中科时代
SINSEGYE

SV3H-E series AC servo driver

User Manual

- Thank you for purchasing SINSEGYE servo drivers.
- Before operating this product, please read the manual carefully.
- Please save this manual for future use.
- If there are some changes of this manual,it wouldn't inform users.

Preface

Thank you for utilizing our products. This manual provides information on SV3H servo drives and the corresponding motors.

Content

- Installation and inspection of servo drives & motors
- servo architecture and the wiring diagrams
- Steps of commissioning operation
- Training on servo tuning
- Description on parameters
- Description on communication protocol
- Alarm clear
- Inspection and maintenance

SV3H features

SV3H servo drive is general AC servo product independently developed by SINSEGYE, which provides inertia identification, automatic gain adjustment and other functions to make the drive simple and easy to use. With the latest development of servo motors, it achieves rapid and accurate control with cost-effective solutions in electronic manufacturing, robot, packaging, lathe and other industries of automation. The latest improved design for servo drive structure can save the inner space of cabinet. The new generation of motor design can meet the need on miniaturization of equipment structure and lightweight.

How to use this manual

This manual will tell you how to install, configure, use and maintain the product. Prior to tuning, read Chapter 1 to Chapter 8.

Technical service

If you still have problems with the application, please contact the distributor or our customer service center.

Version change log

Date of release	Version	Change

2024.7	V1.0	First edition release

Copyright statement

Disclaimer

This product documentation is accurate and reliable at the time of release, and SINSEGYE reserves the right to change this manual without any additional notice.

About the manual

This manual is not attached to the product package. If you need to get electronic PDF files, download on SINSEGYE website (https://www.sinsegye.com.cn/). If you need consulting or assistance, please contact our company.

Contents

Safety precautions

Safety Statement

- This chapter describes the safety precautions for proper use of the product. Before using this product, please read the instruction manual and correctly understand the relevant safety precautions. Failure to comply with the safety precautions may result in death, serious injury, or equipment damage.
- "Danger", "Alarm" and "attention" in the manual do not represent all the safety matters that shall be followed, but only supplement all the safety precautions.
- This product should be used in an environment that meets the requirements of the design specifications, otherwise it may cause failure, and functional abnormalities or component damage caused by failure to comply with the relevant regulations are not within the scope of product quality assurance.
- Our company will not bear any legal responsibility for personal safety accidents and property losses caused by non-compliance with the contents of this chapter and illegal operation of products.

Note for safety levels

⚠ Danger	The sign refers to "To result in death or serious injury".
⚠ Alarm	The sign refers to "The most probably to result in death or serious injury".
⚠ Attention	The sign refers to "The most probably to result in injury or damage to property".

Note for safety precautions

Unpacking acceptance

⚠ Alarm

- Do not install if product and the accessories are found while unpacking with damage, rust, trace of use,etc.
- Do not install if there is any water inside product, or missing part, or damanged part.
- Please check the packing list carefully. If the packing list does not match product name, do not install!

⚠ Attention

- Before unpacking, check if outer package of the device is intact, damaged, soaked, damp, or deformed.
- Please open the package in order. Do not knock it hard!
- Before unpacking, please check the surface of the equipment and accessories for damage, rust or damage.
- After unpacking, please check if quantity and information of equipment and accessories are complete in accordance with the packing list.

Storage and transport

⚠ Alarm

- Be sure to use professional lifting equipment and have qualified personnel operate large/heavy products. Otherwise, there is the risk of injury or product damage!
- Before lifting the product vertically, ensure that the front cover, terminal block and other components of product are firmly secured with screws. Otherwise, components might fall off, that results in personal injury or product damage.
- When the product is being lifted by lifting equipment, it is forbidden to stand or stay under the product.
- When lifting the product with wire rope, please lift it at a steady and uniform speed, prevent products from vibration or impact; Do not turn products over, nor make products in lifting state for a long time, or there is the risk of personal injury or product damage!

⚠ Attention

- While moving the product, be sure to handle it gently and always pay attention to any object under feet to prevent tripping or falling, or it may result in personal injury or product damage!
- When handling the product manually, be sure to grasp product shell firmly to avoid any component falling, or it might result in personal injury!
- Please store and transport in strict accordance with the required storage and transportation conditions of product, or there is a risk of product damage.
- Avoid storage and transportation in such places as water splashing and rain falling, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid product storage time above 3 months, if the period was too long, please take more stringent protection and necessary inspection.
- Please strictly package the product prior to vehicle transportation; For long distance transportation, it must use the enclosed cargo van.
- It's strictly prohibited to transport this product together with equipment or articles that may affect or damage this product.

Installation

⚠ Danger

- Operators must obtain electrical knowledge and have been trained on electrical equipment. Non-professional personnel are strictly prohibited for any operation!

⚠ Alarm

- Please read the user's manual and safety precautions carefully prior to installation!
- Do not install this product in places in strong electric field or with strong electromagnetic wave interference!
- Before installation, please make sure that the mechanical strength of installation positions is sufficient to support device weight. Otherwise, it might casue mechanical hazards.
- Do not wear loose clothing or accessories during installation, otherwise there might be a risk of electric shock!
- When installing the product in the enclosed environment (e.g., cabinet or chassis), please use the

cooling device (e.g., cooling fan or cooling AC.) to cool the product sufficiently in order to meet the environment requirement on installation. Otherwise, it might cause product overheart or even a fire.

- It's strictly prohibited to modify this product!
- It's strictly forbidden to screw the fixing bolts and red marked bolts of parts and components of product!
- When the product is installed in a cabinet or terminal equipment which shall be provided with fire protection shell, electrical protection shell and mechanical protection shell. The protection level shall comply with relevant IEC standards and local rules and regulations.
- When it's necessary to install the equipment with strong electromagnetic interference such as transformer, please install shielding protection device to avoid misoperation of this product!
- Please install the product on flame-retardant metal, do not make flammable substances contact the product or attach flammable substances to the product, otherwise there might be a risk of fire.

⚠ Attention

- During installation, please cover the top of product with cloth or paper to prevent foreign articles, such as scrap metal, oil and water, from entering the product that could result in Errors. After operation, please remove the cover to avoid blocking the ventilation and affecting heat radiation, that results in abnormal heating of product.
- Resonance may occur when a machine at a constant speed runs at variable speeds. Here, it can effectively weaken the resonance to mount the anti-vibration rubber under motor frame or to utilize vibration suppression function.

Wiring

⚠ Danger

- It's strictly prohibited for non-professional personnel to perform equipment installation, wiring, maintenance, inspection or part replacement!
- Before wiring, please power off all devices. As the power-off devices have built-in capacitors which have residual voltage, please wait at least the period specified in the Alarm label before wiring. Measure DC voltage of main loop and confirm that it's under the safe voltage, otherwise there is a risk of electric shock.
- Please perform wiring operation, remove the cover of product, or touch circuit board when it powers off. Otherwise, there is a risk of electric shock.
- Please ensure that devices and products are properly grounded; Otherwise, electric shocks might occur.

⚠ Alarm

- It's strictly prohibited to connect the input power to output of device or product; Otherwise, device might be damaged or even it starts a fire.
- When drive is connected to the motor, please ensure that the phase sequence of product and motor terminals are accurate and consistent so as to avoid reversing motor rotation.
- Cables used for wiring must meet the requirement on diameters and shielding, correspondingly. Shielding layer of shielded cables shall be reliably grounded at single end.
- Tighten terminal screws according to tightening torque specified in the manual. Insufficient or excessive tightening torque may cause overheating or damage to the connection, and even start a fire.

- After wiring operation ends, ensure that all cables are properly connected and no screw, gasket or exposed wire are found inside the product. Otherwise, there might be a risk of electric shock or product damage.

⚠ Attention

- To avoid damage to the equipment or built-in circuit of product, follow the steps specified in ESD preventive measures and wear a wrist strap to handle wiring operation.
- For wiring of control loop, use double-stranded shielding cables to connect the shielding layer to grounding terminal of the product. Otherwise, it might cause abnormal actions of the product.

Power-on

⚠ Danger

- Before power-on, please make sure that the product is installed properly, the wiring is firm, and the motor is allowed to re-start.
- Before power-on, please make sure that power supply meets the product requirement to avoid product damage or starting a fire.
- It is strictly forbidden to open cabinet doors or protective cover plates of product, to touch any terminal of product, to disassemble any device or component of product in the power-on state. Otherwise, there is a risk of electric shock!

⚠ Alarm

- After wiring and parameter setting ends, please do a test run to ensure that the machine can operate safely. Otherwise, it might result in human injury or device damage.
- Before power-on, please make sure that the rated voltage of product is consistent with power supply voltage. If power supply voltage used was incorrect, there is a risk of fire.
- Before power-on, please make sure that no one is around the product, motor or motor. Otherwise, it might result in personal injury or death.

Operation

⚠ Danger

- It is strictly forbidden for non-professional personnel to operate the product, otherwise it might lead to personal injury or death!
- It is strictly forbidden to touch any terminal of the equipment, to disassemble any device or component of the equipment and product during operation, otherwise there is a risk of electric shock!

⚠ Alarm

- Do not touch the device shell, fan or resistor to test the temperature, otherwise it may cause burns!
- During operation, prvent other articles or metal objects from falling into the equipment, otherwise it might start a fire or cause product damage!

Maintenance

⚠ Danger

- It's strictly prohibited for non-professional personnel to perform equipment installation, wiring, maintenance, inspection or part replacement!
- It is strictly prohibited to perform equipment maintenance in the power-on state, otherwise there is the risk of electric shock!
- After powering off all the equipment, wait at least the period specified on the Alarm label before maintenance.
- When using a motor, even if the product is powered off, induced voltage can be generated on motor terminals during motor rotation. Do not touch any terminal of motors, otherwise there may be a risk of electric shock.

⚠ Alarm

- Please perform daily and routine check and maintenance of the equipment and products according to the maintenance requirement, and make the maintenance records.

Repair

⚠ Danger

- It's strictly prohibited for non-professional personnel to perform equipment installation, wiring, maintenance, inspection or part replacement!
- It is strictly prohibited to perform maintenance in power-on state, otherwise there is a risk of electric shock!
- After powering off all devices, please wait at least the period specified in the Alarm label before checking or maintaining.

⚠ Alarm

- Please repair the equipment according to the product warranty.
- When fuse burn-out, circuit breaker trip or ELCB trip, wait at least the period specified on the Alarm label before powering on or operating the machine. Otherwise, it may cause personal injury or equipment damage.
- When the equipment is Errory or damaged, it is necessary for professional to troubleshoot and repair the equipment and products according to the maintenance guidance, and make a repair record.
- Please replace in accordance with the instructions for replacing consumable parts.
- Do not use the machine damaged, otherwise it might cause casualties or further damage to products.
- After replacing the device, be sure to check the wiring and set parameters again.

Scrap

⚠ Alarm

- Please scrap the equipment and products in accordance with the relevant national regulations and standards to avoid property losses or human casualties!
- Scrapped equipment and products should be recycled in accordance with industrial waste treatment

standards to avoid environmental pollution.

Chapter 1 Model selection and installation

1.1 Model Definition for Servo Drives

SV3H - E S 3R5 - S G

① ② ③ ④ ⑤ ⑥

<table>
<tr>
<td>① Product series
SV3H:SV3H series high-performance servo drive</td>
<td rowspan="3">④ Rated current
Single/3-phase 220V
1R6:1.6A
2R8:2.8A
5R5:5.5A
7R6:7.6A
012:12A
014:14A*1
3-phase 220V
018:18A*1
022:22A*1
027:27A*1
3-phase 380V
3R5:3.5A
5R4:5.4A
8R4:8.4A
012:11.9A
017:16.5A
021:20.8A
026:26A</td>
<td>⑤ Safety function
Vacancy: Standard model
S: Safe torque Off (STO) *2</td>
</tr>
<tr>
<td>② Communication method
P: Pulse
E:EtherCAT
C:CANopen
F:Profinet
R:RS485</td>
<td>⑥ Custom function
Vacancy: Standard model
C: Full closed-loop function
G: Gantry function
A: Analog interface *3</td>
</tr>
<tr>
<td>③ Voltage level
S: Single/3-phase 220V
U: 3-phase 220V
T: 3-phase 380V</td>
<td>……</td>
</tr>
</table>

Note *1: S014, U018, U022, U027 models are coming soon.

*2: STO is not supported for CANopen and RS485

*3: Only Canopen and RS485 models are supported

1.2 Model Definition for Motors

1.2.1 SM3-M2 Series Servo Motor

SM3-M2	**H**	**130**	**-**	**S**	**85B**	**15C**	**-**	**N**	**H**	**1**	**B**	**1**
①	②	③		④	⑤	⑥		⑦	⑧	⑨	⑩	⑪

① Product series SM3-M2:SM3-M2 series motors	⑤ Rated power /W B:×10 C:×100 Example: 85B:850W	⑨ Keyway type 0: Round 1:Key way
② Class of inertia A: Low inertia M: Medium inertia H: High inertia	⑥ Rated speed /rpm B:×10 C:×100 Example: 15C:1500rpm	⑩ Holding brake N: Without holding brake B: With holding brake
③ Flange size /mm 130:130 flange 180:180 flange	⑦ Encoder type M:17Bit absolute value of single turn N:17Bit absolute value of multiple turns P:23Bit absolute value of multiple turns	⑪ Oil seal 0: Without oil seal 1: With oil seal
④ Voltage level S:AC220V	⑧ Interface type H: Aviation plug connector	……

1.2.2 SM3-M3 Series Servo Motor

SM3-M3 H 80 - S 75B 30C - M T 1 N 1

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪

① Product series SM3-M3:SM3-M3 series motors	⑤ Rated power /W B:×10 C:×100 Example: 75B:750W	⑨ Keyway type 0:Round 1:Key way
② Class of inertia A: Low inertia M: Medium inertia H: High inertia	⑥ Rated speed /rpm B:×10 C:×100 For example, 30C:3000rpm	⑩ Holding brake N: Without holding brake B: With holding brake
③ Flange size /mm 40:40 Flange 60:60 flange 80:80 flange	⑦ Encoder type M:17Bit absolute value of single turn N:17Bit absolute value of multiple turns P:23Bit absolute value of multiple turns	⑪ Oil seal 0: Without oil seal 1: With oil seal
④ Voltage level S:AC220V	⑧ Interface type T: connector type	……

1.3 Specifications

1.3.1 Basic Parameters of the Model

Table 1-1 Basic parameters of the model

Item			Description
Basic specification	Control mode		IGBT SVPWM control, sine wave current drive mode. 220V, 380V: single-phase or 3-phase full-wave rectification.
	Environment	Usage/storage temperature *1	0~+40 °C/-20~+70°C
		Use/store humidity	Less than 90%RH (no condensation)
		Vibration strength	4.9m/s^2
		Impact strength	19.6m/s^2
		Class of protection	IP20
		Class of contamination	Class PD2
		Altitude	The highest altitude is 5,000m. Derating is unnecessary for 1,000m or below; Derating rate is 1% per 100m rise above 1,000m. Please contact the manufacturer in case of altitudes over 2,000m.
Position control Mode	Performance	Feedforward compensation	Support speed feedforward (0~100.0%) setting to eliminate following deviation
		Command shaping	Position instruction low-pass filtering, average filtering
	Frequency division Output	Output pattern	Phase A, Phase B, Phase Z: differential output
		Frequency division range	The motor rotates one circle, and the frequency can be divided into any pulse from 140 to 1,048,576.
Speed /Torque Control mode	Performance	Dynamic characteristics of current loop	Step response: 187.5us(0~100%) Frequency response: -3dB amplitude attenuation bandwidth, 2000Hz(command signal: ±25%) -90° phase shift bandwidth, 3500Hz(command signal: ±25%);
		Speed control range	from 0 to 12000rpm. In case of the requirement over 6000rpm, please contact the manufacturer.
		Dynamic characteristics of speed loop	Step response: 562.5us(0~1000rpm) Frequency response: -3dB amplitude attenuation bandwidth, 1000Hz(command signal: ±500rpm) -90° phase shift bandwidth, 630Hz(command signal: ±500rpm);
		Torque control	±2%

		accuracy	
I/O	Digital input signal		Functions can be configured: forward overrange switch, reverse overrange switch, origin switch, etc.
	Digital output signal		Functions can be configured: servo ready, zero speed signal, speed arrival, position arrival, positioning approach signal, torque limit, Alarm, servo Error, etc.
Support function	Electronic gear ratio		Built-in two sets of electronic gear ratio, support gear ratio switching function
	Position limitation protection		Stop immediately while forward/reverse overrange switch operates.
	Error detection		Overcurrent, overvoltage, undervoltage, overload, main circuit detection abnormal, radiator overheating, overspeed, encoder abnormal, parameter abnormal, etc.
	Display function		5-digit LED display, power indicator CHARGE
	Vibration suppression		With 4 notch filters, 50Hz~5000Hz, all 4 notch filters can be adaptive setting.
	Ease of use		Self-tuning, speed observer, model tracking
	Debugging interface		MiniUSB
	Other		Status display, alarm logging, JOG running, etc.
⚠ Attention			
Note *1: Install or store servo drives within this temperature range.			

1.3.2 Specifications of EtherCAT Communication

Table 1-2 EtherCAT communication specification

Item		Specification
EtherCAT Basic performance of slave station	Communication protocol	EtherCAT protocol
	Support service	CoE（PDO、SDO）
	Synchronous mode	DC-distributed clock
	Physical layer	100BASE-TX
	Transmission rate	100 MBit/s (100BASE-TX)
	Duplex mode	Full duplex
	Topological structure	Circular, linear
	Transmission medium	Shielded Category 5E cable or higher category
	Transmission distance	Less than 100m between two nodes (good environment, good cable)
	Number of slave stations	Protocol support up to 65,535, the actual quantity is not more than 100 sets
	EtherCAT frame length	from 44 to 1498 bytes
	Process data	A single Ethernet frame has a maximum of 1,486 bytes.
	Synchronous jitter of 2 slave stations	< 1µs
	Refresh time	I/O of 1000 switching quantity is about 30µs; 100 servo shafts about 100µs; Define different refresh time for different interfaces.
	Communication bit error rate	10-10 Ethernet standard
EtherCAT Configuration unit	Fieldbus memory management unit	8
	Storage synchronization management unit	8
	Process data RAM	8K bytes
	Distributed clock,DC	64-bit
	EEPROM capacity	32kBit Initialization data is written by EtherCAT master station

1.3.3 Electrical Parameters of Models

Table 1-3 Electrical specifications of 220V servo drives

Structural dimension	**SIZE A**		**SIZE B**	**SIZE C**			**SIZE D**		
Model SV3H	S1R6	S2R8	S5R5	S7R6	S012	S014*1	U018*1	U022*1	U027*1
Rated output current Arms	1.6	2.8	5.5	7.6	11.6	14.0	18	22	27
Maximum output current Arms	5.8	10.1	16.9	23.0	32.0	42.0	45.0	55.0	72.0
Rated input current Arms	Single-phase 2.3/ 3-phase 1.4	Single-phase 4.0/ 3-phase 2.6	Single-phase 7.9/ 3-phase 4.4	Single-phase 9.6/ 3-phase 5.6	Single-phase 12.8/ 3-phase 8.0	Single-phase 16.0/ 3-phase 10.2	18.7	20.7	24.4
Main circuit power supply	Single/3-phase AC 200V ~ 240V, -10%～+10%，50/60Hz						3-phase AC 200V ~ 240V, -10%～+10%，50/60Hz		
Power supply of control loop	Single-phase AC200V~240V, -10%~+10%, 50/60Hz								
Regenerative resistance	No built-in regenerative resistance as standard		50Ω/50W	25Ω/80W			20Ω/100W		

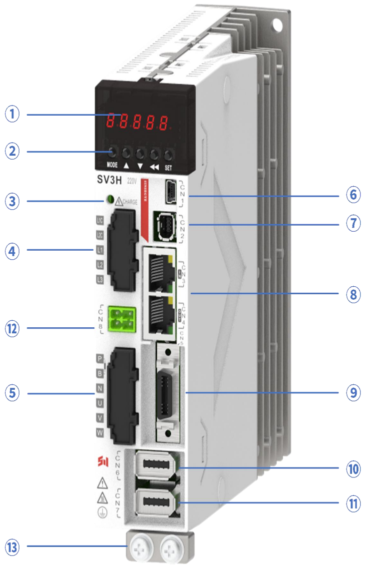
Note *1: S014/U018/U022/U027 models are coming soon.

Table 1-4 Electrical specifications of 380V servo drives

Structural dimension	**SIZE C**				**SIZE D**		
Model SV3H	T3R5	T5R4	T8R4	T012	T017	T021	T026
Rated output current Arms	3.5	5.4	8.4	11.9	16.5	20.8	26.0
Maximum output current Arms	11.0	14.0	20.0	29.8	41.3	52.1	65.0
Rated input current Arms	2.4	3.6	6.6	8.0	12.0	16.0	21.0
Main circuit power supply	3-phase AC380V~440V, -10%~+10%, 50/60Hz						
Power supply of control loop	Single-phase AC380V~440V, -10%~+10%, 50/60Hz						
Regenerative resistance	100Ω/80W		50Ω/80W		35Ω/100W		

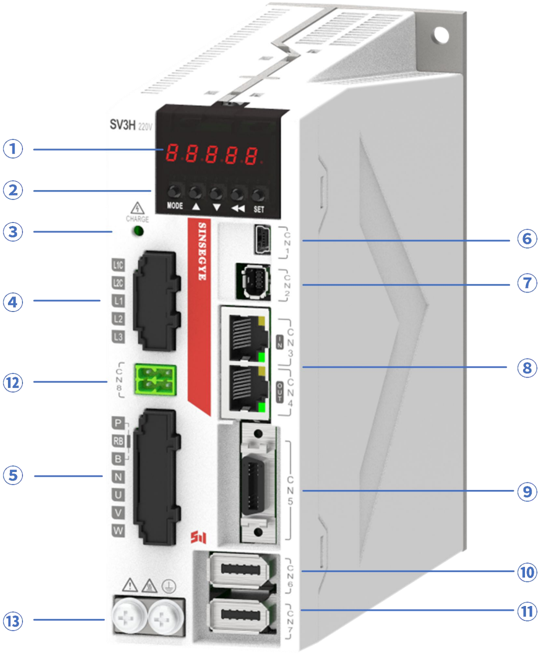
1.4 Description on Components

1.4.1 SIZE A Frame



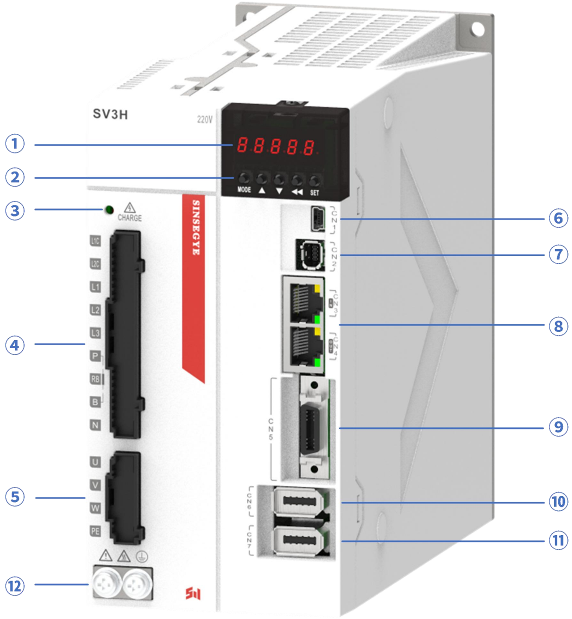
ID	Name	Remarks
①	Nixie tube display	5 digit 7 segment LED digital tube
②	Key-type operator	Operation mode, with settings of functions, parameters and monitoring
③	CHARGE(Bus voltage indicator)	Power indicator light
④	L1C, L2C(Control power input terminal)	Power supply of control loop, connected to single-phase power supply (AC200~240V,50/60Hz power supply)
	L1, L2, L3(Main power input terminal)	Power supply of main loop, connected to single/3-phase power supply (AC200~240V,50/60Hz power supply)
⑤	P/B(Regenerative resistor connection terminal)	P/B are connected to external regenerative resistors
	P/N(common DC bus terminal)	Common DC bus for multiple servos
	U/V/W(servo motor connection terminal)	Servo drive output, connected to motor power connector (U/V/W)
⑥	CN1(Mini USB)	Mini USB connector, connected to PC
⑦	CN2(Connector for safety function)	STO connector, only 'P/E/F' models support this option
⑧	CN3/CN4(Communication terminal)	EtherCAT high-speed communication port
⑨	CN5(I/O Connector)	I/O signals are connected to programmable controller (PLC) or control I/O with connectors
⑩	CN6(Encoder connector)	Encoder connector, connected to the encoder on servo motor
⑪	CN7(Fully Closed Loop Encoder Connector)	Fully closed loop connector, connected to th external second encoder. This function is supported by '-*C/*G' models
⑫	CN8(Reserved)	Reserved interface
⑬	Ground screw	Connect to earth wires of power supply and motors

1.4.2 SIZE B Frame



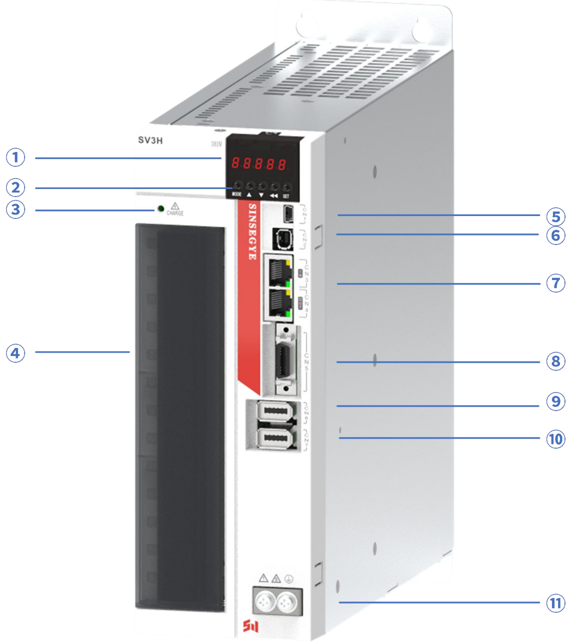
ID	Name	Remarks
①	Nixie tube display	5 digit 7 segment LED digital tube
②	Key-type operator	Operation mode, with settings of functions, parameters and monitoring
③	CHARGE(Bus voltage indicator)	Power indicator light
④	L1C, L2C(Control power input terminal)	Power supply of control loop, connected to single-phase power supply (AC200~240V,50/60Hz power supply)
	L1, L2, L3(Main power input terminal)	Power supply of main loop, connected to single/3-phase power supply (AC200~240V,50/60Hz power supply)
⑤	P, RB, B(Regenerative resistor connection terminal)	Use external regenerative resistor(remove the shorting cap of P and RB; Connect it to both ends of P and B)
	P/N(common DC bus terminal)	Common DC bus for multiple servos
	U/V/W(servo motor connection terminal)	Servo drive output, connected to motor power connector (U/V/W)
⑥	CN1(Mini USB)	Mini USB connector, connected to PC
⑦	CN2(Connector for safety function)	STO connector, only 'P/E/F' models support this option
⑧	CN3/CN4(Communication terminal)	EtherCAT high-speed communication port
⑨	CN5(I/O Connector)	I/O signals are connected to programmable controller (PLC) or control I/O with connectors
⑩	CN6(Encoder connector)	Encoder connector, connected to the encoder on servo motor
⑪	CN7(Fully Closed Loop Encoder Connector)	Fully closed loop connector, connected to th external second encoder. This function is supported by '-*C/*G' models
⑫	CN8(Reserved)	Reserved interface
⑬	Ground screw	Connect to earth wires of power supply and motors

1.4.3 SIZE C Frame



ID	Name	Remarks
①	Nixie tube display	5 digit 7 segment LED digital tube
②	Key-type operator	Operation mode, with settings of functions, parameters and monitoring
③	CHARGE(Bus voltage indicator)	Power indicator light
④	L1C, L2C(Control power input terminal)	Control power supply of loop, connect to single phase power supply(depending on model 200~240VAC or 380~440VAC, 50/60Hz power supply)
	L1, L2, L3(Main power input terminal) R/S/T(Main power input terminal)	Main loop power supply, connect to single/three phase power supply(depending on model 200~240VAC or 380~440VAC, 50/60Hz power supply)
	P, RB, B(Regenerative resistor connection terminal)	Use external regenerative resistor(remove the shorting cap of P and RB; Connect it to both ends of P and B)
	P/N(common DC bus terminal)	Common DC bus for multiple servos
⑤	U/V/W/PE(servo motor connection terminal)	Servo drive output, connected to motor power connectors(U/V/W/PE)
⑥	CN1(Mini USB)	Mini USB port, connected to PC
⑦	CN2(Connector for safety function)	STO connector, only 'P/E/F' models support this option
⑧	CN3/CN4(Communication terminal)	EtherCAT high-speed communication port
⑨	CN5(I/O Connector)	I/O signals are connected to programmable controller (PLC) or control I/O with connectors
⑩	CN6(Encoder connector)	Encoder connector, connected to the encoder on servo motor
⑪	CN7(Fully Closed Loop Encoder Connector)	Fully closed loop connector, connected to th external second encoder. This function is supported by '-*C/*G' models
⑫	Ground screw	Connect to earth wires of power supply and motors

1.4.4 SIZE D Frame



ID	Name	Remarks
①	Nixie tube display	5 digit 7 segment LED digital tube
②	Key-type operator	Operation mode, with settings of functions, parameters and monitoring
③	CHARGE(Bus voltage indicator)	Power indicator light
④	L1C, L2C(Control power input terminal)	Control power supply of loop, connect to single phase power supply(depending on model 200~240VAC or 380~440VAC, 50/60Hz power supply)
	R/S/T(Main power input terminal)	Main loop power supply, connect to single/three phase power supply(depending on model 200~240VAC or 380~440VAC, 50/60Hz power supply)
	P, RB, B(Regenerative resistor connection terminal)	Use external regenerative resistor(remove the shorting cap of P and RB; Connect it to both ends of P and B)
	P/N1/N2(Common DC bus terminals)	Do not remove the shorting cap between N1 and N2. Connect it between P and N1 for common DC bus of multiple servos
	U/V/W(servo motor connection terminal)	Servo drive output, connected to motor power connector (U/V/W)
⑤	CN1(Mini USB)	Mini USB port, connected to PC
⑥	CN2(Connector for safety function)	STO connector, only 'P/E/F' models support this option
⑦	CN3/CN4(Communication terminal)	EtherCAT high-speed communication port
⑧	CN5(I/O Connector)	I/O signals are connected to programmable controller (PLC) or control I/O with connectors
⑨	CN6(Encoder connector)	Encoder connector, connected to the encoder on servo motor
⑩	CN7(Fully Closed Loop Encoder Connector)	Fully closed loop connector, connected to th external second encoder. This function is supported by '-*C/*G' models
⑪	Ground screw	Connect to earth wires of power supply and motors

1.5 Installation of Drives

1.5.1 Installation Site

Table 1-5 Drive installation sites

Please install in an electric control cabinet free from sunshine and rain
Do not use this product in corrosive environment with hydrogen sulfide, chlorine gas, ammonia, sulfur, chlorinated gas, acid, alkali, salt
Do not use this product in the presence of flammable gases or near the combustible
Do not install in an environment with high temperature, humidity, dust, or metal dust
Vibration-free site
Installation site contamination level: PD2

1.5.2 Environmental Conditions

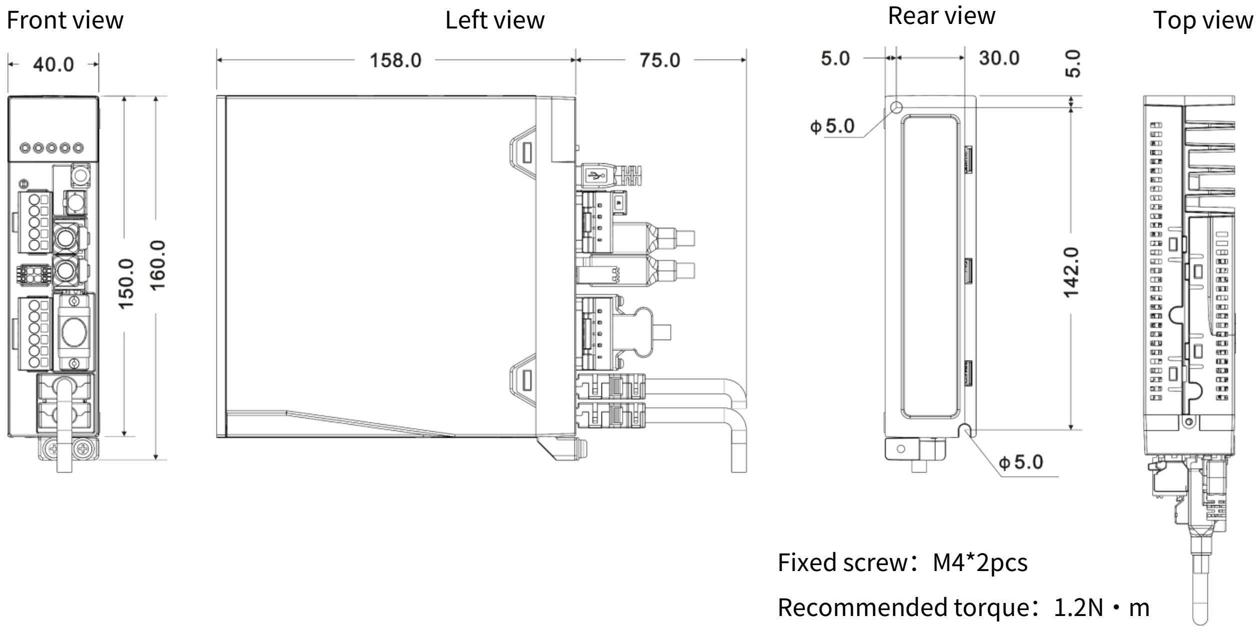
Table 1-6 Environment conditions of drive installation

Item	Description
Operating ambient temperature	0 ~ +40 °C
Ambient humidity	Less than 90%RH (no condensation)
Storage temperature	-20~70°C(non-freezing)
Storage humidity	Less than 90%RH (no condensation)
Vibration	Below 4.9m/s2
Impulse	Below 19.6m/s2
Class of protection	IP20 Note: Except Terminal (IP00)
Altitude	The highest altitude is 5,000m. Derating is unnecessary for 1,000m or below; Derating rate is 1% per 100m rise above 1,000m. Please contact the manufacturer in case of altitudes over 2,000m.

1.5.3 Installation Dimensions

1.5.3.1 SIZE A frame

Approx. weight: 0.77kg.



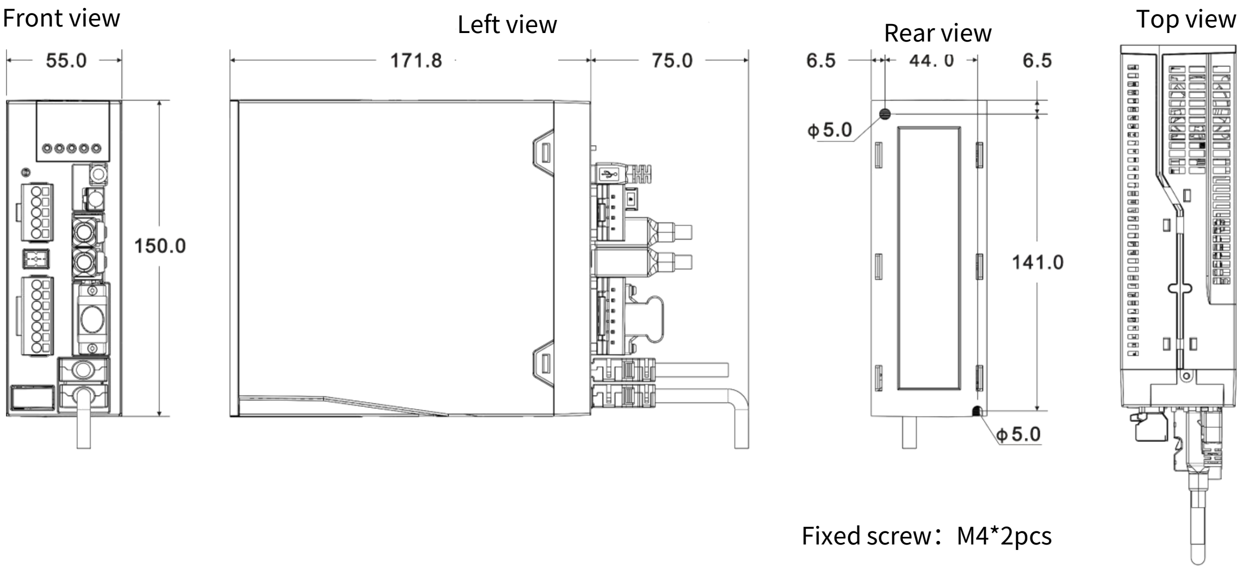
Fixed screw：M4*2pcs

Recommended torque：1.2N・m

Figure 1-1 Appearance of SV3H SIZE A

1.5.3.2 SIZE B frame

Approx. weight: 1.10kg.



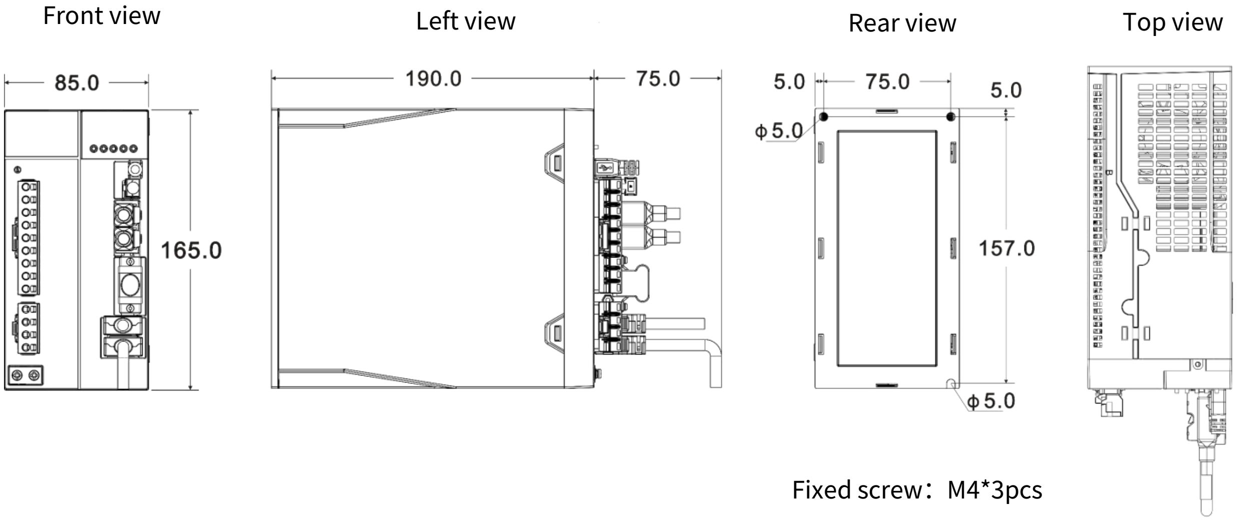
Fixed screw：M4*2pcs

Recommended torque：1.2N・m

Figure 1-2 Appearance of SV3H SIZE B

1.5.3.3 SIZE C frame

Approx. weight: 1.75kg.



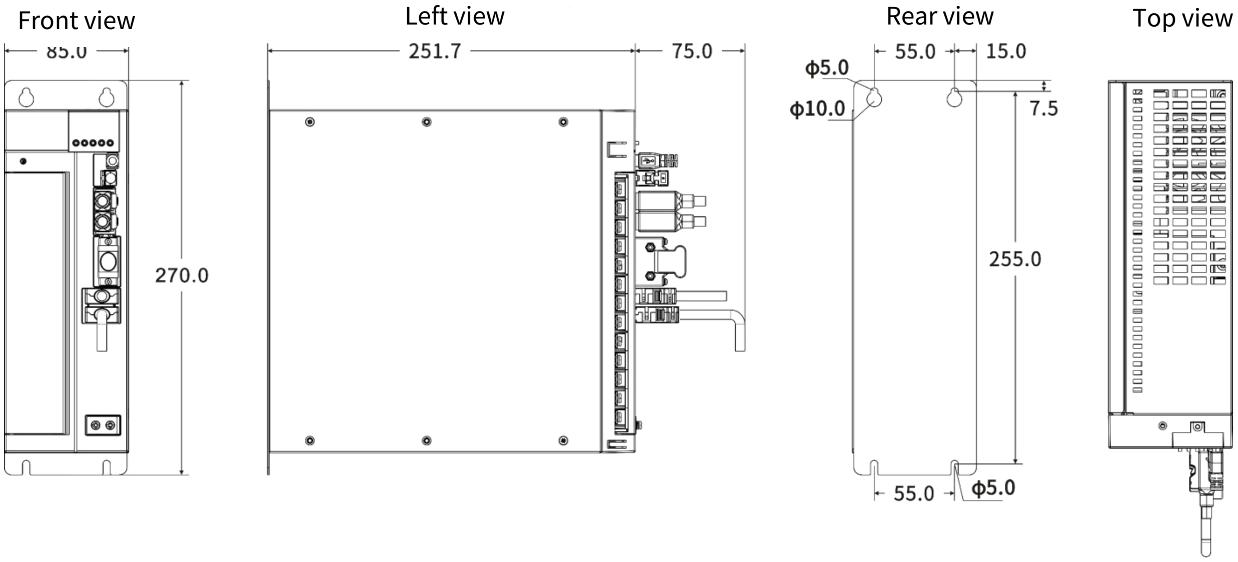
Fixed screw：M4*3pcs

Recommended torque：1.2N·m

Figure 1-3 Appearance of SV3H SIZE C

1.5.3.4 SIZE D frame

Approx. weight: 2.58kg.



Fixed screw：M4*4pcs

Recommended torque：1.2N·m

Figure 1-4 Appearance of SV3H SIZE D

1.5.4 Installation Precautions

7Table 1-7 Notes for drive installation

Installation requirements	Ensure that mounting direction is perpendicular to the wall(drive mounting face is 90° from the bottom surface, vertically upward). Use natural convection or fan to cool servo drives. It is firmly fixed on mounting face through mounting holes of servo drive. Screws and torque used for installation see the above figure. While installing, the front of drive faces operational personnel for easy operation and maintenance.
The requirement for heat radiation	To ensure the heat radiation of drives, please design the heat radiation solution of control cabinet according to the following figure. Please install a cooling fan on the top of servo drive to ensure that temperature of servo drive is uniform without local overheat.
Space requirement	For installation with the spacing reserved, it's recommended to leave the transverse spacing more than 10mm on both sides of the drive and the longitudinal spacing more than 50mm on both sides of the drive. For compact installation, it's recommended to leave the transverse spacing more than 1mm on both sides of the drive and the longitudinal spacing more than 50mm on both sides of the drive. Here, please derate the rated load ratio to 75%.

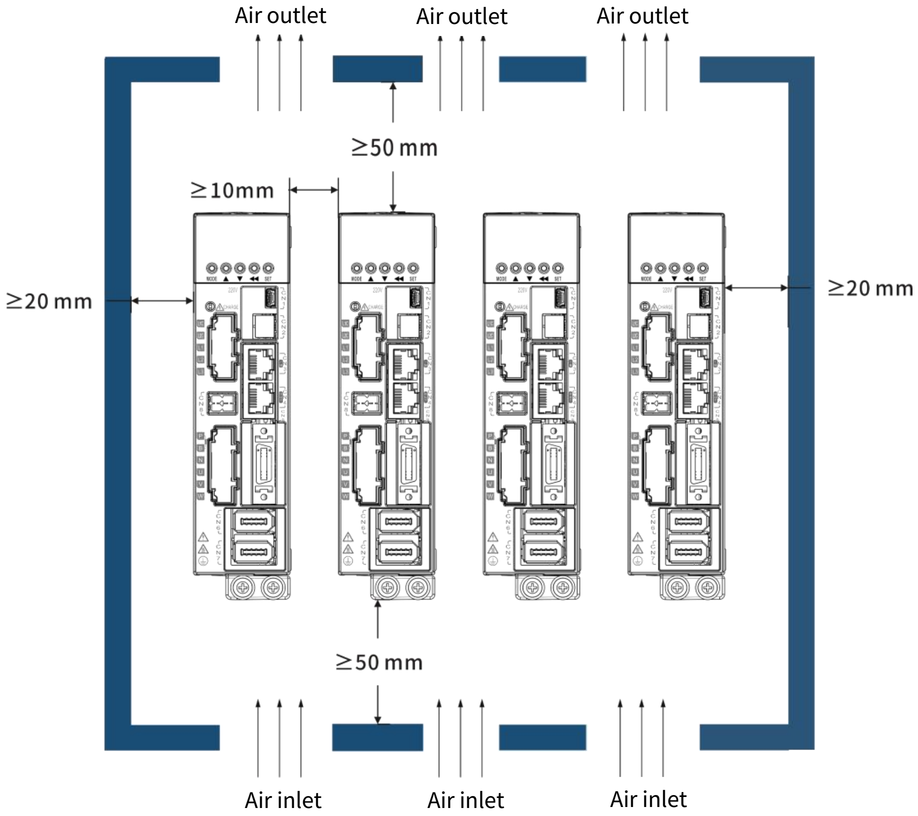


Figure 1-5　Servo drive installation diagram (for the spacing is reserved)

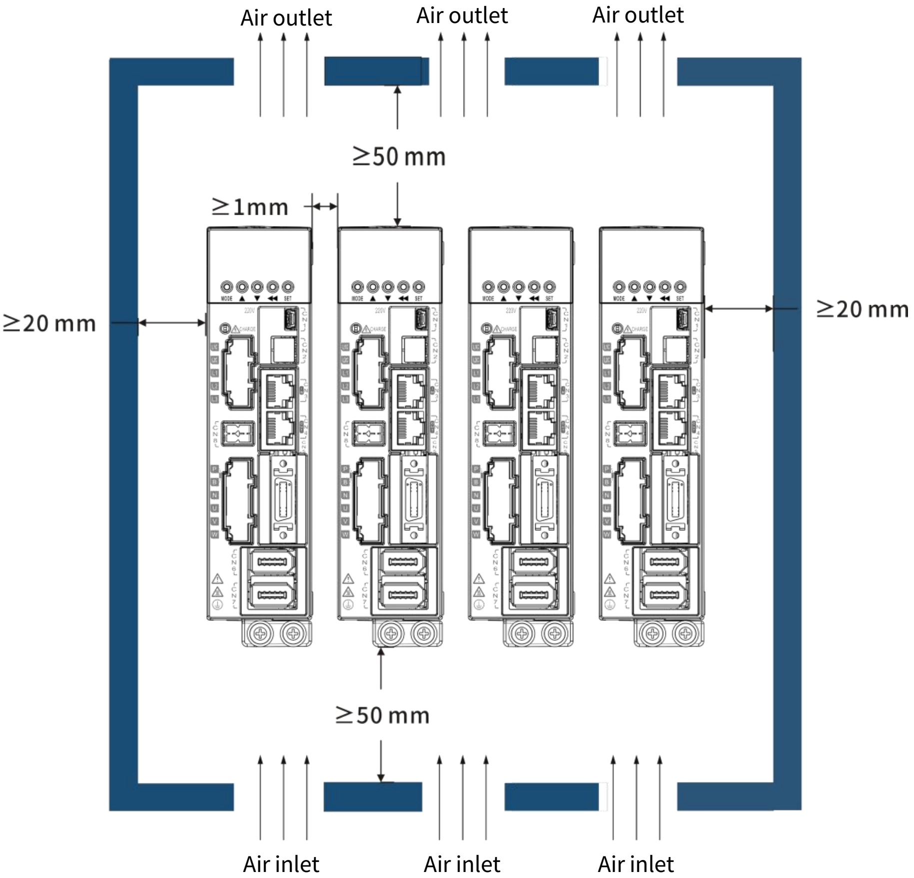


Figure 1-6 Servo drive installation diagram (for compact installation)

1.5.5 Grounding

Please ensure to ground the grounding terminal, otherwise there might be a risk of electric shock or misoperation from intreference.
For details on electrical ground, see 2.9 Grounding and anti-interference Measures.

1.5.6 Wiring Requirements

When connecting cables to the driver, route the cables downward (see the following figure) to prevent any liquid from flowing into drives that might cause damage.

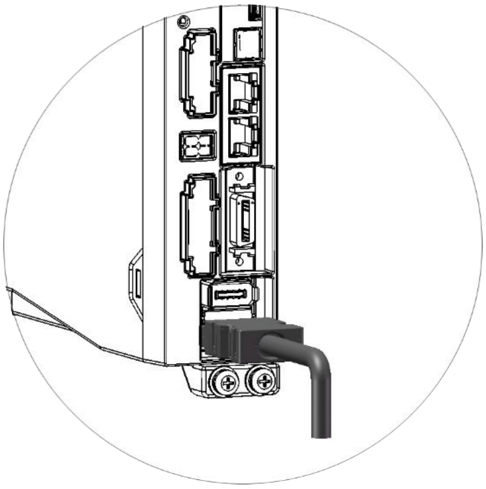


Figure 1-7 Requirement for servo drive routing

1.6 Motor Installation

1.6.1 Installation Site

Table 1-8 Installation site of motors

Please install motors in a room free from rain and direct sunlight.
Do not use this product in corrosive environment with hydrogen sulfide, chlorine gas, ammonia, sulfur, chlorinated gas, acid, alkali, salt,etc.
Do not use this product in the presence of flammable gases or near the combustible.
Places without cutting fluid, oil mist, iron powder, and iron filings.
Places in good ventilation, no moisture or oil or water intrusion, away from furnace and other heat sources.
Vibration-free place.
Place for easy inspection and cleaning.
Do not use a motor in the enclosed environment which will cause high temperature of motor and shorten the service life.

1.6.2 Environment Conditions

Table 1-9 Environmental conditions for motor use

Item	Description	
Operating ambient temperature	0 ~ +40 °C	
Ambient humidity	Less than 90%RH (no condensation)	
Storage temperature	-20~70°C(non-freezing)	
Storage humidity	Less than 90%RH (no condensation)	
Vibration	Only for motor	Below 49 m/s2 when rotating, below 24.5m /s2 when stopping
Impulse	Only for motor	Below 98 m/s2
Class of protection	Connector-type motor	IP67(The cable used is specified, except for connection pins of output shaft rotation, motor connector, encoder connector)
	Wire-type motor	IP65(except for connection pins of output shaft rotation, motor connector, encoder connector)
Altitude	The highest altitude is 5,000m. Derating is unnecessary for 1,000m or below; Derating rate is 1% per 100m rise above 1,000m. Please contact the manufacturer in case of altitudes over 2,000m.	

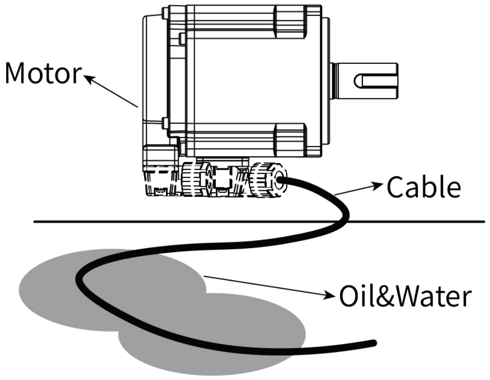
1.6.3 Installation Methods

Motor can be installed vertically or horizontally, but the following requirements must be followed.

Installation mode	Notes
Horizontal installation	Put cable outlet facing down to avoid oil and water infiltration inside motor.
Vertical installation	When a motor with reducer is installed axially, please use the motor with oil seal to avoid reducer oil seeping inside motor.

1.6.4 Protection Countermeasures for Oil and Water

Do not immerse the cable into oil or water, or use the special oil-proof cable
Set the cable outlet downwards.
Do not use in the environment where oil/water often splashes on motor body.
When equipped with a reducer, please use the motor with oil seal so as to avoid the oil seeping from shaft extension into motor.



1.6.5 Cable stress

① Do not stress the lead-in part and connection part of cable due to bending and self-weight.
② Particularly, when move motors and use a trunk cable that can be stored in cable tray, it shall minimize the bending stress of cable.
③ Try to increase the bending radius of cable.

1.7 Drag chain installation cable

High-flex rag chain dcable plays an important role in signal, control and power transmission of the equipment. High-flex drag chain cable must be synchronized with other components in carrier. Furthermore, it must take care of installation and protection of high-flex drag chain cable in carrier particularly. Stable and effective use with a long service life depends on accurate installation.

1. Ensure that cable is completely free to move within the bending radius, i.e., the cable can move relative to each other and to guide device without any forced movement. When high-flex cable is routed in carrier, it can neither be too loose, nor too tight: the former might cause cable to bend and twist in carrier so as to affect its service life; The latter might lead in greater friction between the cable and inner wall of carrier so as to cause cable sheath wear and tear, and increase radial force of cable, as well as cable distortion that affects the service life.

Cable fixture must be mounted at both ends of cable carrier, and the fixing point can't be moved; The distance from the end of bending curve to the fixture shall be as large as possible, in general, greater than 20 to 30 times cable diameter.

It's forbidden to fix the high-flex drag chain cable in any moving part of cable carrier, or bundle the cables in cable carrier together, that would hinder the absorption and dispersion capability of cable for bending stress, and would affect the service life.

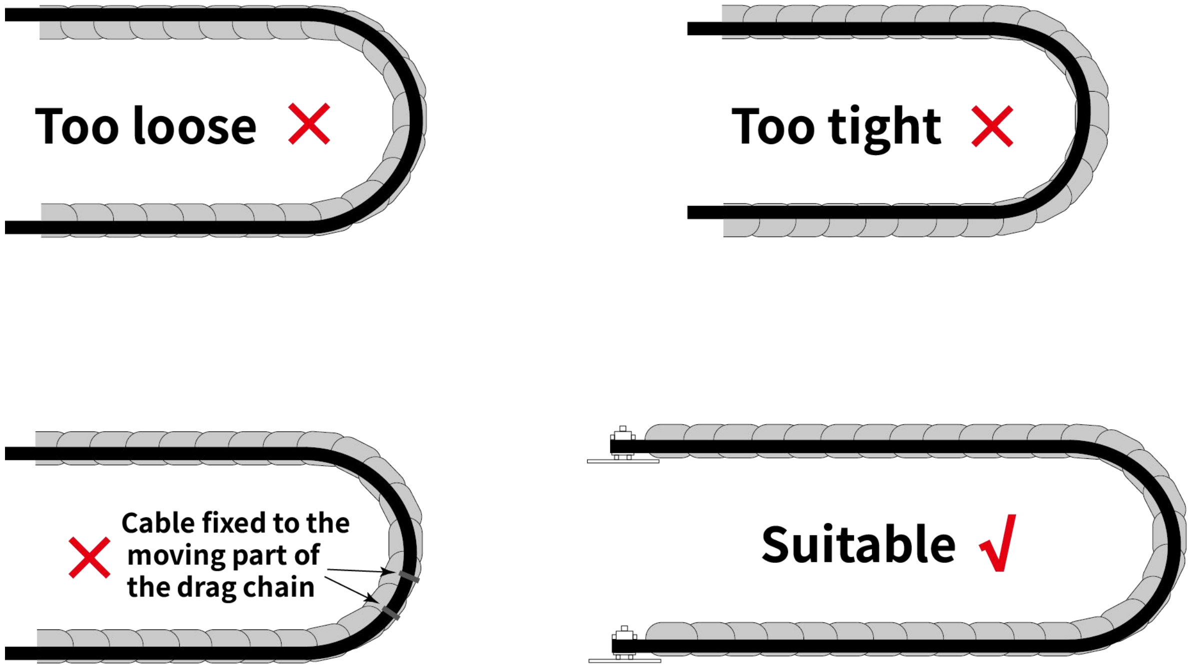


Figure 1-8 Installation status of cables in the drag chain

2. As for wiring of the high-flex cable in carrier, the cable should be laid side by side in the support of carrier as far as possible. There must be a certain gap between two adjacent cables; The gap betwee cables in carrier shall be at least 10% of cable diameter.

Avoid multi-layer routing of cable(i.e., avoid arranging one cable on another without using a spacer). If the space is limited and it need place one cable on another, it must utilize a spacer or shelves!

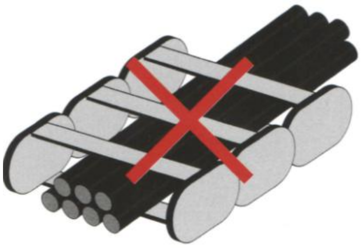
If there is a large difference in diameter of cables, and the diameter difference of cables is greater than 20% wiring size, it is necessary to utilize a partition between two cables to avoid the play of cables or winding each other.

The filling coefficient of cables in carrier should be controlled below 60% (less than 30% is more ideal).

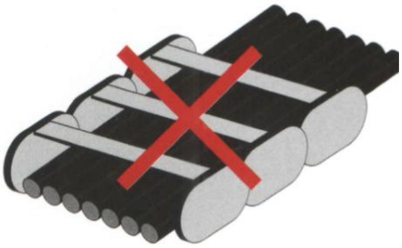
In order to ensure the balance of cable carrier in motion, the weight of the cable distributed on carrier should be as balanced as possible; It's recommended that the heavier cable be located on both sides and the lighter one be located in the middle.

Note: A: After a period of operation, periodically check the position of cable; The check must be performed

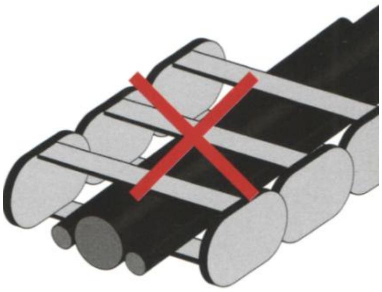
after any push/pull movement; If there is any displacement, it shall be improved and adjusted in time.
B: For vertically suspended cable carrier, there must be more free space inside the bracket, because the cable will be stretched during operation due to gravity. After a period of operation and use, regularly check the length and position of cable; The check must be performed after any push/pull movement; If there is any displacement, it shall be improved and adjusted in time.



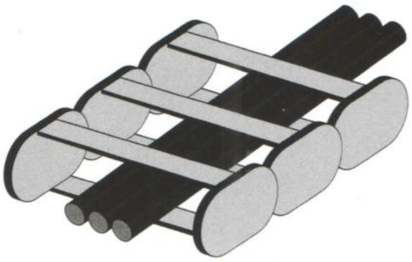
Error



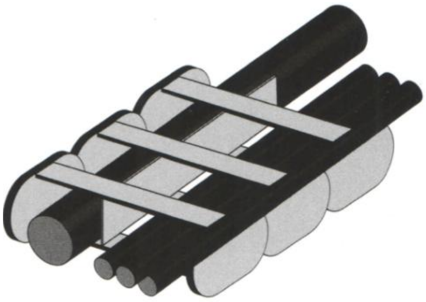
Error



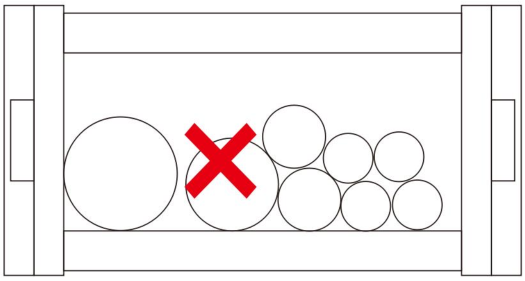
Error

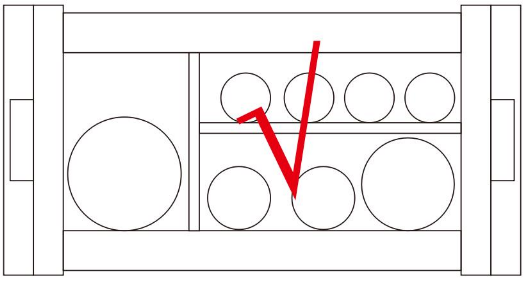


Right



Right

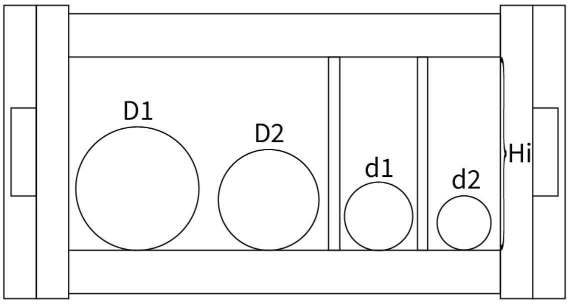




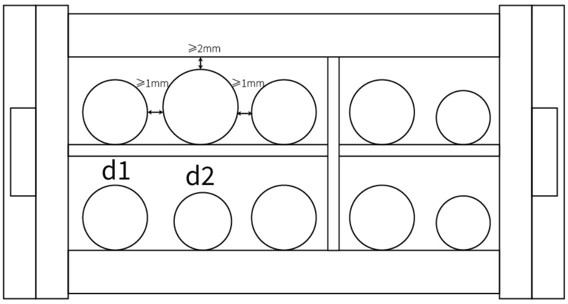
3. If cable carrier is damaged or broken, the cable also needs to be replaced, because damages from excessive stretching can't be prevented or repaired.
4. Bending radius of the flexible cable used in cable carrier should conform to technical parameters in the product specification.
5. After a period of operation, regularly check the position of cable, and often confirm that the cable can follow the carrier movement without any force; The inspection must be performed after push-pull movement; If any displacement or force exists, it shall be improved and adjusted in time.
6. To lay multi-core high-flexible cables with a diameter less than 10mm, it's recommended to use a guide duct.
7. For freely moving pipes, guide duct or partition should be mounted.
8. Adjacent cables can't cross over each other, so the gap over cable should not be greater than 50% of the diameter of adjacent cables.
The rules below must be followed:

Rule 1: If D1+D2>1.2 times the inner height of cable carrier, it's unnecessary to separate the two cables. The cables can't cross over or wrap each other (shown as below).

Rule 2: If D1+D2<1.2 times the inner height of cable carrier, separator must be used to reduce the gap (shown as below).



D1+D2＞1.2×Hi d1+d2⩽1.2×Hi

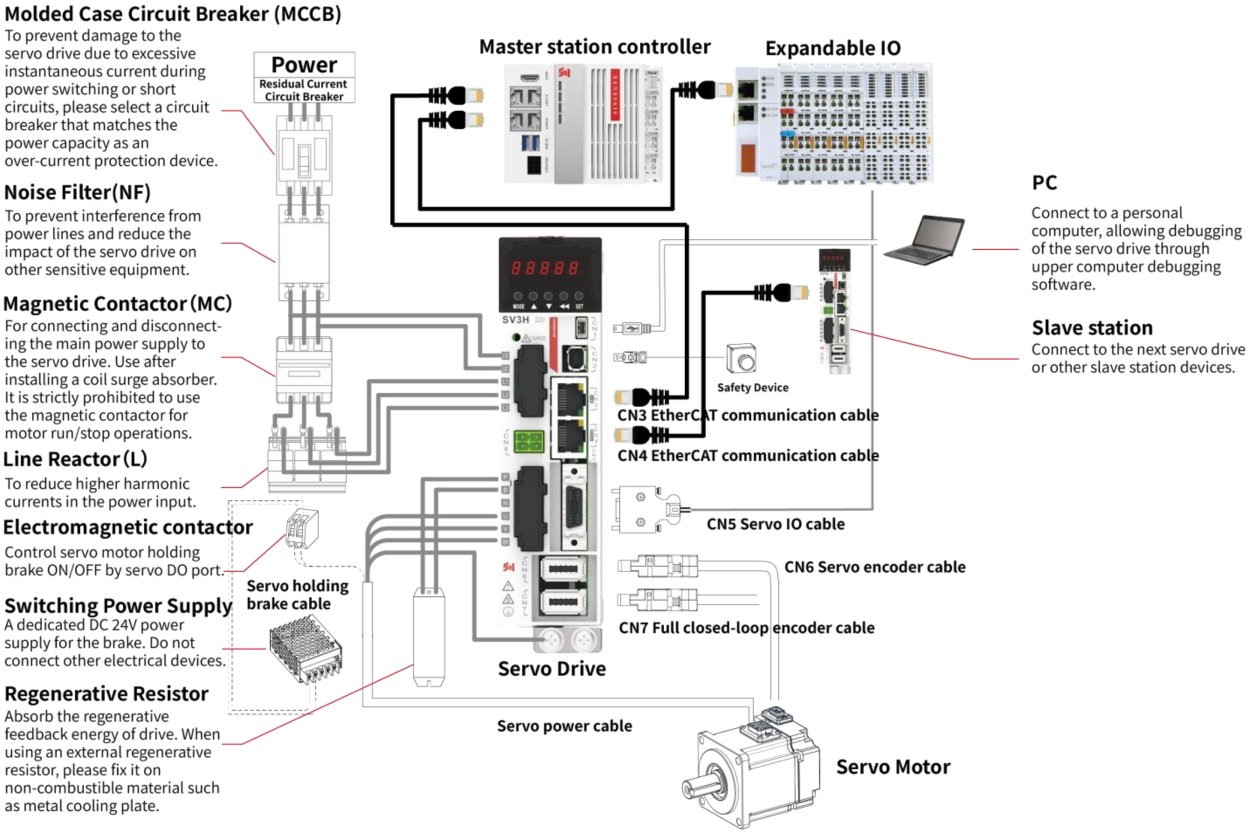


d1+d2⩽1.2×Hi

Chapter 2 Wiring

2.1 Description on System Wiring

2.1.1 SIZE A overall wiring



Molded Case Circuit Breaker (MCCB)
To prevent damage to the servo drive due to excessive instantaneous current during power switching or short circuits, please select a circuit breaker that matches the power capacity as an over-current protection device.

Noise Filter(NF)
To prevent interference from power lines and reduce the impact of the servo drive on other sensitive equipment.

Magnetic Contactor (MC)
For connecting and disconnecting the main power supply to the servo drive. Use after installing a coil surge absorber. It is strictly prohibited to use the magnetic contactor for motor run/stop operations.

Line Reactor (L)
To reduce higher harmonic currents in the power input.

Electromagnetic contactor
Control servo motor holding brake ON/OFF by servo DO port.

Switching Power Supply
A dedicated DC 24V power supply for the brake. Do not connect other electrical devices.

Regenerative Resistor
Absorb the regenerative feedback energy of drive. When using an external regenerative resistor, please fix it on non-combustible material such as metal cooling plate.

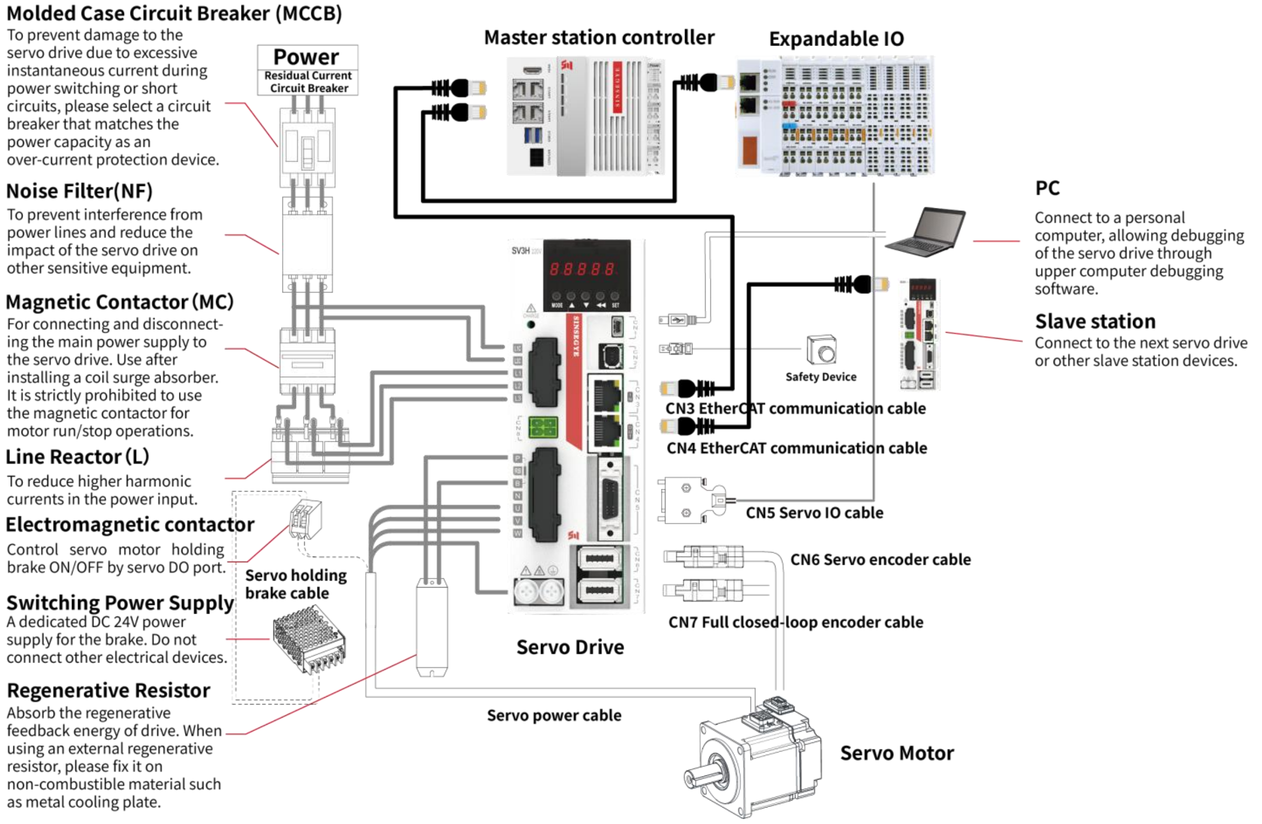
PC
Connect to a personal computer, allowing debugging of the servo drive through upper computer debugging software.

Slave station
Connect to the next servo drive or other slave station devices.

Figure 2-1　SV3H SIZE A wiring diagram

- As for single-phase power input, power supply can be connected to any 2 terminals of L1/L2/L3.
- Please use a circuit breaker with leakage protection and noise filter between power supply and the main power terminal;
- Voltage and power of holding brake power supply should meet the requirement on parameters of motor holding brake.
- SIZE A has no built-in regenerative resistor, in case of the application with external regenerative resistor, please select the appropriate resistance. It can't be less than the allowable minimum external resistance, otherwise it might cause damage to the driver.
- CN3 is the EtherCAT communication input, connected to the controller or the previous servo; CN4 is the EtherCAT communication output, connected to the next servo.

2.1.2 SIZE B overall wiring



Molded Case Circuit Breaker (MCCB)
To prevent damage to the servo drive due to excessive instantaneous current during power switching or short circuits, please select a circuit breaker that matches the power capacity as an over-current protection device.

Noise Filter(NF)
To prevent interference from power lines and reduce the impact of the servo drive on other sensitive equipment.

Magnetic Contactor (MC)
For connecting and disconnecting the main power supply to the servo drive. Use after installing a coil surge absorber. It is strictly prohibited to use the magnetic contactor for motor run/stop operations.

Line Reactor (L)
To reduce higher harmonic currents in the power input.

Electromagnetic contactor
Control servo motor holding brake ON/OFF by servo DO port.

Switching Power Supply
A dedicated DC 24V power supply for the brake. Do not connect other electrical devices.

Regenerative Resistor
Absorb the regenerative feedback energy of drive. When using an external regenerative resistor, please fix it on non-combustible material such as metal cooling plate.

PC
Connect to a personal computer, allowing debugging of the servo drive through upper computer debugging software.

Slave station
Connect to the next servo drive or other slave station devices.

Figure 2-2 SV3H SIZE B wiring diagram

- As for single-phase power input, power supply can be connected to any 2 terminals of L1/L2/L3.
- Please use a circuit breaker with leakage protection and noise filter between power supply and the main power terminal;
- Voltage and power of holding brake power supply should meet the requirement on parameters of motor holding brake.
- SIZE B has the built-in regenerative resistor, in case of the application with external regenerative resistor, please select the appropriate resistance. It can't be less than the allowable minimum external resistance, otherwise it might cause damage to the driver. Remove jumper bar between P and RB, connect it to both ends of P and B.
- CN3 is the EtherCAT communication input, connected to the controller or the previous servo; CN4 is the EtherCAT communication output, connected to the next servo.

2.1.3 SIZE C overall wiring

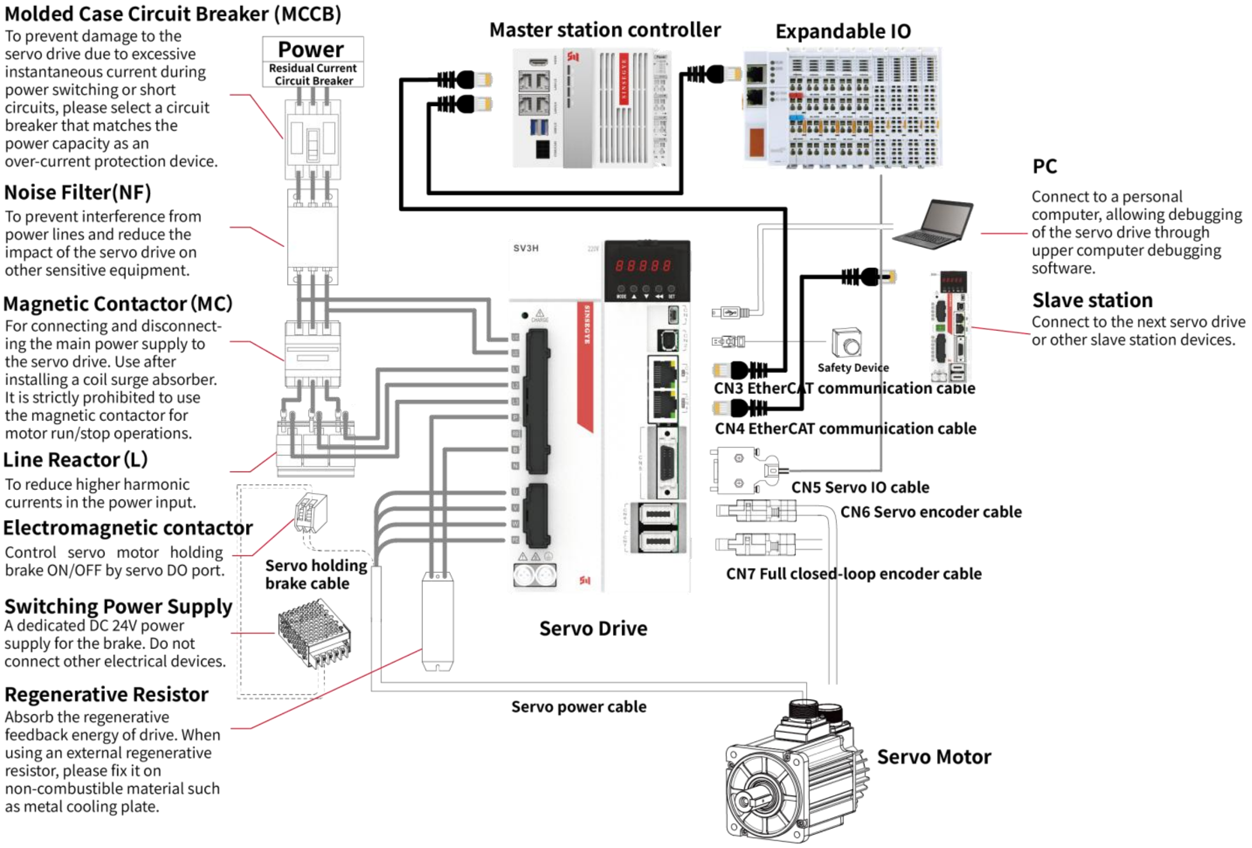
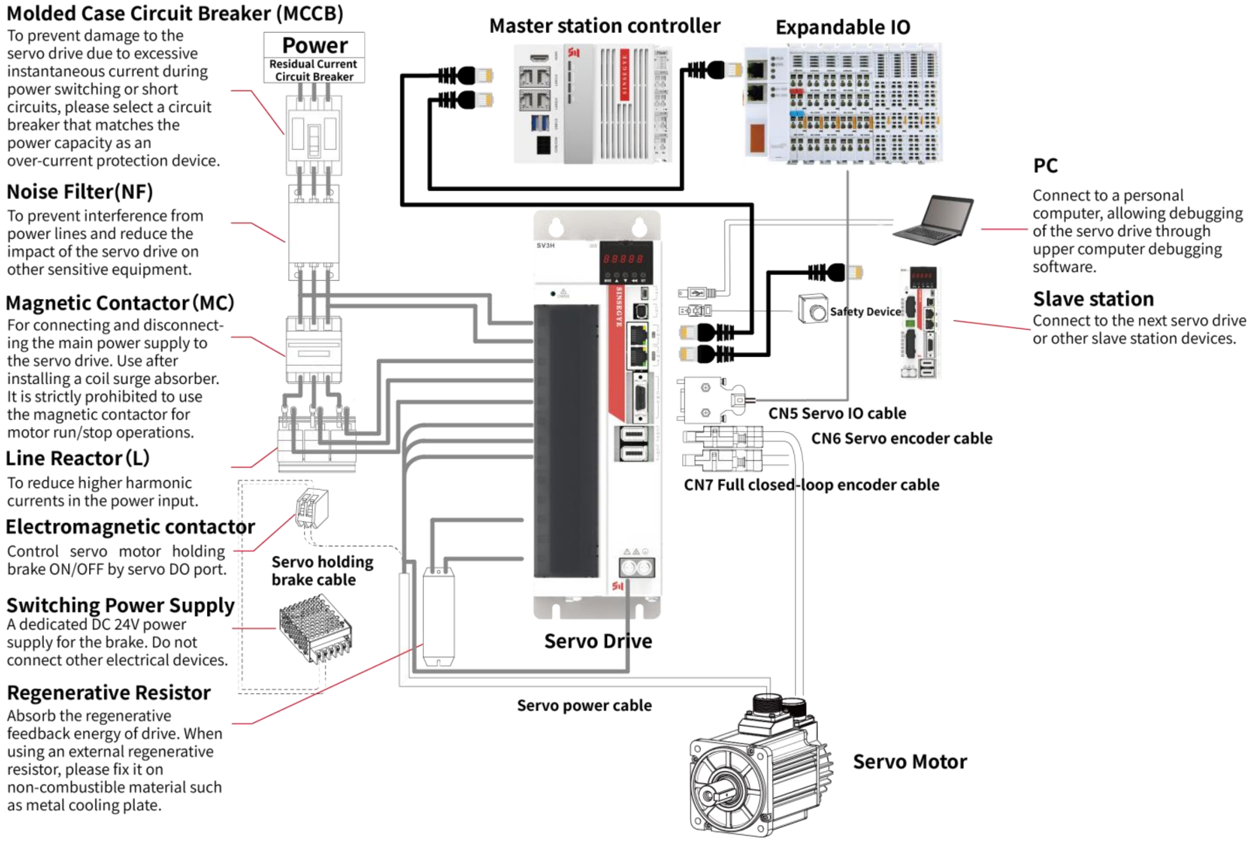


Figure 2-3 SV3H SIZE C system wiring diagram

- SIZE-C has 2 models: 220VAC and 380VAC. Please select the power supply voltage upon the actual model and specification. Wrong power supply may cause drive damage.
- As for single-phase power input, power supply can be connected to any 2 terminals of L1/L2/L3.
- Please use a circuit breaker with leakage protection and noise filter between power supply and the main power terminal;
- Voltage and power of holding brake power supply should meet the requirement on parameters of motor holding brake.
- SIZE C has the built-in regenerative resistor, in case of the application with external regenerative resistor, please select the appropriate resistance. It can't be less than the allowable minimum external resistance, otherwise it might cause damage to the driver. Remove jumper bar between P and RB, connect it to both ends of P and B.
- CN3 is the EtherCAT communication input, connected to the controller or the previous servo; CN4 is the EtherCAT communication output, connected to the next servo.

2.1.4 SIZE D overall wiring



Molded Case Circuit Breaker (MCCB)
To prevent damage to the servo drive due to excessive instantaneous current during power switching or short circuits, please select a circuit breaker that matches the power capacity as an over-current protection device.

Noise Filter(NF)
To prevent interference from power lines and reduce the impact of the servo drive on other sensitive equipment.

Magnetic Contactor (MC)
For connecting and disconnecting the main power supply to the servo drive. Use after installing a coil surge absorber. It is strictly prohibited to use the magnetic contactor for motor run/stop operations.

Line Reactor (L)
To reduce higher harmonic currents in the power input.

Electromagnetic contactor
Control servo motor holding brake ON/OFF by servo DO port.

Switching Power Supply
A dedicated DC 24V power supply for the brake. Do not connect other electrical devices.

Regenerative Resistor
Absorb the regenerative feedback energy of drive. When using an external regenerative resistor, please fix it on non-combustible material such as metal cooling plate.

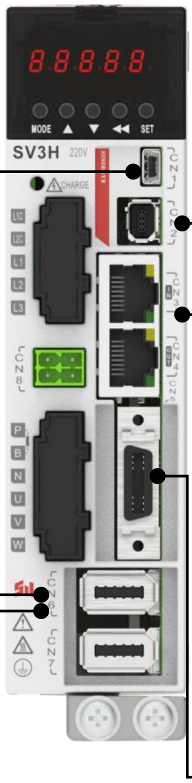
PC
Connect to a personal computer, allowing debugging of the servo drive through upper computer debugging software.

Slave station
Connect to the next servo drive or other slave station devices.

Figure 2-4　SV3H SIZE D wiring diagram

- Please use a circuit breaker with leakage protection and noise filter between power supply and the main power terminal;
- Voltage and power of holding brake power supply should meet the requirement on parameters of motor holding brake.
- SIZE D has the built-in regenerative resistor, in case of the application with external regenerative resistor, please select the appropriate resistance. It can't be less than the allowable minimum external resistance, otherwise it might cause damage to the driver. Remove jumper bar between P and RB, connect it to both ends of P and B.
- CN3 is the EtherCAT communication input, connected to the controller or the previous servo; CN4 is the EtherCAT communication output, connected to the next servo.

2.2 Servo Drive Port Definition



CN1	Serial communication port	
	Pin No.	Signal Name
MINI USB	1	VBUS
	2	D-
	3	D+
	4	-
	5	GND

CN6	Encoder port	
	Pin No.	Signal Name
Recommended model 3M:36210-0100PL	1	5V
	2	GND
	3	-
	4	-
	5	-
	6	-
	7	-
	8	-
	9	SD+
	10	SD-

CN7	Second encoder port	
	Pin No.	Signal Name
Recommended model 3M:36210-0100PL	1	5V
	2	GND
	3	SEC_A+
	4	SEC_A-
	5	SEC_B+
	6	SEC_B-
	7	SEC_Z+
	8	SEC_Z-
	9	-
	10	MTR_TEMP

CN2	Security port	
	Pin No.	Signal name
Recommended model TE: 2013595-1	1	Internal power negative
	2	Internal power positive
	3	STO1-
	4	STO1+
	5	STO2-
	6	STO2+
	7	STO_OUT-
	8	STO_OUT+

EtherCAT communication port				
	CN3（IN）		CN4(OUT)	
	Pin No.	Signal Name	Pin No.	Signal Name
Recommended model RJ45	1	TX+	1	TX+
	2	TX-	2	TX-
	3	RX+	3	RX+
	4	-	4	-
	5	-	5	-
	6	RX-	6	RX-
	7	-	7	-
	8	-	8	-

CN5	Control signal port			
	Pin No.	Signal Name	Pin No.	Signal Name
Recommended model SCSI-20P	1	DO1+	11	DI6
	2	DO1-	12	HDI1
	3	DO3+	13	HDI2
	4	DO3-	14	DO2+
	5	DI1	15	DO2-
	6	DI_COM	16	GND
	7	DI2	17	PAO+
	8	DI3	18	PAO-
	9	DI4	19	PBO+
	10	DI5	20	PBO-

Figure 2-5 Servo Drive Port Definition

2.3 Definition and wiring description of power terminals

2.3.1 Definition of power supply and motor terminals

Table 2-1 Definition of SIZE A main loop ports

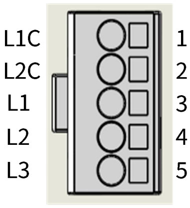
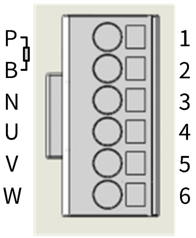
Port classification	Connector	Port No.	Port Code	Port function	Content
Power input		1	L1C	Control power input	Single-phase AC200V ~ 240V, -10 ~ +10%, 50/60Hz
		2	L2C		
		3	L1	Main power input	Single-phase/3-phase AC200V ~ 240V, -10 ~ +10%, 50/60Hz
		4	L2		
		5	L3		
Power output		1	P	Regenerative function and DC bus terminals	When the regeneration function is used, use Port P/B, as detailed in Section 2.5.
		2	B		For common DC bus applications, use P (DC+)/N (DC-) terminals, as described in Section 2.4.
		3	N		
		4	U	Motor drive	Connect U/V/W three phases of the servo motor.
		5	V		
		6	W		

Table 2-2 Definition of SIZE B main loop ports

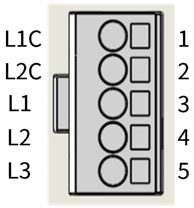
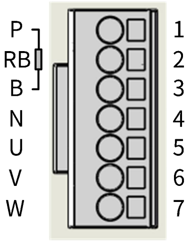
Port classification	Connector	Port No.	Port Code	Port function	Content
Power input		1	L1C	Control power input	Single-phase AC200V ~ 240V, -10 ~ +10%, 50/60Hz
		2	L2C		
		3	L1	Main power input	Single/3-phase AC200V ~ 240V, -10 ~ +10%, 50/60Hz
		4	L2		
		5	L3		
Power output		1	P	Regenerative function and DC bus terminals	When the regeneration function is used, use Port P/RB/B, as detailed in Section 2.5.
		2	RB		
		3	B		For common DC bus applications, use P (DC+)/N (DC-) terminals, as described in Section 2.4.
		4	N		
		5	U	Motor drive	Connect U/V/W three phases of the servo motor.
		6	V		
		7	W		

Table 2-3 Definition of SIZE C main loop ports

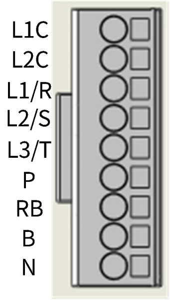
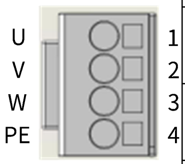
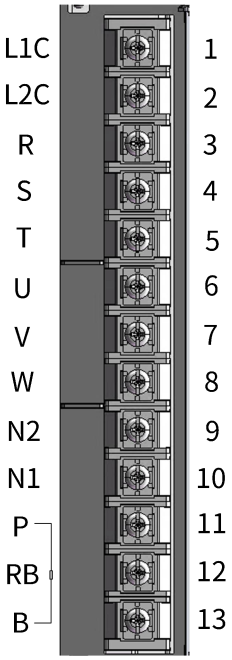
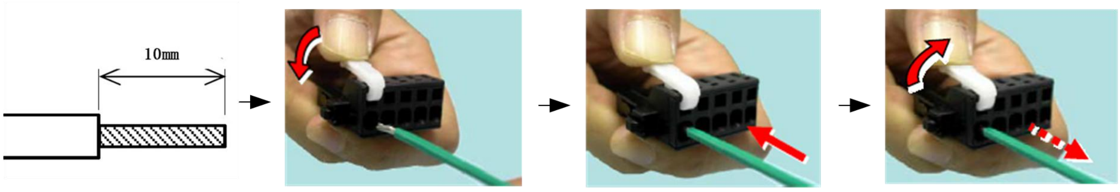
Port classification	Connector	Port No.	Port Code	Port Functions	Content
Power input		1	L1C	Control power supply Input	220V model: single-phase 200V~240VAC, -10 ~ +10%, 50/60Hz 380V model: single-phase 380V~440VAC, -10 ~ +10%, 50/60Hz
		2	L2C		
		3	L1/R	Main power input	220V model: single/3-phase 200V~240VAC, -10 ~ +10%, 50/60Hz 380V model: 3-phase 380V~440VAC, -10 ~ +10%, 50/60Hz
		4	L2/S		
		5	L3/T		
		6	P	Regenerative function and DC bus terminals	When the regeneration function is used, use Port P/RB/B, as detailed in Section 2.5.
		7	RB		
		8	B		For common DC bus applications, use P (DC+)/N (DC-) terminals, as described in Section 2.4.
		9	N		
Power output		1	U	Motor drive	Connect U/V/W three phases and earth PE terminal of servo motor.
		2	V		
		3	W		
		4	PE		

Table 2-4 Definition of SIZE D main loop ports

Connector	Port No.	Port Code	Port function	Remarks
	1	L1C	Control power input	Single-phase 380V~440VAC, -10 ~ +10%, 50/60Hz
	2	L2C		
	3	R	Main power input	3-phase 380V~440VAC, -10 ~ +10%, 50/60Hz
	4	S		
	5	T		
	6	U	Motor drive	Connect U/V/W three phases of the servo motor.
	7	V		
	8	W		
	9	N2	Regeneration function, Common DC bus port, external reactance	When the regeneration function is used, use Port P/RB/B, as detailed in Section 2.5.
	10	N1		For common DC bus applications, use P (DC+)/N2 (DC-) terminals, as described in Section 2.4.
	11	P		
	12	RB		N1/N2 are shorted by deError. It shall suppress high-order harmonics of power supply, remove the short-circuit wire and connect DC reactance between N1 and N2.
	13	B		

2.3.2 Wiring of circlip terminals

Power terminal is circlip connector for quick wiring. During wiring, perform the following process to ensure reliable connection.



Peel off the insulation layer of wires, and the bare wire length is

Press operating lever to press down the internal spring.

Insert all bare wires into the connector.

Release operating lever, gently pull the wire, and confirm that the connection is firm, then

Figure 2-6 Circlip terminal wiring

2.3.3 Wiring of the Main Circuit

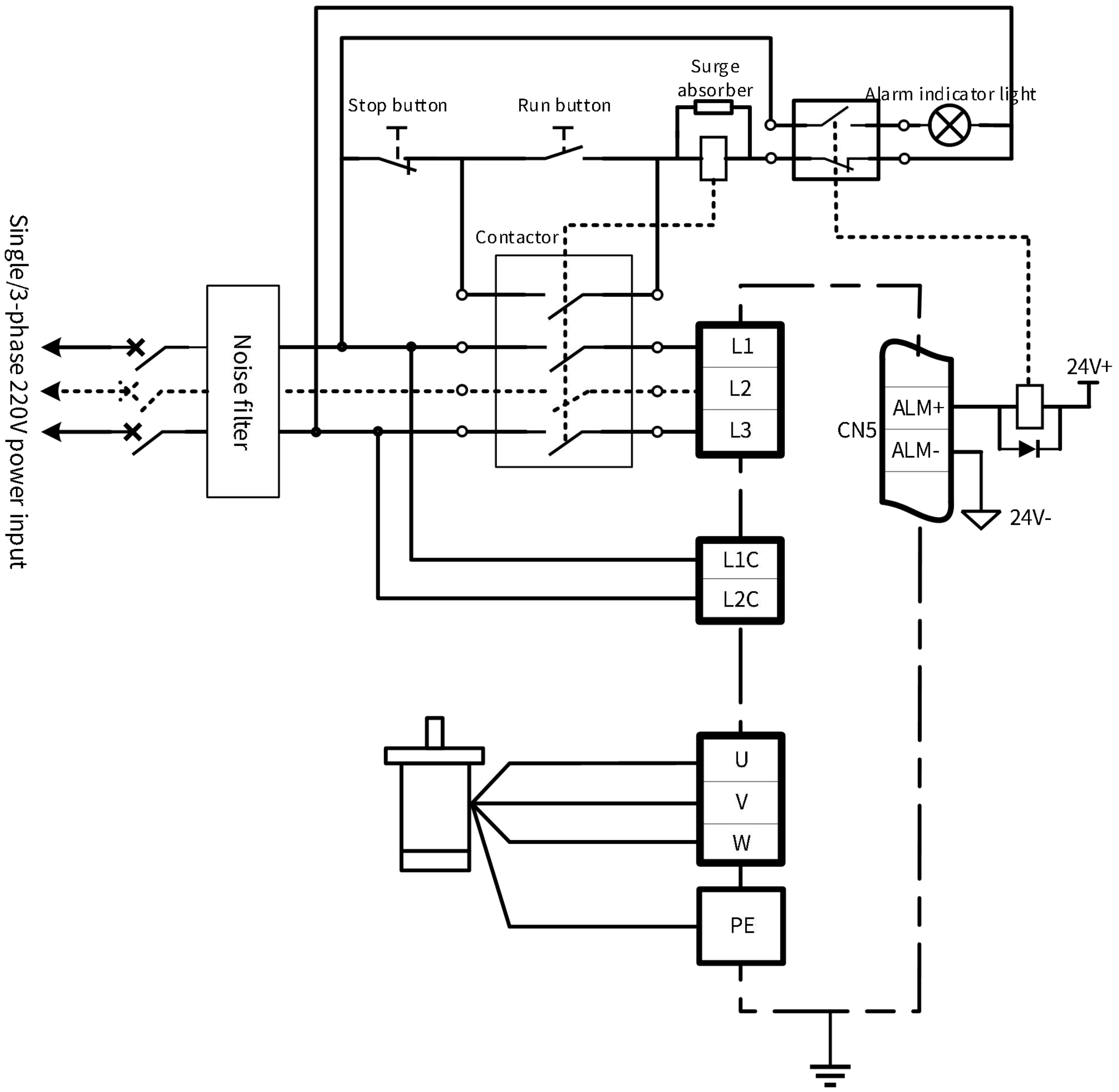


Figure 2-7 SIZE A main circuit wiring

- Do not connect power supply input (L1/L2/L3) to output terminal (U/V/W) for motor;
- Wiring of motor output terminal(U/V/W) is consistent with motor (U/V/W) wiring; The sequence can't be wrong;
- Do not put power cable and signal cable together, and keep a distance more than 30cm.
- Do not switch servo power supply frequently; Otherwise, capacitor will be charged frequently inside the servo, and pre-charging circuit will be overloaded, resulting in performance degradation. Please keep switching frequency below 1 time per minute;
- After the servo is powered off, there might still be residual high voltage inside servo. Only after power-off for 15 minutes and wait until the power indicator is off, can the wiring be executed.

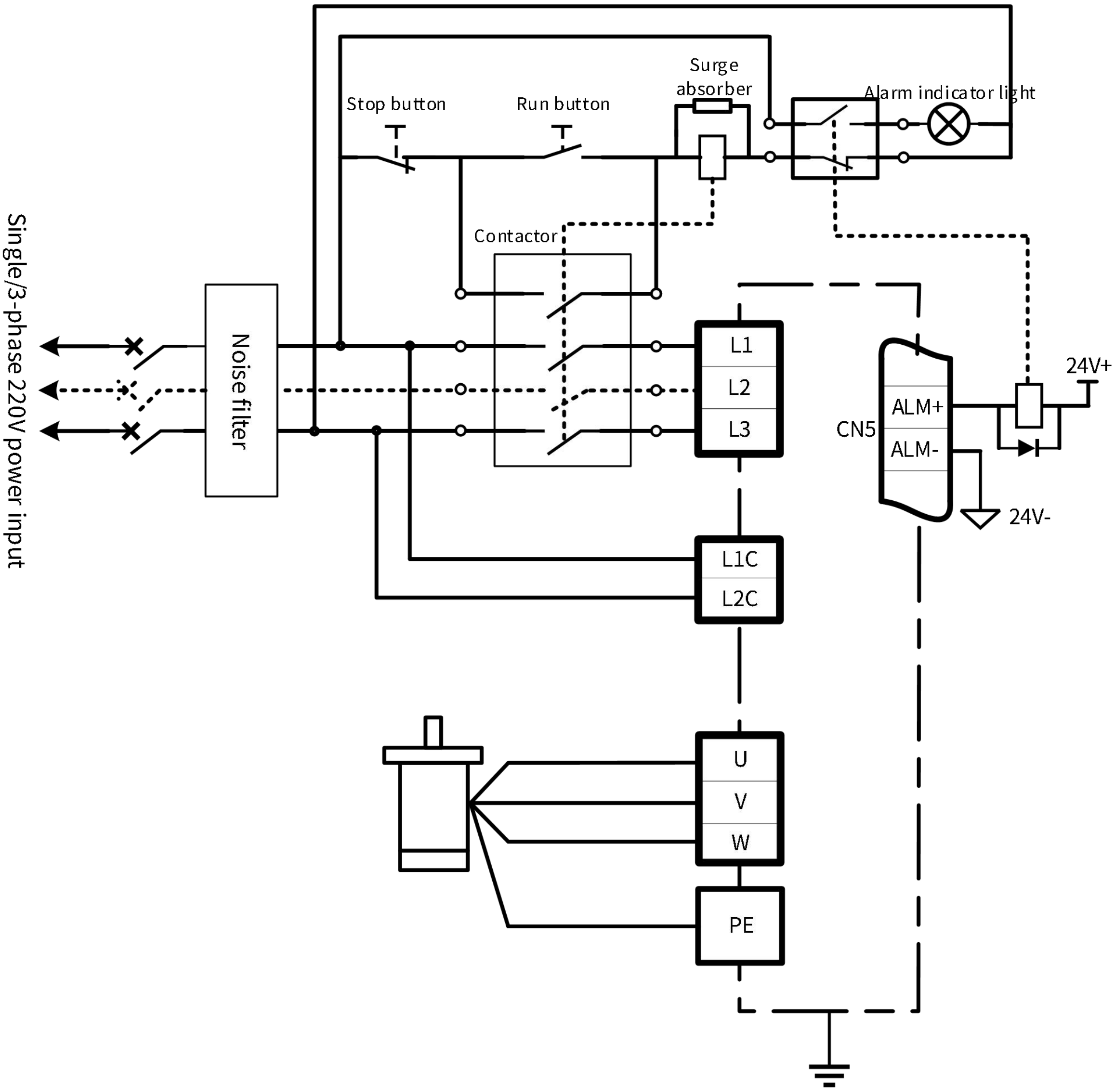


Figure 2-8 SIZE B main circuit wiring

- Do not connect power supply input (L1/L2/L3) to output terminal (U/V/W) for motor;
- Wiring of motor output terminal(U/V/W) is consistent with motor (U/V/W) wiring; The sequence can't be wrong;
- Do not put power cable and signal cable together, and keep a distance more than 30cm.
- Do not switch servo power supply frequently; Otherwise, capacitor will be charged frequently inside the servo, and pre-charging circuit will be overloaded, resulting in performance degradation. Please keep switching frequency below 1 time per minute;
- After the servo is powered off, there might still be residual high voltage inside servo. Only after power-off for 15 minutes and wait until the power indicator is off,can the wiring be executed.

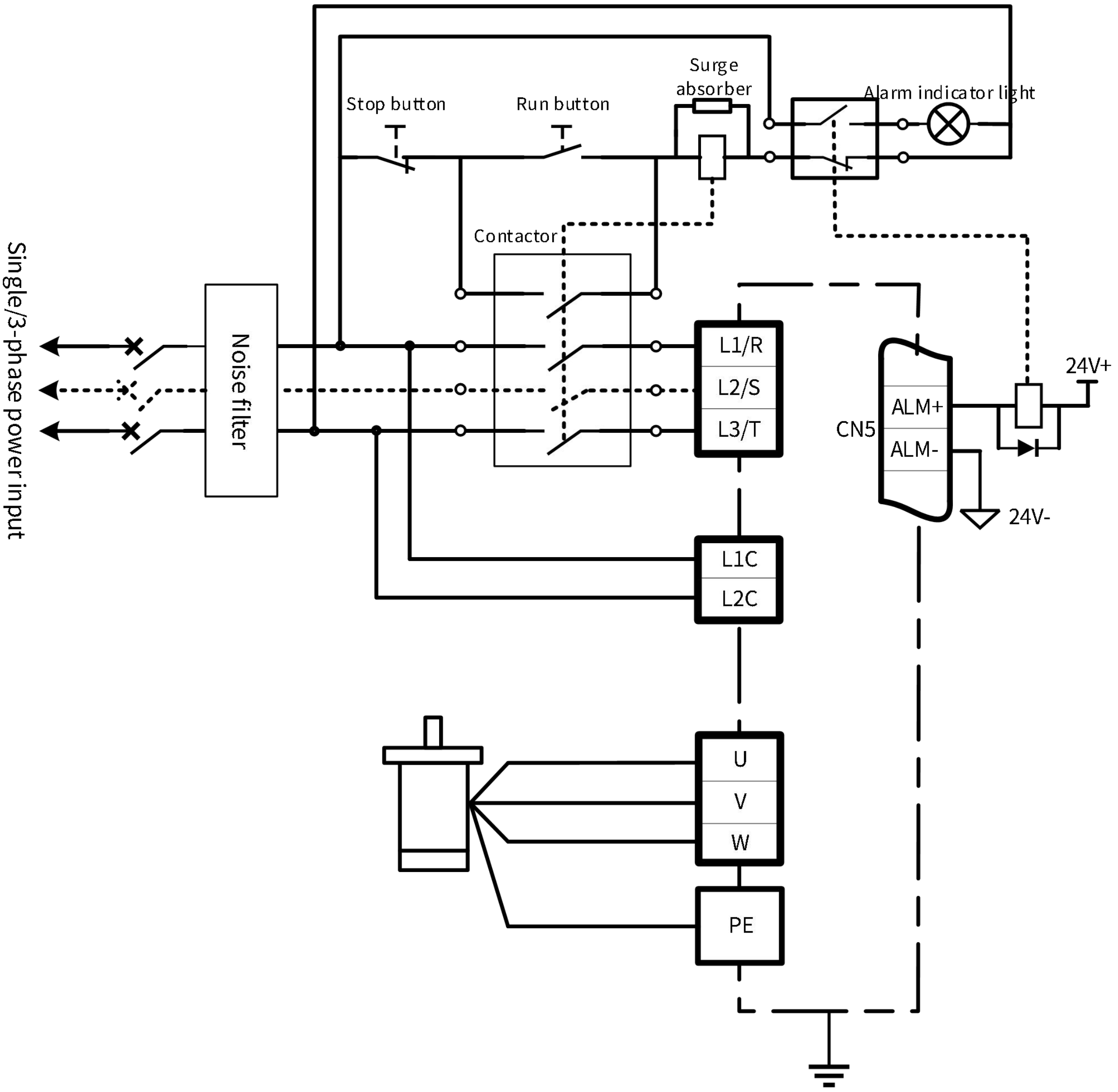


Figure 2-9 SIZE C main circuit wiring

- Do not connect power supply input (L1/R, L2/S, L3/T) to output terminal (U/V/W) of motor;
- Wiring of motor output terminal(U/V/W) is consistent with motor (U/V/W) wiring; The sequence can't be wrong;
- Do not put power cable and signal cable together, and keep a distance more than 30cm.
- Do not switch servo power supply frequently; Otherwise, capacitor will be charged frequently inside the servo, and pre-charging circuit will be overloaded, resulting in performance degradation. Please keep switching frequency below 1 time per minute;
- After the servo is powered off, there might still be residual high voltage inside servo. Only after power-off for 15 minutes and wait until the power indicator is off,can the wiring be executed.

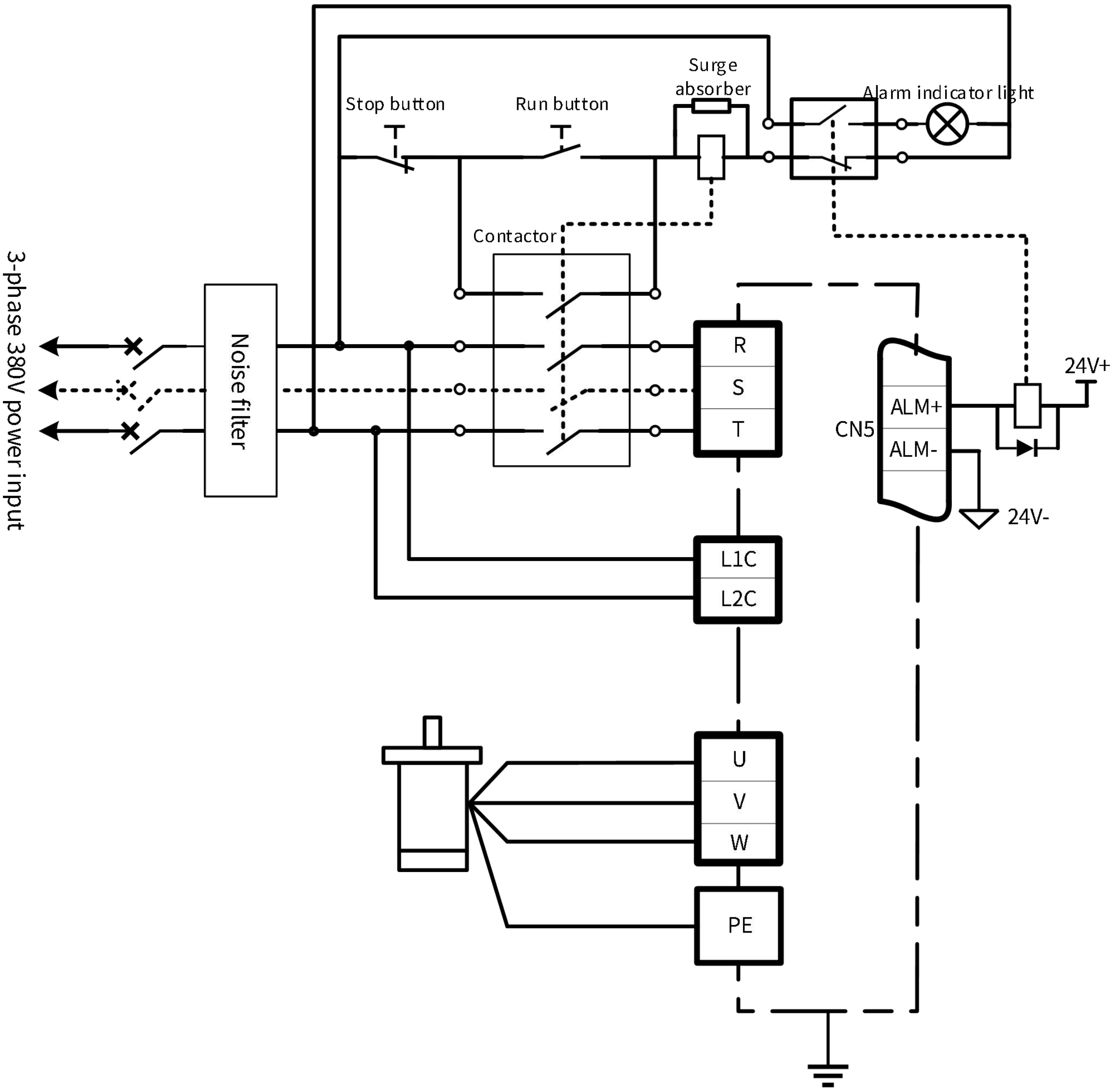


Figure 2-10 SIZE D main circuit wiring

- Do not connect the power input (R, S, T) to the output terminal (U, V, W) of motor;
- Wiring of motor output terminal(U/V/W) is consistent with motor (U/V/W) wiring; The sequence can't be wrong;
- Do not put power cable and signal cable together, and keep a distance more than 30cm.
- Do not switch servo power supply frequently; Otherwise, capacitor will be charged frequently inside the servo, and pre-charging circuit will be overloaded, resulting in performance degradation. Please keep switching frequency below 1 time per minute;
- After the servo is powered off, there might still be residual high voltage inside servo. Only after power-off for 15 minutes and wait until the power indicator is off, can the wiring be executed.

2.3.4 Specification of Main Loop Cable

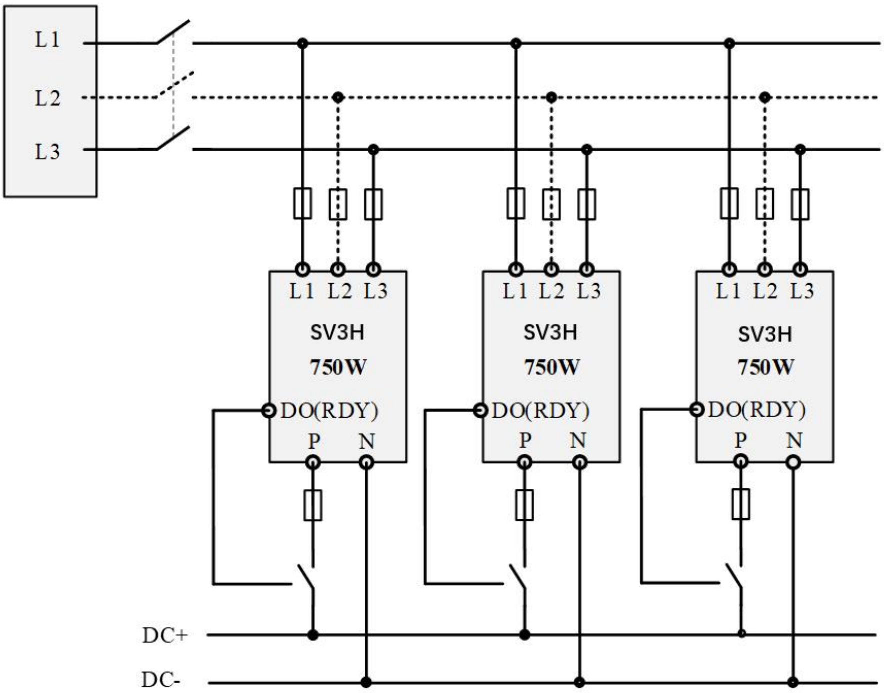
Table 2-5 Recommended cable specifications for main loop

Frame	Drive Model	L1C、L2C		L1、L2、L3 (R、S、T)		P、B		U、V、W		PE	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Single-phase 220V power supply											
SIZE A	S1R6	2x0.5	20	2x0.5	20	2x2.0	14	3x0.5	20	0.5	20
	S2R8	2x0.5	20	2x0.5	20	2x2.0	14	3x0.5	20	0.5	20
SIZE B	S5R5	2x0.75	18	2x0.75	18	2x2.0	14	3x0.75	18	0.75	18
SIZE C	S7R6	2x0.75	18	2x1.5	15	2x2.0	14	3x1.5	15	1.5	15
	S012	2x0.75	18	2x1.5	15	2x2.0	14	3x1.5	15	1.5	15
	S014	2x0.75	18	2x2.0	14	2x2.0	14	3x2.0	14	2.0	14
3-phase 220V power supply											
SIZE A	S1R6	2x0.5	20	3x0.5	20	2x2.0	14	3x0.5	20	0.5	20
	S2R8	2x0.5	20	3x0.5	20	2x2.0	14	3x0.5	20	0.5	20
SIZE B	S5R5	2x0.75	18	3x0.75	18	2x0.75	18	3x0.75	18	0.75	18
SIZE C	S7R6	2x0.75	18	3x1.00	17	2x1.00	17	3x1.0	17	1.00	17
	S012	2x0.75	18	3x1.5	15	2x2.0	14	3x1.5	15	1.5	15
	S014	2x0.75	18	3x2.0	14	2x2.0	14	3x2.0	14	2.0	14
SIZE D	U018	2x0.75	18	3x2.50	13	3x2.5	13	3x2.5	13	2.50	13
	U022	2x0.75	18	3x4.0	11	3x4.0	11	3x4.0	11	4.00	11
	U027	2x0.75	18	3x6.0	9	2x6.0	9	3x6.0	9	6.0	9
3-phase 380V power supply											
SIZE C	T3R5	2x0.75	18	3x0.75	18	2x0.75	18	3x0.75	18	0.75	18
	T5R4	2x0.75	18	3x0.75	18	2x0.75	18	3x0.75	18	0.75	18
	T8R4	2x0.75	18	3x0.75	18	2x1.0	17	3x1.0	17	1.0	17
	T012	2x0.75	18	3x1.0	17	2x1.5	15	3x1.5	15	1.5	15
SIZE D	T017	2x0.75	18	3x1.5	15	3x2.0	14	3x2.0	14	2.0	14
	T021	2x0.75	18	3x4.0	11	2x4.0	11	3x4.0	11	2.5	11
	T026	2x0.75	18	3x6.0	9	2x6.0	9	3x6.0	9	6.0	9

2.4 Common DC Bus Cable Wiring

In some multi-axis application scenarios, the motion state of each axis is different, some servo motors work in the braking power-generation state, and other servo motors work in the energy-consumption state. Use the common DC bus technology for energy interaction, the energy generated by braking motor can be supplied to the energy-consuming motors, other than dissipating by regenerative resistors, so as to realize the energy-saving effect.

Figure 2-11 Sample of Servo Common Bus



Only those drivers of the same specification are allowed to share bus in this way. To utilize common bus with drivers of different specifications may burn the drivers directly. DC bus P and N of the servo are connected in parallel so as to realize energy transfer among drives;

All drives must use the same power input. It's forbidden to utilize the power supply of different voltage and phase number. Otherwise, it might cause drive damage;

All drives mu-st be powered ON/OFF at the same time. Otherwise, it might cause drive damage;

Voltage level and phase sequence of all drives with common bus shall be consistent. Otherwise, it might cause drive damage and start a fire.

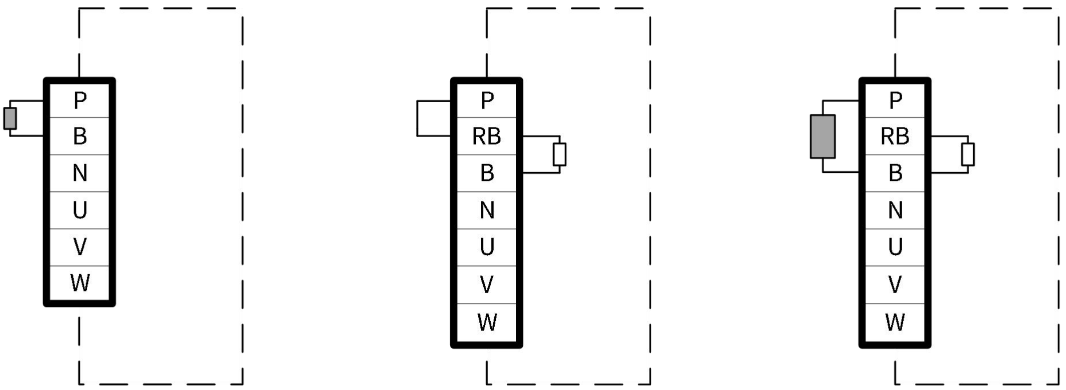
While using common bus, only after completing the configuration of common bus for all drives, can it be allowed for servo drive operation;

After the drive is powered on, when drive Rdy state occurs, drive DO outputs the ready signal, control the relay swich-on so as to realize the common bus connection;

While drive PN is connected to bus, in order to avoid excessive current in case of single-drive exception, please connect a fast fuse between bus bars.

