	Number of mapping objects supported by group 1701	RO	No	UINT8	-	-	0x04
	01	1st mapping object	RO	No	UINT32	-	-	0x60400010
	02	2nd mapping object	RO	No	UINT32	-	-	0x607A0020
	03	3rd mapping object	RO	No	UINT32	-	-	0x60B80010
	04	4th mapping object	RO	No	UINT32	-	-	0x60FE0120
1702	RPDO mapping objects in group 1702							
	00	Number of mapping objects supported by group 1702	RO	No	UINT8	-	-	0x07
	01	1st mapping object	RO	No	UINT32	-	-	0x60400010
	02	2nd mapping object	RO	No	UINT32	-	-	0x607A0020
	03	3rd mapping object	RO	No	UINT32	-	-	0x60B80010
	04	4th mapping object	RO	No	UINT32	-	-	0x60710010
	05	5th mapping object	RO	No	UINT32	-	-	0x60600008
	06	6th mapping object	RO	No	UINT32	-	-	0x60B80010
1702	07	7th mapping object	RO	No	UINT32	-	-	0x607F0020-

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1703	RPDO mapping objects in group 1703							
	00	Number of mapping objects supported by group 1703	RO	No	UINT8	-	-	0x07
	01	1st mapping object	RO	No	UINT32	-	-	0x60400010
	02	2nd mapping object	RO	No	UINT32	-	-	0x607A0020
	03	3rd mapping object	RO	No	UINT32	-	-	0x60FF0020
	04	4th mapping object	RO	No	UINT32	-	-	0x60600008
	05	5th mapping object	RO	No	UINT32	-	-	0x60B80010
	06	6th mapping object	RO	No	UINT32	-	-	0x60E00010
	07	7th mapping object	RO	No	UINT32	-	-	0x60E10010
1704	RPDO mapping objects in group 1704							
	00	Number of mapping objects supported by group 1704	RO	No	UINT8	-	-	0x09
	01	1st mapping object	RO	No	UINT32	-	-	0x60400010
	02	2nd mapping object	RO	No	UINT32	-	-	0x607A0020
	03	3rd mapping object	RO	No	UINT32	-	-	0x60FF0020
	04	4th mapping object	RO	No	UINT32	-	-	0x60710010
	05	5th mapping object	RO	No	UINT32	-	-	0x60600008
	06	6th mapping object	RO	No	UINT32	-	-	0x60B80010
	07	7th mapping object	RO	No	UINT32	-	-	0x607F0020
	08	8th mapping object	RO	No	UINT32	-	-	0x60E00010
1704	09	9th mapping object	RO	No	UINT32	-	-	0x60E10010

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1705	RPDO mapping objects in group 1705							
	00	Number of mapping objects supported by group 1705	RW	No	UINT8	-	-	0x08
	01	1st mapping object	RW	No	UINT32	-	-	0x60400010
	02	2nd mapping object	RW	No	UINT32	-	-	0x607A0020
	03	3rd mapping object	RW	No	UINT32	-	-	0x60FF0020
	04	4th mapping object	RW	No	UINT32	-	-	0x60600008
	05	5th mapping object	RW	No	UINT32	-	-	0x60B80010
	06	6th mapping object	RW	No	UINT32	-	-	0x60E00010
	07	7th mapping object	RW	No	UINT32	-	-	0x60E10010
	08	8th mapping object	RW	No	UINT32	-	-	0x60B20010
1A00	Mapping objects in group 1A00							
	00	Number of mapping objects supported by group 1A00	RW	No	UINT8	-	0 to 0x0A	0x09
	01	1st mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60410010
	02	2nd mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60640020
	03	3rd mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60B90010
	04	4th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60BA0020
	05	5th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60BC0020
	06	6th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x603F0010
	07	7th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60FD0010
1A00	08	8th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60520020
	09	9th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	0x60530020
	0A	10th mapping object	RW	No	UINT32	-	0 to 0xFFFFFFFF	

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1B01	Mapping objects in group 1B01							
	00	Number of mapping objects supported by group 1B01	RO	No	UINT8	-	-	0x09
	01	1st mapping object	RO	No	UINT32	-	-	0x603F0010
	02	2nd mapping object	RO	No	UINT32	-	-	0x60410010
	03	3rd mapping object	RO	No	UINT32	-	-	0x60640020
	04	4th mapping object	RO	No	UINT32	-	-	0x60770010
	05	5th mapping object	RO	No	UINT32	-	-	0x60F40020
	06	6th mapping object	RO	No	UINT32	-	-	0x60B90010
	07	7th mapping object	RO	No	UINT32	-	-	0x60BA0020
	08	8th mapping object	RO	No	UINT32	-	-	0x60BC0020
	09	9th mapping object	RO	No	UINT32	-	-	0x60FD0010
1B02	Mapping objects in group 1B02							
	00	Number of mapping objects supported by group 1B02	RO	No	UINT8	-	-	0x09
	01	1st mapping object	RO	No	UINT32	-	-	0x603F0010
	02	2nd mapping object	RO	No	UINT32	-	-	0x60410010
	03	3rd mapping object	RO	No	UINT32	-	-	0x60640020
	04	4th mapping object	RO	No	UINT32	-	-	0x60770010
1B02	05	5th mapping object	RO	No	UINT32	-	-	0x60610008
	06	6th mapping object	RO	No	UINT32	-	-	0x60B90010
	07	7th mapping object	RO	No	UINT32	-	-	0x60BA0020
	08	8th mapping object	RO	No	UINT32	-	-	0x60BC0020
	09	9th mapping object	RO	No	UINT32	-	-	0x60FD0010

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1B03	Mapping objects in group 1B03							
	00	Number of mapping objects supported by group 1B03	RO	No	UINT8	-	-	0x0A
	01	1st mapping object	RO	No	UINT32	-	-	0x603F0010
	02	2nd mapping object	RO	No	UINT32	-	-	0x60410010
	03	3rd mapping object	RO	No	UINT32	-	-	0x60640020
	04	4th mapping object	RO	No	UINT32	-	-	0x60770010
	05	5th mapping object	RO	No	UINT32	-	-	0x60F40020
	06	6th mapping object	RO	No	UINT32	-	-	0x60610008
	07	7th mapping object	RO	No	UINT32	-	-	0x60B90010
	08	8th mapping object	RO	No	UINT32	-	-	0x60BA0020
	09	9th mapping object	RO	No	UINT32	-	-	0x60BC0020
	0A	10th mapping object	RO	No	UINT32	-	-	0x60FD0010

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1B04	Mapping objects in group 1B04							
	00	Number of mapping objects supported by group 1B04	RO	No	UINT8	-	-	0x0A
	01	1st mapping object	RO	No	UINT32	-	-	0x603F0010
	02	2nd mapping object	RO	No	UINT32	-	-	0x60410010
	03	3rd mapping object	RO	No	UINT32	-	-	0x60640020
	04	4th mapping object	RO	No	UINT32	-	-	0x60770010
	05	5th mapping object	RO	No	UINT32	-	-	0x60610008
	06	6th mapping object	RO	No	UINT32	-	-	0x60B90010
	07	7th mapping object	RO	No	UINT32	-	-	0x60BA0020
	08	8th mapping object	RO	No	UINT32	-	-	0x60BC0020
	09	9th mapping object	RO	No	UINT32	-	-	0x60FD0020
	0A	10th mapping object	RO	No	UINT32	-	-	0x606C0020
1C00	Factory software version							
	00	Number of Sync Manager channels	RO	No	UINT8	-	-	0x04
	01	Communication type of SM0	RO	No	UINT8	-	-	0x01
	02	Communication type of SM1	RO	No	UINT8	-	-	0x02
	03	Communication type of SM2	RO	No	UINT8	-	-	0x03
	04	Communication type of SM3	RO	No	UINT8	-	-	0x04
1C12	Sync Manager 2_Assigned RPDO							
	00	Number of assigned RPDOs	RW	No	UINT8	-	0 to 0x01	0x01
	01	Index of object 1 of assigned RPDO	RW	YES	UINT16	-	0 to 0xFFFF	0x1701

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default
1C13	Sync Manager 2_Assigned TPDO							
	00	Number of assigned TPDOs	RW	No	UINT8	-	0 to 0x1	0x01
	01	Index of object 1 of assigned TPDO	RW	YES	UINT16	-	0 to 0xFFFF	0x1B01
1C32	Sync Manager 2 Synchronization Output							
	00	Number of synchronization parameters	RO	No	UINT8	-	-	0x20
	01	Synchronization type	RO	No	UINT16	-	-	0x0200
	02	Cycle Time	RO	No	UINT32	ns	-	0
	04	Synchronization types supported	RO	No	UINT16	-	-	0x0400
	05	Minimum cycle time	RO	No	UINT32	ns	-	0
	06	Calculation and copy time	RO	No	UINT32	ns	-	0x0003D090
	09	Delay time	RO	No	UINT32	ns	-	0
	20	Sync error	RO	No	BOOL	-	-	FALSE
1C33	Sync Manager 2 Synchronization Input							
	00	Number of synchronization parameters	RO	No	UINT8	-	-	0x20
	01	Synchronization type	RO	No	UINT16		-	0x0002
	02	Cycle Time	RO	No	UINT32	ns	-	0
	04	Synchronization types supported	RO	No	UINT16	-	-	0x0004
	05	Minimum cycle time	RO	No	UINT32	ns	-	0
	06	Calculation and copy time	RO	No	UINT32	ns	-	0
	09	Delay time	RO	No	UINT32	ns	-	0
	20	Sync error	RO	No	BOOL	-	-	FALSE

