XINJE

DL6 series linear servo driver

User manual

Wuxi Xinje Electric Co., Ltd.

Data No.: SL6 01 20241223EN 1.0

Basic explanation

- Thank you for purchasing XJNIE DS5C2 series servo driver products.
- This manual mainly introduces the product information of DS5C2 series servo driver and MS6 series servo motor.
- Before using the product, please read this manual carefully and connect the wires on the premise of fully understanding the contents of the manual.
- Please deliver this manual to the end user.

This manual is suitable for the following users

- Designer of servo system
- Installation and wiring workers
- Commissioning and servo debugging workers
- Maintenance and inspection workers

Get the manual

- Please consult the supplier,agent and office who purchased the product.

Declaration of liability

- Although the contents of the manual have been carefully checked, errors are inevitable, and we cannot guarantee complete consistency.
- We will often check the contents of the manual and make corrections in the subsequent versions.We welcome your valuable comments.
- If there is any change to the contents introduced in the manual, please understand without further notice.

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Before using this product, please read this part carefully and operate after fully understanding the use, safety and precautions of the product. Please connect the product correctly on the premise of paying great attention to safety.

The problems that may arise during the use of the product are basically listed in the safety precautions, and all are indicated by the two levels of attention and danger. For other unmentioned matters, please follow the basic electrical operation rules.

Caution	When used incorrectly, there may be danger, moderate injury or minor injury, and property loss.
Danger	When used incorrectly, it may cause danger, personal casualties or serious injuries as well as serious property losses.

Attention to product confirmation

1. Do not install damaged drives, drives that lack spare parts, or drives whose models do not meet the requirements.

Installation notes

1. Before installing the wiring, please be sure to disconnect the power supply to prevent the risk of electric shock.
2. It is prohibited to use this product in places with water vapor, corrosive gases, flammable gases, and other substances, which may cause electric shock and fire hazards.
3. Do not directly touch the conductive parts of the product, as it may cause misoperation or malfunction.

Wiring precautions

1. Please connect the AC power supply correctly to the dedicated power terminal of the drive. Do not connect the output terminals U, V, W of the driver to a three-phase power supply.
2. Please connect the ground wire correctly, poor grounding may cause electric shock. Please use cables that meet the relevant wire diameter requirements for grounding treatment.
3. Please tighten the fixing screws of the terminals, otherwise it may cause a fire.

Before wiring the drive, be sure to disconnect all external power sources.

5. Please ensure that the encoder and power cables are in a loose state during wiring, and do not tighten them to avoid cable damage.

Precautions for operation

1. Please pay attention to tuning before performing jogging and trial operation.
2. After connecting the machinery, please set the appropriate parameters before running, otherwise it may cause the machinery to lose control or malfunction.
During operation, do not touch the radiator as there is a risk of burns.
4. Do not change the wiring while it is live, as there is a risk of injury.
5. Do not frequently turn on and off the power supply. If you need to turn on and off the power supply multiple times, please control it to once every 2 minutes.

Maintenance and Inspection

1. Do not touch the inside of the servo drive, otherwise it may cause electric shock.
2. When starting the power supply, it is forbidden to remove the driver panel, otherwise it may cause electric shock.
3. Within 15 minutes of turning off the power, do not touch the wiring terminals, otherwise residual voltage may cause electric shock.

Attention to wiring

1. Please do not pass the power line and control signal line through the same pipeline, and do not tie them together. The power line and control signal line are separated by more than 30 centimeters.
2. For signal cables and encoder differential feedback cables, please use multi-stranded wires and multi-core stranded shielded wires. For wiring length, the longest signal input cable is 3 meters, and the longest encoder differential feedback cable is 20 meters.

Catalog

►► Confirmation on product arrival

After the product arrives, please confirm the integrity of the product in the following aspects.

Items	Notes
Does the product on arrival match the specified model?	Please confirm according to the nameplate of servo motor and servo unit.
Is there any damage?	Check the overall appearance, and check for damage or scratches that may have occurred during shipping.
Are there any loose screws?	Check screws for looseness using a screwdrive.

If any of the above is faulty or incorrect, contact Xinje or an authorized distributor.

1 Product overview

1.1 DL6 linear servo drive product overview

The DL6 is a high-performance servo drive that leverages innovative technology and advanced control algorithms, offering advantages of high speed, high precision, and rapid response for controlling direct-drive linear motors. It currently supports ABZ+HALL, ABZ, and Biss-C encoder control.
This model is suitable for various applications such as EtherCAT bus and pulse control, providing easy selection options for customers.
With the use of upper computer debugging software, the DL6 linear servo can be plug-and-play debugged, allowing operations such as tuning, motor setup, parameter configuration, curve acquisition, and gain adjustments to be performed in the upper computer software. For specific tuning and motor setup, please refer to Section 5.1 of this manual on motor function settings. For curve acquisition and gain tuning, please refer to Chapter 9 on servo gain adjustments in this manual.

1.1.1 Model naming

DL6□-2 00□ - □

Code	Product name
DL	Linear servo drive

Code	Product series
6	6 series

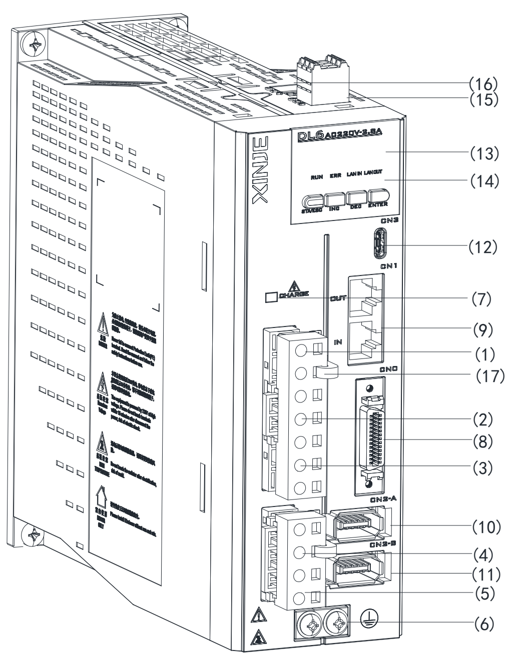
Code	Product type
-	Standard

Code	Rated input voltage
2	AC220V
4	AC380V

Code	Rated output current
003	2.8A
006	6A

Code	Optional
-	Standard
GS	Gantry synchronization

1.1.2 Description of each part



The names of each part of the DL6 servo drive are as follows:

No.	Name	Explanation
(1)	L1/L2/L3 Main circuit power input terminal	Refer to drive nameplate rated voltage level input main circuit power supply: L1/L2/L3: Single phase/three-phase main circuit power supply
(2)	P+, P- bus terminal	Driver bus terminal
(3)	P+, D, C Braking resistor connection terminal	When using the built-in braking resistor, short-circuit the P+ and D terminals, P+ and C are disconnected.When using an external braking resistor, remove the P+ and D short-circuit wires and connect the braking resistor to the P+ and C terminals
(4)	U, V, W Servo motor power terminal	Connect servo motor U/V/W phase
(5)	PE motor grounding terminal	Connect to the motor grounding terminal and perform grounding treatment
(6)	⏚ Drive grounding terminal	Connect to external ground piles and perform grounding treatment. Connect to the power grounding terminal and perform grounding treatment
(7)	CHARGE Bus voltage indicator light	Used to indicate that the bus capacitor is in a charged state. When the indicator light is on, even if the main circuit power is turned off, the internal capacitor of the servo unit may still have charge. Therefore, do not touch the power terminal when the light is on to avoid electric shock

(8)	CN0: Input/output control port	26 pins function control signal terminal
(9)	CN1: EtherCAT port	EtherCAT communication port
(10)	CN2-A: encoder communication port 1	Connect to the motor encoder terminal
(11)	CN3-B: encoder communication port 2	Connect to the motor encoder terminal, ABZ+HALL encoder type interface
(12)	CN3: USB Type-C interface	USB 2.0 communication interface, connected to the servo upper computer debugging software for communication
(13)	Drive display panel	5-digit 8-segment LED digital display, used to display the operating status and parameter settings of the servo
(14)	Drive current status display light	Including enable state, error state, EC bus IN network port physical connection status, EC bus OUT network port physical connection status display
(15)	CN5: STO safety function terminal	STO function safety terminal, used for application scenarios of safety functions, external safety function signal access
(16)	CN4: gantry synchronization interface	Connect to another driver to perform gantry synchronization function
(17)	Wiring auxiliary buckle	Installation and wiring assistance for pin terminals

1.1.3 Performance specifiation

Servo unit		DL6 series linear servo drive
Input power supply		DL6-200□-□: single phase/three phase AC200~240V, 50/60Hz (If using single-phase 220V power supply, it is necessary to connect to L1 and L3, otherwise power failure will affect parameter memory)
Control mode		IGBT PWM Control Sine Wave Current Drive Method
Using condition	Using temperature	-10~+40 ℃
	Storage temperature	-20~+60 ℃
	Environment humidity	Below 90% RH (no condensation)
	Vibration resistance	$4.9m/s^2$
	Altitude	Not exceeding 1000m, please reduce the rating when exceeding 1000m (1% reduction for every 100m higher)

1.1.4 Electrical specification

Driver model	Driver power (kW)	Continuous output current (A)	Maximum output current (A)	Power input current (A)	Power supply	Cooling method
DL6-2003(-GS)	0.4	2.8	9.8	3	Single phase AC200~240V, 50/60Hz	Air cooling
DL6-2006(-GS)	1.0	6	18	9		Air cooling

1.1.5 EtherCAT communication cable

JC – CB - 1

Name	Cable type
JC	EtherCAT communication cable

Name	Plug type
CB	Cat5e

Name	Length (m)
0P2	0.2
0P3	0.3
0P5	0.5
1	1
3	3
5	5

At present, the length of communication cables is 0.2m, 0.3m, 0.5m, 1m, 3m, 5m, 10m, 20m.

1.2 Selection of braking resistor

When the servo motor is driven by the generator mode, the power returns to the servo amplifier side, which is called regenerative power. The regenerated power is absorbed by charging the smooth capacitor of the servo amplifier. After exceeding the rechargeable energy, the regenerative resistance is used to consume the regenerative power.

- During deceleration operation or deceleration stop period.
- When the external load drives the motor to rotate.

Servo driver model	Braking resistor connection terminal
DL6-200□-□	(1) Use the built-in braking resistor and short-circuit the P+ and D terminals, P+ and C are disconnected. (2) When using an external braking resistor for a 1kW driver with a built-in braking resistor, connect the braking resistor to the P+ and C terminals, remove the P+ and D short-circuit wires, P0-25= power value, P0-26= resistance value.

The following table shows the recommended external braking resistor specifications for each model of driver.

Servo driver model	Built in braking resistor	Minimum resistance value (Cannot be less than this value)	External braking resistor (Recommended resistance value)	External braking resistor (Recommended power value)
DL6-2003-(GS)	/	80Ω	80Ω-100Ω	Above 200W
DL6-2006-(GS)	80W45Ω	35Ω	35Ω-75Ω	Above 800W

- The smaller the resistance value, the faster the discharge, but if it is too small, it is easy to break down the resistance. Therefore, when selecting, try to approach the lower limit as much as possible and not lower than it.
- When wiring, please use high temperature resistant and flame-retardant wires, and be careful not to contact the surface of the braking resistor with the wires.

1.3 Line filter

Line filter is an electronic device mainly used for filtering signals in circuits. Capacitors have a small impedance to high-frequency signals, while inductors have a large impedance to high-frequency signals. By utilizing the characteristics of inductors, capacitors, and other components, circuits are designed to block or allow signals within a specific frequency range to pass through, thereby suppressing electromagnetic interference, improving power quality, protecting equipment, and enhancing system reliability.

The following table shows the recommended line filter specifications for each model of driver.

Servo driver model	Voltage/frequency	Manufacturer Part Number
DL6-2003-(GS)	DC/AC 250V 50/60Hz	LCR: 055M.80601.00
		LCR: 092.00623.00
		Schaffner: FN2070-6
DL6-2006-(GS)	DC/AC 250V 50/60Hz	LCR: 0923.01021.00
		LCR: 092.01023.00
		LCR: 055.81011.00
		Schaffner: FN2070-10

- The filter should be installed as close as possible to the driver to prevent capacitance from coupling to other signal lines and cables and generating noise.
- The filter will generate high leakage current, and it must be grounded before connecting to the power supply.
- Do not touch the filter within 10 seconds after turning off the power.

2 Installation of servo system

2.1 Servo driver installation

2.1.1 Installation site

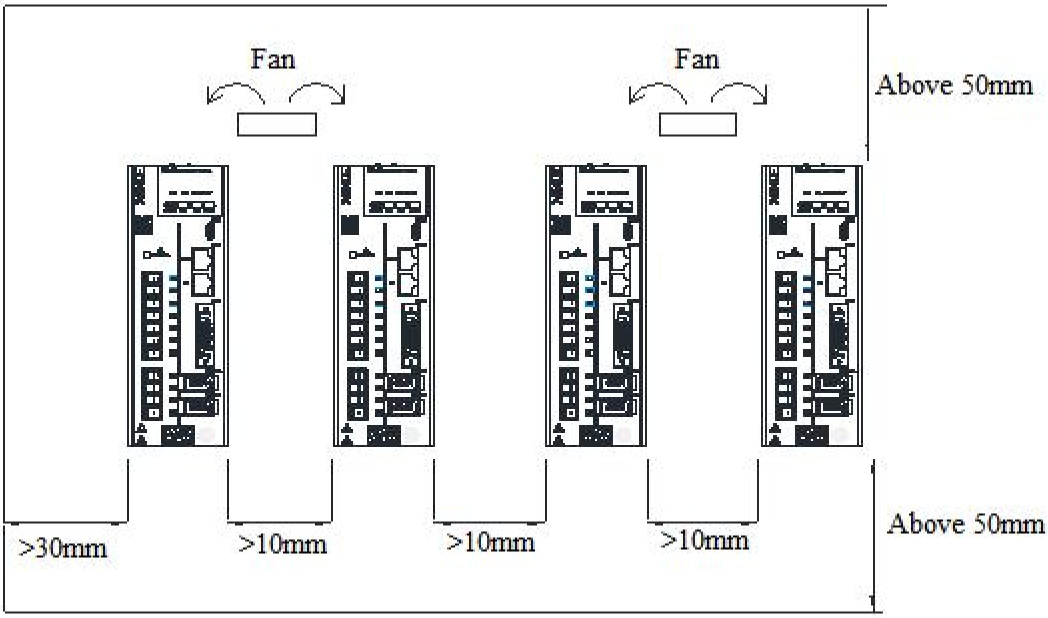
- Please install it in the installation cabinet without sunshine or rain.
- Do not use this product near corrosive and flammable gas environments and combustibles such as hydrogen sulfide, chlorine, ammonia, sulfur, chlorinated gas, acid, alkali, salt, etc.
- Do not install in high temperature, humidity, dust, metal dust environment.
- No vibration place.

2.1.2 Environment condition

Item	Description
Using ambient temperature	-10~40℃
Using ambient humidity	20~90%RH (no condensation)
Storage temperature	-20~60℃
Storage humidity	20~90%RH (no condensation)
Vibration resistance	Not more than 4.9m/s^2
Altitude	Not exceeding 1000m, please reduce the rating when exceeding 1000m (1% reduction for every 100m higher)

2.1.3 Installation standard

Please be sure to follow the installation standards inside the control cabinet shown in the figure below, which apply to situations where multiple servo drives are installed side by side in the control cabinet (hereinafter referred to as "side by side installation").
Taking 1kw and below drives as an example:



■ Side-by-side installation

As shown in the above figure, when installing drives side by side in the installation cabinet:
Drivers of 1kW and below should leave at least 10mm space on both sides horizontally and at least 50mm space on both sides vertically.
In addition, in order to prevent local overheating of the servo drive environment, it is necessary to maintain a uniform temperature inside the control cabinet.

■ Orientation of servo drive

When installing, please make the front of the servo driver (the actual installation surface of the operator) face the operator and make it perpendicular to the wall. For drives with regenerative resistors at the bottom, please pay attention to the heat dissipation of the mounting surface to avoid overheating and fire.

■ Cooling

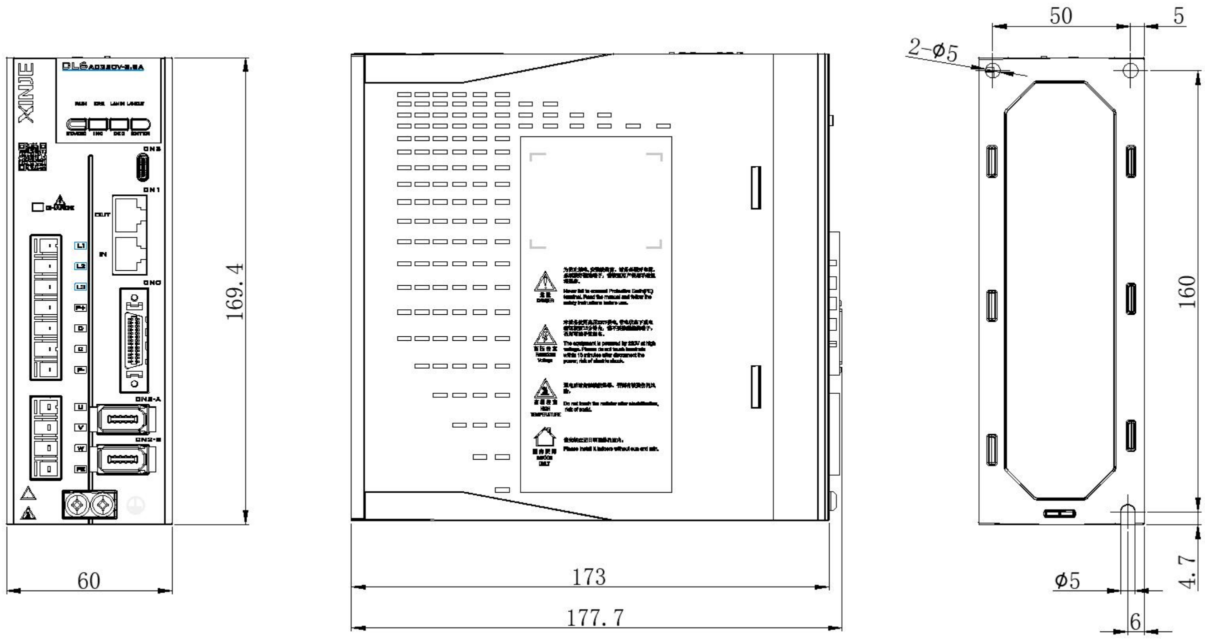
As shown in the figure above, allow sufficient space around each servo drive for cooling by fans or natural convection.

■ Environmental conditions in the control panel

- Servo driver working ambient temperature: -10~40℃.
- Humidity: Below 90%RH(relative humidity)
- Vibration: 4.9m/s^2
- Please do not allow it to freeze or condense.
- In order to ensure the reliability of long-term use, please use it at an ambient temperature lower than 50℃.

2.2 Servo driver dimension

■ DL6-2003/2006(-GS) Unit: mm



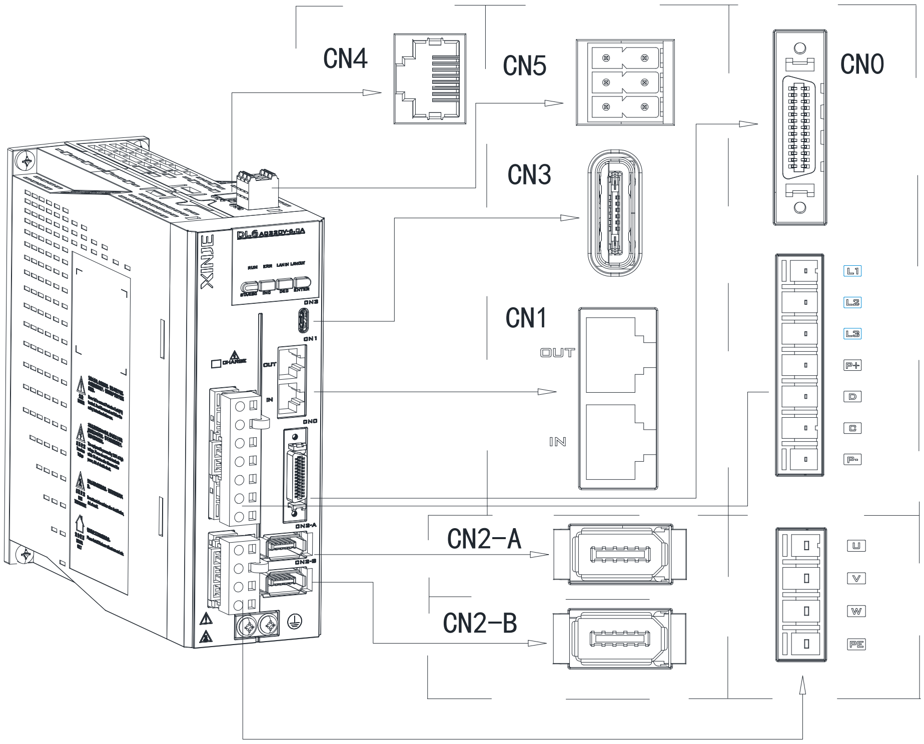
3 Servo system wiring

Precautions for the use of servo drive interface wiring:

- Please do not pass the power cable and signal cable through the same pipeline, and do not tie them together. When wiring, please keep the power cable and signal cable at least 30cm apart.
- For signal cables and encoder (PG) feedback cables, please use multi stranded wires and multi-core twisted overall shielded wires.
- For the wiring length, the maximum length of the instruction input cable is 3m, and the maximum length of the PG feedback cable is 20m.
- Even if the power supply to the driver is disconnected and the panel displays OFF, the internal capacitance of the servo unit will still be stuck with high voltage. Please do not touch the power terminal temporarily (within 10 minutes).
- Do not frequently turn on or off the power supply of the driver. When it is necessary to repeatedly switch on and off the power supply continuously, it is necessary to ensure that the power switch frequency is greater than 2 minutes per time. The servo drive has a large capacitor inside, so when the power is turned on, the internal circuit of the drive will flow a large charging current (charging time of 0.2 seconds). Therefore, if the power supply is frequently switched on and off, it will cause a decrease in the performance of the main circuit components inside the servo drive, affecting the service life of the drive.

3.1 Main circuit terminal

3.1.1 Servo driver terminal layout



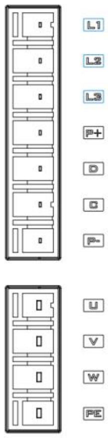
Each part name:

(1): CN3 USB Type-C interface
(2): CN5 STO terminal
(3): CN0 input output signal
(4): CN1 RJ45 port
(5): CN2-A encoder port
(6): CN2-B encoder port
(7): Power supply terminal
(8): Motor wiring terminal
(9): CN4 gantry synchronization terminal

3.1.2 Main circuit terminals

■ DL6-2003/2006(-GS)

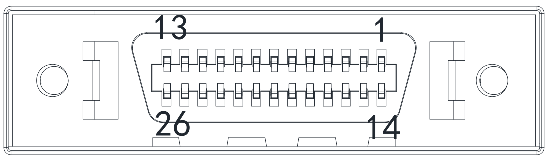
According to the order from top to bottom, the main circuit terminal functions are as follows:



Terminal	Function	Explanation
L1, L2, L3	Main circuit power input terminal	Single phase/three-phase AC 200-240V, 50/60Hz If single-phase power supply is used, please connect L1/L3, otherwise it will affect parameter memory when power is lost
P+, D, C	Use built-in braking resistor	Short circuit P+ and D terminals, disconnect P+ and C.
	Use external braking resistor	Connect the braking resistor to the P+ and C terminals; P0-25=power value, P0-26=resistance value
P+, P-	Bus terminal	Real time voltage of the busbar can be measured, please be aware of the danger
U, V, W, PE	Motor connection terminal	Connect to the motor
⏚	Grounding terminal	The ground wire is on the heat sink. Please confirm good grounding before powering on

3.1.3 CN0, CN1, CN2-A, CN2-B, CN3, CN4, CN5 terminals

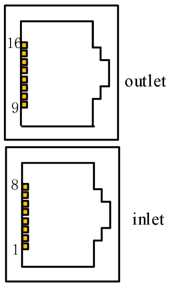
3.1.3.1 CN0 terminal explanation



No.	Name	Note	No.	Name	Note
1	+24V	+24V	14	SI3	Normal input terminal 3
2	SI4	Normal input terminal 4	15	SI5	Normal input terminal 5
3	SI6	Normal input terminal 6	16	SI7	Normal input terminal 7
4	COM	Output common terminal	17	SO3	Normal output terminal 3
5	SO4	Normal output terminal 4	18	SO1	High speed output terminal 1
6	SO2	High speed output terminal 2	19	DO_24V	+24V power supply for high speed output
7	OA+	Encoder frequency division output OA+	20	OA-	Encoder frequency division output OA-
8	OB+	Encoder frequency division output OB+	21	OB-	Encoder frequency division output OB-
9	OZ+	Encoder frequency division output OZ+	22	OZ-	Encoder frequency division output OZ-
10	P+5V	Pulse +5V	23	P-	Pulse -

No.	Name	Note	No.	Name	Note
11	D+5V	Direction +5V	24	D-	Direction -
12	SI1	High speed input terminal 1	25	SI2	High speed input terminal 2
13	P+24V/D+24V	Pulse/direction +24V	26	GND	Ground of frequency division output

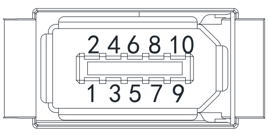
3.1.3.2 CN1 terminal explanation

Port	No.	Name	No.	Name
	1	TX A+	9	TX B+
	2	TX A-	10	TX B-
	3	RX A+	11	RX B+
	4	-	12	-
	5	-	13	-
	6	RX A-	14	RX B-
	7	-	15	-
	8	-	16	-

3.1.3.3 CN2 terminal explanation

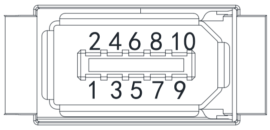
■ CN2-A terminal explanation

The arrangement of the CN2-A driver side - encoder socket terminals is as follows:

	No.	Definition	No.	Definition
	1	Power supply +5V	6	Incremental encoder B-
				Biss-C encoder DATA-
	2	GND	7	Incremental encoder Z+
	3	Incremental encoder A+	8	Incremental encoder Z-
		Biss-C encoder CLK+		
	4	Incremental encoder A-	9	Motor temperature +
		Biss-C encoder CLK-		
	5	Incremental encoder B+	10	Motor temperature -
		Biss-C encoder DATA+		

The driver only supports PT100 for detecting motor temperature and cannot detect the type of NTC/PTC thermistor embedded in the motor. Temperature detection can be blocked in the upper computer software.

■ CN2-B terminal explanation

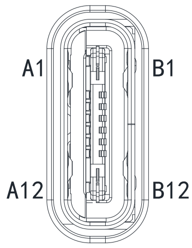


No.	Definition	No.	Definition
1	Power supply +5V	6	-
2	GND	7	Rotary encoder A
3	Hall U+	8	Rotary encoder B
4	Hall V+	9	-
5	Hall W+	10	-

■ CN2 terminal explanation

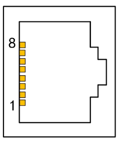
Terminal	Connector	Manufacturer PN
CN2	A plug used for plug-in terminal blocks	1394-10P REV 01

3.1.3.5 CN3 terminal explanation (RS232)



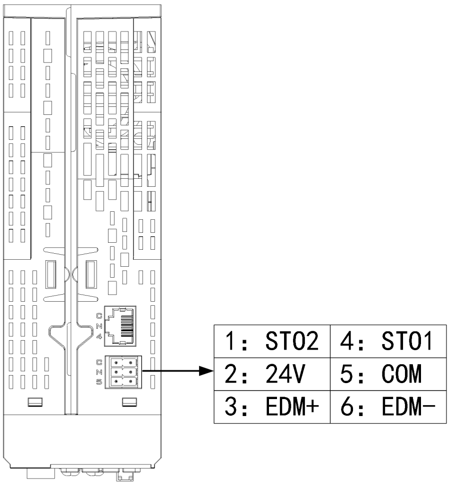
No.	Definition	No.	Definition
A1	GND	B1	GND
A4	USB-VBUS	B4	USB-VBUS
A6	USB-D+	B6	USB-D+
A7	USB-D-	B7	USB-D-
A9	USB-VBUS	B9	USB-VBUS
A12	GND	B12	GND

3.1.3.6 CN4 terminal explanation (gantry synchronization)

Gantry synchronization interface	No.	Name	No.	Name
	1	TX A+	5	-
	2	TX A-	6	RX A-
	3	RX A+	7	-
	4	-	8	-

3.1.3.7 CN5 terminal explanation (STO function)

The terminal arrangement of driver CN5 port is shown below (at the top of the driver), and the safety torque off (STO):



No.	Name	Explanation	No.	Name	Explanation
1	STO2	STO2 circuit input	4	STO1	STO1 circuit input
2	24V	24V output	5	COM	Common ground
3	EDM+	EDM output+	6	EDM-	EDM output-

In order to make the debugging process more user-friendly, a power supply voltage (2: 24V) pin has been added. If the STO function is not required, the STO1 and STO2 terminals need to be connected to the 24V terminal.

The maximum allowable cable length between the driver and the safety switch is 30m.

3.2 Classification and Function of Signal Terminals

3.2.1 SI input signal

Please use a relay or an open collector transistor circuit to connect. When using relay connection, please select the relay for small current. If the relay is not small current, it will cause bad contact.

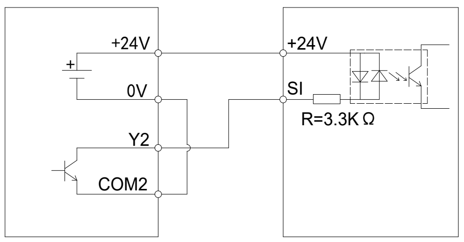
Type	Input terminal	Function
Digital input	SI1~SI7	Multifunctional input signal terminal

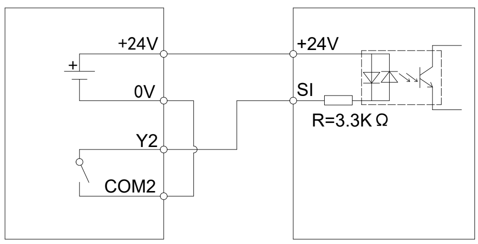
■ Defaulted assignment of input terminals

Terminal	SI1	SI2	SI3	SI4	SI5	SI6	SI7
Function	P-OT/forward run prohibition	N-OT/reverse run prohibition	Home signal	Not distributed	Not distributed	Not distributed	Not distributed

■ 0.4kW~1kW servo driver

Open collector type	Relay type
Upper device Servo drive	Upper device Servo drive





- The SI1 SI2 channels of the driver are high-speed SI inputs with a response speed of less than or equal to 2 μs, and only support NPN connections. The SI3 SI4 SI5 SI6 SI7 channels are low-speed SI inputs with a response time of less than or equal to 2ms, and support NPN and PNP connections (SI3~SI7 can only have NPN or PNP connections at the same time).
- The typical voltage is DC24V, with a minimum not lower than DC18V and a maximum allowable voltage not higher than DC28V.

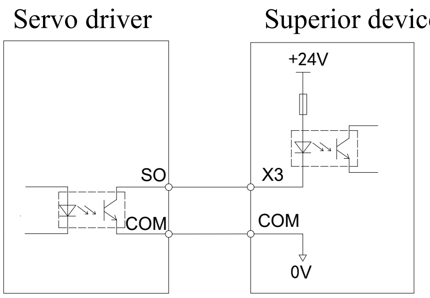
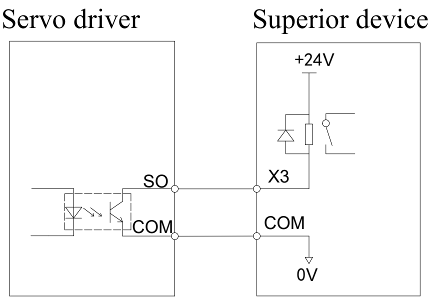
3.2.2 SO output terminals

Type	Output terminal	Function
Optocoupler output	SO1~SO4	Multifunctional output terminal

■ Defaulted assignment of output terminals

Terminal	SO1	SO2	SO3	SO4
Function	/OCMP1 fly capture	ALM/alarm	Not distribute	Not distribute

■ Driver SO output circuit

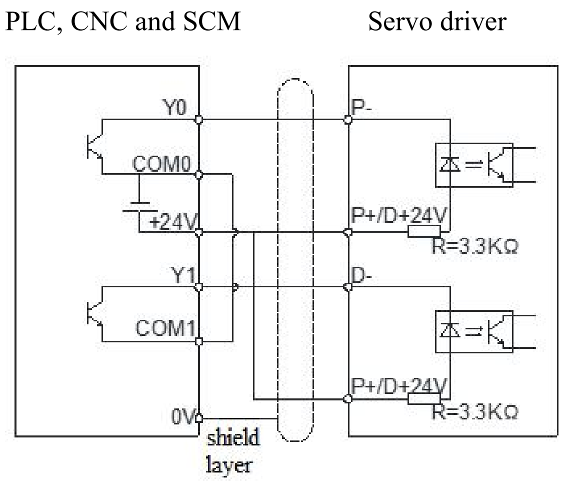
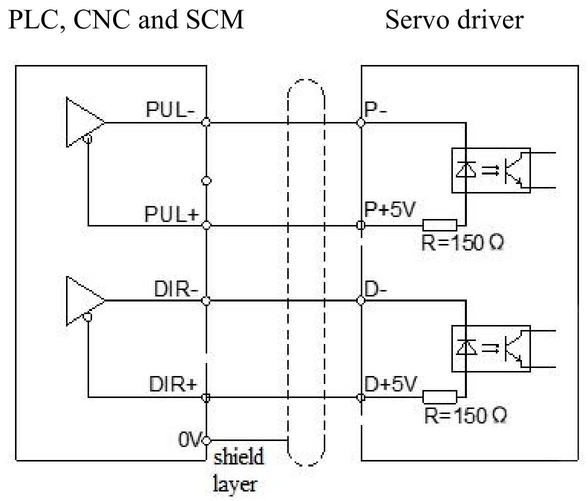
Optocoupler type superior device	Relay type superior device
	

- Driver SO1 and SO2 are high-speed SO outputs, SO3 and SO4 are low-speed SO outputs, and all SO terminals only support NPN connection.
- Maximum load current: SO DC 50mA (maximum).

3.2.3 Pulse signal

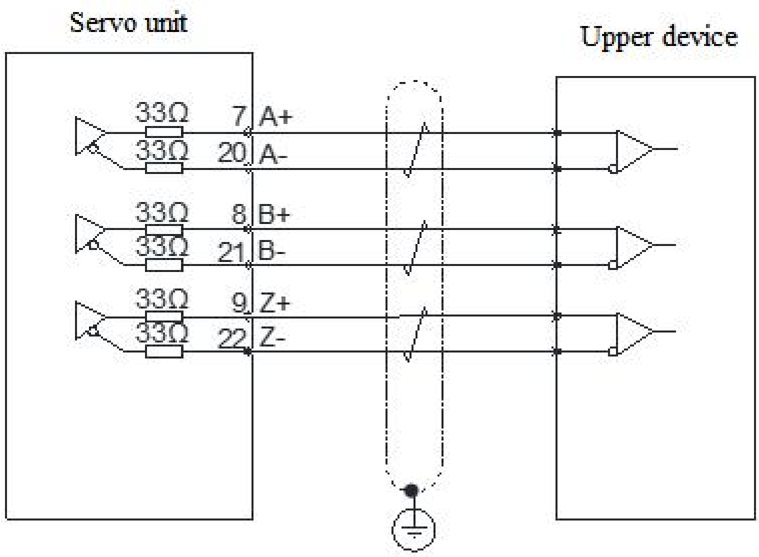
Instruction form	Option	Meaning	P-input signal	D-input signal	Chapter
P0-10 xxx□	0	CW/CCW dual-pulse mode	CW	CCW	5.4.2.3
	1	AB phase mode	A phase	B phase	
	2	Pulse+direction mode	pulse	Direction	
Collector open circuit type (24V voltage) input signal is P+ 24V/D+ 24V Differential mode (5V voltage) input signal is P+5V/D+5V					

The wiring diagram of P+ D, CW, CCW and AB phase interface circuit is as follows:

<table>
<tr><th>Open collector (24V voltage)</th><th>Differential mode (5V voltage)</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

3.2.4 Encoder feedback output signal

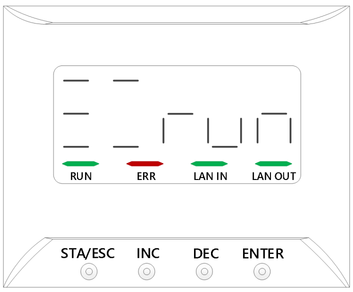
The encoder frequency division output circuit outputs differential signals through differential drivers, providing closed-loop feedback signals for the position control system of the upper device. On the upper device side, please use a differential or optocoupler receiving circuit to receive, with a maximum output current of 20mA.



4 Panel operation

4.1 Basic operation

4.1.1 Operating panel description

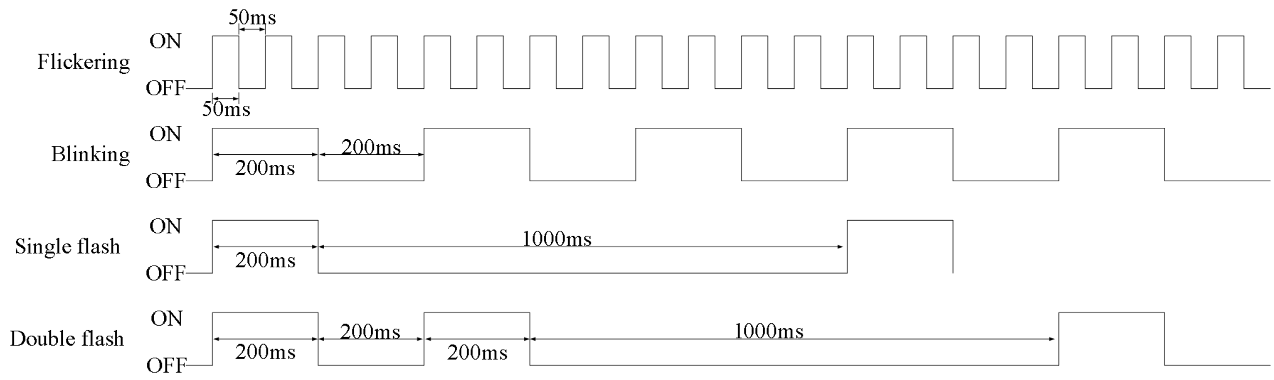


Button	Operation
STA/ESC	Short press: state switch, state return
INC	Short Press: The display data increases Long press: The display data increases continuously
DEC	Short Press: The display data decreases Long press: The display data decreases continuously
ENTER	Short press: shift. Long press: Set and view parameters.

After power on, the panel will perform a self check operation, and all display digital tubes and five decimal points will light up for 1 second at the same time.

Four new status lights have been added, displaying the current activation status, error status, physical connection status, etc. The status description and flashing timing of the indicator lights are shown in the table below (with indicator lights in bus mode and no indicator lights in normal mode):

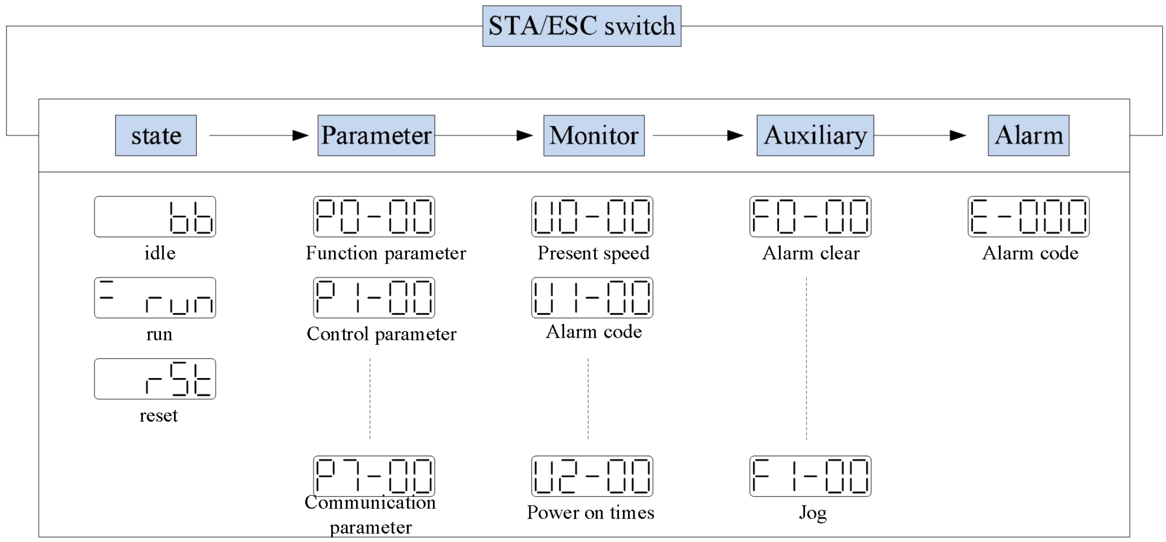
Indicator light	Status	Status
RUN	OFF	INIT status
	Blinking(ON 200ms/OFF 200ms)	Pre-Operational status
	Single flash(ON 200ms/OFF 1000ms)	Safe-Operational status
	ON	Operational status
ERR	OFF	No network malfunction
	Blinking(ON 200ms/OFF 200ms)	Abnormal communication settings
	Single flash(ON 200ms/OFF 1000ms)	Synchronization event exception
	Double flash (ON 200ms, OFF 200ms, ON 200ms, OFF 1000ms)	Application watchdog timeout
L/A IN LA OUT	OFF	Link not established
	Flickering(ON 50ms/OFF 50ms)	Link established, with data transmission and reception signals
	ON	Link established, no data transmission and reception signals



4.1.2 Button operation

By switching the basic state of the panel operator, it can display the running state, set parameters, run auxiliary functions and alarm state. After pressing the STA/ESC key, the states are switched in the order shown in the following figure.

State: BB indicates that the servo system is idle; run indicates that the servo system is running; RST indicates that the servo system needs to be re-energized.



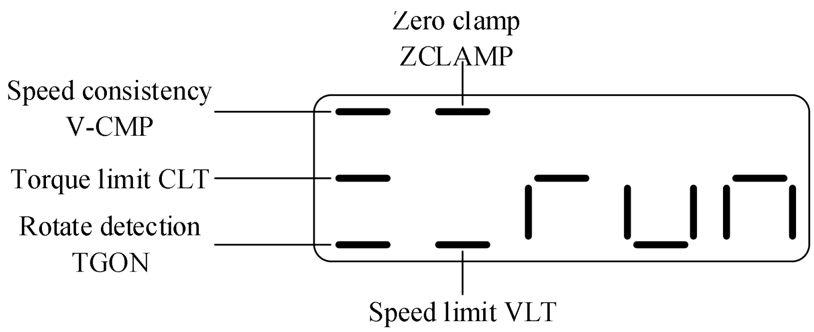
- Parametric setting PX-XX: The first X represents the group number, and the last two X represents the parameter serial number under the group.
- Monitor status UX-XX: The first X represents the group number, and the last two X represents the parameter number under the group.
- Auxiliary function FX-XX: The first X represents the group number, and the last two X represents the parameter number under the group.
- Alarm state E-XXX: The first two X represents the alarm category, and the last □ represents the small category under the category.

4.2 Operation state display

When powered on, the panel displays, which is set according to P8-25 parameters.

Parameter	Name	Default setting	Suitable mode	Meaning	Modify	Effective
P8-25	Panel display settings	0	All	0: normal display, power on display "bb" or "run" 1: display the value of U-00 when powering on,speed feedback,unit:rpm 2: display the value of U0-07 when powering on, torque feedback, unit:%	At once	Repower on

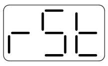
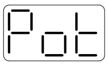
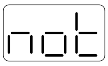
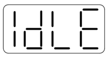
■ Speed, torque control mode



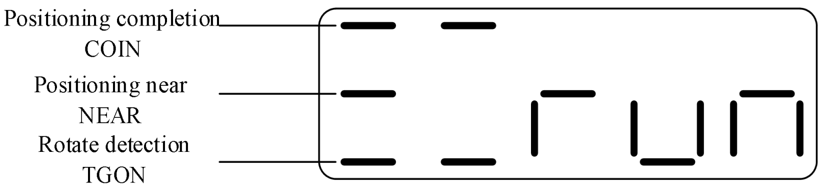
Digit display contents

Digit data	Display contents
P5-39 Same speed detection(/V-CMP)	When the actual speed of the motor is the same as the command speed, turn on the light. Detection Width of Same Speed Signal: P5-04 (Unit: rpm)
P5-42 Torque limit(/CLT)	Speed control mode,when the torque exceeds the set value, turn on the light. Internal Forward Torque Limitation: P3-28 Internal Reverse Torque Limitation of: P3-29
P5-40 Rotate detection(/TGON)	When the motor speed is higher than the rotating speed, turn on the lamp. Rotation detection speed: P5-03 (unit: rpm)
P5-31 Zero clamp(/ZCLAMP)	When the zero clamp signal starts to operate, turn on the light.
P5-43 Speed limit(/VLT)	Torque control mode When the speed exceeds the set value, turn on the light Forward speed limit in torque control: P3-16; Reverse speed limit: P3-17.

Simplified code display content

Simplified code	Display content
	In standby mode Servo OFF status. (The motor is in a non energized state)
	Running Servo enable status. (Motor in energized state)
	Need to reset status The servo needs to be re-powered on
	Prohibit forward drive state P-OT ON status.
	Prohibit reverse drive state N-OT ON status.
	Control mode 2 is empty

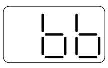
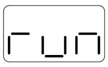
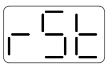
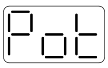
■ Position control mode



Digit display contents

Digit data	Display contents
P5-38 Positioning completion(/COIN)	In position control, when the given position is the same as the actual position, turn on the light. Location Completion Width: P5-00 (Unit: Instruction Pulse)
P5-46 Near (/NEAR)	In position control, when the given position is the same as the actual position, turn on the light. Near signal width: P5-06
P5-40 Rotate detection(/TGON)	When the motor speed is higher than the rotating speed, turn on the lamp. Rotation detection speed: P5-03 (unit: rpm)

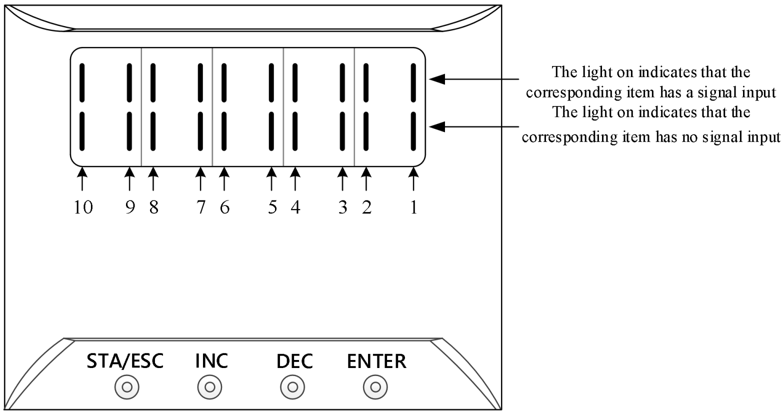
Simplified code display content

Simplified code	Display content
	In standby mode Servo OFF status. (The motor is in a non energized state)
	Running Servo enable status. (Motor in energized state)
	Need to reset status The servo needs to be re-powered on
	Prohibit forward drive state P-OT ON status.

Simplified code	Display content
not	Prohibit reverse drive state N-OT ON status.
idLE	Control mode 2 is empty

4.3 Group U monitor parameter

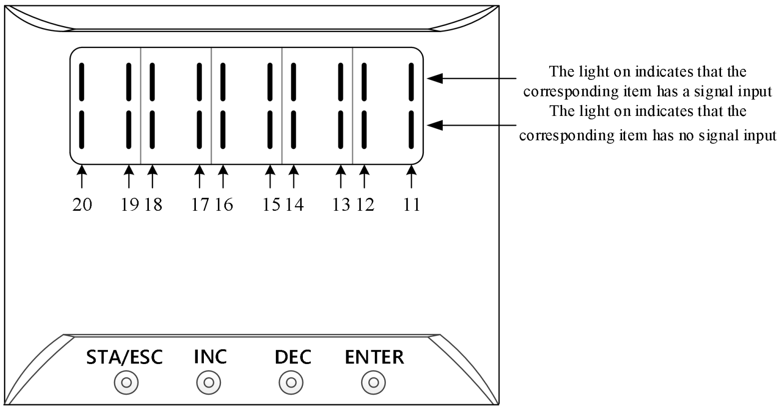
■ U0-21 input signal status



■ U0-21 input signal 1 distribution

Segment code	Description	Segment code	Description
1	/S-ON servo enable	2	/P-CON proportion action instruction
3	/P-OT prohibition of forward drive	4	/N-OT prohibition of reverse drive
5	/ALM-RST alarm reset	6	/P-CL forward side external torque limit
7	/N-CL reverse side external torque limit	8	/SPD-D internal speed direction selection
9	/SPD-A internal speed selection	10	/SPD-B internal speed selection
Note: When reading through communication, the binary numbers read from right to left correspond to the position of /S-ON, /P-CON, 0 means that the position signal is not input, 1 means that the position signal has input. Example: 0x0001 means /S-ON has input, 0x0201 means /S-ON and /SPD-B has input.			

■ U0-22 input signal status

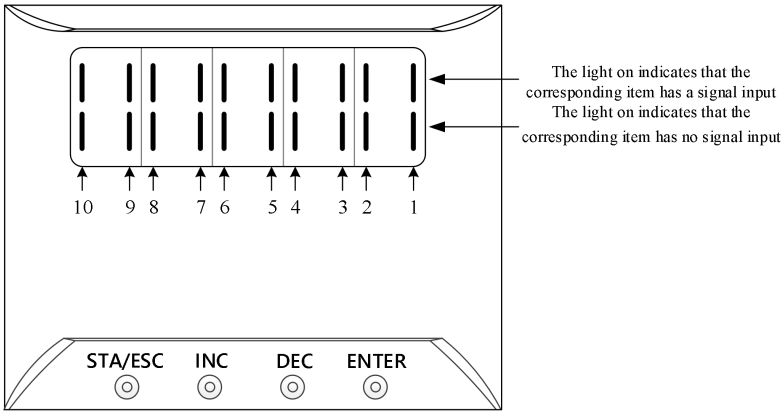


■ U0-22 input signal 2 distribution

Segment code	Description	Segment code	Description
11	/C-SEL control mode selection	12	/ZCLAMP zero clamp
13	/INHIBIT instruction pulse prohibition	14	/G-SEL gain switch
15	/CLR pulse clear	16	/CHGSTPchange step
17	—	18	—
19	—	20	—
Note: When reading through communication, the binary numbers read from right to left correspond to the position of /C-SEL, /ZCLAMP, 0 means that the position signal is not input, 1 means that the position signal has input. Example: 0x0001 means /C-SEL has input, 0x0009 means /C-SEL and / G-SEL have input.			

Note:“-” is for reserved display and does not represent any signal.The status bit is always 0.

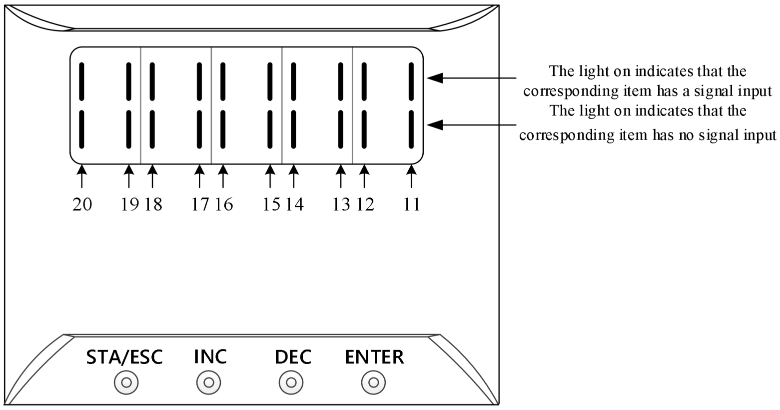
■ U0-23 output signal status



■ U0-23 output signal 1 distribution

Segment code	Description	Segment code	Description
1	Positioning completion hold(/COIN_HD)	2	Position completion(/COIN)
3	Same speed detection(/V-CMP)	4	Rotate detection(/TGON)
5	Ready (/S-RDY)	6	Torque limit(/CLT)
7	Speed limit detection(/VLT)	8	Break lock(/BK)
9	Warn (/WARN)	10	Output near(/NEAR)
Note: when reading status through communication,the binary from right to left correspond to the position of /COIN_HD, /COIN. 0 means that the position signal is not output, 1 means that the position signal has output. Example: 0x0001 means / COIN_HD has output, 0x0201 means /COIN_HD and / NEAR has output.			

■ U0-24 output signal status



■ U0-24 output signal 2 distribution

Segment code	Description	Segment code	Description
11	Alarm (/ALM)	12	Speed arrived (/V-RDY)
13	Customized output 1	14	Customized output 2
15	/Z phase	16	/MRUN
17	—	18	—
19	—	20	—
Note: When reading the status through communication, the binary numbers read correspond to the /ALM and /V-RDY positions from right to left. 0 represents that the position signal has no input, and 1 represents that the position signal has input. Example: 0x0001 indicates that/ALM has an output, and 0x0011 indicates that/ALM and /Z have an output.			

4.4 Group F auxiliary parameters

4.4.1 Group F0 operation

Function code	Explanation	Function code	Explanation
F0-00	Clear the alarm	F0-08	Panel external command auto tuning
F0-01	Restore parameters to factory settings	F0-09	Panel internal command auto tuning
F0-02	Clear position deviation	F0-10	Panel vibration suppression 1
F0-04	Clear historical alarm records	F0-11	Panel vibration suppression 2
F0-07	Panel inertia identification	F0-12	Panel vibration suppression (fast FFT)

4.4.2 Group F1 operation

Function code	Explanation	Function code	Explanation
F1-00	Jog run	F1-05	Software enable
F1-01	Test run	-	-
F1-02	Current sampling zero-correction	-	-

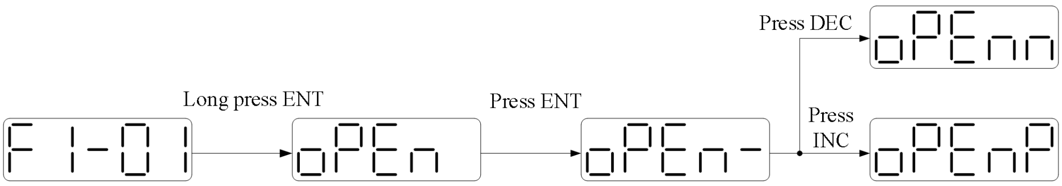
The following text introduces jogging, and the test run can only be carried out after motor identification. Please refer to section 5.1 for motor function settings.

(1) Test run (F1-01)

Before entering the test run mode, please confirm that the motor identification has been completed and the driver needs to be in the BB idle state!

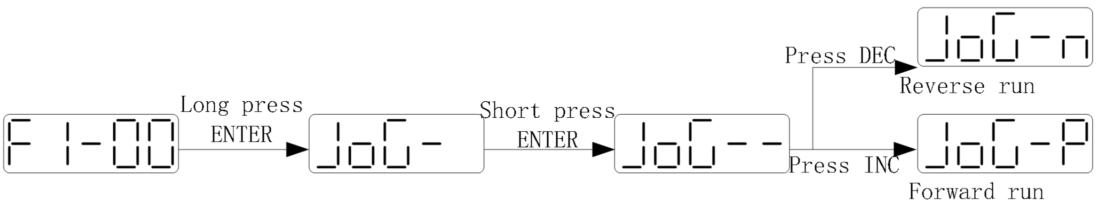
When the servo drive is connected to a non original encoder or power cable, it should first enter the test run mode to verify that the encoder terminal or power terminal is connected correctly.

The test run mainly checks the power cable and encoder feedback cable to determine if the connection is normal. The motor can achieve normal forward and reverse rotation as the following steps. If the motor shaft shakes or prompts an alarm, immediately disconnect the power and recheck the wiring.



(2) Jog run (F1-00)

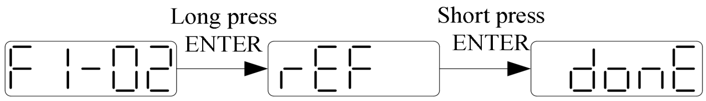
Before entering jog mode, please confirm that the motor shaft is not connected to the machine and the driver is in bb idle status! The jog function is in speed mode, and P3-09 and P3-10 control the acceleration and deceleration time!



Parameter	Meaning	Default value	Unit	Setting range	Modify	Effective
P3-18	JOG speed	100	1mm/s	0～1000	Servo OFF	At once

(3) Current sampling zero calibration (F1-02)

When the servo driver is updated or the motor runs unsteadily after a long time, it is recommended that the user automatically adjust the current detection offset, and carry out the following operations when the driver is bb idle.



Press STATUS/ESC to exit.It needs to repower on the driver.

(4) Forced enable (F1-05)

Parameter	Signal name	Setting	Meaning	Modify	Effective
P0-03	Enable mode	0	disable	Servo OFF	At once
		1	I/O enable/S-ON		
		2	Software enable(F1-05 or communication)		
		3(default)	Bus enable(Models supporting bus)		
Set P0-03=2 F1-05 = 0: cancel enable, enter bb status. F1-05 = 1: forced enable, servo is in RUN status.					

After power on again, the forced enable set by F1-05 will fail.

4.5 Fault alarm operation

When a fault occurs, the alarm status will automatically pop up, displaying the alarm number. If there is no fault, the alarm status will not be visible. In the alarm state, writing 1 to F0-00 through panel operation can reset the fault.
If the servo alarm is casued by power supply turning off, there is no need to clear the alarm.

When an alarm occurs, the cause of the alarm should be eliminated first, and then the alarm should be released.

4.6 Parameter setting example

Provide an example of the operation steps for changing the content of parameter P3-09 from 2000 to 3000.

Step	Panel display	Buttons	Operation
1	bb	STA/ESC INC DEC ENTER	No need any operations
2	P0-00	STA/ESC INC DEC ENTER	Press STA/ESC to enter parameter setting
3	P3-00	STA/ESC INC DEC ENTER	Press INC, press once to add 1, increase the parameter to 3, and display P3-00
4	P3-00	STA/ESC INC DEC **ENTER**	Short press the ENT key, and the last 0 on the panel will flash
5	P3-09	STA/ESC INC DEC ENTER	Press the INC key to add up to 9
6	P3-09	STA/ESC INC DEC **ENTER**	Long press the ENT key to enter P3-09 for numerical changes.
7	3000	STA/ESC INC DEC **ENTER**	Press the INC, DEC, and ENT keys to add, subtract, and shift. After making the changes, press and hold the ENT key to confirm
8	END		

When the set parameters exceed the range that can be set, the driver will not accept the set value and will report E-021 (parameter setting exceeded). Parameter setting exceeding the limit usually occurs when the upper computer writes parameters to the driver through communication.

5 Basic functions

5.1 Motor function setting

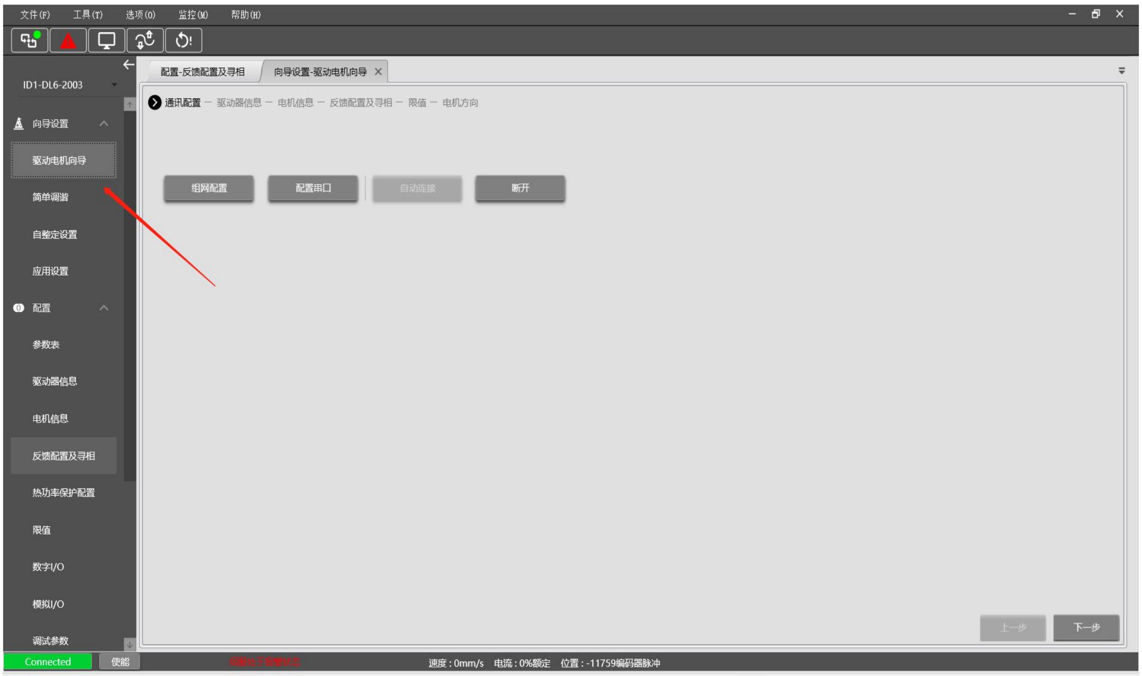
When connecting the driver to the linear motor, it is necessary to set the relevant motor parameters, identify the motor, and perform other operations before the motor can be controlled to operate normally. This section introduces how to use the upper computer software to configure and identify the phase sequence of the drive motor to help control the motor to operate normally.

5.1.1 Connection between upper computer and driver

The communication method between the upper computer software and the servo drive is wired communication, with one end of the Type-C cable connected to the computer and the other end connected to the servo drive.

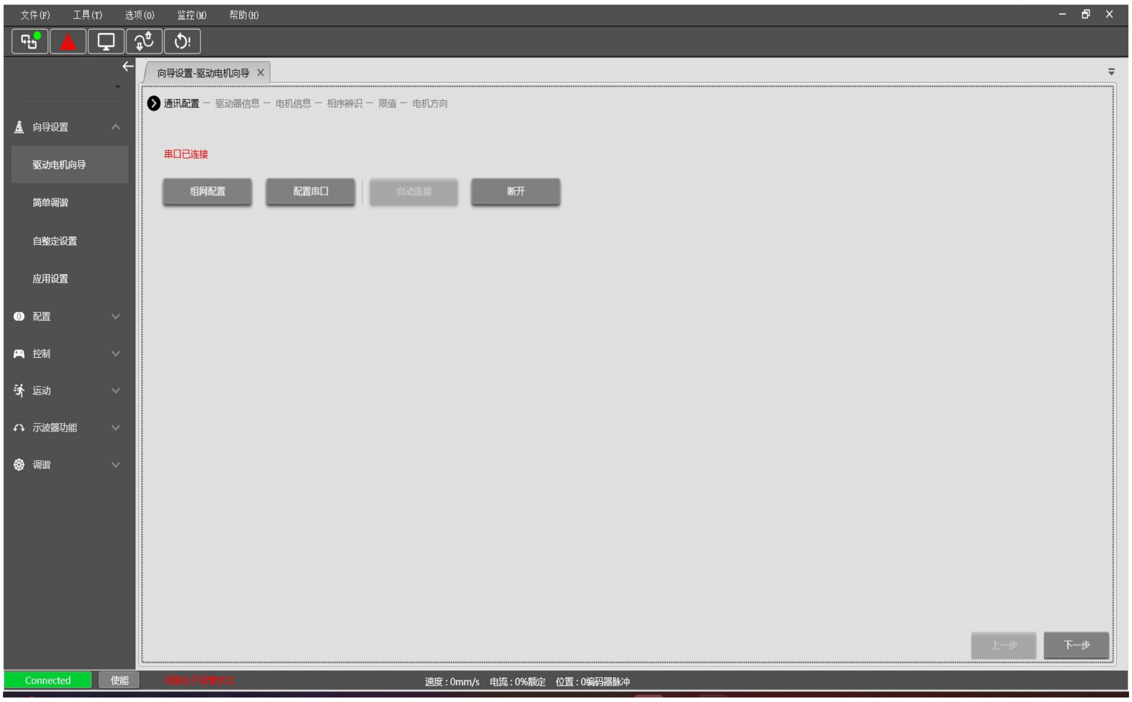
5.1.2 Communication configuration

1. Click on the [Drive Motor Wizard] on the left side of the main interface, and you can see the first step of the Wizard Settings - Drive Motor Wizard - Communication Configuration. After entering the Drive Motor Wizard configuration, the interface will display operation methods such as [Network Configuration], [Configure Serial Port], [Automatic Connection], and [Disconnect].



2. After clicking on [Configure Serial Port], the [Connect Servo] window will pop up. On this interface, you can manually set the serial port number, baud rate, data bits, and other data related to the serial port. After the configuration is complete, click 'Confirm'.

3. After the serial port data configuration is correct, you can click on automatic connection to connect the servo drive. If the drive information and motor information are displayed correctly, click [OK] to exit [Connection] and start reading data. During the data reading process, a progress bar (data reading progress) is displayed in the lower right corner of the interface. After successful connection, Connected will be displayed in the lower left corner.

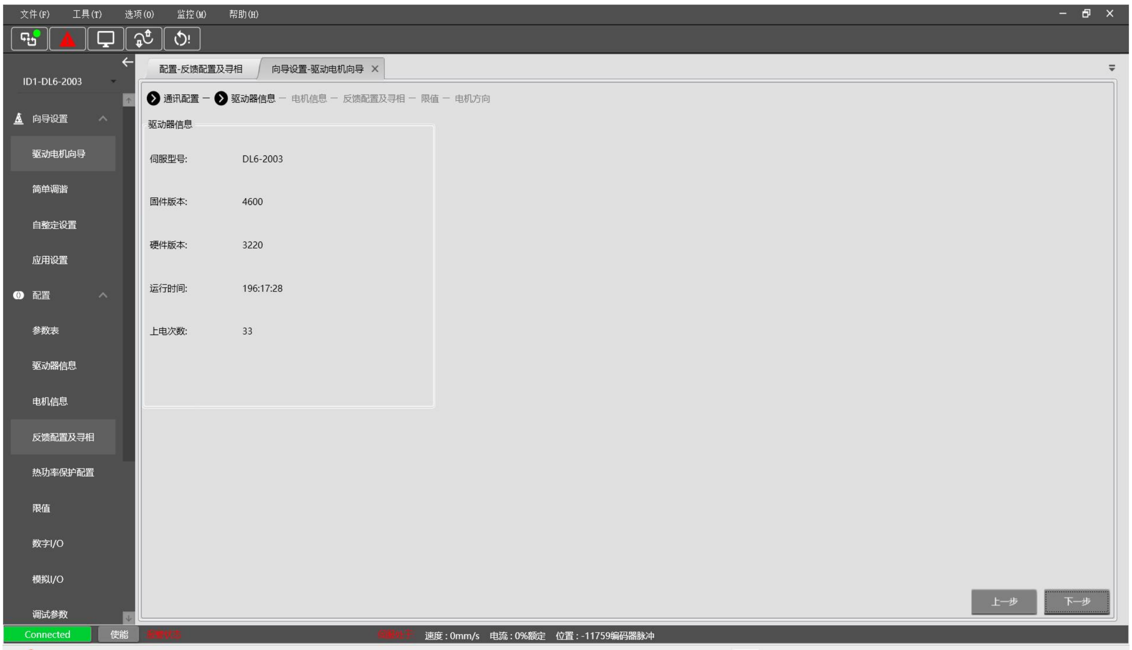


Automatic connection is only valid for station number 1. Automatic connection can automatically search for serial ports that can communicate with the servo, and read information about the driver and motor.

Click [Disconnect] to disconnect the software from the servo.

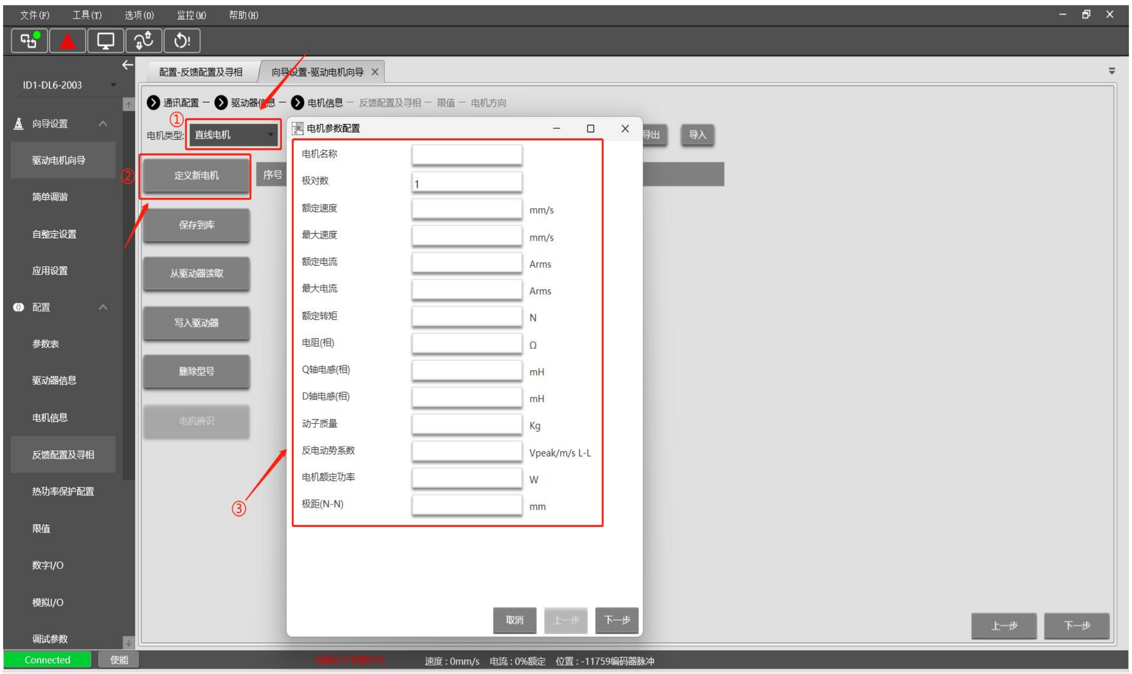
5.1.3 Driver information

After establishing the connection correctly, you can click Next to enter the drive information interface, where you can see the relevant information of the connected drive, as shown in the following figure:



5.1.4 Motor configuration

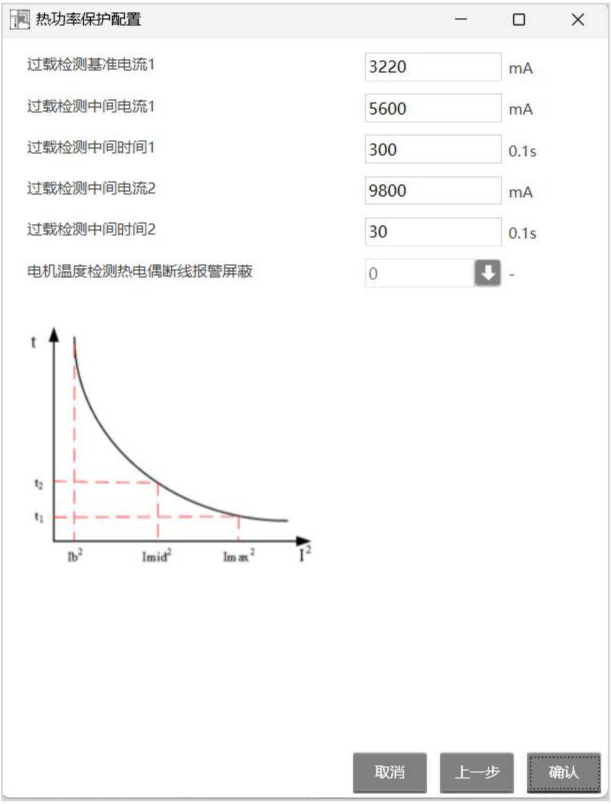
1. After correctly connecting and determining the driver information, a new motor needs to be defined for the first connection. Select [Linear Motor] – [Define New Motor] – [Motor Parameter Configuration] in the following interface, and compare it with the motor parameters provided by the motor manufacturer to complete all the parameters in the configuration table.



2. After filling in the parameters completely, click Next to enter the encoder configuration. On this interface, you can select the corresponding encoder type.

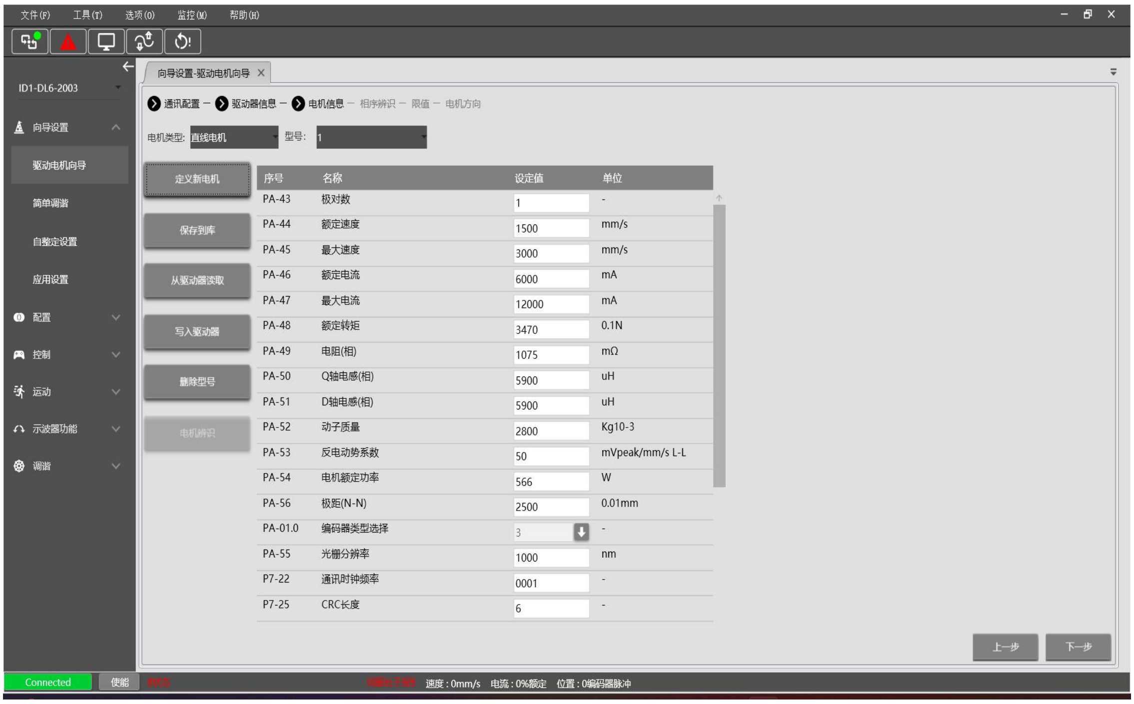
3. Corresponding to different types of encoders, the provided modifiable parameters generally only modify the magnetic grating/grating resolution.

4. After confirming the selected encoder type and magnetic/grating resolution, click Next to enter the thermal power protection interface. Set the [Overload Detection Reference Current 1] to 1.15 times of the rated current, set the [Overload Detection Intermediate Current 1] to 2 times of the rated current, and set the [Overload Detection Intermediate Current 2] to 3 times of the rated current (if the settings are incorrect, a window will pop up saying "Parameter settings are unreasonable, please re-enter").