2.5 Description of regenerative resistance wiring

2.5.1 Connecting regenerative resistance wiring



① Without built-in regenerative resistor, external regenerative resistor

② P-RB short-circuited, configured as built-in regenerative resistor

③ P-RB disconnected, external resistor connected between P-B, configured as external regenerative resistor

Figure 2-12 Regenerating resistor wiring

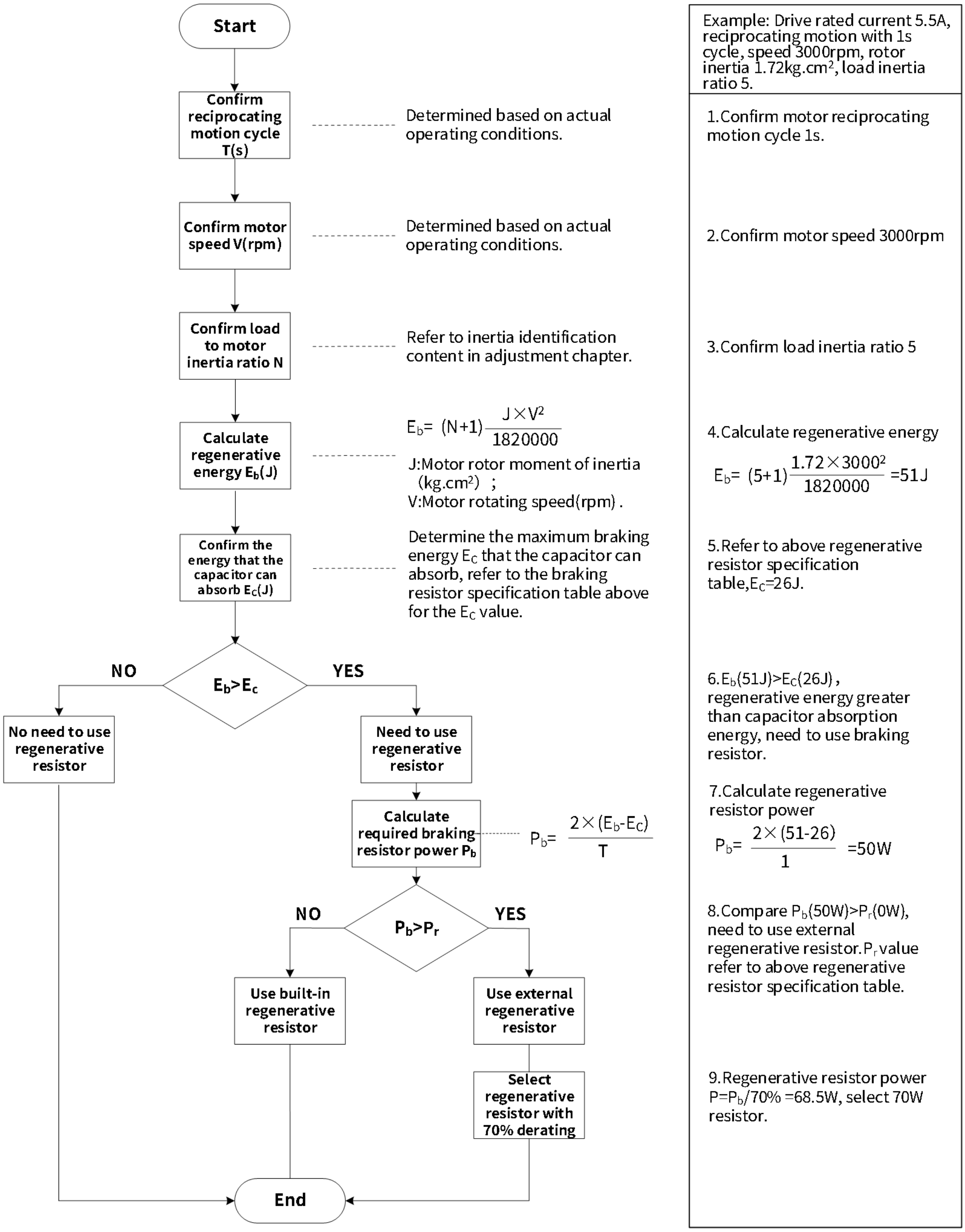
- For models without built-in regenerative resistor, external regenerative resistors are are connected between P-B;
- Do not connect any regenerated resistor between bus P and N, otherwise it might cause damage to drives and start a fire;
- For models with built-in regenerative resistor, short-circuit P-RB terminals while using the built-in resistor. While using the external resistor, remove terminal jumper between P-RB and connect the external resistor between P-B;
- In case of external regenerative resistor, select an appropriate resistor according to Section 2.5.3. Do not use any resitor below Min. external resistance allowed in Table 2-6. Otherwise, it might cause drive damage.
- Before using the servo, please confirm that the parameters related to external regeneration resistor have been properly set: P02.34 (regeneration resistor selection), P02.39 (power of external regeneration resistor), P02.40 (external regeneration resistance).

2.5.2 Specifications of regenerative resistors

Table 2-6　Specifications of regenerative resistors

Servo drive Rated voltage, current		Specifications on internal regenerative resistance			Minimum external resistance	Maximum braking energy absorption of capacitor/Ec
		Resistance value	Resistance power	Applicable power/Pr		
Single/3-phase 220V	1.6A	-	-	-	50Ω	10J
	2.8A	-	-	-	45Ω	15J
	5.5A	50Ω	50W	25W	40Ω	23J
	7.6A	25Ω	80W	40W	20Ω	32J
	12.0A	25Ω	80W	40W	15Ω	47J
	14.0A	25Ω	80W	40W	15Ω	57J
3-phase 220V	18.0A	20Ω	100W	50W	10Ω	64J
	22.0A	20Ω	100W	50W	10Ω	71J
	27.0A	20Ω	100W	50W	10Ω	95J
3-phase 380V	3.5A	100Ω	80W	40W	80Ω	39J
	5.4A	100Ω	80W	40W	60Ω	39J
	8.4A	50Ω	80W	40W	45Ω	57J
	12.0A	50Ω	80W	40W	45Ω	57J
	17.0A	35Ω	100W	50W	35Ω	114J
	21.0A	35Ω	100W	50W	25Ω	114J
	26.0A	35Ω	100W	50W	25Ω	114J

2.5.3 Selection and calculation of regenerative resistance



Determined based on actual operating conditions.

Determined based on actual operating conditions.

Refer to inertia identification content in adjustment chapter.

$$E_b = (N+1)\frac{J \times V^2}{1820000}$$

J:Motor rotor moment of inertia (kg.cm^2) ;

V:Motor rotating speed(rpm) .

Determine the maximum braking energy E_C that the capacitor can absorb, refer to the braking resistor specification table above for the E_C value.

$$P_b = \frac{2 \times (E_b - E_C)}{T}$$

Example: Drive rated current 5.5A, reciprocating motion with 1s cycle, speed 3000rpm, rotor inertia 1.72kg.cm^2, load inertia ratio 5.

1.Confirm motor reciprocating motion cycle 1s.

2.Confirm motor speed 3000rpm

3.Confirm load inertia ratio 5

4.Calculate regenerative energy

$$E_b = (5+1)\frac{1.72 \times 3000^2}{1820000} = 51J$$

5.Refer to above regenerative resistor specification table,E_C=26J.

6.E_b(51J)>E_C(26J) , regenerative energy greater than capacitor absorption energy, need to use braking resistor.

7.Calculate regenerative resistor power

$$P_b = \frac{2 \times (51-26)}{1} = 50W$$

8.Compare P_b(50W)>P_r(0W), need to use external regenerative resistor.P_r value refer to above regenerative resistor specification table.

9.Regenerative resistor power P=P_b/70% =68.5W, select 70W resistor.

Figure 2-13 Illustration of regenerative resistor selection

2.6 Wiring of holding brake

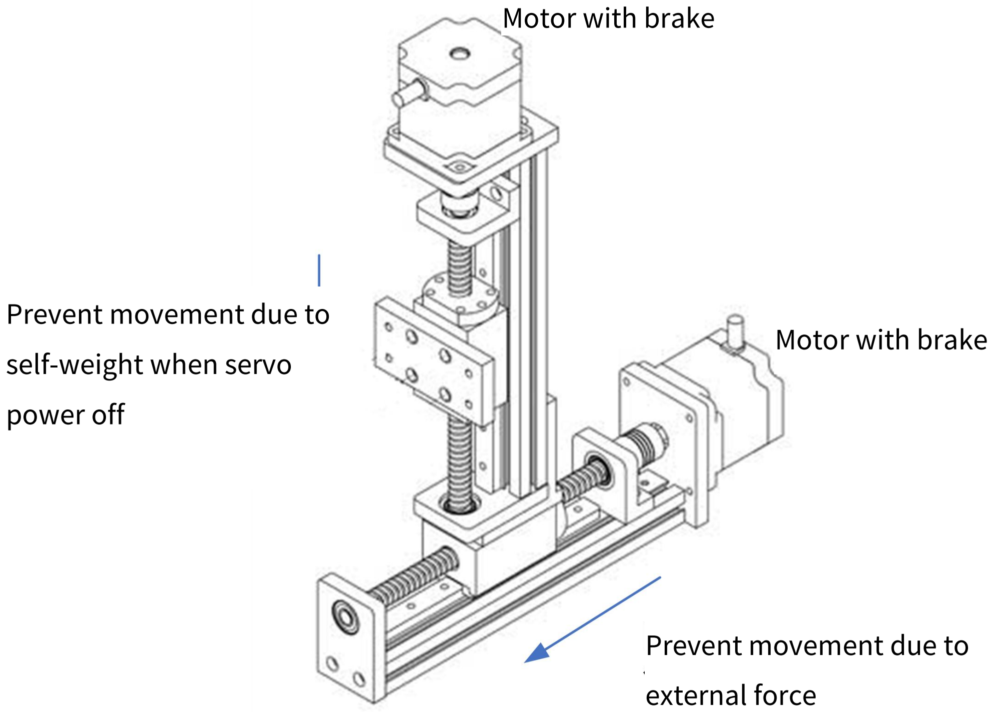


Figure 2-14 Schematic diagram of holdingbrake

Holding brake is used to stop the unexpected movement of moving load(e.g., falling under gravity) when servo system is not activated (e.g., the servo system is powered off) to prevent motors from moving unexpectedly after power off due to its own weight or external force.

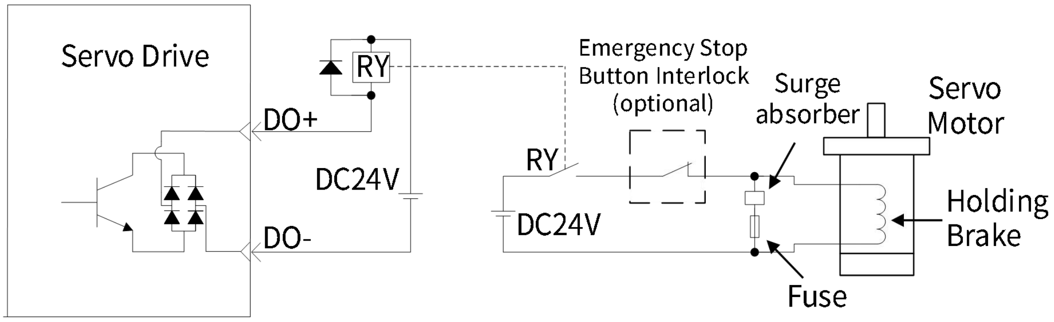


Figure 2-15 Layout diagram of holding brake

Built-in Holding brake of servo motor is only used for shutdown of motors, and frequent use for emergency stop would shorten its service life. Only if motor speed is less than 20rpm, Holding brake can be powered off;

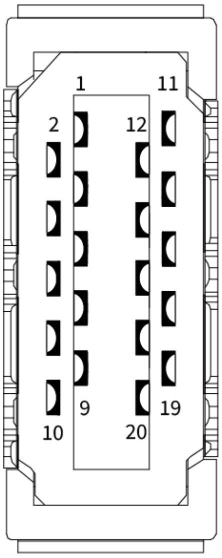
It's recommended to use independent power supply to prevent the abnormal voltage drop from other electrical appliances, that could result in misoperation of Holding brake.

Different power sources are used to power the brake and brake control signal separately in order to prevent electronic devices from electromagnetic interference.

2.7 Description of Control Signal CN5 Port Wiring

2.7.1 Definition of Control Signal CN5 Port

Table 2-7 Definition of CN5 on control signal

IO Interface Connector (CN5)	Module name	Signal name	Pin No.	DeError function
 SCSI 20P	Digital input	DI1	5	Forward limit
		DI2	7	Reverse limit
		DI3	8	Origin switch
		DI4	9	Undefined
		DI5	10	Undefined
		DI6	11	Undefined
		HDI1	12	Probe 1
		HDI2	13	Probe 2
		DI_COM	6	DI common port
	Digital output	DO1+	1	Holding brake signal
		DO1-	2	
		DO2+	14	Servo operation
		DO2-	15	
		DO3+	3	Servo Error output
		DO3-	4	
	Frequency division output	PAO+	17	A phase frequency division output signal
		PAO-	18	
		PBO+	19	B phase frequency division output signal
		PBO-	20	
		GND	16	Frequency division output signal ground

IO Interface Connector (CN5)	Module name	Signal name	Pin No.	DeError function
	Shell	—	—	Connect the cable shielding layer

2.7.2 Description of Digital Input Wiring

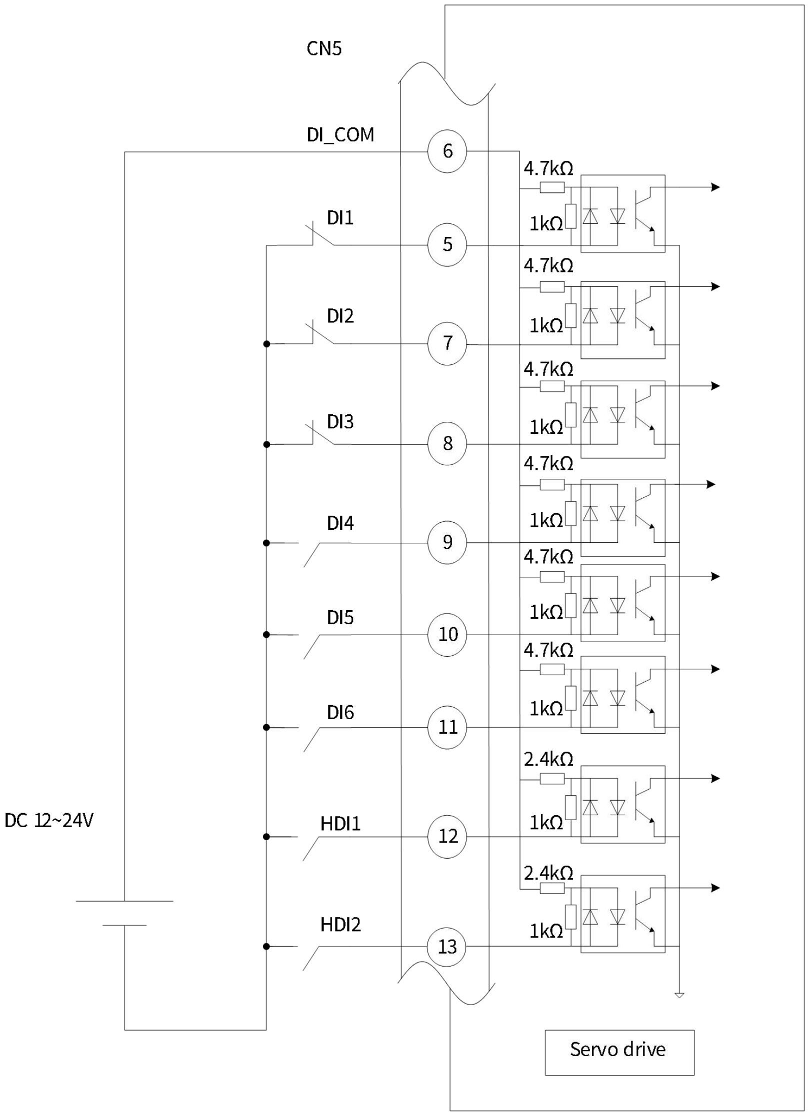


Figure 2-16 Connection wiring of digital input cable

(1) When upper device is relay output

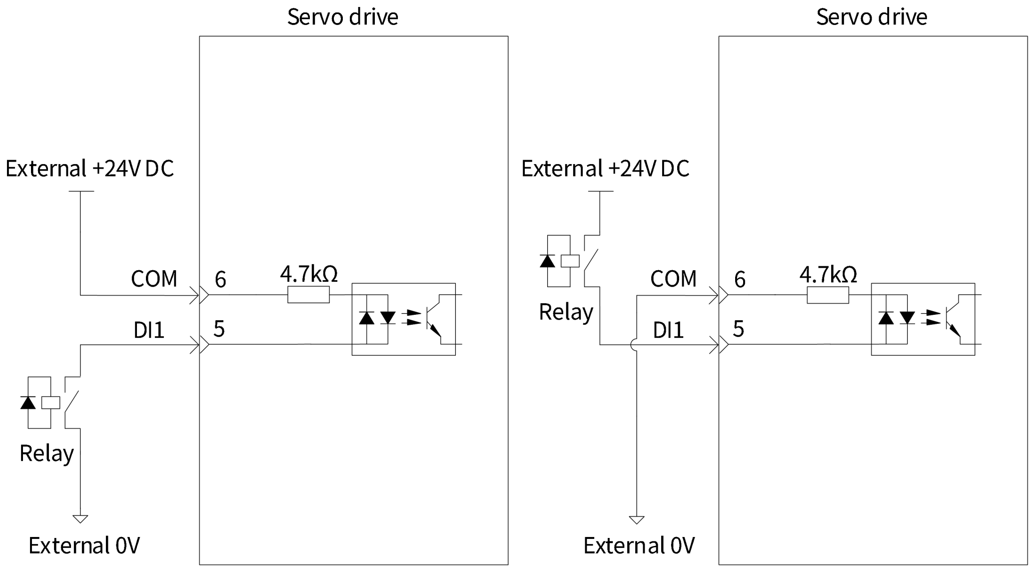
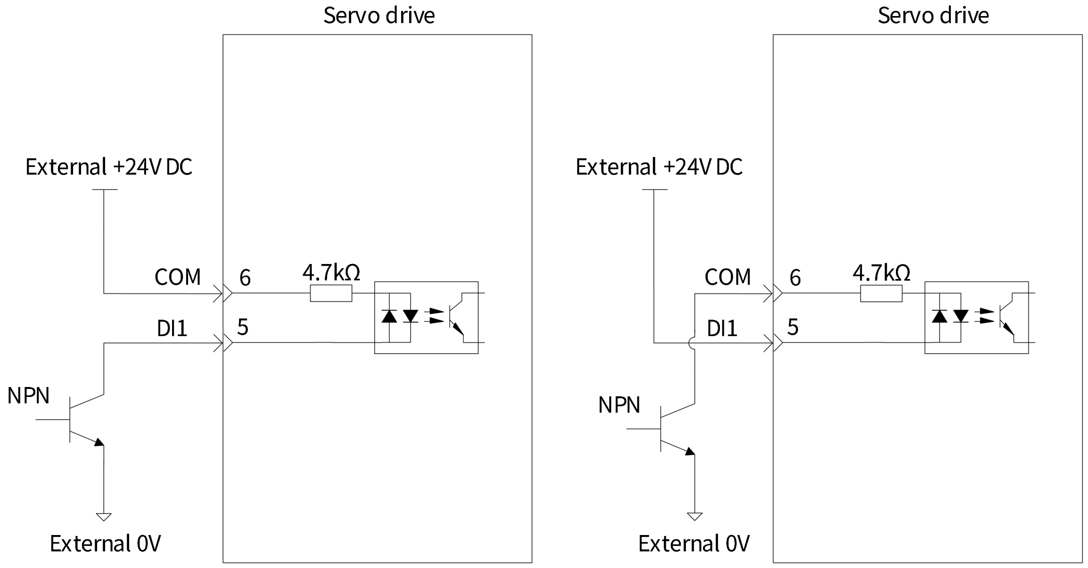


Figure 2-17 Digital input wiring diagram (relay output)

(2) When upper device is open collector



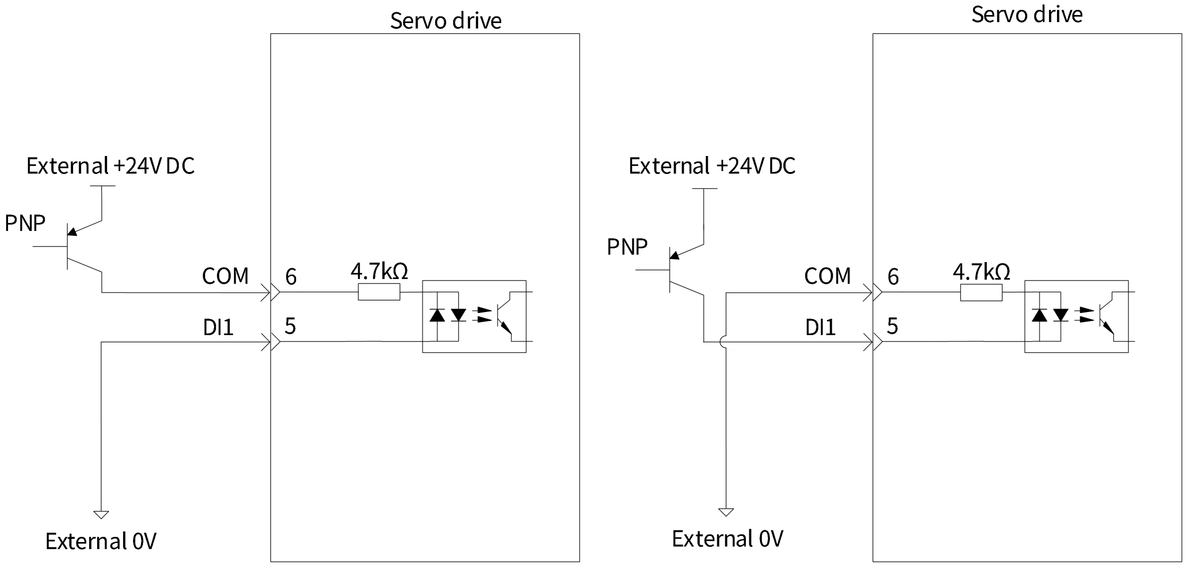


Figure 2-18 Wiring diagram of digital input(open collector)

Mixing input of PNP and NPN is not supported.

2.7.3 Description of Digital Output Wiring

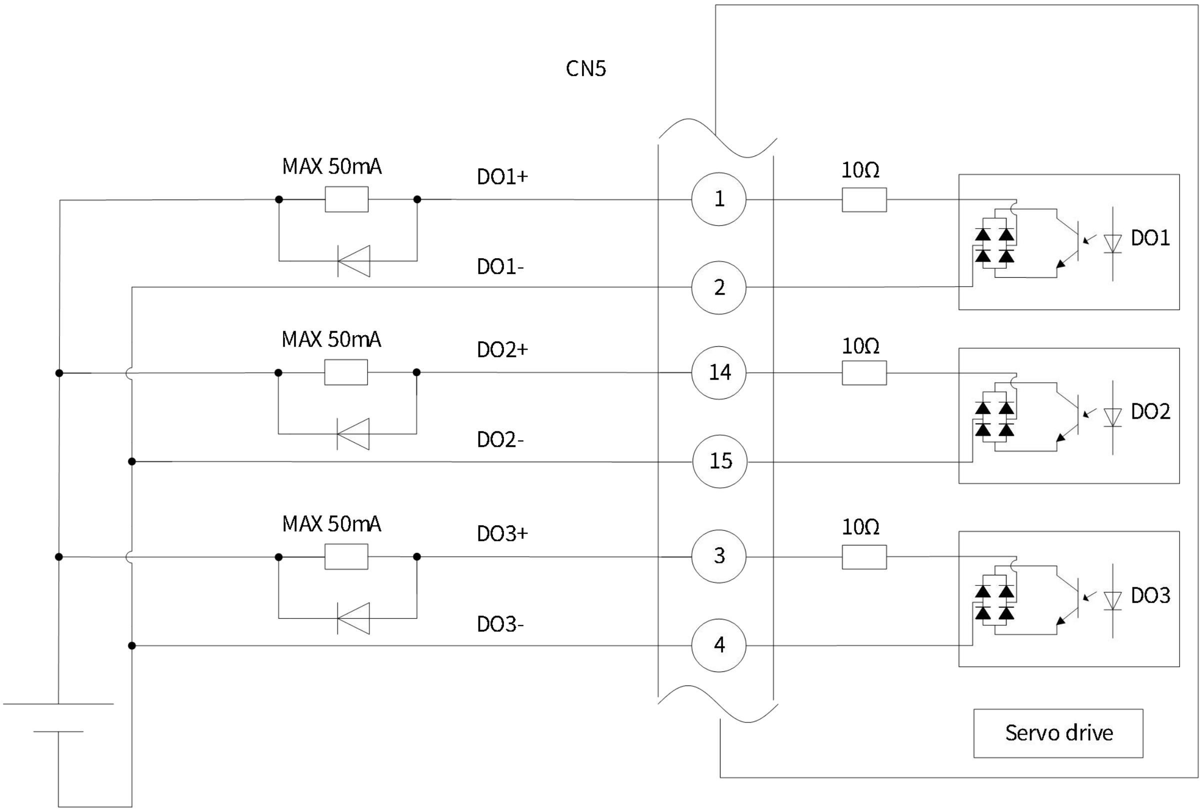


Figure 2-19 Digital output wiring

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

Voltage: DC 30V(Max);

Current: DC 50mA(Max.)

(1) When upper device is relay input

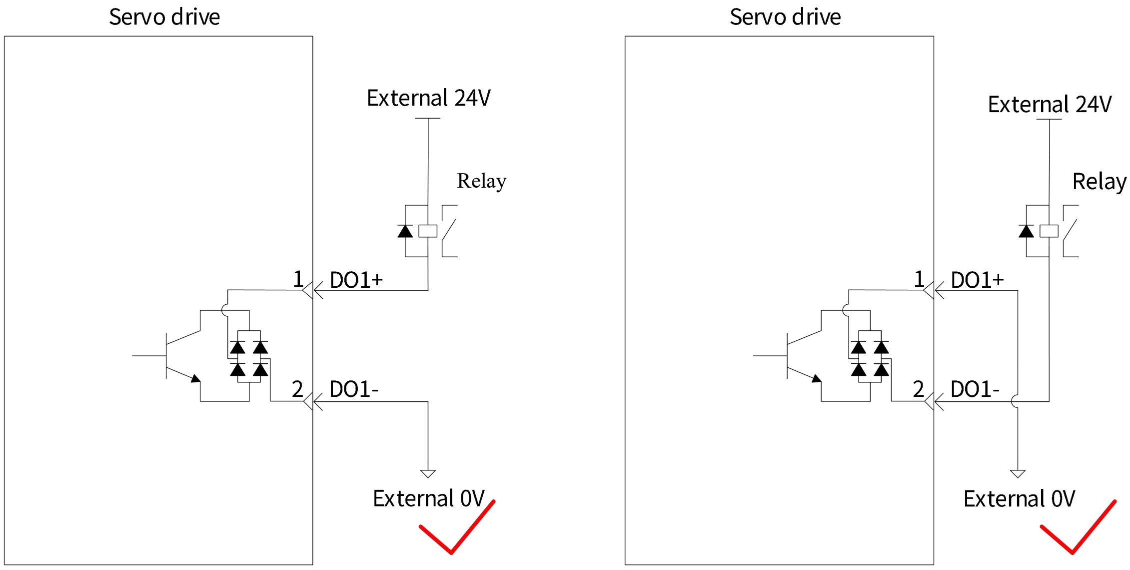
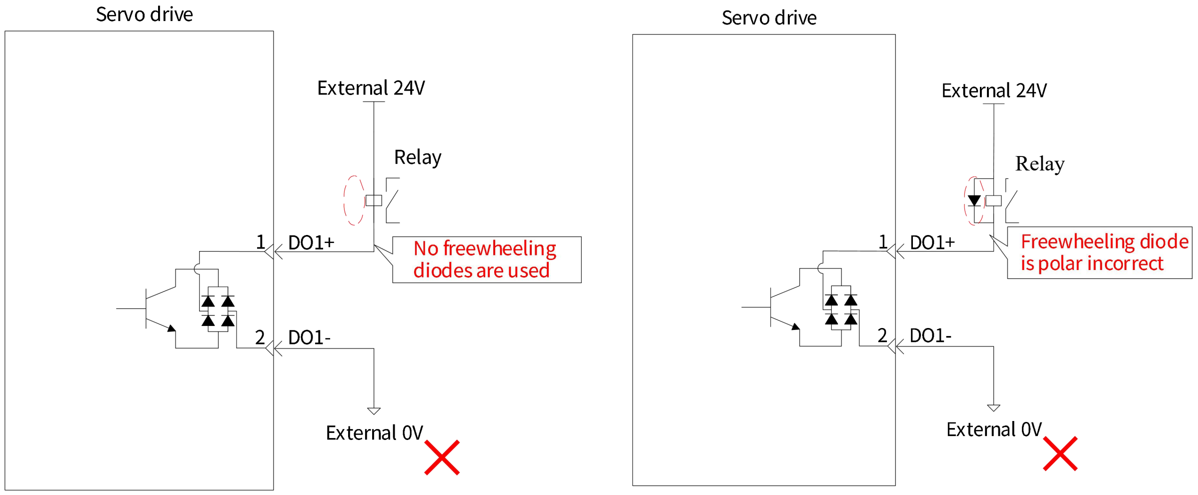


Figure 2-20 Schematic diagram of digital output wiring (relay input, correct wiring)



No freewheeling diodes are used

Freewheeling diode is polar incorrect

Figure 2-21 Schematic diagram of digital output wiring (relay input, error wiring)

(2) When upper device is optocoupler input

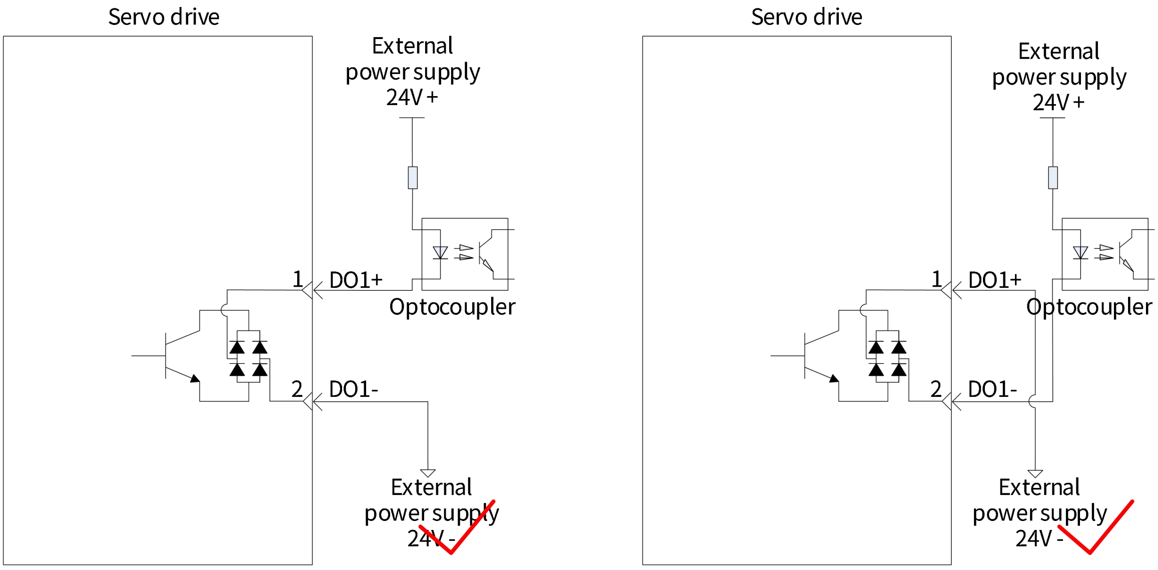


Figure 2-22 Wiring diagram of digital output(optical coupling input, correct wiring)

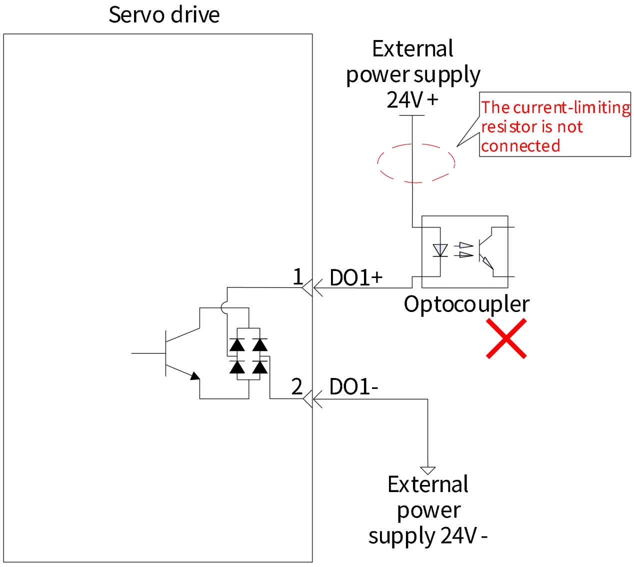


Figure 2-23 Wiring diagram of digital output(optocoupler input, error wiring)

2.7.4 Description of Frequency Division Output Wiring

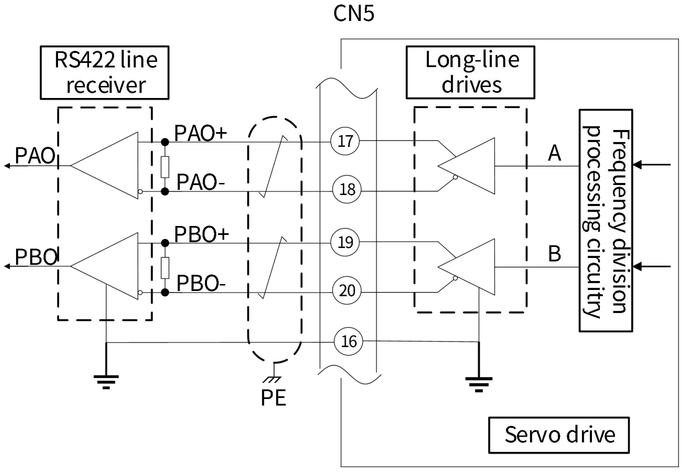


Figure 2-24 Frequency division output wiring

For receiving signal of output pulse, please use RS422 long line receiver (AM26C32 or equivalent);

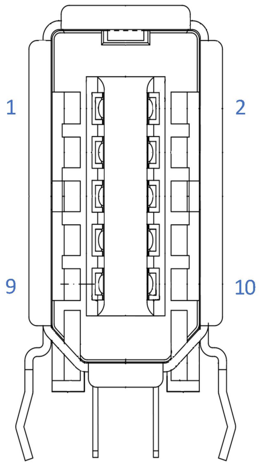
Max. output current of frequency division output is 20mA;

Shielded twisted-pair cable is used. The shielding layer is connected to PE; Ground of frequency division output signal is connected to the receiving terminal.

2.8 Encoder interface definition and wiring description

2.8.1 CN6 Motor encoder

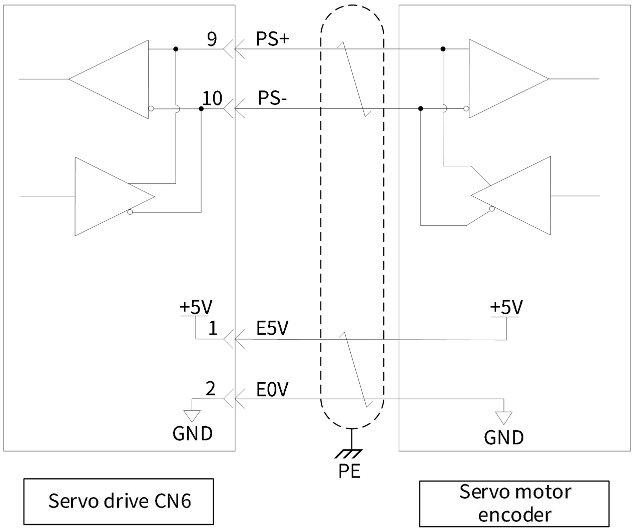
Table 2-8 Definition of drive encoder interfaces

Motor encoder Connector (CN6)	Module name	Signal name	Pin No.	Wiring method
 IEEE 1394 10P	Motor encoder	E5V	1	Twisted pair
		E0V	2	
		—	3	—
		—	4	—
		—	5	—
		—	6	—
		—	7	—
		—	8	—
		PS+	9	Twisted pair
		PS-	10	
		PE	Shell	Connect the cable shielding layer

This port is used for connection between drive and motor encoder. During use, the distance between encoder cable and main circuit wire should be more than 30cm or above. Do not bundle them together with conduit.

The cable length between drive and motor is less than 20m. In case of the requirement above 20m, please negotiate with sellers.

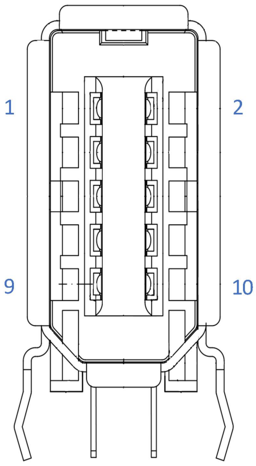
Input voltage range of the encoder-end connector is 4.75V to 5.25V DC. Please select the appropriate wire. For 10m or less, use shielded twisted pair with a cross-sectional area of 0.18 mm^2(AWG24) or above; For 10m or above, use shielded twisted pair with a cross-sectional area of 0.32 mm^2(AWG22) or above.



24Figure 2-25 Motor encoder signal connection

2.8.2 CN7 Full closed-loop encoder

Table 2-9 Definition of fully closed-loop encoder interface

Fully Closed loop encoder Connector (CN7)	Module name	Signal name	Pin No.	Wiring method	Functions
 IEEE 1394 10P	Fully closed-loop encoder	5V	1	Twisted pair	Encoder power supply
		GND	2		
		SEC_A+	3	Twisted pair	Second encoder input interface
		SEC_A-	4		
		SEC_B+	5	Twisted pair	
		SEC_B-	6		
		SEC_Z+	7	Twisted pair	
		SEC_Z-	8		
		—	9		—
		MTR_TEMP	10		Input of motor temperature sensor
		Shell	—	Connect the cable shielding layer	Shielded

This port is used for connection between drive and motor encoder. During use, distance between the cable and main circuit wire should be 30cm;

Please use shielded twisted pair cable for encoders;

Input of fully closed-loop encoder is differential input, and its Max. input frequency and Min. pulse width are shown in the table below:

Table 2-10 Input signal features of fully closed loop encoder

Pulse method	Max. frequency (pps)	Min. pulse width (μs)
Differential input	4M	0.125

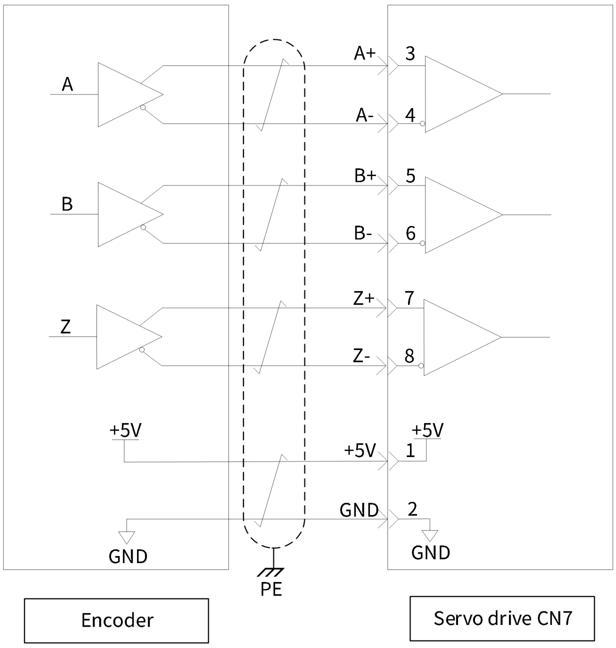


Figure 2-26 Differential signal input of fully closed loop encoder

2.8.3 CN7 Input of motor temperature sensor

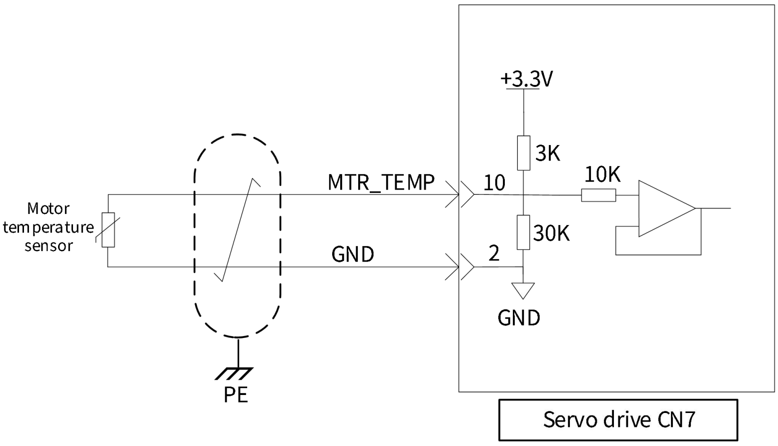


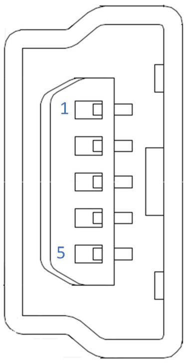
Figure 2-27 Wiring diagram of motor temperature sensor

Support PT/NTC/switch types of motor temperature sensors. Please ensure that function codes P00.05/P08.31/P08.33/P08.34 are set properly.

2.9 Definition of Connector

2.9.1 CN1 Serial communication port

Table 2-11 Definition of serial communication ports

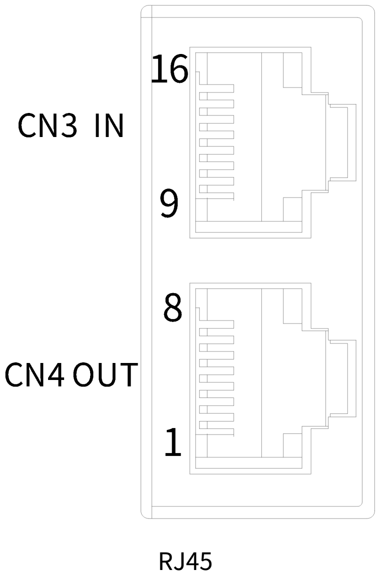
PC debugging connector	Module name	Signal name	Pin No.	Functions
 Mini USB	Serial communication port	VBUS	1	Connect to serial communication port of PC upper computer debugging
		D-	2	
		D+	3	
		—	4	
		GND	5	
		Shell	—	

The port is used to connect drive to PC. It can execute test run, adjust parameters and collect waveform by debugging software of upper computer.

This serial communication port is Mini-USB Type B and compatible with USB 2.0.

2.9.2 CN3&CN4 EtherCAT Connector

Table 2-12 Definitions of EtherCAT connector

EtherCAT Connectors (CN3, CN4)	Pin No.	Signal name	Functions
	1	TX+	Transmit+
	2	TX-	Transmit-
	3	RX+	Receive+
	4	-	-
	5	-	-
	6	RX-	Receive -
	7	-	-
	8	-	-
	9	TX+	Transmit+
	10	TX-	Transmit-
	11	RX+	Receive+
	12	-	-
	13	-	-
	14	RX-	Receive -
	15	-	-
	16	-	-

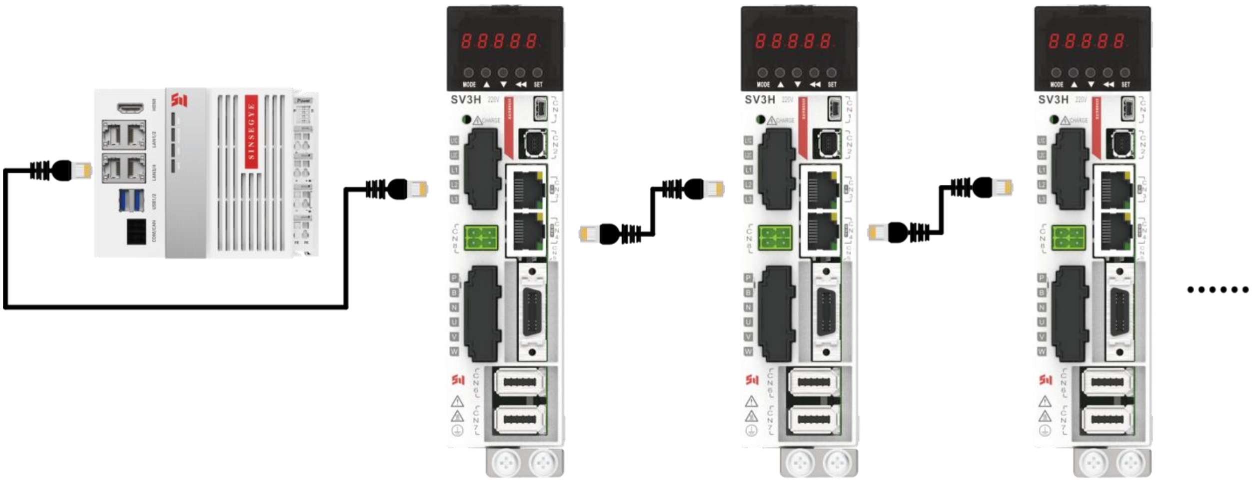


Figure 2-28 Description of EtherCAT communication cables

Please use shielded twisted-pair wire as CAT5E or above, connect to metal shell of network interface to ensure EMC performance.

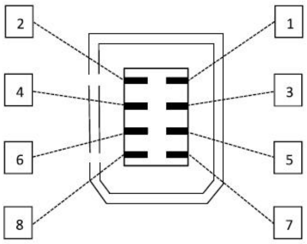
The distribution length of communication cable shall be less than 100m;

The master communication port is connected to CN3(IN), and CN4(OUT) is connected to the next slave device. If the cables were incorrectly connected, the communication would fail.

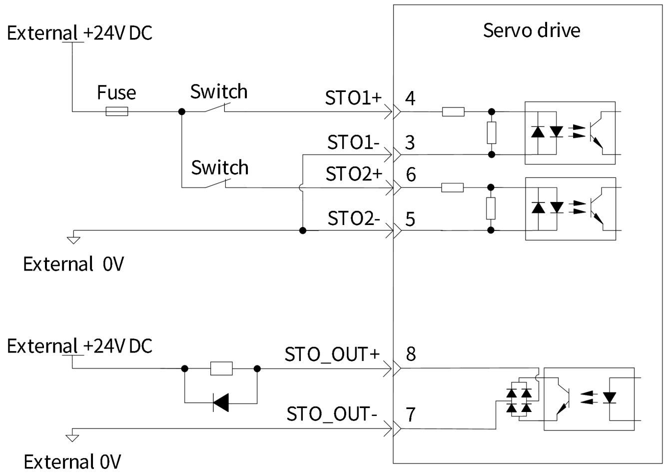
2.10 CN2 Definition and Wiring Description of Functional Safety Connector

2.10.1 Definition of Functional Security Terminals

Table 2-13 Definition of functional security terminals

Functional Safety Connector (CN2)	Module name	Signal name	Pin No.	Functions
	Functional safety	Internal power negative	1	Built-in power supply (Do not use)
		Internal power positive	2	
		STO1-	3	STO1
		STO1+	4	
		STO2-	5	STO2
		STO2+	6	
		STO_OUT-	7	STO status output
		STO_OUT+	8	
		Shell	—	Shielded

2.10.2 Function Safety Wiring Description



28Figure 2-29 Description of functional safety wiring

2.10.3 Relationship of STO I/O Signals

Table 2-14 Relationship of STO input and output signal

STO1 status	STO2 status	STO_OUT status	Power status of motor
Invalid	Invalid	Power on	Power off
Invalid	Active	Power off	Power off
Active	Invalid	Power off	Power off
Active	Active	Power off	Power on

2.11 Grounding and anti-interference measures

2.11.1 Grounding Measures

Table 2-15 Precautions for grounding servo drives

Mount the drive on metal shell(control cabinet)
Please connect the ground terminal of servo motor to GND PE of servo drive, and ground PE terminal reliably
Drive must be single-point ground
Use thick cable(≥2.0mm2) for grounding cables as much as possible; Use thick cable(≥3.5mm2) for external grounding as braided copper wire as much as possible
Type D or above ground(grounding resistance below 100Ω) is recommended.
Ensure to connect ground terminal of drive and ground cable(PE) of control cabinet to avoid electric shock
As there are two protective ground terminals, do not connect all cables together

2.11.2 Anti-interference measures

Due to different application of peripheral wiring, grounding and anti-interference devices, switching noise may affect normal operation of servo drives. Therefore, it must adopt the correct grounding method and anti-interference measure. The following figure is schematic diagram of anti-interference measure for servo drive.

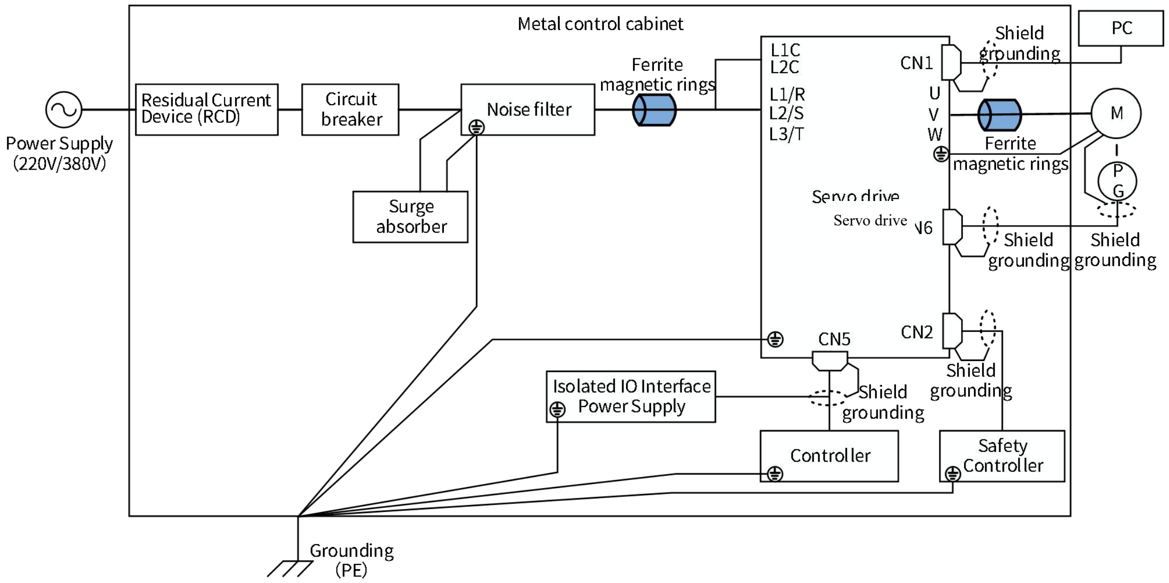


Figure 2-30 Schematic diagram of anti-interference measure of servo drive

The length of command input cable shall be less than 3m. That of encoder cable shall be below 20m and use twisted-pair shielded cable;

Separate strong current cable from weak current cable and keep a distance more than 30cm. Do not put in the same pipeline or tie together;

Cables, I/O lines and power lines of drive are equipped with ferrite magnetic rings;

Install surge suppressors on the coils of relay, solenoid and electromagnetic contactor;

Please install the noise filter at the input of power line, and do not share the power supply with welding machine, discharge processing equipment, etc.

Connect shielded wires of all cables to ground wire (PE).

Please ground both ends of shielded layer of motor encoder cable.

2.11.3 Noise filter

2.11.3.1 Use of noise filter

To prevent the interference of power line and reduce the influence of servo drive on other sensitive equipment. As for selection, installation and wire routing of noise filter, please obey the following guidelines:

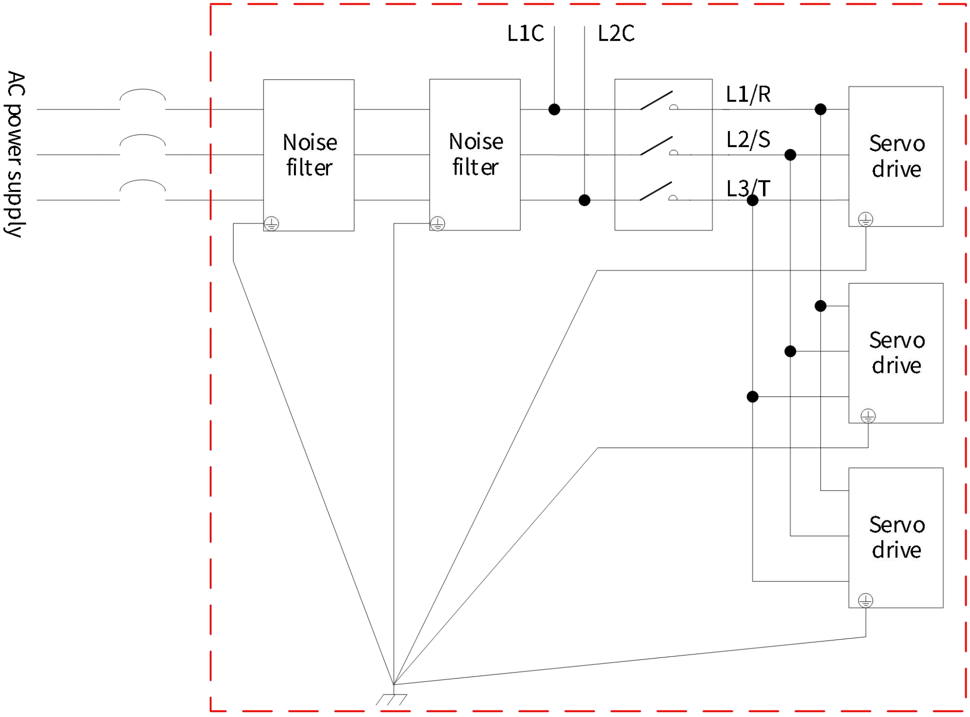


Figure 2-31 Schematic diagram for use, installation and ground of noise filters in series

Please select the corresponding noise filter according to input current;

Please arrange separately the input and output wires of noise filter; Do not put the both in the same pipeline or tie together;

Ground wire of noise filter is arranged separately from the output power line.

Noise filter should use the single-point ground, and grounding wire should be as short and thick as possible.

While noise filter and servo drive are installed in the same cabinet, it is recommended to fix the filter and the servo drive on the same metal plate, ensure that the contact is conductive and well-joint, and ground the metal plate.

For filter installation, the wire between filter and drive must be as short as possible, which shall be less than 30cm. At the same time, ensure that the filter and the drive are connected to the same grounding reference plane. Ensure the reliable ground of filter, or the filtering effect can't be achieved.

While using multiple drives and sharing a noise filter in the power supply department, please consult the noise filter manufacturer. If noises reach the limit, it would be better to use two in series(as shown in the figure above)

2.11.3.2 Model selection of noise filter

In order to meet the requirement of the product per EN/IEC 61800-3 standard on radiation and conducted emission EMC directive, please connect external EMC filter. SCHAFFNER's single-phase FN2090 and 3-phase FN3258 filters are recommended.

SCHAFFNER FN2090 filter

SCHAFFNER FN3258 filter

Figure 2-32 SCHAFFNER EMC filter outline

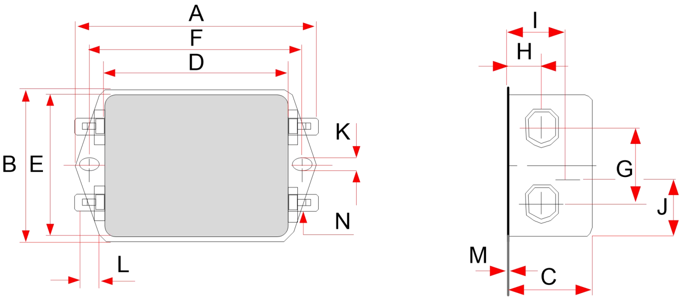
Servo drive model and recommended EMC filter model are shown in the following table:

Table 2-16 Recommended manufacturers and models of EMC filters

Series	Drive type	Rated input current (A)	Filter model
		In	(SCHAFFNER)
Single-phase 220V power supply			
SIZE A	SV3H-ES1R6XX	2.3	FN2090-3-06
	SV3H-ES2R8XX	4.0	FN2090-4-06
SIZE B	SV3H-ES5R5XX	7.9	FN2090-8-06
SIZE C	SV3H-ES7R6XX	9.6	FN2090-10-06
	SV3H-ES012XX	12.8	FN2090-16-06
	SV3H-ES014XX	16.0	FN2090-16-06
3-phase 220V power supply			
SIZE A	SV3H-ES001XX	0.8	FN3258-7-44
	SV3H-ES1R6XX	1.4	FN3258-7-44
	SV3H-ES2R8XX	2.6	FN3258-7-44
SIZE B	SV3H-ES5R5XX	4.4	FN3258-7-44
SIZE C	SV3H-ES7R6XX	5.6	FN3258-7-44
	SV3H-ES012XX	8.0	FN3258-16-44
	SV3H-ES014XX	10.2	FN3258-16-44
SIZE D	SV3H-EU018XX	18.7	FN3258-30-44
	SV3H-EU022XX	20.7	FN3258-30-44
	SV3H-EU027XX	24.4	FN3258-30-44
3-phase 380V power supply			
SIZE C	SV3H-ET3R5XX	2.4	FN 3258-7-44

	SV3H-ET5R4XX	3.6	FN 3258-7-44
	SV3H-ET8R4XX	6.6	FN 3258-7-44
	SV3H-ET012XX	8	FN 3258-16-44
SIZE D	SV3H-ET017XX	12	FN 3258-16-44
	SV3H-ET021XX	16	FN 3258-16-44
	SV3H-ET026XX	21	FN 3258-30-33

Note for EMC filter installation dimensions recommended:



32Figure 2-33 Dimensions of FN 2090 1~20A filters (unit: mm)

17Table 2-17 Dimensions of FN 2090 1~20A filters (unit: mm)

Rated current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	71	46.6	22.3	50.5	44.5	61	21	10.8	16.8	25.25	5.3	6.3	0.7	6.3×0.8
3	85	54	30.3	64.8	49.8	75	27	12.3	20.8	19.9	5.3	6.3	0.7	6.3×0.8
4														
6														
8	113.5±1	57.5±1	45.4±1	94±1	56	103	25	12.4	32.4	15.5	4.4	6	0.9	6.3×0.8
10														
12														
16														

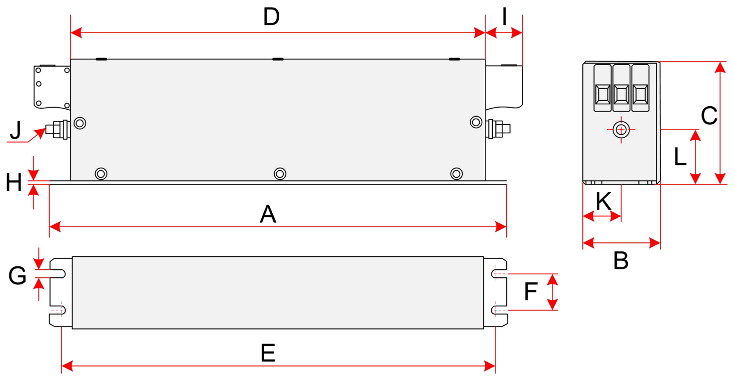


Figure 2-34 Drawing of FN3258 7~30A filter(unit: mm)

Table 2-18 Dimensions of FN3258 7~30A filter size(unit: mm)

Rated current (A)	A	B	C	D	E	F	G	H	I	J	K	L
7	190	40	70	160	180	20	4.5	1	22	M5	20	29.5
16	250	45	70	220	235	25	5.4	1	22	M5	22.5	29.5
30	270	50	85	240	255	30	5.4	1	25	M5	25	39.5

2.11.4 Leakage protection circuit breaker

Servo drive will generate high frequency leakage current during operation. The following matters should be noted in the configuration of cirtuit leakage protection while installing the drive:

The equipment can generate DC leakage current in protective conductor, and must use Type B (delay type) leakage protection circuit breaker;

If multiple drives are required for installation, each drive should be equipped with a leakage protection circuit breaker;

Capacity, carrier frequency, type and length of motor cable, and EMI filter of drive would affect leakage current, so the protection threshold should be set reasonably.

Suc brands as Chint and Schneider are recommended for leakage protection circuit breaker;

When the leakage current generated by drive results in action of leakage protection circuit breaker, the following measures can be taken:

Increase the rated operating current of leakage protection circuit breaker;

Replace the leakage protection circuit breaker to Type B (delay type) with the high-frequency suppression;

Reduce the carrier frequency;

Shorten the output drive cable length;

Install a leakage suppression device.

2.11.5 Cable and wiring Requirements

(1) Power cable requirement

To meet the requirement of CE mark EMC, motor power cable must be shielded witt shielding layer which must be well grounded. Shielded cable consists of a shielded cable with three phase conductors and shielded cable with four phase conductors. If conductive properties of the shielding layer can't meet the requirement, a separate PE line shall be added. Or shielded cable with four phase conductors, herein,one of which is PE line. To effectively suppress the emission and conduction of RF interference, the shielding layer of shielding cable is made of coaxial copper braided tape. To increase the shielding efficiency and conductivity, weaving density of the shielding layer shall be greater than 90%.
Recommended power cable type as shown in the following figure - symmetrical shielded cable:

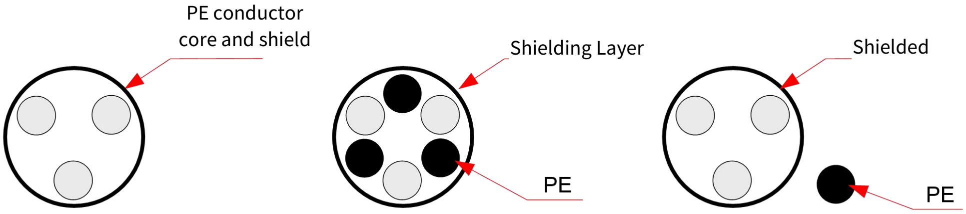


Figure 2-35 Recommended Power Cable Type

I/O cable shielding layer of main loop of servo drive is grounded with PE terminal on drives together(Please refer to the following figure for wiring).

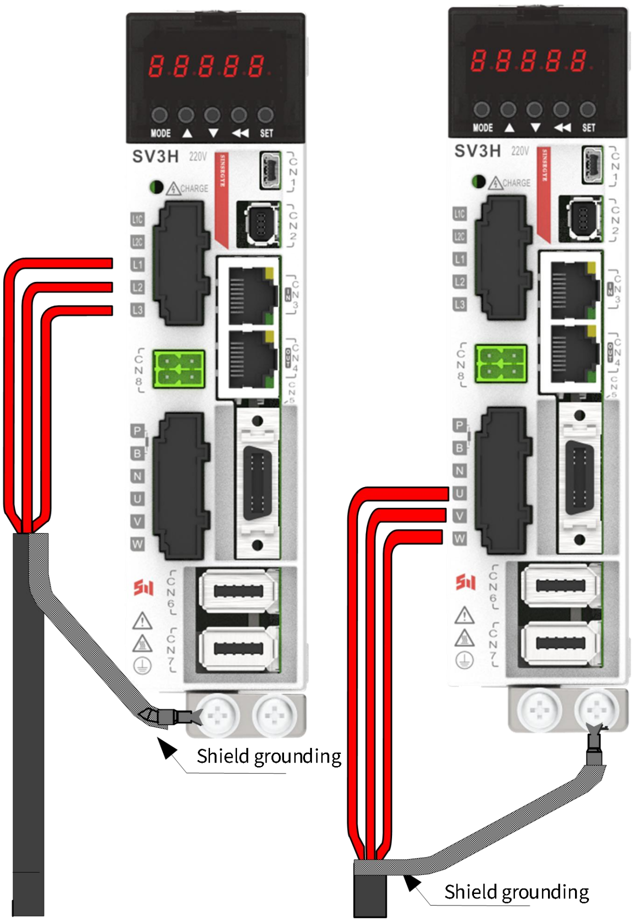


Figure 2-36 Wiring of shielding layer of I/O power cable

The following matters should be noted when selecting output cable of servo drive:

Do not connect any capacitor or surge absorber, otherwise it might activate servo drive regular protection or even damage servo drives;

When motor cable is too long, it's easy to result in electrical resonance due to distributed capacitance, then it might cause motor insulation damage or large leakage current which could activate servo drive overcurrent protection; When the length of motor cable is greater than 100m, AC output reactor must be installed near the servo drive.

Shielding cable is recommended for motor output. Shielding layer shall be bonded for 360°in the structure of grounding support, and shielding layer lead-in wire is crimpped to PE terminals.

The lead-in wire of shielding layer of motor cable should be as short as possible, and width b⩾1/5・a (see Figure 2-37).

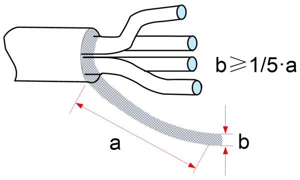


Figure 2-37 Lead-in diagram of motor cable shielding layer

(2) The requirement on encoder cable

The encoder cable must be shielded twisted pair.
Input voltage range of the encoder-end connector is 4.75V to 5.25V DC. Please select the appropriate wire. For 10m or less, use shielded twisted pair with a cross-sectional area of 0.18 mm^2(AWG24) or above; For 10m or above, use shielded twisted pair with a cross-sectional area of 0.32 mm^2(AWG22) or above.

(3) The requirement on USB cable

For connector on driver side, please use the commercially available USB mini-B that meets the specification of computers.

Use shielded USB cable;

While using the cable without any filtering measure, install signal ferrite magnetic rings at both ends of cable.

(4) The requirement on wiring layout

Pay attention to the following matters for routing, and it's recommended to use the routing mode and layout spacing:

Motor cable routing must be far away from other cables. Motor cables of several drives can be parallel wiring;

It is recommended to arrange the motor cable, input power cable, control cable, and encoder cable in different cable ducts. In order to avoid electromagnetic interference due to rapid changes of drive output voltage, long distance parallel wiring of motor cables and other cables should be avoided.

When control cable must pass through power cable, ensure that the angle between two cables is 90 degrees as far as possible. Do not pass other cables through drive;

Power input and output lines and weak current signal lines (e.g., control circuit) of drive shall not be in parallel as far as possible, and vertical layout shall be applied if possible;

It must be properly connected and grounded among cable ducts. Aluminum duct can be used to improve equipotential.

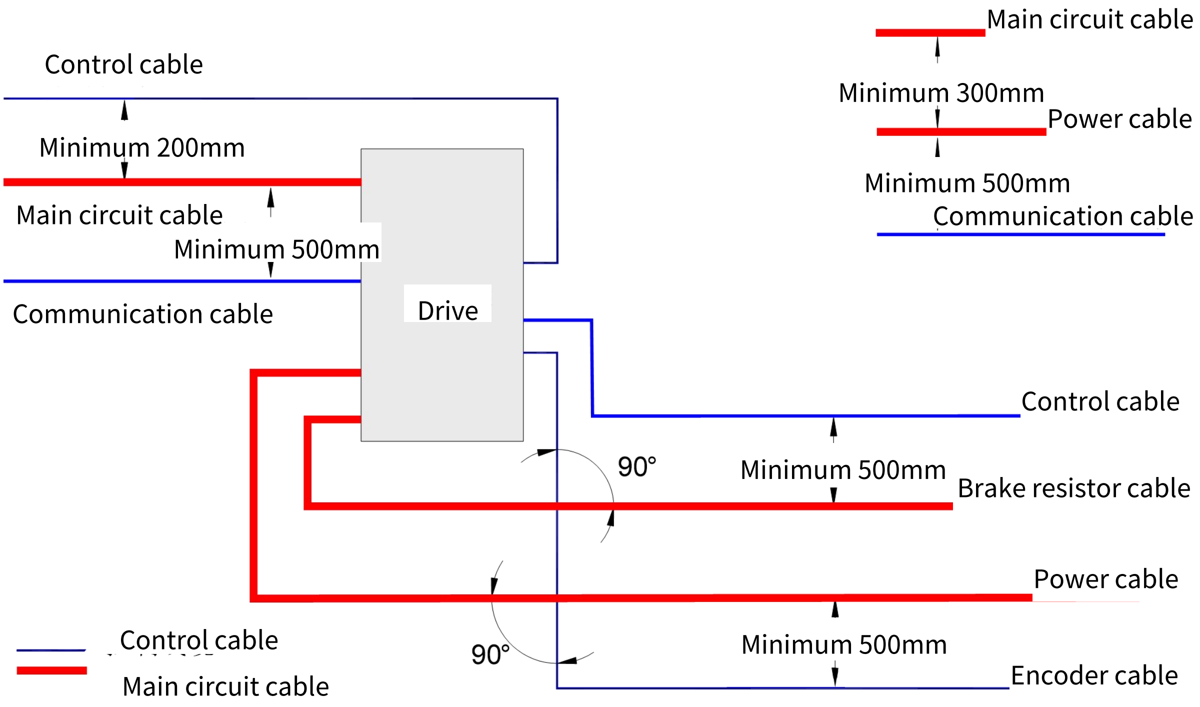


Figure 2-38 Recommended wiring layout

2.11.6 I/O magnetic ring selection

To reduce interference to adjacent devices, it's recommended to add a filter magnetic ring to 3-phase I/O power line of servo drive:

Input cable should be installed far away from servo drive;

Output cable should be installed close to servo drive.

The following table shows magnetic ring models recommended of manufacturer.

Table 2-19 Magnetic ring models recommended of manufacturer

External drawing	Magnetic ring models recommended of manufacturer	Dimensions (outer diameter × inner diameter × thickness) (mm)
	DY644020H	64×40×20
	DY805020H	80×50×20
	DY1207030H	120×70×30

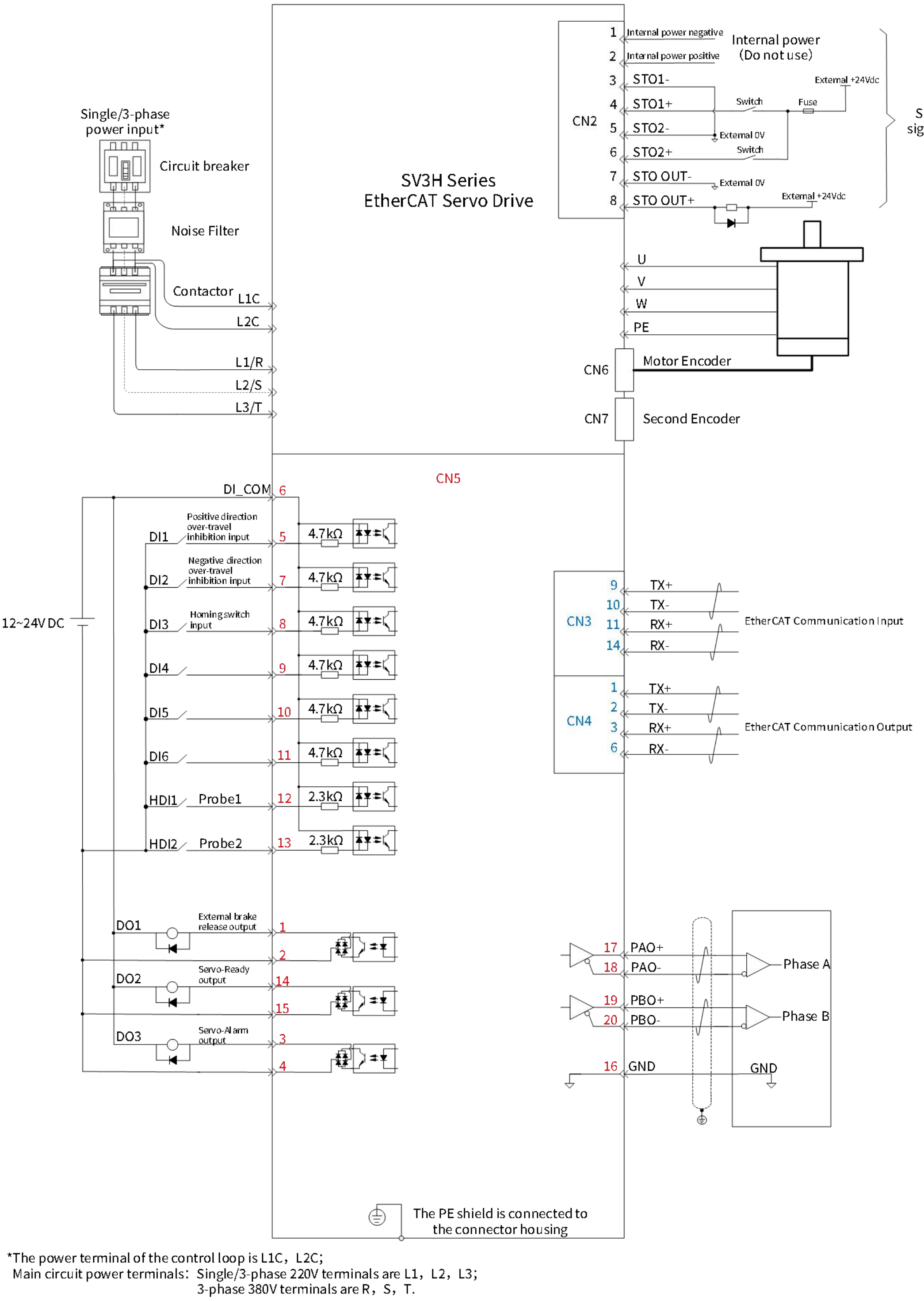
2.11.7 Solutions to common EMC problems

Servo drive is a strong interference equipment, if Error from routing, grounding and protection in the use occurs, it might generate interference. If there is mutual interference with other devices, the following measures can be taken for improvement.

Table 2-20 Common EMC problems and solutions

Interference type	Improvement measure
Switch tripping of leakage protection circuit breaker	1. Under the premise of not affecting the performance, reduce carrier frequency; 2. Shorten the length of drive line; 3. Add magnetic ring around to drive line (not winding PE wire); 4. For power-on instantaneous tripping, it shall disconnect the input larger ground capacitor; (Disconnect the ground of external or built-in filter, and ground of ground Y capacitor at input port); 5. For potential tripping in operation, it shall take the leakage current suppression measure at input port(leakage current filter, safety capacitor + magnetic ring, magnetic ring);
Drive operation causes interference	1. Motor shell is connected to PE end of the driver; 2. Drive PE end is connected to power grid PE; 3. Input power line is equipped with magnetic ring; 4. Mount capacitors or magnetic loops to the interfered signal ports; 5. Add extra common ground among devices;
Communication interference	1. Motor shell is connected to PE end of the driver; 2. Drive PE end is connected to power grid PE; 3. Input power line is equipped with magnetic ring; 4. Communication line source and load end are equipped with matching resistance; 5. Communication line/differential line are equipped with external communication GND; 6. Communication line is shielded, and shielding layer is connected to communication GND; 7. Multi-node communication wiring needs to use Daisy chain; Branch length is less than 30cm;
I/O interference	1. Low speed DI increase capacitance filtering, recommended maximum 0.1uF; 2. AI increase capacitive filter, the recommended maximum 0.22uF;

2.12 General Wiring Diagram



*The power terminal of the control loop is L1C，L2C;
Main circuit power terminals：Single/3-phase 220V terminals are L1，L2，L3;
3-phase 380V terminals are R，S，T.

Figure 2-39 SV3H drive configuration diagram

Internal 24V power supply ranges 20~28V; Max. working current is 200mA.

DI input power supply shall be external connection. Power supply voltage ranges from DC12 to 24V and can't] exceed 30VDC.

Use twisted-pair shielded cable for high-speed/low-speed pulse port. Both ends of the shielded layer must be connected to PE. GND is reliably connected to upper machine signal.

DO output power supply must be external connection and ranges from 5 to 24V. Max. allowable voltage and Max. allowable current of DO port are DC30V and 50mA respectively.

The frequency division output of encoder should use twisted pair shielded cable. The shielding layer must be connected to PE at both ends. GND is reliably connected to the upper machine signal.

Chapter 3 Commissioning

3.1 Settings of Basic Operation

3.1.1 Motor Tuning

Before servo system runs, it is necessary to enter the motor parameters and identify magnetic poles.
This section describes the panel operation process. For details about background operations, see 3.3 Servo3 Designer.

(1)Entering motor parameters

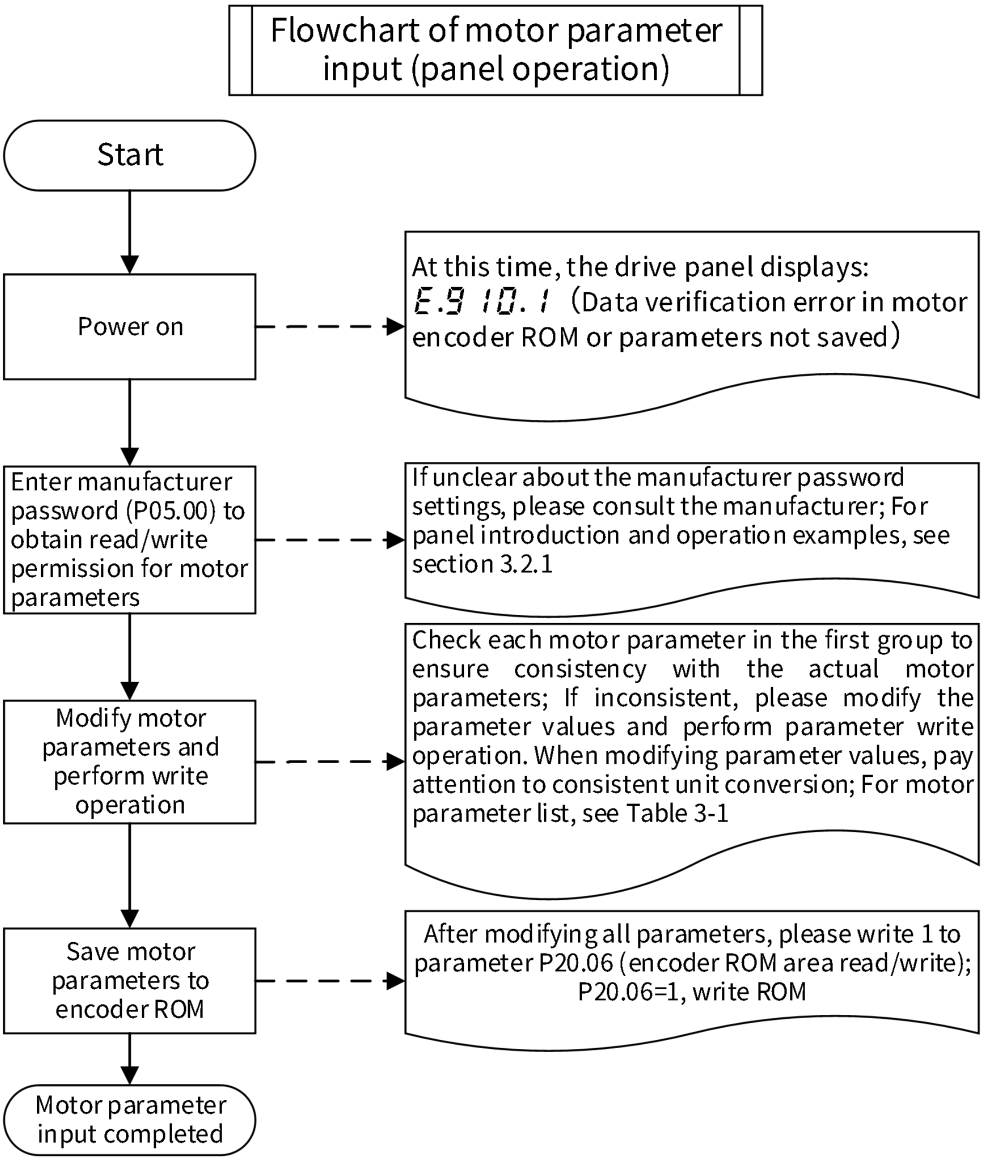
The setting mode of motor parameters is shutdown operation, and the effective mode is power-on reset. List of motor parameters is as follows:

Table 3-1 Parameters of the Motor

Name	Function code	Uit	Initial value	Min.	Max.
Rated voltage	P00.10	V	0-220V	0-220V	655.35
Rated current	P00.11	A	4.70	0	655.35
Rated power	P00.12	kW	0.75	0	655.35
Rated torque	P00.13	N.m	2.39	0	42949672.95
Max. torque	P00.15	N.m	7.16	0	42949672.95
Rated speed	P00.17	rpm	3000	0	65535
Max. speed	P00.18	rpm	6000	0	65535
Inertia of motor	P00.19	kg・cm^2	1.30	0	42949672.95
Number of pole pairs	P00.21	-	4	0	65535
Phase resistance	P00.22	Ω	0.500	0	65.535
Inductance Lq	P00.23	mH	3.27	0	655.35
Inductive Ld	P00.24	mH	3.87	0	655.35
Counter potential	P00.25	mV/rpm	33.30	0	655.35
D-axis back potential compensation	P00.31	%	60.0	0.0	6553.5
Q-axis back potential compensation	P00.32	%	100.0	0.0	6553.5
Current sampling and extraction rate	P00.33	-	0- Extraction rate 32	0- Extraction rate 32	3- Extraction rate 256
D axis proportional gain 1	P00.34	Hz	2000	0	65535
D axis integral gain 1	P00.35	%	2.00	0.00	655.35
Q-axis proportional gain 1	P00.36	Hz	2000	0	65535
Q axis integral gain 1	P00.37	%	1.00	0.00	655.35
D axis proportional gain 2	P00.38	Hz	1000	0	65535

D axis integral gain 2	P00.39	%	2.00	0.00	655.35
Q-axis proportional gain 2	P00.40	Hz	1000	0	65535
Q axis integral gain 2	P00.41	%	1.00	0.00	655.35

Please check the model and parameters of motor used, and enter the motor parameters according to the following process.



At this time, the drive panel displays: E.910.1 (Data verification error in motor encoder ROM or parameters not saved)

If unclear about the manufacturer password settings, please consult the manufacturer; For panel introduction and operation examples, see section 3.2.1

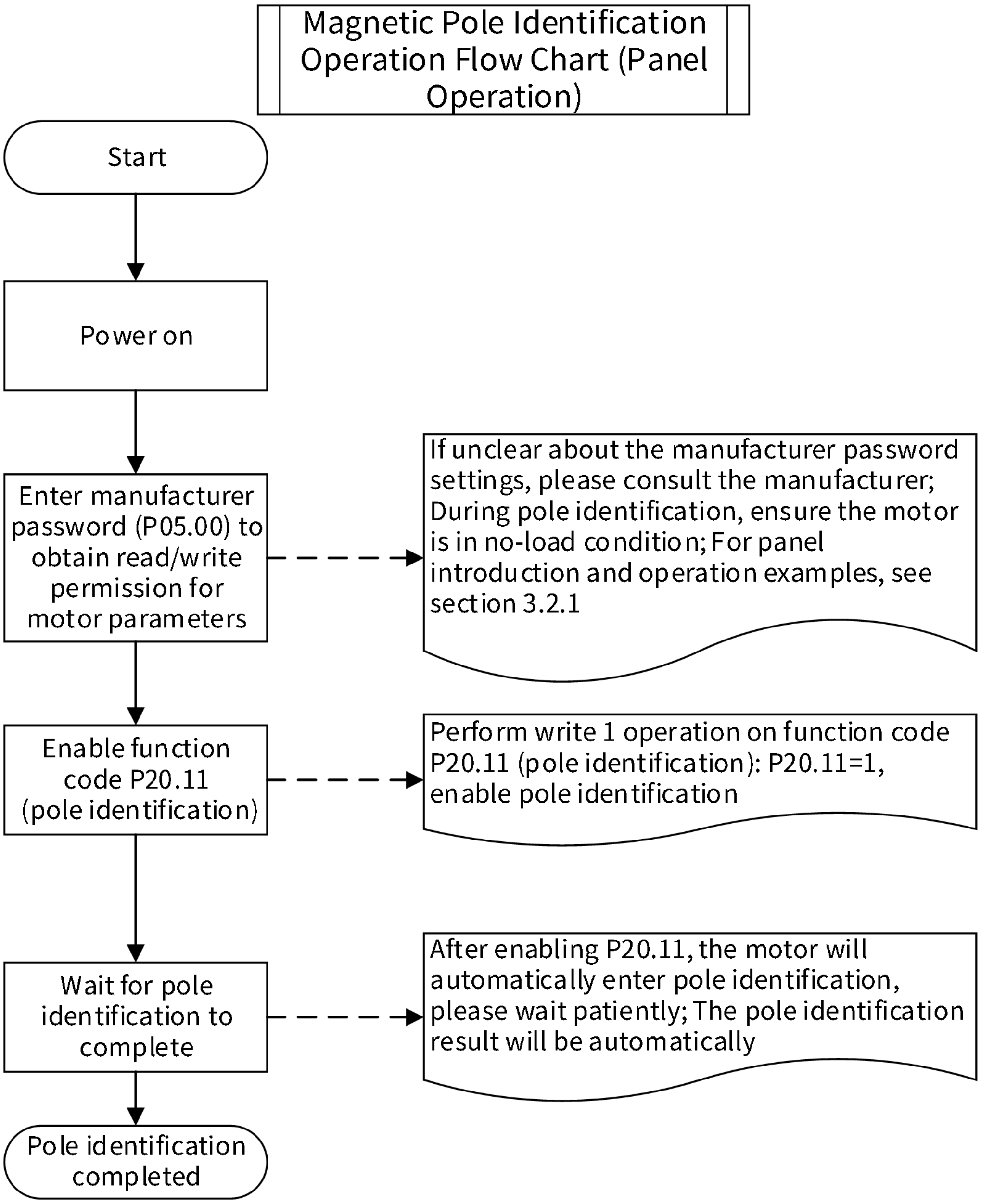
Check each motor parameter in the first group to ensure consistency with the actual motor parameters; If inconsistent, please modify the parameter values and perform parameter write operation. When modifying parameter values, pay attention to consistent unit conversion; For motor parameter list, see Table 3-1

After modifying all parameters, please write 1 to parameter P20.06 (encoder ROM area read/write); P20.06=1, write ROM

Figure 3-1 Panel operation process of motor parameter entering

(2)Magnetic pole identification

Operation process of magnetic pole identification is as follows.



If unclear about the manufacturer password settings, please consult the manufacturer; During pole identification, ensure the motor is in no-load condition; For panel introduction and operation examples, see section 3.2.1

Perform write 1 operation on function code P20.11 (pole identification): P20.11=1, enable pole identification

After enabling P20.11, the motor will automatically enter pole identification, please wait patiently; The pole identification result will be automatically

Figure 3-2 Operation process of magnetic pole identification

3.1.2 Brake Setting

Holding brake is used to stop the unexpected movement of moving loads(e.g., falling under gravity) when the servo system is not activated (e.g., servo system is powered off), to prevent servo motor from moving unexpectedly due to its own weight or external force after being powered off.

⚠ **Note:**

Holding brake is the non-powered action type special mechanism, which can't be used for braking, and can be used only when servo motor is in the stop state.

Non-polarity of Holding brake coil;

After servo motor stops, it shall switch off servo enable.

When the motor with built-in Holding brake runs, the brake might make the clicking, that doesn't affect any function;

When the brake coil is energized (the brake is ON), magnetic flux leakage may occur at shaft ends. When using the magnetic sensor near motors, please pay attention to the possibility of this situation.

(1) Holding brake parameter setting

For applications with Holding brake, it must set Holding brake enable switch(P05.12) ON, and one of servo drive DO terminals must be configured to Function 17 (BK, Holding brake control), and ensure the valid logic for the corresponding DO terminal.

According to the current state of servo drive, working time sequence of the brake mechanism consists of 2 types: the brake time sequence in normal state of servo drive and the brake time sequence in Error state of tservo drive.

Table 3-2 Index code of P05.12 Holding brake enable switch

P05.12- Lock Holding brake switch	
Index - Subindex	0x2005-0D
Data type	UINT16
Accessibility	Readable/writable
Unit	-
DeError value	1
Min.	0
Max.	1
Setting and effective mode	Run settings/Effective immediately
Related mode	-
Note	-

Table 3-3 Holding brake output No.

Encoding	Name	Function name	Functions
17	BK	Holding brake control	Invalid, the brake power supply is ON, the brake runs, motor is in the position stalled state; Effective, the brake power supply is OFF, the brake is cancelled, and motor can move;

(2) Holding brake sequence of servo drive in normal state

Holding brake sequence in the normal state can be divided into such 2 situations as motor static and motor dynamic:

Static: Motor actual speed is below 30rpm;

Dynamic: Motor actual speed reaches 30rpm and above.

(3) The brake sequence when servo motor is static

When servo enable is switched from ON to OFF, if the current motor speed is lower than 30rpm, the drive would run according to static brake sequence;

After the brake output is set from OFF to ON, do not enter any position/speed/torque instruction within P05.13 time, or instructions would be lost or it would run improperly;

Being used in vertical axis, self-weight or external force of mechanical moving part may cause the slight movement of machine. When servo motor is stationary, the servo enable switches OFF, and the brake output immediately turns OFF, but within P05.14 time, the motor is still in the power-on state to prevent mechanical moving part from moving due to self-weight or external force.

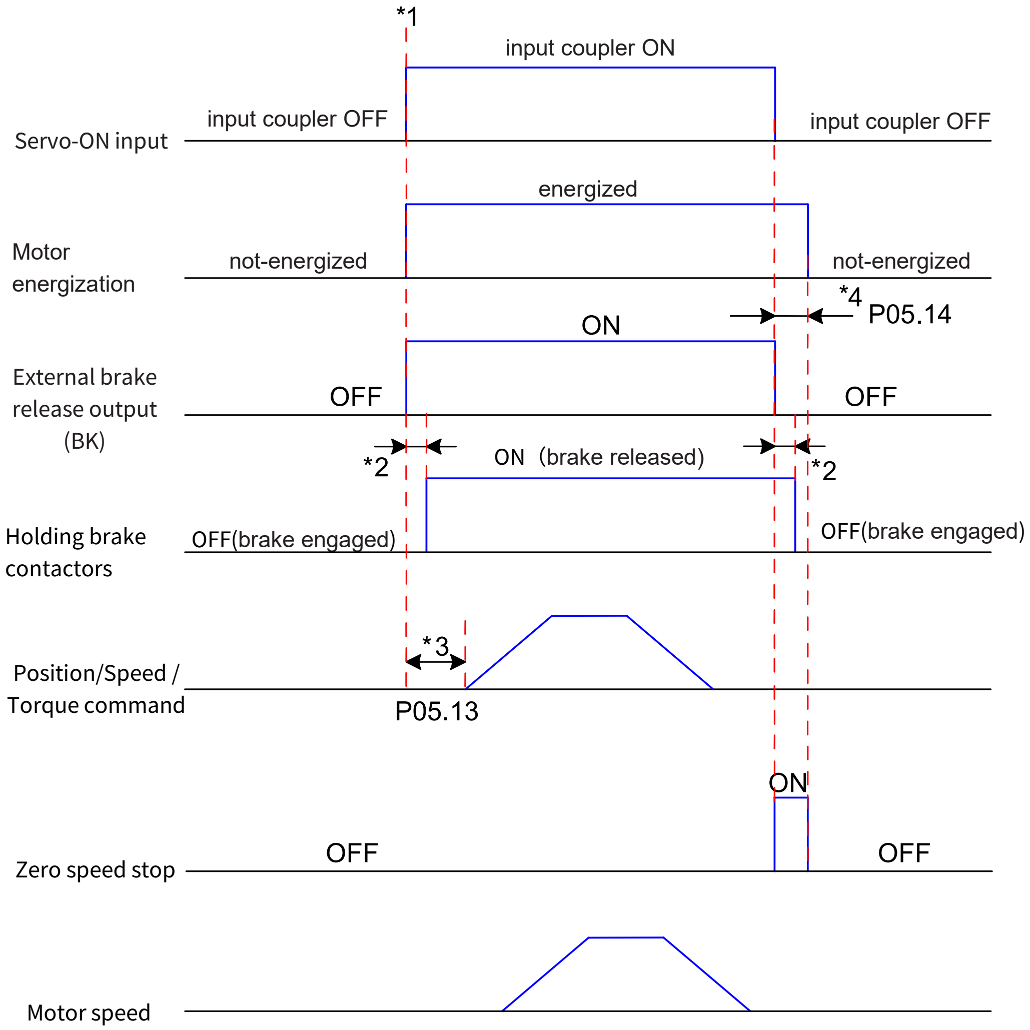


Figure 3-3 Timing diagram of Holding brake when motor is stationary

*1. When servo enable is ON, the brake output is set as ON; At the same time, the motor enters the power-on state;

*2. Please refer to the relevant specification for delay time of action of Holding brake contact part;

*3. From the brake output set as ON to inputing command, please leave an interval above P05.13 time;

*4. When servo motor is static(motor speed below 30rpm), when servo enable is OFF, brake output is set as OFF at the same time. By P05.14, motor enters the delay of non-power-on state after brake output is set as OFF.

Table 3-4 P05.13 Index code from the brake switch-off to receiving command delay(Stop state)

P05.13 - From the brake switch-off to receiving command delay	
Index	0x2005-0E
Data type	Uint16
Accessibility	Readable/writable
Unit	ms
DeError value	250
Min.	0
Max.	500
Setting and effective mode	Run settings/Effective immediately
Related mode	-
Note	-

Table 3-5 P05.14 Index code of zero speed holding time of Holding brake switched on (Stop state)

P05.14- Zero speed holding time for lock suction	
Index	0x2005-0F
Data type	Uint16
Accessibility	Readable/writable
Unit	ms
DeError value	150
Min.	1
Max.	1000
Setting and effective mode	Run settings/Effective immediately
Related mode	-
Note	-

(4) Sequence of Holding brake when servo motor is moving

When servo enable is switched from ON to OFF, if the current motor speed is higher than or equal to 30rpm, the drive will operate according to the motion brake sequence.

When the servo enable is set from OFF to ON, do not enter position/speed/torque command within P05.13 time, or commands will be lost or operates improperly;

While servo motor is moving, servo enable OFF occurs, and servo motor enters zero speed stop state, but Holding brake output can be set as OFF only if any of the following conditions are met. I. P05.16 time hasn't expired, but it has reduced the motor speed to P05.15; ii . P05.16 time ends, but motor speed is still above P05.15.

Output of Holding brakeONchangeOFFthen50msduring the period, motor is still powered on and prevent mechanical parts from moving due to self-weight or external force.

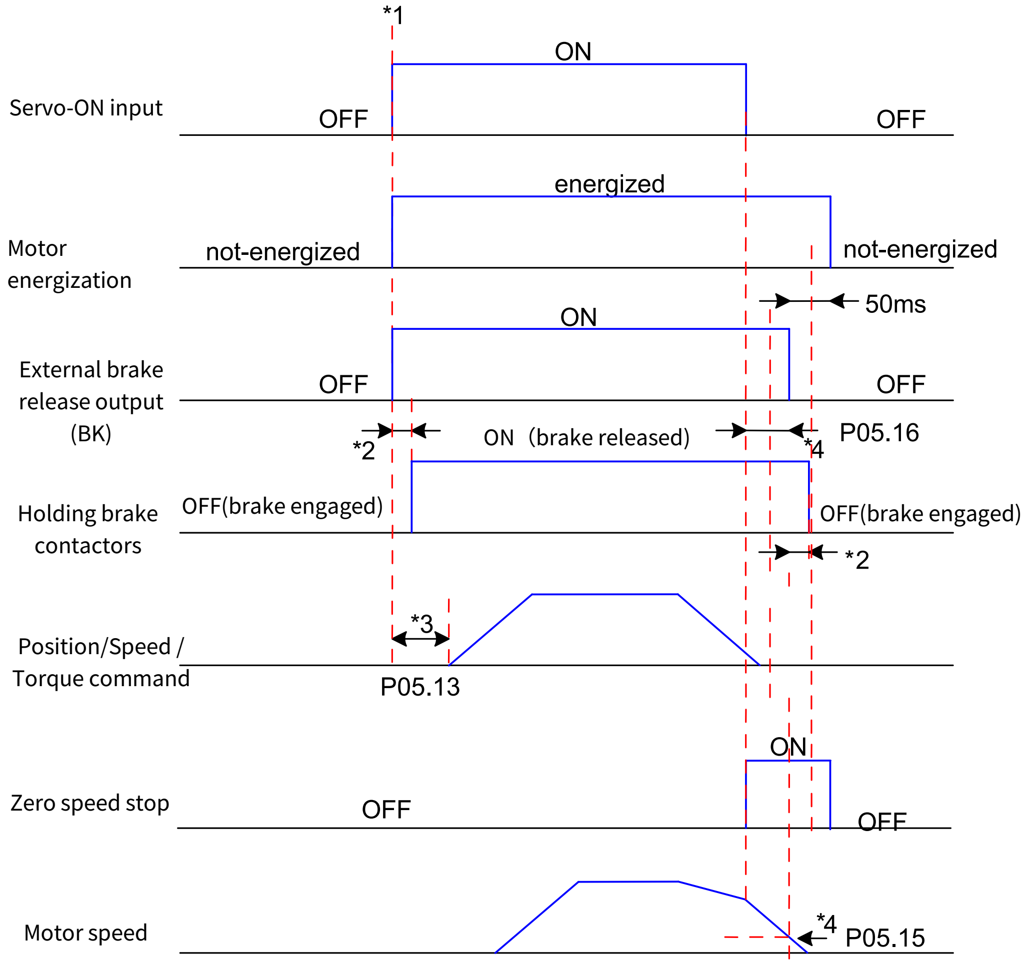


Figure 3-4 Sequence diagram of Holding brake when motor moves

*1. When servo enable is ON, the brake output is set as ON; At the same time, the motor enters the power-on state;

*2. Please refer to the relevant specification for delay time of actions of Holding brake contact part.

*3, From Holding brake output as ON to input command, please set an interval above P05.13.

*4. In the case of servo motor movement, when servo enable is OFF, it can set the delay of Holding brake output OFF after servo enable is OFF. It can be set through P05.15 and P05.16. After Holding brake outputs OFF, delay time is

50ms, then motor would enter the non-powered state.

Table 3-6 P05.15 Holding brake power-on speed threshold

P05.15 - Holding brake power-on speed threshold	
Index	0x2005-10
Data type	Uint16
Accessibility	Readable/writable
Unit	rpm
DeError value	30
Min.	0
Max.	3000
Setting and effective mode	Run settings/Effective immediately
Related mode	-
Note	-

Table 3-7 P05.16 - Holding brake power-on speed threshold

P05.16 - Holding brake power-on speed threshold	
Index	0x2005-11
Data type	Uint16
Accessibility	Readable/writable
Unit	ms
DeError value	500（ms）
Min.	1
Max.	1000
Setting and effective mode	Run settings/Effective immediately
Related mode	-
Note	-

(5) Sequence of Holding brake in servo drive Error state

According to stop modes, servo Errors are classified into Type 1 Errors(referred to as NO.1) and Type 2 Errors (referred to as NO.2). For details, see Chapter 5 Troubleshooting and Alarm. Holding brake sequence of servo drive in Error state can be divided into the following 2 situations:

3.1.3 Selection of Running Direction

By setting the direction, it can reverse motor rotation without changing the polarity of input instruction. After modification, only when powering on the servo again, can it take effect.

When "Direction Selection" is changed, pulse form of servo drive output and positive/negative state of monitoring parameters won't change.

Setting of "Forward drive" in the overrun prevention is identical to that of "Motor operation direction selection (P04.01)".

As for operation direction setting, the selections are available as "2004-02h", or "P04.01" on the panel, or "P04 group - Motor operation direction selection" on background software.

Table 3-8 P04.01- Selection of motor operation reversing

P04.01- Selection of motor operation reversing	
Index - Subindex	0x2004-02
Data type	UINT16
Accessibility	Readable/writable

Unit	1
DeError value	0
Min.	0
Max.	1
Setting and effective mode	Stop setting/power-on reset
Related mode	ALL
Note	When viewed from motor shaft side.its rotation direction is defined as positive.

3.1.4 Absolute Value Function

(1)Instruction of absolute value system

Absolute encoder can simultaneously record the position of servo motor and turns of servo motor rotation. Single-turn resolution is 1048576, and turns of 16-bit Max. 65535 can be recorded. Absolute encoder will back up position data when the upper servo drive is powered off. After power-on reset, machine absolute position can be calculated without re-starting the original zero point(when servo drive uses the incremental encoder, position feedback is 0 after power-on. By the original zero point, it can find the point where mechanical position feedback is really 0, accordingly servo motor can operate properly on the mechanical equipment; After absolute value encoder is used, the correct position feedback will be calculated according to the back-up data by encoder after power-on reset.

⚠ Note:

SV3 servo drives support absolute position linear mode and absolute position rotation mode, which is suitable for position, speed, and torque mode;

E.917 encoder battery Error occurs when battery is switched on for the first time. It shall set P20.05=1 to reset the encoder Error, and then perform the origin zero return.

To modify the direction reservsing selection of P04.01, it shall reset the origin zero return;

In absolute position mode, the servo automatically detects whether motor number is absolute encoder motor, if the setting is wrong, Error E.019 occurs(encoder matching Error).

(2) Object related to absolute value system

Function selection object:

Table 3-9 P04.02 - Selection of Position Feedback System

P04.02 - Selection of Position feedback System	
Index - Subindex	0x2004-03
Data type	UINT16
Accessibility	Readable/writable
Unit	-
DeError value	0
Min.	0
Max.	2
Setting and effective mode	Stop setting/power-on reset
Related mode	ALL

<table>
<tr><td>Note</td><td>Set absolute value system<table><tr><th>Settings</th><th>Selection of absolute value system</th></tr><tr><td>0</td><td>Incremental mode</td></tr><tr><td>1</td><td>Absolutely linear model</td></tr><tr><td>2</td><td>Absolute rotation mode</td></tr></table></td></tr>
</table>

Table 3-10 P20.05- Encoder reset

<table>
<tr><th colspan="2">P20.05- Encoder reset</th></tr>
<tr><td>Index - Subindex</td><td>0x2020-06</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>2</td></tr>
<tr><td>Setting and effective mode</td><td>Stop setting/power-on reset</td></tr>
<tr><td>Related mode</td><td>-</td></tr>
<tr><td>Note</td><td>Encoder reset<table><tr><th>Settings</th><th>Description</th></tr><tr><td>0</td><td>No action</td></tr><tr><td>1</td><td>Reset Error</td></tr><tr><td>2</td><td>Reset Error and multi-turn data</td></tr></table></td></tr>
</table>

Table 3-11 encoder feedback parameter objects

Parameter index	Parameter	Name	Unit	Range	Data type	Accessibility	PDO
0x2009-2B	P09.42	Number of encoder turns	Turn	0~65535	UINT16	RO	-
0x2009-2C	P09.43	Encoder single turn position	Encoder unit	$0\sim(2^{31}-1)$	INT32	RO	-
0x2009-2E	P09.45	Encoder absolute position Low 32 bits	Encoder unit	$(-2^{31})\sim(2^{31}-1)$	INT32	RO	-
0x2009-30	P09.47	Encoder absolute position High 32 bits	Encoder unit	$(-2^{31})\sim(2^{31}-1)$	INT32	RO	-

⚠ **Note:**

P09.43 is the encoder single-turn position, and its range is 0 to encoder resolution. In case of 23-bit encoder, the range is 0~(223-1);

P09.42/P09.43 are both encoder feedback data;

As P09.42 is an unsigned number, absolute position of absolute encoder is calculated as follows:

Encoder absolute position = P09.42 × encoder resolution + P09.43(P09.42<32768)

Or

Encoder absolute position = (P09.42-65536) × encoder resolution + P09.43 (P09.42⩾ 32768)

P09.45 and P09.47 are used to display the absolute position of encoder. The formula is as follows: absolute encoder absolute position = P09.47×232+ P09.45.

(3) Precautions for absolute value system

If the battery is connected for the first time, E.917 (encoder battery Error) will occur. It requires to set P20.05=1 to reset the encoder Error, and then perform absolute position system operation;

If the detected battery voltage is less than 3.0V, E.921 (encoder battery Alarm) will occur. Please replace the battery; Ensure that the servo drive is powered on but not running when replacing the battery;

If the servo drive is powered off, the battery is detached or replaced, please use P20.05=1 to reset the encoder Error after powered-on, and then reset the original zero;

If the servo drive is powered off, Max. speed of the motor should not exceed 6000rpm, otherwise, encoder position data may be recorded improperly;

Please ensure that battery SOC and storage conditions do not damage the battery.

3.1.5 Setting of Electronic Gear Ratio

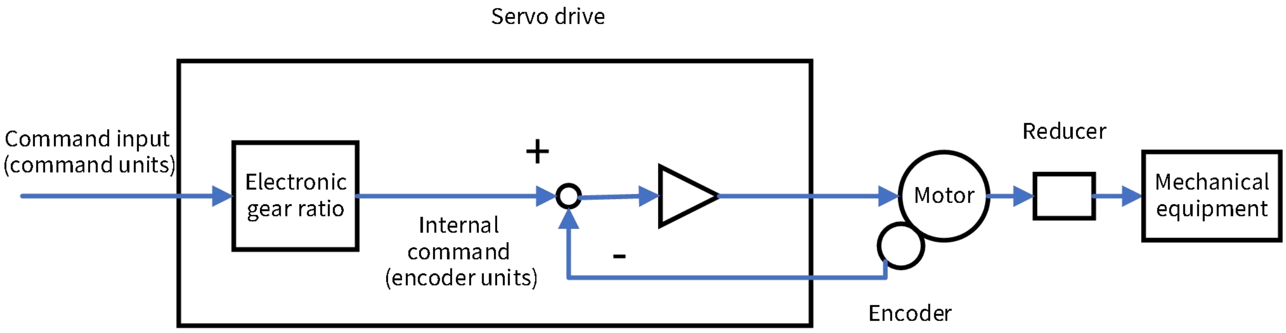


Figure 3-5 Electronic gear ratio

Electronic gear ratio: Electronic gear ratio is a simulated gear that converts control commands (command units) into actual motor displacement (encoder units), shown as the following formula:

$$\text{Encoder unit} = \text{Command unit} \times \frac{\text{Numerator of electronic gear ratio}}{\text{Denominator of electronic gear ratio}}$$

Note: The control variables (non-state feedback variables) in object dictionary are based on command units. If the electronic gear ratio is set of 1:1, then 1 encoder unit is equal to 1 command unit.

Table 3-12 0x6091 electronic gear ratio

0x6091-electronic gear ratio		
Index - Subindex	0x6091-01	0x6091-02
Data type	UINT32	
Accessibility	RW	RW
Unit	-	-
DeError value	1	1
Min.	0	0
Max.	2^{32}-1	2^{32}-1
Setting and effective mode	Operation settings/downtime effective	Operation settings/downtime effective
Related mode	CSP/PP/HM/CSV/PV	
Note	6091-01h：Numerator of electronic gear ratio 6091-02h：Denominator of electronic gear ratio	

3.1.6 Time sequence diagram

(1) Power on subsequence diagram

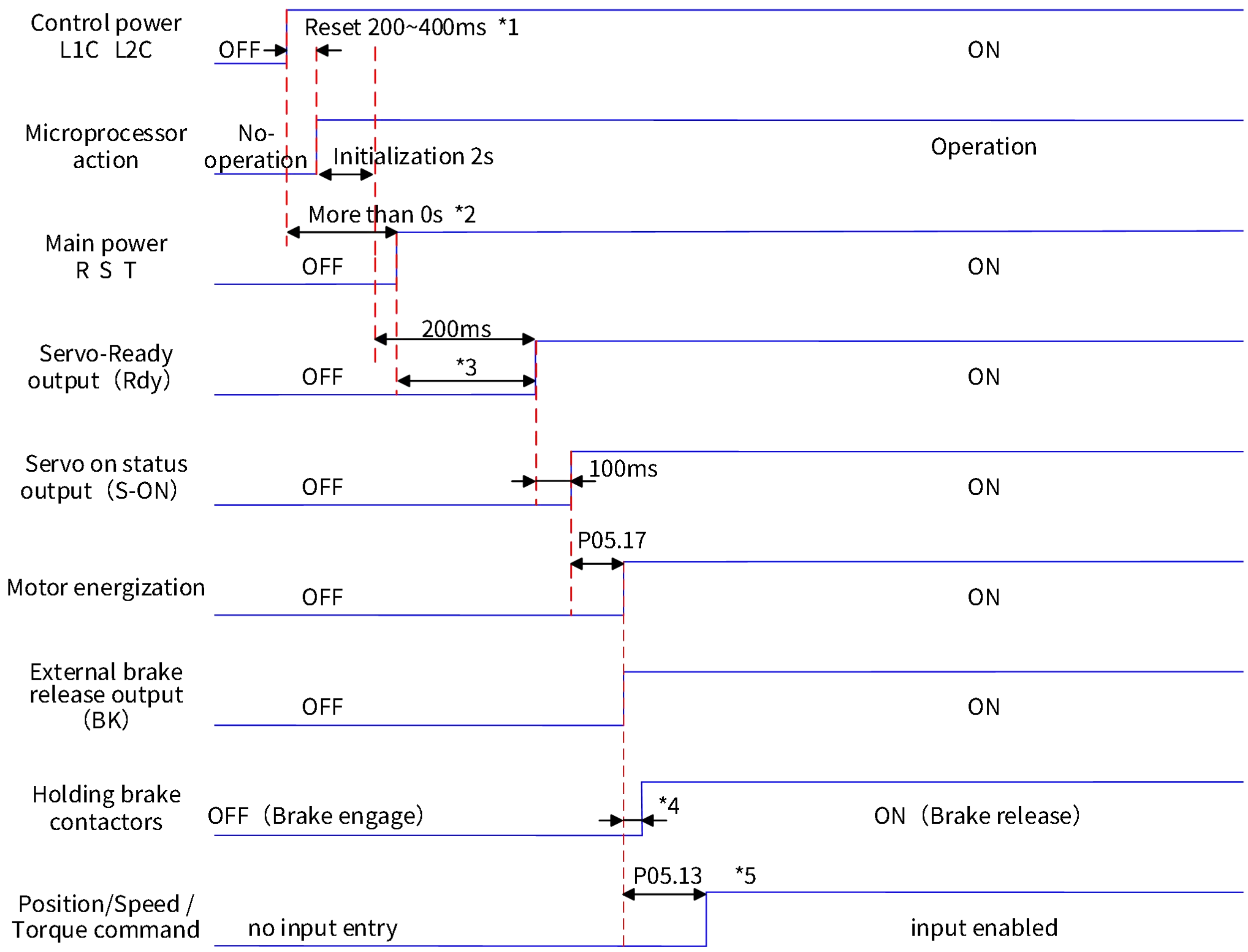


Figure 3-6 Power-on subsequence diagram

*1: The reset time is determined by the establishment time of microprocessor and 5V power supply.

*2: 0s above refers to the time determined by actual time when main power supply is turned on.

*3: When control power supply and main power supply are powered on simultaneously, the time is the same as the period from the completion of microprocessor initialization to Rdy enabled.

*4: Please refer to the relevant specification for delay time of Holding brake contact action.

*5: When Holding brake enable switch (P05.12) is OFF, P05.13 has no effect.

(2) Stop sequence diagram when Alarm or Error occurs

A) Error 1: Free stop, maintain a free running state;

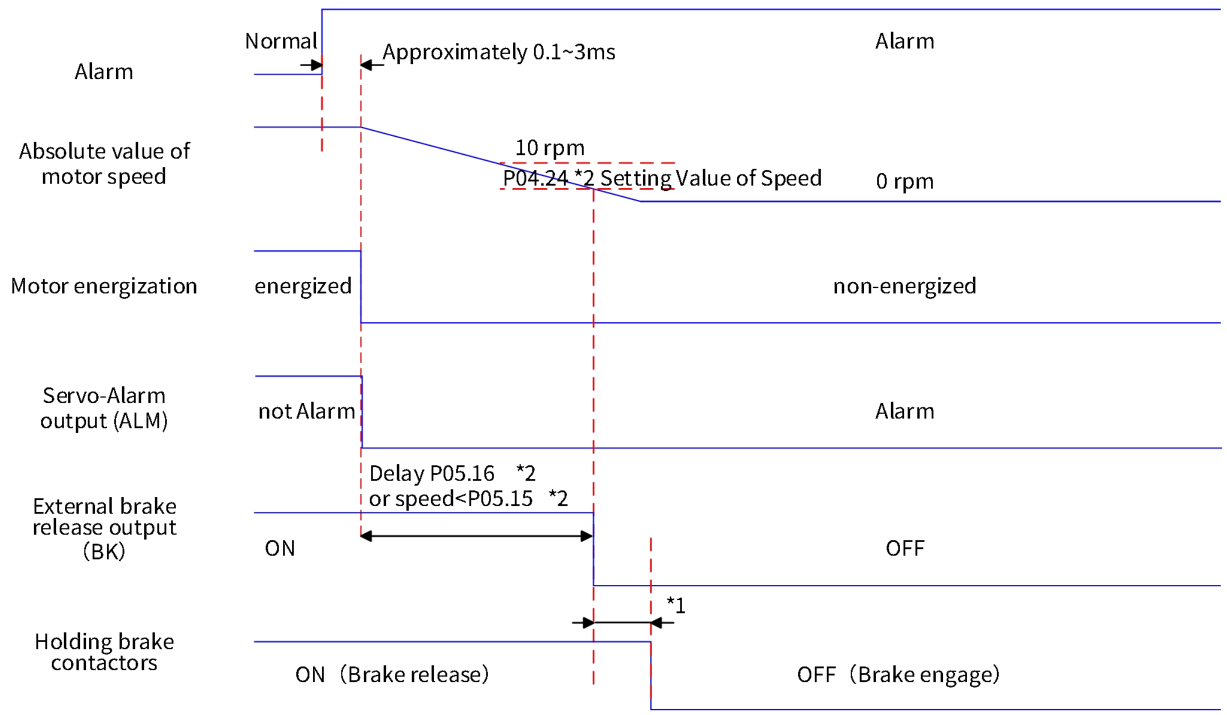


Figure 3-7 Sequence diagram of free stop and free running state during Error 1

*1: Please refer to the relevant specifications for delay time of Holding brake contact action.

*2: When the brake enable switch (P05.12) is OFF, P05.15 and P05.16 have no effect.

B)Error 2: Not a Holding brake. Free shutdown, maintaining a free running state.