Object Group 2000h

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2000h/H00 Servo Motor Parameters										
2000	01h	H00-00	0x2000-01: Motor SN	-	0 to 65535	65535	1	16 bits	At stop	Next power-on
	03h	H00-02	0x2000-03: Customized No.	-	0 to 2147483647	0	1	32 bits	At display	-
	0Ah	H00-09	Rated voltage	0: 220 V 1: 380 V	0 to 1	0	1 V	16 bits	At stop	Next power-on
	0Bh	H00-10	Rated power	-	1 to 65535	39	0.01 kW	16 bits	At stop	Next power-on
	0Ch	H00-11	Continuous current	-	1 to 65535	230	0.01 A	16 bits	At stop	Next power-on
	0Dh	H00-12	Continuous thrust	-	10 to 65535	375	0.1 N	16 bits	At stop	Next power-on
	0Eh	H00-13	Peak current	-	1 to 65535	690	0.01 A	16 bits	At stop	Next power-on
	0Fh	H00-14	Rated speed	-	100 to 30000	1900	mm/s	16 bits	At stop	Next power-on
	10h	H00-15	Maximum speed	-	100 to 60000	3000	mm/s	16 bits	At stop	Next power-on
	11h	H00-16	Rotor weight	-	1 to 65535	290	g	16 bits	At stop	Next power-on
	13h	H00-18	Stator resistance	-	1 to 65535	4000	0.001 Ω	16 bits	At stop	Next power-on
	14h	H00-19	Stator inductance Lq	-	1 to 65535	100	0.01 mH	16 bits	At stop	Next power-on
	15h	H00-20	Stator inductance Ld	-	1 to 65535	100	0.01 mH	16 bits	At stop	Next power-on
	16h	H00-21	Linear back EMF coefficient	-	1 to 65535	67	0.1 V/m/s	16 bits	At stop	Next power-on
	17h	H00-22	Thrust coefficient Kt	-	1 to 65535	1650	0.01 N/A	16 bits	At stop	Next power-on
	18h	H00-23	Electrical constant Te	-	1 to 65535	25	0.01 ms	16 bits	At stop	Next power-on
	19h	H00-24	Mechanical constant Tm	-	1 to 65535	600	0.01 N/W^{-2}	16 bits	At stop	Next power-on
	1Ah	H00-25	Motor temperature detection	0: Hide 1: Enable	0 to 36863	0	1	16 bits	During running	Immediately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2000	1Bh	H00-26	Encoder type	0x00: AB analog with Z signal but without Hall, encoder counting direction unchanged 0x02: AB analog without Z signal or Hall, encoder counting direction unchanged 0x03: AB pulse with Z signal but without Hall, encoder counting direction unchanged 0x04: AB pulse without Z signal or Hall, encoder counting direction unchanged 0x08: AB analog with Z signal and Hall, encoder counting direction unchanged 0x0A: AB analog without Z signal or Hall, encoder counting direction unchanged 0x0B: AB pulse with Z signal and Hall, encoder counting direction unchanged 0x0C: AB pulse without Z signal but with Hall, encoder counting direction unchanged 0x10: AB analog with Z signal but without Hall, encoder counting direction reversed 0x12: AB analog without Z signal or Hall, encoder counting direction reversed 0x13: AB pulse with Z signal but without Hall, encoder counting direction reversed 0x14: AB pulse without Z signal or Hall, encoder counting direction reversed 0x18: AB analog with Z signal and Hall, encoder counting direction reversed 0x1A: AB analog without Z signal but with Hall, encoder counting direction reversed 0x1B: AB pulse with Z signal and Hall, encoder counting direction reversed 0x1C: AB pulse without Z signal but with Hall, encoder counting direction reversed	0 to 65535	4	1	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2000	2Fh	H00-46	Magnetic scale pitch	-	1 to 65535	10	0.1 mm	16 bits	At stop	Next power-on
	30h	H00-47	Encoder type	0: Optical scale 1: Magnetic scale	0 to 1	0	1	16 bits	At stop	Next power-on
	31h	H00-48	Pole pitch (N-S)	-	1 to 65535	160	0.1 mm	16 bits	At stop	Next power-on
	32h	H00-49	Resolution	-	1 to 10000	100	0.01 um/p	16 bits	At stop	Next power-on
2001h/H01: Servo Drive Parameters										
2001	01h	H01-00	MCU software version	-	0 to 65535	0	0.1	16 bits	At display	-
	02h	H01-01	FPGA software version	-	0 to 65535	0	0.1	16 bits	At display	-
	03h	H01-02	servo drive SN	2: 1R6 3: S2R8 5: S5R5 6: S7R6 7: S012	0 to 65535	5	1	16 bits	At stop	Next power-on
	05h	H01-04	Voltage class	-	0 to 65535	220	1 V	16 bits	At display	-
	06h	H01-05	Rated power	-	1 to 65535	7500	0.01 kW	16 bits	At display	-
	07h	H01-06	Maximum output power	-	1 to 65535	7500	0.01 kW	16 bits	At display	-
	08h	H01-07	Rated output current	-	1 to 65535	550	0.01 A	16 bits	At display	-
	09h	H01-08	Maximum output current	-	1 to 65535	1690	0.01 A	16 bits	At display	-
	0Ah	H01-09	Σ-△ Modulator external clock selection	0: Disabled 1: Enabled	0 to 1	0	1	16 bits	At stop	Next power-on
	0Bh	H01-10	Carrier frequency	-	2000 to 20000	16000	1	16 bits	At stop	Next power-on
	0Ch	H01-11	Current loop modulation frequency	0: Carrier frequency 2: Two times the carrier frequency	0	0	-	16 bits	At stop	Next power-on
	0Dh	H01-12	Speed loop modulation frequency-division coefficient	0: Current loop modulation frequency/1 1: Current loop modulation frequency/2 2: Current loop modulation frequency/4 3: Current loop modulation frequency/8 4: Current loop modulation frequency/16 5: Current loop modulation frequency/32	1 to 32	1	1	16 bits	At stop	Next power-on

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2001	0Eh	H01-13	Position loop modulation frequency-division coefficient	2: Current loop modulation frequency/4 3: Current loop modulation frequency/8 4: Current loop modulation frequency/16 5: Current loop modulation frequency/32 6: Current loop modulation frequency/64 7: Current loop modulation frequency/128	2 to 128	4	1	16 bits	At stop	Next power-on
	0Fh	H01-14	Dead zone time	-	1 to 2000	200	0.01 μs	16 bits	At stop	Next power-on
	10h	H01-15	DC bus overvoltage protection threshold	-	0 to 900	420	1 V	16 bits	At stop	Next power-on
	11h	H01-16	DC bus voltage discharge threshold	-	0 to 900	380	1 V	16 bits	At stop	Next power-on
	12h	H01-17	DC bus undervoltage threshold	-	0 to 900	200	1 V	16 bits	At stop	Next power-on
	13h	H01-18	Servo drive overcurrent protection threshold	-	10 to 100	100	1%	16 bits	At stop	Next power-on
	14h	H01-19	7860 sampling coefficient	-	1 to 65535	3200	1	16 bits	At stop	Next power-on
	15h	H01-20	Dead zone compensation	-	0 to 2000	200	0.01 μs	16 bits	At stop	Next power-on
	17h	H01-22	D-axis back EMF constant	-	0 to 65535	0	0.10%	16 bits	During running	Immediately
	18h	H01-23	Q-axis back EMF constant	-	0 to 65535	0	0.10%	16 bits	During running	Immediately
	19h	H01-24	D-axis current loop gain	-	1 to 65535	200	1	16 bits	During running	Immediately
	1Ah	H01-25	D-axis current loop integral compensation factor	-	0 to 65535	100	1	16 bits	During running	Immediately
	1Bh	H01-26	Current sampling Sinc3 filter data extraction rate	0: 32 1: 64 2: 128 3: 256	0 to 3	0	1	16 bits	During running	Next power-on
	1Ch	H01-27	Q-axis current loop gain	-	1 to 65535	1000	1	16 bits	During running	Immediately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2001	1Dh	H01-28	Q-axis current loop integral compensation factor	-	0 to 65535	100	1	16 bits	During running	Immed-iately
	1Fh	H01-30	Bus voltage gain tuning	-	500 to 1500	1000	0.10%	16 bits	During running	Immed-iately
	20h	H01-31	FOC calculation time	-	100 to 10000	260	0.01 μs	16 bits	During running	Next power-on
	21h	H01-32	Relative gain of UV sampling	-	0 to 65535	0	1	16 bits	At display	-
	24h	H01-35	Local mode selection	0: Hide 1: Enable	0 to 3	0	1	16 bits	At stop	Immed-iately
	2Eh	H01-45	Phase U duty cycle obtained upon voltage injection	-	1500 to 65535	1500	1	16 bits	During running	Immed-iately
	30h	H01-47	MCU current reference processing time	-	0 to 6000	5500	0.01 μs	16 bits	During running	Next power-on
	31h	H01-48	AD sampling delay	-	0 to 2000	100	0.01 μs	16 bits	During running	Next power-on
	32h	H01-49	Serial encoder data dissemination delay	-	0 to 50000	6100	0.01 μs	16 bits	During running	Next power-on
	33h	H01-50	DSP software internal version No.	-	0 to 65535	0	0.01	16 bits	During running	Immed-iately
	34h	H01-51	FPGA software internal version No.	-	0 to 65535	0	1	16 bits	At stop	Immed-iately
	35h	H01-52	D-axis proportional gain in performance priority mode	-	0 to 65535	800	1	16 bits	During running	Immed-iately
	36h	H01-53	D-axis integral gain in performance priority mode	-	0 to 65535	200	0.01	16 bits	During running	Immed-iately
	37h	H01-54	Q-axis proportional gain in performance priority mode	-	0 to 65535	100	1	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2001	38h	H01-55	Q-axis integral gain in performance priority mode	-	0 to 65535	100	0.01	16 bits	During running	Immed-iately
	39h	H01-56	2nd proportional gain coefficient in performance priority mode	-	0 to 10000	1000	0.10%	16 bits	During running	Immed-iately
	3Ah	H01-57	3rd proportional gain coefficient in performance priority mode	-	0 to 10000	1000	0.10%	16 bits	During running	Immed-iately
	3Bh	H01-58	1st gain switchover threshold in performance priority mode	-	0 to 3000	10	0.10%	16 bits	During running	Immed-iately
	3Ch	H01-59	2nd gain switchover threshold in performance priority mode	-	0 to 3000	20	0.10%	16 bits	During running	Immed-iately
	3Dh	H01-60	3rd gain switchover threshold in performance priority mode	-	0 to 3000	1000	0.10%	16 bits	During running	Immed-iately
	3Eh	H01-61	4th gain switchover threshold in performance priority mode	-	0 to 3000	2000	0.10%	16 bits	During running	Immed-iately
2002h/H02 Basic control parameters										
2002	01h	H02-00	0x2002-01: Control mode selection	0: Speed control mode 1: Position control mode 2: Torque control mode 3: Torque control mode -> Speed control mode: 4: Speed control mode -> Position control mode 5: Torque control mode -> Position control mode 6: Torque control mode -> Speed control mode -> Position control mode 7: No definition 8: CANopen bus control 9: EtherCAT bus control	0 to 9	9	1	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2002	03h	H02-02	0x2002-03: Forward running direction	0: CCW direction as the forward direction 1: CW direction as the forward direction	0 to 1	0	1	16 bits	At stop	Next power-on
	04h	H02-03	Output pulse phase	0: Phase A leads phase B 1: Phase A lags behind phase B	0 to 1	0	1	16 bits	At stop	Next power-on
	06h	H02-05	Stop mode at S-ON OFF	0: Coast to stop, keeping de-energized state 1: Emergency stop, keeping de-energized state	0 to 1	0	1	16 bits	At stop	Immed-iately
	07h	H02-06	Stop mode at No. 2 fault	0: Coast to stop, keeping de-energized state 1: Emergency stop, keeping de-energized state	0 to 1	0	1	16 bits	At stop	Immed-iately
	08h	H02-07	Stop mode at overtravel	0: Coast to stop, keeping de-energized state 1: Stop at zero speed, keeping position lock state 2: Stop at zero speed, keeping de-energized state	0 to 2	1	1	16 bits	At stop	Immed-iately
	09h	H02-08	Stop mode at No.1 fault	0: Coast to stop, keeping de-energized state	0	0	-	16 bits	At stop	Immed-iately
	10h	H02-15	Warning display	0: Output warning information immediately 1: Not output warning information	0 to 1	0	1	16 bits	At stop	Immed-iately
	15h	H02-20	DB brake	-	0 to 30000	30	ms	16 bits	During running	Immed-iately
	16h	H02-21	Minimum permissible dynamic regenerative resistor	-	0 to 65535	0	1 Ω	16 bits	At display	-
	17h	H02-22	Power of built-in regenerative resistor	-	0 to 65535	0	1 W	16 bits	At display	-
	18h	H02-23	Resistance of built-in regenerative resistor	-	0 to 65535	0	1 Ω	16 bits	At display	-
	19h	H02-24	Heat dissipation coefficient of the resistor	-	10 to 100	30	1	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2002	1Ah	H02-25	Regenerative resistor type	0: Built-in 1: External, natural cooling 2: External, forced air cooling 3: No regenerative resistor needed, using the capacitor only	0 to 3	0	1	16 bits	At stop	Immed-iately
	1Bh	H02-26	Power capacity of external regenerative resistor	-	1 to 65535	40	1 W	16 bits	At stop	Immed-iately
	1Ch	H02-27	Resistance of external regenerative resistor	-	1 to 1000	50	1 Ω	16 bits	At stop	Immed-iately
	1Fh	H02-30	User password	-	0 to 65535	0	1	16 bits	At stop	Next power-on
	20h	H02-31	System parameter initialization	0: No operation 1: Restore default settings 2: Clear fault records	0 to 2	0	1	16 bits	At stop	Immed-iately
	21h	H02-32	Default keypad display function	-	0 to 99	50	1	16 bits	During running	Immed-iately
	22h	H02-33	EtherCAT software version No.	-	0 to 65535	3000	0.0001	16 bits	At display	-
	2Ah	H02-41	Factory password	-	0 to 65535	0	1	16 bits	At stop	Immed-iately
2003h/H03 Terminal Input Parameters										
2003	01h	H03-00	DI function allocation 1 (activated upon power-on)	-	0 to 65535	0	1	16 bits	During running	Next power-on
	02h	H03-01	DI function allocation 2 (activated upon power-on)	-	0 to 65535	0	1	16 bits	During running	Next power-on