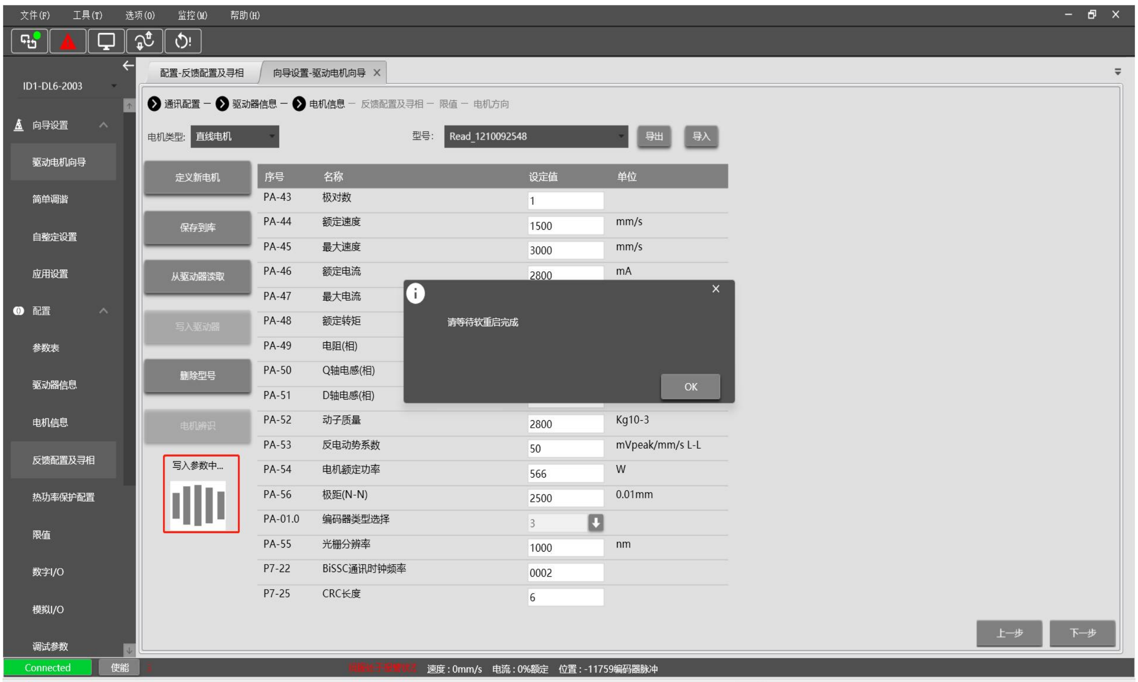


In addition, the motor temperature detection thermocouple disconnection alarm shielding can be set on this interface. Currently, only PT100 thermal resistance temperature detection is supported, and other thermal resistances need to shield this alarm.

5. After completing the thermal power protection configuration, click ok, and the interface parameters will be refreshed to the filled content. After configuring the relevant information, the parameters need to be saved to the library for easy use during each subsequent connection or to write values to other drives.



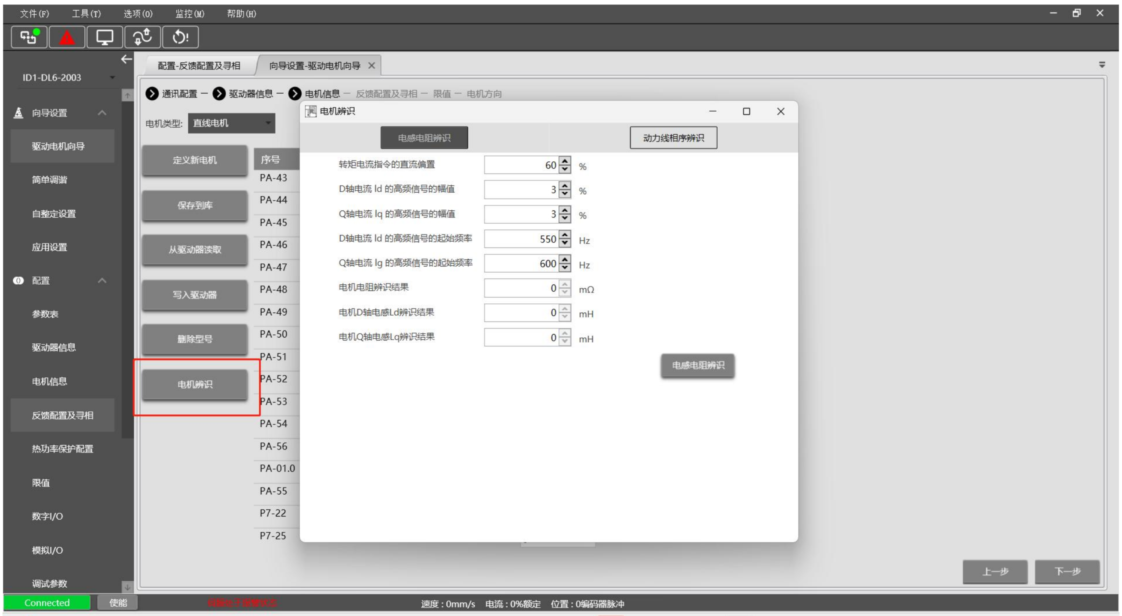
6. After completing the previous operation, write the parameters of the library into the drive, and the interface will display [Please wait for soft reset to complete]. After clicking OK, the drive will automatically perform parameter writing and reset, and the drive panel will display single (-) → E → 1 → (----) → 88888 → bb in sequence. The servo does not need to be repowered on again.



5.1.5 Motor and phase sequence identification

Due to the fact that linear motors and linear drivers are not provided by the same manufacturer. Therefore, the relevant information of linear motors cannot be obtained. Therefore, an automatic motor verification function was developed. The linear motor with ABZ, ABZ+HALL, BISS-C encoder interface can operate normally after completing the motor verification function and phase finding.
The content of verification includes encoder polarity, BISS-C absolute value encoder zero position, HALL polarity and HALL initial position, motor phase sequence identification. Any new motor brought for the first time requires the use of motor verification function. At present, motor verification can only be performed using an upper computer.

- Inductance and Resistance Identification: Find the identification results of motor resistance, motor D-axis inductance Ld, and motor Q-axis inductance Lq. After clicking on motor identification, a motor identification configuration box will pop up. Simply click on inductance and resistance identification to automatically perform inductance and resistance identification.



The identification of inductance and resistance requires correct connection to the motor before operation. After the identification is completed, the identification result will be displayed and filled in the identification result field in the figure.

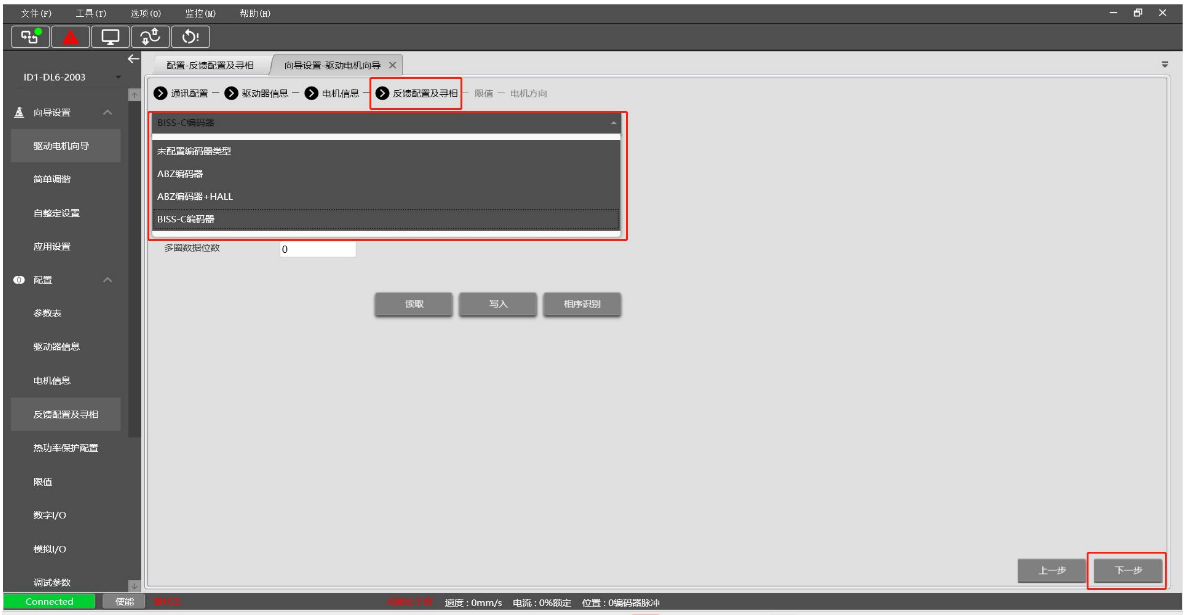
- Power cable phase sequence identification: finding the zero position.

- If it is an ABZ encoder, it needs to undergo phase sequence identification before it can be used normally. Select the phase sequence identification in motor identification, choose the encoder type and configure the magnetic grating/grating resolution, and then write it to the driver. Click on phase sequence identification to complete the operation.


电机辨识
电感电阻辨识
UVW相序辨识
相序辨识
ABZ编码器
光栅分辨率
1000
nm
第一次上电相位寻找开关
1
-
寻相模式
1
-
寻相最大电流
100
%
读取
写入
相序识别

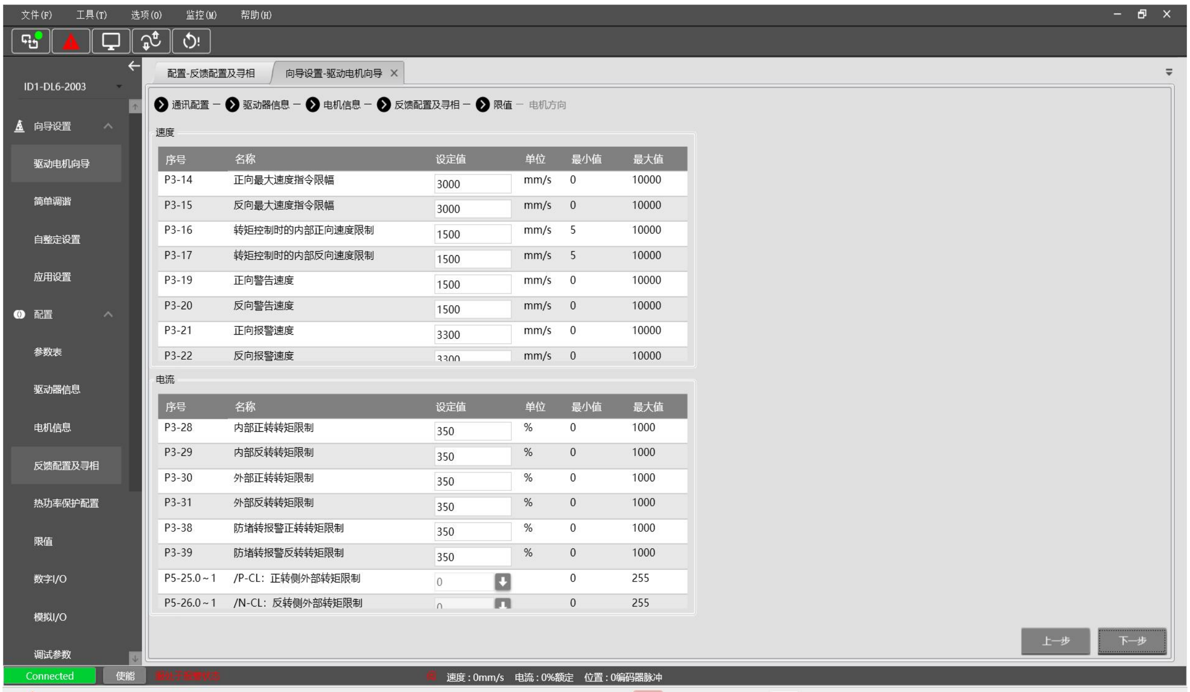
5.1.6 Feedback configuration and phase finding

This interface allows for reconfirmation of the encoder type and resolution configured in the motor information.



5.1.7 Limit parameter setting

This interface will display all speed limit and torque limit parameters. If necessary, they can be set according to specific requirements. If there is no need to set the parameters in this interface, you can directly click next.



5.1.8 Motor direction selection

After entering the direction of the motor, the starting running direction of the motor can be configured and selected according to the specific working conditions. At this point, the drive motor guide ends, and clicking ok will enter the simple tuning interface.

5.2 Error correction function

5.2.1 Error correction function overview

In precision electromechanical applications (such as silicon crystal/semiconductor/TP industries), there are usually high absolute accuracy control requirements.

However, due to the inherent errors of linear driving motors (such as motor installation parallelism/flatness/concentricity, material thermal deformation, design tolerances, etc.), encoder errors (such as grating design tolerances, uneven grating line processes, grating thermal deformation, insufficient parallelism/concentricity of the grating and read head assembly, etc.), and motor wear errors caused by long-term operation, the actual motor position information may significantly differ from the position information fed back by the encoder. In practice, servo drives can only use the position information fed back by encoders as a reference for motor position control. As a result, the inaccuracy of encoder feedback ultimately leads to inaccurate absolute precision control of direct-drive motors, making it difficult to meet the high absolute precision requirements of precision electromechanical applications.

To address this, external measurement devices (such as laser interferometers) can be used to generate an error mapping table. The error mapping is stored in the drive's non-volatile memory. The drive retrieves correction values in real-time based on the actual position and performs error correction. After implementing these corrections, the absolute positioning accuracy of linear motors is improved.

5.2.2 Parameter settings related to error correction

Parameter	Name	Setting range	Meaning	Setting time	Effective time	Default value
PA-70	Error correction switch	0-1	0: OFF 1: ON	Servo OFF	At once	0
PA-71	Error correction starting position low bit	0-65535	Error correction starting position = high bit*10000 + low bit	Servo OFF and the error correction function is turned off	Servo ON	0
PA-72	Error correction starting position high bit	0-65535	Error correction starting position = high bit*10000 + low bit	Servo OFF and the error correction function is turned off	Servo ON	0
PA-73	Error correction interval low bit	0-65535	Error correction interval= high bit*10000 + low bit	Servo OFF and the error correction function is turned off	Servo ON	0

Parameter	Name	Setting range	Meaning	Setting time	Effective time	Default value
PA-74	Error correction interval high bit	0-65535	Error correction interval= high bit*10000 + low bit	Servo OFF and the error correction function is turned off	Servo ON	1
PA-75	Error correction length	0-65535	Can be set to be less than the length of the error correction table	Servo OFF and the error correction function is turned off	Servo ON	10
PA-76	Error correction unit	0-65535	0: um 1: mm	Servo OFF and the error correction function is turned off	Servo ON	0
PA-77	Error correction instruction direction	0-65535	0: Forward, the direction of movement when generating the error correction table is consistent with the encoder's incremental direction. 1: Reverse, the direction of movement when generating the error correction table is not consistent with the encoder's incremental direction.	Servo OFF and the error correction function is turned off	Servo ON	0
PA-78-PA-177	Error correction array [100]	-32768-32767	Error correction data, maximum 1mm	Servo OFF and the error correction function is turned off	Servo ON	0

5.2.3 Parameter monitor

Parameter	Name	Meaning
U4-29	Error correction index value	After the error correction function is activated, the correction index position where the current position of the linear motor is located is also used for the correction position cursor in the upper computer.

Parameter	Name	Meaning
U4-30	High 8 bits: 1: Error correction takes effect 0: Error correction not effective Low 8 bits: 0: Homing unfinished 1: Homing completed	Used for obtaining error correction and homing state on the upper computer.
U0-94~U0-97	Encoder feedback incremental value, clear this position after homing completed	This position is displayed at the bottom of the error correction upper computer interface

5.2.4 Function introduction

- When using the error correction feature for precision compensation, a laser interferometer must be used. The Xinje linear drive upper computer supports directly loading the .rtl error correction table automatically generated by the laser interferometer. If other measuring devices are used, error correction values must be calculated manually and configured in the upper computer.
- After loading the error correction table file (.rtl), you need to configure the starting position, error correction table interval, index length requiring error correction, and the direction configuration of the error correction table according to the correction units.
- Once the above configurations are completed, write the .rtl error correction parameters into the linear servo drive. Before using it, it is necessary to perform a homing operation. After homing, enable the error correction switch and activate the drive for normal operation. At this point, error correction will automatically occur during operation to ensure high-precision functioning.

5.2.5 Error correction interface introduction

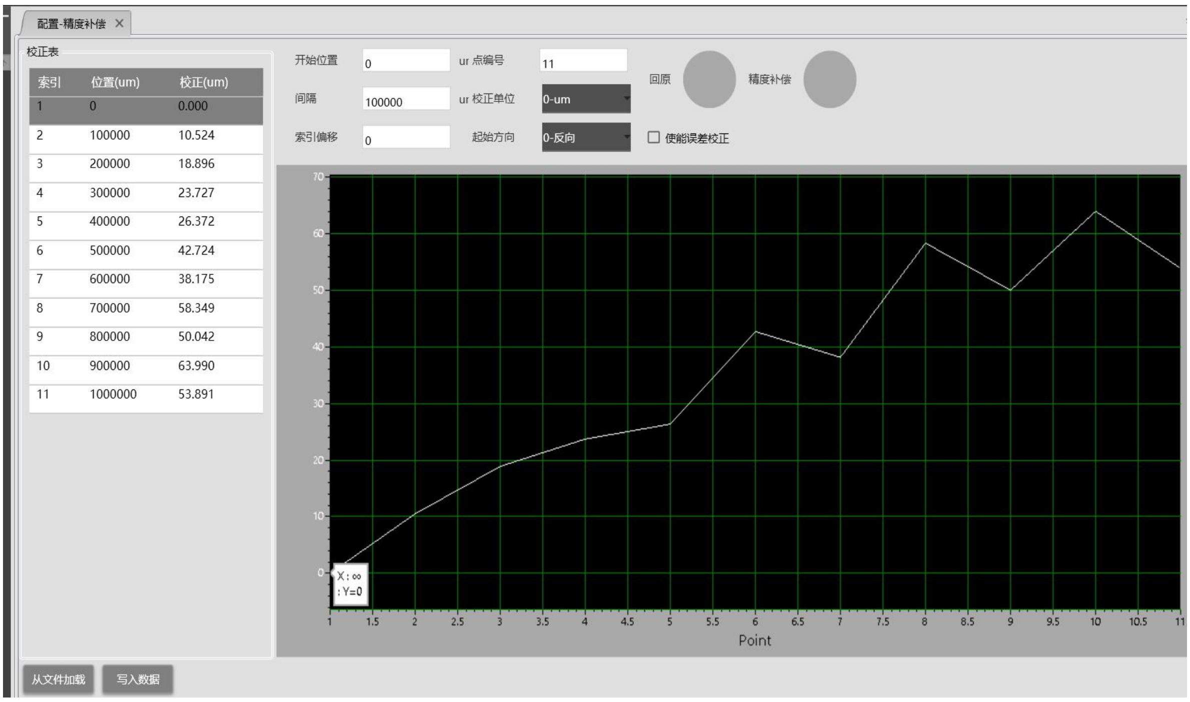
After the laser interferometer completes the measurement, a set of error data is automatically generated, which includes: interval, number of target runs, and error data. Once the upper computer loads the .rtl data generated by the laser interferometer, it will automatically display on the error correction interface. The parameters in the interface are explained as follows:

Parameter name	Explanation
Start position	The starting position for error correction is set to 0 by default.
Point number	The total length of the error correction index is automatically loaded from. rtl and can be manually configured, but must be less than or equal to the length of the correction table.
Interval	The interval distance of the error correction table is automatically loaded from. rtl, and the unit needs to be manually configured.
Correction unit	The unit of error correction table data.
Start	Based on the actual configuration during the measurement phase.

Parameter name	Explanation
direction	Forward Direction: During the error correction measurement phase, the motor movement direction results in increasing encoder counts. Reverse Direction: During the error correction measurement phase, the motor movement direction results in decreasing encoder counts.

Using specification:

- The maximum supported compensation points are 100.
- The error correction function for ABZ encoder takes effect after homing. The BISS-C encoder type can choose not homing.
- After homing, there will be a prompt on the corresponding indicator light, as well as a prompt after the error correction takes effect.
- After the error correction takes effect, when the motor moves to the corresponding error compensation index value, there will be a cursor prompt.
- After the error correction function is enabled, it is not allowed to modify the parameters related to error correction.
- The maximum error data in error correction is 1mm.
- The interval setting must be a positive number and negative intervals should not be used.
- The error correction function is only effective in position mode.



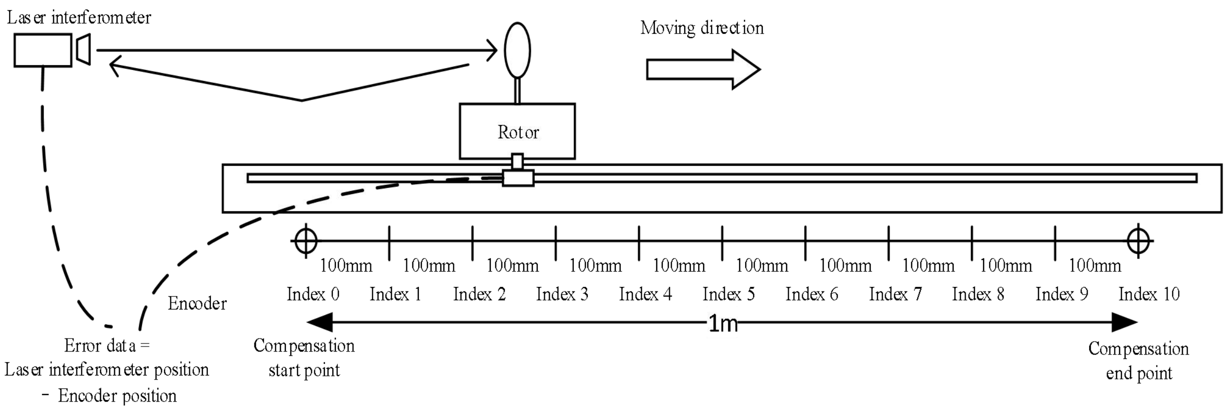
5.2.6 Error correction application

(1) Configuration of laser interferometer

In this example, a laser interferometer is used to generate error correction data. The total stroke of error correction compensation is 1m. The driver moves at equal intervals of 100mm for a total of 11 times. After each 100mm run, it stops for 6 seconds. The longer this time, the more accurate the data obtained by the laser interferometer. After the operation, the laser interferometer generated a total of 11 error data points.

Before collecting data with a laser interferometer, please do homing operation for the motor.

(2) Schematic diagram of using laser interferometer

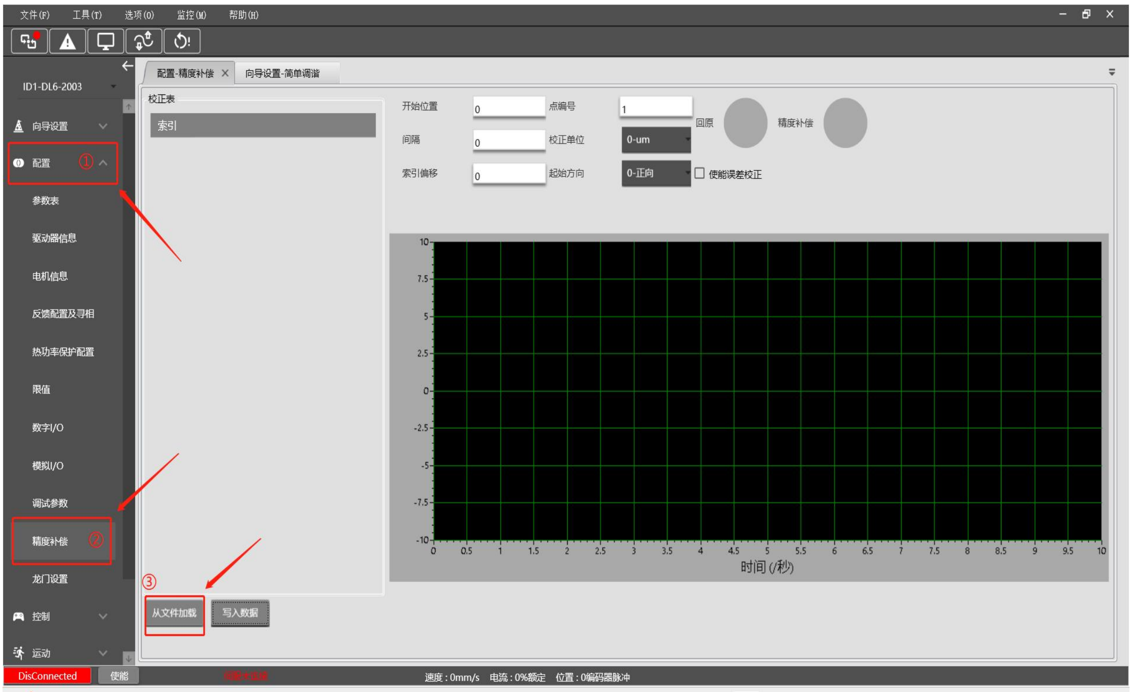


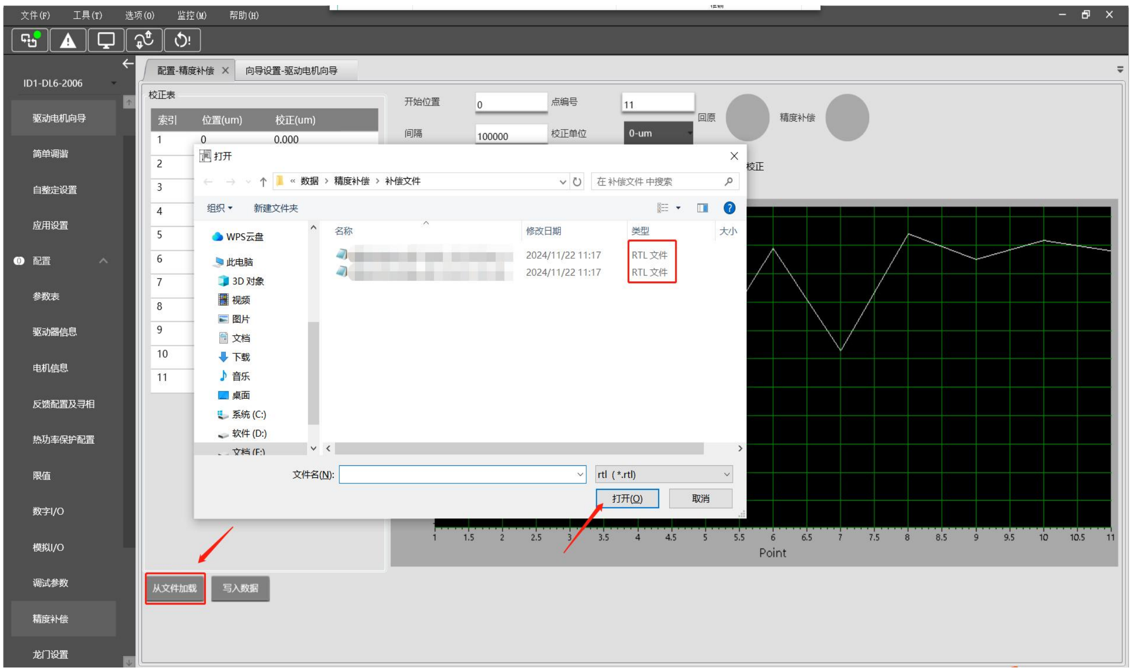
(3) Precision compensation (error correction) data table generated by laser interferometer

Index	Encoder position (um) Y1	Laser interferometer external detection location (um) Y2	Correction value(um) Y3 = Y2-Y1
Index 0	0	0	0
Index 1	100000	100010.524	10.524
Index 2	200000	200018.896	18.896
Index 3	300000	300023.727	23.727
Index 4	400000	400026.372	26.372
Index 5	500000	500042.724	42.724
Index 6	600000	600038.175	38.175
Index 7	700000	700058.349	58.349
Index 8	800000	800050.042	50.042
Index 9	900000	900063.90	63.90
Index 10	1000000	1000053.891	53.891

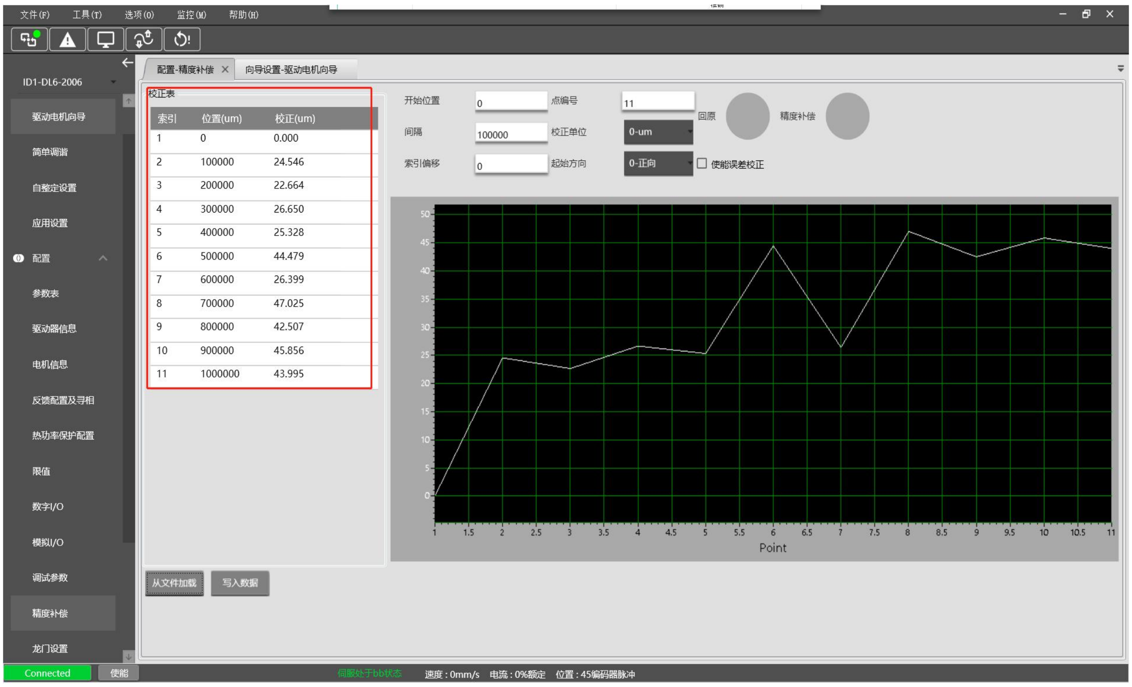
(4) Upper computer software processing

After generating the precision compensation (error correction) data table (. rtl) for the laser interferometer, click on the upper computer software precision compensation interface, click on load from file, and select the data table saved from the laser interferometer:

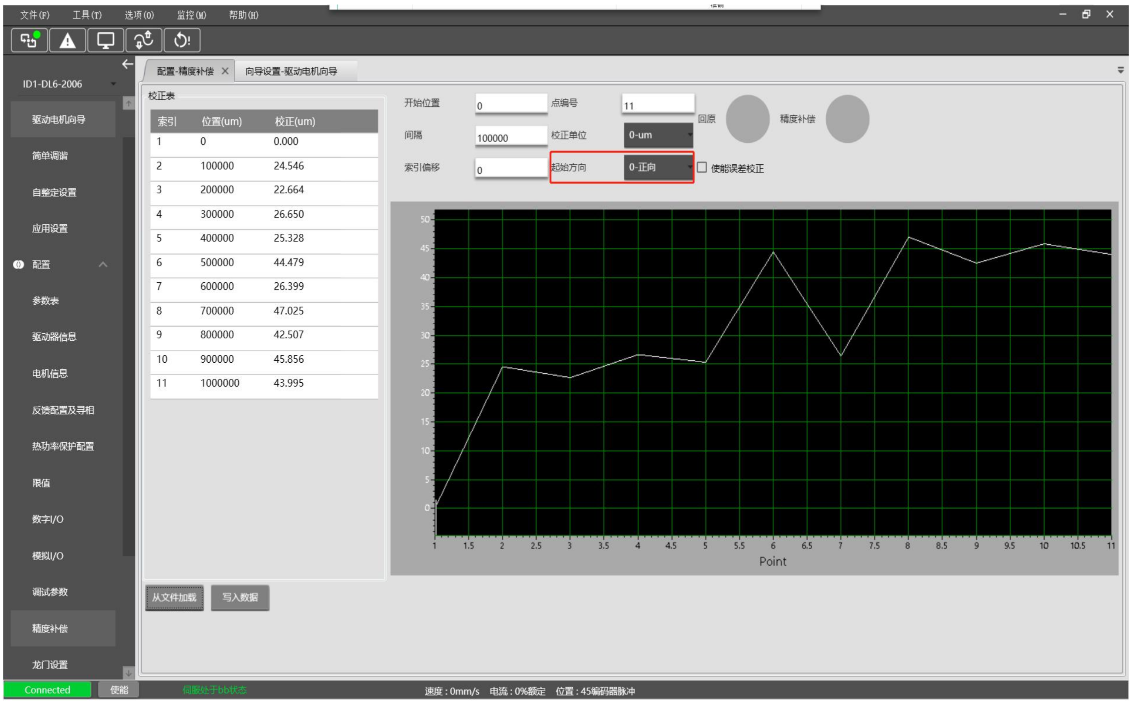




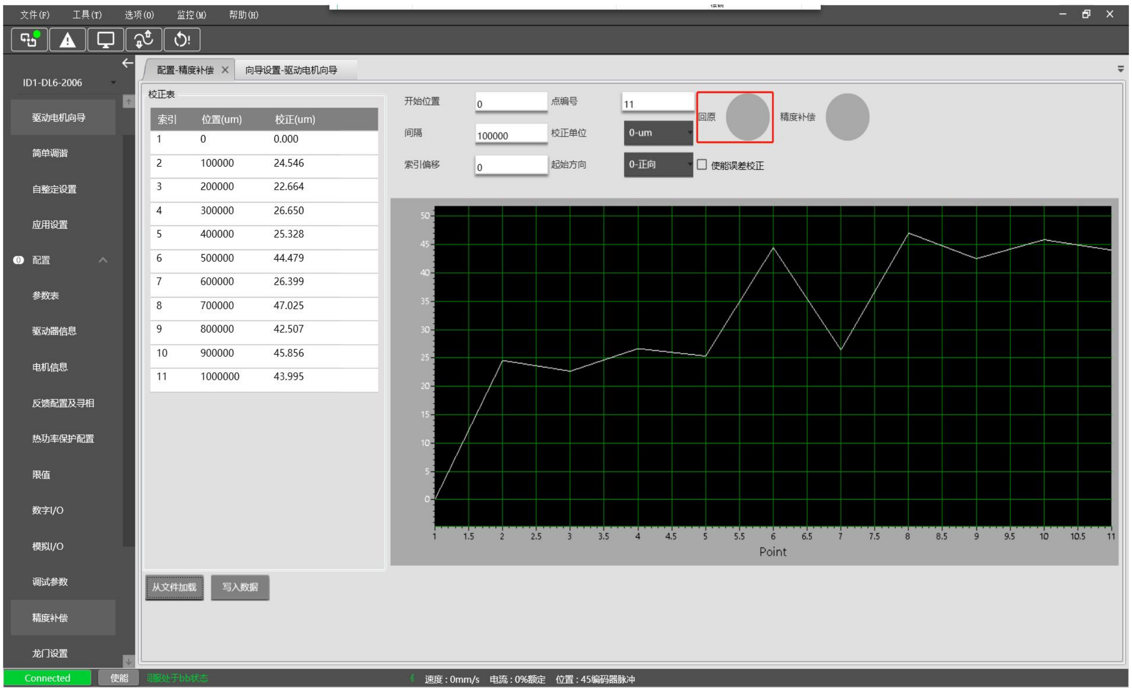
After the file is loaded, the current interface will display the parameter file data and corresponding curve:



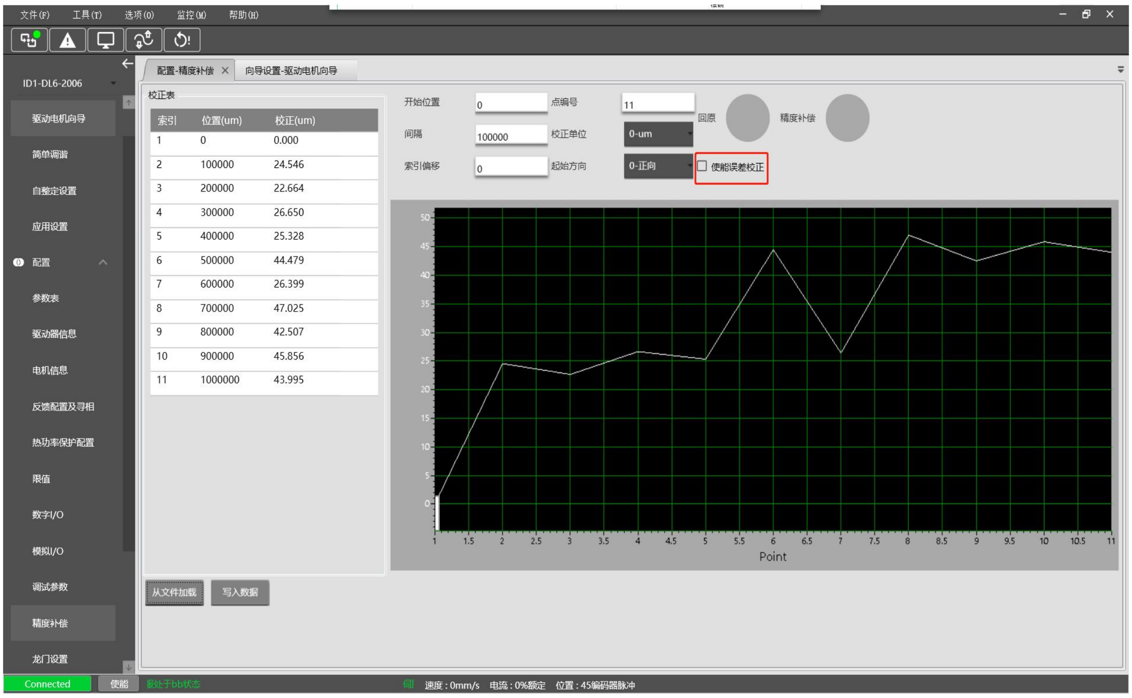
After confirming that the imported data is correct, simply modify the starting direction;



Before turning on the error correction switch, the motor needs to perform a homing operation (after homing completed, the homing light in the red box will light up), and accuracy compensation can only be turned on after the operation is completed.

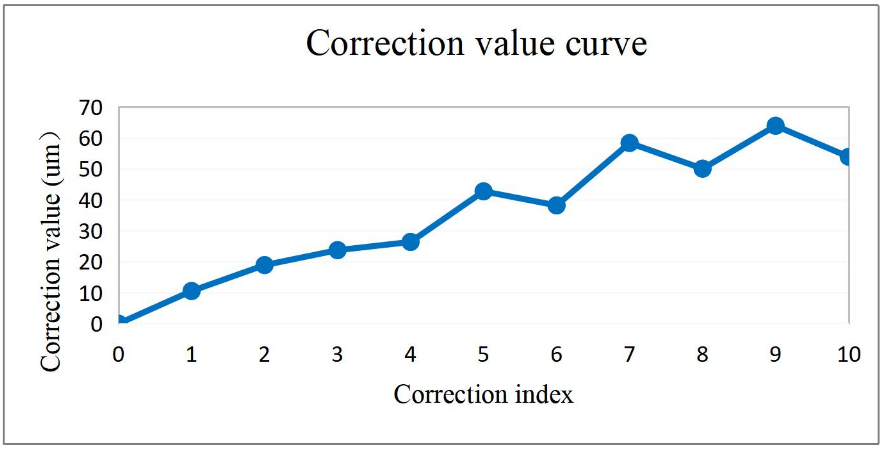


After completion, click on enable error correction (turn on the precision compensation switch), enable normal operation, and complete the precision compensation configuration.

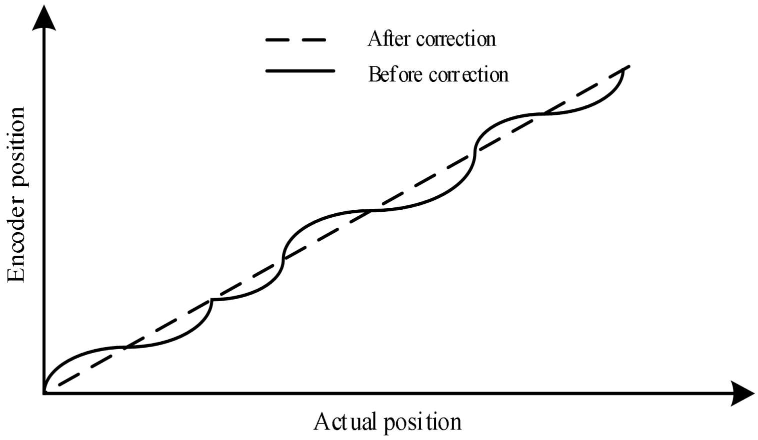


- There is no unit data in the. rtl file. Please ensure that the correction unit configuration is correct before use.
- The default starting position parameter is 0. For error correction using BISS-C encoder, if it does not homing, the starting position can be configured as the encoder feedback count value (encoder unit) at the starting position when generating the error correction table.
- The interval needs to be configured as a positive number. If the movement direction of the error correction table is generated and the encoder feedback is increasing (speed is positive), the starting direction is set to 0 (positive direction). If the movement direction of the error correction table is generated and the encoder feedback decreases (with a negative speed), the starting direction is set to 1 (reverse).

Correction value curve:



The schematic diagram of the position curve after error correction is as follows:



5.3 Stop mode

Servo shutdown can be divided into free shutdown, deceleration shutdown, and dynamic braking (DB) shutdown according to the shutdown methods. The following is an explanation of the servo shutdown methods.

Stop mode	Free shutdown	Decelerating shutdown	DB shutdown
Shutdown principle	The servo drive is not enabled, the servo motor is not powered on, and it can freely decelerate to 0. The deceleration time is affected by mechanical inertia, equipment friction, and other factors.	The servo driver outputs reverse braking torque, and the motor quickly decelerates to 0.	The servo motor operates in a short-circuit braking state.
Shutdown characteristics	Advantages: Smooth deceleration, low mechanical impact, but slow deceleration process, smooth deceleration, low mechanical impact Disadvantage: Slow deceleration process	Advantages: Short deceleration time Disadvantage: There is mechanical impact	Advantages: Short deceleration time Disadvantage: There is mechanical impact

According to the different scenarios of servo shutdown, it can be divided into servo OFF shutdown, alarm shutdown, and overtravel shutdown.

All power segments of the DL6 series come standard with Dynamic Braking (DB) function.

5.3.1 Servo OFF and alarm shutdown

■ Related parameters

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P0-30	Stop timeout time	20000	1ms	0~65535	Servo bb	At once
P0-27	Servo turn off enable shutdown mode	0	-	0~5	Servo bb	At once
P0-29	Alarm shutdown mode	2	-	0~5	Servo bb	At once

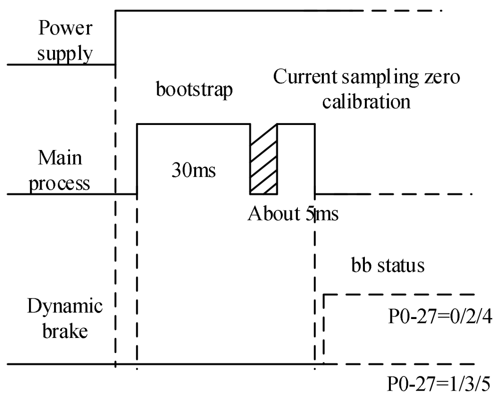
Parameter	Value	Meaning
P0-27	0	Free running stops and remains in a free running state after stopping.
	1	Free running stops and maintains DB status after stopping.
	2	Deceleration braking stops, and after stopping, it remains in a free running state.
	3	Deceleration braking stops and maintains DB status after stopping.
	4	DB stops and remains in a free running state after stopping.
	5	DB stops and remains in DB state after stopping.
P0-29	Turn off enable property alarm	
	0	Free running stops and remains in a free running state after stopping.
	1	Free running stops and maintains DB status after stopping.

	2	DB stops and remains in a free running state after stopping.
	3	DB stops and remains in DB state after stopping.
	4	DB stops and remains in a free running state after stopping.
	5	DB stops and remains in DB state after stopping.
	Not turn off enable property alarm	
	0	Free running stops and remains in a free running state after stopping.
	1	Free running stops and maintains DB status after stopping.
	2	Deceleration braking stops, and after stopping, it remains in a free running state.
	3	Deceleration braking stops and maintains DB status after stopping.
	4	DB stops and remains in a free running state after stopping.
	5	DB stops and remains in DB state after stopping.

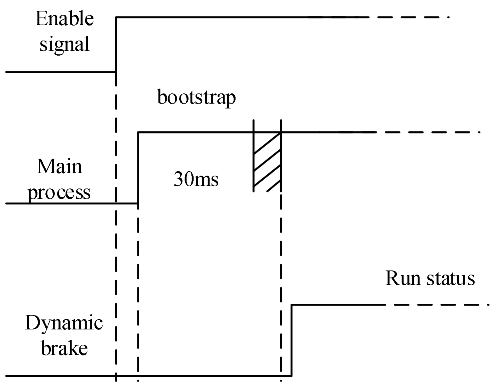
Note:
1. servo turn off enable shutdown mode (P0-27)
① When P0-27=0, if the servo OFF occurs, the motor starts to rely on free stop without any alarm.
② When P0-27=1, if the servo OFF occurs, the motor starts to rely on free stop and maintains the DB state after stopping.
③ When P0-27=2, if the servo OFF occurs, the motor starts to rely on deceleration to stop, until the speed is less than 50rpm before turning to free stop. At the same time, the servo will time the deceleration stop stage. If the timing time has exceeded P0-30 and the motor speed has not dropped below 50rpm during the deceleration process, an alarm E-262 will show.
④ When P0-27=3, if the servo OFF occurs, the motor starts to rely on deceleration to stop, until the speed is less than 50rpm before turning to free stop. At the same time, the servo will time the deceleration stop stage. If the timing time has exceeded P0-30 and the motor speed has not dropped below 50rpm during the deceleration process, an alarm E-262 will show. Maintain DB status after stopping.
⑤ When P0-27=4, if the servo OFF occurs, the motor DB stops and remains in a free running state after stopping.
⑥ When P0-27=5, if servo OFF occurs, the motor DB stops and maintains the DB state after stopping.
2. Servo alarm shutdown mode (P0-29)
(1) Turn off enable property alarm
When P0-29=0, if a servo alarm occurs, the motor starts to rely on free stop.
When P0-29=1, if a servo alarm occurs, the motor starts to rely on free stop and remains in DB state after stopping.
When P0-29=2, if a servo alarm occurs, the motor DB stops and remains in a free running state after stopping.
When P0-29=3, if a servo alarm occurs, the motor DB stops and maintains the DB state after stopping.
When P0-29=4, the motor DB stops and remains in a free running state after stopping.
When P0-29=5, if a servo alarm occurs, the motor DB stops and maintains the DB state after stopping.
(2) Not turn off enable property alarm
When P0-29=0, if a servo alarm occurs, the motor starts to stop freely.
When P0-29=1, if a servo alarm occurs, the motor starts to stop freely and remains in DB state after stopping.
When P0-29=2, if a servo alarm occurs, the motor starts to rely on deceleration to stop, until the speed is less than 50mm/s before turning to a free stop. At the same time, the servo will time the deceleration stop stage. If the timing time exceeds P0-30 during the deceleration process, the servo will directly stop freely. At this time, due to the servo being in an alarm state, regardless of the value of P0-29, there will be no alarm E-262. Maintain free running status after stopping.
When P0-29=3, if a servo alarm occurs, the motor starts to rely on deceleration to stop, until the speed is less than 50mm/s before turning to a free stop. At the same time, the servo will time the deceleration stop stage. If the

timing time exceeds P0-30 during the deceleration process, the servo will directly stop freely. At this time, due to the servo being in an alarm state, regardless of the value of P0-29, there will be no alarm E-262. Maintain DB status after stopping.
When P0-29=4, if a servo alarm occurs, the motor DB stops and remains in a free running state after stopping.
When P0-29=5, if a servo alarm occurs, the motor DB stops and maintains the DB state after stopping.

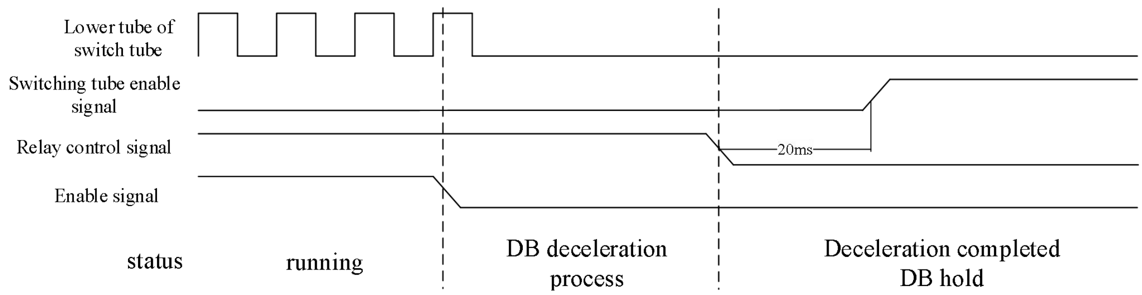
Dynamic Braking (DB) Timing Diagram (Dynamic Braking Low Level indicates effectiveness):



Power on



Enable



DB stop

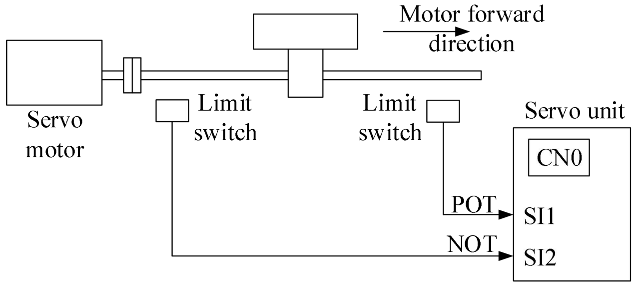
5.3.2 Stop mode when overtravel in normal mode

The overtravel prevention function of the linear servo unit refers to the safety function of forcibly stopping the linear servo motor by inputting a limit switch signal when the movable part of the machine exceeds the designed safe movement range.

■ Related parameter

parameter	Meaning	Default setting	Unit	Setting range	Modify	Effective
P0-28	Servo override stop mode	2	-	0~3	Servo bb	At once
P0-30	Stop timeout	20000	1ms	0~65535	Servo bb	At once
P5-22	Forward run prohibition /P-OT	n.0001	-	0~ff	Anytime	At once
P5-23	Reverse run prohibition /N-OT	n.0002	-	0~ff	Anytime	At once

Be sure to connect the limit switch as shown in the figure below.



Rotary applications such as round tables and conveyors do not need the function of overrun prevention. At this time, there is no need to connect the overrun prevention with input signals.

Parameter setting	Signal /POT, terminal input status	Overtravel signal (/POT, /NOT) terminal logic
P5-22/P5-23=n.0000	No need to connect external input	invalid
P5-22/P5-23=n.000□	SI□ terminal has no signal input	
P5-22/P5-23=n.001□	SI□ terminal has signal input	
P5-22/P5-23=n.0010	No need to connect external input	valid
P5-22/P5-23=n.000□	SI□ terminal has signal input	
P5-22/P5-23=n.001□	SI□ terminal has no signal input	

Parameter settings in forward limit signal /POT and reverse limit signal /NOT can not be set to the same terminal input at the same time.

Direction	Meet the limit	Operation status
Forward run	positive limit is valid	POT, set the servo overrun stop mode as P0-28
	negative limit is valid	Alarm E-261
Reverse run	positive limit is valid	Alarm E-261
	negative limit is valid	NOT, set the servo overrun stop mode as P0-28

Parameter	Value	Meaning
P0-28	0	The deceleration stops 1, the overrun direction moment is 0 after stopping, and receiving instructions.
	1	Inertia stops, after stopping, overrun direction moment is 0, receiving instructions.
	2	The deceleration stops 2, after stopping, the overrun direction does not receive instructions.
	3	Alarm (E-260)

- When P0-28 = 0/2, the motor starts to decelerate and stop after receiving the overtravel stop signal, and the stop timeout also plays a role in the overtravel process.
- During position control, when the motor is stopped by over travel signal, there may be position deviation pulse. To clear the position deviation pulse, the clear signal /CLR must be input. If the servo unit still receives pulses, they will accumulate until the servo unit gives an alarm.

5.3.3 Stop mode when overtravel in bus mode

In the bus control modes PP, CSP, PV, CSV, TQ, and CST, according to the P0-28 setting value, when encountering POT and NOT signals, the servo has different processing methods.

Parameter	Meaning	Default setting	Unit	Setting range	Modify	Effective
P0-28.0	0: Direct alarm, using servo deceleration shutdown method 1: Alarm triggered after deceleration and shutdown in 605Ah mode 2: Not using overtravel, controlled by the master station	2	-	0~3	○	1|3|4|8|9|10

■ The motor is in a prohibited state

Scenario 1: When the servo is in an enabled or disabled state and touches the reverse limit switch, the panel will display NOT, cancel the reverse limit signal, and the panel will return to its previous state.

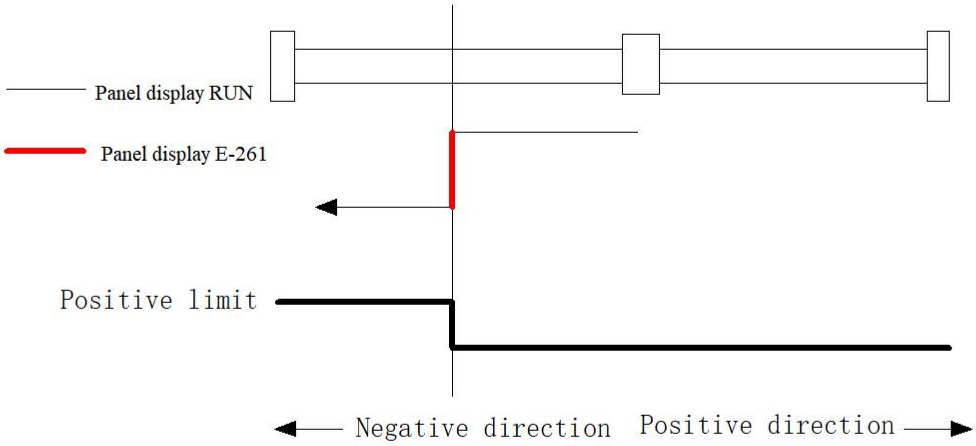
Scenario 2: When the servo is in an enabled or disabled state and touches the forward limit switch, the panel will display POT, cancel the forward limit signal, and the panel will return to its previous state.

Scenario 3: When the servo is in an enabled or disabled state and simultaneously touches the forward and reverse limit switches, the servo will report E-261. If two limit signals are cancelled, the panel will return to its previous state; If any limit signal is cancelled, the panel will display another limit signal, which needs to be cancelled before the panel can return to its previous state.

■ The motor is in motion state

1. Mistakenly touching the reverse limit

Taking the initial movement direction of the motor as the left as an example, when accidentally touching the forward limit switch, the servo will report E-261. If the forward limit switch is cancelled first, and then the alarm is cleared, the shaft will return to a non enabled state, and both the forward and reverse directions of the shaft can move; If the alarm is cleared first and the axis returns to the disabled state, but the panel still displays POT, the axis is still in the forward limit restricted state. The forward limit signal needs to be cancelled in order to release the forward overtravel prohibition.



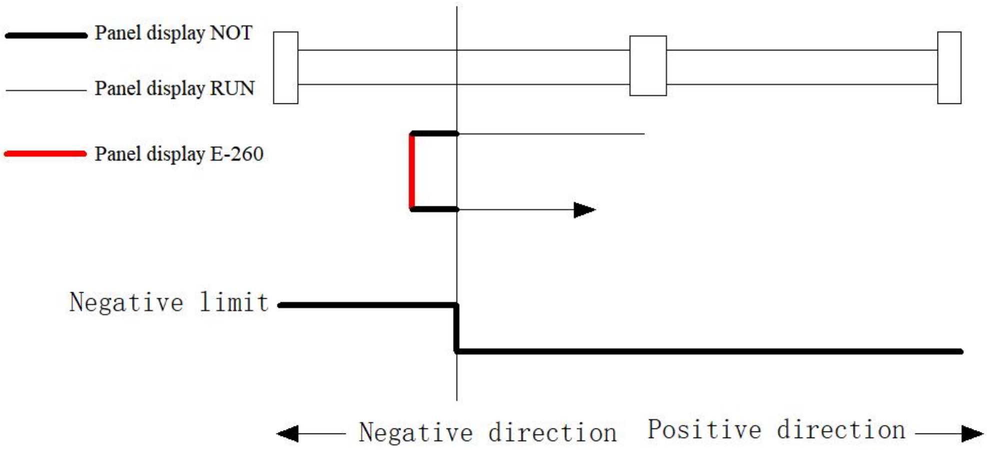
2. Limit overtravel state

When P0-28 is 1, servo will control the deceleration stop alarm.

(1) Initial movement direction to the left, triggering the overtravel signal without occurrence of offside

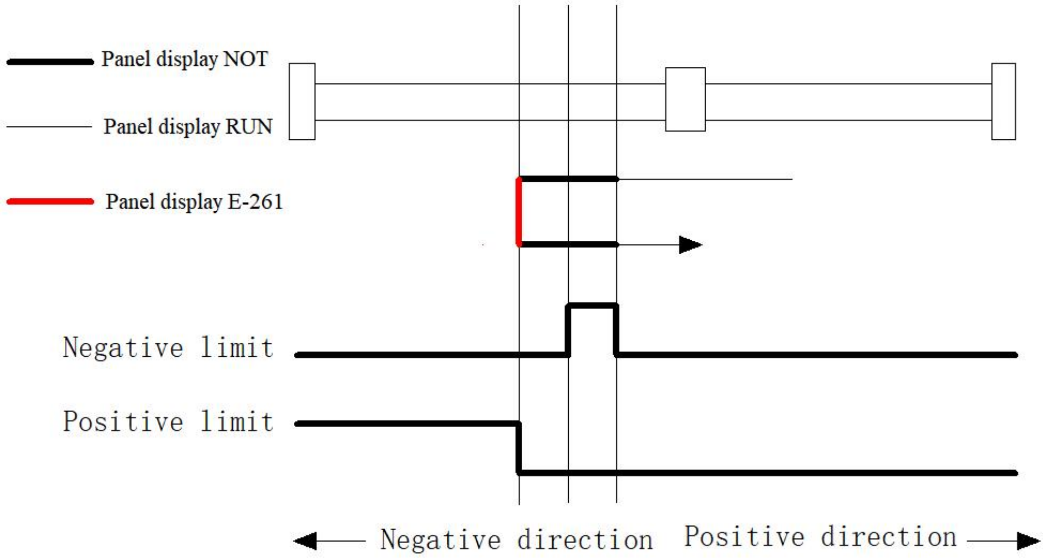
Scenario 1: Failure to touch the forward limit switch

The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. The shaft stops on the reverse limit switch, and the servo will report E-260. The alarm must be cleared to move the axis in the forward direction. When it touches the falling edge of the reverse limit switch, the panel display can change from NOT to RUN, and the reverse overtravel prohibition can be released.



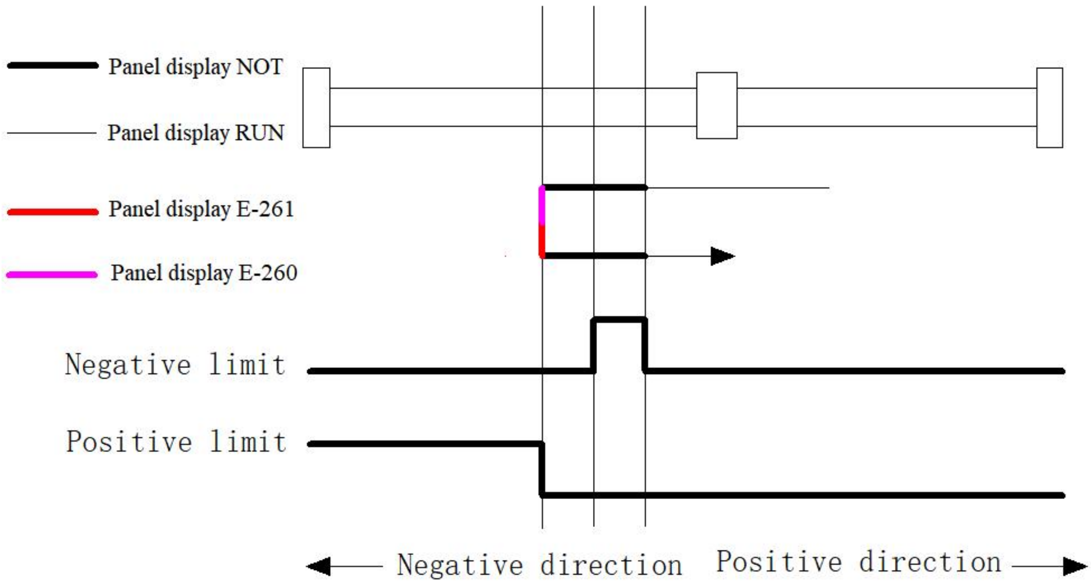
Scenario 2: In the case of offside, touch the forward limit switch before the axis deceleration stop is completed.

The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. However, the axis crosses the reverse limit switch and triggers the falling edge of the reverse limit switch. Before the shaft stops, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled in order to clear the E-261 alarm. Otherwise, the alarm cannot be cleared. Then, the shaft moves forward and touches the rising and falling edges of the reverse limit switch again. Only then can the panel display change from NOT to RUN, and the reverse overtravel prohibition be released.



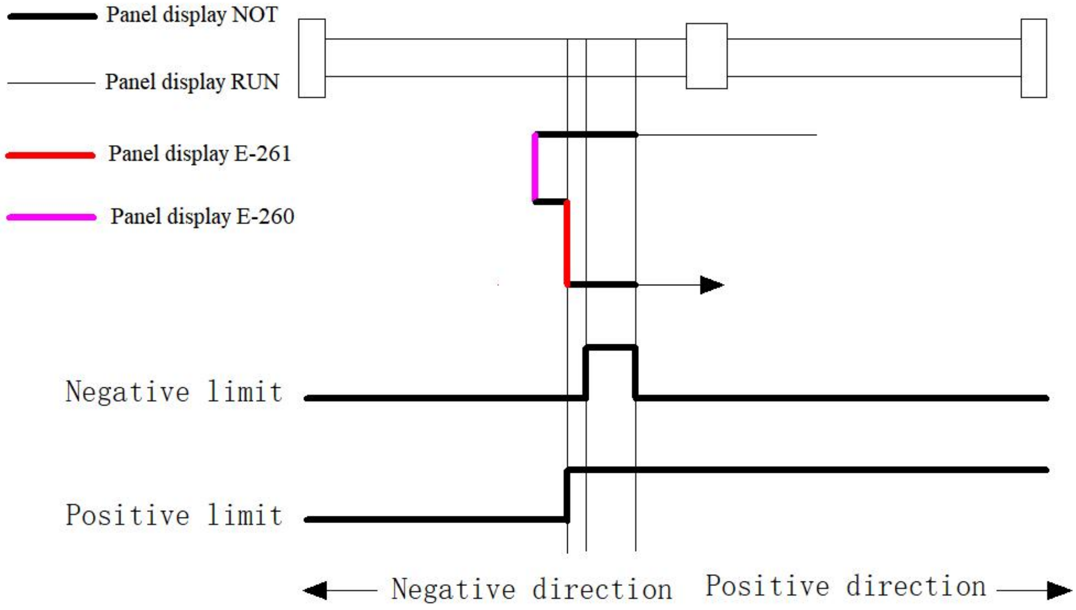
Scenario 3: In the case of offside, when the shaft stops, touch the forward limit switch.

The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. However, the axis crosses the reverse limit switch and triggers the falling edge of the reverse limit switch. When the shaft stops, the servo will report E-260. At this time, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled before the E-261 alarm can be cleared. Otherwise, the alarm cannot be cleared. Then, the shaft will move forward and touch the rising and falling edges of the reverse limit switch again. Only then can the panel display change from NOT to RUN, and the reverse overtravel prohibition be released.



Scenario 4: In the case of offside, touching the forward limit switch during axial forward movement.

The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. However, the axis crosses the reverse limit switch and triggers the falling edge of the reverse limit switch. When the shaft stops, the servo will report E-260. After clearing the alarm to move the shaft forward, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled before the E-261 alarm can be cleared. Otherwise, the alarm cannot be cleared. Continue to move the shaft forward, touch the rising and falling edges of the reverse limit switch again, and the panel display can change from NOT to RUN to release the reverse overtravel prohibition.



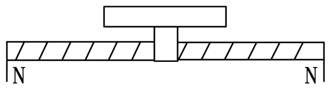
5.4 Position control

5.4.1 Universal position mode

5.4.1.1 Pulses per polar distance/electronic gear ratio

The so-called electronic gear ratio is actually the displacement of the motor when the load shaft displacement is one instruction unit. Linear motors are used for linear motion, with a default reduction ratio of 1:1.

- After writing the polar distance into the motor parameters, only the required number of pulses for each polar distance needs to be allocated to P0-11/P0-12. For example, 10000 pulses move one polar distance, and the parameter is set to: P0-11=0/P0-12=1.
- In precise positioning, if the required number of pulses per polar distance P0-11/P0-12 cannot be achieved, electronic gear ratios can be used, and the setting method is:



$$\frac{\text{Electronic gear ratio numerator P0} - 13}{\text{Electronic gear ratio denominator P0} - 14} = \frac{\text{Grating resolution}}{\text{Pulses per polar distance}}$$

■ Related parameters

Parameter	Meaning	Default setting	Unit	Setting range	Modify	Effective
P0-11	Pulses per polar distance*1	0	pul	0～9999	Servo OFF	At once
P0-12	Pulses per polar distance *10000	0	pul	0～9999	Servo OFF	At once
P0-13	Electronic gear ratio (numerator)	1	-	0～65535	√	At once
P0-14	Electronic gear ratio (denominator)	1	-	0～65535	Servo OFF	At once
P0-92	Group 2 Electronic gear ratio (numerator) low bit*1	1	-	1～9999	○(mode 5) √(mode 6)	At once
P0-93	Group 2 Electronic gear ratio (numerator) high bit*10000	0	-	0～65535	○(mode 5) √(mode 6)	At once
P0-94	Group 2 Electronic gear ratio (denominator) low bit*1	1	-	1～9999	Servo OFF	At once
P0-95	Group 2 Electronic gear ratio (denominator) high bit*10000	0	-	0～65535	Servo OFF	At once

- Parameters P0-11 to P0-14 all relate to the electronic gear ratio. P0-11 and P0-12 form one group, while P0-13 and P0-14 form another group. The pulses per polar distance, P0-11 and P0-12, take precedence over the electronic gear ratio, P0-13 and P0-14. The electronic gear ratio P0-13 and P0-14 only becomes effective when both P0-11 and P0-12 are set to zero. In special cases, if the calculated pulses per polar distance result in a decimal number, the use of the electronic gear ratio should be considered.
- When P0-11, P0-12, P0-13, and P0-14 are all set to zero, then P0-92, P0-93, and P0-94, P0-95 will become effective. If P0-13 and P0-14 exceed the set range, please reduce the electronic gear ratio to its simplest form. If it still exceeds the parameter setting range after reduction, please use the second set of gear ratios, P0-92 to P0-95. The second set of gear ratios only becomes effective when P0-11 to P0-14 are all set to zero.
- Instruction units do not represent machining accuracy. Refining the instruction unit quantity based on mechanical accuracy can improve the positioning accuracy of servo.

5.4.1.2 Positioning completion signal (/COIN, /COIN_HD)

In position control, the signal indicating the completion of servo motor positioning is used when the command controller needs to complete positioning confirmation.

■ Related parameters

Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P5-00	Positioning completion width	144	Command unit	0～65535	Anytime	At once
P5-01	Positioning completion detection mode	0	-	0～3	Anytime	At once
P5-02	Positioning completion hold time	0	ms	0～65535	Anytime	At once

Parameter	Signal name	Default setting	Suitable mode	Meaning	Modify	Effective
P5-37	/COIN-HD	n.0000	5|6	Positioning complete holding	Anytime	At once
P5-38	/COIN	n.0000	5|6	Positioning complete output	Anytime	At once
Refer to section 3.2.2 for hardware wiring details. If it is necessary to output signal from SO2, P5-37 and P5-38 are set to n.0002/0012. Note that an SO terminal can only be used as a signal function.						

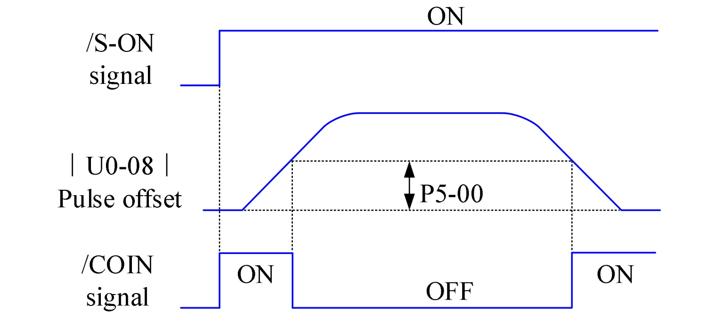
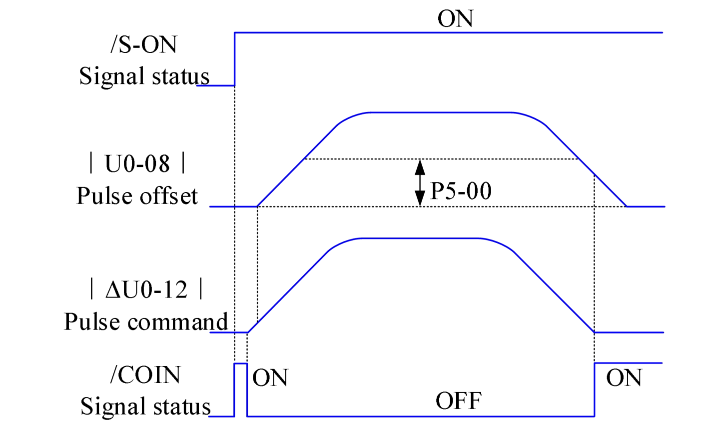
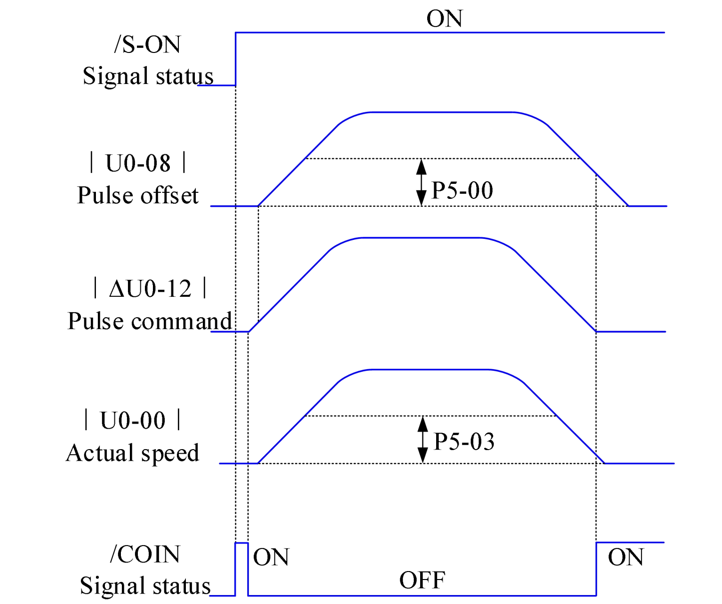
1. Conditions for positioning completion signal output

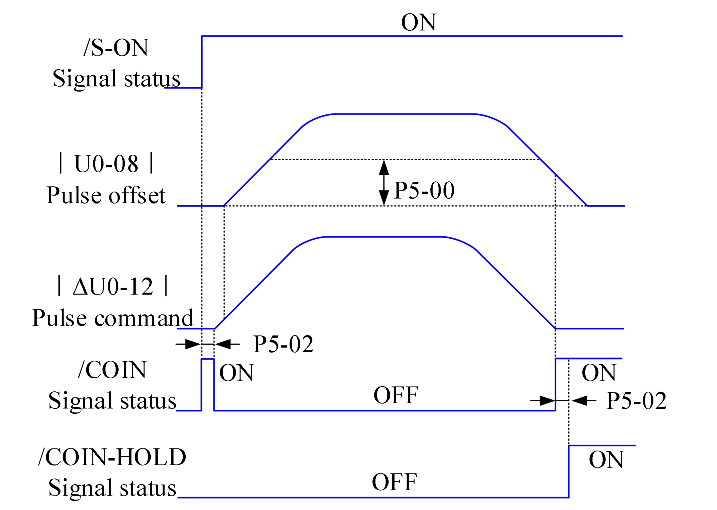
(1) /COIN-HD signal output conditions

When the positioning completion detection mode P5-01 is set to 3, the positioning completion holding /COIN-HD signal can be output. When the /COIN signal holds P5-02 time, the COIN-HD signal can be output.

(2) /COIN signal output conditions

According to the positioning completion detection mode set in P5-01, output positioning completion /COIN signal. The following is the precondition for positioning output and the output diagram.

<table>
<tr><th>P5-01 setting</th><th>Content</th><th>Diagram</th></tr>
<tr><td>0</td><td>If the absolute deviation is below P5-00, the COIN signal will be output.</td><td>
</td></tr>
<tr><td>1</td><td>After the instruction is finished, the deviation is below P5-00 and COIN signal is output.</td><td>
</td></tr>
<tr><td>2</td><td>When the instruction ends and the motor speed is under the rotation detection speed (P5-03) and the absolute deviation is less than P5-00, the COIN signal is output.</td><td>
</td></tr>
</table>

3	At the end of instruction, the absolute deviation value under P5-00, it outputs COIN signal. If COIN maintains P5-02 time, COIN-HOLD signal is output.	

2. Description of positioning completion width

(1) The positioning completion width P5-00 changes proportionally due to the change of electronic gear ratio, and the factory default is 144 command units.

The following table is an example:

The number of command pulses required for a motor to operate at one polar distance	positioning completion width P5-00
10000(default)	144(default)
20000	288
5000	72
3000	42
2000	28

The positioning completion width P5-00 varies proportionally with the number of command pulses required for the motor to run one polar distance. The output of the positioning completion signal depends on the positioning completion width. The smaller the width, the later the positioning completion signal output, but the signal output does not affect the actual operating status of the motor.

(2) The positioning completion width can also be set separately, and its modification will not affect the number of command pulses required for the motor to operate at one polar distance.

5.4.1.3 Positioning near signal (/NEAR)

The servo motor is located near the positioning completion signal, so that the equipment can prepare the next action in advance.

■ Related parameters

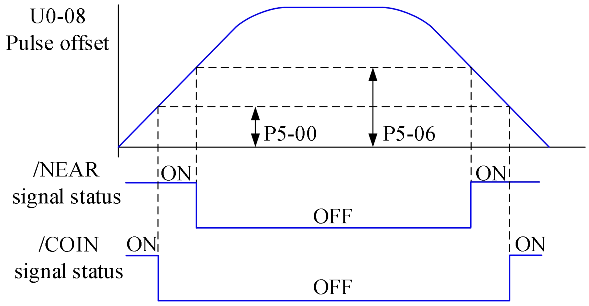
Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P5-06	Near signal output width	655	Command unit	0~65535	Anytime	At once

Parameter	Signal name	Default setting	Suitable mode	Meaning	Modify	Effective
P5-46	/NEAR	n.0000	5|6	Positioning near	Anytime	At once
Refer to section 3.2.2 for hardware wiring details.						