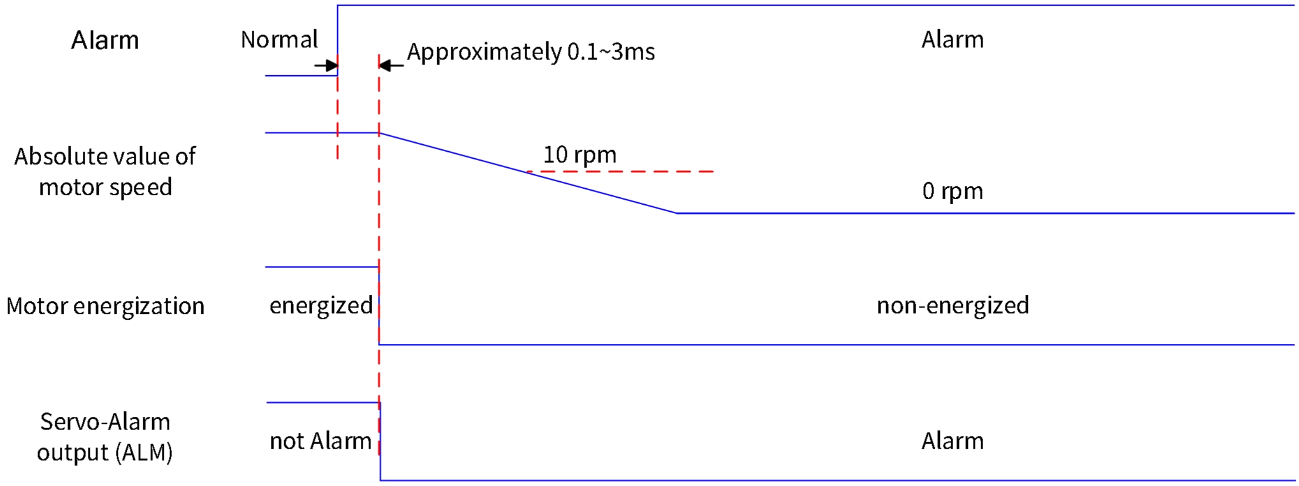


Figure 3-8 Sequence diagram of free stop and free running state during Error 2

C) Error 2: Not Holding brake: DB stop, maintain DB status

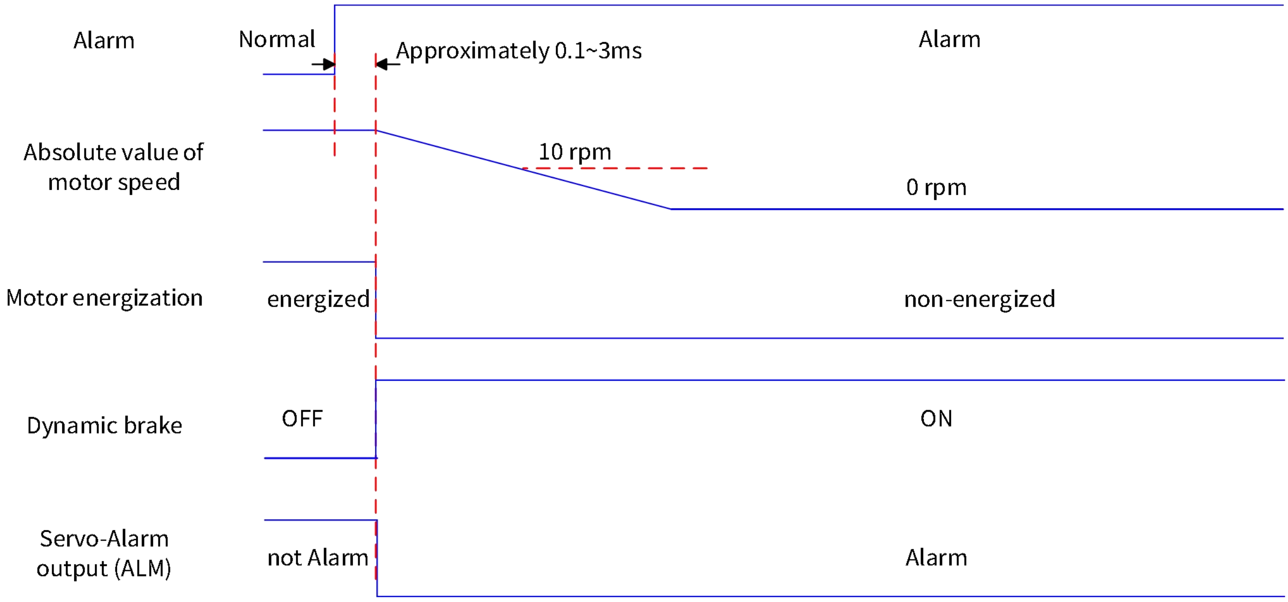


Figure 3-9 Sequence diagram of DB stop, maintain DB status during Error 2

D) Error 2: Not Holding brake: Zero speed stop, maintain free running status

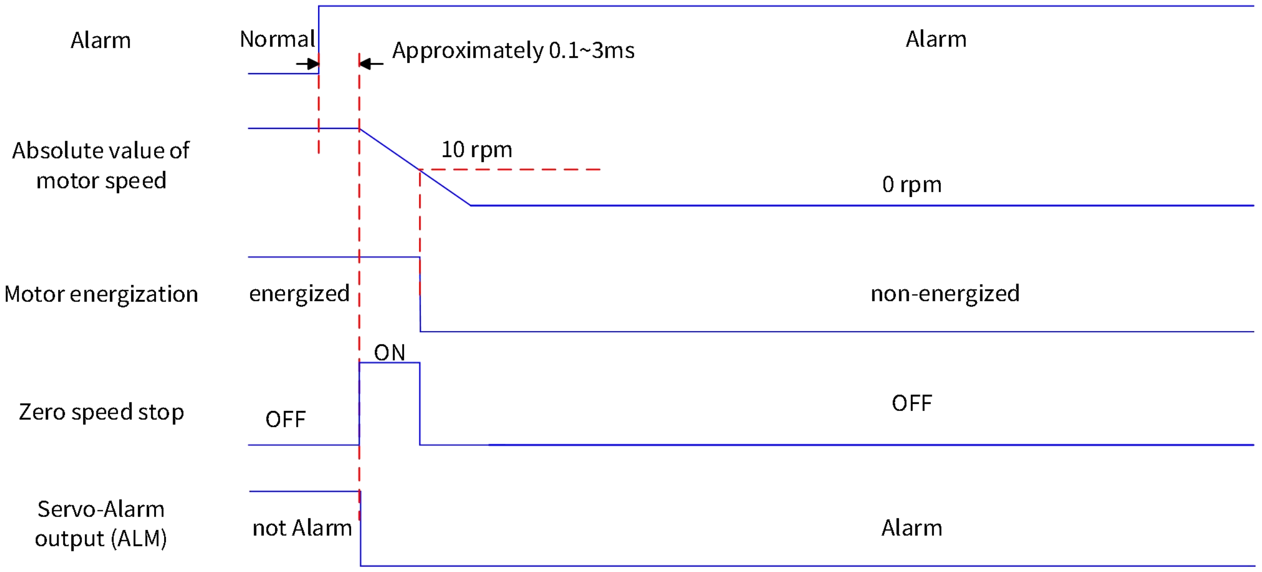


Figure 3-10 Sequence diagram of zero speed stop and free run state during Error 2 (not Holding brake)

E) Error 2 with Holding brake: forced to be zero speed stop, and maintain free run state

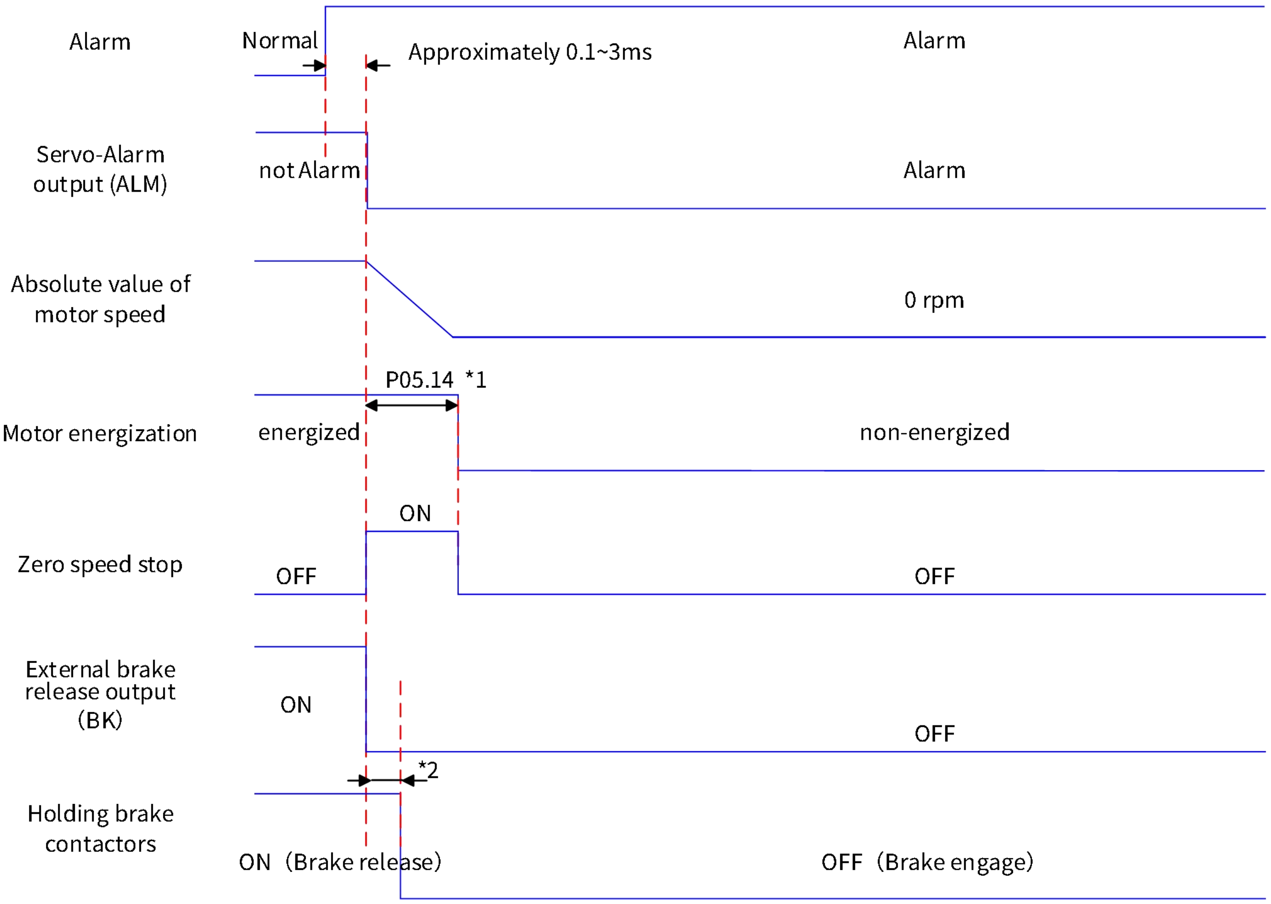


Figure 3-11 Sequence diagram of free stop state in zero speed stop mode during Error 2 (with Holding brake)

*1: When the brake enable switch(P05.12) is OFF, P05.14 has no effect;

*2: Please refer to the relevant specifications for delay time of Holding brake contact action.

When the servo encounters Type 3 Alarm: A.220 (forward overtravel Alarm)/A.221 (reverse overtravel Alarm), the current operating state of servo will be interrupted, and its stop sequency is shown in F).

F) Overtravel stop Alarm: Zero speed stop, maintain position latched state

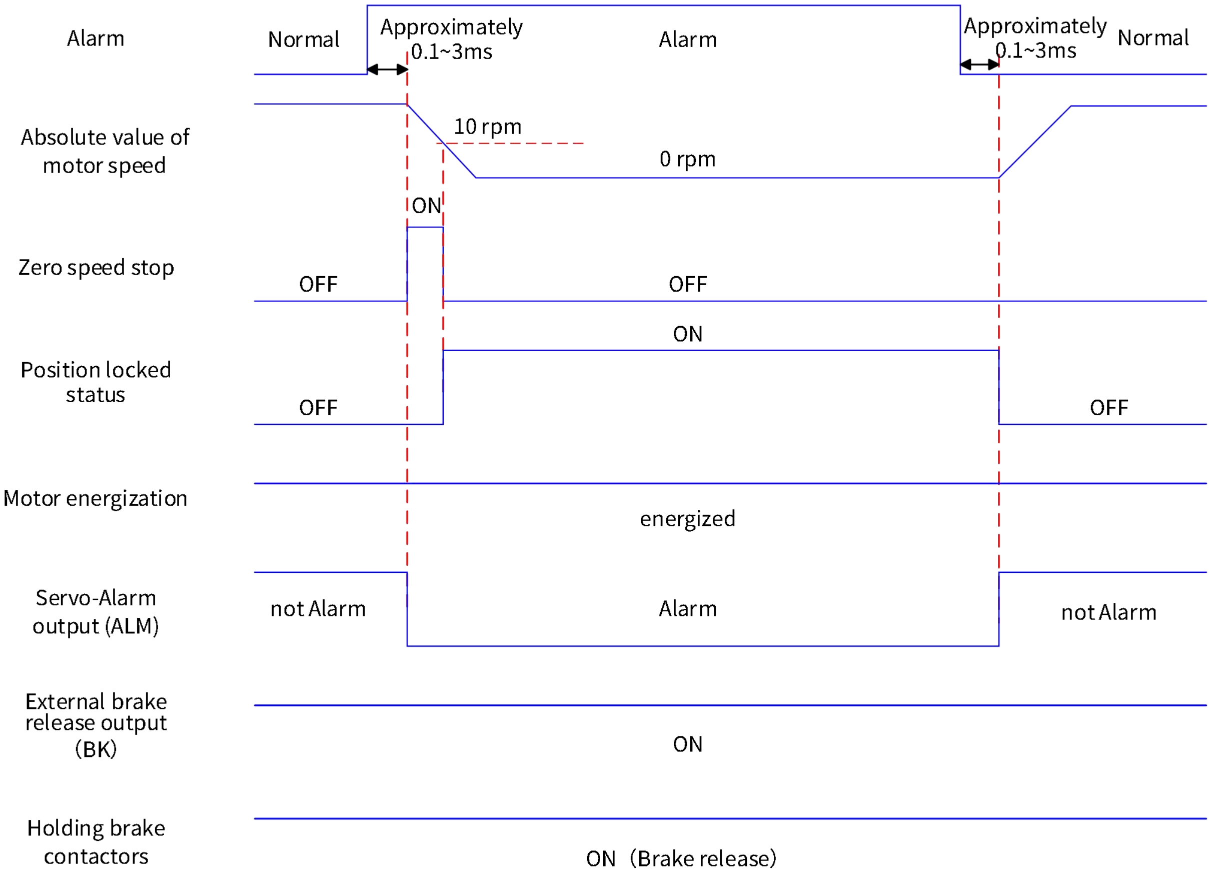


Figure 3-12 Timing diagram of shutdown Alarm

Except for the above two types of Class 3 Alarms, other Alarms have no impact on the current status of the servo, as shown in G).

G) Non shutdown Alarm:

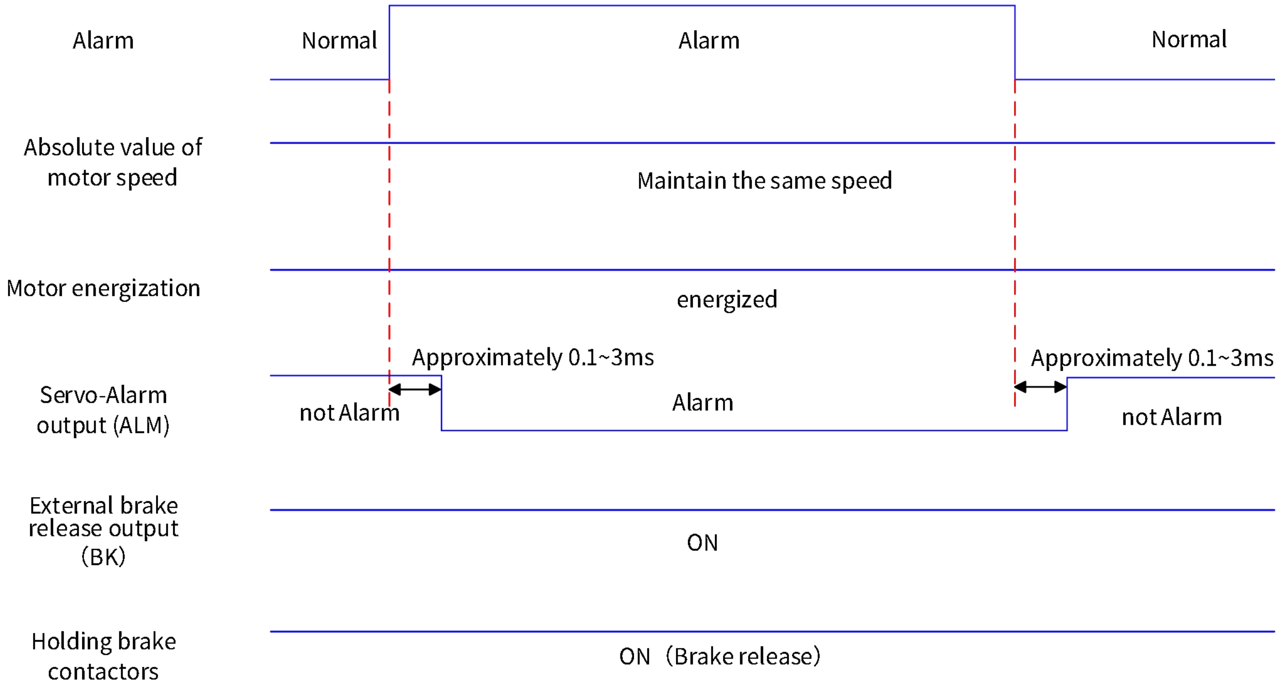


Figure 3-13 Non stop Alarm Sequence Diagram

H) Alarm reset:

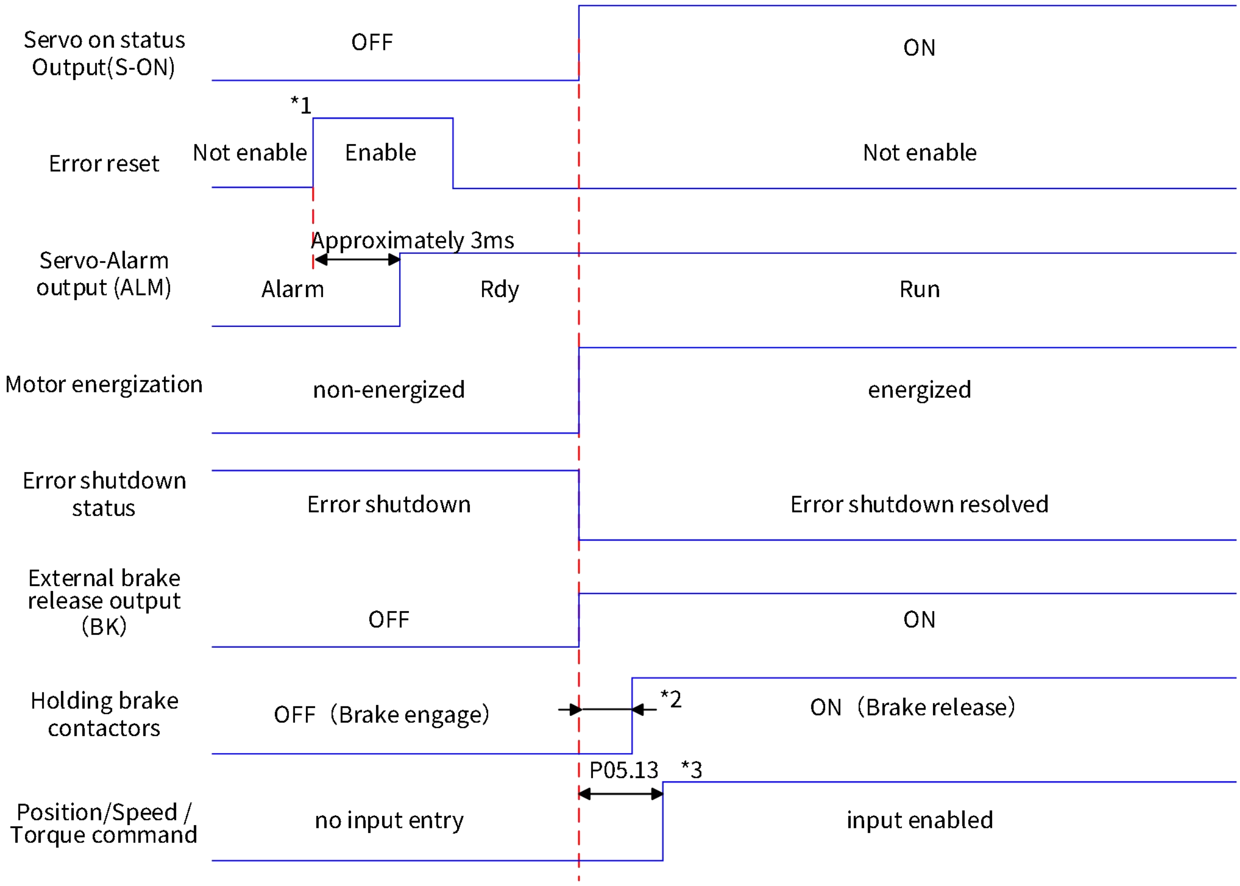


Figure 3-14 Error reset timing diagram

*1: The DI Error reset signal (5: Error reset) is valid along the variation.

*2: Please refer to the relevant specifications for delay time of Holding brake contact action.

*3: When the brake enable switch (P05.12) is not turned on, P05.13 has no effect.

3.1.7 Operation

(1) Check before operation

Table 3-13 Check procedure before operation

Item	Content
Wiring inspection	Motor power line UVW line sequence (Special attention) Whether GND is loose or short-circuited with UVW Whether encoder cable is loose
Mechanical connection inspection	Check if there are strict requirements for the direction of motor rotation by the mechanical part which is connected to motor. It's recommended that the motor should be unloaded prior to 'safe operation' execution
Environmental inspection	Do not operate any motor in high temperature/humidity

(2) Safe operation

Table 3-14 Safe operation procedures

Steps	Description
Power on and confirm the Panel display	After the servo controller is powered on, the last 2-digit of panel displays 'ry' under normal conditions. If the panel flashes an alarm code, please troubleshoot it according to Chapter 5
Low-speed rotation	1) Operate the drive motor according Section 3.2.2 JOG 2) Observe the direction of motor movement. If the direction is wrong, stop driving the motor and check the drive parameters according to Section 3.2.1 Panel Introduction 3) Use Servo3 Designer oscilloscope to observe the speed waveform. If the speed is incorrect, please check the electronic gear ratio setting according to section 3.1.5 or correct the upper computer unit conversion

(3) Operation

Table 3-15 Operational steps

Item	Description
Mechanical connection	Please connect motor to load after 'safe operation' is executed correctly. Multi-diaphragm coupler is recommended
Inertia recognition	Set proper inertia ratio by inertia recognition function
Gain adjustment	Adjust gain parameters, filter parameters, advanced adjustment parameters to realize high precision, high response speed control
Operation under program	Use the drive for devices, write control program, and complete specific functions

3.1.8 Stop

In order to meet the various working conditions of servo, servo drive supports different stop modes and stop states.

(1) Stop mode

Free stop: servo motor is not powered on, and the motor is free to reduce its speed to 0 by mechanical friction;

DB stop: stop the servo motor in motion state by the reverse braking torque provided by UVW 3-phase short-circuit;

Ramp stop: Smoothly stop according to pre-set position/speed/current ramp instructions;

Zero speed stop: servo drive outputs reverse braking torque, immediately set the target motor speed to zero and execute stop;

Emergency torque stop: servo drive outputs reverse braking torque and quickly reduces the motor speed to 0.

(2) Stop state

Hold position state: after the motor stops, the motor shaft is locked and can't rotate freely;

Free motion state: after the motor stops, the motor is not powered on, and the motor shaft can rotate freely;

Hold DB state: after the motor stops, the motor is connected to the drive, UVW 3-phase short-circuit, and the motor shaft can slowly rotate by external force.

(3) Stop condition

Servo drive supports the following stop conditions:

Table 3-16 Stop modes of SV3 servo drives

Stop condition	Settings of related parameter		Stop action and status	Description
Type I Error stop	P04.10	0	Free stop, free movement	Stop conditions while type I failure occurs
		1	DB down, free movement	
		2	DB stop, keep DB	
Type II Error stop	P04.11	0	Free stop, free movement	Stop conditions while type II failure occurs
		1	Zero speed stop, free movement	
		2	Zero speed stop. Keep DB	
		3	DB down, free movement	
		4	DB stop, keep DB	
Disable stop mode	P04.12	0	Free stop	Stop condition when servo drive stops enabling
		1	DB stop	
		2	Zero speed stop	
Disable stop state	P04.13	0	Free movement	
		1	Hold DB	

Power-off stop	P04.14	0	Stop by disabled mode	Stop condition when servo drive is powered off
		1	Zero speed stop	
Overrun stop	P04.15	0	Free stop, free movement	Stop condition when motor shaft position exceeds the pre-set one which can be the position limit value of the servo internal software or the position at external limit DI triggering time
		1	Zero speed stop, maintain the position	
		2	Zero speed stop, free movement	
Fast stop	605Ah	The stop method is different for each motion. For details, please refer to the object dictionary 605Ah		Stop when control word 6040h fast stop position is valid Condition
Pause	605Dh	The stop method is different for each motion. For details, please refer to the object dictionary 605Dh		Stop condition when control word 6040h pause position is valid

Table 3-17 0x605A - Fast Stop Mode Selection

<table>
<tr><th colspan="2">0x605A - Fast Stop Mode Selection</th></tr>
<tr><td>Index - Subindex</td><td>0x605A-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>2</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>7</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>Fast stop, when Bit2 of control word 6040h is valid, fast stop will be 6executed. Under the same set value, different stop modes have different stop methods as shown in the following table:
PP：
<table>
<tr><th>Settings</th><th>Description</th></tr>
<tr><td>0</td><td>Free shutdown, maintain free run state</td></tr>
<tr><td>1</td><td>Ramp stop by 6084h, maintain free run state</td></tr>
<tr><td>2</td><td>Ramp stop by 6085h, maintain free run state</td></tr>
<tr><td>3</td><td>Emergency stop by P04.23 braking torque, maintain free run state</td></tr>
<tr><td>4</td><td>NA</td></tr>
<tr><td>5</td><td>Ramp stop by 6084h, maintain position latched state</td></tr>
<tr><td>6</td><td>Ramp stop by 6085h, maintain position latched state</td></tr>
<tr><td>7</td><td>Emergency stop by P04.23 braking torque, maintain position latched state</td></tr>
</table>
CSP：
<table>
<tr><th>Settings</th><th>Description</th></tr>
<tr><td>0</td><td>Free shutdown, maintain free run state</td></tr>
<tr><td>1</td><td>Emergency stop by P04.23 braking torque, maintain free run state</td></tr>
</table>
</td></tr>
</table>

2	
3	
4	NA
5	Emergency stop by P04.23 braking torque, maintain position latched state
6	
7	

PV/CSV/HM

Settings	Description
0	Free shutdown, maintain free run state
1	Ramp stop by 6084h(HM: 609Ah), maintain free run state
2	Ramp stop by 6085h, maintain free run state
3	Emergency stop by P04.23 braking torque, maintain free run state
4	NA
5	Ramp stop by 6084h(HM: 609Ah), maintain position latched state
6	Ramp stop by 6085h, maintain position latched state
7	Emergency stop by P04.23 braking torque, maintain position latched state

CST/PT

Settings	Description
0	Free shutdown, maintain free run state
1	Ramp stop by 6087h, maintain free run state
2	
3	Free shutdown, maintain free run state
4	NA
5	Ramp stop by 6087h, maintain position latched state
6	
7	Free stop, maintain position latched state

Table 3-18 0x605D Pause Mode Selection

0x605D - Pause mode selection	
Index - Subindex	0x605D-00
Data type	UINT16
Accessibility	Readable/writable
Unit	-
DeError value	1
Min.	1
Max.	3
Setting and effective mode	Operation settings/downtime effective
Related mode	ALL
Note	Pause, when Bit8 of control word 6040h is valid, pause will be executed. Under the same setting value, different pause modes have different pause methods as shown in the following table: PP:

Settings	Description

1	Ramp stop by 6084h, maintain position latched state
2	Ramp stop by 6085h, maintain position latched state
3	Emergency stop by P04.23 braking torque, maintain free run state

CSP：

Settings	Description
1	Emergency stop by P04.23 braking torque, maintain position latched state
2	
3	

PV/CSV/HM

Settings	Description
1	Ramp stop by 6084h(HM: 609Ah), maintain position latched state
2	Ramp stop by 6085h, maintain position latched state
3	Emergency stop by P04.23 braking torque, maintain position latched state

CST/PT

Settings	Description
1	Ramp stop by 6087h, maintain position latched state
2	
3	Free stop, maintain position latched state

3.2 Panel Control Operation

3.2.1 Introduction of Panel

(1) Panel composition

SV3 servo panel consists of buttons and a digital display, which can be used for information and parameter display, parameter setting, user password setting, and general function execution.

(2) Button Introduction

Functions of each button are shown in the following figure:

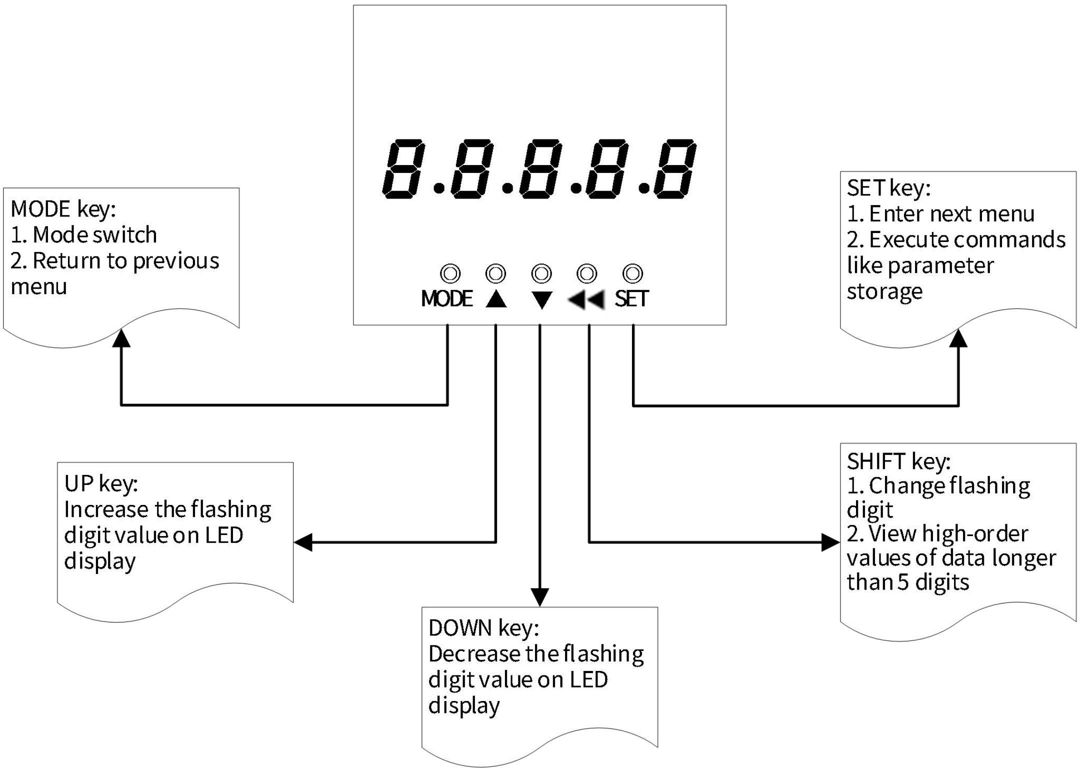


Figure 3-15 Introduction of Functions of Button

Take panel jog operation for example, the following case is for button usage:

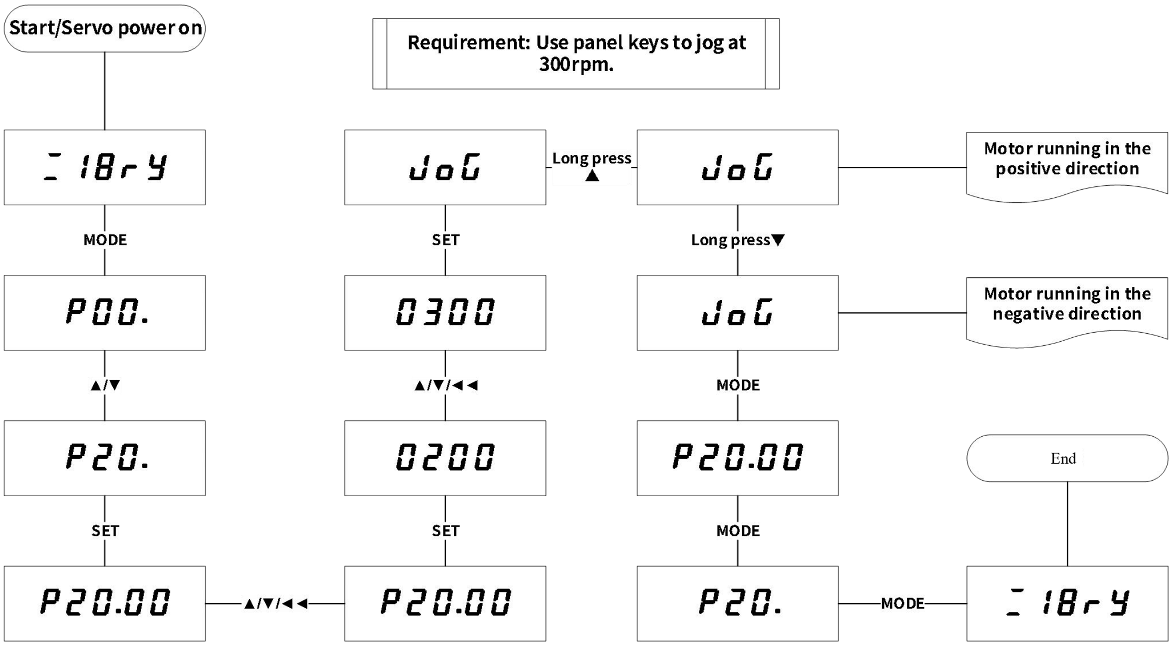


Figure 3-16 Case Operation and Display of Panel Jogging Operation

(3) Introduction of Panel Display

The panel display consists of 5-digit 7-segment digital tubes. When the servo drive is running, the display can be used for servo status display, parameter display, Error display and monitoring display.

(4) Type of Panel Displays

Table 3-19 Type of Panel Displays

Type of Displays	Function description	Entry method	Sample
Status display	Display the current status of the servo, e.g., servo ready, servo running, etc	1. While power on, enter immediately; 2. Under the parameter display, press MODE key to enter; 3. Under the monitoring display, enter when the motor is stationary;	rocco
Parameter display	Display function code and the setting value	1. Under the status display, press MODE key to enter; 2. Under the monitoring display, press MODE key to enter; 3. Under the Error display, first press SET key, then press MODE key to enter;	P20.00
Error display	Display the Error/Alarm codes of servo	1. Under the parameter display, press MODE key to enter; 2. Enter when a Error occurs;	E.910.1
Monitoring display	Display the current operating parameters of the servo	1. Under the parameter display, set function code of Group 21 and enter; Under the status display, set function code P05.03,	200

		enter after the motor runs;	

(5) Introduction of panel display content

Table 3-20 Status description

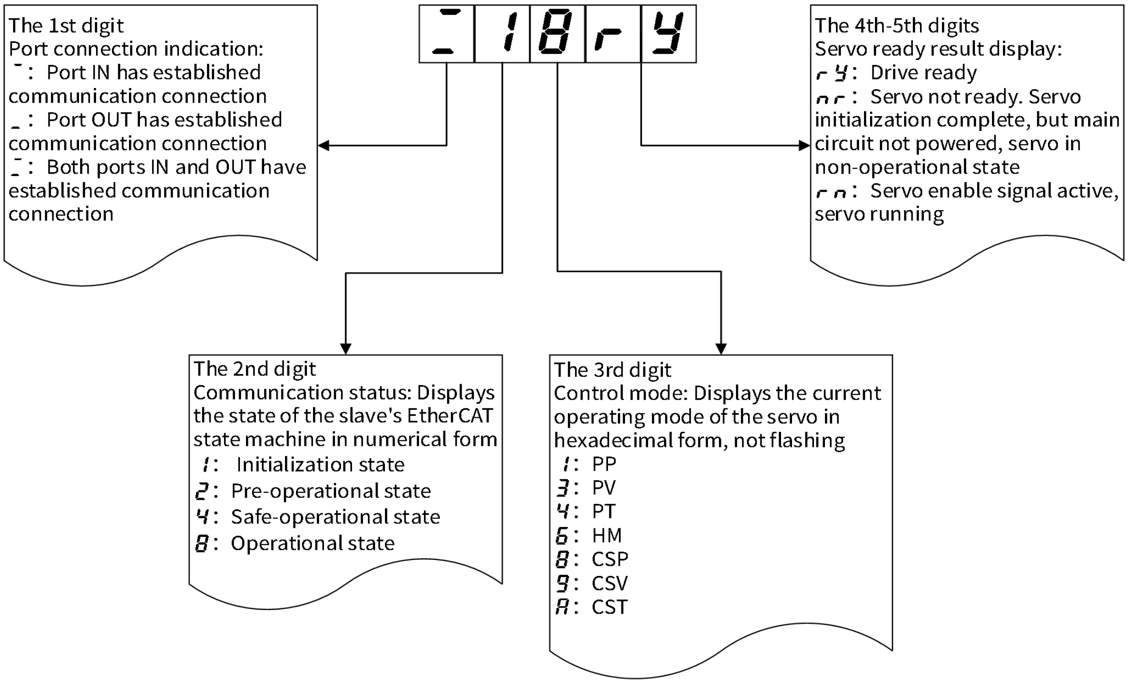
Type of Displays	Display content					Name	Display site	Meaning
Status Display	r	o	c	c	o	rocco: servo initialization	Servo power-on moment	The servo drive is in initialization or reset state, waits for the completion of initialization or reset, and automatically enters other state
	‾_	1	8	r	y	18ry: Servo is ready	Servo is ready	The servo drive is in the runnable state with port 1 established connection, communication initialization status, and periodic synchronization control mode
	 The 1st digit Port connection indication: ‾: Port IN has established communication connection _: Port OUT has established communication connection ‾_: Both ports IN and OUT have established communication connection The 2nd digit Communication status: Displays the state of the slave's EtherCAT state machine in numerical form 1: Initialization state 2: Pre-operational state 4: Safe-operational state 8: Operational state The 3rd digit Control mode: Displays the current operating mode of the servo in hexadecimal form, not flashing 1: PP 3: PV 4: PT 6: HM 8: CSP 9: CSV A: CST The 4th-5th digits Servo ready result display: ry: Drive ready nr: Servo not ready. Servo initialization complete, but main circuit not powered, servo in non-operational state rn: Servo enable signal active, servo running							

Table 3-21 Parameter description

Type of Displays	Display content					Name	Display site	Meaning
Parameter display	P	2	0.	0	0	Function code: P20.00		P: function code 20: function code group 00: Serial No. in function code group
	1	2	3	4	5	Data (5 digits or below) Display: 12345		
	-	1	2	3	4	Negative data (4 digits or below) Display: - 1234		
	_	7	8	9	0	Data (above 5 digits) Display: 1234567890		_: The lower four digits of multi-digit data -: The middle four digits of multi-digit data ‾:The top four digits of multi-digit data
	-	3	4	5	6			
	‾			1	2			
	_.	7	8	9	0	Negative data (5 or more digits) Display: - 1234567890		-: Indicates a negative sign _: The low four digits of multi-digit negative data -: The middle four digits of multi-digit negative data ‾: The top four digits of multi-digit negative data
	-.	3	4	5	6			
	‾		-	1	2			
		1	0	0.	0	Decimal point Display: 100.0		.: Decimal point, non-flashing
	d	o	n	E		Done: Parameter setting completed	Parameter setting successful	Parameter setting completed, and stored into servo drive
	=	=	.	.	.	= = . . .: Parameter restored to factory settings	When using system parameter initialization (P05.01), set of 1	The servo drive is in the process of parameter initialization. Please wait for the completion of system parameter initialization, and power it on for use

Example of parameter display

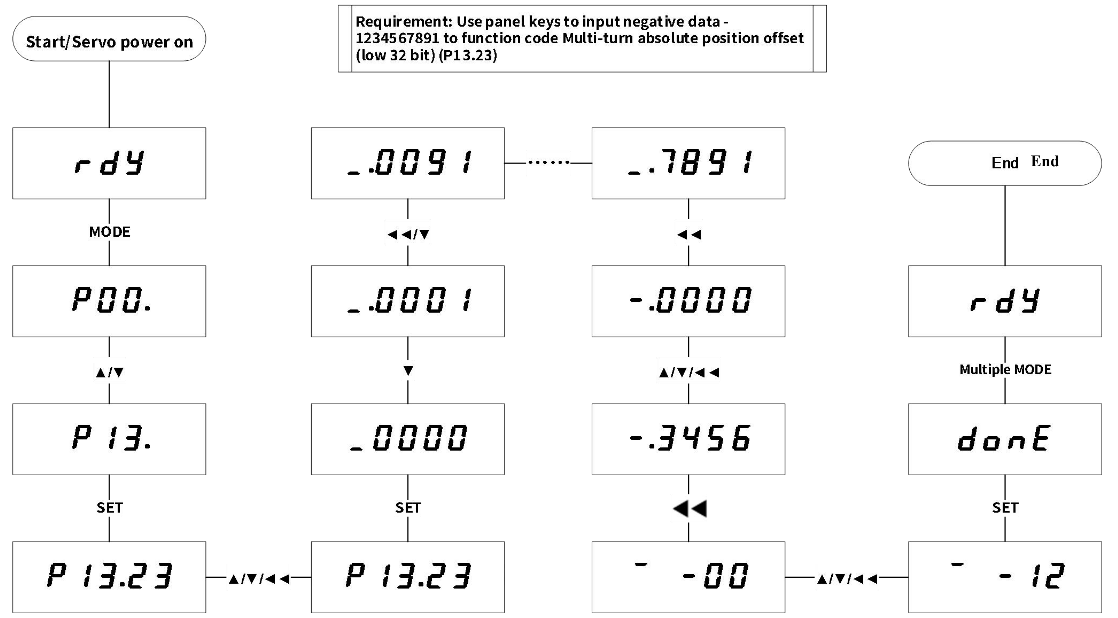
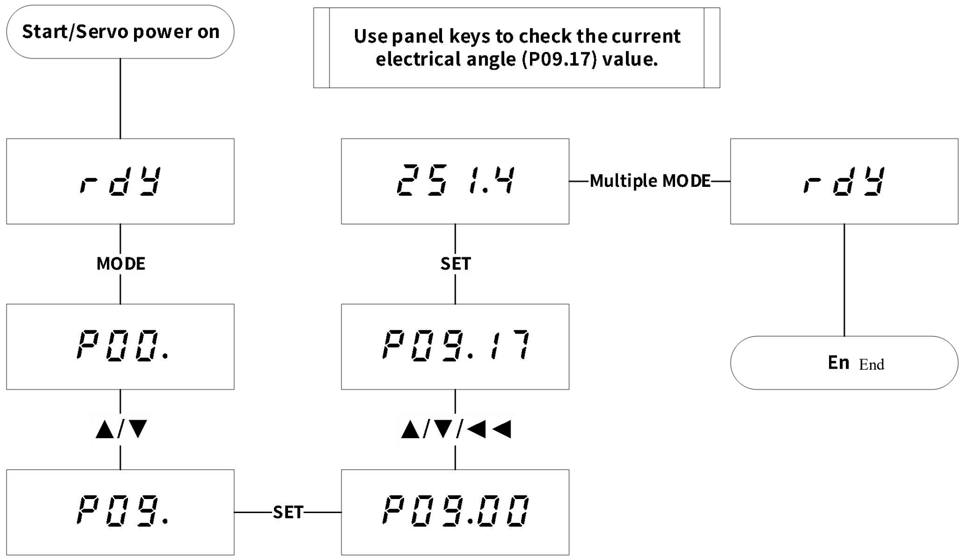


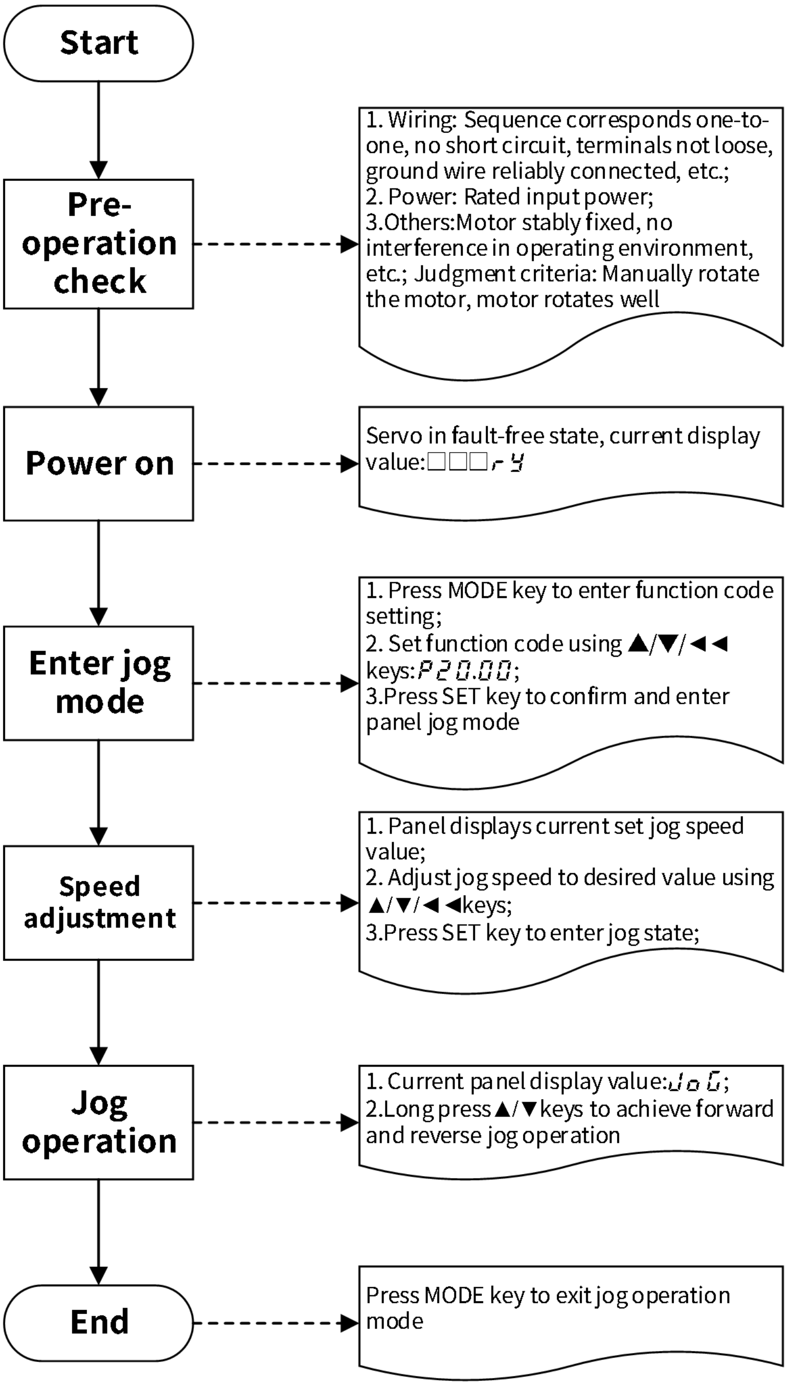
Table 3-22 Error Display and Monitoring Display

Display Type	Display content					Name	Display site	Meaning
Error Display	E.	0	1	0.	0	Error code: E.010.0	Software parameter error	E.:Error Before decimal point:error main code After decimal point: error sub code
Alarm Display	A.	2	2	4.	0	Alarm code: A.224.0	Regenerative resistor overload	A.: Alarm: Before decimal point: Alarm main code After decimal point: Alarm subcode
monitor Display	1	2	3	4	5	Current parameter value: 12345		

monitor Display Sample	

3.2.2 Jog Operation

Before performing panel jog operation, please conduct a pre operation check on the servo system to confirm that the system is operating without interference. Connect the power supply, power on the servo system, and perform panel jog operation. The flowchart of panel jog operation is as follows:



1. Wiring: Sequence corresponds one-to-one, no short circuit, terminals not loose, ground wire reliably connected, etc.;
2. Power: Rated input power;
3.Others:Motor stably fixed, no interference in operating environment, etc.; Judgment criteria: Manually rotate the motor, motor rotates well

Servo in fault-free state, current display value:□□□ry

1. Press MODE key to enter function code setting;
2. Set function code using ▲/▼/◄◄ keys:P20.00;
3.Press SET key to confirm and enter panel jog mode

1. Panel displays current set jog speed value;
2. Adjust jog speed to desired value using ▲/▼/◄◄keys;
3.Press SET key to enter jog state;

1. Current panel display value:JoG;
2.Long press▲/▼keys to achieve forward and reverse jog operation

Press MODE key to exit jog operation mode

Figure 3-17 Panel jog operation flowchart

Use panel jog operation to confirm whether the servo system can operate normally, and whether there are any abnormal vibrations or sounds when the motor rotates.

3.3 Use the Servo3 Designer

Servo3 Designer is a debugging software for SV3 servo drives.

3.3.1 Overview

设备添加

设备选择

产品系列 SV3-S

产品型号: ECAT标准型

产品版本号: V_3100.0

在线识别

通信设置

串口号: COM6

波特率: 115200

通信协议: 8-N-2

站号: 1

确认　取消

Figure 3-18 Main interface

The software is divided into three areas, as shown in the following figure:
Area 1: Toolbar area, entrance for servo debugging function, where users can click on relevant buttons to enter the corresponding function window;
Area 2: Function view layer, debugging function presentation area;
Area 3: Status bar area, displaying device status in real-time; Whether it is online, operating status, Error information, motor operation information, etc;

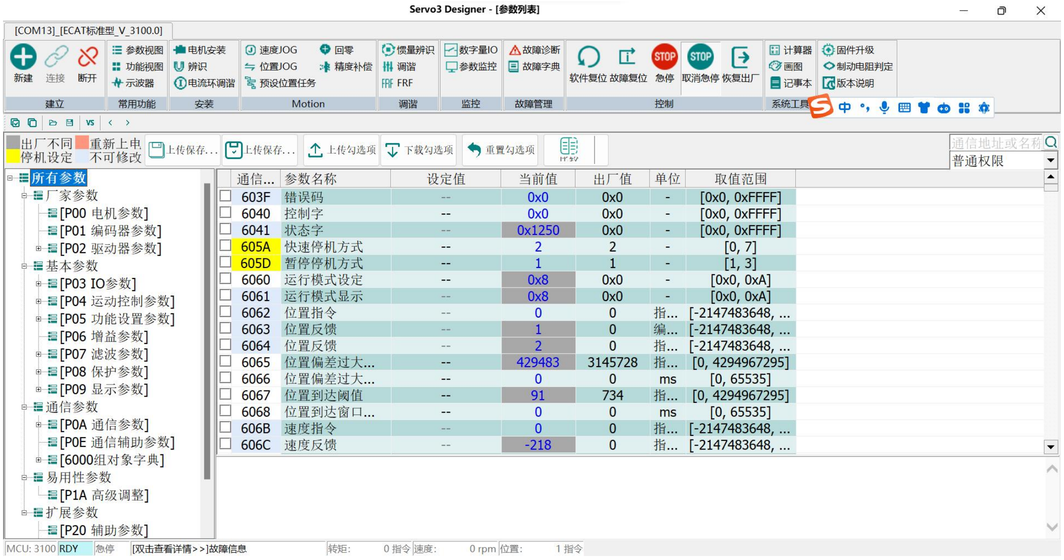
3.3.2 Operating Environment

This software is a green installation-free version.
Operational requirements

Hardware environment: PC
Operating System: Windows 7 x86&64 Windows10 x64、Windows11 x64
Dependency: Net Framework 4.5 and above

3.3.3 Parameter Management

☰ Click on the toolbar to access the function code parameter setting interface.



	通信...	参数名称	设定值	当前值	出厂值	单位	取值范围
☐	603F	错误码	--	0x0	0x0	-	[0x0, 0xFFFF]
☐	6040	控制字	--	0x0	0x0	-	[0x0, 0xFFFF]
☐	6041	状态字	--	0x1250	0x0	-	[0x0, 0xFFFF]
☐	605A	快速停机方式	--	2	2	-	[0, 7]
☐	605D	暂停停机方式	--	1	1	-	[1, 3]
☐	6060	运行模式设定	--	0x8	0x0	-	[0x0, 0xA]
☐	6061	运行模式显示	--	0x8	0x0	-	[0x0, 0xA]
☐	6062	位置指令	--	0	0	指...	[-2147483648, ...
☐	6063	位置反馈	--	1	0	编...	[-2147483648, ...
☐	6064	位置反馈	--	2	0	指...	[-2147483648, ...
☐	6065	位置偏差过大...	--	429483	3145728	指...	[0, 4294967295]
☐	6066	位置偏差过大...	--	0	0	ms	[0, 65535]
☐	6067	位置到达阈值	--	91	734	指...	[0, 4294967295]
☐	6068	位置到达窗口...	--	0	0	ms	[0, 65535]
☐	606B	速度指令	--	0	0	指...	[-2147483648, ...
☐	606C	速度反馈	--	-218	0	指...	[-2147483648, ...

MCU: 3100 RDY 急停 [双击查看详情>>]故障信息 转矩: 0 指令 速度: 0 rpm 位置: 1 指令

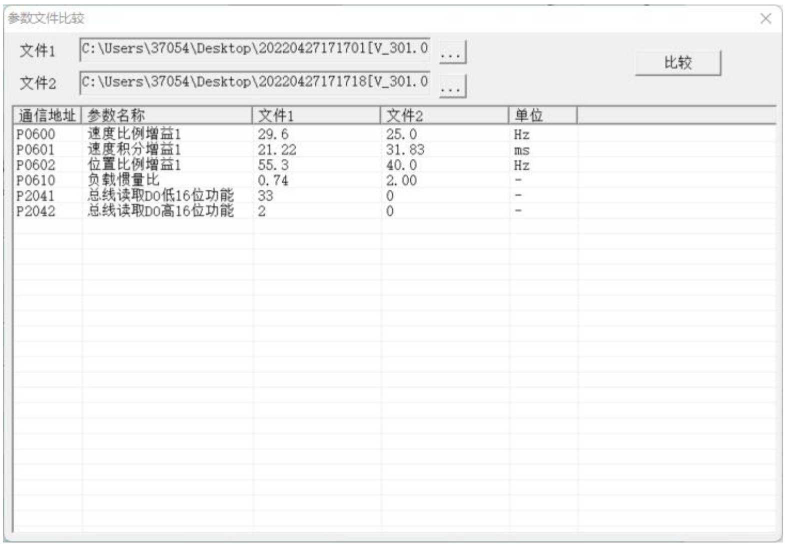
Figure 3-19 Parameter List

Toolbar area

Select all or none of the function codes on the current page;

Open and save recipe file, saving recipe only saves the selected function codes on the current page;

VS Parameter formula comparison function, shown as in the following figure:



文件1 C:\Users\37054\Desktop\20220427171701[V_301.0

文件2 C:\Users\37054\Desktop\20220427171718[V_301.0

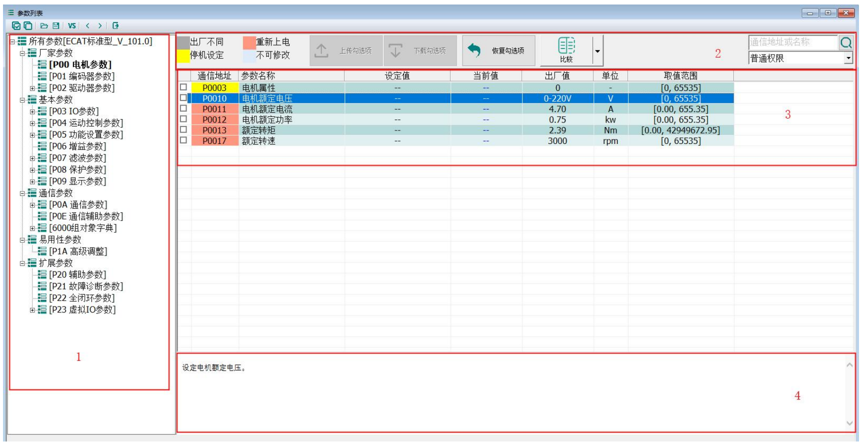
通信地址	参数名称	文件1	文件2	单位
P0600	速度比例增益1	29.6	25.0	Hz
P0601	速度积分增益1	21.22	31.83	ms
P0602	位置比例增益1	55.3	40.0	Hz
P0610	负载惯量比	0.74	2.00	-
P2041	总线读取DO低16位功能	33	0	-
P2042	总线读取DO高16位功能	2	0	-

Figure 3-20 Parameter Comparison

The previous editing group and the next editing group;

Restore factory settings;

View Area



	通信地址	参数名称	设定值	当前值	出厂值	单位	取值范围
☐	P0003	电机属性	--	--	0	-	[0, 65535]
☐	P0010	电机额定电压	--	--	0-220V	V	[0, 65535]
☐	P0011	电机额定电流	--	--	4.70	A	[0.00, 655.35]
☐	P0012	电机额定功率	--	--	0.75	kw	[0.00, 655.35]
☐	P0013	额定转矩	--	--	2.39	Nm	[0.00, 42949672.95]
☐	P0017	额定转速	--	--	3000	rpm	[0, 65535]

设定电机额定电压。

Figure 3-21 Parameter List View

1.Function code grouping area: from user's view, functional groups are divided to make it more convenient for users;

3.3.4 Oscilloscope

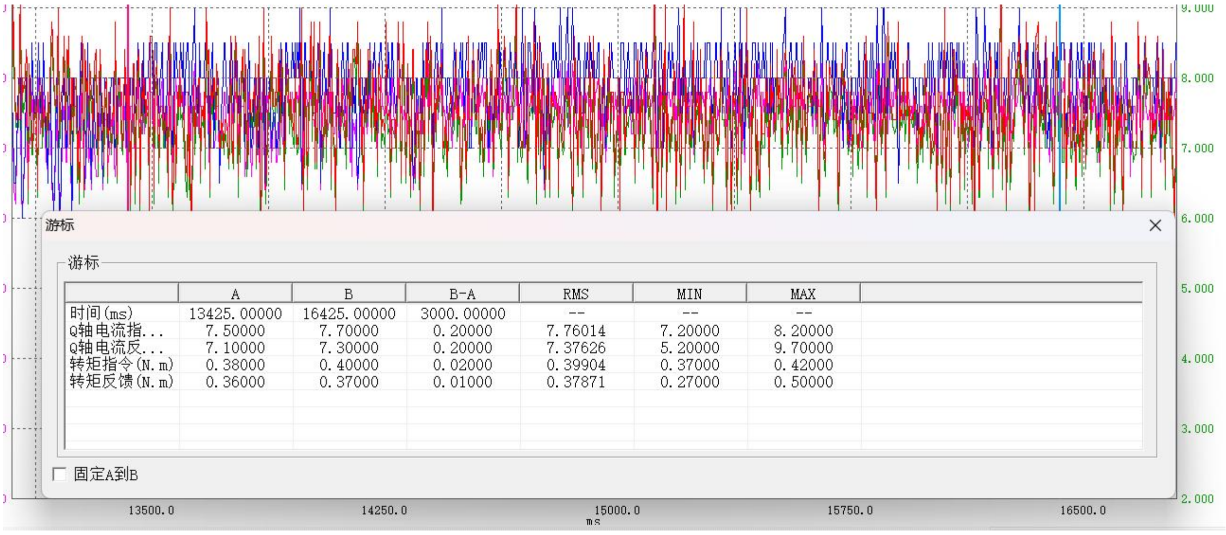
toolbar

Open the waveform file, file format is csv;

Save the current waveform file only, file format is csv;

Take a screenshot of the current waveform display area, picture format is bmp;

Measurement function: Click this button to perform measurement operations on the AB interval waveform by dragging A and B cursors in the waveform area;



	A	B	B-A	RMS	MIN	MAX
时间(ms)	13425.00000	16425.00000	3000.00000	--	--	--
Q轴电流指...	7.50000	7.70000	0.20000	7.76014	7.20000	8.20000
Q轴电流反...	7.10000	7.30000	0.20000	7.37626	5.20000	9.70000
转矩指令(N.m)	0.38000	0.40000	0.02000	0.39904	0.37000	0.42000
转矩反馈(N.m)	0.36000	0.37000	0.01000	0.37871	0.27000	0.50000

Figure 3-22 Vernier measurement

Vernier function: After clicking this button, the mouse hovers over the waveform area to display the values of each channel in the waveform at the current mouse position;

: Waveform amplification. Clicking this button will enable amplification function when the button is pressed down; Click the button again to disable the amplification function; Left click to circle the waveform and zoom in on the circled area;

Waveform Recovery: Click this button to restore the waveform to its original state;

Adaptive coordinate system. Clicking this button will automatically calculate Max./Min. values of the waveform for vertical axis adaptation;

FFT analysis: Click this button and use the left mouse button to circle the waveform area. When the left mouse button is lifted, the software makes FFT analysis and pops up the analysis result, identifies 3 resonance point frequencies shown as in the following figure:

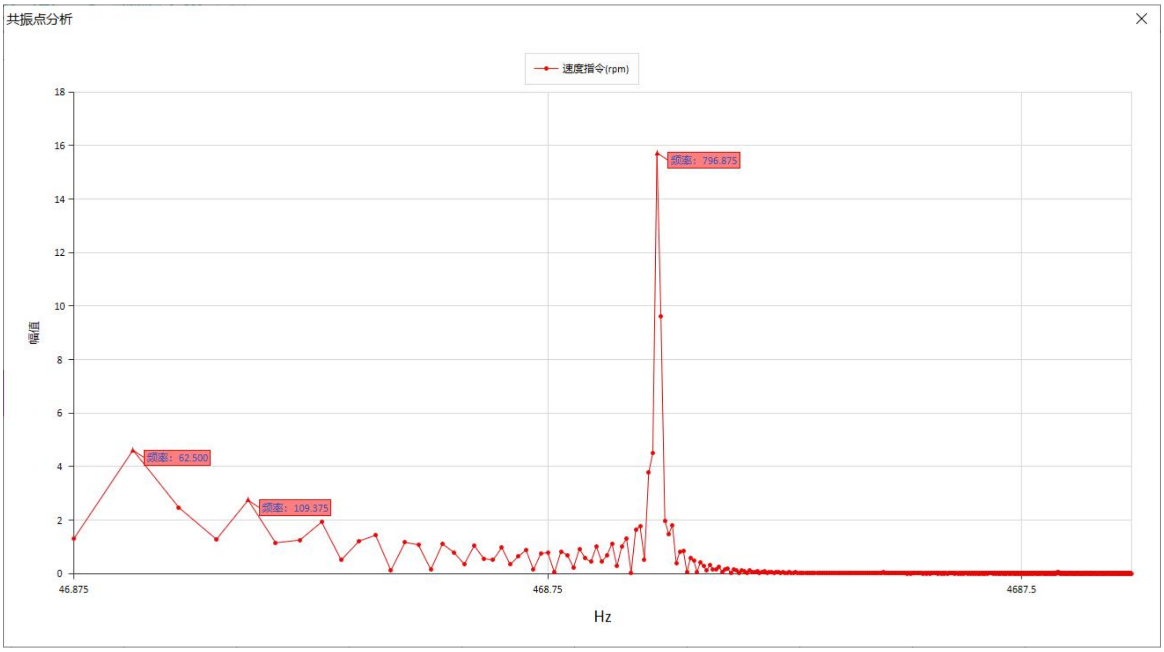
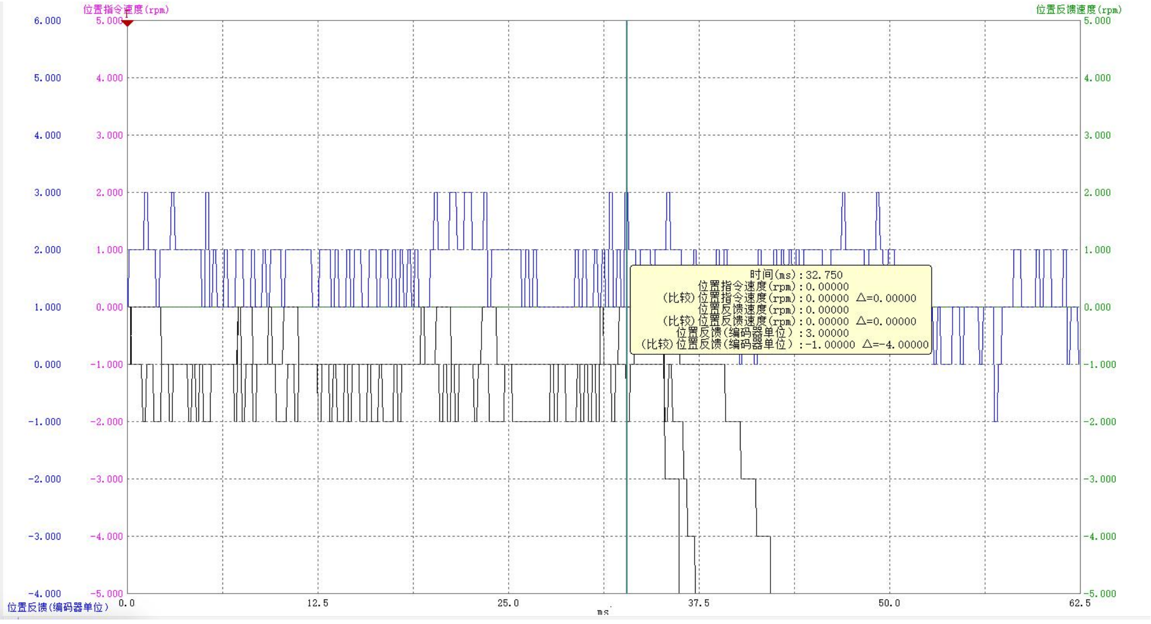


Figure 3-23 FFT resonance point analysis

Waveform comparison: Click this button and select the waveform to be compared, the waveform files in the file will be overlaid onto the existing waveform area



```
           时间(ms):32.750
     位置指令速度(rpm):0.00000
(比较)位置指令速度(rpm):0.00000 △=0.00000
     位置反馈速度(rpm):0.00000
(比较)位置反馈速度(rpm):0.00000 △=0.00000
   位置反馈(编码器单位）:3.00000
(比较)位置反馈(编码器单位）:-1.00000 △=-4.00000
```

Figure 3-24 Waveform Comparison

◐: To cancel waveform comparison, click that button, the compared waveform is deleted from waveform area;

Configuration

Channel configuration: Oscilloscope supports up to four channels for acquisition. Users can quickly generate the corresponding channel configuration of its mode through such 3 buttons as "position acquisition", "speed acquisition" and "torque acquisition".

Sampling mode: Supports 2 ways of trigger sampling and continuous sampling.

Trigger sampling: The accuracy can be 1 times carrier frequency, but number of sampling points is few(1024 points per channel). Users can click Button "trigger condition" to enter trigger condition setting interface to set it;

Continuous sampling: The precision of continuous sampling is millisecond level. It supports continuous sampling for a long time and wave form is automatically saved in Directory wavedata during sampling.

通道1
编码器单圈数据(编码器 ▾ ☑ 2000.000

通道2
FPGA速度反馈(0.0001rp ▾ ☑ 2000.000

通道3
速度跟随偏差（rp ▾ ☑ 2000.000

通道4
Q轴电流指令(%) ▾ ☑ 2000.000

时间轴
采样间隔 1 *62.5us
X轴每格 ms

Figure 3-25 Sampling configuration interface

3.3.5 Initialization

(1) Motor parameter setting

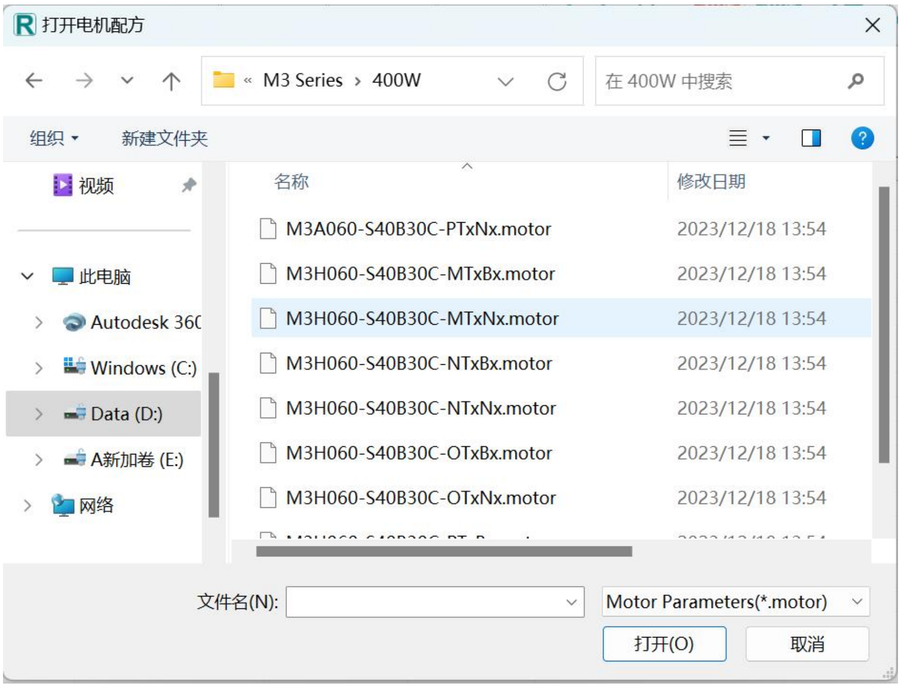
Click the toolbar to set the parameters of the motor encoder:

电机参数设置

	通信地址	参数名称	设定值	出厂值	单位	取值范围
□	P0003	电机属性	0	0	-	[0, 65535]
□	P0010	电机额定电压	0-220V	0-220V	V	[0, 65535]
□	P0011	电机额定电流	4.70	4.70	A	[0.00, 655.35]
□	P0012	电机额定功率	0.75	0.75	kw	[0.00, 655.35]
□	P0013	额定转矩	2.39	2.39	Nm	[0.00, 42949672.95]
□	P0015	最大转矩	7.16	7.16	Nm	[0.00, 42949672.95]
□	P0017	额定转速	3000	3000	rpm	[0, 65535]
□	P0018	最大转速	6000	6000	rpm	[0, 65535]
□	P0019	电机惯量	1.30	1.30	kg...	[0.00, 42949672.95]
□	P0021	极对数	4	4	-	[0, 65535]
□	P0022	相电阻	0.500	0.500	Ω	[0.000, 65.535]
□	P0023	电感Lq	3.27	3.27	mH	[0.00, 655.35]
□	P0024	电感Ld	3.87	3.87	mH	[0.00, 655.35]
□	P0025	反电势	33.30	33.30	mv...	[0.00, 655.35]
□	P0026	转矩系数Kt	0.51	0.51	NA	[0.00, 655.35]
□	P0027	电气常数Te	6.54	6.54	ms	[0.00, 655.35]
□	P0028	机械常数Tm	0.24	0.24	ms	[0.00, 655.35]
□	P0031	D轴反电势补偿	60.0	60.0	%	[0.0, 6553.5]
□	P0032	Q轴反电势补偿	100.0	100.0	%	[0.0, 6553.5]
□	P0034	D轴比例增益1	2000	2000	Hz	[0, 65535]
□	P0035	D轴积分增益1	2.00	2.00	%	[0.00, 655.35]
□	P0036	Q轴比例增益1	2000	2000	Hz	[0, 65535]

Figure 3-26 Motor parameter management

Open the file: The formula of SV3 servo-related motor parameters has been integrated in the debugging software, and the user can directly select the formula corresponding to the motor model. Click the "Open" button after selecting the recipe as shown below.



打开电机配方

名称	修改日期
M3A060-S40B30C-PTxNx.motor	2023/12/18 13:54
M3H060-S40B30C-MTxBx.motor	2023/12/18 13:54
M3H060-S40B30C-MTxNx.motor	2023/12/18 13:54
M3H060-S40B30C-NTxBx.motor	2023/12/18 13:54
M3H060-S40B30C-NTxNx.motor	2023/12/18 13:54
M3H060-S40B30C-OTxBx.motor	2023/12/18 13:54
M3H060-S40B30C-OTxNx.motor	2023/12/18 13:54

Figure 3-27 Opening the motor parameter formula

Save the file: by editing the parameter value column, edit the parameters, after editing, click the "save file" button to save the motor formula;

Upload check: Read all motor parameters from the encoder;

Download check items: Check the parameters to be downloaded and click "Download" button to download the motor parameters to the encoder.

(2) Magnetic pole identification

This function is used to initialize the Angle of the motor during its initial operation.

Click toolbar to enter the magnetic pole identification interface:

☑ 是否进行相序辨识

Z信号电角度：180 °

初始位置偏置：27

响应等级设置：99

Figure 3-28 Magnetic pole identification

(3) DI/DO monitoring

This function displays DI/DO function, status, and pin wiring information. It also supports forced DI/DO output and can make DI/DO simulation.

○ 强制DI使能 ○ 强制DO使能 ○ 强制DI/DO使能 ● 关闭强制使能

[10] DI1 9-正向限位 ● □ 强制-L

[9] DI2 10-反向限位 ● □ 强制-L

[8] DI3 11-原点开关 ● □ 强制-L

[7] DI4 0-无定义 ● □ 强制-L

[11] DI5 0-无定义 ● □ 强制-L

[+1\-6] DO1 17-抱闸控制 (Blk) ● □ 强制-L

[+3\-2] DO2 2-伺服运行(Run) ● □ 强制-L

[+6\-4] DO3 4-伺服故障输出（Error）● □ 强制-L

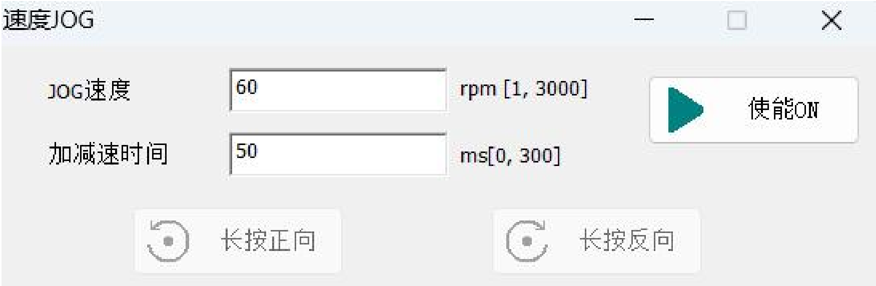
Figure 3-29 DI/DO monitoring

3.3.6 Commissioning

(1) Speed JOG

This function can be used to control motor rotation in jog mode to detect if the motor can run normally and if there is any abnormality during the rotation.

Click toolbar to enter the speed JOG interface:



JOG速度 60 rpm [1, 3000]

加减速时间 50 ms[0, 300]

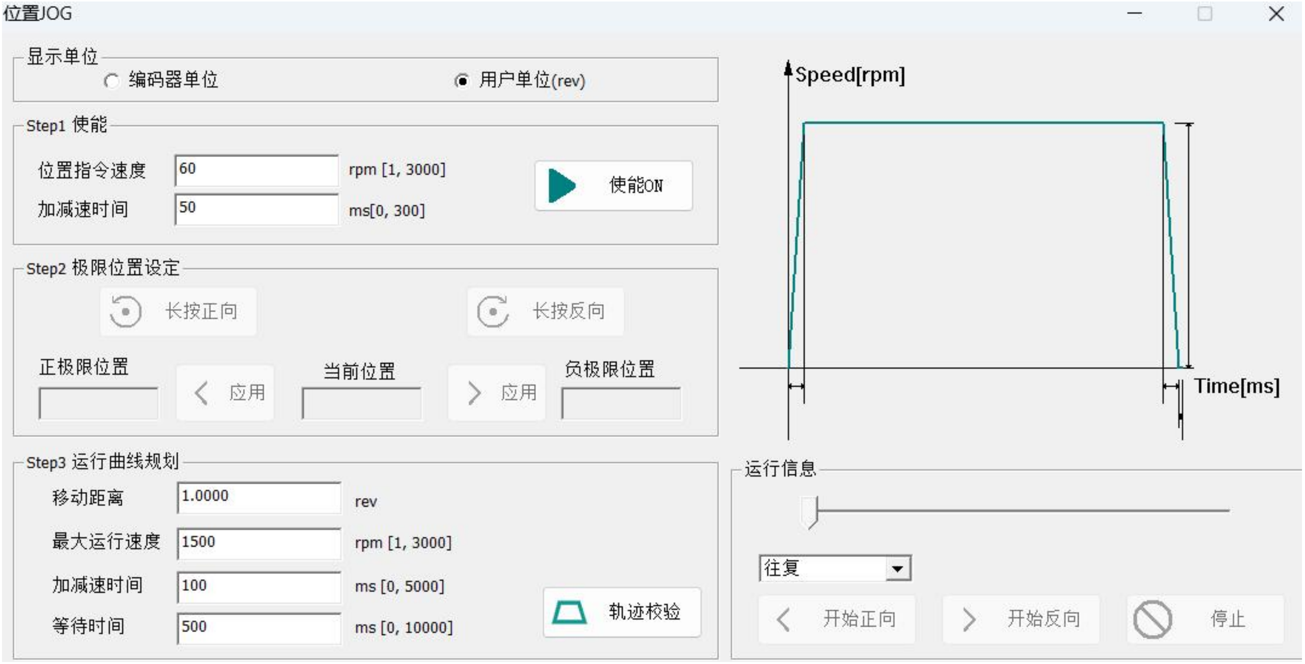
Figure 3-30 Speed JOG

Steps are as follows:
1. Enter the parameters of motor operating speed and acceleration/deceleration time;
2. Click enable switch to enable the drive;
3. Long press Button "Long press forward" and Button "Long press reverse" with the left mouse key to control the motor to move forward and reverse; After releasing the mouse, stop running.

(2) Position JOG

This function is mainly used to control the motor to run in a reciprocating or fixed distance manner at a specified speed within a specified operating limit.

Click toolbar to enter the JOG interface:



显示单位: ○ 编码器单位 ● 用户单位(rev)

Step1 使能

位置指令速度 60 rpm [1, 3000]

加减速时间 50 ms[0, 300]

Step2 极限位置设定

正极限位置

当前位置

负极限位置

Step3 运行曲线规划

移动距离 1.0000 rev

最大运行速度 1500 rpm [1, 3000]

加减速时间 100 ms [0, 5000]

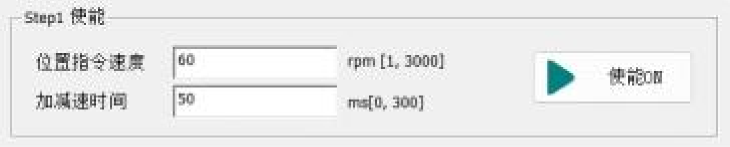
等待时间 500 ms [0, 10000]

往复

Figure 3-31 Position JOG

Steps are as follows:

1. Enter the parameters of motor operating speed and acceleration/deceleration time, and click Button Enable ON;



Step1 使能

位置指令速度 60 rpm [1, 3000]

加减速时间 50 ms[0, 300]

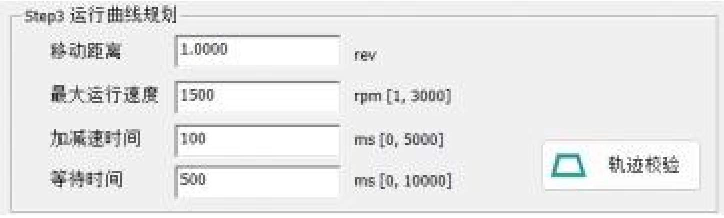
Figure 3-32 Enable ON

2. Setting of operating limit position: Long press Button Long-press Forward and Button Long-press Reverse with the left mouse key to set positive/negative limit positions

Step2 极限位置设定

Figure 3-33 Setting of Positive/Negative Limit Positions

3. Operation curve planning: Set the trajectory parameters on operation curve;



Step3 运行曲线规划

移动距离 1.0000 rev

最大运行速度 1500 rpm [1, 3000]

加减速时间 100 ms [0, 5000]

等待时间 500 ms [0, 10000]

Figure 3-34 Operating Curve Configuration

Click "Trajectory Verification" to generate a simulated curve;

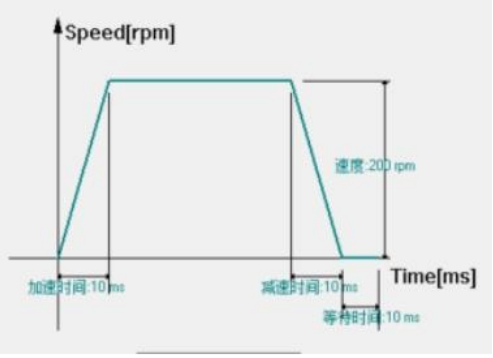


Figure 3-35: Generation of Running Trajectory

4. Run

Single time: The motor moves a specified distance within the operating limit.

Reciprocating: The motor moves back and forth within the specified limit.

Click "Start Forward" and "Start Reverse" for launch; Click Button "Stop" to stop the motor;

运行信息

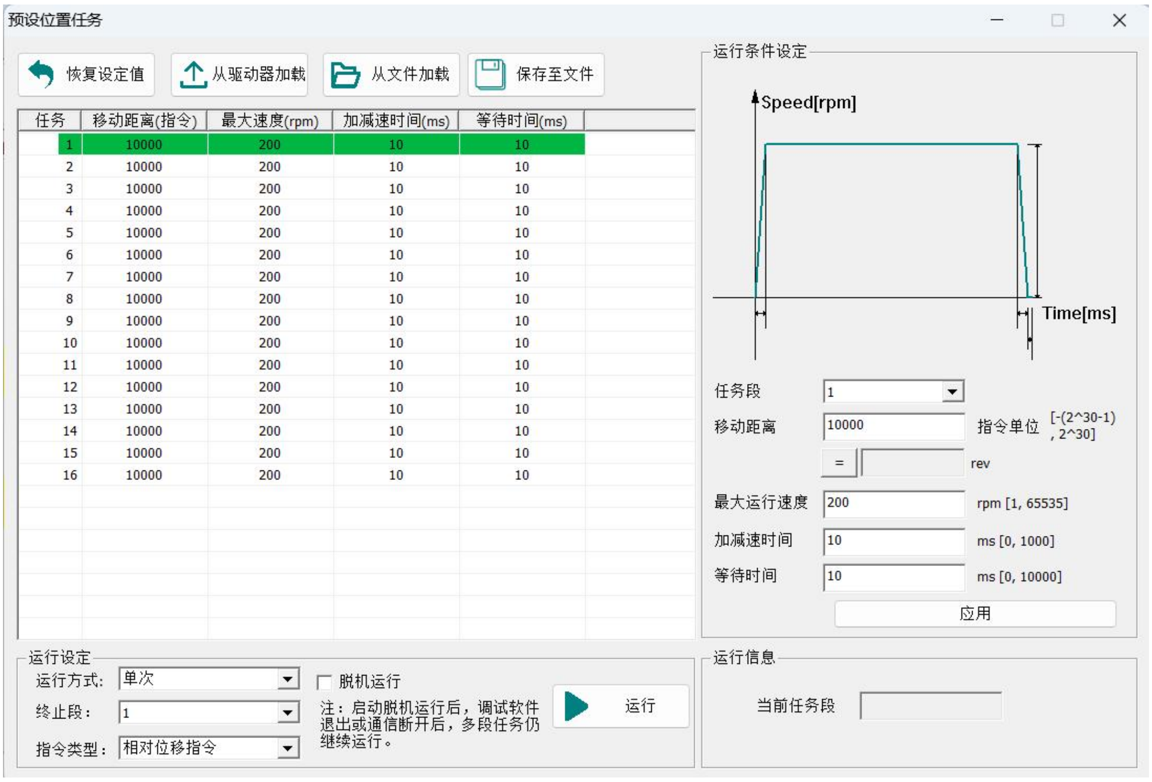
往复

Figure 3-36 Run

(3) Preset position task

This function supports users to preset multiple running trajectories, up to 16 segments.

Click toolbar to enter the preset position task interface:



任务	移动距离(指令)	最大速度(rpm)	加减速时间(ms)	等待时间(ms)
1	10000	200	10	10
2	10000	200	10	10
3	10000	200	10	10
4	10000	200	10	10
5	10000	200	10	10
6	10000	200	10	10
7	10000	200	10	10
8	10000	200	10	10
9	10000	200	10	10
10	10000	200	10	10
11	10000	200	10	10
12	10000	200	10	10
13	10000	200	10	10
14	10000	200	10	10
15	10000	200	10	10
16	10000	200	10	10

任务段 1
移动距离 10000 指令单位 [-(2^30-1), 2^30]
= rev
最大运行速度 200 rpm [1, 65535]
加减速时间 10 ms [0, 1000]
等待时间 10 ms [0, 10000]

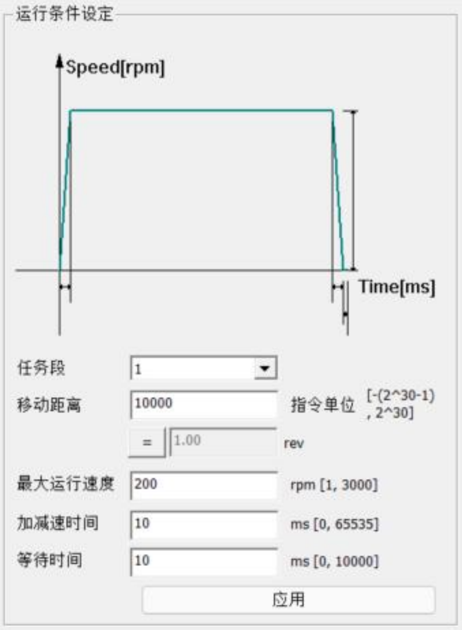
运行方式: 单次
终止段: 1
指令类型: 相对位移指令
☐ 脱机运行
注：启动脱机运行后，调试软件退出或通信断开后，多段任务仍继续运行。

当前任务段

Figure 3-37 Position JOG

Steps are as follows:

1. Edit trajectory parameters for each segment: Select the specified task segment in the list, edit the running parameters, and click "Apply" to update the parameters to the list;



任务段 1
移动距离 10000 指令单位 [-(2^30-1), 2^30]
= 1.00 rev
最大运行速度 200 rpm [1, 3000]
加减速时间 10 ms [0, 65535]
等待时间 10 ms [0, 10000]

Figure 3-38 Position Segment Configuration

2. Operation settings

Operation mode: Support single and loop operations. Multi-stage position task can only run once in single mode; Multi-stage position task operates cyclically in loop mode;

Termination segment: The user can choose the number of segments to execute, and the program will run from the first segment to the termination segment;

Instruction type: Support relative displacement instruction and absolute displacement instruction;

Click 'Run' to start the multi-stage trajectory task, and the motor will run according to the preset trajectory;

运行设定

运行方式: 单次

终止段： 1

指令类型： 相对位移指令

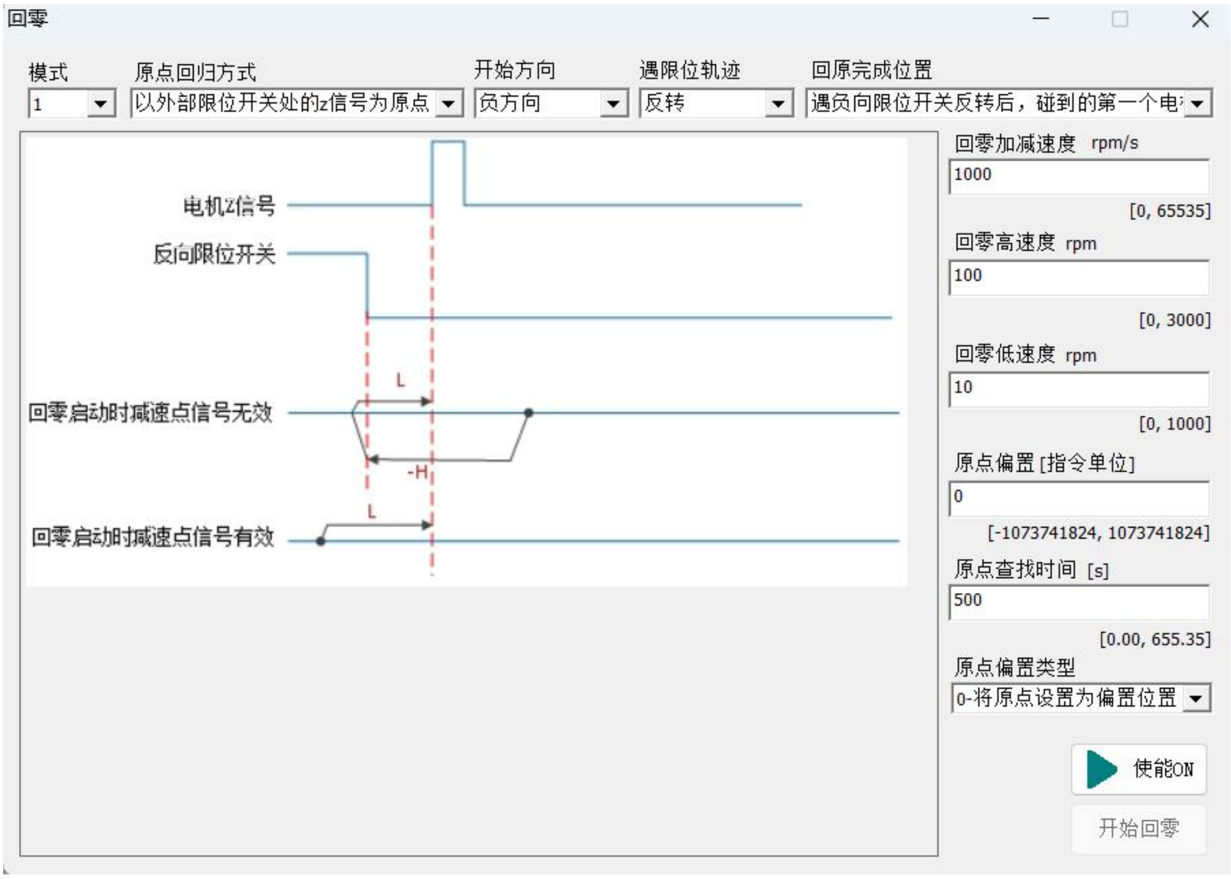
☐ 脱机运行

注：启动脱机运行后，调试软件退出或通信断开后，多段任务仍继续运行。

Figure 3-39 Operation

(4) Return to Zero

This function supports 35 zeroing modes, and users can directly select the mode or generate corresponding zeroing modes based on the origin return method, starting direction, encountering limit trajectory, zeroing completion position, etc.



回零

模式: 1

原点回归方式: 以外部限位开关处的z信号为原点

开始方向: 负方向

遇限位轨迹: 反转

回原完成位置: 遇负向限位开关反转后，碰到的第一个电

回零加减速度 rpm/s: 1000 [0, 65535]

回零高速度 rpm: 100 [0, 3000]

回零低速度 rpm: 10 [0, 1000]

原点偏置 [指令单位]: 0 [-1073741824, 1073741824]

原点查找时间 [s]: 500 [0.00, 655.35]

原点偏置类型: 0-将原点设置为偏置位置

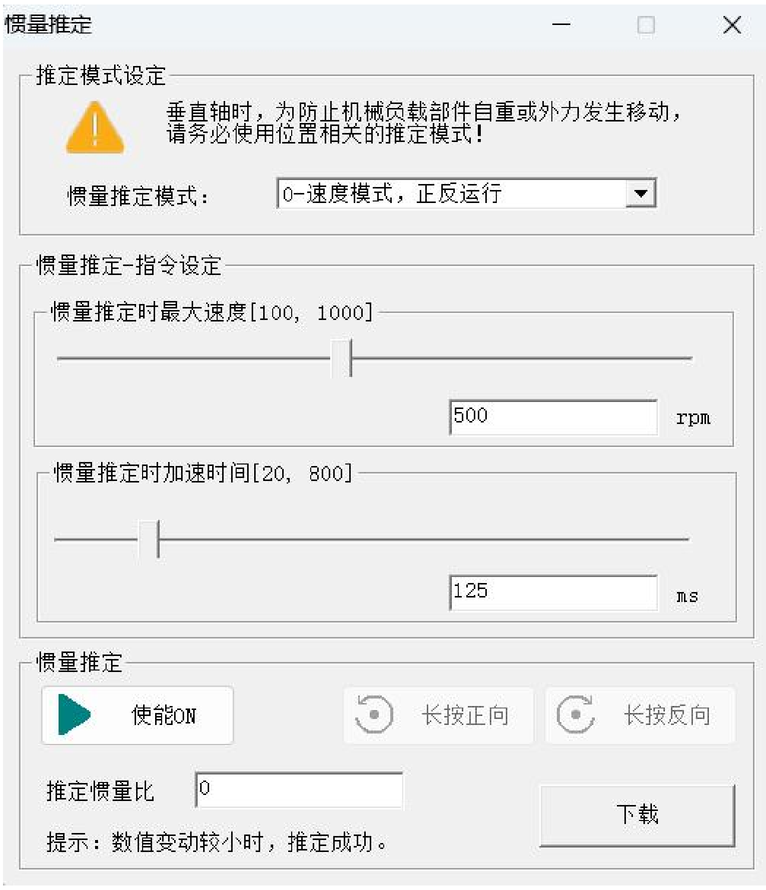
Figure 3-40 Zeroing

3.3.7 Tuning

(1) Offline inertia identification

This function is an offline inertia identification.

Click toolbar to enter the offline inertia recognition interface:



垂直轴时，为防止机械负载部件自重或外力发生移动，
请务必使用位置相关的推定模式！

惯量推定模式：0-速度模式，正反运行

惯量推定时最大速度[100, 1000] 500 rpm

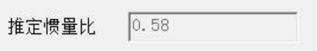
惯量推定时加速时间[20, 800] 125 ms

推定惯量比 0

提示：数值变动较小时，推定成功。

Figure 3-41 Inertia Identification

Steps are as follows:

1. Parameter settings: Set identification mode, maximum speed, acceleration time. The software supports 4 modes: "0: speed mode, forward/reverse operation", "1: speed mode, electric operation", "2: position mode, forward/reverse operation", and "3: position mode, unidirectional operation";
2. Click enable switch to enable the drive;
3. Long press the "Long press forward" and "Long press reverse" buttons with the left mouse button to identify inertia,
4.  推定惯量比 0.58 Real time display of the current identification result. If the change in the identification results is small, it can be determined that the identification is complete. Click "Download" button to write the identification result to the drive.

(2) Gain adjustment

The software supports 2 gain adjustment modes: automatic gain adjustment and manual gain adjustment.

Automatic gain adjustment

Users can drag the slider with mouse or click "-" and "+" buttons to reduce or increase the rigidity level.

Step1 场景设定
● 点到点定位应用(P2P)
○ 轨迹插补应用

Step2 运行设定
● 本地指令
○ 上位机指令

Step3 响应等级设定
16

调整结果
实时响应等级 16

注：响应等级不再变化，且电机没有共振声音时，标识调整完成，请点击完成按钮结束调整；

Figure 3-42 Rigid table settings

Manual gain adjustment

It supports both sine and step forms of command, supports the adjustment of the corresponding loop gain under 3 control modes of position/speed/torque.

控制模式: 速度

指令设定
指令类型: Sin
频率: 1 Hz
幅值: 10 rpm
偏置: 0 rpm

速度环
速度比例增益1[Hz] 0162.9
速度前馈比例增益[%] 0000.0
速度积分增益1[ms] 003.97
转矩前馈比例增益[%] 0000.0
转矩滤波1[ms] 000.05
二自由度前馈系数[%] 0100.0
负载惯量比[-] 000.16

Figure 3-43 Adjust the speed loop gain

(3) Frequency domain analysis -FRF

Frequency domain analysis supports 3 modes: velocity closed loop, velocity open loop, and mechanical characteristics.

Velocity closed loop: automatically calculate and label the amplitude bandwidth and phase bandwidth.

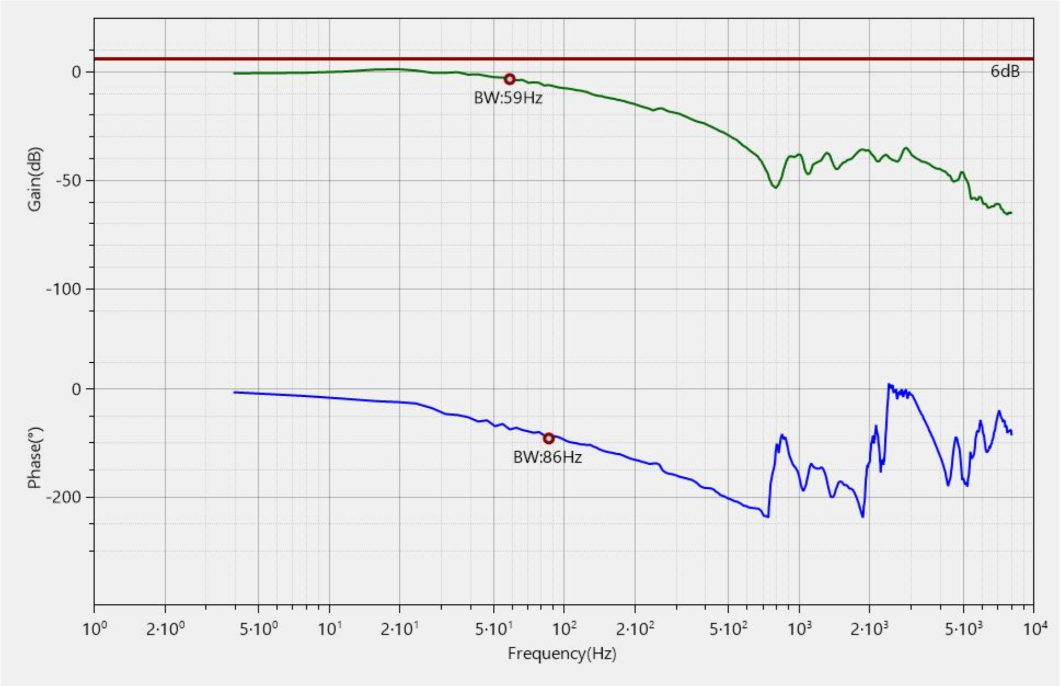


Figure 3-44 Velocity closed loop

Velocity open loop: automatically calculate and mark the amplitude margin and phase margin.

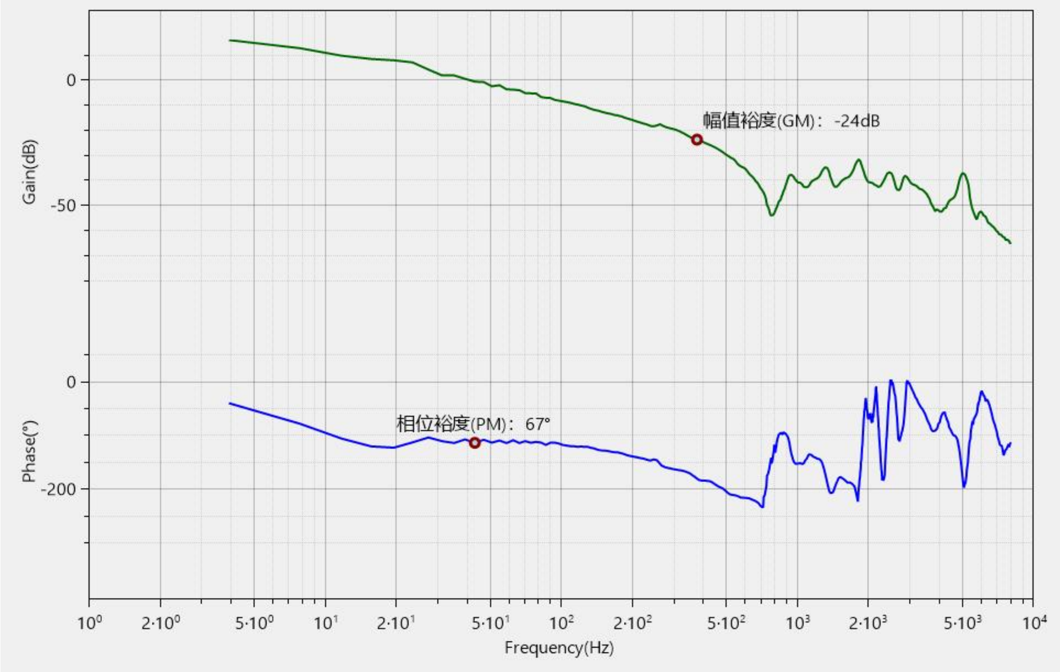
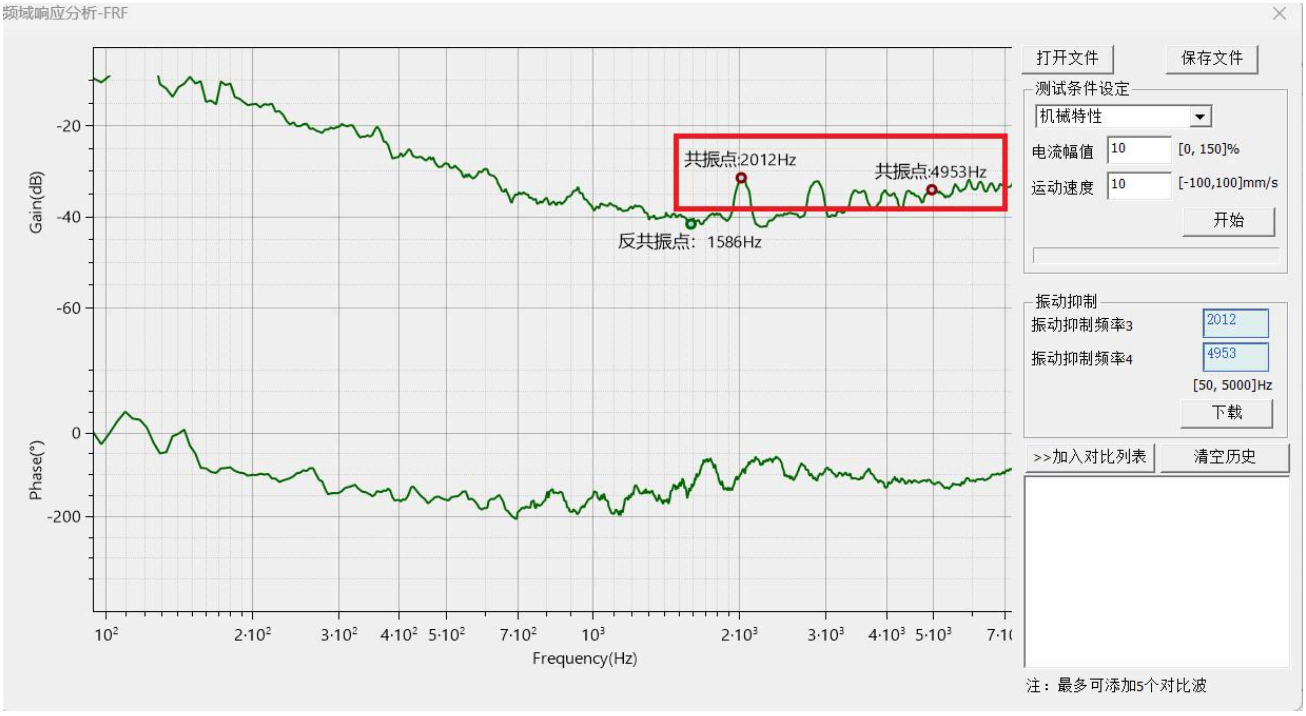


Figure 3-45 Velocity open loop

Mechanical characteristics: Automatic identification of resonance points and anti-resonance points. At present, the debugging software will automatically identify 2 resonance points. After identification, it will automatically update to the setting parameters of notch filter, and users can directly click download to write the identified resonance point frequency to the drive.



机械特性

电流幅值 10 [0, 150]%

运动速度 10 [-100,100]mm/s

振动抑制频率3 2012

振动抑制频率4 4953

[50, 5000]Hz

注：最多可添加5个对比波

Figure 3-46 Mechanical Characteristics

3.3.8 Troubleshooting

(1) Real time Error

In case of equipment Error, the debugging software status bar will prompt users in real time (as shown below). User can double-click the Error area to view the Error details. Error is marked in red and Alarm is marked in yellow.

MCU: 101.3 | ERR | 急停 | [双击查看详情>>][不可复位] E910.1 编码器参数故障 | 转矩: 0 指令 | 速度: 0 rpm | 位置: 0 指令

MCU: 101.3 | RDY | 急停 | [双击查看详情>>][可复位] A426.0 需重新上下电警告 | 转矩: 0 指令 | 速度: 0 rpm | 位置: -16 指令

Figure 3-47 Error prompt

The Error details include: Error name, level, whether it can be reset, Error cause, detection method, and solution, etc., which facilitates users to quickly troubleshoot the Error.

Figure 3-48 Error Diagnosis

(2) Error History

This function supports querying the lastest 10 errors, information shown as above figure.

索引	时间戳(s)	故障码	故障名称	子故障名称
当前故障	493896.7	426.0	需重新上下电警告	需重新上下电警告
上1次	493817.1	910.1	编码器参数故障	上电时编码器通讯异常
上2次	493786.7	910.1	编码器参数故障	上电时编码器通讯异常
上3次	493756.3	910.1	编码器参数故障	上电时编码器通讯异常
上4次	493725.9	910.1	编码器参数故障	上电时编码器通讯异常
上5次	493695.5	910.1	编码器参数故障	上电时编码器通讯异常
上6次	493665.1	910.1	编码器参数故障	上电时编码器通讯异常

功能码	值
总上电时间(s)	493725.9
单次上电时间(s)	0.0
FPGA系统状态	0xE001
FPGA系统故障	0x10
U相电流(A)	0.00
V相电流(A)	0.00
母线电压(V)	0.0
电机转速(rpm)	0
DI状态	0x0
DO状态	0x0
编码器状态	0x1
控制字	0x0
状态字	0x0
Port0帧无效...	0
Port1帧无效...	0
Port0或1帧...	0

原因

1. 驱动器和电机类型不匹配。
2. 总线式增量编码器ROM中参数校验错误或未存放参数。

检测方法

1. 参考手册，确认电机和驱动器是否匹配。
2. 检查编码器线缆是否插好，是否存在破损断线的情况。

解决方法

1. 更换为相互匹配的驱动器及电机。
2. 检查编码器线缆，请使用我司标配的编码器线缆。
3. 编码器线和动力线分开走线。

49Figure 3-49 Error History

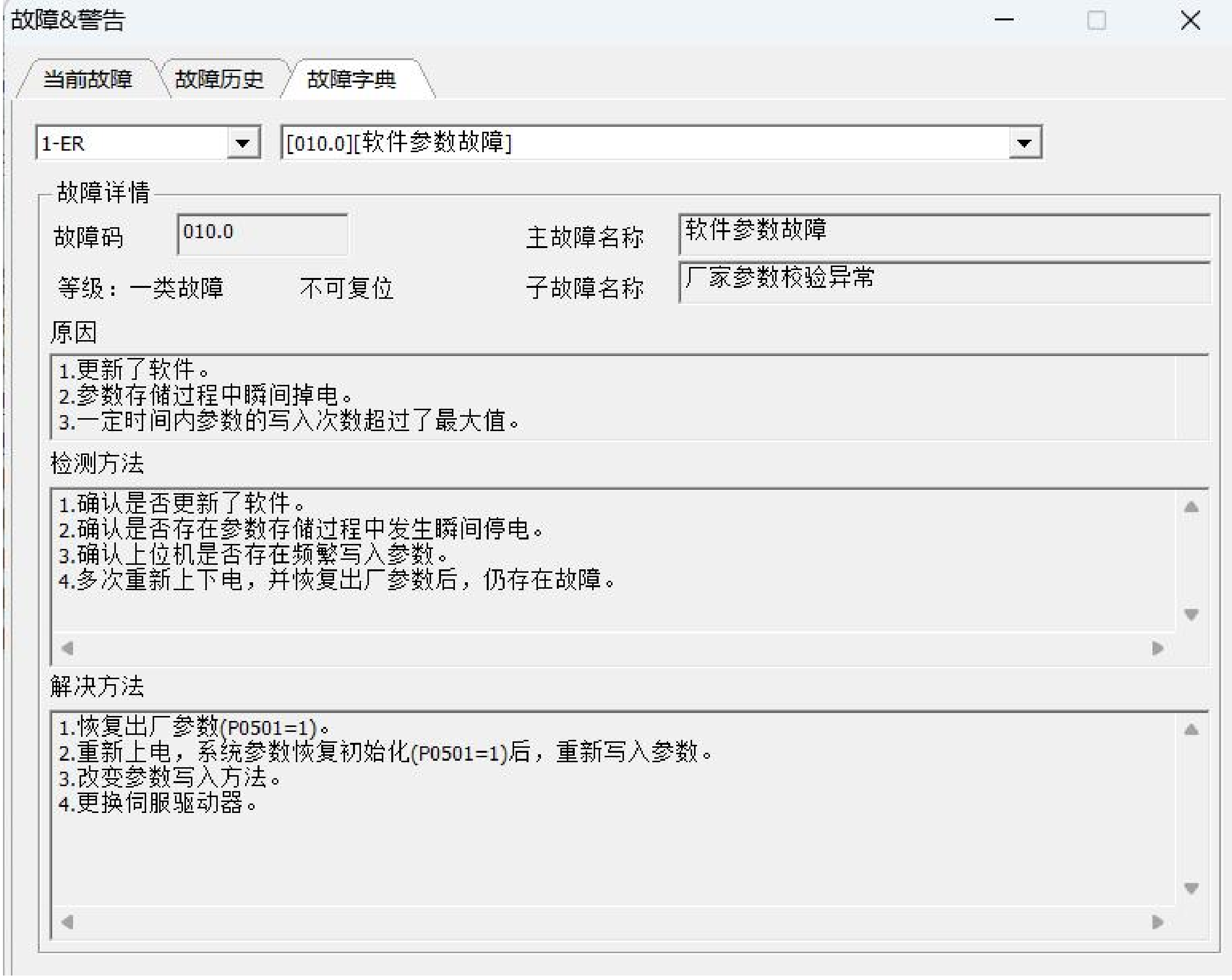
Query button: query the recent failure history of the device, as shown in the above figure;

Clear button: Clear the historical Error records in the drive;

Select the historical list row with the mouse, and the relevant parameter information and troubleshooting of the selected Error will be displayed below the list;

(3) Error Dictionary

This function can query the Error information of all SV3 servos;



1-ER

[010.0][软件参数故障]

故障详情

故障码 010.0

主故障名称 软件参数故障

等级：一类故障　　不可复位

子故障名称 厂家参数校验异常

原因

1.更新了软件。
2.参数存储过程中瞬间掉电。
3.一定时间内参数的写入次数超过了最大值。

检测方法

1.确认是否更新了软件。
2.确认是否存在参数存储过程中发生瞬间停电。
3.确认上位机是否存在频繁写入参数。
4.多次重新上下电，并恢复出厂参数后，仍存在故障。

解决方法

1.恢复出厂参数(P0501=1)。
2.重新上电，系统参数恢复初始化(P0501=1)后，重新写入参数。
3.改变参数写入方法。
4.更换伺服驱动器。

Figure 3-50 Error Dictionary

3.4 EtherCAT control operation

3.4.1 Running Status Control

(1) Status machine

The relationship between control word 6040h, status word 6041h, internal event and status machine is shown in the following figure: status switching can be performed through control words or internal events, and the current status can be read from status word.

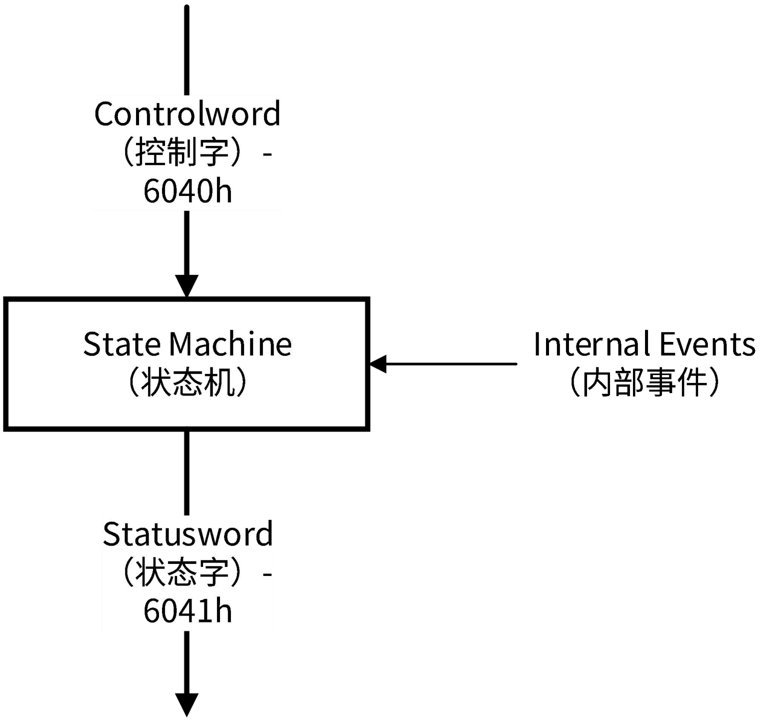


Figure 3-51 Overview of CiA402 Protocol

Status machine describes the device status and possible control sequence of drive. A single status represents a particular internal or external behavior. The status of drive also determines which command is received. For example, point-to-point movement can start only when the drive is in the 'operation enabled' state.