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2003	03h	H03-02	DI1 function	0: No definition 2: Alarm reset signal 3: Gain switchover switch 12: Zero clamp signal 13: Position reference inhibited 14: Positive limit switch 15: Negative limit switch 16: Forward external torque limit 17: Reverse external torque limit 18: Forward jog 19: Reverse jog 25: Torque reference direction selection 26: Speed reference direction selection 27: Position reference direction selection 31: Home switch 34: Emergency stop 35: Position deviation cleared 36: Internal speed limit source 38: Touch probe 1 39: Touch probe 2	0 to 39	14	1	16 bits	During running	At stop
	04h	H03-03	DI1 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	0	1	16 bits	During running	At stop
	05h	H03-04	DI2 function selection	See H03-02 for details.	0 to 39	15	1	16 bits	During running	At stop
	06h	H03-05	DI2 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	0	1	16 bits	During running	At stop
	07h	H03-06	DI3 function selection	See H03-02 for details.	0 to 39	0	1	16 bits	During running	At stop
	08h	H03-07	DI3 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	0	1	16 bits	During running	At stop
	09h	H03-08	DI4 function selection	See H03-02 for details.	0 to 39	0	1	16 bits	During running	At stop

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2003	0Ah	H03-09	DI4 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	0	1	16 bits	During running	At stop
	0Bh	H03-10	DI5 function selection	See H03-02 for details.	0 to 39	0	1	16 bits	During running	At stop
	0Ch	H03-11	DI5 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	0	1	16 bits	During running	At stop
	0Dh	H03-12	DI6 function selection	See H03-02 for details.	0 to 39	0	1	16 bits	During running	At stop
	0Eh	H03-13	DI6 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	0	1	16 bits	During running	At stop
	11h	H03-16	DI8 function selection	See H03-02 for details.	0 to 39	38	1	16 bits	During running	At stop
	12h	H03-17	DI8 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	1	1	16 bits	During running	At stop
	13h	H03-18	DI9 function selection	See H03-02 for details.	0 to 39	31	1	16 bits	During running	At stop
	14h	H03-19	DI9 logic selection	0: Active low 1: Active high 2: Rising edge-triggered 3: Falling edge-triggered 4: Rising/Falling edge-triggered	0 to 4	0	1	16 bits	During running	At stop
	23h	H03-34	DI function allocation 3 (activated upon power-on)	-	0 to 65535	0	1	16 bits	During running	Next power-on
	24h	H03-35	DI function allocation 4 (activated upon power-on)	-	0 to 65535	0	1	16 bits	During running	Next power-on