If it is necessary to output from the SO2, P5-46 can be set to n.0002/0012.

1. Positioning approach signal output conditions

When the pulse deviation value U0-08 of the servo driver is lower than the P5-06 setting value, the positioning approach signal (/NEAR) is output.



2. Description of approach signal output

(1) The approach signal output width P5-06 changes proportionally due to the change of the electronic gear ratio. The default setting is 655 command units.

The following table is an example:

The number of command pulses required for one polar distance during motor operation	Near signal output width P5-06
10000(default)	655(default)
20000	1310
5000	327
3000	196
2000	131

The output width P5-06 of the proximity signal varies proportionally with the number of command pulses required to run one polar distance.

The output of the positioning completion signal depends on the positioning completion width. The smaller the width is, the later the positioning completion signal output is, but the signal output does not affect the actual operation state of the motor.

(2) The output width of the proximity signal can also be set separately, and its modification will not affect the number of command pulses required for the motor to operate at one polar distance.

(3) Please set this parameter larger than the positioning completion width.

5.4.1.4 Command pulse prohibition (/INHIBIT)

Position command prohibition, including internal and external position commands. Stop the function of command pulse input during position control. When the /INHIBIT signal is on, the pulse command is no longer counted.

- Related parameters

Parameter	Signal name	Default setting	Suitable mode	Meaning	Modify	Effective
P5-32	/INHIBIT	n.0000	5|6	Command pulse prohibition	Anytime	At once
Parameter range n.0000-0017, assigned to other input terminals by parameter P5-32. If it is necessary to input from SI2, P5-32 can be set to n.0002/0012. Refer to section 3.2.1 for hardware wiring details.						

1. /INHIBIT terminal effectiveness description

Parameter setting	Signal/INHIBIT terminal input status	Signal/INHIBIT terminal

status		logic
P5-32=n.0000	No external terminal input	Invalid
P5-32=n.000□	SI□ terminal has no signal input	
P5-32=n.001□	SI□ terminal has signal input	
P5-32=n.0010	No external terminal input	Valid
P5-32=n.000□	SI□ terminal has signal input	
P5-32=n.001□	SI□ terminal has no signal input	

2. The influence of /INHIBIT terminal signal on the running state of motor

Control mode	Motor operation status	
	/INHIBIT terminal logic valid	/INHIBIT terminal logic invalid
5- internal position control	Pause current segment	/INHIBIT signal is from ON→OFF, continue running from pause point.
6- external pulse position control	Pause pulse command reception	/INHIBIT signal is from ON→OFF, continue running from the pulse command received after OFF.

5.4.1.5 Offset clear (/CLR)

Position offset=(position command – position feedback)(encoder unit)
The position deviation clearing function means that the driver can clear the position deviation when the servo is off or the /CLR signal is received.

■ Related parameters

Parameter	Signal name	Default setting	Suitable mode	Meaning	Modify	Effective
P5-34	/CLR	n.0000	All	Pulse deviation clear	Anytime	At once
Parameter range n.0000-0017, assigned to other input terminals by parameter P5-34. If it is necessary to input signal from SI2, P5-34 can be set to n.0002/0012. Refer to section 3.2.1 for hardware wiring details.						

1. /CLR signal effectiveness

parameter setting status	Signal /CLR terminal input status	Signal /CLR terminal logic
P5-34=n.0000	No external terminal input	Invalid
P5-34=n.000□	SI□ terminal has no signal input	
P5-34=n.001□	SI□ terminal has signal input	
P5-34=n.0010	No external terminal input	Valid
P5-34=n.000□	SI□ terminal has signal input	
P5-34=n.001□	SI□ terminal has no signal input	

2. /CLR signal explanation

Send the pulse to the servo, execute the /CLR input signal, the servo will lock the current pulse counts, then update the current position of the encoder to the position feedback in the control, at the same time, clear the

intermediate quantity of the position loop, speed loop and current loop.
/CLR signal is triggered by edge.

3. Other description of pulse position deviation clearing signal
Setting F0-02 to 1 can also clear the pulse position deviation.

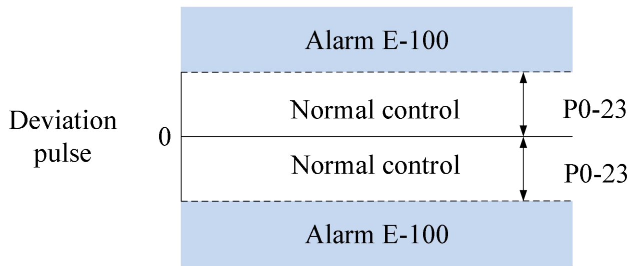
5.4.1.6 Position pulse deviation

Pulse deviation value refers to the difference between command pulse of command controller (such as PLC) and feedback pulse of servo unit in position mode. Its unit is 1 command unit, which is related to the command unit determined by electronic gear ratio.
In position control, when the deviation pulse exceeds a certain limit value, an alarm will occur, and this threshold value is the deviation pulse limit value.

- Related parameters

parameter	Meaning	Default setting	Unit	Range	Change	Effective
P0-23	pulse deviation limit value	2000	0.01 polar distance	0~65535	Anytime	At once

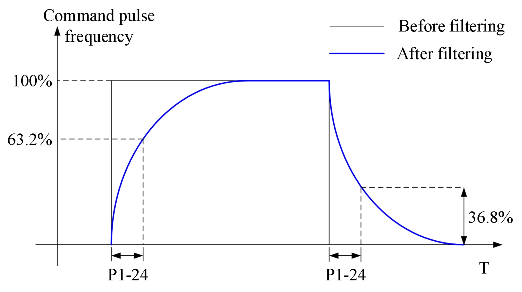
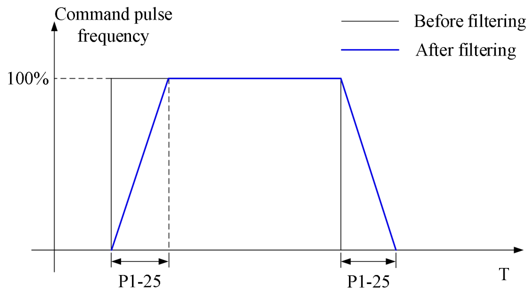
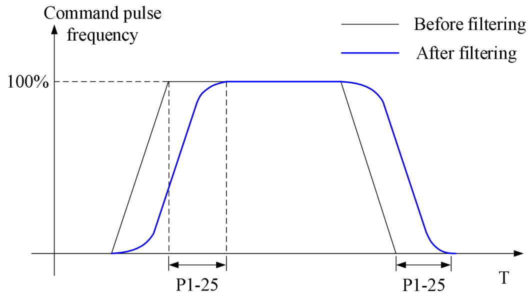
When the deviation pulse limit is 0, the deviation pulse will not be detected.



5.4.1.7 Position command filter

- Related parameters

Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P1-24	Position command acceleration and deceleration filtering time	0	0.1ms	0~65535	Servo OFF	At once
P1-25	Position command smoothing filtering time	0	0.1ms	0~65535	Servo OFF	At once

Position command acceleration and deceleration filter	Position command smoothing filter
	
	

5.4.1.8 Reference origin

1. Find the reference origin

To find out the physical origin of working table and make it as the coordinates origin of point position control. Users can select finding reference origin at forward or reverse side.

Function setting:

Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P4-00 n.xx□x	Origin function	0	-	0~1	Servo OFF	At once
Note: This function is applicable to position mode 5 and 6; when this parameter is set to 0, the function of Origin-finding is invalid; when it is set to n.001x, the function of Origin-finding can be used. (please set P9-21=0)						

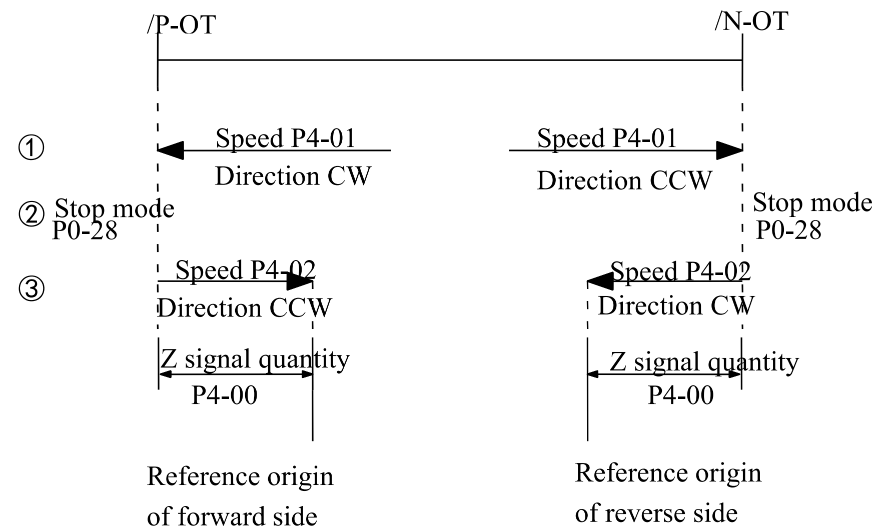
Signal setting

Parameter	Signal	Default	Meaning	Modify
P5-28	/SPD-A	n.0000	Mode 3: internal speed selecting signal	Range: 0000-0017, distributes to input terminal through P5-28. When it set to 0001, it means input signal from SI1.
			Mode 5: find origin point at forward direction	
P5-29	/SPD-B	n.0000	Mode 3: internal speed selecting signal	Range: 0000-0017, distributes to input terminal through P5-29. When it set to 0001, it means input signal from SI1.
			Mode 5: find origin point at reverse direction	

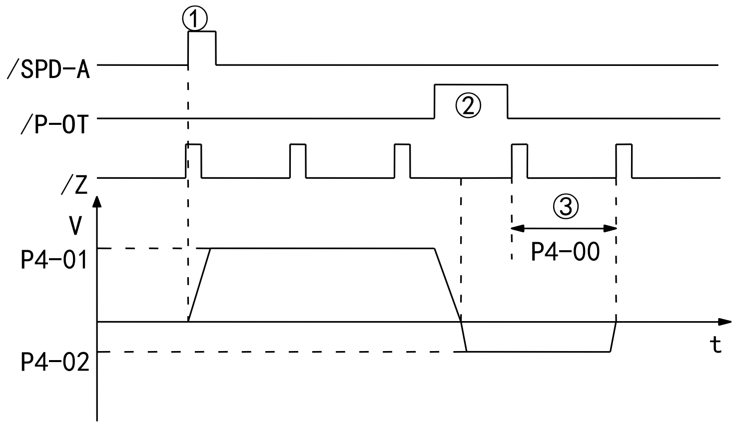
Related parameter setting:

Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P4-00 n.xxx□	Z phase signal numbers	2	-	0~f	Servo OFF	At once
P4-01	The speed hitting the proximity switch	600	rpm	0~65535	Servo OFF	At once
P4-02	The speed leaving the proximity switch	100	rpm	0~65535	Servo OFF	At once

Find reference origin diagram:



Sequential diagram of finding reference origin on forward side:



Steps:

(1) Install limit switch at forward and reverse side. At the rising edge of /SPD-A, motor runs forward at the speed of P4-01 to find the reference origin on forward side.

(2) After the working table hit the limit switch, the motor stop as the mode set by parameter P0-28

(3) Motor leaves the limit switch at the speed of P4-02. After the working table left the limit switch, the motor run at the Z phase signal position of No.n optical encoder. This position is considered as the coordinates origin, n is decided by parameter P4-00.

5.4.1.9 Homing function

1. Function overview

The return to origin function refers to that when the servo enable is on in the position control mode, after the return to origin function is triggered, the servo motor will find the origin and complete the positioning function. The found origin can be used as the position reference point for subsequent position control.

During the homing operation, other position commands (including the retriggered homing signal) are shielded. After the homing is completed, the servo driver can respond to other position commands.

After the homing is completed, the servo driver outputs the homing completion signal, and the upper computer can confirm that the homing has been completed after receiving the signal.

1. Parameter setting

Parameter	Name	Range	Meaning	Set time	Effective	Default
P9-11.0	Z phase numbers	0~F	P9-11.0=0: not find Z phase P9-11.0=1: find one Z phase P9-11.0=2: find two Z phases And so on	Servo OFF	Servo ON	0
P9-11.1	Homing trigger mode	0~2	P9-11.1=0: not trigger homing P9-11.1=1: trigger homing through SI terminal (P5-28) P9-11.1=2: trigger homing after enabling	Servo OFF	Servo ON	0
P9-11.2	Homing mode	0~7	P9-11.2=0: homing mode 0 P9-11.2=1: homing mode 1 P9-11.2=2: homing mode 2 And so on	Servo OFF	Servo ON	0
P9-11.3	Deceleration mode when meeting the overlimit signal	0, 1	P9-11.3=0: decelerate as the setting of P9-14 P9-11.3=1: decelerate at once	Servo OFF	Servo ON	0

Note: P9-11.0 can set up to 15 Z phases. P9-11.1 = 0 means that the homing function cannot be used. This parameter can be understood as the enabling bit of the homing function. Homing modes 1, 3, 5 and 7 are the opposite situation of homing modes 0, 2, 4 and 6 respectively.

Parameter	Name	Range	Unit	Meaning	Set time	Effective	Default value
P9-12	Homing high speed	0~3000	mm/s	Return to the origin at high speed, find the deceleration point and execute the mechanical offset	Servo OFF	Servo ON	200
P9-13	Homing low speed	0~1000	mm/s	Homing with low speed. This low speed should be low enough not to cause mechanical shock when stopping	Servo OFF	Servo ON	20
P9-14	Homing acc/dec time	0~1000	ms	The acceleration and deceleration time here refers to the time required for 0 to 1000mm/s	Servo OFF	Servo ON	1000
P9-15	Maximum time allowed to return to the origin	0~12000	10ms	If the time spent in the whole process of homing exceeds the time set by this parameter, an alarm will be given. When P9-15 = 0, the timeout alarm will be shielded	Servo OFF	Servo ON	0
P9-16	Touch stop mode homing speed threshold	0~1000	mm/s	This parameter is only available for home mode 6 and 7	Servo OFF	Servo ON	2

Parameter	Name	Range	Unit	Meaning	Set time	Effective	Default value
P9-17	Touch stop mode homing torque threshold	0~300%	%	This parameter is only available for home mode 6 and 7 The base value of the percentage is the rated torque	Servo OFF	Servo ON	100%
P9-18	Touch stop mode homing time threshold	10~1500	ms	This parameter is only available for home mode 6 and 7	Servo OFF	Servo ON	500
P9-19	Quantitative pulses low bit	-9999~9999	-	Quantitative pulses low bit	Servo OFF	Servo ON	0
P9-20	Quantitative pulses high bit	-9999~9999	-	Quantitative pulses high bit	Servo OFF	Servo ON	0
P9-21	New/old homing function selection	0~2	-	P9-21=0: old homing function P9-21=1: new homing function P9-21=2: 402 standard homing function	Servo OFF	Power on again	2
P9-22	New homing end filter time	50~10000	ms	When the homing is about to end, this filtering time is required. Wait until the motor stops completely before completely exiting the homing mode. After this filtering time, the return to origin completion signal will be output.	Servo OFF	Servo ON	500

Actual mechanical offset =P9-19 + P9-20×10000，P9-19 and P9-20 need same symbol (all positive or negative value). The mechanical offset here is the absolute position of the servo after homing.

Parameter n.xxxx	Name	Meaning	Set time	Effective	Default
P5-22	Forward overtravel signal POT	Forward limit signal in homing mode	Operation setting	Take effect at once	0
P5-23	Reverse overtravel signal NOT	Reverse limit signal in homing mode	Operation setting	Take effect at once	0
P5-54	Homing completion signal	When the homing action and status are completed, the homing completion signal will be output. Even if other modes are executed after the homing is completed, the homing completion signal will not disappear. When the homing is started again, the homing completion signal will disappear.	Operation setting	Take effect at once	0

Parameter n.xxxx	Name	Meaning	Set time	Effective	Default
P5-64	Homing switch signal	The origin switch signal is required in the process of returning to the origin.	Operation setting	Take effect at once	0
P5-28	SI terminal start homing	When P9-11.1=1, P5-28 distributed the SI terminal, the homing can be triggered by SI terminal.	Operation setting	Take effect at once	0

1. New homing mode selection

To use the new homing function, first set **P9-21=1**, then set the overtravel switch (POT/NOT) and the origin switch. If the mechanical offset (P9-19 and P9-20 are set), please set the offset within the travel range to ensure that the mechanical equipment will not be damaged during the homing process!

The number of Z phases (P9-11.0) and the mechanical offset (P9-19, P9-20) can be valid at the same time. If the number of Z phases (P9-11.0) and the mechanical offset (P9-19, P9-20) are not set to 0, the servo will find the number of Z phases (P9-11.0) first, and then execute the mechanical offset (P9-19, P9-20). If the number of Z phases (P9-11.0) is 0 and the mechanical offset (P9-19, P9-20) is not 0, the servo does not find the Z phase, but executes the mechanical offset (P9-19, P9-20). If the number of Z phases is not 0 but the mechanical offset is 0, the servo will find the Z phase (P9-11.0) without performing the mechanical offset.

There are 8 homing modes in total, as follows:

(1) Positive homing, the deceleration point is the origin switch, and the origin is the origin switch or motor Z signal (P9-11.2 = 0)

(2) Reverse homing, the deceleration point is the origin switch, and the origin is the origin switch or motor Z signal (P9-11.2 = 1)

(3) Positive homing, the deceleration point and origin are motor Z signal (P9-11.2 = 2)

(4) Reverse homing, the deceleration point and origin are the motor Z signal (P9-11.2 = 3)

(5) Forward homing, the deceleration point is the forward overtravel switch, and the origin is the forward overtravel switch or motor Z signal (P9-11.2 = 4)

(6) Reverse homing, the deceleration point is the reverse overtravel switch, and the origin is the reverse overtravel switch or motor Z signal (P9-11.2 = 5)

(7) Positive homing, the deceleration point is the mechanical limit position, and the origin is the mechanical limit position or motor Z signal (P9-11.2 = 6)

(8) Reverse homing, the deceleration point is the mechanical limit position, and the origin is the mechanical limit position or motor Z signal (P9-11.2 = 7)

Each homing mode is analyzed in detail below:

1. **Homing mode 0 —— Positive homing, the deceleration point is the origin switch, and the origin is the origin switch or motor Z signal (P9-11.2 = 0)**

To use this mode, you need to connect pot, not and origin switches.

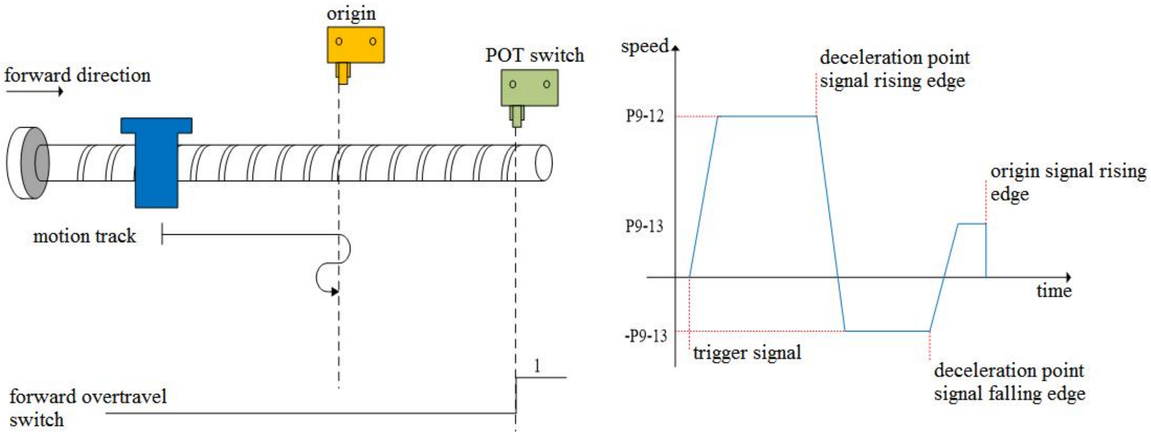
(1) When the motor starts to move, the signal of the origin switch (deceleration point) is invalid (P5-64 = 0-invalid, 1-valid), and the forward overtravel switch (POT) (P5-22) is not triggered in the whole process.

Firstly, the servo motor searches the deceleration point (origin) signal in the high-speed forward direction with the set value of P9-12 (homing high speed) until it meets the rising edge of the deceleration point (origin) signal. After gradually decelerating to -P9-13 (homing low speed) according to the setting of P9-14 (homing acceleration and deceleration time), the servo motor searches the deceleration point(origin) signal falling edge in the reverse direction at the low speed set by -P9-13 (homing low speed). When encountering the deceleration point (origin) signal falling edge, it will reverse, and continue to search the deceleration point (origin) signal rising edge at low speed with P9-13 (homing low speed). The next homing action can be divided into four cases:

(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:

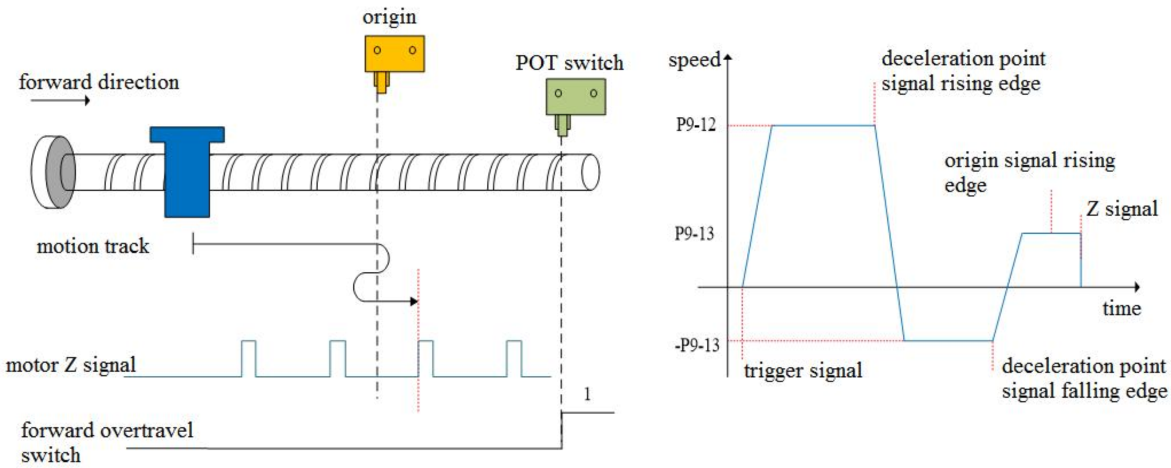
During the operation of continuing to search the rising edge of deceleration point (origin) signal at low speed with

P9-13 (homing low speed), stop immediately when encountering the rising edge of deceleration point (origin) signal.



(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:
In the operation process of continuing to search the rising edge of deceleration point (origin) signal at low speed with P9-13 (homing low speed), stop immediately when encountering the rising edge of deceleration point (origin) signal. After the motor is completely stopped, the motor will move a quantitative pulse (P9-19, P9-20) with speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (either positive direction or negative direction), then the motor will stop.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:
During the operation of continuing to search the rising edge of deceleration point (origin) signal at low speed P9-13 (homing low speed), continue to run after encountering the rising edge of deceleration point (origin) signal, and then find the first Z-phase signal and stop immediately.



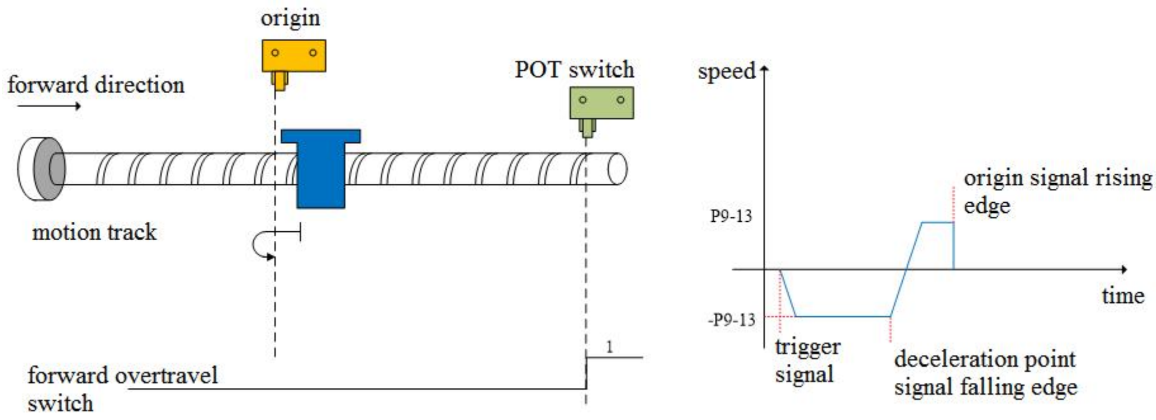
(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:
During the operation of continuing to search the rising edge of the deceleration point (origin) signal at low speed P9-13 (homing low speed), continue to run after encountering the rising edge of the deceleration point (origin) signal, then find the first z-phase signal and stop immediately. After the motor is completely stopped, according to the set number of mechanical offset pulses (P9-19, P9-20) and direction (it can be positive direction or negative direction), the motor goes through a quantitative pulses (P9-19, P9-20) at the speed set by P9-12 (homing high speed), and then the motor stops.

(2) When the motor starts to move, the origin switch (deceleration point) signal is valid (P5-64 = 0-invalid, 1-valid), and the forward overtravel switch (P5-22) is not triggered in the whole process:

The servo motor directly searches for the falling edge of the deceleration point (origin) signal at low speed -P9-13 (homing low speed). If it encounters the falling edge of the deceleration point (origin) signal, it will reverse (i.e. forward), and continue to search for the rising edge of the deceleration point (origin) signal at low speed with P9-13 (homing low speed). The next homing action can be divided into four cases:

(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:

In the process of forward acceleration or forward constant speed operation, stop immediately when encountering the rising edge of deceleration point (origin) signal.

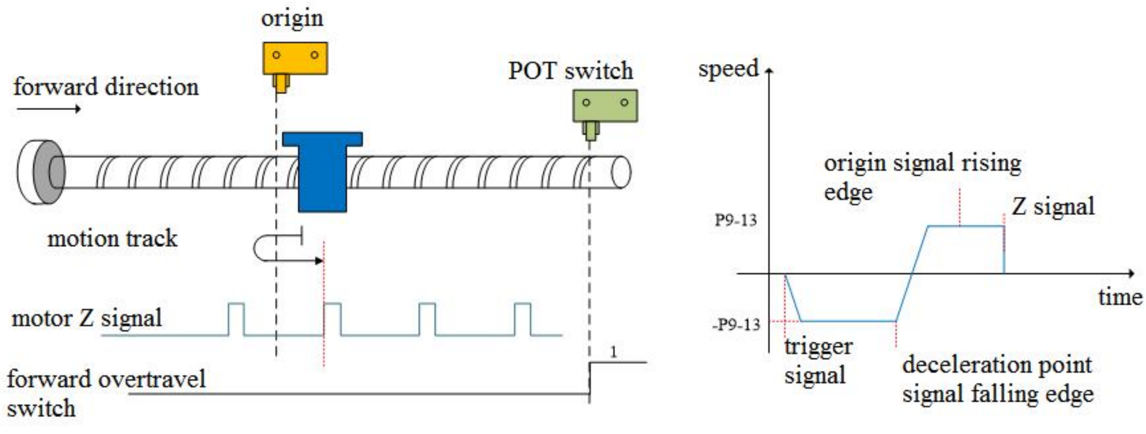


(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:

In the process of positive acceleration or positive constant speed operation, stop immediately after encountering the rising edge of the origin signal. After the motor is completely stopped, according to the set number of mechanical offset pulses and direction (either positive or negative direction), the motor will move a quantitative pulse (P9-19, P9-20) at the speed set by P9-12 (homing high speed), and then the motor will stop.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:

In the process of forward acceleration or forward constant speed operation, continue to run after encountering the rising edge of the origin signal, and then find the first Z-phase signal and stop immediately.



(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:

In the process of positive acceleration or positive constant speed operation, continue to run after encountering the rising edge of the origin signal, and then find the first Z-phase signal and stop immediately. After the motor is completely stopped, the motor will run a quantitative pulse (P9-19, P9-20) at the set speed P9-12 (homing high speed) according to the set number of mechanical offset pulses (P9-19, P9-20) and direction (either positive or negative direction), then the motor stops.

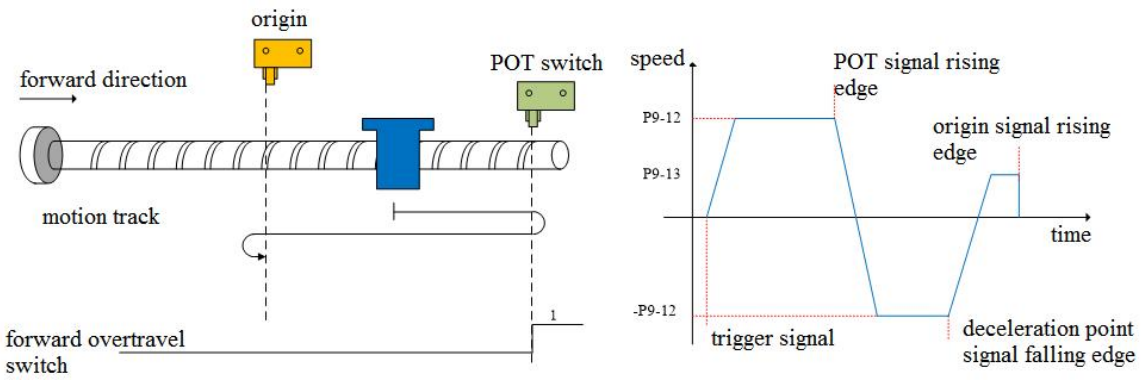
(3) When the motor starts to move, the signal of the origin switch (deceleration point) is invalid (P5-64 =

0-invalid, 1-valid), and the forward overtravel switch (P5-22) triggered in the process is valid.

Firstly, the servo motor forward searches for the deceleration point signal at high speed P9-12 (homing high speed). After encountering the forward overtravel switch (POT) (P5-22), the driver immediately reverse searches for the falling edge of the deceleration point (origin) signal at the speed -P9-12 (homing high speed) according to the value set by P9-14 (homing acceleration and deceleration time). After encountering the falling edge of the deceleration point (origin) signal, decelerate in the reverse direction (i.e. restore the forward direction) according to the set value of P9-14 (homing acceleration and deceleration time). The servo motor forward searches the rising edge of the deceleration point (origin) signal at low speed of P9-13 (homing low speed). The next action back to the origin can be divided into four cases:

(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:

In the process of forward acceleration or forward constant speed operation, stop immediately when encountering the rising edge of the origin signal.

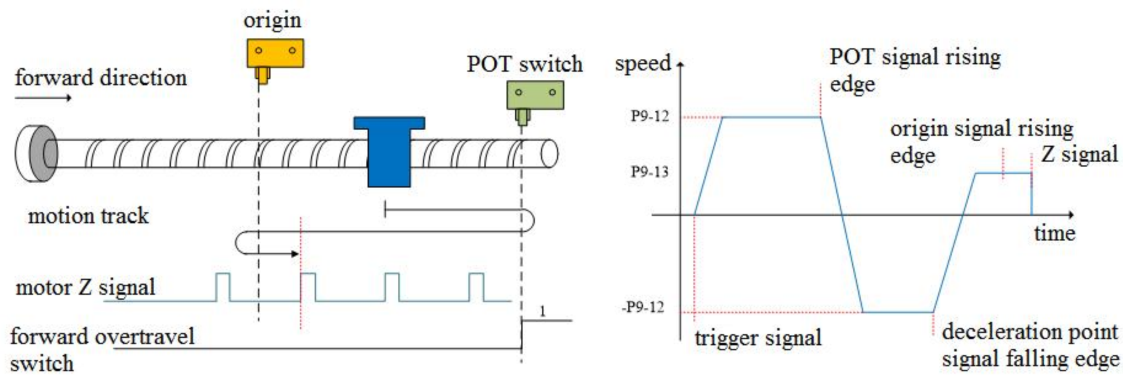


(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:

In the process of positive acceleration or positive constant speed operation, stop the machine immediately after encountering the rising edge of the deceleration point (origin) signal. After the motor is completely stopped, the motor will move a quantitative pulse (P9-19, P9-20) at the speed set by P9-12 (homing high speed) according to the set number and direction of mechanical offset pulses (either positive direction or negative direction), then the motor stops.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:

In the process of forward acceleration or forward constant speed operation, continue to run after encountering the rising edge of deceleration point (origin) signal, and then find the first Z-phase signal and stop immediately.



(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:

In the process of positive acceleration or positive constant speed operation, continue to run after encountering the rising edge of the deceleration point (origin) signal, and then find the first Z-phase signal to stop immediately.

After the motor is completely stopped, the motor will run a quantitative pulse (P9-19, P9-20) at the set speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (either positive direction or negative direction), then the motor stops.

2. Homing mode 1——Reverse return to zero, the deceleration point is the origin switch, and the origin is the origin switch or motor Z signal（P9-11.2=1）

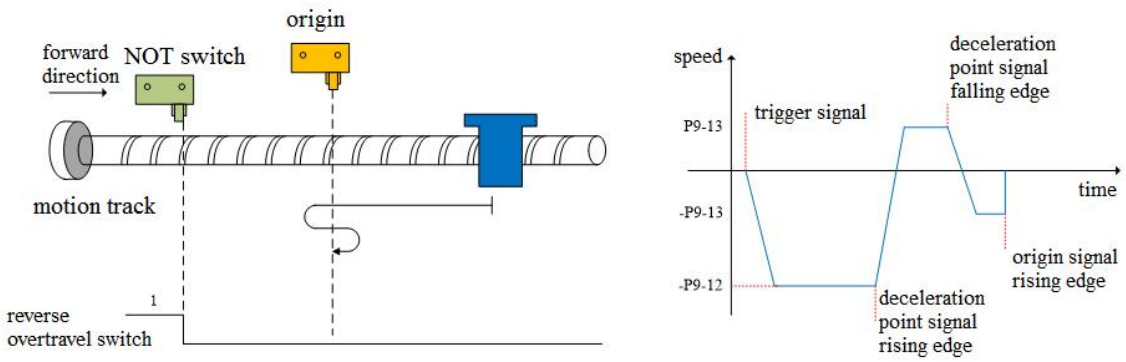
It needs to connect POT, NOT, origin switch to use this mode.

(1) When the motor starts to move, the signal of origin switch (deceleration point) is invalid, and the reverse overtravel switch (NOT)(P5-23) is not triggered in the whole process

Firstly, the servo motor searches for the deceleration point signal at high speed -P9-12 (homing high speed) in reverse until it meets the rising edge of the deceleration point signal. After gradually accelerating to P9-13 (homing low speed) according to the setting of P9-14 (homing acceleration and deceleration time), the servo motor forward searches for the falling edge of deceleration point (origin) signal at the low speed P9-13 (homing low speed). When encountering the falling edge of deceleration point (origin) signal, it will reverse (resume reverse), and continue to search the rising edge of the deceleration point (origin) signal at a low speed -P9-13(homing low speed). The next back to origin action can be divided into four cases:

(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:

During the operation of continuing to search for the rising edge of deceleration point (origin) signal at low speed -P9-13 (homing low speed), stop immediately when encountering the rising edge of deceleration point (origin) signal.

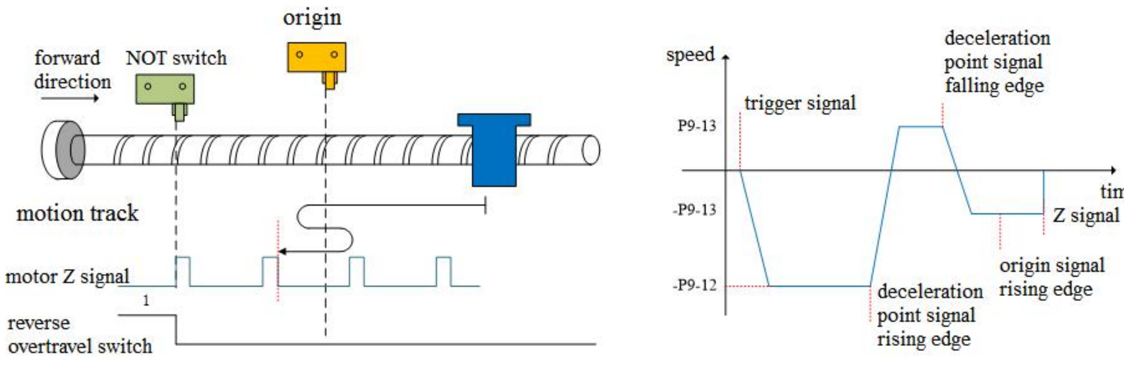


(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:

During the operation of continuing to search the rising edge of deceleration point (origin) signal at low speed -P9-13 (homing low speed), stop the machine immediately after encountering the rising edge of deceleration point (origin) signal. After the motor is completely stopped, the motor will run a quantitative pulse (P9-19, P9-20) at the set speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (either positive direction or negative direction), then the motor stops.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:

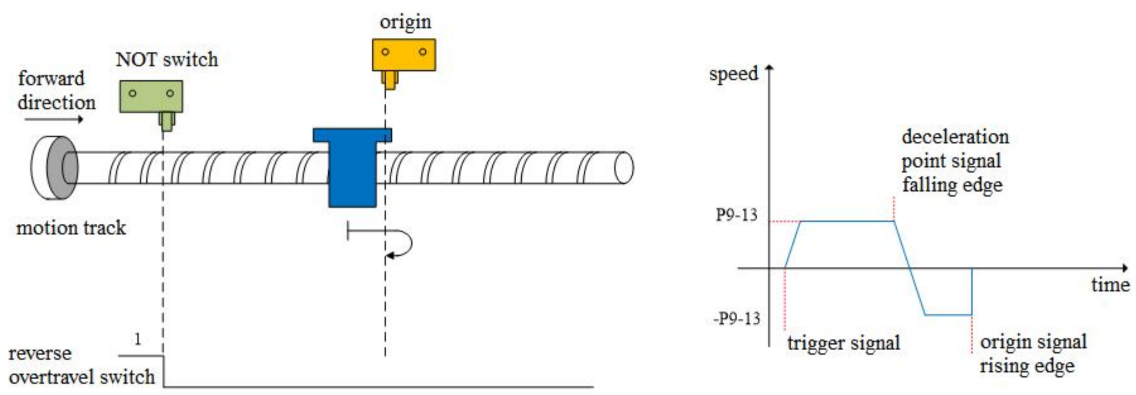
During the operation of continue to search the rising edge of deceleration point (origin) signal at low speed -P9-13 (homing low speed), continue to run after encountering the rising edge of deceleration point (origin) signal, and then find the first Z-phase signal and stop immediately.



(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:
During the operation of continue to search the rising edge of the deceleration point (origin) signal at low speed -P9-13 (homing low speed), continue to operate after encountering the rising edge of the deceleration point (origin) signal, then find the first Z-phase signal and stop immediately. After the motor stops completely, according to the set number of mechanical offset pulses and direction (either positive direction or negative direction), the motor goes through a quantitative pulse (P9-19, P9-20) at the speed P9-12 (homing high speed), and then the motor stops.

(2) When the motor starts to move, the signal of origin switch (deceleration point) is valid (P5-64 = 0-invalid, 1-valid), and the reverse overtravel switch is not triggered in the whole process (NOT) (P5-23).

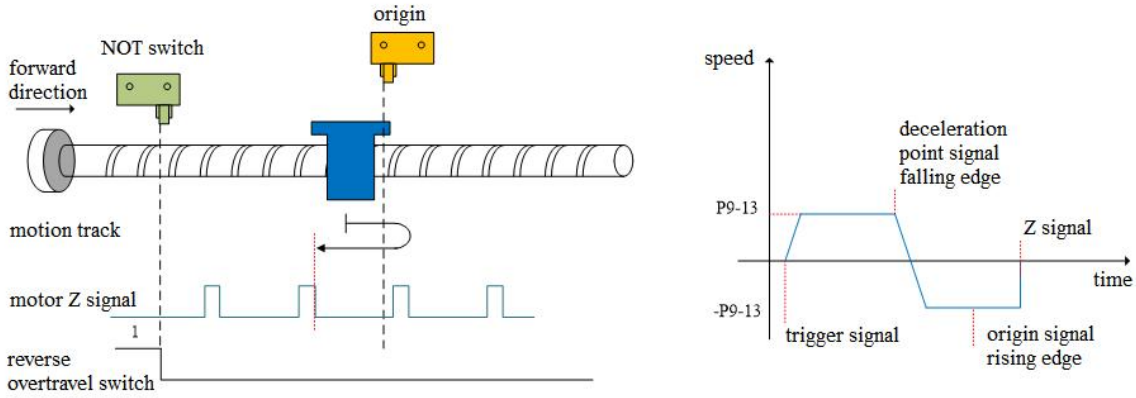
The servo motor directly forward searches for the falling edge of the deceleration point (origin) signal at low speed P9-13 (homing low speed). If it encounters the falling edge of the deceleration point (origin) signal, it will reverse (i.e. negative direction), and continue to search for the rising edge of the deceleration point (origin) signal at low speed -P9-13 (homing low speed). The next action of returning to origin can be divided into four cases:
(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:
In the process of negative acceleration or negative constant speed operation, stop immediately when encountering the rising edge of the origin signal.



(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:
In the process of negative acceleration or negative constant speed operation, stop the machine immediately after encountering the rising edge of the origin signal. After the motor is completely stopped, the motor will walk a quantitative pulse (P9-19, P9-20) at the speed P9-12 (homing high speed) according to the set number and direction of mechanical offset pulses (either positive direction or negative direction), and then stop the motor.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:

During negative acceleration or negative constant speed operation, continue operation after encountering the rising edge of deceleration point (origin) signal, and then stop immediately after finding the first Z-phase signal.

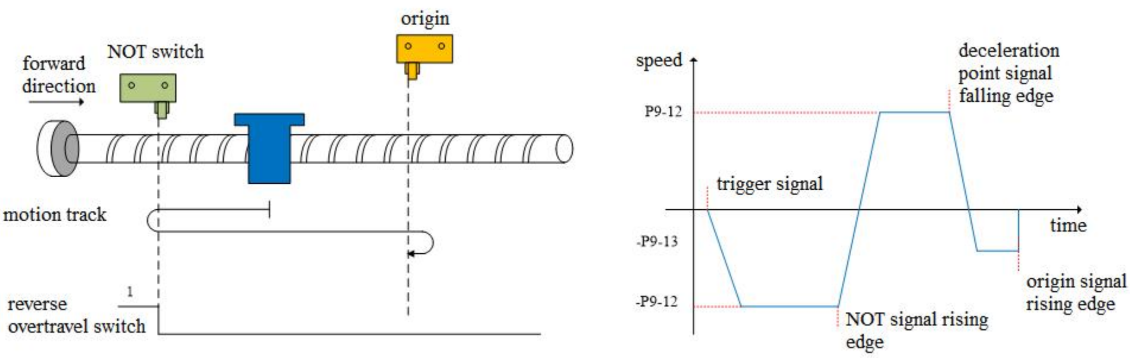


(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:
In the process of negative acceleration or negative constant speed operation, continue to operate after encountering the rising edge of the deceleration point (origin) signal, and then find the first Z-phase signal to stop immediately. After the motor stops completely, the motor will run a quantitative pulse (P9-19, P9-20) at the set speed P9-12 (homing high speed) according to the set mechanical offset pulse numbers and direction (either positive or negative direction), then the motor stops.

(3) When the motor starts to move, the signal of the origin switch (deceleration point) is invalid (P5-64 = 0-invalid, 1-valid), and the reverse overtravel switch triggered in the process is valid (NOT) (P5-23).

Firstly, the servo motor reverse searches for the deceleration point (origin) signal at high speed -P9-12 (homing high speed). After encountering the reverse overtravel switch (NOT), the driver decelerates in reverse (i.e. forward) according to the value set in P9-14 (homing acceleration and deceleration time), and immediately searches for the falling edge of the deceleration point (origin) signal at high speed P9-12 (homing high speed) in the forward direction. After encountering the falling edge of the deceleration point (origin) signal, decelerate in the reverse direction (i.e. negative direction) according to the set value of P9-14 (homing acceleration and deceleration time), and the servo motor searches the rising edge of the deceleration point (origin) signal in the reverse low speed -P9-13 (homing low speed). The next homing action can be divided into four cases:

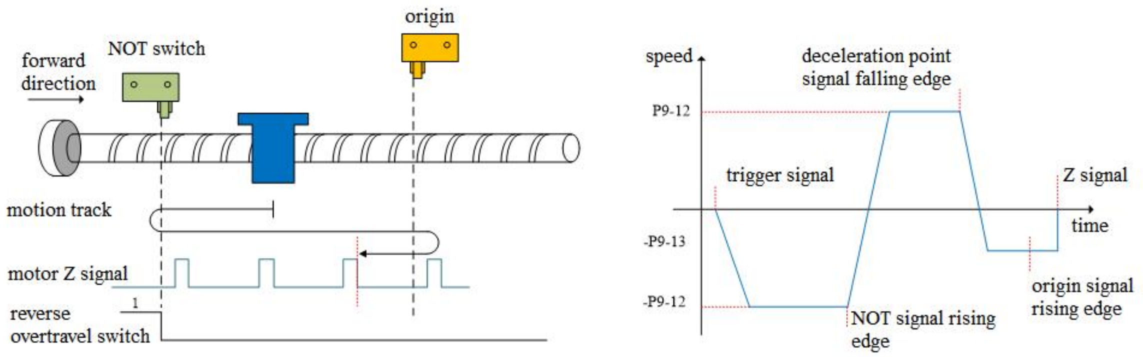
(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:
In the process of reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge of the origin signal.



(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:

In the process of reverse acceleration or reverse constant speed operation, stop the machine immediately after encountering the rising edge of the deceleration point (origin) signal. After the motor is completely stopped, the motor will move a quantitative pulse (P9-19, P9-20) at the speed set by P9-12 (homing high speed) according to the set number and direction of mechanical offset pulses (either positive direction or negative direction), then the motor stops.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:
In the process of reverse acceleration or reverse constant speed operation, continue the operation after encountering the rising edge of the origin signal, and then stop immediately after finding the first Z-phase signal.

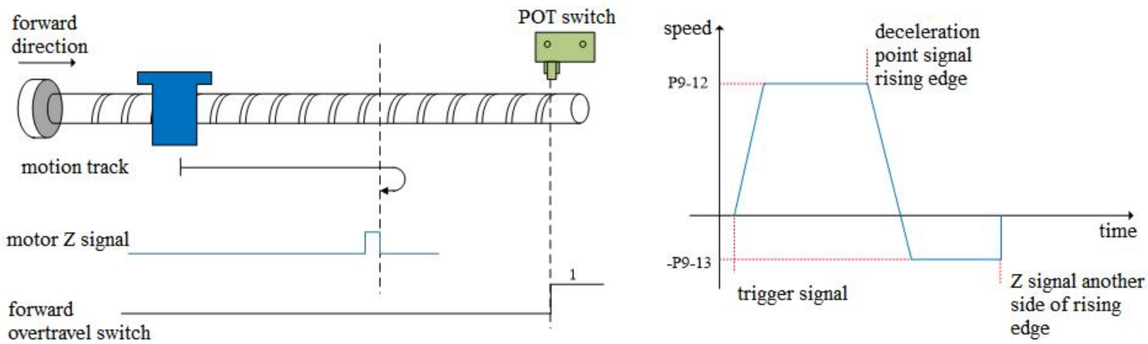


(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:
In the process of reverse acceleration or reverse constant speed operation, continue to operate after encountering the rising edge of the deceleration point (origin) signal, and then find the first Z-phase signal to stop immediately. After the motor is completely stopped, the motor will run a quantitative pulse (P9-19, P9-20) at the set speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (either positive direction or negative direction), then the motor stops.

3. Homing mode 2——forward homing, deceleration point and origin are motor Z signal (P9-11.2=2)
In this mode, the number of Z phases of the motor is not found. To use this mode, you need to connect POT and NOT.

(1) When the motor starts to move, the Z signal is invalid or valid (P5-64 = 0-invalid, 1-valid), and the forward overtravel switch (POT) is not triggered in the whole process.

Firstly, the servo motor forward searches the Z signal at the high-speed P9-12 (homing high speed). After encountering the rising edge of the Z signal, it decelerates in the reverse direction according to the set value of P9-14 (homing acceleration and deceleration time), accelerates to -P9-13 (homing low speed) and reverse searches the Z signal at low speed. Next, the homing action is divided into two cases:
(a) Mechanical offset (P9-19, P9-20) is 0:
In the process of reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge of the other side of the motor Z signal.



(b) Mechanical offset (P9-19, P9-20) is not 0:

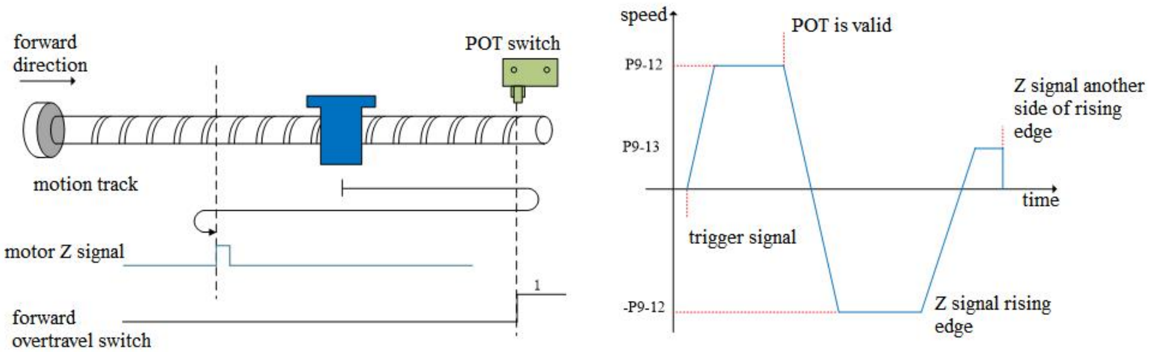
In the process of reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge on the other side of the motor Z signal. After the motor is completely stopped, the motor will walk a quantitative pulse (P9-19, P9-20) at the speed set by P9-12 (homing high speed) according to the set number and direction of mechanical offset pulses (either positive direction or negative direction), then the motor stops.

(2) When the motor starts to move, the Z signal is invalid or valid (P5-64 = 0-invalid, 1-valid), and the forward overtravel switch is triggered in the process (POT) (P5-22).

Firstly, the servo motor searches for the Z signal in forward direction with the high speed P9-12 (homing high-speed speed). After encountering the forward overtravel switch, the driver decelerates in the reverse direction according to P9-14 (homing acceleration and deceleration time), and searches for the Z signal in the reverse direction with the high-speed -P9-12 (homing high-speed) until encountering the rising edge of the Z signal. The machine gradually decelerates in the reverse direction (i.e. returns to the forward direction) according to P9-14 (homing acceleration and deceleration time). The servo motor searches the rising edge of the other side of the Z signal in the forward direction and low speed P9-13 (homing low speed). The next homing action is divided into two cases:

(a) Mechanical offset (P9-19, P9-20) is 0:

In the process of forward acceleration or forward constant speed operation, stop immediately when encountering the rising edge of the other side of the Z signal.



(b) Mechanical offset (P9-19, P9-20) is not 0:

In the process of positive acceleration or positive constant speed operation, stop immediately when encountering the rising edge on the other side of the motor Z signal. After the motor is completely stopped, the motor will walk a quantitative pulse at the speed set by P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (either positive direction or negative direction), and then stop the motor.

4. Homing mode 3——reverse homing, the deceleration point and origin are motor Z signal (P9-11.2=3)

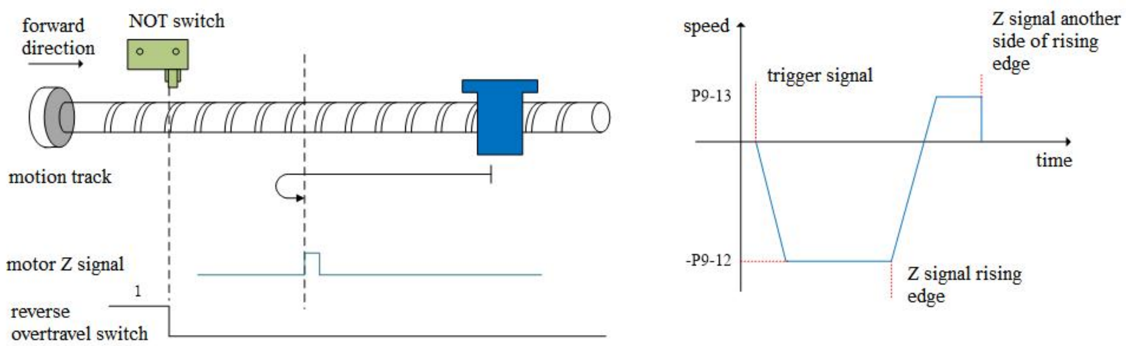
In this mode, the number of Z phases of the motor is not found. To use this mode, you need to connect POT and NOT.

(1) When the motor starts to move, the Z signal is invalid or valid (P5-64 = 0-invalid, 1-valid), and the reverse overtravel switch is not triggered in the whole process (NOT).

Firstly, the servo motor searches for the Z signal in reverse direction with the high speed -P9-12 (homing high speed). After encountering the rising edge of the Z signal, it decelerates and reverses according to the set value of P9-14 (homing acceleration and deceleration time), accelerates to P9-13 (homing low speed) and searches for the Z signal at low speed in forward direction. Next, the homing action is divided into two cases:

(a) Mechanical offset (P9-19, P9-20) is 0:

In the process of forward acceleration or forward constant speed operation, stop immediately when encountering the rising edge of the other side of the motor Z signal.



(b) Mechanical offset (P9-19, P9-20) is not 0:

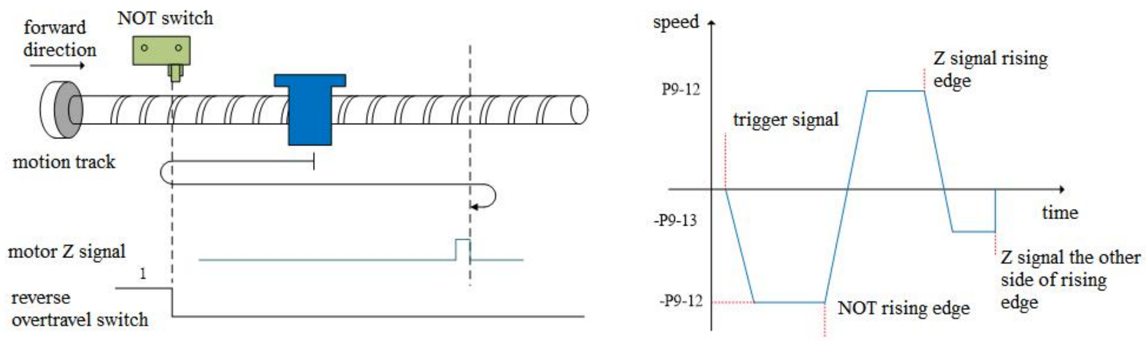
In the process of positive acceleration or positive constant speed operation, stop the machine immediately when encountering the rising edge on the other side of the motor Z signal. After the motor is completely stopped, the motor will walk a quantitative pulse (P9-19, P9-20) at the speed set by P9-12 (homing high speed) according to the set number and direction of mechanical offset pulses (either positive direction or negative direction), then the motor stops.

(2) When the motor starts to move, the Z signal is invalid or valid (P5-64 = 0-invalid, 1-valid), and the reverse overtravel switch is triggered in the process (NOT)

The servo motor searches for the Z signal at high speed -P9-12 (homing high speed) in reverse direction. After encountering the reverse overtravel switch, the driver decelerates and reverses according to P9-14, and then searches for the Z signal at high speed P9-12 (homing high speed) in forward direction until encountering the rising edge of the Z signal, and gradually decelerates and reverses (i.e. restores the reverse direction) according to the set value of P9-14 (homing acceleration and deceleration time). The servo motor searches the rising edge on the other side of the Z signal at low speed -P9-13 (homing low speed) in reverse direction. Next, the homing action is divided into two cases:

(a) Mechanical offset (P9-19, P9-20) is 0:

In the process of reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge of the other side of the Z signal.



(b) Mechanical offset (P9-19, P9-20) is not 0:

In the process of reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge on the other side of the motor Z signal. After the motor is completely stopped, the motor will walk a quantitative pulse (P9-19, P9-20) at the speed set by P9-12 (homing high speed) according to the set number and direction of mechanical offset pulses (either positive direction or negative direction), then the motor stops.

5. Homing mode 4——forward homing, deceleration point and origin are forward overtravel switch POT

(P5-22) (P9-11.2=4)

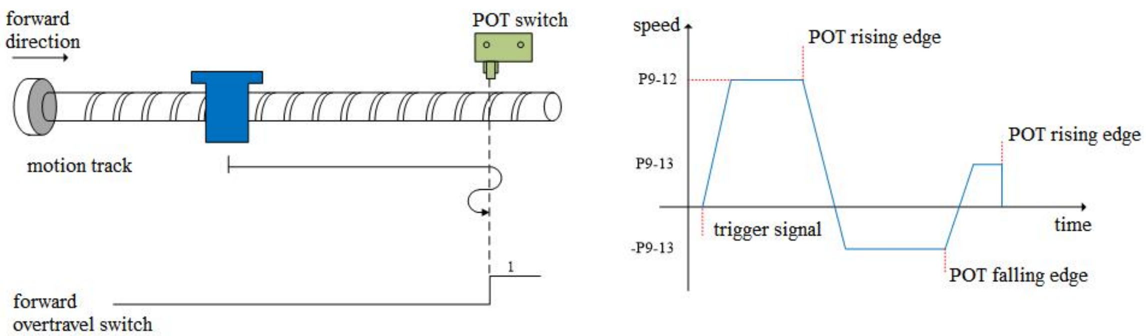
To use this mode, it needs to connect NOT, POT.

(1) When the motor starts moving, the forward overtravel switch (POT) is invalid

Firstly, the servo motor searches the forward overtravel switch at high speed P9-12 (homing high speed). After encountering the rising edge of the forward overtravel switch signal, it gradually decelerates in reverse according to the setting of P9-14 (homing acceleration and deceleration time). The servo motor searches the falling edge of the forward overtravel switch signal in reverse direction at low speed -P9-13 (homing low speed). After encountering the falling edge of the forward overtravel switch signal, the next action of returning to the origin can be divided into four cases:

(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:

Decelerate in the reverse direction (i.e. restore the forward direction), and search for the rising edge of the forward overtravel switch signal in the forward direction and low speed P9-13 (homing low speed). In the process of forward acceleration or forward constant speed operation, stop immediately when encountering the rising edge of the forward overtravel switch signal.

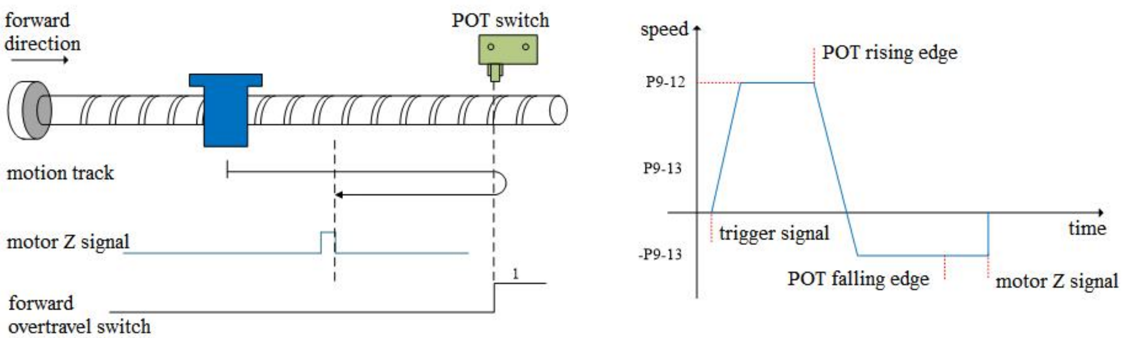


(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:

Decelerate in the reverse direction (i.e. restore the forward direction), and search the rising edge of the forward overtravel switch signal in the forward with low speed P9-13 (homing low speed). In the process of forward acceleration or forward uniform speed operation, stop immediately when encountering the rising edge of the forward overtravel switch signal. After the motor is completely stopped, motor walks a quantitative pulse at the speed set by P9-12 (homing high speed) according to the set number and direction of mechanical offset pulses (it can only be in the negative direction, that is, it must move between the origin switch and NOT), and then the motor will stop.

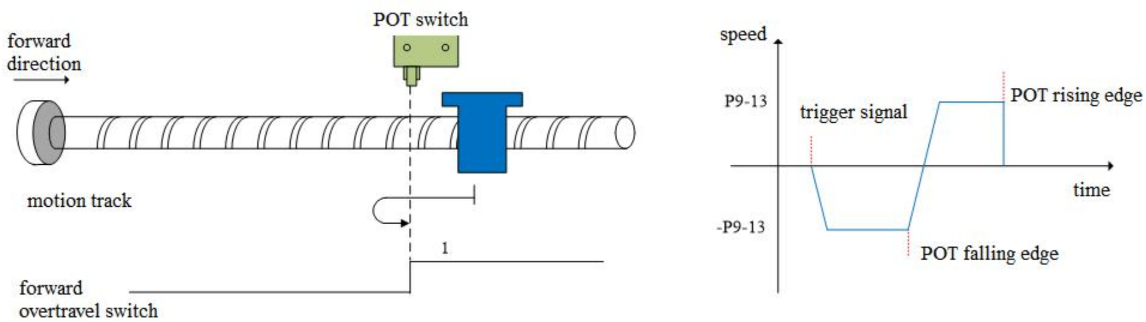
(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:

Continue to operate in reverse at the low speed set by -P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal.



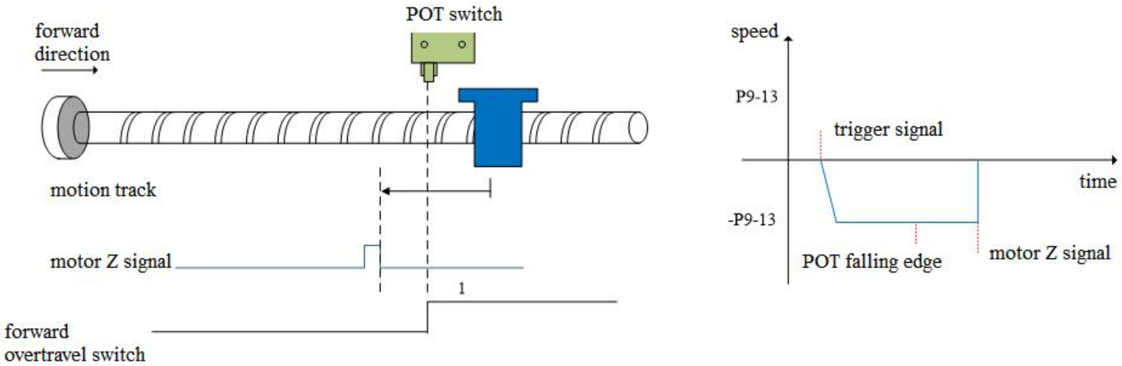
(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:
Continue to operate in the reverse direction at the low speed set by -P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal. After the motor stops completely, the motor will move a quantitative pulse at the speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (it can be negative or positive, but it must move between the origin switch and NOT), and then the motor stops.

(2) Forward overtravel switch is valid when motor starts moving (POT) (P5-22)
The servo motor directly searches for the falling edge of the forward overtravel switch signal (POT) at a reverse low speed -P9-13 (homing low speed). After encountering the falling edge of POT, the next homing action is divided into four cases:
(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:
Decelerate in the reverse direction (i.e. restore the forward direction), search for the rising edge of POT in the forward low-speed P9-13 (homing low speed), and stop immediately when encountering the rising edge of POT during forward acceleration or forward constant speed operation.



(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:
Decelerate in reverse direction (i.e. restore the positive direction), search the rising edge of POT at low speed and positive direction with P9-13 (homing low speed). In the process of positive acceleration or positive constant speed operation, stop immediately when encountering the rising edge of POT. After the motor stops completely, the motor will move a quantitative pulse at the speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (it only can be negative direction, but it must move between the origin switch and NOT), and then the motor stops.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:
Continue to operate in reverse at the low speed -P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal.



(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:
Continue to operate in the reverse direction at the low speed -P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal. After the motor stops completely, the motor will move a quantitative pulse at the speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (it can be negative or positive, but it must move between the origin switch and NOT), and then the motor stops.

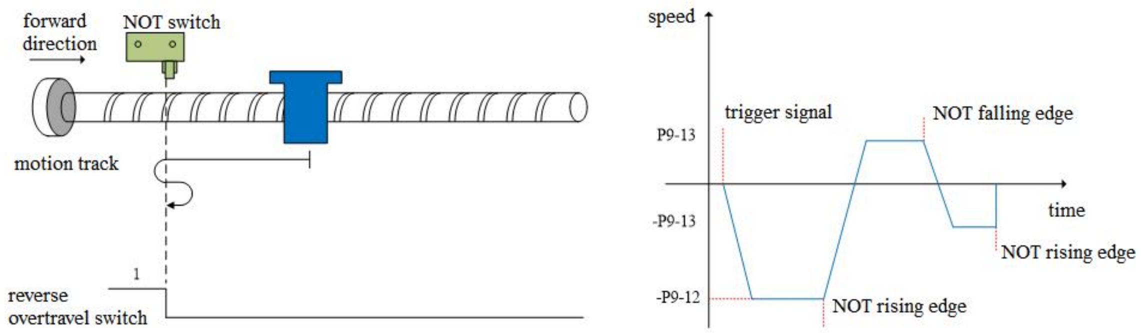
6. Homing mode 5——reverse homing, deceleration point and origin are reverse overtravel switch NOT (P5-23) (P9-11.2=5)

To use this mode, please connect POT, NOT.

(1) When the motor starts moving, the reverse override switch (NOT) is invalid

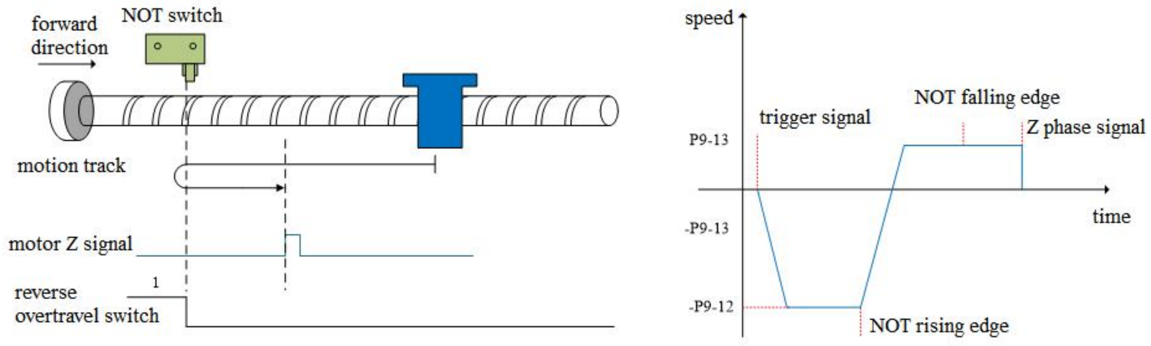
Firstly, the servo motor searches for the reverse overtravel switch (NOT) at reverse high speed -P9-12 (homing high speed). After encountering the rising edge of NOT, it gradually decelerates in reverse according to the setting of P9-14 (homing acceleration and deceleration time). The servo motor searches for the falling edge of NOT at forward low speed P9-13 (homing low speed). After encountering the falling edge of NOT, the next homing action can be divided into four cases:

(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:
Decelerate in the reverse direction (i.e. restore the reverse direction), and search for the rising edge of NOT at the reverse low speed -P9-13 (homing low speed). In the process of reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge of NOT.



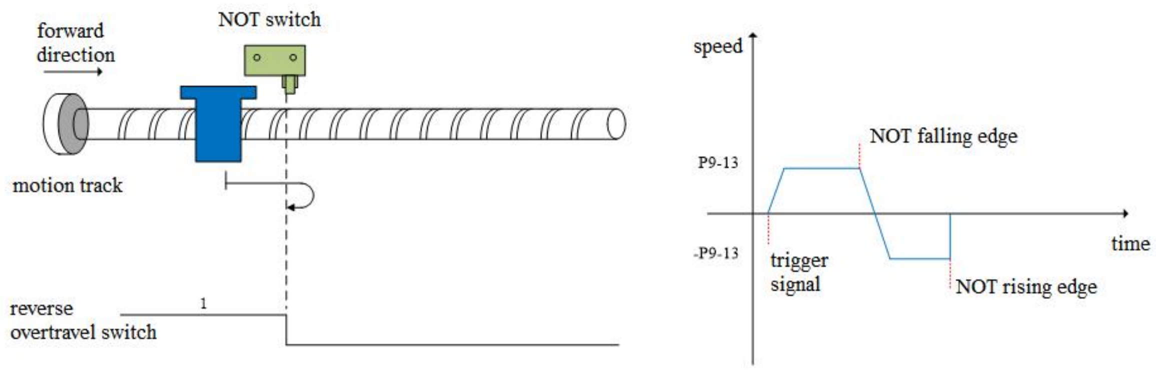
(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:
Decelerate in the reverse direction (i.e. restore the reverse direction), and search for the rising edge of the reverse overtravel switch signal (NOT) at the reverse low speed -P9-13 (homing low speed). In the process of reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge of NOT. After the motor stops completely, the motor will move a quantitative pulse at the speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (it only can be positive, but it must move between the origin switch and POT), and then the motor stops.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:
Continue to operate in the forward low-speed P9-13, and then stop immediately after encountering the rising edge of the first Z-phase signal.



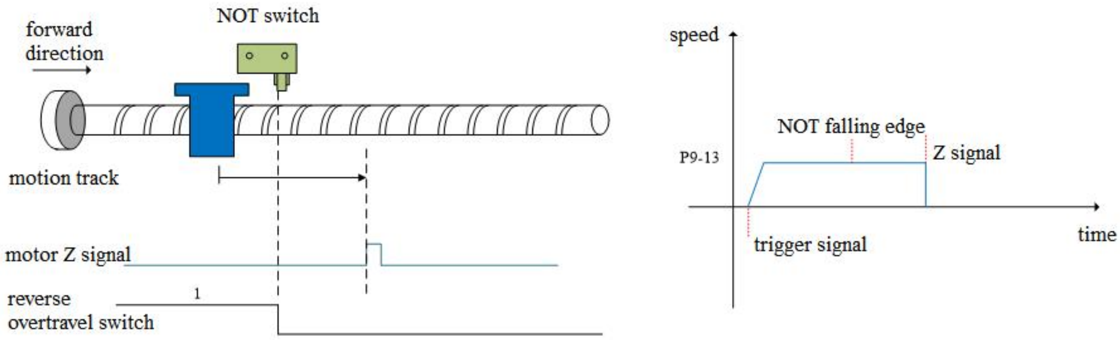
(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:
Continue to operate in the forward low-speed P9-13, and then stop immediately after encountering the rising edge of the first Z-phase signal. After the motor stops completely, the motor will move a quantitative pulse at the speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (it can be positive or negative), but it must move between the origin switch and POT), and then the motor stops.

(2) When the motor starts to move, the reverse overtravel switch (NOT) (P5-23) is valid
The servo motor directly searches for the falling edge of the reverse overtravel switch signal (NOT) at the forward low speed P9-13 (homing low speed). After encountering the falling edge of NOT, the next homing action is divided into four cases:
(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:
Decelerate in reverse direction (i.e. resume reverse direction), search for the rising edge of NOT in reverse direction at low speed -P9-13(homing low speed). During reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge of NOT.



(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:
Decelerate in reverse direction (i.e. recover in reverse direction), search for the rising edge of NOT in reverse direction at low speed -P9-13 (homing low speed). During reverse acceleration or reverse constant speed operation, stop immediately when encountering the rising edge of NOT. After the motor stops completely, the motor will move a quantitative pulse at the speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (it only can be positive), but it must move between the origin switch and POT), and then the motor stops.

(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:
Continue to operate at the forward low speed P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal.



(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:

Continue to operate at the forward low speed P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal. After the motor stops completely, the motor will move a quantitative pulse at the speed P9-12 (homing high speed) according to the set number of mechanical offset pulses and direction (it can be positive or negative, but it must move between the origin switch and POT), and then the motor stops.

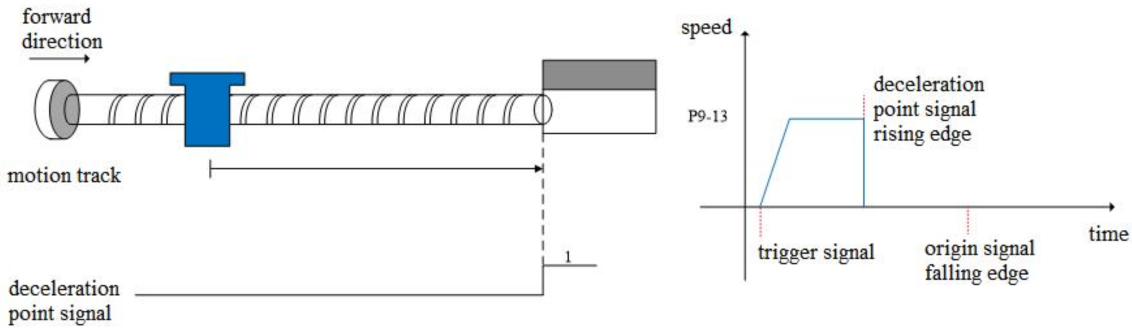
7. Homing mode 6——forward homing, deceleration point and origin are forward mechanical limit position (P9-11.2=6)

To use this mode, no need to connect POT, NOT and origin switch.

Firstly, the servo motor runs forward at low speed P9-13 (homing low speed). After hitting the mechanical limit position, if the absolute value of torque reaches the upper torque limit of P9-17 (touch stop homing mode torque threshold), and the absolute value of speed is lower than the set value of P9-16 (touch stop homing mode speed threshold), this state remains P9-18 (touch stop homing mode time threshold) After the set time, it is judged that the mechanical limit position is reached, and the next homing action can be divided into four cases:

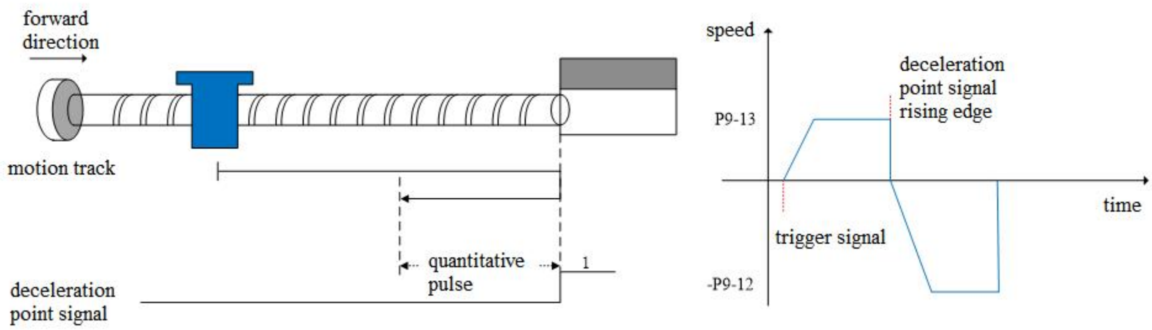
(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:

Shut down immediately.