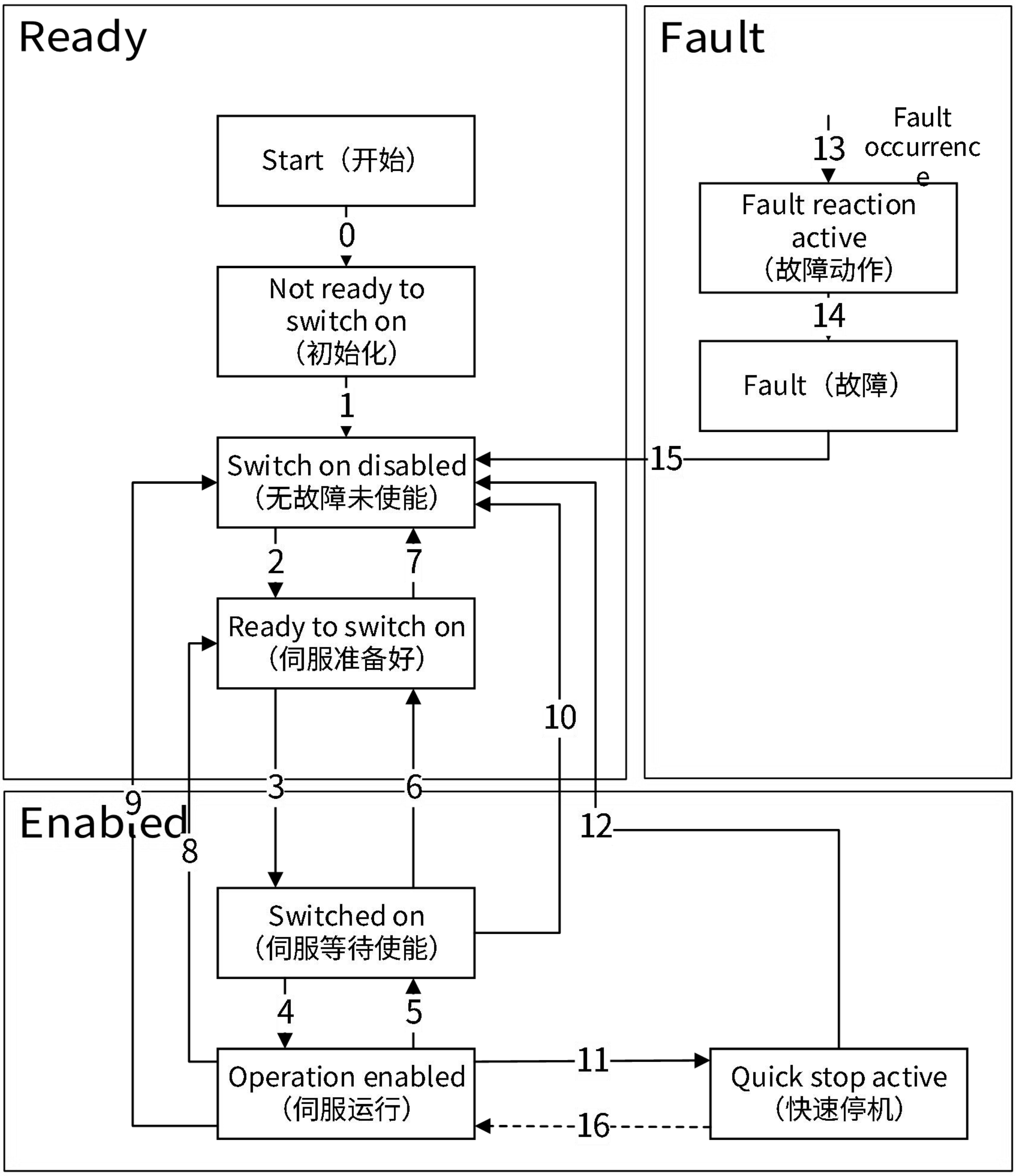


Figure 3-52 CiA402 Status Machine Switching Diagram

Table 3-23 Status Description

Status	Description
Initialization	Control electricity input of servo drive; Servo drive is initializing or self-checking; If Holding brake function exists, it's currently in operation; Driving function is invalid;
No Error, not enabled	Servo driver initialization is completed; Parameters of servo drive can be modified; Power electricity of servo drive is not input; Driving function is invalid;
Servo is ready	Power electricity input of servo drive; Parameters of servo drive can be modified; Driving function is invalid;
Servo waiting enable	Servo drive waits to be enabled;
Servo operation	Servo drive doesn't detect any Error; Motor power-on; Part of parameters of servo drive can be modified; Driving function is valid;
Fast stop	Perform rapid stop action; Motor power-on; Driving function is valid;
Error action	Servo drive detects a Error; Perform Error stop action; Motor power-on; Driving function is valid;
Error	Servo drive alarm; Potor power-off; Driving function is invalid;

Table 3-24 Control Commands and Status Switching

CiA402 status switching			Event	Action
Serial No.	**Initial status**	**Termination status**		
0	Start	Initialization	Reset	Servo self-test/initialization
1	Initialization	No Error, not enabled	Self check/initialization successful	Activate communication
2	No Error, not enabled	Servo is ready	Receive 'Shutdown' command from the master * 1	No
3	Servo is ready	Servo waiting enable	Receive 'SwitchOn' command from the master	If no power electricity, input power electricity
4	Servo waiting enable	Servo operation	Receive 'Enable Operation' command from the master	Driving function is valid
5	Servo operation	Servo waiting enable	Receive 'Disable Operation' command from the master	Driver function is invalid
6	Servo waiting enable	Servo is ready	Receive 'Shutdown' command from the master	Power off
7	Servo is ready	No Error, not enabled	Receiving "Quick Stop" or "Disable Voltage" command from the master	No
8	Servo operation	Servo is ready	Receive 'Shutdown' command from the master	Immediately power off. If no Holding brake is available, the motor will stop freely
9	Servo operation	No Error, not enabled	Received 'Disable Voltage' command from the master	Immediately power off. If no Holding brake is available, the motor will stop freely
10	Servo waiting enable	No Error, not enabled	Receiving "Quick Stop" or "Disable Voltage" command from the master	Immediately power off. If no Holding brake is available, the motor will stop freely
11	Servo operation	Fast stop	Receive 'Quick Stop' command from the master	Perform rapid stop action
12	Fast stop	No Error, not enabled	Quick Stop execution is completed or receive 'Disable Voltage' command from the master	Power off
13	Arbitrary state	Error action	Error occurrence	Error execution stop
14	Error action	Error	Error complete	Power off
15	Error	No Error, not enabled	Error Reset command received from the host	For Error clearing, set the control word "Error Reset" of 0 after the

CiA402 status switching			Event	Action
Serial No.	Initial status	Termination status		
				Error is cleared
16	Fast stop	Operation enable	Receive 'Enable Operation' command from the master	Servo enable (need to set the fast stop mode to 5, 6, 7 or 8, please see the fast stop section)

*1. The master sends stop command through control word. Various logical combinations of 1 to 0 in different bit positions constitue different commands.

(2) Control word 6040h

25Table 3-25 Control word 6040h

0x6040- Control word	
Index - Subindex	0x6040-00
Data type	UINT16
Accessibility	Readable/writable
Unit	-
DeError value	0
Min.	0
Max.	65535
Setting and effective mode	Operation settings/downtime effective
Related mode	ALL
Note	(see below)

Bit	Name	Description
0	Servo operation is available	Setting mode: 1-valid, 0-invalid
1	Switch on the main circuit	Setting mode: 1-valid, 0-invalid
2	Fast stop	Setting mode: 0-valid, 1-invalid
3	Servo operation	Setting mode: 1-valid, 0-invalid
4~6	For operation mode	Different operating modes have different meanings
7	Error reset	Reset Errors and Alarms that can be reset. Setting mode: Rising edge, if the value is 1, all the other control commands are invalid
8	Pause	The stop mode is different for each motion mode. For details, see object dictionary 605A
9	For operation mode	Different operating modes have different meanings
10	Reserved	Parameter reserved, no meaning temporarily
11~15	Manufacturer's custom	Manufacturer custom parameters

Control command

Command	Control word

	Bit7	Bit3	Bit 2	Bit 1	Bit0
Shut down	0	X	1	1	0
Switch on	0	0	1	1	1
Enable operation	0	1	1	1	1
Disable voltage	0	X	X	0	X
Quick stop	0	X	0	1	X
Disable operation	0	0	1	1	1
Error reset	Rising edge	X	X	X	X

(3) Status word 6041h

Table 3-26 Status word 6041h

<table>
<tr><th colspan="2">0x6041- Status word</th></tr>
<tr><td>Index - Subindex</td><td>0x6041-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>0~65535</td></tr>
<tr><td>Setting and effective mode</td><td>-</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>Reflect servo state
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Servo is ready</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>1</td><td>Servo operation is available</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>2</td><td>Servo operation</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>3</td><td>Error</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>4</td><td>The main circuit is ON</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>5</td><td>Fast stop</td><td>Status: 0- valid, 1- invalid</td></tr>
<tr><td>6</td><td>Servo can't run</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>7</td><td>Alarm</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>8</td><td>Manufacturer's custom</td><td>Manufacturer custom parameters</td></tr>
<tr><td>9</td><td>Remote control</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>10</td><td>Target arrival</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>11</td><td>Internal restriction valid</td><td>Status: 1- Valid, 0- invalid</td></tr>
<tr><td>12~13</td><td>For operation mode</td><td>Different operating modes have different meanings</td></tr>
<tr><td>14</td><td>Manufacturer's custom</td><td>Manufacturer custom parameters</td></tr>
<tr><td>15</td><td>Origin found</td><td>Status: 1- Valid, 0- invalid</td></tr>
</table>
State feedback
<table>
<tr><th rowspan="2">Status</th><th colspan="7">Status word</th></tr>
<tr><th>Bit6</th><th>Bit5</th><th>Bit4</th><th>Bit3</th><th>Bit2</th><th>Bit1</th><th>Bit0</th></tr>
<tr><td>initialization</td><td>0</td><td>X</td><td>X</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>No Error, not enabled</td><td>1</td><td>X</td><td>X</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Servo is ready</td><td>0</td><td>1</td><td>X</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Servo waiting enable</td><td>0</td><td>1</td><td>X</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Servo operation</td><td>0</td><td>1</td><td>X</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Fast stop</td><td>0</td><td>0</td><td>X</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Error action</td><td>0</td><td>X</td><td>X</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Error</td><td>0</td><td>X</td><td>X</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
</table>
</td></tr>
</table>

3.4.2 PDO Configuration

PDO is divided into RxPDO and TxPDO. The master station sends instructions to the slave station through RxPDO, and the slave station feeds back its own status to the master station through TxPDO, as shown in the following figure.

Table 3-27 PDO communication

	Sending side	Receiving side
RxPDO	Master station	Slave station
TxPDO	Slave station	Master station

In practical applications, SV3 servo drive can only be used as a slave station, and the master station is usually PC or PLC. RxPDO sends control words, operation modes, speed commands,etc.; The servo drive feeds back status words, actual operation modes, speed actual values, and other status variables by TxPDO.

(1) PDO mapping

The mapping from object dictionary to the application object of PDO is called PDO mapping. (For PDO and SDO related, please refer to CANopen protocol manual)

SV3 servo provides 5 sets of fixed RxPDO and 4 sets of fixed TxPDO, as well as 1 set of variable RxPDO and 1 set of variable TxPDO. Max. application object has a data length of 32 bytes for each set of PDO.

The fixed PDO is shown in the following table:

Table 3-28 Fixed PDO Mapping List (RxPDO)

RxPDO	Total number of bytes	Mapping objects
1701h	12	6040h - Control Word 607Ah - Target position 60B8h - probe function 60FEh - digital output
1702h	19	6040h - Control Word 607Ah - Target position 60FFh - target speed 6071h - target torque 6060h - mode selection 60B8h - probe function 607Fh - maximum speed
1703h	17	6040h - Control Word 607Ah - Target position 60FFh - target speed 6060h - mode selection 60B8h - probe function 60E0h - forward torque limit 60E1h - reverse torque limit
1704h	23	6040h - Control Word 607Ah - Target position 60FFh - target speed 6071h - target torque 6060h - mode selection 60B8h - probe function 607Fh - maximum speed 60E0h - forward torque limit

RxPDO	Total number of bytes	Mapping objects
		60E1h - reverse torque limit
1705h	19	6040h - Control Word 607Ah - Target position 60FFh - target speed 6060h - mode selection 60B8h - probe function 60E0h - forward torque limit 60E1h - reverse torque limit 60B2h - torque bias

Table 3-29 Fixed PDO Mapping List (TxPDO)

TxPDO	Total number of bytes	Mapping objects
1B01h	28	603Fh - error code 6041h - status Word 6064h - position feedback 6077h - torque feedback 60F4h - position deviation 60B9h - probe status 60BAh - probe 1 rising edge position 60FDh - DI status
1B02h	25	603Fh - error code 6041h - status Word 6064h - position feedback 6077h - torque feedback 6061h - Mode Display 60B9h - probe status 60BAh - probe 1 rising edge position 60BCh - probe 2 rising edge position 60FDh - DI status
1B03h	29	603Fh - error code 6041h - status Word 6064h - position feedback 6077h - torque feedback 60F4h - position deviation 6061h - Mode Selection 60B9h - probe status 60BAh - probe 1 rising edge position 60BCh - probe 2 rising edge position 60FDh - DI status

TxPDO	Total number of bytes	Mapping objects
1B04h	29	603Fh - error code 6041h - status Word 6064h - position feedback 6077h - torque feedback 60F4h - position deviation 6061h - Mode Selection 60B9h - probe status 60BAh - probe 1 rising edge position 60BCh - probe 2 rising edge position 606Ch - speed feedback

The variable PDO is shown in the following figure:

Table 3-30 Variable PDO Mapping List

PDO	Index	DeError mapping object	Remarks
RxPDO	1600h	6040h - Control Word 607Ah - Target position 60B8h - probe function 6060h operating mode	Max. mapping objects of 10 The longest byte number is 40
TxPDO	1A00h	603Fh - error code 6041h - status Word 6061h - Current operating mode 6064h - position feedback 60BCh - probe 2 rising edge position 60B9h - probe status 60BAh - probe 1 rising edge position 60FDh - DI status	

(2) PDO allocation object

SM channel (SyncManager) is a memory segment on the slave control chip. In order to use PDO for data exchange, the list of PDO mapping objects must be switched to SM channel. As mentioned in the above section, SV3 has multiple sets of PDO mapping lists, but in practical application, one RxPDO and one TxPDO are selected for data exchange, as shown in the following table:

Table 3-31 SM Channel configuration

Index	Subindex	Description
0x1C12h	01h	Select one RxPDO as the actual RxPDO
0x1C13h	01h	Select one TxPDO as the actual TxPDO

Note: RxPDO:0x1600h, 0x1701h~0x1705h are mapping lists and can be understood as a collection of partial data objects, 0x1C12h is to select a collection of data objects for the actual master-slave communication. The same goes for TxPDO.

3.4.3 Setting of Operation Mode

(1) Introduction of servo mode

SV3 servo drive supports 7 operating modes, Mode Control 6060h is used to control the servo operation in different control modes, and Mode Display 6061 is used to display the current control mode.

Table 3-32 Supported operating modes of SV3 servo drives

Control mode	Control Mode 6060h Setting Value	Minimum communication cycle
Profile position model	1	1ms
Profile velocity model	3	500µs
Profile torque mode	4	125µs
Cyclic synchronization position mode	8	1ms
Cyclic synchronization speed mode	9	500µs
Cyclic synchronization torque mode	10	125µs
The origin return model	6	1ms

Note: When the value is greater than 1ms, the synchronization cycle is an integer multiple of the position loop control cycle(the position loop control cycle is 250µs).

(2) Cyclic Synchronous Position(CSP)

In CSP mode, motion planning of the servo motor is completed by the master, and then the position command is sent to the servo drive periodically, and the communication cycle and sync mode are set by the master station.

⚠ **Note:**

Min. communication cycle of CSP is 1ms. If the communication cycle is greater than 1ms, ensure that the communication cycle is an integer multiple of the position loop control cycle(the position loop control cycle is 250µs).

In CSP mode, use DC synchronization.

When the CSP mode is switched to other modes, the unexecuted position instruction will be discarded in any state.

When switching from other modes to cyclic synchronization mode in servo operation state, please wait at least 1ms before sending instructions, otherwise instruction loss or errors might occur.

Control block diagram

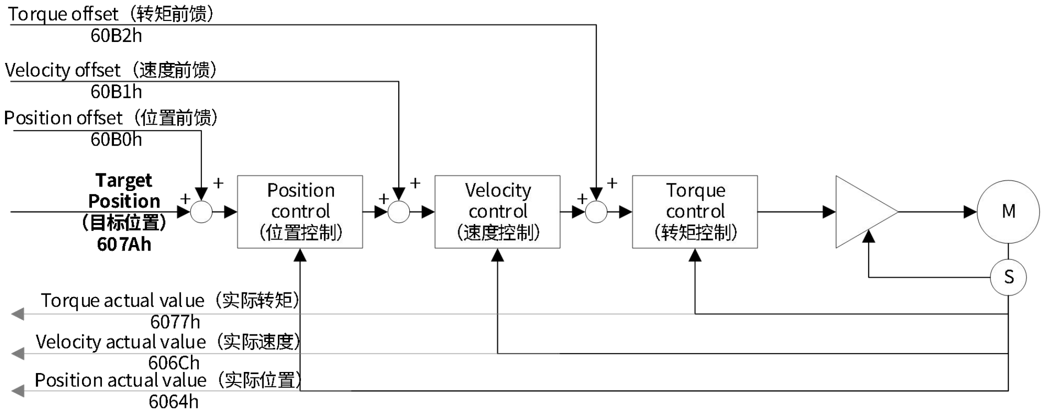


Figure 3-53 Overview of cyclic synchronization position mode

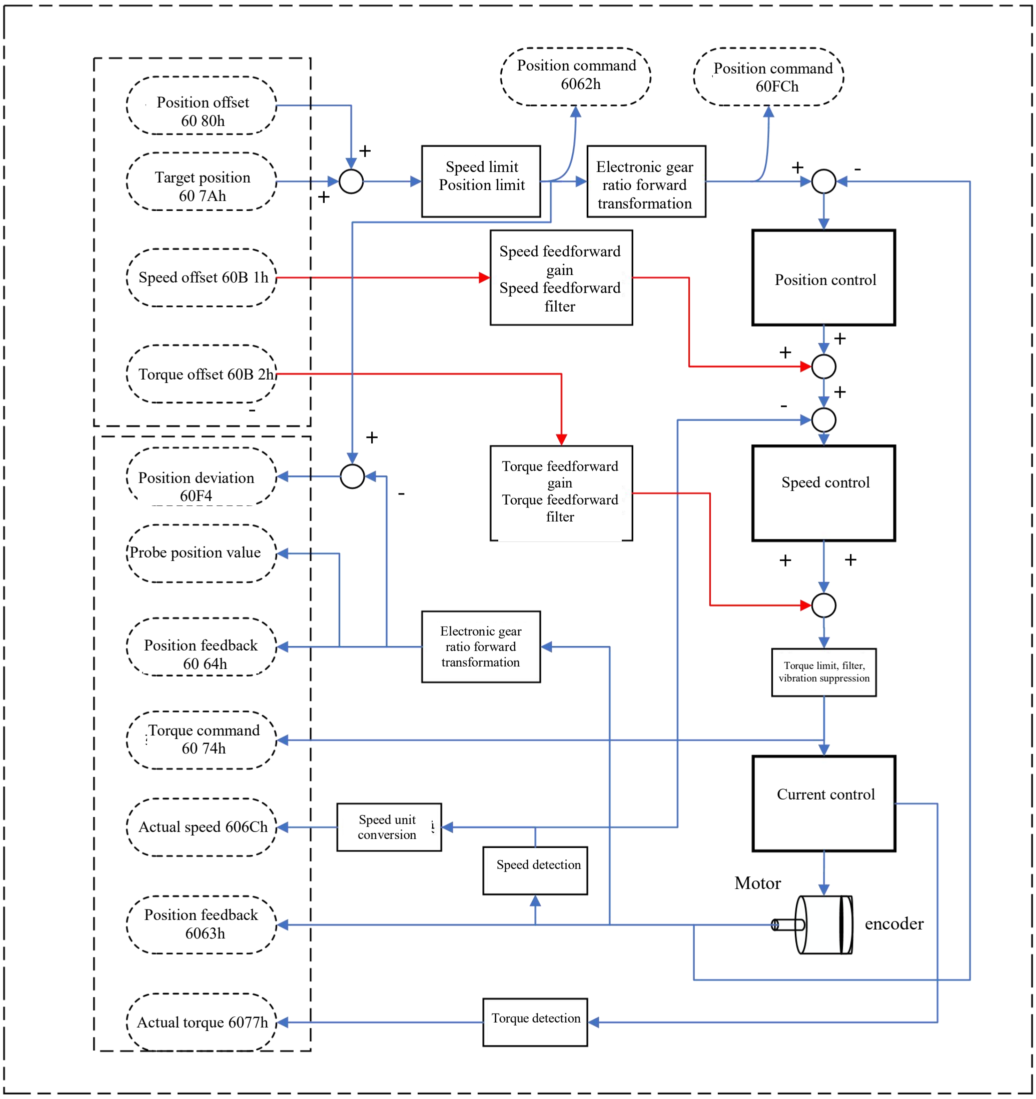


Figure 3-54 Block diagram of cyclic synchronization position mode

Related object (instruction * setting class)

Note: For detailed instructions on related objects, see Chapter 6 Object Dictionary.
Common object:

33Table 3-33 0x6040- Control word

<table>
<tr><th colspan="2">0x6040- Control word</th></tr>
<tr><td>Index - Subindex</td><td>0x6040-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>In CSP mode, only absolute position instruction is supported
Mode correlation: Bit0 to Bit3 are 1, indicating that the system is started
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Servo is ready</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>1</td><td>Switch on the main circuit</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>2</td><td>Fast stop</td><td>Setting mode: 0-valid, 1-invalid</td></tr>
<tr><td>3</td><td>Servo operation</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>8</td><td>Pause</td><td>0: invalid.
1: The servo is set pause by 605Dh.</td></tr>
</table>
</td></tr>
</table>

Table 3-34 Objects related to command Settings in CSP mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	-	0~65535	UINT16	RW	RxPDO
6060	00	Servo mode selection	-	0~10	INT8	RW	RxPDO
6065	00	Threshold of large position deviation	Instruction unit	0~(2^{32}-1)	UINT32	RW	RxPDO
6067	00	Threshold of position arrival	Encoder unit	0~(2^{32}-1)	UINT32	RW	RxPDO
6068	00	Position arrival window time	ms	0~65535	UINT16	RW	RxPDO
6072	00	Maximum torque instruction	0.1%	0~5000	UINT16	RW	RxPDO
607A	00	Target position	Instruction unit	-2^{31}~(2^{31}-1)	INT32	RW	RxPDO
6091	01	Motor resolution	-	1~(2^{32}-1)	UINT32	RW	RxPDO
	02	Load shaft resolution	-	1~(2^{32}-1)	UINT32	RW	RxPDO
60B0	00	Position bias	Instruction unit	-2^{31}~(2^{31}-1)	INT32	RW	RxPDO
60B1	00	Velocity bias	Instruction unit /s	-2^{31}~(2^{31}-1)	INT32	RW	RxPDO
60B2	00	Torque bias	0.1%	-5000~5000	INT32	RW	RxPDO
2006	01	Velocity proportional gain 1	0.1Hz	1~20000	UINT16	RW	-
	02	Velocity integral gain 1	0.01ms	15~51200	UINT16	RW	-
	03	Position proportional gain 1	0.1Hz	0~20000	UINT16	RW	-
	09	Speed feedforward proportional gain	0.1%	0~1000	UINT16	RW	-
	0A	Torque feedforward proportional gain	0.1%	0~2000	UINT16	RW	-
2007	03	Torque filtering 1	0.01ms	0~3000	UINT16	RW	-
	07	Velocity feedforward filtering time	0.01ms	0~6400	UINT16	RW	-
	08	Torque feedforward filtering time	0.01ms	0~6400	UINT16	RW	-

Related objects (status * monitor class)

35Table 3-35 0x6041- Status words

<table>
<tr><th colspan="2">0x6041- Status word</th></tr>
<tr><td>Index - Subindex</td><td>0x6041-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>-</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>Reactive servo state
For mode:
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>10</td><td>Target position arrival</td><td>Status display: 1- Arrived, 0- not arrived</td></tr>
<tr><td>11</td><td>The software internal position overrun</td><td>Status display: 1- overrun, 0- not overrun</td></tr>
<tr><td>12</td><td>Follow instructions from the slave station</td><td>Status: 1- Follow, 0- not follow</td></tr>
<tr><td>13</td><td>Following error</td><td>Status display: 1- overrun, 0- not overrun</td></tr>
<tr><td>15</td><td>Return to zero completion</td><td>Status display: 1- completed, 0- not completed</td></tr>
</table></td></tr>
</table>

Table 3-36 Status monitoring objects in CSP mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
603F	00	Error code	-	0~65535	UINT16	RO	TxPDO
6041	00	Status word	-	0~65535	UINT16	RO	TxPDO
6061	00	Run mode display	-	0~10	INT8	RO	TxPDO
6062	00	Position instruction	Instruction unit	-	DINT32	RO	TxPDO
6063	00	Position feedback	Encoder unit	-	INT32	RO	TxPDO
6064	00	Position feedback	Instruction unit	-	INT32	RO	TxPDO
606C	00	Actual velocity	Instruction unit /s	-	INT32	RO	TxPDO
6077	00	Actual torque	0.1%	-5000~5000	INT16	RO	TxPDO
60F4	00	Position deviation	Instruction unit	-	DINT32	RO	TxPDO
60FC	00	Position	Encoder	-	DINT32	RO	TxPDO

		instruction	unit				

Related function Settings

A) Positioning is complete

If the difference between the actual position and the target position is within a certain threshold range and maintains for a certain time, the positioning completion DO is valid, and Bit10=1 of 6041.

⚠ Note:

Both positioning completion threshold and completion window time must be met at the same time. The control block diagram is as follows:

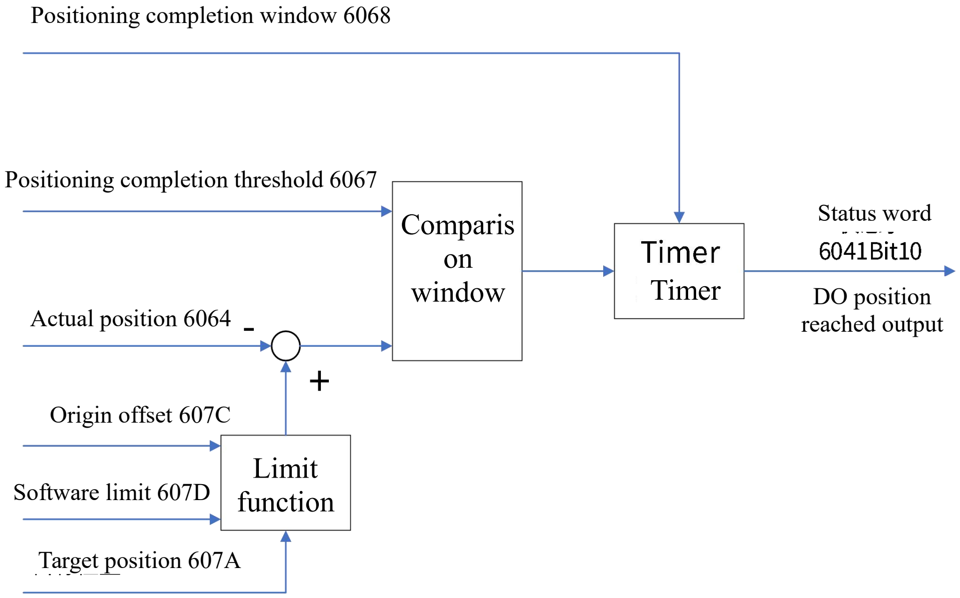


Figure 3-55 overview of CSP positioning completion

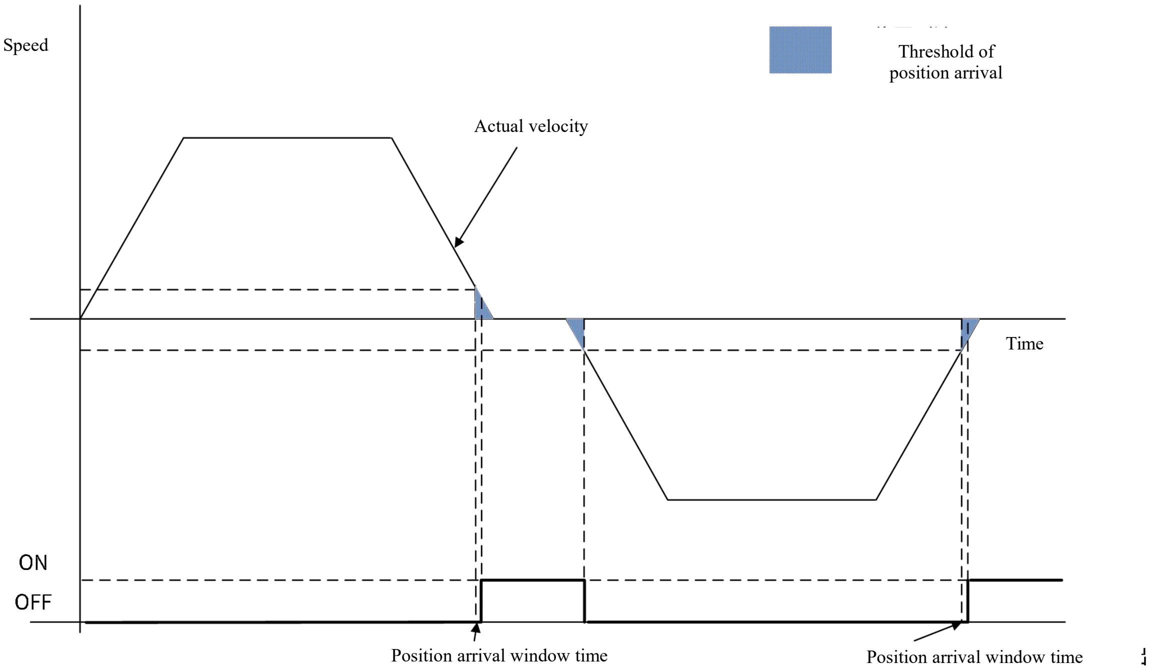


Figure 3-56 diagram of CSP mode positioning completion

Related object parameters are shown in the following table:

Table 3-37 objects related to CSP positioning completion

Index	Subindex	Name	Setting range
2013	0C	Unit of position arrival threshold	0: encoder unit 1: command unit
6067	00	Positioning completion threshold	0~65535
6068	00	Positioning completion window time	0~65535

B) Threshold of garge position deviation

When the difference between the target position and the actual position exceeds a certain threshold, the servo drive will alarm.

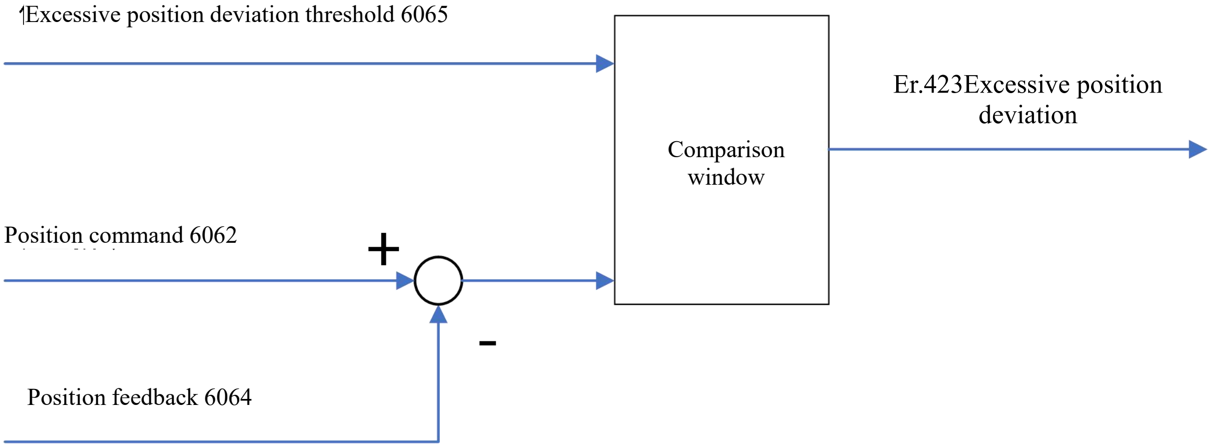


Figure 3-57 Overview of large CSP position deviation

Related object parameters are shown in the following table:

Table 3-38 Objects related to large CSP position deviation

Index	Subindex	Name	Setting range
6065	00	Threshold of large position deviation	0~(2^{32}-1)

C) Position alignment

Before the servo is enabled, ensure that 607A (target position) +60B0 (position bias) is consistent with 6064 (actual position) so as to avoid high-speed motor movement due to misalignment, as shown in the following figure.

Solution: The upper software periodically assigns the position feedback value to the target position.

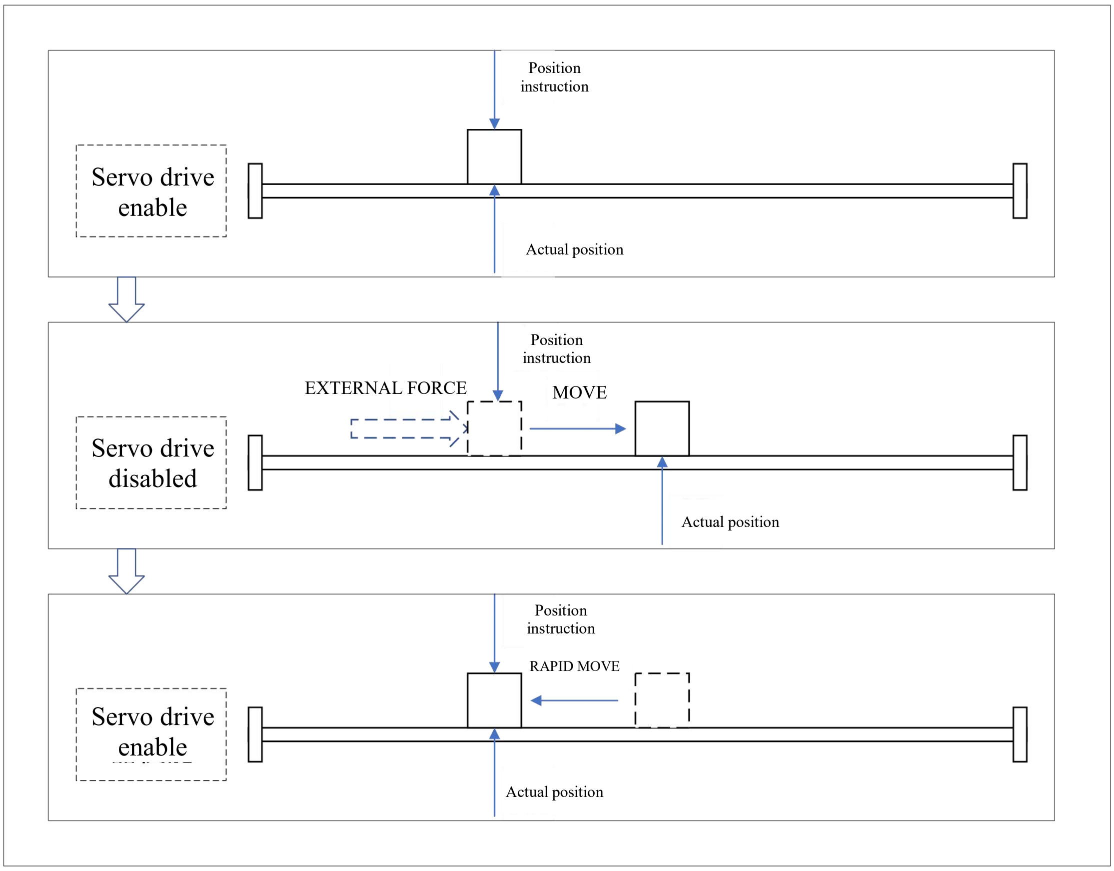


Figure 3-58 Case for CSP position alignment

(3) Cyclic Synchronization Speed(CSV) Mode

In cyclic synchronous speed mode, speed planning of the servo motor is completed by the master computer, and then the speed command is sent to the servo drive periodically, and the communication cycle and synchronization mode are set by the master station.

⚠ Note:

The minimum communication cycle of CSV mode is 500μs.

Please use DC synchronization in CSV mode.

When CSV mode is switched to other modes, perform ramp stop in any state, and when the stop is complete, it may switch to others.

Control block diagram

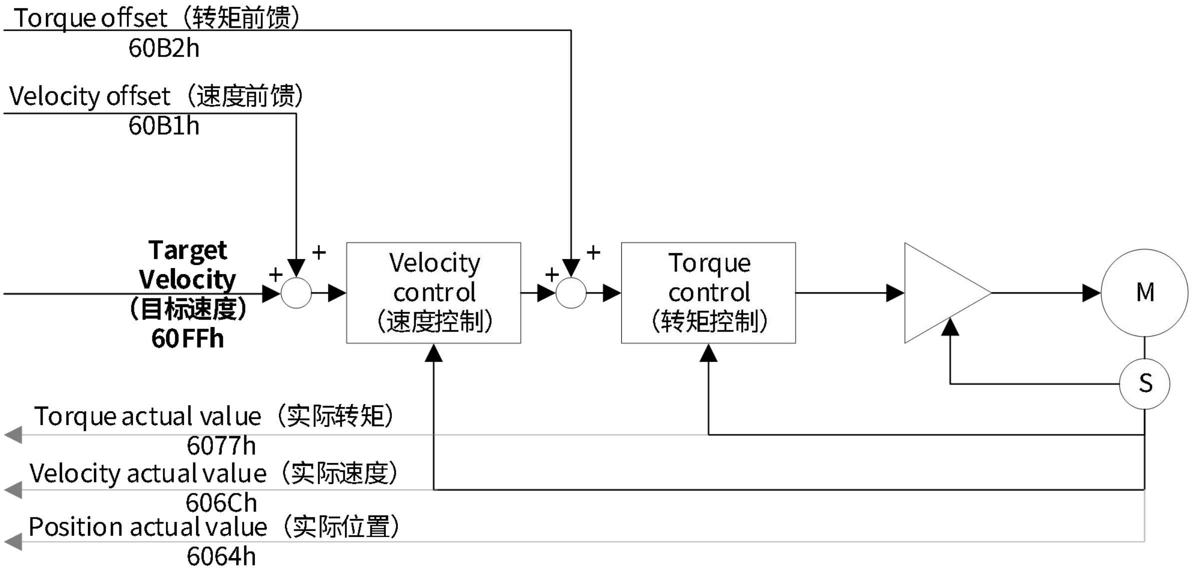


Figure 3-59 Cyclic Synchronization Velocity (CSV) overview diagram

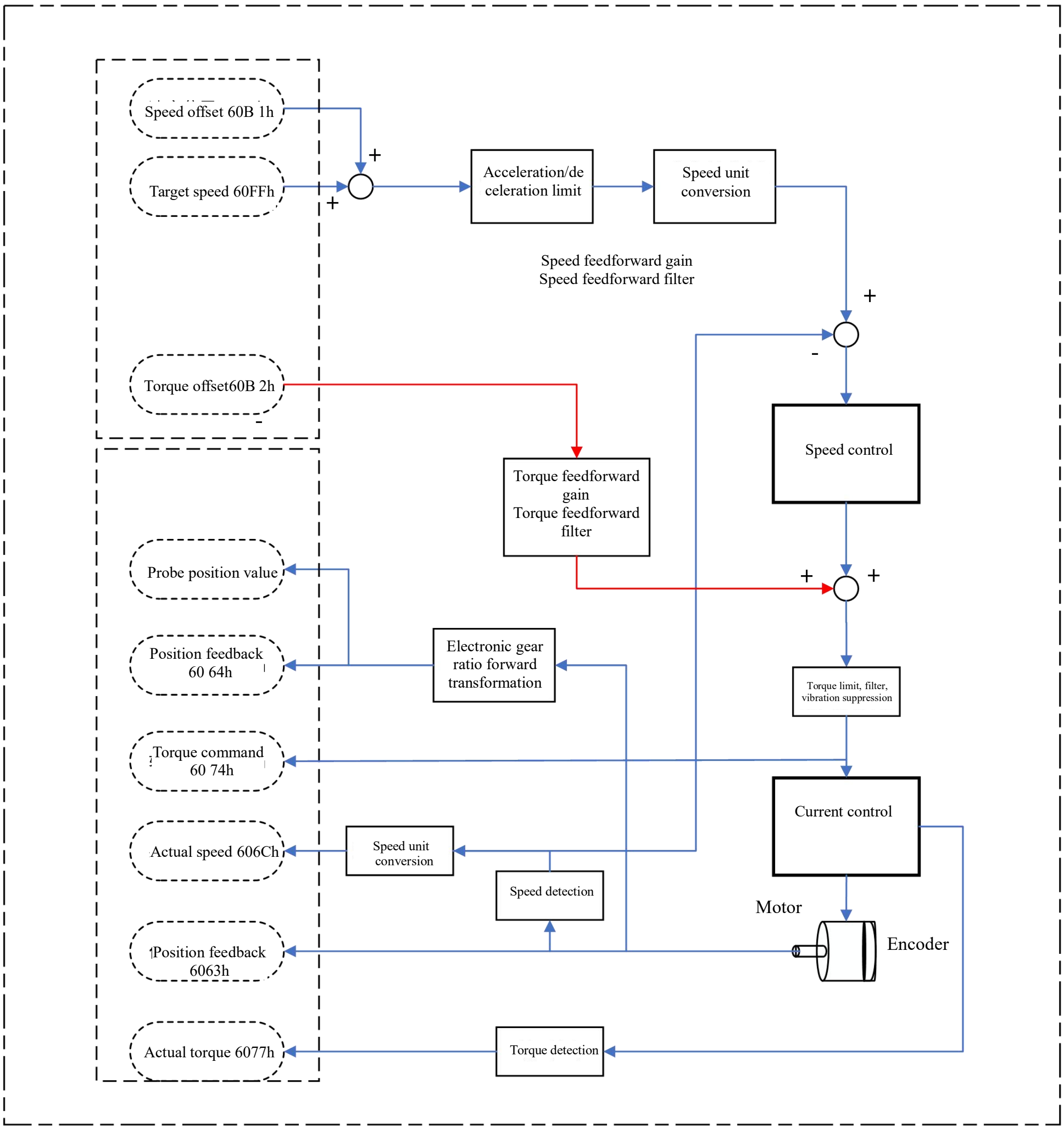


Figure 3-60 CSV block diagram

Related object (instruction * setting class)

Note: For detailed instructions on related objects, see Chapter 6 Object Dictionary.
Common object:

Table 3-39 0x6040- Control word

<table>
<tr><th colspan="2">0x6040- Control word</th></tr>
<tr><td>Index - Subindex</td><td>0x6040-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>In CSP mode, only absolute position instruction is supported
Mode correlation: Bit0 to Bit3 are 1, indicating that the system is started
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Servo is ready</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>1</td><td>Switch on the main circuit</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>2</td><td>Fast stop</td><td>Setting mode: 0-valid, 1-invalid</td></tr>
<tr><td>3</td><td>Servo operation</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>8</td><td>Pause</td><td>0: invalid.
1: The servo is set pause by 605Dh.</td></tr>
</table>
</td></tr>
</table>

Table 3-40 Commands set objects in CSV mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	-	0~65535	UINT16	RW	RxPDO
6060	00	Servo mode selection	-	0~10	INT8	RW	RxPDO
607F	00	Max. speed	Instruction unit /s	$0\sim(2^{32}-1)$	UDINT32	RW	RxPDO
6083	00	Profile acceleration	Instruction unit /s^2	$0\sim(2^{32}-1)$	UDINT32	RW	RxPDO
6084	00	Profile deceleration	Instruction unit /s^2	$0\sim(2^{32}-1)$	UDINT32	RW	RxPDO
60B1	00	Velocity bias	Instruction unit /s	$-2^{31}\sim(2^{31}-1)$	INT32	RW	RxPDO
60B2	00	Torque bias	0.1%	-5000~5000	INT32	RW	RxPDO
60E0	00	Forward torque limit	0.1%	0~5000	UINT16	RW	RxPDO
60E1	00	Reverse torque limit	0.1%	0~5000	UINT16	RW	RxPDO
60FF	00	Target speed	Instruction unit /s	$-2^{31}\sim(2^{31}-1)$	INT32	RW	RxPDO
2006	01	Velocity proportional gain 1	0.1Hz	1~20000	UINT16	RW	-
	02	Velocity integral gain 1	0.01ms	15~51200	UINT16	RW	-
	0A	Torque feedforward proportional gain	0.1%	0~2000	UINT16	RW	-
2007	03	Torque filtering 1	0.01ms	0~3000	UINT16	RW	-
	08	Torque feedforward filtering time	0.01ms	0~6400	UINT16	RW	-

Related objects (status * monitor class)

Table 3-41 0x6041- Status word

<table>
<tr><th colspan="2">0x6041- Status word</th></tr>
<tr><td>Index - Subindex</td><td>0x6041-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>-</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>Reactive servo state
For mode:
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>10</td><td>Target speed arrival</td><td>Status display: 1- Arrived, 0- not arrived</td></tr>
<tr><td>12</td><td>Follow instructions from the slave station</td><td>Status: 1- Follow, 0- not follow</td></tr>
<tr><td>15</td><td>The origin return to zero is complete</td><td>Status display: 1- completed, 0- not completed</td></tr>
</table></td></tr>
</table>

42Table 3-42 Status monitoring objects in CSV mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
603F	00	Error code	-	0~65535	UINT16	RO	TxPDO
6041	00	Status word	-	0~65535	UINT16	RO	TxPDO
6061	00	Run mode display	-	0~10	INT8	RO	TxPDO
6063	00	Position feedback	Encoder unit	-	INT32	RO	TxPDO
6064	00	Position feedback	Instruction unit	-	INT32	RO	TxPDO
606C	00	Actual velocity	Instruction unit /s	-	INT32	RO	TxPDO
6077	00	Actual torque	0.1%	-5000~5000	INT16	RO	TxPDO

Related function Settings

A) Speed limit
Speed limit of motor is determined by Max. speed;
B) Speed arrival function
If actual speed exceeds the threshold of speed arrival signal and remains for a period, the speed arrival DO is valid and Bit10 =1 of status word 6041.
Related object parameters are shown in the following table:

Table 3-43 CSV mode speed arrival function related objects

Index	Subindex	Name	Setting range
606Dh	00	the threshold of speed arrival	0~65535
606Eh	00	Speed arrives window time	0~65535

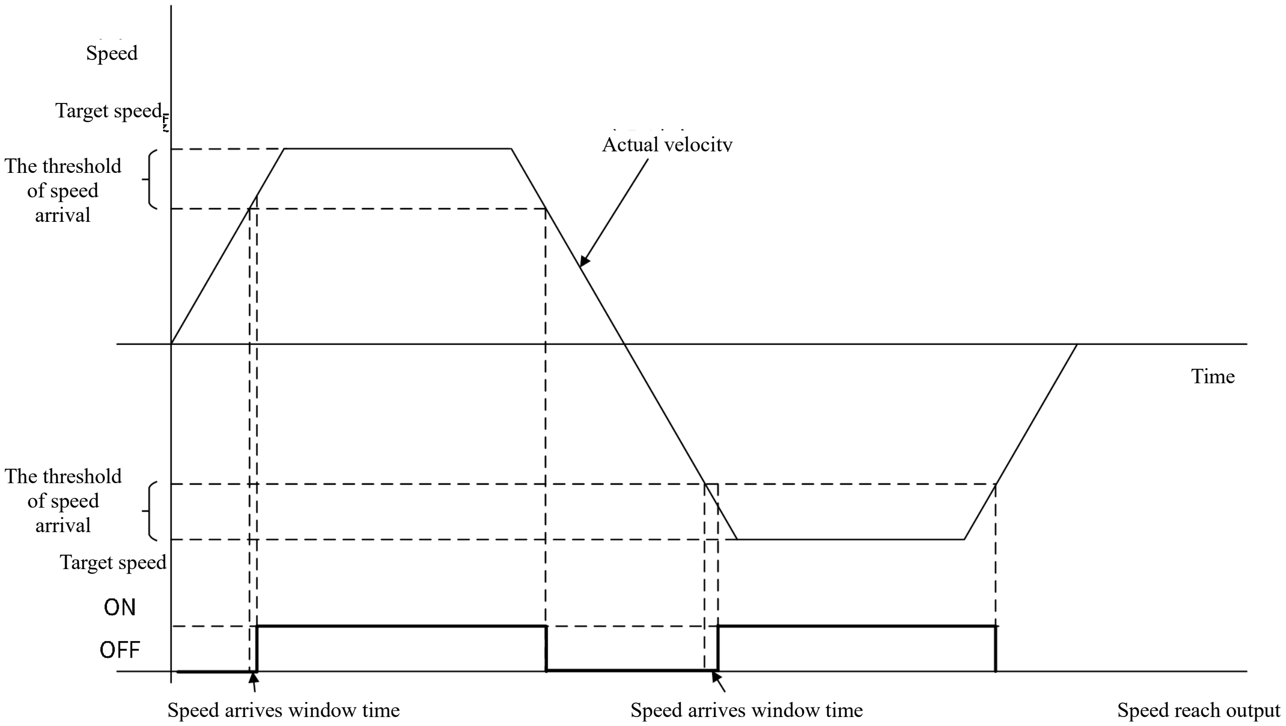


Figure 3-61 Diagram of CSV speed arrival function

(4) Cyclic Synchronous Torque(CST) Mode

In CST mode, motion planning of the servo motor is completed by the master computer, and then the torque command is periodically sent to the servo drive, and the communication cycle and synchronization mode are set by the master station.

⚠ Note:

Min. communication cycle of CST mode is 125μs.

Please use DC synchronization in CST mode.

When CST mode is switched to other modes, perform ramp stop in any state. After the stop is completed, it may switch to other modes;

In CST mode, the speed will enter the speed control when it reaches the limit.

Control block diagram

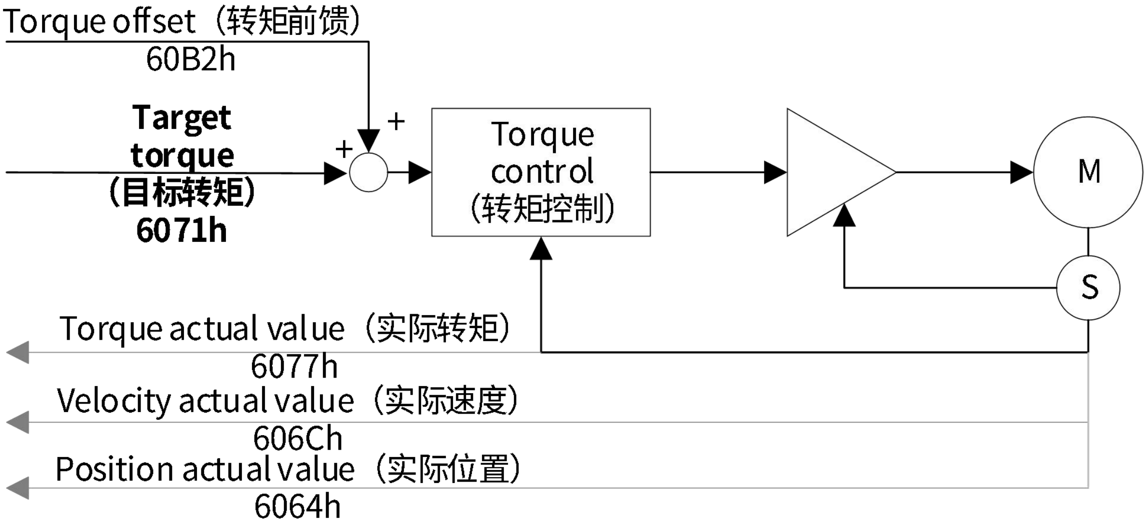


Figure 3-62 Overview of cyclic synchronous torque (CST)

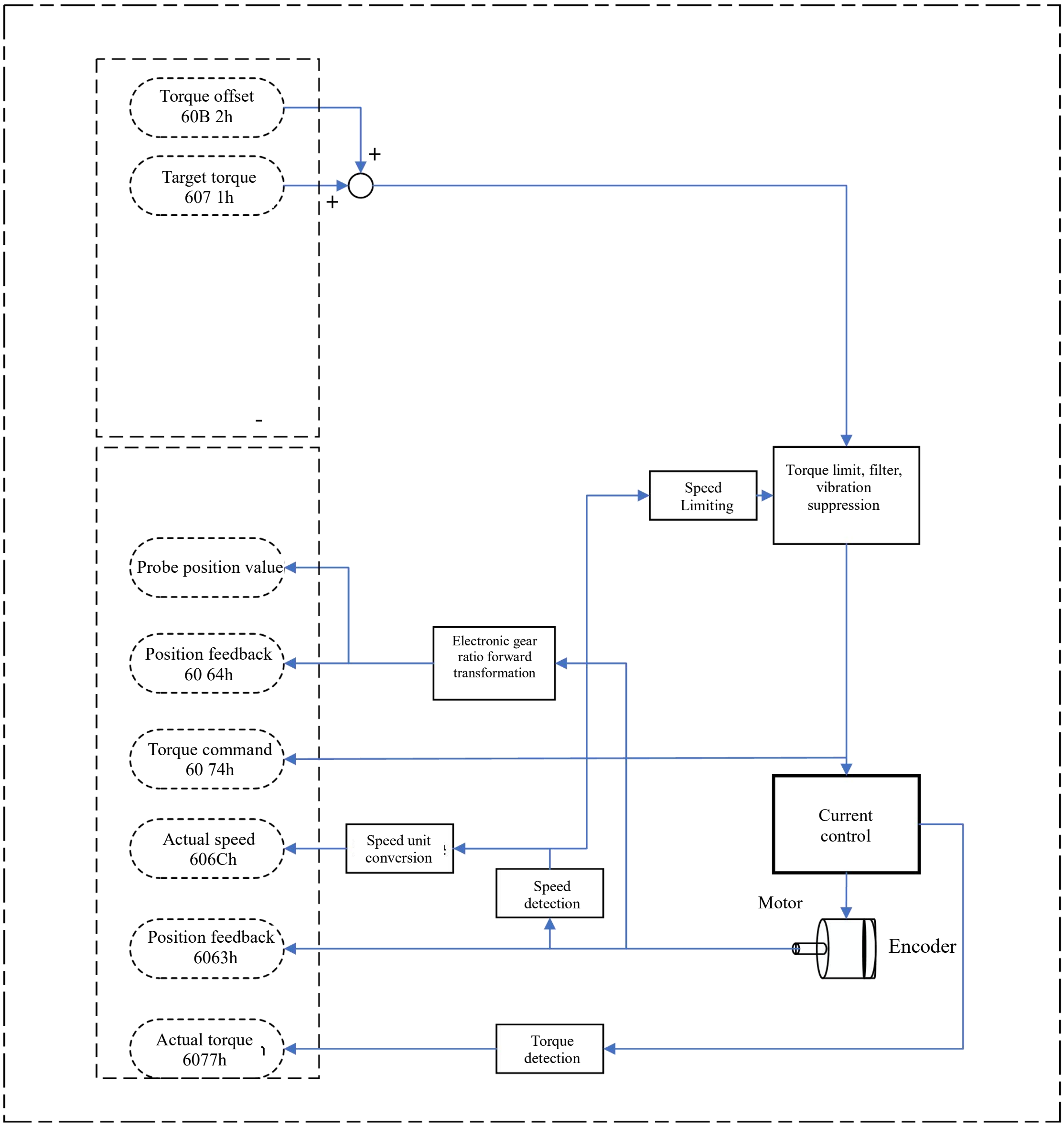


Figure 3-63 Block diagram of CST mode

Related object (instruction * setting class)

Note: For detailed instructions on related objects, see Chapter 6 Object Dictionary.
Common object:

Table 3-44 0x6040- Control word

0x6040- Control word	
Index - Subindex	0x6040-00
Data type	UINT16
Accessibility	Readable/writable
Unit	-
DeError value	0
Min.	0
Max.	65535
Setting and effective mode	Operation settings/downtime effective
Related mode	ALL

<table>
<tr><th>Note</th><td>In CSP mode, only absolute position instruction is supported
Mode correlation: Bit0 to Bit3 are 1, indicating that the system is started
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Servo is ready</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>1</td><td>Switch on the main circuit</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>2</td><td>Fast stop</td><td>Setting mode: 0-valid, 1-invalid</td></tr>
<tr><td>3</td><td>Servo operation</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>8</td><td>Pause</td><td>0: invalid.
1: The servo is set pause by 605Dh.</td></tr>
</table>
</td></tr>
</table>

Table 3-45 Objects related to command settings in CST mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	-	0~65535	UINT16	RW	RxPDO
6060	00	Servo mode selection	-	0~10	INT8	RW	RxPDO
6071	00	Target torque	0.1%	-5000~5000	INT16	RW	RxPDO
607F	00	Max. speed	Instruction unit /s	0~(2^{32}-1)	UDINT32	RW	RxPDO
60B2	00	Torque bias	0.1%	-5000~5000	INT32	RW	RxPDO
60E0	00	Forward torque limit	0.1%	0~5000	UINT16	RW	RxPDO
60E1	00	Reverse torque limit	0.1%	0~5000	UINT16	RW	RxPDO
2006	01	Velocity proportional gain 1	0.1Hz	1~20000	UINT16	RW	-
	02	Velocity integral gain 1	0.01ms	15~51200	UINT16	RW	-
2007	03	Torque filtering 1	0.01ms	0~3000	UINT16	RW	-

Related objects (status * monitor class)

Table 3-46 0x6041- Status words

<table>
<tr><th colspan="2">0x6041- Status word</th></tr>
<tr><th>Index - Subindex</th><td>0x6041-00</td></tr>
<tr><th>Data type</th><td>UINT16</td></tr>
<tr><th>Accessibility</th><td>Readable</td></tr>
<tr><th>Unit</th><td>-</td></tr>
<tr><th>DeError value</th><td>0</td></tr>
<tr><th>Min.</th><td>0</td></tr>
<tr><th>Max.</th><td>65535</td></tr>
<tr><th>Setting and effective mode</th><td>-</td></tr>
<tr><th>Related mode</th><td>ALL</td></tr>
<tr><th>Note</th><td>Reactive servo state
For mode:
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>10</td><td>Target torque arrival</td><td>Status display: 1- Arrived, 0- not</td></tr>
</table>
</td></tr>
</table>

			arrived
	12	Follow instructions from the slave station	Status: 1- Follow, 0- not follow
	15	The origin return to zero is complete	Status display: 1- completed, 0-not completed

Table 3-47 Status monitoring objects in CST mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	RW	UINT16	-	0~65535	TxPDO
603F	00	Error code	RO	UINT16	-	0~65535	TxPDO
6041	00	Status word	RO	UINT16	-	0~65535	TxPDO
6061	00	Run mode display	RO	INT8	-	0~10	TxPDO
606C	00	Actual velocity	RO	INT32	Instruction unit /s	-	TxPDO
6074	00	Torque command	RO	INT16	0.1%	-5000~5000	TxPDO
6077	00	Actual torque	RO	INT16	0.1%	-5000~5000	TxPDO

Related function Settings

A) Speed limit

The speed limit is determined by the smaller value of 607Fh and Max. motor speed;

Table 3-48 Related objects of the speed limit in CST mode

Index	Subindex	Name	Setting range
607F	00	Max. speed	$0\sim(2^{32}-1)$

B) Torque arrival

When the difference between torque and reference value is greater than the value of 2015h:12, it outputs valid arrival signal TOQREACH, and Bit10 of status word 6041 is set of 1.

When the difference between torque and reference value is less than the value of 2015h:13, the output is invalid, and Bit10 of status word 6041 is cleared to zero.

Table 3-49 Objects related to torque arrival in CST mode

Index	Subindex	Name	Setting range
2015	11	Reference value of torque arrival	0~3000 (unit: 0.1%)
2015	12	Torque arrival valid value	0~3000 (unit: 0.1%)
2015	13	Torque arrival invalid value	0~3000 (unit: 0.1%)

(5) Profile Position(PP) Mode

In PP mode, the upper controller specifies the target position, profile speed, profile acceleration, profile deceleration, etc. Motor motion planning is carried out inside the servo drive, suitable for point-to-point motion.

⚠ Note:

Min. communication cycle in PP mode is 1ms. If the communication cycle is set to more than 1ms, ensure that the communication cycle is an integer multiple of the position loop control cycle(the position loop control cycle is 250μs).

When the PP mode is switched to other modes, any unexecuted position instruction would be discarded in any state.

Control block diagram

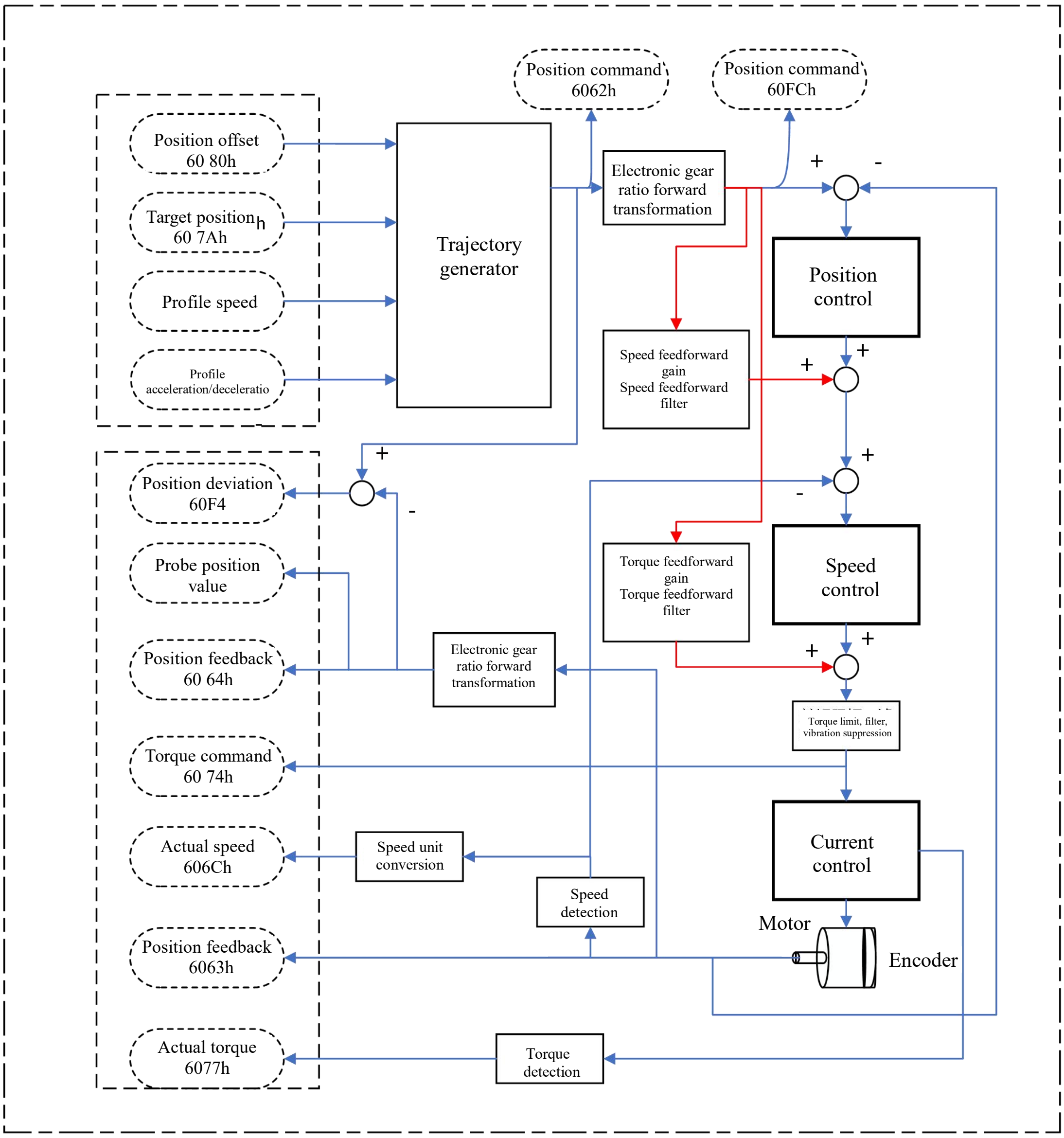


Figure 3-64 Block diagram of outline position mode

Related object (instruction * setting class)

Note: For detailed instructions on related objects, see Chapter 6 Object Dictionary.

Common object:

Table 3-50 0x6040- Control word

0x6040- Control word

<table>
<tr><td>Index - Subindex</td><td>0x6040-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>In CSP mode, only absolute position instruction is supported
Mode correlation: Bit0 to Bit3 are 1, indicating that the system is started
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Servo is ready</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>1</td><td>Switch on the main circuit</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>2</td><td>Fast stop</td><td>Setting mode: 0-valid, 1-invalid</td></tr>
<tr><td>3</td><td>Servo operation</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>4</td><td>New target location: New set-point</td><td>Effective mode: Rising edge</td></tr>
<tr><td>5</td><td>Change set immediately</td><td>0: Non-immediate change mode
1: Immediate change mode</td></tr>
<tr><td>6</td><td>Absolute position /relative position abs/rel</td><td>0: Position instruction is an absolute position instruction
1: Position instruction is a relative position instruction</td></tr>
</table>
</td></tr>
</table>

Table 3-51 Objects related to instruction setting in PP mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	-	$0\sim(2^{32}-1)$	UINT16	RW	RxPDO
6060	00	Servo mode selection	-	0~65535	INT8	RW	RxPDO
6065	00	Threshold of large position deviation	Instruction unit	0~65535	UDINT32	RW	RxPDO
6067	00	Threshold of position arrival	Encoder unit	$-2^{31}\sim(2^{31}-1)$	UINT32	RW	RxPDO
6068	00	Position arrival window	ms	$0\sim(2^{32}-1)$	UINT16	RW	RxPDO
607A	00	Target position	Instruction unit	$0\sim(2^{32}-1)$	INT32	RW	RxPDO
6083	00	Profile acceleration	Instruction unit /s^2	$0\sim(2^{32}-1)$	UDINT32	RW	RxPDO
6084	00	Profile deceleration	Instruction unit /s^2	$1\sim(2^{32}-1)$	UDINT32	RW	RxPDO
6091	01	Motor resolution	-	0~5000	UINT32	RW	RxPDO
6091	02	Load shaft resolution	-	0~5000	UINT32	RW	RxPDO
60E0	00	Forward torque limit	0.1%	0~3000	UINT16	RW	RxPDO
60E1	00	Reverse torque limit	0.1%	1~20000	UINT16	RW	RxPDO

2006	01	Velocity proportional gain 1	0.1Hz	0~20000	UINT16	RW	-
	02	Velocity integral gain 1	0.01ms	0~6400	UINT16	RW	-
	03	Position proportional gain 1	0.1Hz	0~1000	UINT16	RW	-
	09	Speed feedforward proportional gain	0.1%	0~2000	UINT16	RW	-
	0A	Torque feedforward proportional gain	0.1%	0~65535	UINT16	RW	-
2007	03	Torque filtering 1	0.01ms	15~51200	UINT16	RW	-
	07	Velocity feedforward filtering time	0.01ms	0~6400	UINT16	RW	-
	08	Torque feedforward filtering time	0.01ms	0~(2^{32}-1)	UINT16	RW	-

Related objects (status * monitor class)

Table 3-52 0x6041 Status word

<table>
<tr><th colspan="2">0x6041- Status word</th></tr>
<tr><td>Index - Subindex</td><td>0x6041-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>-</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>Reactive servo state
Mode related: After quick stop ends, Bit10 of status word 6041 is set as 1, and the servo is in the stop\ state.
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>10</td><td>Target position arrival</td><td>Status display: 1- Arrived, 0- not arrived</td></tr>
<tr><td>12</td><td>Follow instructions from the slave station</td><td>Status: 1- Follow, 0- not follow</td></tr>
<tr><td>13</td><td>Following error</td><td>Status: 1- Error, 0- No error</td></tr>
<tr><td>15</td><td>The origin return to zero is complete</td><td>Status display: 1- completed, 0- not completed</td></tr>
</table>
</td></tr>
</table>

Table 3-53 Objects related to state monitoring in PP mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
603F	00	Error code	-	0~65535	UINT16	RO	TxPDO
6041	00	Status word	-	0~65535	UINT16	RO	TxPDO
6061	00	Run mode display	-	0~10	INT8	RO	TxPDO
6062	00	Position instruction	Instruction unit	-	DINT32	RO	TxPDO

6063	00	Position feedback	Encoder unit	-	INT32	RO	TxPDO
6064	00	Position feedback	Instruction unit	-	INT32	RO	TxPDO
606C	00	Actual velocity	Instruction unit /s	-	INT32	RO	TxPDO
6077	00	Actual torque	0.1%	-5000~5000	INT16	RO	TxPDO
60F4	00	Position deviation	Instruction unit	-	DINT32	RO	TxPDO
60FC	00	Position instruction	Encoder unit	-	DINT32	RO	TxPDO

Related function Settings

A) Positioning is complete

If the difference between the actual position and the target position is within a certain threshold range and maintains for a certain time, the positioning completion DO is valid, and Bit10=1 of 6041.

⚠ Note:

It must meet simultaneously both positioning completion threshold and completion window time.

Related object parameters are shown in the following table:

Table 3-54 Objects related to positioning completion in PP mode

Index	Subindex	Name	Setting range
2013	0C	Unit of position arrival threshold	0: instruction unit 1: encoder unit
6067	00	Threshold of position arrival	0~65535
6068	00	Position arrival window time	0~65535

B) Threshold of garge position deviation

When the difference between the target position and the actual position exceeds a certain threshold, the servo drive will alarm.

Related object parameters are shown in the following table:

Table 3-55 Objects related to excessive position deviation in PP mode

Index	Subindex	Name	Setting range
6065	00	Threshold of large position deviation	0~(2^{32}-1)

C) Speed limit

The speed limit is determined by the smaller value of 607Fh and Max. motor speed;

56Table 3-56 Objects related to speed limit in PP mode

Index	Subindex	Name	Setting range
607F	00	Max. speed	0~(2^{32}-1)

(6) Cases for PP action

A)Case 1: Basic set-point

①: Upper controller inputs new target position instruction;

②: 6040h control word Bit4 (New set-point) is set as 1;

③: Receive position instructions from the rising edge of control word Bit4 at 6040h, and start positioning, then set 6041h status word Bit12 (Set-point acknowledgement) of 1;

④: The master station confirms that 6041h status word Bit12 has been set of 1, and then sets 6040h control word Bit4 of 0, and it can receive new position instruction;

⑤: The slave statio confirms that 6040h control word Bit4 has been set of 0, and set 6041h status word Bit12 of 0;

⑥: Positioning completed, 6041h status word Bit10 positioning completed set to 1.

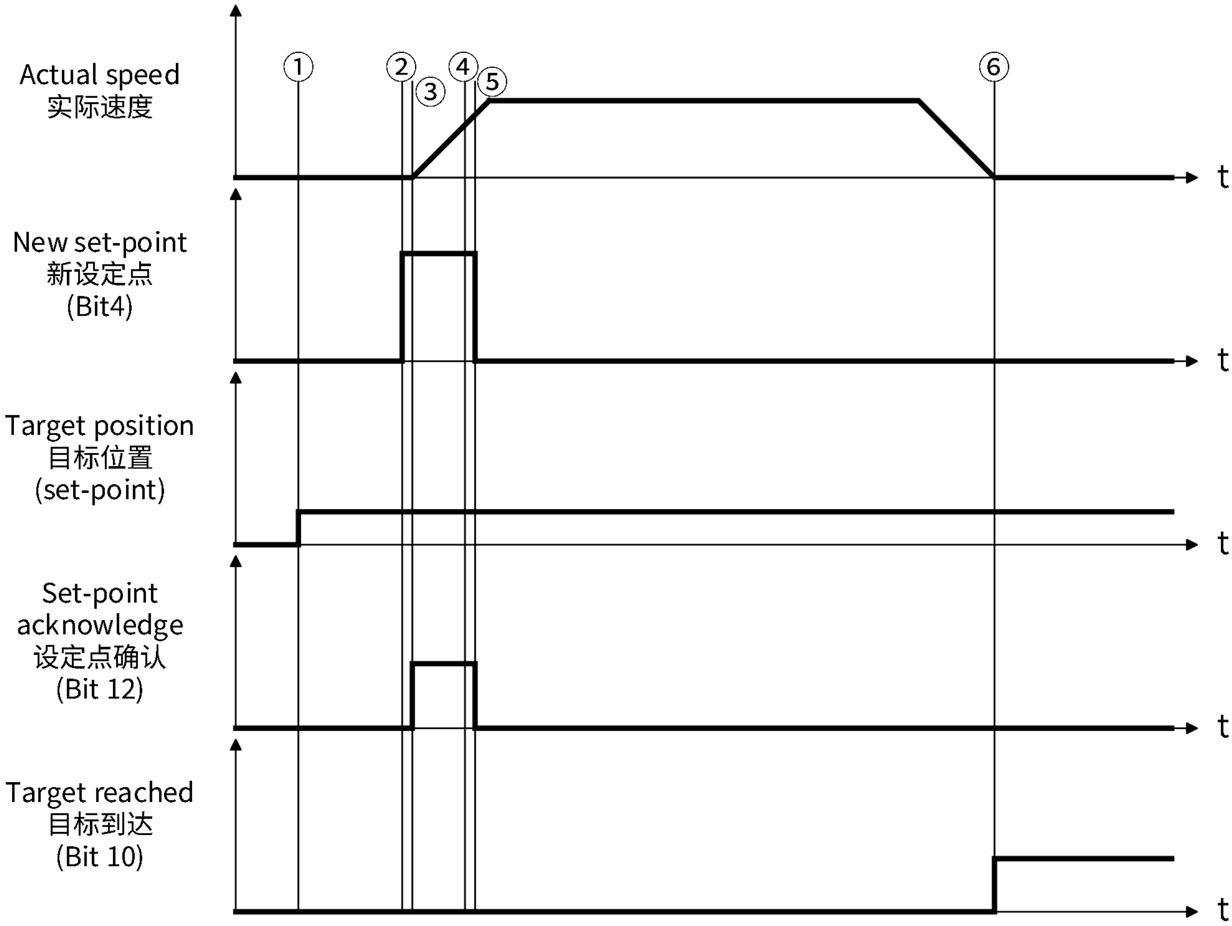


Figure 3-65 PP Mode Basic Set-Point

B) Case 2: Set of set-point (not immediate update mode)

①: The upper controller inputs the target position command;

②: 6040h control word Bit4 (New set-point) is set as 1;

③: Receive position instructions from the rising edge of control word Bit4 at 6040h, and start positioning, then set 6041h status word Bit12 (Set-point acknowledgement) of 1;

④: The master station confirms that 6041h status word Bit12 has been set of 1, and then sets 6040h control word Bit4 of 0, and it can receive new position instruction;

⑤: The slave station confirms that 6040h control word Bit4 has been set of 0, then set 6041h status word Bit12 of 0;

⑥: The upper controller inputs the target position command;

⑦: Set 6040h control word Bit4 (New set-point) of 1;

⑧: The slave station receives position command from the rising edge of 6040h control word Bit4, but not start positioning. Then set 6041h status word Bit12 (Set point acknowledgement) of 1;

⑨ The master station confirms that 6041h status word Bit12 has been set of 1, and then sets 6040h control word Bit4 of 0, and it can receive new position instructions;

A: After the completion of the first position command, the servo motor stops, the slave station sets 6041h status word Bit12 of 0, and starts a new positioning;

B: Positioning completed, 6041h status word Bit10 positioning completed set of 1.

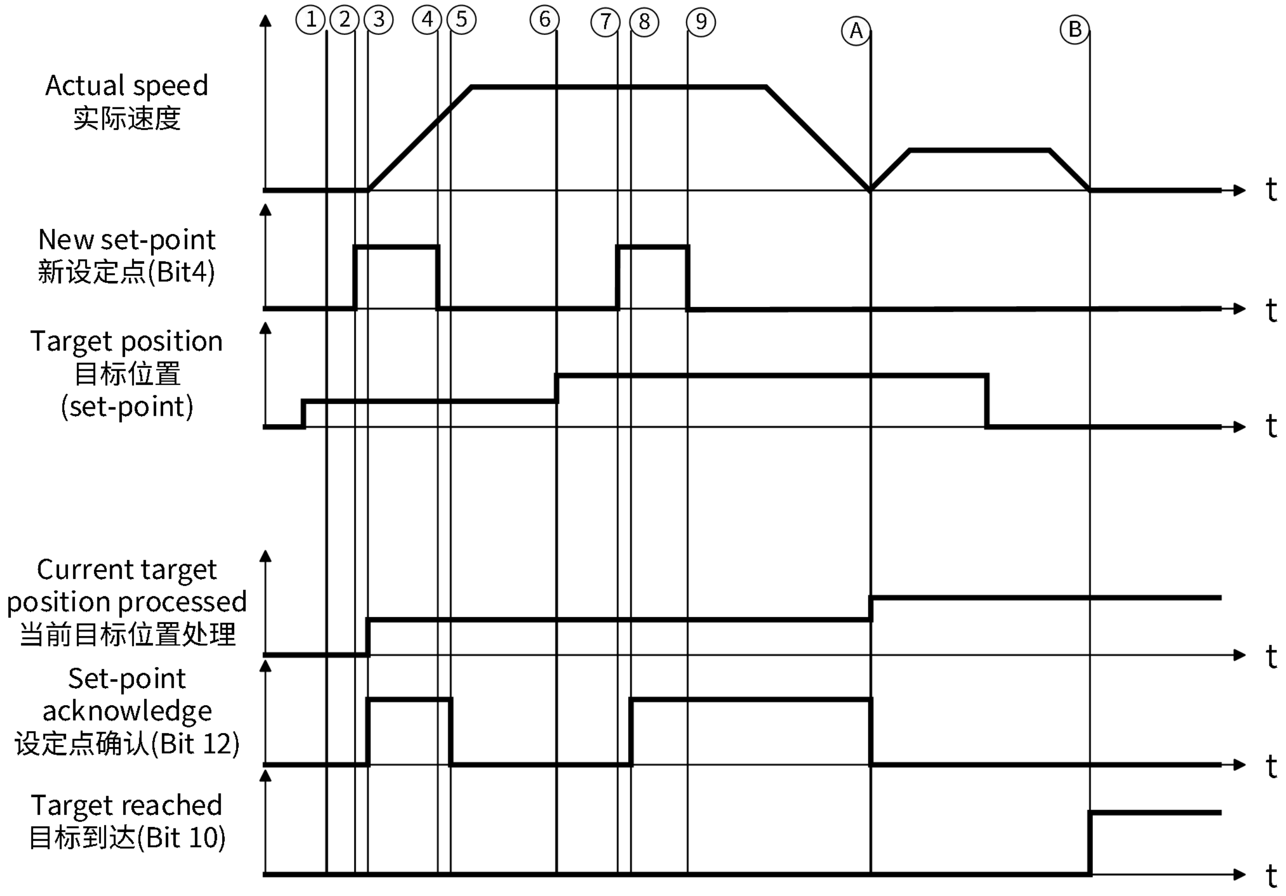


Figure 3-66 PP mode set of set-point (not immediate update mode)

C) Case 3: Single set-poinT (immediate update mode)

①: The upper controller inputs the target position command;

②: 6040h control word Bit4 (New set-point) is set as 1;

③: Receive position instructions from the rising edge of control word Bit4 at 6040h, and start positioning, then set 6041h status word Bit12 (Set-point acknowledgement) of 1;

④: The master station confirms that 6041h status word Bit12 has been set of 1, and then sets 6040h control word Bit4 of 0, and it can receive new position instruction;

⑤: The slave station confirms that 6040h control word Bit4 has been set of 0, then set 6041h status word Bit12 of 0;

⑥: The upper controller inputs the target position command;

⑦: Set 6040h control word Bit4 (New set-point) of 1;

⑧: The slave station receives position instructions on the rising edge of 6040h control word Bit4, executes new positioning with new instructions (profile speed, acceleration/deceleration, etc.), and then set 6041h status word Bit12 (Set-point acknowledgement) of 1;

⑨ The master station confirms that 6041h status word Bit12 has been set of 1, and then sets 6040h control word Bit4 of 0, and it can receive new position instructions;

A: The slave station confirms that 6040h control word Bit4 has been set of 0. Set 6041h status word Bit12 of 0;

B: Positioning completed, 6041h status word Bit10 positioning completed set of 1.

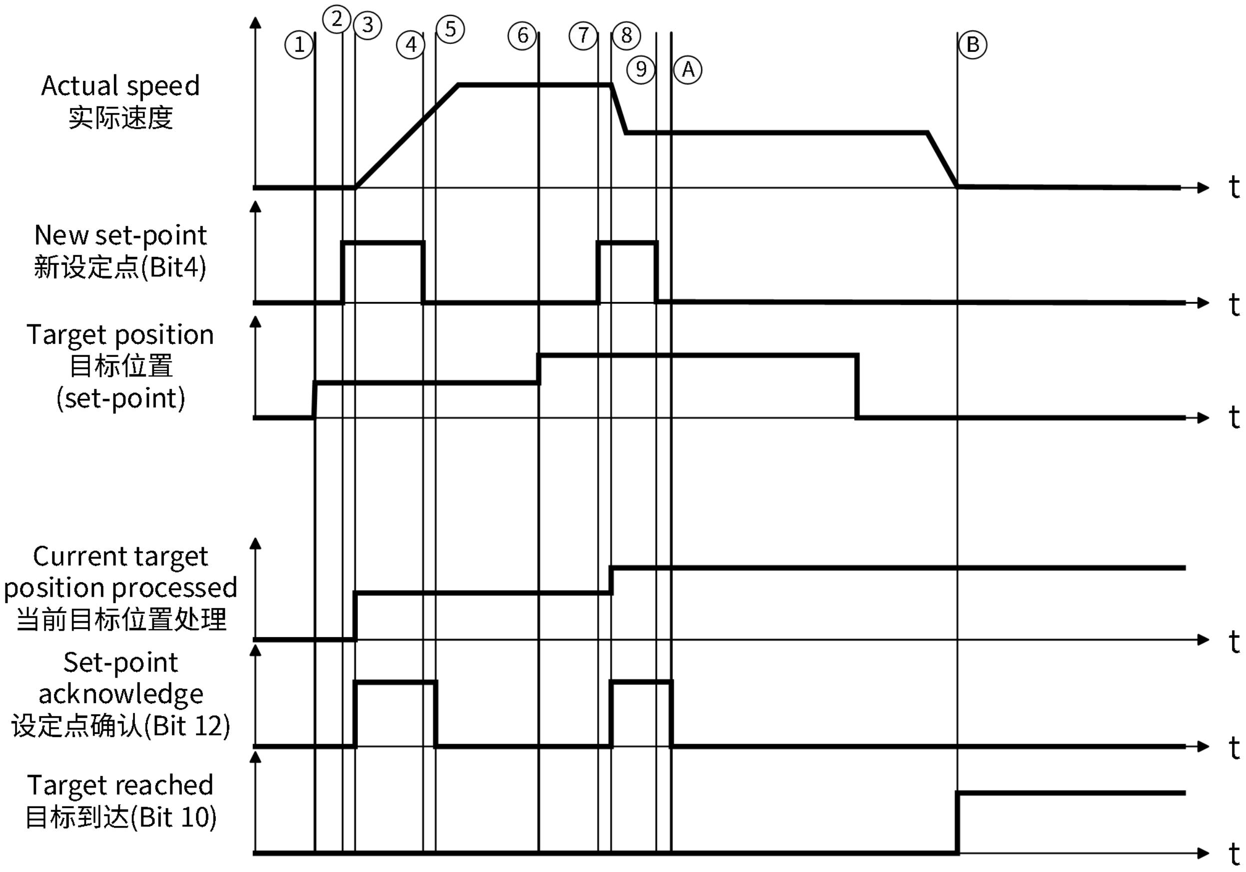


Figure 3-67 PP mode Single set-Point (immediate update mode)

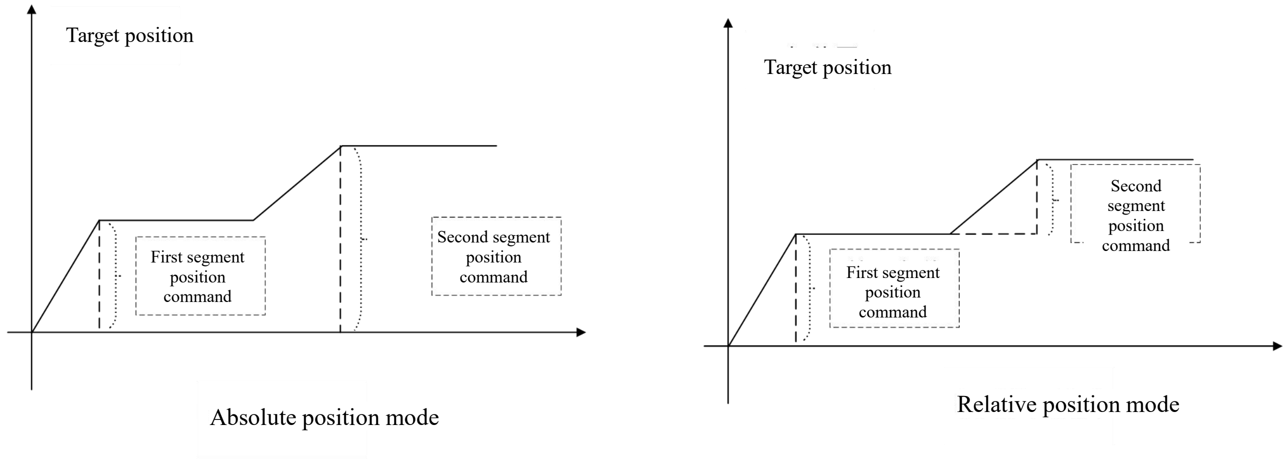
D) Case 4: Relative motion and absolute motion

CSP mode only supports absolute position commands, while PP mode supports both absolute and relative position commands.

Absolute position command: After receiving the position command, the servo drive will drive the motor to make the actual feedback position consistent with the target position. After positioning is completed, the actual position of the servo motor remains consistent with the target position.

Relative position command: After receiving the position command, the servo drive will drive the motor to make the actual position increment fed back by the motor consistent with the target position. After positioning is completed, the actual position of the servo motor doesn't need to be consistent with the target position.

Shown as in the following figure:



Absolute position mode

Relative position mode

Figure 3-68 PPSchematic diagram of the difference between relative motion and absolute motion

(7) Profile Velocity(PV)

In PV mode, the upper controller specifies target speed, profile acceleration, profile deceleration, etc., and the servo drive performs motor motion planning internally.

⚠ Note:

Min. communication cycle in PV mode is 500 μs;

When switching PV mode to other modes, perform ramp stop in any state, and after the stop is completed, it may switch to other modes.

Control block diagram

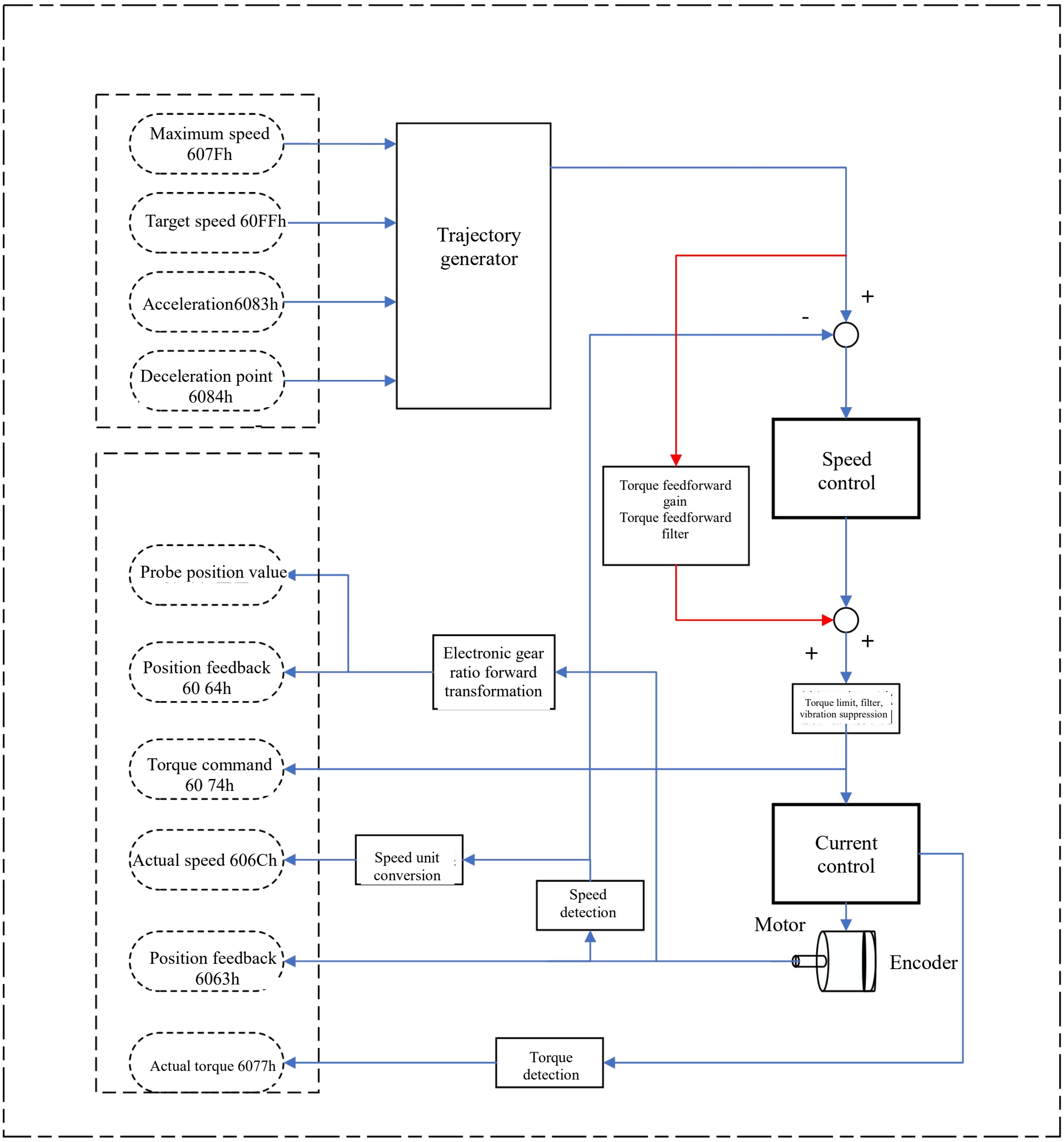


Figure 3-69 Control Block Diagram of Profile Velocity(PV)

Related object (instruction * setting class)

Note: For detailed instructions on related objects, see Chapter 6 Object Dictionary.

Common object:

Table 3-57 0x6040- Control word

0x6040- Control word

<table>
<tr><td>Index - Subindex</td><td>0x6040-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>In CSP mode, only absolute position instruction is supported
Mode correlation: Bit0 to Bit3 are 1, indicating that the system is started
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Servo is ready</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>1</td><td>Switch on the main circuit</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>2</td><td>Fast stop</td><td>Setting mode: 0-valid, 1-invalid</td></tr>
<tr><td>3</td><td>Servo operation</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>8</td><td>Pause</td><td>0: invalid.
1: The servo is set pause by 605Dh.</td></tr>
</table></td></tr>
</table>

58Table 3-58 0x6040- Control word

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	-	0~65535	UINT16	RW	RxPDO
6060	00	Servo mode selection	-	0~10	INT8	RW	RxPDO
607F	00	Max. profile velocity	Instruction unit /s	0~(2^{32}-1)	UINT32	RW	RxPDO
60FF	00	Target speed	Instruction unit /s	-2^{31}~(2^{31}-1)	INT32	RW	RxPDO
60E0	00	Forward torque limit	0.1%	0~5000	UINT16	RW	RxPDO
60E1	00	Reverse torque limit	0.1%	0~5000	UINT16	RW	RxPDO
2006	01	Velocity proportional gain 1	0.1Hz	1~20000	UINT16	RW	-
	02	Velocity integral gain 1	0.01ms	15~51200	UINT16	RW	-
	0A	Torque feedforward proportional gain	0.1%	0~2000	UINT16	RW	-
2007	03	Torque filtering 1	0.01ms	0~3000	UINT16	RW	-
	08	Torque feedforward filtering time	0.01ms	0~6400	UINT16	RW	-

Related objects (status * monitor class)

Table 3-59 0x6041- Status word

0x6041- Status word	
Index - Subindex	0x6041-00
Data type	UINT16
Accessibility	Readable
Unit	-
DeError value	0
Min.	0

<table>
<tr><th>Max.</th><td>65535</td></tr>
<tr><th>Setting and effective mode</th><td>-</td></tr>
<tr><th>Related mode</th><td>PST</td></tr>
<tr><th>Note</th><td>Reactive servo state
For mode:
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>10</td><td>Target speed arrival</td><td>Status display: 1- Arrived, 0- not arrived</td></tr>
<tr><td>11</td><td>The software internal position overrun</td><td>Status display: 1- overrun, 0- not overrun</td></tr>
<tr><td>15</td><td>The origin return to zero is complete</td><td>Status display: 1- completed, 0- not completed</td></tr>
</table>
</td></tr>
</table>

60Table 3-60 Objects related to state monitoring in PV mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
603F	00	Error code	-	0~65535	UINT16	RO	TxPDO
6041	00	Status word	-	0~65535	UINT16	RO	TxPDO
6061	00	Run mode display	-	0~10	INT8	RO	TxPDO
6063	00	Position feedback	Encoder unit	-	INT32	RO	TxPDO
6064	00	Position feedback	Instruction unit	-	INT32	RO	TxPDO
606C	00	Actual velocity	Instruction unit /s	-	INT32	RO	TxPDO
6077	00	Actual torque	0.1%	-5000~5000	INT16	RO	TxPDO

Related function Settings

A) Speed limit

The speed limit is determined by the smaller value of 607Fh and Max. motor speed;

Table 3-61 Objects related to speed limit in PV mode

Index	Subindex	Name	Setting range
607F	00	Max. speed	0-(2^{32}-1)

B) Speed arrival function

If the difference between target speed and actual speed is within a certain threshold and maintained for a period, the speed reaches DO valid and Bit10=1 of status word 6041.

Related object parameters are shown in the following table:

62Table 3-62 Objects related to speed arrival function in PV mode

Index	Subindex	Name	Setting range
606D	00	the threshold of speed arrival	0~65535
606E	00	Speed arrives window time	0~65535

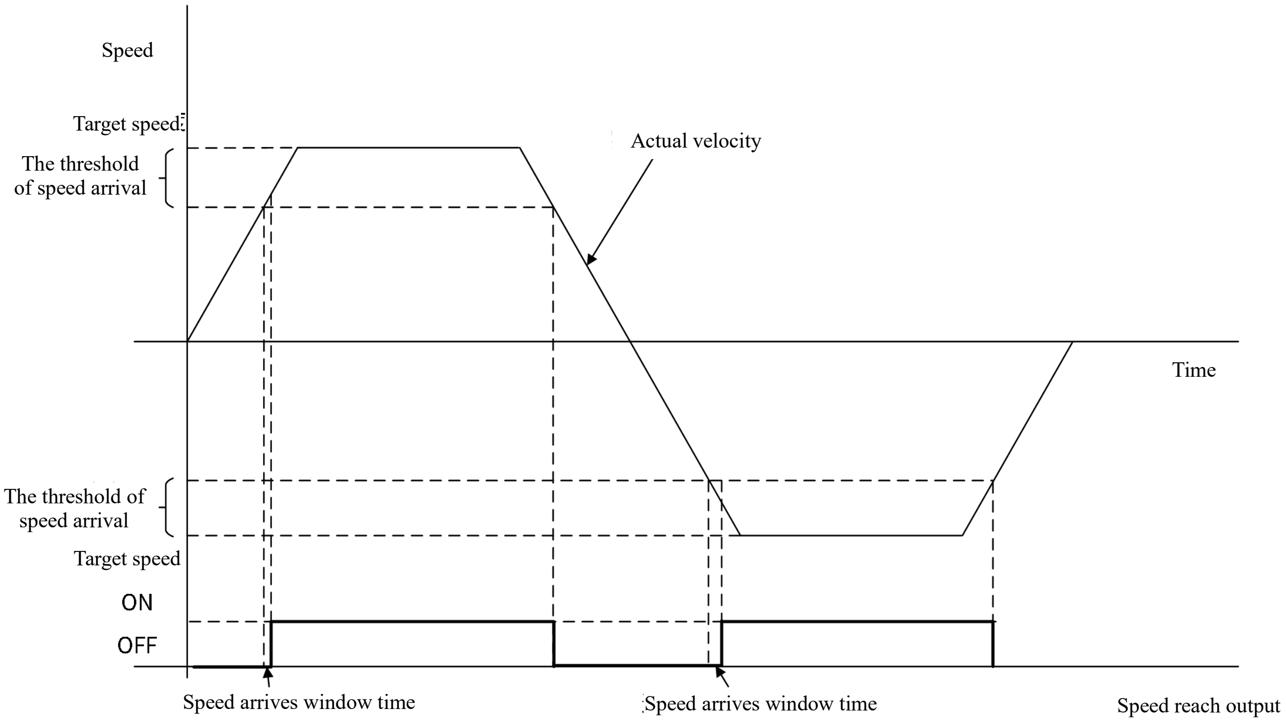


Figure 3-70 Schematic diagram of speed arrival in PV mode

(8) Profile Torque(PT)

In PT mode, upper controller specifies the target torque, torque slope, etc. Motor motion planning is performed inside servo drive.

⚠ Note:

Min. communication cycle in PT mode is 125μs;

When PT mode is switched to others, perform ramp stop in any state. After the stop is completed, it can switch to other modes;

In CST mode, the speed will enter the speed control when it reaches the limit.

Control block diagram

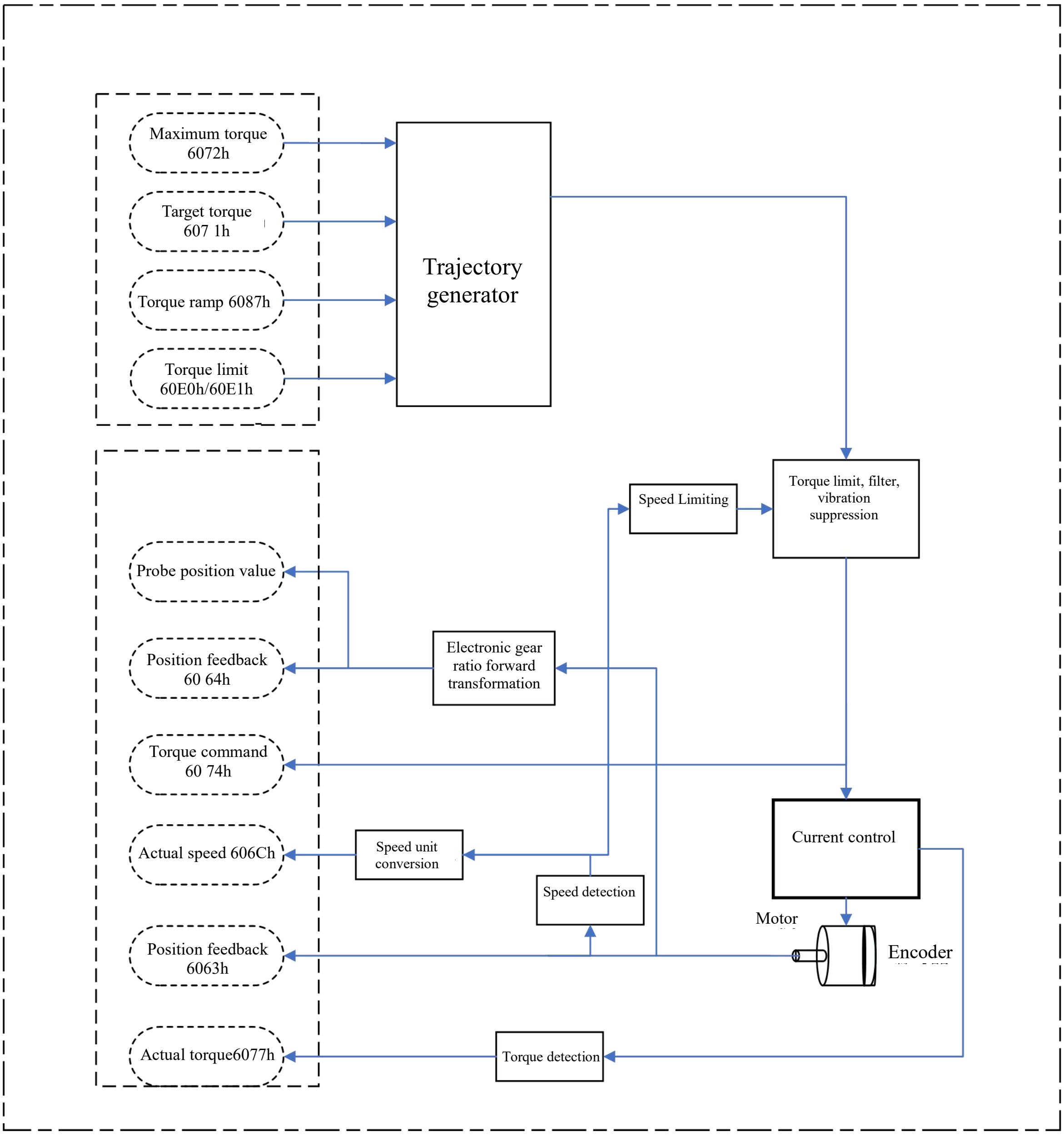


Figure 3-71 Control Block Diagram of Profile Torque(PT)

Related object (instruction * setting class)

Note: For detailed instructions on related objects, see Chapter 6 Object Dictionary.

Common object:

Table 3-63 0x6040- Control word

<table>
<tr><th colspan="2">0x6040- Control word</th></tr>
<tr><td>Index - Subindex</td><td>0x6040-00</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>In CSP mode, only absolute position instruction is supported
Mode correlation: Bit0 to Bit3 are 1, indicating that the system is started
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Servo is ready</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>1</td><td>Switch on the main circuit</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>2</td><td>Fast stop</td><td>Setting mode: 0-valid, 1-invalid</td></tr>
<tr><td>3</td><td>Servo operation</td><td>Setting mode: 1-valid, 0-invalid</td></tr>
<tr><td>8</td><td>Pause</td><td>0: invalid.
1: The servo is set pause by 605Dh.</td></tr>
</table></td></tr>
</table>

Table 3-64 Objects related to instruction settings in PT mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	-	0~65535	UINT16	RW	RxPDO
6060	00	Servo mode selection	-	0~10	INT8	RW	RxPDO
6071	00	Target torque	0.1%	-5000~5000	INT16	RW	RxPDO
6072	00	Max. torque	0.1%	0~5000	UINT16	RW	RxPDO
607F	00	Max. profile velocity	Instruction unit /s	0~(2^{32}-1)	UINT32	RW	RxPDO
6087	00	Torque ramp	0.1%/s	0~(2^{32}-1)	UDINT32	RW	RxPDO
2007	03	Torque filtering 1	0.01ms	0~3000	UINT16	RW	-

Related objects (status * monitor class)

Table 3-65 0x6041- Status words

0x6041- Status word	
Index - Subindex	0x6041-00
Data type	UINT16
Accessibility	Readable
Unit	-
DeError value	0
Min.	0
Max.	65535
Setting and effective mode	-

Related mode	ALL
Note	Reactive servo state For mode: <table><tr><th>Bit</th><th>Name</th><th>Description</th></tr><tr><td>10</td><td>Target torque arrival</td><td>Status display: 1- Arrived, 0- not arrived</td></tr><tr><td>11</td><td>The software internal position overrun</td><td>Status display: 1- overrun, 0- not overrun</td></tr><tr><td>15</td><td>The origin return to zero is complete</td><td>Status display: 1- completed, 0- not completed</td></tr></table>

Table 3-66 Objects related to status monitoring in PT mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
603F	00	Error code	-	0~65535	UINT16	RO	TxPDO
6041	00	Status word	-	0~65535	UINT16	RO	TxPDO
6061	00	Run mode display	-	0~10	INT8	RO	TxPDO
606C	00	Actual velocity	Instruction unit /s	-	INT32	RO	TxPDO
6074	00	Torque command	0.1%	-	INT16	RO	TxPDO
6077	00	Actual torque	0.1%	-	INT16	RO	TxPDO

Related function Settings

A) Speed limit

Speed limit in PT mode is set by 2007-12h.

Table 3-67 Objects related to speed limit in PT mode

<table>
<tr><th colspan="2">P15.03- Speed limit source selection</th></tr>
<tr><td>Index - Subindex</td><td>0x2015-04</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>1</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>65535</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>
<table>
<tr><th>Settings</th><th colspan="2">Description</th></tr>
<tr><td>0</td><td>Internal speed limit</td><td>Forward speed limit: P15.05
Reverse speed limit: P15.06</td></tr>
<tr><td>1</td><td>EtherCAT External speed limits</td><td>Forward speed limit: min{607Fh, P15.07}
Reverse speed limit: min{607Fh, P15.08}</td></tr>
<tr><td>2</td><td>Speed limiting is done in DI function 13</td><td>DI(Function 13) invalid: Forward/reverse speed is limited by P15.11
DI(Function 13) valid: Forward and reverse speed is limited by P15.12</td></tr>
</table>
</td></tr>
</table>

B) Torque arrival

When the difference between the torque and the reference is greater than P15.17 value, the valid arrival signal TOQREACH is output, and Bit10 of status word 6041 is set of 1. When the difference between the torque and the reference is less than P15.18 value, the output is invalid, and Bit10 of status word 6041 is cleared to zero.

Table 3-68 Objects related to PT mode torque arrival

Index	Subindex	Name	Setting range
2015	11	Reference value of torque arrival	0-3000 (unit 0.1%)
2015	12	Torque arrival valid value	0-3000 (unit 0.1%)
2015	13	Torque arrival invalid value	0-3000 (unit 0.1%)

C) Torque limit

Torque limit is the maximum limit of the servo output torque, applicable to position/speed/torque modes.

Table 3-69 P15.03 torque limit source selection

P15.03 Torque limit source selection	
Index - Subindex	0x2015-04
Data type	UINT16
Accessibility	Readable/writable
Unit	1
DeError value	2
Min.	0

<table>
<tr><td>Max.</td><td>4</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>Torque limiting source selection
<table>
<tr><th>Settings</th><th>Description</th></tr>
<tr><td>0</td><td>Forward internal torque limit: P15.05
Reverse internal torque limit: P15.06</td></tr>
<tr><td>1</td><td>Positive external torque limit:
When P-CL is valid: P15.07
When P-CL is invalid: P15.05
Reverse external torque limit:
When N-CL is valid: P15.08
When N-CL is invalid: P15.06</td></tr>
<tr><td>2</td><td>Forward torque limit: Min. in 6072h and 60E0h
Reverse torque limit: Min. in 6072h, 60E1h</td></tr>
<tr><td>3</td><td>Forward torque limit:
When P-CL is valid: Min. in P15.07, 6072h, 60E0h
When P-CL is invalid: Min. in 6072h and 60E0h
Reverse torque limit:
N-CL valid: Min. in P15.08, 6072h, 60E1h
When N-CL is invalid: Min. in 6072h and 60E1h</td></tr>
<tr><td>4</td><td>Forward torque limit:
When P-CL is valid: Min. in 6072h and 60E0h
When P-CL is invalid: P15.05
Reverse torque limit:
When N-CL is valid: Min. in 6072h and 60E1h
When N-CL is invalid: P15.06</td></tr>
</table>
</td></tr>
</table>

(9) Home Mode (HM)

HM refers to the operating mode in which the servo drive performs mechanical origin positioning upon external signal, at the given action speed.

After returning to zero, actual position feedback of motor = 607Ch (origin bias);

The mechanical origin can correspond to the origin switch signal, forward/reverse limit switch, and Z signal of motor ;

There are various mechanical zeroing methods. If it is impossible to disconnect mechanical connection between motor and the equipment in actual application, please refer to "Introduction to Zeroing Methods" to choose the appropriate zeroing method, avoid the equipment damage; If the upper controller is used to return-to-zero, the reset methods in this Chapter will not be applicable. Please refer to the relevant zeroing introduction of the upper controller;

When the servo is in return-to-zero mode and running, it can't switch to other modes; When return-to-zero is completed or interrupted (Error or disabled), it can switch to other modes;

Please pay attention to the distance between limit switch and the forward/reverse limit switches; They should not be too close, and appropriate acceleration should be set. Otherwise, it might cause collision!

Control block diagram

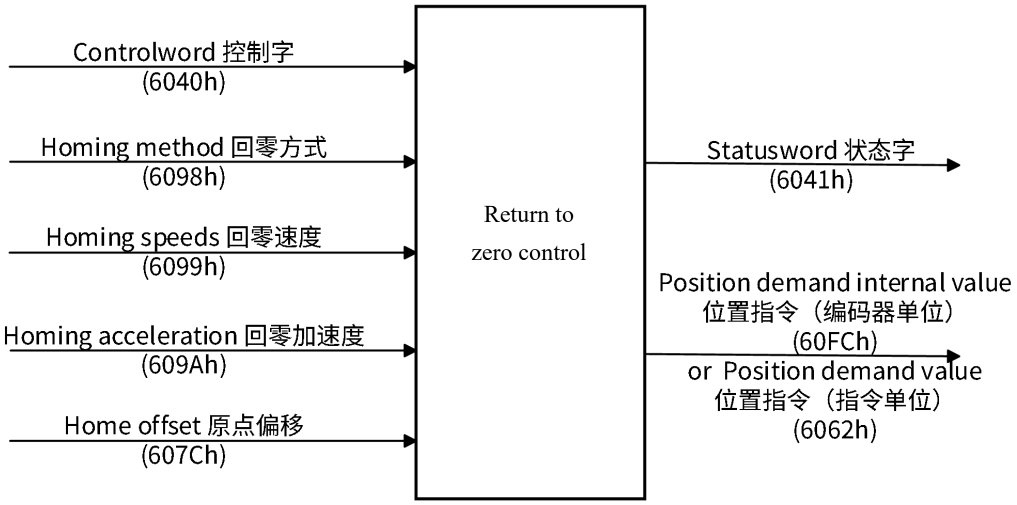


Figure 3-72 HM control block diagram

Related object (instruction * setting class)

Note: For detailed instructions on related objects, see Chapter 6 Object Dictionary.
Common object:

Table 3-70 0x6040- Control word

0x6040- Control word	
Index - Subindex	0x6040-00
Data type	UINT16
Accessibility	Readable/writable
Unit	-
DeError value	0
Min.	0
Max.	65535
Setting and effective mode	Operation settings/downtime effective
Related mode	ALL
Note	In CSP mode, only absolute position instruction is supported

	Mode correlation: Bit0 to Bit3 are 1, indicating that the system is started

Bit	Name	Description
0	Servo is ready	Setting mode: 1-valid, 0-invalid
1	Switch on the main circuit	Setting mode: 1-valid, 0-invalid
2	Fast stop	Setting mode: 0-valid, 1-invalid
3	Servo operation	Setting mode: 1-valid, 0-invalid
4	Start HM	Start HM: rising edge End HM: falling edge HM in progress: constant as 1
8	Pause	0: invalid. 1: The servo is set pause by 605Dh.

Table 3-71 Objects related to instruction setting in HM mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
6040	00	Control word	-	0~65535	UINT16	RW	RxPDO
6060	00	Servo mode selection	-	0~10	INT8	RW	RxPDO
6067	00	Threshold of position arrival	Encoder unit	0~65535	UINT32	RW	RxPDO
6068	00	Position arrival window	ms	0~65535	UINT16	RW	RxPDO
6098	00	Origin return method	-	-2~35	INT8	RW	RxPDO
6099	01	Deceleration point of high-speed search	Instruction unit /s	0~(2^{32}-1)	UINT32	RW	RxPDO
	02	Search origin low speed	Instruction unit /s	10~(2^{32}-1)	UINT32	RW	RxPDO
609A	00	acceleration	Instruction unit /s^2	0~(2^{32}-1)	UDINT32	RW	RxPDO
2013	32	Timeout period	10ms	100~65535	UINT16	RW	-

Related objects (status * monitor class)

Table 3-72 0x6041- Status word

0x6041- Status word	
Index - Subindex	0x6041-00
Data type	UINT16
Accessibility	Readable
Unit	-
DeError value	0
Min.	0
Max.	65535
Setting and effective mode	-
Related mode	ALL
Note	Reactive servo state For mode:

Bit	Name	Description

	10	Target position arrival	Status display: 1- Arrived, 0- not arrived
	12	HM end	Status: 1- Succeeded, 0- failed
	13	HM error	Status: 1- Error, 0- No error
	15	The origin return to zero is complete	Status display: 1- completed, 0- not completed

Table 3-73 Objects related to status monitoring in HM mode

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
603F	00	Error code	-	0~65535	UINT16	RO	TxPDO
6041	00	Status word	-	0~65535	UINT16	RO	TxPDO
6061	00	Run mode display	-	0~10	INT8	RO	TxPDO
6062	00	Actual position	Instruction unit	-	INT32	RO	TxPDO
6064	00	Position feedback	Instruction unit	-	INT32	RO	TxPDO
6077	00	Actual torque	0.1%	-5000~5000	INT16	RO	TxPDO
606C	00	Actual velocity	Instruction unit /s	-	INT32	RO	TxPDO
60F4	00	Position deviation	Instruction unit	-	UINT16	RO	TxPDO

Related function Settings

A) HM time limit

The zeroing time limit in zeroing mode is set by P13.49. If zeroing is uncompleted within this period, Alarm of zero return timeout (A.425) will be reported.

Table 3-74 Objects related to the time limit for the origin return

Index	Subindex	Name	Setting range
2013	32	Zero return timeout	0~65535 (unit: 10ms)

B) Calculation methods for position after zeroing completion

After the zero return mode is completed, the servo motor position is the mechanical origin, and the position feedback can be set of different calculation methods by 60E6h, as shown in the below table. Different calculation methods are applicable to different industrial machinery.