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2004h/H04 Terminal Output Parameters										
2004	01h	H04-00	DO1 function selection	0: No definition 1: Servo drive ready 2: Motor running 3: Zero speed signal 4: Speed matching 5: Positioning completed 7: Torque limit 8: Speed limit 9: Brake 10: Warning 11: Fault 12: 3-digit warning code output 13: 3-digit warning code output 14: 3-digit warning code output 18: Torque reached 19: Speed reached 20: Initial angle auto-tuning completed 21: DB brake enabled	0 to 21	1	1	16 bits	During running	At stop
	02h	H04-01	DO1 logic level selection	0: Output low (L) level upon valid logic (optocoupler ON) 1: Output high (H) level upon valid logic (optocoupler OFF)	0 to 1	0	1	16 bits	During running	At stop
	03h	H04-02	DO2 function selection	See H04-00 for details.	0 to 21	5	1	16 bits	During running	At stop
	04h	H04-03	DO2 logic level selection	0: Output low (L) level upon valid logic (optocoupler ON) 1: Output high (H) level upon valid logic (optocoupler OFF)	0 to 1	0	1	16 bits	During running	At stop
	05h	H04-04	DO3 function selection	See H04-00 for details.	0 to 21	3	1	16 bits	During running	At stop
	06h	H04-05	DO3 logic level selection	0: Output low (L) level upon valid logic (optocoupler ON) 1: Output high (H) level upon valid logic (optocoupler OFF)	0 to 1	0	1	16 bits	During running	At stop
	17h	H04-22	DO source selection	-	0 to 7	0	1	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2005h/H05 Position Control Parameters										
2005	07h	H05-06	Moving average filter time constant	-	0 to 1280	0	0.1 ms	16 bits	At stop	Immed-iately
	11h	H05-16	Clear action selection	0: Position deviation cleared upon S-ON OFF and fault occurrence 1: Position deviation pulses cleared upon fault occurrence 2: Position deviation cleared upon ClrPosErr signal input from DI	0 to 2	0	1	16 bits	At stop	Immed-iately
	12h	H05-17	Number of encoder frequency-division pulses	-	35 to 1073741824	2500	1P/pole pitch	32 bits	At stop	Next power-on
	14h	H05-19	Speed feedforward control	0: No speed feedforward 1: Internal speed feedforward 2: 60B1h used as speed feedforward input	0 to 2	1	1	16 bits	At stop	Immed-iately
	15h	H05-20	Condition for positioning completed signal output	0: The absolute value of position deviation is smaller than the value of 6067h. 1: The absolute value of position deviation is smaller than the value of 6067h and the filtered position reference is 0. 2: The absolute value of position deviation is smaller than the value of 6067h and the non-filtered position reference is 0.	0 to 2	0	1	16 bits	At stop	Immed-iately
	24h	H05-35	Duration limit of homing	-	0 to 65535	50000	10 ms	16 bits	During running	Immed-iately
	27h	H05-38	Servo pulse output source	0: Encoder frequency-division output 2: Frequency-division output inhibited	0 to 2	0	1	16 bits	At stop	Next power-on
	2Ah	H05-41	Z pulse output polarity	0: Positive (high level at active Z pulse) 1: Negative (low level at active Z pulse)	0 to 1	1	1	16 bits	At stop	Next power-on
	3Eh	H05-61	Position window time (0x6067) unit	0: Reference unit 1: Encoder unit	0 to 1	1	1	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2006h/H06 Speed Control Parameters										
2006	05h	H06-04	Jog speed setpoint	-	0 to 6000	100	1 mm/s	16 bits	During running	Immed-iately
	0Ch	H06-11	Torque feedforward control	0: No torque feedforward 1: Internal torque feedforward 2: 60B2h used as the torque feedforward input	0 to 2	1	1	16 bits	During running	Immed-iately
	10h	H06-15	Speed limit for zero clamp signal	-	0 to 6000	10	1 mm/s	16 bits	During running	Immed-iately
	11h	H06-16	Motor running signal threshold	-	0 to 1000	20	1 mm/s	16 bits	During running	Immed-iately
	13h	H06-18	Speed reached signal threshold	-	10 to 6000	1000	1 mm/s	16 bits	During running	Immed-iately
	14h	H06-19	Zero speed output signal threshold	-	1 to 6000	10	1 mm/s	16 bits	During running	Immed-iately
	1Dh	H06-28	Cogging torque ripple compensation selection	0: Hide 1: Enable	0 to 1	0	1	16 bits	During running	Immed-iately
2007h/H07 Torque Control Parameters										
2007	06h	H07-05	Torque reference filter time constant	-	0 to 3000	79	0.01 ms	16 bits	During running	Immed-iately
	07h	H07-06	2nd torque reference filter time constant	-	0 to 3000	79	0.01 ms	16 bits	During running	Immed-iately
	08h	H07-07	Torque limit source	0: Forward/Reverse internal torque limit 1: Forward/Reverse external torque limit (using P-CL, N-CL) 2: EtherCAT forward/reverse external torque limit 3: Minimum of external forward/reverse torque and EtherCAT external forward/reverse torque limit (using P-CL, N-CL) 4: Switchover between forward/reverse internal torque and EtherCAT forward/reverse external torque limit (using P-CL, N-CL)	0 to 4	2	1	16 bits	At stop	Immed-iately
	0Ah	H07-09	Forward internal torque limit	-	0 to 3000	3000	0.10%	16 bits	During running	Immed-iately
	0Bh	H07-10	Reverse internal torque limit	-	0 to 3000	3000	0.10%	16 bits	During running	Immed-iately
	0Ch	H07-11	Forward external torque limit	-	0 to 3000	3000	0.10%	16 bits	During running	Immed-iately
	0Dh	H07-12	Reverse external torque limit	-	0 to 3000	3000	0.10%	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2007	12h	H07-17	Speed limit source	0: Internal speed limit 1: EtherCAT external speed limit 2: 2007-14h/2007-15h used as internal speed limit (defined by FunIN.36)	0 to 2	1	1	16 bits	During running	Immediately
	14h	H07-19	Forward speed limit/1st speed limit in torque control	-	0 to 6000	3000	1 mm/s	16 bits	During running	Immediately
	15h	H07-20	Reverse speed limit/2nd speed limit in torque control	-	0 to 6000	3000	1 mm/s	16 bits	During running	Immediately
	16h	H07-21	Reference value for torque reached	-	0 to 3000	0	0.10%	16 bits	During running	Immediately
	17h	H07-22	Valid value for torque reached	-	0 to 3000	200	0.10%	16 bits	During running	Immediately
	18h	H07-23	Invalid value for torque reached	-	0 to 3000	100	0.10%	16 bits	During running	Immediately
	29h	H07-40	Speed limit window in torque control	-	5 to 300	10	0.1 ms	16 bits	During running	Immediately
2008h/H08 Gain Parameters										
2008	01h	H08-00	Speed loop gain	-	1 to 20000	250	0.1 Hz	16 bits	During running	Immediately
	02h	H08-01	Speed loop integral time constant	-	15 to 51200	3183	0.01 ms	16 bits	During running	Immediately
	03h	H08-02	Position loop gain	-	0 to 20000	400	0.1 Hz	16 bits	During running	Immediately
	04h	H08-03	2nd speed loop gain	-	1 to 20000	400	0.1 Hz	16 bits	During running	Immediately
	05h	H08-04	2nd speed loop integral time constant	-	15 to 51200	2000	0.01 ms	16 bits	During running	Immediately
	06h	H08-05	2nd position loop gain	-	0 to 20000	640	0.1 Hz	16 bits	During running	Immediately
	09h	H08-08	2nd gain mode	0: Fixed at the 1st gain, P/PI switchover through external DI 1: Gain switchover activated based on the condition defined by H08-09	0 to 1	1	1	16 bits	During running	Immediately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2008	0Ah	H08-09	Gain switchover condition	0: Fixed at the 1st gain (PS) 1: Switchover through external DI (PS) 2: Torque reference too large (PS) 3: Speed reference too large (PS) 4: Speed reference change rate too large (PS) 5: Speed reference high-speed/low-speed threshold (PS) 6: Position deviation too large (P) 7: Position reference available (P) 8: Positioning uncompleted (P) 9: Actual speed (P) 10: Position reference available + Actual speed (P)	0 to 10	0	1	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2008	0Bh	H08-10	Gain switchover delay	-	0 to 10000	50	0.1 ms	16 bits	At stop	Immed-iately
	0Ch	H08-11	Gain switchover level	-	0 to 20000	50	1	16 bits	At stop	Immed-iately
	0Dh	H08-12	Gain switchover hysteresis	-	0 to 20000	30	1	16 bits	At stop	Immed-iately
	0Eh	H08-13	Position gain switchover time	-	0 to 10000	30	0.1 ms	16 bits	At stop	Immed-iately
	10h	H08-15	Load moment of inertia ratio	-	0 to 12000	100	0.01	16 bits	During running	Immed-iately
	13h	H08-18	Speed feedforward filter time constant	-	0 to 6400	50	0.01 ms	16 bits	During running	Immed-iately
	14h	H08-19	Speed feedforward gain	-	0 to 1000	0	0.10%	16 bits	During running	Immed-iately
	15h	H08-20	Torque feedforward filter time constant	-	0 to 6400	50	0.01 ms	16 bits	During running	Immed-iately
	16h	H08-21	Torque feedforward gain	-	0 to 2000	0	0.10%	16 bits	During running	Immed-iately
	17h	H08-22	Speed feedback filter selection	0: Disabled 1: 2 times of average filtering on speed feedback 2: 4 times of average filtering on speed feedback 3: 8 times of average filtering on speed feedback 4: 16 times of average filtering on speed feedback	0 to 4	0	1	16 bits	At stop	Immed-iately
	18h	H08-23	Cutoff frequency of speed feedback low pass filter	-	100 to 4000	1000	1 Hz	16 bits	During running	Immed-iately
	19h	H08-24	PDFF control coefficient	-	0 to 1000	1000	0.10%	16 bits	During running	Immed-iately
	1Ch	H08-27	Speed observation cutoff frequency	-	10 to 2000	170	1 Hz	16 bits	During running	Immed-iately
	1Dh	H08-28	Speed inertia correction coefficient	-	10 to 10000	100	1%	16 bits	During running	Immed-iately
	1Eh	H08-29	Speed observation filter time	-	2 to 2000	80	0.01 ms	16 bits	During running	Immed-iately
	20h	H08-31	Disturbance observation cutoff frequency	-	10 to 1700	600	1 Hz	16 bits	During running	Immed-iately
	21h	H08-32	Disturbance observation compensation coefficient	-	0 to 100	0	1%	16 bits	During running	Immed-iately
	22h	H08-33	Disturbance inertia correction coefficient	-	1 to 10000	100	1%	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2008	23h	H08-34	Medium- and high-frequency vibration suppression phase modulation 1	-	0 to 1600	0	1%	16 bits	During running	Immed-iately
	24h	H08-35	Medium- and high-frequency vibration suppression frequency 1	-	0 to 1000	0	1 Hz	16 bits	During running	Immed-iately
	25h	H08-36	Medium- and high-frequency vibration suppression compensation 1	-	0 to 200	0	1%	16 bits	During running	Immed-iately
	26h	H08-37	Medium-frequency vibration suppression phase modulation 2	-	0 to 1600	0	1%	16 bits	During running	Immed-iately
	27h	H08-38	Medium-frequency vibration suppression frequency 2	-	0 to 800	0	1 Hz	16 bits	During running	Immed-iately
	28h	H08-39	Medium-frequency vibration suppression compensation 2	-	0 to 200	0	1%	16 bits	During running	Immed-iately
	29h	H08-40	Speed observation selection	0: Hide 1: Enable	0 to 1	0	1	16 bits	At stop	Immed-iately
	2Ah	H08-41	Disturbance observation torque switch	0: Hide 1: Enable	0 to 2	0	1	16 bits	During running	Immed-iately
	2Bh	H08-42	Model control selection	0: Hide 1: Enable	0 to 1	0	1	16 bits	At stop	Immed-iately
	2Ch	H08-43	Model gain	-	0 to 10000	400	0.1	16 bits	During running	Immed-iately
	2Fh	H08-46	Model feedforward	-	0 to 1024	950	1	16 bits	During running	Immed-iately
	34h	H08-51	Model filter time 2	-	0 to 2000	0	0.01 ms	16 bits	During running	Immed-iately
	36h	H08-53	Medium- and low-frequency vibration suppression frequency 3	-	0 to 6000	0	0.1 Hz	16 bits	During running	Immed-iately
	37h	H08-54	Medium- and low-frequency vibration suppression compensation 3	-	0 to 200	0	1%	16 bits	During running	Immed-iately
	39h	H08-56	Medium- and low-frequency vibration suppression phase modulation 3	-	0 to 1600	100	1	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2008	3Ch	H08-59	Medium- and low-frequency jitter suppression frequency 4	-	0 to 6000	0	0.1 Hz	16 bits	During running	Immed-iately
	3Dh	H08-60	Medium- and low-frequency jitter suppression compensation 4	-	0 to 200	0	1%	16 bits	During running	Immed-iately
	3Eh	H08-61	Medium- and low-frequency jitter suppression phase modulation 4	-	0 to 1600	100	1	16 bits	During running	Immed-iately
	3Fh	H08-62	Position integral time constant	-	15 to 51200	51200	0.01 ms	16 bits	During running	Immed-iately
	40h	H08-63	2nd position integral time constant	-	15 to 51200	51200	0.01 ms	16 bits	During running	Immed-iately
2009h/H09 Auto-tuning Parameters										
2009	01h	H09-00	Gain auto-tuning mode	0: Invalid 1: Standard stiffness level mode 2: Positioning mode 3: Reserved 4: Standard mode - Manual inertia setting 6: Positioning mode - Manual inertia setting	0 to 7	0	1	16 bits	During running	Immed-iately
	02h	H09-01	Stiffness level	-	0 to 40	12	1	16 bits	During running	Immed-iately
	03h	H09-02	Adaptive notch mode	0: Adaptive notch no longer updated 1: One adaptive notch activated (3rd notch) 2: Two adaptive notches activated (3rd and 4th notches) 3: Resonance point tested only (displayed in H09-24) 4: Adaptive notch cleared, 3rd and 4th notch parameters restored to default values	0 to 4	0	1	16 bits	During running	Immed-iately
	06h	H09-05	Offline inertia auto-tuning mode	0: Positive/Negative triangular wave mode 1: Jog mode 2: Bidirectional auto-tuning mode 3: Unidirectional auto-tuning mode	0 to 3	0	1	16 bits	At stop	Immed-iately
	07h	H09-06	Maximum speed of inertia auto-tuning	-	100 to 1000	500	1 mm/s	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2009	08h	H09-07	Time constant for accelerating to the maximum speed during inertia auto-tuning	-	20 to 800	125	1 ms	16 bits	At stop	Immed-iately
	09h	H09-08	Inertia auto-tuning interval	-	50 to 10000	800	1 ms	16 bits	At stop	Immed-iately
	0Ah	H09-09	Motor revolutions per inertia auto-tuning	-	15 to 10000	2000	0.01 mm	16 bits	At stop	Immed-iately
	0Ch	H09-11	Vibration threshold	-	0 to 1000	100	0.10%	16 bits	During running	Immed-iately
	0Dh	H09-12	Frequency of the 1st notch	-	50 to 4000	4000	1 Hz	16 bits	During running	Immed-iately
	0Eh	H09-13	Width level of the 1st notch	-	0 to 20	2	1	16 bits	During running	Immed-iately
	0Fh	H09-14	Depth level of the 1st notch	-	0 to 99	0	1	16 bits	During running	Immed-iately
	10h	H09-15	Frequency of the 2nd notch	-	50 to 4000	4000	1 Hz	16 bits	During running	Immed-iately
	11h	H09-16	Width level of the 2nd notch	-	0 to 20	2	1	16 bits	During running	Immed-iately
	12h	H09-17	Depth level of the 2nd notch	-	0 to 99	0	1	16 bits	During running	Immed-iately
	13h	H09-18	Frequency of the 3rd notch	-	50 to 4000	4000	1 Hz	16 bits	During running	Immed-iately
	14h	H09-19	Width level of the 3rd notch	-	0 to 20	2	1	16 bits	During running	Immed-iately
	15h	H09-20	Depth level of the 3rd notch	-	0 to 99	0	1	16 bits	During running	Immed-iately
	16h	H09-21	Frequency of the 4th notch	-	50 to 4000	4000	1 Hz	16 bits	During running	Immed-iately
	17h	H09-22	Width level of the 4th notch	-	0 to 20	2	1	16 bits	During running	Immed-iately
	18h	H09-23	Depth level of the 4th notch	-	0 to 99	0	1	16 bits	During running	Immed-iately
	19h	H09-24	Auto-tuned resonance frequency	-	0 to 4000	0	1	16 bits	At display	-
	1Fh	H09-30	Torque disturbance compensation gain	-	0 to 1000	0	0.10%	16 bits	During running	Immed-iately
	20h	H09-31	Filter time constant of torque disturbance observer	-	0 to 2500	50	0.01 ms	16 bits	During running	Immed-iately
	21h	H09-32	Gravity compensation value	-	0 to 500	0	0.1	16 bits	During running	Immed-iately
	22h	H09-33	Forward friction compensation	-	0 to 1000	0	0.10%	16 bits	During running	Immed-iately
	23h	H09-34	Reverse friction compensation	-	–1000 to 0	0	0.10%	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2009	24h	H09-35	Friction compensation speed threshold	-	1 to 300	20	1 mm/s	16 bits	During running	Immed-iately
	25h	H09-36	Friction compensation speed	0: Speed reference 1: Model tracking speed 2: Speed feedback 0x10: Reserved 0x11: Reserved 0x12: Reserved	0 to 18	0	1	16 bits	During running	Immed-iately
	26h	H09-37	Vibration detection time	-	0 to 65535	600	1s	16 bits	During running	Immed-iately
	27h	H09-38	Low-frequency resonance suppression frequency at the mechanical end	-	10 to 1000	1000	0.1 Hz	16 bits	During running	Immed-iately
	28h	H09-39	Low-frequency resonance suppression at the mechanical end	-	0 to 3	2	1	16 bits	During running	Immed-iately
	2Ah	H09-41	Frequency of the 5th notch	-	50 to 8000	4000	1 Hz	16 bits	During running	Immed-iately
	2Bh	H09-42	Width level of the 5th notch	-	0 to 20	2	1	16 bits	During running	Immed-iately
	2Ch	H09-43	Depth level of the 5th notch	-	0 to 2000	0	0.1 Hz	16 bits	During running	Immed-iately
	2Dh	H09-44	Frequency of low-frequency resonance suppression 1 at the mechanical end	-	1 to 1000	100	0.01	16 bits	During running	Immed-iately
	2Eh	H09-45	Response of low-frequency resonance suppression 1 at the mechanical end	-	0 to 200	100	0.01	16 bits	During running	Immed-iately
	30h	H09-47	Width of low-frequency resonance suppression 1 at the mechanical end	-	0 to 2000	0	0.1 Hz	16 bits	During running	Immed-iately
	32h	H09-49	Frequency of low-frequency resonance suppression 2 at the mechanical end	-	1 to 1000	100	0.01	16 bits	During running	Immed-iately
	33h	H09-50	Response of low-frequency resonance suppression 2 at the mechanical end	-	0 to 200	100	0.01	16 bits	During running	Immed-iately
	35h	H09-52	Width of low-frequency resonance suppression 2 at the mechanical end	-	0 to 200	100	0.01	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200Ah/H0A Fault and Protection Parameters										
200A	01h	H0A-00	Power input phase loss protection	0: Enable power input phase loss fault and inhibit power input phase loss warning 1: Enable power input phase loss fault and warning 2: Inhibit power input phase loss fault and warning	0 to 2	0	1	16 bits	During running	Immed-iately
	02h	H0A-01	Absolute position limit	0: Disabled 1: Enabled 2: Enabled after homing	0 to 2	0	1	16 bits	At stop	Immed-iately
	04h	H0A-03	Power-off memory selection	0: Disabled 1: Enabled	0 to 1	0	1	16 bits	During running	Immed-iately
	05h	H0A-04	Motor overload protection gain	-	50 to 300	100	1%	16 bits	At stop	Immed-iately
	08h	H0A-07	Phase sequence auto-tuning	0: Disabled during angle auto-tuning 1: Enabled during angle auto-tuning	0 to 1	0	1	16 bits	During running	Immed-iately
	09h	H0A-08	Overspeed threshold	-	0 to 10000	0	1 mm/s	16 bits	During running	Immed-iately
	0Dh	H0A-12	Runaway protection selection	0: Disabled 1: Enabled	0 to 1	1	1	16 bits	During running	Immed-iately
	0Eh	H0A-13	Initial angle auto-tuning mode	0: Pre-positioning mode 1: Jog mode 6: Static Hall mode 8: Closed-loop pre-positioning mode 9: Position lock mode	0 to 9	1	1	16 bits	At stop	Immed-iately
	10h	H0A-15	Motor running threshold in jog auto-tuning	-	1 to 1000	100	0.01% pole pitch	16 bits	At stop	Immed-iately
	11h	H0A-16	Threshold of low-frequency resonance position deviation	-	1 to 1000	5	1	16 bits	During running	Immed-iately
	14h	H0A-19	DI8 filter time constant	-	0 to 255	80	1	16 bits	At stop	Next power-on
	15h	H0A-20	DI9 filter time constant	-	0 to 255	80	1	16 bits	At stop	Next power-on
	1Ah	H0A-25	Filter time constant of displayed speed feedback	-	0 to 5000	50	1 ms	16 bits	At stop	Immed-iately
	1Bh	H0A-26	Motor overload selection	0: Not hide 1: Hide motor overload warning (Er.909) and fault (Er.620)	0 to 1	0	1	16 bits	At stop	Immed-iately
	1Ch	H0A-27	Speed DO filter time constant	-	0 to 5000	10	1 ms	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200A	1Dh	H0A-28	Filter time constant of quadrature encoder	-	0 to 255	5	125 ns	16 bits	At stop	Next power-on
	21h	H0A-32	Time window of locked rotor over-temperature protection	-	10 to 65535	200	1 ms	16 bits	During running	Immed-iately
	22h	H0A-33	Locked rotor over-temperature protection	0: Hide 1: Enable	0 to 1	1	1	16 bits	During running	Immed-iately
	27h	H0A-38	Encoder disconnection detection	0: Hide 1: Enable	0 to 1	1	1	16 bits	At stop	Immed-iately
	2Eh	H0A-45	Injection current rising slope in jog auto-tuning	-	1 to 255	5	1	16 bits	At stop	Immed-iately
	32h	H0A-49	Motor standstill threshold in jog auto-tuning	-	2 to 999	2	1p	16 bits	At stop	Immed-iately
	33h	H0A-50	Pre-positioning electrical angle	-	0 to 359	90	1°	16 bits	At stop	Immed-iately
	34h	H0A-51	Hall auto-tuning selection	0: Disabled 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
	40h	H0A-63	Current amplitude of position lock auto-tuning	-	0 to 300	200	1%	16 bits	At stop	Immed-iately
	43h	H0A-66	Acceleration feedback threshold in position lock auto-tuning	-	0 to 1000	100	0.10%	16 bits	At stop	Immed-iately
	45h	H0A-68	Position lock auto-tuning gain	-	0 to 65535	200	1 Hz	16 bits	At stop	Immed-iately
	4Bh	H0A-74	Closed-loop pre-positioning auto-tuning gain	-	0 to 20000	50	0.1 Hz	16 bits	At stop	Immed-iately
	4Ch	H0A-75	Injection current rising slope in closed-loop pre-positioning auto-tuning	-	1 to 4096	50	1	16 bits	At stop	Immed-iately
	50h	H0A-79	Closed-loop pre-positioning auto-tuning damping	-	1 to 1000	50	1%	16 bits	At stop	Immed-iately
	63h	H0A-98	2nd encoder disconnection detection	0: Hide 1: Enable	0 to 1	0	1	16 bits	During running	Immed-iately
200Bh/H0B Monitoring Parameters										
200B	01h	H0B-00	Actual motor speed	-	–9999 to +9999	0	1 mm/s	16 bits	At display	-
	02h	H0B-01	Speed reference	-	–9999 to +9999	0	1 mm/s	16 bits	At display	-