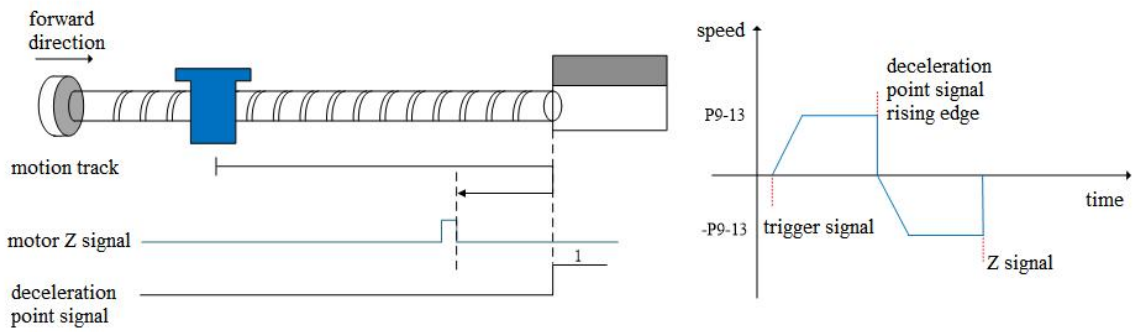
(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:

The servo motor stops immediately. After it stops completely, according to the set number of mechanical offset pulses, the motor reverse moves a quantitative pulse (P9-19, P9-20) at the speed set by -P9-12 (homing high speed), and then the motor stops.



(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:

Operate in reverse at the low speed set by -P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal.



(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:

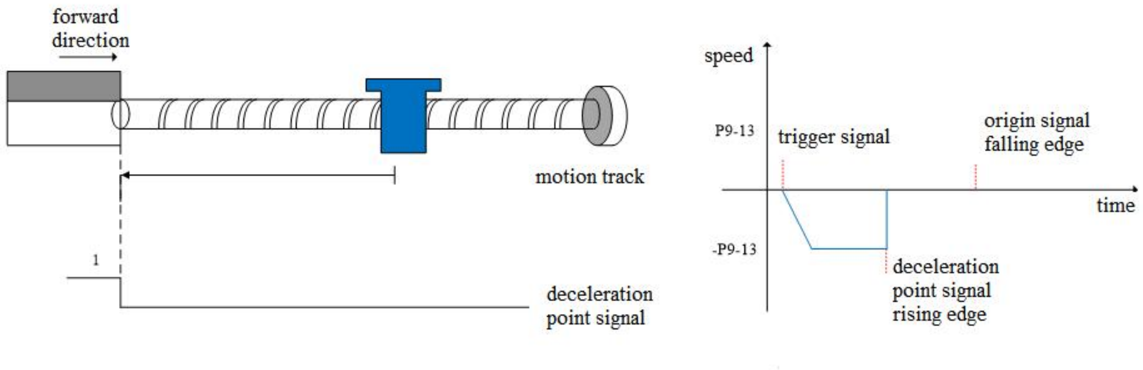
Run in reverse at the low speed set by -P9-13 (homing low speed), then stop immediately after encountering the rising edge of the first Z-phase signal, and then walk a quantitative pulse (it can run in positive direction or negative direction, but it must be within the mechanical limit position) at the speed set by -P9-12 (homing high speed) according to the set number of mechanical offset pulses after complete stop, and then the motor stops.

8. Homing mode 7——reverse homing, deceleration point and origin are reverse mechanical limit position (P9-11.2=7)

To use this mode, no need to connect POT, NOT and origin switch.

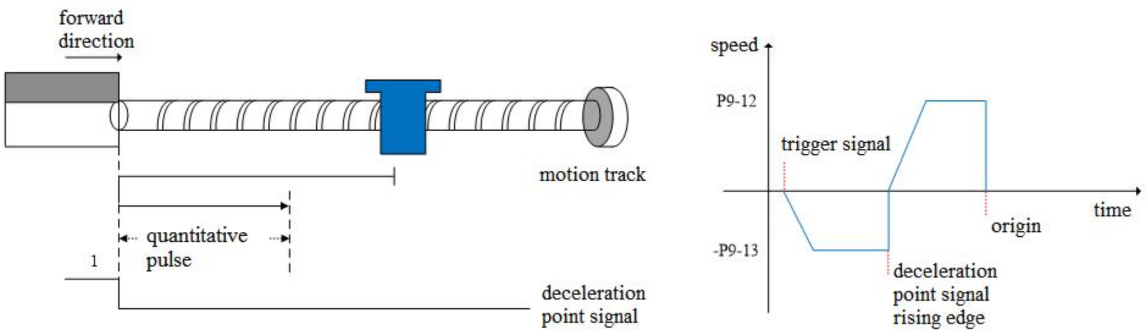
Firstly, the servo motor runs in reverse direction with the low speed -P9-13 (homing low speed). After hitting the mechanical limit position, if the absolute value of torque reaches the upper torque limit of P9-17 (touch stop homing mode torque threshold), and the absolute value of speed is lower than the set value of P9-16 (touch stop homing mode speed threshold), this state remains P9-18 (touch stop homing mode time threshold). After the set time, it is judged that the mechanical limit position is reached, and the next action of returning to the origin can be divided into four cases:

(a) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is 0:
Shut down immediately.



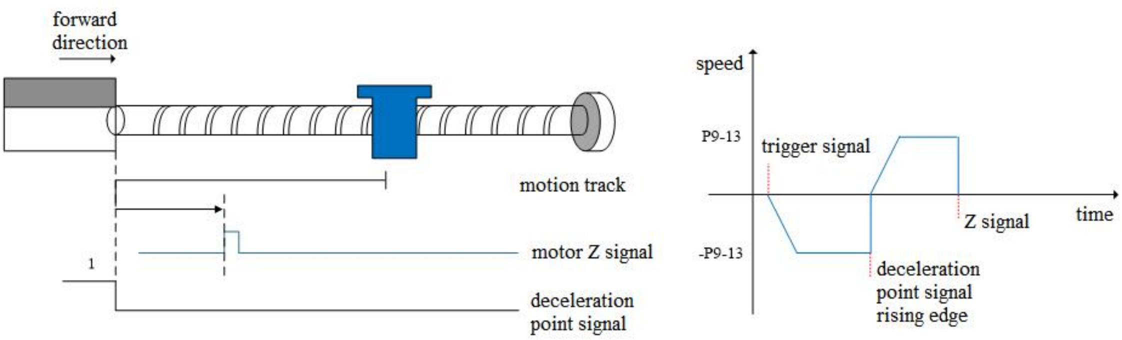
(b) Z phase number (P9-11.0) is 0 and mechanical offset (P9-19, P9-20) is not 0:

The servo motor stops immediately. After it stops completely, the motor moves forward a quantitative pulse (P9-19, P9-20) at the speed set by P9-12 (high speed back to the origin) according to the set number of mechanical offset pulses, and then the motor stops.



(c) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is 0:

Operate in the forward direction at the low speed P9-13 (homing low speed), and then stop immediately after encountering the rising edge of the first Z-phase signal.



(d) Z phase number (P9-11.0) is 1 and mechanical offset (P9-19, P9-20) is not 0:

Operate in the forward direction with low-speed P9-13 (homing low-speed), and then stop immediately after encountering the rising edge of the first Z-phase signal. After complete stop, the motor will walk a fixed pulse (P9-19, P9-20) at the speed set by P9-12 (homing high-speed) according to the set number of mechanical offset pulses (it can operate in positive direction or negative direction, but it must be within the mechanical limit position), and then the motor stops.

Note: only for homing mode 6 and 7.

For homing modes 6 and 7, once these two homing modes are triggered, the maximum torque during homing is 1.1 times of the set value of P9-17 (touch stop homing torque threshold). If the internal forward and reverse torque limits P3-28 and P3-29 are smaller than 1.1 times of the set value of P9-17 (touch stop homing torque threshold), the torque limit is the set value of P3-28 and P3-29. Similarly, if the external forward and reverse torque limits P3-30 and P3-31 are enabled, the actual torque limit is the minimum of the internal torque limit, the external torque limit and 1.1 times of the P9-17 set value.

Only when these two homing modes are triggered, 1.1 times of the set value of torque limit P9-17 (touch stop homing torque threshold) will take effect. If only the homing is enabled and (homing mode) P9-11.2 is 6 or 7, but the homing is not triggered, 1.1 times of the set value of torque limit P9-17 (touch stop homing torque threshold) will not take effect.

5.4.1.10 Upper computer homing function (CIA402)

■ Function description:

402 standard homing function in non ECAT mode of linear drive DL6.
1. In non ECAT mode and position control mode, when P9-21 is set to 2, it can homing in the following ways:
① P9-41.1=1, trigger the homing through the SI terminal.
② P9-41.1=2, the first power on enable will automatically trigger the homing.
③ P9-41.1=3, set F2-08=1, trigger homing. Set F2-08 to 2 to stop homing (F2-08 only supports writing through communication).
2. During the homing operation, other position commands (including the triggered homing signal) are blocked. After the homing is completed, the servo drive can respond to other position commands.
3. The homing mode is the same as the bus HM mode (except for the 35 and 37 modes), refer to the "EtherCAT Bus Control Mode ->HM Mode ->Homing Mode" section of the manual, and reference chapter: 7.5.3 HM Mode.

■ Parameter setting

Parameter	Name	Setting range	Meaning	Setting time	Effective time	Default value
P9-21	Homing selection	0-2	0: old homing function 1: new homing function 2: 402 standard homing function	Servo OFF	Repower on	2
P9-41.1	402 homing mode triggering method	0-3	0: Prohibit triggering homing 1: Trigger homing through SI terminal (P5-28) 2: After the first power on and enable, start homing 3: Trigger the homing through communication (F2-08)	Servo OFF	Servo ON	0
P9-42	402 homing mode	-2~37	Same as the homing method of bus HM	Servo OFF	Servo ON	1

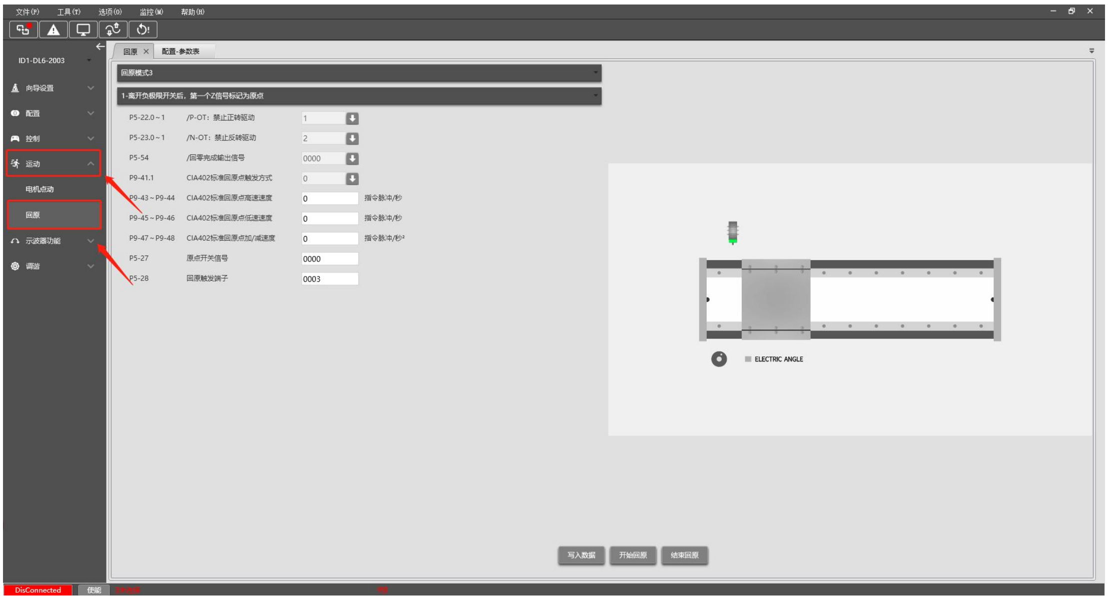
Parameter	Name	Setting range	Meaning	Setting time	Effective time	Default value
			mode			
P9-43~ P9-44	402 homing searching switch signal speed P9-43*1+P9-44*65535	0-65535	Unit: command unit/S	Servo OFF	Servo ON	0
P9-45~ P9-46	402 homing searching origin speed P9-45*1+P9-46*65535	0-65535	Unit: command unit/S	Servo OFF	Servo ON	0
P9-47~ P9-48	402 homing acceleration and deceleration speed P9-47*1+P9-48*65535	0-65535	Homing acceleration and deceleration speed Unit: command unit/S^2	Servo OFF	Servo ON	0

Parameter	Name	Setting range	Setting time	Effective time	Default value
P5-22	/P-OT: forward operation prohibited	0000-FFFF	Operation setting	At once	0001
P5-23	/N-OT: reverse operation prohibited	0000-FFFF	Operation setting	At once	0002
P5-27	Origin switch signal	0000-FFFF	Operation setting	At once	0003
P5-28	Homing triggering terminal	0000-FFFF	Operation setting	At once	0000
P5-54	Homing completion signal	0000-FFFF	Operation setting	At once	0000

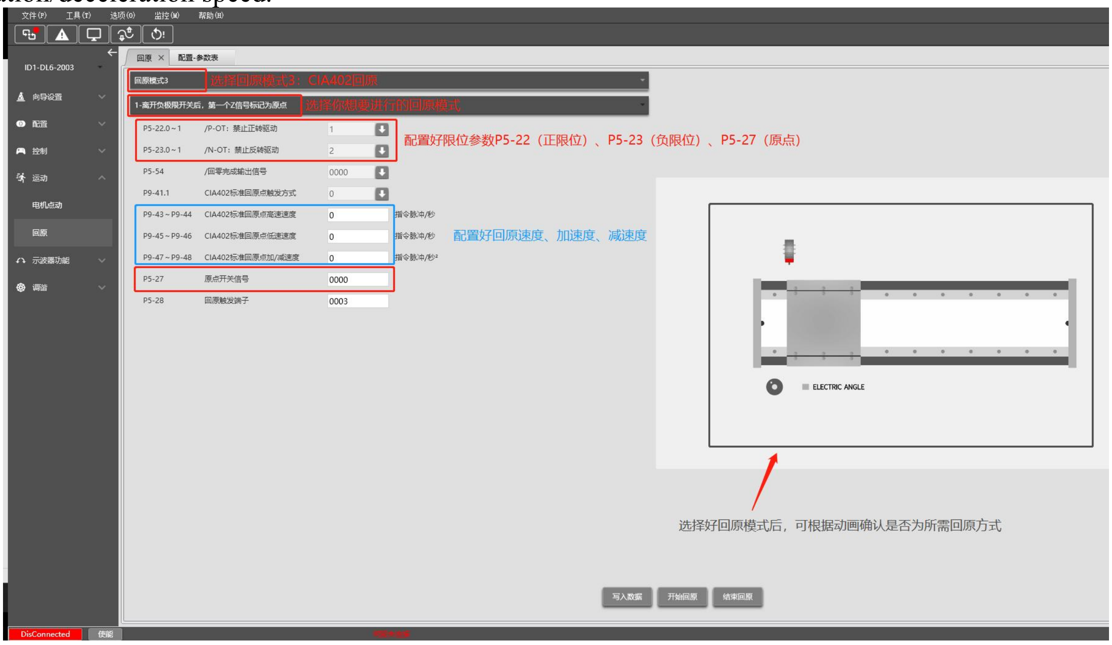
- P9-42 is bound to the 6098h object word, P9-43~P9-44 is bound to the 6099h01h object word, P9-45~P9-46 is bound to the 6099h02h object word, P9-47~P9-48 is bound to the 609Ah object word. After setting the P group parameters, the software synchronously changes the object words associated with the P group parameters.
- In non EtherCAT, 402 standard homing mode, the maximum speed limit during the homing process (original 6080h) is changed to the maximum speed in the motor parameters (U3-06), and the homing offset parameter (original 607Ch) is invalid.

■ Upper computer operation

① After connecting to the upper computer, click on "Motion" → "Homing", and the following interface will be displayed:



② Select Homing Mode 3: CIA402 Homing → Select Homing Mode -2~34 (After selecting the homing mode, you can watch the corresponding animation on the right side) → Configure the limit, homing speed, and acceleration/deceleration speed.



③ Select the corresponding homing trigger method (P9-41.1) → configure the homing completion output signal (P5-54) as required, homing trigger terminal (P5-28). After completing the configuration, you can click on write data, start or stop homing.

文件(F)
工具(T)
选项(O)
监控(M)
帮助(H)
ID1-DL6-2003
向导设置
配置
控制
运动
电机点动
回原
示波器功能
调谐
回原
配置-参数表
回原模式3
1-离开负极限开关后，第一个Z信号标记为原点
P5-22.0～1 /P-OT：禁止正转驱动 1
P5-23.0～1 /N-OT：禁止反转驱动 2
P5-54 /回零完成输出信号 0000
回原完成后，通过设置的SO端子输出信号
P9-41.1 CIA402标准回原点触发方式 0
可设置1：SI端子触发回原，2：上电第一次使能触发回原，3：F2-08触发/停止回原
P9-43～P9-44 CIA402标准回原点高速速度 0 指令脉冲/秒
P9-45～P9-46 CIA402标准回原点低速速度 0 指令脉冲/秒
P9-47～P9-48 CIA402标准回原点加/减速度 0 指令脉冲/秒²
P5-27 原点开关信号 0000
P5-28 回原触发端子 0003
若P9-41.1设置为1，需配置P5-28，通过外部端子触发回原
ELECTRIC ANGLE
配置完成后，可点击写入数据，开始回原/停止回原操作
写入数据
开始回原
结束回原
DisConnected
使能

5.4.2 Position control (external pulse command)

Parameter	Overview	Reference chapter
P0-01 control mode selection	Set to 6: external pulse mode	5.4.2.1
P0-10 pulse instruction form	Set the pulse form 0-CW/CCW 1-AB 2-P+D	5.4.2.3
P0-11 Set the number of pulses per polar distance of the motor *1 P0-12 Set the number of pulses per polar distance of the motor *10000 P0-13 Electronic gear ratio (numerator) P0-14 Electronic gear ratio (denominator) P0-92~P0-93 32-bit electronic gear ratio (numerator) P0-94~P0-95 32-bit electronic gear ratio (denominator)	Setting the number of command pulses required for the motor to operate at one polar distance P0-11 and P0-12=0, P0-13/P0-14 are effective P0-11～P0-14 are 0, P0-92~P0-95 are valid 32-bit electronic gear ratio (numerator): P0-92*1 + P0-93 *10000 32-bit electronic gear ratio denominator: P0-94*1 + P0-95 *10000	5.4.1.1
P0-09 Pulse command setting	You can set the command direction and filter time of low-speed pulse respectively	5.4.2.5

5.4.2.1 External pulse position mode

Parameter	Setting value	Meaning	Modify	Effective
P0-01	6	Control the position by external pulse	Servo OFF	At once

5.4.2.2 Pulse input specification

Pulse specification		Max input frequency	Voltage	Forward current
Low speed pulse	Open collector signal	200Kpps	24V	<25mA
	Differential signal	4MKpps	3.3~5V	<25mA

5.4.2.3 Pulse command form selection

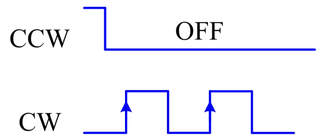
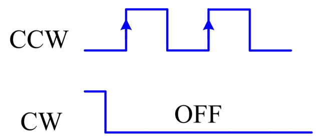
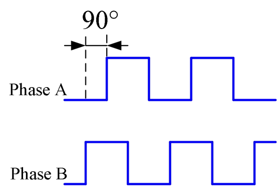
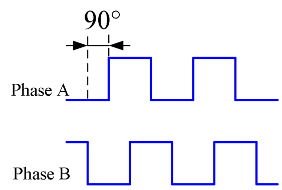
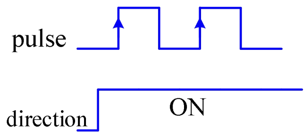
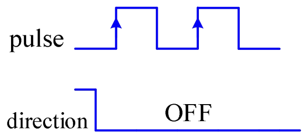
Set the pulse form received by the servo driver based on the upper computer or other pulse output devices:

- Double pulse (CW+CCW);
- A phase+B phase orthogonal pulse, 4-time frequency;
- Pulse+direction (positive or negative logic).

Parameter	Meaning	Setting	Meaning	Modify	Take effect
P0-10 n.xxx□	Pulse command form	0	CW, CCW mode	Servo OFF	At once
		1	AB phase		
		2	Pulse + direction (default)		
P0-10	Pulse	0	Falling edge is effective (default)	Servo OFF	At once

n.xx□x	signal effective edge	1	Rising edge is effective		

5.4.2.4 Pulse command logic form

P0-10.0	Forward rotation	Reverse rotation
0：CW/CCW		
1：AB		
2：P+D		

5.4.2.5 Pulse command forward direction selection

Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P0-09.0 n.xxx□	forward direction of pulse instruction	0	-	0/1	Servo OFF	Re-power on
P0-09 will change the counting direction of the internal counter in the servo system. The counting direction determines the rotation direction of the motor. Therefore, this parameter can be adjusted if the actual rotation direction of the motor is different from the expected direction in the position mode.						

Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P0-09.2 n.x□xx	Pulse command filter time	0	ns	0~4	Servo OFF	Re-power on
1.24V pulse: The pulse command filtering time can only be set to 3/4, and the pulse filtering time can enhance the anti-interference ability of low-speed pulses (within 200K). 2.5V differential pulse: When using 4M frequency pulse input, the pulse command filtering time can only be set to 0. P0-09.2 = 0: Turn off the noise filter. P0-09.2 = 1~4: Turn on the noise filter with a filtering time of 4^(n-1)/clk(ns). Clk=50m (ns) in speed mode and 100m (ns) in position mode.						

In AB phase input mode, the maximum receiving frequency hardware design is 4M, which means that for an encoder with a resolution of 1um, the maximum speed should not exceed 4M/s.

5.4.3 Position control (Internal command)

Parameter	Overview	Reference chapter
P0-01 control mode selection	Set to 5: internal position mode	5.4.3.1
P4-03 internal position mode P4-04 valid segment number P4-10~P4-254 internal position 1 to 35 parameters	Control mode setting of internal position mode: including step change mode, positioning mode and adjustment time Configuration of pulse displacement, speed, acceleration and deceleration time of each segment	5.4.3.3
P5-35 change step signal/GHGSTP P5-32 pause present segment signal /INHIBIT P5-31 jump present segment signal /Z-CLAMP	Common terminal function assignment	5.4.3.4 5.4.1.4 5.4.3.5
P4-00 number of Z-phase signal after leaving limit switch P4-01 speed of hitting the proximity switch P4-02 speed of leaving proximity switch P5-28 /SPD-A: find reference origin on forward side in position mode P5-29 /SPD-B: find reference origin on reverse side in position mode	Internal position back to origin setting parameters	5.4.1.8
F2-09 35 segments position setting	Set segment no. by communication	5.4.3.6

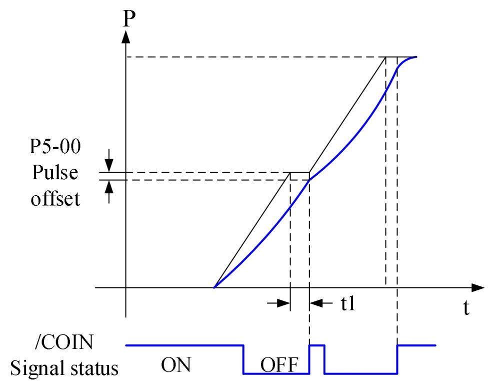
5.4.3.1 Internal position mode

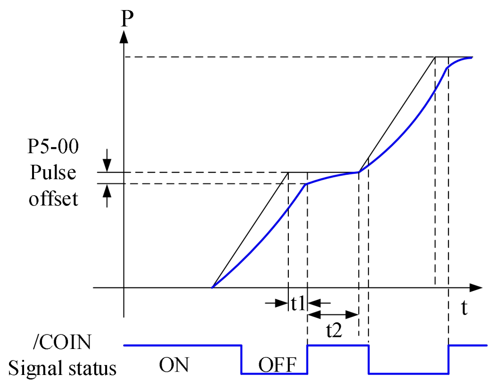
Parameter	Setting value	Meaning	Change	Effective
P0-01	5	Position control by preset values of internal registers in servo units	Servo bb	At once

5.4.3.2 Internal position mode setting

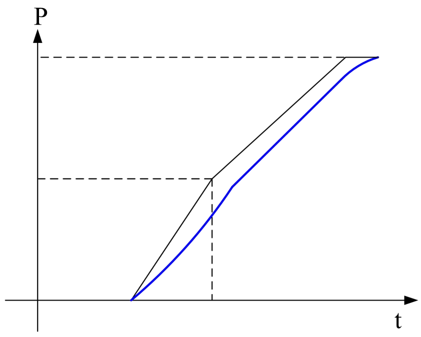
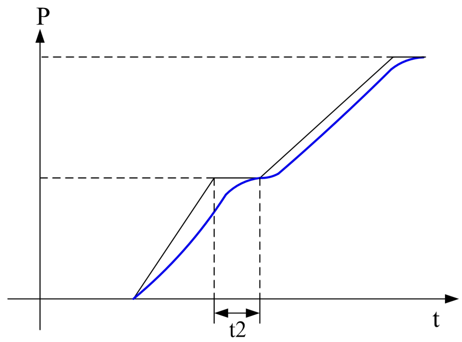
Parameter	Function	Unit	Default setting	Suitable mode	modify	Effective
P4-03	Internal position mode setting	—	n.0000	5	Servo bb	At once
	Parameter setting	Meaning	Default setting	Setting range		
	n.□xxx	No meaning				
	n.x□xx	Waiting mode	0	0~1		
	n.xx□x	Change step mode	0	0~6		
	n.xxx□	Positioning mode	0	0~1		

1. waiting mode

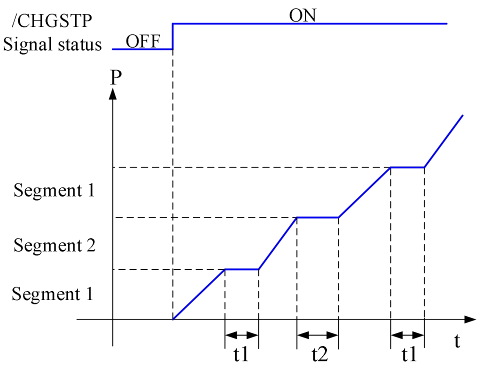
<table>
<tr><th>n.x□xx</th><th colspan="2">Meaning</th></tr>
<tr><td>0</td><td colspan="2">Wait for positioning completion</td></tr>
<tr><td>1</td><td colspan="2">Not wait for positioning completion</td></tr>
<tr><td colspan="3">Note: Waiting mode refers to whether the driver waits for the motor to be positioned after outputing a position instruction in internal position mode. It takes effect in all Step-Changing modes.</td></tr>
<tr><th colspan="2">Waiting mode=0, adjust time =0ms</th><th>Waiting mode =0, adjust time >0ms</th></tr>
<tr><td colspan="2">

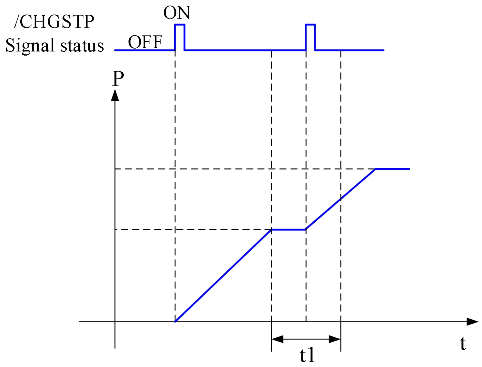
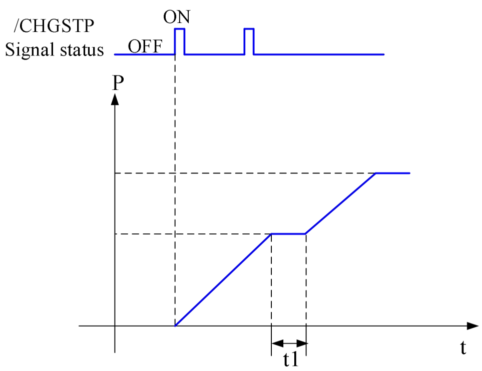
After the drive output 1-segment position command, it will wait for the completion of motor positioning, and then start the next position command at once. T1 is positioning time, which means the time from pulse output complete to the output of positioning completion signal.</td><td>

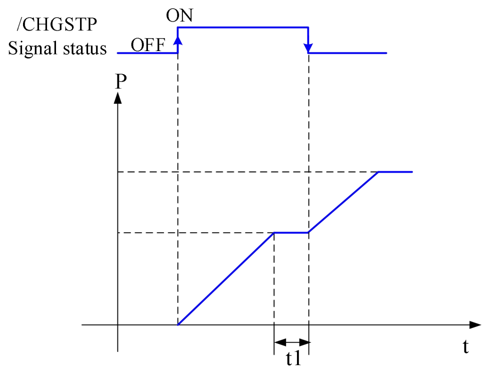
After the drive output 1-segment position command, it will wait for the completion of motor positioning, and pass the adjust time, then start the next position command. T1 is positioning time, t2 is adjust time. Refer to parameter P4-16.</td></tr>
<tr><th colspan="2">Wait mode = 1, adjust time = 0ms</th><th>Wait mode = 1, adjust time > 0ms</th></tr>
</table>

 After the drive output 1-segment position command, it will not wait for the completion of motor positioning, and start the next position command at once.	 After the drive output 1-segment position command, it will not wait for the completion of motor positioning, but pass the adjust time, and then start the next position command. T2 is adjust time. Refer to parameter P4-16.

2. change step mode

n.xx□x	Description	
0: Change the step when signal is ON, recycling	 	t1=P4-16, t2=P4-23. 1. If the /CHGSTP signal is always on, the servo unit will cycle the set position segment all the time. 2. If the /CHGSTP signal is set to off when executing a certain segment, the servo will continue to complete the execution of that segment without the execution of the next segment. 3. In this mode, the step change signal /CHGSTP is triggered at high level. 4. When the servo enable is off during a certain section of operation, the motor stops according to the servo off shutdown mode. After the shutdown, the positioning is invalid. 5. After each operation completion, positioning completion and positioning approach signal are all effective. 6. In this mode, the adjustment time of each period is valid.

n.xx□x	Description	
1: Change the step at the rising edge of the signal, single-step execution		Take setting two segments as an example, t1 = p4-16 in the figure. 1. Note that as shown in the figure, in this mode, the set adjustment time actually does not work. As long as the previous position command has been sent out, the next command will be entered immediately when a new step change signal arrives. 2. In this mode, the step change signal /CHGSTP is triggered by rising edge. 3. After each operation completion, positioning completion and positioning approach signal are all effective. 4. When the servo enable is off during a certain section of operation, the motor stops according to the servo off shutdown mode. After the shutdown, the positioning is invalid. 5. The adjustment time is not valid in this mode.
2: Start at the rising edge of the signal, sequential run all, not recycling		Take setting two segments as an example, t1 = p4-16 in the figure. 1. The /CHGSTP signal before the completion of a cycle will not be counted, as shown in the second /CHGSTP signal in the figure. 2. In this mode, the step change signal /CHGSTP is triggered by rising edge. 3. After each operation completion, positioning completion and positioning approach signal are all effective. 4. When the servo enable is off during a certain section of operation, the motor stops according to the servo off shutdown mode. After the shutdown, the positioning is invalid. 5. The adjustment time is valid in this

<table>
<tr><td></td><td></td><td>mode.</td></tr>
<tr><td>3: set segment no. through communication</td><td colspan="2">Servo is ON, set parameter P2-09=0, then set the running segment. The motor will run the setting segment. Refer to chapter 5.4.3.6</td></tr>
<tr><td>4: /CHGSTP double edge triggering</td><td>
</td><td>t1 = p4-16 in the figure.
1. /CHGSTP rising edge triggers the first segment and falling edge triggers the second segment. Where, if the first segment position is required to operate completely, the /CHGSTP signal remains on until the end of the first segment.
2. Only in this mode, the number of p4-04 valid segments is invalid.
3. After each operation completion, positioning completion and positioning approach signal are all effective.
4. When the servo enable is off during a certain section of operation, the motor stops according to the servo off shutdown mode. After the shutdown, the positioning is invalid.
5. The adjustment time is not valid in this mode.
6. Before using this mode, p5-35 terminals need to be allocated first, but not when using this mode.</td></tr>
<tr><td>5: /PREFA(P5-57) /PREFB(P5-58) /PREFC(P5-59) Choose the</td><td colspan="2"><table>
<tr><th>/PREFC</th><th>/PREFB</th><th>/PREFA</th><th>Segment no.</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1 (segment 1 position)</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2 (segment 2 position)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>3 (segment 3 position)</td></tr>
</table>
1. After each operation completion, positioning completion and positioning approach signal are all effective.</td></tr>
</table>

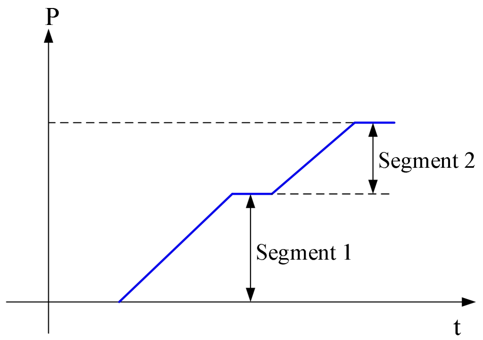
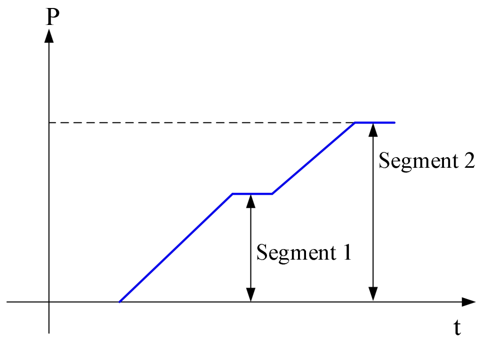
<table>
<tr>
<td>segment through terminal, the range is segment 1~3</td>
<td>2. When the servo enable is off during a certain section of operation, the motor stops according to the servo off shutdown mode. After the shutdown, the positioning is invalid.
3. The adjustment time is valid in this mode.
4. /CHGSTP signal is invalid only in this mode.
5. The segment number selection terminal can not only trigger the step change at the edge, but also keep on state. This mode supports continuous and repeated triggering of a certain segment. If the segment number selection terminal remains on, the motor stops after encountering the overtravel signal, it is necessary to change the segment number selection terminal to off, otherwise, the motor will execute the position segment after the overtravel signal is cancelled.</td>
</tr>
<tr>
<td>6: /PREFA(P5 -57) /PREFB(P5 -58) /PREFC(P5 -59) /PREFD(P5 -60) Choose the segment through terminal, the range is segment 1~16.</td>
<td>
<table>
<tr><th>/PREFD</th><th>/PREFC</th><th>/PREFB</th><th>/PREFA</th><th>Segment no.</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1 (segment 1 position)</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>2 (segment 2 position)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>3 (segment 3 position)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>4 (segment 4 position)</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>5 (segment 5 position)</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>6 (segment 6 position)</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>7 (segment 7 position)</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>8 (segment 8 position)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>9 (segment 1 position)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>10 (segment 2 position)</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>11 (segment 3 position)</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>12 (segment 4 position)</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td>13 (segment 5 position)</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>14 (segment 6 position)</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td><td>15 (segment 7 position)</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>16 (segment 8 position)</td></tr>
</table>
Note: the rising edge of P5-35 step change signal triggers each position (the rising edge is invalid during operation).
1. When the servo enable is off during a certain section of operation, the motor stops according to the servo off shutdown mode. After the shutdown, the positioning is invalid.
2. The adjustment time is not valid in this mode.
3. After each operation completion, positioning completion and positioning approach signal are all effective.
4. After the segment number is selected, the rising edge of P5-35/CHGSTP step change signal is required to trigger to run the position segment, and the step change triggering during segment operation is invalid.
5. Segment number selection terminal logic is voltage level valid. Input high voltage level is valid, input low voltage level is invalid.</td>
</tr>
</table>

The following input signal can switch the segment 1 to 3 or 1 to 16:

Parameter	Signal name	Default setting	Suitable mode	Setting range	Modify	Effective
P5-57	/PREFA	n.0000	5	Range 0000-0017,	Anytime	At once

	internal position segment 1			distribute to input terminal through P5-57		
P5-58	/PREFB internal position segment 2	n.0000	5	Range 0000-0017, distribute to input terminal through P5-58		
P5-59	/PREFC internal position segment 3	n.0000	5	Range 0000-0017, distribute to input terminal through P5-59		
P5-60	/PREFD internal position segment 4	n.0000	5	Range 0000-0017, distribute to input terminal through P5-60		

3. Positioning mode

<table>
<tr><th>n.xxx□</th><th colspan="2">Meaning</th></tr>
<tr><td>0</td><td colspan="2">Relative positioning</td></tr>
<tr><td>1</td><td colspan="2">Absolute positioning</td></tr>
<tr><td colspan="2">0: relative positioning</td><td>1: absolute positioning
(take the reference origin as the absolute positioning origin)</td></tr>
<tr><td colspan="2">
</td><td>
</td></tr>
</table>

5.4.3.3 Position segment 1 to 35 parameter settings

Parameter	Meaning	Default setting	Unit	Range	Change	Effective
P4-10+（n-1）*7	Pulse number (low bit)	0	1 pulse	-9999～9999	Anytime	At once
P4-11+（n-1）*7	Pulse number (high bit)	0	10000 pulses	-32767～32767	Anytime	At once
P4-12+（n-1）*7	Speed	0	0.1rpm	0～65535	Anytime	At once
P4-13+（n-1）*7	Trapezoid acceleration time	0	ms	0～65535	Anytime	At once
P4-14+（n-1）*7	Trapezoid deceleration time	0	ms	0～65535	Anytime	At once

P4-15+（n-1）*7	Reserved	-				
P4-16+（n-1）*7	Adjust time	0	ms	0～65535	Anytime	At once

Notes:

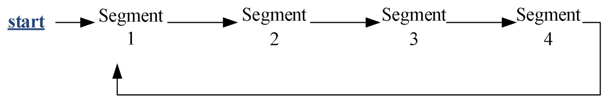
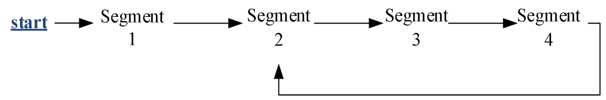
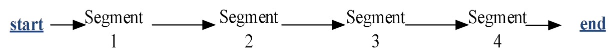
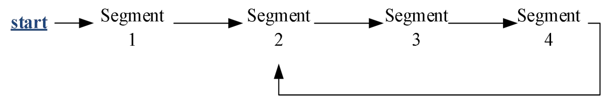
1. Set pulse number = pulse number (high bit) ×10000 + pulse number (low bit).
2. In formula P4-10+(n-1)*7, n is the segment no. of internal position; the range is 1~35. Segment 1~12 can be set through the operate panel, segment 13~35 needs to write in parameters through communication (RS232 or RS485).
3. In the relative positioning mode, if the pulse high position is set to 9999, the pulse low position is set to 9999, or the pulse high position is set to - 9999, and the pulse low position is set to - 9999, and p4-03.3 = 1 (do not wait for the positioning to be completed), the infinite pulse mode will be entered. On the contrary, the number of pulses is limited.
4. If one of the segment speed is zero, servo will skip this segment and run the next segment.
5. In relative positioning mode, if one segment speed is not zero but the pulse number is zero, the motor will not run, but the wait mode is effective. The servo will run the next segment when the adjust time is out.
6. In absolute positioning mode, if one segment speed is not zero but the pulse number is zero, the motor will return to the reference origin with the speed of this segment.
7. In absolute positioning mode, if two consecutive segments speed are not zero, but the pulse number is the same, the servo motor will not run but the wait mode is effective.
8. In the absolute positioning mode, the number of rotations of the motor is limited and cannot be unlimited.
9. At present, there are only two kinds of velocity in the internal position mode: step speed and slope speed. When the trapezoidal acceleration time and trapezoidal deceleration time are set to 0, it is in the form of step speed. When the trapezoidal acceleration time and trapezoidal deceleration time are greater than 0, it is in the form of slope speed.
10. Trapezoidal acceleration time and trapezoidal deceleration time refer to the time required to change from 0 to rated speed.
11. If the speed of a certain parameter set is 0, the position command of this section will be ignored in the step change mode of 0 / 1 / 2. However, in the mode of 4 / 5 / 6, the motor does not rotate when the step change is triggered at this section.
12. In the internal position section parameters, the position commands of pulse settings are still affected by the electronic gear ratio. The actual number of turns of the motor should be determined by combining the set pulse command and the electronic gear ratio.
13. In the absolute positioning mode, the starting position of each step change is based on the starting position of the first triggering step change. In the relative positioning mode, the starting position of each step change is based on the position at the end of the last step change.
14. In the relative positioning mode, the infinite pulse position segment can be set in the 35 segment positions. The motor will run continuously in this segment, unless the trigger skips the current segment.

Parameter	Meaning	Default setting	Range	Change	Effective
P4-04	Effective segment	0	0～35	Servo bb	At once

There are 35 sections in total in the internal position. If 10 sections need to be operated and 5 sections need to be operated switched for use due to process requirements, the effective segment can be set. For example, parameters are set for sections 1-10, and P4-04 is set to 5, that is, the position of section 1-5 is valid; if it is set to 10, the position of section 1-10 is valid.

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P4-08	Internal position mode start segment number	1	-	0～35	Servo bb	At once

P4-08 sets the starting operation section number after the first round, and it is valid when the change mode P4-03.1 is set to 0 and 1. The settings are explained below, and valid values are set for No.1-No.8 sections.

Change step mode	Setting	Parameter	Actions
P4-03.1=0	P4-08=0 or P4-08>P4-04	P4-08=8 P4-04=4	
	1≤P4-08≤P4-04	P4-08=2 P4-04=4	
P4-03.1=1	P4-08=0 or P4-08>P4-04	P4-08=8 P4-04=4	
	1≤P4-08≤P4-04	P4-08=2 P4-04=4	

When using skip current segment function, the SI terminal assigned by P5-31 needs rising edge trigger.

5.4.3.4 Change step signal (/CHGSTP)

Parameter	Name	Setting	Meaning	Range
P5-35	Change step signal /CHGSTP	n.0000	Defaulted is not distribute to input terminal. Refer to chapter 5.4.3.2.	Range: 0000-0017. Distribute to input terminal through P5-35. When it set to 0001, it means input from SI1.

5.4.3.5 Skip present segment signal (/ZCLAMP)

Parameter	Signal name	Setting	Meaning	Range
P5-31	Skip the present segment /Z-CLAMP	n.0000	Defaulted is not distribute to input terminal.	Range: 0000-0017. Distribute to input terminal through P5-31. When it set to 0001, it means input from SI1.

In different Step-Changing modes, the function of skipping the current segment will have different effects, as follows:

Change step mode P4-03 n.xx□x	Skip the present segment	Actions
0	/Z-CLAMP	Cancel current segment, execute the next segment at once
1		Cancel current segment, execute the next segment when the change step signal is ON
2		Cancel current segment, execute the next segment at once
3		Cancel current segment, set the F2-09 again
4		The current segment is cancelled and the next segment is executed on the falling edge of the /CHGSTP step change signal
5		If the current segment is cancelled, the corresponding segment will be executed after selecting other segments
6		The current segment is cancelled, the selected position segment is executed at the rising edge of /CHGSTP step signal

5.4.3.6 Set segment through communication

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
F2-09	Set the segment number through communication	0	-	0～35	Anytime	At once
If this parameter is set to a certain segment number, this segment position will be executed without step change signal. Parameters need to be modified through communication. Suggestion: After modifying the F2-09 assignment, it will automatically reset to zero. Simply assign the value. To ensure the normal operation of the data and prevent conflicts between the cache and the current segment, use a rising edge for communication instruction to prevent multiple triggering.						

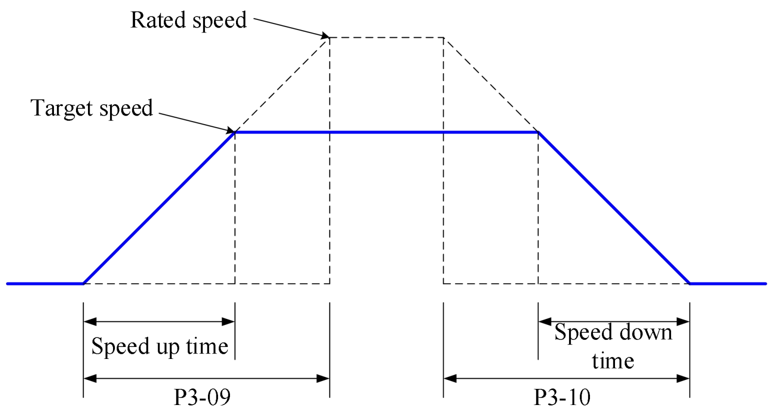
5.4.3.7 Motion start signal (/MRUN)

Parameter	Signal name	Default setting	Meaning	Modify
P5-50	Motion start /MRUN	n.0000	Terminal output is not assigned by default. It is only valid in the internal position mode, similar to the positioning completion signal in the external pulse mode; there is output when the motor is running, and there is no output when the motor stops.	Parameter range 0000-0014, assigned to the output interface through parameter P5-50. When it is set to 0001, the signal is output from SO1 terminal.

5.5 Speed control

5.5.1 Speed mode general control

5.5.1.1 Soft start

<table>
<tr><th>Parameter</th><th>Meaning</th><th>Defaulted setting</th><th>Unit</th><th>Range</th><th>Modify</th><th>Effective</th></tr>
<tr><td>P3-09</td><td>Soft Start Acceleration Time</td><td>200</td><td>ms</td><td>0～65535</td><td>Servo bb</td><td>At once</td></tr>
<tr><td>P3-10</td><td>Soft Start deceleration Time</td><td>200</td><td>ms</td><td>0～65535</td><td>Servo bb</td><td>At once</td></tr>
<tr><td colspan="7">Soft start acceleration and deceleration time is suitable for mode 3/4/7. Smooth speed control can be carried out when step speed instruction is input or internal setting speed is selected.
P3-09: Time from stop to rated speed
P3-10: Time from rated speed to stop

</td></tr>
</table>

5.5.1.2 Zero clamp (/ZCLAMP)

1. Overview

This function is used when host controller uses speed command input and the servo system isn't configured the position loop. In other words, the function will be used when the motor must stop and enter lock state even the V-REF input voltage is not zero.

When set ON the zero clamp function, it will configure the position loop inside the servo, the motor will do zero clamp within ±1 pulse at this position. The motor will return to zero clamp position even it is run by external force.

The present speed must be smaller than zero clamp speed when using zero clamp function, it can clamp the motor shaft from moving. The motor will switch from speed mode to position mode when starting the zero clamp function. At this time, rotate the motor shaft, it will return to the original position. It will not return to original position in speed mode, because it has no position feedback.

2. Input signal setting

Parameter	Signal	Setting	Meaning	Range
P5-31	Zero clamp /ZCLAMP	n.0000 (default)	Defaulted is not distribute to input terminal	/Z-CLAMP signal is distributed to input terminal by parameter P5-31, Range: 0000-0017.
		n.0002	Input signal from SI2 terminal	

3. Parameter setting

parameter	Meaning	Default setting	Unit	Range	Change	Effective
P3-13	Zero clamp speed	10	mm/s	0～300	Servo bb	At once
P3-12	Zero clamp mode	0	-	0～3	Servo bb	At once

P3-12 setting	Contents
0	ZCLAMP input signal is ON, forced speed command is 0, when the speed below P3-13, switch to position mode and the servo lock in this position.
1	ZCLAMP input signal is ON, forced set the speed command to 0.
2	ZCLAMP input signal is ON, the speed below P3-13, switch to position mode and the servo lock in the position. Note: after entering zero clamp mode, present setting speed is higher than P3-13, motor doesn't run, the ZCLAMP signal must be OFF, then motor will run again.
3	ZCLAMP signal is ON, the setting speed is less than P3-13, switch to position control mode, and servo is locked at this position. At this time, if setting speed is over P3-13, the motor will run again.

5.5.1.3 Speed reach signal (/V-RDY)

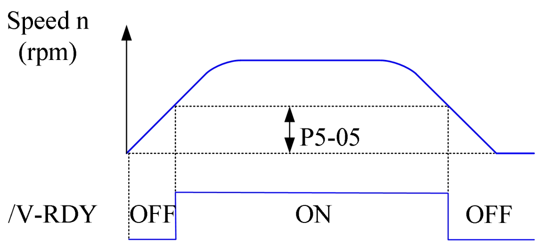
■ Related parameter

Parameter	Signal	Default setting	Suitable mode	Meaning	Modify	Effective
P5-51	/V-RDY	n.0000	3, 4, 7	Speed reach signal	Anytime	At once

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P5-05	Reach speed	1000	mm/s	0~10000	Anytime	At once

Speed arrival signal output condition

When the actual motor speed is greater than P5-05, output speed reach signal (/V-RDY).

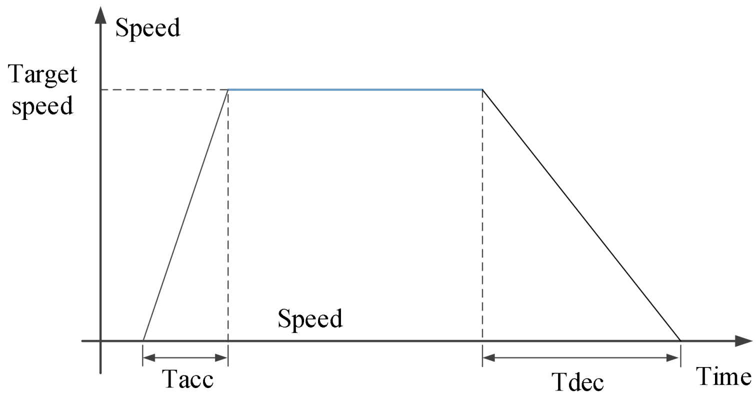


5.5.1.4 Speed command filter

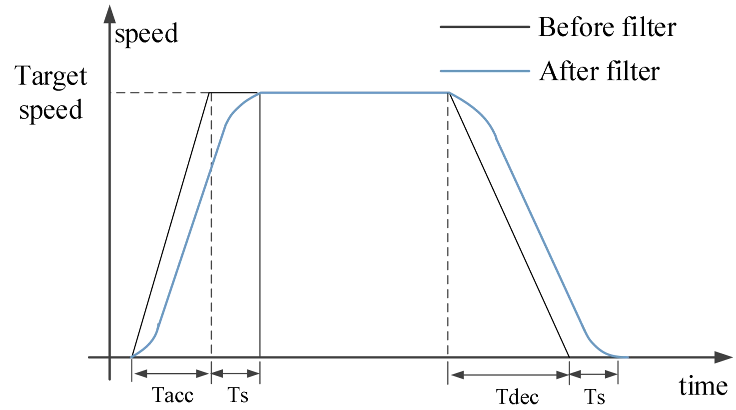
■ Related parameter

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P1-23	Speed command filter time	0	0.1ms	0~65535	Servo bb	At once
P3-09	Acceleration time	200	1ms	0~65535	Servo bb	At once
P3-10	Deceleration time	200	1ms	0~65535	Servo bb	At once
P3-11	Moving average filtering time constant	0	0.1ms	0~65535	Servo bb	At once

Firstly, set P3-09 and P3-10. Plan the speed command acceleration and deceleration time.

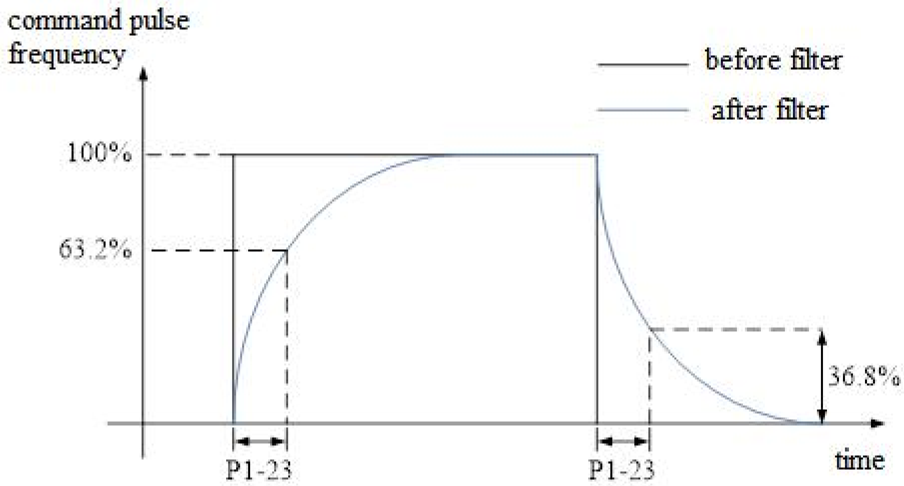


Among them, the acceleration time Tacc=(target speed/rated speed) * P3-09 [ms], and the deceleration time Tdec=(target speed/rated speed) * P3-10 [ms].
Set an appropriate sliding average filtering time constant P3-11 (S-type acceleration and deceleration time constant). Ts=P3-11*0.1 [ms].



Note: The setting of the sliding average filtering time constant must meet the requirements, Ts<0.5 * Tacc, Ts<0.5*Tdec. Otherwise, excessive sliding average filtering time will result in an increase in deceleration time, which does not comply with the settings of P3-09 and P3-10.

When P3-09 and P3-10 are set to 0, setting the sliding average filtering time will change the speed command into a trapezoidal acceleration/deceleration speed command. Set P1-23 (speed command filtering time constant) and P1-24 (first-order low-pass filtering time constant), and the effect is as follows:



Note: If acceleration and deceleration are set, the first-order low-pass filtering will increase the lag of the speed command.

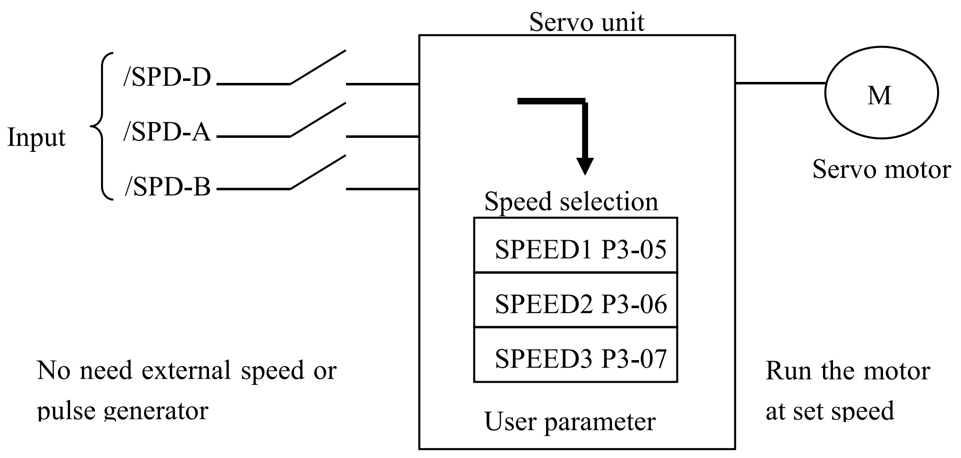
5.5.2 Speed control (internal speed)

Parameter	Overview	Chapter
P0-01 Control mode selection	Set to 3: internal speed control mode	5.5.2.1
P3-05 Internal speed 1 P3-06 Internal speed 2 P3-07 Internal speed 3	Speed value setting of internal 3-segment speed in rpm	5.5.2.1
P5-28 internal speed selection /SPD-A P5-29 internal speed selection /SPD-B	The combination of terminals determines the speed of corresponding section	5.5.2.1
P5-27 internal speed direction selection /SPD-D	Direction changing, default is n.0000 If the direction changing is given through SI2 terminal, P5-27 can be set to n.0002	5.5.2.1
P3-09 soft start acceleration time P3-10 soft start deceleration time	Set acceleration and deceleration time in ms	5.5.1.1

5.5.2.1 Internal speed mode

Parameter	Set value	Meaning	Modify	Effective
P0-01	3	Speed control: internal speed selection	Servo bb	At once

Function: internal speed selection will set 3 motor speeds and select the speed by external signal. It is no need to configure external speed generator or pulse generator.



■ Related parameter

Parameter	Meaning	Defaulted setting	Unit	Range	Modify	Effective
P3-05	Internal speed 1	0	mm/s	-9999～+9999	Anytime	At once
P3-06	Internal speed 2	0	mm/s	-9999～+9999	Anytime	At once

P3-07	Internal speed 3	0	mm/s	-9999～+9999	Anytime	At once

Parameter	Signal	Default setting	Range	Modify	Effective
P5-27	Internal direction /SPD-D	n.0000	Range: 0000-0017. Distribute to input terminal through P5-27.	Anytime	At once
P5-28	Internal speed /SPD-A	n.0000	Range: 0000-0017. Distribute to input terminal through P5-28.		
P5-29	Internal speed /SPD-B	n.0000	Range: 0000-0017. Distribute to input terminal through P5-29.		

1. Correlation between running speed and terminal signal

Input signal			Running speed
SPD-D（P5-27）	SPD-A （P5-28）	SPD-B （P5-29）	
0: forward run	0	0	Internal speed is zero
	0	1	P3-05：SPEED1
	1	1	P3-06：SPEED2
	1	0	P3-07：SPEED3
1: reverse run	0	0	Internal speed is zero
	0	1	P3-05：SPEED1
	1	1	P3-06：SPEED2
	1	0	P3-07：SPEED3

Note:

(1) /SPD-D signal is direction control, input SI terminal can be changed according to P5-27. The validity of the terminal signal determines the direction of the motor.

(2) The combination of /SPD-A and /SPD-B input terminal effectiveness determines the multi segment speed

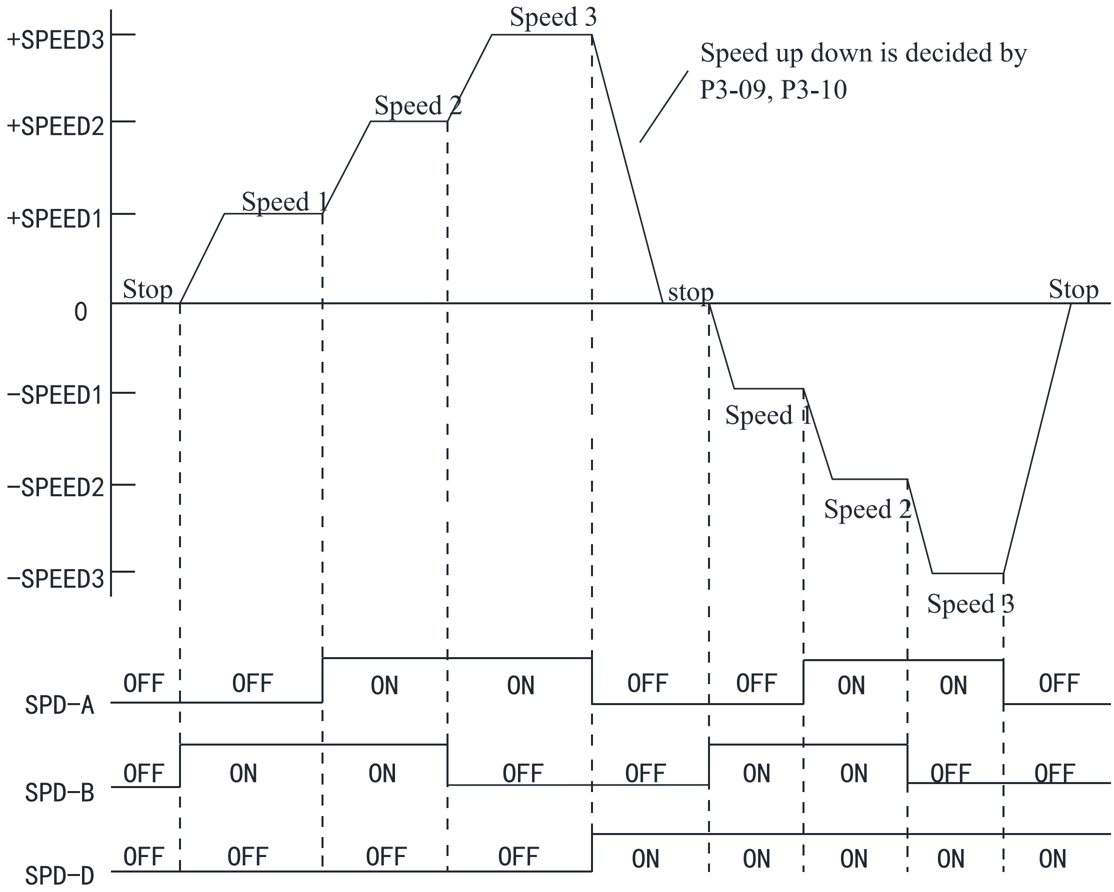
(3) 0/1 of the above table represent the validity of the signal. The 0-bit terminal input is invalid. 1 is the terminal input valid.

2. Terminal effectiveness description

The following table takes /SPD-D as an example, /SPD-A, /SPD-B signals are the same.

Parameter setting	Signal/SPD-D terminal input status	Signal/SPD-D terminal logic
P5-27=n.0000	No need external terminal input	Invalid
P5-27=n.000□	SI□ terminal no signal input	
P5-27=n.001□	SI□ terminal has signal input	
P5-27=n.0010	No need external terminal input	Valid
P5-27=n.000□	SI□ terminal has signal input	
P5-27=n.001□	SI□ terminal no signal input	

3. Running example



5.5.3 Speed control (pulse frequency command)

Parameter	Overview	Reference chapter
P0-01 Control mode selection	Set to 7: external pulse speed mode	5.5.3.1
P0-10 Pulse command form	Set pulse form 0-CW/CCW 2-P+D	5.5.2.2
P0-15 Command pulse frequency at rated speed	Determine the linear relationship between the command pulse frequency and the speed	5.5.3.3
P0-16 Speed command pulse filter time	When the command pulse frequency is relatively low, setting this parameter properly can reduce the speed fluctuation	5.5.3.4
P5-71 Function selection of direction terminal in pulse speed mode	change the pulse direction	5.5.3.5

5.5.3.1 External pulse speed mode

Parameter	Setting value	Meaning	Modify	Effective
P0-01	7	Speed control: pulse frequency speed command	Servo bb	At once
Function: speed command is decided by external pulse frequency, but not related to pulse quantity. The wiring is the same as position command. Select CW, CCW mode or direction + pulse mode, AB phase pulse mode.				

5.5.3.2 Pulse frequency command

Pulse frequency command is the same as external pulse command position control, refer to chapter 5-4-2.

5.5.3.3 Command pulse frequency at rated speed

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P0-15	command pulse frequency at rated speed	1000	100Hz	0~10000	Servo bb	At once
Note: the unit is 100Hz. Example: P0-15=300, command pulse frequency at rated speed=30kHz; P0-15=1000, command pulse frequency at rated speed= 100kHz.						

5.5.3.4 Speed command pulse filter time

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P0-16	speed command pulse filter time	100	0.01ms	0~10000	Servo bb	At once
When the command pulse frequency is low, setting a suitable value for this parameter can decrease the speed fluctuation.						

5.5.3.5 Speed command pulse direction

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P5-71	Function selection of direction terminal in pulse speed mode	0	-	0~1	Servo bb	At once

5.6 Torque control

Parameter	Overview	Reference chapter
P0-01 Control mode selection	Set to 1: internal torque mode	5.6.1
P3-33 Internal torque command	The given value is the percentage of rated torque	5.6.1.1
P3-16 Internal forward speed limit of torque control P3-17 Internal reverse speed limit of torque control P3-14 Forward max speed limit (MAX speed) P3-15 Reverse max speed limit (MAX speed)	Speed limit in torque mode	5.6.1.2
P5-27 Speed direction switch /SPD-D	Change the direction, default is n.0000 If it is given through SI2 terminal, P5-27 can be set to n.0002	

5.6.1 Torque control (internal setting)

Parameter	Set value	Function	Modify	Effective
P0-01	1	Torque control: internal setting	Servo bb	At once
Function: Control the torque by internal torque command.				

5.6.1.1 Internal torque command

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P3-33	Preset torque 1	0	1% rated torque	-1000~+1000	Anytime	At once
The unit of this parameter is 1% of the rated torque. Positive and negative values correspond to the forward and reverse rotation of the motor. For example: P3-33=50, motor forward run with 50% of the rated torque; P3-33= -20, motor reverse run with 20% of the rated torque. In addition to using the torque to control the direction of servo operation, it can also use / SPD-D to control the direction.						

5.6.1.2 Internal speed limit of torque control

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P3-16	internal forward speed limit in torque control mode	Motor rated	mm/s	5～65535	Anytime	At once
P3-17	internal reverse speed limit in torque control mode	Motor rated	mm/s	5～65535	Anytime	At once
Note: Even if the setting speed of this parameter is greater than the speed limit of P3-14, the actual effective speed limit is the lower speed limit. (The maximum speed is the smaller value in P3-14/P3-15 and P3-16/P3-17)						

5.6.1.3 Speed reach signal output (/VLT)

In torque mode, when the absolute value of the actual speed of the servo motor exceeds the speed limit value, it is considered that the actual speed of the servo motor is limited. At this time, the servo driver can output /VLT signal. Otherwise, if any condition is not met, the speed limit signal is invalid.

Parameter	Signal name	Default setting	Suitable mode	Meaning	Modify	Effective
P5-43	/VLT	n.0000	1, 2	Speed limit detection	Anytime	At once
By default, no terminal is allocated, the parameter range is 0000-0014, and is allocated to the output interface through parameter P5-43. When set to 0002, the signal is output from the SO2 terminal. /VLT signal is only valid in torque mode.						

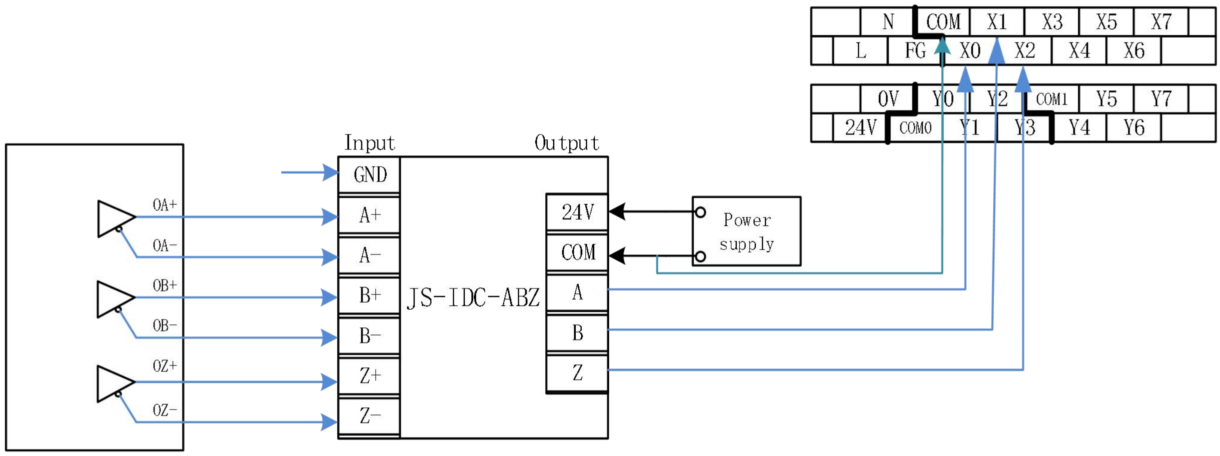
5.7 Encoder ABZ phase frequency division output

The servo drive outputs differential signals through a frequency division output circuit and a differential driver. Provide position signals for the control of the upper computer device, or provide pulse signals for the slave servo, thereby achieving servo control of the master and slave axes.

• Encoder frequency division output specifications

Terminal name	Terminal function	
	CN0 port	
OA+	7	A phase frequency division signal output
OA-	20	
OB+	8	B phase frequency division signal output
OB-	21	
OZ+	9	Z phase frequency division signal output
OZ-	22	

• Wiring diagram



• Set the number of feedback pulses per polar distance of the encoder

P0-18	Number of feedback pulses per polar distance of encoder (low bit)					
	Setting unit	Default setting	Setting range	Suitable mode	Modify	Effective
	1	0	0~9999	All	Servo OFF	At once
P0-19	Number of feedback pulses per polar distance of encoder (high bit)					
	Setting unit	Default setting	Setting range	Suitable mode	Modify	Effective
	10000	1	0~9999	All	Servo OFF	At once
P0-20	Encoder feedback pulse output frequency division (numerator)					
	Setting unit	Default setting	Setting range	Suitable mode	Modify	Effective

	-	1	0~65535	All	Servo OFF	At once
P0-21	Encoder feedback pulse output frequency division (denominator)					
	Setting unit	Default setting	Setting range	Suitable mode	Modify	Effective
	-	1	0~65535	All	Servo OFF	At once

Explanation:

(1) Number of feedback pulses per polar distance: P0-19*10000 + P0-18. P0-18~P0-21 are all parameters related to encoder feedback. P0-18 and P0-19 are grouped together, P0-20 and P0-21 are grouped together, but the number of feedback pulses per polar distance is P0-18, the priority of P0-19 is higher than the feedback pulse output frequency division P0-20, P0-21. Only P0-18, P0-19 all set to 0, P0-20, P0-21 will take effect.

For example, if the motor needs to provide feedback of 2500 pulses per polar distance, P0-18 can be set to 2500, P0-19=0, or set P0-18=P0-19=0, P0-20/P0-21=required motor feedback per polar distance/encoder resolution=2500/131072=625/32768.

(2) The encoder feedback will be output from the CN0 port. If single-phase counting is used, the motor running with a polar distance count value is equal to the set value. If AB phase counting is used, the motor running with a polar distance count value is four times the set value. It is recommended that the lower computer accept pulses using AB phase counting.

(3) The pulse output frequency does not exceed 1MHz per phase, and the number of feedback pulses per polar distance can be set in conjunction with the Z-phase pulse estimation formula.

Example: Assuming the actual speed of the motor is 3000mm/s,

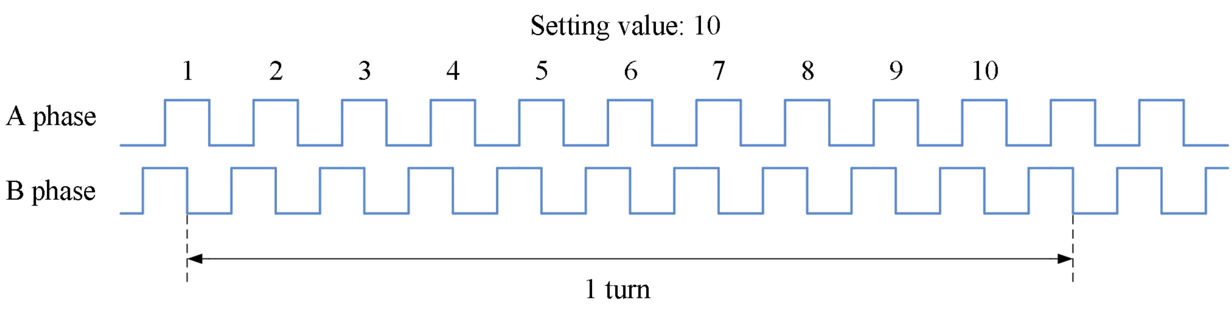
$$\frac{28.08}{3000\times ppr}\times 2 \geqslant \frac{1}{10^6} \Rightarrow ppr \leqslant 18720$$

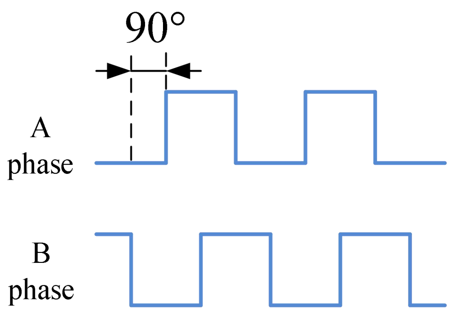
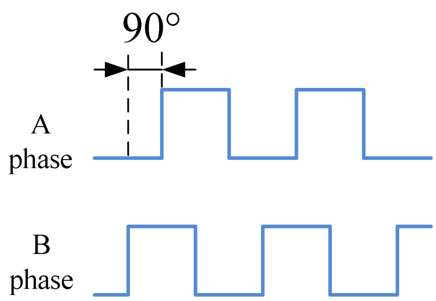
, the feedback setting for the number of pulses per polar distance shall not exceed 18720 (above 50KHz).

$$\frac{1}{\frac{n}{60}\times ppr} \geqslant \frac{1}{10^6} \Rightarrow ppr \leqslant 20000$$

, the feedback setting for the number of pulses per pole distance shall not exceed 20000 (below 50KHz).

(4) Assuming that the number of feedback pulses per polar distance is 10, the encoder frequency division pulse output A-phase (PAO) signal and the B-phase (PBO) signal are as follows:



<table>
<tr><td rowspan="7">P0-87.0</td><td colspan="6">Encoder feedback output direction selection</td></tr>
<tr><td>Setting value</td><td>Function</td><td>Default value</td><td>Suitable mode</td><td>Modify</td><td>Effective</td></tr>
<tr><td>0</td><td>Phase A leads phase B is forward rotation</td><td rowspan="2">0</td><td rowspan="2">All</td><td rowspan="2">Servo OFF</td><td rowspan="2">At once</td></tr>
<tr><td>1</td><td>Phase B leads phase A is forward rotation</td></tr>
<tr><td colspan="3">Phase A leads phase B is forward rotation</td><td colspan="3">A-phase lags behind B-phase is forward rotation</td></tr>
<tr><td colspan="3">
</td><td colspan="3">
</td></tr>
<tr></tr>
<tr><td rowspan="4">P0-87.1</td><td colspan="6">Differential feedback output Z-phase mode</td></tr>
<tr><td>Setting value</td><td>Function</td><td>Default value</td><td>Suitable mode</td><td>Modify</td><td>Effective</td></tr>
<tr><td>0</td><td>Only forward output encoder frequency division Z-phase pulses</td><td rowspan="2">1</td><td rowspan="2">All</td><td rowspan="2">Servo OFF</td><td rowspan="2">At once</td></tr>
<tr><td>1</td><td>Both positive and negative directions output encoder frequency division Z-phase pulses</td></tr>
<tr><td rowspan="2">Z phase pulse width</td><td colspan="3">Pulse output frequency below 50KHz (unit: s)</td><td colspan="3">Pulse output frequency above 50KHz (unit: s)</td></tr>
<tr><td colspan="3">$\frac{1}{\frac{n}{60}\times ppr}\div 2$</td><td colspan="3">$\frac{28.08}{n\times ppr}$</td></tr>
</table>

n: Speed, unit: mm/s; ppr: P0-19*10000 + P0-18, Unit Pulse

The above formula is only an estimate.

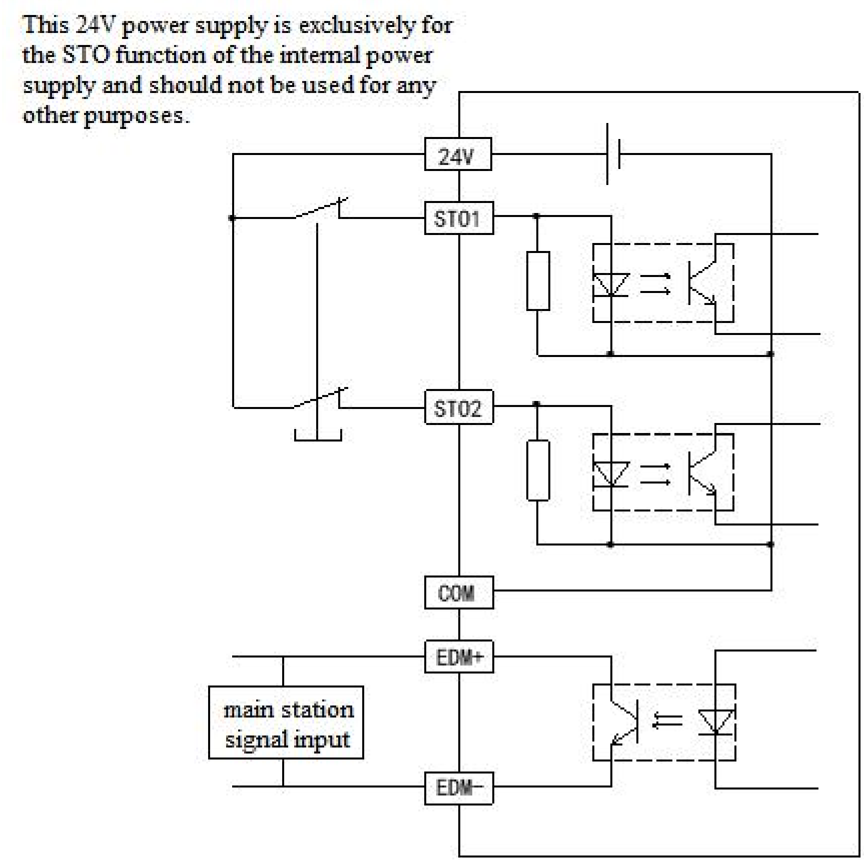
The frequency division output needs to consider the hardware frequency limitations of the receiving end. If the frequency is too high or improperly connected cables are used, it may cause pulse loss.