Table 3-75 0x60E6- Position Calculation Method

<table>
<tr><th colspan="2">0x60E6- Position calculation method</th></tr>
<tr><td>Index - Subindex</td><td>0x60E6-00</td></tr>
<tr><td>Data type</td><td>UINT8</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>1</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>1</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>HM</td></tr>
<tr><td>Note</td><td><table><tr><th>Settings</th><th>Description</th></tr><tr><td>0</td><td>After return to zero is completed, actual feedback value of the origin position is the original bias 607C</td></tr><tr><td>1</td><td>After return to zero is completed, actual feedback value of the origin position is the original position feedback 6064 + the origin bias 607C</td></tr></table></td></tr>
</table>

Introduction on Zero Return Method

Zero Return Speed Setting

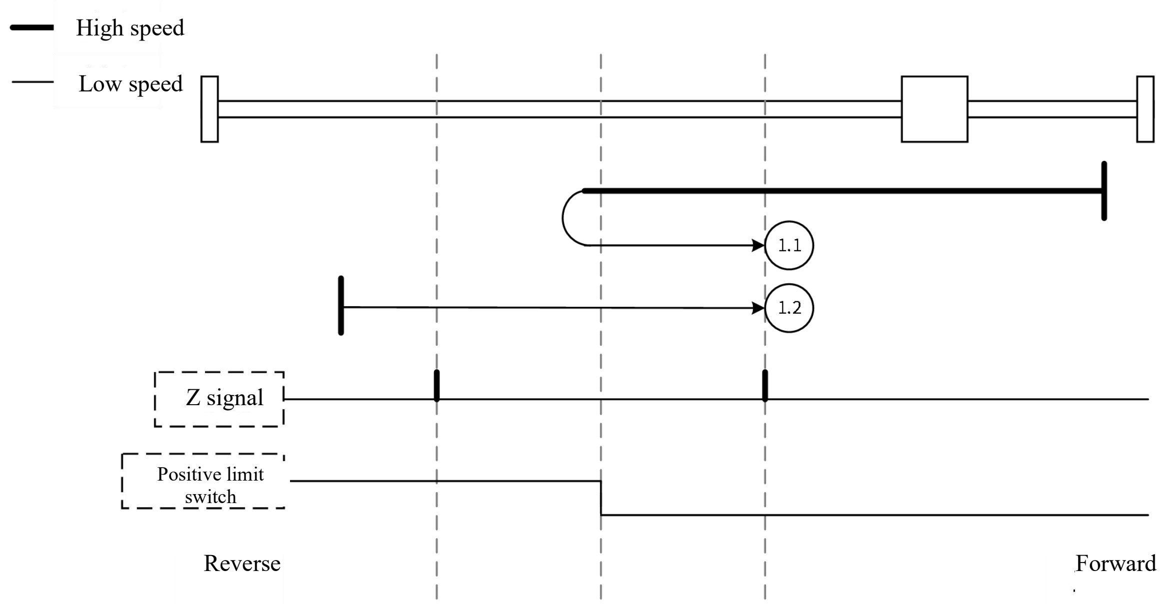
Table 3-76 Objects related to Zero Return Speed Setting

Index	Subindex	Name	Setting range
6099	01h	Deceleration point of high-speed search	0~(2^{32}-1)
	02h	Low-speed search for the origin	0~(2^{32}-1)

Note: In the following action description, high-speed operation refers to running at the speed set by 6099-01h, while low-speed operation refers to running at the speed set by 6099-02h. It can be understood as follows: high-speed operation searches for the deceleration point, after finding the deceleration point, low-speed operation searches for the origin.

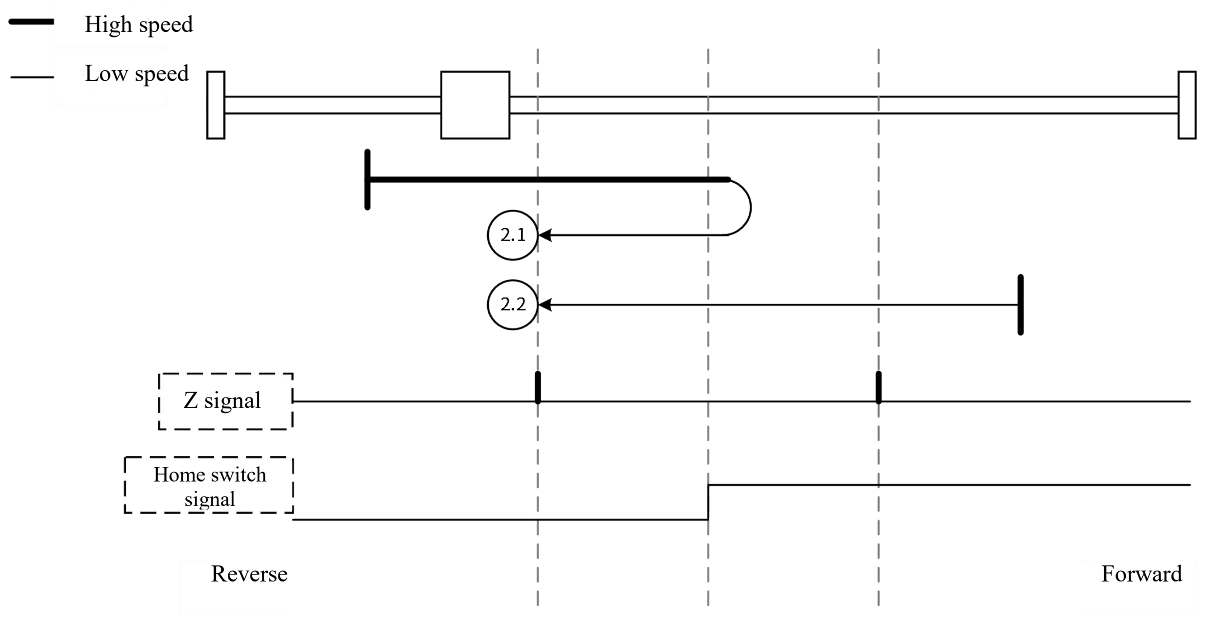
I) Method 1:

Table 3-77 Origin return mode 1

movement Block diagram		
Positioning signal	**Origin**	**Decelerating point**
	Z-phase signal	Negative limit switch
Method 1	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	1.1 - Deceleration point is invalid when returning to zero	While start zero return, run at the reverse high speed. When encountering the rising edge of reverse limit signal, run at the forward low speed. When encountering the first Z-phase signal after the falling edge of reverse limit signal, stop running
	1.2- Deceleration point is valid when returning to zero	While start zero return, directly start the forward low-speed return to zero, and stop running when encountering the first Z-phase signal after the falling edge of reverse limit signal

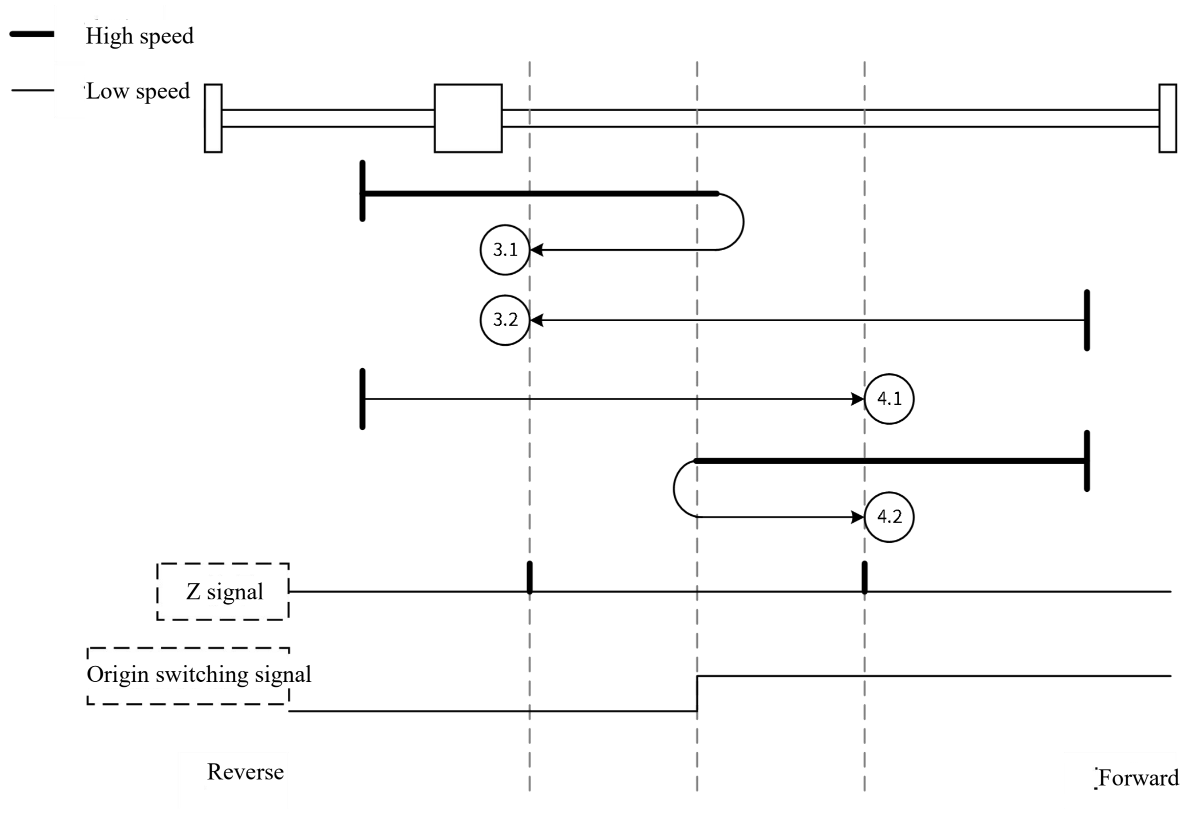
II) Method 2:

Table 3-78 Origin return mode 2

<table>
<tr><td>movement Block diagram</td><td colspan="2">
</td></tr>
<tr><td rowspan="2">Positioning signal</td><td>Origin</td><td>Decelerating point</td></tr>
<tr><td>Z-phase signal</td><td>Forward limit switch</td></tr>
<tr><td rowspan="5">Mode 2</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Note: different actions in different initial conditions</td></tr>
<tr><td>Initial condition</td><td>Return to zero action</td></tr>
<tr><td>2.1 - Deceleration point is invalid when returning to zero</td><td>While start zero return, run at the forward high speed. When encountering the rising edge of forward limit signal, run at the reverse low speed. When encountering the first Z-phase signal after the falling edge of forward limit signal, stop running</td></tr>
<tr><td>2.2- Deceleration point is valid when returning to zero</td><td>While start zero return, directly start the reverse low-speed return to zero, and stop running when encountering the first Z-phase signal after the falling edge of forward limit signal</td></tr>
</table>

III) Methods 3 to 4:

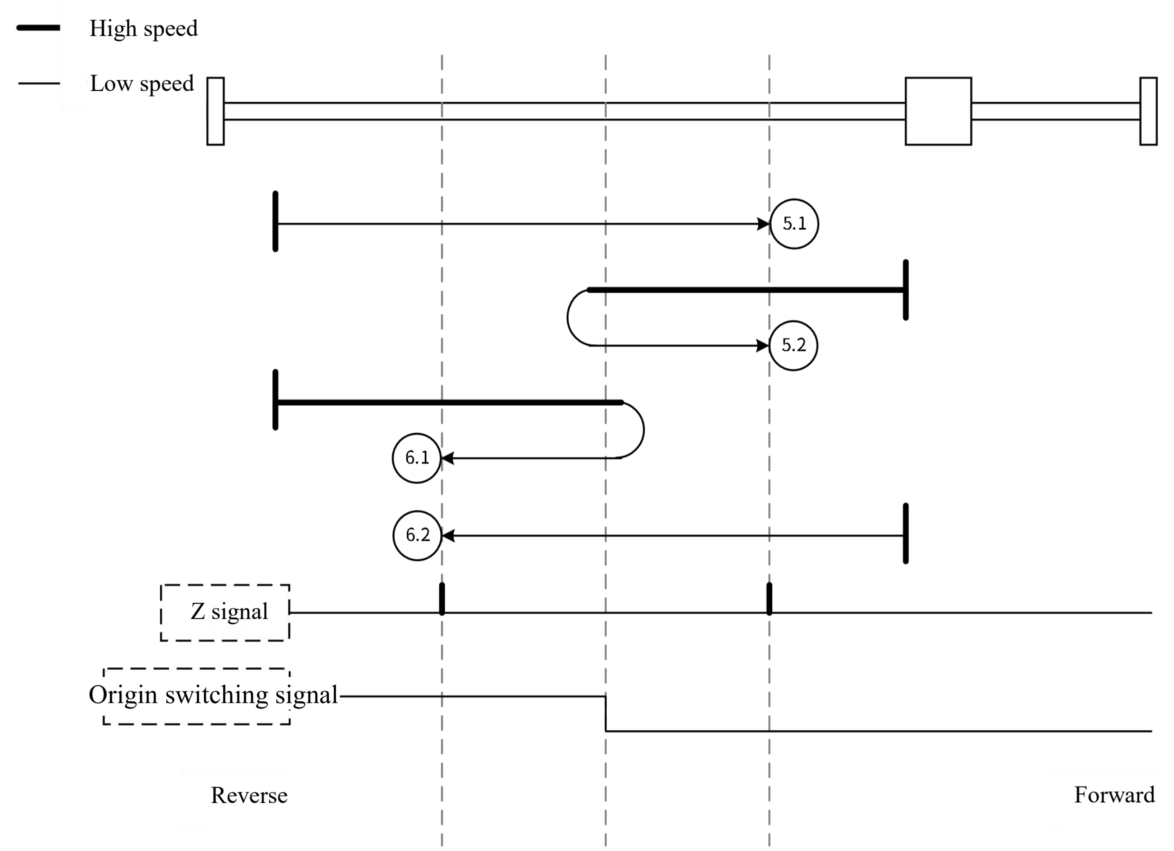
Table 3-79 Origin return modes 3 to 4

Motion block diagram		
Positioning signal	**Origin**	**Decelerating point**
	Z-phase signal	Origin switching signal
Mode 3	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	3.1 - Deceleration point is invalid when returning to zero	While start zero return, run at the forward high speed. When encountering the rising edge of the original switch signal, run at the reverse low speed. When encountering the first Z-phase signal after the falling edge of the original switch signal, stop running
	3.2- Deceleration point is valid when returning to zero	While start zero return, directly start the reverse low-speed return to zero, and stop running when encountering the first Z-phase signal after the falling edge of the original switch signal, stop running
Method 4	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	4.1- Deceleration point is invalid when returning to zero	While start zero return, run at the forward low speed. When encountering the first Z-phase signal after the rising edge of the original switch signal, stop running
	4.2- Deceleration point is valid when returning to zero	While start zero return, run at the reverse high speed. When encountering the falling edge of the original switch signal, run at the forward low speed. When encountering the first Z-phase signal

		after the rising edge of the original switch signal, stop running

IV) Methods 5-6:

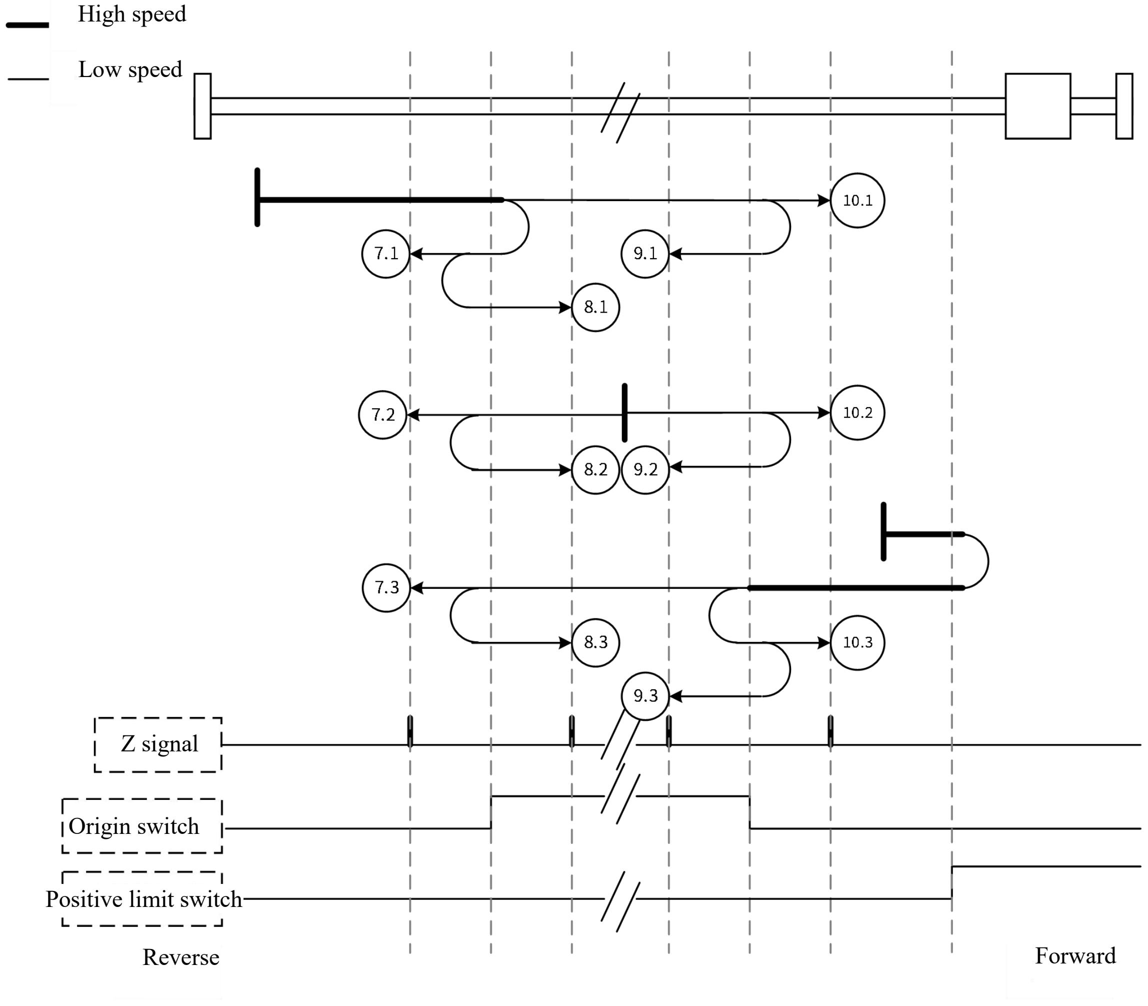
Table 3-80 Origin Return Modes 5-6

Motion block diagram		
Positioning signal	**Origin**	**Decelerating point**
	Z-phase signal	Origin switching signal
Method 5	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	5.1 - Zeroing deceleration point is valid	While start zeroing, directly start the forward low-speed zeroing and stop when the first Z-phase signal occurs after falling edge of the origin switch signal
	5.2 - Zeroing deceleration point is invalid	While start zeroing, run at the reverse high speed. When encountering rising edge of the origin switch signal, run at the forward low speed. Stop when the first Z-phase signal occurs after falling edge of the origin switch signal
Method 6	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	6.1- Zeroing deceleration point is valid	While start zeroing, run at the forward high speed. When encountering falling edge of the origin switch signal, run at the reverse low speed. Stop when the first Z-phase signal occurs after rising edge of the origin switch signal

	6.2- Zeroing deceleration point is invalid	While start zeroing, directly start the reverse low-speed zeroing and stop when the first Z-phase signal occurs after rising edge of the origin switch signal

V) Methods 7-10:

Table 3-81 Origin Return Modes 7-10

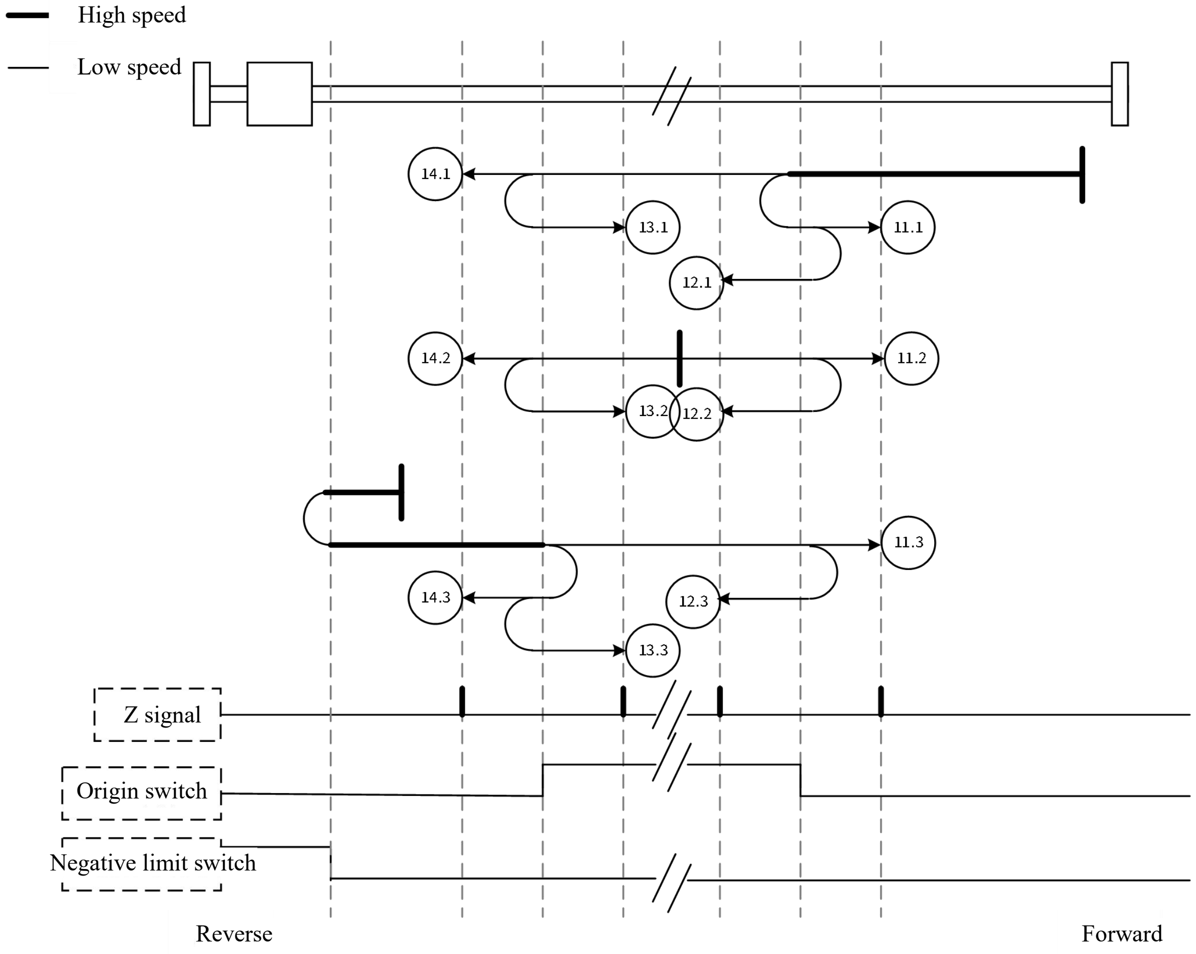
Motion block diagram		
Positioning signal	**Origin**	**Decelerating point**
	Z-phase signal	Origin switching signal
Method 7	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	7.1- Deceleration point is invalid upon zeroing, and no forward limit switch was encountered during the process	While start zero return, run at the forward high speed. When encountering the rising edge of the original switch signal, run at the reverse low speed. When encountering the first Z-phase signal after the falling edge of the original switch signal, stop running
	7.2- Deceleration point is valid upon zeroing	While start zero return, directly start the reverse low-speed return to zero, and stop running when encountering the first Z-phase signal after the falling edge of the original switch signal, stop

<table>
<tr><td></td><td></td><td>running</td></tr>
<tr><td></td><td>7.3- Deceleration point is invalid upon zeroing, and forward limit switch was encountered during the process</td><td>While start zeroing, run at the forward high speed. If encountering forward limit signal prior to the origin switch signal, run at the reverse high speed. Run at reverse low speed when encountering the rising edge of the original switch signal.When encountering the first Z-phase signal after falling edge of the origin switch signal,stop running.</td></tr>
<tr><td rowspan="6">Method 8</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Note: different actions in different initial conditions</td></tr>
<tr><td>Initial condition</td><td>Return to zero action</td></tr>
<tr><td>8.1- The deceleration point is invalid when returning to zero, and no forward limit switch was encountered in the process</td><td>While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the reverse low speed. Run at forward low speed when encountering falling edge of the original switch signal.When encountering the first Z-phase signal after rising edge of the origin switch signal,stop running.</td></tr>
<tr><td>8.2- The deceleration point is valid when returning to zero</td><td>While start zeroing, run at the reverse low speed. When encountering falling edge of the origin switch signal, run at the forward low speed. Stop when encountering the first Z-phase signal after rising edge of the origin switch signal</td></tr>
<tr><td>8.3- The deceleration point is invalid when returning to zero, and forward limit switch was encountered in the process</td><td>While start zeroing, run at the forward high speed. If encountering forward limit signal prior to the origin switch signal, run at the reverse high speed. Run at reverse low speed when encountering the rising edge of the original switch signal. Run at forward low speed when encountering the falling edge of the original switch signal. When encountering the first Z-phase signal after rising edge of the origin switch signal,stop running.</td></tr>
<tr><td rowspan="6">Method 9</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Note: different actions in different initial conditions</td></tr>
<tr><td>Initial condition</td><td>Return to zero action</td></tr>
<tr><td>9.1- The deceleration point is invalid when returning to zero, and no forward limit switch was encountered in the process</td><td>While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the forward low speed. When encountering falling edge of the original switch signal, run at the reverse low speed. Stop when encountering the first Z-phase signal after rising edge of the origin switch signal</td></tr>
<tr><td>9.2- Deceleration point is valid when returning to zero</td><td>While start zeroing, run at the forward low speed. When encountering falling edge of the origin switch signal, run at the reverse low speed. Stop when encountering the first Z-phase signal after rising edge of the origin switch signal</td></tr>
<tr><td>9.3- The deceleration point is invalid when returning to zero, and forward limit switch was encountered in the</td><td>While start zeroing, run at the forward high speed. If encountering forward limit signal prior to the origin switch signal, run at the reverse high speed. Run at forward low speed when encountering the rising edge of the original switch signal. Run at reverse low speed when encountering the falling edge of the original switch</td></tr>
</table>

<table>
<tr><td></td><td>process</td><td>signal. When encountering the first Z-phase signal after rising edge of the origin switch signal,stop running.</td></tr>
<tr><td rowspan="6">Method 10</td><th colspan="2">Action description</th></tr>
<tr><td colspan="2">Note: different actions in different initial conditions</td></tr>
<tr><th>Initial condition</th><th>Return to zero action</th></tr>
<tr><td>10.1- The deceleration point is invalid when returning to zero, and no forward limit switch was encountered in the process</td><td>While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the forward low speed. When encountering falling edge of the original switch signal, run at the forward low speed. Stop when encountering the first Z-phase signal after falling edge of the origin switch signal</td></tr>
<tr><td>10.2- Deceleration point is valid when returning to zero</td><td>While start zeroing, run at the forward low speed. When encountering falling edge of the origin switch signal, run at the forward low speed. Stop when encountering the first Z-phase signal after falling edge of the origin switch signal</td></tr>
<tr><td>10.3- The deceleration point is invalid when returning to zero, and forward limit switch was encountered in the process</td><td>While start zeroing, run at the forward high speed. If encountering forward limit signal prior to the origin switch signal, run at the reverse high speed. Run at forward low speed when encountering the rising edge of the original switch signal. Run at forward low speed when encountering the falling edge of the original switch signal. When encountering the first Z-phase signal after falling edge of the origin switch signal,stop running.</td></tr>
</table>

VI) Method 11 to 14:

Table 3-82 Origin return modes 11 to 14

<table>
<tr><td>Motion block diagram</td><td colspan="2"> </td></tr>
<tr><td rowspan="2">Positioning signal</td><th>Origin</th><th>Decelerating point</th></tr>
<tr><td>Z-phase signal</td><td>Origin switching signal</td></tr>
<tr><td rowspan="6">Method 11</td><th colspan="2">Action description</th></tr>
<tr><td colspan="2">Note: different actions in different initial conditions</td></tr>
<tr><th>Initial condition</th><th>Return to zero action</th></tr>
<tr><td>11.1- Deceleration point is invalid upon zeroing, and no forward limit switch was encountered during the process</td><td>While start zeroing, run at the reverse high speed. When encountering rising edge of the origin switch signal, run at the forward low speed. Stop when the first Z-phase signal occurs after falling edge of the origin switch signal</td></tr>
<tr><td>11.2- Deceleration point is valid upon zeroing</td><td>While start zeroing, directly start the forward low-speed zeroing and stop when the first Z-phase signal occurs after falling edge of the origin switch signal</td></tr>
<tr><td>11.3- Deceleration point is invalid upon zeroing, and reverse limit switch</td><td>While start zeroing, run at the reverse high speed. If encountering reverse limit signal prior to the origin switch signal, run at the forward high speed. Run at forward low speed when</td></tr>
</table>

	was encountered during the process	encountering the rising edge of the original switch signal. When encountering the first Z-phase signal after falling edge of the origin switch signal,stop running.
Method 12	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	12.1- Deceleration point is invalid upon zeroing, and no reverse limit switch was encountered during the process	While start zeroing, run at the reverse high speed. When encountering rising edge of the origin switch signal, run at the forward low speed. When encountering falling edge of the original switch signal, run at the reverse low speed. Stop when encountering the first Z-phase signal after rising edge of the origin switch signal
	12.2- Deceleration point is valid upon zeroing	While start zeroing, run at the forward low speed. When encountering falling edge of the origin switch signal, run at the reverse low speed. Stop when encountering the first Z-phase signal after rising edge of the origin switch signal
	12.3- Deceleration point is invalid upon zeroing, and reverse limit switch was encountered during the process	While start zeroing, run at the reverse high speed. If encountering reverse limit signal prior to the origin switch signal, run at the forward high speed. Run at forward low speed when encountering the rising edge of the original switch signal. Run at the reverse low speed when encountering the falling edge of the original switch signal. When encountering the first Z-phase signal after rising edge of the origin switch signal,stop running.
Method 13	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	13.1- Deceleration point is invalid upon zeroing, and no reverse limit switch was encountered during the process	While start zeroing, run at the reverse high speed. When encountering rising edge of the origin switch signal, run at the reverse low speed. When encountering falling edge of the original switch signal, run at the forward low speed. Stop when encountering the first Z-phase signal after rising edge of the origin switch signal
	13.2- Zero return deceleration point is valid upon zeroing	While start zeroing, run at the reverse low speed. When encountering falling edge of the origin switch signal, run at the forward low speed. Stop when encountering the first Z-phase signal after rising edge of the origin switch signal
	12.3- Deceleration point is invalid upon zeroing, and reverse limit switch was encountered during the process	While start zeroing, run at the reverse high speed. If encountering reverse limit signal prior to the origin switch signal, run at the forward high speed. Run at reverse low speed when encountering the rising edge of the original switch signal. Run at the forward low speed when encountering the falling edge of the original switch signal. When encountering the first Z-phase signal after rising edge of the origin switch signal,stop running.

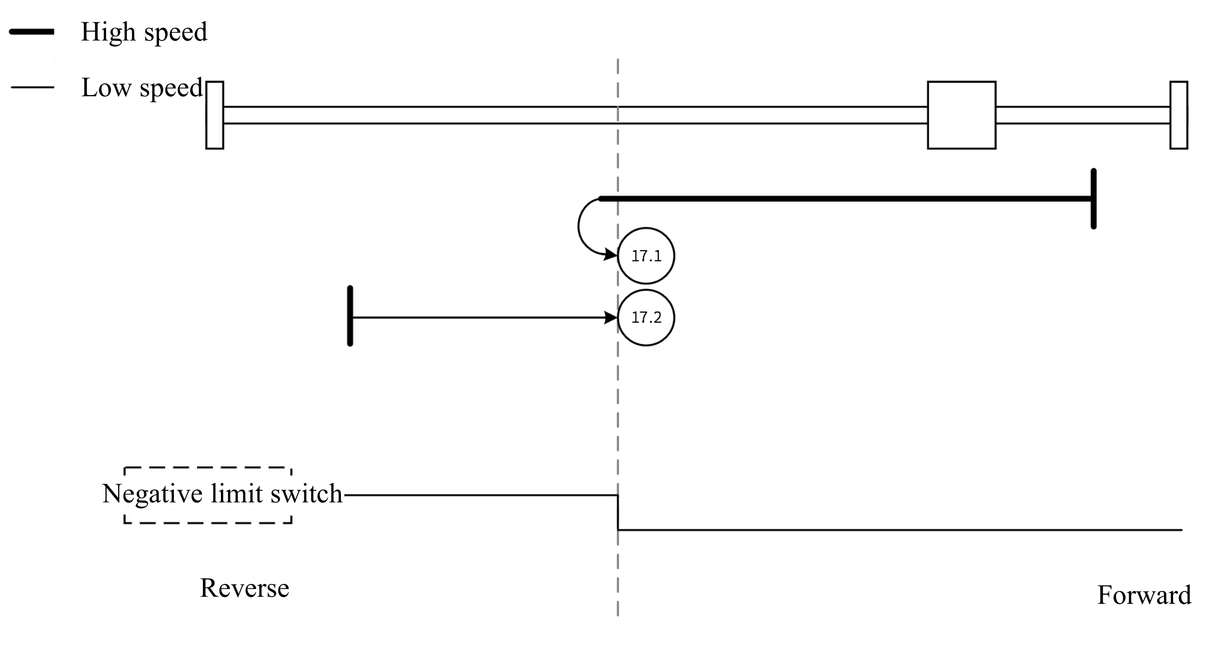
<table>
<tr><td rowspan="3">Method 14</td><th>Action description</th></tr>
<tr><td>Note: different actions in different initial conditions</td></tr>
<tr><td>
<table>
<tr><th>Initial condition</th><th>Return to zero action</th></tr>
<tr><td>14.1- Deceleration point is invalid upon zeroing, and no reverse limit switch was encountered during the process</td><td>While start zeroing, run at the reverse high speed. When encountering rising edge of the origin switch signal, run at the reverse low speed. When encountering falling edge of the original switch signal, run at the reverse low speed. Stop when encountering the first Z-phase signal after falling edge of the origin switch signal</td></tr>
<tr><td>14.2- Deceleration point is valid when returning to zero</td><td>While start zeroing, run at the reverse low speed. When encountering falling edge of the origin switch signal, run at the reverse low speed. Stop when encountering the first Z-phase signal after falling edge of the origin switch signal</td></tr>
<tr><td>14.3- The deceleration point is invalid when returning to zero, and forward limit switch was encountered in the process</td><td>While start zeroing, run at the reverse high speed. If encountering reverse limit signal prior to the origin switch signal, run at the forward high speed. Run at reverse low speed when encountering the rising edge of the original switch signal. Run at reverse low speed when encountering the falling edge of the original switch signal. When encountering the first Z-phase signal after falling edge of the origin switch signal,stop running.</td></tr>
</table>
</td></tr>
</table>

VII) Method 15-16: Reserved

Note that methods 17-30 are similar to methods 1-14, except that they no longer rely on the Z-phase signal as the origin, detailed methods as follows.

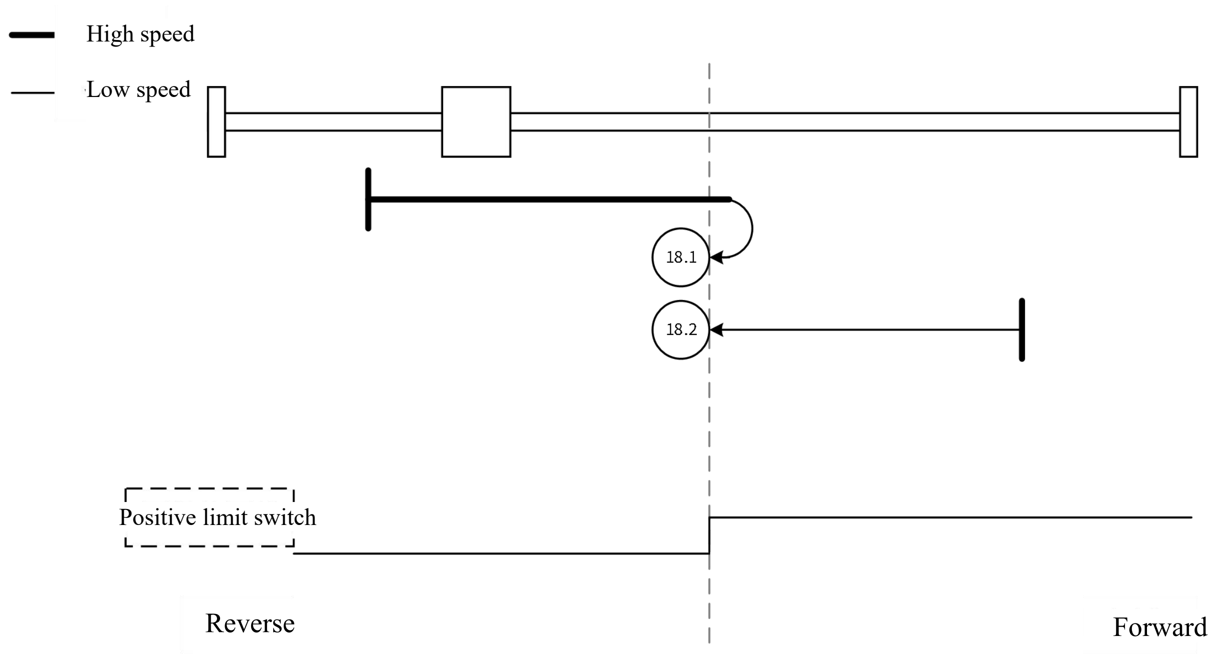
VIII) Method 17:

Table 3-83 Origin Return Mode 17

Motion block diagram		
Positioning signal	**Origin**	**Decelerating point**
	Negative limit switch	Negative limit switch
Method 17	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	17.1- Deceleration point is invalid when returning to zero	While start zeroing, run at the reverse high speed. When encountering rising edge of the reverse limit signal, run at the forward low speed. When encountering falling edge of the reverse limit signal, stop running.
	17.2- Deceleration point is valid when returning to zero	While start zeroing, directly start the forward low-speed zeroing and stop when encountering the falling edge of reverse limit signal.

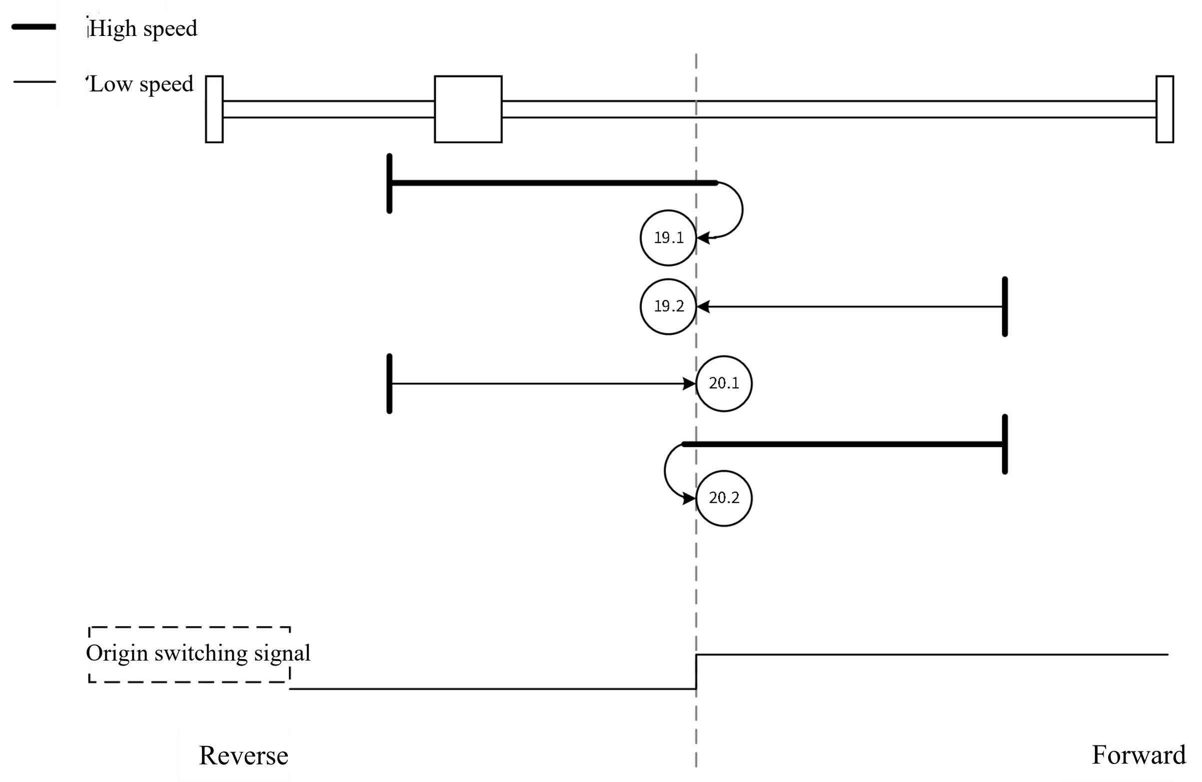
VIII) Method 18:

Table 3-84 Origin Return Mode 18

<table>
<tr><td>Motion block diagram</td><td colspan="2">
</td></tr>
<tr><td rowspan="2">Positioning signal</td><td>Origin</td><td>Decelerating point</td></tr>
<tr><td>Forward limit switch</td><td>Forward limit switch</td></tr>
<tr><td rowspan="5">Method 18</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Note: different actions in different initial conditions</td></tr>
<tr><td>Initial condition</td><td>Return to zero action</td></tr>
<tr><td>18.1- Deceleration point is invalid when returning to zero</td><td>While start zeroing, run at the forward high speed. When encountering rising edge of the forward limit signal, run at the reverse low speed. When encountering falling edge of the forward limit signal, stop running.</td></tr>
<tr><td>18.2- Deceleration point is valid when returning to zero</td><td>While start zeroing, directly start the reverse low-speed zeroing and stop when encountering the falling edge of forward limit signal.</td></tr>
</table>

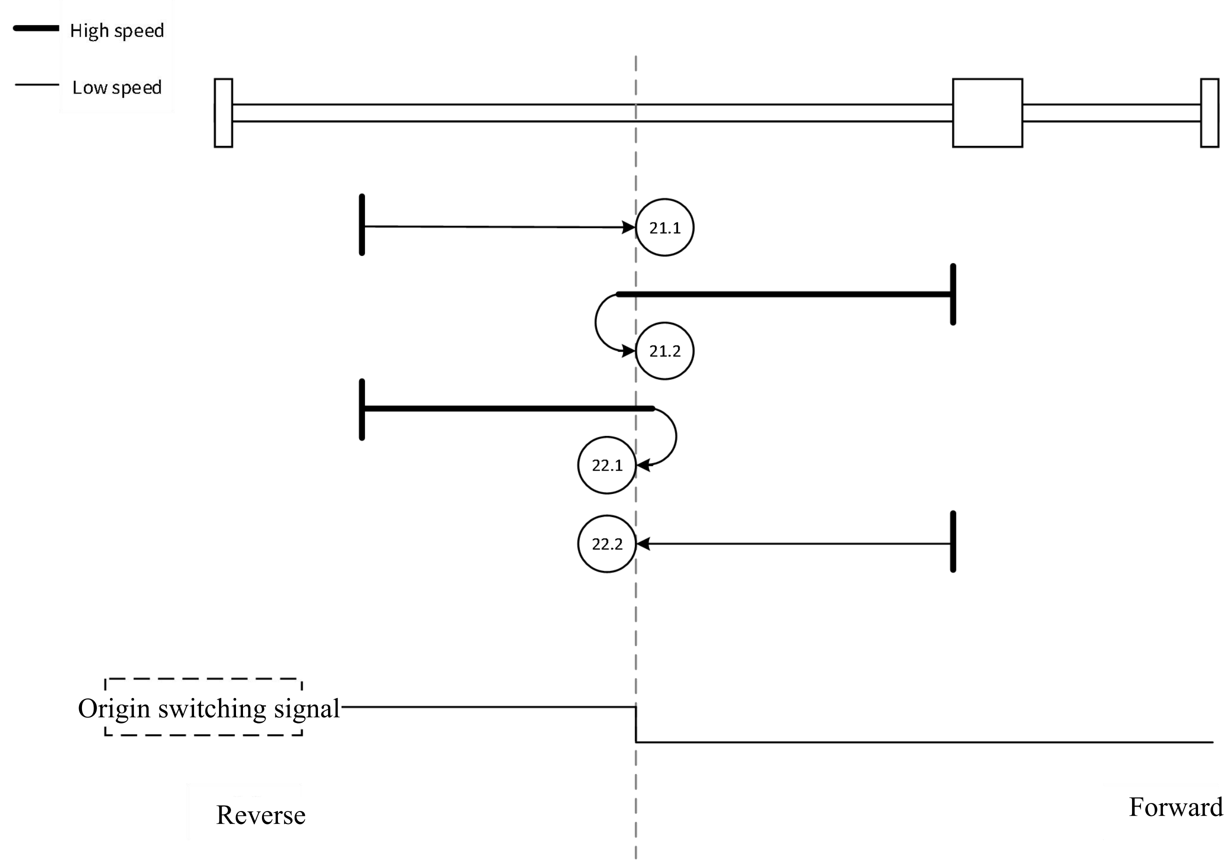
X)Method 19~20：

Table 3-85 Origin Return Method 19~20

<table>
<tr><td>Motion block diagram</td><td colspan="2">
</td></tr>
<tr><td>Positioning signal</td><td colspan="2"><table><tr><th>Origin</th><th>Decelerating point</th></tr><tr><td>Origin switching signal</td><td>Origin switching signal</td></tr></table></td></tr>
<tr><td rowspan="2">Method 19</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Note: different actions in different initial conditions<table><tr><th>Initial condition</th><th>Return to zero action</th></tr><tr><td>19.1- Deceleration point is invalid when returning to zero</td><td>While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the reverse low speed. When encountering falling edge of the origin switch signal, stop running.</td></tr><tr><td>19.2- Deceleration point is valid when returning to zero</td><td>While start zeroing, directly start the reverse low-speed zeroing and stop when encountering the falling edge of the origin switch signal.</td></tr></table></td></tr>
<tr><td rowspan="2">Method 20</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Note: different actions in different initial conditions<table><tr><th>Initial condition</th><th>Return to zero action</th></tr><tr><td>20.1- Deceleration point is invalid when returning to zero</td><td>While start zeroing, run at the forward low speed. When encountering rising edge of the origin switch signal, stop running.</td></tr><tr><td>20.2- Deceleration point is valid when returning to zero</td><td>While start zeroing, run at the reverse high speed zeroing and run at the forward low speed when encountering the falling edge of the origin switch signal.When encountering the rising edge of the origin switch signal, stop running.</td></tr></table></td></tr>
</table>

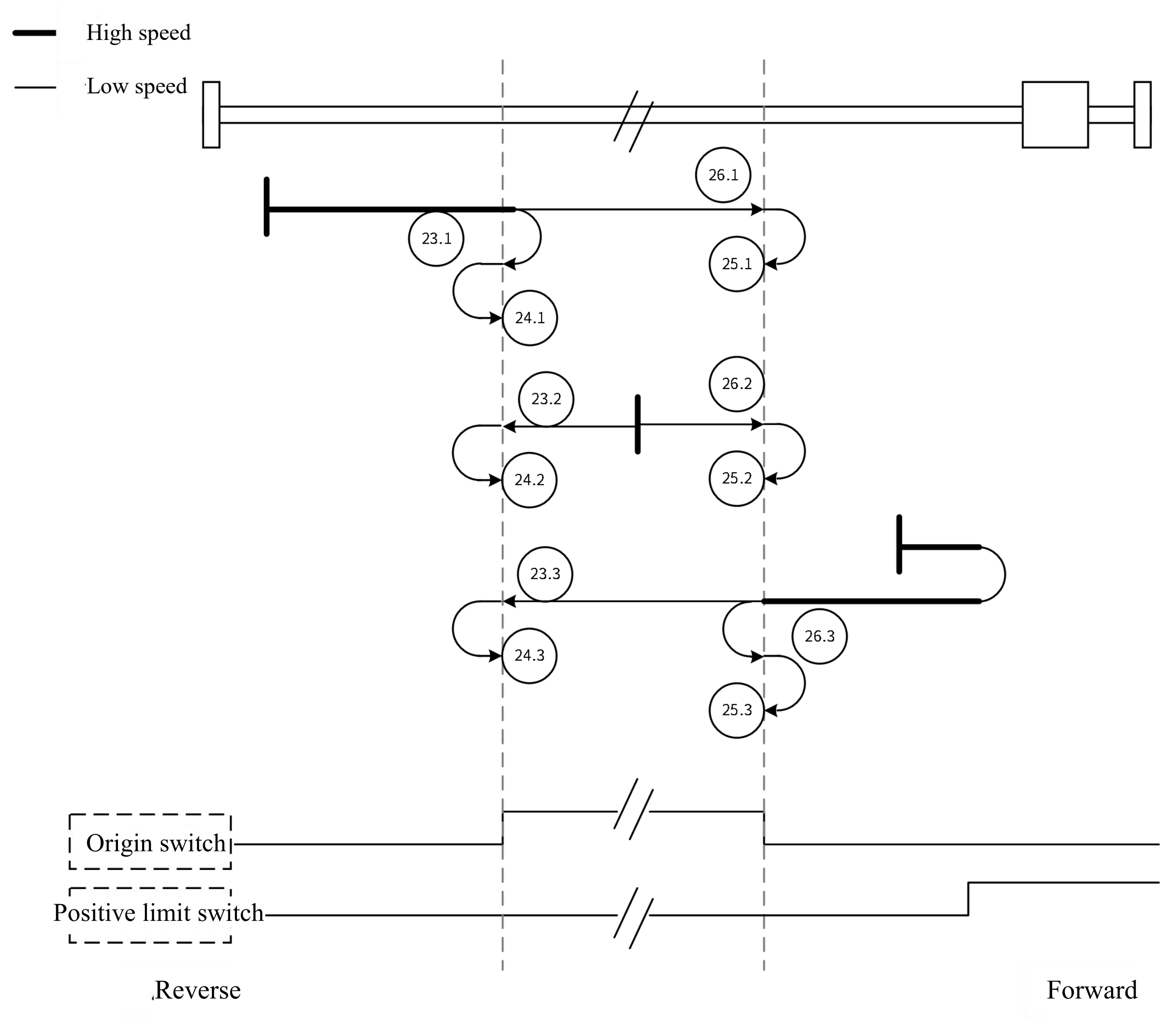
X)Method 21-22：

Table 3–86 Origin Return Method 21~22

Motion block diagram		
Positioning signal	**Origin**	**Decelerating point**
	Origin switching signal	Origin switching signal
Method 21	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	21.1- Deceleration point is valid when returning to zero	While start zeroing, directly start at the forward low speed. When encountering falling edge of the origin switch signal, stop running.
	21.2- Deceleration point is invalid when returning to zero	While start zeroing, run at the reverse high speed. When encountering the rising edge of the origin switch signal, run at the forward low speed. When encountering the falling edge of the origin switch signal, stop running..
Method 22	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	22.1- Deceleration point is valid when returning to zero	While start zeroing, run at the forward high speed. When encountering falling edge of the origin switch signal, run at the reverse low speed. When encountering rising edge of the origin switch signal, stop running.
	22.2- Deceleration point is invalid when returning to zero	While start zeroing, run at the reverse high speed. When encountering the rising edge of the origin switch signal, run at the forward low speed. When encountering the falling edge of the origin switch signal, stop running..

XII) Method 23-26:

Table 3-87 Origin Return Mode 23-26

movement Block diagram	

Positioning signal	**Origin**	**Decelerating point**
	Origin switching signal	Origin switching signal

Action description

Note: different actions in different initial conditions

	Initial condition	**Return to zero action**
Method 23	23.1- The deceleration point is invalid while returning to zero, and no forward limit switch was encountered during the process	While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the reverse low speed. When encountering falling edge of the origin switch signal, stop running.
	23.2- The deceleration point is valid when returning to zero	While start zeroing, directly start the reverse low-speed zeroing and stop when encountering the falling edge of the origin switch signal.
	23.3- The deceleration point is invalid when	While start zeroing, run at the forward high speed. When encountering the forward limit signal prior to the origin switch

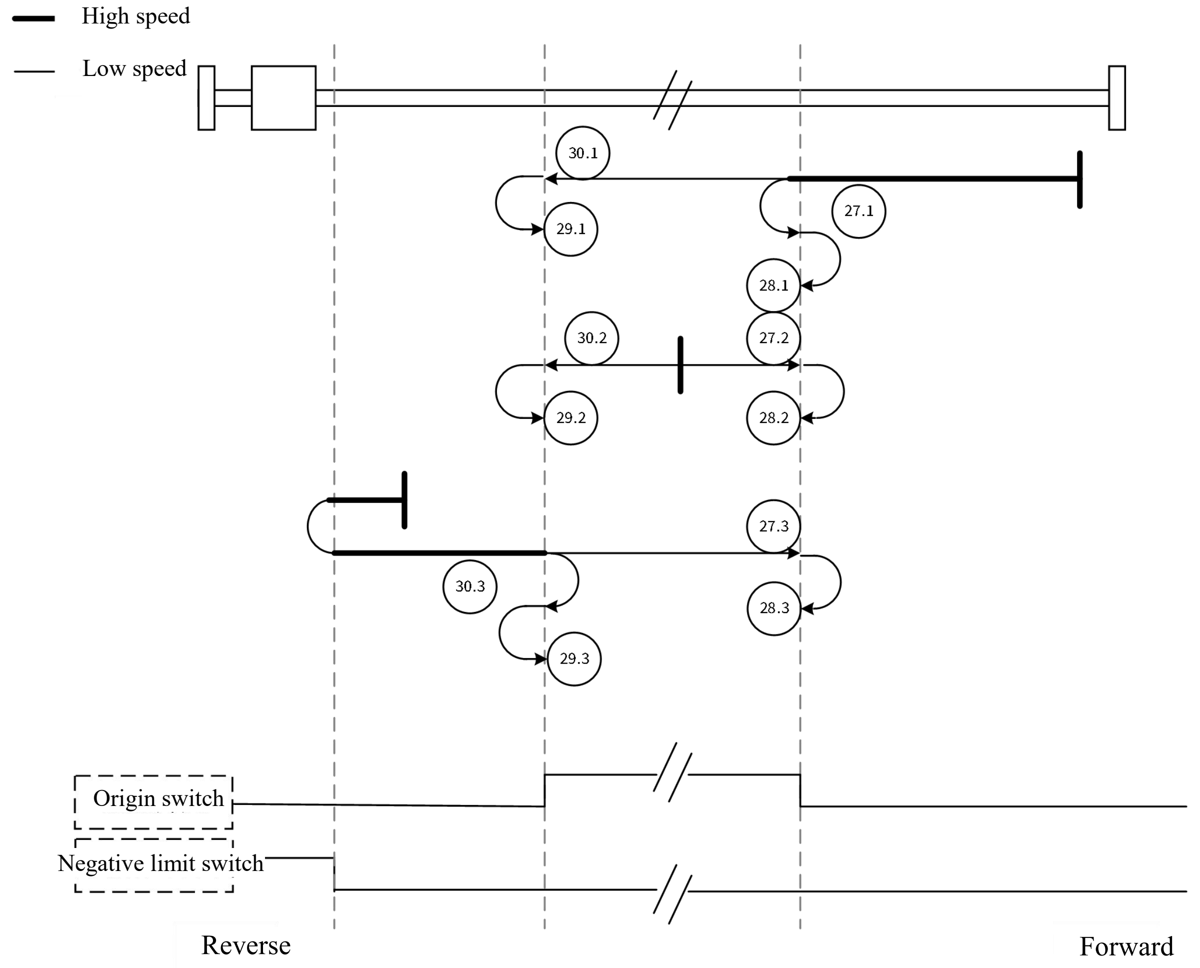
	returning to zero, and forward limit switch is encountered during the process	signal, run at the reverse high speed. When encountering the rising edge of the origin switch signal, run at the reverse low speed. When encountering the falling edge of the origin switch signal, stop running..

Method 24	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	24.1- The deceleration point is invalid when returning to zero, and no forward limit switch was encountered in the process	While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the reverse low speed. When encountering falling edge of the original switch signal, run at the forward low speed. When encountering the rising edge of the origin switch signal, stop running.
	24.2- Deceleration point is valid when returning to zero	While start zeroing, run at the reverse low speed. When encountering falling edge of the origin switch signal, run at the forward low speed. Stop when encountering the rising edge of the origin switch signal
	24.3- The deceleration point is invalid when returning to zero, and forward limit switch was encountered in the process	While start zeroing, run at the forward high speed. If encountering forward limit signal prior to the origin switch signal, run at the reverse high speed. Run at reverse low speed when encountering the rising edge of the original switch signal. Run at the forward low speed when encountering the falling edge of the original switch signal. When encountering the rising edge of the origin switch signal,stop running.
Method 25	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	25.1- The deceleration point is invalid when returning to zero, and no forward limit switch was encountered in the process	While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the forward low speed. When encountering falling edge of the original switch signal, run at the reverse low speed. When encountering the rising edge of the origin switch signal, stop running.
	25.2- Deceleration point is valid when returning to zero	While start zeroing, run at the forward low speed. When encountering falling edge of the origin switch signal, run at the reverse low speed. Stop when encountering the rising edge of the origin switch signal
	25.3- The deceleration point is invalid when returning to zero, and forward limit switch was encountered in the process	While start zeroing, run at the forward high speed. If encountering forward limit signal prior to the origin switch signal, run at the reverse high speed. Run at forward low speed when encountering the rising edge of the original switch signal. Run at the reverse low speed when encountering the falling edge of the original switch signal.

		When encountering the rising edge of the origin switch signal,stop running.
Method 26	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	26.1- The deceleration point is invalid when returning to zero, and no forward limit switch was encountered in the process	While start zeroing, run at the forward high speed. When encountering rising edge of the origin switch signal, run at the forward low speed. When encountering falling edge of the original switch signal, run at the forward low speed. When encountering the falling edge of the origin switch signal, stop running.
	26.2- Deceleration point is valid when returning to zero	While start zeroing, run at the forward low speed. When encountering falling edge of the origin switch signal, run at the forward speed. Stop when encountering the falling edge of the origin switch signal
	26.3- The deceleration point is invalid when returning to zero, and forward limit switch was encountered in the process	While start zeroing, run at the forward high speed. If encountering forward limit signal prior to the origin switch signal, run at the reverse high speed. Run at forward low speed when encountering the rising edge of the original switch signal. Run at the forward low speed when encountering the falling edge of the original switch signal. When encountering the falling edge of the origin switch signal,stop running.

XIII) Method 27-30:

Table 3-88 Origin Return Mode 27-30

movement Block diagram		
Positioning signal	**Origin**	**Decelerating point**
	Origin switching signal	Origin switching signal
Method 27	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	27.1: The deceleration point is invalid when returning to zero, and no forward limit switch was encountered during the process	While start zeroing, run at the reverse high speed. When encountering the rising edge of the origin switch signal, run at the forward low speed. When encountering the falling edge of the origin switch signal, stop running..
	27.2: The deceleration point is valid when returning to zero	While start zeroing, directly start at the forward low speed. When encountering falling edge of the origin switch signal, stop running.
	27.3: The deceleration point is invalid when returning to	When starting to return to zero, run at reverse high speed . If encountering reverse limit signal prior to the origin signal, run

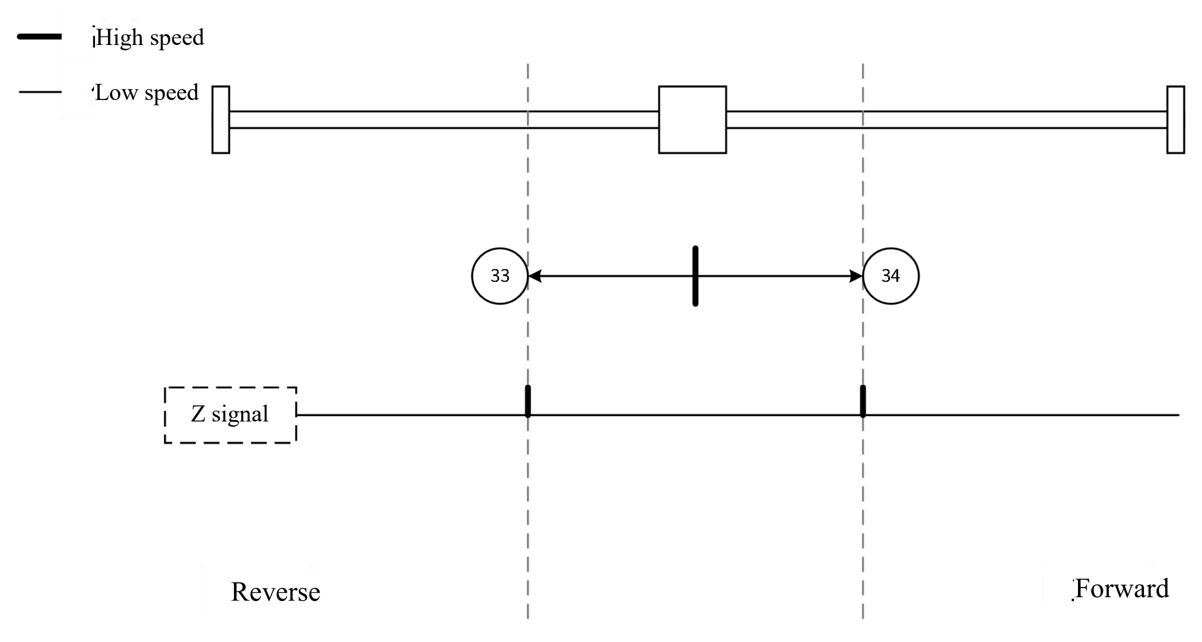
	zero, and a reverse limit switch is encountered during the process	at the forward high speed. When encountering the rising edge of the origin switch signal, run at forward low speed. When encountering the falling edge of the origin switch signal, stop running
Method 28	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	28.1: The deceleration point is invalid when returning to zero, and no reverse limit switch was encountered during the process	When starting to return to zero, run at the reverse high speed. When encountering the rising edge of the origin switch signal, run at the forward low speed. When encountering the falling edge of the origin switch signal, run at the reverse low speed. Stop running when encountering the rising edge of the origin switch signal
	28.2: The deceleration point is valid when returning to zero	While start zeroing, run at the forward low speed. When encountering falling edge of the origin switch signal, run at the reverse low speed. Stop when encountering the rising edge of the origin switch signal
	28.3: The deceleration point is invalid when returning to zero, and reverse limit switch is encountered during the process	When starting to return to zero, run at the reverse high speed. If encountering reverse limit signal prior to the origin switch, runs at the forward high speed. When encountering the rising edge of the origin switch signal, it runs at the forward low speed. When encountering the falling edge of the origin switch signal, it runs at the reverse low speed. When encountering the rising edge of the origin switch signal, stop running
Method 29	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	29.1: The deceleration point is invalid when returning to zero, and no reverse limit switch was encountered during the process	When starting to return to zero, run at the reverse high speed in reverse. When encountering the rising edge of the origin switch signal, it runs at the reverse low speed in reverse. When encountering the falling edge of the origin switch signal, it runs at the forward low speed. When encountering the rising edge of the origin switch signal, it stops running
	29.2: The deceleration point is valid when returning to zero	While start zeroing, run at the reverse low speed. When encountering falling edge of the origin switch signal, run at the forward low speed. Stop when encountering the rising edge of the origin switch signal
	29.3: The deceleration point is invalid when returning to zero, and a reverse limit switch is encountered during the process	When starting to return to zero, it runs at the reverse high speed. If encountering reverse limit signal prior to the origin switch signal, run at the forward high speed. When encountering the rising edge of the origin switch signal, it runs at the reverse low speed. When encountering the falling edge of the origin switch signal, run at the forward low speed. When encountering the rising edge of the origin switch signal,

		stop running
Method 30	**Action description**	
	Note: different actions in different initial conditions	
	Initial condition	**Return to zero action**
	30.1: The deceleration point is invalid when returning to zero, and no reverse limit switch was encountered during the process	While starting to return to zero, run at the reverse high speed. When encountering the rising edge of the origin switch signal, run at the reverse low speed. When encountering the falling edge of the origin switch signal, continue to run at the reverse low speed. Stop running, when encountering the falling edge of the origin switch signal
	30.2: The deceleration point is valid when returning to zero	While starting to return to zero, run at the reverse low speed. When encountering the falling edge of the origin switch signal, continue to run at the reverse low speed. Stop running, when encountering the falling edge of the origin switch signal
	30.3: The deceleration point is invalid when returning to zero, and a reverse limit switch is encountered during the process	While starting to return to zero, run at the reverse high speed. If encountering the reverse limit signal prior to the origin switch, run at the forward high speed. When encountering the rising edge of the origin switch signal, run at the reverse low speed. When encountering the falling edge of the origin switch signal, continue running at reverse low speed. Stop running, when encountering the falling edge of the origin switch signal

XIV) Method 31-32: Reserved

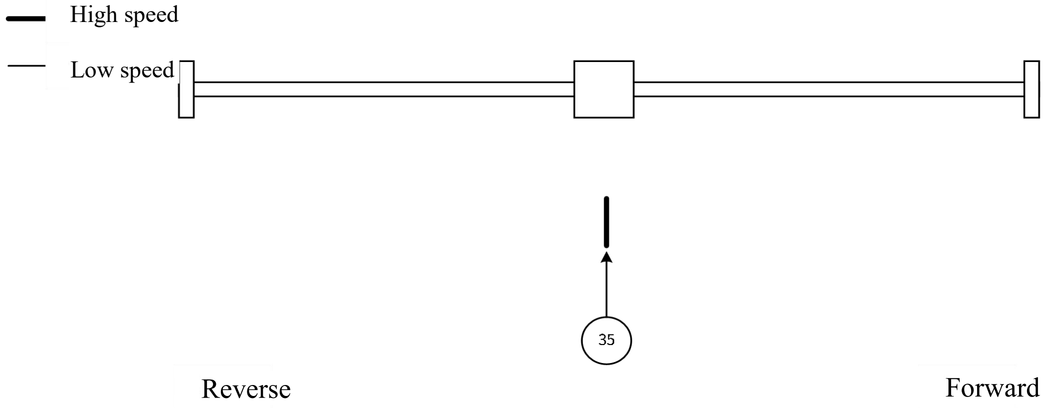
XV) Methods 33-34:

Table 3-89 Origin Return Modes 33-34

<table>
<tr><td>movement Block diagram</td><td colspan="2"> </td></tr>
<tr><td rowspan="2">Positioning signal</td><td>Origin</td><td>Decelerating point</td></tr>
<tr><td>Z-phase signal</td><td>No</td></tr>
<tr><td rowspan="2">Method 33</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">33: Running at low speed in reverse, encountering the first Z-phase signal, stop</td></tr>
<tr><td rowspan="2">Method 34</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">34: Running forward at low speed, encountering the first Z-phase signal, stop</td></tr>
</table>

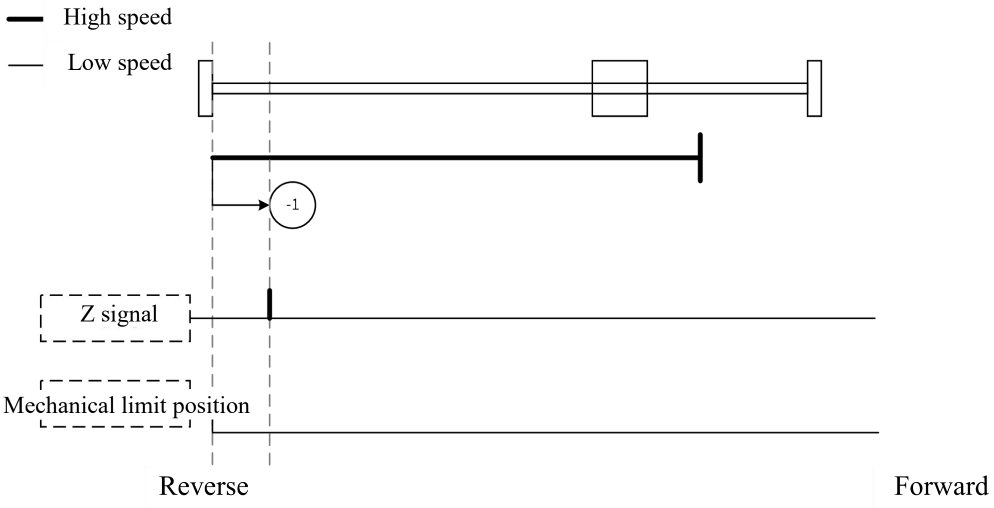
XVI) Method 35:

Table 3-90 Origin Return Mode 35

<table>
<tr><td>movement Block diagram</td><td colspan="2">
</td></tr>
<tr><td rowspan="2">Positioning signal</td><td>Origin</td><td>Decelerating point</td></tr>
<tr><td>Current position</td><td>No</td></tr>
<tr><td rowspan="2">Method 35</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">35: Use the current position as the origin</td></tr>
</table>

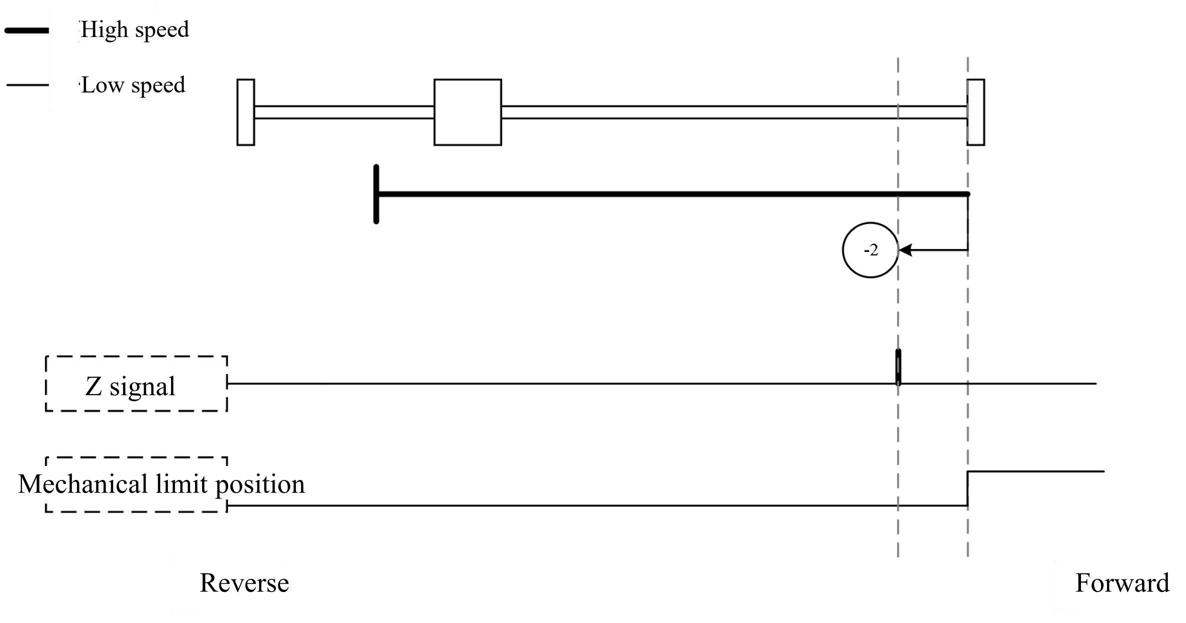
XVII) Method 1:

Table 3-91 Origin Return Mode-1

<table>
<tr><td>movement Block diagram</td><td colspan="2">
</td></tr>
<tr><td rowspan="2">Positioning signal</td><td>Origin</td><td>Decelerating point</td></tr>
<tr><td>Z-phase signal</td><td>Mechanical limit position</td></tr>
<tr><td rowspan="2">Method 1</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Method 1: The motor first runs at high speed in reverse direction. After hitting the mechanical limit, if the torque reaches the torque limit and the speed is near zero speed, besides this state maintains for a period, it proves that the shaft has reached the mechanical limit position. The motor runs at low speed in forward direction; Stop running, when encountering the first Z-phase signal.</td></tr>
</table>

XVIII) Method 2

Table 3-92 Origin Return Mode -2

<table>
<tr><td>movement Block diagram</td><td colspan="2">
</td></tr>
<tr><td rowspan="2">Positioning signal</td><td>Origin</td><td>Decelerating point</td></tr>
<tr><td>Z-phase signal</td><td>Mechanical limit position</td></tr>
<tr><td rowspan="2">Method 2</td><td colspan="2">Action description</td></tr>
<tr><td colspan="2">Method 2: The motor first runs at the forward high speed. After hitting the mechanical limit position, if the torque reaches the torque limit value and the speed is near zero speed, and this state maintains for a period, it proves to have reached the mechanical limit position. The motor runs at the reverse low speed, stop running when encountering the first Z-phase signal.</td></tr>
</table>

3.4.4 Application Functions

(1) Probe function

Function Overview

SV3 servo drive supports servo motor position recording function, also known as probe function. With this function, motor position (command unit) can be latched when the external signal is valid or during riseing/falling edge of the servo motor Z-phase signal.

Table 3-93 Probe Lock Signal Selection

Serial No.	Latch enable signal
Probe 1	HDI1
	Z signal
Probe 2	HDI2
	Z signal

Note:

The latch time can be rising or falling edge of the external signal, so SV3 can simultaneously latch 4 positions.

SV3 servo drive supports 2 types of latching: single latching position and continuous latching.

If using HDI 1 and HDI 2 as trigger signals for probe functions, please disable the DI and DO forcing function.

If using HDI 1 and HDI 2 as trigger signals for probe functions, please assign HDI 1 function as 33 probe 1 and HDI 2 function as 34 probe 2. The relevant objects are as follows:

Table 3-94 HDI 1~HDI 2 objects

Parameter	Name	Set
P03.14	HDI1 terminal function selection	Please set 33-probe 1
P03.16	HDI2 terminal function selection	Please set 34-probe 2

Related object (instruction * setting class)

Table 3-95 Probe Function Command Setting Objects

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
0x2003	0F	HDI1 Function Settings	-	0~34	UINT16	RW	-
0x2003	11	HDI2 Function Settings	-	0~34	UINT16	RW	-
0x60B8	00	Probe function	-	0~65535	UINT16	RW	RxPDO

Table 3-96 0x60B8- Probe Function

0x60B8- Probe Function	
Index - Subindex	0x60B8-00
Data type	UINT16
Accessibility	Readable/writable
Unit	-
DeError value	0
Min.	0
Max.	65535
Setting and effective mode	Operation settings/downtime effective
Related mode	ALL

<table>
<tr><td>Note</td><td>
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Probe 1 Function</td><td>0-Disable; 1- Enable</td></tr>
<tr><td>1</td><td>Probe 1 mode</td><td>0-Single recording; 1- Continuous recording</td></tr>
<tr><td>2</td><td>Probe 1 Trigger signal</td><td>0-HDI1; 1-Z signal</td></tr>
<tr><td>3</td><td>NA</td><td>Reserved</td></tr>
<tr><td>4</td><td>Probe 1 rising edge action*</td><td>0- Not latch; 1- Latch</td></tr>
<tr><td>5</td><td>Probe 1 falling edge action*</td><td>0- Not latch; 1- Latch</td></tr>
<tr><td>6</td><td>NA</td><td>Reserved</td></tr>
<tr><td>7</td><td>NA</td><td>Reserved</td></tr>
<tr><td>8</td><td>Probe 2 Function</td><td>0-Disable; 1- Enable</td></tr>
<tr><td>9</td><td>Probe 2 Mode</td><td>0-Single recording; 1- Continuous recording</td></tr>
<tr><td>10</td><td>Probe 2 trigger signal</td><td>0-HDI2; 1-Z signal</td></tr>
<tr><td>11</td><td>NA</td><td>Reserved</td></tr>
<tr><td>12</td><td>Probe 2 rising edge action*</td><td>0- Not latch; 1- Latch</td></tr>
<tr><td>13</td><td>Probe 2 falling edge action*</td><td>0- Not latch; 1- Latch</td></tr>
<tr><td>14</td><td>NA</td><td>Reserved</td></tr>
<tr><td>15</td><td>NA</td><td>Reserved</td></tr>
</table>
</td></tr>
</table>

⚠ **Note:**

Please set trigger mode, trigger signal, rising edge action, and falling edge action before enabling probe function.

Related objects (status * monitor class)

Table 3-97 Probe function status monitoring objects

Index	Subindex	Name	Unit	Range	Data type	Accessibility	PDO
0x60B9	00	Probe status	-	-	UINT16	RO	TxPDO
0x60BA	00	Probe 1 rising edge latch position	Instruction unit	-	INT32	RO	TxPDO
0x60BB	00	Probe 1 falling edge latch position	Instruction unit	-	INT32	RO	TxPDO
0x60BC	00	Probe 2 rising edge latch position	Instruction unit	-	INT32	RO	TxPDO
0x60BD	00	Probe 2 falling edge latch position	Instruction unit	-	INT32	RO	TxPDO

Table 3-98 0x60B9 Probe status word

0x60B9- Probe status word	
Index - Subindex	0x00
Data type	UINT16
Accessibility	Readable
Unit	-
DeError value	0
Min.	0

<table>
<tr><th>Max.</th><td>65535</td></tr>
<tr><th>Setting and effective mode</th><td>-</td></tr>
<tr><th>Related mode</th><td>PST</td></tr>
<tr><th>Note</th><td>
<table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>Probe 1 Function</td><td>0 - Not enabled; 1 - Enable</td></tr>
<tr><td>1</td><td>Probe 1 rising edge latch status</td><td>0- Rising edge not latched, 1- Rising edge latch\ed</td></tr>
<tr><td>2</td><td>Probe 1 falling edge latch status</td><td>0-Falling edge not latched, 1- Falling edge latched</td></tr>
<tr><td>3~7</td><td>NA</td><td>Reserved</td></tr>
<tr><td>8</td><td>Probe 2 Function</td><td>0 - Not enabled; 1 - Enable</td></tr>
<tr><td>9</td><td>Probe 2 rising edge latch status</td><td>0- Rising edge not latched, 1- Rising edge latch\ed</td></tr>
<tr><td>10</td><td>Probe 2 falling edge latch status</td><td>0-Falling edge not latched, 1- Falling edge latched</td></tr>
<tr><td>11~15</td><td>NA</td><td>Reserved</td></tr>
</table>
</td></tr>
</table>

Probe usage

Single rising edge latch

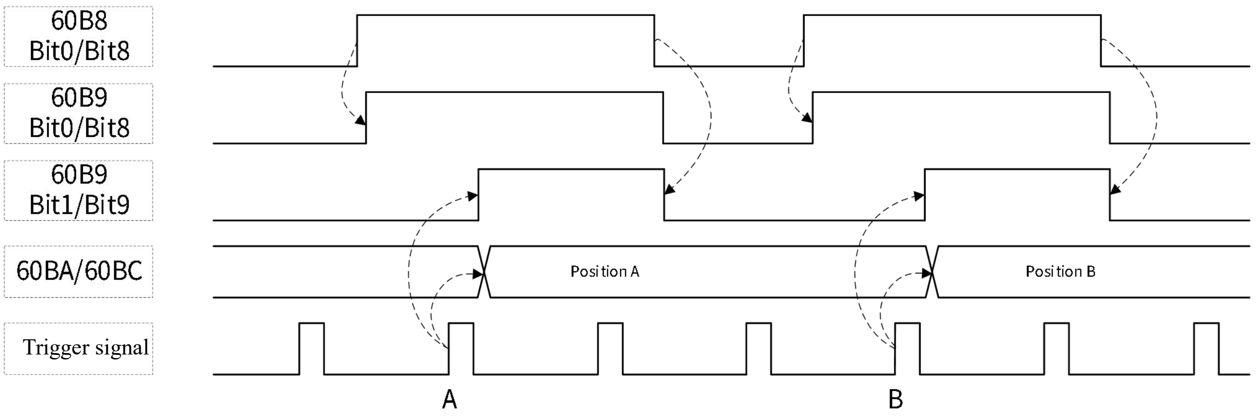


Figure 3-73 Schematic diagram of single rising edge latch

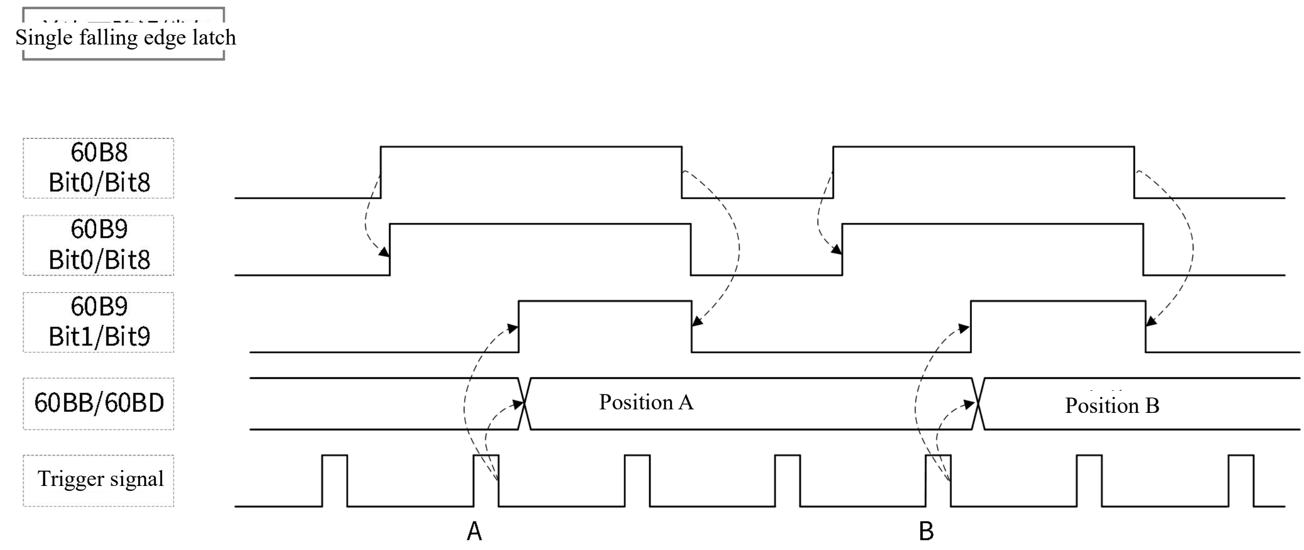


Figure 3-74 Schematic diagram of single falling edge latch

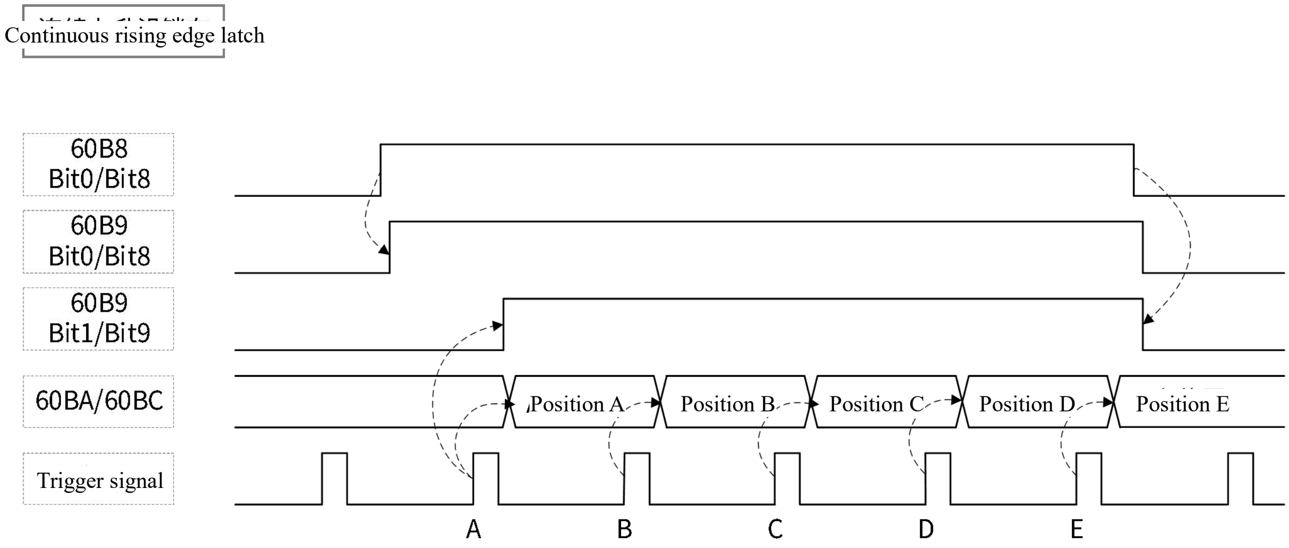


Figure 3-75 Continuous rising edge latch

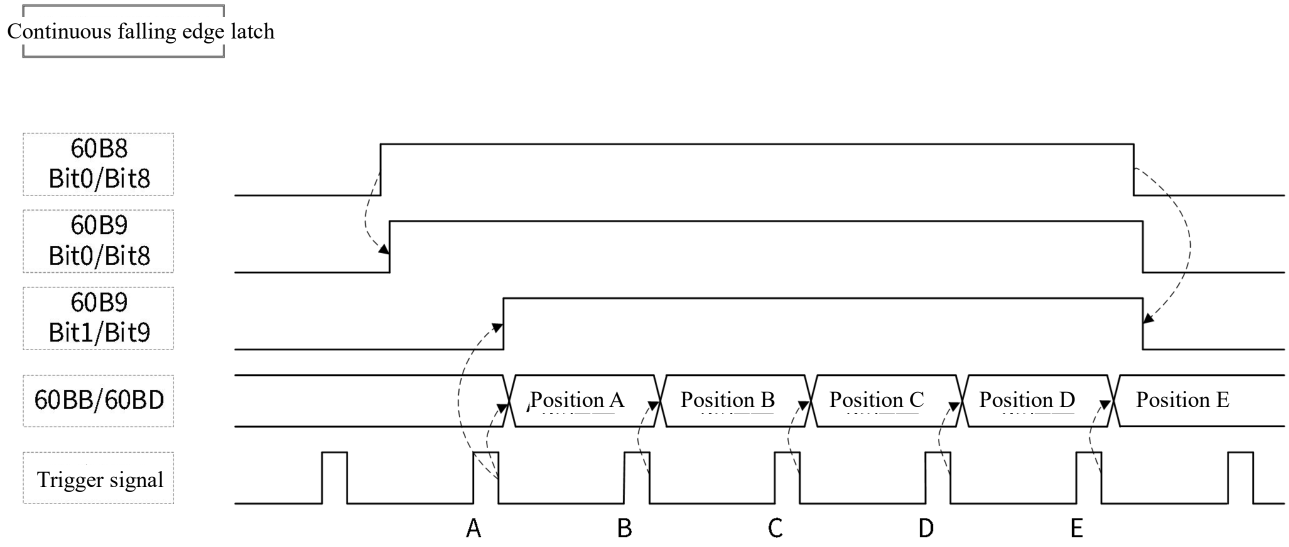


Figure 3-76 Continuous falling edge latch

(2) Soft limit function

Function Overview

Software limit refers to the function of limiting the position of servo motor by the built-in of drive so as to protect the equipment.

The software limit function can be available in any mode, and different overtravel stop modes can be set according to the actual connection method of devices. If it is in position mode and the target position is out of the limit interval, the servo motor moves toward the destination of the endpoint of limit interval. If in other modes, it stops in the specified way when the position feedback is out of the limit interval.

The software limit function is to restrict the value of position feedback 6064h (instruction unit) in a certain range, pay attention to the unit.

Please ensure that the lower limit of limit interval is less than the upper limit.

If both DI overtravel switch and the software limit are enabled simultaneously, the overtravel state is determined by external DI overtravel switch.

Related object (instruction * setting class)

Table 3-99 P05.43 Soft Limit Setting

<table>
<tr><th colspan="2">P05.43- Soft limit setting</th></tr>
<tr><td>Index - Subindex</td><td>0x2005-2C</td></tr>
<tr><td>Data type</td><td>UINT16</td></tr>
<tr><td>Accessibility</td><td>Readable/writable</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>DeError value</td><td>0</td></tr>
<tr><td>Min.</td><td>0</td></tr>
<tr><td>Max.</td><td>2</td></tr>
<tr><td>Setting and effective mode</td><td>Operation settings/downtime effective</td></tr>
<tr><td>Related mode</td><td>ALL</td></tr>
<tr><td>Note</td><td>Set the enable mode for software limit function<table><tr><th>Settings</th><th>Software limit function</th></tr><tr><td>0</td><td>Disable software limit function</td></tr><tr><td>1</td><td>Enable software limit function</td></tr><tr><td>2</td><td>Enable software limit function after the origin return,</td></tr></table></td></tr>
</table>

Table 3-100 0x607D - Software Absolute Position Limit

<table>
<tr><th colspan="3">0x607D - Software absolute position limit</th></tr>
<tr><td>Index - Subindex</td><td>1h</td><td>2h</td></tr>
<tr><td>Data type</td><td colspan="2">UINT32</td></tr>
<tr><td>Accessibility</td><td>RW</td><td>RW</td></tr>
<tr><td>Unit</td><td>-</td><td>-</td></tr>
<tr><td>DeError value</td><td>-2^{31}</td><td>$2^{31}-1$</td></tr>
<tr><td>Min.</td><td>-2^{31}</td><td>-2^{31}</td></tr>
<tr><td>Max.</td><td>$2^{31}-1$</td><td>$2^{31}-1$</td></tr>
<tr><td>Setting and effective mode</td><td colspan="2">Operation settings/downtime effective</td></tr>
</table>

Related mode	ALL
Note	607D-01h: Min. position limit 607D-02h: Max. position limit

Chapter 4 Gain Adjustment

4.1 Purpose

In order to enable the servo system to quickly and accurately track instructions from the upper computer or internal settings, fully utilize mechanical performance, improve production cycle and efficiency, it is necessary to adjust the gain of the servo control loop reasonably.
Taking common screw loads as an example, such as errors! Reference source not found. As shown, by reasonably increasing the gain related to the speed loop and position loop, ensuring gain matching, and combining with the speed feedforward function, the trajectory tracking effect can be greatly improved.

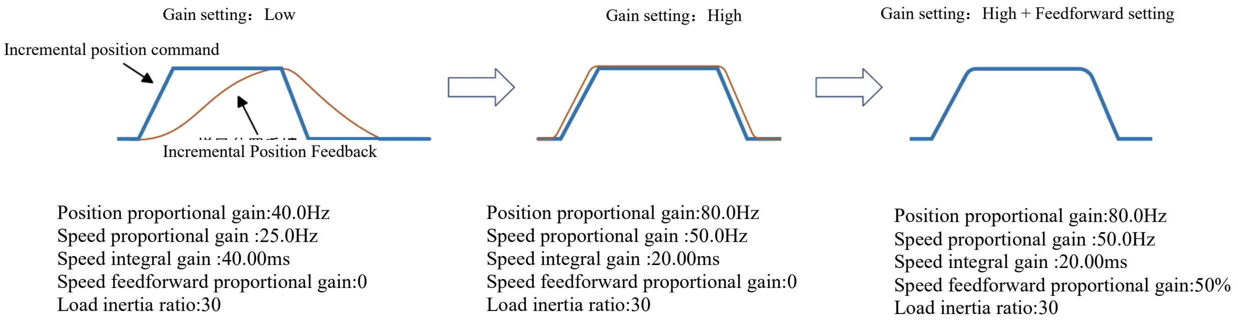


Figure 4-1 Example of gain setting

The basic gain parameters of the servo loop include the proportional coefficient Kp of the position loop, the gain coefficient Kv of the velocity loop, the integral coefficient Ki of the velocity loop, the low-pass filtering coefficient τ m of the torque, the inertia ratio Jr of the load, etc. They affect each other, and generally need to ensure that the inner loop bandwidth is higher than the outer loop bandwidth to ensure the stability of the entire system. By setting these parameters in a reasonable combination, the servo system can achieve ideal control effects in both tracking and disturbance rejection dimensions. Therefore, in order to achieve the maximum performance of the servo, the setting of the gain must take into account the balance between the set values of various parameters, which poses high capability requirements for on-site debugging personnel. The SV3 series high-performance servo supports two modes: manual parameter tuning and automatic parameter adjustment. In general application scenarios, such as 3C, lithium battery, TP and other industries, using the automatic adjustment function can meet the needs; In trajectory application scenarios that pursue ultimate performance, such as semiconductor, machine tool, laser and other industries, detailed settings of servo system parameters are required to achieve ideal results; For P2P point application scenarios that require high speed and high precision, such as high-speed glue dispensing machines, solidification machines, and sorting machines, the SV3 series servo provides gain switching function, which can achieve ultimate tracking performance through reasonable gain settings.
Before adjusting the gain, it is necessary to perform the trial operation in Chapter 3 to confirm that the motor can operate normally without interference!

4.2 Tuning Method

The general process of gain adjustment is shown in the following figure:

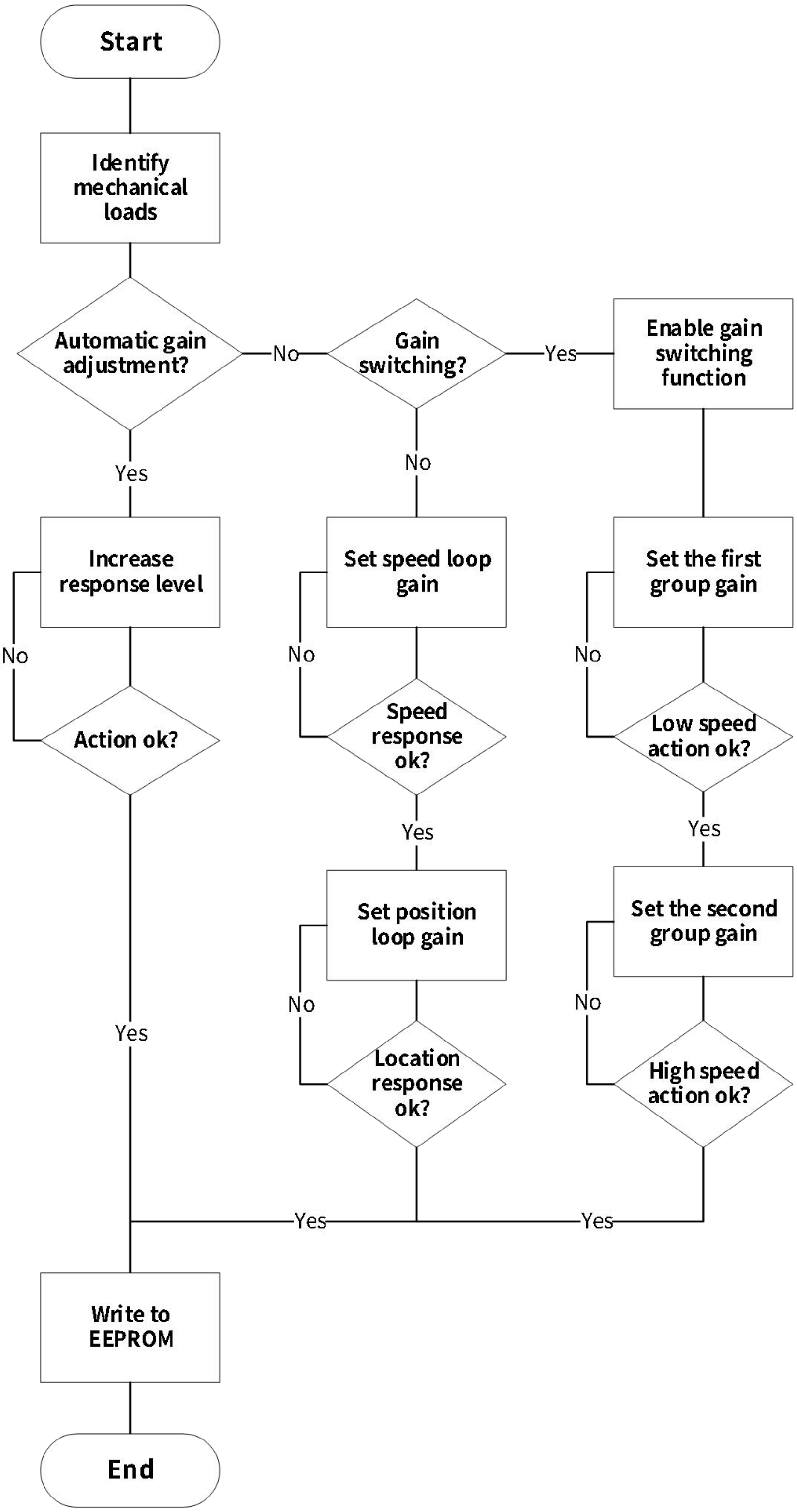


Figure 4-2 Gain Adjustment Process

The SV3 series servo provides three gain adjustment modes, namely "automatic gain adjustment", "manual gain adjustment", and "gain automatic switching". Among them,

- The "automatic gain adjustment" method only requires setting one parameter, P1A group - "response level setting", to achieve the linkage setting of multiple internal gain parameters and achieve the desired response action. The higher the response level, the faster the response; For detailed introduction, please refer to section 4.2.4 on automatic gain adjustment.
- Manual gain adjustment "requires the user to turn off the automatic gain adjustment mode P1A group -" Real time Self adjustment Setting "set to" 0-off ", and sequentially set P06 gain parameters, including speed loop and position loop gain parameters, from the inner loop to the outer loop, to achieve the desired response performance;
- Manual gain adjustment "requires the user to turn off the automatic gain adjustment mode P1A group -" Real time Self adjustment Setting "set to" 0-off ", and sequentially set P06 gain parameters, including speed loop and position loop gain parameters, from the inner loop to the outer loop, to achieve the desired response performance;

To achieve good tracking performance, the prerequisite for the above three gain adjustment methods is to execute a rigorous "mechanical load recognition" program. The SV3 series servo has a built-in mechanical load recognition algorithm, which can automatically identify the mechanical load situation through forward and reverse operation. The following will introduce the contents of mechanical load recognition, manual gain adjustment, automatic gain adjustment, and gain switching in sequence.

4.2.1 Mechanical load identification

For servo systems, mechanical loads are the controlled objects and important components of the system; Mechanical load identification includes parts such as load inertia, friction force, and load mechanical resonance point. Servo can automatically identify key mechanical characteristics, set control loop parameters and compensation parameters reasonably, and achieve dynamic response performance that meets application requirements, greatly reducing the tuning pressure of on-site debugging personnel.

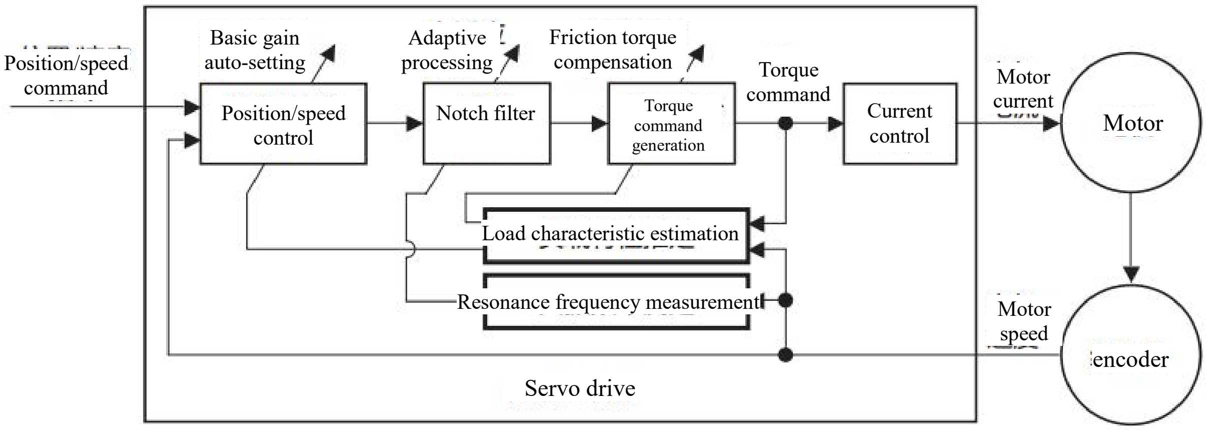


Figure 4-3 Mechanical Load Identification

Usually, we do not pay much attention to the absolute value of mechanical load inertia, but rather focus more on the relative size of load inertia and motor inertia, so it usually appears in the form of "inertia ratio" in the control loop.

Load inertia ratio' refers to:

$$\text{Load inertia ratio=}\frac{\text{Mechanical load inertia}}{\text{Motor rotor inertia}}$$

Load inertia ratio is a key parameter in the servo system, and the proper setting can help to reduce the debugging time.

The servo drive has a built-in load inertia identification function, which can automatically identify the load inertia by this algorithm.

Inertia identification automatic recognition method:
By the buttons on the servo drive panel, make the motor move, so as to realize inertia identification without the intervention of upper computer;

⚠ Note:
Under the following conditions, it migt be impossible to perform mechanical load identification normally. In this case, please adjust the gain manually.

Table 4-1 Factors of Mechanical Load Identification

	Factors of mechanical load identification
Load inertia	Inertia mismatch, load inertia ratio greater than 100 times Load inertia is unstable, time-varying or slowly changing
Mechanical properties	Extremely low mechanical rigidity, for example, in belt transmission mechanism where the belt is not tensioned. Nonlinear factors such as excessive tooth clearance in operation or excessive backlash in forward/reverse rotation, e.g., misaligned gear installation in gear transmission mechanism
Movement conditions	Movement speed less than 150rpm When the torque for acceleration/deceleration is less than the offset load torque or less than the viscous friction torque When the acceleration is less than 3,000rpm/s

If the actual load inertia ratio is too large, that causes the motor to run slowly, then increase P1A group - "Response Level Setting" and re-identify the inertia.
If vibration occurs in the identification process, the inertia identification should be stopped immediately and P1A group - "Response Level Setting" should be reduced.
Before conducting offline inertia identification, first confirm the following:

There is a movable stroke of more than 1 turn in each direction between the mechanical limit switches:

Before identifying offline inertia, please ensure that limit switches are installed on the machinery to prevent overtravel and accidents in the inertia identification process!

If the actual load inertia ratio is large, estimated to be over 30 times greater than the motor inertia, inertia mismatch phenomenon may occur, that results in slow motor operation. In this case, the following 2 measures can be taken:

Preset load inertia ratio of a large initial value, and it's recommended to use the 5.00 times as the starting value, gradually increases until the identification is updated accordingly; The load inertia ratio can be set of '2006-0Bh' by object word, or of "P06.10" through the panel, or of "P06 group load inertia ratio" parameter on the background software

It can be set by appropriately increasing the driver "P1A Advanced Adjustment - Response Level Setting" on the background software, or be set by object word "201A-02h".

The general process for identifying panel operation inertia is as follows:

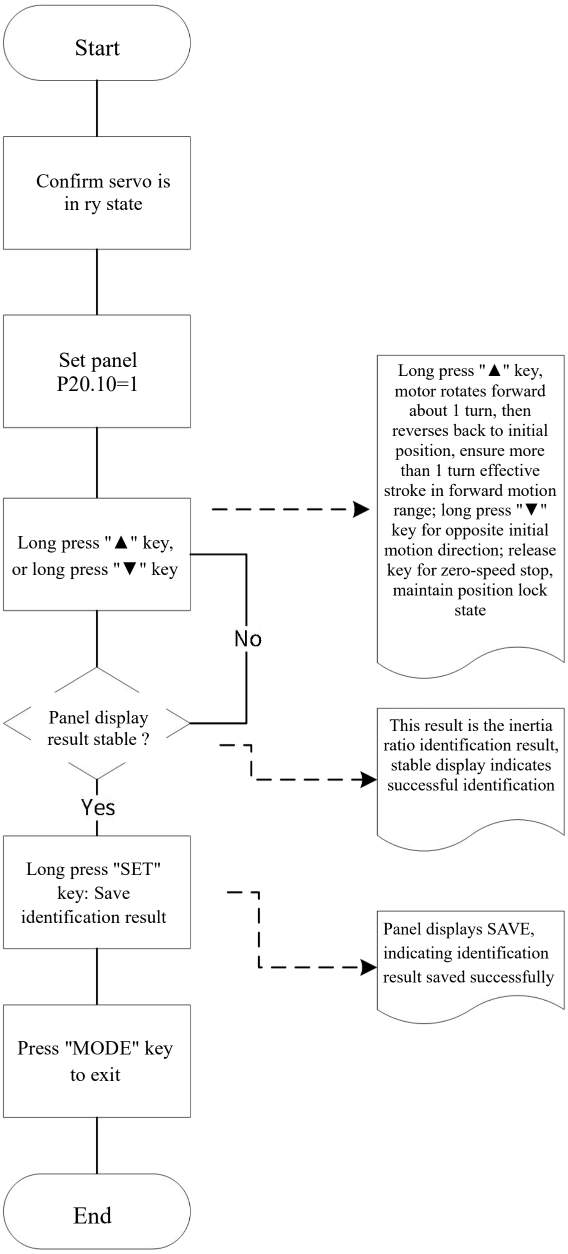


Figure 4-4 Flow Chart of Inertia Identification for Panel Operation

Inertia identification adopts the form of forward/backward triangular wave motion, and the program has already deErrored to the optimal motion parameters; Users can adjust the motion parameter settings according to actual application scenarios to realize the on-site demands. The identification program motion curve and parameter settings are as follows.

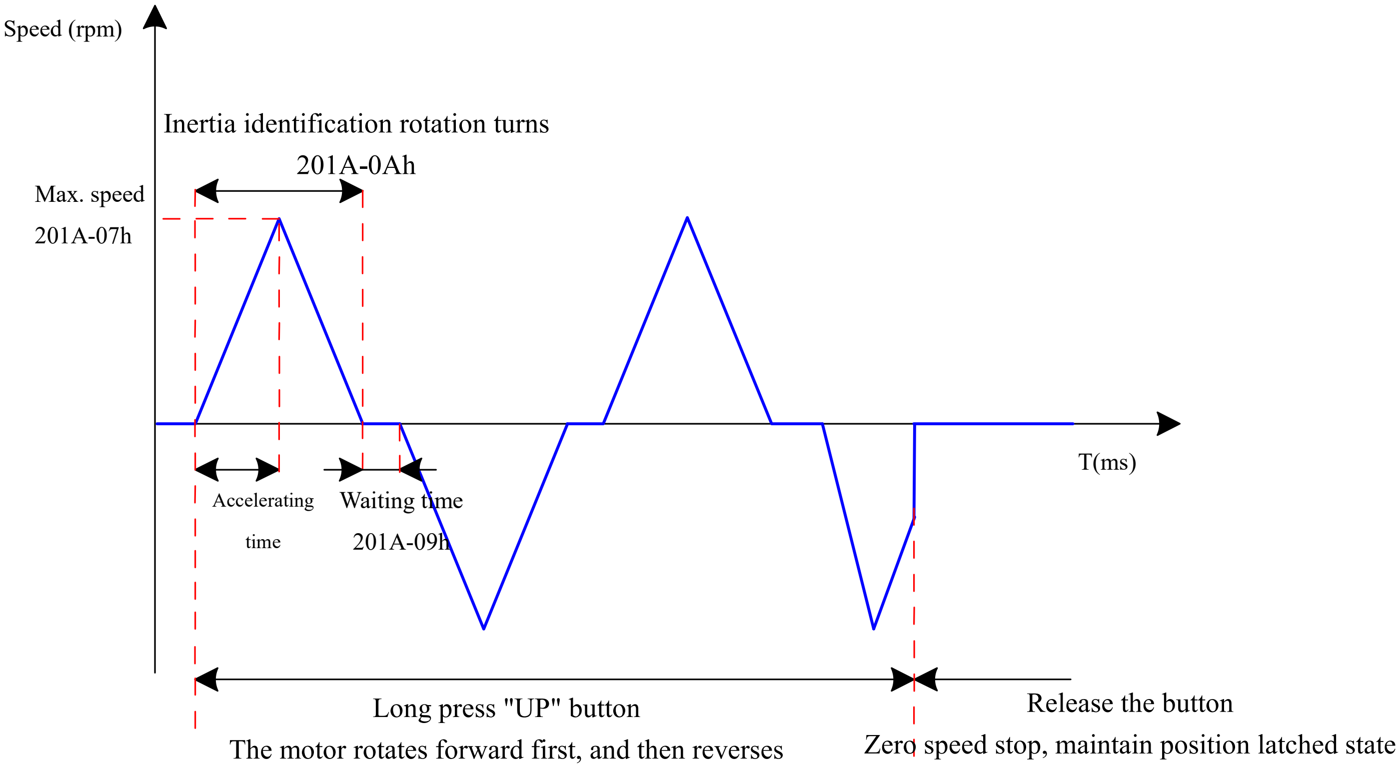


Figure 4-5 Inertia Identification Motion Curve

Table 4-2 Self-tuning Parameter Index Codes

0x201A - Advanced Adjustment				
Subindex	0x07- Max. speed estimated by inertia	0x08- Accelerating time estimated by inertia	0x09- Waiting time estimated by inertia	0x0A- Rotation turns estimated by inertia
Data type	UINT16			
Accessibility	Readable/writable	Readable/writable	Readable/writable	Read-only
Unit	rpm	ms	ms	turn
DeError value	100	125	800	1.00
Min.	100	20	50	0
Max.	1000	800	10000	655.35
Set enable mode	Stop setting/immediate enable	Stop setting/immediate enable	Stop setting/immediate enable	--
Related mode	PST			
Note	Settings of the parameters related to offline inertia identification have been the internal deError optimal values. Generally, there is no need to set them			

4.2.2 Manual gain adjustment

(1) Basic gain parameters

In scenarios with extreme performance requirements, the gain can be manually fine tuned. By making more detailed adjustments, optimize the debugging effect.

The servo system consists of 3 control loops, i.e., current loop, speed loop and position loop from the inside out. The basic control block diagram is shown in the following figure.

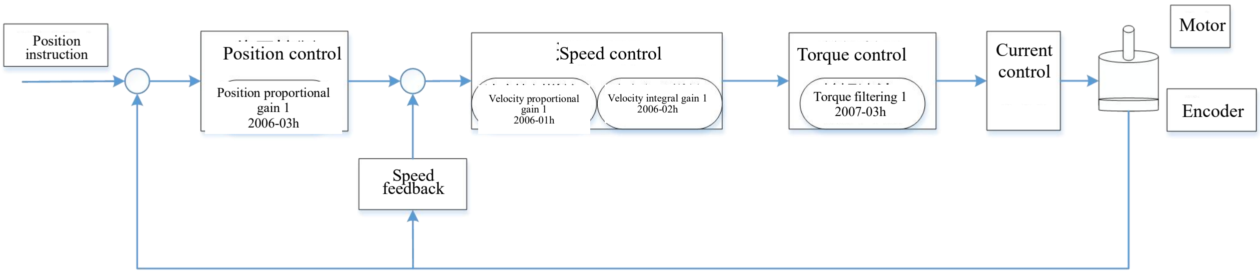


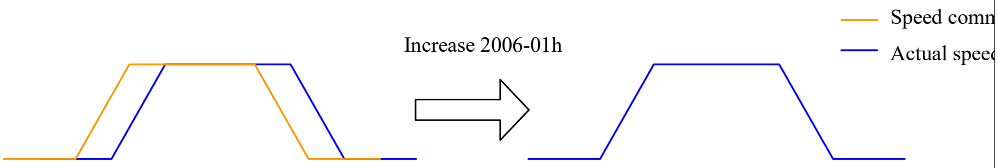
Figure 4-6 Basic Explanation Block Diagram of Manual Gain

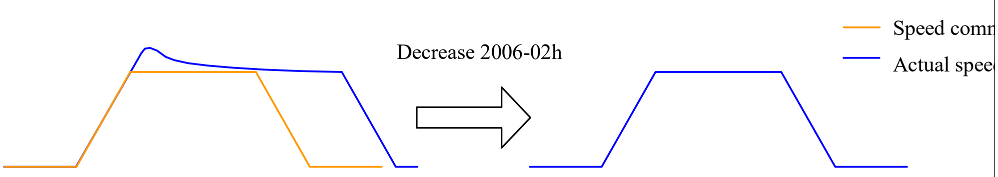
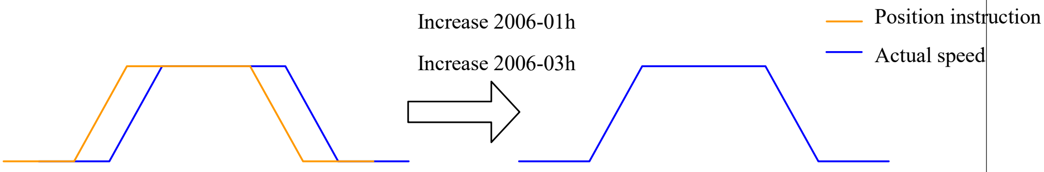
The more inner the loop, the higher the responsiveness required. Generally, the inner loop bandwidth should be set to at least 4 times the outer loop bandwidth. For example, the current loop bandwidth should be 2,000Hz, the speed loop bandwidth should be set not higher than 500Hz, and the position loop bandwidth should be set not higher than 125Hz. In the debugging process, it should adhere to this principle as much as possible, otherwise it might lead to system instability!

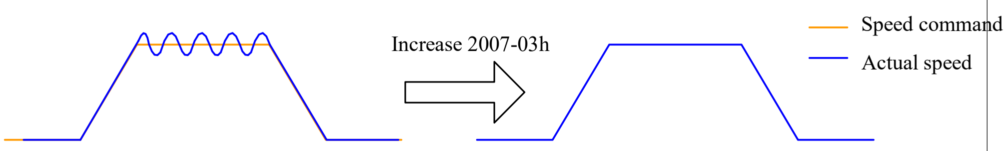
The deError current loop gain of servo drive ensures responsiveness and generally doesn't need any adjustment. Only the position loop gain, velocity loop gain, and other auxiliary gains need to be adjusted. Therefore, when adjusting the gain in position control mode, if users want to improve the position response performance, to ensure system stability, first increase the speed loop gain and ensure that the inner loop bandwidth between loops is 4 times higher than the outer loop bandwidth, and then increase the position loop gain and reduce position tracking error. It must ensure the order of loop gain adjustment from the inside out.

The basic gain parameter adjustment method is as follows.

Table 4-3 Adjustment Instructions of Loop Gain Parameters

Steps	Index codes	Name	Adjustment instructions
1	2006-01h	Velocity proportional gain 1	Parameter function: Determine Max. frequency of speed command that can follow speed-loop change. On the premise that the average of load inertia ratio (2006-0Bh) is set properly, it can be considered that: Max. follow-up frequency of speed loop = 2006-01h  Adjustment method: In the case of no noise and vibration, increasing this parameter can speed up the positioning time and bring better velocity stability and followability.

Steps	Index codes	Name	Adjustment instructions
			If noise is generated, reduce the parameter setting value; When mechanical vibration occurs, the vibration can be suppressed by using the notch filter or torque low-pass filter function in Section 4.3.2 Vibration Suppression".
2	2006-02h	Velocity integral gain 1	 Parameter function: Eliminate velocity loop deviation. Adjustment method: Set values may follow these relations recommended: 500⩽2006-01h×2006-02h⩽1000 For example, if the velocity loop gain 2006-01h=40.0Hz, the time constant of the velocity loop integral shall satisfy: 12.50ms⩽2006-02h⩽25.00ms. Reducing the settings can strengthen the integration function and speed up the positioning time, but too small the settings are prone to mechanical vibration. If the settings are too high, the velocity loop deviation can't be returned to zero. When 2006-02h=512.00ms, the integral is invalid.
3	2006-03h	Position proportional gain 1	Parameter function: Determines the highest frequency of changes in the position instruction that the position ring can follow. The highest following angular frequency of the position ring =2006-03h  Adjustment method: To ensure system stability, the maximum following frequency of the speed loop should be 3-5 times that of the position loop, so: $3\le \frac{2\times\pi\times 2006\text{-}01\text{h}}{2006\text{-}03\text{h}} \le 5$ For example, when velocity loop gain 2006-01h = 40.0Hz, The position loop gain should satisfy: 50.2Hz ⩽ 2006-03h ⩽ 83.7Hz. Adjust according to the positioning time. Increasing this parameter can speed up the positioning time and improve the ability of the motor to resist external disturbances when it is stationary. Excessively high settings may cause system instability and oscillation.