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200B	03h	H0B-02	Internal torque reference	-	–3000 to +3000	0	0.10%	16 bits	At display	-
	04h	H0B-03	Monitored DI states	-	0 to 65535	0	1	16 bits	At display	-
	06h	H0B-05	Monitored DO states	-	0 to 65535	0	1	16 bits	At display	-
	08h	H0B-07	Absolute position counter	-	0 to 65535	0	1	16 bits	At display	-
	0Ah	H0B-09	Mechanical angle	-	–2147483648 to 2147483647	0	1 reference unit	32 bits	At display	-
	0Bh	H0B-10	Electrical angle	-	0 to 65535	0	1 encoder unit	16 bits	At display	-
	0Ch	H0B-11	Speed corresponding to the input position reference	-	0 to 3600	0	0.1°	16 bits	At display	-
	0Dh	H0B-12	Average load ratio	-	–9999 to +9999	0	1 mm/s	16 bits	At display	-
	0Eh	H0B-13	Input position reference counter	-	0 to 65535	0	0.10%	16 bits	At display	-
	10h	H0B-15	Encoder position deviation counter	-	–2147483648 to 2147483647	0	1 reference unit	32 bits	At display	-
	12h	H0B-17	Feedback pulse counter	-	–2147483648 to 2147483647	0	1 encoder unit	32 bits	At display	-
	14h	H0B-19	Total power-on time	-	–2147483648 to 2147483647	0	1 encoder unit	32 bits	At display	-
	16h	H0B-21	Displayed AI1 voltage	-	0 to 2147483647	0	0.1s	32 bits	At display	-
	17h	H0B-22	Displayed AI2 voltage	-	–1200 to +1200	0	0.01 V	16 bits	At display	-
	19h	H0B-24	RMS value of phase current	-	–1200 to +1200	0	0.01 V	16 bits	At display	-
	1Bh	H0B-26	Bus voltage	-	0 to 65535	0	0.01 A	32 bits	At display	-
	1Ch	H0B-27	Power module temperature	-	0 to 65535	0	0.1 V	16 bits	At display	-