5.8 STO safe torque off

5.8.1 STO function overview

STO (Safe Torque Off) function: refers to the safety function of cutting off motor current through hardware.
The STO safety function terminal (CN5) adopts a dual circuit design, with two safety signal input channels STO1 and STO2. If either terminal is triggered, it will enter the STO state. Through an independent circuit, it prevents the power module that controls the motor current from outputting PWM control signals, thereby cutting off the motor current and achieving a torque free state.

5.8.2 STO wiring diagram



5.8.3 STO parameters

Parameter	Name	Unit	Range	Effective	Function	Default
P0-88	STO synchronous detection configuration	100us	0-1000	At once	STO asynchronous alarm detection time	60
P0-89.0~1	STO buffer circuit Abnormal alarm	100us	0-255	At once	STO buffer circuit Abnormal alarm detection	32

	detection filtering				filtering time	
P0-89.2~3	STO input detection filtering	100us	10-30	At once	STO input detection filtering	12
P0-90.0~1	EDM circuit abnormality alarm	100us	0-255	At once	EDM circuit abnormality alarm detection filtering	200

5.8.4 STO working principle

- STO triggering

The driver can only operate normally when both the input signals of STO1 and STO2 terminals are at high level. In addition, when an STO alarm occurs, the current STO status can be determined based on the EDM output signal status, as shown in the table below:

STO1 input	STO2 input	EDM output status	PWM control signal
H	H	No output	Normal
H	L	No output	Prohibited
L	H	No output	Prohibited
L	L	With output	Prohibited

When either STO1 or STO2 is at a low level, the servo enters the STO state. At this time:

(1) PWM control signal prohibition;
(2) The servo stops as the turn off enable mode in P0-29 alarm stop mode;
(3) The servo/S-RDY signal output is 0;
(4) The panel displays STO.

When both STO1 and STO2 are at low levels, the EDM output circuit becomes conductive;
When the status of STO1 and STO2 is inconsistent and the time exceeds the set time of P0-88, alarm E-340: STO status is not synchronized.
Ensure that the STO1 and STO2 pins do not respond to pulses below 1ms, and ensure that it responds to the pulse higher than the setting in P0-89.2-3.
An alarm occurs in the STO state, and the panel displays the alarm information. However, the servo is still in the STO state at this time, and the dynamic braking and holding brake configurations are configured according to the STO state.

- STO release

When both STO1 and STO2 terminals are at high level and the enable signal is in a non enable state, the STO state is released, the servo ready output signal/S-RDY is output according to P5-70 configuration, the dynamic braking is output according to P0-27 or P0-29 configuration.

5.8.5 STO function precautions

After the STO function is activated, the motor safely enters a torque free state, and the servo drive will no longer have control over the motor. Therefore, before using the STO function, please evaluate the hazards that still exist after the STO function is enabled:

- After the STO function is enabled, the servo cannot guarantee that the motor will move due to external forces, such as the vertical axis;
- The STO function cannot cut off the power supply of the servo unit. The strong electrical part of the driver is still charged, so there is still a risk of electric shock or other electrical hazards. When maintaining the servo unit, please be sure to cut off the power supply and other devices of the servo unit;
- Please use the single power supply provided by the safety function terminal CN5 to supply power to the STO signal input, otherwise the STO function may malfunction due to leakage current, making it impossible to enter the STO cut-off state.

If the STO function is used to stop a running servo, the motor will gradually stop. If it is not acceptable, the system should use the correct stop mode instead of using the STO function to stop.

All cables suitable for STO function must have good protection, wiring, and fixation. During installation, it is necessary to ensure that the cables are not pulled or squeezed. The requirements for the cables used are as follows:

Cable requirements	Explanation
Type	Double shielded or single shielded twisted pair multiple pair cables
Max length	The maximum allowable cable length between the driver and safety switch is 30m
Max size	$0.8mm^2$ (18 AWG)
Min size	$0.3mm^2$ (28 AWG)

6 EtherCAT bus communication

6.1 EtherCAT technical overview

This section mainly introduces the basic concept, system composition, communication specifications and connection instructions of EtherCAT.

6.1.1 EtherCAT introduction

EtherCAT, the full name is Ethernet for Control Automation Technology, which is developed by Beckhoff Atuomation GmbH. It is a kind of real-time Ethernet used for open network communication between master station and slave station. As a mature industrial Ethernet technology, EtherCAT has the characteristics of high performance, low cost and easy to use.

XG2, XDH or XLH series controller (master station) and DL6 linear servo driver (slave station) comply with the standard EtherCAT protocol, supports the maximum 64-axis slave stations, 64-axis synchronization cycle is 4ms, supports touch probe function, position, speed, torque and other control modes, is widely applicable to various industries.

6.1.2 System composition(master and slave station)

The connection form of EtherCAT is: the network system of linear connection master station (FA controller) and multiple slave stations.

The number of nodes that can be connected by the slave station depends on the processing or communication period of the master station, the number of bytes transmitted, etc.

6.2 EtherCAT communication specification

This section mainly introduces EtherCAT's frame structure, state machine, ESC, SDO, PDO, SII area, communication synchronization mode, etc.

6.2.1 Communication specification

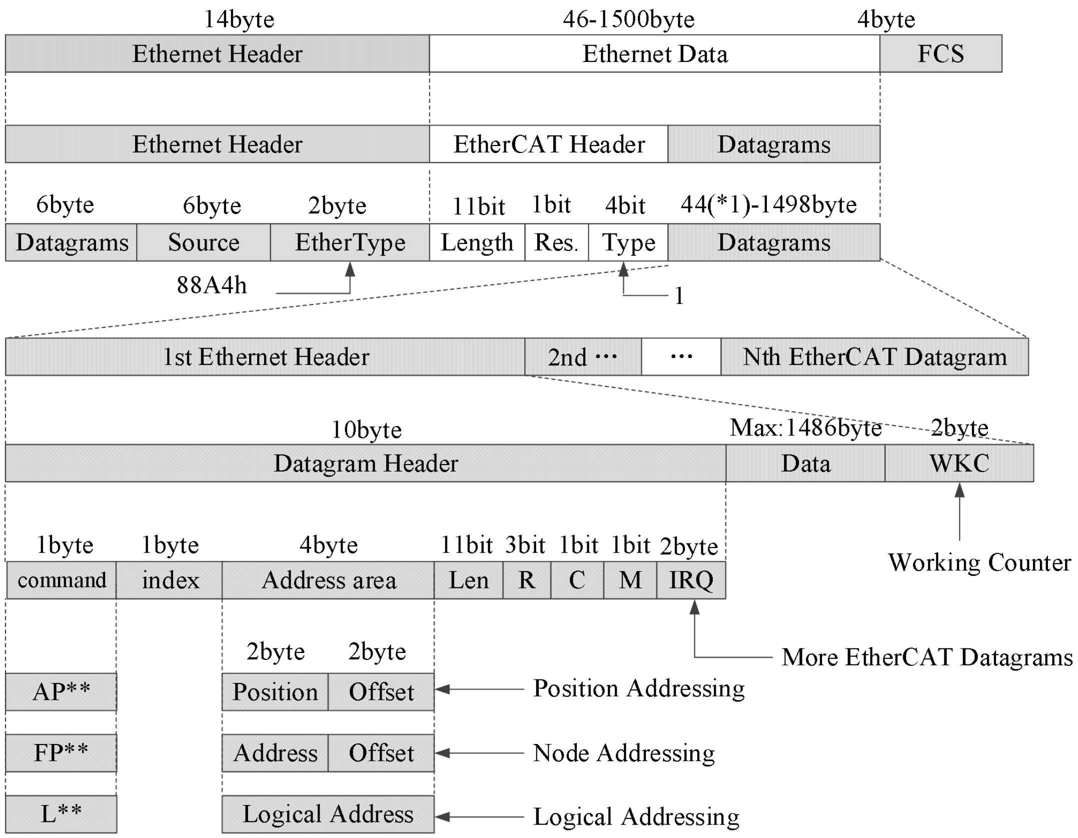
<table>
<tr><th>Item</th><th>Specification</th></tr>
<tr><td>Physical layer</td><td>100BASE-TX(IEEE802.3)</td></tr>
<tr><td>Baud rate</td><td>100[Mbps](full duplex)</td></tr>
<tr><td>Topology</td><td>Line</td></tr>
<tr><td>Connection cable</td><td>JC-CB/JC-CA twisted pair(shield twisted pair)</td></tr>
<tr><td>Cable length</td><td>Maximum 50m between nodes</td></tr>
<tr><td>Com port</td><td>2 Port(RJ45)</td></tr>
<tr><td>EtherCAT indicators (LED)</td><td>[Run] RUN indicator
[L/A IN] Port0 Link/Activity indicator(Green)
[L/A OUT] Port1 Link/Activity indicator(Green)</td></tr>
<tr><td>Station Alias(ID)</td><td>Setting range: 0~65535
Setting address:2700h</td></tr>
<tr><td>Explicit Device ID</td><td>Not support</td></tr>
<tr><td>Mailbox protocol</td><td>COE(CANopen Over EtherCAT)</td></tr>
<tr><td>SyncManager</td><td>4</td></tr>
<tr><td>FMMU</td><td>3</td></tr>
<tr><td>Modes of operation</td><td>
<table>
<tr><th></th><th colspan="2">Modes of operation</th></tr>
<tr><td rowspan="3">Position</td><td>Csp</td><td>Cyclic synchronous position mode</td></tr>
<tr><td>PP</td><td>Profile position mode</td></tr>
<tr><td>Hm</td><td>Homing mode</td></tr>
<tr><td rowspan="2">Speed</td><td>Csv</td><td>Cyclic synchronous velocity mode</td></tr>
<tr><td>Pv</td><td>Profile velocity mode</td></tr>
<tr><td rowspan="2">Torque</td><td>Cst</td><td>Cyclic synchronous torque mode</td></tr>
<tr><td>Tq</td><td>Torque profile mode</td></tr>
</table>
</td></tr>
<tr><td>Touch Probe</td><td>2 channels</td></tr>
<tr><td>Synchronization mode</td><td>DC(SYNCO event synchronization mode)</td></tr>
<tr><td>Cyclic time
(DC communication period)</td><td>250, 500,1000,2000,4000, 8000, 10000[μs]</td></tr>
<tr><td>Communication object</td><td>SDO[service data object], PDO[process data object]</td></tr>
<tr><td>Maximum PDO allocation per station</td><td>TxPDO:4 [piece] RxPDO:4 [piece]</td></tr>
<tr><td>Single station PDO Max bytes</td><td>TxPDO:32[byte] RxPDO:32[byte]</td></tr>
<tr><td>Mailbox communication interval in PreOP mode</td><td>1ms</td></tr>
<tr><td>Mailbox</td><td>SDO request and SDO information</td></tr>
</table>

Note:SDO and PDO refer to chapter 6.2.3 state machine.

6.2.2 EtherCAT frame structure

EtherCAT is an industrial communication protocol based on real-time control of Ethernet. It only expands the IEEE 802.3 Ethernet specification and does not change the basic structure, so it can transmit the data within the standard Ethernet frame.
Because the EthernetType of the Ethernet Header is [88A4h], the subsequent Ethernet data is processed as the EtherCAT frame.
The EtherCAT frame is composed of the EtherCAT frame header and more than one EtherCAT sub message, which is further subdivided. Only the EtherCAT frame with type = 1 of the EtherCAT frame header is processed according to ESC.

EtherNet/EtherCAT frame structure



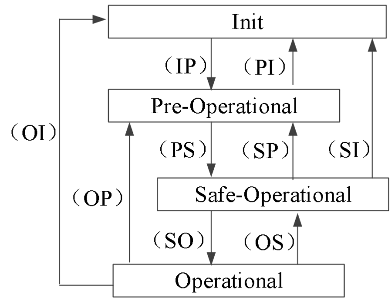
*1:When Ethernet frame is shorter than 64byte, add 1～32byte.
(Ethernet Header + Ethernet Data + FCS)

6.2.3 State machine ESM

The EtherCAT state machine (ESM) is responsible for coordinating the state relationship between the master and slave applications at initialization and runtime.
The state change request is executed by the master station, and the master station puts forward the control request to the application layer service. The latter generates the application layer control event in the slave

station, and the slave station responds to the application layer control service through the local application layer state write service after the state change request succeeds or fails. If the state change fails, the slave station keeps the state and shows the error flag.

The figure below shows the state transformation diagram of ESM:



※The (IP) etc. in the state transformation diagram is the abbreviation of state transformation.
（IP）： Init→Pre-Operational
（PS）： Pre-Operational→Safe-Operational...

Init: Initialization status
Pre-Operational: Pre operation status
Safe-Operational: Safe operation status
Operational: Running state

Slave station status	Actions in various states	Communication action		
		SDO(mailbox) receive and send messages	PDO Send messages	PDO Receive message s
Init	Communication initialization, SDO, PDO unable to receive and send messages	-	-	-
Pre-Operational (PreOP)	Only SDO receives and sends messages	Yes	-	-
Safe-Operationa l(SafeOP)	Only SDO receives and sends messages, PDO sends messages	Yes	Yes	-
Operational (OP)	SDO receives and sends messages, PDO receives and sends messages	Yes	Yes	Yes

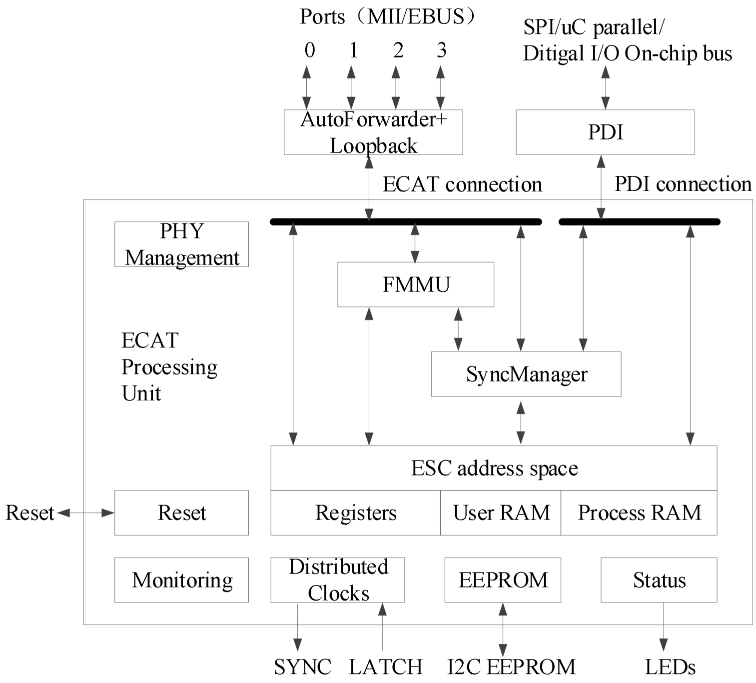
Note: the access from the master station to the ESC register is independent of the above table and is available at any time.
PDO (Process Data Object) Used to transmit periodic communication data.
SDO (Service Data Object) Used to transmit aperiodic communication data.
Command or interface operation during ESM state switching may cause abnormal communication error

6.2.4 Slave station controller ESC

6.2.4.1 Principle overview

ESC refers to the EtherCAT slave controller. The communication process is completely processed by ESC, which has four data receiving and transmitting ports, each with a Tx and Rx. Each port can send and receive

Ethernet data frames. The data flow direction in ESC is fixed: port 0 →-port 3 → port 1 → port 2 →port 0 are transmitted in sequence. If ESC detects that a port has no external PHY, it will automatically close the port and forward to the next port through the internal loopback.



6.2.4.2 Address space

The DL6 series have 8 Kbyte of physical address space.
The first 4kbyte (0000h-0FFFh) is used as register space, and the other 4kbyte (1000h-1FFFh) is used as process data PDO in RAM field. For details of registers, please refer to the data table of IP (ET1810 / ET1811 / ET1812).

ESC Register byte address	Length (Byte)	Description	Initial value *1
ESC Information (Slave controller information)			
0000h	1	Type	04h
0001h	1	Revision	02h
0002h~0003h	2	Build	0040h
0004h	1	FMMUs supported	03h
0005h	1	SyncManagers supported	04h
0006h	1	RAM Size	08h
0007h	1	Port Descriptor	0Fh
0008h~0009h	2	ESC Features supported	0184h
Station Address			
0010h~0011h	2	Configured Station Address	-
0012h~0013h	2	Configured Station Alias	-
…			
Data Link Layer			

ESC Register byte address	Length (Byte)	Description	Initial value *1
…			
0100h~0103h	4	ESC DL Control	-
…			
0110h~0111h	2	ESC DL Status	-
Application Layer			
0120h~0121h	2	AL Control	-
0130h~0131h	2	AL Status	-
0134h~0135h	2	AL Status Code	-
…			
PDI process data interface			
0140h	1	PDI Control	08h
0141h	1	ESC Configuration	0Ch
0150h	1	PDI Configuration	-
0151h	1	SYNC/LATCH PDI Configuration	66h
0152h~153h	2	Extend PDI Configuration	-
…			
Watchdog			
0400h~0401h	2	Watchdog Divider	-
0410h~0411h	2	Watchdog Time PDI	-
0420h~0421h	2	Watchdog Time Process Data	-
0440h~0441h	2	Watchdog Status Process Data	-
0442h	1	Watchdog Counter Process Data	-
0443h	1	Watchdog Counter PDI	-
…			
FMMU			
0600h~062Fh	3x16	FMMUs[2:0]	-
+0h~3h	4	Logical Start Address	-
+4h~5h	2	Length	-
+6h	1	Logical Start bit	-
+7h	1	Logical Stop bit	-
+8h~9h	2	Physical Start Address	-
+Ah	1	Physical Start bit	-
+Bh	1	Type	-
+Ch	1	Activate	-
+Dh~Fh	3	Reserved	-
…			
Distributed Clocks(DC)-SYNC Out Unit			
0981h	1	Activation	-
…			
0984h	1	Activation Status	-
098Eh	1	SYNCO Status	-

ESC Register byte address	Length (Byte)	Description	Initial value *1
…			
0990h~0993h	4	Start Time Cyclic Operation/Next SYNC0 Pulse	-
…			
09A0h~09A3h	4	SYNC0 Cycle Time	-
…			

6.2.5 SII area (0000h～003Fh)

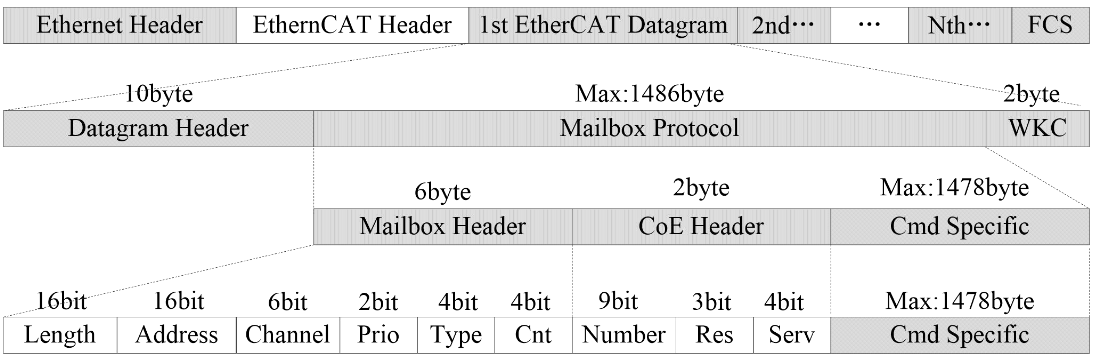
In the ESC configuration area (EEPROM word address 0000h-0007h), after the power of the driver is started, the Configured Station Alias automatically reads and writes the ESC register according to ESC. When the value of SII EEPROM is reflected in the ESC register, the power supply needs to be started again. In addition, the initial value of IP core (ET1810 / ET1811 / ET1812) is set. Please refer to the data table of IP core (ET1810 / ET1811 / ET1812) for details.

6.2.6 SDO(Service Data Object)

DL6 series supports SDO (Service Data Object). The data exchange of SDO uses mailbox communication, so the data refresh time of SDO becomes unstable.
The master station reads and writes data in the records of the object dictionary, which can set the object and monitor various states of the slave station. The response to a read-write action to SDO takes time. For objects refreshed with PDO, please do not refresh with SDO, and overwrite with PDO value.

6.2.6.1 Mailbox frame structure

Mailbox/SDO frame structure is shown as below. Please refer to ETG specification book (ETG1000-5 and ETG1000-6).



Frame	Data area	Data type	Function
MailBox Header	Length	WORD	Mailbox data length
	Address	WORD	Sending source station address
	Channel	Unsigned6	(Reserved)
	Prority	Unsigned2	Priority
	Type	Unsigned4	Mailbox type

Frame	Data area	Data type	Function
			00h: error 01h: (Reserved) 02h: EoE (no response) 03h: CoE 04h: FoE (no response) 05h: SoE (no response) 06h-0Eh: (Reserved) 0Fh: VoE (no response)
	Cnt	Unsigned3	Mailbox counter
	Reserved	Unsigned1	(Reserved)
CoE Header	Number	Unsigned9	Reserved
	Reserved	Unsigned3	Reserved
	Service	Unsigned4	Information type
Cmd specific	Size Indicator	Unsigned1	Data Set Size use license
	Transfer Type	Unsigned1	Normal Forwarding/Expedited Forwarding
	Data Set Size	Unsigned2	Specify data size
	Complete Access	Unsigned1	Object access method selection (not corresponding)
	Command Specfier	Unsigned3	Upload / download Selection of requirements / responses, etc
	Index	WORD	Object Index
	Subindex	BYTE	Object Subindex
			Object data or Abort message, etc.

6.2.6.2 Mailbox overtime

This servo driver performs the following timeout settings in mailbox communication.
Timeout of mailbox request: 100ms
The master station sends a request to the slave station (driver). If the WKC of the transmission data of the request frame is updated, the slave station is considered to receive the request normally. Until WKC is updated, retry again and again. However, if WKC is not updated until this set time, the master station will time out.Timeout for mailbox response: 10s
The master receives a response from a request from a slave (driver), which is considered normal if the WKC is updated. Until this set time, if the response of updated WKC cannot be received, the master station will time out. The maximum time required for the response of the slave (driver) to complete.

6.2.6.3 Alarm information

1) Error code
Error code returns the same value as 603Fh (Error code).
0000h～FEFFh are defined as IEC61800-7-201.
FF00h～FFFFh are defined by manufacturer, shown as below.

Index	Sub-index	Name/Description	Range	Data type	Access	PDO	Op-mode
603Fh	00h	Error code	0-65535	U16	ro	TxPDO	All

		Now the alarm of the servo driver (only the main number). When the alarm does not occur, it will display 0000H. When an alarm occurs, an alarm is displayed. FF**h Alarm (main) code (00h～FFh) Eg. FF03h … 03h=3d E-030 (over voltage protection) FF55h …55h=85d E-850 (TxPDO configuration error protection), E-851 (RxPDO configuration error protection), any of them occurred. As an exception, A000h is displayed in the case of E-817 (Syncmanager 2/3 setting error).

1) Error register

Error register returns same value as 1001h (Error register).

Index	Sub-index	Name/Description	Range	Data type	Access	PDO	Op-mode
1001h	00h	Error register	0-65535	U16	ro	TxPDO	All
		Displays the type of alarm (status) that is occurring to the servo driver. When the alarm does not occur, it will display 0000H. Do not display warnings.					

Bit	Contents
0	Not support
1	
2	
3	
4	AL status code defined alarm occured *1
5	Not support
6	Reserved
7	AL status code defined alarm occured*2

*1:“AL status code defined alarm” means EtherCAT communication related error E-800～7, E-810～7, E-850～7.

*2:“AL status code not defined alarm” means EtherCAT communication related error E-880～7 and except EtherCAT communication related error.

6.2.7 PDO(Process Data object)

DL6 series supports PDO (process data object).

The real-time data transfer based on EtherCAT is carried out through the data exchange of PDO (process data object).

PDO has RxPDO transferred from master station to slave station and TxPDO transferred from slave station to master station.

	Send	Receive
RxPDO	Main station	Slave station
TxPDO	Slave station	Main station

6.2.7.1 PDO mapping objects

PDO mapping refers to the mapping from object dictionary to application object of PDO.

Tables for DL6 series PDO mapping can use 1600h-1603h mapping objects for RxPDO and 1A00h-1A03h mapping objects for TxPDO.
The maximum number of application objects that a mapping object can map is as follows:
RxPDO: 32 [byte] , TxPDO: 32 [byte]

The following is an example of setting up a PDO map.
< Setting example >
Allocation of application objects 6040h, 6060h, 607ah, 60b8h to 1600h (receive PDO mapping 1: RxPDO_1).

Index	Sub	Object contents	
1600h	00h	04h	
	01h	6040 00 10 h	
	02h	6060 00 08 h	
	03h	607A 00 20 h	
	04h	60B8 00 10 h	
	05h	0000 00 00 h	
	…		
	18h	0000 00 00 h	
6040h	00h	Controlword	U16
6060h	00h	Mode of operation	I8
607Ah	00h	Target Position	I32
60B8h	00h	Touch probe function	U16

6.2.7.2 PDO distribution objects

In order to exchange PDO data, a table for PDO mapping must be assigned to SyncManager. The relationship between the table used for PDO mapping and SyncManager is described to PDO allocation object. DS5C2 series, as PDO allocation object, can use 1C12h for RxPDO (SyncManager2) and 1C13h for TxPDO (SyncManager3).
The maximum number of application objects that a mapping object can map is as follows:
RxPDO：4 [Table] (1600h～1603h)
RxPDO：4 [Table](1A00h～1A03h)
Generally, since one mapping object is enough, no change is required by default.

Example of setting PDO assignment object:
Allocation mapping object 1600h to allocation object 1C12h (Sync Manager Channel 2).

Index	Sub	Object contents
1C12h	00h	01h
	01h	1600h
	02h	0000h
	03h	0000h
	04h	0000h

Allocation mapping object 1600h to allocation object 1C13h (Sync Manager Channel 3).

Index	Sub	Object contents
1C13h	00h	01h
	01h	1A00h
	02h	0000h

Index	Sub	Object contents
	03h	0000h
	04h	0000h

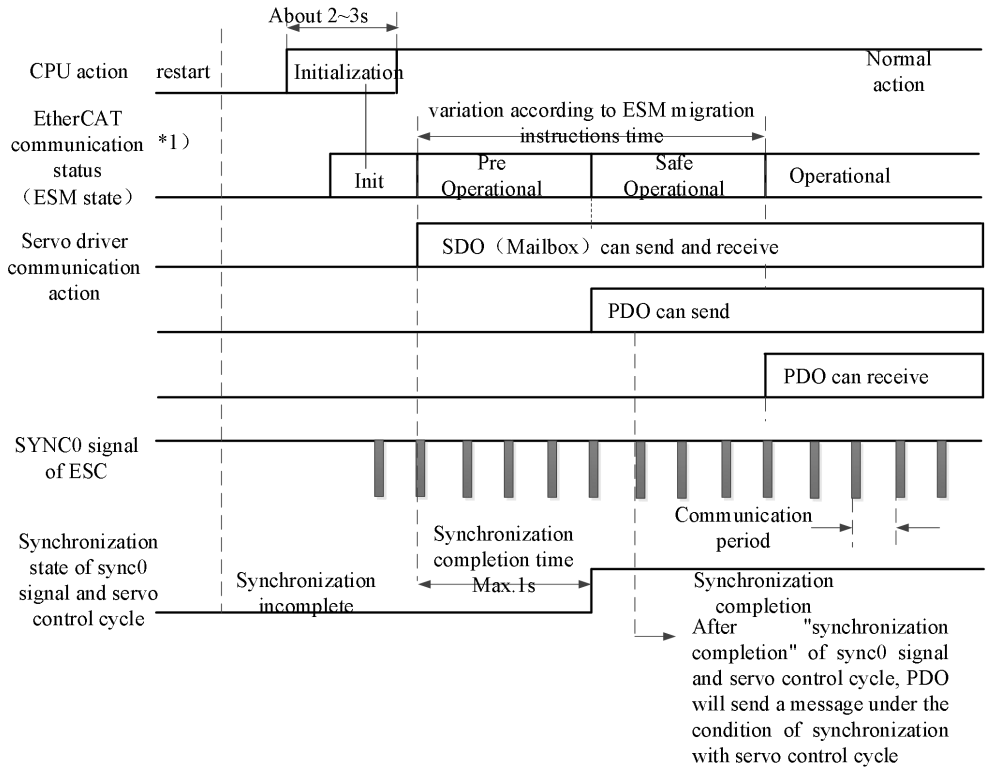
6.2.8 Communication synchronization mode

DL6 series can select the following synchronization modes.

Synchronization modes	Contents	Synchronization methods	Features
DC	SYNC0 Event synchronization	Synchronize the time information of other slave stations based on the time of the first axis	High-precision Compensation treatment shall be carried out at the main station
SM2	SM2 Event synchronization	Synchronize according to RxPDO's receiving time	No transmission delay compensation, poor accuracy Need to keep transmission time on controller side (special hardware, etc.)
FreeRun	Asynchronous	Asynchronous	Simple handling Poor real-time performance

6.2.8.1 DC(SYNC0 event synchronization)

DL6 series have 64bit DC (Distributed Clock).
The synchronization of EtherCAT communication is based on this DC. According to the DC slave station, synchronization is realized through the system time with the same reference. The local cycle of the slave station starts with the SYNC0 event. Since the slave processing (servo processing) starts from the SYNC0 event cycle, it is always synchronized with the SYNC0 event.
The master station needs to carry out transmission delay compensation (offset compensation) and regular deviation compensation during communication initialization. The following figure shows the process of synchronous completion from the input of control power to the event of SYNC0 and the processing of slave station (servo processing).

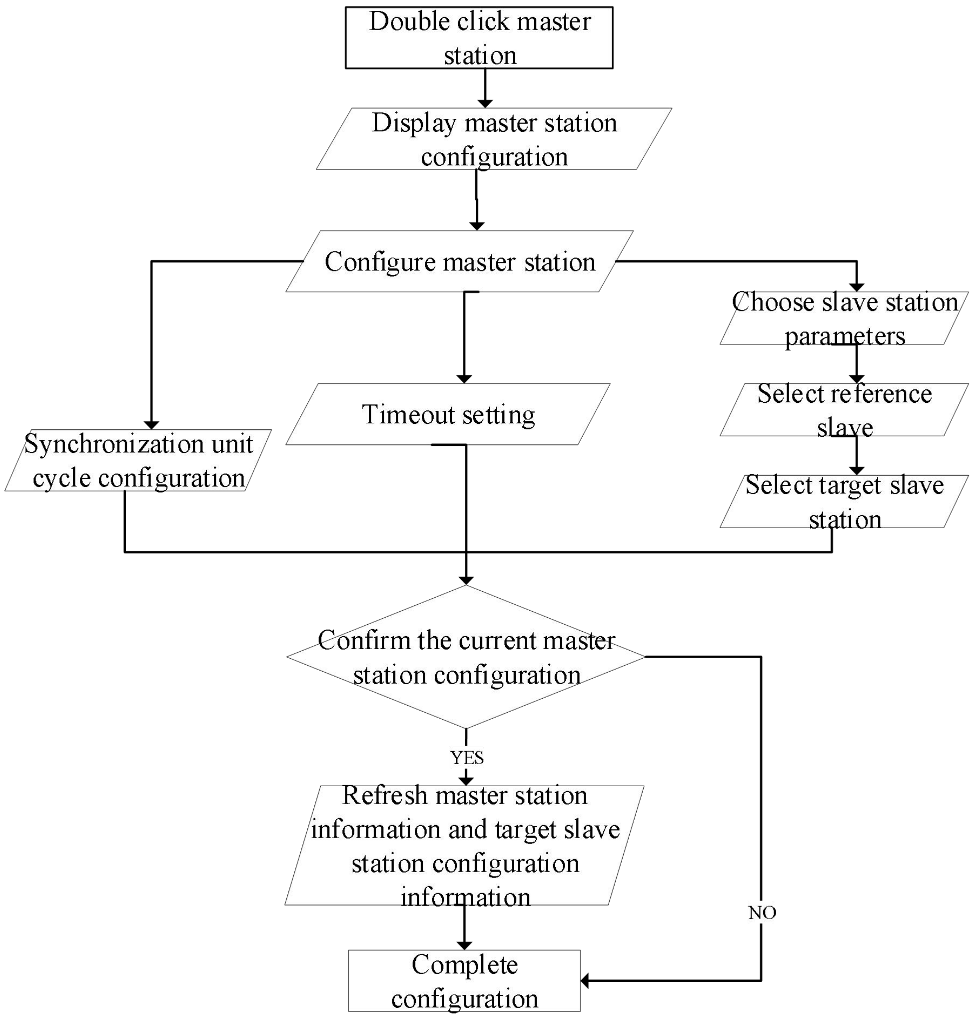


6.2.8.2 SM2(SM2 event synchronization)

The local cycle of the slave station starts with SM2 events.
Since the processing of the slave station starts from the SM2 event cycle, it is always synchronized with SM2 events.
Because SM2 event occurs when PDO receiving is completed, it is necessary to ensure that the upper (Master) side sends the message regularly. If the fluctuation (deviation) of sending time is too large, synchronization cannot be completed, or an alarm occurs.
If this happens, please use DC (SYNC0 event synchronization).

7 EtherCAT bus control mode

7.1 EtherCAT operation

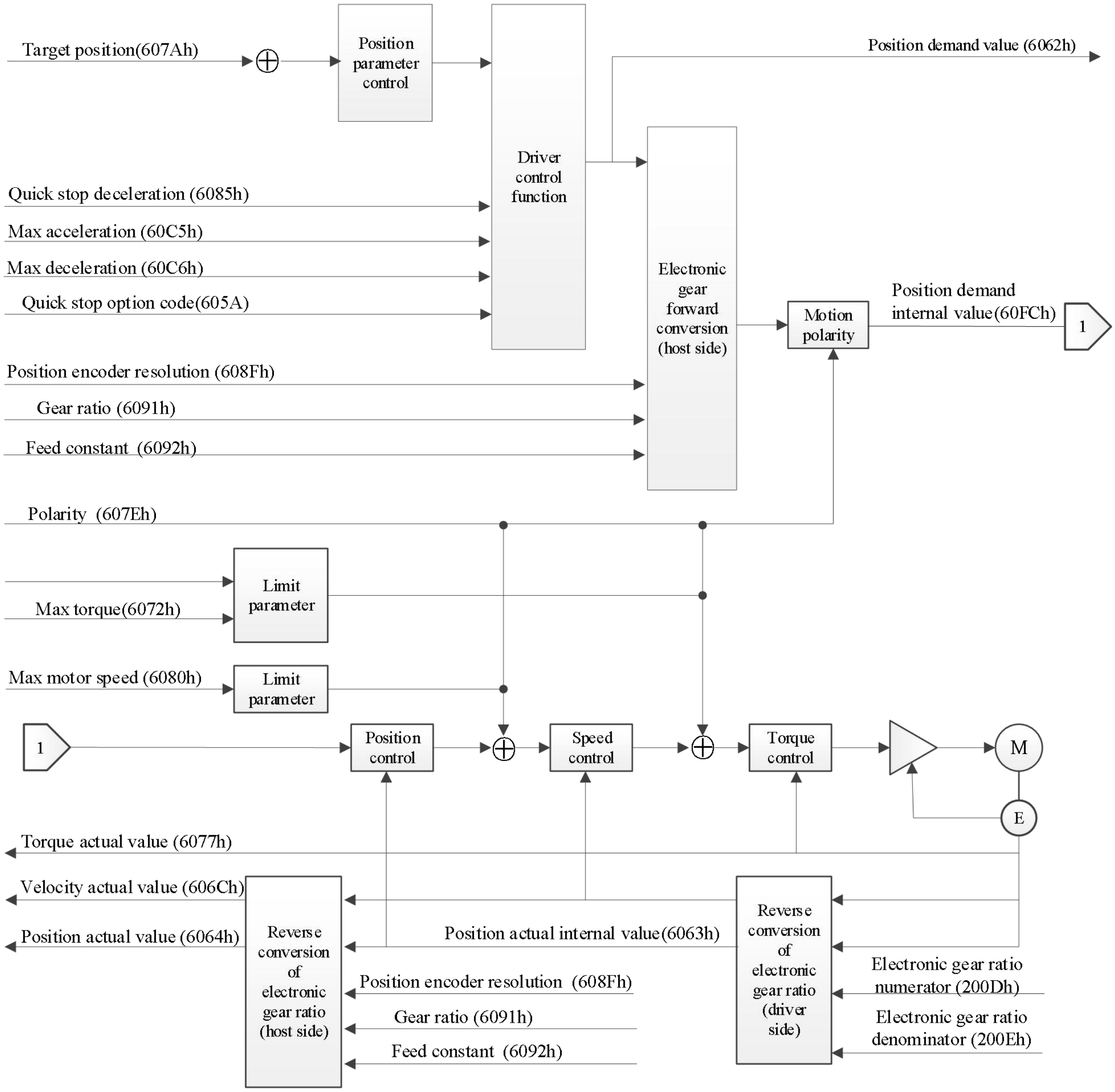


The following table shows the parameters that must be configured uniformly in CSP, CSV, CST, PP, PV and TQ modes.

Register	Explanation
RXPDO[0x6040]	Controlword must be added to the PDO configuration. It is invalid to modify it through IO mapping in CSP, CSV and CST modes. It is controlled by the NC module
RXPDO[0x6060]	Modes of operation, must be added to the PDO configuration,and can be modified by IO mapping in the task mode.
RXPDO[0x607A]	Target position, the given location of the program, must be added to the PDO configuration
TXPDO[0x6041]	Statusword, must be added to PDO configuration
TXPDO[0x6061]	Modes of operation display, must be added to PDO configuration
TXPDO[0x6064]	Position actual value, must be added to PDO configuration
TXPDO[0x606C]	Velocity actual value,must be added to PDO configuration

7.2 CSP mode

CSP (periodic synchronous position mode), whose motion trajectory is calculated by the upper computer, periodically sends the target position to the slave station.



7.2.1 Related parameters

1)CSP Control mode associated object(Command・setting)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6040h	00h	Control word	-	0~65535	U16	rw	RxPDO

Other positions control common associated objects.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO
607Ah	00h	Target position	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Dh	-	Software position limit	-	-	-	-	-
	00h	Number of entries	-	2	U8	ro	No
	01h	Min position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Fh	00h	Max profile velocity	Command unit/s	0~4294967295	U32	rw	RxPDO
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO
60B1h	00h	Velocity offset	Command unit/s	-2147483648~ 2147483647	I32	rw	RxPDO
60B2h	00h	Torque offset	0.1%	-32768~32767	I16	rw	RxPDO

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO
605Ch	00h	Disable operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO
607Dh	-	Software position limit	-	-	-	-	-
	00h	Number of entries	-	2	U8	ro	No
	01h	Min position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Ch	00h	Home offset	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Eh	00h	Polarity	-	0~255	U8	rw	NO
6085h	00h	Quick stop deceleration	Command unit/s^2	0~4294967295	U32	rw	RxPDO
6086h	00h	Motion profile type	-	-32768~32767	I16	rw	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	Number of entries	-	2	U8	ro	No
	01h	Encoder increments	pulse	1~4294967295	U32	ro	No
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	No
6091h	-	Gear ratio	-	-	-	-	-
	00h	Number of entries	-	2	U8	ro	No
	01h	Motor revolutions	r(motor)	1~4294967295	U32	ro	No
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	No

6092h	-	Feed constant	-	-	-	-	-
	00h	Number of entries	-	2	U8	ro	No
	01h	Feed	Command unit	1~4294967295	U32	ro	No
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	No
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO

Other related objects with common actions

Controlword(6040h) < functions in CSP control mode>

Index	Sub-index	Name	Unit	Range	Data type	PDO	Op-mode
6040h	00h	Control word	0~65535	U16	Rw	RxPDO	All

Set the control command for the servo driver such as PDS state conversion.

Bit information

15	14	13	12	11	10	9	8
R						om	h

7	6	5	4	3	2	1	0
fr	oms			eo	qs	ev	so
	r	r	r				

r = reserved(not corresponding)
fr = fault reset
oms = operation mode specific
(control mode is based on bit)
eo = enable operation
qs = quick stop
h = halt
ev = enable voltage
so = switch on

CSP mode does not use oms bit.

2) realted CSP control mode (monitor)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6041h	00h	Statusword	-	0~65535	U16	ro	TxPDO

Other associated objects with common position control

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6062h	00h	Position demand value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
6063h	00h	Position actual internal value	pulse	-2147483648~ 2147483647	I32	ro	TxPDO
6064h	00h	Position actual value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
6065h	00h	Position deviation too large threshold	Command unit	0~4294967295	U32	rw	RxPDO
6066h	00h	Following error time out	1ms	0~65535	U16	rw	RxPDO
6067h	00h	Position window	Command	0~4294967295	U32	rw	RxPDO

			unit				
6068h	00h	Position window time	1ms	0~65535	U16	rw	RxPDO
606Ch	00h	Velocity actual value	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
6074h	00h	Torque value	0.1%	-32768~32767	I16	ro	TxPDO
6076h	00h	Motor rated torque	Mn·m	0~4294967295	U32	ro	TxPDO
6077h	00h	Torque actual value	0.1%	-32768~32767	I16	ro	TxPDO
60F4h	00h	Following error actual value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60FAh	00h	Control	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
60FCh	00h	Position demand internal value	pulse	-2147483648~ 2147483647	I32	ro	TxPDO

There are other related objects common to actions.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
603Fh	00h	Error code	-	0~65535	U16	ro	TxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BCh	00h	The rising edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648 ~2147483647	I32	ro	TxPDO

Statusword (6041h) < functions in csp control mode >

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	Ro	TxPDO	All

Servo driver status

Bit information

15	14	13	12	11	10	9	8
r		oms		ila	oms	rm	r
		Following error	Drive follow Command value		r		
7	6	5	4	3	2	1	0
w	sod	qs	Ve	f	oe	so	rsto

r = reserved(not corresponding) w = warning
sod = switch on disabled
oms = operation mode specific qs = quick stop
(control mode is based on bit) ve = voltage enabled
ila = internal limit active f = fault
oe = operation enabled
rm = remote so = switched on
rtso = ready to switch on

bit13,12,10(operation mode specific):

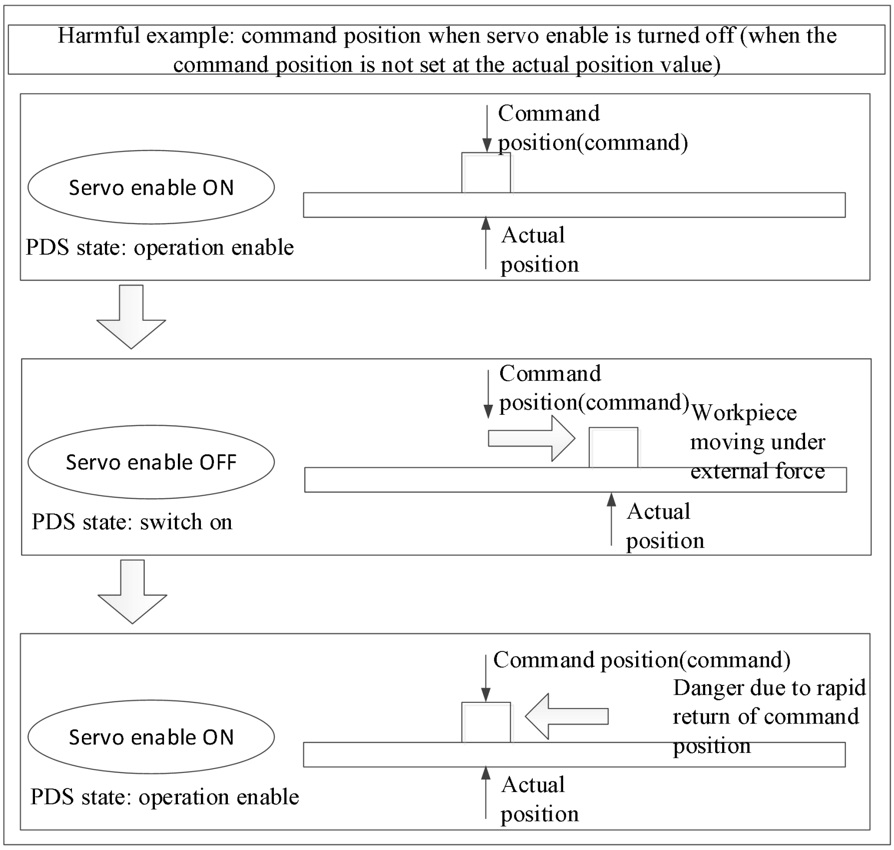
Bit	Name	Value	Definition
10	Reserved	-	unuse
12	Set-point acknowledge	0	No action based on target location
		1	Perform actions based on target location
13	Following error	0	60F4h (Following error actual value) =6062h (Position demand value) – 6064h (Position actual value) is over the setting range of 6065h (Following error window) or 60F4h value is over the setting value of 6065h, not through the setting time of 6066h.
		1	60F4h (Following error actual value) is over the setting range of 6065h (Following error window) and above the setting time of 6066h (Following error time out)

Note: the "performing actions according to the target position" means that if all the following conditions are met:

- ◆ PDS status is operation enabled
- ◆ Not in deceleration process(Halt, Quick stop, Shutdown, Disable operation, Fault)
- ◆ Non Halt stop status

Actions in CSP control mode

- ◆ The cyclic position control mode is to generate the action model (track) through the host rather than the slave.
- ◆ The target position is the sum of 607Ah (target position) and 60B0h (position offset), which is understood as absolute position.
- ◆ The update (sending) of action command is that after the servo enable command (operation enabled command), please input after about 100 ms.
- ◆ 60C2h (interpolation time period), which means updating the period of 607AH (target position) and 60B0h (position offset). This value is set to the same period as 1C32h-02h (cycle time). The upper device (host) must update the target position through 60C2h (interpolation time period).
- ◆ The servo enable can be turned off. Please form 607Ah (target position) + 60B0h (position offset) to follow the host processing of 6064h (position actual value). If the motor moves by external force during the servo enable is turned off, if the servo enable is turned on next time, it is very dangerous because it needs to return to the input target position. In addition, when switching from control mode other than CSP control mode to CSP control mode, please also do the follow operation.

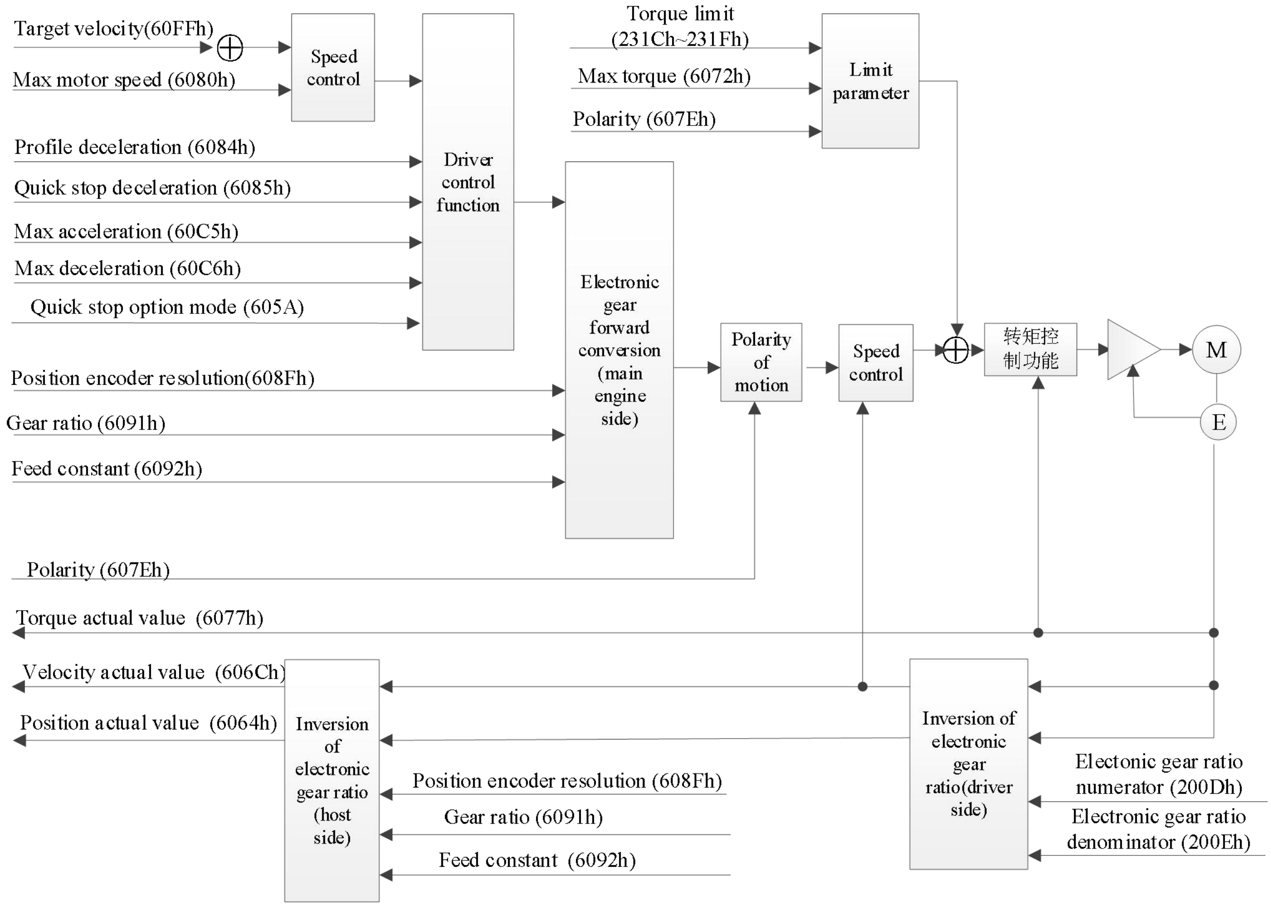


7.2.2 Common parameters

Register	Explanation	Unit
RXPDO[0x607A]	Target position, modification via IO mapping in CSP mode is invalid, which is controlled by NC module	Command unit
TXPDO[0x6064]	Position feedback (motor actual position)	Command unit
TXPDO[0x606C]	Velocity feedback	Command unit/s
RXPDO[0x6060]	Control mode is CSP (Periodic synchronization position mode), set to 8	-

7.3 CSV mode

CSV (periodic synchronous speed mode) enables the motor to run at a constant speed through the speed given by the upper computer.



7.3.1 Related parameter

1)CSV Object associated with control mode (Command ・ setting)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6040h	00h	Control word	-	0~65535	U16	rw	RxPDO
607Fh	00h	Max profile velocity	Command unit/s	0~4294967295	U32	rw	RxPDO

Other objects that are commonly associated with speed control.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO
60B1h	00h	Velocity offset	Command unit/s	-2147483648~ 2147483647	I32	rw	RxPDO

60B2h	00h	Torque offset	0.1%	-32768~32767	I16	rw	RxPDO
60FFh	00h	Target velocity	Command unit/s	0~4294967295	U32	rw	RxPDO

Other related objects with common actions.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO
605Ch	00h	Disable operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO
607Bh	-	Position range limit	-	-	-	-	-
	00h	607Bh sub index numbers	-	2	U8	ro	NO
	01h	Min position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO
607Ch	00h	Home offset	Command unit	-2147483648~2147483647	I32	rw	RxPDO
607Eh	00h	Polarity	-	0~255	U8	rw	NO
6085h	00h	Quick stop deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
6086h	00h	Motion profile type	-	-32768~32767	I16	rw	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	608Fh sub index numbers	-	2	U8	ro	NO
	01h	Encoder increments	pulse	1~4294967295	U32	ro	NO
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
6091h	-	Gear ratio	-	-	-	-	-
	00h	6091h sub index numbers	-	2	U8	ro	NO
	01h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
6092h	-	Feed constant	-	-	-	-	-
	00h	6092h sub index numbers	-	2	U8	ro	NO
	01h	Feed value	Command unit	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
60B8h	00h	Touch probe mode	-	0~65535	U16	rw	RxPDO

Controlword(6040h) < Function in csv control mode >

<table>
<tr><th>Index</th><th>Sub-index</th><th>Name</th><th>Unit</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th></tr>
<tr><td rowspan="2">6040h</td><td rowspan="2">00h</td><td>Controlword</td><td>0~65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>All</td></tr>
<tr><td colspan="6">Set the control command for the servo driver such as PDS state conversion.
Bit information
<table>
<tr><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th></tr>
<tr><td colspan="6">R</td><td>om</td><td>h</td></tr>
</table>
</td></tr>
</table>

7	6	5	4	3	2	1	0
fr	oms			eo	qs	ev	so
	r	r	r				

r = reserved(not corresponding)

oms = operation mode specific (control mode is based on bit)

h = halt

so = switch on

fr = fault reset

eo = enable operation

qs = quick stop

ev = enable voltage

Csv mode doesn't use oms bit.

2)Objects associated with CSV control mode (monitoring)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6041h	00h	Statusword	-	0~65535	U16	ro	TxPDO

Other related objects common to speed control.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6063h	00h	Position actual internal value	pulse	-2147483648~ 2147483647	I32	ro	TxPDO
6064h	00h	Position feedback	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
606Bh	00h	Velocity command	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
606Ch	00h	Velocity feedback	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
6074h	00h	Torque command	0.1%	-32768~32767	I16	ro	TxPDO
6076h	00h	Motor rated torque	Mn·m	0~4294967295	U32	ro	TxPDO
6077h	00h	Torque feedback	0.1%	-32768~32767	I16	ro	TxPDO

Other associated objects that share the same mode.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
603Fh	00h	Error Code	-	0~65535	U16	ro	TxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BCh	00h	The rising edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

Statusword (6041h) < Function of csv control mode >

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6041h	00h	Status word	0~65535	U16	ro	TxPDO	All
		Servo driver status.					

Bit information

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="2" rowspan="2">r</td><td colspan="2">oms</td><td rowspan="2">ila</td><td>oms</td><td rowspan="2">rm</td><td rowspan="2">r</td></tr>
<tr><td>r</td><td>follow drive command vaule</td><td>r</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>w</td><td>sod</td><td>qs</td><td>ve</td><td>f</td><td>oe</td><td>so</td><td>rsto</td></tr>
</table>

r = reserved(not corresponding) w = warning
sod = switch on disabled
oms = operation mode specific qs = quick stop
(control mode is based on bit) ve = voltage enabled
ila = internal limit active f = fault
oe = operation enabled
rm = remote so = switched on
rtso = ready to switch on

bit13,12,10(operation mode specific):

<table>
<tr><th>Bit</th><th>Name</th><th>Value</th><th>Definition</th></tr>
<tr><td>10</td><td>Reserved</td><td>-</td><td>Unuse</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">Reserved</td><td>0</td><td>Action not performed according to target speed</td></tr>
<tr><td>1</td><td>Perform the action according to the target speed</td></tr>
<tr><td>13</td><td>Reserved</td><td>-</td><td>Unuse</td></tr>
</table>

The "performing actions according to target speed" should meet the following conditions:

- The PDS status is operation enabled
- Not in deceleration processing (halt, quickstop, shutdown, disable operation, falut)
- It is not a halt state.
- The torque limit does not occur

Actions in CSV control mode

- In the cyclic speed control mode, the motion model (trajectory) is generated not on the slave but on the master.
- The target speed is 60FFh (target velocity)
- The update (sending) of action command is that after the operation enabled command, please input it after about 100 ms.
- 60C2h (interpolation time period) means the period of updating 60FFh (target velocity) and 60B1h (velocity offset). This value is set to the same period as 1C32h-02h (cycle time).
- As monitoring information, provide 606Ch (velocity actual value), etc.
- The 60FFh (target velocity) value is limited by 6080h (max motor speed).

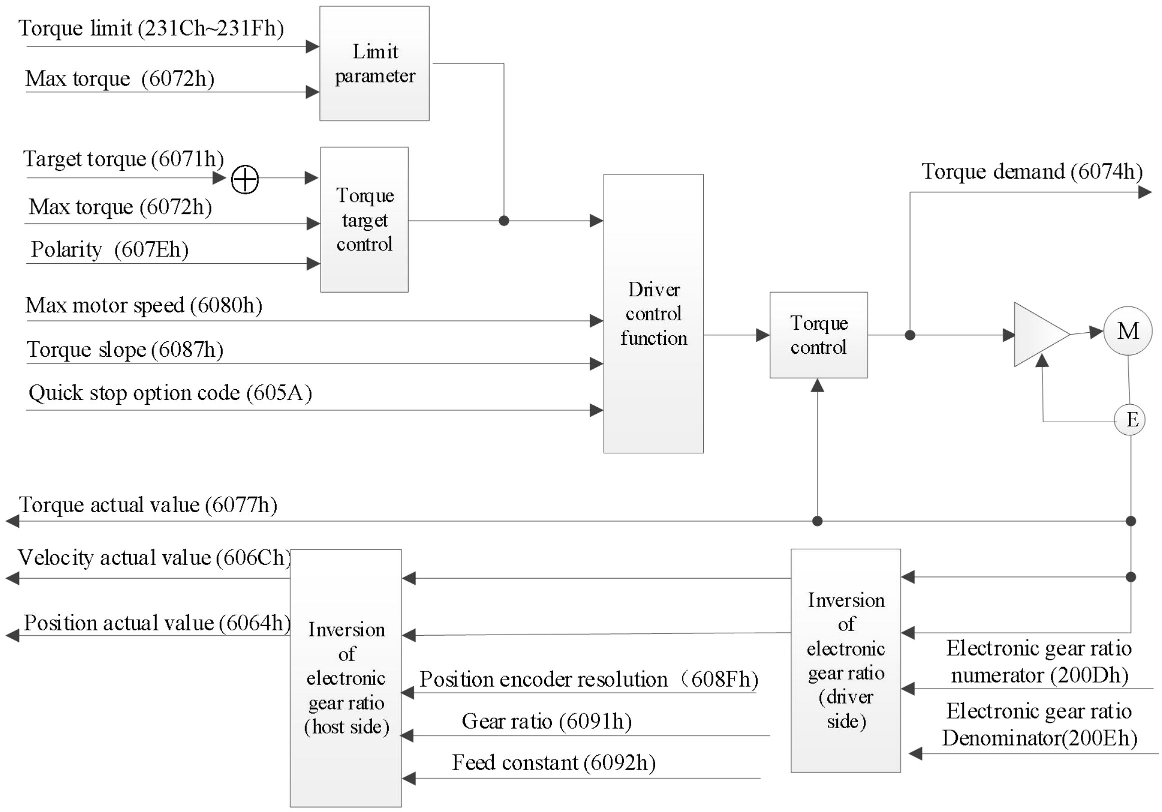
7.3.2 Common parameters

Register	Explanation	Unit
RXPDO[0x60FF]	Target velocity	Command unit/s
TXPDO[0x6064]	Position feedback	Command unit
TXPDO[0x606C]	Velocity feedback	Command unit/s
RXPDO[0x6080]	Max motor speed, which can be modified through COE-Online	r/min

RXPDO[0x6060]	Control mode is CSV (Periodic Synchronous Speed Mode), set its value to 9	-

7.4 CST mode

CST (periodic synchronous torque mode) allows the motor to run at a constant torque through the torque given by the upper computer.



7.4.1 Related parameter

1)Objects associated with CST control mode (Command・setting)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6040h	00h	Controlword	-	0~65535	U16	rw	RxPDO

Other related objects with common torque control.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6071h	00h	Target torque	0.1%	-32768~32767	I16	rw	RxPDO
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO
6087h	00h	Torque slope	0.1%/S	0~4294967295	U32	rw	RxPDO
60B2h	00h	Torque offset	0.1%	-32768~32767	I16	rw	RxPDO

Other related objects with common actions.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
605Ch	00h	Disable operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO
607Bh	-	Position range limit	-	-	-	-	-
	00h	607Bh sub index numbers	-	2	U8	ro	NO
	01h	Min position limit	Command unit	-2147483648 ~ 2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648 ~ 2147483647	I32	rw	RxPDO
607Ch	00h	Home offset	Command unit	-2147483648 ~ 2147483647	I32	rw	RxPDO
607Eh	00h	Polarity	-	0~255	U8	rw	NO
6085h	00h	Quick stop deceleration	Command unit / s^2	0~4294967295	U32	rw	RxPDO
6086h	00h	Motion profile type	-	-32768~32767	I16	rw	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	608Fh sub index numbers	-	2	U8	ro	NO
	01h	Encoder increments	pulse	1~4294967295	U32	ro	NO
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
6091h	-	Gear ratio	-	-	-	-	-
	00h	6091h sub index numbers	-	2	U8	ro	NO
	01h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
6092h	-	Feed constant	-	-	-	-	-
	00h	6092h sub index numbers	-	2	U8	ro	NO
	01h	Feed value	Command unit	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO

Control word (6040h) <function in cst control mode>

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	Rw	RxPDO	All

Set the control command to the servo driver such as PDS state conversion.
Bit information

15	14	13	12	11	10	9	8
r						om	h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
fr	oms			eo	qs	ev	so
	r	r	r				

r = reserved(not corresponding)
oms = operation mode specific
(control mode is based on bit)
h = halt
so = switch on

fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage

Cst mode doesn’t use oms bit.

2)Objects associated with CST torque control (monitoring)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
6041h	00h	Statusword	-	0~65535	U16	ro	TxPDO
6073h	00h	Max current	0.1%	0~65535	U16	ro	NO

Other objects commonly associated with torque control (monitoring)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
6063h	00h	Position actual internal value	pulse	-2147483648~ 2147483647	I32	ro	TxPDO
6064h	00h	Position actual value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
606Ch	00h	Velocity actual value	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
6074h	00h	Torque demand	0.1%	-32768~32767	I16	ro	TxPDO
6075h	00h	Motor rated current	1mA	0~4294967295	U32	ro	TxPDO
6076h	00h	Motor rated torque	Mn·m	0~4294967295	U32	ro	TxPDO
6077h	00h	Torque actual value	0.1%	-32768~32767	I16	ro	TxPDO
6078h	00h	Current actual value	0.1%	-32768~32767	I16	ro	TxPDO

Other associated objects that share the same mode.

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
603Fh	00h	Error Code	-	0~65535	U16	ro	TxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

60BCh	00h	The rising edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

Statusword (6041h) < functions in tq control mode >

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	All

Servo driver status.

Bit information

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="2" rowspan="2">r</td><td colspan="2">oms</td><td rowspan="2">ila</td><td>oms</td><td rowspan="2">rm</td><td rowspan="2">r</td></tr>
<tr><td>r</td><td>Drive following command vaule</td><td>r</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>w</td><td>sod</td><td>qs</td><td>ve</td><td>f</td><td>oe</td><td>so</td><td>rsto</td></tr>
</table>

r = reserved(not corresponding) w = warning

sod = switch on disabled

oms = operation mode specific qs = quick stop

(control mode is based on bit） ve = voltage enabled

ila = internal limit active f = fault

oe = operation enabled

rm = remote so = switched on

rtso = ready to switch on

bit13,12,10(operation mode specific):

Bit	Name	Value	Definition
10	Reserved	-	Unuse
12	Torque	0	Action not performed according to target torque
		1	Perform the action according to the target torque
13	Reserved	-	Unuse

Performing actions according to target torque should meet the following conditions:

- The PDS status is operation enabled
- not in deceleration processing (halt, quickstop, shutdown, disable operation, falut)
- It is not a halt state

Actions of CST control mode

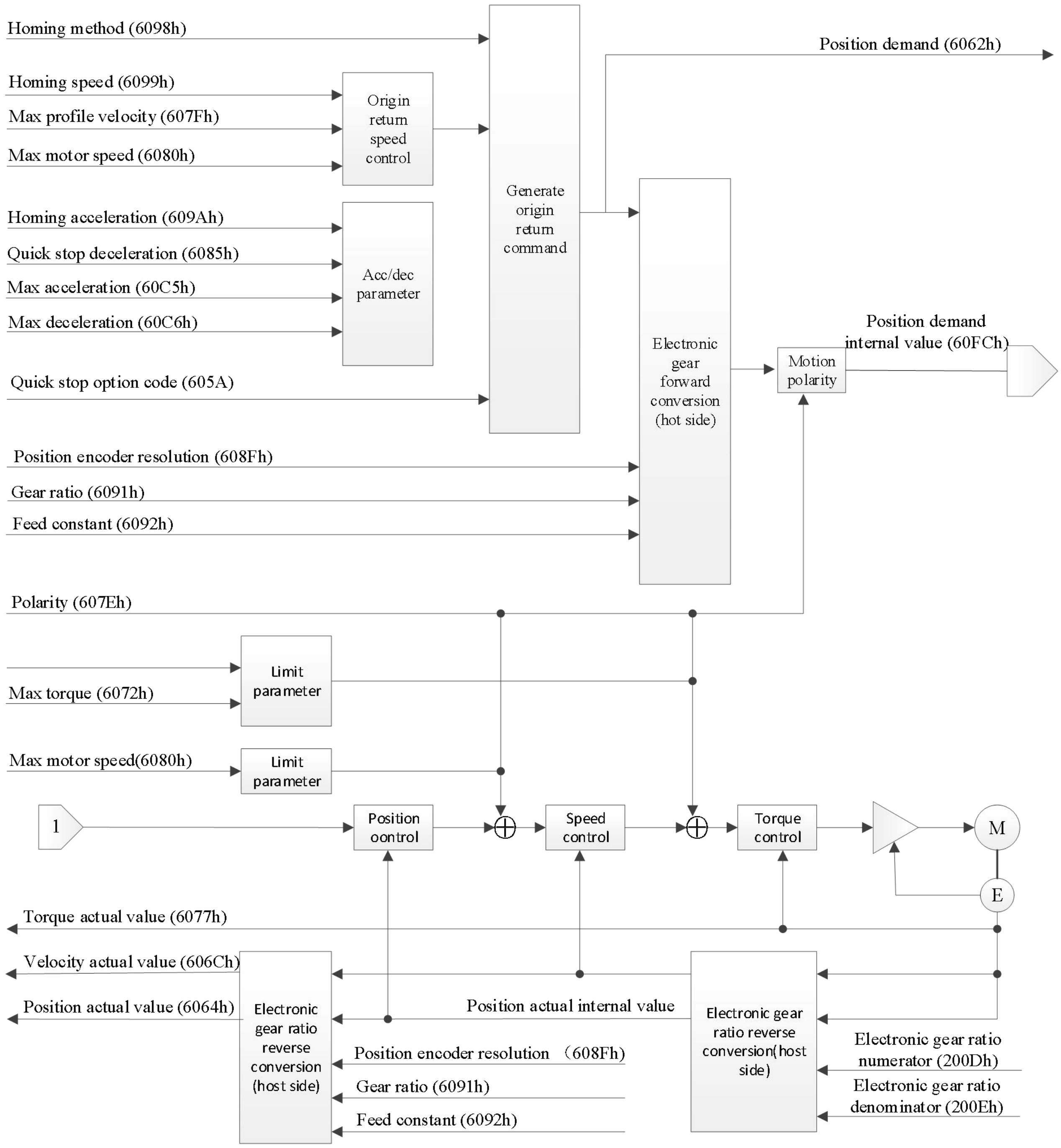
- In the cyclic torque control mode, the mode profile generation is not in the slave but in the host.
- The target torque is 6071h (target torque)
- The torque feedforward is 60B2h (torque offset), which is not supported temporarily.
- The update (sending) of action command, after the servo is on, please input after about 100ms.
- 60C2h (interpolation time period) means updating the period of 6071h (target torque) and 60B2h (torque offset). This value is set to the same period as 1C32h-02h (cycle time).
- As monitoring information, provide 6077h (torque actual value), etc.
- The 6071h (target torque) value is limited by 6072h (max torque), 2312h (P3-28), 2313h (P3-29), the minimum value.
- The speed limit is 6080h (max motor speed).

7.4.2 Common parameters

Register	Explanation	Unit
RXPDO[0x6071]	Target torque	0.1%
TXPDO[0x6064]	Position feedback	Command unit
TXPDO[0x606C]	Velocity feedback	Command unit /s
TXPDO[0x6077]	Torque feedback	0.1%
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6060]	Control mode is CST (Periodic Synchronous Torque Mode), set its value to 10	-

7.5 HM mode

HM mode (i.e. home mode) is used for initialization of the slave station position. An origin reset method is a position control mode that specifies an operation speed and generates a position command inside the servo driver to perform an origin reset operation. If it is used in the incremental mode, after the control power is put into operation, it is necessary to perform the zero point reset action before performing the position positioning work.



7.5.1 Related parameter

1)Related object of HM control mode(Command・setting)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
6040h	00h	ControlWord	-	0~65535	U16	rw	RxPDO
6098h	00h	Homing method	-	-128~127	I8	rw	RxPDO
6099h	-	Homing speeds	-	-	-	-	-
	00h	Item numbers	-	2	U8	ro	NO
	01h	Homing switch speed	Command unit/s	0~4294967295	U32	rw	RxPDO
	02h	Homing speed	Command unit/s	0~4294967295	U32	rw	RxPDO
609Ah	00h	Homing acceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO

Other related objects with common position control

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO
607Fh	00h	Max profile velocity	Command unit/s	0~4294967295	U32	rw	RxPDO
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO
60B1h	00h	Velocity offset	Command unit/s	-2147483648~2147483647	I32	rw	RxPDO
60B2h	00h	Torque offset	0.1%	-32768~32767	I16	rw	RxPDO
60C5h	00h	Max acceleration	Command unit/ s²	0~4294967295	U32	rw	RxPDO
60C6h	00h	Max deceleration	Command unit/ s²	0~4294967295	U32	rw	RxPDO

Other related objects with common actions

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO
605Ch	00h	Disable operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO
607Dh	-	Software position limit	-	-	-	-	-
	00h	607Dh sub index numbers	-	2	U8	ro	NO
	01h	Min position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
607Ch	00h	Home offset	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Eh	00h	Polarity	-	0~255	U8	rw	NO
6085h	00h	Quick stop deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
6086h	00h	Motion profile type	-	-32768~32767	I16	rw	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	608Fh sub index numbers	-	2	U8	ro	NO
	01h	Encoder increments	Pulse	1~4294967295	U32	ro	NO
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
6091h	-	Gear ratio	-	-	-	-	-
	00h	6091h sub index numbers	-	2	U8	ro	NO
	01h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
6092h	-	Feed constant	-	-	-	-	-
	00h	6092h sub index numbers	-	2	U8	ro	NO
	01h	Set Feed	Command unit	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO

Controlword (6040h) < Functions in HM control mode >

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6040h	00h	Control word	0~65535	U16	Rw	RxPDO	All

Set the control command to the servo driver such as PDS state conversion.

Bit information

15	14	13	12	11	10	9	8
r						oms	h

7	6	5	4	3	2	1	0
Fr	oms			eo	qs	ev	so
	r	r	start homing				

r = reserved(not corresponding)

oms = operation mode specific

(control mode is based on bit)

h = halt

so = switch on

fr = fault reset

eo = enable operation

qs = quick stop

ev = enable voltage

bit9,6-4(operation mode specific):

Bit	Name	Value	Definition
4	start homing	0 -> 1	Start the origin point reset action
5	(reserved)	-	not used
6	(reserved)	-	not used
9	(reserved)	-	not used

Through the opening of bit4 (start homing) of 6040h (control word), obtain the parameters (timing method, speed, acceleration and deceleration, etc.) associated with the origin reset position control mode (HM), and start the action.

In addition, in the origin reset action, even if a new origin reset action (bit4 of 6040h is started again), the new origin reset action is ignored.

Homing method(6098h)

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6098h	00h	Homing method	-128~127	I8	rw	RxPDO	All

Set the zero point reset method

Value	Definition
-2	Reverse hitting homing
-1	Forward hitting homing
0	No homing method assigned
1	-Ve LS & Index Pulse
2	+Ve LS & Index Pulse
3	+Ve HS & Index Pulse direction reversal
4	+Ve HS & Index Pulse no direction changed
5	-Ve HS & Index Pulse direction reversal
6	-Ve HS & Index Pulse no direction changed
7	On +Ve HS -Index Pulse
8	On +Ve HS +Index Pulse
9	After +Ve HS reverse +Index Pulse
10	After +Ve HS +Index Pulse
11	On -Ve HS -Index Pulse
12	On -Ve HS +Index Pulse
13	After -Ve HS reverse +Index Pulse
14	After -Ve HS +Index Pulse
15	Reserved
16	Reserved
17	Same as 1 without Index pulse
18	Same as 2 without Index pulse
19	Same as 3 without Index pulse
20	Same as 4 without Index pulse
21	Same as 5 without Index pulse
22	Same as 6 without Index pulse
23	Same as 7 without Index pulse
24	Same as 8 without Index pulse
25	Same as 9 without Index pulse
26	Same as 10 without Index pulse

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
		27	Same as 11 without Index pulse				
		28	Same as 12 without Index pulse				
		29	Same as 13 without Index pulse				
		30	Same as 14 without Index pulse				
		33	On Index Pulse +Ve direction				
		34	On Index Pulse –Ve direction				
		35	Current postion = home				
		37	Current postion = home				
		+Ve: positive	LS: Limit switch				
		-Ve: negative	HS: Home switch				

Homing speeds(6099h)

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6099h	-	Homing speeds	-	-	-	-	-
		Set the speed in the home reset position control mode (HM).					
	00h	Number of entries	2	U8	ro	NO	HM
		Sub-Index number of 6099h (Homing speeds)					
	01h	Speed during search	0~4294967295	U32	rw	RxPDO	HM
		Set the speed of the action to be detected by the switch signal. The maximum value is limited by any smaller one of the internal processing of 6080h (max motor speed) and 2147483647.					
	02h	Speed during search for zero	0~4294967295	U32	rw	RxPDO	HM
		Set the action speed to zero point detection. If the edge of the switch signal is used as the origin detection position, in order to reduce the detection error, please set a value as small as possible. The maximum value is limited by the smaller side of the internal processing of 6080h (max motor speed) and 2147483647.					

Homing acceleration (609Ah)

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
609Ah	00h	Homing acceleration	0~4294967295	U32	rw	RxPDO	All
		Set the acceleration and deceleration in the origin reset position control mode (HM). The deceleration of the home reset position control mode (HM) is also used for this object. When each homing method is finally stopped (when the origin position is checked out), the setting of this object is not needed, and the servo lock stops. If set to 0, internal processing is treated as 1.					