Steps	Index codes	Name	Adjustment instructions
4	2007-03h	Torque filtering 1	Parameter function: Eliminate high-frequency noise and suppress mechanical resonance.  Adjustment method: It should ensure that the cut-off frequency of the torque command low-pass filter is 4 times higher than the maximum following frequency of the speed loop, so: $\frac{1000}{2 \times \pi \times 2007-03h} \geq (2006-01h) \times 4$ For example, when velocity loop gain 2006-01h = 40.0Hz, The time constant of torque command filtering should satisfy: 2007-03h ≤ 1.00ms. When vibration results from 2006-01h increasement, it can be suppressed by adjusting from 2007-03h. Please refer to "4.3.2 Vibration Suppression Low Pass Filter" for specific settings Excessively large settings may cause deduction of current ring response To suppress the vibration during stop, try increasing 2006 -01h and decreasin 2007-03h; The motor vibration in the stop state is too large. It may try reducing the setting of 2007-03h.

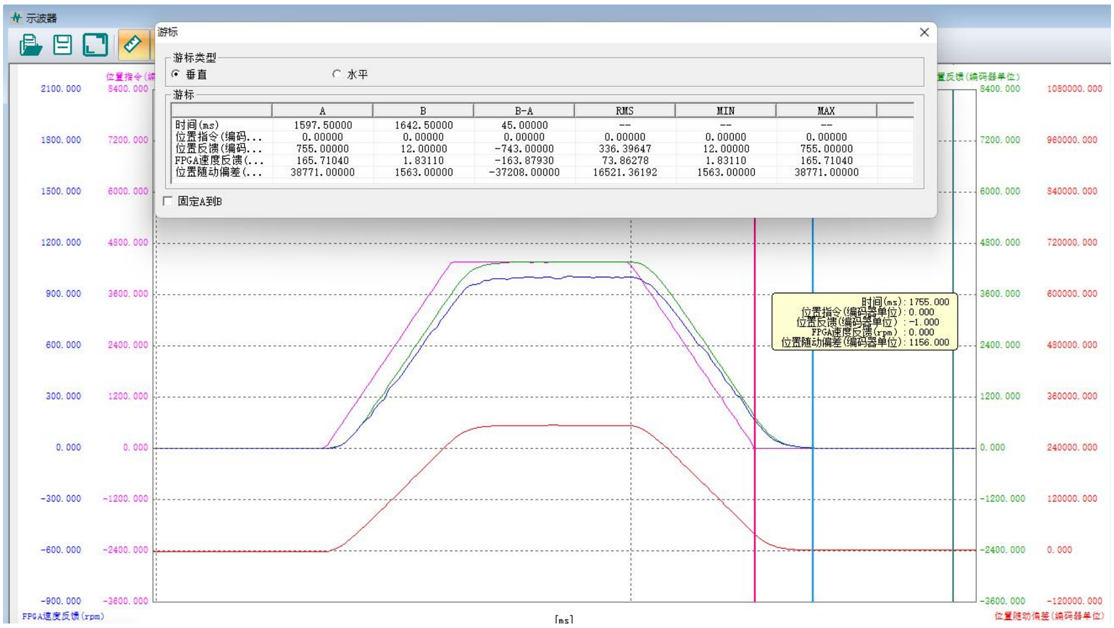
The position loop gain Kp, velocity loop gain Kv, velocity loop integral Ti, and torque low-pass filtering time Tf are the basic loop gain parameters of servo control. A certain relationship needs to be maintained between the 4 basic gain parameters to ensure the balance between stability and high performance of the entire servo system. The mathematical relationship between the 4 basic parameters is as follows:

$$K_p \leq \frac{\pi}{2} \cdot K_v$$

$$T_i \geq 4 \cdot \frac{1}{K_v}$$

$$T_f \leq \frac{1}{4} \cdot \frac{1}{K_v}$$

Below, based on experimental waveforms, we will introduce the role of basic gain parameters in position control mode.



游标

游标类型

● 垂直　○ 水平

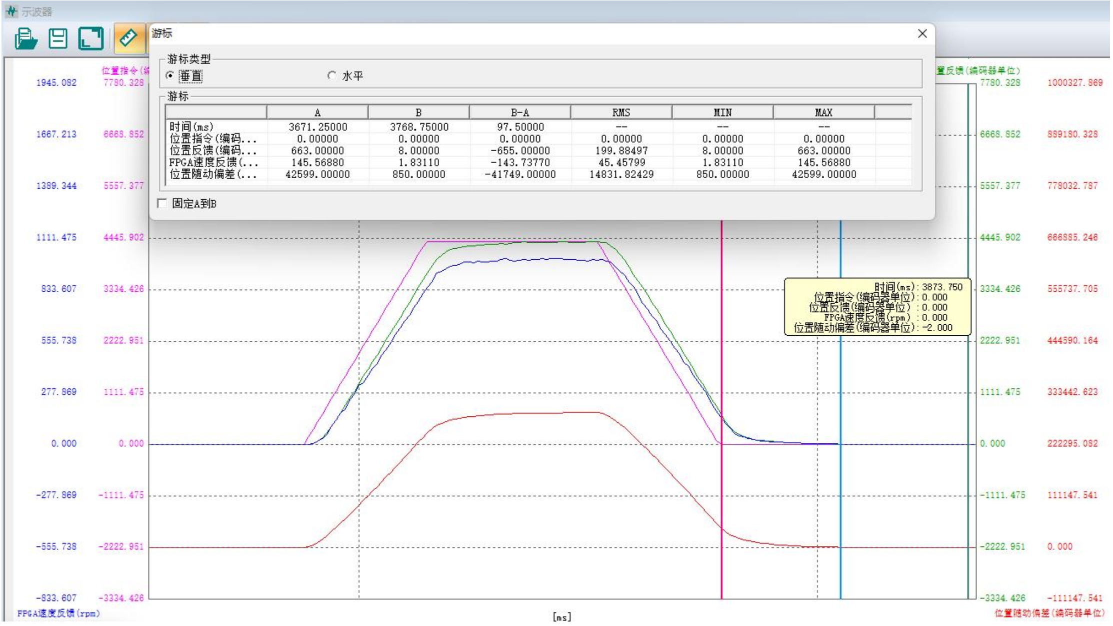
游标

	A	B	B-A	RMS	MIN	MAX
时间(ms)	1597.50000	1642.50000	45.00000	--	--	--
位置指令(编码...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
位置反馈(编码...	755.00000	12.00000	-743.00000	336.39647	12.00000	755.00000
FPGA速度反馈(...	165.71040	1.83110	-163.87930	73.86278	1.83110	165.71040
位置随动偏差(...	38771.00000	1563.00000	-37208.00000	16521.36192	1563.00000	38771.00000

☐ 固定A到B

时间(ms)：1755.000
位置指令(编码器单位)：0.000
位置反馈(编码器单位)：-1.000
FPGA速度反馈(rpm)：0.000
位置随动偏差(编码器单位)：1156.000

Figure 4-7 Waveform of position tracking without velocity integration



游标

游标类型

● 垂直　○ 水平

游标

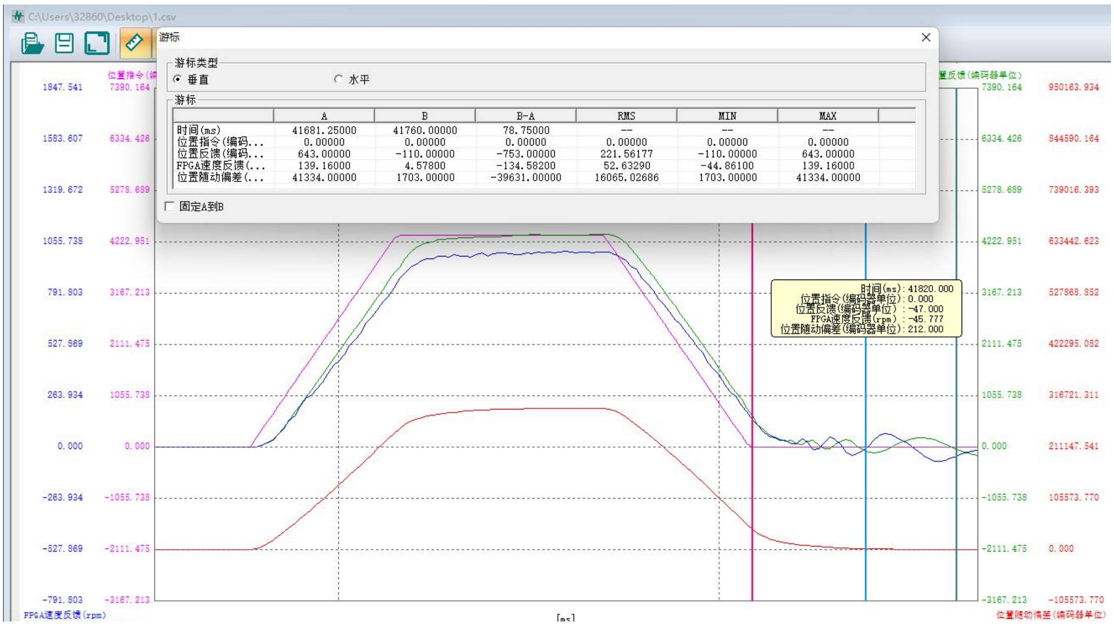
	A	B	B-A	RMS	MIN	MAX
时间(ms)	3671.25000	3768.75000	97.50000	--	--	--
位置指令(编码...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
位置反馈(编码...	663.00000	8.00000	-655.00000	199.88497	8.00000	663.00000
FPGA速度反馈(...	145.56880	1.83110	-143.73770	45.45799	1.83110	145.56880
位置随动偏差(...	42599.00000	850.00000	-41749.00000	14831.82429	850.00000	42599.00000

☐ 固定A到B

时间(ms)：3873.750
位置指令(编码器单位)：0.000
位置反馈(编码器单位)：0.000
FPGA速度反馈(rpm)：0.000
位置随动偏差(编码器单位)：-2.000

Figure 4-8 Waveform of position tracking with velocity integration

By comparing errors! Reference source not found. With errors! Reference source not found., It can be observed that when there are only position gain and velocity gain coefficients without velocity integration, fast positioning can be achieved with steady-state error. Increasing the loop gain can reduce steady-state error; When there is velocity integration, there is no steady-state error, but the tuning time becomes longer.



游标类型

● 垂直　○ 水平

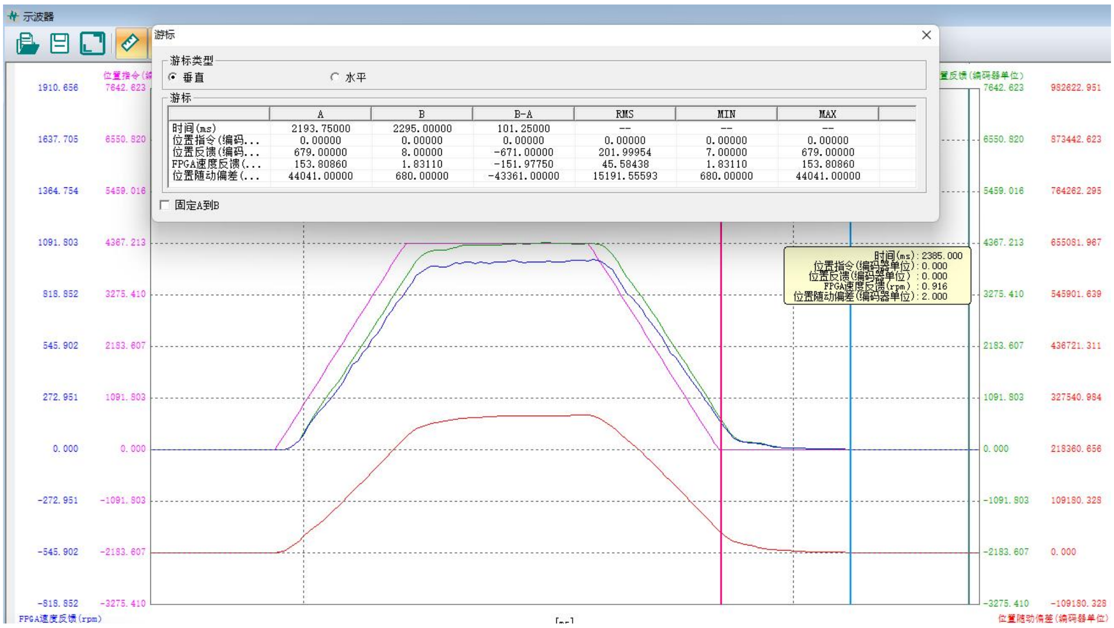
游标

	A	B	B-A	RMS	MIN	MAX
时间(ms)	41681.25000	41760.00000	78.75000	--	--	--
位置指令(编码...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
位置反馈(编码...	643.00000	-110.00000	-753.00000	221.56177	-110.00000	643.00000
FPGA速度反馈(...	139.16000	4.57800	-134.58200	52.63290	-44.86100	139.16000
位置随动偏差(...	41334.00000	1703.00000	-39631.00000	16065.02686	1703.00000	41334.00000

☐ 固定A到B

时间(ms): 41820.000
位置指令(编码器单位): 0.000
位置反馈(编码器单位): -47.000
FPGA速度反馈(rpm): -45.777
位置随动偏差(编码器单位): 212.000

6Figure 4-9 No torque low-pass filtering



游标类型

● 垂直　○ 水平

游标

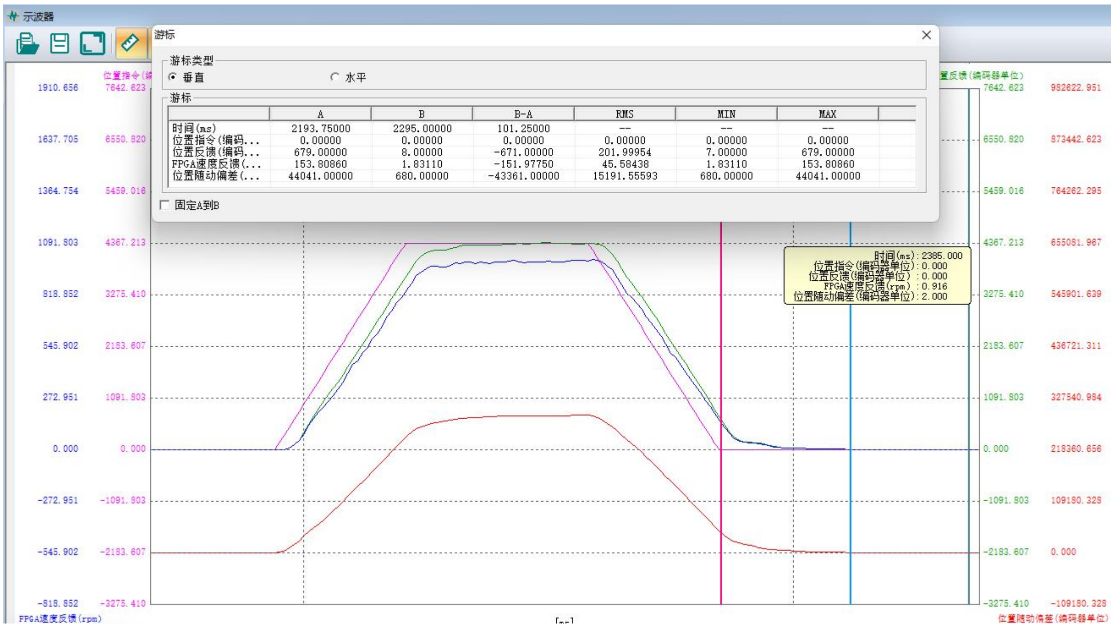
	A	B	B-A	RMS	MIN	MAX
时间(ms)	2193.75000	2295.00000	101.25000	--	--	--
位置指令(编码...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
位置反馈(编码...	679.00000	8.00000	-671.00000	201.99954	7.00000	679.00000
FPGA速度反馈(...	153.80860	1.83110	-151.97750	45.58438	1.83110	153.80860
位置随动偏差(...	44041.00000	680.00000	-43361.00000	15191.55593	680.00000	44041.00000

☐ 固定A到B

时间(ms): 2385.000
位置指令(编码器单位): 0.000
位置反馈(编码器单位): 0.000
FPGA速度反馈(rpm): 0.916
位置随动偏差(编码器单位): 2.000

Figure 4-10: Wiht torque low-pass filtering Tf=4ms

By comparing errors! Reference source not found. And wrong! Reference source not found. It can be observed that adding torque low-pass filtering can eliminate torque oscillation, but the filtering transition frequency is low, the phase lag increases, and the gain cannot be improved, resulting in longer tuning time.



游标

游标类型

● 垂直　○ 水平

游标

	A	B	B-A	RMS	MIN	MAX
时间(ms)	2193.75000	2295.00000	101.25000	--	--	--
位置指令(编码...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
位置反馈(编码...	679.00000	8.00000	-671.00000	201.99954	7.00000	679.00000
FPGA速度反馈(...	153.80860	1.83110	-151.97750	45.58438	1.83110	153.80860
位置随动偏差(...	44041.00000	680.00000	-43361.00000	15191.55593	680.00000	44041.00000

☐ 固定A到B

时间(ms): 2385.000
位置指令(编码器单位): 0.000
位置反馈(编码器单位) : 0.000
FPGA速度反馈(rpm) : 0.916
位置随动偏差(编码器单位): 2.000

Figure 4-11 with torque low-pass filter with Tf=0.2ms

By comparing errors! Reference source not found. And wrong! Reference source not found. It can be found that by setting the torque low-pass filter reasonably, torque oscillation can be eliminated while ensuring fast position adjustment, achieving a good balance between speed and stability.

The specific function codes for gain class and torque control parameters are shown in the table below:

Table 4-4 Index codes for gain class and torque control parameters

	0x2006- Gain class parameter			0x2007- Torque Control Parameter
Subindex	0x01- Speed Proportional Gain 1	0x02- Speed Integral Gain 1	0x03 Position Proportional Gain 1	0x03- Torque Filter 1
Data type	UINT16			
Accessibility	Readable/writable	Readable/writable	Readable/writable	Readable/writable
Unit	Hz	ms	Hz	ms
DeError value	25	31.83	40	0.79
Min.	1	15	1	0
Max.	20000	51200	20000	3000
Setting and effective mode	Stop setting/immediate enable	Stop setting/immediate enable	Stop setting/immediate enable	Stop setting/immediate enable
Related mode	-			
Note	-			

(2) Feedforward control

Speed feedforward

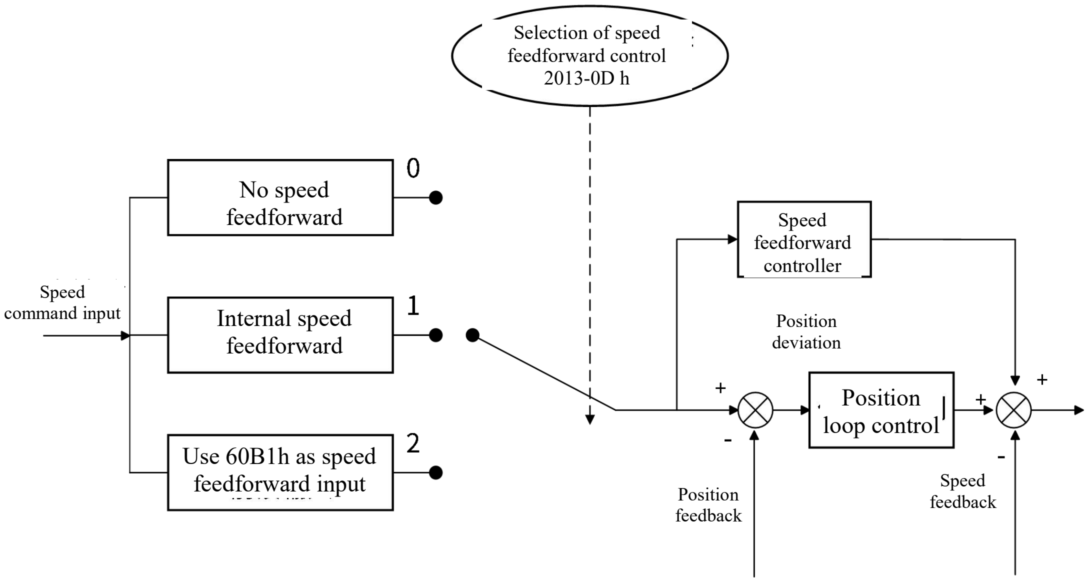


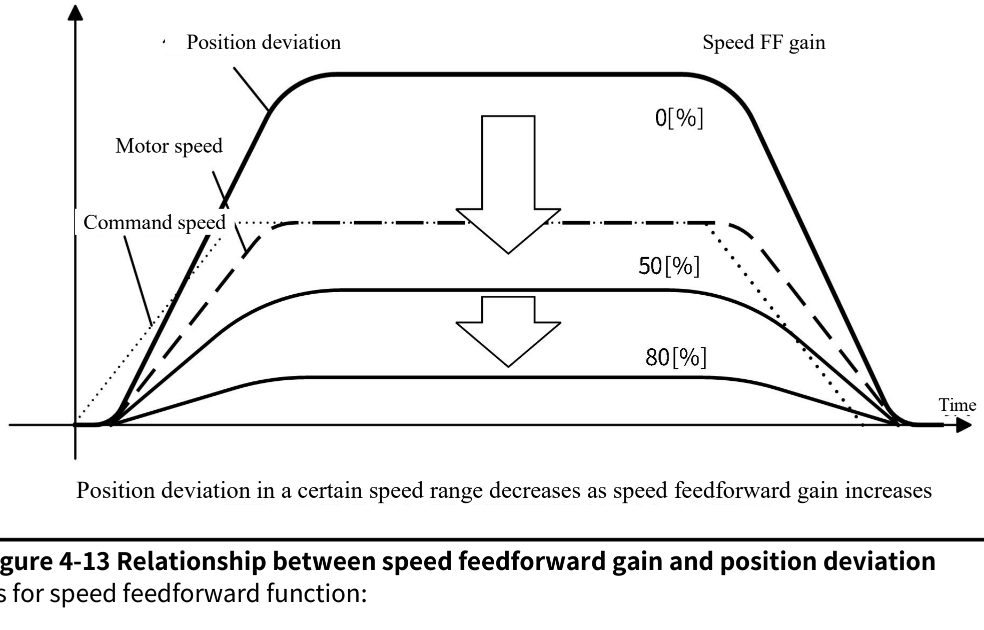
Figure 4-12 Block Diagram of Speed Feedforward Control

In position control mode, the theoretical speed command required for the action is directly calculated through internal position commands, and added to the speed command calculated by the position feedback loop. It is applied to the input of the speed regulator command, which can significantly reduce position tracking errors and improve response performance compared to simple feedback control. Therefore, using the speed feedforward function can improve the speed command response and reduce the position deviation when the speed is fixed.

In theory, the relationship between position deviation and position loop gain, as well as velocity feedforward gain, is shown below. If the speed feedforward gain is set to 100%, theoretically the position deviation will become zero, but an excessively large feedforward gain coefficient will cause excessive speed overshoot during acceleration and deceleration.

When the update cycle of the position command is less than the servo control cycle, the differential operation of speed feedforward will cause significant differential errors, which will be converted into high-frequency torque command components, thereby inducing electromagnetic noise during operation. In this case, please use a position command filter (FIR filter or sliding mean filter), or increase the speed feedforward filter value.

Position deviation [command units] = Command speed [command units/s] / Position loop



Position deviation in a certain speed range decreases as speed feedforward gain increases

Figure 4-13 Relationship between speed feedforward gain and position deviation

Operational steps for speed feedforward function:

A) Set the source of speed feedforward signal
Set 2013-0Dh(Speed Feedforward Control Selection) as a non-0 value, enable speed feedforward function, and the speed feedforward signal source can be selected internally and externally, shown as in the following table.

5Table 4-5 Speed Feedforward Control and Selection of Index Codes

Index codes	Name	Settings	Remarks
2013-0Dh	Selection of speed feedforward control	0: No speed feedforward	-
		1: Internal speed feedforward	Use the velocity data corresponding to position command as the source of the velocity feedforward signal.
		2: Use 60B1h as speed feedforward input	Use 60B1h speed bias (instruction unit/second) as the source of the speed feedforward signal. By using bit 6 of 607Eh (polarity), polarity of the velocity feedforward signal can be changed at this time.

B) Set speed feedforward parameters
Including speed feedforward gain (2006-09h) and speed feedforward filtering time (2007-07h).

6Table 4-6 Index codes for speed feedforward parameters

Index codes	Name	Adjustment instructions
2007-07h	Velocity feedforward filtering time	Reducing filtering time can suppress speed overshoot of acceleration and deceleration; Increasing the filtering time can suppress noise in situations where the update cycle of the position command is longer than the control cycle of the driver, and the pulse frequency of the position command is uneven, thus suppressing the jitter of the positioning completion signal;
2006-09h	Speed feedforward proportional gain	See error! Reference source not found.

Torque feedforward

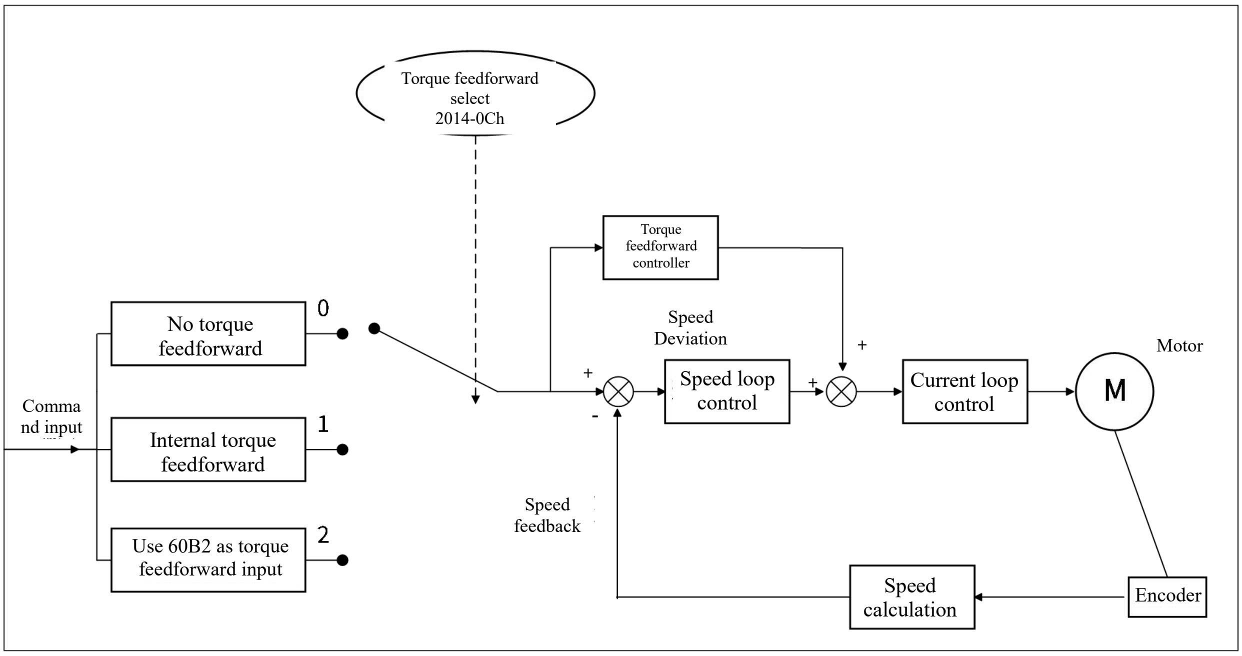
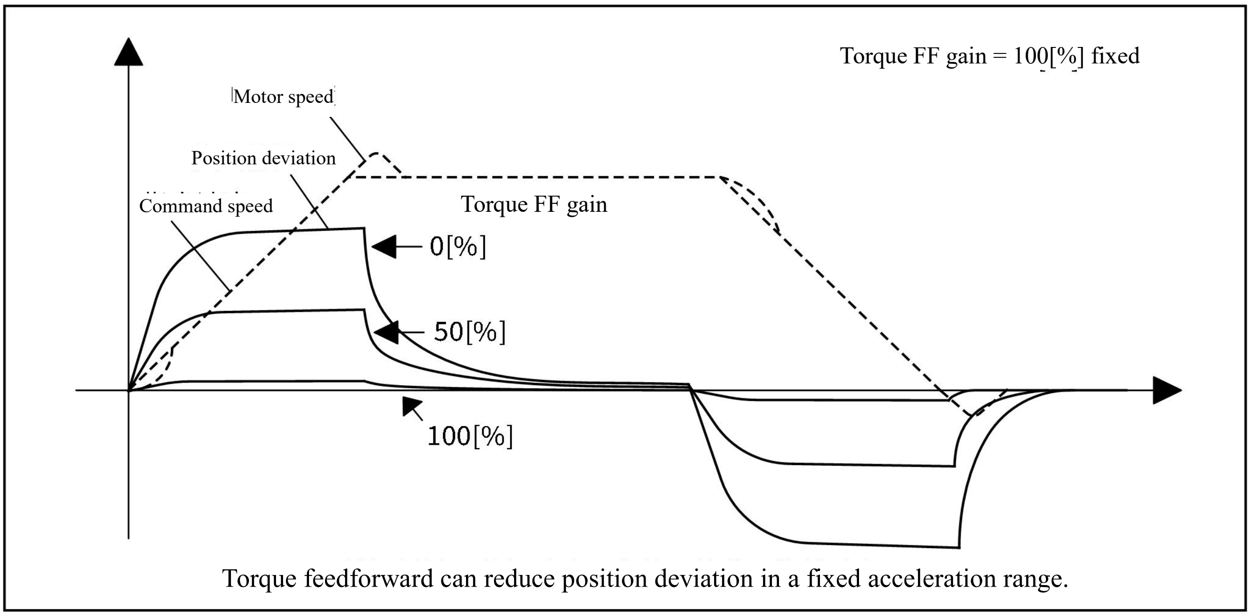


Figure 4-14 Torque Feedforward Control Operation Diagram

Position control mode, using torque feedforward can improve dynamic velocity response and reduce position deviation during fixed acceleration/deceleration; To use torque feedforward, it is necessary to set the correct load torque inertia ratio. Please refer to the mechanical load identification results in Section 0. The torque feedforward gain is set to a non-zero value, and the torque feedforward function is enabled. By increasing the torque feedforward gain, the position deviation during constant acceleration /deceleration can be controlled to around 0, and the trapezoidal motion curve can be perfectly tracked without external torque interference.



12Figure 4-15 Relationship between torque feedforward gain and position deviation of acceleration and deceleration sections

Operation steps for torque feedforward function:

A) Set the source of torque feedforward signal

Set 2014-0Ch (torque feedforward control selection) as non-zero value, enable the torque feedforward function. The feedforward signal source can be selected from internal and external sources, as shown in the table below.

Table 4-7 Parameter Index Code for Speed Feedforward Control Selection

Index codes	Name	Settings	Remarks

2014-0Ch	Selection of torque feedforward control	0: No torque feedforward	-
		1: Internal torque feedforward	Use speed command as the source of torque feedforward signal. In position control mode, the speed command comes from the output of the position controller.
		2: Use 60B2h as torque feedforward input	Use 60B2h (torque bias, 0.1%) as the source of torque feedforward signal. By using bit 5 of 607Eh (polarity), the polarity of the torque feedforward signal can be changed at this time.

B) Set torque feedforward parameters

Including torque feedforward proportional gain (2006-0A) and torque feedforward filtering time (2007-08).

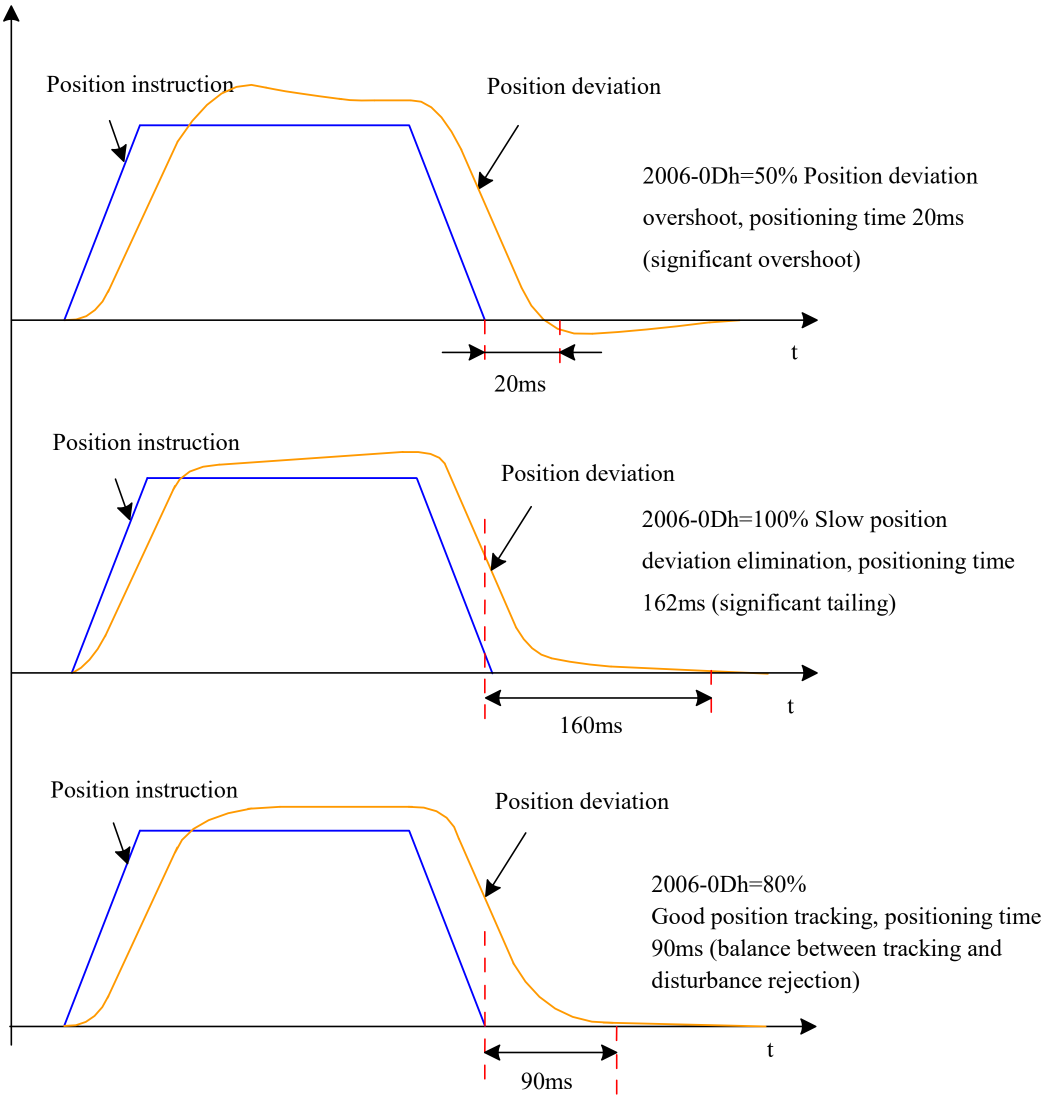
Table 4-8 Index codes for speed feedforward parameters

Index codes	Name	Adjustment instructions
2006-0Ah	Torque feedforward proportional gain	Increasing the proportional gain can improve response, but overshoot may occur during acceleration/deceleration; Reducing filtering time can suppress overshoot during acceleration and deceleration; Increasing the filtering time can suppress noise; Adjustment method: When adjusting, first, keep the filtering time at the deError value; Then, gradually increase the proportional gain setting value from 0 until the torque feedforward effect is achieved at a certain setting value. When adjusting, the settings of 2006-0Ah and 2007-08h should be repeatedly adjusted to find a balanced setting
2007-08h	Torque feedforward filtering time	

(3) Two-degree-of-freedom control

In non torque control mode, two-degree-of-freedom control coefficient can be used to improve the control effect, set to 100%, which is the normal PI control mode; Setting it other than 100%, i.e.,two-degree-of-freedom control, which can be used to increase resistance to external forces and improve velocity response waveforms.

The following figure shows the improvement of the two-degree-of-freedom control coefficient on slow speed increase and slow positioning completion.



13Figure 4-16 Example of two-degree-of-freedom Control

two-degree-of-freedom control enhances the anti-interference ability of the velocity loop and improves its ability to follow speed commands by adjusting the velocity loop control method.

9Table 4-9 Index codes for two-degree-of-freedom feedforward coefficients

Index codes	Name	Adjustment instructions
2006-0Dh	Two-degree-of-freedom feedforward coefficient	Parameter function: The control method for changing the speed loop in non torque control mode. Adjustment method: The setting of 2006-0Dh is too small, resulting in slow speed loop response; When overshoot exists in velocity feedback, gradually reduce 2006-0Dh from 100.0 until the two-degree-of-freedom control achieves effect at a certain set value. When 2006-0Dh=100.0, the velocity loop control method remains unchanged and deErrors to proportional integral control.

4.2.3 Gain Switching

The gain switching function is only effective in position and speed control mode and can be triggered by the internal state of the servo or external DI. Using gain switching can have the following effects:

When the motor is enabled to be stationary, the position latched state can be switched to a lower gain to suppress vibration and reduce static noise;

During the motor stop process, when the position is set, it can be switched to a higher gain to shorten the positioning time;

It is possible to switch to a higher gain during motor operation to achieve better command tracking performance;

Different gain settings can be switched through external signals based on the load device situation.

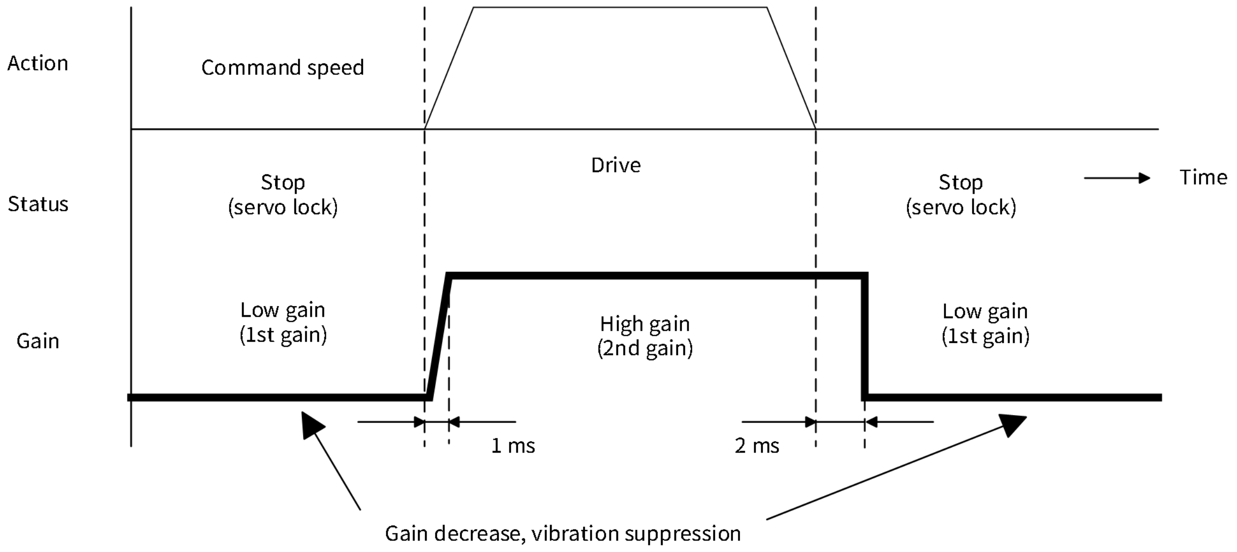


Figure 4–14 Gain Switching Diagram

give an example:

In the application scenario of LED die bonder, there is a demand for high-speed, high-precision and high response servo, which is a typical application of fast positioning P2P. The gain switching function is adopted to ensure fast setting requirement and reduce the noise when the servo is enabled to be stationary.

Table 4-10 Steps for peed gain adjustment

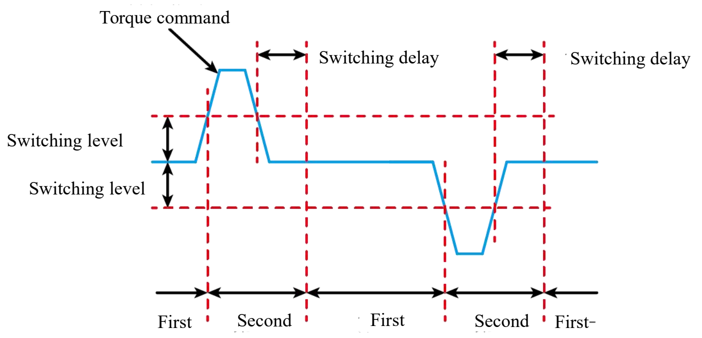
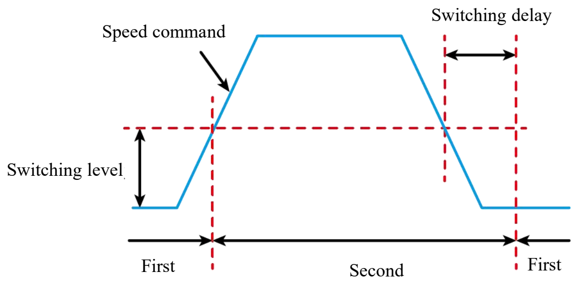
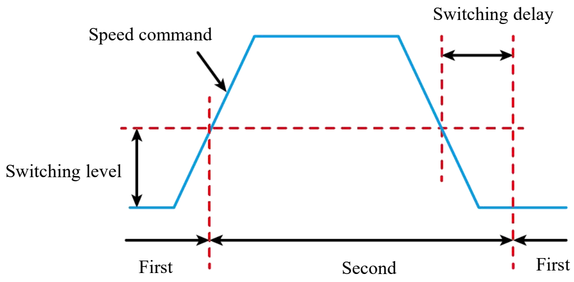
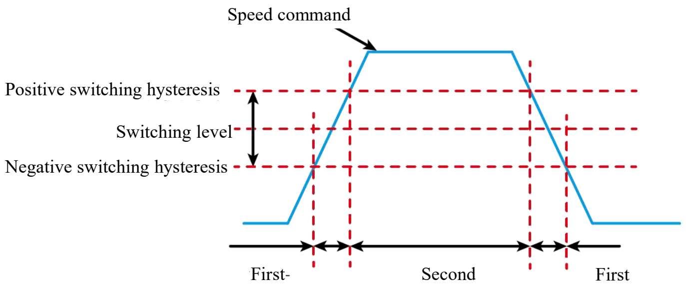
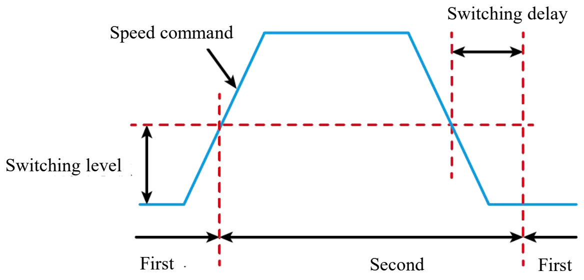
Parameter group	Steps for gain switching adjustment	Not using gain switching, adjust the gain manually		The second gain is set the same as base gain		Enable gain switching function		In static state, adjust the first group of gain parameters, eliminate static noise
P06	Velocity proportional gain 1	35.0Hz						27.0Hz
P06	Velocity integral gain 1	16.00ms						
P06	Position proportional gain 1	63.0Hz						
P07	Torque filtering 1	0.65ms						0.84ms
P06	Velocity proportional gain 2		→	35.0Hz	→		→	
P06	Velocity integral gain 2			16.00ms				
P06	Position proportional gain 2			63.0Hz				
P07	Torque filtering 2			0.65ms				
P06	Gain switching - Mode selection	0				1		
P06	Gain switching - Condition selection					10		
P06	Load inertia ratio	Obtained by inertia identification						

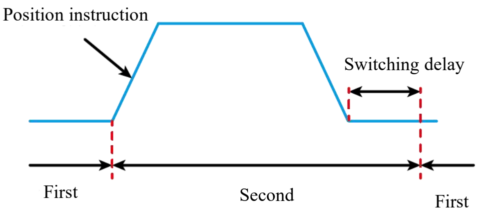
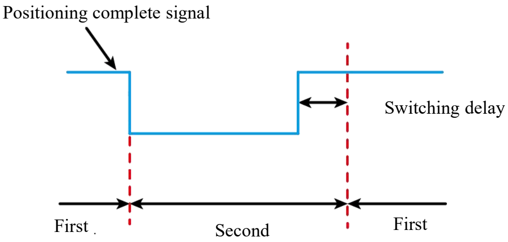
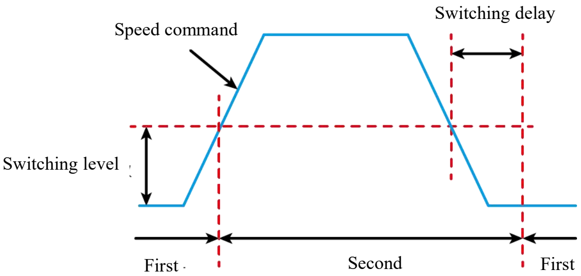
SV3 servo supports the following 10 gain switching methods, including 1 external DI switching and 9 switching methods upon internal motion status of the servo:

0: The first gain is fixed (PS)
1: Use external DI for switching (PS)
2: Torque instruction (PS)
3: Speed instruction (PS)
4: Speed instruction change rate (PS)
5: High/low speed threshold of speed instruction (PS)
6: Position deviation (P)
7: With position instruction (P)
8: Positioning is incomplete (P)
9: Actual speed (P)
10: With position instruction + actual speed (P)

Herein, (P) represents that that switching method only supports position control mode; (PS) represents that the switching method supports both position control and speed control modes. Below is the detailed instructions about the 9 internal switching methods of the servo.

Table 4-11 Change Diagram of Internal Switching Method of Servo

Gain switching method	Switching method change diagram
2: Torque instruction	
3: Speed instruction	
4: Speed instruction change rate	
5: High/low speed threshold of speed instruction	
6: Position deviation	

Gain switching method	Switching method change diagram
7: Position instruction	
8: Positioning is completed	
9: Actual speed	
10: With position instruction + actual speed	Combination of method 7 and method 9 is generally chosen to ensure fast and stable setting in place

⚠ Note:

The delay time '06-12h' is only valid when the second gain is switched into the first gain.

12Table 4-12 Index codes for gain class parameters

0x2006- Gain class parameter						
Subindex	0x10- Gain Switching - Mode Setting	0x11- Gain Switching - Condition Selection	0x12- Gain Switching - Delay	0x13- Gain Switching - Level	0x14- Gain Switching - Time Delay	0x15- Gain Switching - Time
Data type	UINT16					
Accessibility	Readable/writable	Readable/writable	Readable/ writable	read-only		read-only
Unit	-	-	ms	-	-	ms
DeError value	1	0	5.0	50	30	3.0
Min.	0: The first gain fixed, use external DI for P/PI switching 1: Switching between the first gain and the second gain is valid, and the switching condition is P06.16	0: The first gain fixed (PS) 1: Switching by external DI (PS) 2: High torque instruction(PS) 3: High speed instruction(PS) 4: High change rate of speed instruction(PS) 5: Speed instruction high/low speed threshold (PS) 6: Large positional deviation (P) 7: With position instruction (P) 8: Positioning is uncompleted (P) 9: Actual speed (P) 10: With position instruction+actual speed (P)	0	0	0	0
Max.			1000	20000	20000	1000
Setting and effective mode	Run settings/Effective immediately	Run settings/Effective immediately	Stop setting/immediate enable	Stop setting/immediate enable	Stop setting/immediate enable	Stop setting/immediate enable
Related mode	-					
Note	-					

4.2.4 Automatic gain adjustment

Automatic gain adjustment refers that SV3 servo drive automatically generates a set of matching basic gain parameters upon parameter settings of "P1A Group - Advanced Adjustment Function - Response Level Selection" so as to meet the requirement on speed and stability.
SV3 servo provides 2 automatic gain adjustment modes: 1. Basic mode; 2. Positioning mode.

⚠ Note:

Before using the automatic gain adjustment function, it is essential to correctly obtain the load inertia ratio!

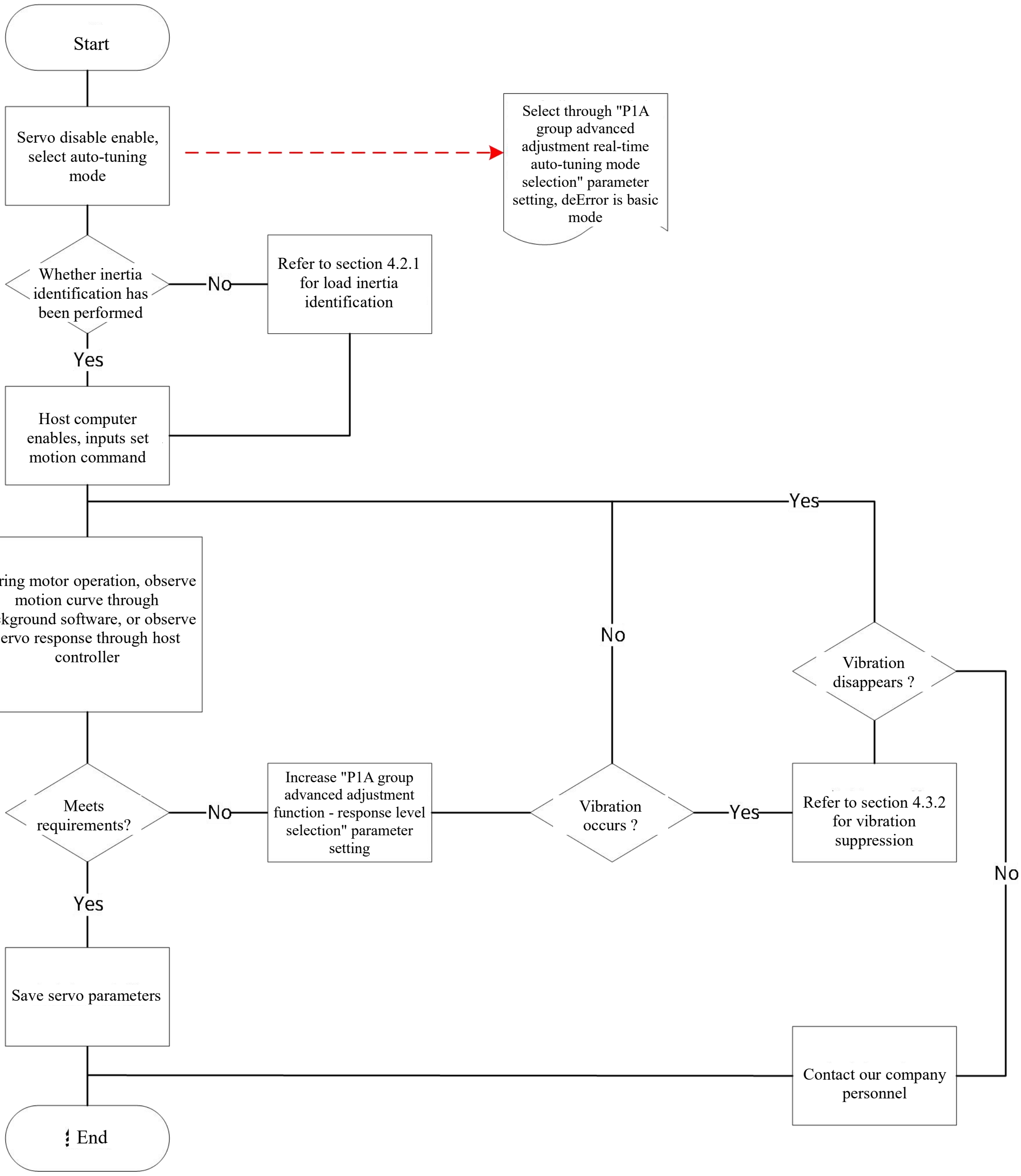


Figure 4-18 Steps for automatic gain adjustment

(1) Standard rigid table mode

Real-time automatic gain adjustment - Standard rigid table mode(201A-01h=1) is suitable for most of situations, with response levels (201A-02h) ranging from 0 to 40 levels. The higher response level means the stronger gain and the faster response. Based on different load types, the following empirical values are for reference:

13Table 4-13 Response Level Reference

Recommended response level	Type of load mechanism
Level 4 to Level 8	Some large machinery
Level 8 to Level 15	Applications with low rigidity such as belt
Level 15-20	Applications with high rigidity such as ball screws and direct connections
Level 20-40	Directly connected high rigidity, small inertia load application

Real-time automatic adjustment of standard rigid table mode (201A-01h=1), basic gain (2006-01h~206-03h, 2007-03h) parameters, automatically updated according to the response level set in 201A-02h and stored in the corresponding index code:

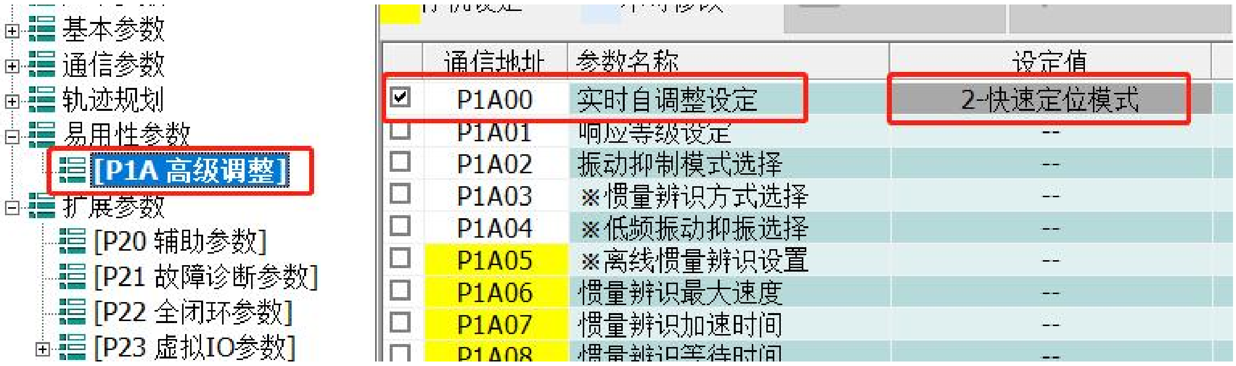
14Table 4-14 Real-time automatic adjustment mode with automatic parameter update

Index codes	Name
2006-01h	Velocity proportional gain 1
2006-02h	Velocity integral gain 1
2006-03h	Position proportional gain 1
2007-03h	Torque filtering 1

(2) Quick positioning mode

Quick positioning mode (201A-01h=2)

The parameter settings on the background software are as follows:,



	通信地址	参数名称	设定值
☑	P1A00	实时自调整设定	2-快速定位模式
☐	P1A01	响应等级设定	--
☐	P1A02	振动抑制模式选择	--
☐	P1A03	※惯量辨识方式选择	--
☐	P1A04	※低频振动抑振选择	--
☐	P1A05	※离线惯量辨识设置	--
☐	P1A06	惯量辨识最大速度	--
☐	P1A07	惯量辨识加速时间	--
☐	P1A08	惯量辨识等待时间	--

16Figure 4-19 Quick positioning mode setting

The quick positioning mode inside SV3 servo automatically realizes the gain switching function in Section 0 and the feedforward control function in Section 4.2.2, organically combining the two to realize the quick positioning function. Upon "Automatic Adjustment Standard Rigid Table Mode", the second gain parameter (2006-04h~2006-06h, 2007-04h) is also automatically updated and stored in the corresponding index code according to the response level set in 201A-02h, and the position loop gain of the second gain parameter should be 1 response level higher than the first gain parameter.

Table 4-15: Automatic Parameter Update for Quick Positioning Mode

Index codes	Name

2006-04h	Velocity proportional gain 2
2006-05h	Velocity integral gain 2
2006-06h	Position proportional gain 2
2007-04h	Torque filtering 2

The parameters related to speed feedforward are set to fixed values:

Table 4-16 Fixed Parameters for Quick Positioning Mode

Index codes	Name	Parameters
2006-08h	Speed feedforward proportional gain	30.0%
2006-07h	Velocity feedforward filtering time	0.50ms

The parameters related to gain switching are set to fixed values:

In fast positioning mode, gain switching function is automatically enabled.

Table 4-17 Gain Parameters of Fast Positioning Mode

Index codes	Name	Parameters	Remarks
2006-10h	Gain switching - Mode selection	1	In fast positioning mode, the switching between the first gain (2006-01h~206-03h, 2007-03h) and the second gain (2006-04h~206-06h, 2007-04h) is valid; Maintain the original settings other than fast positioning mode.
2006-11h	Gain switching - Condition selection	10	In fast positioning mode, the gain switching condition is 2008-0Ah=10; Maintain the original settings other than fast positioning mode.
2006-12h	Gain Switching - Delay	5.0ms	In fast positioning mode, gain switching delay time is 5.0ms; Maintain the original settings other than fast positioning mode.
2006-13h	Gain Switching - Level	50	In fast positioning mode, gain switching level is 50; Maintain the original settings other than fast positioning mode.
2006-14h	Gain switching - time delay	30	In fast positioning mode, gain switching delay is 30; Maintain the original settings other than fast positioning mode

⚠ Note:

In automatic gain adjustment mode, parameters that are automatically updated with response level selection (201A-02h); Parameters with fixed values can't be manually modified. In order to modify it, it must set 201A-01h of 0 and exit the real-time automatic adjustment mode.

Table 4-18 Advanced Adjustment Index Codes

0x201A - Advanced Adjustment		
Subindex	0x01- Real time self-adjusting settings	0x02- Response Level Setting
Data type	UINT16	
Accessibility	Readable/writable	Readable/writable
Unit	-	-
DeError value	7	16
Min.	0: Invalid 1: Standard rigid table mode 2: Quick positioning mode 5: Adaptive interpolation mode 7: Adaptive positioning mode	0
Max.		40
Setting and effective mode	Run settings/Effective immediately	Run settings/Effective immediately
Related mode	PST	
Note	-	

4.3 Vibration suppression

4.3.1 Notch Filter

When the servo gain coefficient is relatively large, high-frequency vibration components can't be effectively attenuated, that would trigger system resonance. In order to maintain the servo response performance and drive the mechanical load smoothly without reducing the gain, it rquires to effectively suppress resonance. Generally, servo manufacturers will install notch filter in the front channel of control loop to attenuate loop gain amplitude at the resonance point by a fixed point so as to realize vibration suppression.

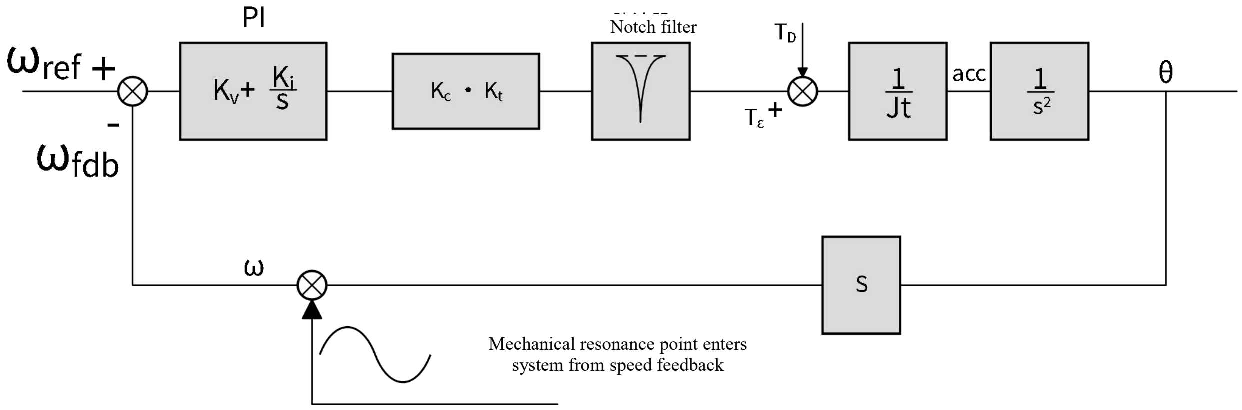


Figure 4-20 Block Diagram of Resonance Suppression Control

Transfer function of notch filter is

$$G_{notch}(s) = \frac{s^2+2\zeta_1\omega_n s+\omega_n{}^2}{s^2+2\zeta_2\omega_n s+\omega_n{}^2}$$

4.3.2 Vibration Suppression

SV3 servo has the built-in adaptive vibration suppression algorithm, which extracts vibration components from motor speed during actual operation, calculates the resonance frequency, and sets relevant parameters of adaptive notch filter automatically so as to realize vibration suppression.

(1) Automatic notch filter

To enable the adaptive notch filter function, just set "P1A Group - Advanced Adjustment - Vibration Suppression Mode Selection" of 1 or 2 in the backend software; SV3 servo supports up to 4 adaptive notch filters. When the system has 5 or more resonance points, it shall manually set the notch filters. It supports up to 4 different notch frequency settings.

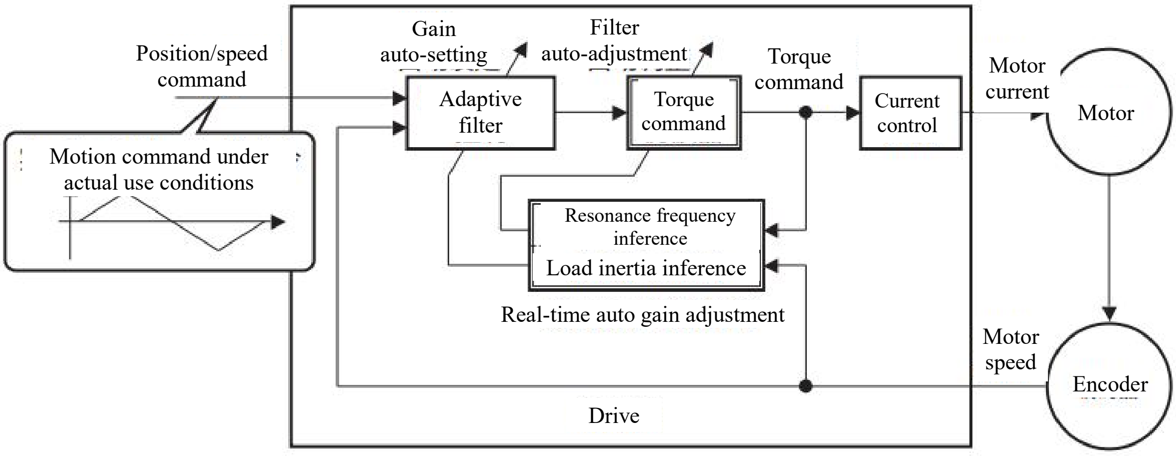


Figure 4-21 Block diagram of adaptive vibration suppression principle

⚠ Note:

Under the following conditions, it might be impossible to perform normal automatic vibration suppression. In this situation, please perform manual vibration suppression.

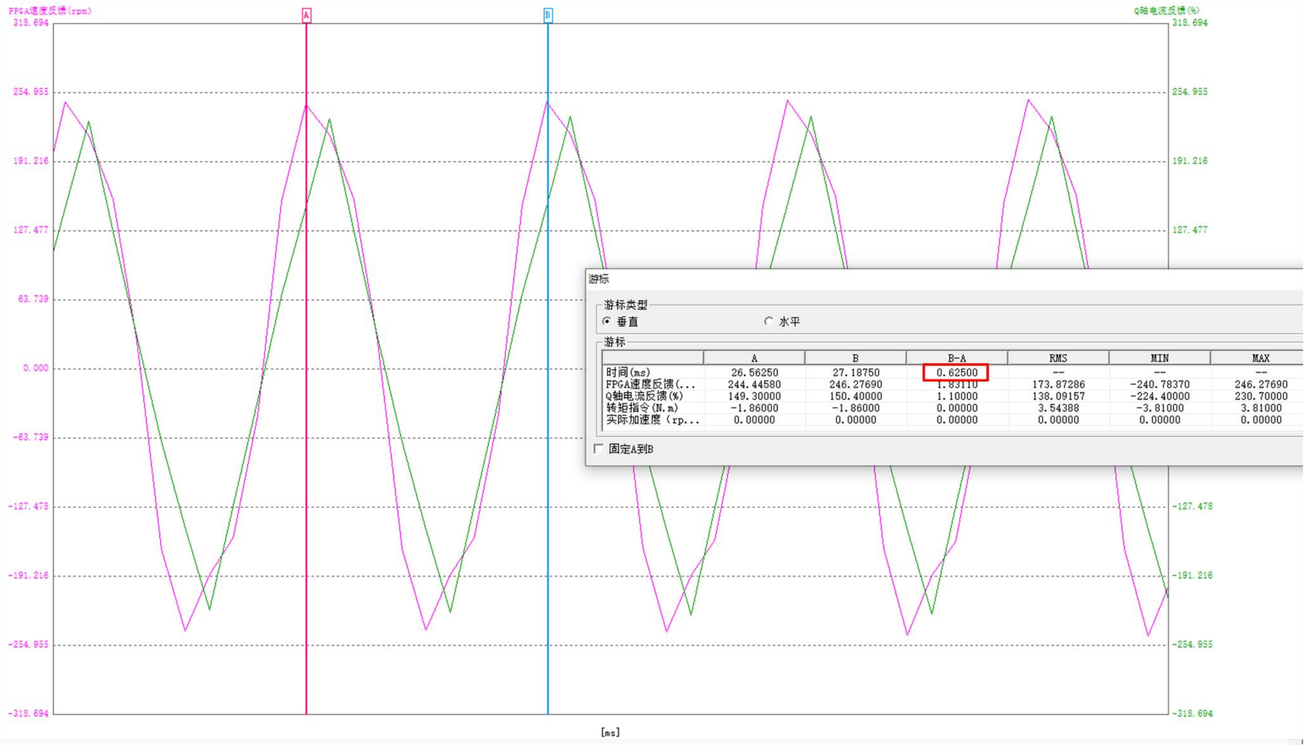
Table 4-19 Factors of Adaptive Vibration

	Factors of adaptive vibration suppression
Resonance characteristics	When resonance frequency is lower than the velocity response frequency When 3 or more resonance points exist When vibration amplitude is small, or control gain is low, and the impact on motor speed is nonsignificant
Mechanical properties	Nonlinear factors such as excessive tooth clearance in operation or excessive backlash in forward/reverse rotation, e.g., misaligned gear installation in gear transmission mechanism Vibration components randomly appear and last for a short period
Movement conditions	Rapid acceleration/deceleration, when acceleration is greater than 30000rpm/s When the servo operates in torque mode

(2) Manual notch filter

A) Analyze resonance frequency;
Using the manual notch filter, it's necessary to set the notch filter frequency as actual resonance frequency.
The resonance frequency can be obtained by driving the oscilloscope interface of debugging platform, and there are 2 methods as follows:
Obtained by the motor current displayed on oscilloscope interface(phase current/torque command/current feedback). As shown in the figure below, the measured period is 0.625ms, and the calculated resonance frequency is:

$$f = 1/t = 1600 \text{ Hz}$$



	A	B	B-A	RMS	MIN	MAX
时间(ms)	26.56250	27.18750	0.62500	--	--	--
FPGA速度反馈(...	244.44580	246.27690	1.83110	173.87286	-240.78370	246.27690
Q轴电流反馈(%)	149.30000	150.40000	1.10000	138.09157	-224.40000	230.70000
转矩指令(N.m)	-1.86000	-1.86000	0.00000	3.54388	-3.81000	3.81000
实际加速度（rp...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

☐ 固定A到B

Figure 4-22 Screenshot of resonance frequency test ,on the background software

① Obtained by "resonance point identification" function on oscilloscope interface. As shown in the figure below, the measured resonance frequency is 1593.750Hz.

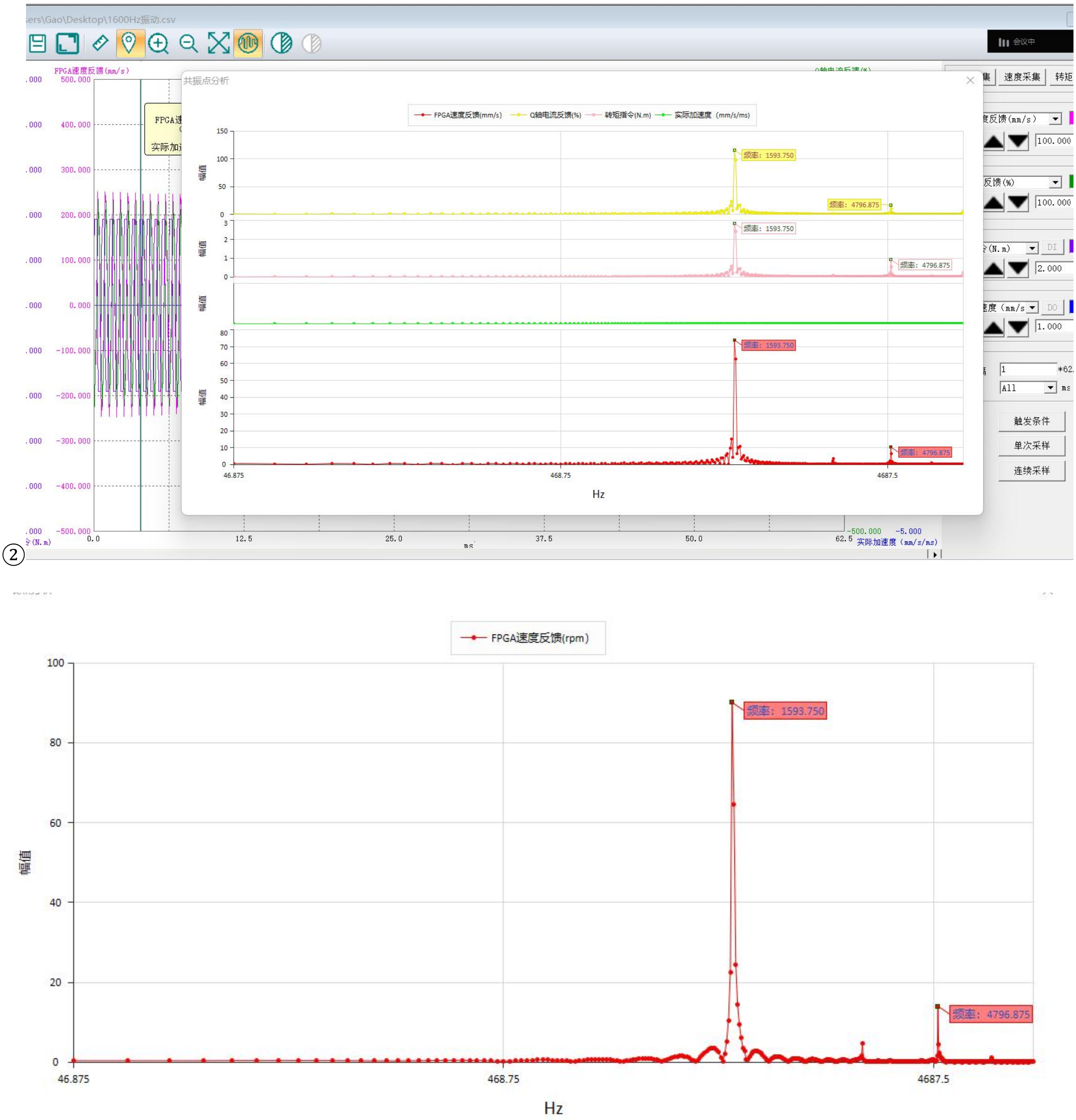


Figure 4-23 Screenshot of Resonance Point Identification Function on Backeground Software

B) Input the resonance frequency obtained in Step A) into notch frequency parameter of a notch filter, and other parameters generally don't need to be set;

	通信地址	参数名称	设定值	当前值	出厂值	单位	取值范围
□	P0710	振动抑制频率1	--	--	5000	Hz	[50, 5000]
□	P0711	振动抑制带宽1	--	--	2	-	[0, 20]
□	P0712	振动抑制衰减1	--	--	0	-	[0, 99]
□	P0713	振动抑制频率2	--	--	5000	Hz	[50, 5000]
□	P0714	振动抑制带宽2	--	--	2	-	[0, 20]
□	P0715	振动抑制衰减2	--	--	0	-	[0, 99]
□	P0716	振动抑制频率3	--	--	5000	Hz	[50, 5000]
□	P0717	振动抑制带宽3	--	--	2	-	[0, 20]
□	P0718	振动抑制衰减3	--	--	0	-	[0, 99]
□	P0719	振动抑制频率4	--	--	5000	Hz	[50, 5000]
□	P0720	振动抑制带宽4	--	--	2	-	[0, 20]
□	P0721	振动抑制衰减4	--	--	0	-	[0, 99]
□	P0722	振动抑制频率5	--	--	5000	Hz	[50, 8000]
□	P0723	振动抑制带宽5	--	--	2	-	[0, 20]
□	P0724	振动抑制衰减5	--	--	0	-	[0, 99]
□	P0725	振动抑制频率6	--	--	5000	Hz	[10, 5000]
□	P0726	振动抑制带宽6	--	--	2	-	[0, 20]
□	P0727	振动抑制衰减6	--	--	0	-	[0, 99]

Figure 4-24: Parameter Settings of Notch Filter

If resonance is suppressed, it proves that the notch filter is effective and the gain can be further adjusted. If new resonance occurs after the gain increases, repeat steps A) to B);

If vibration can't be eliminated for a long time, please turn off the servo enable in time to reduce the loop gain.

(3) Low-pass filter

It may also attenuate the amplitude of all high-frequency vibration components above the transition frequency to below the sensitive value by means of appropriate torque low-pass filter.

The torque command filtering can be set in 2 ways,

Background debugging software "P07 Group filtering parameters - torque filtering"

Object Dictionary Object Word (2007-03h)

By setting a filtering-time constant, make the high-frequency range above the cutoff frequency in torque command be attenuated so as to suppress mechanical resonance.

The setting parameter for torque low-pass filtering is the filtering-time constant, with a unit of 0.01ms. The conversion relationship between the filtering-time constant τm and the filter cutoff frequency ƒc is:

$$f_c = \frac{1}{2\pi \times \tau_m \times 0.001}$$

4.4 Common Application Scenarios

4.4.1 Load of ball screw

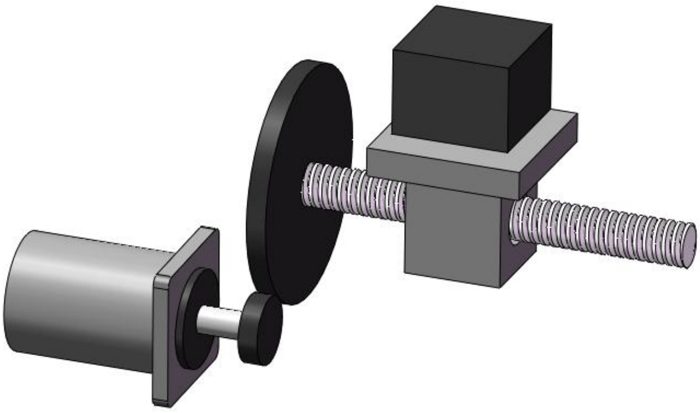


Figure 4-25 Ball screw transmission

(1) Feature of ball screw

Low friction resistance, the difference of dynamic and static friction forces is extremely small, ensure stable movement and avoid low-speed crawling. Low wear, long lifespan, and good precision retention.

After pre-tightening with double nuts, the clearance can be effectively eliminated and transmission stiffness is high.

Low friction loss, high transmission efficiency, up to 90% to 96%.

(2) Debugging precautions

The stiffness of screw load transmission is relatively high, and it is generally easy to adjust. If the inertia ratio is reasonable, only the inertia needs to be identified, and automatic gain adjustment can be performed according to Section 4.2.4 Automatic Gain Adjustment.

If high response performance is required, it is necessary to manually adjust the gain according to Section 4.2.2 Introduction on Manual Gain Adjustment, and even resonance analysis and suppression are required. Refer to Chapter 4.3 Vibration Suppression.

4.4.2 Synchronous Belt Load

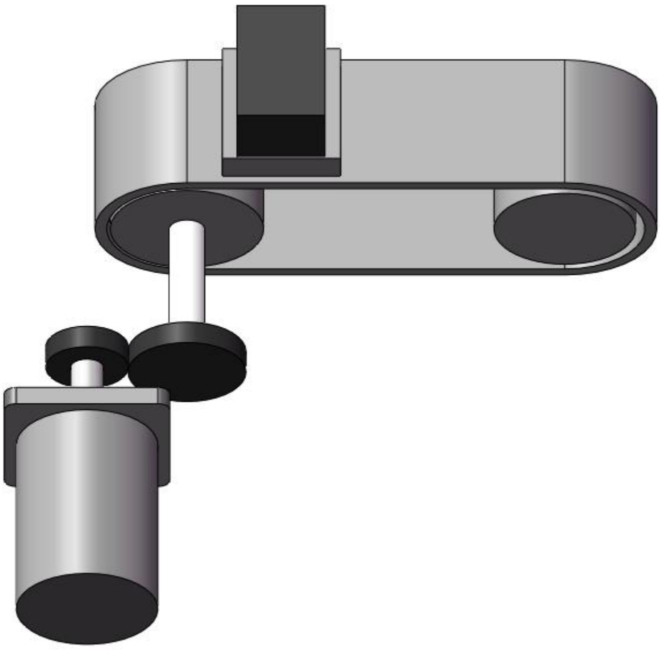


Figure 4-26 Synchronous belt transmission

(1) Feature of synchronous belt transmission

During operation, convex teeth of the synchronous belt mesh with teeth grooves of the belt to transmit motion and power.

During operation, as no sliding exists and and it has accurate transmission ratio, it's called synchronous belt.

High transmission efficiency and good energy-saving effect. It has a high transmission efficiency, generally up to 98%.

Range of transmission ratio is large, the structure is compact, and the rigidity is weak.

(2) Debugging precautions

Short synchronous belt is easy to test. In the case of reasonable inertia ratio, it's only necessary to identify the inertia ratio and perform automatic gain adjustment.

If the synchronous belt is relatively long and has a large inertia, it's prone to overshoot during operation. The requirement for position command forms is high, and position command filtering can be performed under the servo.

4.4.3 Rack and pinion load

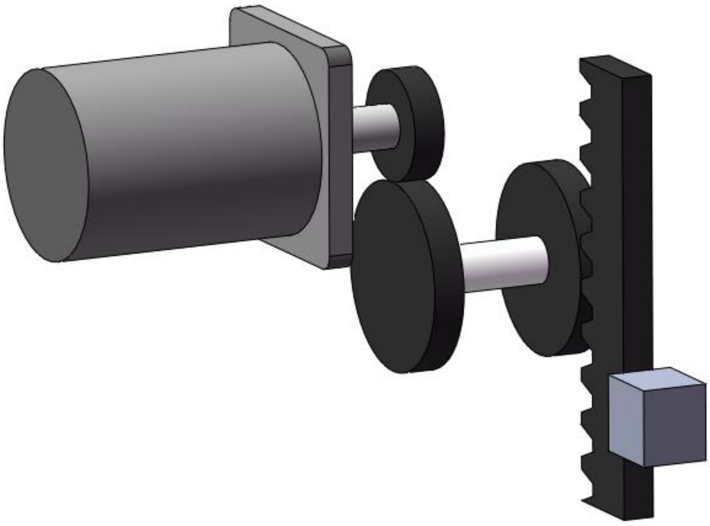


Figure 4-27 Gear and Rack Transmission

(1) Feature of Gear and Rack Transmission

Be able to configure larger reduction ratio, strong load driving capability. Increase output torque by reducing load operating speed.

Backlash of the transmission is big, that may lose partial transmission accuracy.

(2) Debugging precautions

Generally, reducer can effectively reduce the load inertia ratio, so such equipment has a relatively small inertia ratio and is easy to test. Generally, automatic gain adjustment is used.

The installation rigidity of rack at different positions may vary, and the machining accuracy of rack may differ. It's necessary to ensure that no vibration or operating noise occurs in the full-run range.

4.4.4 Inertia disk load

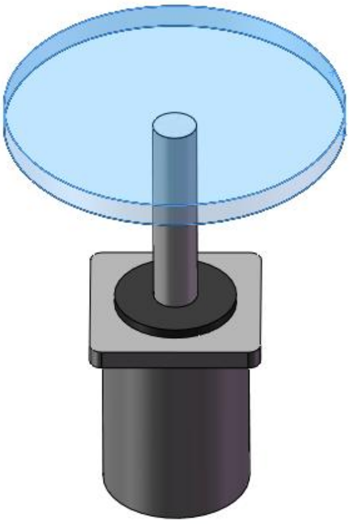


Figure 4-28 Directly connected inertia disk

(1) Load feature of directly connected inertia disk

Directly connected inertia disk load has good transmission accuracy.

Highly synchronized with motor, no backlash, high transmission rigidity.

Anti-resonance frequency is low. Max. bandwidth available of system shall be lower than anti-resonance points, besides being far away from resonance point.

(2) Debugging precautions

As this connection will inevitably bring a large inertia ratio to motor, speed gain can't be set too high.

Vertical installation condition of motor is generally used in indexing control applications, requiring fast and accurate start/stop.For adjustmnet, refer to Gain Switching in Section 4.2.3.

Horizontal installation condition of motor generally has a larger inertia and is more prone to vibration; The gain can't be set too high, that requires resonance analysis and suppression.

4.4.5 Long cantilever load

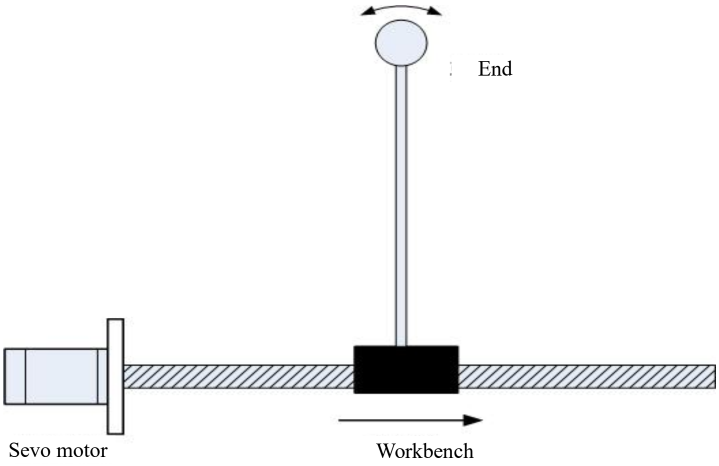


Figure 4-29 Long cantilever load

For long cantilever load, there is usually end jitter or overall equipment swing in high-speed motion. Vibration can be suppressed by eliminating frequency components from position command. SV3 servo provides a damping filter that can effectively suppress end jitter. Parameter "P07 group filtering parameters - position notch frequency A" can be set by the backend software to suppress low-frequency jitter.

- 基本参数
  - [P03 IO参数]
  - [P04 运动控制参数]
  - [P05 功能设置参数]
  - [P06 增益参数]
  - [P07 滤波参数]
  - [P08 保护参数]
  - [P09 显示参数]
- 通信参数
  - [P0A 通信参数]
- 轨迹规划
  - [P13 位置控制参数]
  - [P14 速度控制参数]
  - [P15 转矩控制参数]
  - [P16 预设速度任务参数]
  - [P17 预设位置任务参数]
- 易用性参数

□	P0725	振动抑制频率6	--	--	5000	Hz
□	P0726	振动抑制带宽6	--	--	2	-
□	P0727	振动抑制衰减6	--	--	0	-
□	P0734	※转矩二阶滤波频率	--	--	5000	Hz
□	P0735	※转矩二阶滤波Q值	--	--	0.500	-
□	P0736	※位置调节器输出滤波...	--	--	0.00	ms
□	P0737	※输入整形滤波频率A	--	--	100.0	Hz
□	P0738	※输入整形滤波阶数A	--	--	2	阶
□	P0739	※输入整形滤波衰减A	--	--	1.0	-
□	P0747	位置陷波频率A	--	--	100.0	Hz
□	P0748	※位置陷波宽度A	--	--	2	-
□	P0749	※位置陷波频率比A	--	--	1.2	-
□	P0769	磁栅尺速度波动抑制滤...	--	--	0.50	ms
□	P0770	※MCU侧STO信号滤波...	--	--	10	ms
□	P0772	探针滤波	--	--	15	25ns
□	P0774	低速脉冲指令滤波	--	--	30	25ns
□	P0775	高速脉冲指令滤波	--	--	3	25ns
□	P0776	速度到达信号滤波	--	--	10	ms
□	P0777	※速度显示滤波	--	--	50	ms

Figure 4-30: Screenshot of the upper computer for function code "position notch frequency"

There are 2 ways to obtain jitter frequency:

Obtain the end jitter frequency of mechanical load by external sensor, if Error! Reference source not found, as shown;

By waveform of the backend software, obtain end jitter frequency of motor. If Error! Reference source not found. As shown.

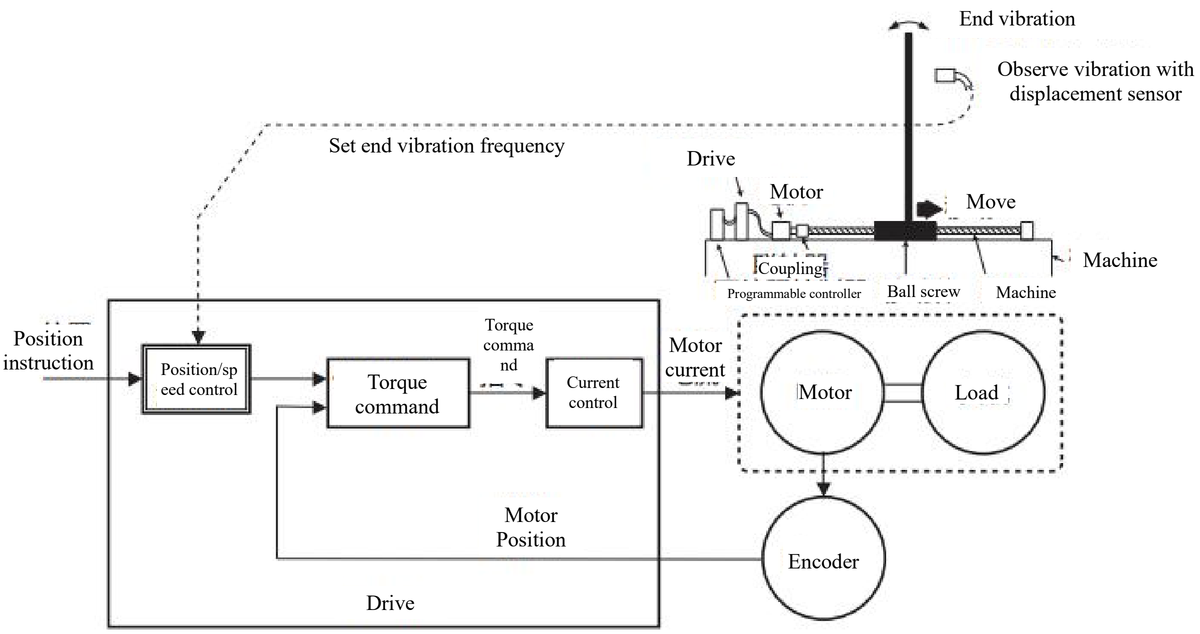


Figure 4-31 Method for acquisition and suppression of \Vibration Frequency of Long Cantilever Load

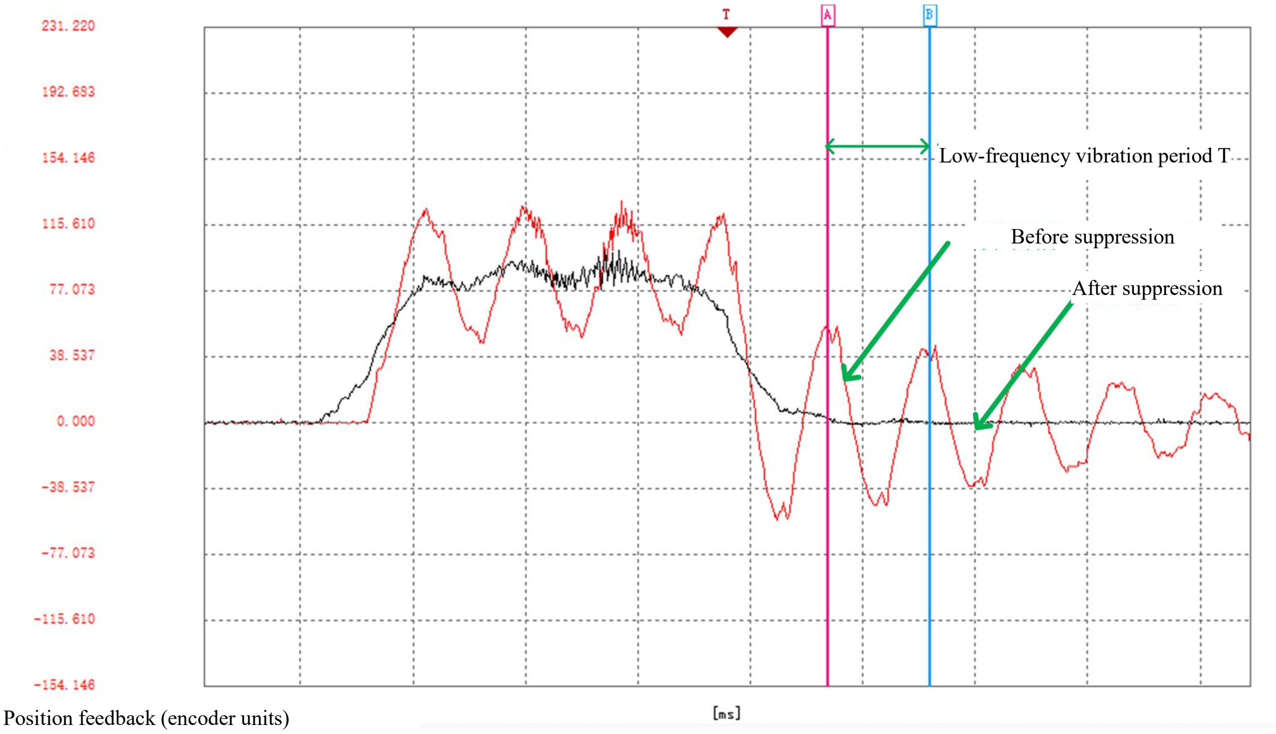


Figure 4-32 Vibration frequency acquisition and comparison of before-and-after suppression effects of long cantilever load

After measuring the low-frequency vibration period by the background, the low-frequency resonance frequency can be calculated by f=1/T, and Parameter "P07 group filtering parameters - position notch frequency A" can directly be set. Note that the unit of this parameter is 0.1Hz.

Chapter 5 Troubleshooting and Alarm

5.1 Display and Review

Alarm of SV3 servo consists of Error and Alarm. The main difference is that when a Error occurs, the servo will stop ; When a Alarm occurs, the servo can still run normally. According to the display of Error or Alarm on the panel, detailed description and solutions for corresponding Error or Alarm can be found in this manual.

After power-on, if the servo panel is off or rdy is not displayed at the last 3 digits, possible causes and solutions are as follows:

Table 5-1 Troubleshooting for the Error that the power-on servo is not ready

Serial No.	Error cause	Confirmation method
1	Error of control power supply voltage	After CN1, CN3, CN4, and CN5 are removed, the Error still exists. Measure AC voltage between L1C and L2C.
2	Error of main power supply voltage	Check whether 220VAC/380VAC power supply for drives is normal per specifications.
3	Servo drive Error	Contact the manufacturer for after-sales service.

After power-on, when the servo has any Error or Alarm, the panel will present the corresponding display. Herein, definitions of the display are as follows:

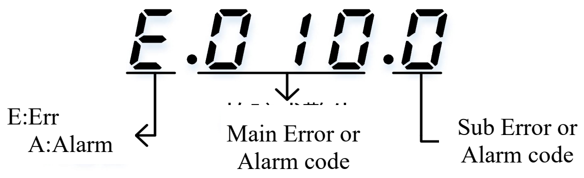


Figure 5-1 Error display sample

For example, if E.010.0 is displayed on panel, it presents that servo drive has Error. The Error main code is 0x010, and the Error subcode is 0x0. The panel displays A.218.0, i.e., Alarm has occurred on the servo drive. Main code of the Alarm is 0x218 and its sub-code is 0x0.

After above Errors are rectified, rdy shall be displayed in the last 3 digits of panel.

SV3 servo drive has Error logging function which can record the last 10 Errors and Alarm names, and the status parameters of servo drive when the Error or Alarm occurred. If repeated Errors or Alarms occurred in the last 5 times, the Error or Alarm code(i.e., drive status) is recorded only once.

After Error or Alarm is reset, the Error and Alarm are still saved in the Error record. By Error & Alarm management module in Servo3 Designer, it can review and clear the records. For details, see the Servo3 Designer instruction.

In addition, by Error & Alarm management module in Servo3 Designer, it can review the detailed information of present Error and reset it.

5.2 Error Code Overview

Table 5-2 List of error codes

Error code	Error name	Reset or not	CiA402 Protocol Error Code (603Fh)
E.010	Software parameter Error	×	0x6320
E.011	Error of software internal	×	0x7500
E.012	Error of software version not	×	0x7500
E.013	Error of software internal	×	0x7500
E.014	Error of software internal	×	0x0014
E.015	Error of current sampling	×	0x0015
E.016	Error of torque instruction	×	0x0016
E.017	Error of parameter storage	×	0x5530
E.018	Error of out-of-range	×	0x6320
E.019	Product matching Error	×	0x7122
E.210	Error of hardware overcurrent	×	0x2312
E.211	Error of output short-circuit to	×	0x2330
E.212	Error of UVW phase sequence	×	0x0212
E.213	Overrun Error	×	0x0213
E.214	Error of control power supply	×	0x3120
E.216	STO Error	√	0x0216
E.217	Error of input phase loss	√	0x3130
E.218	Error of servo emergency stop	√	0x5442
E.219	Error of drive overtemperature	√	0x4210
E.227	Error of output phase loss	√	0x0227
E.228	Error of abnormal precharge	√	0x0228
E.228	Error of abnormal precharge	√	0x0228
E.411	Error of DI allocation	√	0x6320
E.412	Error of DO allocation	√	0x6320
E.413	Error of current calculation	√	0x0413
E.414	Error of DC bus undervoltage	√	0x3220
E.415	Error of DC bus overvoltage	√	0x3210
E.416	Overspeed Error	√	0x8400
E.417	Error of startup overspeed	√	0x0417
E.418	Error of server repeatedly	√	0x5441
E.419	Error of drive overload	√	0x3230
E.420	Error of excessively-high	√	0x0420
E.421	Error of electronic gear ratio	√	0x0421
E.422	Error of fully closed loop	√	0x0422
E.423	Error of excessively large	√	0x8611
E.424	Error of position instruction	√	0x0424
E.430	Error of gantry compensation	√	0x0430
E.710	Overspeed Error	√	0x8400
E.711	Error of inertia identification	√	0x0711
E.712	Error of magnetic pole	√	0x0712

E.715	Error of motor parameter	√	0x0715
E.716	Error of gain self-adjusting	√	0x0716
E.910	Error of encoder parameters	×	0x7305
E.911	Error of encoder	×	0x7305
E.912	Error of encoder parameter	×	0x7305
E.913	Error of encoder 3-phase Hall	×	0x7305
E.914	Error of encoder disconnected	×	0x7305
E.916	Error of encoder disconnected	√	0x7306
E.917	Error of encoder battery	√	0x7305
E.918	Error of rncoder multi-turn	√	0x7305
E.919	Error of encoder multi-turn	√	0x7305
E.922	Encoder overheating Alarm	√	0x0922
E.B10	Error of motor overload	√	0x3230
E.B11	Error of motor stall	√	0x7121
E.B13	Error of motor vibration	√	0x0B13
E.B14	Running exception detection	√	0x0B14
E.B15	Error of motor PTC	√	0x0B15
E.D15	Error of upper/lower soft limit	√	0x0D15
E.D16	Origin bias out of soft limit	√	0x0D16
E.D20	EtherCAT communication	√	0x0D20
E.D21	EtherCAT communication	√	0x0D21
E.D22	EtherCAT communication	√	0x0D22
E.D23	EtherCAT extended card	√	0x0D23
E.D24	EtherCAT station name conflict	√	0x0D24
E.D25	EtherCAT station name setting	√	0x0D25
E.D26	EtherCAT communication	√	0x0D26
E.D27	EtherCAT system parameter	√	0x0D27
E.D28	EtherCAT configuration error	√	0x0D28
E.D29	EtherCAT not programming	√	0x0D29
E.D30	EtherCAT communication	√	0x0D30
E.D31	EtherCAT synchronization	√	0x0D31
E.D32	EtherCAT synchronization	√	0x0D32

⚠ Note:

√ indicates that this Error can be reset. For details about Error reset, see 5.5 Alarm Handling. It should be noted that any Error can be successfully reset only if its source has been removed.

X indicates that this Error can't be reset and must be powered on and off again.

5.3 Alarm Code Overview

All Alarms can be reset automatically after the Alarm conditions have been removed. Or press any key on the control panel to reset.

Table 5-3 List of alarm codes

Alarm display	Alarm name	CiA402 Protocol Error Code (603Fh)
A.220	Forward overtravel Alarm	0x5443

A.221	Negative overtravel Alarm	0x5444
A.222	Alarm of input phase loss	0x3130
A.224	Alarm of regenerative resistor overload	0x3210
A.225	Alarm of brake resistance disconnected	0x0225
A.226	Alarm of excessively small external regenerative resistance	0x6320
A.425	Alarm of zero return failure	0x0425
A.426	Alarm of power ON/OFF reset	0x6320
A.427	Alarm of parameter storage exception	0x7600
A.428	Alarm of frequency divider output setting error	0x0428
A.920	Encoder exception Alarm	0x7305
A.921	Alarm of low voltage of encoder battery	0x7305
A.928	ABZ encoder feedback overclock	0x0928
A.D35	Alarm of synchronous zeroing setting error	0x6320

5.4 Troubleshooting

Table 5-4 Troubleshooting list

Error codes and their descriptions	Error cause	Handling measures
E.010.0 Factory parameter verification is abnormal	1. Software has been updated. 2. An instant power-off occurs during parameter storage. 3. Number of write times exceeds Max. value within a certain period. 4. Error of servo drive.	1. Restore factory parameters (P0501=1). 2. Power on again, after initialization of system parameters (P0501=1), re-write parameters. 3. Change the parameter writing method. 4. Replace the servo drive.
E.011.0 Software internal communication initialization is abnormal.	1. Software versions of FPGA and MCU are inconsistent. 2. FPGA Error.	1. Consult our technical support to update the matching FPGA or MCU software. 2. Contact technical support of the manufacturer.
E.012.0 Software version doesn't match the product model	1. FPGA version is too low. 2. FPGA Error.	1. Update the matching FPGA or MCU software. 2. Contact technical support of the manufacturer.
E.013.0 FPGA interruption is lost	1. FPGA Error. 2. Handshake between FPGA and MCU is abnormal. 3. Dive internal calculation timeout.	1. Replace the servo drive. 2. Contact technical support of the manufacturer.
E.014.0 Communication between MCU and FPGA timeout	1. MCU communication timeout. 2. Encoder communication timeout.	1. Use our standard motor cable and encoder cable. 2. Check whether cable connection is damaged. 3. Separate high voltage cable and weak current cable.
E.015.0 Current chip sampling timeout	1. Check if output power line is broken or in poor contact. 2. Current sampling timeout.	1. Use our standard motor cable and encoder cable. 2. Check whether cable connection is damaged. 3. Separate high voltage cable and weak current cable.
E.016.0 Torque instruction update timeout	1. Servo drive Error.	1. Replace the servo drive. 2. Contact technical support of the manufacturer.
E.017.0 Parameter storage writing is abnormal.	1. EEPROM data Error.	1. After system parameters are initialized (P0501=1), power it on again. 2. Replace the servo drive.
E.018.0 Factory parameters are out of range	1. Software is updated; Present value of function code exceeds the allowed range. 2. EEPROM Error.	1. Power it on again, after initialization of system parameters (P0501=1), re-write parameters. 2. Replace the servo drive.

Error codes and their descriptions	Error cause	Handling measures
	3. Servo drive Error.	
E.019.0 Encoder matching Error	1. Product No.(motor or drive) doesn't exist. 2. Power levels of motor and drive don't match.	1. Replace the mismatched products according to "Supporting Equipment Specification of Servo System".
E.210.0 P/N phase overflow	1. Brake resistance is too small or short circuit. 2. Motor cable is in poor contact or short-circuited. 3. Motor cable isn't properly grounded. 4. Motor burned out. 5. Improper gain parameter settings, motor vibration. 6. Encoder cable Error.	1. Select an appropriate brake resistance and set related parameters according to the specification. 2. Check if motor cable is properly connected and if there is short circuit, poor contact, or no grounding. 3. Check if encoder cable is damaged. 4. Re-adjust the gain. 5. Replace the motor.
E.211.0 Output short-circuit to GND causes bus overvoltage	1. Drive power line(UVW) is short-circuited to GND. 2. Motor is short-circuited to GND. 3. Servo drive Error. 4. Bus voltage discharge(P0219) is set too low.	1. Reconnect or replace drive power cable. 2. Replace the motor. 3. Set the bus voltage release point (P0219) correctly.
E.212.0 UVW phase sequence Error	1. When the drive performs angle identification, UVW phase sequences of driver and motor doesn't match.	1. Connect UVW cables in the correct phase sequence.
E.213.0 Overrun Error	1. UVW phase sequence wiring Error. 2. Power-on interference causes the rotor initial phase error. 3. The encoder model is incorrect or wiring is wrong. 4. Under working condition of vertical axis, gravity load is excessive.	1. Connect UVW cables in the correct phase sequence. 2. Power on/off it again and re-start angle self-learning. 3. Replace the driver and motor that match mutually, and set motor model properly. 4. Check if encoder and motor cables are properly connected. 5. Reduce loads on vertical axis, or improve the rigidity, or shield this Error without affecting safety and use.
E.214.0 Undervoltage of control power supply	1. Power supply voltage is unstable or it powers off. 2. Control line in poor contact.	1. Check the wiring or replace cables. 2. Power on it again. For abnormal power-off, ensure that power supply is stable. 3. Increase the power capacity.

Error codes and their descriptions	Error cause	Handling measures
E.216.0 STO disconnected	1. STO disconnected causes STO valid.	1. STO wiring is correct. 2. Replace the servo drive.
E.217.0 One phase loss of 3-phase input	1. Per 3-phase specification input drive is connected to single-phase input. 2. 3-phase power input cable is in poor contact. 3. 3-phase voltage is unbalanced or the 3-phase voltage is too low.	1. Check the wiring of 3-phase power supply. 2. 3-phase drive and allow single-phase operation (below 1kW), switch off the alarm (set P0800=2).
E.218.0 Error of servo emergency stop	1.DI function 2: Emergency stop is triggered. 2. Background communication emergency stop is triggered.	1. Check the operating mode, and on the premise of safety remove the effective signal of DI brake(after the effective scram signal is removed, the Error is automatically reset).
E.219.0 Error of drive overtemperature	1. Ambient temperature is too high. 2. After overload, power off to reset the overload Error, and repeat it for several times. 3. Fan is damaged and can't work normally. 4. It's unreasonable of installation direction of servo drive and interval between the servo drive and other servo drives.	1. Improve cooling conditions of servo drive and reduce the ambient temperature. 2. Change Error reset method. Wait 30 seconds after overload, and then reset again. Increase the capacity of drive and motor, increase acceleration/deceleration time, and reduce the load. 3. Install servo drive per installation standard. 4. Replace the servo drive.
E.227.0 Phase loss of UVW output	1. U/V/W phase power line of motor is broken.	1. Check the power cable connection of the motor, reconnect the cable, and replace the cable if necessary.
E.228.0 Preloaded relay is not drawn	1. The hardware is damaged.	1. Replace the servo drive. 2. Contact technical support of the manufacturer.
E.228.0 Open circuit of precharge resistor	1. Open circuit of precharge resistor	1. Contact the factory for technical support.
E.411.0 DI function is allocated repeatedly	1. When DI function is allocated, the same function is allocated to multiple DI terminals.	1. Re-allocate DI function to avoid duplication.
E.412.0 Allocation of DO function is out of range	1. DO functio codes exceed number of DO functions.	1. Restore factory parameters and power on/off it again.
E.413.0 Error of current calculation overflow	1. DQ axis current overflows.	1. Restore factory parameters and power on/off it again. 2. Replace the servo drive.

Error codes and their descriptions	Error cause	Handling measures
E.414.0 Error of DC bus undervoltage	1. Power supply of main loop is unstable or power=off. 2. Instantaneous power failure occurs. 3. Power supply voltage drops during operation. 4. Per 3-phase specification input drive is connected to single-phase input.	1. Adjust or replace the power supply per the specification of input power supply. 2. Increase the power capacity. 3. Shield phase loss Error detection.
E.415.0 Error of DC bus overvoltage	1. Input voltage of main loop is excessive. 2. Power supply is unstable or affected by lightning strike. 3. Brake resistance fails. 4. External brake resistance is too large, and Max. braking energy can't be fully absorbed. 5. The sampled bus voltage has a large deviation. 6. The motor runs in high acceleration/deceleration, and Max. braking energy exceeds the absorbable value.	1. Adjust or replace the power supply per the specification of input power supply. 2. Connect the surge suppressor. 3. Select the appropriate external brake resistance per the specification of external brake resistor. 4. Increase the acceleration/deceleration time if possible.
E.416.0 Speed exceeds Max. RPM	1. Error of U/V/W phase sequence of motor cable. 2. Motor or encoder parameters are set improperly, e.g., pole-pair number, encoder resolution. 3. Motor Angle identification is not done. 4. Input command exceeds the overspeed threshold. 5. Motor speed closed-loop overshoot.	1. Perform the wiring in the proper U/V/W phase sequence. 2. Set motor parameters or encoder resolution properly. 3. Increase the power capacity. 4. Re-adjust the gain. 5. On the premise of the demand satisfied, reduce electronic gear ratio. 6. Set speed threshold within overspeed threshold.
E.417.0 Starting speed is higher than rated speed	1. When the drive is enabled, actual motor speed is higher than rated speed.	1. Reset the Error, reduce the actual speed, and re-operate the motor.
E.418.0 The servo is enabled repeatedly	1. When internal function is enabled, communication servo enable is valid.	1. Switch off servo enable signal of upper computer.

Error codes and their descriptions	Error cause	Handling measures
E.419.0 Error of drive overload	1. Error of parameter settings. 2. Drive load rate is excessive, load inertia is too large or the machine is stuck. 3. Error of motor stall.	1. Set P0102 per the drive model. 2. Adjust parameters per the current feedback. 3. Replace it with a drive of larger power. 4. Adjust the machine to remove problems of the machine stuck. 5. Refer to E.B11.0 troubleshooting method.
E.420.0 Error of excessively-high frequency of frequency division output	1. Output pulse frequency exceeds upper limit of hardware frequency allowed(4MHz for a single channel).	1. Reduce the number of frequency division output pulses (P1316) of encoder. 2. Use twisted-pair shielded wire to prevent interference pulses from superimposing on real pulses, that might result in false alarm.
E.421.0 Error of local electronic gear ratio setting	1. Electronic gear ratio settings exceed the above range. 2. Parameter change sequence	1. Set gear ratio according to the range specification of electronic gear ratio. 2. Use the Error reset function or power it on again.
E.422.0 Full closed-loop can't switch internal and external loops in the multi-stage absolute position mode	1. In full closed-loop position mode, the source of position instruction is internal position instruction, but use internal/external ring switching mode.	1. When the full closed-loop function is used, and the position instruction source is internal, only the external encoder feedback mode can be used, i.e., P2200 can only be 1.
E.423.0 Internal-ring position deviation is excessive	1. Drive U/V/W output loses phase or phase sequence is connected inproperly. 2. Drive U/V/W output is disconnected or the encoder is disconnected. 3. Motor stall from mechanical factors. 4. Low servo drive gain. 5. Increment of position instruction is excessive. 6. Deviation threshold 6065h/P0806 is too small. 7. Error of servo drive/motor.	1. Re-connect the cable properly, or replace it. 2. Re-connect the cable, replace it with brand-new one, if necessary, and ensure that it's reliably connected. 3. Exclude mechanical factors. 4. Adjust the gain manually or automatically. 5. Increase acceleration/deceleration ramp of position instruction. 6. Increase the deviation threshold 6065h/P0806. 7. Replace servo drive or motor.
E.424.0 Position instruction has double overspeed for several times	1. Increment of position instruction is excessive. 2. Target position (607A target position) isn't aligned with the present position prior to mode switching or when the servo is enabled. 3. Synchronization loss which	1. Reduce the increment of target position instruction. 2. Assign the value of present position to target position (607A target position) prior to mode switching or when the servo is enabled. 3. Confirm if Max. speed of motor meets the application requirement.

Error codes and their descriptions	Error cause	Handling measures
	causes excessive accumulation of position instructions. 4. Motor speed limit error.	
E.430.0 Write overflow of Gantry compensation data	Reserved	Reserved
E.710.0 Overflow of FPGA internal speed measured	1. Overflow of FPGA internal speed measured calculation .	1. Check and confirm that encoder cable is properly connected. 2. Power it on/off again and re-try it. 3. Replace motor or drive.
E.711.0 Error of offline inertia identification	1. Offline inertia identification is uncompleted.	1. Contact the factory for technical support.
E.712.0 Error of magnetic pole identification	1. Failure of initial magnetic pole angle identification of motor.	1. Dis-connect motor shaft and re-identify the angle.
E.715.0 Exception of parameter identification result	1. Identification result is 0	1. Contact the factory for technical support.
E.716.0 Self-adjust gain is too small	1. Self-adjust gain is too small	1. Execute self-adjustment again; 2. Contact technical support of the manufacturer.
E.910.0 Exception of encoder parameter verification during power-on	1. Models of drive and motor don't match. 2. Parameter verification error or no parameter stored in bus incremental encoder ROM.	1. Replace with a matching drive and motor. 2. Check the encoder cable, please use our company standard encoder cable. 3. Separate encoder cable from power cable.
E.911.0 (Detailed definition on pending)	1. ault of encoder wiring. 2. Encoder cable is loose. 3. Encoder Z signal is interfered (EMC issues). 4. Encoder Error.	1. Re-connect cables per the wiring diagram. 2. Re-connect cables, and ensure that encoder terminals are firmly connected. 3. Use standard encoder cables of our company. 4. Replace the servo motor.
E.912.0 Error of encoder parameter verification	1. Bus incremental encoder cable is broken or loose. 2. Exception of Read/Write parameters of bus incremental encoder.	1. Check if encoder cable is improperly connected, broken, or in poor contact. 2. Separate encoder cable from power cable. 3. Replace the servo motor.
E.913.0 Error of reading initial	1. Models of drive and motor don't match.	1. Replace with a matching motor and drive. 2. Replace with quality encoder cable and fix

Error codes and their descriptions	Error cause	Handling measures
angle during power-on initialization	2. The encoder cable is broken.	it firmly.
E.914.0 Z signal line is broken	1. Encoder Error causes Z signal loss. 2. Poor wiring connection or wrong connection causes encoder Z signal loss.	1. Replace the servo motor. 2. Check if the encoder cable is in proper contact, and re-connect or replace the cable.
E.916.0 Wire of full closed-loop grating ruler is broken	1. Frequency division output isn't disabled. 2. While using the full closed-loop function or non-standard pulse input, level difference of 2-way signals of any group A+/A-, B+/B-, Z+/Z- does not meet the requirement: Level difference is greater than or equal to 2V.	1. Set P1315 value as 2 (frequency division or synchronous output disabled). 2. Adjust the level until it meets the specification.
E.917.0 Error of encoder battery	1. Absolute encoder isn't connected any battery during power-off. 2. Voltage of encoder battery is too low.	1. Reconnect the battery or replace with a new battery. 2. Set P2005 as 1 and clear the Error.
E.918.0 Error of rncoder multi-turn count	1. Encoder Error.	1. Set P2005-2 to clear the Error and power on it again. 2. Replace the motor.
E.919.0 Overflow of encoder multi-turn counter	1. As for overflow of absolute value encoder multi-turn count, only if multi-turn value is 32767 or 32768, it would report Error. This Error is reported by servo drive detection, not encoder.	1. Set P2005=2 to clear multiple-turn data of encoder and power on it again.
E.922.0 Encoder overheating Alarm	1. Temperature of encoder is too high.	1. The drive stops for a period. 2. Ensure the encoder is well ventilated to reduce environmental temperature.
E.B10.0 Error of motor overload	1. Wiring of motor or encoder is wrong and bad contact. 2. Load is too heavy; Effective output torque of motor exceeds the rated torque, and runs continuously for a long time. 3. Acceleration and deceleration are too frequent or load inertia is too large. 4. Gain adjustment is unsuitable or rigidity is too strong. 5. Setting of drive or motor model is	1. Set parameters of drive model and motor model properly. 2. Check the wiring by our company's standard wire and according to wiring diagram. 3. Replace large-capacity drive and the matching motor, or reduce load to increase acceleration/deceleration time. 4. Increase acceleration/deceleration time in a single run. 5. Re-adjust the gain. 6. Exclude mechanical factor.