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200B	22h	H0B-33	Fault record	0: Present fault 1: Last fault 2: 2nd to last fault 3: 3rd to last fault 4: 4th to last fault 5: 5th to last fault 6: 6th to last fault 7: 7th to last fault 8: 8th to last fault 9: 9th to last fault	0 to 9	0	1	16 bits	During running	Immed-iately
	23h	H0B-34	Fault code of the selected fault	-	0 to 65535	0	1	16 bits	At display	-
	24h	H0B-35	Time stamp upon occurrence of the selected fault	-	0 to 2147483647	0	0.1s	32 bits	At display	-
	26h	H0B-37	Motor speed upon occurrence of the selected fault	-	–32767 to +32767	0	1 mm/s	16 bits	At display	-
	27h	H0B-38	Motor phase U current upon occurrence of the selected fault	-	–32767 to +32767	0	0.01 A	16 bits	At display	-
	28h	H0B-39	Motor phase V current upon occurrence of the selected fault	-	–32767 to +32767	0	0.01 A	16 bits	At display	-
	29h	H0B-40	Bus voltage upon occurrence of the selected fault	-	0 to 65535	0	0.1 V	16 bits	At display	-
	2Ah	H0B-41	Input terminal status upon occurrence of the selected fault	-	0 to 65535	0	1	16 bits	At display	-
	2Bh	H0B-42	Output terminal status upon occurrence of the selected fault	-	0 to 65535	0	1	16 bits	At display	-
	2Ch	H0B-43	Group No. of the abnormal parameter	-	0 to 65535	0	1	16 bits	At display	-
	2Dh	H0B-44	Offset of the abnormal parameter within the group	-	0 to 65535	0	1	16 bits	At display	-
	2Eh	H0B-45	Internal fault code	-	0 to 65535	0	1	16 bits	At display	-
	36h	H0B-53	Position deviation counter	-	–2147483648 to 2147483647	0	1 reference unit	32 bits	At display	-
	38h	H0B-55	Actual motor speed	-	–60000 to +60000	0	0.1 mm/s	32 bits	At display	-

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200B	3Ah	H0B-57	Bus voltage of the control circuit	-	0 to 65535	0	0.1 V	16 bits	At display	-
	3Bh	H0B-58	Mechanical absolute position (low 32 bits)	-	–2147483648 to 2147483647	0	1 encoder unit	32 bits	At display	-
	3Dh	H0B-60	Mechanical absolute position (high 32 bits)	-	–2147483648 to 2147483647	0	1 encoder unit	32 bits	At display	-
	3Fh	H0B-62	Effective value of drive output voltage	-	0 to 65535	0	1 V	16 bits	At display	-
	41h	H0B-64	Real-time input position reference counter	-	–2147483648 to 2147483647	0	1 reference unit	32 bits	At display	-
200Ch/H0C Communication Parameters										
200C	01h	H0C-00	Servo axis address	-	0 to 247	1	1	16 bits	During running	Immed-iately
	02h	H0C-01	Moment when magnetic pole auto-tuning triggered by initial controller enabling	[0]: Triggered when 6040 set to 15, this moment not enabled after auto-tuning [6]: Triggered when 6040 set to 6, this moment not enabled after auto-tuning [7]: Triggered when 6040 set to 7, this moment not enabled after auto-tuning [15]: Triggered when 6040 set to 15, this trigger enabled after auto-tuning	0 to 15	15	1	16 bits	At stop	Next power-on
	03h	H0C-02	Serial port baud rate	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps 5: 57600 bps	0 to 5	5	1	16 bits	During running	Immed-iately
	04h	H0C-03	Modbus data format	0: No parity check, 2 stop bits 1: Even parity check, 1 stop bit 2: Odd parity check, 1 stop bit 3: No parity check, 1 stop bit	0 to 3	0	1	16 bits	During running	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200C	05h	H0C-04	Station name	-	0 to 65535	0	1	16 bits	At display	-
	06h	H0C-05	Station alias	-	0 to 65535	0	1	16 bits	At stop	Immed-iately
	07h	H0C-06	Return to the starting position after pre-positioning auto-tuning completed	0: Disabled 1: Enabled	0 to 1	1	1	16 bits	At stop	Immed-iately
	0Ah	H0C-09	Communication VDI	0: Disabled 1: Enable	0 to 1	0	1	16 bits	At stop	Immed-iately
	0Bh	H0C-10	Default VDI value after power-on	0x0: VDI1 default value 0x1: VDI2 default value 0x2: VDI3 default value 0x3: VDI4 default value 0x4: VDI5 default value 0x5: VDI6 default value 0x6: VDI7 default value 0x7: VDI8 default value 0x8: VDI9 default value 0x9: VDI10 default value 0xa: VDI11 default value 0xb: VDI12 default value 0xc: VDI13 default value 0xd: VDI14 default value 0xe: VDI15 default value 0xf: VDI16 default value	0 to 65535	0	1	16 bits	During running	Next power-on
	0Ch	H0C-11	Communication VDO	0: Disable 1: Enable	0 to 1	0	1	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200C	0Dh	H0C-12	Default level when VDO allocated with function 0	0x0: VDO1 default value 0x1: VDO2 default value 0x2: VDO3 default value 0x3: VDO4 default value 0x4: VDO5 default value 0x5: VDO6 default value 0x6: VDO7 default value 0x7: VDO8 default value 0x8: VDO9 default value 0x9: VDO10 default value 0xa: VDO11 default value 0xb: VDO12 default value 0xc: VDO13 default value 0xd: VDO14 default value 0xe: VDO15 default value 0xf: VDO16 default value	0 to 65535	0	1	16 bits	At stop	Immed-iately
	0Eh	H0C-13	Update parameter values written through communication to EEPROM	0: Not update 1: Update 2000h series parameters written through communication to EEPROM 2: Update 6000h series parameters written through communication to EEPROM 3: Update 2000h and 6000h series parameters written through communication to EEPROM	0 to 3	3	1	16 bits	During running	Immed-iately
	0Fh	H0C-14	Modbus error code	0x1-0x0001: Illegal parameter No. (command code) 0x2-0x0002: Command code data address 0x3-0x0003: Illegal data 0x4-0x0004: Slave device fault	0 to 4	0	1	16 bits	At display	-
	1Ah	H0C-25	Modbus command response delay	-	0 to 5000	1	1 ms	16 bits	During running	Immed-iately
	1Bh	H0C-26	Modbus communication data sequence	0: High 16 bits before low 16 bits 1: Low 16 bits before high 16 bits	0 to 1	1	1	16 bits	During running	Immed-iately
	1Fh	H0C-30	Modbus error frame format	0: Old protocol 1: New protocol (standard)	0 to 1	1	1	16 bits	During running	Immed-iately
	21h	H0C-32	XML version No.	-	0 to 65535	0	0.01	16 bits	At display	-

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200C	22h	H0C-33	Communication fault code	-	0 to 65535	0	1	16 bits	At display	-
	23h	H0C-34	Number of synchronization interrupts	-	0 to 65535	0	1	16 bits	At display	-
	24h	H0C-35	Allowable number of EtherCAT synchronization interrupts	-	4 to 20	9	1	16 bits	During running	Immed-iately
	25h	H0C-36	Invalid frames and receiving error counter of port 0	-	0 to 65535	0	1	16 bits	At display	-
	26h	H0C-37	Invalid frames and receiving error counter of port 1	-	0 to 65535	0	1	16 bits	At display	-
	27h	H0C-38	Transfer error counter of port 0/1	-	0 to 65535	0	1	16 bits	At display	-
	28h	H0C-39	Processing unit and PDI error counter	-	0 to 65535	0	1	16 bits	At display	-
	29h	H0C-40	Port 0/1 loss counter	-	0 to 65535	0	1	16 bits	At display	-
	2Ah	H0C-41	Master type	-	0 to 3	2	1	16 bits	At stop	Next power-on
	2Bh	H0C-42	Synchronization error monitoring mode	-	0 to 1	0	1	16 bits	At stop	Immed-iately
	2Ch	H0C-43	Synchronization mode	-	0 to 2	1	1	16 bits	At stop	Immed-iately
	2Dh	H0C-44	Synchronization error threshold	-	0 to 3000	3000	1 ns	16 bits	At stop	Immed-iately
	2Eh	H0C-45	Position buffer setting	-	0 to 1	0	1	16 bits	At stop	Immed-iately
	2Fh	H0C-46	Threshold of excessive position reference increment in CSP mode	-	1 to 7	3	1	16 bits	During running	Immed-iately
	30h	H0C-47	Occurrence count of excessive position reference increment in CSP mode	-	0 to 65535	0	1	16 bits	At display	-
	31h	H0C-48	EtherCAT state machine	-	0 to 65535	0	1	16 bits	At display	-