2) Objects associated with HM control mode (monitor)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6041h	00h	Statusword	-	0~65535	U16	ro	TxPDO
60E3h	-	Supported homing method	-	-	-	-	TxPDO
	00h	60E3h sub index numbers	-	1~254	U8	ro	TxPDO
	01h	Homing mode 1	-	0~32767	U16	ro	TxPDO
	..	..	..	..	..	..	..
	20h	Homing mode 32	-	0~32767	U16	ro	TxPDO

Other associated objects with common position control

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6062h	00h	Position command	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
6063h	00h	Actual internal position feedback	pulse	-2147483648~ 2147483647	I32	ro	TxPDO
6064h	00h	Position feedback	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
6065h	00h	Position offset too large threshold	Command unit	0~4294967295	U32	rw	RxPDO
6066h	00h	Error time out	1ms	0~65535	U16	rw	RxPDO
6067h	00h	Position reach the threshold	Command unit	0~4294967295	U32	rw	RxPDO
6068h	00h	Position reach window time	1ms	0~65535	U16	rw	RxPDO
606Ch	00h	Velocity feedback	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
6074h	00h	Torque command	0.1%	-32768~32767	I16	ro	TxPDO
6076h	00h	Motor rated torque	Mn·m	0~4294967295	U32	ro	TxPDO
6077h	00h	Torque feedback	0.1%	-32768~32767	I16	ro	TxPDO
60F4h	00h	Position offset	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60FAh	00h	Internal command speed (position loop output)	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
60FCh	00h	Internal position command	pulse	-2147483648~ 2147483647	I32	ro	TxPDO

Note: 6064h (position feedback) will reset after HM homing.

Other related objects with common actions

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
603Fh	00h	Error Code	-	0~65535	U16	ro	TxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BCh	00h	The rising edge clamping	Command	-2147483648~	I32	ro	TxPDO

		position of Touch probe 2	unit	2147483647			
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

Statusword (6041h) < functions in hm control mode >

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	All

Servo driver status

Bit information

15	14	13	12	11	10	9	8
r		oms		ila	oms	rm	r
		Homing error	Homing attained		Target reached		
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
W	sod	qs	ve	f	oe	so	rsto

r = reserved(not corresponding)　　w = warning

sod = switch on disabled

oms = operation mode specific　　qs = quick stop

(control mode is based on bit)　　ve = voltage enabled

ila = internal limit active　　f = fault

oe = operation enabled

rm = remote　　so = switched on

rtso = ready to switch on

bit13,12,10(operation mode specific):

Bit	Name	Value	Definition
10	target reached	0	In action
		1	Stop status
12	homing attained	0	Homing action not completed
		1	Homing action completed
13	Homing error	0	Homing abnormality does not occur
		1	Abnormal homing (the homing action cannot be executed normally)

bit13,12,10(operation mode specific):

Bit13	Bit12	Bit10	Definition
0	0	0	Homing in action
0	0	1	Homing action interrupted or not started
0	1	0	Homing action is completed, but the target position is not reached
0	1	1	Normal completion of homing
1	0	0	Detect out that the homing abnormality is still in operation
1	0	1	Detect out the abnormal homing and stop state

bit12 (homing attained) is 0 in the following states:

- When the power is on
- When the ESM state is transferred from Init to PreOP
- At the beginning of origin point reset

When the homing action (method35, method37) without motor action is started, the homing attached is also set to 0. However, the time set to 0 is short (about 2 ms).

Supported homing method (60E3)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
60E3h	-	Supported Homing method	-	-	-	-	TxPDO
	Indicates the supported homing method						
	00h	Number of entries	-	1~254	U8	ro	TxPDO
	Represents the number of homing methods supported by 60E3h (supported homing method).						
	01h	1st supported Homing method	-	0~32767	U16	ro	TxPDO
	Indicates that the first home method is supported.						
	..	..	..	..	..	..	..
	20h	32nd supported Homing method	-	0~32767	U16	ro	TxPDO
	Indicates that the 32nd home method is supported						

Index	Sub-index	bit 15~8	bit 7~0
		Reserved	Supported Homing method
60E3	01h	0	1
	02h	0	2
	03h	0	3
	04h	0	4
	05h	0	5
	06h	0	6
	07h	0	7
	08h	0	8
	09h	0	9
	0Ah	0	10
	0Bh	0	11
	0Ch	0	12
	0Dh	0	13
	0Eh	0	14
	0Fh	0	17
	10h	0	18
	11h	0	19
	12h	0	20
	13h	0	21
	14h	0	22
	15h	0	23
	16h	0	24
	17h	0	25
	18h	0	26
	19h	0	27
	1Ah	0	28
	1Bh	0	29
	1Ch	0	30
	1Dh	0	33
	1Eh	0	34
	1Fh	0	35
	20h	0	37

The relationship between * value and Homing method please refer to 6098h (Homing method).

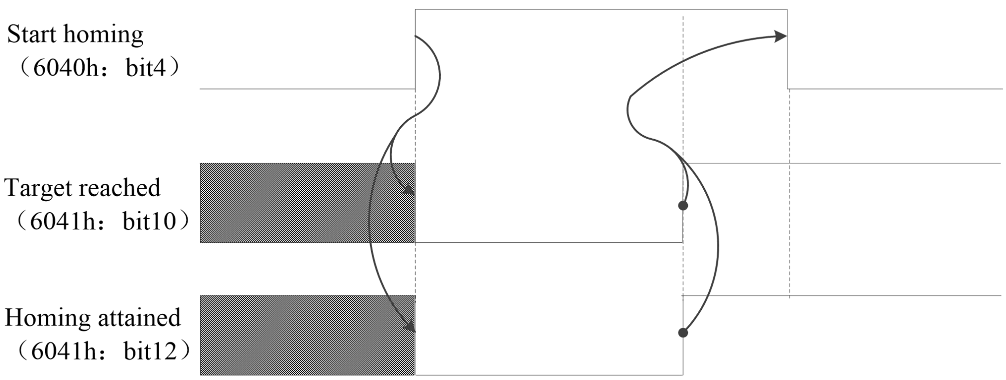
2) The action of HM control mode (Homing action)

When using in incremental mode, in order to initialize the location information before starting the normal action, please execute the homing action.

- After the origin position is detected, this position is used as the reference to initialize the following objects (preset).
  6062h(Position demand value)= 6064h(Position actual value)= 607Ch(Home offset)
  6063h(Position actual internal value)= 60FCh(Position demand internal value)= 0
- If the origin point reset is performed, the position information is initialized (preset). Therefore, it is necessary to obtain the data based on the old location information again (touch probe location, etc.).
- Whether 607Ch (home offset) is changed or not in the homing action, it is not reflected in the executing homing action. The next homing action will be reflected (initialization of position information upon completion).
- 607C (me offset) is only valid in homing mode 35 and 37.
- If the edge of the switch signal (T, NOT, HOME) is used as the detection position of the origin, please assign each clamping compensation pin to SI1, SI2, SI3. If it is not allocated correctly, an error will be reported in the origin reset. (Note: P5-22 of DS5C2 series servo is the setting address of positive limit, the default value is 1, the corresponding servo terminal is SI1; P5-23 is the setting address of negative limit NOT, the default value is 2, the corresponding servo terminal is SI2; P5-27 is the setting address of origin, the default value is 3, the corresponding servo terminal is SI3.)
- In the Method diagrams described later, the meaning of below terms:

Index pulse	Z phase signal of encoder
Home switch	Theoretical signal state of near origin input(ME)
Positive limit	Theoretical signal state of forward drive inhibit input(POT)
Negative limit	Theoretical signal state of negative drive inhibit input(NOT)

- After the update (sending) of action command and the operation enabled command, please input after about 100 ms.
- The following shows the timing of the HM control mode.



- Homing error occurrence condition

According to the homing action, the conditions for an exception (homing error = 1) are as follows.

Homing error occurrence condition	Details
Startup except Operation	Start Homing when PDS status is not Operation enabled (except for method35,

enabled	37)
Startup under target speed 0	Startup Homing when 6099h-01h and 6099h-02h is set to 0 (except 6099h-02h of method33, 34 and 6099h-01h, 6099h-02h of method35, 37 are 0)
detected out two Limit switch	Two limit switches of positive/negative are detected during the homing start or the homing action.
Use Limit switch	Under the method reversed by limit switch, in the reverse deceleration action after the rising edge of limit switch is detected, the falling edge of limit switch is detected
Home switch, Limit switch not distributed	Not distribute IO terminal

7.5.2 Related parameters

Register	Explanation	Unit
RXPDO[0x6040]	Control word, modify the control word to enable the homing	-
RXPDO[0x6098]	Homing method	-
RXPDO[0x609A]	Homing acceleration	Command unit/s^2
RXPDO[0x6060]	Set to 6 when the motor is not enabled	-
SDO[0x6099]	Homing speed, can be modified online through COE-Online	Command unit/s

Control word (6040h)

Set it to (0x06 > 0x0f > 0x1f) in sequence, enable the driver and start the motor to operate, and homing is enabled.

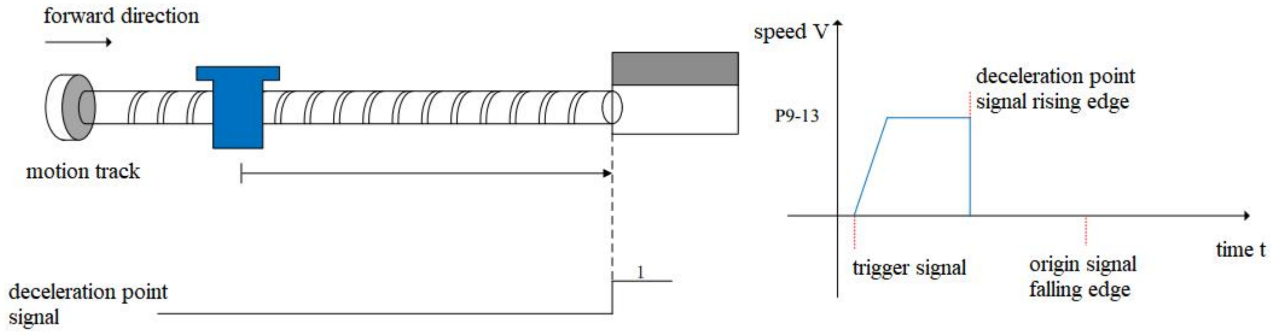
7.5.3 Homing method

Now DL6 servo driver support 1~14, 17~30, 33, 34, 35, 37 and -1, -2 homing method.

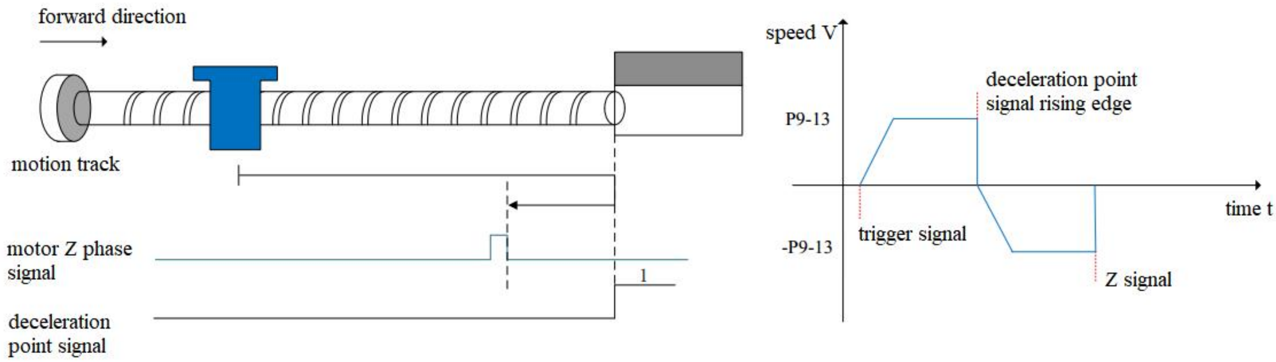
- Method -1:

The servo motor first runs at a forward low speed with the set value of 6099h:02 (low speed for homing). After hitting the mechanical limit position, if the absolute value of the torque reaches the upper limit of P9-17 (touch stop homing torque threshold), and the absolute value of the speed is lower than the set value of P9-16 (touch stop homing speed threshold), this state is maintained for the set time of P9-18 (touch stop homing time threshold), and it is judged to have reached the mechanical limit position. Then it can be divided into two situations:

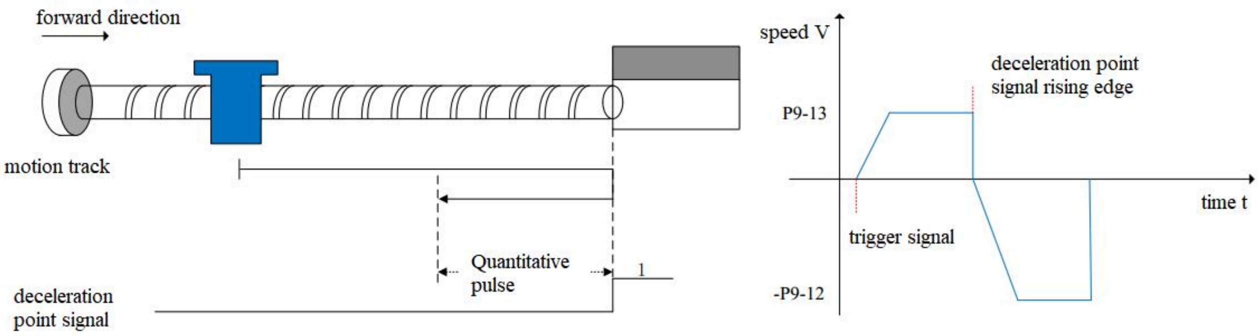
① P7-20=0, and the number of quantitative pulses is 0. At this point, immediately stop the machine and calibrate it as zero (position reset);



② P7-20>0, the number of quantitative pulses is 0, and it runs in reverse at the setting homing low speed. When encountering the rising edge of P7-20 Z-phase signals, it immediately stops and calibrates the zero point (position reset).



③ P7-20=0, and the number of quantitative pulses is not 0. First, run in the forward direction at low speed (6099h: 02), and after touching the mechanical point, run in the reverse direction at homing high speed (6099h: 01). After the quantitative pulse length is reached, stop the machine and calibrate it as the zero point (Ecat position is reset to zero);



④ P7-20>0, the number of quantitative pulses is not 0. First, run in the forward direction at low speed (6099h: 02), and then run in the reverse direction at the set homing low speed (6099h: 02) when encountering the mechnical origin, stop machine when encountering the rising edge of P7-20 Z-phase signals. After stopping, run the quantitative pulse length at the homing high speed (6099h: 01), and then stop the machine. Calibrate the zero point (Ecat position is reset).

Parameter	Function	Unit	Default value	Range	Effective time	Suitable mode
P7-20	Ethercat homing find the Z phase	-	1	-9999~9999	○	EtherCAT

	numbers					mode

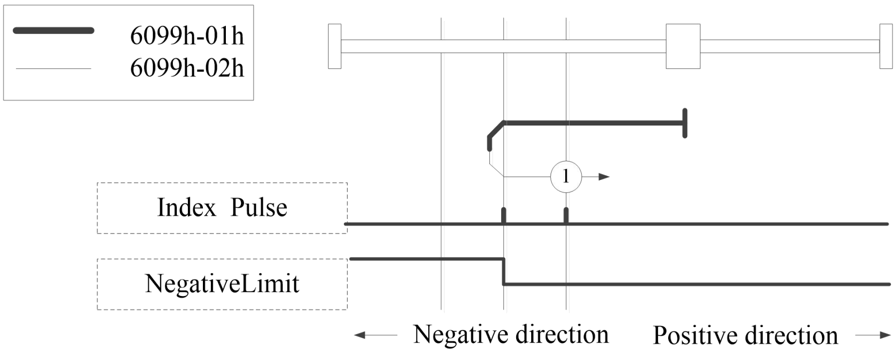
The positive and negative values of the P7-20 parameters represent the direction of homing, with positive values indicating the forward direction of finding the origin, negative values indicating the reverse direction of finding the origin, and absolute values indicating the number of Z-phase points for homing.

- Method -2:

Similar to the previous homing action, running in the opposite direction.

- Method 1:

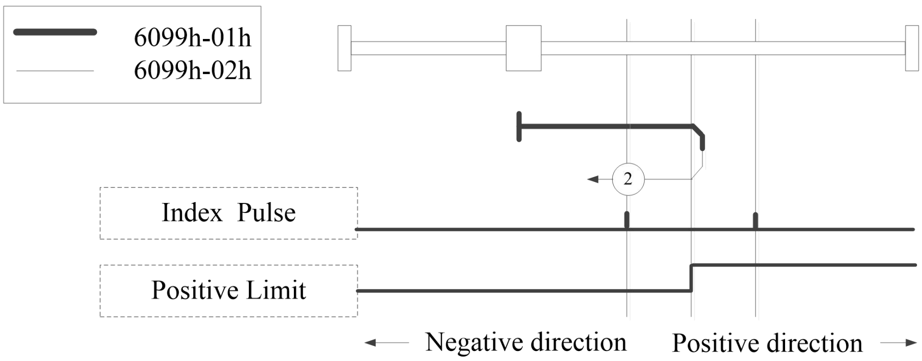
When using this homing method 1, if the reverse limit switch is in a non triggered state, the initial direction of movement is left. The first Z-phase pulse to the right of the position where the negative limit switch becomes invalid at the origin position.



Homing on negative limit switch and index pulse

- Method 2:

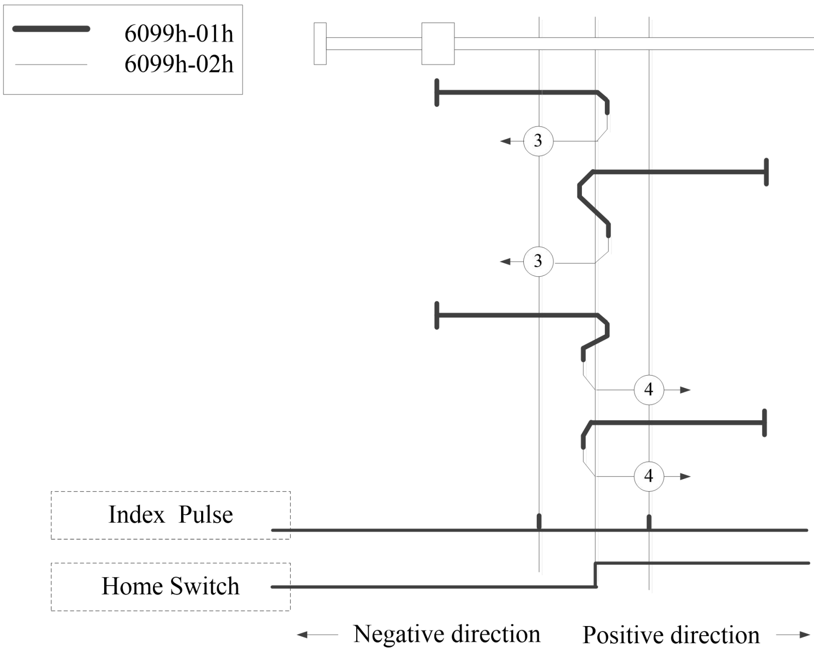
When using method 2, if the forward limit switch is not triggered, the initial movement direction is to the right. The origin position is at the first Z-phase pulse to the left of the position where the forward limit switch becomes invalid.



Homing on positive limit switch and index pulse

- Method 3, 4:

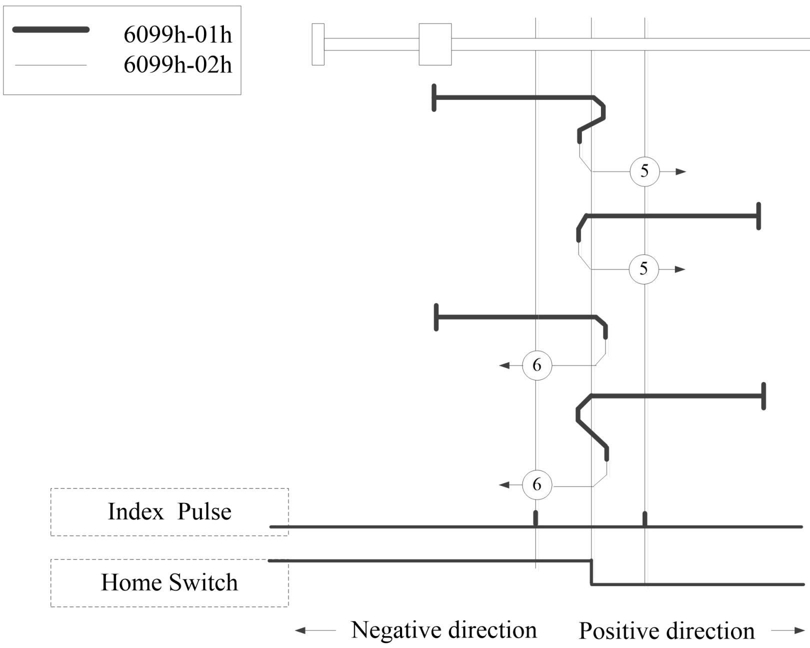
Using method 3 or 4, the initial direction of movement depends on the state of the origin switch. The origin position is on the reverse side of the origin switch or at the initial detected Z-phase position in the forward rotation direction.



Homing on positive home switch and index pulse

- Method 5, 6:

Using method 5 or 6, the initial direction of movement depends on the state of the origin switch. The origin position is on the reverse side of the origin switch or at the initial detected Z-phase position in the forward rotation direction.



Homing on negative home switch and index pulse

■ Method 7~14:

7-14 all use origin switches and Z-phase signals;

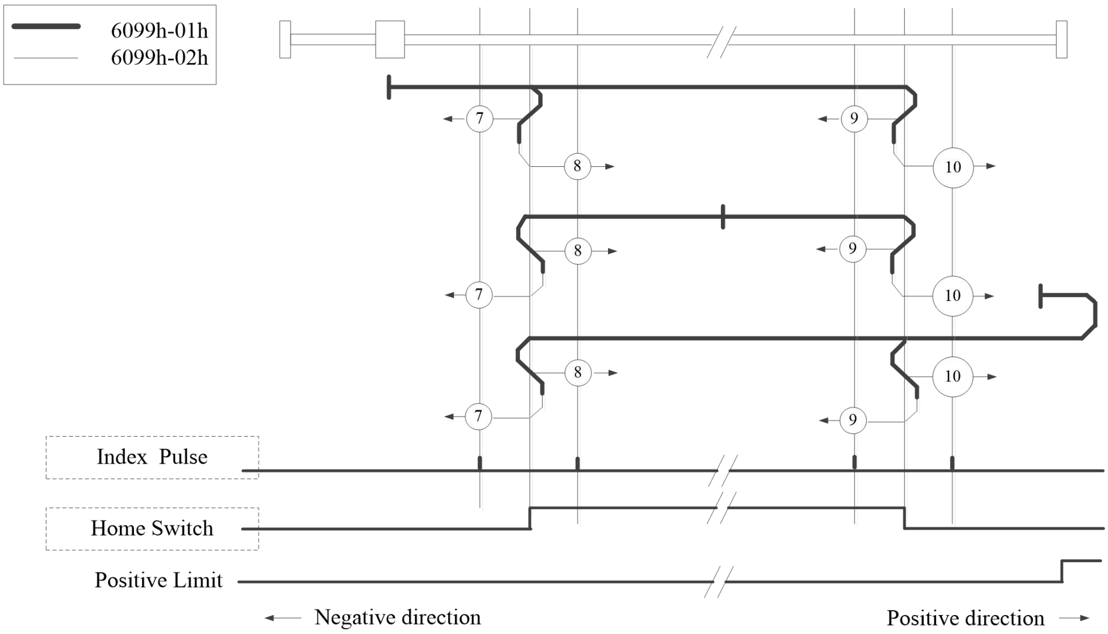
The initial action direction of modes 7 and 8 is negative if the origin switch is already activated at the beginning of the action;

The initialization direction of modes 9 and 10 is positive if the origin switch is already activated at the beginning of the action;

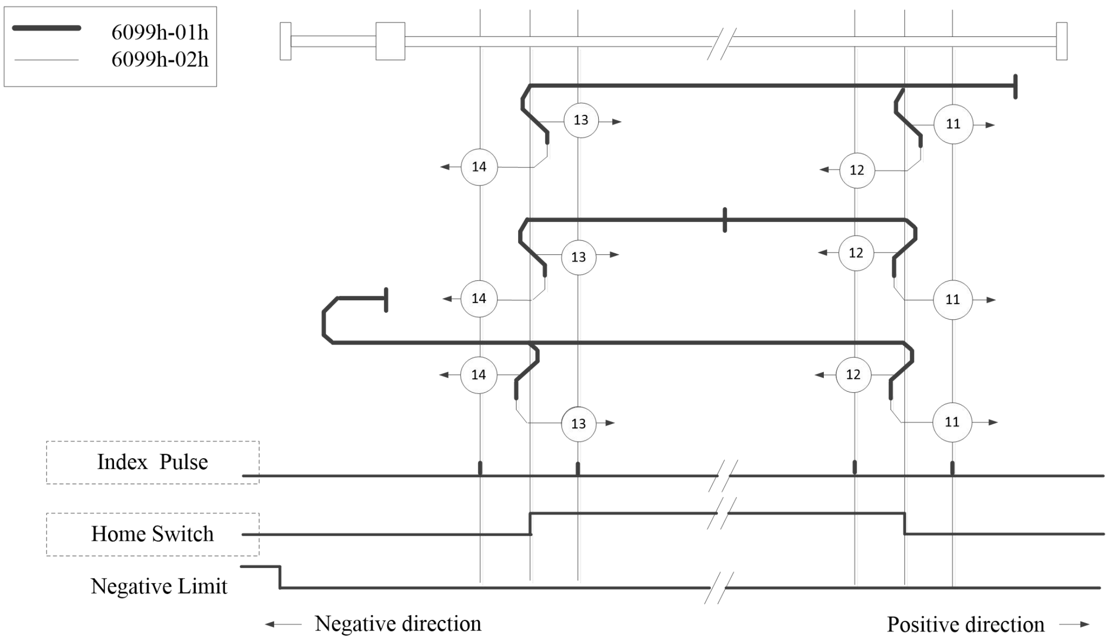
The initialization direction of modes 11 and 12 is positive if the origin switch is already activated at the beginning of the action;

The initialization direction of modes 13 and 14 is negative if the origin switch is already activated at the beginning of the action;

The final position returned to the origin is the Z-phase signal near the rising or falling edge of the origin switch.



Homing on home switch and index pulse – positive initial motion



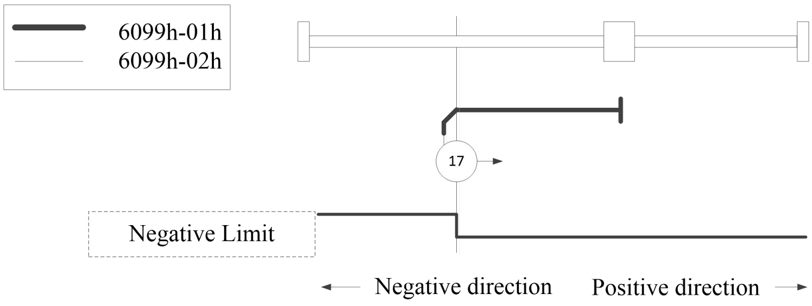
Homing on home switch and index pulse – Negative initial motion

■ Method 17:

This method is similar to Method 1.

The difference is that the origin detection position is not the index pulse, but the position where the Limit switch changes. (Please refer to the following figure)

When NOT is not assigned, Homing error=1.



Homing on negative limit switch

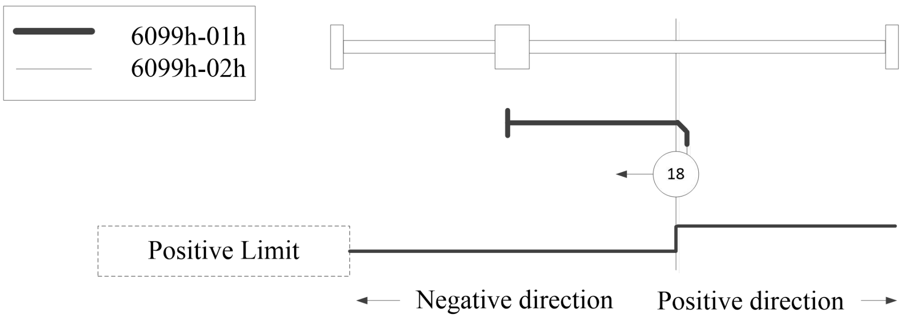
■ Method 18:

This method is similar to Method 2.

The difference is home detection position is not Index pulse. It is becoming the position where limit switch changed.

When POT is not allocated, Homing error = 1.

(Please refer to the figure below)



Homing on positive limit switch

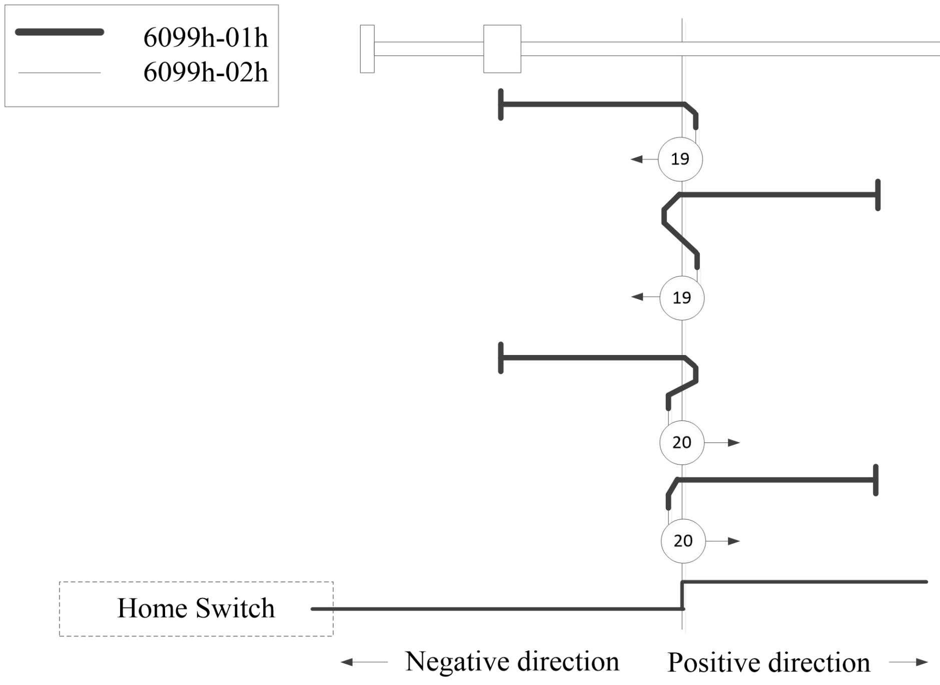
■ Method 19,20:

These methods is similar to Method 3 and 4.

The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.

When HOME is not assigned, homing error = 1.

(Please refer to the figure below)



Homing on positive home switch

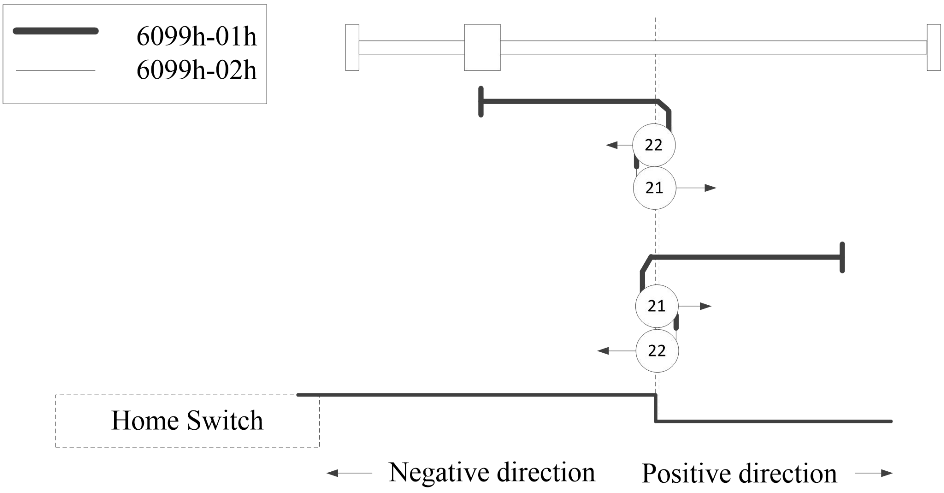
■ Method 21,22:

These methods is similar to Method 5 and 6.

The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.

When HOME is not assigned, homing error = 1.

(Please refer to the figure below)



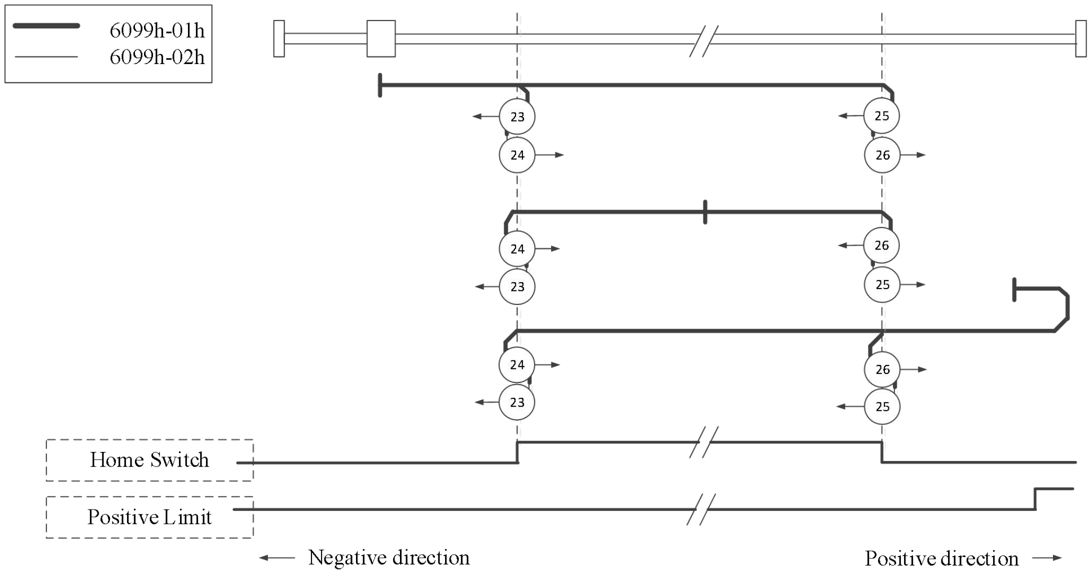
Homing on positive home switch and index pulse

■ Method 23,24,25,26:

These methods is similar to Method 7, 8, 9, 10.

The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.

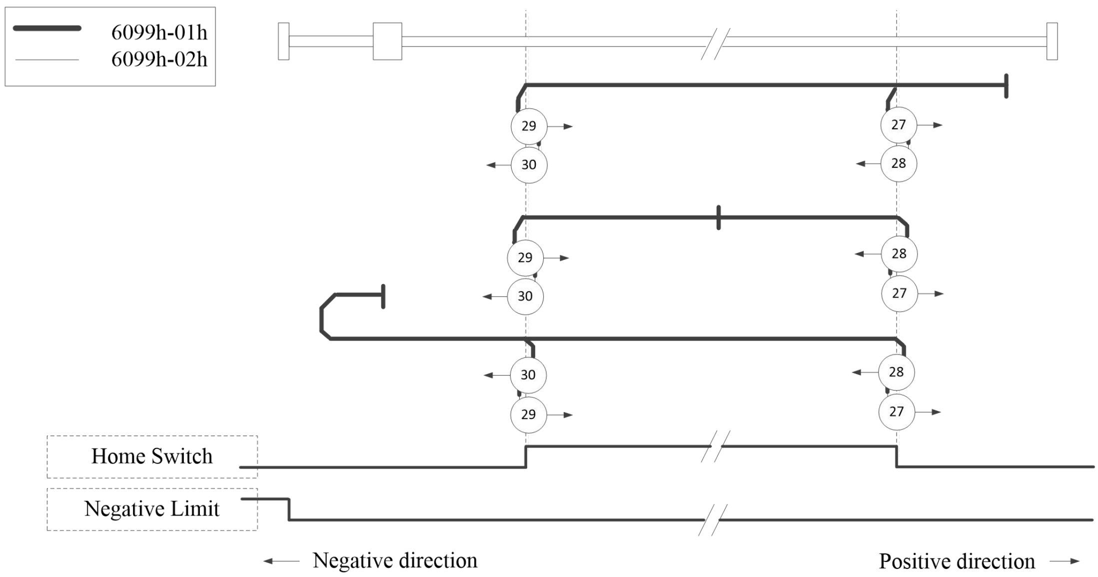
When HOME,POT is not assigned, homing error = 1.
(Please refer to the figure below)



Homing on home switch and index pulse – positive initial motion

■ Method 27,28,29,30:

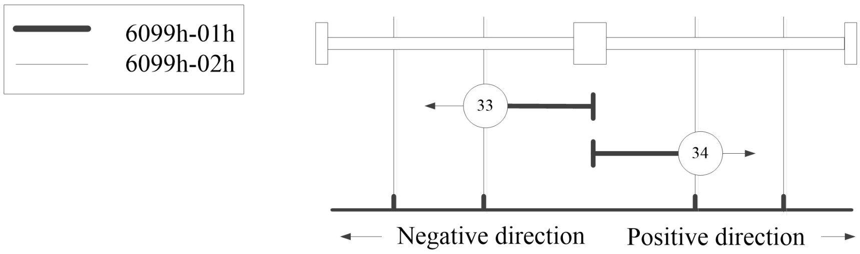
These methods is similar to Method 11,12,13,14。
The difference is home detection position is not Index pulse. It is becoming the position where Home switch changed.
When HOME,NOT is not assigned, homing error = 1.(Please refer to the figure below)



Homing on home switch and index pulse – Negative initial motion

■ Method 33, 34:

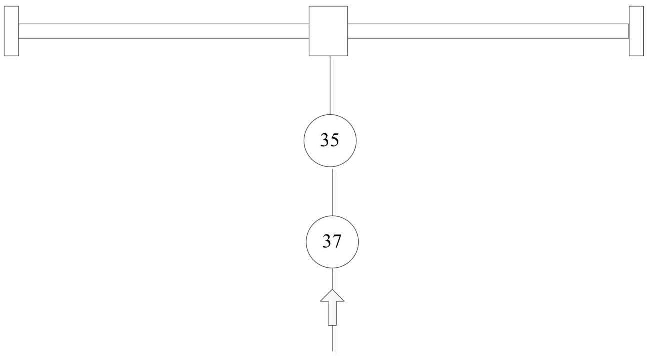
Using methods 33 or 34, homing direction with negative or positive values, respectively. The original position is located near Z in the selected direction.



Homing on index pulse

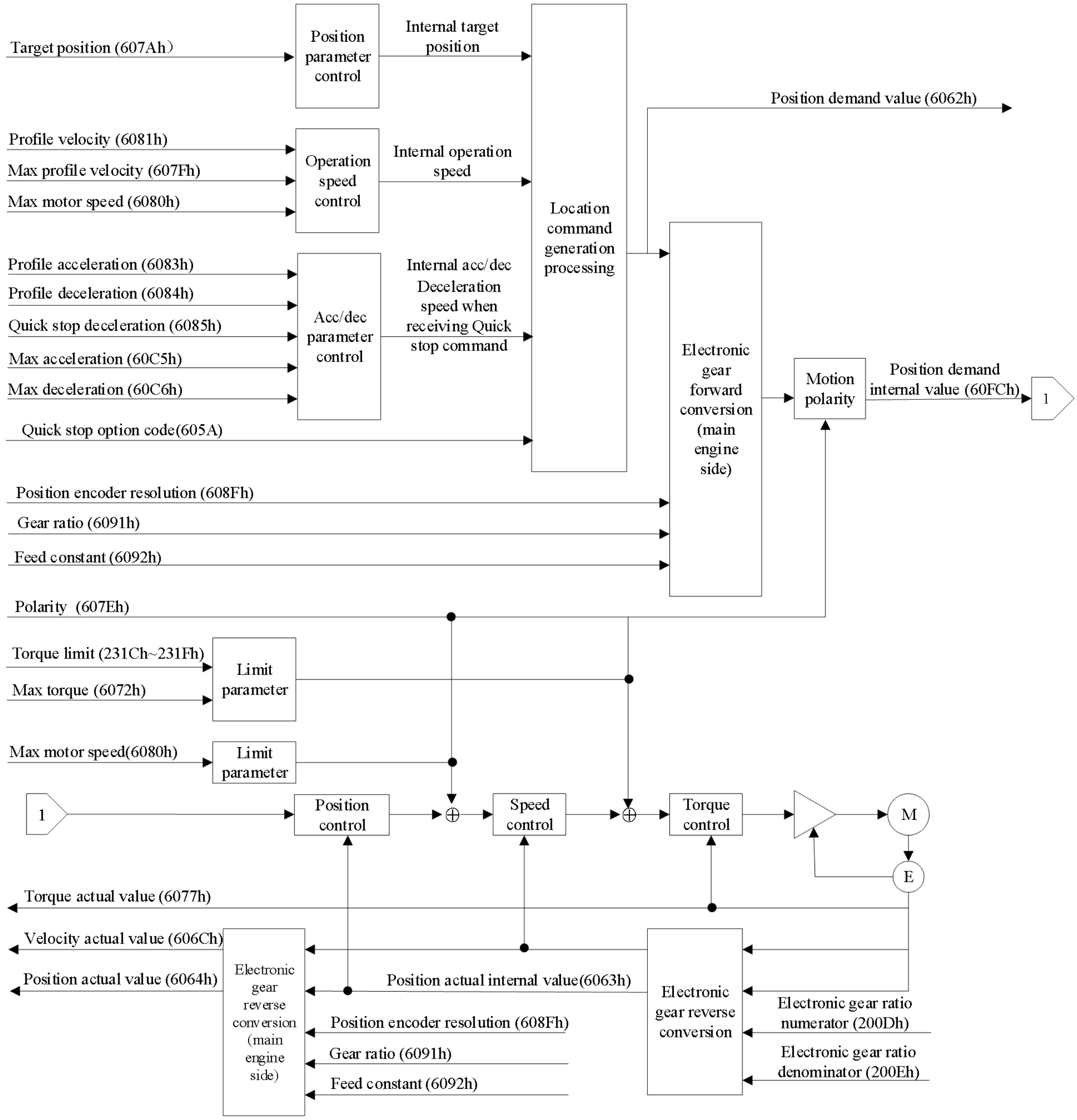
- Method 35, 37:

In modes 35 and 37, the position after power on is the home position.



7.6 PP mode

PP (profile position control mode) is the position control mode that specifies the target position, target speed, acceleration/deceleration, etc., and acts after generating a position command in the servo driver. For this control mode, please check the communication cycle 500 µs or more.



7.6.1 Related parameters

1)PP control mode related objects(Command ・settings)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
6040h	00h	Control word	-	0~65535	U16	rw	RxPDO
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO
607Ah	00h	Target position	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Dh	-	Software absolute position limit	-	-	-	-	-
	00h	607Dh sub index numbers	-	2	U8	ro	NO
	01h	Min position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Fh	00h	Max profle velocity	Command unit/s	0~4294967295	U32	rw	RxPDO
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO
6081h	00h	Profile velocity	Command unit/s	0~4294967295	U32	rw	RxPDO
6083h	00h	Profile acceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
6084h	00h	Profile deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
60B1h	00h	Velocity offset	Command unit/s	-2147483648~ 2147483647	I32	rw	RxPDO
60B2h	00h	Torque offset	0.1%	-32768~32767	I16	rw	RxPDO
60C5h	00h	Max acceleration	Command unit/ s²	0~4294967295	U32	rw	RxPDO
60C6h	00h	Max deceleration	Command unit/ s²	0~4294967295	U3	rw	RxPDO

Other related objects with common actions

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO
605Ch	00h	Disable operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO
607Dh	-	Software position limit	-	-	-	-	-
	00h	607h sub index numbers	-	2	U8	ro	NO

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
	01h	Min position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO
607Ch	00h	Home offset	Command unit	-2147483648~2147483647	I32	rw	RxPDO
607Eh	00h	Polarity	-	0~255	U8	rw	NO
6085h	00h	Quick stop deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
6086h	00h	Motion profile type	-	-32768~32767	I16	rw	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	608Fh sub index numbers	-	2	U8	ro	NO
	01h	Encoder increments	pulse	1~4294967295	U32	ro	NO
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
6091h	-	Gear ratio	-	-	-	-	-
	00h	6091 sub index numbers	-	2	U8	ro	NO
	01h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
6092h	-	Feed constant	-	-	-	-	-
	00h	6092h sub index numbers	-	2	U8	ro	NO
	01h	Feed	Command unit	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO

Controlword(6040h) <functions in PP control mode>

<table>
<tr><th>Index</th><th>Sub-index</th><th>Name</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td rowspan="2">6040h</td><td rowspan="2">00h</td><td>Controlword</td><td>0~65535</td><td>U16</td><td>rw</td><td>RxPDO</td><td>All</td></tr>
<tr><td colspan="6">Set the control command to the servo driver such as PDS state conversion.
Bit information
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="6">r</td><td>om</td><td>h</td></tr>
</table>
<table>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">fr</td><td colspan="3">oms</td><td rowspan="2">eo</td><td rowspan="2">qs</td><td rowspan="2">ev</td><td rowspan="2">so</td></tr>
<tr><td>abs/rel</td><td>Change set immediately</td><td>New set-point</td></tr>
</table>
r = reserved(not corresponding) fr = fault reset
oms = operation mode specific eo = enable operation
qs = quick stop
h = halt ev = enable voltage
so = switch on</td></tr>
</table>

Bit6-4(operation mode specific):

Bit	Name	Value	Definition
4	new set-point	0 -> 1	Start the positioning action and trigger the setting value update. Get the new location determination task (607Ah (Target position), 6081h (Profile velocity), etc.).
5	change set immediately	0	Complete the currently running positioning action. That is, during the movement, if the target position 607A, acceleration 6083, deceleration 6084 are changed, and then the control command is sent, it will not operate according to the new movement parameters. It is necessary to send a new command after the last movement is completed to execute the new movement.
		1	Interrupt the current positioning action and immediately start the downward positioning action. That is, during the movement, the target position 607A, acceleration 6083 and deceleration 6084 are changed, and then the control command is sent. For example, after the control word 0x6f (111) → 0x7F (127) (relative mode) or 0x2F (47) → 0x3f (63) (absolute mode) is changed, the system will immediately operate according to the new motion parameters.
6	absolute/relative	0	607Ah(target position) Process as absolute position
		1	607Ah(target position) Process as absolute position

Note:

(1) please do not change the acceleration and deceleration during motor operation (*).

If the acceleration and deceleration are changed, please change bit4 (new set point) from 0 to 1 after the motor stops.

6083h (Profile acceleration)

6084h (Profile deceleration)

60C5h (Max acceleration)

60C6h (Max deceleration)

(2) In the following status, if set point is executed (bit4 (new set-point) is changed from 0 to 1), please note that its positioning task is revoked.

--6081h (profile speed) = 0.

(3) if the driving prohibition in deceleration is detected according to halt = 1, all the positioning tasks are invalid.

(4) start the PP action, and keep it for more than 2ms until the next PP action is started (new set-point changes from 0 to 1).

2) Related objects in pp control mode(monitor)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6041h	00h	Controlword	-	0~65535	U16	ro	TxPDO

Other related objects with common position control.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6062h	00h	Position demand value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
6063h	00h	Position actual internal value	pulse	-2147483648~ 2147483647	I32	ro	TxPDO
6064h	00h	Position actual value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
6065h	00h	Threshold for excessive	Command	0~4294967295	U32	rw	RxPDO

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
		positional deviation	unit				
6066h	00h	Error time out	1ms	0~65535	U16	rw	RxPDO
6067h	00h	Position reach the threshold	Command unit	0~4294967295	U32	rw	RxPDO
6068h	00h	Position window time	1ms	0~65535	U16	rw	RxPDO
606Ch	00h	Velocity feedback	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
6074h	00h	Torque command	0.1%	-32768~32767	I16	ro	TxPDO
6076h	00h	Motor rated torque	Mn·m	0~4294967295	U32	ro	TxPDO
6077h	00h	Torque feedback	0.1%	-32768~32767	I16	ro	TxPDO
60F4h	00h	Position deviation	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60FAh	00h	Internal command speed (position loop output)	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
60FCh	00h	Internal position command	pulse	-2147483648 ~ 2147483647	I32	ro	TxPDO

Other related objects with common actions。

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
603Fh	00h	Error code	-	0~65535	U16	ro	TxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BCh	00h	The rising edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

Statusword (6041h)< functions in pp control mode >

<table>
<tr><th>Index</th><th>Sub-index</th><th>Name</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td rowspan="2">6041h</td><td rowspan="2">00h</td><td>Statusword</td><td>0~65535</td><td>U16</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Servo driver status
Bit information
<table>
<tr><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th></tr>
<tr><td colspan="2" rowspan="2">r</td><td colspan="2">oms</td><td rowspan="2">ila</td><td>oms</td><td rowspan="2">rm</td><td rowspan="2">r</td></tr>
<tr><td>Following Error</td><td>set- point acknowledge</td><td>Target Reached</td></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>w</td><td>sod</td><td>Qs</td><td>ve</td><td>f</td><td>oe</td><td>so</td><td>rsto</td></tr>
</table>
r = reserved(not corresponding) w = warning
sod = switch on disabled</td></tr>
</table>

		oms = operation mode specific qs = quick stop (control mode is based on bit) ve = voltage enabled ila = internal limit active f = fault oe = operation enabled rm = remote so = switched on rtso = ready to switch on

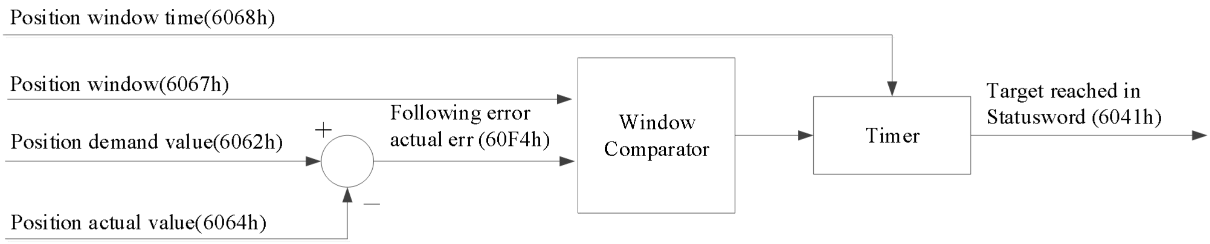
bit13,12,10(operation mode specific):

Bit	Name	Value	Definition
10	target reached	0	halt=0(normal): positioning incompleted halt=1(stop as halt):shaft is decelerating
		1	halt=0(normal):positioning completed halt=1(stop as halt):shaft stop(shaft speed is 0)
12	set-point acknowledge	0	The new-setpoint is 0, and the buffer is empty after the current target position is executed (in execution)
		1	The new location task puts data into the buffer, which is not empty.
13	following error	0	60F4h(Following error actual value) (= 6062h(Position demand value)– 6064h(Position actual value)), not over the setting range of 6065h(Following error window), or the value of 60F4h is over 6065h, not through the setting time of 6066h.
		1	The value of 60F4h (Following error actual value), the status over the setting range of 6065h (Following error window), above the setting time of 6066h(Following error time out), continue.

bit10:target reached(Position reached)

When the servo enable state (operation effective state) and the set-points all give the completion instruction generation state, the difference between 6062h (position required value) and 6064h (position actual value) is within the range set in 6067h (position window). After the time set in 6068H (position window time), the bit10 (target reached) of 6041h (status word) changes to 1.

Bit	Name	Vlaue	Definition
10	Target reached	0	halt=0 (normal): positioning incompleted halt=1 (stop as halt): shaft is decelerating
		1	halt=0 (normal): positioning completed halt=1 (stop as halt): shaft stop (shaft speed is 0)



Location arrival diagram

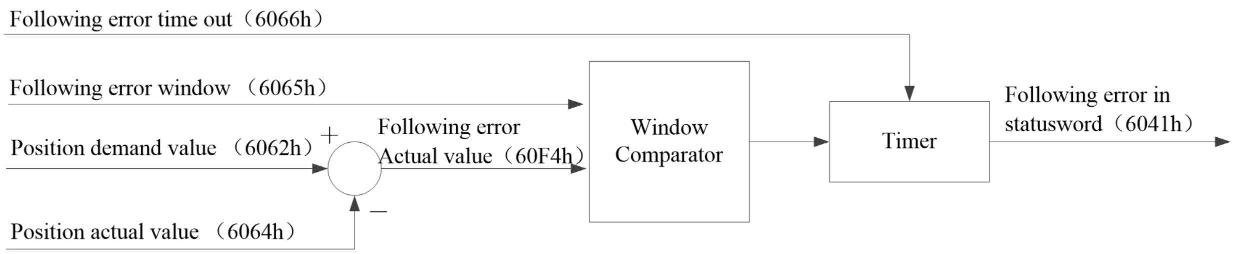
Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
6067h	00h	Position reach	Command	0~4294967295	U32	rw	RxPDO	PP

		threshold	unit					
		The difference between 6062h (Position command) and 6064h (Position feedback) is within the set value of this parameter. After the time set in 6068H (Position window time), set the bit10 (Target reached) of 6041h (Status word) as the threshold value of 1. If the difference is a value other than this parameter setting, bit10 of 6041h is 0.						
6068h	00h	Position window time	1ms	0~65535	U16	rw	RxPDO	PP
		The difference between 6062h (position command) and 6064h (position feedback) is the time when the bit10 (target reached) of 6041h (status word) is set to 1 in the range of 6067h (position window) setting.						

bit13:following error

The status that the value of 60F4h (position deviation) is over the setting range of 6065h (position offset too large threshold). If continue the setting time of 6066h (error time out), bit13(following error) of 6041h (state word) changes to 1.

Bit	Name	Value	Definition
13	Following error	0	60F4h (position deviation) (= 6062h (Position command) – 6064h(Position feedback)), not over the setting range of 6065h (position offset too large threshold), or the value of 60F4h is over 6065h, not after the setting time of 6066h
		1	The value of 60F4h (position offset) is over the setting range of 6065h (position offset too large threshold), above the setting time of 6066h (error time out), continue.



Follow error function diagram

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
6065h	00h	Position offset too large threshold	Command unit	0~ 4294967295	U32	rw	RxPDO	PP CSP
		60F4h(Following error actual value): the condition except the setting value of this parameter, set 6041h (statusword) bit 13 (following error) to 1.						
6066h	00h	error time out	1ms	0~65535	U16	rw	RxPDO	PP CSP
		The status that 60F4h (position offset) value is over the setting range of 6065h (position offset too large threshold) is above this parameter, if continue, set 6041h (Statusword) bit13(following error) to 1.						

3) pp control mode action

Action example 1:(basic set-point)

(1) For the master station, after setting the value of 607Ah (Target position), change the bit4 (new set point) of 6040h (control word) from 0 to 1. At this time, please also set 6081h (profile velocity).

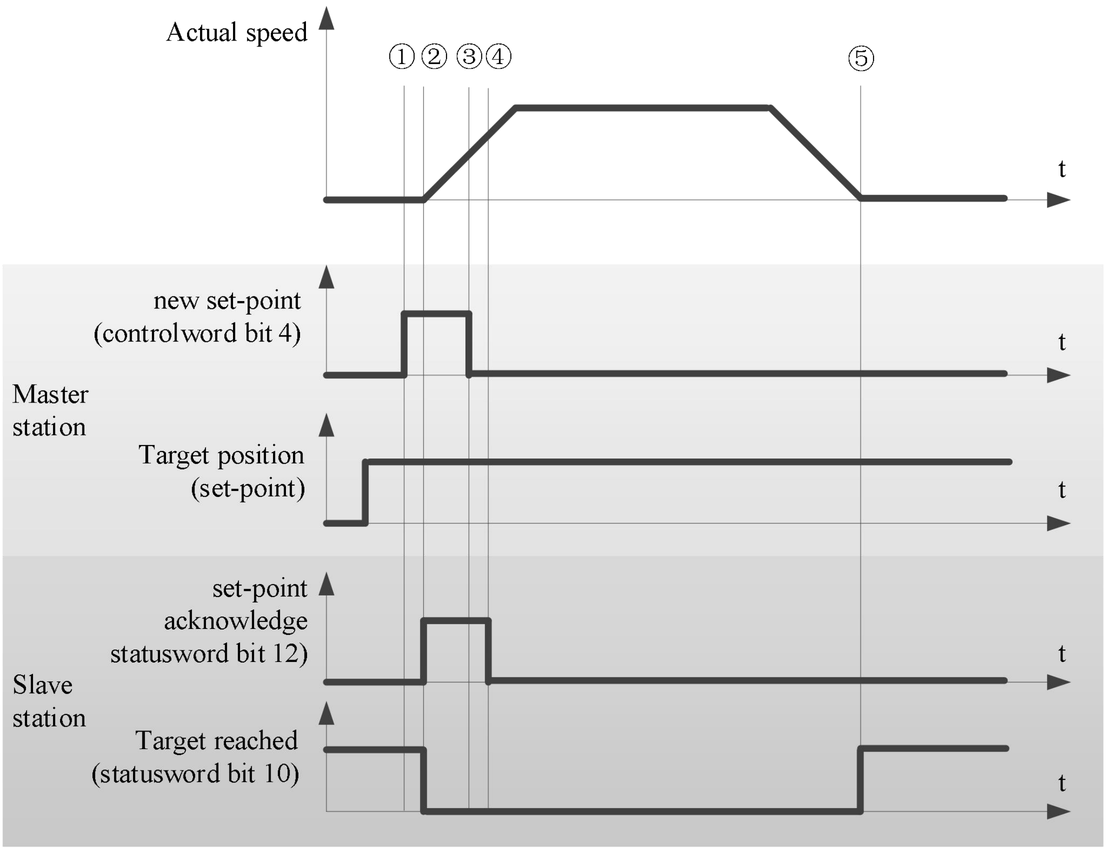
When 6081h (profile velocity) is 0, the motor does not act.

(2) For the slave station, confirm the rising edge (0 → 1) of bit4 (New set-point) of 6040h (control word), 607Ah (target position) as the target position to start positioning. At this time, bit12 (set point acknowledge) of 6041h (status word) is changed from 0 to 1.

(3) For the master station, confirm that bit12 (set-point acknowledge) of 6041h (status word) has changed from 0 to 1, bit4 (new set-point) of 6040h (control word) returns 0.

(4) For the slave station, confirm that the bit4 (new set-point) of 6040h (control word) has been 0, 6041h (status word) bit12 (set-point acknowledge) has changed to 0.

(5) when the target position is reached, the bit10 (target reached) of 6041h (control word) is changed from 0 to 1.



< Set-point example >

Note:

(1) 6081h (profile velocity) is limited by the smaller one of 607fh (max profile velocity) and 6080h (max motor speed).

(2) changing the set value of 607Fh (max profile velocity) or 6080h (max motor speed) in the action is not reflected in the action.

Action example 2: (Action data change without buffer: single set-point)

When bit5 (change set immediately) of 6040h (control word) is 1, if the data used for positioning action in the action has been changed, the current positioning action will be interrupted and the next positioning action will be started immediately.

(1) For the master station, confirm that the bit12 (set-point acknowledge) of 6041h (status word) is 0. After changing the value of 607Ah (target position), change the bit4 (New set-point) of 6040h (control word) from 0 to

Note: at this time, please do not change the acceleration and deceleration.

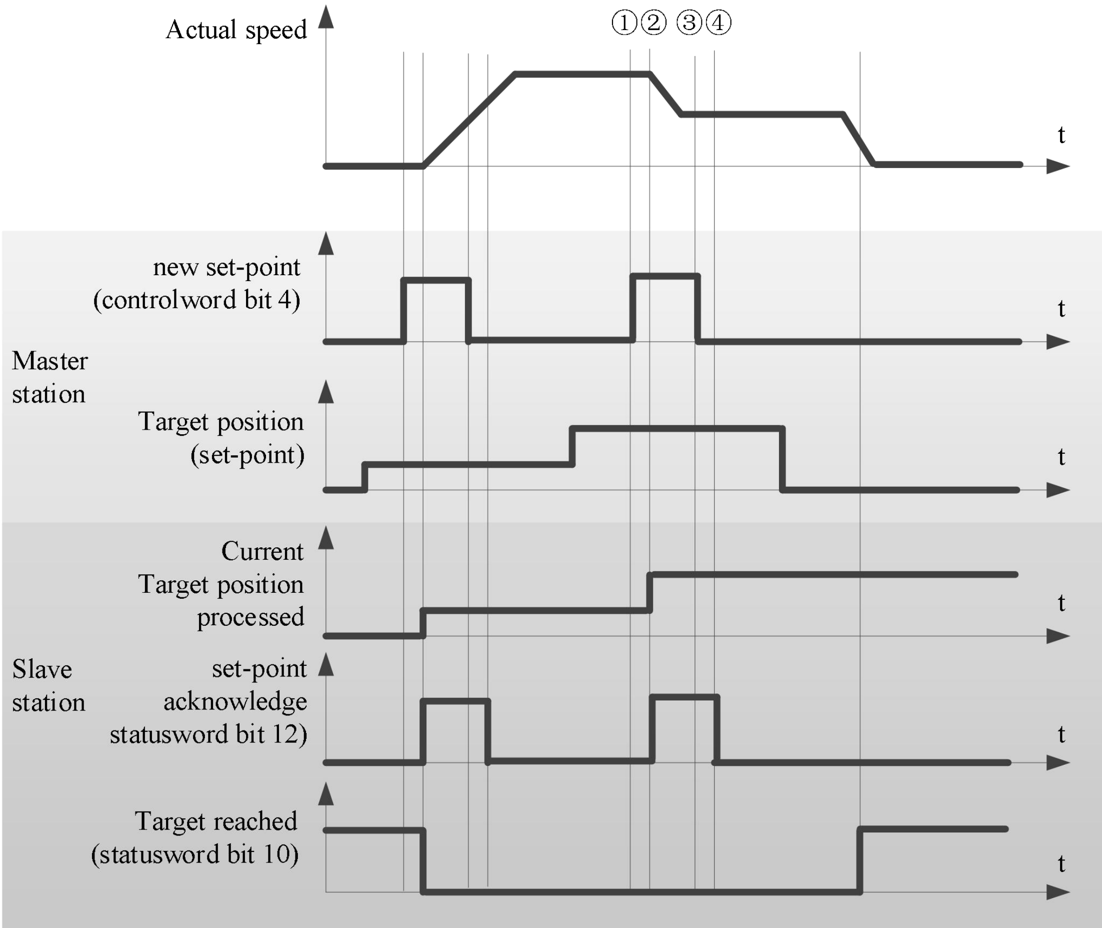
(2) For the slave station, confirm the rising edge (0 → 1) of bit4 (New set-point) of 6040h (control word), and update 607Ah (target position) as the new target position immediately. At this time, bit12 (set-point acknowledge) of 6041h (status word) is changed from 0 to 1.

(3) For master station, confirm that bit12 (set point acknowledge) of 6041h (status word) has changed from 0 to 1, bit4 (new set-point) of 6040h (control word) returns 0.

(4) For slave station, confirm that the bit4 (new set point) of 6040h (control word) has been 0, the bit12 (set point acknowledge) of 6041h (status word) is 0.

Note: 6081h (profile velocity) can be changed in the same steps (1) - (4).

After changing the 607Ah (target position) and 6081h (profile velocity), update the 607Ah (target position) and 6081h (profile velocity) simultaneously according to the above steps (1) - (4).



< handshaking procedure for the single set-point method >

7.6.2 Common parameters

PP Control mode associated object(Command setting)

Register	Explanation	Unit
RXPDO[0x6040]	Controlword	-
RXPDO[0x6060]	Control mode is PP(Profile position control mode), set to 1	-
RXPDO[0x607A]	Target position	Command unit
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x607F]	Max profile velocity	Command unit /s
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6081]	Profile velocity	Command unit /s
RXPDO[0x6083]	Profile acceleration	Command unit /s^2
RXPDO[0x6084]	Profile deceleration	Command unit /s^2
RXPDO[0x60C5]	Max acceleration	Command unit /s^2
RXPDO[0x60C6]	Max deceleration	Command unit /s^2
RXPDO[0x6065]	Following error window	Command unit
RXPDO[0x6066]	Following error time out	ms
RXPDO[0x6067]	Position window	Command unit
RXPDO[0x6068]	Position window time	ms

Note:

(1) 6081h (Profile velocity) is limited by the smaller of 607Fh (Max profile velocity) and 6080h (Max motor speed.

(2) The set values of 607Fh (Max profile velocity) or 6080h (Max motor speed) are changed during the operation and are not reflected in the operation.

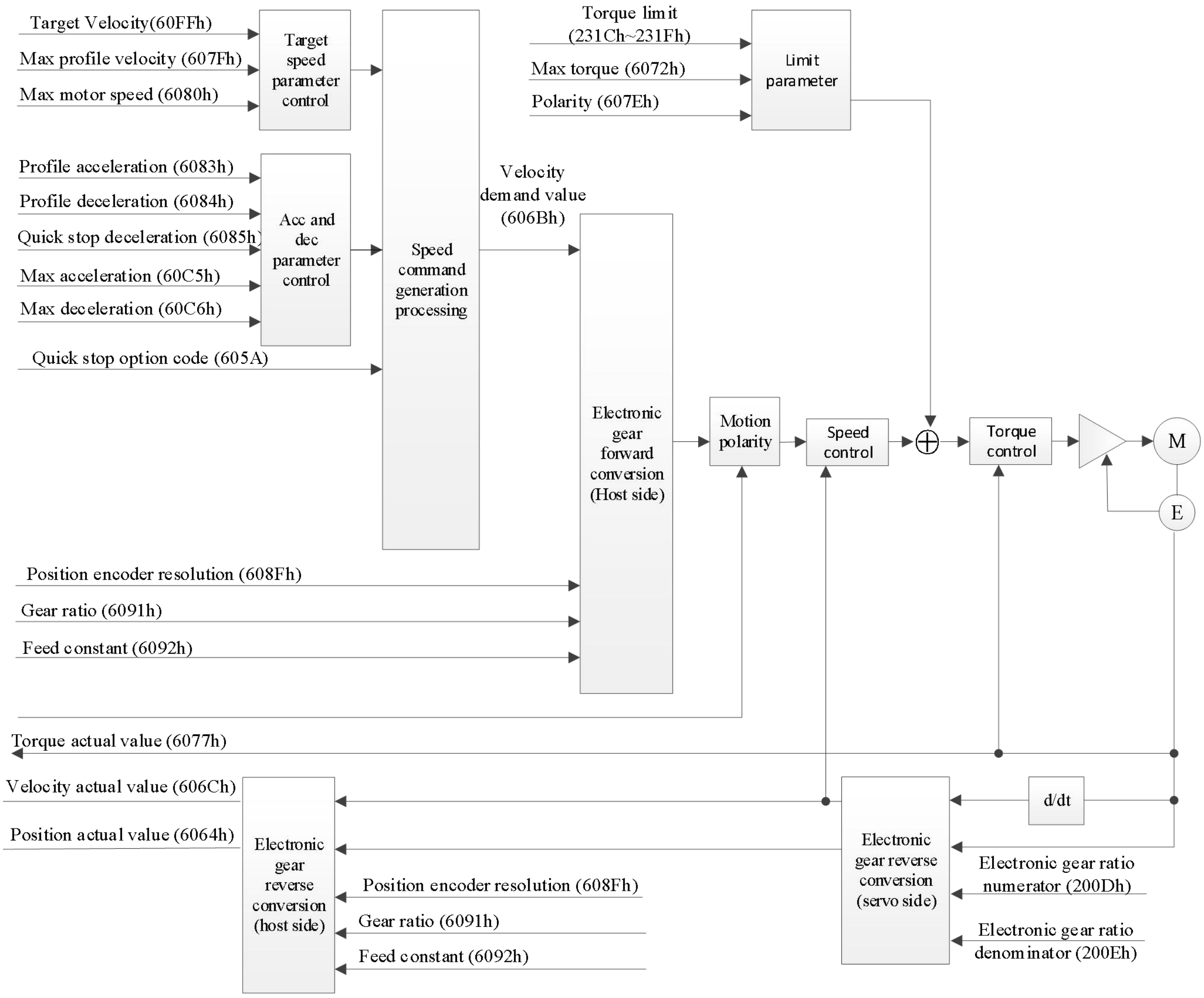
PP control mode associated object(Command monitoring)

Register	Explanation	Unit
TXPDO[0x6041]	Statusword	-
TXPDO[0x6063]	Position actual internal value	Command unit
TXPDO[0x6064]	Position feedback	Command unit
TXPDO[0x606C]	Velocity feedback	Command unit /s
TXPDO[0x6077]	Torque actual value	0.1%
TXPDO[0x60F4]	Following error actual value	Command unit

7.7 PV mode

PV(Profile speed control mode), specify the target speed, acceleration and deceleration, etc., and generate the speed control mode of position command action in the servo driver.

Please use this control mode in the communication cycle of more than 500μs.



7.7.1 Related parameters

1)PV control mode related parameters(Command・setting)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6040h	00h	Controlword	-	0~65535	U16	rw	RxPDO
607Fh	00h	Max profile velocity	Command unit/s	0~4294967295	U32	rw	RxPDO
6083h	00h	Profile acceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
6084h	00h	Profile deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO

60C5h	00h	Max acceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
60C6h	00h	Max deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO

Other speed control common related objects

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO
60B1h	00h	Velocity offset	Command unit/s	-2147483648~2147483647	I32	rw	RxPDO
60B2h	00h	Torque offset	0.1%	-32768~32767	I16	rw	RxPDO
60FFh	00h	Target velocity	Command unit/s	0~4294967295	U32	rw	RxPDO

Other related objects with common actions

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO
605Ch	00h	Diasble operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO
607Bh	-	Position range limit	-	-	-	-	-
	00h	607Bh sub index numbers	-	2	U8	ro	NO
	01h	Min position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~2147483647	I32	rw	RxPDO
607Ch	00h	Home offset	Command unit	-2147483648~2147483647	I32	rw	RxPDO
607Eh	00h	Polarity	-	0~255	U8	rw	NO
6085h	00h	Quick stop deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	608Fh sub index numbers	-	2	U8	ro	NO
	01h	Encoder increments	pulse	1~4294967295	U32	ro	NO
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
6091h	-	Gear ration	-	-	-	-	-
	00h	6091h sub index numbers	-	2	U8	ro	NO
	01h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO

	02h	shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
6092h	-	Feed constant	-	-	-	-	-
	00h	6092h sub index numbers	-	2	U8	ro	NO
	01h	Feed value	Command unit	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
60B8h	00h	touch	-	0~65535	U16	rw	RxPDO

Controlword (6040h)< functions in pv control mode>

Index	Sub-index	Name	Range	Data type	access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	All

Set the control command to the servo driver such as PDS state conversion.

Bit information

15	14	13	12	11	10	9	8
r						om	h

7	6	5	4	3	2	1	0
fr	oms			eo	qs	ev	so
	r	r	r				

r = reserved(not corresponding) fr = fault reset

oms = operation mode specific eo = enable operation

(control mode is based on bit) qs = quick stop

h = halt ev = enable voltage so = switch on

Pv mode doesn't use oms bit.

Speed related parameters

Index	Sub-index	Name	Unit	Range	Data type	access	PDO	OP-mode
607Fh	00h	Max profile velocity	Command unit/s	0~4294967295	U32	rw	RxPDO	PP PV HM
		the speed limit value in profile position mode (PP), origin reset position mode (HM), profile speed mode (PV). The maximum value is limited by 6080h (max motor speed) for internal processing.						
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO	PV TQ CSV CST
		Set the maximum speed of the motor. When the control power is put into operation, the maximum speed read out from the motor is set. The maximum value is limited by the maximum speed read from the motor according to the internal processing. In TQ and CST, the speed is limited by the set value of this object.						

Acceleration and deceleration related parameters

Index	Sub-index	Name	Unit	Range	Data type	access	PDO	OP-mode
6083h	00h	Profile acceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV

		Set profile acceleration. When set to 0, internal processing is treated as 1.						
6084h	00h	Profile deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV
		Set profile deceleration. When set to 0, internal processing is treated as 1.						
60C5h	00h	Max acceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV HM
		Set the maximum acceleration. When set to 0, internal processing is treated as 1.						
60C6h	00h	Min deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV HM
		Set the maximum deceleration. When set to 0, internal processing is treated as 1.						

2)pv control mode related parameters(monitoring)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6041h	00h	Statusword	-	0~65535	U16	ro	TxPDO
6065h	00h	Position offset too large threshold	Command unit/s	0~4294967295	U32	rw	RxPDO
6066h	00h	Velocity time out	1ms	0~65535	U16	rw	RxPDO
6067h	00h	Velocity threshold	Command unit/s	0~4294967295	U32	rw	RxPDO
6068h	00h	Velocity threshold time	1ms	0~65535	U16	rw	RxPDO

Other related objects with common speed control

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6063h	00h	Position actual internal value	pulse	-2147483648~ 2147483647	I32	ro	TxPDO
6064h	00h	Position actual value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
606Bh	00h	Velocity demand value	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
606Ch	00h	Velocity actual value	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
6074h	00h	Torque demand	0.1%	-32768~32767	I16	ro	TxPDO
6076h	00h	Motor rated torque	Mn·m	0~4294967295	U32	ro	TxPDO
6077h	00h	Torque actual value	0.1%	-32768~32767	I16	ro	TxPDO

Other related objects with common modes

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
603Fh	00h	Error code	-	0~65535	U16	ro	TxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping	Command	-2147483648	I32	ro	TxPDO

		position of Touch probe 1	unit	~2147483647			
60BCh	00h	The rising edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

Statusword (6041h) <functions of pv control mode >

Index	Sub-index	Name/description	Range	Data type	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	All

Servo driver status

Bit information

15	14	13	12	11	10	9	8
r		oms		ila	oms	rm	r
		r	speed		Target reached		
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
w	sod	qs	ve	f	oe	so	rsto

r = reserved(not corresponding)   w = warning

sod = switch on disabled

oms = operation mode specific   qs = quick stop

(control mode is based on bit)   ve = voltage enabled

ila = internal limit active   f = fault

oe = operation enabled

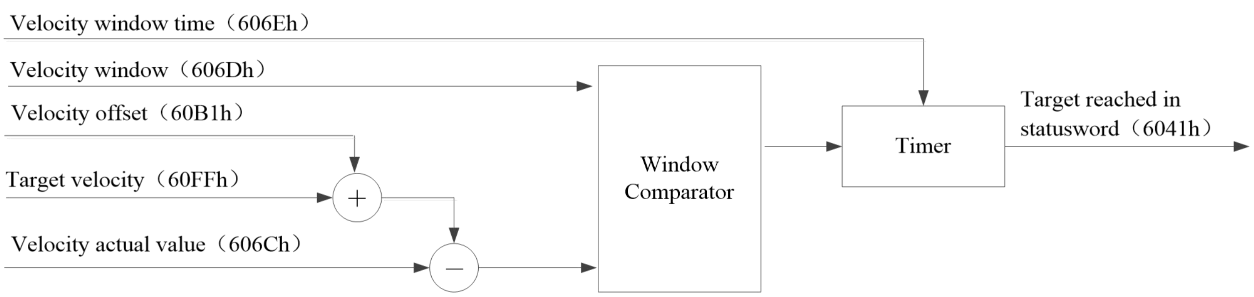
rm = remote   so = switched on

rtso = ready to switch on

(1)bit10(target reached(Velocity reached)):

The difference between the total value of 60FFh (target velocity) and 60B1h (velocity offset) and 606Ch (velocity actual value) is within the range set by 606Dh (velocity window). If the time set by 606Eh (velocity window time) passes, the bit10 of 6041h (status word) becomes 1.