Error codes and their descriptions	Error cause	Handling measures
	wrong. 6. Motor is stalled from mechanical factor, resulting in excessive load during operation.	
E.B11.0 Motor stall protection	1. Phase missing, broken wire, phase sequence connection error of drive U/V/W output. 2. Motor parameters are set impropery, e.g., number of pole-pairs. 3. Motor Angle identification is not done. 4. Communication command is interfered. 5. Motor is stalled from mechanical factor.	1. Re-connect the cable properly, or replace it. 2. Set motor parameters properly. 3. Check if communication line between upper computer and the servo is interfered. 4. Exclude mechanical factors, Check if motor stall occurs, occasionally stall and eccentric situation.
E.B13.0 Excessive motor vibration	1. Motor vibration is excessive	1. Adjust gain parameters 2. Start vibration suppression
E.B14.0 Position exception detection		
E.B15.0 Thermistor line is broken or thermistor is disconnected	1. Thermistor line is broken or thermistor is disconnected	1. Check thermistor and its wires
E.D15.0 Error of upper/lower soft limit settings	1. Software lower limit is equal to or greater than the upper limit.	1. Reset parameters; Ensure that 607D-01h is smaller than 607D-02h(P0B45 is smaller than P0B47).
E.D16.0 Origin bias out of soft limit range	1. The origin is offset out of soft position limit.	1. Reset the parameters of 607D-01h and 607D-02h (P0B45/P0B47) reasonably.
E.D20.0 EtherCAT communication disconnected	Reserved	Reserved
E.D21.0 EtherCAT communication disabled	Reserved	Reserved
E.D22.0 EtherCAT communication connection timeout	Reserved	Reserved
E.D23.0 EtherCAT extended card communication timeout	Reserved	Reserved

Error codes and their descriptions	Error cause	Handling measures
E.D24.0 EtherCAT station name conflict	Reserved	Reserved
E.D25.0 EtherCAT station name setting error	Reserved	Reserved
E.D26.0 EtherCAT communication exception	1. The server is enabled. Due to misoperation of master station or human misoperation, EtherCAT network status is switched from OP to other status, and network status switchover is abnormal.	1. Check network status switching program of upper computer.
E.D27.0 EtherCAT system parameter error	Reserved	Reserved
E.D28.0 EtherCAT configuration error	Reserved	Reserved
E.D29.0 EtherCAT not programming XML file	1. No XML programmed in EEPROM. 2. XML file in EEPROM is modified abnormally.	1. Programme XML file.
E.D30.0 EtherCAT communication initialization failure	1. FPGA software isn't programmed. 2. Error of servo drive.	1. Contact the manufacturer to programme FPGA software. 2. Replace the servo drive.
E.D31.0 EtherCAT synchronization cycle setting error	1. After network is switched to the operation mode, synchronization cycle isn't an integer multiple of 125us or 250us.	1. Change the synchronization cycle to an integer multiple of 125us or 250us.
E.D32.0 EtherCAT synchronization signal excessive deviation	1. Synchronization cycle error exceeds the threshold; Synchronization cycle error of controller is excessive.	1. Increase factory parameter P0A32.

5.5 Alarm Handling

Table 5-5 Alarm handling list

Error codes and their descriptions	Error cause	Handling measures
A.220.0 Forward overtravel Alarm	1. For DI Function 9, forward limit input is valid and forward drive is disabled.	1. Check the operation mode, under the premise of safety, send motor reverse instruction or reverse the motor rotation so as to make positive limit invalid.
A.221.0 Negative overtravel Alarm	1. For DI Function 10, reverse limit input is valid and reverse drive is disabled.	1. Check the operation mode, under the premise of safety, give the motor forward instruction or rotate the motor forward, so as to make reverse limit invalid.
A.222.0 Alarm of input phase loss	1. Phase loss of 3-phase power input.	1. Check the wiring of 3-phase power supply. 2. 3-phase drive and allow single-phase operation (below 1kW), switch off the alarm (set P0800=2).
A.224.0 Brake resistor overload	1. Wiring of external brake resistor is improperly. 2. While using built-in brake resistor, power terminals P/D are disconnected. 3. Erros of such parameters as brake resistor type, resistance and power. 4. Input voltage of main loop exceeds the specification. 5. Load moment of inertia ratio is excessive. 6. Motor has been in the deceleration for a long period. 7. Capacity of servo drive or brake resistor capacity is insufficient.	1. Check if wiring of external brake resistor is proper. 2. While using the built-in brake resistor, connect P/D terminals properly. 3. Set the parameters of brake resistor propertly. 4. Per the specification, select the appropriate brake resistance. 5. Use the appropriate power input per the specification. 6. Reduce the load, or increase acceleration/deceleration time, or increase the operation cycle.
A.225.0 Software detects that the brake resistor is disconnected	1. Brake discharge resistor is disconnected, or P/RB terminals are not short-circuited;	1. Check the connection of brake resistor.
A.226.0 External brake resistance is too small	1. While using external brake resistor, external brake resistance is less than Min.value by the specification.	1. Per the specification, select the appropriate brake resistor, and connect it properly between P/C. 2. Set the parameters of external brake resistor properly.
A.425.0 Alarm of the origin zero timeout	1. Error of the origin switch. 2. Search time for the origin is too short. 3. Switch signal speed of high-speed search for the origin is too small. 4. Switch setting is unreasonable.	1. If hardware DI is used, ensure that DI Function 11 is configured in P03h group, and then check if wiring of DI terminal is normal; Error in the origin return operation was found, and operate this function correctly. If virtual DI is used, check if VDI handling process is proper. 2. Increase the origin search time P1349. 3. Increase return-to-zero high-speed 6099-01h. 4. Set hardware switch position reasonably.
A.426.0 Alarm of power ON/OFF reset	1. After the parameters are changed, only when power ON/OFF	1. Power it ON/OFF again.

	again, can parameters be valide.	
A.427.0 Alarm of parameter storage exception	1. Write data into EEPROM very frequently and abundantly.	1. Reduce unnecessary parameters written into EEPROM. 2. Set 2005-0Bh of 0 and do not store parameters into EEPROM.
A.428.0 Error of frequency division output setting	1. While using output function (P1315=0) of encoder frequency division, pulse number (P1316) setting of encoder frequency division doesn't meet the range requirement.	1. Reset the pulse number (P1316) of encoder frequency division so as to satisfy the specified range.
A.713.2 Sampling error Alarm	1. Contact the factory for technical support.	1. Parameter identification can be performed repeatedly. 2. Contact technical support of the manufacturer.
A.713.3 Check the error Alarm of rising edge	1. Contact the factory for technical support.	1. Parameter identification can be performed repeatedly. 2. Contact technical support of the manufacturer.
A.713.4 Check overshoot error Alarm	1. Contact the factory for technical support.	1. Parameter identification can be performed repeatedly. 2. Contact technical support of the manufacturer.
A.713.5 Alarm of Q-axis current steady state error test	1. Contact the factory for technical support.	1. Parameter identification can be performed repeatedly. 2. Contact technical support of the manufacturer.
A.713.6 Alarm of D-axis current steady state error test	1. Contact the factory for technical support.	1. Parameter identification can be performed repeatedly. 2. Contact technical support of the manufacturer.
A.920.0 Encoder internal algorithm error	1. The encoder zero search algorithm fails. 2. Error of frequency division counting algorithm of encoder.	1. Power on/off the servo drive again. 2. Replace the servo motor.
A.921.0 Encoder battery voltage is too low	1. Battery voltage of absolute encoder is lower than 3.0V.	1. Replace it with the new matching battery.
A.D35.0 Error of 6098h parameter settings in return-to-zero mode	1. In return-to-zero mode, input non-existent return-to-zero modes such as 15/16/31/32 in EtherCAT 6098h (or P0B.30 of PN)	1. EtherCAT model is properly set to 6098h (PN model is properly set to P0B.30).
nr Servo not ready	1. Control loop voltage is too low; 2. Bus voltage of power loop is too low; 3. Exception of encoder feedback;	1. Confirm that AC power supply of the drive is normal per the specification. 2. Remove the motor structure being reversed, or replace the motor encoder.

5.6 Resetting Methods

There are 3 ways as follows to reset Errors and Alarms of SV3 servo:

Set parameter P20.03 = 1 to reset.

Reset via DI input (Function 5, Error reset);

Reset by setting the rising edge of Bit7 of control word 0x6040 through the upper computer;

Herein, for Error reset, the servo should be disabled first, and then the Error reset signal is sent; For Alarm reset, the Error reset signal can be directly sent. The premise for Error reset is that Error condition has been removed. After the Alarm condition is removed, the Alarm will automatically reset.

Chapter 6 EtherCAT Communication

The application of Ethernet technology in computer networks to industrial automation constitutes industrial control Ethernet, generally known as industrial Ethernet or Ethernet fieldbus; Those servo drives that add Ethernet fieldbus are called Bus Servo, which is the principal development trend of servo drive. Compared with traditional bus servo and pulse servo, it has the following advantages:

Industrial Ethernet has fast transmission speed, large packet capacity, and long transmission distance;
Utilize general Ethernet components, cost-effective;
Compatible with the standard Ethernet system, can access the standard Ethernet end;
The network topology is diversified, the lines are simple, and it's easy to extend.

6.1 Overview

6.1.1 Overview of EtherCAT

EtherCAT is the abbreviation of Ethernet for Control Automation Technology, which is an Ethernet-based fieldbus technology proposed by German Beckhoff company in 2003. It is currently managed by ETG(EtherCAT Technology Group). EtherCAT is a high-speed and efficient Ethernet bus, and supports a variety of topologies such as line, tree, star, etc. Slave node uses a special control chip (ESC), and master station uses a standard Ethernet controller. Main features of EtherCAT are as follows:

Wide applications, any control unit of commercial Ethernet controller can be used as EtherCAT master station.
Fully compatible with standard Ethernet, both can coexist in the same system;
Short delay, data transmission of single-axis slave station can't exceed 1us;
The data refresh cycle is short, and it can reach the data refresh cycle less than 100us.
Good synchronization, synchronization accuracy less than 1us;
High efficiency, maximize the use of Ethernet broadband for user data transmission;

Currently, EtherCAT has entered several relevant international standards:
Type12 in IEC61158;
CPF12 in IEC61784;
In IEC61800, EtherCAT supports CANopen DS402 and SERCOS.
In ISO15745, EtherCAT supports DS301.

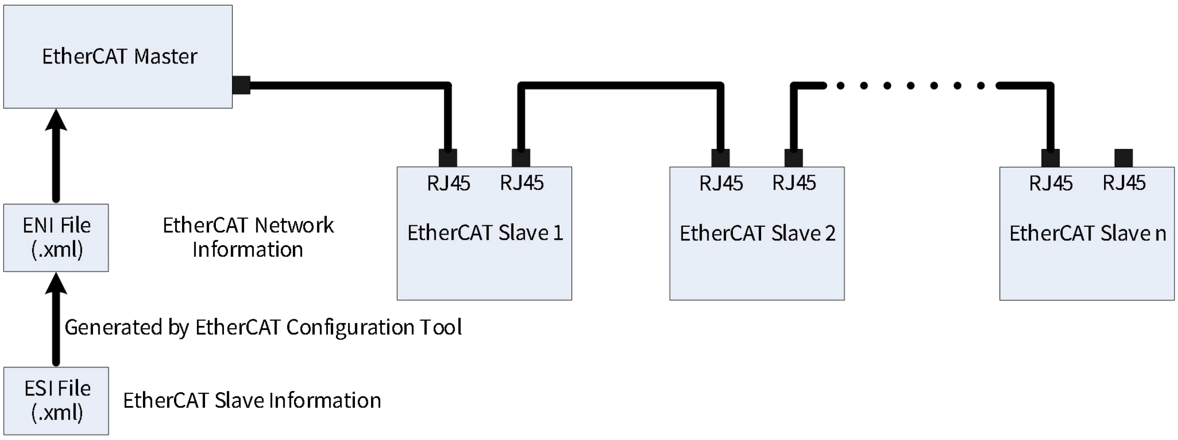
The topology of EtherCAT system supports a variety of topologies such as star, tree, and line. At present, mainstream servo drives may reserve 2 network interfaces which are used as IN/OUT port of signal. EtherCAT can select the physical medium of 100Base-TX standard Ethernet cable or optical cable. As for 100Base-TX cable, the distance between stations can reach 100m and the entire network can link up to 65,535 devices.

EtherCAT uses a specific Ethernet data frame type(0x88A4) definition to transfer EtherCAT data packets by Ethernet data frame. EtherCAT packet can also be transferred in UDP/IP protocol format. An EtherCAT packet can consist of multiple EtherCAT sub-messages. EtherCAT slave station doesn't process non-EtherCat data frames, and non-EtherCat data frame can be packaged in segments into EtherCAT data sub-message for transparent transmission in network segment, so EtherCAT slave system and standard Ethernet devices can coexist on the same system through network links and are independent of each other.

6.1.2 Host/Slave System Composition

EtherCAT system follows the principle of one master and multiple slaves. Number of slave stations that a master station can link depends on the processing capacity of the master station, communication cycle, transfer volume, etc., but Max. number of slave stations shall not exceed 65,535.

Master station works on the basis of ENI files which are generated by ESI files provided by our company through EtherCAT Configuration Tool or suppliers of master station in a special way.



EtherCAT Slave Information (ESI):

Files in .xml format provided by our company.

Records information inherent to slave station, including supplier information, product information, profile, data type, object dictionary, process data, synchronization method, SyncManager settings, etc.

EtherCAT Network Information (ENI):

Files generated by master station on basis of information of slave stations.

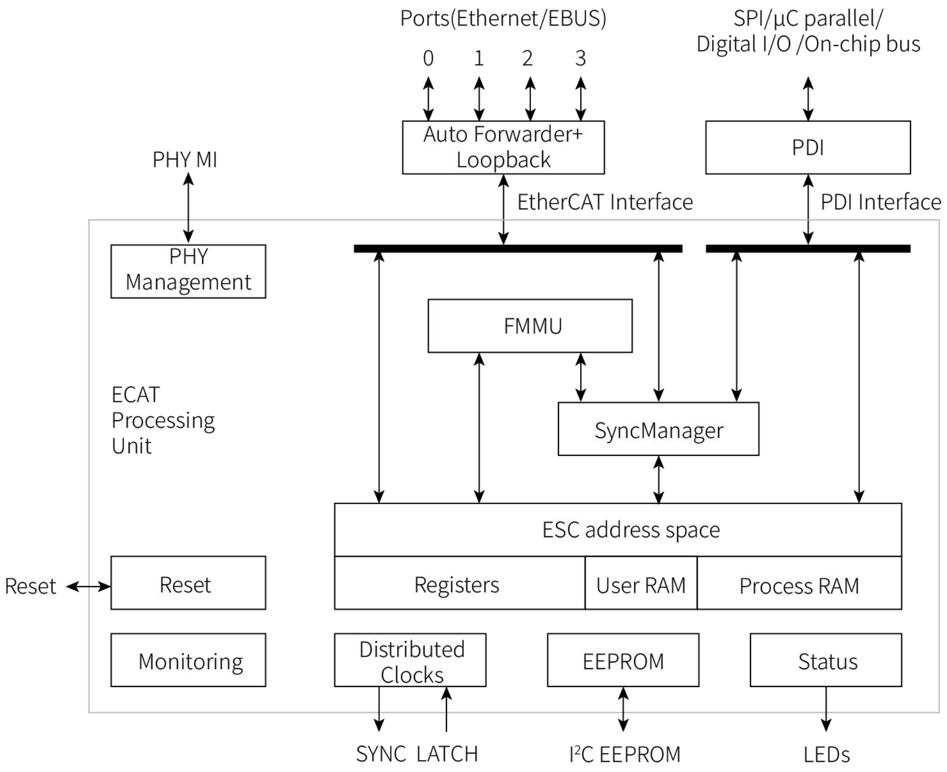
ENI contains information to identify slave station and initialize each slave station. Master station initializes the network and constructs the system based on the information recorded in ENI.

6.1.3 ESC Overview

ESC, the full name is EtherCAT Slave Controller, i.e., controller of EtherCAT slave station, is the key part of EtherCAT technology. It's the intermediate component of master-and-slave station communication. The following is the mainstream information on ESC in markets.

Feature	**ET1200**	**ET1100**	**IP Core**	**ESC20**
Ports	2~3 (eachEBUS/ MII,max.1xMII)	2~4 (eachEBUS/MI)	1~3 MII/1~3 RGMII/ 1~2 RMII	2 MII
FMMUS	3	8	0~8	4
SyncManagers	4	8	0~8	4
RAM [Kbyte]	1	8	0~60	4
Distributed Clocks	64bit	64bit	32/64bit	32bit
Process Data Interfaces				
Digital I/O	16bit	32bit	8~32bit	32bit
SPI Slave	Yes	Yes	Yes	Yes
8/16 bit µController	-	Async/Sync	Async	Async
On-chip bus	-	-	Yes	-

The internal architecture and external interfaces are shown as follows:



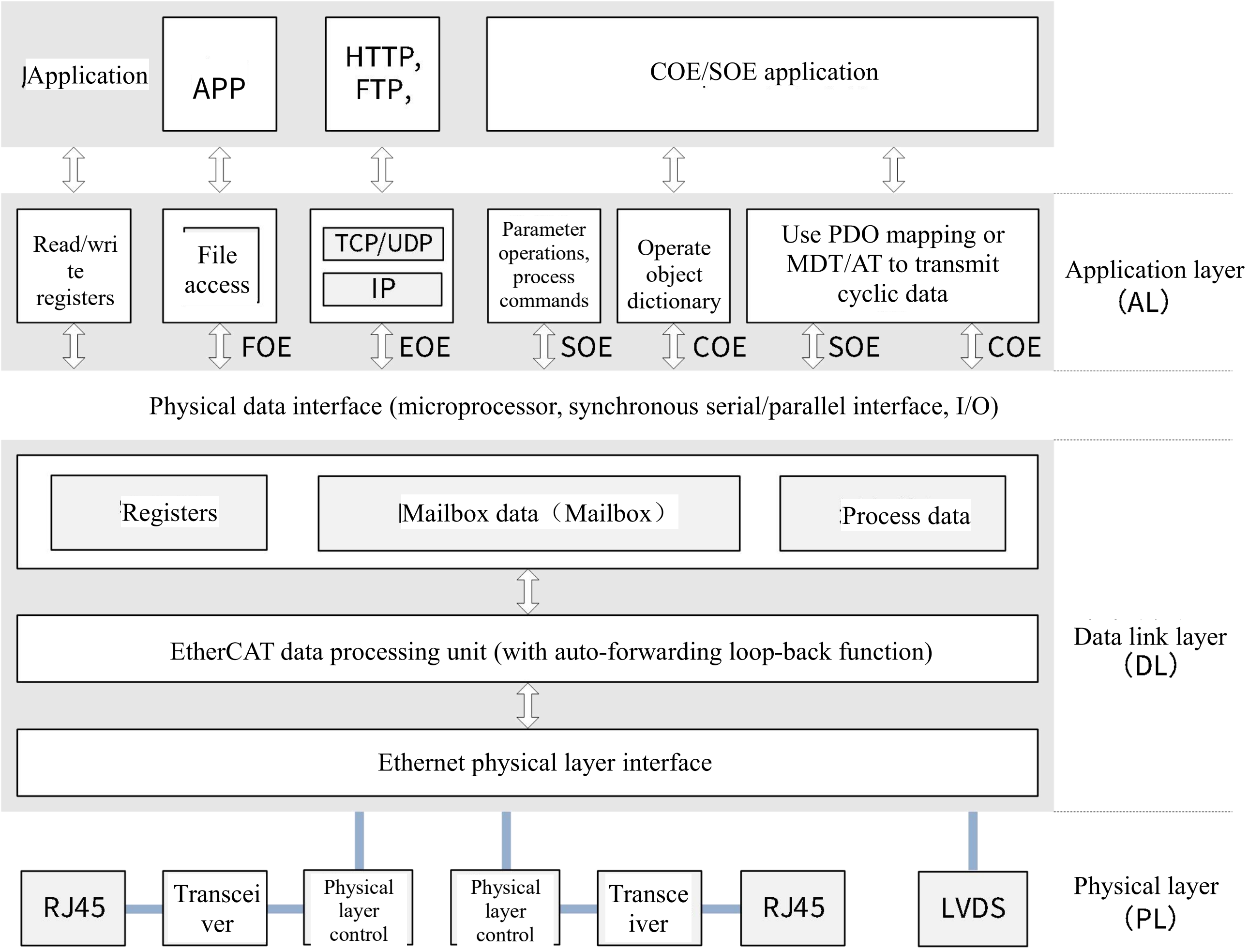
ESC processes EtherCAT data frames. ESC of each EtherCAT slave station reads and writes data frames according to its physical position on the loop. When a message passes through the slave station, the built-in processing unit of ESC extracts sub-message data sent by master station from messages and stores it in the internal storage area. Output data is written from internal storage area to the corresponding sub-message; Data extraction and insertion are completed by the hardware of data link layer.

The number of sending/receiving ports for each ESC is slightly different. Taking ET1100 for example, it has 4 PORTs, each PORT can send and receive Ethernet data frames which has the fixed sequence in ESC transmission. As there is the data processing unit between PORT0 and PORT3, it's better for data to enter ESC from PORT0. If ESC detects that a PORT has no external link, it automatically closes that PORT, and data is looped back and forwarded to the next PORT automatically. Therefore, the servo supports at least 2 ports.

ESC can use 2 physical layer interface modes: MII and EBUS. MII is the standard physical layer interface of Ethernet that requires external physical layer chip. Transmission delay of one port is about 500us. EBUS is the data transmission standard defined by German Beckford Company using LVDS(Low Voltage Differential Signaling) standard, which can directly link to ESC chip without any extra physical layer chip. Transmission delay of one port is about 100ns. EBUS has a maximum transmission distance of 10m and is suitable for links between I/O devices or servo drives in close proximity.

6.1.4 Structure of EtherCAT Application Layer Protocol

Application Layer (AL) is the highest functional layer of EtherCAT protocol. It's directly oriented to control task, which provides the means for control program to access the network environment, and provides services for control program. EtherCAT protocol structure is as follows:



6.2 EtherCAT Specification

6.2.1 EtherCAT Frame Structure

As EtherCAT uses the standard IEEE 802.3 Ethernet frame, standard network controller can be used, and no special hardware is required on master station. EtherCAT only extends IEEE 802.3 Ethernet specification and doesn't make any change to basic structure of Ethernet protocol.

EtherType of EtherCAT Header is 0x88A4, which distinguishes it from other Ethernet frames. Subsequently, EtherCAT can run in parallel with other Ethernet protocols.

EtherCAT doesn't require IP protocol, but can encapsulate it into IP/UDP. EtherCAT slave controllers process frames in a hardware method. Therefore, communication performance is independent of processor power.

An EtherCAT frame can be divided into EtherCAT frame header, followed by one or more EtherCAT datagrams. There must be at least one EtherCAT datagram in data frame. Currently, ESC only processes EtherCAT frames with the type of 1 in EtherCAT header. ESC also supports IEEE802.1Q VLAN tags, although ESC doesn't evaluate the content of VLAN tags.

If EtherCAT frame size doesn't meet Min. size requirement of Ethernet frame(64bytes), padding bytes (typically padding 0) must be added. Size of EtherCAT frame is exactly the sum of all EtherCAT datagrams plus EtherCAT header(i.e., EtherCAT header+datagrams).

The following diagram shows how an Ethernet frame contains EtherCAT data:

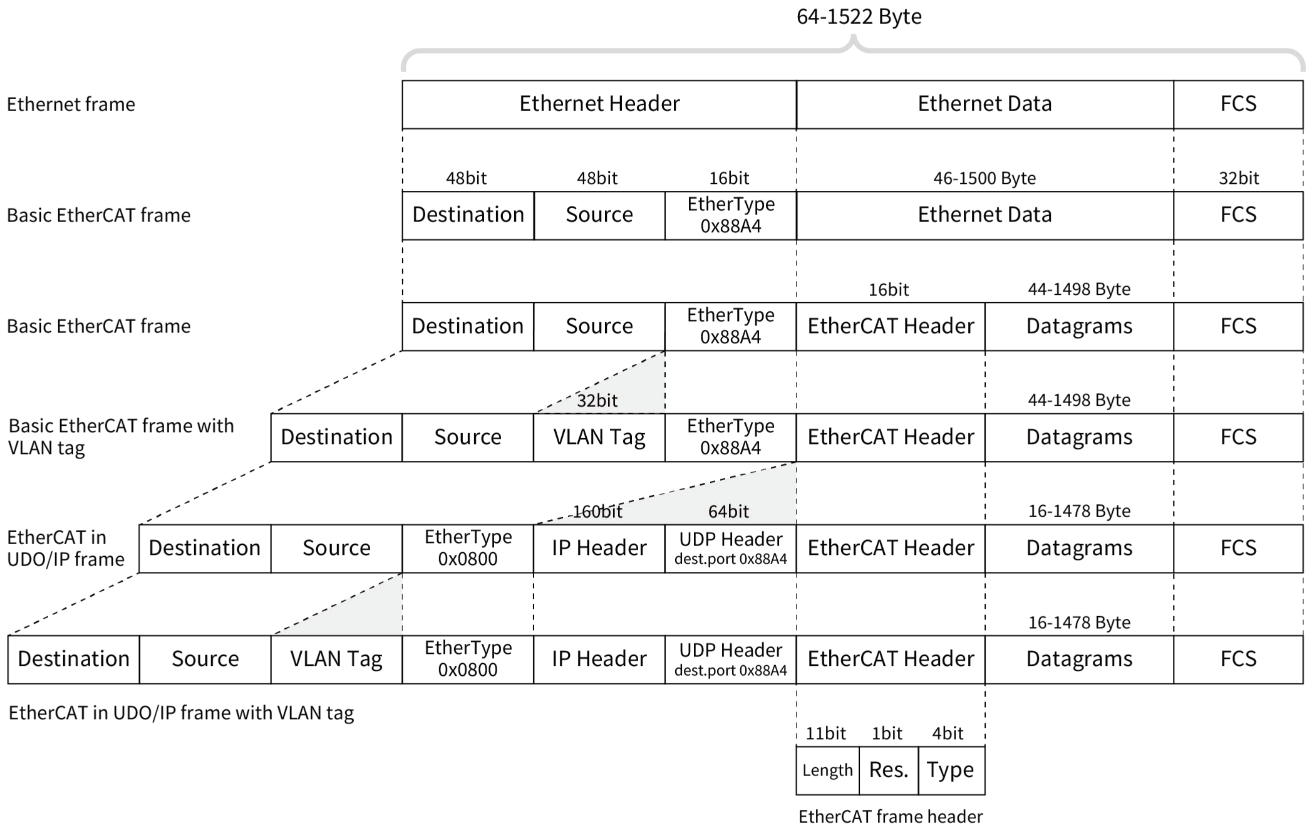


Figure 6-1 How does an Ethernet frame contain EtherCAT data

Table 6-1 Description on EtherCAT Header

Field	Data Type	Value/Description
Length	11bit	Length of the EtherCAT datagrams(excl.Fcs)
Reserved	1bit	Reserved,0
Type	4bit	Protocol type.only EtherCAT commands(type=0x01) are supported by ESCs

ESC doesn't care about the length of EtherCAT Header(i.e., length), ESC cares about the length of Datagram section.
Structure of EtherCAT frame:

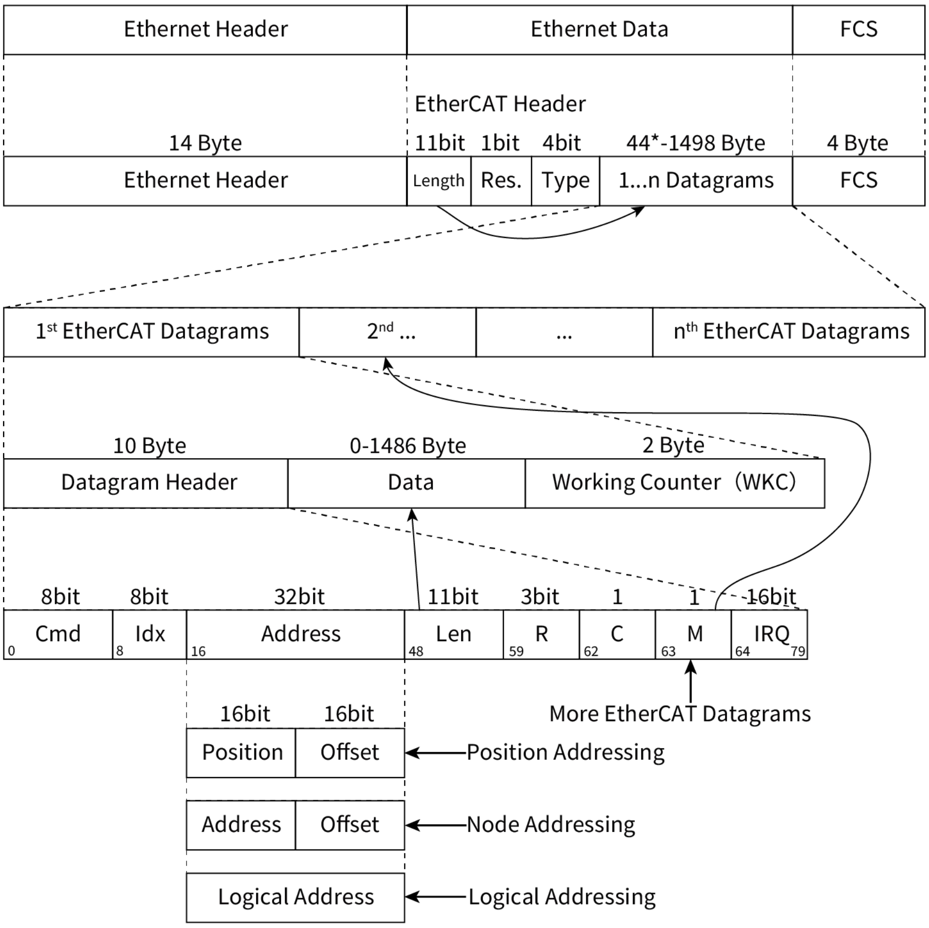


Figure 6-2 Structure of EtherCAT frame

Note: When Ethernet frame is shorter than 64bytes, add 1 to 32bytes(Ethernet Header+Ethernet Data+FCS).

Table 6-2 EtherCAT Datagram

Field	Data Type	Value/Description
Cmd	Byte	EtherCAT Command Type; Instruction type, i.e., the way to find;
Idx	Byte	The index is a numeric identifier used by the master for identification of duplicates/lost datagrams. It shall not be changed by EtherCAT slaves; Index is a digital identifier used by master station to distinguish duplicate or lost datagrams; Slave station can't modify it.
Address	Byte[4]	Address (Auto Increment, Configured Station Address, or Logical Address); Address(auto-addressing, configured site addressing, logical addressing);
Len	11bit	Length of the following data within this datagram; Length of data in Datagram;
R	3bit	Reserved, 0;
C	1bit	Circulating frame: 0: Frame is not circulating; 1: Frame has circulated once;
M	1bit	More EtherCAT datagrams; 0: Last EtherCAT datagram;

<table>
<tr><td></td><td></td><td>1: More EtherCAT data.grams will follow, EtherCAT datagram will follow;</td></tr>
<tr><td>IRQ</td><td>WORD</td><td>EtherCAT Event Request registers of all slaves combined with a logical OR;
All EtherCAT Event Request registers (0x210::0x211) of slave station perform logical or.</td></tr>
<tr><td>Data</td><td>Byte[n]</td><td>Read/Write Data;</td></tr>
<tr><td>WKC</td><td>WORD</td><td>Working Counter;
Details are as follows:
<table>
<tr><th>Command</th><th>Operate</th><th>Increment</th></tr>
<tr><td rowspan="2">Read command</td><td>Not successful</td><td>No change</td></tr>
<tr><td>Read successfully</td><td>+1</td></tr>
<tr><td rowspan="2">Write command</td><td>Not successful</td><td>No change</td></tr>
<tr><td>Write successfully</td><td>+1</td></tr>
<tr><td rowspan="4">Read/Write command</td><td>Not successful</td><td>No change</td></tr>
<tr><td>Read successfully</td><td>+1</td></tr>
<tr><td>Write successfully</td><td>+2</td></tr>
<tr><td>The read and write were both successful</td><td>+3</td></tr>
</table>
</td></tr>
</table>

6.2.2 Addressing Mode

Two modes for EtherCAT device addressing are supported in a network segment: device addressing and logicaladdressing. EtherCAT provides 3 device addressing modes: auto increment addressing, configured station address, and broadcast (broadcast addressing). EtherCAT device can have up to 2 configured station addresses: one is assigned by the master (Configured Station Address) and the other is stored in SII EEPROM. It can be changed by the slave station application (Configured Station Alias address). EEPROM settings of Configured Station Alias address takes over only when EEPROM is loaded for the first time after power-on/reset.

Table 6-3 Addressing methods

Mode		Field	Data Type	Remarks
Device addressing	Auto-increment addressing	Position	WORD	Each slave station will increase Position by 1, if position=0, then addressing is successful;
		Offset	WORD	ESC logical register or memory address;
	Configured station address	Position	WORD	If Address matches either Configured Station Address (Configured station address) or Configured Station Alias (Configured station alias)(if enabled), the slave station will be addressed.
		Offset	WORD	ESC logical register or memory address;
	Broadcast	Position	WORD	Each slave station increase 1 to Position, but not used for addressing;
		Offset	WORD	ESC logical register or memory address;
Logicaladdressing		Address	DWORD	Logical Address (configured by FMMUs). If Address matches logical address configured by FMMU, addressing is successful.

Table 6-4 Cmd details

Addressing mode	Cmd	Abbreviation	Name	Remarks
-	00h	NOP	No Operation	No operation is executed.
Position Addressing	01h	APRD	Auto Increment Read	Each slave station has an incremental increase of Address. When slave station receives a frame with Address value of 0, the slave station reads data in the specified memory unit and inserts EtherCAT datagram. Position of EtherCAT datagram will be increased by 1,.
	02h	APWR	Auto Increment Write	Each slave station has an incremental increase of Address. When slave station receives a frame with Address value of 0, slave station receives the data and writes it to the specified local storage unit. Position of EtherCAT datagram will be increased by 1.
	03h	APRW	Auto Increment Read Write	Each slave station has an incremental increase of Address. When slave station receives a frame with Address value of 0, the specified local storage unit exchanges data (read&write) with the data frame EtherCAT datagram. Position of EtherCAT datagram will be increased by 1.
Node Addressing	04h	FPRD	Configured Address Read	When the address configured for slave station is the same as Address value of EtherCAT datagram, slave station reads data in the specified memory unit and inserts EtherCAT datagram.
	05h	FPWR	Configured Address Write	When the address configured for slave station is the same as Address value of EtherCAT datagram, slave station receives data and writes it into the specified local storage unit.
	06h	FPRW	Configured Address Read Write	When the address configured for slave station is the same as Address value of EtherCAT datagram, the specified local storage unit exchanges data (read&write) with the data frame EtherCAT datagram.
Broadcast	07h	BRD	Broadcast Read	All slave stations read data in the specified memory unit, perform logical-or operations with data of EtherCAT datagram, and then store the data to EtherCAT datagram. Position of EtherCAT datagram will be increased by 1.
	08h	BWR	Broadcast Write	All slave stations store EtherCAT datagram in the specified storage unit. Position of EtherCAT datagram will be increased by 1.
	09h	BRW	Broadcast Read Write	All slave stations read data in the specified memory unit, perform logical-or operations with data of EtherCAT datagram, then inserts the data to EtherCAT datagram, and store the original EtherCAT datagram

				in the specified memory unit. Position of EtherCAT datagram will be increased by 1.
Logical Addressing	0Ah	LRD	Logical Memory Read	If the received address matches one of the configured FMMU areas, slave station reads data in the specified memory unit and inserts EtherCAT datagram.
	0Bh	LWR	Logical Memory Write	If the received address matches one of the configured FMMU areas, slave station receives data and writes it in the specified local storage unit.
	0Ch	LRW	Logical Memory Read Write	If the received address matches one of the configured FMMU zones, the specified local storage unit performs data exchange (read&write) with the data frame EtherCAT datagram.
Position Addressing	0Dh	ARMW	Auto Increment Read Multiple Write	If the received address is 0, slave station reads data in the specified memory unit and inserts EtherCAT datagram; Otherwise, slave station receives data and writes it into the specified local storage unit.Position of EtherCAT datagram will be increased by 1.
Node Addressing	0Eh	FRMW	Configured Read Multiple Write	If received address is the same as configured address, slave station reads data in the specified memory unit and inserts EtherCAT datagram; Otherwise, slave station receives data and writes it into the specified local storage unit.
-	0Fh~FFh	-	reserved	-

6.2.3 Frame Processing Sequence

Frame processing sequence by EtherCAT slave station controller depends on logical port No.

Table 6-5 Frame processing sequence

Port No.	Frame processing sequence
1	0→EtherCAT Processing Unit→0
2	0→EtherCAT Processing Unit→1 / 1→0
3	0→EtherCAT Processing Unit→1 / 1→2 / 2→0 Or, 0→EtherCAT Processing Unit→3 / 3→1 / 1→0
4	0→EtherCAT Processing Unit→3 / 3→1 / 1→2 / 2→0

The direction through ESC that includes EtherCAT processing units is called the "processing" direction, while other directions that don't pass through EtherCAT processing units are called the "forwarding" direction. The behavior of an unimplemented port is similar to that of a closed port; That data frame will be forwarded to the next port.

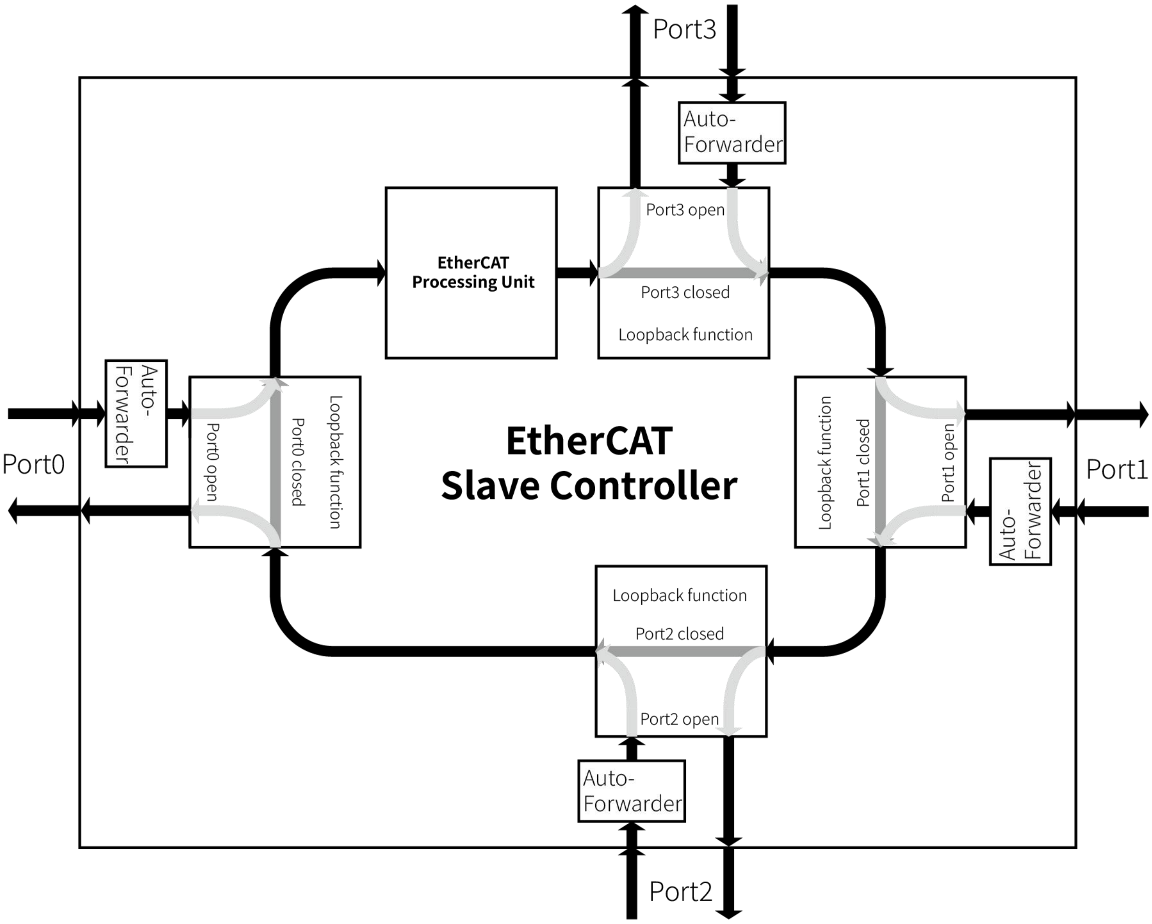


Figure 6-3 Frame processing sequence

6.2.4 ESC Register

Address	Length (byte)	Description	Status
ESC information			
0x0000	1	Type	Y
0x0001	1	Revision	Y
0x0002:0x0003	2	Build	Y
0x0004	1	FMMUs Supported	Y
0x0005	1	SyncManagers supported	Y
0x0006	1	RAM Size	Y
0x0007	1	Port Descriptor	Y
0x0008:0x0009	2	ESC Features supported	Y
Station address			
0x0010:0x0011	2	Configured Station Address	Y
0x0012:0x0013	2	Configured Station Alias	Y
write-protect			
0x0020	1	Write Register Enable	Y
0x0021	1	Write Register Protection	Y
0x0030	1	ESC Write Enable	Y
0x0031	1	ESC Write Protection	Y
Data link layer			
0x0040	1	ESC Reset ECAT	Y
0x0041	1	ESC Reset PDI	N
0x0100:0x0101	2	ESC DL Control	Y
0x0102:0x0103	2	Extended ESC DL Control	Y
0x0108:0x0109	2	Physical Read/Write Offset	Y
0x0110:0x0111	2	ESC DL Status	Y
Application layer			
0x0120	5 bits [4:0]	AL Control	Y
0x0120:0x0121	2	AL Control	Y
0x0130	5 bits [4:0]	AL Status	Y
0x0130:0x0131	2	AL Status	Y
0x0134:0x0135	2	AL Status Code	Y
0x0138	1	RUN LED Override	N
0x0139	1	ERR LED Override	N
PDI (Process Data Interface)			
0x0140	1	PDI Control	Y
0x0141	1	ESC Configuration	Y
0x014E:0x014F	2	PDI Information	N
0x0150	1	PDI Configuration	Y
0x0151	1	DC Sync/Latch Configuration	Y
0x0152:0x0153	2	Extended PDI Configuration	Y
Interrupt			
0x0200:0x0201	2	ECAT Event Mask	Y

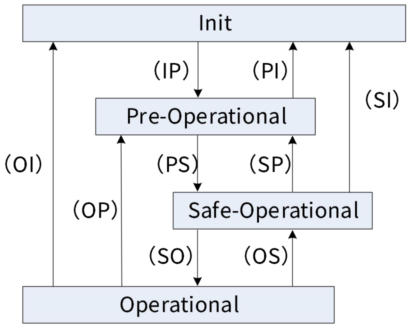
0x0204:0x0207	4	PDI AL Event Mask	Y
0x0210:0x0211	2	ECAT Event Request	Y
0x0220:0x0223	4	AL Event Request	Y
Error counter			
0x0300:0x0307	4×2	Rx Error Counter[3:0]	Y
0x0308:0x030B	4×1	Forwarded Rx Error counter [3:0]	Y
0x030C	1	ECAT Processing Unit Error Counter	Y
0x030D	1	PDI Error Counter	Y
0x030E	1	PDI Error Code	N
0x0310:0x0313	4×1	Lost Link Counter[3:0]	Y
Watchdog			
0x0400:0x0401	2	Watchdog Divider	Y
0x0410:0x0411	2	Watchdog Time PDI	Y
0x0420:0x0421	2	Watchdog Time Process Data	Y
0x0440:0x0441	2	Watchdog Time Process data	Y
0x0442	1	Watchdog Counter Process Data	Y
0x0443	1	Watchdog Counter PDI	Y
EEPROM interface			
0x0500:0x050F	16	SII EEPROM Interface	Y
MII management interface			
0x0510:0x0515	6	MII Management Interface	Y
0x0516:0x0517	2	MII Management Access State	N
0x0518:0x051B	4	PHY Port Status[3:0]	N
0x0600:0x06FC	16×13	FMMU[15:0]	8
0x0800:0x087F	16×8	SyncManager[15:0]	8
Distributed clock,DC			
0x0900:0x090F	4×4	DC – Receive Times[3:0]	Y
0x0918:0x091F	8	DC – Receive Time EPU	S/I
0x0920:0x0935	24	DC – Time Loop Control Unit	S/I
0x0910:0x0917	8	DC – System Time	S/I
0x0936	1	DC – Receive Time Latch mode	N
0x0980	1	DC – Cyclic Unit Control	S
0x0981	1	DC – Activation	S
0x0982:0x0983	2	DC – Pulse length of SyncSignals	S
0x0984	1	DC – Activation Status	N
0x098E:0x09A7	26	DC – SYNC Out Unit	S
0x09A8	1	DC – Latch0 Control	I
0x09A9	1	DC – Latch1 Control	I
0x09AE	1	DC – Latch0 Status	I
0x09B0:0x09B7	8	DC – Latch0 Positive Edge	I
0x09B8:0x09BF	8	DC – Latch0 Negative Edge	I
0x09C0:0x09C7	8	DC – Latch1 Positive Edge	I
0x09C7:0x09CF	8	DC – Latch1 Negative Edge	I

0x09F0:0x09F3 0x09F8:0x09FF	12	DC – SyncManager Event Times	S/I
ESC specific			
0x0E00:0x0E03	4	Power-On Values (Bits)	16bits
0x0E00:0x0E07	8	Product ID	N
0x0E08:0x0E0F	8	Vendor ID	N
0x0E10	1	ESC Health Status	N
Digital I/O			
0x0F00:0x0F03	4	Digital I/O Output Data	Y
0x0F10:0x0F17	8	General Purpose Outputs [Byte]	2bytes
0x0F18:0x0F1F	8	General Purpose Inputs [Byte]	2bytes
User RAM			
0x0F80:0x0FFF	128	User RAM	Y
Process data RAM			
0x1000:0x1003	4	Digital I/O Input Data	IO
0x1000:0x1FFF		Process Data RAM [Kbyte]	4KB

Note) : Y Support
N Not support
S If 0x0140.10=1, it is valid
I If 0x0140.11=1, it is valid
S/I If 0x0140.10=1 and/or 0x0140.11=1,, it is valid

6.2.5 ESM(EtherCAT State Machine)

EtherCAT State Machine (ESM) coordinates the state relationship of master/slave stations during application initialization and runtime.
EtherCAT bus servo supports 4 states:
(1)Init: Initialization
(2)Pre-Operational: Pre-operational (PreOP)
(3)Safe-Operational: Safe operation, or SafeOP
(4)Operational: Operation, or OP
Diagram of each state transition:



Switching of EtherCAT state machine must strictly follow the arrow direction in the above figure. When transitioning from initialization state to running state, it must be done in the order of "INIT → PREOP → SAFEOP → OP" and can't be skipped. When returning from the running state, it's possible to bypass the path. All state changes are initiated by the master which sends a state control command to the slave and requests the new state. Slave station responds to this command, executes the requested state transition, and writes the result into the state indication register of slave station. If the requested state transition fails, the slave will give an error flag.

Table 6-6 Executable operations in each status

Status and transition	Action
Init	Master station can only read & write ESC registers, and the application layer has no communication
Init→PreOP	Master station configures address register (ESC reg: 0x0010~0x0011) of slave station. If email communication is supported, configure mailbox channel parameters(SM channel). If distributed clocks are supported, configure DC-related registers. Control register (ESC reg: 0x0120~0x0121) for master station write-status, requesting PreOP status
PreOP	Mailbox communication is activated. Process data communication is disabled
PreOP→SafeOP	The master uses mailbox initialization process data mapping; SM channel for process data communication configured by the master; The master configures FMMU. Control register (ESC reg: 0x0120~0x0121) for master station write-status, requesting SafeOP status
SafeOP	The application layer supports mailbox data communication. Process data can be transmitted between master station and slave station, but the slave doesn't update the data sent by the master, i.e., the slave doesn't respond to any command of the master .
SafeOP→OP	Master station sends valid output data; Control register (ESC reg: 0x0120~0x0121) for master station write-status, requesting OP status

OP	The application layer supports mailbox data communication. Process data communication (slave to master) is valid; Process data communication (master to slave) is valid

Table 6-7 Relationship between PDS status and ESM status

ESM status PDS status	Init	Preop	Safeop	OP
Not ready to switch on	Yes	No	No	No
Switch on disabled	Yes	Yes	Yes	Yes
Ready to switch on*1)	No	Yes	Yes	Yes
Switch on*1)	No	Yes	Yes	Yes
Operation enabled *2) *5)	No	Yes*4)	Yes*4)	Yes
Error reaction active	Yes	Yes	Yes	Yes
Error*3)	Yes	Yes	Yes	Yes

*1) : If ESM status is to receive the migration command from PreOP,SafeOP,OP to Init, PDS status is migrated to Switch on disabled.

*2) : PDS status means that in Operation enabled status, if ESM status receives ESM migration command, PDS status is automatically enabled and PDS status is migrated to Switch on disabled.

*3) : Keep ESM state when PDS state is migrated to Error.

*4) : ESM status is to request PDS status to Operation enabled in OP status.

*5) : Because master station has requirements on ESM, it takes time to complete the state migration. Please pay attention to the timeout setting on master station.

6.2.6 SII(Slave Information Interface) EEPROM

6.2.6.1 EEPROM Data Layout

Table 6-8 EEPROM data layout

Word Address	+0h	+1h	+2h	+3h	+4h	+5h	+6h	+7h
0000h	EtherCAT Slave Controller Configuration Area							
0008h	VendorId		ProductCode		RevisionNo		SerialNo	
0010h	Hardware Delays				Bootstrap Mailbox Config			
0018h	Mailbox Sync Man Config							
0020h … 0030h	Reserved							
0038h			Size			Version		
0040h …	Additional Information (Subdivided in Categories)							
	Category Strings							
	Category Generals							
	Category FMMU							
	Category SyncManager							
	Category Tx- / RxPDO for each PDO							

6.2.6.2 SII Area (0000h to 003Fh)

ESC configuration data is stored in ESC-EEPROM character addresses 0x0000 to 0x0007. During the power-on and initialization of ESC, ESC automatically reads EEPROM data and writes the content of that storage area into the corresponding register of ESC.

Note: Please do not change the content of EEPROM storage area at will.

SII EEPROM Word Address	Name	Remarks	ESC Register Word Address	Initial value
0x0000h	PDI Control/ ESC Configuration	Initial values of PDI control register and ESC configuration register	0140h 0141h	0C08h
0x0001h	PDI Configuration	Initial value of PDI configuration register	0150h 0151h	6608h
0x0002h	Pulse Length of SYNC Signals	Initial value of pulse length of synchronization signal	0982h 0983h	01F4h
0x0003h	Extended PDI Configuration	Extend the initial value of PDI configuration register	0152h 0153h	0000h
0x0004h	Configured Station Alias	Initial value of station alias configuration register	0012h 0013h	0000h
0x0005h	Reserved	Reserved, it should be 0	-	0000h
0x0006h	Reserved	Reserved, it should be 0	-	0000h
0x0007h	CheckSum	Character Address 0 to 6h checksum	-	00D2h
0x0008h	Vendor ID	Manufacturer ID	-	07FBh
0x0009h				0000h
0x000Ah	Product Code	Product code	-	-
0x000Bh				
0x000Ch	Revision Number	Revision No.	-	-
0x000Dh				
0x000Eh	Serial Number	Serial No.	-	-
0x000Fh				
0x0010h	Execution Delay	Execution delay	-	0000h
0x0011h	Port0 Delay	Port 0 delay	-	0000h
0x0012h	Port1 Delay	Port 1 delay	-	0000h
0x0013h	Reserved	Reserved	-	0000h
0x0014h	Bootstrap Receive Mailbox Offset	Bootstrap status receiving Mailbox offset (SM0, MbxOut, master → slave)	-	0000h
0x0015h	Bootstrap Receive Mailbox Size	Bootstrap status receiving Mailbox size (SM0, MbxOut, master → slave)	-	0000h
0x0016h	Bootstrap Send Mailbox Offset	Bootstrap Status sending Mailbox offset (SM1, MbxIn, slave → master)	-	0000h
0x0017h	Bootstrap Send Mailbox Size	Bootstrap Status sending Mailbox size (SM1, MbxIn, slave → master)	-	0000h
0x0018h	Standard Receive Mailbox Offset	Standard status receiving Mailbox offset (SM0, MbxOut, master → slave)	-	1000h
0x0019h	Standard Receive Mailbox Size	Standard status receving Mailbox size (SM0, MbxOut, master → slave)	-	0080h
0x001Ah	Standard Send	Standard status sending Mailbox	-	1400h

SII EEPROM Word Address	Name	Remarks	ESC Register Word Address	Initial value
	Mailbox Offset	offset (SM1, MbxIn, slave → master)		
0x001Bh	Standard Send Mailbox Size	Standard status sending Mailbox size (SM1, MbxIn, slave → master)	-	0080h
0x001Ch	Mailbox Protocol	Supported Mailbox protocol	-	0004h
0x001Dh … 0x003Dh	Reserved	Reserved	-	-
0x003Eh	Size	EEPROM size	-	000Fh
0x003Fh	Version	edition	-	0001h
0040h …	Types of data			

6.2.7 Synchronization Mode

The servo supports DC_sync0 synchronization mode.

EtherCAT's distributed clock (DC) uses the DC clock of the first slave station as reference clock, and the master distributes the reference clock to all slave stations. When EtherCAT master station periodically sends an ARMW command to read the bus time stored in ESC register of the clock master, and writes this value into DC, the corresponding register of slave station to update local time. In order to ensure the accuracy of request, EtherCAT frame delay between slave stations must be additionally compensated. For each slave station, the time from sending to receiving a frame will be measured. Upon the bus topology, master station calculates the delay between slave stations and writes the corresponding delay compensation value into the register 0x928 in ESC.

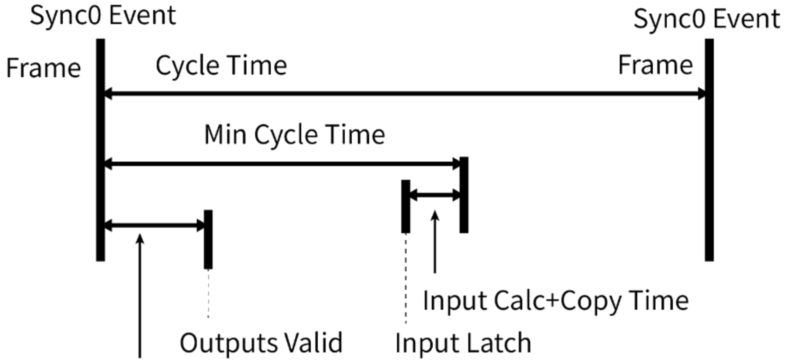


Figure 6-4 Sequence diagram of DC mode communication

6.2.8 MailBox Mailbox Structure

Mailbox mailbox frame structure is shown as below:
For details, see ETG Specification (ETG1000-4).

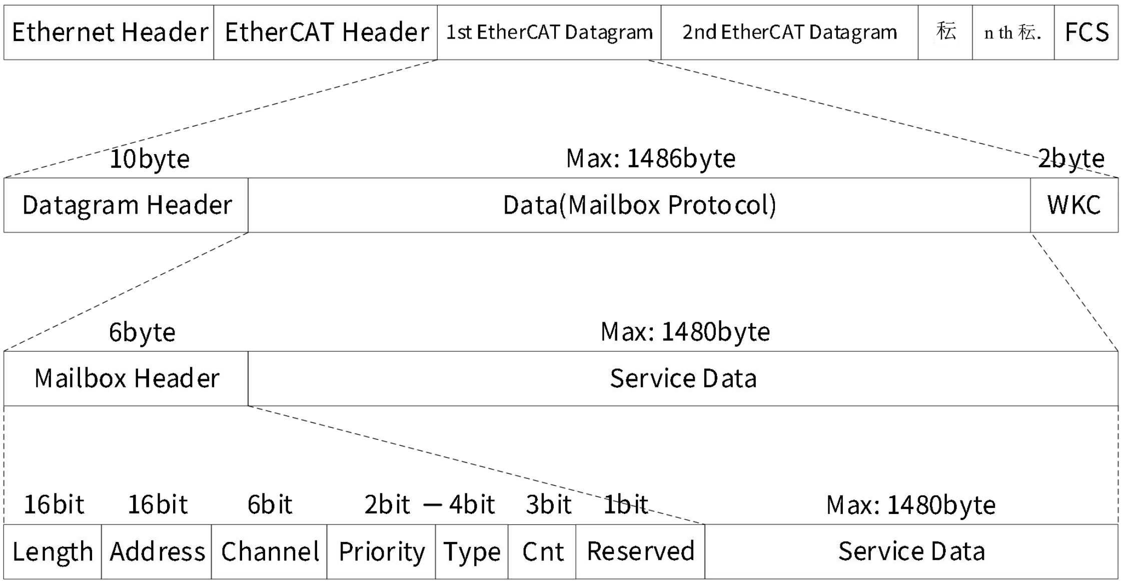


Figure 6-5 Mailbox frame structure

Table 6-9 EtherCAT mailbox codes

Frame part	Data area	Data type	Value/Description
Mailbox Header	Length	WORD	Length of mailbox service data
	Address	WORD	If the master station is a client, it's the source station address; If the slave station is a client, it's the destination station address.
	Channel	Unsigned6	0x00(Reserved)
	Priority	Unsigned2	0x00: The lowest priority … 0x03: The highest priority
	Type	Unsigned4	0x00：Mailbox Error 0x01：(Reserved) 0x02：EOE(Not supported) 0x03：COE 0x04：FOE(Not supported) 0x05：SOE(Not supported) 0x06~0x0E：(Reserved) 0x0F：Manufacturer Specific
	Cnt	Unsigned3	Mailbox service counter (0 is reserved, 1 is the starting value, and the value after 7 is 1). Slave station increments Cnt value for each new mailbox service, and master station should check that value to prevent mailbox service loss; Slave station should also check that value to find duplicate written services, while slave station should not check the sequence of Cnt values; Cnt values of the master and the slave are independent.
	Reserved	Unsigned1	0x00
Service Data	Service Data	OctetString[Length]	Mailbox service data

6.2.8.1 Mailbox Error

The service data responded by Mailbox Error is shown as below:

Table 6-10 Service data responded by Mailbox Error

Frame part	Data area	Data type	Value/Description
Mailbox Header		6byte	
Service Data	Type	Unsigned16	0x01：MBXSERVICE_MBXERRORCMD Mail error command.
	Detail	Unsigned16	0x01h：MBXERR_SYNTAX (Not Supported) Syntax error of 6byte mailbox header; 0x02h：MBXERR_UNSUPPORTEDPROTOCOL Mailbox protocol is not supported. 0x03h：MBXERR_INVALIDCHANNEL (Not Supported) Channel field contains the error value; 0x04h：MBXERR_SERVICENOTSUPPORTED Services in the mailbox protocol are not supported. 0x05h：MBXERR_INVALIDHEADER Mailbox protocol Header error (excluding 6 bytes of Mailbox Header); 0x06h：MBXERR_SIZETOOSHORT Length of received mailbox data is too short; 0x07h：MBXERR_NOMOREMEMORY Unable to provide sufficient memory for mailbox service due to resource constraints; 0x08h：MBXERR_INVALIDSIZE Data length is inconsistent; 0x09h：MBXERR_SERVICEINWORK (Not Supported) Mailbox service in process;

Note: The above table is the abstract description on Mailbox Error service. For details, see ETG1000-4.
When Mailbox Error occurs, Mailbox Header.Type = 0x00

6.2.8.2 SDO(Service Data Object)

SV3 servo supports Service Data Objects (SDO) :
Note) ・When PDO modifies data, do not refresh the data by SDO
・SDO response may take some time.
For details, see ETG specifications (ETG1000-5 and ETG1000-6).

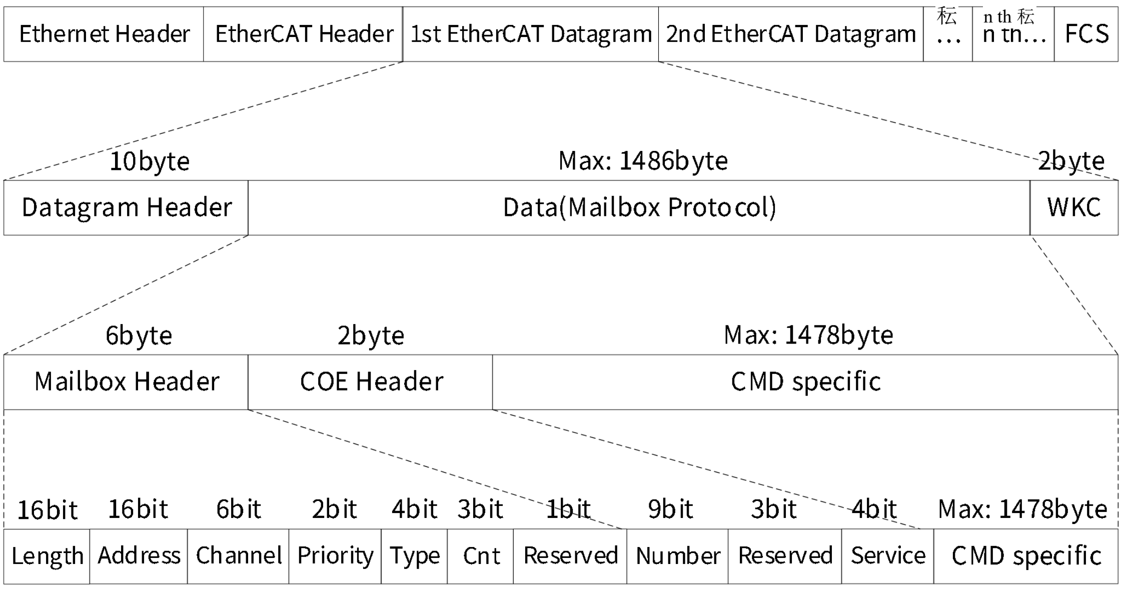


Figure 6-6 Mailbox/SDO frame structure

Table 6-11 COE mailbox codes

Frame part	Data area	Data type	Value/Description
Mailbox Header	Length	WORD	Length of mailbox service data
	Address	WORD	If the master station is a client, it's the source station address; If the slave station is a client, it's the destination station address.
	Channel	Unsigned6	0x00
	Priority	Unsigned2	Priority 0x00: The lowest priority … 0x03: The highest priority
	Type	Unsigned4	0x03：COE
	Cnt	Unsigned3	Mailbox service counter (0 is reserved, 1 is the starting value, and the value after 7 is 1)
	Reserved	Unsigned1	0x00
COE Header	Number	Unsigned9	Depend on COE service
	Reserved	Unsigned3	0x00
	Service	Unsigned4	0x01：Emergency 0x02：SDO Request 0x03：SDO Response 0x04：TxPDO (Not Supported) 0x05：RxPDO (Not Supported) 0x06：TxPDO remote request (Not Supported) 0x07：RxPDO remote request (Not Supported) 0x08：SDO information
Cmd Specific	Cmd Specific		

Note: The above table is the abstract description on COE services. For details, see ETG1000-6.
Supported services:

SDO Download Expedited
SDO Download Normal
Download SDO Segment
SDO Upload Expedited
SDO Upload Normal
Upload SDO Segment
Abort SDO Transfer
Abort Message

When SDO data exchange processing (Read or Write) fails, Abort Message is returned, which is specified by Abort Code as the error message indicating the reason for SDO termination.

Table 6-12 Abort Message

Value	Meaning	
0x05030000	Toggle bit not changed	Toggle bit no change
0x05040000(Not Supported)	SDO protocol timeout	SDO protocol timeout
0x05040001	Client/Server command specifier not valid or unknown	The client/server command qualifier is invalid or unknown
0x05040005	Out of memory	Memory overflow
0x06010000	Unsupported access to an object	Unsupported object access
0x06010001	Attempt to read to a write only object	Attempt to read a write-only object
0x06010002	Attempt to write to a read only object	Attempt to write to a read-only object
0x06010003	Entry can not be written because Subindex0 is not 0	Unable to write into sub-index because Subindex 0 is not 0
0x06010004 (Not Supported)	The object can not be accessed via complete access	The specified object can't be accessed in the full access method
0x06020000	Object not existing	That object does not exist in the object directory
0x06040041 (Not Supported)	Object can not be mapped to PDO	That object cannot be mapped to PDO
0x06040042 (Not Supported)	The number and length of the objects to be mapped would exceed the PDO length	The number and length of mapped objects will exceed PDO length
0x06040043 (Not Supported)	General parameter incompatibility reason	General parameters are not compatible
0x06040047 (Not Supported)	General internal incompatibility in the device	The device has general internal incompatibility
0x06060000 (Not Supported)	Access failed due to a hardware error	Access failed due to a hardware error
0x06070010	Data type does not match,length of service parameter does not match	The data type is inconsistent, and the length of service parameter are inconsistent
0x06070012 (Not Supported)	Data type does not match,length of service parameter too high	The data type is inconsistent, and the length of service parameter is too long
0x06070013 (Not Supported)	Data type does not match,length of service parameter too low	The data type is inconsistent, and the length of service parameter is too short
0x06090011	Subindex does not exist	Subindex does not exist
0x06090030	Value range of parameter exceeded (only for write access)	Parameter value out of range (for write access only)
0x06090031	Value of parameter written too great	Value of the parameter written is too large

0x06090032 (Not Supported)	Value of parameter written too small	Value of the parameter written is too small
0x06090036 (Not Supported)	Maximum value is less than minimum value	The maximum is less than the minimum
0x08000000 (Not Supported)	General error	General alarm
0x08000020	Data cannot be transferred or stored the application	Data can't be transferred or stored to the application layer
0x08000021	Data cannot be transferred or stored to the application because of local control	Data can't be transferred/stored to the application layer due to local control
0x08000022	Data cannot be transferred or stored to the application because of the present device state	Due to current device state, data can't be transferred/stored to the application layer
0x08000023	Object dictionary dynamic generation fails or no object dictionary is present	Object dictionary fails to be dynamically generated or does not exist

6.2.8.3 SDO Information

Table 6-13 COE-SDO Information Service data

Frame part	Data area	Data type	Value/Description
Mailbox Header	Length	WORD	n>0x06: Length of mailbox service data
	Address	WORD	If the master station is a client, it's the source station address; If the slave station is a client, it's the destination station address.
	Channel	Unsigned6	0x00
	Priority	Unsigned2	priority 0x00: The lowest priority … 0x03: The highest priority
	Type	Unsigned4	0x03：COE
	Cnt	Unsigned3	Mailbox service counter (0 is reserved, 1 is the starting value, and the value after 7 is 1)
	Reserved	Unsigned1	0x00
COE Header	Number	Unsigned9	0x00
	Reserved	Unsigned3	0x00
	Service	Unsigned4	0x08：SDO information
SDO Info Header	Opcode	Unsigned7	0x01：Get OD List request 0x02：Get OD List response(Not Supported) 0x03：Get Object Description request 0x04：Get Object Description response(Not Supported) 0x05：Get Entry Description request 0x06：Get Entry Description response(Not Supported) 0x07：SDO Info Error(Not Supported)
	Incomplete	Unsigned1	Whether it is the last SDO Information segment(Not Supported)
	Reserved	Unsigned8	0x00
	Fragments	WORD	Number of subsequent segments

Frame part	Data area	Data type	Value/Description
	Left		
SDO Info Service Data	Data		SDO Information service data

Note: The above table is the abstract description on SDO Information service, see ETG1000-6 for details

The following services are supported:
Get OD List
OD List Segment
Get Object Description
Get Entry Description
Entry Description Segment
Emergency
Emergency Message
When servo operation Error occurs, the servo actively sends an emergency frame to notify operation controller of the servo Error.
Emergency Message can occur only in Non-Init state.
When Emergency Message occurs, object 0x603F is set of the corresponding Error code.

Table 6–14 COE-SDO Emergency service data

Frame part	Data area	Data type	Value/Description
Mailbox Header		6byte	
COE Header	Number	Unsigned9	0x00
	Reserved	Unsigned3	0x00
	Service	Unsigned4	0x01：SDO emergency
Emergency	Error Code	WORD	Error code
	Error Register	Byte	Error register
	Data	Byte[5]	Diagnostic data
	Reserved		

Note: The above table is the abstract description on SDO Information service, see ETG1000-6 for details

Table 6-15 Diagnostic Data[0]

Data [0]	Data [1~4]	Meaning
0x00+channel*4	Sync Manager Address Error(address is odd)	Address of synchronization manager channel is odd
0x01+channel*4	Sync Manager Address Error(address invalid)	Address of synchronization manager channel is invalid
0x02+channel*4	Sync Manager Length Error	Length of synchronization manager channel is invalid
0x03+channel*4	Sync Manager Setting Error	Setting of synchronization manager channel is invalid

Table 6-16 Sync Manager address error: Diagnostic Data [1-4]

Data [1~4]	Data type	Value/Description
Minimum Address	WORD	Min. value of the physical start address of synchronization manager channel
Maximum Address	WORD	Max.value of the physical start address of synchronization manager channel

Table 6-17 Error of Sync Manager Length: Diagnostic Data [1~4]

Data [1~4]	Data type	Value/Description
Minimum Length	WORD	Min. value for the length of sync manager channel
Maximum Length	WORD	Max. value for the length of sync manager channel

Table 6-18 Error of Sync Manager Settings: Diagnostic Data[1-4]

Data [1~4]	Data type	Value/Description
0x02 + channel *4	WORD	0x02 + channel *4
0x0001	WORD	Sync Manager setting enable value

2) Servo operation error

Error code is the same as Object 0x603F.
SDO Emergency is used as follows:
Error code: the same as Object 0x603F
Error register: the corresponding error register

Table 6-19 Diagnostic Data[0~4]

Data	Numerical value	Data type	Value/Description
[0]	(err_code-0xFF00)&0xFF	Byte	That's err in the table
[1~2]	error data[0]+0x320	WORD	Panel display data
[3~4]	0	WORD	Forced to be 0

6.2.8.4 Processing Capability

The servo has the cache for the received mailbox data. Max. cache number is 4 pieces of mailbox data. If master station continuously sends over 4 pieces of mailbox data, the subsequent data 3will not be received temporarily. Only when the cache is free, can it continue to receive subsequent mailbox data.

Therefore, in the case of not processing mailbox feedback data, it is recommended that number of consecutive mailbox messages sent by master station should not exceed 4.

6.2.9 PDO(Process Data Object)

EtherCAT bus servo supports Process Data Object (PDO) and can be configured online. Real-time data transmission based on EtherCAT is exchanged by PDO. PDO has RxPDO for transmitting data from master station to slave station and has TxPDO for transmitting data from slave station to master station.

RxPDO	≤68byte: Number of allocated objects is 1; Number of mapped application objects ≤20
TxPDO	≤68byte: Number of allocated objects is 1; Number of mapped application objects ≤20

SV3 servo supports PDO online dynamic mapping.

Dynamic mapping can be performed in 2 steps: allocating objects and mapping objects.

6.2.9.1 PDO allocates objects

SV3 servo must allocate objects to SyncManager PDO, 0x1C12 used for RxPDO(SyncManager2) and 0x1C13 used for TxPDO(SyncManager2).

Table 6-20 RxPDO allocation objects

Index	Sub	DeError Value	Remarks
1C12h	00h	01h	Only one object can be configured
	01h	1600h	1600h/1601h/1602h/1603h one out of four 1600h/1601h/1602h/1603h are mutually exclusive

Table 6-21 TxPDO allocation objects

Index	Sub	DeError Value	Remarks
1C13h	00h	01h	Only one object can be configured
	01h	1A00h	1A00h/1A01h/1A02h/1A03h one out of four 1A00h/1A01h/1A02h/1A03h are mutually exclusive

Configuration case: < Take 1C12h configured of 1603h for example>

1) Switch ESM status into PreOP;

Activate mailbox communication and configure 1C12h by SDO.

2) Set 1C12h-00h of 0 by SDO;

Value of 1C12h-01h can be changed only after 1C12h-00h is set of 0.

3) Set 1C12h-01h of 1603h by SDO;

Set the specific allocation object

4) Set 1C12h-00h of 1 by SDO;

Activate the setting of 1C12h.

5) Switch ESM status into SafeOP;

Activate TxPDO.

6) Switch ESM status into OP.

Activate RxPDO.

6.2.9.2 PDO Mapping Objects

The mapping objects used for RxPDO can be 1600h/1601h/1602h/1603h.

The mapping objects used for TxPDO can be 1A00h/1A01h/1A02h/1A03h.

Table 6-22 Mapping object 1600h

Index	Sub	DeError Value	Remarks
1600h	00h	07h	Max. 20
	01h	60400010h	1st receive PDO mapped
	02h	607A0020h	2nd receive PDO mapped
	03h	60FF0020h	3rd receive PDO mapped
	04h	60710010h	4th receive PDO mapped
	05h	60600008h	5th receive PDO mapped
	06h	5FFE0008h	6th receive PDO mapped

	07h	60B80010h	7th receive PDO mapped
	08h	00000000h	8th receive PDO mapped
	…	…	…
	14h	00000000h	20th receive PDO mapped

Other, omit.

Configuration case: < Take 1600h-08h configured of 606Eh for example.

1) Switch ESM status into PreOP;

Activate mailbox communication and configure 1600h by SDO.

2) Set 1600h-00h of 0 by SDO;

It must set 1600h-00h of 0 first, then value of 1600h-08h can be changed.

3) Set 1600h-08h of 606E0010h by SDO;

Set the specific mapping object

4) Set 1600h-00h of 8 by SDO;

Activate 1600h setting.

5) Switch ESM status into SafeOP;

Activate TxPDO.

6) Switch ESM status into OP.

Activate RxPDO.

Chapter 7 Object Dictionary

7.1 Allocation List of Object Group 1000h

Table 7-1 List of 1000h object group

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
1000	0	Drive type	RO	NO	UINT32	-	-	0x00020192
1008	0	Drive name	RO	NO	-	-	-	SV3H-ECAT
1009	0	Hardware version	RO	NO	-	-	-	Depends on the software version
100A	0	Software version	RO	NO	-	-	-	Depends on the hardware version
1018	**ID object**							
	0	Max. subindex number included by ID object	RO	NO	UINT8	-	-	04 hex
	1	Supplier ID	RO	NO	UINT32	-	-	0010 0000 hex
	2	Product code	RO	NO	UINT32	-	-	0x000C0108
	3	Revision No.	RO	NO	UINT32	-	-	0x00010001
1C00	**Manufacturer's software version**							
	0	Max. subindex number of synchronous management communication type	RO	NO	UINT8	-	-	04 hex
	1	SM0 communication type	RO	NO	UINT8	-	-	01hex
	2	SM1 communication type	RO	NO	UINT8	-	-	02hex
	3	SM2 communication type	RO	NO	UINT8	-	-	03hex
	4	SM3 communication type	RO	NO	UINT8	-	-	04hex

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
1600	**RxPDO1 Mapping object 1st**							
	0	RxPDO1 Number of supported mapping objects	RW	NO	UINT8	-	0~10	3
	1	The first mapping object	RW	NO	UINT32	-	0~4294967295	6040 0010
	2	The second mapping object	RW	NO	UINT32	-	0~4294967295	607A 0020
	3	The third mapping object	RW	NO	UINT32	-	0~4294967295	60B8 0010
	4	The fourth mapping object	RW	NO	UINT32	-	0~4294967295	-
	5	The fifth mapping object	RW	NO	UINT32	-	0~4294967295	-
	6	The sixth mapping object	RW	NO	UINT32	-	0~4294967295	-
	7	The seventh mapping object	RW	NO	UINT32	-	0~4294967295	-
	8	The eighth mapping object	RW	NO	UINT32	-	0~4294967295	-
	9	The ninth mapping object	RW	NO	UINT32	-	0~4294967295	-
	0A	The tenth mapping object	RW	NO	UINT32	-	0~4294967295	-
1701	**RxPDO1 Mapping object 258th**							
	0	RxPDO1 Number of supported mapping objects	RO	NO	UINT8	-	-	04hex

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
	1	The first mapping object	RO	NO	UINT32	-	-	6040 0010
	2	The second mapping object	RO	NO	UINT32	-	-	607A 0020
	3	The third mapping object	RO	NO	UINT32	-	-	60B8 0010
	4	The fourth mapping object	RO	NO	UINT32	-	-	60FE 0120
1702	**RxPDO1 Mapping object 259th**							
	0	RxPDO259 Number of supported mapping objects	RO	NO	UINT8	-	-	07 hex
	1	The first mapping object	RO	NO	UINT32	-	-	6040 0010
	2	The second mapping object	RO	NO	UINT32	-	-	607A 0020
	3	The third mapping object	RO	NO	UINT32	-	-	60FF 0020
	4	The fourth mapping object	RO	NO	UINT32	-	-	6071 0010
	5	The fifth mapping object	RO	NO	UINT32	-	-	6060 0008
	6	The sixth mapping object	RO	NO	UINT32	-	-	60B8 0010
	7	The seventh mapping object	RO	NO	UINT32	-	-	607F0020
1703	**RxPDO1 Mapping object 260th**							
	0	RxPDO260 Number of	RO	NO	UINT8	-	-	07 hex

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
		supported mapping objects						
	1	The first mapping object	RO	NO	UINT32	-	-	6040 0010
	2	The second mapping object	RO	NO	UINT32	-	-	607A 0020
	3	The third mapping object	RO	NO	UINT32	-	-	60FF 0020
	4	The fourth mapping object	RO	NO	UINT32	-	-	6060 0008
	5	The fifth mapping object	RO	NO	UINT32	-	-	60B8 0010
	6	The sixth mapping object	RO	NO	UINT32	-	-	60E0 0010
	7	The seventh mapping object	RO	NO	UINT32	-	-	60E1 0010
1704	**RxPDO1 Mapping object 261st**							
	0	RxPDO261 Number of supported mapping objects	RO	NO	UINT8	-	-	09 hex
	1	The first mapping object	RO	NO	UINT32	-	-	6040 0010
	2	The second mapping object	RO	NO	UINT32	-	-	607A 0020
	3	The third mapping object	RO	NO	UINT32	-	-	60FF 0020
	4	The fourth mapping object	RO	NO	UINT32	-	-	6071 0010

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
	5	The fifth mapping object	RO	NO	UINT32	-	-	6060 0008
	6	The sixth mapping object	RO	NO	UINT32	-	-	60B8 0010
	7	The seventh mapping object	RO	NO	UINT32	-	-	607F0020
	8	The eighth mapping object	RO	NO	UINT32	-	-	60E0 0010
	9	The ninth mapping object	RO	NO	UINT32	-	-	60E1 0010
1705	**RxPDO1 Mapping object 262nd**							
	0	RxPDO262 Number of supported mapping objects	RO	NO	UINT8	-	-	08hex
	1	The first mapping object	RO	NO	UINT32	-	-	6040 0010
	2	The second mapping object	RO	NO	UINT32	-	-	607A 0020
	3	The third mapping object	RO	NO	UINT32	-	-	60FF 0020
	4	The fourth mapping object	RO	NO	UINT32	-	-	6060 0008
	5	The fifth mapping object	RO	NO	UINT32	-	-	60B8 0010
	6	The sixth mapping object	RO	NO	UINT32	-	-	60E0 0010
	7	The seventh mapping object	RO	NO	UINT32	-	-	60E1 0010

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
	8	The eighth mapping object	RO	NO	UINT32	-	-	60B2 0010
1A00	**TxPDO1 Mapping object 1st**							
	0	TxPDO1 Number of supported mapping objects	RW	NO	UINT8	-	0~10	7
	1	The first mapping object	RW	NO	UINT32	-	0~4294967295	6041 0010
	2	The second mapping object	RW	NO	UINT32	-	0~4294967295	6064 0020
	3	The third mapping object	RW	NO	UINT32	-	0~4294967295	60B9 0010
	4	The fourth mapping object	RW	NO	UINT32	-	0~4294967295	60BA 0020
	5	The fifth mapping object	RW	NO	UINT32	-	0~4294967295	60BC0020
	6	The sixth mapping object	RW	NO	UINT32	-	0~4294967295	603F0010
	7	The seventh mapping object	RW	NO	UINT32	-	0~4294967295	60FD0020
	8	The eighth mapping object	RW	NO	UINT32	-	0~4294967295	-
	9	The ninth mapping object	RW	NO	UINT32	-	0~4294967295	-
	0A	The tenth mapping object	RW	NO	UINT32	-	0~4294967295	-
1B01	**TxPDO258 Mapping object**							
	0	TxPDO258 Number of	RO	NO	UINT8	-	-	8

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
		supported mapping objects						
	1	The first mapping object	RO	NO	UINT32	-	-	603F0010
	2	The second mapping object	RO	NO	UINT32	-	-	6041 0010
	3	The third mapping object	RO	NO	UINT32	-	-	6064 0020
	4	The fourth mapping object	RO	NO	UINT32	-	-	6077 0010
	5	The fifth mapping object	RO	NO	UINT32	-	-	60F40020
	6	The sixth mapping object	RO	NO	UINT32	-	-	60B90010
	7	The seventh mapping object	RO	NO	UINT32	-	-	60BA0020
	8	The eighth mapping object	RO	NO	UINT32	-	-	60FD0020
1B02	**TxPDO259 Mapping object**							
	0	TxPDO259 Number of supported mapping objects	RO	NO	UINT8	-	-	9
	1	The first mapping object	RO	NO	UINT32	-	-	603F0010
	2	The second mapping object	RO	NO	UINT32	-	-	6041 0010
	3	The third mapping object	RO	NO	UINT32	-	-	6064 0020

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
	4	The fourth mapping object	RO	NO	UINT32	-	-	6077 0010
	5	The fifth mapping object	RO	NO	UINT32	-	-	6061 0008
	6	The sixth mapping object	RO	NO	UINT32	-	-	60B9 0010
	7	The seventh mapping object	RO	NO	UINT32	-	-	60BA 0020
	8	The eighth mapping object	RO	NO	UINT32	-	-	60BC0020
	9	The ninth mapping object	RO	NO	UINT32	-	-	60FD0020
1B03	**TxPDO260 Mapping object**							
	0	TxPDO260 Number of supported mapping objects	RO	NO	UINT8	-	-	10
	1	The first mapping object	RO	NO	UINT32	-	-	603F0010
	2	The second mapping object	RO	NO	UINT32	-	-	6041 0010
	3	The third mapping object	RO	NO	UINT32	-	-	6064 0020
	4	The fourth mapping object	RO	NO	UINT32	-	-	6077 0010
	5	The fifth mapping object	RO	NO	UINT32	-	-	60F4 0020
	6	The sixth mapping object	RO	NO	UINT32	-	-	6061 0008

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
	7	The seventh mapping object	RO	NO	UINT32	-	-	60B9 0010
	8	The eighth mapping object	RO	NO	UINT32	-	-	60BA 0020
	9	The ninth mapping object	RO	NO	UINT32	-	-	60BC0020
	0A	The tenth mapping object	RO	NO	UINT32	-	-	60FD0020
1B04	**TxPDO261 Mapping object**							
	0	TxPDO261 Number of supported mapping objects	RO	NO	UINT8	-	-	10
	1	The first mapping object	RO	NO	UINT32	-	-	603F0010
	2	The second mapping object	RO	NO	UINT32	-	-	6041 0010
	3	The third mapping object	RO	NO	UINT32	-	-	6064 0020
	4	The fourth mapping object	RO	NO	UINT32	-	-	6077 0010
	5	The fifth mapping object	RO	NO	UINT32	-	-	6061 0008
	6	The sixth mapping object	RO	NO	UINT32	-	-	60F4 0020
	7	The seventh mapping object	RO	NO	UINT32	-	-	60B9 0010
	8	The eighth mapping object	RO	NO	UINT32	-	-	60BA 0020

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
	9	The ninth mapping object	RO	NO	UINT32	-	-	60BC0020
	0A	The tenth mapping object	RO	NO	UINT32	-	-	606C0020
1C12	**Sync management 2_ RxPDO allocation**							
	0	Sync management 2_RxPDO allocation Max. subindex No.	RW	NO	UINT8	-	0~1	1
	1	Index of RxPDO allocation objects	RW	YES	UINT16	-	0~65535	0x1701
1C13	Sync management 2_TxPDO allocation		RW	NO	UINTER16	-	OD data range	OD deError value
	0	Sync management 2_TxPDO allocation Max. subindex No.	RW	NO	UINT8	-	0~1	1
	1	Index of TxPDO allocation objects	RW	YES	UINT16	-	0~65535	0x1B01
1C32	**Sync management 2 Synchronize output parameters**							
	0	Sync management 2 Maximum sub-index number of synchronization parameters	RO	NO	UINT8	-	-	0x20
	1	Synchronization type	RO	NO	UINT16	-	-	0x0002
	2	Cycle time	RO	NO	UINT32	ns	-	0
	4	Supported synchronizatio	RO	NO	UINT16	-	-	0x0004

Index	Subindex	Name	Accessibility	PDO mapping	Data type	Unit	Data range	Factory setting
		n types						
	5	Min. cycle time	RO	NO	UINT32	ns	-	0x0001E848
	6	Calculate and copy time	RO	NO	UINT32	ns	-	-
	9	Delay time	RO	NO	UINT32	ns	-	-
	20	Sync error	RO	NO	BOOL	-	-	-
1C33	**Sync management 2 Synchronize input parameters**							
	0	Sync management 2 Maximum sub-index number of synchronization parameters	RO	NO	UINT8	-	-	0x20
	1	Synchronization type	RO	NO	UINT16		-	0x0002
	2	Cycle time	RO	NO	UINT32	ns	-	0
	4	Supported synchronization types	RO	NO	UINT16	-	-	0x0004
	5	Min. cycle time	RO	NO	UINT32	ns	-	0x0001E848
	6	Calculate and copy time	RO	NO	UINT32	ns	-	-
	9	Delay time	RO	NO	UINT32	ns	-	-
	20	Sync error	RO	NO	BOOL	-	-	-

7.2 Allocation List of Object Groups 2000h

Table 7-2 List of 2000h object group

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
2000 Motor parameters									
2000	04h	P0003	Motor property	RW	-	0~65535	0	Stop change	Immediate effect
2000	0Bh	P0010	Rated voltage of motor	RW	V	0:220V 1:380V	0	Stop change	Power-on reset
2000	0Ch	P0011	Rated current of motor	RW	0.01A	0~65535	100	Stop change	Power-on reset
2000	0Dh	P0012	Rated power of motor	RW	0.01kW	0~65535	75	Stop change	Power-on reset
2000	0Eh	P0013	Rated torque	RW	0.01Nm	0~4294967295	239	Stop change	Power-on reset
2000	12h	P0017	Rated speed	RW	rpm	0~65535	3000	Stop change	Power-on reset
2001 Encoder parameters									
2001	01h	P0100	Encoder communication protocol	RW	-	0~65535	11233	Stop change	Power-on reset
2001	04h	P0103	Encoder version No.	RO	-	0~65535	0	Display	Immediate effect
2001	06h	P0105	Encoder wire count	RW	-	0~4294967295	1048576	Stop change	Power-on reset
2002 Drive Parameters									
2002	01h	P0200	MCU software version No.	RO	-	0~65535	0	Display	Immediate effect
2002	02h	P0201	FPGA software version No.	RO	-	0~65535	0	Display	Immediate effect
2002	03h	P0202	MCU non-standard	RO	-	0~4294967295	0	Display	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			No.						effect
2002	05h	P0204	FPGA non-standard No.	RO	-	0~4294967295	0	Display	Immediate effect
2002	0Dh	P0212	Drive input voltage	RO	-	0~65535	220	Display	Immediate effect
2002	0Eh	P0213	Drive rated power	RO	0.01kW	1~65535	75	Display	Immediate effect
2002	10h	P0215	Drive rated current	RO	0.01A	1~65535	550	Display	Immediate effect
2002	23h	P0234	Regenerative resistance selection	RW	-	0: Built-in regenerative resistor 1: External regenerative resistance, natural cooling 2: external regenerative resistance, forced air cooling 3: No regenerative resistance	0	Stop change	Immediate effect
2002	24h	P0235	Heat radiation coefficient of regenerative resistance	RW	-	10~100	30	Stop change	Immediate effect
2002	25h	P0236	Built-in regenerative resistor power	RO	W	1~65535	40	Display	Immediate effect
2002	26h	P0237	Built-in regenerative resistance	RO	Ω	1~1000	50	Display	Immediate effect
2002	27h	P0238	Min. external regenerative resistance	RO	Ω	1~1000	40	Display	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
2002	28h	P0239	External regenerated resistor power	RW	W	1~65535	40	Stop change	Immediate effect
2002	29h	P0240	External regenerative resistance	RW	Ω	1~1000	50	Stop change	Immediate effect
2003 IO Parameters									
2003	01h	P0300	DI1 function	RW	-	0: no definition 1: Servo enabled 2: Emergency shutdown 3: Command forbidden 4: Position deviation cleared 5: Reset the Error 6: Zero speed retention 7: Forward jogging 8: Reverse jogging 9: Forwar limit 10: Reverse limit 11: Origin switch 12: Zero to return enabled 13: Speed limit selection 14: Forward torque limit selection 15: Reverse torque limit selection 16: Preset	9	Stop change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						position enabled			
						19: Torque instruction reversing			
						20: Speed instruction reversing switch			
						21: Position command reversing switch			
						22: Gain switch selection			
						23: Operation command switch			
						24: Mode switch 1			
						25: Mode switch 2			
						26: Electronic gear switch			
						27: Preset command selection 1			
						28: Preset command selection 2			
						29: Preset command selection 3			
						30: Preset command selection 4			
						31: Current DI trigger point as the origin			
						33: Probe 1			
						34: Probe 2			

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
2003	02h	P0301	DI1 Polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	03h	P0302	DI2 function	RW	-	Refer to DI1 function	10	Stop change	Immediate effect
2003	04h	P0303	DI2 polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	05h	P0304	DI3 function	RW	-	Refer to DI1 function	11	Stop change	Immediate effect
2003	06h	P0305	DI3 polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	07h	P0306	DI4 function	RW	-	Refer to DI1 function	0	Stop change	Immediate effect
2003	08h	P0307	DI4 polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	09h	P0308	DI5 function	RW	-	Refer to DI1 function	0	Stop change	Immediate effect
2003	0Ah	P0309	DI5 polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	13h	P0318	Initial effect DI function 1	RW	-	0: no definition 1: Servo enabled 2: Emergency shutdown 3: Command forbidden 4: Position deviation	0	Stop change	Power-on reset

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						cleared 5: Reset the Error 6: Zero lock 7: Forward jogging 8: Reverse jogging 9: Forwar limit 10: Reverse limit 11: Origin switch 12: Zero to return enabled 13: Speed limit selection 14: Forward torque limit selection 15: Reverse torque limit selection 16: Preset position enabled			
2003	14h	P0319	Initial effect DI function 2	RW	-	0: no definition 19: Torque instruction reversing 20: Speed instruction reversing switch 21: Position command reversing switch 22: Gain switch selection 23: Speed	0	Stop change	Power-on reset

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						command source switch			
						24: Mode switch 1			
						25: Mode switch 2			
						26: Electronic gear switch			
						27: Preset command selection 1			
						28: Preset command selection 2			
						29: Preset command selection 3			
						30: Preset command selection 4			
						31: Current DI trigger point as the origin			
2003	15h	P0320	DO1 function	RW	-	0: no definition	17	Stop change	Immediate effect
						1: Rdy			
						2: Run			
						3: Warn			
						4: Error			
						5: TGon			
						6: Zero			
						7: VCmp			
						8: VArr			
						9: TArr			
						10: Near			
						11: Coin			
						12: Clt			
						13: Vlt			
						14: HomeOK			
						15: eHomeOK			
						17: BK			
						18: DB			

Index	Subindex	Parameter	Name	Property	Unit	Range	FactorydeError	Setting mode	Enable mode
						19: AngRdy			
2003	16h	P0321	DO1 polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	17h	P0322	DO2 function	RW	-	Refer to DO1 function	2	Stop change	Immediate effect
2003	18h	P0323	DO2 polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	19h	P0324	DO3 function	RW	-	Refer to DO1 function	4	Stop change	Immediate effect
2003	1Ah	P0325	DO3 polarity	RW	-	0: Normally open 1: Normally close	0	Stop change	Immediate effect
2003	1Fh	P0330	DIDO enforcement	RW	-	0: no operation is performed 1: Forcibly DI enabled 2: Forcibly DO enabled 3: Forcibly DIDO enabled 4: Bus forcibly DO enabled	0	Arbitrary change	Immediate effect
2003	20h	P0331	DI Enforcement	RW	-	0~447	447	Arbitrary change	Immediate effect
2003	21h	P0332	DO Channel selection	RW	-	0~7	0	Arbitrary change	Immediate effect
2003	23h	P0334	Communication forcibly DO output switch	RW	-	0~7	0	Stop change	Immediate effect
2004 Motion control parameters									
2004	01h	P0400	Control mode	RW	-	0: Speed mode 1: Position	10	Stop change	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	FactorydeError	Setting mode	Enable mode
						mode 2: Torque mode 3: Torque mode → speed mode 4: Speed mode → position mode 5: Torque mode → position mode 6: Torque mode → speed mode → position hybrid mode 10: EtherCAT bus mode			effect
2004	02h	P0401	Direction of motor rotation	RW	-	0: CCW as positive direction 1: CW as positive direction	0	Stop change	Power-on reset
2004	03h	P0402	Position feedback system	RW	-	0: Incremental mode 1: Absolute linear mode 2: Absolute rotation mode	0	Stop change	Power-on reset
2004	0Bh	P0410	Type I Error stop mode	RW	-	0: Free stop, keep free state 1: DB stop, keep free state 2: DB stop, keep DB state	2	Stop change	Immediate effect
2004	0Ch	P0411	Type II Error stop mode	RW	-	0: Free stop, keep free state 1: Zero speed stop, keep free state 2: Zero speed stop, keep DB	2	Stop change	Immediate effect

Index	**Subindex**	**Parameter**	**Name**	**Property**	**Unit**	**Range**	**Factory deError**	**Setting mode**	**Enable mode**
						state 3: DB stop, keep free state 4: DB stop, keeps DB statte			
2004	0Dh	P0412	Selection of disable stop mode	RW	-	0: Free stop 1: DB stop 2: Zero speed stop	2	Stop change	Immediate effect
2004	0Eh	P0413	Selection of disable stop state	RW	-	0: Keep free state 1: Keep DB state	1	Stop change	Immediate effect
2004	0Fh	P0414	Selection of power-off stop mode	RW	-	0: Disabled mode 1: Forced zero speed mode	0	Stop change	Immediate effect
2004	10h	P0415	Overrun stop mode	RW	-	0: Free stop, keep free running state 1: Zero speed stop, keep position locked state 2: Zero speed stop, keep free running state	1	Stop change	Immediate effect
2004	18h	P0423	Torque for emergency stop	RW	0.1%	0~3000	1000	Stop change	Immediate effect
2005 Function setting parameters									
2005	01h	P0500	Manufacturer's password	RW	-	0~65535	0	Arbitrary change	Immediate effect
2005	02h	P0501	Initialization of system parameters	RW	-	0: no operation is performed 1: Parameter initialization	0	Stop change	Immediate effect
2005	0Bh	P0510	Save for communication write	RW	-	0: Not save 1:2000 group save	3	Arbitrary change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			parameters			2:6000 groups save 3:2000 group and 6000 group save			
2005	0Ch	P0511	Save for power-off parameters	RW	-	0: Not save 1: Save	0	Arbitrary change	Immediate effect
2005	0Dh	P0512	Holding brake enable switch	RW	-	0: Disable 1: Enable	1	Stop change	Immediate effect
2005	0Eh	P0513	Holding brake switch off to receive command delay	RW	ms	0~500	250	Arbitrary change	Immediate effect
2005	0Fh	P0514	Holding brake switch on zero speed time	RW	ms	1~1000	150	Arbitrary change	Immediate effect
2005	10h	P0515	Holding brake switch on speed threshold	RW	rpm	0~3000	30	Arbitrary change	Immediate effect
2005	11h	P0516	Holding brake switch on time threshold	RW	ms	1~1000	500	Arbitrary change	Immediate effect
2005	14h	P0519	Pre-charge test enabled	RW	-	0: Disable 1: Enable 1:A lags B	1	Stop change	Immediate effect
2005	18h	P0523	Frequency division output phase	RW	-	0-A leads B 1-A lags B	0	Stop change	Power-on reset
2005	2Ch	P0543	Soft limit Settings	RW	-	0: no limit 1: Limit 2: Limit after zero return	0	Stop change	Immediate effect
2006 Gain Parameters									
2006	01h	P0600	Velocity proportional gain 1	RW	0.1Hz	1~20000	250	Arbitrary change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
2006	02h	P0601	Velocity integral gain 1	RW	0.01ms	15~51200	3183	Arbitrary change	Immediate effect
2006	03h	P0602	Position proportional gain 1	RW	0.1Hz	0~20000	400	Arbitrary change	Immediate effect
2006	09h	P0608	Speed feedforward proportional gain	RW	0.1%	0~1000	0	Arbitrary change	Immediate effect
2006	0Ah	P0609	Torque feedforward proportional gain	RW	0.1%	0~2000	0	Arbitrary change	Immediate effect
2006	0Bh	P0610	Load inertia ratio	RW	-	0~12000	200	Arbitrary change	Immediate effect
2007 Filter parameters									
2007	01h	P0700	Position instruction FIR filtering	RW	0.1ms	0~65535	0	Stop change	Immediate effect
2007	02h	P0701	Position instruction mean filtering	RW	0.1ms	0~1280	0	Stop change	Immediate effect
2007	03h	P0702	Torque filtering 1	RW	0.01ms	0~3000	79	Arbitrary change	Immediate effect
2007	07h	P0706	Velocity feedforward filtering time	RW	0.01ms	0~6400	50	Arbitrary change	Immediate effect
2007	08h	P0707	Torque feedforward filtering time	RW	0.01ms	0~6400	50	Arbitrary change	Immediate effect
2007	0Bh	P0710	Vibration suppression frequency 1	RW	Hz	50~5000	5000	Arbitrary change	Immediate effect
2007	0Ch	P0711	Vibration suppression bandwidth 1	RW	-	0~20	2	Arbitrary change	Immediate effect
2007	0Dh	P0712	Vibration suppression	RW	-	0~99	0	Arbitrary	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			attenuation 1					change	effect
2007	0Eh	P0713	Vibration suppression frequency 2	RW	Hz	50~5000	5000	Arbitrary change	Immediate effect
2007	0Fh	P0714	Vibration suppression bandwidth 2	RW	-	0~20	2	Arbitrary change	Immediate effect
2007	10h	P0715	Vibration suppression attenuation 2	RW	-	0~99	0	Arbitrary change	Immediate effect
2007	11h	P0716	Vibration suppression frequency 3	RW	Hz	50~5000	5000	Arbitrary change	Immediate effect
2007	12h	P0717	Vibration suppression bandwidth 3	RW	-	0~20	2	Arbitrary change	Immediate effect
2007	13h	P0718	Vibration suppression attenuation 3	RW	-	0~99	0	Arbitrary change	Immediate effect
2007	14h	P0719	Vibration suppression frequency 4	RW	Hz	50~5000	5000	Arbitrary change	Immediate effect
2007	15h	P0720	Vibration suppression bandwidth 4	RW	-	0~20	2	Arbitrary change	Immediate effect
2007	16h	P0721	Vibration suppression attenuation 4	RW	-	0~99	0	Arbitrary change	Immediate effect
2007	30h	P0747	Position notch frequency A	RW	Hz	10~1000	1000	Stop change	Immediate effect
2007	49h	P0772	Probe filter	RW	25ns	0~31	15	Stop change	Power-on reset
2007	4Dh	P0776	Speed arrival signal filtering	RW	ms	0~5000	10	Stop change	Immediate effect
2008 Protection Parameters									
2008	01h	P0800	Input phase missing detection	RW	-	0: Error detection 1: Error	0	Arbitrary change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						detection and Alarm 2: No detection			
2008	02h	P0801	Error detection for encoder multi-turn overflow	RW	-	0: No detection 1: Detection	1	Stop change	Immediate effect
2008	04h	P0803	Overspeed threshold	RW	rpm	0~10000	0	Arbitrary change	Immediate effect
2008	09h	P0808	Position deviation removal mode	RW	-	0: Remove when the server is not running 1: Remove when servo OFF or DI signal is effective	0	Stop change	Immediate effect
2008	0Ah	P0809	Runaway protection detection	RW	-	0: No detection 1: Detection	1	Arbitrary change	Immediate effect
2008	0Bh	P0810	Runaway current judgment threshold	RW	0.1%	1000~4000	2000	Arbitrary change	Immediate effect
2008	0Ch	P0811	Runaway speed threshold	RW	rpm	1~1000	10	Arbitrary change	Immediate effect
2008	0Dh	P0812	Runaway speed feedback filtering time	RW	0.1ms	1~1000	20	Arbitrary change	Power-on reset
2008	0Eh	P0813	Runaway protection identification time	RW	ms	10~1000	30	Arbitrary change	Immediate effect
2008	0Fh	P0814	Motor overload protection gain	RW	%	50~300	100	Stop change	Immediate effect
2008	11h	P0816	Motor overload	RW	-	0: Neither detects	3	Stop change	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			detection			1: Motor overload is detected, drive overload is not detected 2: Motor overload is not detected, drive overload ia detected 3: Both detect			effect
2008	12h	P0817	Stall detection	RW	-	0: No detection 1: Detection	1	Arbitrary change	Immediate effect
2008	13h	P0818	Stall protection time	RW	ms	10~65535	200	Arbitrary change	Immediate effect
2008	16h	P0821	Overtemperature protection point of drives	RW	℃	0~100	0	Stop change	Power-on reset
2009 Display parameters									
2009	01h	P0900	Position command speed	RO	rpm	-32767~32767	0	Display	Immediate effect
2009	02h	P0901	Speed command	RO	rpm	-32767~32767	0	Display	Immediate effect
2009	03h	P0902	Torque command	RO	0.1%	-32767~32767	0	Display	Immediate effect
2009	04h	P0903	Position feedback speed	RO	rpm	-32767~32767	0	Display	Immediate effect
2009	05h	P0904	Actual speed	RO	rpm	-32767~32767	0	Display	Immediate effect
2009	07h	P0906	Actual speed (accuracy 0.1rpm)	RO	rpm	-2147483648 ~2147483647	0	Display	Immediate effect
2009	0Bh	P0910	Bus voltage	RO	0.1V	0~65535	0	Display	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	FactorydeError	Setting mode	Enable mode
									effect
2009	0Ch	P0911	Control voltage	RO	0.1V	0~65535	0	Display	Immediate effect
2009	0Dh	P0912	Output phase current RMS(U phase) of drive	RO	0.01A	0~65535	0	Display	Immediate effect
2009	0Eh	P0913	Output line voltage RMS of drive	RO	0.1V	0~65535	0	Display	Immediate effect
2009	0Fh	P0914	Average load rate	RO	0.1%	0~8000	0	Display	Immediate effect
2009	10h	P0915	Drive temperature	RO	°C	0~65535	0	Display	Immediate effect
2009	12h	P0917	Electrical Angle	RO	0.1°	0~65535	0	Display	Immediate effect
2009	13h	P0918	DI input level monitoring	RO	-	0~65535	0	Display	Immediate effect
2009	15h	P0920	DO output level monitoring	RO	-	0~65535	0	Display	Immediate effect
2009	1Ah	P0925	Total running time	RO	0.1s	0~4294967295	0	Display	Immediate effect
2009	1Ch	P0927	Current power-on running time	RO	-	0~4294967295	0	Display	Immediate effect
2009	1Fh	P0930	Real-time instruction counter	RO	Instruction unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	21h	P0932	Run instruction counter	RO	Instruction unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	23h	P0934	Position feedback counter	RO	Instruction unit	-2147483648 ~2147483647	0	Display	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
2009	25h	P0936	Position feedback counter	RO	Encoder unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	27h	P0938	Position tracking deviation	RO	Instruction unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	29h	P0940	Position tracking deviation	RO	Encoder unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	2Bh	P0942	Number of encoder turns	RO	turn	0~65535	0	Display	Immediate effect
2009	2Ch	P0943	Encoder single turn position	RO	p	0~2147483647	0	Display	Immediate effect
2009	2Eh	P0945	Encoder absolute position (low 32 bits)	RO	Encoder unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	30h	P0947	Encoder absolute position (high 32 bits)	RO	Encoder unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	32h	P0949	Mechanical absolute position (low 32 bits)	RO	Encoder unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	34h	P0951	Mechanical absolute position (high 32 bits)	RO	Encoder unit	-2147483648 ~2147483647	0	Display	Immediate effect
2009	36h	P0953	Rotating load single-turn position (low 32 bits)	RO	Encoder unit	0~4294967295	0	Display	Immediate effect
2009	38h	P0955	Rotating load single-turn position (high 32 bits)	RO	Encoder unit	0~4294967295	0	Display	Immediate effect
2009	3Ah	P0957	Rotating load single-turn position	RO	Instruction unit	0~4294967295	0	Display	Immediate effect

Index	**Subindex**	**Parameter**	**Name**	**Property**	**Unit**	**Range**	**Factory deError**	**Setting mode**	**Enable mode**
200A Communication parameters									
200A	01h	P0A00	Slave station No.	RW	-	1~247	1	Arbitrary change	Immediate effect
200A	03h	P0A02	ModBus Baud rate of communication	RW	-	0:2400bps 1:4800bps 2:9600bps 3:19200bps 4:38400bps 5:57600bps 6:115200bps	6	Arbitrary change	Immediate effect
200A	04h	P0A03	ModBus communication protocol	RW	-	0: No check, 2 end bits (8-N-2) 1: Even parity check, 1 end bit (8-O-1) 2: Odd parity check, 1 end bit (8-E-1) 3: No check, 1 end bit (8-N-1)	0	Arbitrary change	Immediate effect
200A	0Bh	P0A10	EtherCAT version No.	RO	-	0~65535	0	Display	Immediate effect
200A	0Ch	P0A11	EtherCAT XML version No.	RO	-	0~65535	0	Display	Immediate effect
200A	0Dh	P0A12	EtherCAT Slave station name	RO	-	0~65535	0	Display	Immediate effect
200A	0Eh	P0A13	EtherCAT Slave station alias	RW	-	0~65535	0	Stop change	Immediate effect
200A	0Fh	P0A14	EtherCAT State machine	RO	-	0~65535	0	Display	Immediate effect
200A	10h	P0A15	EtherCAT State code	RO	-	0~65535	0	Display	Immediate effect
200A	11h	P0A16	EtherCAT Sync signal loss	RO	-	0~65535	0	Display	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			count						effect
200A	12h	P0A17	EtherCAT port 0 frame invalid error count	RO	-	0~65535	0	Display	Immediate effect
200A	13h	P0A18	EtherCAT port 1 frame invalid error count	RO	-	0~65535	0	Display	Immediate effect
200A	14h	P0A19	EtherCAT port 0/1 frame send error count	RO	-	0~65535	0	Display	Immediate effect
200A	15h	P0A20	EtherCAT port 0/1 frame loss error count	RO	-	0~65535	0	Display	Immediate effect
200A	16h	P0A21	EtherCAT PDI interface error count	RO	-	0~65535	0	Display	Immediate effect
200A	1Ah	P0A25	CSP mode instruction cache depth	RW	-	0~1	0	Stop change	Immediate effect
200A	20h	P0A31	EtherCAT Sync Allowed times of signal loss	RW	-	0~65535	9	Arbitrary change	Immediate effect
200A	21h	P0A32	EtherCAT Sync Signal detection deviation threshold	RW	ns	0~4000	3000	Stop change	Immediate effect
200A	22h	P0A33	CSP position instruction increase threshold	RW	times	1~7	3	Arbitrary change	Immediate effect
200E Communication auxiliary parameters									
200E	12h	P0E17	Numerator of the 2nd set of communication electronic gear ratio	RW	-	1~65535	1	Stop change	Immediate effect
200E	13h	P0E18	Denominator of the 2nd	RW	-	1~65535	1	Stop change	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			group of communication electronic gear ratio						effect
201A Advanced adjustment									
201A	01h	P1A00	Real-time self-adjusting settings	RW	-	0: Off 1: Standard rigid table mode 2: Quick positioning mode 5: Adaptive interpolation mode 7: Adaptive positioning mode	7	Arbitrary change	Immediate effect
201A	02h	P1A01	Response level setting	RW	level	0~40	16	Arbitrary change	Immediate effect
201A	03h	P1A02	Selection of vibration suppression mode	RW	-	0: Off 1: Vibration suppression 3 effective 2: Vibration suppression 3 and 4 are effective 3: P1A.14 shows the resonance frequency 4: Restore vibration suppression 3 and 4	0	Arbitrary change	Immediate effect
201A	07h	P1A06	Max. speed of inertia identification	RW	rpm	100~1000	500	Stop change	Immediate effect
201A	08h	P1A07	Acceleration time of inertia	RW	ms	20~800	125	Stop change	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			identification						effect
201A	09h	P1A08	Waiting time of inertia identification	RW	ms	50~10000	800	Stop change	Immediate effect
201A	0Ah	P1A09	Inertia identification rotation turns	RW	0.01 ring	0~65535	100	Arbitrary change	Immediate effect
201A	13h	P1A18	Disturbance compensation gain	RW	0.1%	-1000~1000	0	Arbitrary change	Immediate effect
201A	14h	P1A19	Disturbance filtering time	RW	ms	0~2500	50	Arbitrary change	Immediate effect
201A	15h	P1A20	Partial load compensation	RW	0.1%	-1000~1000	0	Arbitrary change	Immediate effect
201A	16h	P1A21	Forward friction compensation	RW	0.1%	-1000~1000	0	Arbitrary change	Immediate effect
201A	17h	P1A22	Reverse friction compensation	RW	0.1%	-1000~1000	0	Arbitrary change	Immediate effect
201A	18h	P1A23	Friction compensation speed	RW	0.1rpm	1~300	20	Arbitrary change	Immediate effect
201A	19h	P1A24	Selection of friction compensation speed	RW	-	0~18	0	Arbitrary change	Immediate effect
201A	1Ah	P1A25	Low frequency vibration detection enabled	RW	-	0: Off 1: Start	0	Arbitrary change	Immediate effect
2020 Auxiliary parameters									
2020	03h	P2002	Emergency shutdown	RW	-	0: no operation is performed 1: Emergency shutdown	0	Arbitrary change	Immediate effect
2020	04h	P2003	Error reset	RW	-	0: no operation is performed	0	Stop change	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						1: Error reset			effect
2020	05h	P2004	Software reset	RW	-	0: no operation is performed 1: Software reset	0	Stop change	Immediate effect
2020	06h	P2005	Encoder reset	RW	-	0: no operation is performed 1: Reset the Error 2: Reset the Error and number of rings	0	Stop change	Immediate effect
2020	07h	P2006	Read/write of encoder parameters	RW	-	0: no operation is performed 1: Write operation 2: Read operation	0	Stop change	Immediate effect
2020	27h	P2038	Call enable	RW	-	0~1	0	Arbitrary change	Immediate effect
2020	29h	P2040	Bus read and servo state	RO	-	0~65535	0	Display	Immediate effect
2020	2Ah	P2041	Bus read DO low 16-bit function	RO	-	0~65535	0	Display	Immediate effect
2020	2Bh	P2042	Bus read DO high 16-bit function	RO	-	0~65535	0	Display	Immediate effect
2020	33h	P2050	Bus setting VDI level	RW	-	0~65535	0	Arbitrary change	Immediate effect
2020	34h	P2051	Bus setting DO output	RW	-	0~7	0	Arbitrary change	Immediate effect
2021 Error diagnosis parameters									
2021	01h	P2100	Exception parameter group ID	RO	-	0~65535	0	Display	Immediate effect
2021	02h	P2101	Exception	RO	-	0~65535	0	Display	Imme

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			parameter group bias						diate effect
2021	03h	P2102	FPGA-side system status information	RO	-	0~65535	0	Display	Immediate effect
2021	04h	P2103	FPGA-side system Error information	RO	-	0~65535	0	Display	Immediate effect
2021	05h	P2104	FPGA-side timeout Error information	RO	-	0~65535	0	Display	Immediate effect
2021	06h	P2105	FPGA-side encoder Error information	RO	-	0~65535	0	Display	Immediate effect
2021	07h	P2106	Encoder status information	RW	-	0~65535	0	Arbitrary change	Immediate effect
2021	09h	P2108	Current Error code	RO	-	0~65535	0	Display	Immediate effect
2021	1Fh	P2130	Error logging query	RW	-	0: current Error 1: the latest one Error 2: the latest two Errors 3: the last three Errors 4: the last four Errors 5: the last five Errors 6: the last six Errors 7: the last seven Errors 8: the last eight Errors 9: the last nine Errors	0	Arbitrary change	Immediate effect
2021	20h	P2131	When the Error is	RO	-	0~65535	0	Display	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			selected,the Error code						effect
2021	21h	P2132	When the Error is selected,internal Error code	RO	-	0~65535	0	Display	Immediate effect
2021	22h	P2133	When the Error is selected,time stamp	RO	0.1s	0~4294967295	0	Display	Immediate effect
2021	24h	P2135	When the Error is selected,rotation speed	RO	rpm	-32767~32767	0	Display	Immediate effect
2021	25h	P2136	When the Error is selected,U-phase current	RO	0.01A	-32767~32767	0	Display	Immediate effect
2021	26h	P2137	When the Error is selected,V-phase current	RO	0.01A	-32767~32767	0	Display	Immediate effect
2021	27h	P2138	When the Error is selected,Bus voltage	RO	0.1V	0~65535	0	Display	Immediate effect
2021	28h	P2139	When the Error is selected,DI input state	RO	-	0~65535	0	Display	Immediate effect
2021	29h	P2140	When the Error is selected,DO output state	RO	-	0~65535	0	Display	Immediate effect
2021	2Ah	P2141	When the Error is selected,FPGA-side system state info.	RO	-	0~65535	0	Display	Immediate effect
2021	2Bh	P2142	When the Error is selected,FPGA	RO	-	0~65535	0	Display	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			-side system Error info.						
2021	2Ch	P2143	When the Error is selected,FPGA -side system timeout info.	RO	-	0~65535	0	Display	Immediate effect
2021	2Dh	P2144	When the Error is selected,FPGA -side system encoder Error info.	RO	-	0~65535	0	Display	Immediate effect
2021	2Eh	P2145	When the Error is selected,encoder state info.	RO	-	0~65535	0	Display	Immediate effect
2022 Fully closed loop parameters									
2022	01h	P2200	Encoder selection	RW	-	0: Internal encoder feedback 1: External encoder feedback 2: When DI switches the electronic gear ratio, internal/external ring encoder feedback is switched	0	Stop change	Immediate effect
2022	02h	P2201	External encoder Enable selection	RW	-	0: Disables external encoder 1: Enable external ABZ encoder	0	Stop change	Power-on reset
2022	03h	P2202	External encoder Direction selection	RW	-	0: Use deError direction 1: Use reverse direction	0	Stop change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
2022	04h	P2203	Number of external encoder pulses per motor rotation	RW	p	1~1073741824	10000	Stop change	Immediate effect
2022	06h	P2205	Numerator of the 2nd set of communication electronic gear ratio	RW	-	1~1073741824	4	Arbitrary change	Immediate effect
2022	08h	P2207	Denominator of the 2nd group of communication electronic gear ratio	RW	-	1~1073741824	1	Arbitrary change	Immediate effect
2022	0Bh	P2210	Fully closed loop deviation Filtering time	RW	0.1ms	0~65535	0	Stop change	Immediate effect
2022	0Ch	P2211	Hybrid control deviation threshold	RW	-	0~1073741824	1000	Arbitrary change	Immediate effect
2022	0Eh	P2213	Hybrid control deviation Clear setting	RW	-	0~100	1	Arbitrary change	Immediate effect
2022	0Fh	P2214	Fully closed loop external Position error	RO	p	-1073741824 ~1073741824	0	Display	Immediate effect
2022	11h	P2216	Internal encoder feedback value	RO	p	-1073741824 ~1073741824	0	Display	Immediate effect
2022	13h	P2218	External encoder feedback value	RO	p	-1073741824 ~1073741824	0	Display	Immediate effect
2023 Virtual I/O parameters									
2023	01h	P2300	VDI enabled	RW	-	0: Disable 1: Enable	0	Stop change	Immediate effect
2023	02h	P2301	Initial status	RW	-	0~65535	0	Arbitrar	Powe

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			of VDI power-on					y change	r-on reset
2023	03h	P2302	VDO enabled	RW	-	0: Disable 1: Enable	0	Stop change	Immediate effect
2023	04h	P2303	DeError value for undefined VDO	RW	-	0x0:VDO1 DeError value 0x1:VDO2 DeError value 0x2:VDO3 DeError value 0x3:VDO4 DeError value 0x4:VDO5 DeError value 0x5:VDO6 DeError value 0x6:VDO7 DeError value 0x7:VDO8 DeError value 0x8:VDO9 DeError value 0x9:VDO10 DeError value 0xa:VDO11 DeError value 0xb:VDO12 DeError value 0xc:VDO13 DeError value 0xd:VDO14 DeError value 0xe:VDO15 DeError value 0xf:VDO16 DeError value	0	Stop change	Immediate effect
2023	07h	P2306	VDI1 function	RW	-	0: no definition 1: Servo enabled 2: Emergency	0	Arbitrary change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						shutdown			
						3: Command forbidden			
						4: Position deviation cleared			
						5: Reset the Error			
						6: Zero speed retention			
						7: Forward jogging			
						8: Reverse jogging			
						9: Forwar limit			
						10: Reverse limit			
						11: Origin switch			
						12: Zero to return enabled			
						13: Speed limit selection			
						14: Forward torque limit selection			
						15: Reverse torque limit selection			
						16: Preset position enabled			
						19: Torque instruction reversing			
						20: Speed instruction reversing switch			
						21: Position command			

Index	**Subindex**	**Parameter**	**Name**	**Property**	**Unit**	**Range**	**Factory deError**	**Setting mode**	**Enable mode**
						reversing switch			
						22: Gain switch selection			
						23: Operation command switch			
						24: Mode switch 1			
						25: Mode switch 2			
						26: Electronic gear switch			
						27: Preset command selection 1			
						28: Preset command selection 2			
						29: Preset command selection 3			
						30: Preset command selection 4			
						31: Current DI trigger point as the origin			
						33: Probe 1			
						34: Probe 2			
2023	08h	P2307	VDI1 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	09h	P2308	VDI2 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	0Ah	P2309	VDI2 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	FactorydeError	Setting mode	Enable mode
2023	0Bh	P2310	VDI3 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	0Ch	P2311	VDI3 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	0Dh	P2312	VDI4 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	0Eh	P2313	VDI4 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	0Fh	P2314	VDI5 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	10h	P2315	VDI5 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	11h	P2316	VDI6 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	12h	P2317	VDI6 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	13h	P2318	VDI7 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	14h	P2319	VDI7 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	15h	P2320	VDI8 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	16h	P2321	VDI8 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid	0	Arbitrary change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	FactorydeError	Setting mode	Enable mode
						(0→1)			
2023	17h	P2322	VDI9 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	18h	P2323	VDI9 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	19h	P2324	VDI10 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	1Ah	P2325	VDI10 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	1Bh	P2326	VDI11 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	1Ch	P2327	VDI11 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	1Dh	P2328	VDI12 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	1Eh	P2329	VDI12 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	1Fh	P2330	VDI13 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	20h	P2331	VDI13 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	21h	P2332	VDI14 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	22h	P2333	VDI14 polarity	RW	-	0: Write 1 valid 1: Write rising	0	Arbitrary	Imme diate

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						edge valid (0→1)		change	effect
2023	23h	P2334	VDI15 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	24h	P2335	VDI15 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	25h	P2336	VDI16 function	RW	-	Refer to VDI1 function	0	Arbitrary change	Immediate effect
2023	26h	P2337	VDI16 polarity	RW	-	0: Write 1 valid 1: Write rising edge valid (0→1)	0	Arbitrary change	Immediate effect
2023	2Bh	P2342	VDO output level	RO	-	0~65535	0	Display	Immediate effect
2023	2Ch	P2343	VDO1 function	RW	-	0: no definition 1: Rdy 2: Run 3: Warn 4: Error 5: TGon 6: Zero 7: VCmp 8: VArr 9: TArr 10: Near 11: Coin 12: Clt 13: Vlt 14: HomeOK 15: eHomeOK 17: BK 18: DB 19: AngRdy	0	Arbitrary change	Immediate effect
2023	2Dh	P2344	VDO1 polarity	RW	-	0: Output 1 when valid 1: Output 0	0	Arbitrary change	Immediate effect

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
						when valid			
2023	2Eh	P2345	VDO2 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	2Fh	P2346	VDO2 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	30h	P2347	VDO3 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	31h	P2348	VDO3 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	32h	P2349	VDO4 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	33h	P2350	VDO4 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	34h	P2351	VDO5 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	35h	P2352	VDO5 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	36h	P2353	VDO6 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	37h	P2354	VDO6 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	38h	P2355	VDO7 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	39h	P2356	VDO7 polarity	RW	-	0: Output 1 when valid	0	Arbitrary	Immediate

Index	Subindex	Parameter	Name	Property	Unit	Range	FactorydeError	Setting mode	Enable mode
						1: Output 0 when valid		change	effect
2023	3Ah	P2357	VDO8 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	3Bh	P2358	VDO8 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	3Ch	P2359	VDO9 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	3Dh	P2360	VDO9 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	3Eh	P2361	VDO10 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	3Fh	P2362	VDO10 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	40h	P2363	VDO11 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	41h	P2364	VDO11 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	42h	P2365	VDO12 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	43h	P2366	VDO12 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	44h	P2367	VDO13 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	45h	P2368	VDO13	RW	-	0: Output 1	0	Arbitrar	Imme

Index	Subindex	Parameter	Name	Property	Unit	Range	Factory deError	Setting mode	Enable mode
			polarity			when valid 1: Output 0 when valid		y change	diate effect
2023	46h	P2369	VDO14 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	47h	P2370	VDO14 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	48h	P2371	VDO15 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	49h	P2372	VDO15 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect
2023	4Ah	P2373	VDO16 function	RW	-	Refer to VDO1 function	0	Arbitrary change	Immediate effect
2023	4Bh	P2374	VDO16 polarity	RW	-	0: Output 1 when valid 1: Output 0 when valid	0	Arbitrary change	Immediate effect

7.3 Allocation List of Object Group 6000h

6000h object group contains the objects related to supported sub-protocol DSP 402.