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200Dh/H0D Auxiliary Function Parameters										
200D	01h	H0D-00	Software reset	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
	02h	H0D-01	Fault reset	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
	04h	H0D-03	Initial angle auto-tuning	0: No operation 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
	06h	H0D-05	Emergency stop	0: No operation 1: Emergency stop	0 to 1	0	1	16 bits	During running	Immed-iately
	07h	H0D-06	Current loop parameter auto-tuning	0: No operation 1: Auto-tuning with parameters saved 2: Auto-tuning with parameters unsaved 3: Static auto-tuning with parameters saved 4: Static auto-tuning with parameters unsaved 5: D-axis tuning test 6: Q-axis tuning test	0 to 6	0	1	16 bits	At stop	Immed-iately
	09h	H0D-08	Motor parameter auto-tuning	0: No operation 11: Parameter auto-tuning with parameters saved 12: Parameter auto-tuning with parameters unsaved 3: Static auto-tuning with parameters saved 4: Static auto-tuning with parameters unsaved 5: D-axis tuning test 6: Q-axis tuning test	0 to 6	0	1	16 bits	At stop	Immed-iately
	0Ah	H0D-09	One-button tuning selection	0: Disabled 1: Enabled	0 to 1	0	1	16 bits	At stop	Immed-iately
	0Dh	H0D-12	UV phase current balance correction	0: No operation 1: UV phase current balance correction	0 to 1	0	1	16 bits	At stop	Immed-iately
	0Eh	H0D-13	Rise time of current loop auto-tuning	-	0 to 99	0	62.5 μs	16 bits	At stop	Immed-iately
	0Fh	H0D-14	Steady-state error in current loop auto-tuning	-	10 to 500	10	0.10%	16 bits	At stop	Immed-iately

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
200D	10h	H0D-15	Overshoot in current loop auto-tuning	-	0 to 500	10	0.10%	16 bits	At stop	Immed-iately
	12h	H0D-17	Forced DI/DO mode	0: No operation 1: Forced DI enabled, forced DO disabled 2: Forced DO enabled, forced DI disabled 3: Forced DI and DO enabled 4: Forced DO enabled, forced DI disabled through EtherCAT control	0 to 4	0	1	16 bits	During running	Immed-iately
	13h	H0D-18	Forced DI setting	-	0 to 447	447	1	16 bits	During running	Immed-iately
	14h	H0D-19	Forced DO setting	-	0 to 7	0	1	16 bits	During running	Immed-iately
200Fh/H0F Hall Status										
200F	20h	H0F-31	Electrical angle corresponding to Hall status 1	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
	21h	H0F-32	Electrical angle corresponding to Hall status 2	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
	22h	H0F-33	Electrical angle corresponding to Hall status 3	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
	23h	H0F-34	Electrical angle corresponding to Hall status 4	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
	24h	H0F-35	Electrical angle corresponding to Hall status 5	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on
	25h	H0F-36	Electrical angle corresponding to Hall status 6	-	0 to 65535	0	1 degree	16 bits	At stop	Next power-on

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2017h/H17 VDI/VDO setting										
2017	01h	H17-00	VDI1 function selection	See H03-02 for details. Enable H0C-09 first, and then set H31-00 through communication.	0 to 39	0	1	16 bits	At stop	At stop
	02h	H17-01	VDI1 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	03h	H17-02	VDI2 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	04h	H17-03	VDI2 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	05h	H17-04	VDI3 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	06h	H17-05	VDI3 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	07h	H17-06	VDI4 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	08h	H17-07	VDI4 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	09h	H17-08	VDI5 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	0Ah	H17-09	VDI5 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	0Bh	H17-10	VDI6 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	0Ch	H17-11	VDI6 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	0Dh	H17-12	VDI7 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	0Eh	H17-13	VDI7 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	0Fh	H17-14	VDI8 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	10h	H17-15	VDI8 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	11h	H17-16	VDI9 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	12h	H17-17	VDI9 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	13h	H17-18	VDI10 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2017	14h	H17-19	VDI10 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	15h	H17-20	VDI11 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	16h	H17-21	VDI11 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	17h	H17-22	VDI12 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	18h	H17-23	VDI12 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	19h	H17-24	VDI13 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	1Ah	H17-25	VDI13 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	1Bh	H17-26	VDI14 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	1Ch	H17-27	VDI14 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	1Dh	H17-28	VDI15 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	1Eh	H17-29	VDI15 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	1Fh	H17-30	VDI16 function selection	See H17-00 for details.	0 to 39	0	1	16 bits	At stop	At stop
	20h	H17-31	VDI16 logic selection	0: Valid when logic is 1 1: Valid when logic changes from 0 to 1	0 to 1	0	1	16 bits	At stop	At stop
	21h	H17-32	VDO virtual level	-	0 to 65535	0	1	16 bits	At display	-
	22h	H17-33	VDO1 function selection	See H04-00 for details. Enable H0C-11 first, and then set H31-04 through communication.	0 to 19	0	1	16 bits	At stop	At stop
	23h	H17-34	VDO1 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	24h	H17-35	VDO2 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	25h	H17-36	VDO2 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	26h	H17-37	VDO3 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2017	27h	H17-38	VDO3 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	28h	H17-39	VDO4 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	29h	H17-40	VDO4 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	2Ah	H17-41	VDO5 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	2Bh	H17-42	VDO5 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	2Ch	H17-43	VDO6 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	2Dh	H17-44	VDO6 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	2Eh	H17-45	VDO7 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	2Fh	H17-46	VDO7 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	30h	H17-47	VDO8 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	31h	H17-48	VDO8 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	32h	H17-49	VDO9 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	33h	H17-50	VDO9 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2017	34h	H17-51	VDO10 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	35h	H17-52	VDO10 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	36h	H17-53	VDO11 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	37h	H17-54	VDO11 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	38h	H17-55	VDO12 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	39h	H17-56	VDO12 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	3Ah	H17-57	VDO13 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	3Bh	H17-58	VDO13 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	3Ch	H17-59	VDO14 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	3Dh	H17-60	VDO14 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	3Eh	H17-61	VDO15 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	3Fh	H17-62	VDO15 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
	40h	H17-63	VDO16 function selection	See H17-33 for details.	0 to 19	0	1	16 bits	At stop	At stop
	41h	H17-64	VDO16 logic level selection	0: Output 1 when function valid 1: Output 0 when function valid	0 to 1	0	1	16 bits	At stop	At stop
2030h/H30 Servo Status Variables Read Through Communication										
2030	01h	H30-00	Servo status read through communication	-	0 to 65535	0	1	16 bits	At display	-
	02h	H30-01	DO function status 1 read through communication	-	0 to 65535	0	1	16 bits	At display	-
	03h	H30-02	DO function status 2 read through communication	-	0 to 65535	0	1	16 bits	At display	-

Parameter group			Name	Description	Value Range	Default	Min. Unit	Width	Change Condition	Effective Time
Hex.		Dec.								
Group	Index Code	Para. No.								
2031h/H31 Variables Related to Communication Settings										
2031	01h	H31-00	VDI virtual level set through communication	-	0 to 65535	0	1	16 bits	During running	Immed-iately
	05h	H31-04	DO state set through communication	-	0 to 65535	0	1	16 bits	During running	Immed-iately

Object Group 6000h

Object group 6000h contains DSP402 objects supported.

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
603F	00	Error code	RO	TPDO	UINT16	-	-	-	-	-
6040	00	Control word	RW	RPDO	UINT16	-	0 to 0xFFFF	0	During running	Immed-iately
6041	00	Status word	RO	TPDO	UINT16	-	-	-	-	-
6052	00	AI1	RO	TPDO	INT32	-	-	-	-	-
6053	00	AI2	RO	TPDO	INT32	-	-	-	-	-
605A	00	Quick stop option code	RW	No	INT16	-	0 to 0x07	0x02	During running	At stop
605D	00	Stop option code	RW	No	INT16	-	0x01 to 0x03	0x01	During running	At stop
605E	00	Fault reaction option code	RW	No	INT16	-	0xFFFB to 0x03	0x02	During running	At stop
6060	00	Modes of operation	RW	RPDO	INT8	-	0 to 0x0A	0	During running	Immed-iately
6061	00	Modes of operation display	RO	TPDO	INT8	-	-	-	-	-
6062	00	Position demand value	RO	TPDO	INT32	Position unit	-	-	-	-
6063	00	Position actual value	RO	TPDO	INT32	Encoder unit	-	-	-	-
6064	00	Position actual value	RO	TPDO	INT32	Position unit	-	-	-	-
6065	00	Following error window	RW	RPDO	UINT32	Position unit	0 to 0xFFFFFFFF	0x00300000	During running	Immed-iately
6067	00	Position window	RW	RPDO	UINT32	Position unit	0 to 0xFFFFFFFF	0x000002DE	During running	Immed-iately
6068	00	Position window time	RW	RPDO	UINT16	ms	0 to 0xFFFF	0	During running	Immed-iately