Bit	Name	Value	Definition
10	Target reached	0	Halt = 0 (normal): speed control not completed Halt = 1 (stop according to halt): shaft in deceleration
		1	Halt = 0 (normal): speed control completed Halt = 1 (according to halt stop): shaft stop (shaft speed is 0)



Index	Sub-index	Name	Unit	Range	Data type	Access	PDO	OP-mode
606Dh	00h	Velocity window	Command unit	0~4294967295	U32	rw	RxPDO	PV

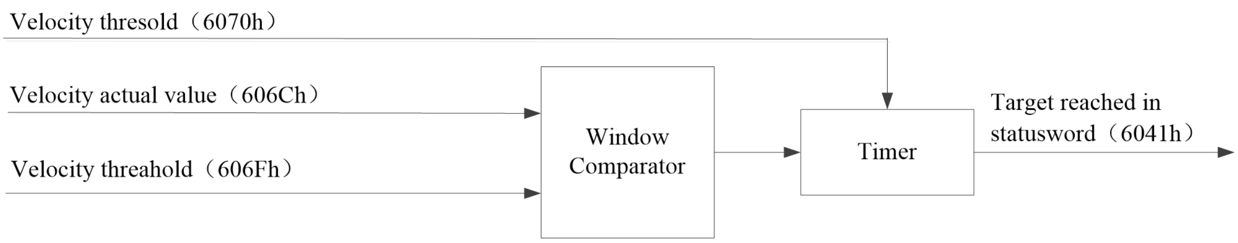
		The difference between the total value of 60FFh (target velocity) and 60B1h (velocity offset) and 606Ch (velocity actual value) is within the set value of this parameter. If the time set by 606Eh (velocity window time) passes, set the bit10 (target reached) of 6041h (status word) to 1 as the threshold value. If the speed deviation is a value other than the set value of this parameter, bit10 of 6041h becomes 0.						
606Eh	00h	Velocity window time	1ms	0~65535	U16	rw	RxPDO	PV
		Set the time from the point when the difference between the sum of 60FFh(target velocity) and 60B1h (velocity offset),and 606Ch(velocity actual value), fall within the range set by 606Dh (Velocity window) to bit10 (target reached) of 6041h (Statusword) becomes 1.						

(2)bit12(speed)

When 606Ch (Velocity actual value) exceeds the value set in 606Fh (Velocity threshold) and the time set by 6070h (Velocity threshold time) has elapsed, bit 12 of 6041h (Statusword) changes to 0.

When 606Ch (Velocity actual value) becomes lower than the value set in 606Fh (Velocity threshold), bit12 of 6041h (Statusword) changes to 1, which indicates that the motor has stopped.

Bit	Name	Value	definition
10	speed	0	Motor is operating
		1	Motor is not operating



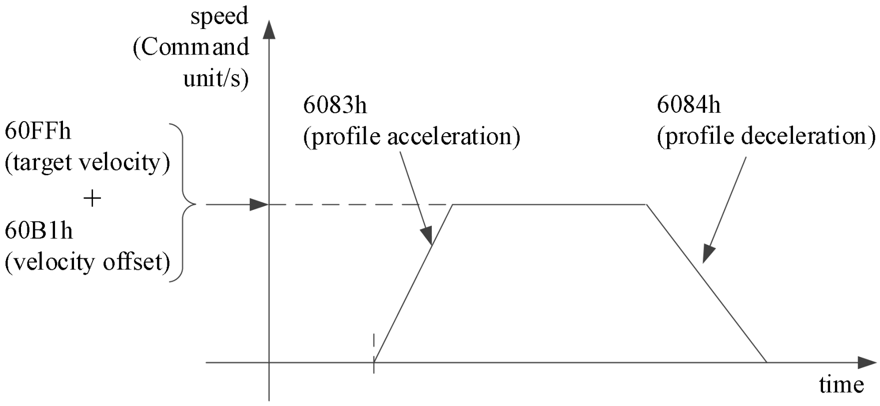
< Speed（functional overview）>

Index	Sub-index	Name	Unit	Range	Data type		PDO	OP-mode
606Fh	00h	Velocity threshold	Command unit	0~4294967295	U32	rw	RxPDO	PV
		606Ch (speed feedback) exceeds the set value of this parameter. If 6070h (velocity threshold time) has passed, set the threshold of bit12 (speed) for 6041h (status word) to 0. If the speed is below the set value of this parameter, bit12 of 6041h becomes 1.						
6070h	00h	Velocity threshold time	1ms	0~65535	U16	rw	RxPDO	PV
		Set the time from the point when 606Ch (Velocity actual value) exceeds the value set to 606Fh (Velocity threshold) until the point when bit 12 of 6041h (Statusword) changes to 0.						

3) PV operations

- Profile velocity control mode generates a velocity command value according to the following parameters
- Target velocity(60FFh)

- Velocity offset(60B1h)
- Profile acceleration(6083h)
- Profile deceleration(6084h)
- Target speed is 60FFh(Target velocity)
- Speed feedforward is 60B1h(Velocity offset) cannot support now
- The update (sending) of action command is that after the servo enable is turned on, please input it after about 100ms.
- As test information, provide 606Ch (velocity actual value), etc.



- The 60FFh (target velocity) is limited by 607Fh (max profile velocity) and 6080h (max motor speed).

7.7.2 Common parameters

PV control mode related objects(Command ・setting)

Register	Explanation	Unit
RXPDO[0x6040]	Controlword	-
RXPDO[0x6060]	Set to 3	-
RXPDO[0x60FF]	Target velocity	Command unit/s
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x607F]	Max profile velocity	Command unit/s
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6083]	Internal acceleration	Command unit/s^2
RXPDO[0x6084]	Internal deceleration	Command unit/s^2
RXPDO[0x60C5]	Max acceleration	Command unit/s^2
RXPDO[0x60C6]	Max deceleration	Command unit/s^2
RXPDO[0x606D]	Velocity reached threshold	Command unit/s
RXPDO[0x606E]	Velocity timeout	ms
RXPDO[0x606F]	Velocity threshold	Command unit/s
RXPDO[0x6070]	Velocity threshold time	ms

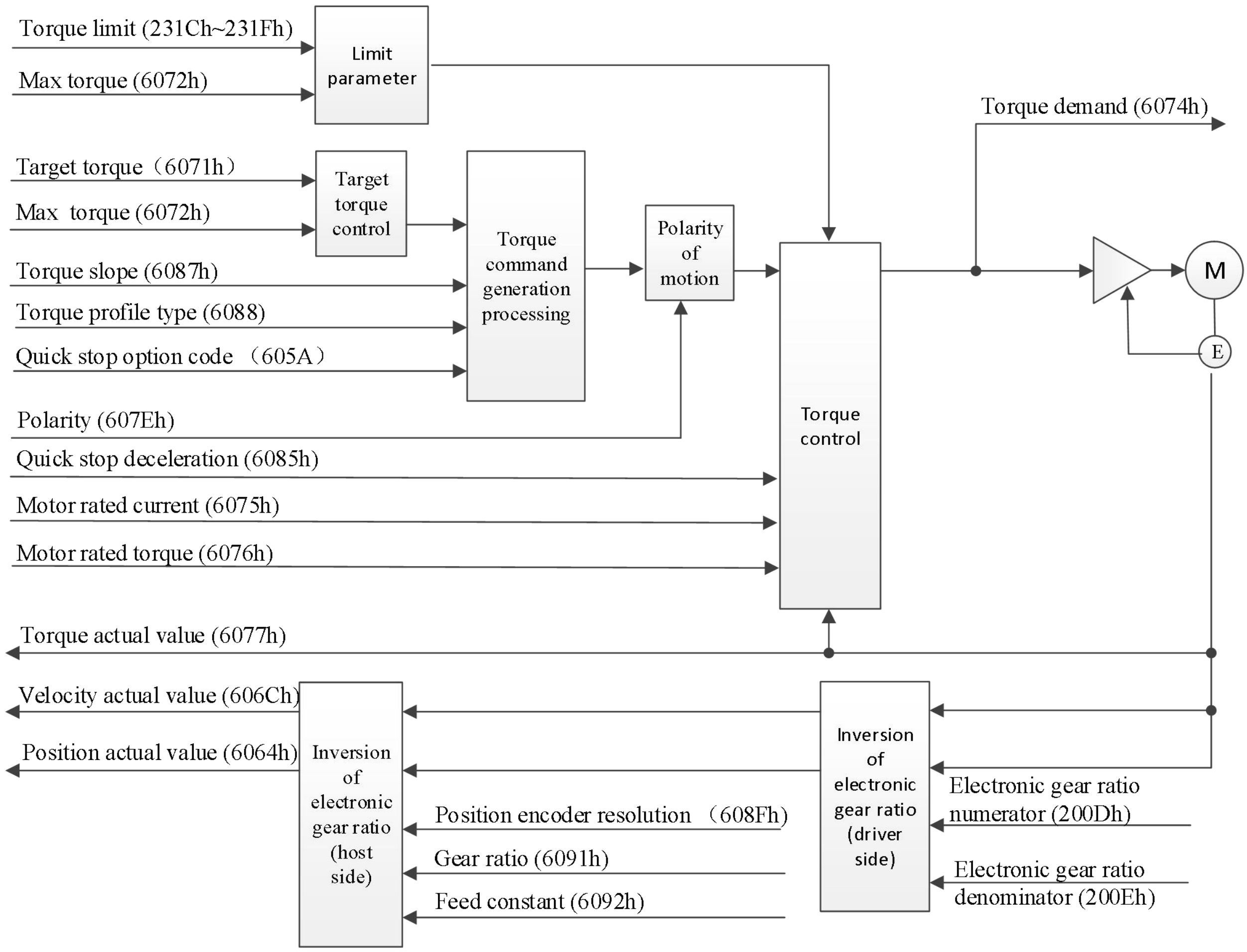
PV control mode realated objects(Command ・monitoring)

Register	Explanation	Unit
TXPDO[0x6041]	Statusword	-
TXPDO[0x6064]	Position feedback (motor actual position)	Command unit
TXPDO[0x606C]	Velocity feedback	Command unit/s

TXPDO[0x6077]	Torque actual value	0.1%

7.8 TQ mode

TQ(Profile torque mode),specify target torque, acceleration and deceleration,etc.,this torque control mode after generating position command in servo driver. Please use this control mode in the communication period of more than 500μs.



7.8.1 Related parameters

1)TQ control mode related objects(Command・setting)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6040h	00h	Controlword	-	0~65535	U16	rw	RxPDO
6088h	00h	Torque profile type	-	-32768~32767	I16	rw	RxPDO

Other related objects that are common to torque control

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6071h	00h	Target torque	0.1%	-3276~32767	I16	rw	RxPDO
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO
6087h	00h	Torque slope	0.1%/S	0~4294967295	U32	rw	RxPDO

60B2h	00h	Torque offset	0.1%	-32768~32767	I16	rw	RxPDO

Other related objects with common actions

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO
605Ch	00h	Disable operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO
607Bh	-	Position range limit	-	-	-	-	-
	00h	607Bh sub index numbers	-	2	U8	ro	No
	01h	Min position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
	02h	Max position limit	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Ch	00h	Home offset	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO
607Eh	00h	Polarity	-	0~255	U8	rw	NO
6085h	00h	Quick stop deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO
6086h	00h	Motion profile type	-	-32768~32767	I16	rw	RxPDO
608Fh	-	Position encoder resolution	-	-	-	-	-
	00h	608Fh sub index numbers	-	2	U8	ro	NO
	01h	Encoder increments	pulse	1~4294967295	U32	ro	NO
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
6091h	-	Gear ratio	-	-	-	-	-
	00h	6091h sub index numbers	-	2	U8	ro	NO
	01h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
6092h	-	Feed constant	-	-	-	-	-
	00h	6092h sub index numbers	-	2	U8	ro	NO
	01h	Setting feed value	Command unit	1~4294967295	U32	ro	NO
	02h	Shaft revolutions	r(shaft)	1~4294967295	U32	ro	NO
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO

Controlword (6040h)< functions in TQ control mode >

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	All
		Set the control command to the servo driver such as PDS state conversion. Bit information					

15	14	13	12	11	10	9	8
R						om	h
7	6	5	4	3	2	1	0
fr	oms			eo	qs	ev	so
	r	r	r				

r = reserved(not corresponding)
oms = operation mode specific
(control mode is based on bit)
h = halt
so = switch on

fr = fault reset
eo = enable operation
qs = quick stop
ev = enable voltage

TQ mode doesn’t use oms bit.

Torque type

Index	Sub-index	Name	Unit	Range	Data type	access	PDO	OP-mode
6087h	00h	Torque slope	0.1 %	0~4294967295	U32	rw	RxPDO	tq cst
		• Set a parameter value for giving slope to a torque command. • In the cyclic synchronous torque mode (cst), torque slope is effective only during the deceleration stop sequence. • When 0 has been set, the setting is regarded as 1 internally.						
6088h	00h	Torque profile type	-	-32768~32767	I16	rw	RxPDO	tq
		Set the torque profile type used for changing in the torque 0:linear slope 1:Not supported						

2)TQ control mode related objects(monitoring)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6041h	00h	Statusword	-	0~65535	U16	ro	TxPDO
6073h	00h	Max current	0.1%	0~65535	U16	ro	NO

Other objects commonly associated with torque control (monitoring)

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
6063h	00h	Actual internal position feedback	pulse	-2147483648~ 2147483647	I32	ro	TxPDO
6064h	00h	Position feedback	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
606Ch	00h	Velocity feedback	Command unit/s	-2147483648~ 2147483647	I32	ro	TxPDO
6074h	00h	Torque command	0.1%	-32768~32767	I16	ro	TxPDO
6075h	00h	Motor rated current	1mA	0~4294967295	U32	ro	TxPDO
6076h	00h	Motor rated torque	Mn·m	0~4294967295	U32	ro	TxPDO
6077h	00h	Torque actual value	0.1%	-32768~32767	I16	ro	TxPDO
6078h	00h	Current actual value	0.1%	-32768~32767	I16	ro	TxPDO

Other associated objects that share the same mode

Index	Sub-index	Name	Unit	Range	Data type	access	PDO
603Fh	00h	Error code	-	0~65535	U16	ro	TxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BCh	00h	The rising edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

Statusword (6041h) < functions of TQ control mode >

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	All

Servo driver status

Bit information

15	14	13	12	11	10	9	8
r		oms		ila	oms	rm	r
		r	r		target reached		
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
w	sod	qs	ve	f	oe	so	rsto

r = reserved(not corresponding) w = warning

sod = switch on disabled

oms = operation mode specific qs = quick stop

(Control mode is based on bit) ve = voltage enabled

ila = internal limit active f = fault

oe = operation enabled

rm = remote so = switched on

rtso = ready to switch on

bit13,12,10(operation mode specific):

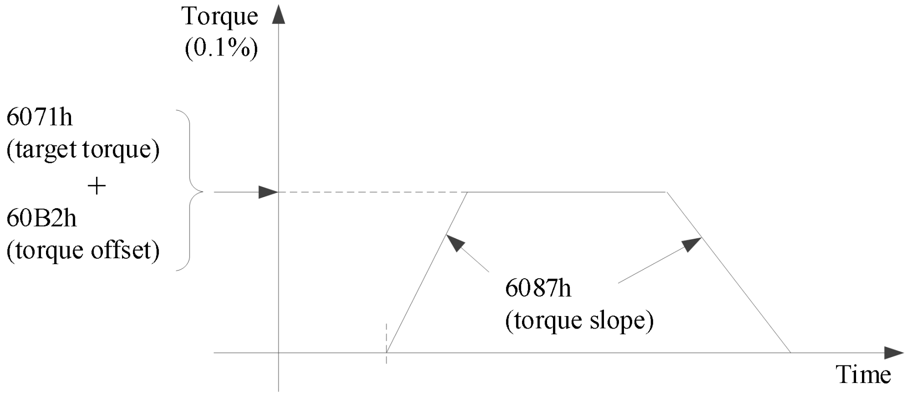
Bit	Name	Value	Definition
10	Target reached	0	halt=0 (normal): 6074h (Torque demand) not reach the target torque halt=1 (stop as halt): shaft is decelerating
		1	halt=0 (normal): 6074h (Torque demand) reach the target torque halt=1 (stop as halt): shaft stops (shaft speed is 0)
12	reserved	-	Not used
13	reserved	-	Not used

Action of TQ control mode

- The profile torque control mode generates torque command values based on the following parameters.
- Target torque(6071h)
- Torque offset(60B2h)(cannot support)
- Torque slope(6087h)
- For the operation command update(transmission),do input when approx 100ms has elapsed after the

servo ON(operation enabled command)

- As monitoring information,we provide 6077h(Torque actual value) etc.



- The 6071h (target torque) value is 6072h (max torque), 2312h (P3-28), 2313h (P3-29), which is limited by the minimum value.
- The speed is limited by 6080h (max motor speed).

7.8.2 Common parameters

TQ control mode related objects(Command ・setting)

Register	Explanation	Unit
RXPDO[0x6040]	Controlword	-
RXPDO[0x6060]	Set to 4	-
RXPDO[0x6071]	Target torque	0.1%
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6087]	Torque slope	0.1%/S
RXPDO[0x6088]	Torque Profile type	-

TQ control mode related objects(Command ・monitoring)

Register	Explanation	Unit
TXPDO[0x6041]	Statusword	-
TXPDO[0x6064]	Position feedback (motor actual position)	Command unit
TXPDO[0x606C]	Velocity feedback	Command unit/s
TXPDO[0x6077]	Torque actual value	0.1%

TQ mode does not use oms bit.

7.9 Fly capture function

7.9.1 Function overview

To address the issue of insufficient production efficiency with traditional vision-based fixed-point photography, users in linear drive motor applications are increasingly adopting the vision "on-the-fly" photography feature. This function allows the system to move along a predetermined trajectory, capturing images instantaneously at designated points without stopping the motion axis. The process involves position comparison output, and throughout this operation, the moving mechanism never halts, thus saving operation time and ensuring efficiency and precision. This technique is widely used in the photovoltaic and 3C industries.

7.9.2 Parameter setting

Parameter	Bit	Explanation	Default value	Setting range
P5-79 OCMP1(pulse output 1)	0	0: Not output to the terminal 1: Output from SO1	1(only can use SO1)	0-65535
	1	0: Output positive signal 1: Output negative signal	0	-
	2~3	-	-	-
P5-80	-	OCMP1 output pulse width (0.1ms) Pulse width according to the previous output width (0.1ms)	5	0-20000

7.9.3 Bus parameter setting

Object word	Parameter	Type	Function
B000h	Position comparison output allocation settings	UINT8 (RXPDO)	The comparison value corresponding to the position takes effect bit0: position 1 comparison value 1 takes effect, 0 does not take effect bit1: position 1 comparison value 2 takes effect, 0 does not take effect bit2: position 1 comparison value 3 takes effect, 0 does not take effect ...... bit7: position 1 comparison value 7 takes effect, 0 does not take effect
B001h	Position comparison value 1	INT32	Set the comparison value for position comparison 1
B002h	Position	INT32	Set the comparison value for position comparison 2

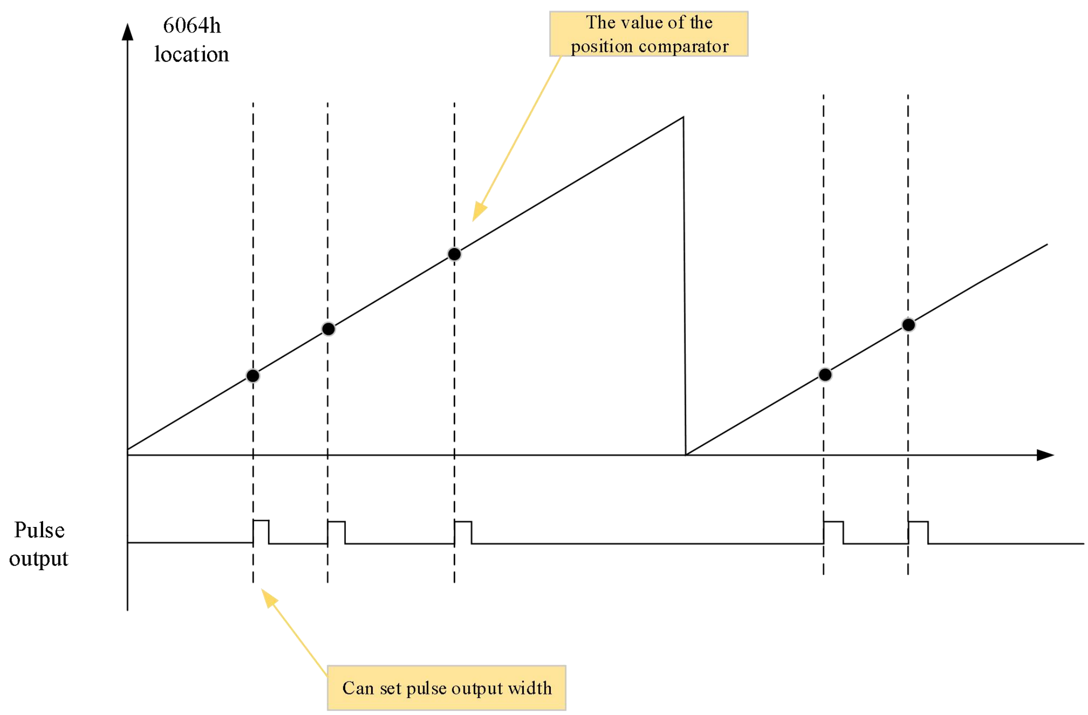
Object word	Parameter	Type	Function
	comparison value 2		
B003h	Position comparison value 3	INT32	Set the comparison value for position comparison 3
B004h	Position comparison value 4	INT32	Set the comparison value for position comparison 4
B005h	Position comparison value 5	INT32	Set the comparison value for position comparison 5
B006h	Position comparison value 6	INT32	Set the comparison value for position comparison 6
B007h	Position comparison value 7	INT32	Set the comparison value for position comparison 7
B008h	Position comparison value 8	INT32	Set the comparison value for position comparison 8
B009h	OCMP1 output setting	UINT8 (RXPDO)	bit0: 1 enable, 0 stop bit1: 1 Continuous trigger mode 0 Single trigger mode bit2~3: reserved bit4~7: End position comparison point (0~8) Note: The end position comparison point only takes effect in single trigger mode ①When set to 0, it means that only one comparison value will be triggered and stopped. When any comparator position is triggered, the comparison ends and the state bit 0 will be set to 0. ②When set to 1-8 and the corresponding comparator set by B000h is activated, the comparison ends when the corresponding comparator position is triggered, and the state bit 0 will be set to 0.
B00Ah	OCMP1 output status	UINT8 (TXPDO)	bit0: 1 During action (automatically set to 1 after enabling), 0 action stops bit1: 1 trigger once completion status, 0 incompleted bit2~3: reserved bit4~7: The position of the triggered comparison value (valid when bit1 is 1)

7.9.4 Usage of the fly capture function

In the bus OP state, first set the P group parameters, allocate the SO pin to the OCMP output, then use the object word to set the effective bit of the position comparator (set B000h), and finally set the value of the position comparator. Bidirectional triggering.

Continuous comparison mode, with bit0 and bit1 set to 1 for OCMP output (B009h).

Single trigger mode, bit0 is set to 1 corresponding to the OCMP output (B009h), bit1 is set to 0, and bit4-7 selects the position point to stop comparing. When the position comparison point is triggered, bit0 of the OCMP output state will be set to 0, and it needs to be reset for the next use.



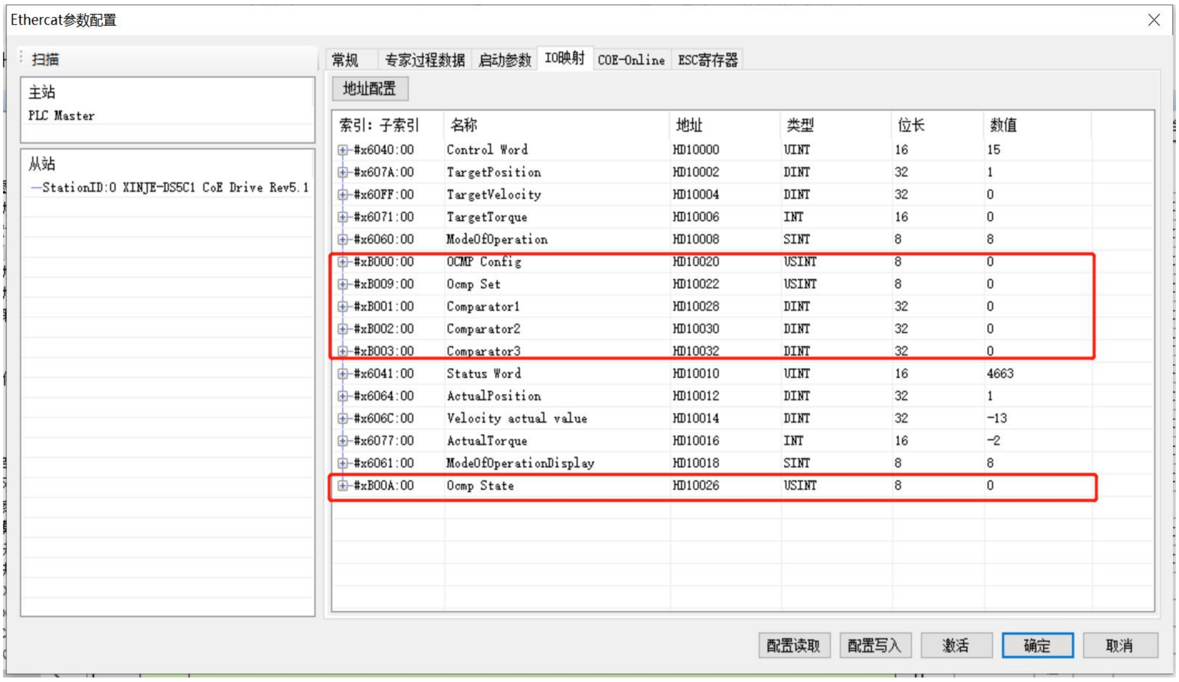
7.9.5 Fly capture application

- Allocate SO terminals and set pulse width (P5-79)

First set P5-79, assign SO1 pin to OCMP output, and then set P5-80 pulse width. For example: P5-79 is set to 0x0001, P5-80=50, which means that when the feedback position 6064h reaches the comparison position, the SO1 terminal outputs a forward 5ms pulse signal.

- Add the parameters related to fly capture to PDO

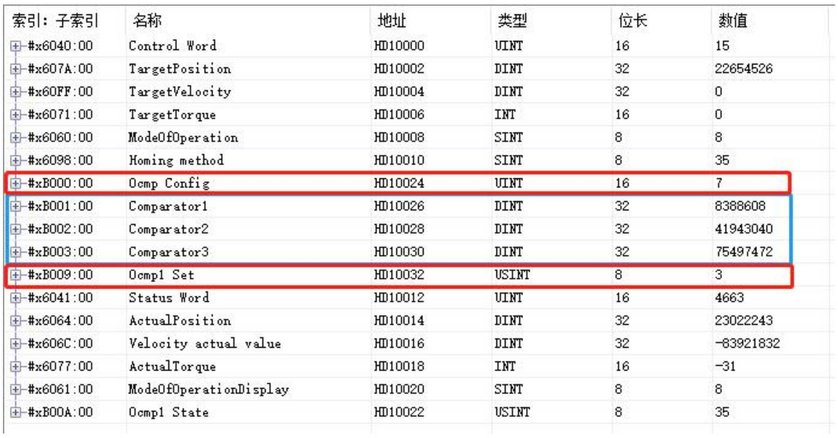
B000h (position comparison output allocation setting), B009h (OCMP output setting), B001h (position comparison value 1), B002h (position comparison value 2), Add B003h (position comparison value 3) and B00Ah (OCMP output status) are added to PDO, as shown in the I/O mapping below. The object word can be modified by modifying the HD register corresponding to the object word.



索引：子索引	名称	地址	类型	位长	数值
#x6040:00	Control Word	HD10000	UINT	16	15
#x607A:00	TargetPosition	HD10002	DINT	32	1
#x60FF:00	TargetVelocity	HD10004	DINT	32	0
#x6071:00	TargetTorque	HD10006	INT	16	0
#x6060:00	ModeOfOperation	HD10008	SINT	8	8
#xB000:00	OCMP Config	HD10020	USINT	8	0
#xB009:00	Ocmp Set	HD10022	USINT	8	0
#xB001:00	Comparator1	HD10028	DINT	32	0
#xB002:00	Comparator2	HD10030	DINT	32	0
#xB003:00	Comparator3	HD10032	DINT	32	0
#x6041:00	Status Word	HD10010	UINT	16	4663
#x6064:00	ActualPosition	HD10012	DINT	32	1
#x606C:00	Velocity actual value	HD10014	DINT	32	-13
#x6077:00	ActualTorque	HD10016	INT	16	-2
#x6061:00	ModeOfOperationDisplay	HD10018	SINT	8	8
#xB00A:00	Ocmp State	HD10026	USINT	8	0

- Set the effective position of the position comparator (B000h) and the values of the position comparator (B001h~B008h)

Set the effective bit (B000h) of the position comparator corresponding to the position comparator that needs to be allocated to 1, and set the values of the position comparator (B001h~B008h). As shown in the figure below, the effective bit (B000h) of the position comparator is set to 7, that is, bit0~bit2 is set to 1, and position comparators 1-3 are enabled. Set three comparison points for the values of position comparators 1-3.

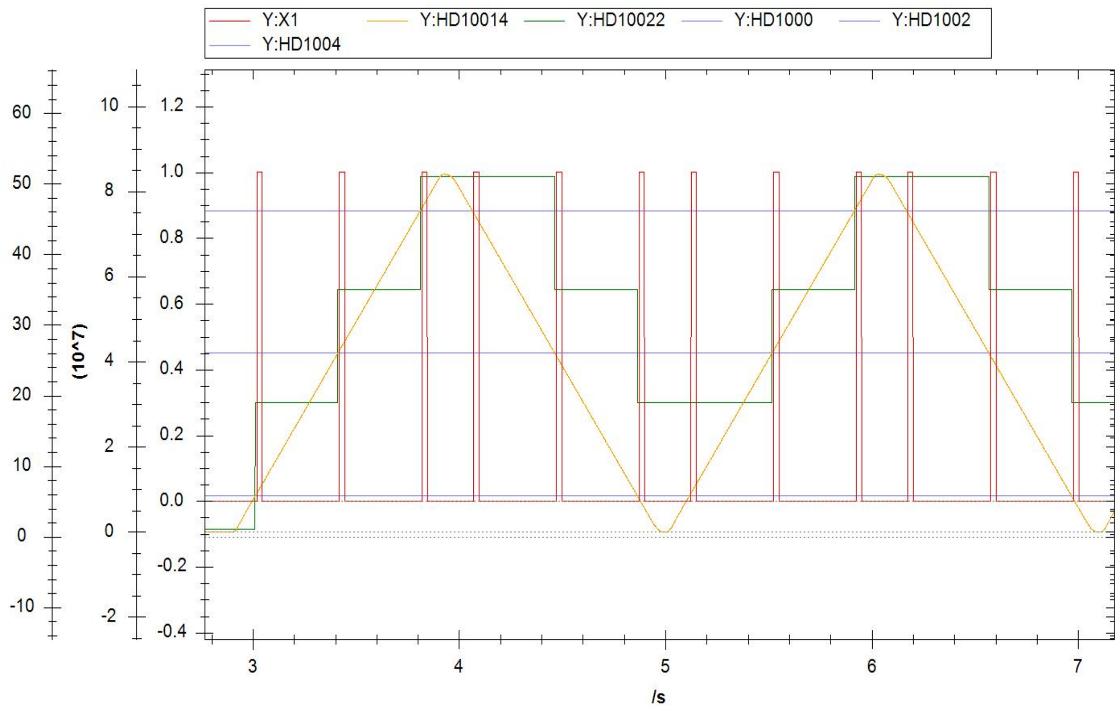


索引：子索引	名称	地址	类型	位长	数值
#x6040:00	Control Word	HD10000	UINT	16	15
#x607A:00	TargetPosition	HD10002	DINT	32	22654526
#x60FF:00	TargetVelocity	HD10004	DINT	32	0
#x6071:00	TargetTorque	HD10006	INT	16	0
#x6060:00	ModeOfOperation	HD10008	SINT	8	8
#x6098:00	Homing method	HD10010	SINT	8	35
#xB000:00	Ocmp Config	HD10024	UINT	16	7
#xB001:00	Comparator1	HD10026	DINT	32	8388608
#xB002:00	Comparator2	HD10028	DINT	32	41943040
#xB003:00	Comparator3	HD10030	DINT	32	75497472
#xB009:00	Ocmp1 Set	HD10032	USINT	8	3
#x6041:00	Status Word	HD10012	UINT	16	4663
#x6064:00	ActualPosition	HD10014	DINT	32	23022243
#x606C:00	Velocity actual value	HD10016	DINT	32	-83921832
#x6077:00	ActualTorque	HD10018	INT	16	-31
#x6061:00	ModeOfOperationDisplay	HD10020	SINT	8	8
#xB00A:00	Ocmp1 State	HD10022	USINT	8	35

- OCMP output setting (B009h)

① Continuous comparison mode

This example compares three positions, namely positions 1-3.
Set the OCMP output setting (B009h) to 3 (0000 0011), that is, set the bit0 and bit1 of B009h to 1. In the bus OP state, when the feedback position 6064h reaches the comparison position, the SO1 terminal outputs a pulse signal.



In the above figure, the purple color represents the position value of the fly capture comparison point.
Green B00Ah (OCMP1 output status): 1, 19, 35, 51

【1】 0000 0001;

【19】0001 0011;

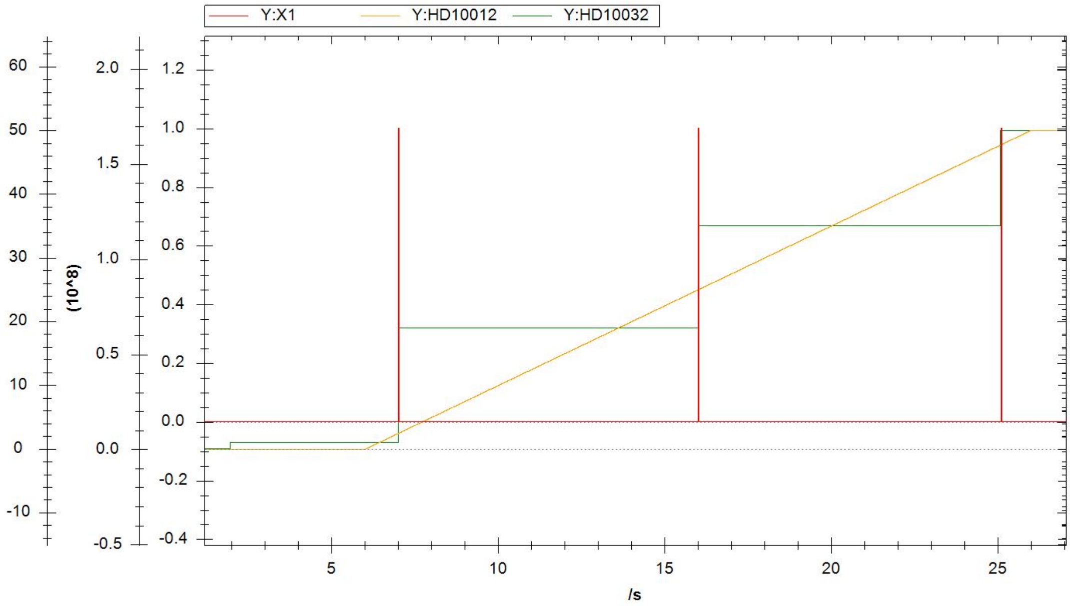
【35】0010 0011;

【51】0011 0011;

The red color SO1 output(fly capture signal) connected to the X1 input of the PLC.
The yellow color represents the position feedback change of 6064h.

② Single triggering mode

This example compares three positions, namely positions 1-3.
Set the OCMP output (B009h) to 49(0011 0001), which is 0x31. In the bus OP state, when the feedback position 6064h reaches the comparison position 3, the SO1 terminal outputs a pulse signal, and the OCMP output state changes to the completed state (B00A.0=0). If you want to make a position comparison again, you need to reset the bit0 of B009h from 0 to 1 before it can take effect.



In the above picture, green B00Ah: 0, 1, 19, 35, 50.

【1】 0000 0001;

【19】0001 0011;

【35】0010 0011;

【50】0011 0010;

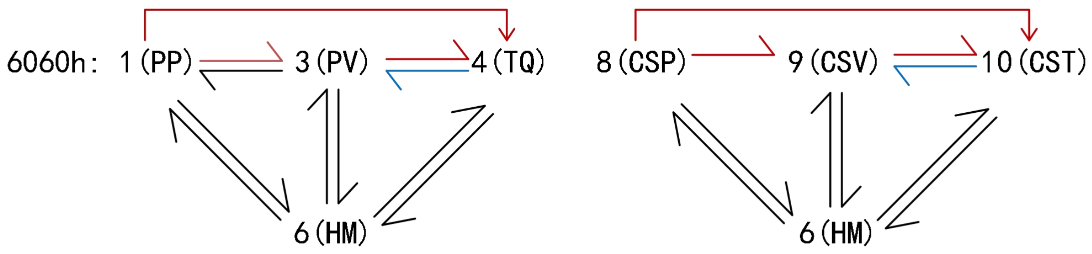
The red color SO1 output(fly capture signal) connected to the X1 input of the PLC.

The yellow color represents the position feedback change of 6064h.

7.10 Mode common function

7.10.1 Mode mutual switching function

DS5C2 supports mode switching during runtime, with a mode switching time of 2ms. In the servo enabled state, it supports position mode switching to speed mode, position mode switching to torque mode, and speed mode switching to torque mode, making it convenient for users to achieve multi-mode switching control in project engineering.



7.10.2 Stop mode

PDS is a motor deceleration stop method for setting the main power supply interruption or alarm occurrence in the operation enabled state (servo enabled state).
The deceleration function (selection code) defined by COE (CIA402) and the deceleration function (free running stop, deceleration stop) on the servo (DS5C2) side are combined.

PDS code list

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO
605Bh	00h	Shutdown option code	-	0~1	I16	rw	NO
605Ch	00h	Disable operation option code	-	0~1	I16	rw	NO
605Dh	00h	Halt option code	-	1~3	I16	rw	NO
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO

Related object list

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO	OP-mode
6084h	00h	Profile deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV HM CSP CSV
		Set profile deceleration.						

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO	OP-mode
		When set to 0, internal processing is treated as 1.						
6085h	00h	Quick stop deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV HM CSP CSV
		・ If 605Ah (Quick stop option code) is "2" or "6", set the deceleration parameter of motor deceleration stop when quick stop. ・ 605Dh (Halt option code) and 605Eh (Fault reaction option code) are also used when they are "2".						
6087h	00h	Torque slope	0.1%	0~4294967295	U32	rw	RxPDO	TQ CST
		・Set the parameter value to give the inclination torque command. ・Only deceleration stop time is valid in cyclic synchronous torque mode (CST).						
609Ah	00h	Homing acceleration	Command unit /s²	0~4294967295	U32	rw	RxPDO	HM
		・Set the acceleration and deceleration of the origin point reset position control mode (HM). ・The deceleration of the origin reset position control mode (HM) is also used for this object. ・when each homing method finally stops(when the origin position is detected), it is unnecessary to use the set value of this object, and the servo lock stops.						
60C6h	00h	Max deceleration	Command unit /s²	0~4294967295	U32	rw	RxPDO	PP HM CSP
		・Set the maximum deceleration. ・If it is set to 0, internal processing is operated as 1.						

1) Quick stop option code (605Ah)

Set the motor deceleration stop method when PDS command [Quick stop] is received.

Index	Sub-index	Name	Unit	Range	Data type	Access	PDO	OP-mode
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO	ALL
		pp,csp,csv,pv 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled. 1: after motor stop through 6084h (Profile deceleration), migrate to Switch on disabled. 2: after motor stop through 6085h (Quick stop deceleration), migrate to Switch on disabled. 3: after motor stop through 60C6h (Max deceleration), migrate to Switch on disabled. 5: after motor stop through 6084h (Profile deceleration), migrate to Quick stop active. 6: after motor stop through 6085h (Quick stop deceleration), migrate to Quick stop active. 7: after motor stop through 60C6h (Max deceleration), migrate to Quick stop active. hm						

		0: after motor stop through (Sequence at Servo-off), migrate to Switch on disabled. 1: after motor stop through 609Ah (Homing acceleration), migrate to Switch on disabled. 2: after motor stop through 6085h (Quick stop deceleration), migrate to Switch on disabled. 3: after motor stop through 60C6h (Max deceleration), migrate to Switch on disabled. 5: after motor stop through 609Ah (Homing acceleration), migrate to Quick stop active. 6: after motor stop through 6085h (Quick stop deceleration), migrate to Quick stop active. 7: after motor stop through 60C6h (Max deceleration), migrate to Quick stop active. cst, tq 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled. 1, 2: after motor stop through 6087h (Torque slope), migrate to Switch on disabled. 3: after motor stop through torque 0, migrate to Switch on disabled. 5, 6: after motor stop through 6087h (Torque slope), migrate to Quick stop active. 7: after motor stop through torque 0, migrate to Quick stop active.

Deceleration stop examples according to the Quick stop command:

A: if 6040h: bit2 (control word: quick stop) changes from 1 to 0, it starts to slow down and stop.

The PDS status in deceleration changes to quick stop active.

B: the motor stops when the actual speed is less than 10r / min.

The PDS status after stopping is switch on disabled, or it changes to quick stop active.

2) Shutdown option code (605Bh)
Set the motor deceleration stop method when PDS command [Shutdown] and [Disable voltage] are received.

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
605Bh	00h	Shutdown option code	-	0~1	I8	rw	RxPDO	ALL
		Set the timing when PDS command [shutdown] and [disable voltage] are received. It is different according to the definition of control mode. The settings except the following values are not allowed. (1) receiving PDS command「Shutdown」 pp, csp, csv, pv 0: after motor stop through servo side (Sequence at Servo-off), migrate to Ready to switch on. 1: after motor stop through 6084h (Profile deceleration), migrate to Ready to switch on. hm 0: after motor stop through servo side (Sequence at Servo-off), migrate to Ready to switch on. 1: after motor stop through 609Ah (Homing acceleration), migrate to Ready to switch on. cst, tq 0: after motor stop through servo side (Sequence at Servo-off), migrate to Ready to switch on. 1: after motor stop through 6087h (Torque slope), migrate to Ready to switch on. (2) receiving PDS command「Disable voltage」						

		pp, csp, csv, pv 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled. 1: after motor stop through 6084h (Profile deceleration), migrate to Switch on disabled. hm 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled. 1: after motor stop through 609Ah (Homing acceleration), migrate to Switch on disabled. cst, tq 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switch on disabled. 1: after motor stop through 6087h (Torque slope), migrate to Switch on disabled.

The slowing down stop examples according to shutdown command:

A: if receiving PDS command "shutdown" to deceleration stop.

PDS status in deceleration remains operation enabled.

B: the motor stops when the actual speed is less than 10r / min.

The PDS status after stopping is Ready to switch on.

3) Disable operation option code(605Ch)

Set the motor deceleration stop method when receiving the PDS command 「Disable operation」.

Index	Sub-index	Name	Units	Range	Datatype	Access	PDO	OP-mode
605Ch	00h	Disable operation option code	-	0~1	I8	rw	RxPDO	ALL
		Set the timing when PDS command [disable operation] is received. It is different according to the definition of control mode. The settings except the following values are not allowed. pp, csp, csv, pv 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switched on. 1: after motor stop through 6084h (Profile deceleration), migrate to Switched on. hm 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switched on. 1: after motor stop through 609Ah (Homing acceleration), migrate to Switched on. cst, tq 0: after motor stop through servo side (Sequence at Servo-off), migrate to Switched on. 1: after motor stop through 6087h (Torque slope), migrate to Switched on.						

The slowing down stop examples according to Disable operation command:

A: if receiving PDS command "Disable operation" to deceleration stop.

PDS status in deceleration remains operation enabled.

B: the motor stops when the actual speed is less than 10r / min.

The PDS status after stop is Switched on.

4) Halt option code(605Dh)

Set motor decelerating stop method when bit8 of 6040h(controlword)is 1.

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
605Dh	00h	Halt option code	-	1~3	I16	rw	NO	ALL
		Set the timing when PDS command [disable operation] is received. It is different according to the definition of control mode. ・set the timing of Halt action. It is different according to the definition of control mode. The settings except the following values are not allowed. pp, csp, csv, pv 1: after motor stop through 6084h (Profile deceleration), keep Operation enabled. 2: after motor stop through 6085h (Quick stop deceleration), keep Operation enabled. 3: after motor stop through 6072h (Max torque), 60C6h (Max deceleration) keeps Operation enabled. hm 1: after motor stop through 609Ah (Homing acceleration), keep Operation enabled. 2: after motor stop through 6085h (Quick stop deceleration), keep Operation enabled. 3: after motor stop through 6072h (Max torque), 60C6h(Max deceleration), keep Operation enabled. cst, tq 1, 2: after motor stop through 6087h (Torque slope), keep Operation enabled. 3: after motor stop through torque 0, keep Operation enabled.						

Examples of slowing down and stop according to the halt function

A: if 6040h: bit8 (control word: halt) changes from 0 to 1, it deceleration stops. PDS status in deceleration remains operation enabled.

B: the motor stops when the actual speed is less than 10 r/min. The PDS state after stop remains operation enabled.

5) Fault reaction option code(605Eh)

Set the motor stop method when alarm occurs.

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO	ALL
		Set the timing when the alarm occurs. It is different according to the definition of control mode. The settings except the following values are not allowed. (1) When the Err80.0～80.7, 81.0～81.7, 85.0～85.7, 88.0～88.7 occured pp, csp, csv, pv 0: after motor stop through servo side (Sequence at alarm), migrate to Fault. 1: after motor stop through 6084h (Profile deceleration), migrate to Fault. 2: after motor stop through 6085h (Quick stop deceleration), migrate to Fault. hm 0: after motor stop through servo side (Sequence at alarm), migrate to Fault. 1: after motor stop through 609Ah (Homing acceleration), migrate to Fault. 2: after motor stop through 6085h (Quick stop deceleration), migrate to Fault.						

		cst, tq 0: after motor stop through servo side (Sequence at alarm), migrate to Fault. 1, 2: after motor stop through 6087h (Torque slope), migrate to Fault. (2) alarm except above (1) listed occurred 0, 1, 2: after motor stop through servo side (Sequence at alarm), migrate to Fault.

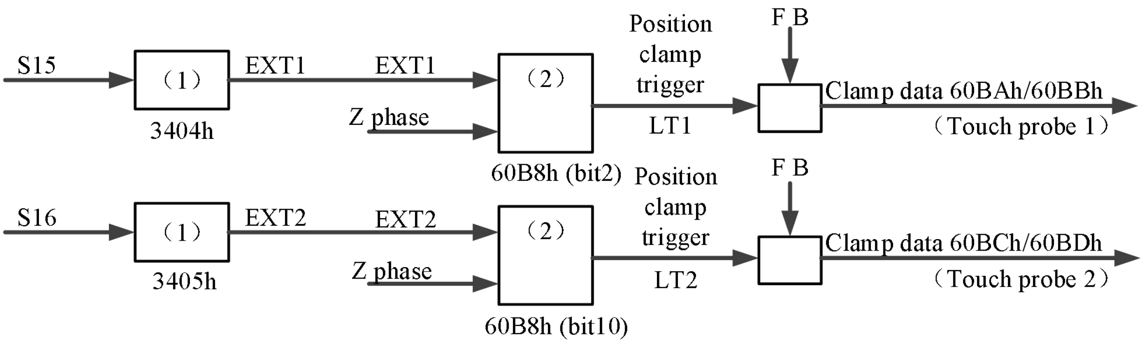
Deceleration stop examples according to alarm
A: if there is an alarm, it starts to slow down and stop. PDS status in deceleration is Fault reaction active.
B: the motor stops when the actual speed is less than 10 r / min. PDS status after stop is Fault.

7.10.3 Touch Probe function(position clamp request/release)

The probe function is the position locking function. When the trigger condition (EXT1 / EXT2) is met, the probe function is triggered and the motor encoder value when the condition is triggered is locked. According to the setting of probe control word 60B8, single or multiple triggering can be realized.

Note:
(1) Probe function is not supported in HM mode.
(2) Currently, only external signals are supported as trigger sources.

1) Touch probe function composition



60B8h:Touch probe function
60BAh:Touch probe pos1 pos value
60BBh:Touch probe pos1 neg value
60BCh:Touch probe pos2 pos value
60BDh:Touch probe pos2 neg value

If the trigger position is at the same point of one rotation of the motor, theoretically, the difference between the two latched probe values shall be the number of pulses sent by the motor encoder for one rotation.
It should be noted that it takes a certain time from the generation of the external trigger signal to the driver receiving the signal and performing the latch operation. Therefore, the latch value of the probe must have an error with the actual value. The error is related to the motor speed, hardware performance and software processing.

Notes for function use:

Product model	Default value		Set when using probe function	
	P5-62	P5-63	P5-62	P5-63 (terminal)

			(terminal)	
DL6	0	0	1(SI1)	2(SI2)

- The clamping trigger signal uses external inputs (EXT1/EXT2), and P5-62 and P5-63 are terminal assignment parameters for Touch Probe1 and Touch Probe2 functions. The default parameters for the driver probe function are shown in the table above.

60B8h (Touch probe function)			
Bit10	LT2	Bit2	LT1
0	EXT2	0	EXT1
1	Z phase	1	Z phase

- if the touch probe is executed to an unassigned port, E-883 (abnormal action protection) will occur.
- when the clamping trigger signal is an external input (EXT1/EXT2), the acquisition error occurs. Make the speed near the clamp signal input as low as possible.
- the width of input ON and OFF of clamping trigger signal shall be more than 2ms respectively.
- in the following cases, touch probe is invalid (cancelled). (the value of 60B9h is cleared).
  ① when ESM status is init
  ② switch to HM mode
- for the same touch probe, please do not set the rising edge and the falling edge at the same time. The action of setting the situation at the same time is unknown.
- it should be noted that it takes a certain time from the generation of external trigger signal to the reception of signal by driver and the execution of latch operation. Therefore, the value of probe latch must have error with the actual value, and the difference is related to the motor speed, hardware performance and software processing.

2) Touch probe objects

Index	Sub-index	Name	Units	Range	Data type	Access	PDO
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO
60BAh	00h	The rising edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BBh	00h	The falling edge clamping position of Touch probe 1	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BCh	00h	The rising edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO
60BDh	00h	The falling edge clamping position of Touch probe 2	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO

3) Touch probe function (60B8h)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO	ALL
		Execute the function setting of Touch probe.						

Related bit information

bit	Value	Note	
0	0	Switch off touch probe 1	Touch Probe 1 execute/stop
	1	Enable touch probe 1	
1	0	Trigger first event	Touch Probe 1 event mode selection
	1	Continuous	

2	0	Trigger with touch probe 1 input	Touch Probe 1 Trigger selection (external input/Z phase)
	1	Trigger with zero impulse signal of position encoder	
3	-	Reserved	Not used
4	0	Switch off sampling at positive edge of touch probe 1	Touch Probe 1 Rising edge selection
	1	Enable sampling at positive edge of touch probe 1	
5	0	Switch off sampling at negative edge of touch probe 1	Touch Probe 1 Falling edge selection
	1	Enable sampling at negative edge of touch probe 1	
6-7	-	Not Supported	Not used
8	0	Switch off touch probe 2	Touch Probe 2 execute/stop
	1	Enable touch probe 2	
9	0	Trigger first event	Touch Probe 2 event mode selection
	1	Continuous	
10	0	Trigger with touch probe 2 input	Touch Probe 2 Trigger selection (external input/Z phase)
	1	Trigger with zero impulse signal of position encoder	
11	-	Reserved	Not used
12	0	Switch off sampling at positive edge of touch probe 2	Touch Probe 2 Rising edge selection
	1	Enable sampling at positive edge of touch probe 2	
13	0	Switch off sampling at negative edge of touch probe 2	Touch Probe 2 Falling edge selection
	1	Enable sampling at negative edge of touch probe 2	
14-15	-	Not Supported	Not used

Note:

under the same probe, do not set the rising edge and the falling edge at the same time.

4) Touch probe status (60B9h)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO	ALL
		Touch probe function status.						

Related bit information

Bit	Value	Note	
0	0	Touch probe 1 is switch off	Touch Probe 1 action stop
	1	Touch probe 1 is enabled	Touch Probe 1 in action
1	0	Touch probe 1 no positive edge value stored	Rising edge touch probe 1 incomplete status
	1	Touch probe 1 positive edge value stored	Rising edge touch probe 1 complete status
2	0	Touch probe 1 no negative edge value stored	Falling edge touch probe 1 incomplete status
	1	Touch probe 1 negative edge value stored	Falling edge touch probe 1 complete status
3-5	-	Reserved	Not used
6-7	-	Not Supported	Not used
8	0	Touch probe 2 is switch off	Touch Probe 2 action stop
	1	Touch probe 2 is enabled	Touch Probe 2 in action
9	0	Touch probe 2 no positive edge value stored	Rising edge touch probe 2 incomplete status

Bit	Value	Note	
	1	Touch probe 2 positive edge value stored	Rising edge touch probe 2 complete status
10	0	Touch probe 2 no negative edge value stored	Falling edge touch probe 2 incomplete status
	1	Touch probe 2 negative edge value stored	Falling edge touch probe 2 complete status
11-13	-	Reserved	Not used
14-15	-	Not Supported	Not used

5) Obtained clamping position (0x60BA~0x60BD)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
60BAh	00h	Touch probe pos1 pos value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL
		Touch probe1 rising edge clamp position.						
60BBh	00h	Touch probe pos1 neg value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL
		Touch probe1 falling edge clamp position.						
60BCh	00h	Touch probe pos2 pos value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL
		Touch probe2 rising edge clamp position.						
60BDh	00h	Touch probe pos2 neg value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL
		Touch probe2 falling edge clamp position.						

6) Startup of Touch probe action

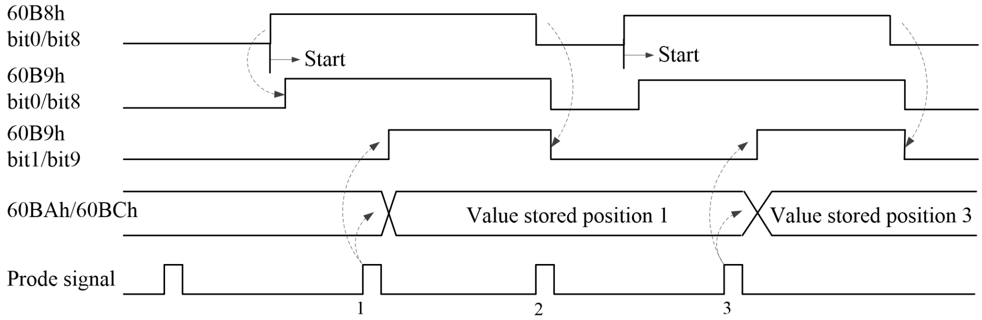
When bit0 / bit8 of 60B8h (touch probe function) is from "0 (stop) → 1 (start)", obtain various setting conditions (60B8h: bit1 ~ 7 / bit9 ~ 15), and start Touch probe action.
To make the changes of various setting conditions valid, bit0 / bit8 return "0 (stop)" and then to "1 (start)" again. To switch the control mode and then use the probe function, also bit0 / bit8 return "0 (stop)" and then to "1 (start)" again.

7) Touch probe event mode

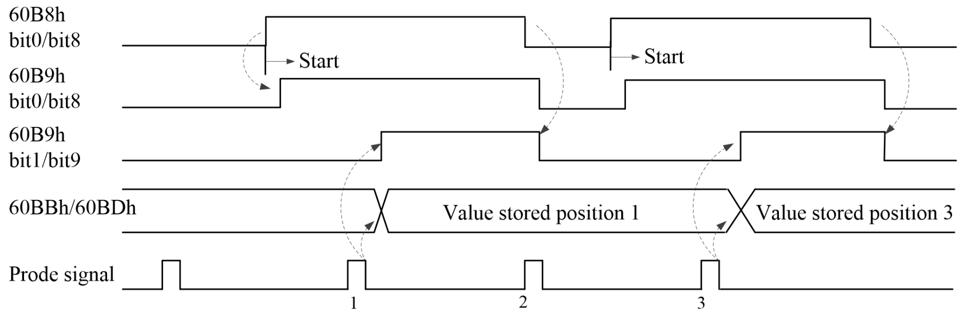
According to 60B8h (Touch probe function) bit1/bit9 (event mode selection), “0(Trigger first event mode)” and “1(Continuous mode)” can be selected.

a. < Trigger first event mode>(60B8h:bit1=0 / bit9=0)

After starting, this mode only clamps position for the first trigger signal. In order to get it again, it is necessary to start touch probe again.



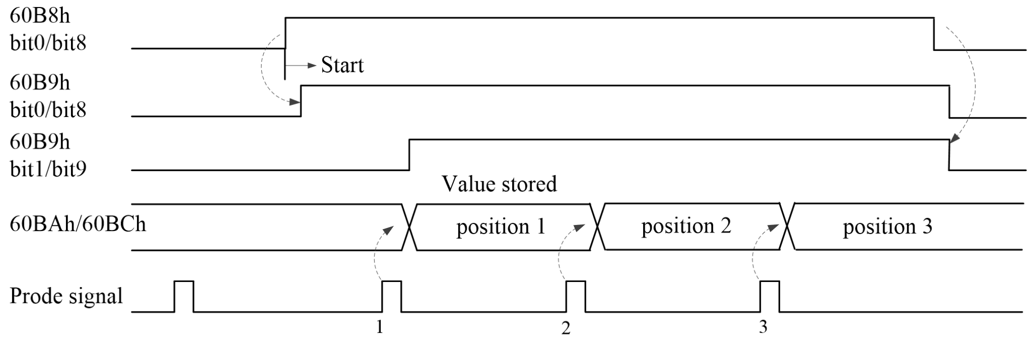
Positive edge



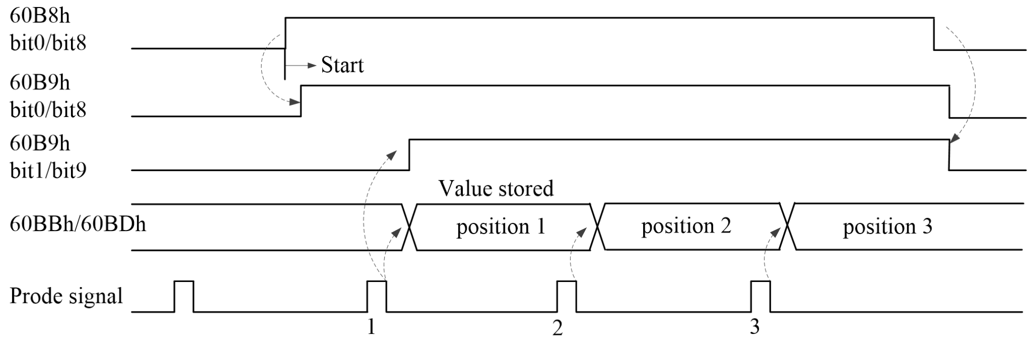
Negtive edge

b. < Continuous mode >(60B8h:bit1=1 / bit9=1)

After startup, this mode clamps position for every trigger signal. The obtained value will be kept for the next Probe signal.



Positive edge



Negtive edge

7.10.4 Digital input(60FDh)

The digital input 60FDh's bits are assigned to represent various function signals through the parameters of the DL6 series servo, specifically P5-22 (POT setting address), P5-23 (NOT setting address), P5-27 (HOME origin setting address), P5-62 (Probe 1 setting address), P5-63 (Probe 2 setting address), P5-72 (Remote SI input 1), P5-73 (Remote SI input 2), P5-74 (Remote SI input 3), and P5-75 (Remote SI input 4). These signals indicate the input states for the positive limit switch (POT), negative limit switch (NOT), home switch (HOME), Touch probe 1, Touch probe 2, and the remote input states 1 to 4.

Digital inputs (60FDh)

Index	Sub-	Name/description	Range	Data	Access	PDO	Op-mode

	index			type			
60FDh	00h	Digital inputs	0~4294967295	U32	ro	TxPDO	All

Represents the theoretical input state to an external input signal.

Bit information

31	30	29	28	27	26	25	24
r							
23	22	21	20	19	18	17	16
r				ris4	ris3	ris2	ris1
15	14	13	12	11	10	9	8
r							
7	6	5	4	3	2	1	0
r			tp2	tp1	hs	pls	nls

r = reserved

pls= positive limit switch

nls = negative limit switch hs=home switch

tp1=Touch probe 1 tp2=Touch probe 2

ris1= remote input state1

ris2= remote input state2

ris3= remote input state3

ris4= remote input state4

Bits details:

Value	Description
0	Input status OFF
1	Input status ON

The values of bit0 (reverse overtravel switch), bit1 (forward overtravel switch), bit2 (origin switch), bit3 (probe 1), bit4 (probe 2) and bit5 (Z phase output), bit16 (remote SI input1), bit17(remote SI input2), bit18 (remote SI input3), bit19 (remote SI input4) for 60FD (digital input) represent the positive signal states of driving limit input, negative driving limit input, near origin input, probe 1 input, and probe 2 input, Z phase output, remote SI input1, remote SI input2, remote SI input3, remote SI input4 respectively.

The Z-phase output holding time is modified by the driver parameters:

Parameter	Meaning	Default value	Unit	Range	Modify	Effective
P5-19	Z-phase output holding time	2	ms	1~65535	Anytime	At once

The Z-phase output is affected by the EtherCAT communication cycle and its own software processing, resulting in poor consistency.

7.10.5 Digital output (60FEh)

The bit0 in sub object word 1 of digital output 60FEh represents the zero crossing Z-phase output status bit, and the bit0 in sub object word 2 represents the zero crossing Z-phase output enable bit. Set the Z-phase output enable bit to 1. When the encoder crosses zero, the Z-phase output status bit changes from 0 to 1. After the holding time set in P5-19, the Z-phase output status bit changes from 1 to 0. If the Z-phase output enable bit is set to 0, there is no Z-phase output state, and the value of the Z-phase output state bit is 0.

Digital output (60FEh)

<table>
<tr><th>Index</th><th>Sub index</th><th>Name</th><th>Range</th><th>Data type</th><th>Accessibility</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td rowspan="6">60FEh</td><td rowspan="2">00h</td><td>Number of entries</td><td>2</td><td>U8</td><td>ro</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The number of Sub Index for 60FEh.</td></tr>
<tr><td rowspan="2">01h</td><td>Physical outputs</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>All</td></tr>
<tr><td colspan="6">Indicates the output status of the external output signal for operation.
Bit information
<table>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td></tr>
<tr><td colspan="8">r</td></tr>
<tr><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td></tr>
<tr><td colspan="5">r</td><td>ros3</td><td>ros2</td><td>ros1</td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="8">r</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">r</td></tr>
</table>
r = reserved (Not corresponding)
ros1= remote output state1 (remote SO output status 1)
ros2= remote output state2 (remote SO output status 2)
ros3= remote output state3 (remote SO output status 3)</td></tr>
<tr><td rowspan="2">02h</td><td>Bit mask</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>All</td></tr>
<tr><td colspan="6">Indicates the output operation host function for setting external output signals.
Bit information
<table>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td></tr>
<tr><td colspan="8">r</td></tr>
<tr><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td></tr>
<tr><td colspan="5">r</td><td>roe3</td><td>roe2</td><td>roe1</td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="8">r</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">r</td></tr>
</table>
r = reserved (Not corresponding)
roe1= remote output enable1 (remote SO1 output enable 1)
roe2= remote output enable2 (remote SO1 output enable 2)
roe3= remote output enable3 (remote SO1 output enable 3)</td></tr>
</table>

The details of each bit are as follows:

Subindex 01h: Physical outputs

bit	Name	Value	Description
16	Remote SO1 output status bit	0	Remote SO1 status OFF
		1	Remote SO1 status ON
17	Remote SO2 output status bit	0	Remote SO2 status OFF
		1	Remote SO2 status ON
18	Remote SO3 output status bit	0	Remote SO3 status OFF
		1	Remote SO3 status ON

Subindex 02h: Bit mask

bit	Name	Value	Description
16	Remote SO1 output enable bit	0	Remote SO1 output enable OFF

bit	Name	Value	Description
		1	Remote SO1 output enable ON
17	Remote SO2 output enable bit	0	Remote SO2 output enable OFF
		1	Remote SO2 output enable ON
18	Remote SO3 output enable bit	0	Remote SO3 output enable OFF
		1	Remote SO3 output enable ON

The bits 16, 17, and 18 in Subindex 01h (sub object word 1) of digital output 60FEh represent the remote SO1 output status bit, remote SO2 output status bit, and remote SO3 output status bit, respectively. The bits 16, 17, and 18 in Subindex 02h (sub object word 2) represent the remote SO1 output enable bit, remote SO2 output enable bit, and remote SO3 output enable bit.

7.10.6 Position information

1) Initialization time of location information
The servo driver initializes (presets) the position information related objects in the following time sequence.

- Initialization sequence (condition):
  - When the power is put into operation
  - When communication is established (ESM status Init → OP migration)
  - When the original point is reset
  - Absolute multi-turn zero clearing
- Initialization objects
  - 6062h(Position demand value)
  - 6063h(Position actual internal value)
  - 6064h(Position actual value)
  - 60FCh(Position demand internal value)

The object here is based on the Position actual internal value (6063h) that represents the feedback position of the motor, the electronic gear function described later will add Home offset, etc. according to the polarity change symbol, and initialize (preset) when the communication is established.
In addition, the changes of the set values of electronic gear ratio, Polarity and Home offset are reflected by the time sequence described later in this chapter.
Note: please refer to "initialization of absolute encoder" in Section 4 of this chapter for details of precautions for using absolute encoder.

2) Electronic gear ratio
(1) Function overview
The electronic gear is a function of multiplying the position command input from the upper computer by the electronic gear ratio set by the object as the position command of the position control unit. According to the use of this function, the motor rotation and movement amount of each command unit can be set arbitrarily.

(2) DL6 series electronic gear ratio setting method

Method 1: set the electronic gear ratio according to the internal parameters of the servo, please refer to chapter 5.4.1.1 for details.
Method 2:

DS5C2 series servo driver can set electronic gear ratio through the object 608Fh (Position encoder resolution), 6091h (Gear ratio), 6092h (Feed constant) specified by CoE (CiA402).

The following is mainly about setting the electronic gear ratio according to COE (CiA402).
The relationship between user-defined units (instruction units) and internal units (pulse) is calculated according to the following equation.
Calculation formula of electronic gear ratio:

$$\text{Electronic gear ratio} = \frac{\text{Position encoder resolution} \times \text{Gear ratio}}{\text{Feed constant}}$$

$$\text{Position encoder resolution} = \frac{\text{608F：01(encoderincrements)}}{\text{608F：02(motorrevolutions)}}$$

$$\text{Gear ratio} = \frac{\text{6091：01(Motorrevolutions)}}{\text{6091：02(Shaftrevolutions)}}$$

$$\text{Feed constant} = \frac{\text{6092：01(Feed)}}{\text{6092：02(Shaftrevolutions)}}$$

$$\text{Position demand value(6062h)} \times \text{electronic gear ratio} = \text{Position demand internal value(60FCh)}$$

Note:
(1) The ratio of electronic gear is valid in the range of 8000 to 1/1000 times.
If the out of range value is saturated within the range, E-883 (abnormal action abnormal protection) occurs.

(2)608FH-01h (encoder increments) is automatically set according to the resolution of the encoder. The factory value of 6092h-01h (feed) is set according to the resolution of encoder.

(3) The setting of electronic gear ratio is reflected by the following time sequence.
- When the power is put into operation
- When communication is established (ESM status Init → OP migration)
- When the original point is reset
- Absolute multi-turn zero clearing

(4) Please note that it does not reflect whether the set value of the associated object changes or not.
The position information initialization when Init ⇒ OP in absolute mode, please set the value of absolute encoder position [pulse / unit] / electronic gear ratio within the range of - 2 ^ 31 (- 2147483648) ～ + 2 ^ 31-1 (2147483647). Actions outside this range are not guaranteed.
Please confirm the action range of absolute encoder position and gear ratio.
(5) Try to use the electronic gear ratio setting in Cia402 protocol.
(6) Linear motor 6099-01h: 609-02h is fixed at a 1:1 ratio.

- Related parameter

Position encoder resolution(608Fh)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
608Fh	-	Position encoder resolution	-	-	-	-	-	-
		The resolution of encoder is set automatically.						

	00h	Highest sub-index supported	-	2	U8	ro	NO	ALL
		Represents the Sub-Indexes of 608FH.						
	01h	Encoder increments	Pulse	1~4294967295	U32	ro	NO	ALL
		Indicates the amount of encoder movement. Value is set automatically by the encoder resolution.						
	02h	Motor revolutions	r(motor)	1~4294967295	U32	ro	NO	ALL
		Indicates the number of motor rotations. The value is fixed to 1.						

This object defines the encoder resolution for each polar distance of the motor during operation.
Position encoder resolution = Encoder increments(608Fh-01h)/ Motor revolutions (608Fh-02h)
This object is automatically set based on manually set motor information.
Example: encoder resolution 1μm, polar distance 20mm
608Fh-01h(Encoder increments)=20000
608Fh-02h(Motor revolutions)= 1
Position encoder resolution =20000 / 1 =20000. When the linear encoder moves one polar distance (N-N), the encoder position changes by 20000 units.

Gear ratio (6091h)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
6091h	-	Gear ratio	-	-	-	-	-	-
		Set gear ratio						
	00h	Highest sub-index supported	-	2	U8	ro	NO	ALL
		Represents the Sub-Indexes of 6091H.						
	01h	Motor revolutions	Pulse	1~4294967295	U32	rw	NO	ALL
		Motor rotation numbers.						
	02h	Shaft revolutions	r(motor)	1~4294967295	U32	rw	NO	ALL
		Shaft rotation numbers.						

For this object, Gear ratio = Motor shaft revolutions(6091h-01h)/ Driving shaft revolutions(6091h-02h), linear motor fixed at 6091-01h: 6092-02h=1: 1.

Feed constant(6092h)

Index	Sub-index	Name	Units	Range	Data type	Access	PDO	OP-mode
6092h	-	Feed constant	-	-	-	-	-	-
		Set the feed constant.						
	00h	Highest sub-index supported	-	2	U8	ro	NO	ALL
		Represents the Sub-Indexes of 6092h.						
	01h	Feed	Command unit	1~4294967295	U32	rw	NO	ALL
		Set the feed quantity.						
	02h	Shaft revolutions	r (motor)	1~4294967295	U32	rw	NO	ALL
		Set the shaft rotation number (linear motor fixed to 1)						

This object represents the amount movement of shaft moving one polar distance after the output of the gearbox.
Feed constant =Feed(6092h-01h)/ Driving shaft revolutions(6092h-02h)

3) Polarity function (607Eh)

For position commands, speed commands, torque commands, and their offsets, polarity (motor rotation direction) can be set. The DL6 series sets the rotation direction based on the object Polarity command polarity (607Eh) specified by CoE (CiA402). But the polarity of the Polarity command (607Eh) specified by CoE (CiA402) will change with the change of the rotation direction of parameter P0-05 (rotation direction setting). If P0-05 is set from 0 to 1 and Cia402 object word 607Eh becomes 0xE0, the driver can move in the opposite direction. P0-05 is set from 1 to 0, its object word 607Eh becomes 0, and the drive returns to the default specified positive direction motion.

In addition, the Polarity instruction polarity (607Eh) of the object is not the object of the original replacement parameter P0-05 (rotation direction setting). It is valid when transferring object data corresponding to the table below between the CoE (CiA402) processing unit and the motor control processing unit.

<table>
<tr><th>Index</th><th>Sub-index</th><th>Name</th><th>Units</th><th>Range</th><th>Data type</th><th>Access</th><th>PDO</th><th>OP-mode</th></tr>
<tr><td rowspan="2">607Eh</td><td rowspan="2">00h</td><td>Polarity</td><td>-</td><td>0~255</td><td>U8</td><td>rw</td><td>NO</td><td>ALL</td></tr>
<tr><td colspan="7">Set the polarity when the values of position instruction, speed instruction, torque instruction and position offset, speed offset (speed addition) and torque offset (torque addition) are transferred from the object to the internal processing, and the polarity when the values of position feedback, speed feedback and torque feedback are transferred from the internal processing to the object.
Note: for the setting value of this object, please set the polarity of position, speed and torque to 0 or 224 (bit 7-5 = 1).
Actions under other settings cannot be guaranteed.
<table>
<tr><th>Setting value</th><th>Contents</th></tr>
<tr><td>0</td><td>Symbol of position, speed and torque has no reversal</td></tr>
<tr><td>224</td><td>Symbol of position, speed and torque has reversal</td></tr>
<tr><td>Others</td><td>Cannot support (do not set)</td></tr>
</table>
bit7: position polarity
0: symbol no reversal 1: symbol has reversal
bit6: speed polarity
0: symbol no reversal 1: symbol has reversal
bit5:torque polarity
0: symbol no reversal 1: symbol has reversal
bit4-0: Reserved, please set to 0

object <command・setting> ・607Ah (Target position)
・60B0h (Position offset)
・60FFh (Target velocity)
・60B1h (Velocity offset)
・6071h (Target torque)</td></tr>
</table>

		・60B2h (Torque offset) <monitor> ・6062h(Position demand value) ・6064h(Position actual value) ・606Bh(Velocity demand value) ・606Ch(Velocity actual value) ・6074h(Torque demand) ・6077h(Torque actual value) ・6078h(Current actual value)

Symbol no reversal: for the positive direction command, the motor rotation reverse direction is CCW direction;
Symbol has reversal: for the positive direction command, the motor rotation reverse direction is CW direction.
When the rotation direction of the motor is viewed from the shaft end of the load side, CW is defined as clockwise and CCW is defined as anticlockwise.

4) Position range limit (607Bh)
The DL6 series servo driver does not support wrap-around。
Infinite rotation mode acts as 607Bh-01h=80000000h, 607Bh-02h=7FFFFFFFh in the interior. Modifying this object is not affected either.

5) Homing offset(607Ch)
Set the offset quantity of the mechanical origin offset after returning to the mechanical origin, and use this position as the mechanical zero point. If it is set to 0, the mechanical origin will coincide with the mechanical zero point. The origin offset can be set as a positive or negative number to indicate the left or right deviation from the mechanical origin.

This object can be updated at any time, but it needs to reflect the actual location information through the following time sequence.

・When the power is put into operation

・When communication is established (when ESM status is Init → OP migration)

・When the original point is reset

The position under the above time sequence is used as the reference to initialize(preset) the following objects

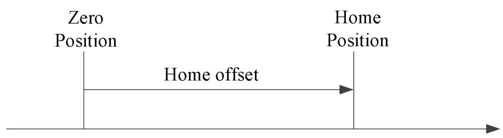
・ When the origin position is detected

6063h(Position actual internal value)＝60FCh(Position demand internal value)＝0
6062h(Position demand value)＝6064h(Position actual value)＝607Ch(Home offset)

・Initialization (preset) in time sequence other than the origin position is detected

6063h(Position actual internal value)＝60FCh(Position demand internal value)
6062h(Position demand value)＝6064h(Position actual value)
＝6063h(Position actual internal value)＋607Ch(Home offset)

Note: the above is the case when the electronic gear ratio is 1:1 and there is no polarity reversal.



Home offset definition

Home position: Index pulse position (origin position)

Zero position: Incremental system＝0 (The position when the power is on, or the position from hm detected index pulse substract by Home offset position)

Absolute system＝Zero position of absolute encoder.

7.10.7 Overtravel function in Ethercat mode

Parameter	Meaning	Default value	Unit	Range	Modify	Effective
P0-28.0	0: Direct alarm, using servo deceleration shutdown method 1: Alarm after decelerating and stopping as 605Ah mode 2: Do not use overtravel	2	-	0~3	○	1|3|4|8|9|10

■ Prohibited status

Scenario 1:

When the servo is in an enabled not motion or disabled state and touches the reverse limit switch, the panel will display NOT, cancel the reverse limit signal, and the panel will return to its previous state.