Table 7-3 List of 6000h object group

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
603Fh	0	Error code	RO	TxPDO	UINT16	-	0~65535	0	Display	No
6040h	0	Control word	RW	RxPDO	UINT16	-	0~65535	0	Arbitrary change	Stop effect
6041h	0	Status word	RO	TxPDO	UINT16	-	0~65535	0	Display	No
605Ah	0	Selection of quick stop mode	RW	NO	INT16		0~7	2	Arbitrary change	Stop effect
605Dh	0	Selection of pause stop mode	RW	NO	INT16		1~3	1	Arbitrary change	Stop effect
6060h	0	Servo mode selection	RW	RxPDO	INT8	-	0~10	0	Arbitrary change	Stop effect
6061h	0	Run mode display	RO	TxPDO	INT8	-	0~10	0	Display	No
6062h	0	Position instruction	RO	TxPDO	DINT32	1 instruction unit	-	-	Display	No
6063h	0	Position feedback	RO	TxPDO	DINT32	1 encoder unit	-	-	Display Parameter	No
6064h	0	Position feedback	RO	TxPDO	DINT32	1 instruction unit	-	-	Display	No
6065h	0	Threshold of large	RW	RxPDO	UDINT32	1 instructio	20bit motor: 3145728	1048576	Arbitrary	Stop effec

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
		position deviation				n unit	23bit motor: 25165824		change	t
6067h	0	Threshold of position arrival	RW	RxPDO	UINT32	1 encoder unit	0~65535	734	Arbitrary change	Immediate effect
6068h	0	Position arrival window time	RW	RxPDO	UINT16	1ms	0~65535	x16	Arbitrary change	Immediate effect
606Ch	0	Actual velocity	RO	TxPDO	INT32	1 Command unit /s	-	-	Display	No
606Dh	0	the threshold of speed arrival	RW	RxPDO	UINT16	1rpm	0~65535	10	Arbitrary change	Stop effect
606Eh	0	Speed arrives window time	RW	RxPDO	UINT16	1ms	0~65535	0	Arbitrary change	Stop effect
6071h	0	Target torque	RW	RxPDO	INT16	0.10%	-5000~5000	0	Arbitrary change	Stop effect
6072h	0	Maximum torque instruction	RW	RxPDO	UINT16	0.10%	0~5000	5000	Arbitrary change	Stop effect
6074h	0	Torque command	RO	TxPDO	INT16	0.10%	-5000~5000	0	Display	No
6077h	0	Actual torque	RO	TxPDO	INT16	0.10%	-5000~5000	0	Display Parameter	No
607Ah	0	Target position	RW	RxPDO	INT32	1 instructio	-2^{31}~$(2^{31}-1)$	0	Arbitrary	Stop effec

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
						n unit			change	t
607Ch	0	Origin offset	RW	RxPDO	INT32	1 instruction unit	-2^{31}~$(2^{31}-1)$	0	Arbitrary change	Stop effect
607Dh	Software absolute location restrictions									
	0	Number of subindex	RO	NO	UINT8	-	-	2	Display	No
	1	Min. position restriction	RW	RxPDO	INT32	1 User position unit	-2^{31}~$(2^{31}-1)$	-231	Arbitrary change	Stop effect
	2	Max. position restriction	RW	RxPDO	INT32	1 User position unit	-2^{31}~$(2^{31}-1)$	231-1	Arbitrary change	Stop effect
607Eh	0	Command polarity	RW	RxPDO	UINT8	-	00~FF	0	Arbitrary change	Stop effect
607Fh	0	Max. speed	RW	RxPDO	UDINT32	1 Command unit /s	0~$(2^{32}-1)$	108	Arbitrary change	Stop effect
6081h	0	Profile speed	RW	RxPDO	UDINT32	1 User speed unit	0~$(2^{32}-1)$	0	Arbitrary change	Stop effect
6083h	0	Profile acceleration	RW	RxPDO	UDINT32	1 instruction unit /s2	0~$(2^{32}-1)$	100	Arbitrary change	Stop effect
6084h	0	Profile deceleration	RW	RxPDO	UDINT32	1 instruction unit /s2	0~$(2^{32}-1)$	100	Arbitrary change	Stop effect
6085h	0	Quick stop deceleration	RW	RxPDO	UDINT32	1 User acceleration unit	0~$(2^{32}-1)$	100	Arbitrary chan	Stop effect

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
									ge	
6086h	0	Operation curve selection	RW	RxPDO	INT16	-	-2^{15}~$(2^{15}-1)$	0	Arbitrary change	Stop effect
6087h	0	Torque ramp	RW	RxPDO	UDINT32	0.1%/s	0~$(2^{32}-1)$	232-1	Arbitrary change	Stop effect
6091h	Gear ratio									
	0	Number of subindex	RO	NO	UINT8	-	-	2	Display	No
	1	Motor resolution	RW	RxPDO	UINT32	-	1~$(2^{32}-1)$	1	Arbitrary change	Immediate effect
	2	Load shaft resolution	RW	RxPDO	UINT32	-	1~$(2^{32}-1)$	1	Arbitrary change	Immediate effect
6098h		Origin return method	RW	RxPDO	INT8	-	-2~35	1	Arbitrary change	Stop effect
6099h	Return-to-zero velocity									
	0	Number of subindexes of return to zero speed	RO	NO	UINT8	-	2	2	Display	No
	1	Deceleration point of high-speed search	RW	RxPDO	UINT32	1 Command unit /s	0~$(2^{32}-1)$	100	Arbitrary change	Stop effect
	2	Search origin low speed	RW	RxPDO	UINT32	1 Command unit /s	10~$(2^{32}-1)$	100	Arbitrary change	Stop effect
609Ah	0	Return-to-z	R	RxPDO	UDINT	1	0~$(2^{32}-1)$	100	Arbit	Stop

Index	Subi ndex	Name	Pr o p er ty	PDO mappin g	Data type	Unit	Data range	Factory deError	Chan ge mod e	Enab le mod e
		ero acceleratio n	W		32	instructio n unit /s2			rary chan ge	effec t
60B0h	0	Position bias	R W	RxPDO	INT32	1 instructio n unit	-2^{31}~$(2^{31}$-1)	0	Arbit rary chan ge	Stop effec t
60B1h	0	Velocity bias	R W	RxPDO	INT32	1 Command unit /s	-2^{31}~$(2^{31}$-1)	0	Arbit rary chan ge	Stop effec t
60B2h	0	Torque bias	R W	RxPDO	INT16	0.10%	-5000~5000	0	Arbit rary chan ge	Stop effec t
60B8h	0	Probe mode	R W	RxPDO	UINT16	-	0~65535	0	Arbit rary chan ge	Stop effec t
60B9h	0	Probe status	R O	TxPDO	UINT16	-	0~65535	0	Displ ay	No
60BAh	0	Probe 1 rising edge position value	R O	TxPDO	INT32	1 instructio n unit	-2^{31}~$(2^{31}$-1)	0	Displ ay	No
60BB h	0	Probe 1 falling edge position value	R O	TxPDO	INT32	1 instructio n unit	-2^{31}~$(2^{31}$-1)	0	Displ ay	No
60BC h	0	Probe 2 rising edge position value	R O	TxPDO	INT32	1 instructio n unit	-2^{31}~$(2^{31}$-1)	0	Displ ay	No
60BD h	0	Probe 2 falling edge position value	R O	TxPDO	INT32	1 instructio n unit	-2^{31}~$(2^{31}$-1)	0	Displ ay	No
60E0h	0	Forward torque limit	R W	RxPDO	UINT16	0.10%	0~5000	5000	Arbit rary chan	Stop effec t

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
									ge	
60E1h	0	Reverse torque limit	RW	RxPDO	UINT16	0.10%	0~5000	5000	Arbitrary change	Stop effect
60E3h	Supported zero return mode									
	0	Number of subindexes of supported zero return modes	RO	NO	UINT8	-	-	31	Display	No
	1	Zero return mode 1 supported	RO	NO	UINT16	-	-	0301h	Display	No
	2	Zero return mode 2 supported	RO	NO	UINT16	-	-	0302h	Display	No
	3	Zero return mode 3 supported	RO	NO	UINT16	-	-	0303h	Display	No
	4	Zero return mode 4 supported	RO	NO	UINT16	-	-	0304h	Display	No
	5	Zero return mode 5 supported	RO	NO	UINT16	-	-	0305h	Display	No
	6	Zero return mode 6 supported	RO	NO	UINT16	-	-	0306h	Display	No
	7	Supported Zero return mode 7	RO	NO	UINT16	-	-	0307h	Display	No
	8	Zero return mode 8 supported	RO	NO	UINT16	-	-	0308h	Display	No
	9	Zero return mode 9 supported	RO	NO	UINT16	-	-	0309h	Display	No
	0A	Zero return	R	NO	UINT16	-	-	030Ah	Displ	No

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
		mode 10 supported	O						ay	
	0B	Zero return mode 11 supported	RO	NO	UINT16	-	-	030Bh	Display	No
	0C	Zero return mode 12 supported	RO	NO	UINT16	-	-	030Ch	Display	No
	0D	Zero return mode 13 supported	RO	NO	UINT16	-	-	030Dh	Display	No
	0E	Zero return mode 14 supported	RO	NO	UINT16	-	-	030Eh	Display	No
	0F	Zero return mode 15 supported	RO	NO	UINT16	-	-	030Fh	Display	No
	10	Zero return mode 16 supported	RO	NO	UINT16	-	-	0310h	Display	No
	11	Zero return mode 17 supported	RO	NO	UINT16	-	-	0311h	Display	No
	12	Zero return mode 18 supported	RO	NO	UINT16	-	-	0312h	Display	No
	13	Zero return mode 19 supported	RO	NO	UINT16	-	-	0313h	Display	No
	14	Zero return mode 20 supported	RO	NO	UINT16	-	-	0314h	Display	No
	15	Zero return mode 21 supported	RO	NO	UINT16	-	-	0315h	Display	No
	16	Zero return mode 22 supported	RO	NO	UINT16	-	-	0316h	Display	No
	17	Zero return mode 23	RO	NO	UINT16	-	-	0317h	Display	No

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
		supported								
	18	Zero return mode 24 supported	RO	NO	UINT16	-	-	0318h	Display	No
	19	Zero return mode 25 supported	RO	NO	UINT16	-	-	0319h	Display	No
	1A	Zero return mode 26 supported	RO	NO	UINT16	-	-	031Ah	Display	No
	1B	Zero return mode 27 supported	RO	NO	UINT16	-	-	031Bh	Display	No
	1C	Zero return mode 28 supported	RO	NO	UINT16	-	-	031Ch	Display	No
	1D	Zero return mode 29 supported	RO	NO	UINT16	-	-	031Dh	Display	No
	1E	Zero return mode 30 supported	RO	NO	UINT16	-	-	031Eh	Display	No
	1F	Zero return mode 31 supported	RO	NO	UINT16	-	-	031Fh	Display	No
60E6h	0	Actual position calculation	RW	NO	UINT8	-	0~1	0	Arbitrary change	Stop effect
60F4h	0	Position deviation	RO	RxPDO	DINT32	1 instruction unit	-	-	Display	No
60FCh	0	Position instruction	RO	TxPDO	DINT32	1 encoder unit	-	-	Display	No
60FDh	0	DI state	RO	RxPDO	UDINT 32	-	0~FFFFFFFF	0	Display	No
Th present DI t-erminal logic of response drive Logic invalid Logic valid Each bit represents the corresponding DI signal as follows:										

P0A28=2			P0A28=0 P0A28=1 P0A28=3	
bit	signal		bit	signal
0	Reverse overrange switch		0	Reverse overrange switch
1	Forward overrange switch		1	Forward overrange switch
2	Origin switch		2	Origin switch
3~15	NA		3~15	NA
16	Z signal		16	DI1
17	Probe1		17	DI2
18	Probe2		18	DI3
19	NA		19	DI4
20	DI1		20	DI5
21	DI2		21	DI6
22	DI3		22	NA
23	Forward torque output		23	HDI1
24	Reverse torque output		24	HDI2
25~31	NA		25~31	NA

Index	Subindex	Name	Property	PDO mapping	Data type	Unit	Data range	Factory deError	Change mode	Enable mode
60FEh	Digital output									
	0	DO state	RO	NO	UINT8	-	-	1	Display	No
	1	Physical output	RW	RxPDO	UINT32	-	0~FFFFFFFF	0	Arbitrary change	Stop effect
	2	Physical output enable	RW	NO	UINT32	-	0~FFFFFFFF	0	Arbitrary change	Stop effect
60FFh	0	Target speed	RW	RxPDO	INT32	1 Command unit /s	-461	0	Arbitrary change	Stop effect
6502h	0	Supported drive mode	RO	NO	UDINT 32	-	-	3A1h	Display	No

Chapter 8 Appendix

8.1 Definition of DI/DO functions

Function No.	Function name	Description
Description on Input signal functions		
1	Servo enable	Valid: Servo motor power-on enable Invalid: Servo motor power-on is disabled
2	Emergency shutdown	Valid: Position locked after zero speed stop; Invalid: Present running status is not affected.
3	Instruction disable	Valid: Disable position instruction input Invalid: Position instruction input is allowed
4	Position deviation cleared (edge effective function)	Valid: Position deviation is zero cleared; Invalid: Position deviation is not cleared.
5	Error reset (Edge effective function)	Invalid: Disable; Valid: Enable.
6	Zero speed retention	Valid: Enables the zero fixed function. Invalid: Zero fixed function is disabled.
7	Forward Jogging	Valid: Input per the given instruction; Invalid: Run instruction to stop input.
8	Reverse jogging	Valid: Reverse input per the given instruction; Invalid: Run instruction to stop input.
9	Forward limit	Valid: Forward drive is disabled. Invalid: Forward drive is allowed.
10	Reverse limit	Valid: Reverse drive is disabled; Invalid: Reverse drive is allowed.
11	Origin switch	Invalid: Not triggered. Valid: Triggered.
12	Return-to-zero function is enabled	Invalid: Disabled Valid: Enabled

Function No.	Function name	Description
Description on Input signal functions		
13	Speed limit selection	Valid: Torque instruction absolute value reaches the setting value Invalid: Torque instruction absolute value is below the setting value
14	Forward torque limit selection	According to the selection of 2015:04h, torque limit source is switched.
15	Reverse torque limit selection	According to the selection of 2015:04h, torque limit source is switched.
16	The preset position enable	Valid: servo motor runs multi-stage position instructions; Invalid: servo motor is locked;
19	Torque instruction reversing	Invalid: Positive direction; Effective: Reverse direction.
20	Speed instruction reversing selection	Invalid: Positive direction; Effective: Reverse direction.
22	Gain switching selection	2008-09h=0 时: Invalid: Speed control loop is PI control; Valid: Speed control loop is P control. 2008-09h =1 hour: Execute per the settings of 2008-0Ah.
23	Runing instruction switch	Invalid: The present running instruction is A Valid: The present running instruction is B
24	Mode switch 1	According to the selected control mode (3/4/5), switch between speed/position/torque modes
25	Mode switch 2	According to the selected control mode (6), switch between speed/position/torque modes
26	Electronic gear switch	Invalid: Electronic gear ratio 1 Valid: Electronic gear ratio 2
27	DeError instruction selection 1	16 preset instruction selection
28	DeError instruction selection 2	16 preset instruction selection
29	DeError instruction selection 3	16 preset instruction selection

Function No.	**Function name**	**Description**
Description on Input signal functions		
30	DeError instruction selection 4	16 preset instruction selection.
31	The present DI trigger point used as the origin	Valid: Triggered Invalid: Not triggered

8.2 SDO Transmission Stop Code

When exception of communication or drive occurs, servo drive would send an emergency message to network as a producer, or send an abort response when SDO transmission is abnormal. There are 4Byte abort codes in SDO abort response data, representing various termination reasons, as shown in the following table:

Abort code	Function description	Abort code	Function description
0x05 03 00 00	Rollover bit doesn't change in segmented transmission	0x06 07 00 12	Data type doesn't match, and length of service parameters is too long
0x05 04 00 00	SDO transfer timeout	0x06 07 00 13	Data type doesn't match, and length of service parameters is too short
0x05 04 00 01	Command code is invalid or unknown	0x06 09 00 11	Subindex does not exist
0x05 04 00 05	Memory overflow	0x06 09 00 30	The written data is out of range
0x06 01 00 00	The object is not accessible	0x06 09 00 31	The value of written data is too large.
0x06 01 00 01	Read a write-only object	0x06 09 00 32	Data value written is too small
0x06 01 00 02	To write a read-only object	0x06 09 00 36	The maximum is less than the minimum
0x06 02 00 00	The data object doesn't exist in data dictionary	0x08 00 00 00	Common error
0x06 04 00 41	Object can't be mapped to PDO	0x08 00 00 20	Data can't be transferred or saved to application
0x06 04 00 42	Number and length of mapped objects exceed PDO length	0x08 00 00 21	Data can't be transferred or saved to application due to local control

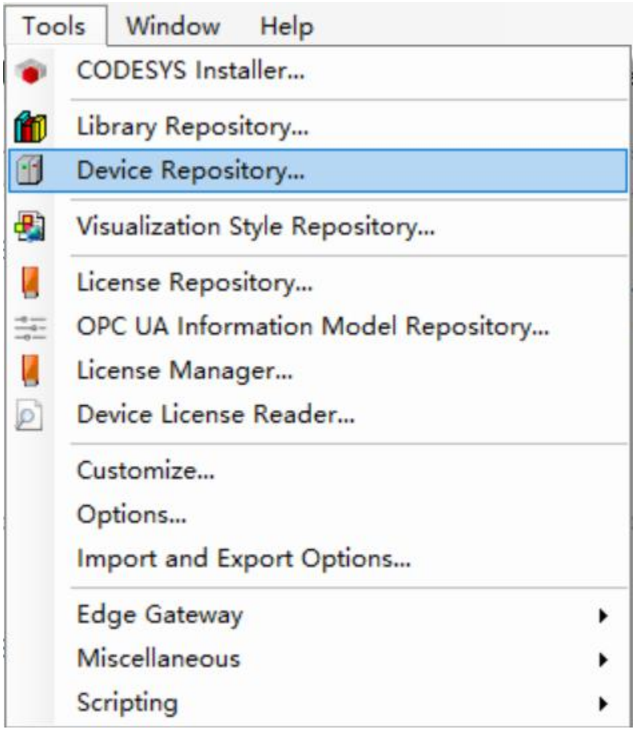
Function No.	Function name	Description	Remarks
Description on output signal functions			
1	Servo Ready (rdy)	Servo state is ready to receive S:ON effective signal: Valid: Servo ready; Invalid: Servo is not ready.	Servo is not ready: the servo has a Type I or Type II Error, or DI emergency stop is valid.
2	Servo Run (Run)	Server is in the RUN state and can receive commands: Valid: Servo can run; Invalid: Servo can't run.	-
3	Servo Warn Output (Warn)	Alarm output signal is valid.(Conductive)	-

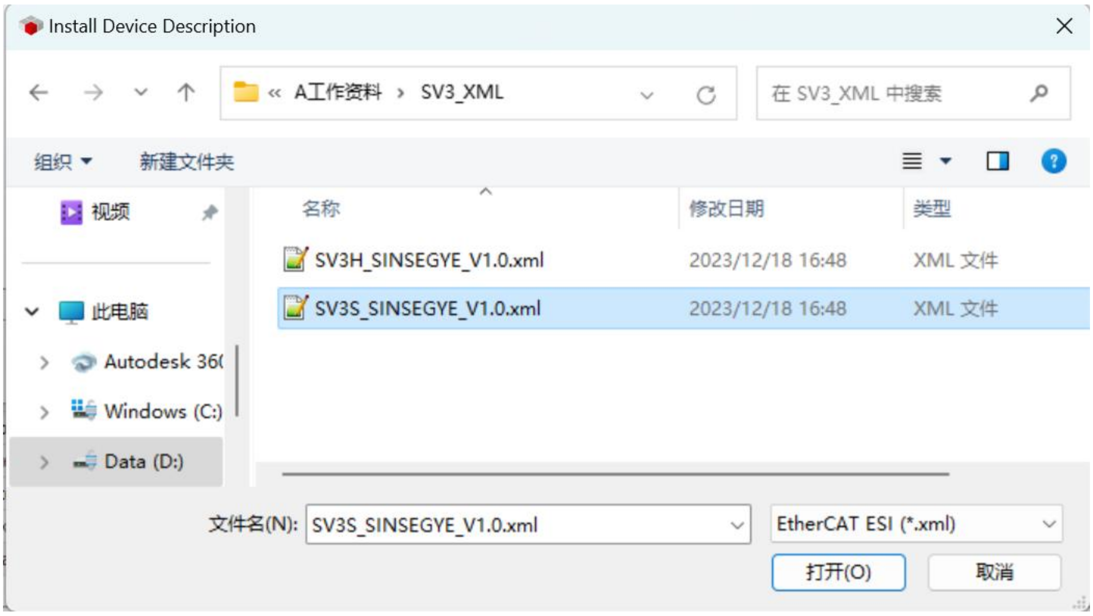
Function No.	Function name	Description	Remarks
Description on output signal functions			
4	Servo Error output (Error)	The status is valid when Error is detected.	-
5	Motor Motion (TGon)	When motor speed is higher than the threshold 2006:11h: Valid: Motor motion signal is valid; Invalid: Motor motion signal is invalid.	-
6	Zero speed signal (Zero)	Output signal when servo motor stops Valid: Motor speed is zero; Invalid: Motor speed is not zero.	-
7	Consistent Speed (VCmp)	Under speed control, absolute value of the difference between motor speed and speed instruction is less than 606Dh; It reaches the speed threshold, and the time meets 606Eh, it's valid.	-
8	Velocity Arrival (VArr)	Valid: Speed feedback reaches the setting; Invalid: Speed feedback doesn't reach the setting.	-
9	Torque Arrival (TArr)	Valid: Absolute torque reaches the setting; Invalid: Torque absolute value is less than the setting.	-
10	Positioning Near	Under position control, it's effective when position deviation pulse reaches the setting of positioning near signal amplitude P13.09.	-
11	Position arrival(Coin)	Under position control, position deviation pulse reaches the threshold 6067h of positioning completion, and the time reaches 6068h; It is valid.	-
12	Torque Limit (Clt)	Confirmation signal of torque limit: Valid: Motor torque is limited; Invalid: Motor torque isn't limited.	-
13	Speed Limit (Vlt)	Confirmation signal of speed limitation in torque control: Valid: Motor speed is limited; Invalid: Motor speed is not limited.	-
14	Zero return completed, HomeOK	Valid: The origin zeroing is completed; Invalid: The origin zeroing is uncomplete;	-

Function No.	Function name	Description	Remarks
Description on output signal functions			
17	Holding brake control (BK)	Brake signal output Valid: Switch off, brake is cancelled; Invalid: Start the brake.	-
18	Dynamic Brake (DB)	Valid: Dynamic brake relay is OFF, dynamic brake is enabled; Invalid: Dynamic brake relay is ON, dynamic brake is disabled;	-
19	Magnetic pole identification ready (AngRdy)	Valid: Magnetic pole identification is ready; Invalid: Magnetic pole identification bit is uncomplete;	-

8.3 Application Cases of Adapting Codesys Host Station

Click Device Repository in Tools drop-down, and click Install XML file SV3H_SINSEGYE_V1.0.xml.

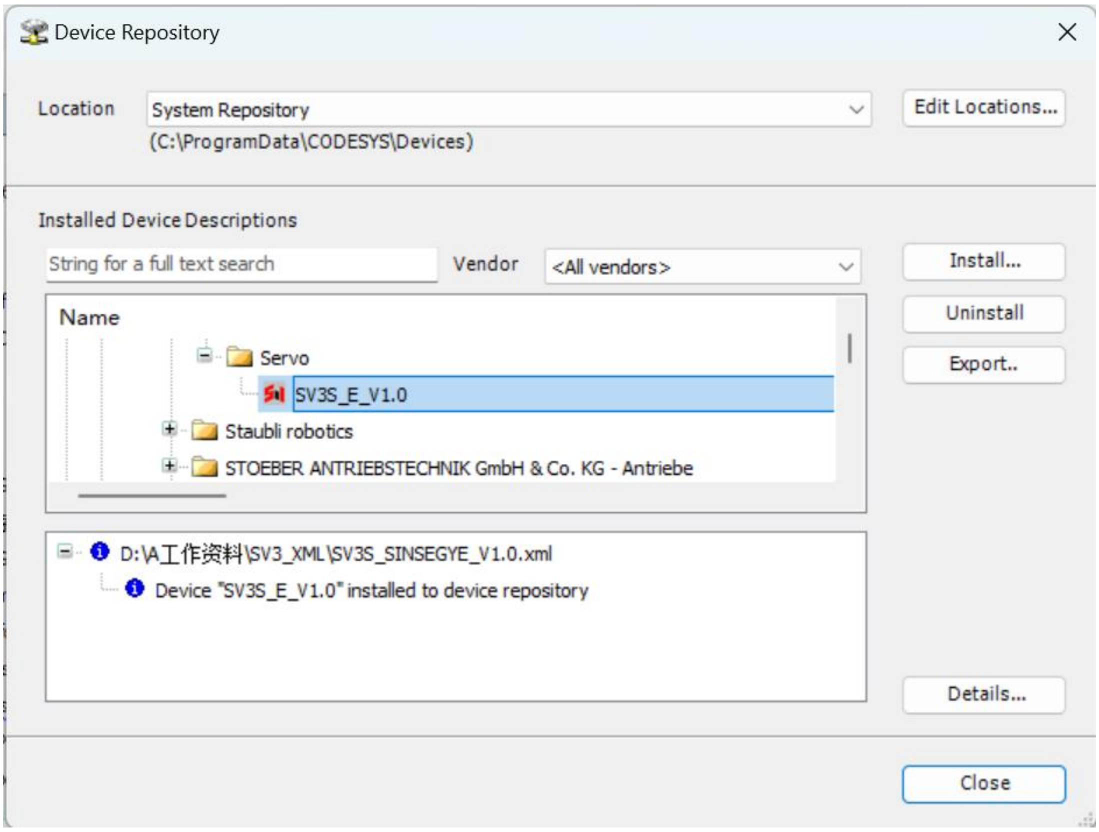




名称	修改日期	类型
SV3H_SINSEGYE_V1.0.xml	2023/12/18 16:48	XML 文件
SV3S_SINSEGYE_V1.0.xml	2023/12/18 16:48	XML 文件

文件名(N): SV3S_SINSEGYE_V1.0.xml

EtherCAT ESI (*.xml)



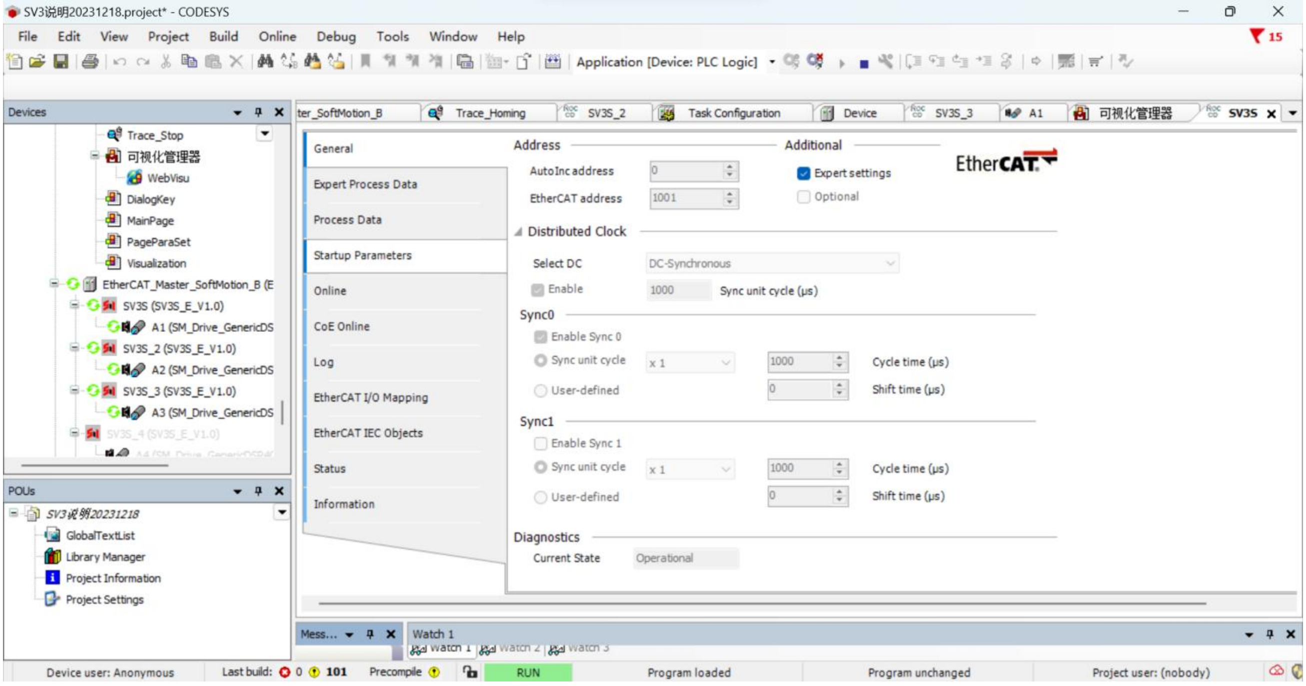
Location: System Repository (C:\ProgramData\CODESYS\Devices)

Vendor: <All vendors>

D:\A工作资料\SV3_XML\SV3S_SINSEGYE_V1.0.xml

Device "SV3S_E_V1.0" installed to device repository

After the installation, on the premise of physical wiring is proper, if scanning EtherCAT master station, slave station data can be scanned. After the configuration, SV3 can be enabled normally.



Address

AutoInc address: 0

EtherCAT address: 1001

Additional

☑ Expert settings

☐ Optional

Distributed Clock

Select DC: DC-Synchronous

☑ Enable 1000 Sync unit cycle (μs)

Sync0

☑ Enable Sync 0

● Sync unit cycle x 1 1000 Cycle time (μs)

○ User-defined 0 Shift time (μs)

Sync1

☐ Enable Sync 1

● Sync unit cycle x 1 1000 Cycle time (μs)

○ User-defined 0 Shift time (μs)

Diagnostics

Current State: Operational

Device user: Anonymous Last build: 0 101 Precompile RUN Program loaded Program unchanged Project user: (nobody)

8.4 Adapting TwinCAT Operation Guide

8.4.1 TwinCAT Jog Operation

TwinCAT is PC-based control software, which transforms control function from hardware to software module, and integrates PLC, motion control and CNC into a PC software solution. In this section, TwinCAT3 will be used for jogging operation of SV3 servo.

Jogging operation of TwinCAT3-NC axis debugging interface

A) Place description file (SV3H_SINSEGYE_V1.0.xml) of EtherCAT in the path C:\TwinCAT\3.1\Config\Io\EtherCAT;

B) Open TwinCAT3;

C) Install NIC driver:

  I) Click TwinCAT option on the menu bar and select Show Realtime EtherCAT Compatible Decives from the drop-down list as shown below.

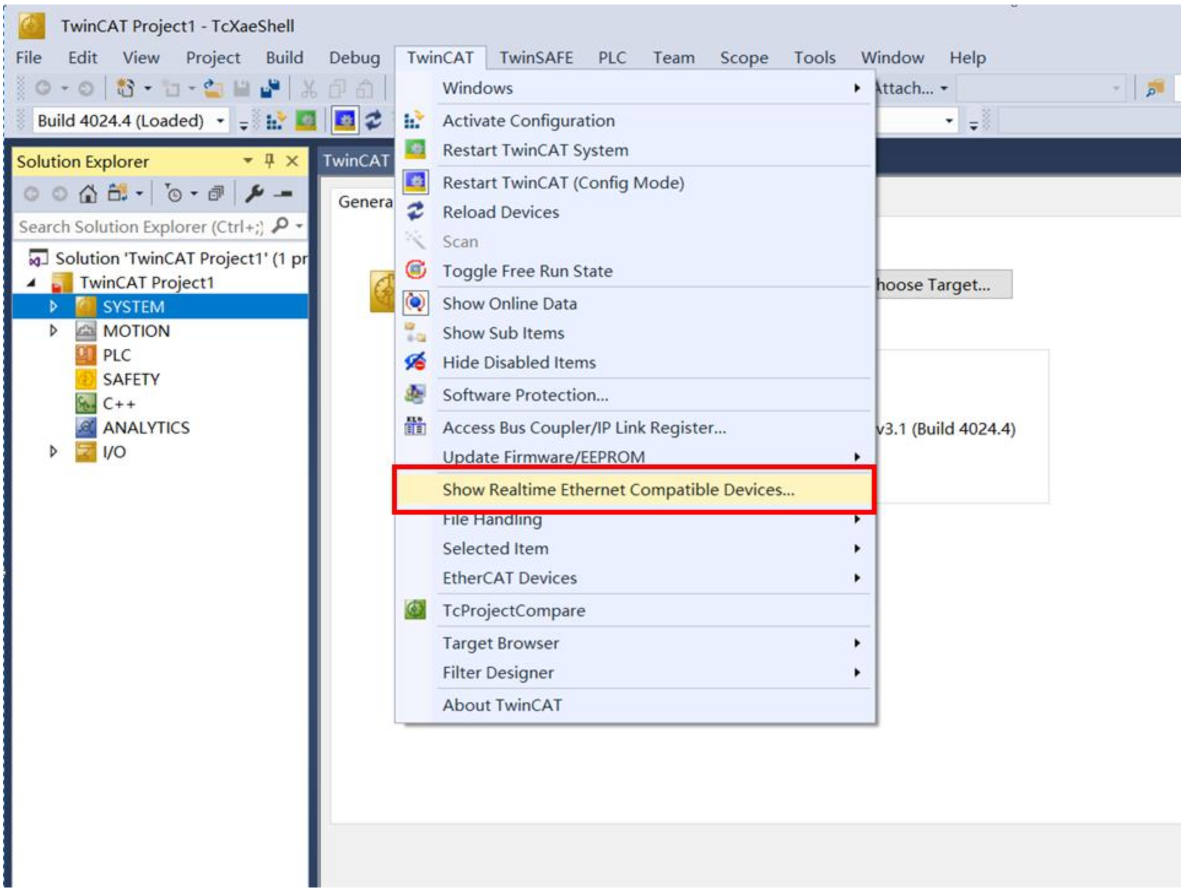


Figure 8-1 Open NIC driver and install

  II) The following popup is as follows: Select local connection in Incompatible devices, then click Install to install NIC, and click Enable.

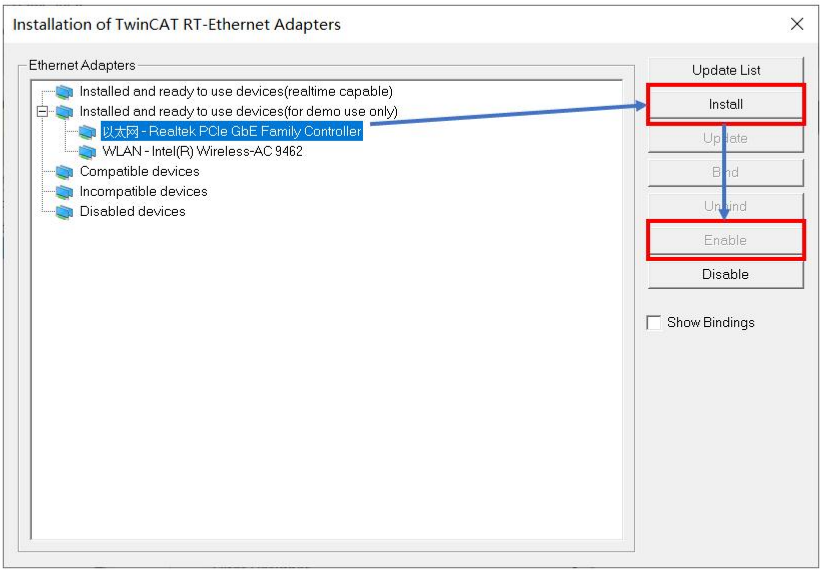


Figure 8-2 NIC driver installation window

D） New TwinCAT3 project

I) As shown in the following figure, there are 2 ways to create a TwinCAT3 project:

Method 1: Click File-New-Project in menu bar,

Method 2: Click the middle view window of software and click New TwniCAT Project.

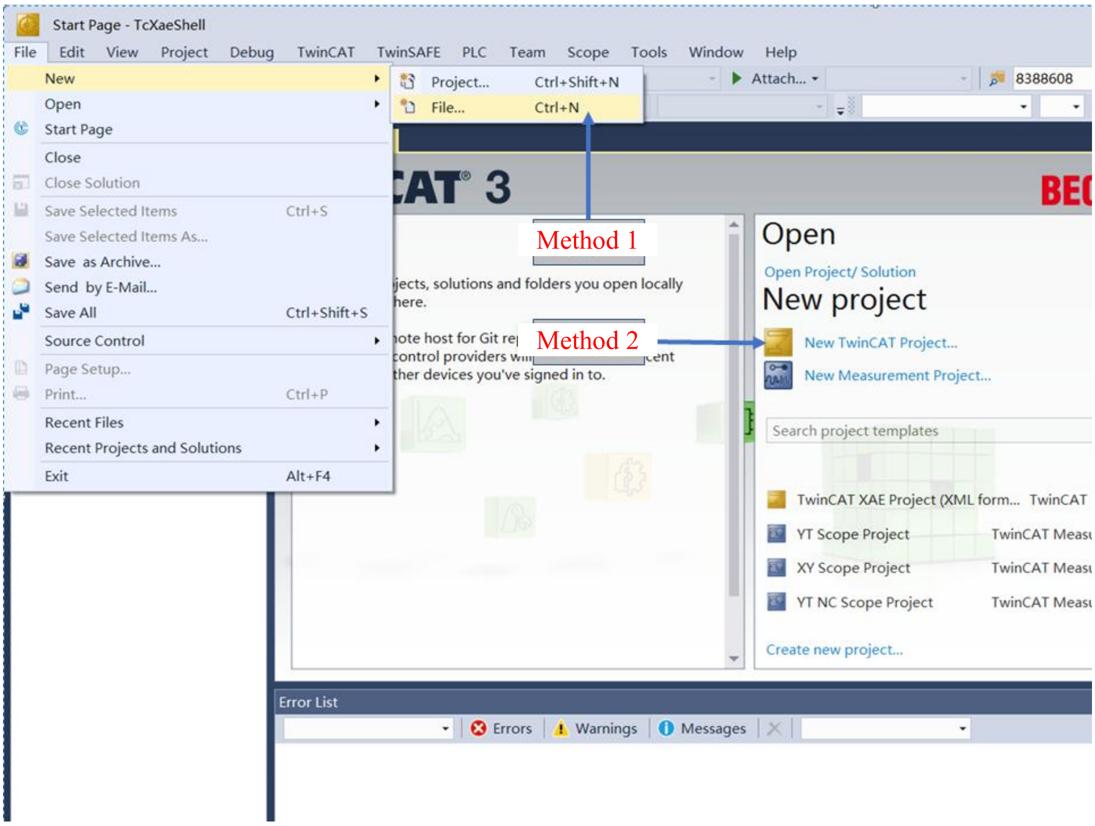
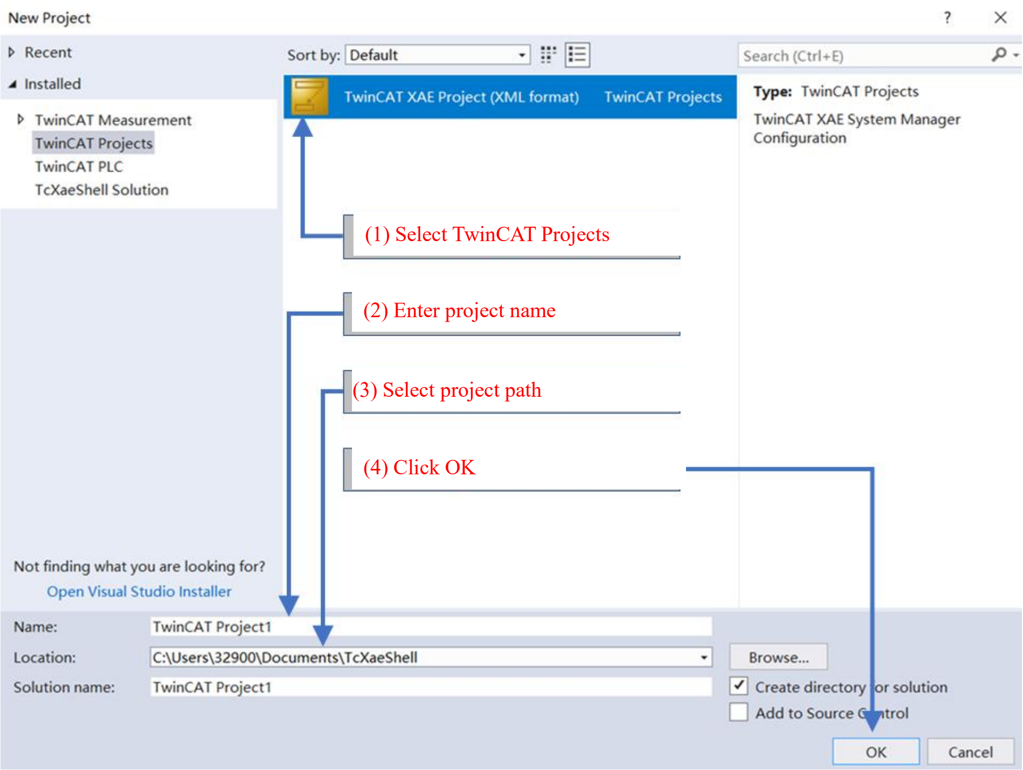


Figure 8-3 New TwinCAT3 Project

II) Pop up the following window, select TwinCAT XAE Project(XML format), enter project name, select project path, and click OK



Name: TwinCAT Project1

Location: C:\Users\32900\Documents\TcXaeShell

Solution name: TwinCAT Project1

(1) Select TwinCAT Projects

(2) Enter project name

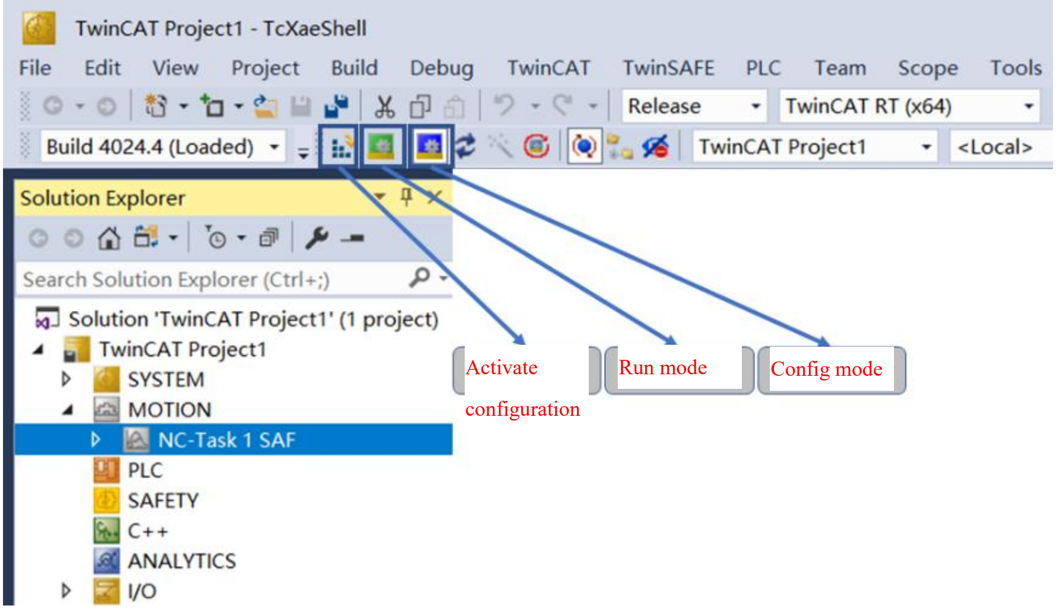
(3) Select project path

(4) Click OK

Figure 8-4 TwinCAT new project interface

E) Switch TwinCAT3 to Config mode

Click Config mode button as shown below.(Note: If Activate Configuration, Restart TwinCAT System and Config Mode in the menu bar are all gray and unavailable, click TwinCAT icon at the lower right corner of PC, select System option in list, and then click Config so as to switch TwinCAT3 status)



Activate configuration

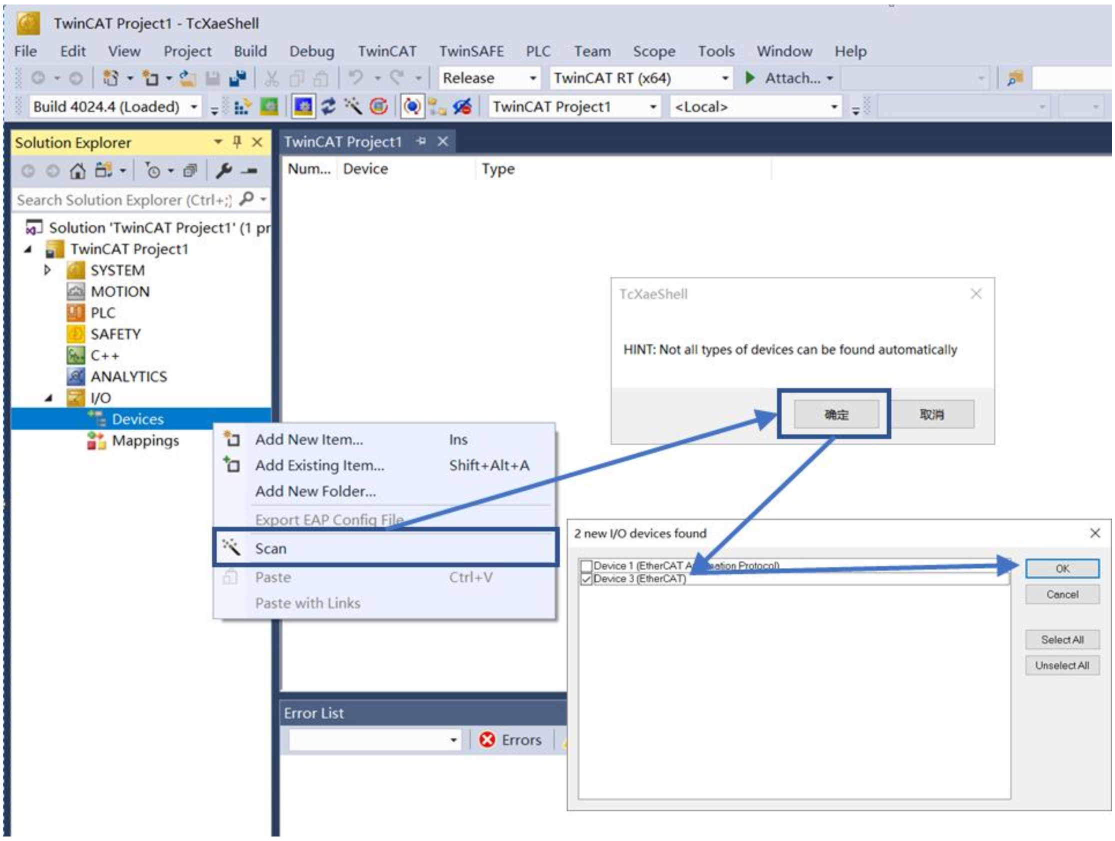
Run mode

Config mode

5Figure 8-5 TwinCAT3 toolbar

F) Scan the servo and add NC axis

I) In the left tree list, expand I/O node, right-click Devices, click Scan, click OK in the popup prompt, and then pop up new I/O devices found window in which it lists the scanned EtherCAT devices. Check the servo (usually as Devices* (EtherCAT)) and click OK.



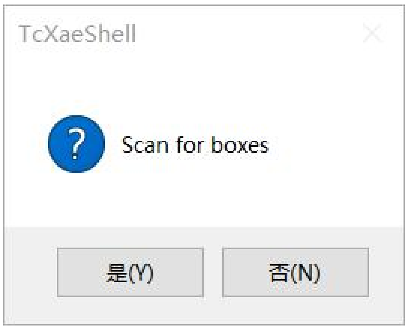
HINT: Not all types of devices can be found automatically

2 new I/O devices found

☐ Device 1 (EtherCAT Automation Protocol)
☑ Device 3 (EtherCAT)

Figure 8-6 TwinCAT3 Scanner

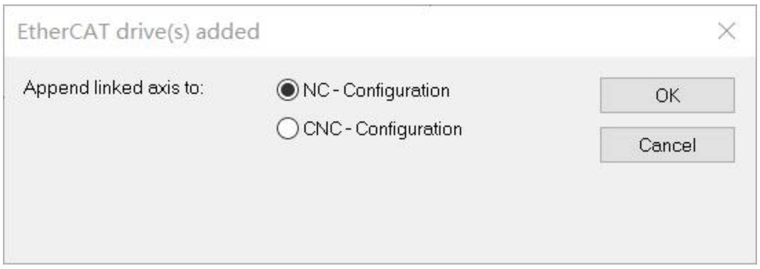
II) Inquiry window will pop up, as shown below. Click YES



Scan for boxes

Figure 8-7 ScanBox popup

III) Inquiry window will pop up, as shown below. Click OK



Append linked axis to: ● NC - Configuration ○ CNC - Configuration

Figure 8-8 Add NC axis popup

IV) Inquiry window will pop up as shown below. Click No

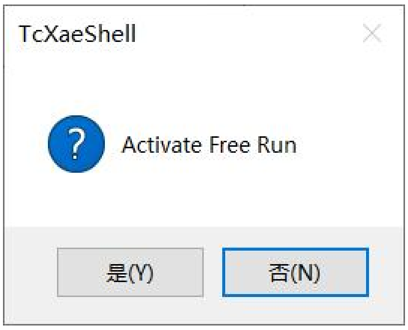


Figure 8-9 Switch to the Free Run popup or not

G) Configure NC axis parameters

PLC axis-NC axis-physical axis, there are control variable output and state variable input between these axis. PLC axis is the one controlled by PLC program; NC axis is the CNC shaft that directly controls physical axis, and physical axis is the actual one scanned.

I) Link NC axis to physical axis. If no axis was created in PLC, it's unnecessary to link PLC axis, shown as in the following figure(while scanning the device, a window will pop up to ask if it's linked to NC axis or CNC axis. Click Yes, then NC axis will be automatically linked).

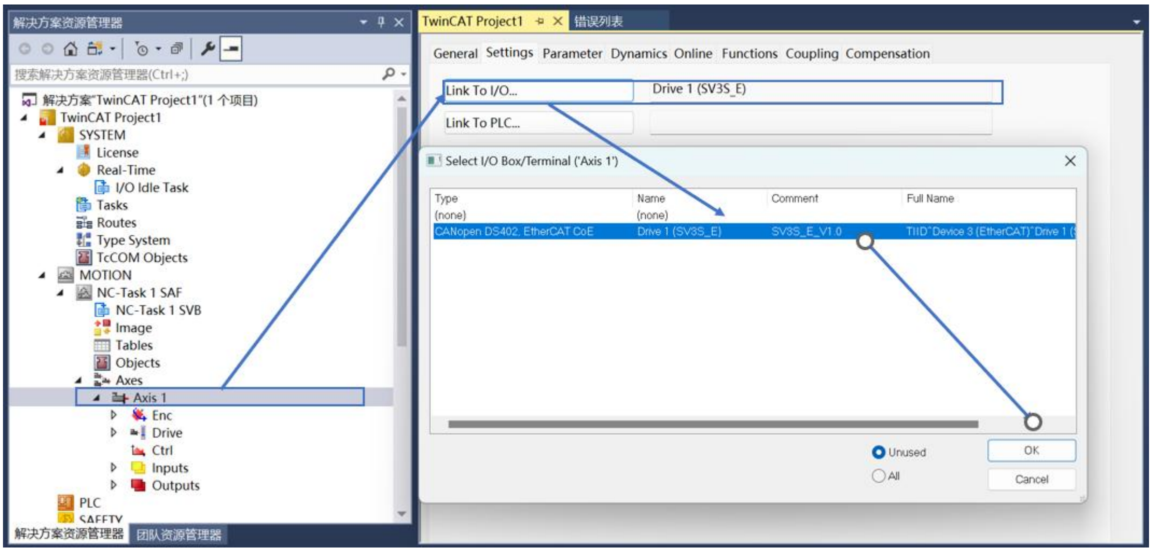
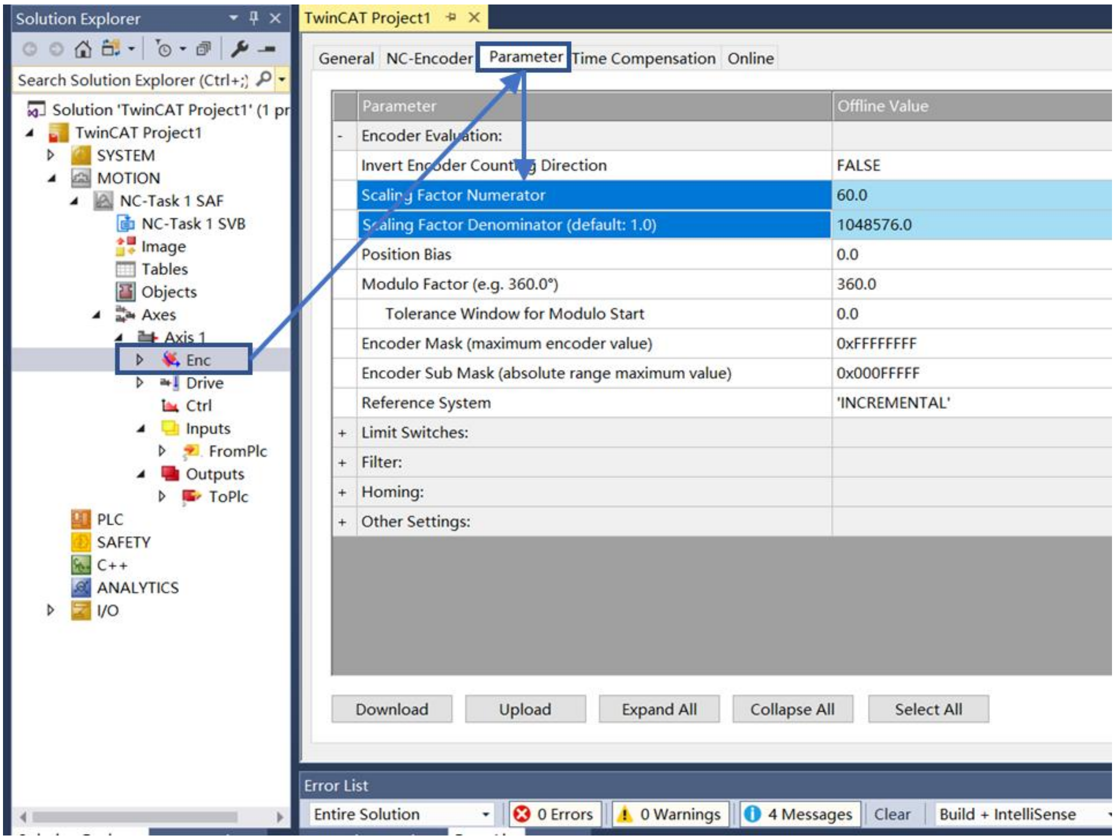


Figure 8-10 Link NC axis and physical axis

II) To change NC axis Enc parameter, click Enc node in the left tree list, then click on Parameter tab in the expanded view in the middle of the software. In Encoder Evaluation, find the following 2 parameters:

Scaling Factor Number: Electronic gear ratio numerator - NC axis displacment per 1 turn of motor rotation. Here,enter 60, i.e., NC axis moves 60mm per 1 turn of motor rotation.

Scaling Factor Denominator (deError: 1.0): Electronic gear ratio denominator - motor encoder resolution,



	Parameter	Offline Value
-	Encoder Evaluation:	
	Invert Encoder Counting Direction	FALSE
	Scaling Factor Numerator	60.0
	Scaling Factor Denominator (default: 1.0)	1048576.0
	Position Bias	0.0
	Modulo Factor (e.g. 360.0°)	360.0
	Tolerance Window for Modulo Start	0.0
	Encoder Mask (maximum encoder value)	0xFFFFFFFF
	Encoder Sub Mask (absolute range maximum value)	0x000FFFFF
	Reference System	'INCREMENTAL'
+	Limit Switches:	
+	Filter:	
+	Homing:	
+	Other Settings:	

Figure 8-11 Change the electronic gear ratio of NC axis

III) To change Axis parameters, click Axis 1 node in the left tree list, click on Parameter tab in the expanded view in the middle of the software. In Manual Motion and Homing and in Monitoring, find the following 5 parameters and set them to the following values:

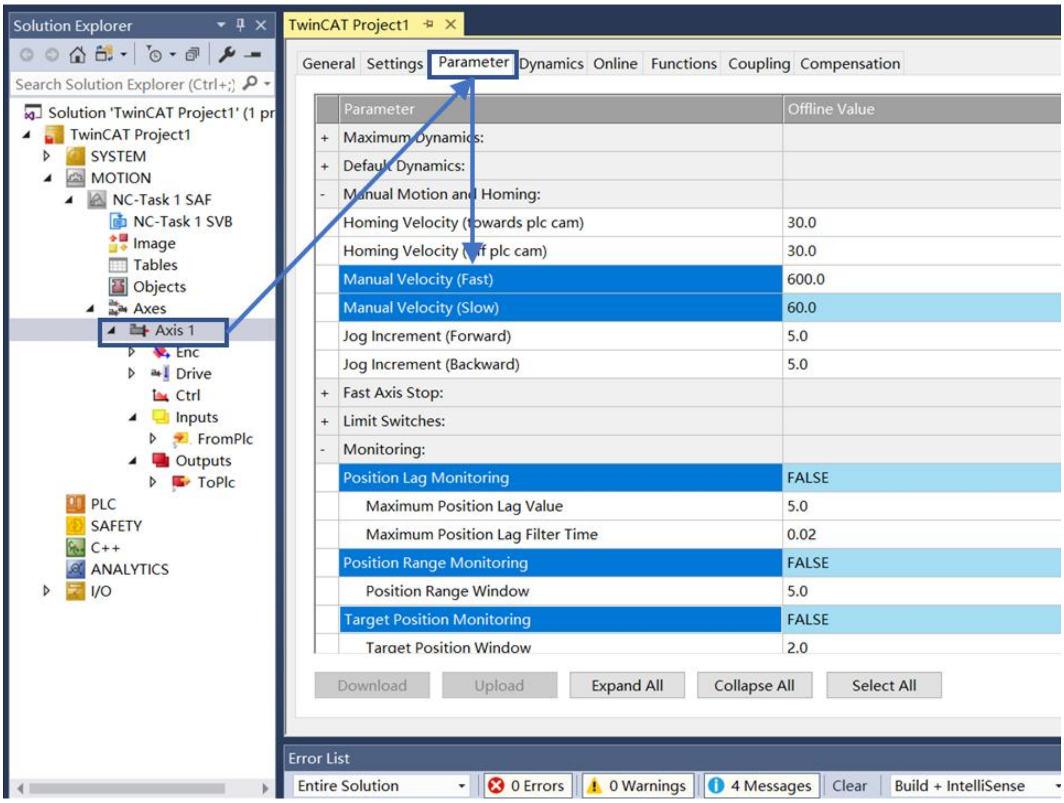
Manual Velocity(Fast) : High JOG speed - 600mm/s

Manual Velocity(Slow) : Low JOG speed - 60mm/s

Position Lag Monitoring: Position lag monitoring --FALSE

Position Range Monitoring: Position range monitoring --FALSE

Target Poistion Monitoring: Target location monitoring --FALSE

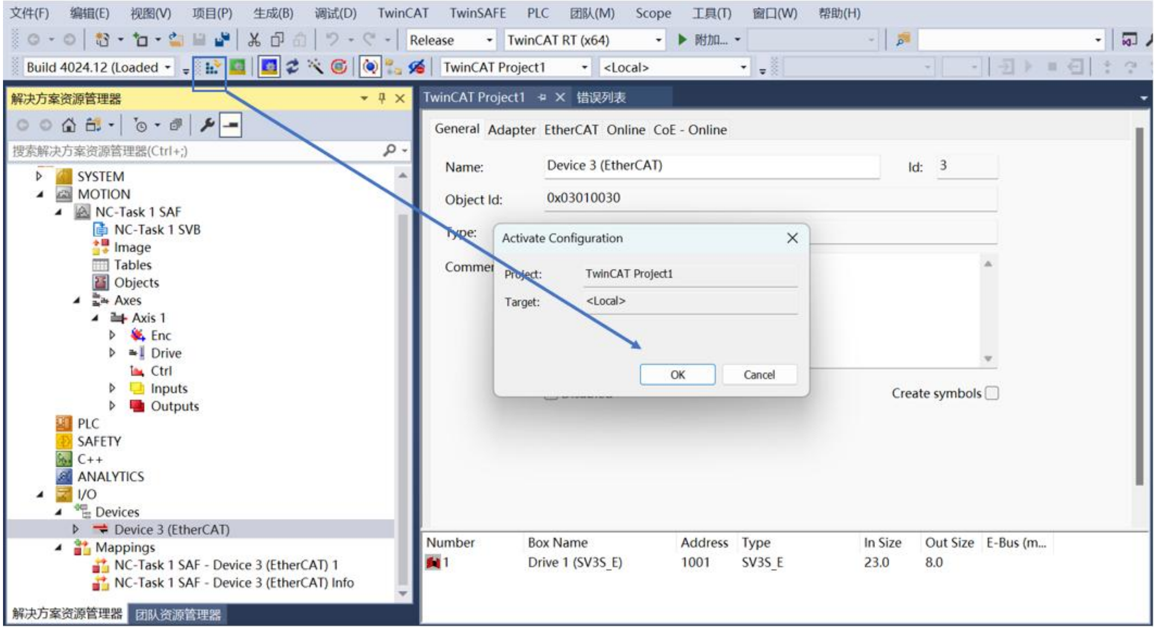


	Parameter	Offline Value
+	Maximum Dynamics:	
+	Default Dynamics:	
-	Manual Motion and Homing:	
	Homing Velocity (towards plc cam)	30.0
	Homing Velocity (off plc cam)	30.0
	Manual Velocity (Fast)	600.0
	Manual Velocity (Slow)	60.0
	Jog Increment (Forward)	5.0
	Jog Increment (Backward)	5.0
+	Fast Axis Stop:	
+	Limit Switches:	
-	Monitoring:	
	Position Lag Monitoring	FALSE
	Maximum Position Lag Value	5.0
	Maximum Position Lag Filter Time	0.02
	Position Range Monitoring	FALSE
	Position Range Window	5.0
	Target Position Monitoring	FALSE
	Target Position Window	2.0

Figure 8-12 High/low speed setting of NC axis jog

H) Activation configuration

Click Activate Configuration, click OK in the pop-up, and pop up query window again, click OK to enter Run Mode



Name: Device 3 (EtherCAT)
Id: 3
Object Id: 0x03010030

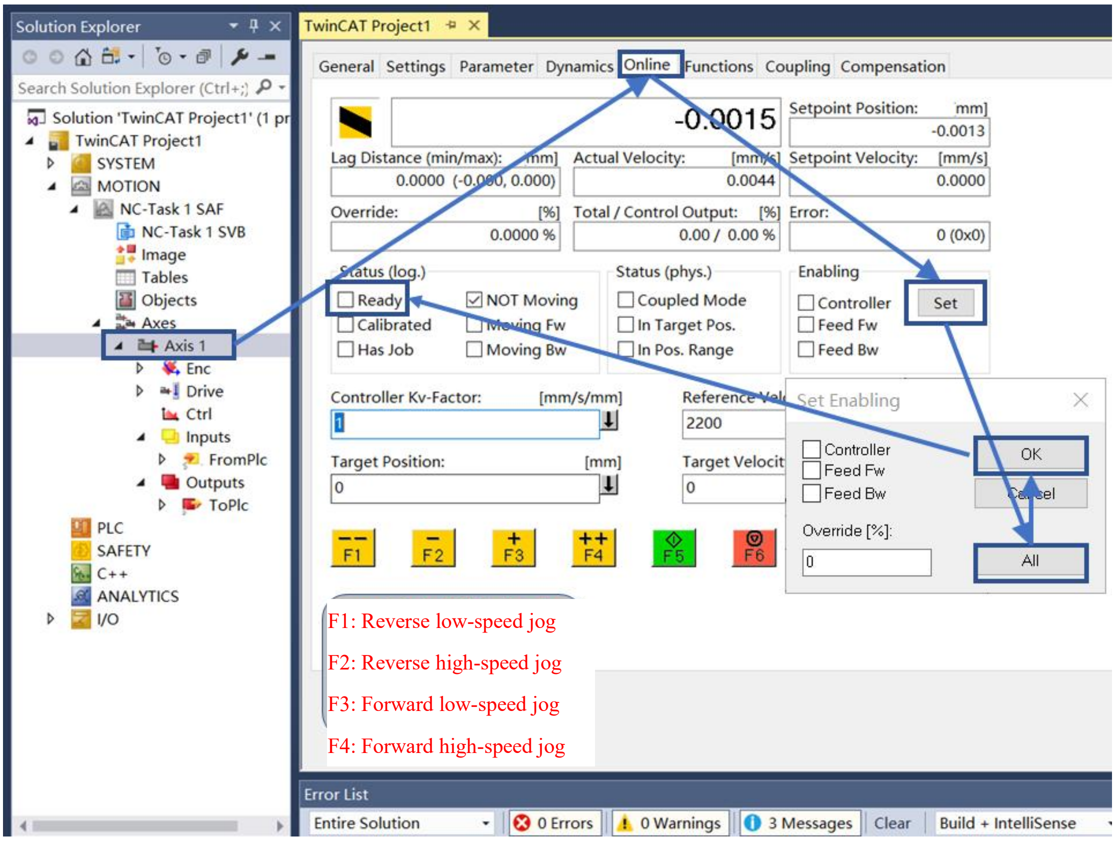
Activate Configuration
Project: TwinCAT Project1
Target: <Local>

Number	Box Name	Address	Type	In Size	Out Size	E-Bus (m...
1	Drive 1 (SV3S_E)	1001	SV3S_E	23.0	8.0	

Figure 8-13 Activating configuration and switching to Run mode

I) TwinCAT3 execute servo JOG

- I) Select Axis 1 node in the left tree list and click Online tab in the middle view window of the software;
- II) Click Set button, then pop up Set Enabling window, click All, and then click OK.
- III) Here, Ready check box under State (log.) should be checked (if not, please check if the servo reports an error and clear NC axis error in TwinCAT3);
- IV) Click F1-F4 at will, and then perform JOG of servo device.



F1: Reverse low-speed jog

F2: Reverse high-speed jog

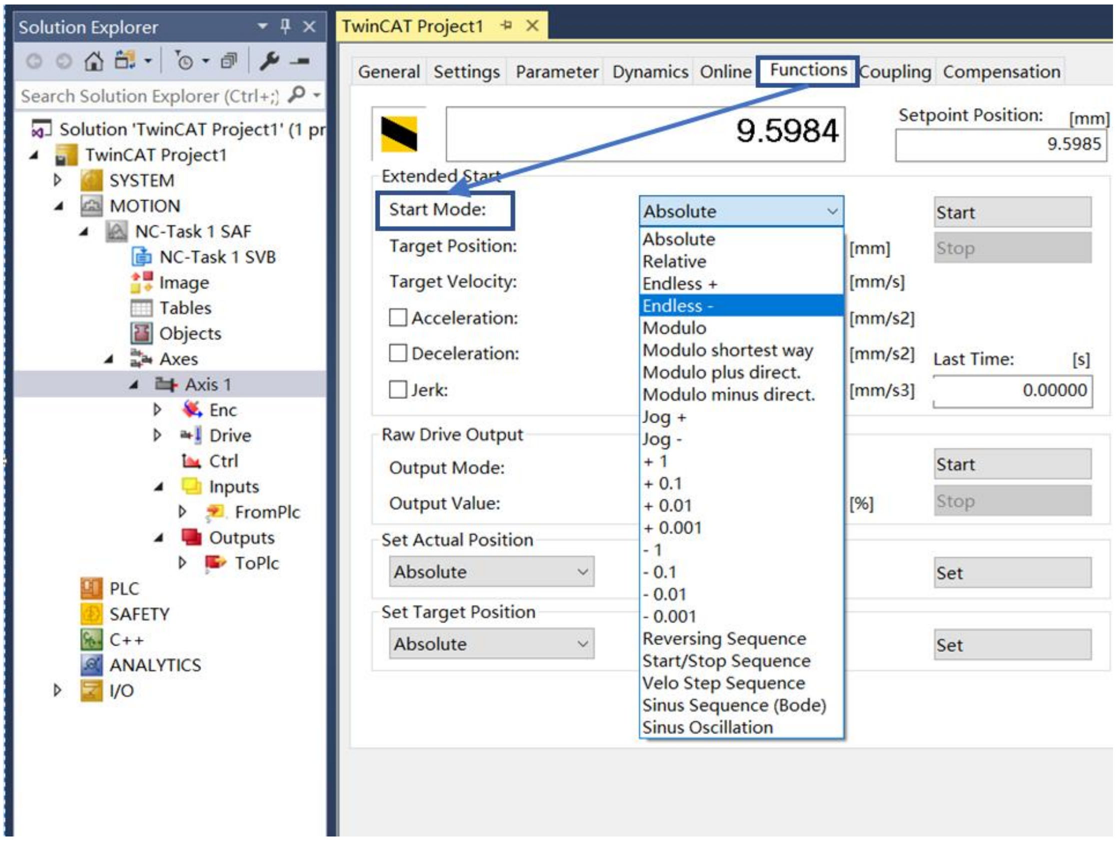
F3: Forward low-speed jog

F4: Forward high-speed jog

Figure 8-14 NC axis jog

J） TwinCAT3 performs simple movements of servo device

Shown as below, select Axis 1 node in the left tree list, select Functions tab in the middle view of the software, and select Run mode in Start Mode so as to perform various forms of motion of servo device.



9.5984

Setpoint Position: [mm] 9.5985

Start Mode: Absolute

Last Time: [s] 0.00000

Figure 8-15 NC axis compound movement

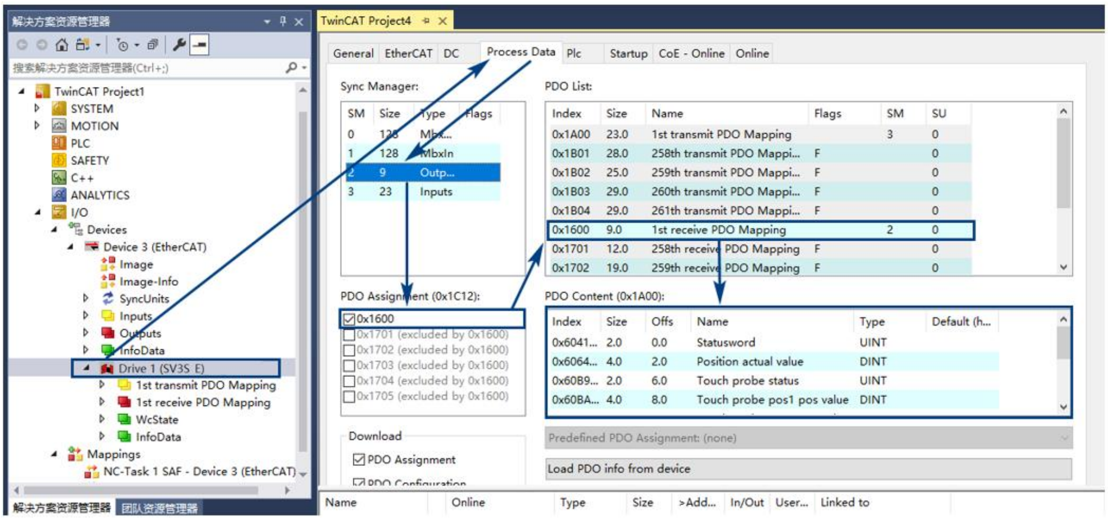
8.4.2 TwinCAT3-PDO Control Operation

(1) Change of PDO mapping objects

Application object and PDO allocation object in PDO variable mapping objects can be changed by upper machine software. The specific steps are as follows:

A) TwinCAT3 changes transmit PDO Maooing: As shown in the following figure

- I) Click the scanned servo device in the left tree list, and click Process Data in the middle view of the software.
- II) Click SV3H in Sync Manager;
- III) In PDO Assignment(0x1C12), uncheck 0x1701 and check 0x1600;
- IV) Click 0x1600 in Index column of PDO List;
- V) Right click in PDO Content (0x1600), remove the existing PDO by Delete option, and add PDO by Add new Item.



Sync Manager:

SM	Size	Type	Flags
0	128	Mbx...	
1	128	MbxIn	
2	9	Outp...	
3	23	Inputs	

PDO List:

Index	Size	Name	Flags	SM	SU
0x1A00	23.0	1st transmit PDO Mapping		3	0
0x1B01	28.0	258th transmit PDO Mappi...	F		0
0x1B02	25.0	259th transmit PDO Mappi...	F		0
0x1B03	29.0	260th transmit PDO Mappi...	F		0
0x1B04	29.0	261th transmit PDO Mappi...	F		0
0x1600	9.0	1st receive PDO Mapping		2	0
0x1701	12.0	258th receive PDO Mapping	F		0
0x1702	19.0	259th receive PDO Mapping	F		0

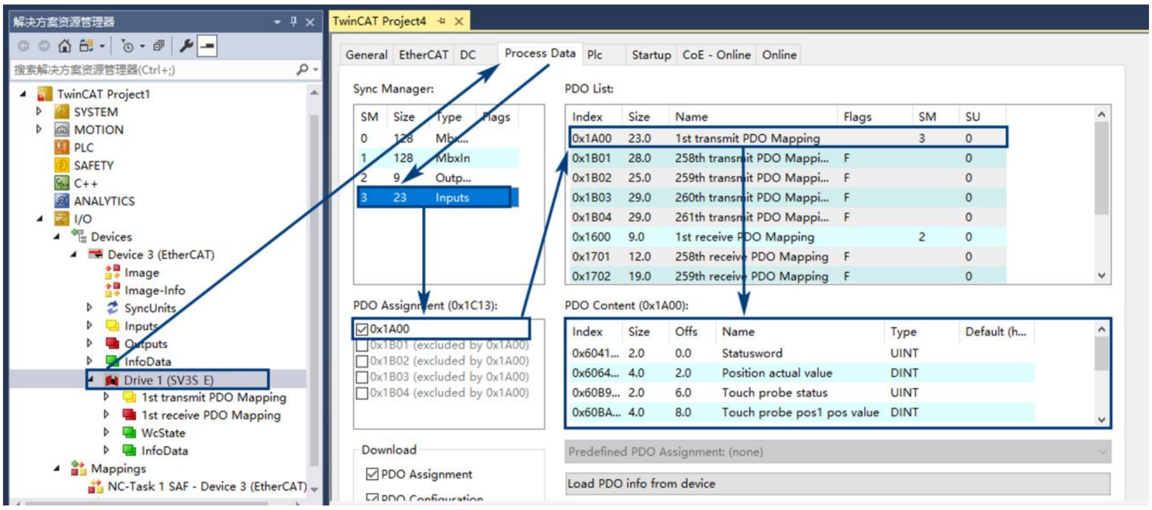
PDO Assignment (0x1C12):

☑0x1600
☐0x1701 (excluded by 0x1600)
☐0x1702 (excluded by 0x1600)
☐0x1703 (excluded by 0x1600)
☐0x1704 (excluded by 0x1600)
☐0x1705 (excluded by 0x1600)

PDO Content (0x1A00):

Index	Size	Offs	Name	Type	Default (h...
0x6041...	2.0	0.0	Statusword	UINT	
0x6064...	4.0	2.0	Position actual value	DINT	
0x60B9...	2.0	6.0	Touch probe status	UINT	
0x60BA...	4.0	8.0	Touch probe pos1 pos value	DINT	

Figure 8-16 TwinCAT3 Modify RxPDO mapping list



Sync Manager:

SM	Size	Type	Flags
0	128	Mbx...	
1	128	MbxIn	
2	9	Outp...	
3	23	Inputs	

PDO List:

Index	Size	Name	Flags	SM	SU
0x1A00	23.0	1st transmit PDO Mapping		3	0
0x1B01	28.0	258th transmit PDO Mappi...	F		0
0x1B02	25.0	259th transmit PDO Mappi...	F		0
0x1B03	29.0	260th transmit PDO Mappi...	F		0
0x1B04	29.0	261th transmit PDO Mappi...	F		0
0x1600	9.0	1st receive PDO Mapping		2	0
0x1701	12.0	258th receive PDO Mapping	F		0
0x1702	19.0	259th receive PDO Mapping	F		0

PDO Assignment (0x1C13):

☑0x1A00
☐0x1B01 (excluded by 0x1A00)
☐0x1B02 (excluded by 0x1A00)
☐0x1B03 (excluded by 0x1A00)
☐0x1B04 (excluded by 0x1A00)

PDO Content (0x1A00):

Index	Size	Offs	Name	Type	Default (h...
0x6041...	2.0	0.0	Statusword	UINT	
0x6064...	4.0	2.0	Position actual value	DINT	
0x60B9...	2.0	6.0	Touch probe status	UINT	
0x60BA...	4.0	8.0	Touch probe pos1 pos value	DINT	

Figure 8-17 TwinCAT3 Modify TxPDO list

B) TwinCAT3 modify transmit PDO Maooing: As shown in the following figure

I) Click the scanned servo device in the left tree list, and click Process Data in the middle view of the software.

II) Click SM3 in Sync Manager;

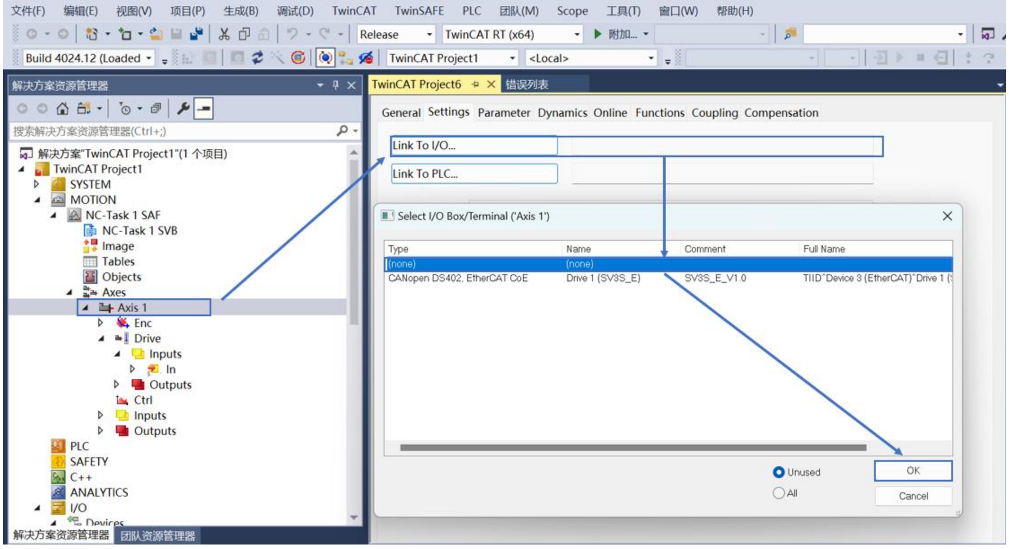
III) Under PDO Assignment (0x1B01), uncheck 0x1701 and then check 0x1A00;

IV) Click 0x1A00 in Index column of PDO List;

V) Right click in PDO Content (0x1A00); Remove the existing PDO by Delete option, and add PDO by Add new Item.

(2) PDO assignment

Switch TwinCAT3 status to Config mode, select NC axis in the left tree list, click Link To I/O in Setting interface, a window will pop up, select none, click OK, then disconnect the variable link between NC axis and servo drive device.



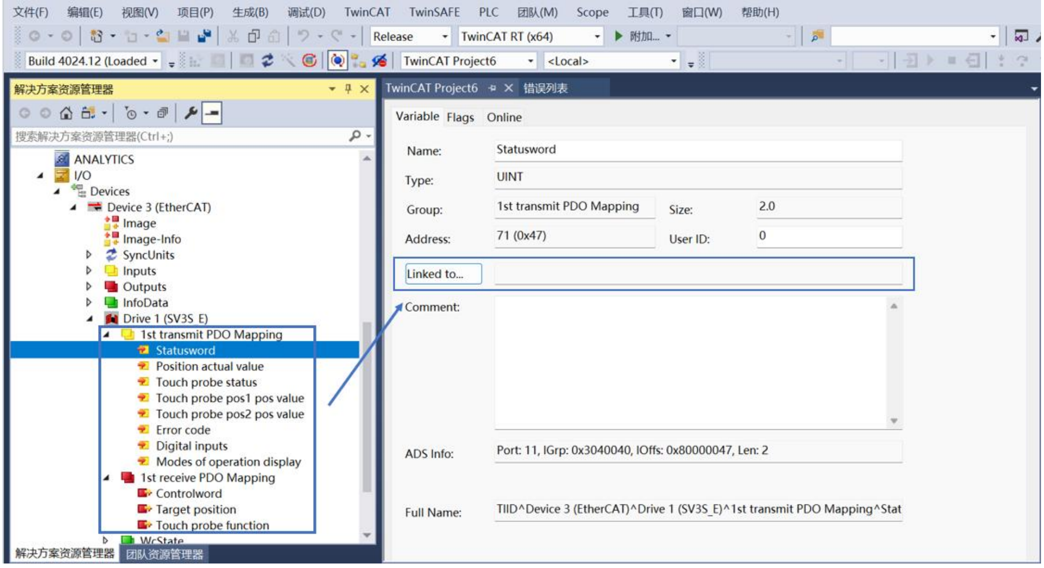
Select I/O Box/Terminal ('Axis 1')

Type	Name	Comment	Full Name
(none)	(none)		
CANopen DS402, EtherCAT CoE	Drive 1 (SV3S_E)	SV3S_E_V1.0	TIID^Device 3 (EtherCAT)^Drive 1 (

● Unused
○ All

Figure 8-18 Unlink NC axis and physical axis

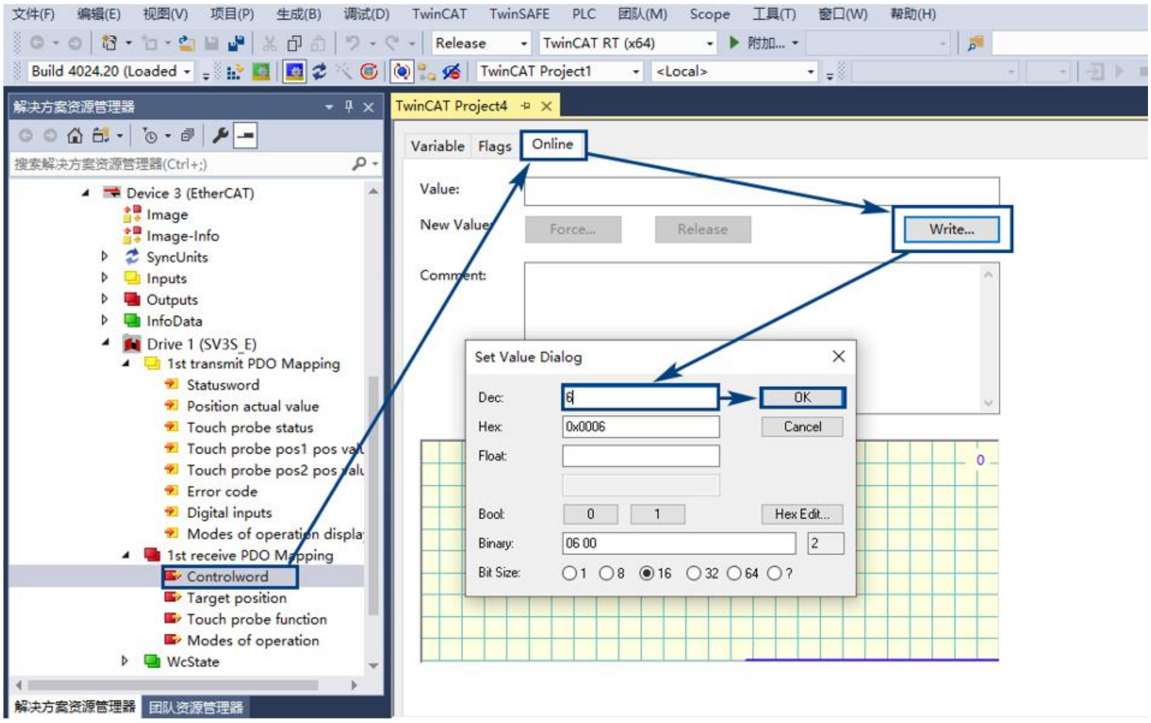
After unlinking the variable of PDO and NC axis, click servo drive PDO list, and set Link to of all response objects as empty, and re-activate the configuration.



Name: Statusword
Type: UINT
Group: 1st transmit PDO Mapping
Size: 2.0
Address: 71 (0x47)
User ID: 0
Comment:
ADS Info: Port: 11, IGrp: 0x3040040, IOffs: 0x80000047, Len: 2
Full Name: TIID^Device 3 (EtherCAT)^Drive 1 (SV3S_E)^1st transmit PDO Mapping^Stat

Figure 8-19 Link interface of physical axis variables

A) Double click Controlword in PDO list, click Online in the middle view box of the software, and click one by one as shown below, then assignment of control word is successful.



Dec: 6

Hex: 0x0006

Float:

Bool: 0 1

Binary: 06 00 2

Bit Size: ○ 1 ○ 8 ● 16 ○ 32 ○ 64 ○ ?

Figure 8-20 RxPDO assignment

8.5 Samples for Various Mode Operation

8.5.1 Samples for CSP Mode

Take TwinCAT3 for example, drive the motor in periodic position mode.
Flowchart as follows:

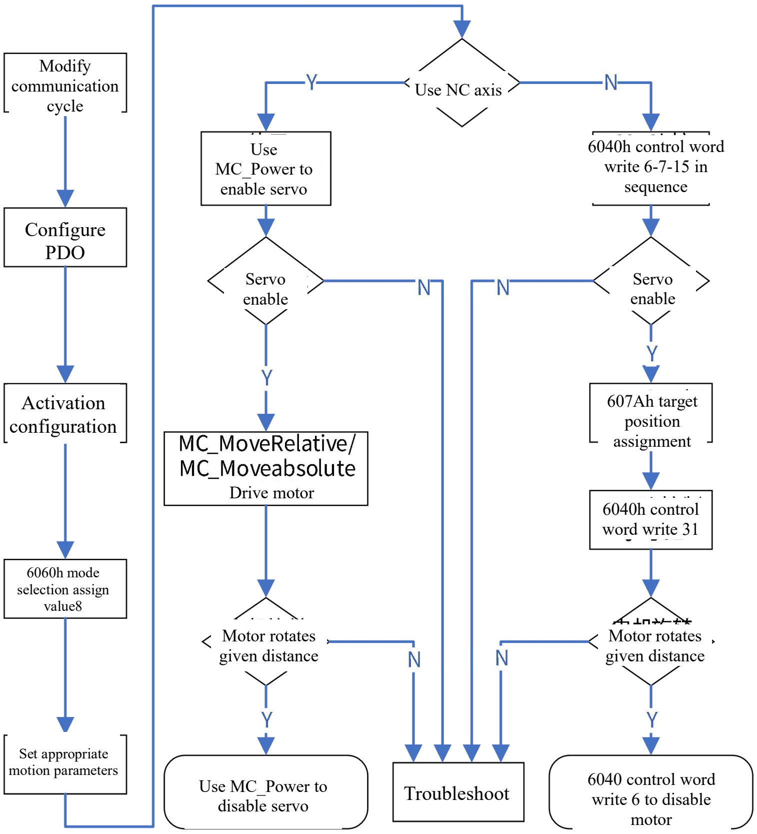


Figure 8-21 Flowchart of cases in CSP mode

Detailed steps as follows:

I)Set communication cycle in upper controller;

II) Select the appropriate PDO mapping object according to 0 run mode settings and activate the configuration.

III) Assign 6060h mode as 8;

IV) Set appropriate motion parameters according to the relevant objects in this section.

V) If using NC axis, select NC_Power to enable servo drive.

If NC axis link is disconnected, write 6-7-15 to 6040h control word in turn. Here, the servo should be enabled, if not, please check if servo alarm occurs, if the first 2 arrays show 88, if upper computer software alarm occurs;

VI) If using NC axis, drive function block corresponding to the upper controller is used for positioning;

If NC axis link is disconnected, 607Ah target position is assigned (low-speed run recommended: 607A value = communication cycle (s) * Max. motor speed (r/s) /10), and then assign 6040h control word of 31;

VII) After operation ends, write 6040h control word as 6 and the test ends.

8.5.2 Samples for CSV Mode

Take TwinCAT3 for example, drive the motor in periodic speed mode.
Flowchart as follows:

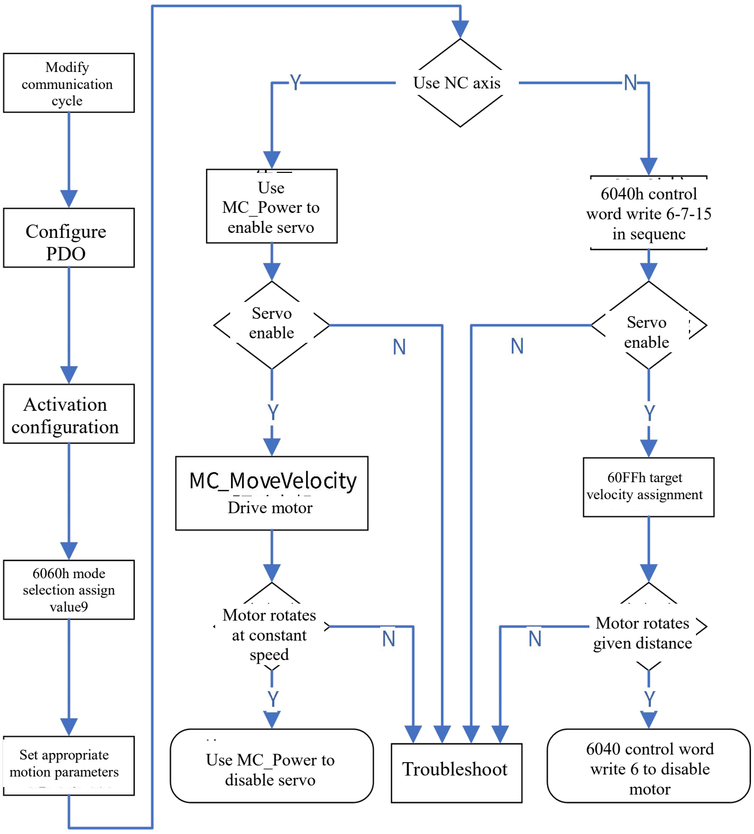


Figure 8-22 Flowchart for case in CSV mode

Detailed steps as follows

I)Set communication cycle in upper controller;

II) Select the appropriate PDO mapping object according to 0 run mode settings and activate the configuration.

III) Assign 6060h mode selection of 9;

IV) Per the relevant objects in this section, set the appropriate motion parameters, but do not assign 60FFh target speed;

V) If using NC axis, select NC_Power to enable servo drive.

If NC axis link is disconnected, write 6-7-15 to 6040h control word in turn. Here, the servo should be enabled, if not, please check if servo alarm occurs, if the first 2 arrays show 89, if upper computer software alarm occurs;

VI) If using NC axis, drive function block corresponding to the upper controller is used for positioning;

If NC axis link is disconnected, 60FFh target speed is assigned (note the setting of electronic gear ratio);

VII) In order to finish the run, first write 60FFh target speed of 0, and then write 6040h control word of 6 and then the test ends.

8.5.3 Samples for CST Mode

Take TwinCAT3 for example, drives the motor in periodic torque mode.
Flowchart as follows:

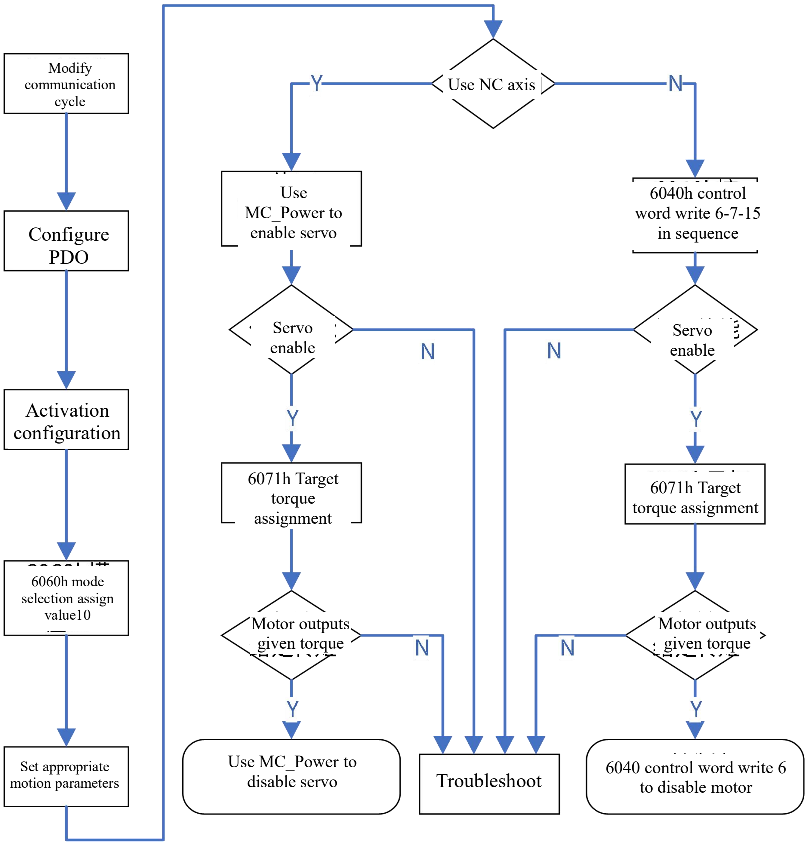


Figure 8-23 Flowchart for case in CST mode

Detailed steps as follows

I) Set communication cycle in upper controller;

II) According to 3.4.3 Setting of Running Mode, select the appropriate PDO mapping object and activate the configuration.

III) Assign 6060h mode selection of 10;

IV) Set appropriate motion parameters according to the relevant objects in this section.

V) If using NC axis, use NC_Power to enable servo drive,
If NC axis link is disconnected, write 6-7-15 to 6040h control word in turn. Here, the servo should be enabled, if not, please check if servo alarm occurs, if the first 2 arrays show 8A, if upper computer software alarm occurs;

VI) TwinCAT3 has no functional block supporting torque instruction. Assign 6071h target torque. Note: the unit is 0.1%.

VII) In order to finish the run, first write 6071h target torque of 0, and then write 6040h control word of 6 and then the test ends.

8.5.4 Samples for PP Mode

Take TwinCAT3 for example, drives the motor in profile position mode.

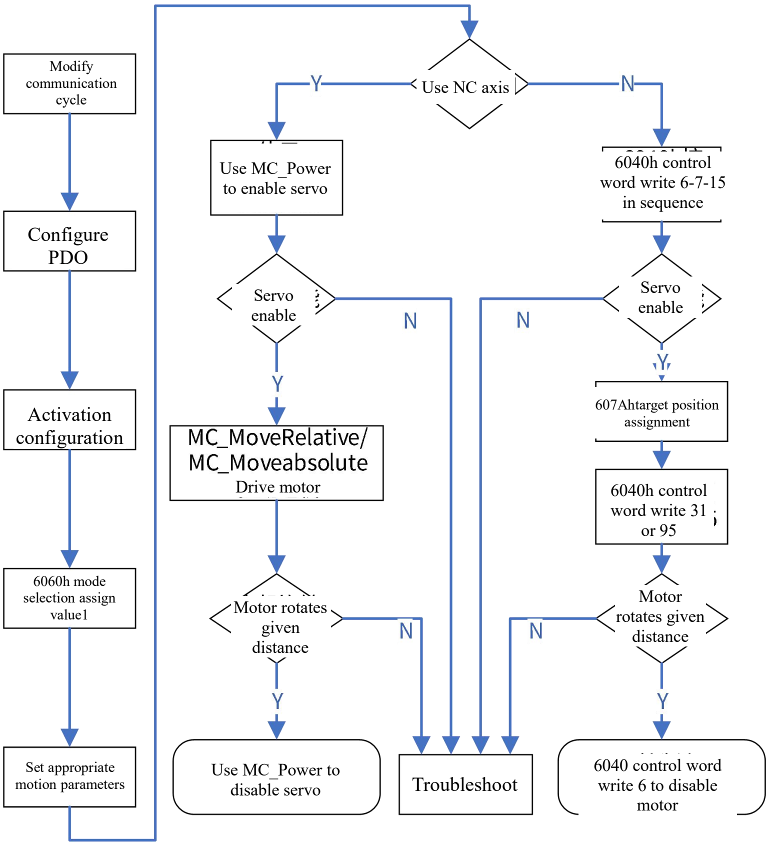


Figure 8-24 Flowchart for case in PP mode

Detailed steps as follows

I) According to 3.4.3 Setting of Running Mode, select the appropriate PDO mapping object and activate the configuration.

II) Assign 6060h mode selection of 1;

III) Set appropriate motion parameters according to the relevant objects in this section.

IV) If using NC axis, select NC_Power to enable servo drive.

If NC axis link is disconnected, write 6-7-15 to 6040h control word in turn. Here, the servo should be enabled,if not, please check if servo alarm occurs, if the first 2 arrays show 81, if upper computer software alarm occurs;

V) If using NC axis, drive function block corresponding to the upper controller is used for positioning;

If NC axis link is disconnected, assign 607Ah target position, and then write 6040h control word as 31 or 95;

VI) In order to finish the run, write 6040h control word of 6, and then the test ends.

8.5.5 Samples for PV Mode

Take TwinCAT3 for example, drives the motor in profile speed mode.Flowchart as follows:

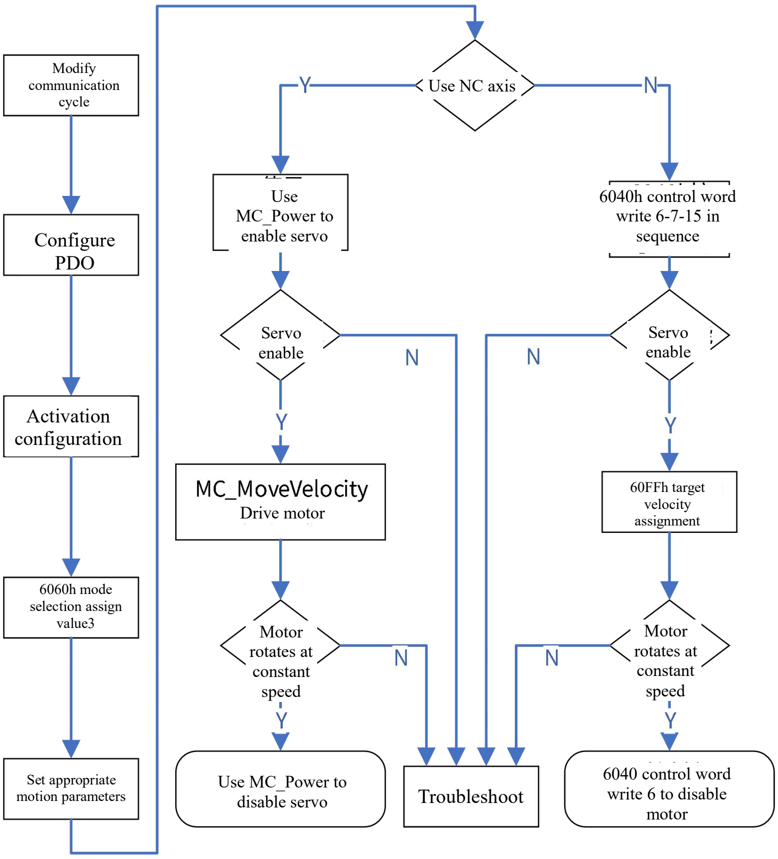


Figure 8-25 Flowchart for case in PV mode

Detailed steps as follows

I) Select an appropriate PDO mapping object based on 0 Settings, and activate the configuration;

II) Assign 6060h mode selection of 3;

III) According to the relevant objects in this section, set the appropriate motion parameters, but do not assign 60FFh target speed;

IV) If using NC axis, use NC_Power to enable servo drive,

If NC axis link is disconnected, write 6-7-15 to 6040h control word in turn. Here, the servo should be enabled, if not, please check if servo alarm occurs, if the first 2

arrays displays 83, if upper computer software alarm occurs;

V) If using NC axis, drive function block corresponding to the upper controller is used for positioning;

If NC axis link is disconnected, assign 60FFh target speed(Note for settings of electronic gear ratio here, if it can't be assigned, please check if it's a link variable, if link variable exists, please cancel it; If 60FFh assignment is successful, when the servo motor doesn't run, please check if the acceleration/deceleration are 0);

VI) In order to finish the run, first write 60FFh target speed of 0, and then write 6040h control word of 6 and then the test ends.

8.5.6 Samples for PT mode

Taking TwinCAT3 for example, drive the motor in profile torque mode.
Flowchart as follows:

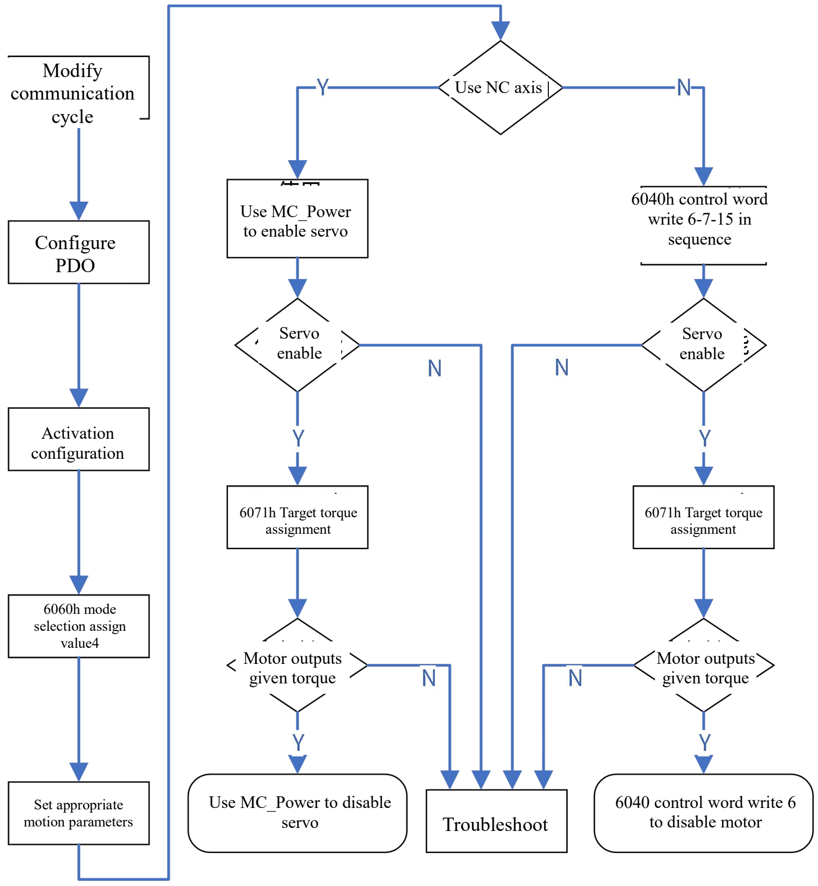


Figure 8-26 Flowchart for case in PT mode

Detailed steps as follows

I) Select the appropriate PDO mapping object according to 0 run mode settings and activate the configuration.

II) Assign 6060h mode selection of 4;

III) Set appropriate motion parameters according to the relevant objects in this section.

IV) If using NC axis, use NC_Power to enable servo drive,

If NC axis link is disconnected, write 6-7-15 to 6040h control word in turn. Here, the servo should be enabled,if not, please check if servo alarm occurs, if the first 2 arrays show 84, if upper computer software alarm occurs;

V) TwinCAT3 has no function block supporting torque instruction. Assign 6071h target torque, and note that the unit is 0.1%.(Note that the unit is 0.1%, if assignment fails, please check if it is a link variable, if a link variable exists, please cancel it; If 6071h assignment is successful, when servo motor doesn't run, please check if torque ramp is 0 and if motor speed limit is 0);

VI) In order to finish the run, first write 6071h target torque of 0, and then write 6040h control word of 6 and then the test ends.

8.5.7 Return to Zero Operation Sample

Take TwinCAT3 for example, drive the motor in the origin zeroing mode.
Flowchart as follows:

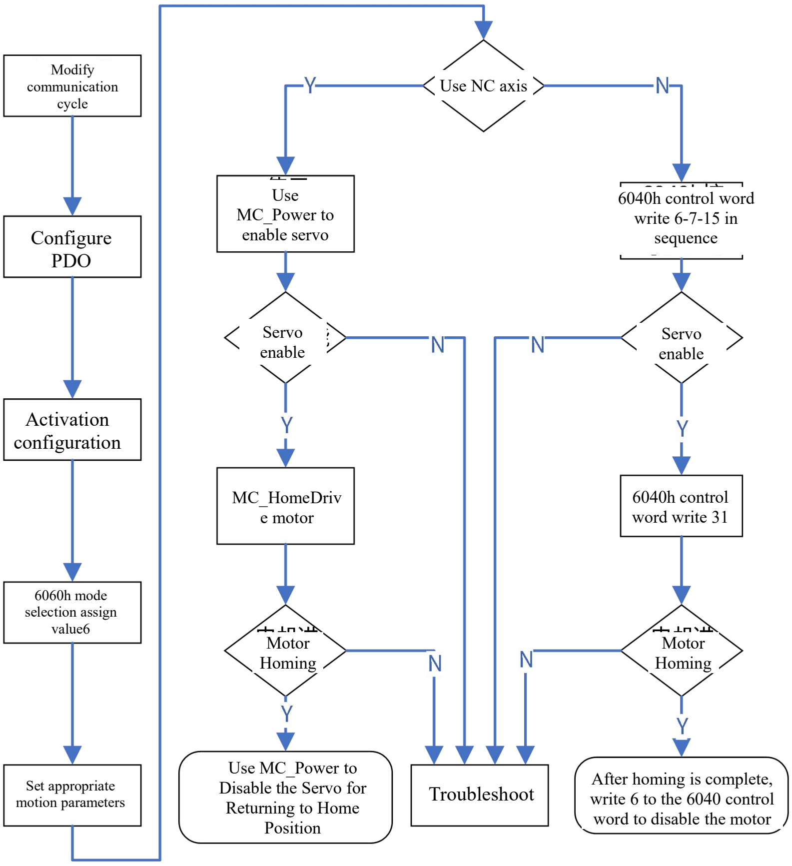


Figure 8-27 Flowchart of return-to-zero operation

Detailed steps as follows

I) According to 3.4.3 Setting of Running Mode, select the appropriate PDO mapping object and activate the configuration.

II) Assign 6060h mode selection of 6;

III) Set appropriate motion parameters according to the relevant objects in this section.

IV) If NC axis is used, use NC_Power to enable the servo drive, and then use MC_Home to return to zero. Note that the return-to-zero method of the upper controller, please refer to the corresponding software introduction. It isn't equivalent to the return-to-zero mode of servo drive.

V) If NC axis link is disconnected, first set control mode of 6, and then write 6-7-15 to 6040h control word in turn. Here, enable the servo to return to zero. If fails, please check if servo alarm occurs, if the first 2-bit arrays show 86;

VI) After the return to zero ends, write 6040h control word of 6 and the test ends