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
606C	00	Velocity actual value	RO	TPDO	INT32	Velocity unit/s	-	-	-	-
606D	00	Velocity window	RW	RPDO	UINT16	RPM	0 to 0xFFFF	0x0A	During running	Immed-iately
606E	00	Velocity window time	RW	RPDO	UINT16	ms	0 to 0xFFFF	0	During running	Immed-iately
6071	00	Target torque	RW	RPDO	INT16	0.1%	0xF448 to 0x0BB8	0	During running	Immed-iately
6072	00	Max. torque	RW	RPDO	UINT16	0.1%	0 to 0x0BB8	0x0BB8	During running	Immed-iately
6074	00	Torque demand value	RO	TPDO	INT16	0.1%	-	0	-	-
6077	00	Torque actual value	RO	TPDO	INT16	0.1%	-	0	-	-
607A	00	Target position	RW	RPDO	INT32	Position unit	0x80000000 to 0x7FFFFFFF	0	During running	Immed-iately
607C	00	Home offset	RW	RPDO	INT32	Position unit	0x80000000 to 0x7FFFFFFF	0	During running	Immed-iately
607D	Software position limit									
	00	Highest sub-index supported	RO	No	UINT8	-	-	0x02	-	-
	01	Min. position limit	RW	RPDO	INT32	Position unit	0x80000000 to 0x7FFFFFFF	0x80000000	During running	Immed-iately
	02	Max. position limit	RW	RPDO	INT32	Position unit	0x80000000 to 0x7FFFFFFF	0x7FFFFFFF	During running	Immed-iately
607E	00	Polarity	RW	RPDO	UINT8	-	0 to 0xFF	0	During running	Immed-iately
607F	00	Max. profile velocity	RW	RPDO	UINT32	Velocity unit/s	0 to 0xFFFFFFFF	0x06400000	During running	Immed-iately
6081	00	Profile velocity	RW	RPDO	UINT32	User-defined velocity unit	0 to 0xFFFFFFFF	0x001AAAAB	During running	Immed-iately
6083	00	Profile acceleration	RW	RPDO	UINT32	Acceleration unit/s^2	0 to 0xFFFFFFFF	0x0A6AAAAA	During running	Immed-iately
6084	00	Profile deceleration	RW	RPDO	UINT32	Acceleration unit/s^2	0 to 0xFFFFFFFF	0x0A6AAAAA	During running	Immed-iately
6085	00	Quick stop deceleration	RW	RPDO	UINT32	User-defined acceleration unit	0 to 0xFFFFFFFF	0x7FFFFFFF	During running	Immed-iately
6086	00	Motion profile type	RW	RPDO	INT16	-	0x8000 to 0x7FFF	0	During running	Immed-iately
6087	00	Torque slope	RW	RPDO	UINT32	0.1%/s	0 to 0xFFFFFFFF	0xFFFFFFFF	During running	Immed-iately

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
6091	Gear ratio									
	00	Highest sub-index supported	RO	No	UINT8	Uint8	-	0x02	-	-
	01	Pulses per motor displacement of 1 mm	RW	RPDO	UINT32	-	0 to 0xFFFFFFFF	1	During running	Immed-iately
	02	Resolution of reference unit per load displacement of 1 mm	RW	RPDO	UINT32	-	1 to 0xFFFFFFFF	1	During running	Immed-iately
6098	00	Homing method	RW	RPDO	INT8	-	-2 to +35	0x01	During running	Immed-iately
6099	Homing speeds									
	00	Highest sub-index supported	RO	No	UINT8	-	-	0x02	-	-
	01	Speed during search for switch	RW	RPDO	UINT32	Velocity unit/s	0 to 0xFFFFFFFF	0x001AAAAB	During running	Immed-iately
	02	Speed during search for zero	RW	RPDO	UINT32	Velocity unit/s	0 to 0xFFFFFFFF	0x0002AAAB	During running	Immed-iately
609A	00	Homing acceleration	RW	RPDO	UINT32	Acceleration unit/s^2	0 to 0xFFFFFFFF	0x0A6AAAAA	During running	Immed-iately
60B0h	00	Position offset	RW	RPDO	INT32	Position unit	0x80000000 to 0x7FFFFFFF	0	During running	Immed-iately
60B1h	00	Velocity offset	RW	RPDO	INT32	Velocity unit/s	0x80000000 to 0x7FFFFFFF	0	During running	Immed-iately
60B2h	00	Torque offset	RW	RPDO	INT16	0.1%	0xF448 to 0x0BB8	0	During running	Immed-iately
60B8h	00	Touch probe function	RW	RPDO	UINT16	-	0 to 0xFFFF	0	During running	Immed-iately
60B9h	00	Touch probe status	RW	TPDO	UINT16	-	-	0	-	-
60BAh	00	Touch probe 1 positive edge	RW	TPDO	INT32	Position unit	-	0	-	-
60BBh	00	Touch probe 1 negative edge	RW	TPDO	INT32	Position unit	-	0	-	-
60BCh	00	Touch probe 2 positive edge	RW	TPDO	INT32	Position unit	-	0	-	-

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
60BDh	00	Touch probe 2 negative edge	RW	TPDO	INT32	Position unit	-	0	-	-
60D5h	0x00	Touch probe 1 positive edge counter	RO	TPDO	UINT16	-	-	0	-	-
60D6h	0x00	Touch probe 1 negative edge counter	RO	TPDO	UINT16	-	-	0	-	-
60D7h	0x00	Touch probe 2 positive edge counter	RO	TPDO	UINT16	-	-	0	-	-
60D8h	0x00	Touch probe 2 negative edge counter	RO	TPDO	UINT16	-	-	0		-
60E0h	00	Positive torque limit value	RW	RPDO	UINT16	0.1%	0 to 0x0BB8	0x0BB8	During running	Immed-iately
60E1h	00	Negative torque limit value	RW	RPDO	UINT16	0.1%	0 to 0x0BB8	0x0BB8	During running	Immed-iately

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
60E3h	Supported homing method									
	00	Highest sub-index supported	RO	No	UINT8	-	-	0x1F	-	-
	01	1st supported homing method	RO	No	UINT16	-	-	0x0301	-	-
	02	2nd supported homing method	RO	No	UINT16	-	-	0x0302	-	-
	03	3rd supported homing method	RO	No	UINT16	-	-	0x0303	-	-
	04	4th supported homing method	RO	No	UINT16	-	-	0x0304	-	-
	05	5th supported homing method	RO	No	UINT16	-	-	0x0305	-	-
	06	6th supported homing method	RO	No	UINT16	-	-	0x0306	-	-
	07	7th supported homing method	RO	No	UINT16	-	-	0x0307	-	-
	08	8th supported homing method	RO	No	UINT16	-	-	0x0308	-	-
	09	9th supported homing method	RO	No	UINT16	-	-	0x0309	-	-
	0A	10th supported homing method	RO	No	UINT16	-	-	0x030A	-	-
	0B	11th supported homing method	RO	No	UINT16	-	-	0x030B	-	-

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
60E3h	0C	12th supported homing method	RO	No	UINT16	-	-	0x030C	-	-
	0D	13th supported homing method	RO	No	UINT16	-	-	0x030D	-	-
	0E	14th supported homing method	RO	No	UINT16	-	-	0x030E	-	-
	0F	15th supported homing method	RO	No	UINT16	-	-	0x030Fh	-	-
	10	16th supported homing method	RO	No	UINT16	-	-	0x0310	-	-
	11	17th supported homing method	RO	No	UINT16	-	-	0x0311	-	-
	12	18th supported homing method	RO	No	UINT16	-	-	0x0312	-	-
	13	19th supported homing method	RO	No	UINT16	-	-	0x0313	-	-
	14	20th supported homing method	RO	No	UINT16	-	-	0x0314	-	-
	15	21th supported homing method	RO	No	UINT16	-	-	0x0315	-	-
	16	22th supported homing method	RO	No	UINT16	-	-	0x0316	-	-

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
60E3h	17	23th supported homing method	RO	No	UINT16	-	-	0x0317	-	-
	18	24th supported homing method	RO	No	UINT16	-	-	0x0318	-	-
	19	25th supported homing method	RO	No	UINT16	-	-	0x0319	-	-
	1A	26th supported homing method	RO	No	UINT16	-	-	0x031A	-	-
	1B	27th supported homing method	RO	No	UINT16	-	-	0x031B	-	-
	1C	28th supported homing method	RO	No	UINT16	-	-	0x031C	-	-
	1D	29th supported homing method	RO	No	UINT16	-	-	0x031D	-	-
	1E	30th supported homing method	RO	No	UINT16	-	-	0x031E	-	-
	1F	31th supported homing method	RO	No	UINT16	-	-	0x031F	-	-
60E6h	00	Encoder increments for the additional position	RW	No	UINT16	-	0 to 1	0	During running	Immed-iately
60F4h	00	Following error actual value	RO	TPDO	INT32	Position unit	-	-	-	-
60FCh	00	Position demand value*	RO	TPDO	INT32	Encoder unit	-	-	-	-

Index (hex)	Sub-index (hex)	Name	Access	PDO Mapping	Data Type	Unit	Data Range	Default	Change Condition	Effective Time
60FDh	00	Digital inputs	RO	TPDO	UINT32	-	-	-	-	-
60FEh	Digital outputs									
	00	DO status	RO	No	UINT8	-	-	0x02	-	-
	01	Physical outputs	RW	RPDO	UINT32	-	0 to 0xFFFFFFFF	0	During running	Immed-iately
	02	Output mask	RW	No	UINT32	-	0 to 0xFFFFFFFF	0	During running	Immed-iately
60FFh	00	Target velocity	RW	RPDO	INT32	Velocity unit/s	0x80000000 to 0x7FFFFFFF	0	During running	Immed-iately
6502h	00	Supported drive modes	RO	No	UINT32	-	-	0x000003AD	-	-

SDO transfer abort code

Abort Code	Description
0503 to 0000	Trigger bits not alternated
0504 to 0000	SDO protocol timeout
0504 to 0001	Client/server command word invalid or unknown
0504 to 0005	Memory overflow
0601 to 0000	Access to objects not supported
0601 to 0001	Attempt to read a write-only object
0601 to 0002	Attempt to write a read-only object
0602 to 0000	Object not existed in the object dictionary
0604 to 0041	Object cannot be mapped to PDO
0604 to 0042	Number and length of mapped objects exceed the PDO length
0604 to 0043	General parameters incompatible
0604 to 0047	General device content incompatible
0606 to 0000	Access to object failed due to a hardware error
0607 to 0010	Data type and service parameter length not match
0607 to 0012	Data type not match and service parameter too long
0607 to 0013	Data type not match and service parameter too short
0609 to 0011	Sub-index not existed
0609 to 0030	Invalid parameter value
0609 to 0031	Parameter value entered too large
0609 to 0032	Parameter value entered too small
0609 to 0036	Maximum value smaller than the minimum value
0800 to 0000	General error
0800 to 0020	Data cannot be transmitted or stored to the application

Abort Code	Description
0800 to 0021	Data cannot be transmitted or stored to the application due to local control
0800 to 0022	Data cannot be transmitted or stored to the application due to current device status
0800 to 0023	Object dictionary error occur or object dictionary not exist
0800 to 0024	Value not exist

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