Scenario 2:

When the servo is in an enabled not motion or disabled state and touches the forward limit switch, the panel will display POT, cancel the forward limit signal, and the panel will return to its previous state.

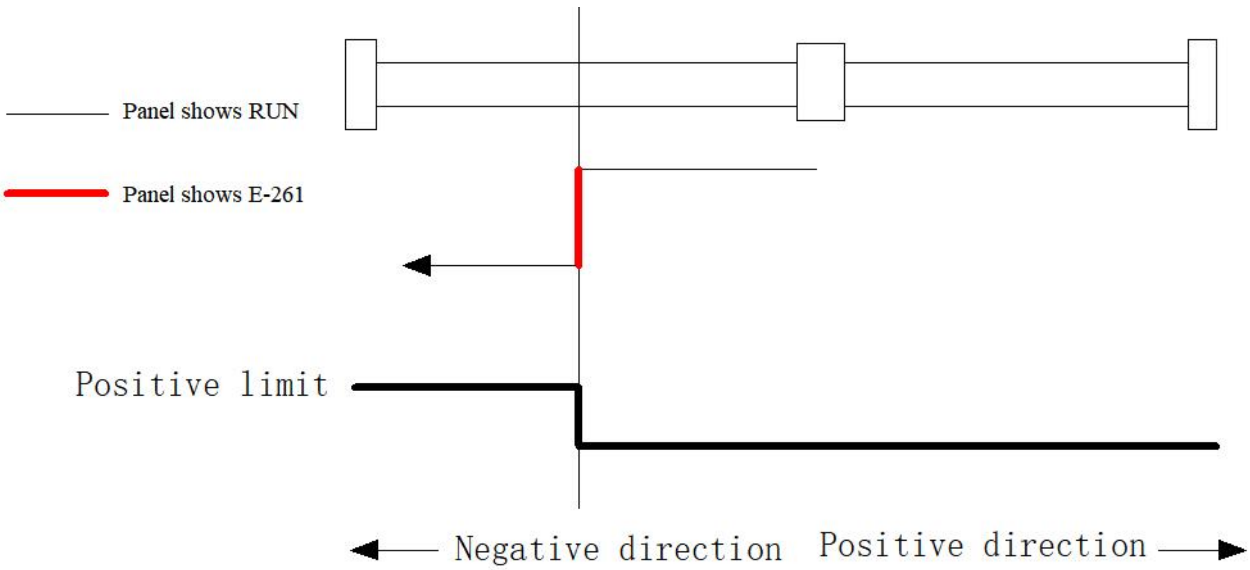
Scenario 3:

When the servo is in an enabled not motion or disabled state and simultaneously touches the forward and reverse limit switches, the servo will report E-261. If two limit signals are cancelled, the panel will return to its previous state; If any limit signal is cancelled, the panel will display another limit signal, which needs to be cancelled before the panel can return to its previous state.

■ Normaly operation status

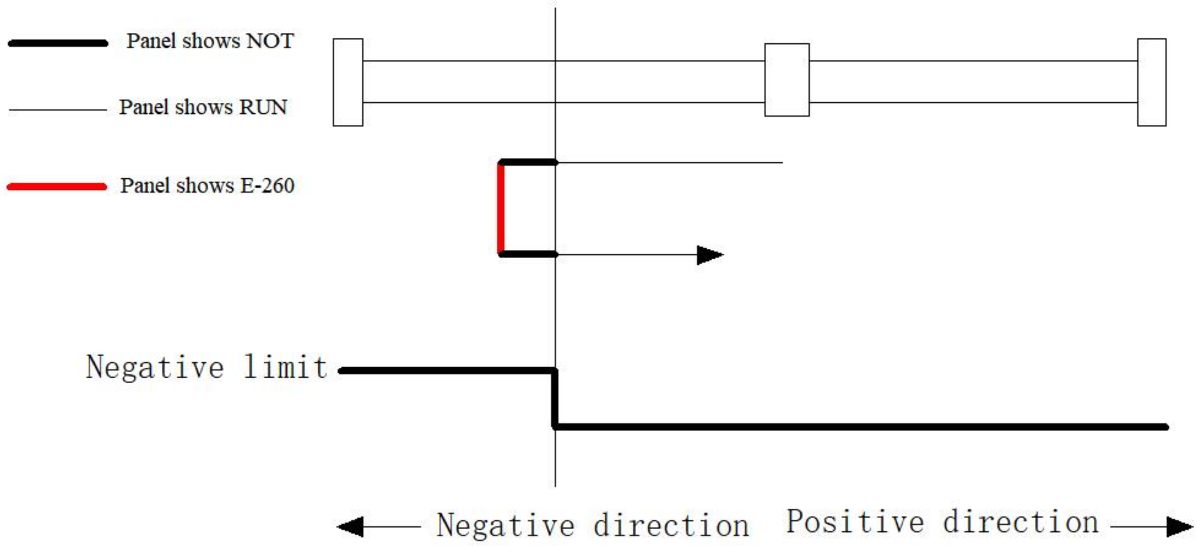
(1) Initial movement direction to the left

The initial direction of movement is left. When touching the forward limit switch, the servo will report E-261. If the forward limit switch is cancelled first, and then the alarm is cleared, the shaft will return to a non enabled state, and both the forward and reverse directions of the shaft can move; If the alarm is cleared first and the axis returns to the disabled state, but the panel still displays POT, the axis is still in the forward limit restricted state. The forward limit signal needs to be cancelled in order to release the forward overtravel prohibition.



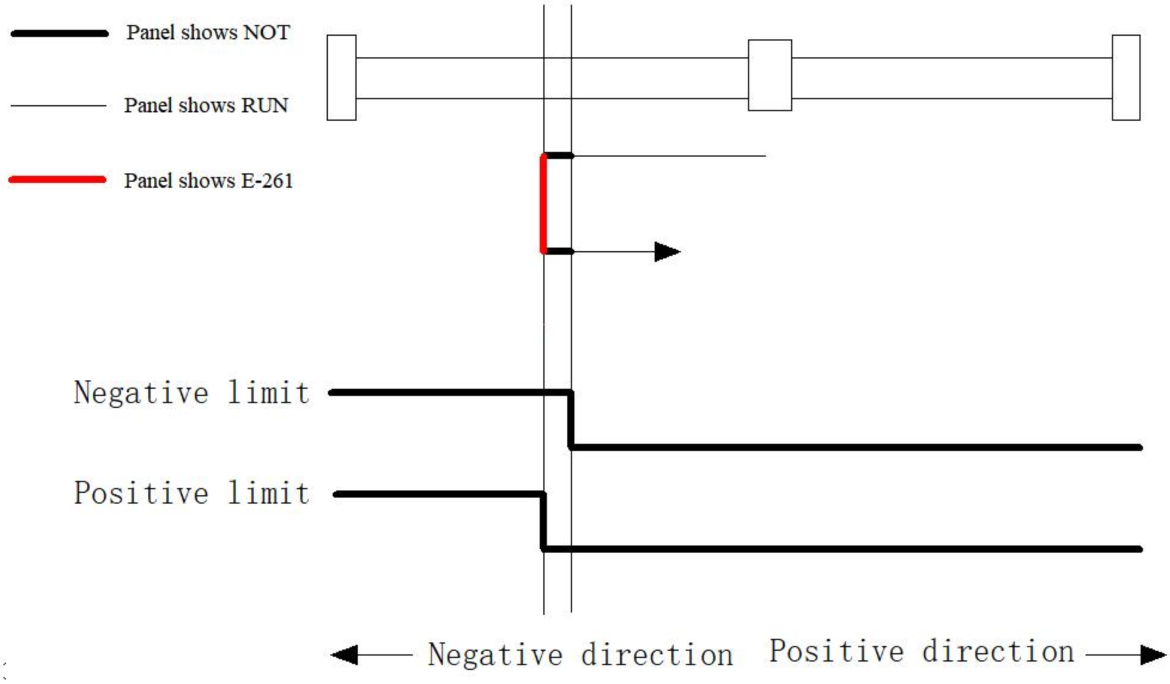
■ Overtravel status

P0-28 set to 1 (Alarm deceleration stop)
(1) Initial movement direction to the left, triggering the overtravel signal without occurrence of offside
Scenario 1: Failure to touch the forward limit switch
The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. The shaft stops on the reverse limit switch, and the servo will report E-260. The alarm must be cleared to move the axis in the forward direction. When it touches the falling edge of the reverse limit switch, the panel display can change from NOT to RUN, and the reverse overtravel prohibition can be released.

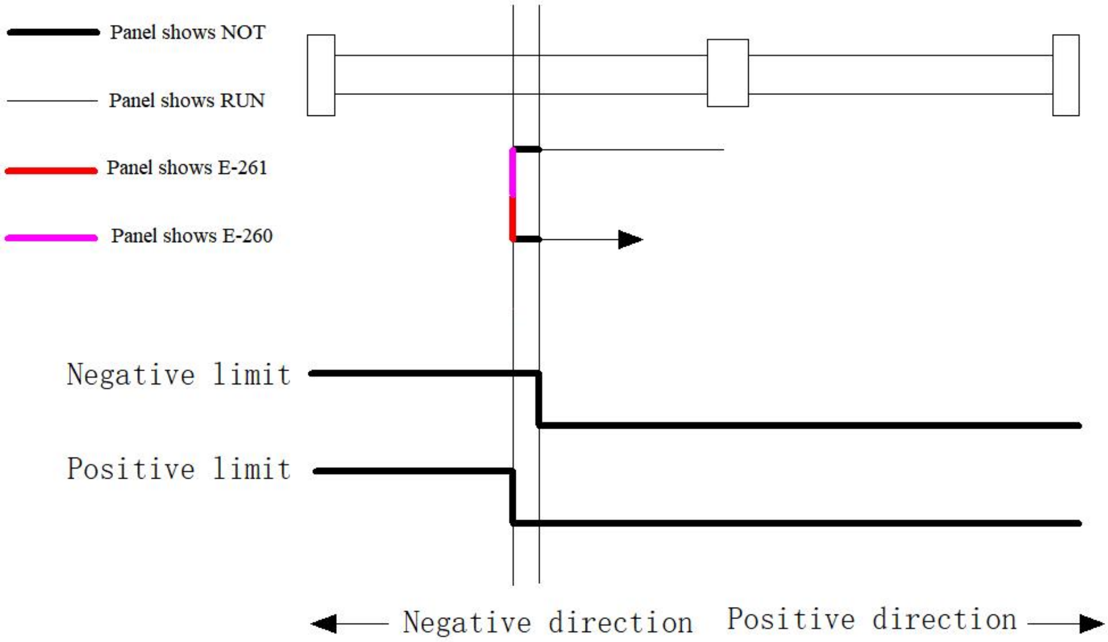


Scenario 2: Before the axis deceleration stops, touch the forward limit switch
The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. Before the shaft stops, if the forward limit switch is touched, the servo will report E-261. The forward limit switch

must be cancelled in order to clear the E-261 alarm. Otherwise, the alarm cannot be cleared. Then, the shaft moves forward and touches the falling edge of the reverse limit switch. Only then can the panel display change from NOT to RUN, and the reverse overtravel prohibition be released.

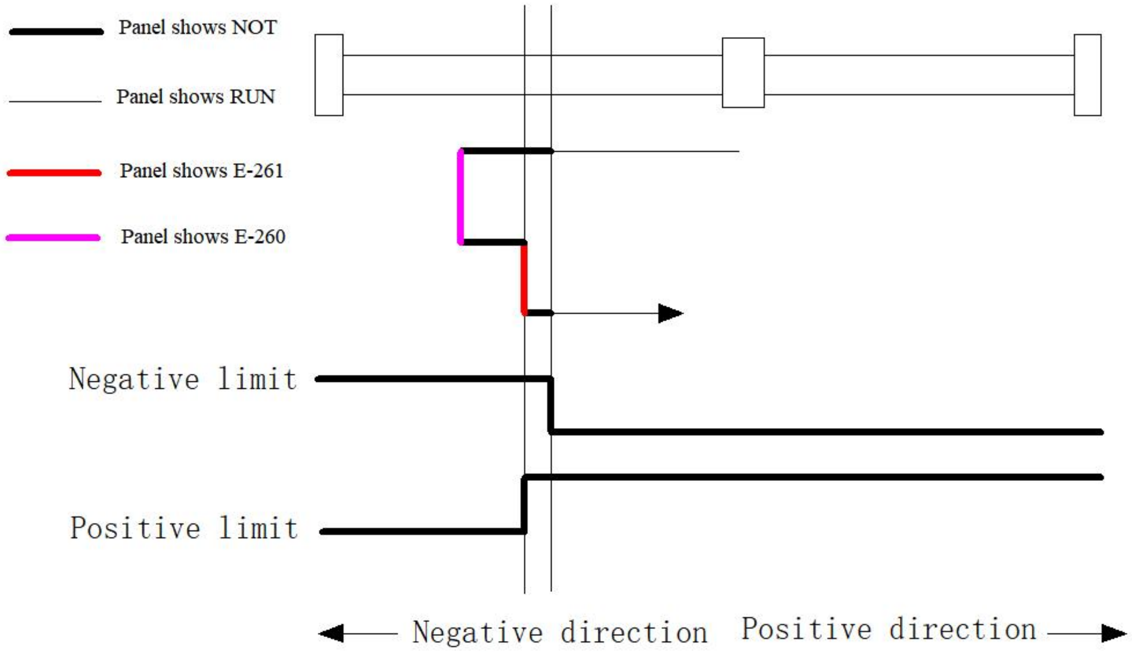


Scenario 3: When the shaft stops at the negative limit switch and touches the positive limit switch
The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. When the shaft stops on the reverse limit switch, the servo will report E-260. At this time, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled before the E-261 alarm can be cleared. Otherwise, the alarm cannot be cleared. Then, when the shaft moves forward and touches the falling edge of the reverse limit switch, the panel display can change from NOT to RUN, and the reverse overtravel prohibition can be released.



Scenario 4: When touching the forward limit switch during axis forward movement

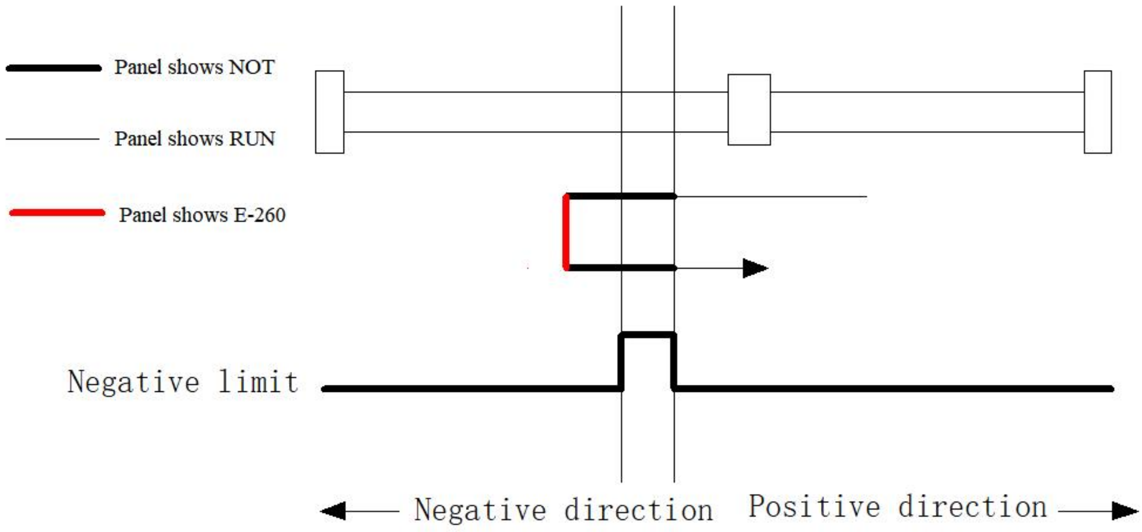
The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. When the shaft stops on the reverse limit switch, the servo will report E-260. After clearing the alarm to make the shaft move forward, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled before the E-261 alarm can be cleared. Otherwise, the alarm cannot be cleared. Continue to move the shaft forward, touch the falling edge of the reverse limit switch, and the panel display can change from NOT to RUN to release the reverse overtravel prohibition.



(2) The initial movement direction is to the left, triggering an overtravel signal and out of range occured

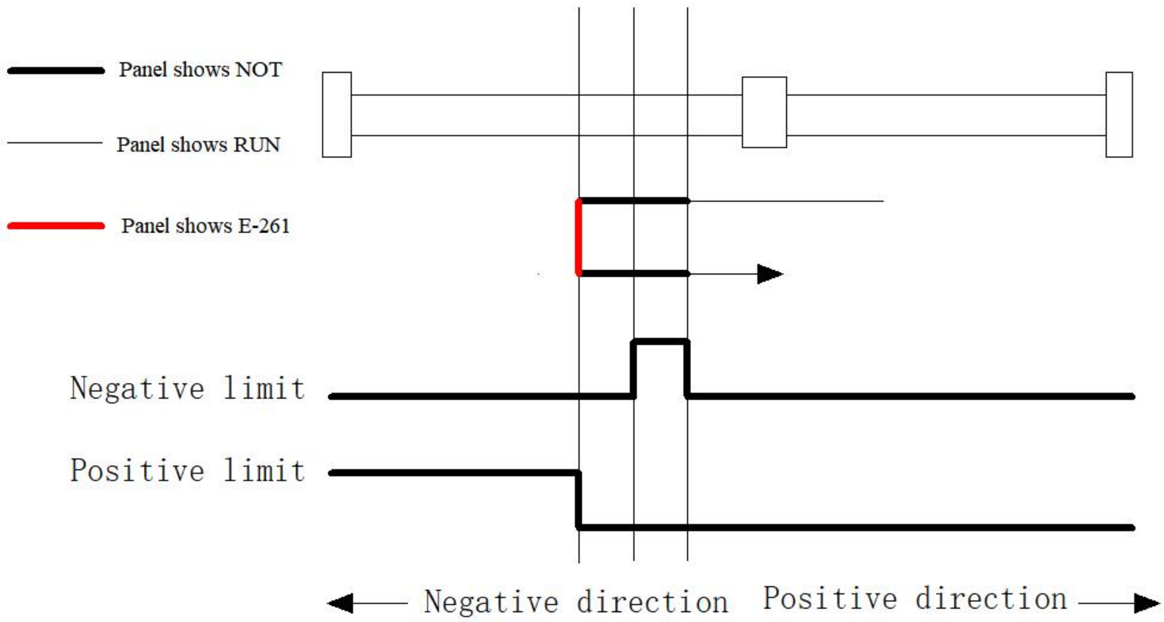
Scenario 1: Without touching the forward limit switch while offside

The initial direction of movement is to the left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. However, the axis crosses the reverse limit switch and triggers the falling edge of the reverse limit switch. The axis stops outside the limit, and the servo will report E-260. The alarm must be cleared to make the axis move forward. Touch the rising and falling edges of the reverse limit switch again before the panel display can change from NOT to RUN, and the reverse overtravel prohibition can be released.



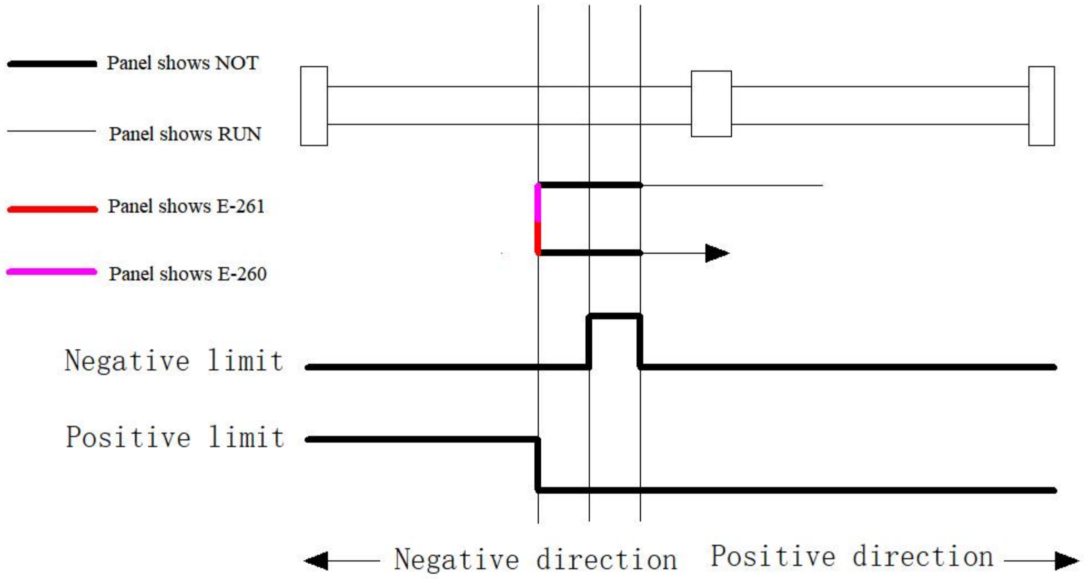
Scenario 2: In the case of offside, touch the forward limit switch before the axis deceleration stop is completed

The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. However, the axis crosses the reverse limit switch and triggers the falling edge of the reverse limit switch. Before the shaft stops, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled in order to clear the E-261 alarm. Otherwise, the alarm cannot be cleared. Then, the shaft moves forward and touches the rising and falling edges of the reverse limit switch again. Only then can the panel display change from NOT to RUN, and the reverse overtravel prohibition be released.

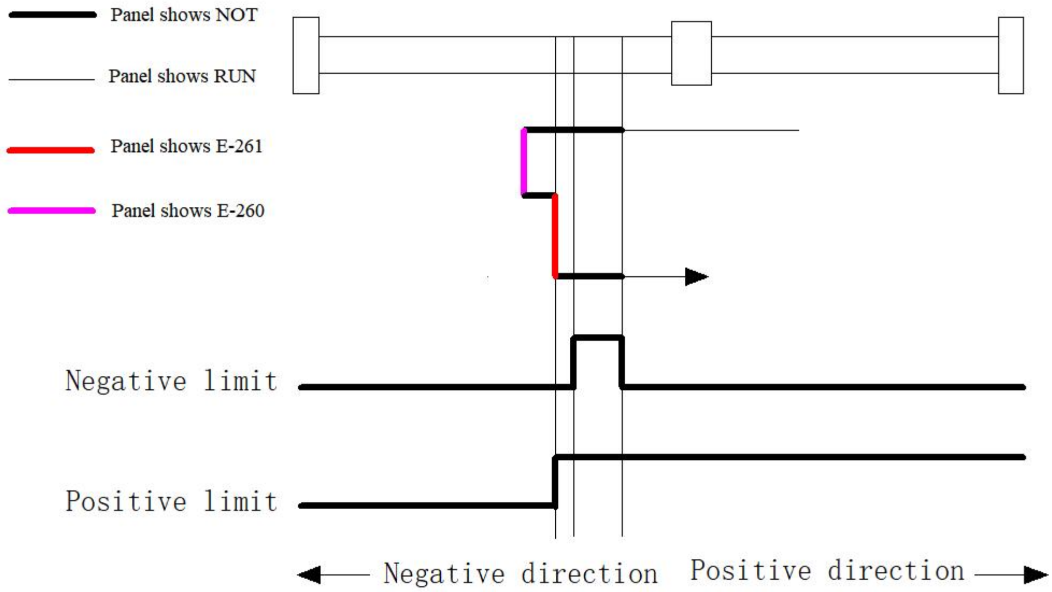


Scenario 3: In the case of offside, when the shaft stops, touch the forward limit switch

The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. However, the axis crosses the reverse limit switch and triggers the falling edge of the reverse limit switch. When the shaft stops, the servo will report E-260. At this time, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled before the E-261 alarm can be cleared. Otherwise, the alarm cannot be cleared. Then, the shaft will move forward and touch the rising and falling edges of the reverse limit switch again. Only then can the panel display change from NOT to RUN, and the reverse overtravel prohibition be released.



Scenario 4: In the case of offside, touching the forward limit switch during axis forward movement
The initial direction of movement is left. When touching the rising edge of the reverse limit switch, the panel display changes from RUN to NOT, triggering the reverse overtravel deceleration stop. However, the axis crosses the reverse limit switch and triggers the falling edge of the reverse limit switch. When the shaft stops, the servo will report E-260. After clearing the alarm to move the shaft forward, if the forward limit switch is touched, the servo will report E-261. The forward limit switch must be cancelled before the E-261 alarm can be cleared. Otherwise, the alarm cannot be cleared. Continue to move the shaft forward, touch the rising and falling edges of the reverse limit switch again, and the panel display can change from NOT to RUN to release the reverse overtravel prohibition.



7.10.8 Remote I/O function

■ General related parameters

Parameter	Meaning	Default	Setting
P5-72	Remote SI input 1	0	0: Invalid 1: Input positive signal from SI1 2: Input positive signal from SI2 3: Input positive signal from SI3 4: Input positive signal from SI4 10: Always set as valid 11: Input reverse signal from SI1 12: Input reverse signal from SI2 13: Input reverse signal from SI3 14: Input reverse signal from SI4
P5-73	Remote SI input 2	0	0: Invalid 1: Input positive signal from SI1 2: Input positive signal from SI2 3: Input positive signal from SI3 4: Input positive signal from SI4 10: Always set as valid 11: Input reverse signal from SI1 12: Input reverse signal from SI2 13: Input reverse signal from SI3 14: Input reverse signal from SI4
P5-74	Remote SI input 3	0	0: Invalid 1: Input positive signal from SI1 2: Input positive signal from SI2 3: Input positive signal from SI3 4: Input positive signal from SI4 10: Always set as valid 11: Input reverse signal from SI1 12: Input reverse signal from SI2 13: Input reverse signal from SI3 14: Input reverse signal from SI4
P5-75	Remote SI input 4	0	0: Invalid 1: Input positive signal from SI1 2: Input positive signal from SI2 3: Input positive signal from SI3 4: Input positive signal from SI4 10: Always set as valid 11: Input reverse signal from SI1 12: Input reverse signal from SI2 13: Input reverse signal from SI3 14: Input reverse signal from SI4
P5-76	Remote SO output 1	0	0: Do not output to terminals

Parameter	Meaning	Default	Setting
			1: Output positive signal from SO1 2: Output positive signal from SO2 3: Output positive signal from SO3 11: Output reverse signal from SO1 12: Output reverse signal from SO2 13: Output reverse signal from SO3
P5-77	Remote SO output 2	0	0: Do not output to terminals 1: Output positive signal from SO1 2: Output positive signal from SO2 3: Output positive signal from SO3 11: Output reverse signal from SO1 12: Output reverse signal from SO2 13: Output reverse signal from SO3
P5-78	Remote SO output 3	0	0: Do not output to terminals 1: Output positive signal from SO1 2: Output positive signal from SO2 3: Output positive signal from SO3 11: Output reverse signal from SO1 12: Output reverse signal from SO2 13: Output reverse signal from SO3

■ Remote I/O related dictionary objects

Object	Meaning	Unit	Explanation
60FDh	Digital inputs	-	Bit0: N-OT signal Bit1: P-OT signal Bit2: SPDD signal Bit3: Probe 1 signal Bit4: Probe 2 signal Bit5: Z-phase signal output Bit6~Bit15 reserved Bit16: Remote SI input 1 Bit17: Remote SI Input 2 Bit18: Remote SI input 3 Bit19: Remote SI input 4
60FEh:01	Physical outputs	-	Bit0~Bit15 reserved Bit16: Remote SO output 1 Bit17: Remote SO output 2 Bit18: Remote SO output 3
60Feh:02	Bit mask	-	When using, Bit16~Bit18 should correspond to position 1

For specific information on 60FDh, please refer to Chapter 7.10.4 Digital Input (60FDh)

For specific information on 60FEh, please refer to Chapter 7.10.5 Digital Output (60FEh)

7.10.9 Cascade alarm function

When this function is enabled, if the terminal signal is conductive, the driver will generate an alarm E-320.

The driver can be used in cascade, and by connecting the alarm output to this functional terminal of the next driver, a cascade alarm can be triggered.

New function parameter P5-68, default setting of P5-68 to 0:

Parameter	Meaning	Default value	Unit	Range	Modify	Effective
P5-68	Terminal emergency alarm function	0	-	00~ff	Anytime	At once

8 Object dictionary

This chapter mainly introduces the object dictionary area allocation, COE communication area, driver profile area and so on.

8.1 Object dictionary area assignment

All objects are configured in the object dictionary of each group through 4 digits 16-bit index configuration address.
The object dictionary of CoE (CANopen over EtherCAT) specified by CiA402 and the object dictionary of DL6 series are as follows:

Object dictionary specified by CiA402		DS5C2 series object dictionary	
Index	Content	Index	Content
0000h～0FFFh	Data type area	0000h～0FFFh	Data type area
1000h～1FFFh	COE communication area	1000h～1FFFh	COE communication area
2000h～5FFFh	Factory custom area	2000h～2FFFh	Servo parameter area
		3000h～3FFFh	Reserved
		4000h～4FFFh	Reserved
		5000h～5FFFh	Reserved
6000h～9FFFh	Profile area	6000h～6FFFh	Driver Profile area
		7000h～9FFFh	Reserved
A000h～FFFFh	Reserved	A000h～FFFFh	Reserved

8.2 COE communication area (0x1000-0x1FFF)

8.2.1 Object list

1) Device information object:

Index	Sub-index	Name
1000h	00h	Device type
1001h	00h	Error register
1008h	00h	Manufacturer device name
1009h	00h	Manufacturer hardware version
100Ah	00h	Manufacturer software version
1018h	-	Identity object
	00h	Number of entries
	01h	Vendor ID
	02h	Product code
	03h	Revision number

	04h	Serial number

2） RxPDO object mapping

Index	Sub-index	Name
1600h	-	Receive PDO mapping 1
	00h	Number of entries
	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped
1601h	-	Receive PDO mapping 2
	00h	Number of entries
	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped
1602h	-	Receive PDO mapping 3
	00h	Number of entries
	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped
1603h	-	Receive PDO mapping 4
	00h	Number of entries
	01h	1st receive PDO mapped
	02h	2nd receive PDO mapped
	03h	3rd receive PDO mapped
	04h	4th receive PDO mapped
	05h	5th receive PDO mapped
	…	…
	18h	24th receive PDO mapped

3）TxPDO object mapping:

Index	Sub-index	Name
1A00h	-	Transmit PDO mapping 1
	00h	Number of entries
	01h	1st transmit PDO mapped

Index	Sub-index	Name
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped
1A01h	-	Transmit PDO mapping 2
	00h	Number of entries
	01h	1st transmit PDO mapped
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped
1A02h	-	Transmit PDO mapping 3
	00h	Number of entries
	01h	1st transmit PDO mapped
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped
1A03h	-	Transmit PDO mapping 4
	00h	Number of entries
	01h	1st transmit PDO mapped
	02h	2nd transmit PDO mapped
	03h	3rd transmit PDO mapped
	04h	4th transmit PDO mapped
	05h	5th transmit PDO mapped
	…	…
	18h	24th transmit PDO mapped

4）PDO object distribution:

Index	Sub-Index	Name
1C12h	-	Sync manager channel 2
	00h	Number of assigned PDOs
	01h	Assigned RxPDO 1
	02h	Assigned RxPDO 2
	03h	Assigned RxPDO 3
	04h	Assigned RxPDO 4
Index	Sub-Index	Name
1C13h	-	Sync manager channel 3

	00h	Number of assigned PDOs
	01h	Assigned TxPDO 1
	02h	Assigned TxPDO 2
	03h	Assigned TxPDO 3
	04h	Assigned TxPDO 4

5) PDO synchronous management channel

Index	Sub-Index	Name
1C32h	-	Sync manager 2 synchronization
	00h	Number of sub-objects
	01h	Sync mode
	02h	Cycle time
	03h	Shift time
	04h	Sync modes supported
	05h	Minimum cycle time
	06h	Calc and copy time
	08h	Command (not support)
	09h	Delay time (not support)
	0Ah	Sync0 cycle time
	0Bh	Cycle time too small (not support)
	0Ch	SM-event missed (not support)
	0Dh	Shift time too short (not support)
	0Eh	RxPDO toggle failed (not support)
	20h	Sync error
1C33h	-	Sync manager 3 synchronization
	00h	Number of sub-objects
	01h	Sync mode
	02h	Cycle time
	03h	Shift time
	04h	Sync modes supported
	05h	Minimum cycle time
	06h	Calc and copy time
	08h	Command (not support)
	09h	Delay time (not support)
	0Ah	Sync0 cycle time
	0Bh	Cycle time too small (not support)
	0Ch	SM-event missed (not support)
	0Dh	Shift time too short (not support)
	0Eh	RxPDO toggle failed (not support)
	20h	Sync error

8.2.2 Device information

This section describes the equipment information.

<table>
<tr><th>Index</th><th>Sub-index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td rowspan="2">1000h</td><td rowspan="2">00h</td><td>Divece type</td><td>0~4294967295</td><td>U32</td><td>ro</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">Indicates the device type. In case of servo driver, the value is fixed to 04020192h.</td></tr>
<tr><td rowspan="2">1001h</td><td rowspan="2">00h</td><td>error register</td><td>0~65535</td><td>U16</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Displays the type (status) of alarm that is occurring in the servo drive.
When the alarm does not occur, it will display 0000H.
Do not display warnings.
<table>
<tr><th>Bit</th><th>Contents</th></tr>
<tr><td>0</td><td rowspan="4">Not support</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td>AL status code defined alarm occured*1</td></tr>
<tr><td>5</td><td>Not support</td></tr>
<tr><td>6</td><td>Reserved</td></tr>
<tr><td>7</td><td>AL status code undefined alarm occured*2</td></tr>
</table>
*1: “AL status code defined alarm” refers to abnormal communication association of EtherCAT E-800~7, E-810~7, E-850~7.
*2: “AL status code undefined alarm” refers to abnormal communication association of EtherCAT E-880~7 and abnormal except EtherCAT communication association.</td></tr>
<tr><td rowspan="2">1008h</td><td rowspan="2">00h</td><td>Manufacturer Device name</td><td>-</td><td>-</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Represents the device name.</td></tr>
<tr><td rowspan="2">1009h</td><td rowspan="2">00h</td><td>Manufacturer Hardware version</td><td>-</td><td>-</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Indicates the hardware version.</td></tr>
<tr><th>Index</th><th>Sub-index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td rowspan="10">1018h</td><td rowspan="2">00h</td><td>Number of entries</td><td>0~255</td><td>U8</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Represents the object subindexes. The value is fixed to 04H.</td></tr>
<tr><td rowspan="2">01h</td><td>vendor ID</td><td>0~4294967295</td><td>U32</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Indicates the manufacturer ID of EtherCAT. The value is fixed to 00000556h.</td></tr>
<tr><td rowspan="2">02h</td><td>product code</td><td>0~4294967295</td><td>U32</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Represents the product code. The value is 10305070h.</td></tr>
<tr><td rowspan="2">03h</td><td>Revision umber</td><td>0~4294967295</td><td>U32</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Indicates the product version number. The value is 02040608h.</td></tr>
<tr><td rowspan="2">04h</td><td>Divece type</td><td>0~4294967295</td><td>U32</td><td>ro</td><td>TxPDO</td><td>All</td></tr>
<tr><td colspan="6">Indicates the product serial number. The value is 00000000h.</td></tr>
</table>

8.2.3 Sync manager communication type(1C00h)

The action mode assigned to each SyncManager is set by 1C00h object.
The value is fixed for the servo driver.

Index	Sub-index	Name/Description	Range	DateType	Access	PDO	Op-mode
1C00h	00h	Number of used sync manager channels	0~255	U8	ro	TxPDO	All
		Represents the object subindexes. The value is fixed to 04H.					
	01h	Communication type sync manager 0	0~4	U8	ro	TxPDO	All
		Set the purpose of SYNC Manager 0. 0: unused 1: Mailbox receive message (master station→slave station) 2: Mailbox send message (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because SYNC Manager0 uses mailbox to receive messages, the value is fixed to 1.					
	02h	Communication type sync manager 1	0~4	U8	ro	TxPDO	All
		Set the purpose of SYNC Manager 1. 0: unused 1: Mailbox receive message (master station→slave station) 2: Mailbox send message (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because SYNC Manager1 uses mailbox to send messages, the value is fixed to 2.					
	03h	Communication type sync manager 2	0~4	U8	ro	TxPDO	All
		Set the purpose of SYNC Manager 2. 0: unused 1: Mailbox receive message (master station→slave station) 2: Mailbox send message (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because SYNC Manager2 uses Process data output (RxPDO), the value is fixed to 3.					
	04h	Communication type sync manager 3	0~4	U8	ro	TxPDO	All
		Set the purpose of SYNC Manager 3. 0: unused 1: Mailbox receive message (master station→slave station) 2: Mailbox send message (slave station→master station) 3: RxPDO (master station→slave station) 4: TxPDO (slave station→master station) Because SYNC Manager3 uses Process data output (RxPDO), the value is fixed to 4.					

8.2.4 PDO mapping

1. PDO distribution object (1C12h ~ 1C13h)

The table for PDO mapping allocated by the syncmanager is set by the objects 1C12h to 1C13h.

Index	Sub-index	Name/Description	Range	DateType	Access	PDO	Op-mode
1C12h	00h	Number of assigned PDOs	0~4	U8	rw	NO	All
		Represents the subindexes for this object.					
	01h	Assigned RxPDO 1	1600h~1603h	U16	rw	NO	All
		Specifies the RxPDO mapping object.					
	02h	Assigned RxPDO 2	1600h~1603h	U16	rw	NO	All
		Specifies the RxPDO mapping object.					
	03h	Assigned RxPDO 3	1600h~1603h	U16	rw	NO	All
		Specifies the RxPDO mapping object.					
	04h	Assigned RxPDO 4	1600~1603	U16	rw	NO	All
		Specifies the RxPDO mapping object.					
1C13h	00h	Number of assigned PDOs	0~4	U8	rw	NO	All
		Represents the object subindexes. The value is fixed to 04H.					
	01h	Assigned TxPDO 1	1A00h~1A03h	U16	rw	NO	All
		Specifies the TxPDO mapping object.					
	02h	Assigned TxPDO 2	1A00h~1A03h	U16	rw	NO	All
		Specifies the TxPDO mapping object.					
	03h	Assigned TxPDO 3	1A00h~1A03h	U16	rw	NO	All
		Specifies the TxPDO mapping object.					
	04h	Assigned TxPDO 4	1A00h~1A03h	U16	rw	NO	All
		Specifies the TxPDO mapping object.					

Sub-index 01h-04h of 1C12h and 1C13h can only be changed when the ESM state is PreOP and sub-index 00h = 0. Other status will return port code (06010003h).

After the settings changed, set the Sub-index number of Sub-index 00h. PDO allocation object settings are reflected by changing ESM status to SafeOP.

2.PDO mapping object (1600h~1603h, 1A00h~1A03h)

As a table for PDO mapping objects, 1600h-1603h for RxPDO and 1A00h-1A03h for TxPDO can be used. After subindex 01h, it represents the information of the mapped application layer object.

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td rowspan="6">1600h</td><td rowspan="2">00h</td><td>Number of entries</td><td>0~4294967295</td><td>U8</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">Represents the subindexes for this object.</td></tr>
<tr><td rowspan="2">01h</td><td>1st receive PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">Set the first mapping object.<table><tr><th>bit</th><th>31 …16</th><th>15 ….8</th><th>7 ….0</th></tr><tr><td></td><td>Index number</td><td>Sub-index number</td><td>Bit length</td></tr></table></td></tr>
<tr><td rowspan="2">02h</td><td>2nd receive PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The setting method is same to Subindex01h.</td></tr>
</table>

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
	03h	3rd receive PDO mapped	0~4294967295	U32	rw	NO	All
		The setting method is same to Subindex01h.					
	04h	4th receive PDO mapped	0~4294967295	U32	rw	NO	All
		The setting method is same to Subindex01h.					
	05h	5th receive PDO mapped	0~4294967295	U32	rw	NO	All
		The setting method is same to Subindex01h.					
	06h	6th receive PDO mapped	0~4294967295	U32	rw	NO	All
		The setting method is same to Subindex01h.					
	…	…					
	16h	16th receive PDO mapped	0~4294967295	U32	rw	NO	All
		The setting method is same to Sub-index01h.					
1601h	-	Receive PDO mapping 2, Sub-index specification is same to 1600h.					
1602h	-	Receive PDO mapping 3, Sub-index specification is same to 1600h.					
1603h	-	Receive PDO mapping 4, Sub-index specification is same to 1600h.					

Do not map duplicate objects. The change of repeated setting is not guaranteed.

Sub-index 01h-18h of 1600h-1603h can only be changed when the ESM state is PreOP and Sub-index 00h = 0. Other status will return Abort Code (06010003h).

After the settings changed, set the Sub-index number of Sub-index 00h. PDO allocation object settings are reflected by changing ESM status to SafeOP.

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name/Description</th><th>Range</th><th>DateType</th><th>Access</th><th>PDO</th><th>Op-mode</th></tr>
<tr><td rowspan="19">1A00h</td><td rowspan="2">00h</td><td>Number of entries</td><td>0~4294967295</td><td>U8</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">Represents the subindexes for this object.</td></tr>
<tr><td rowspan="2">01h</td><td>1st transmit PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">Set the first mapping object.<table><tr><th>bit</th><th>31 …16</th><th>15 ….8</th><th>7 … 0</th></tr><tr><td></td><td>Index number</td><td>Sub-index number</td><td>Bit length</td></tr></table></td></tr>
<tr><td rowspan="2">02h</td><td>2nd transmit PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The setting method is same to Subindex01h.</td></tr>
<tr><td rowspan="2">03h</td><td>3rd transmit PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The setting method is same to Subindex01h.</td></tr>
<tr><td rowspan="2">04h</td><td>4th transmit PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The setting method is same to Subindex01h.</td></tr>
<tr><td rowspan="2">05h</td><td>5th transmit PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The setting method is same to Subindex01h.</td></tr>
<tr><td rowspan="2">06h</td><td>6th transmit PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The setting method is same to Subindex01h.</td></tr>
<tr><td>…</td><td colspan="6">…</td></tr>
<tr><td rowspan="2">16h</td><td>16th transmit PDO mapped</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>All</td></tr>
<tr><td colspan="6">The setting method is same to Subindex01h.</td></tr>
<tr><td>1A01h</td><td>-</td><td colspan="6">Transmit PDO mapping 2, Subindex specification is same to 1600h.</td></tr>
<tr><td>1A02h</td><td>-</td><td colspan="6">Transmit PDO mapping 3, Subindex specification is same to 1600h.</td></tr>
</table>

1A03h	-	Transmit PDO mapping 4, Subindex specification is same to 1600h.

Do not map duplicate objects. The change of repeated setting is not guaranteed.

Subindex 01h-18h of 1A00h-1A03h can only be changed when the ESM state is PreOP and Subindex00h = 0. Other status will return Abort Code (06010003h).

After the settings changed, set the Subindex number of Subindex00h. PDO allocation object settings are reflected by changing ESM status to SafeOP.

8.2.5 Sync manager 2/3 synchronization (1C32h, 1C33h)

Sync manager2 setting is executed according to 1C32h (Sync maneger 2 synchronization).

Sync manager3 setting is executed according to 1C33h (Sync maneger 3 synchronization).

Sync manager 2 synchronization(1C32h)

Index	Sub-Index	Name / Description	Range	DateType	Access	PDO	Op-mode
1C32	00h	Number of entries	0~20h	U8	ro	NO	All
		Represents the number of subindexes for this object. The value is fixed at 20h.					
	01h	Sync mode	0-65535	U16	rw	NO	All
		Set Sync Manager 2 synchronization mode. 00h:FreeRun(not synchronized) 01h:SM2(synchronized with SM 2 Event) 02h:DC SYNC0(synchronized with Sync0 Event)					
	02h	Cycle time	0~4294967295	U32	rw	NO	All
		Set Sync Manager period. Set one of 1000000 (1ms), 2000000 (2ms), 4000000 (4ms), 8000000 (8ms), 10000000 (10ms). If set other value, it will show E-810 (Abnormal protection of synchronization cycle setting).					
	03h	Shift time	0~4294967295	U32	rw	NO	All
		Offset time.					
	04h	Sync modes supported	0~65535	U16	ro	NO	All
		Set the supported synchronization type. BIT0:FreeRun mode supported 0:not supported；1:FreeRun mode supported This servo driver is set to 1. BIT1:SM synchronization mode supported 0:not supported；1:SM2 event synchronization supported This servo driver is set to 1. BIT4-2:DC synchronization mode supported 000b:not supported 001b:DC sync0 event supported This servo driver is set to 001b. BIT6-5: output offset supported 00b:not supported 01b:local clock offset supported This servo driver is set to 00b. BIT15-7:Reserved					
1C32	05h	Minimum cycle time	0~4294967295	U32	ro	NO	All

Index	Sub-Index	Name / Description	Range	DateType	Access	PDO	Op-mode
		The minimum value of the communication cycle that can be set.					
	06h	Calc and copy time	0~4294967295	U32	ro	NO	All
		From SM2 event, SYNC0 event to ESC read completion time. This time can also be extended when there is a deviation in the signal.					
	08h	Command	0~65535	U16	ro	NO	All
		Not support					
	09h	Delay time	0~4294967295	U32	ro	NO	All
		Not support					
	0Ah	Sync0 cycle time	0~4294967295	U16	ro	NO	All
		When DC SYNC0 (1C32h-01h=02h), ESC register 09A0h value is set. Except DC SYNC0, please set to 0.					
	0Bh	Cycle time too small	0~65535	U16	ro	NO	All
		Not support					
	0Ch	SM-event missed	0~65535	U16	ro	NO	All
		Not support					
	0Dh	Shift time too short	0~65535	U16	ro	NO	All
		Not support					
	0Eh	RxPDO toggle failed	0~65535	U16	rw	NO	All
		Not support					
	20h	Sync error	0~1	BOOL	ro	NO	All
		Sync error					

This setting value is a reference value, not a guaranteed value.

Sync manager 3 synchronization (1C33h)

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
1C33h	00h	Number of entries	0~20h	U8	ro	NO	All
		Represents the subindexes for this object. The value is fixed at 20h.					
	01h	Sync mode	0~65535	U16	rw	NO	All
		Set Sync Manager 3 synchronization mode. 00h:FreeRun (not synchronized) 01h:SM2 (synchronized with SM 2 Event) 02h:DC SYNC0 (synchronized with Sync0 Event)					
	02h	Cycle time	0~4294967295	U32	rw	NO	All
		Set Sync Manager period. Set one of the 1000000(1ms), 2000000(2ms), 4000000(4ms), 8000000(8ms), 10000000(10ms). If set other value, it will show E-810 (Abnormal protection of synchronization cycle setting).					
	03h	Shift time	0~4294967295	U32	rw	NO	All
		Offset time					
	04h	Sync modes supported	0~65535	U16	ro	NO	All
		Set the supported synchronization type. BIT0: FreeRun mode supported 0:not supported; 1:FreeRun mode supported This servo driver is set to 1.					

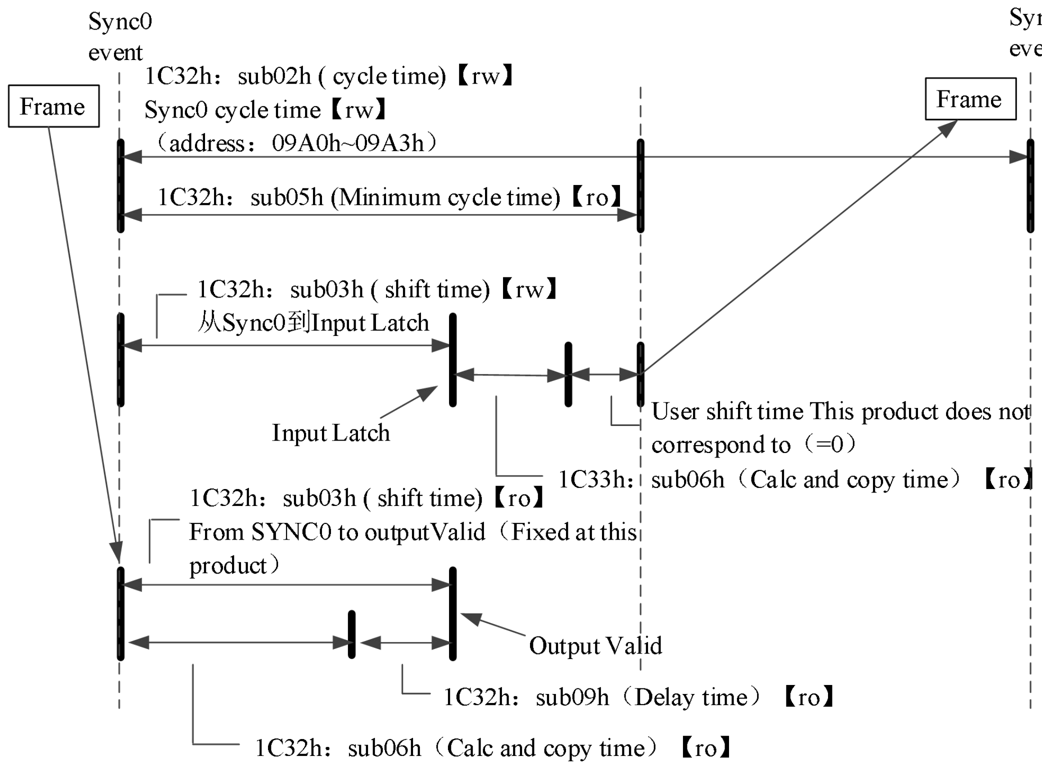
Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
		BIT1:SM synchronization mode supported 0:not supported; 1:SM2 event synchronization supported This servo driver is set to 1. BIT4-2:DC synchronization mode supported 000b:not supported 001b:DC sync0 event supported This servo driver is set to 001b. BIT6-5:output offset supported 00b:not supported 01b:local clock offset supported This servo driver is set to 00b. BIT15-7:Reserved					
1C33h	05h	Minimum cycle time	0~4294967295	U32	ro	NO	All
		The minimum value of the communication cycle that can be set.					
	06h	Calc and copy time	0~4294967295	U32	ro	NO	All
		From SM2 event, SYNC0 event to ESC read completion time. This time can also be extended when there is a deviation in the signal.					
	08h	Command	0~65535	U16	ro	NO	All
		Not support					
	09h	Delay time	0~4294967295	U32	ro	NO	All
		Not support					
	0Ah	Sync0 cycle time	0~4294967295	U16	ro	NO	All
		The same value to 1C32h-0Ah.					
	0Bh	Cycle time too small	0~65535	U16	ro	NO	All
		Not support					
	0Ch	SM-event missed	0~65535	U16	ro	NO	All
		Not support					
	0Dh	Shift time too short	0~65535	U16	ro	NO	All
		Not support					
	0Eh	RxPDO toggle failed	0~65535	U16	rw	NO	All
		Not support					
	20h	Sync error	0~1	BOOL	ro	NO	All
		Sync error					

This setting value is a reference value, not a guaranteed value.

1)DC (SYNC0 event synchronization)

Synchronization method	Features
Based on the time of the first axis synchronize time information of other slave stations	High-precision Compensation treatment shall be carried out at the main station side

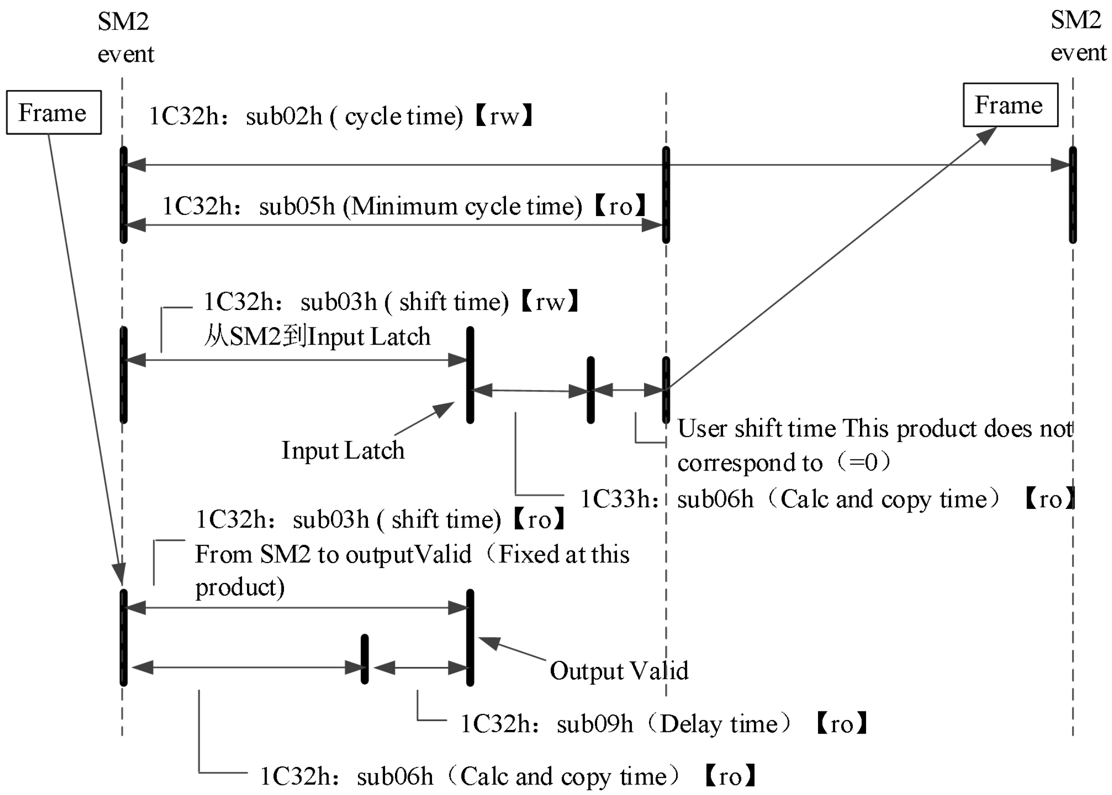
The specification of DC synchronous mode in this servo driver is as follows:



2)SM2 (SM2 event synchronization)

Synchronization method	Features
Synchronize with RxPDO receiving time	No transmission delay compensation accuracy difference Ensure the transmission time at the upper device side (special hardware, etc.)

The specification of SM2 synchronous mode in this servo driver is as follows:


SM2
event
SM2
event
Frame
Frame
1C32h：sub02h (cycle time)【rw】
1C32h：sub05h (Minimum cycle time)【ro】
1C32h：sub03h (shift time)【rw】
从SM2到Input Latch
Input Latch
User shift time This product does not correspond to（=0）
1C33h：sub06h（Calc and copy time）【ro】
1C32h：sub03h (shift time)【ro】
From SM2 to outputValid（Fixed at this product)
Output Valid
1C32h：sub09h（Delay time）【ro】
1C32h：sub06h（Calc and copy time）【ro】

8.3 Servo parameter area (0x2000~0x2FFF)

8.3.1 Object list

The object of 2000h – 5FFFh is distributed servo parameters. (servo parameter please refer to appendix of this manual).

Index	Sub-index	Name
2000h	00h	P0-00
2001h	00h	P0-01
2002h	00h	P0-02
2003h	00h	P0-03
...	...	...
205Fh	00h	P0-95
2100h	00h	P1-00
2101h	00h	P1-01
2102h	00h	P1-02
2103h	00h	P1-03
...	...	...
214Ah	00h	P1-74
2200h	00h	P2-00
2201h	00h	P2-01
2202h	00h	P2-02
2203h	00h	P2-03
...	...	...
2263h	00h	P2-99
2300h	00h	P3-00
2301h	00h	P3-01
2302h	00h	P3-02
2303h	00h	P3-03
...	...	...
232Eh	00h	P3-46

Index	Sub-index	Name
2500h	00h	P5-00
2501h	00h	P5-01
2502h	00h	P5-02
2503h	00h	P5-03
...	...	...
2547h	00h	P5-71
2700h	00h	P7-00
2701h	00h	P7-01
2702h	00h	P7-02
2703h	00h	P7-03
...	...	...
2715h	00h	P7-21
2800h	00h	P8-00
2801h	00h	P8-01
2802h	00h	P8-02
2803h	00h	P8-03
...	...	...
281Ah	00h	P8-26

Index	Sub-index	Name
3000h	00h	U0-00
3001h	00h	U0-01
3002h	00h	U0-02
...	...	...
3061h	00h	U0-97

Index	Sub-index	Name
3100h	00h	U1-00
3101h	00h	U1-01
...	...	...

Index	Sub-index	Name
4000h	00h	F0-00
...	...	...
4106h	00h	F1-06

Index	Sub-index	Name	Unit	Data range	Data type	Flag	PDO
5000h	00h	Encode Single Position	-	-2147483648 ~ 2147483647	I32	ro	TxPDO
5001h	00h	Encode MultRevolutions	-	-2147483648~ 2147483647	I32	ro	TxPDO
5002h	00h	ModeSwitch Deceleration time	-	0~65535	U16	rw	RxPDO

8.3.2 Object overview

For example:
P1-04, EtherCAT distributes to 2104h.
P3-10, EtherCAT distributes to 230Ah.
12-15bit : 2 represents servo parameter area
8-11 bit : 0-F represents group P number
0-7 bit : 00-FF represents parameters in group P

8.4 Driver Profile area(0x6000~0x6FFF)

8.4.1 Object list

Index	Sub-index	Name
603Fh	00h	Abort connection option code
6040h	00h	Control word
6041h	00h	Status word
605Ah	00h	Quick stop option code
605Bh	00h	Shutdown option code
605Bh	00h	Disable operation option code
605Bh	00h	Halt option code
605Eh	00h	Fault reaction option code
6060h	00h	Modes of operation
6061h	00h	Modes of operation display
6062h	00h	Position demand value
6063h	00h	Position actual internal value
6064h	00h	Position actual value
6065h	00h	Following error window
6066h	00h	Following error time out
6067h	00h	Position window
6068h	00h	Position window time
6069h	00h	Velocity sensor actual value

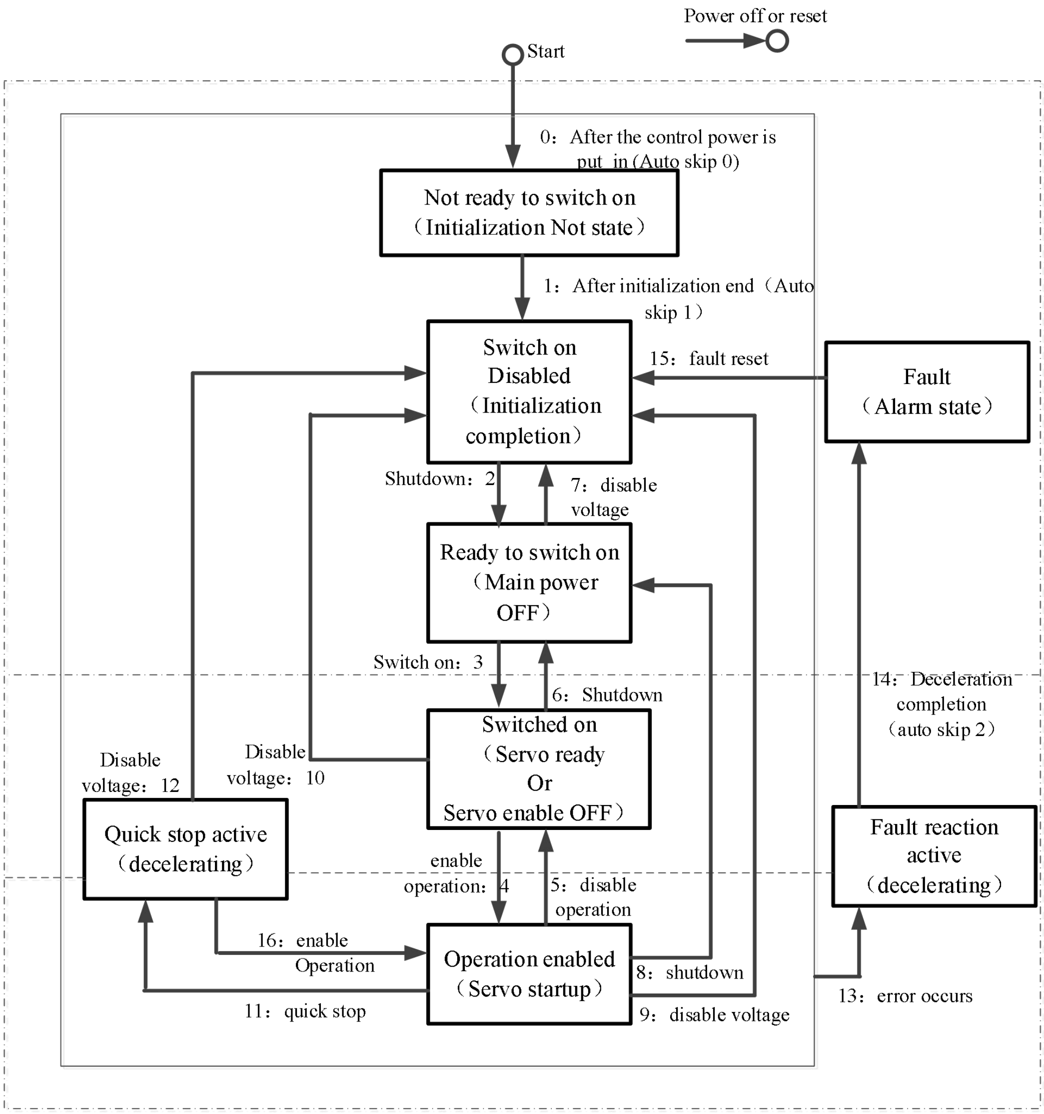
Index	Sub-index	Name
606Bh	00h	Velocity demand value
606Ch	00h	Velocity actual value
606Dh	00h	Velocity window
606Eh	00h	Velocity window time
606Fh	00h	Velocity threshold
6070h	00h	Velocity threshold time
6071h	00h	Target torque
6072h	00h	Max torque
6073h	00h	Max current
6074h	00h	Torque demand
6075h	00h	Motor rated current
6076h	00h	Motor rated torque
6077h	00h	Torque actual value
6078h	00h	Current actual value
6079h	00h	DC link circuit voltage
607Ah	00h	Target position
607Bh	-	Position rang limit
	00h	Number of entries
	01h	Min position range limit
	02h	Max position range limit
607Ch	00h	Home offset
607Dh	-	Software position limit
	00h	Number of entries
	01h	Min position limit
	02h	Max position limit
606Eh	00h	Polarity
607Fh	00h	Max Profile velocity
6080h	00h	Max motor speed
6081h	00h	Profile velocity
6082h	00h	End velocity
6083h	00h	Profile acceleration
6084h	00h	Profile deceleration
6085h	00h	Quick stop deceleration
6086h	00h	Motion profile type
6087h	00h	Torque slope
6088h	00h	Torque profile type
608Fh	-	Position encoder resolution
	00h	Number of entries
	01h	Encoder increments
	02h	Motor revolutions
6091h	-	Gear ratio
	00h	Number of entries
	01h	Motor revolutions
	02h	Shaft revolutions

Index	Sub-index	Name
6092h	-	Feed constant
	00h	Number of entries
	01h	Feed
	02h	Shaft revolutions
6098h	00h	Homing method
6099h	-	Homing speeds
	00h	Number of entries
	01h	Speed during search for switch
	02h	Speed during search for zero
609Ah	00h	Homing acceleration
60A3h	00h	Profile jerk use
60A4h	-	Profile jerk
	00h	Number of entries
	01h	Profile jerk1
	02h	Profile jerk2
60B0h	00h	Position offset
60B1h	00h	Velocity offset
60B2h	00h	Torque offset
60B8h	00h	Touch probe function
60B9h	00h	Touch probe status
60BAh	00h	Touch probe pos1 pos value
60BBh	00h	Touch probe pos1 neg value
60BCh	00h	Touch probe pos2 pos value
60BDh	00h	Touch probe pos2 neg value
60C2h	-	Interpolation time period
	00h	Number of entries
	01h	Interpolation time period value
	02h	Interpolation time index
60C5h	00h	Max acceleration
60C6h	00h	Max deceleration
60E3h	-	Supported Homing method
	00h	Number of entries
	01h	1st supported Homing method
	..	..
	20h	32nd supported Homing method
60F2h	00h	Positioning option code
60F4h	00h	Following error actual value
60FAh	00h	Control effort
60FCh	00h	Position demand internal value
60FDh	00h	Digital inputs
60FEh	-	Digital outputs
	00h	Number of entries
	01h	Physical outputs
	02	Bit mask

Index	Sub-index	Name
60FEh	00h	Target velocity
6502h	00h	Supported drive modes

8.4.2 PDS(Power Drive Systems)specification

According to the user command or abnormal detection, the state transition of the PDS associated with the power control of the servo driver is defined as follows.



After migrating to Operation enabled, please increase the time to more than 100ms and input the action command. The following table shows the PDS state migration events (migration conditions) and actions during migration. For the migration of PDS, the status migration is performed at the same time as the handshake is obtained (through 6041h: Statusword, confirm the status has been converted, and then send the next migration instruction).

PDS conversion		Event	Action
0	Auto skip 0	After the power supply is put into operation, or after the application layer is reset, it will automatically migrate.	After the power supply is put into operation, or after the application layer is reset, it will

			automatically migrate.
1	Auto skip 1	Automatic conversion after initialization.	Communications are established.
2	Shut down	The condition of receiving the Shutdown instruction.	Nothing special
3	Switch on	When the power supply is on, the condition of receiving the Switch on command.	Nothing special
4	Enable operation	The condition of receiving the Enable operation instruction.	The driver function is effective. In addition, all previous Set point data are cleared.
5	Disable operation	The condition of receiving the Disable operation instruction.	Invalid driver function.
6	Shutdown	When the power supply is on, the condition of receiving Shutdown command. Check out the condition of the power supply is off.	Nothing special
7	Disable voltage	the condition of receiving Disable voltage instruction. the condition of receiving Quick stop instruction. When ESM status is PreOP, SafeOP, OP, the condition of migrating to Init.	Nothing special
8	Shutdown	When the power supply is on, the condition of receiving the Shutdown instruction.	Driver function is invalid
9	Disable voltage	The condition of receiving the Disable voltage command.	Driver function is invalid
10	Disable voltage	The condition of receiving the Disable voltage command. The condition of receiving the Quick stop command. When ESM status is PreOP, SafeOP, OP, the condition of migrating to Init.	Nothing special
11	Quick stop	The condition of receiving Quick stop command.	Execute Quick stop function.
12	Disable voltage	When Quick stop selected code is 1, 2, 3 and the condition of Quick stop action completion. When Quick stop code is 5, 6, 7, and the action of Quick stop is completed, the condition of receiving Disable voltage command. Check out the condition of power OFF.	Driver function is invalid.
13	Error occurs	Abnormal detection.	Execute Fault reaction function.
14	Auto skip 2	After the abnormal detection and deceleration processing is completed, it will be migrated automatically.	Driver function is invalid.
15	Fault reset	After the removal of abnormal factors, the condition of receiving the Fault reset instruction.	The fault factor does not exist, Excute the reset of the Fault state.
16	Enable operation	When Quick stop selected code is 5, 6, 7, the condition of receiving Enable operation command.	Driver function is effective.

8.4.3 Controlword (6040h)

The command to control the slave station (servo driver) such as PDS status migration is set through 6040h (control word).

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	All

Set the servo driver control command for PDS status conversion.

Bit information

15	14	13	12	11	10	9	8
R						oms	h
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
fr	R			eo	qs	ev	so

r = reserved(not corresponded)　　fr = fault reset

oms = operation mode specific　　eo = enable operation

(control mode is based on bit)　　qs = quick stop

h = halt　　ev = enable voltage

so = switch on

Command	bits of the controlword					PDS conversion
	bit7	bit3	bit2	bit1	bit0	
	Fault reset	Enable operation	quick stop	Enable voltage	Switch on	
Shutdown	0	-	1	1	0	2,6,8
Switch on	0	0	1	1	1	3
Switch on + Enable operation	0	1	1	1	1	3+4
Enable operation	0	1	1	1	1	4,16
Disable voltage	0	-	-	0	-	7,9,10,12
Quick stop	0	-	0	1	-	7,10,11
Disable operation	0	0	1	1	1	5
Fault reset	0->1	-	-	-	-	13

① Bit logic of quick stop command is effective under 0.
Please note that other bit logic and the opposite actions are performed.
② Bit8 (halt): When it is 1, motor decelerating and stop are performed through 605Dh (Halt select code)
After the pause, the enable must be turned off to restart the action.
③ Bit9, 6-4 (operation mode specific):
The following shows the change of OMS bit inherent in the control mode (OP mode). (for details, please refer to the chapter of related objects of each control mode.)

Op-mode	Bit9	Bit6	Bit5	Bit4
pp	change on set-point	absolute / relative	change set immediately	new set-point
pv	-	-	-	-
tq	-	-	-	-
hm	-	-	-	start homing

csp	-	-	-	-
csv	-	-	-	-
cst	-	-	-	-

8.4.4 Statusword (6041h)

The status confirmation of slave station (servo driver) is carried out by 6041h (status word).

Index	Sub-index	Name	Range	Data type	Access	PDO	Op-mode
6041h	00h	Status word	0~65535	U16	ro	TxPDO	All

Indicates the status of the servo driver.

Bit information

15	14	13	12	11	10	9	8
r		oms		ila	oms	rm	r
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
w	sod	qs	ve	f	oe	so	rsto

r = reserved (not corresponded) w = warning

sod = switch on disabled

oms = operation mode specific qs = quick stop

(control mode is based on bit) ve = voltage enabled

ila = internal limit active f = fault

oe = operation enabled

rm = remote so = switched on

rtso = ready to switch on

Bit6,5,3-0 (switch on disabled/quick stop/fault/operation enabled/switched on/ready to switch on): confirm the PDS status based on this bit. The following is the relationship between status and related bit.

StatusWord	PDS State	
xxxx xxxx x0xx 0000 b	Not ready to switch on	Initialize incompleted state
xxxx xxxx x1xx 0000 b	Switch on disabled	Initialize completed state
xxxx xxxx x01x 0001 b	Ready to switch on	Initialize completed state
xxxx xxxx x01x 0011 b	Switched on	Servo enable OFF/servo ready
xxxx xxxx x01x 0111 b	Operation enabled	Servo enable ON
xxxx xxxx x00x 0111 b	Quick stop active	Stop at once
xxxx xxxx x0xx 1111 b	Fault reaction active	Abnormal (alarm) judgment
xxxx xxxx x0xx 1000 b	Fault	Abnormal (alarm) state

Bit4 (voltage enabled) = 1: power supply is ON PDS.

Bit5 (quick stop) = 0: PDS receives quick stop request. The bit logic of quick stop is effective under 0. Please note that other bit logic and the opposite actions are performed.

Bit7 (warning) = 1, warning occurs. When warning, PDS status will not change and motor will continue to operate.

Bit9 (remote) = 0(local), the status that 6040(Controlword) cannot operate.

Bit9 =1(remote), the status that 6040(Controlword) can operate. The ESM state changes to 1 when the state transforms above PreOP.

Below bit13,12,10 (operation mode specific): change of OMS bit inherent in control mode. (for details, please refer to the chapter of related objects of each control mode.)

Op-mode	Bit13	Bit12	Bit10
pp	following error	set-point acknowledge	target reached
pv	-	speed	target reached
tq	-	-	target reached
hm	homing error	homing attained	target reached
csp	following error	drive follows command value	-
csv	-	drive follows command value	-
cst	-	drive follows command value	-

Bit11(internal limit active): the main reason for the internal limit is that the bit11 (internal limit active) of 6041h (status word) changes to 1.
Bit15,14(reserved): This bit is not used (fixed 0).

8.5 Control mode setting

8.5.1 Supported drive modes (6502h)

This servo driver can confirm the supported modes of operation according to 6502h (supported drive modes).

Index	Sub-index	Name / Description	Range	Data type	Access	PDO	Op-mode
6502h	00h	Supported drive modes	0~4294967295	U32	ro	TxPDO	All

supported control mode (Mode of operation).

When the value is 1, it represents the supported mode in this mode.

Bit information

<table>
<tr><td colspan="3">31…16</td><td colspan="3">15…10</td><td>9</td><td>8</td></tr>
<tr><td colspan="3">r</td><td colspan="3">r</td><td>cst</td><td>csv</td></tr>
<tr><td colspan="3">0</td><td colspan="3">0</td><td>1</td><td>1</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>csp</td><td>r</td><td>hm</td><td>r</td><td>tq</td><td>pv</td><td>r</td><td>pp</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr>
</table>

Bit	Mode of operation	Abbr.	Corresponding
0	Profile position mode (Profile position control mode)	pp	YES
2	Profile velocity mode(Profile speed control mode)	pv	YES
3	Torque profile mode(Profile torque control mode)	tq	YES
5	Homing mode(origin reset position mode)	hm	YES
7	Cyclic synchronous position mode(Cyclic position control mode)	csp	YES
8	Cyclic synchronous velocity mode(Cyclic speed control mode)	csv	YES
9	Cyclic synchronous torque mode (Cyclic torque control mode)	cst	YES

8.5.2 Modes of operation(6060h)

Set the control mode through 6060h (Modes of operation).

Index	Sub-index	Name/Description	Range	DateType	Access	PDO	Op-mode
6060h	00h	Mode of operation	-128~127	I8	rw	RxPDO	All

Set the control mode of servo driver.

Non corresponding control mode setting is inhibited.

bit	Mode of operation	Abbr.	Corresponding
-128~ -1	Reserved	-	-
0	No mode changed/No mode assigned (no control mode changed/no control mode distribution)	-	-

		1	Profile position mode (Profile position control mode)	pp	YES
		3	Profile velocity mode (Profile speed control mode)	pv	YES
		4	Torque profile mode (Profile torque control mode)	tq	YES
		6	Homing mode (origin reset position mode)	hm	YES
		8	Cyclic synchronous position mode (Cyclic position control mode)	csp	YES
		9	Cyclic synchronous velocity mode (Cyclic speed control mode)	csv	YES
		10	Cyclic synchronous torque mode(Cyclic torque control mode)	cst	YES
		11~127	Reserved	-	-

Because 6060h (modes of operation) is default = (no mode change / no mode assigned), please set the control mode value to be used after the power is put into operation. When the set value of 6060h is 0 and the set value of 6061h is 0, if the PDS state is migrated to Operation enabled, E-881 (control mode setting fault protection) occurs. After the initial state of 6060h = 0 (no mode assigned) is transferred to the supported control mode (PP, PV, TQ, HM, CSP, CSV, CST), set 6060h = 0 is seemed as "no mode changed", and the control mode can not be switched. (keep the previous control mode).

8.5.3 Modes of operation display(6061h)

The confirmation of the control mode inside the servo driver is performed according to 6061h (modes of operation display). After 6060h (modes of operation) is set, please confirm whether it is feasible to set this object action through detection.

Index	Sub-index	Name/Description	Range	DateType	Access	PDO	Op-mode
6061h	00h	Mode of operation display	-128~127	I8	ro	TxPDO	All
		The current control mode.					

bit	Mode of operation	Abbr.	Corresponding
-128~ -1	Reserved	-	-
0	No mode changed/No mode assigned (no control mode changed/no control mode distribution)	-	-
1	Profile position mode (Profile position control mode)	pp	YES
3	Profile velocity mode (Profile speed control mode)	pv	YES
4	Torque profile mode (Profile torque control mode)	tq	YES
6	Homing mode (origin reset position mode)	hm	YES
8	Cyclic synchronous position mode (Cyclic position control mode)	csp	YES
9	Cyclic synchronous velocity mode (Cyclic speed control mode)	csv	YES
10	Cyclic synchronous torque mode (Cyclic torque control mode)	cst	YES

		11~127	Reserved	-	-

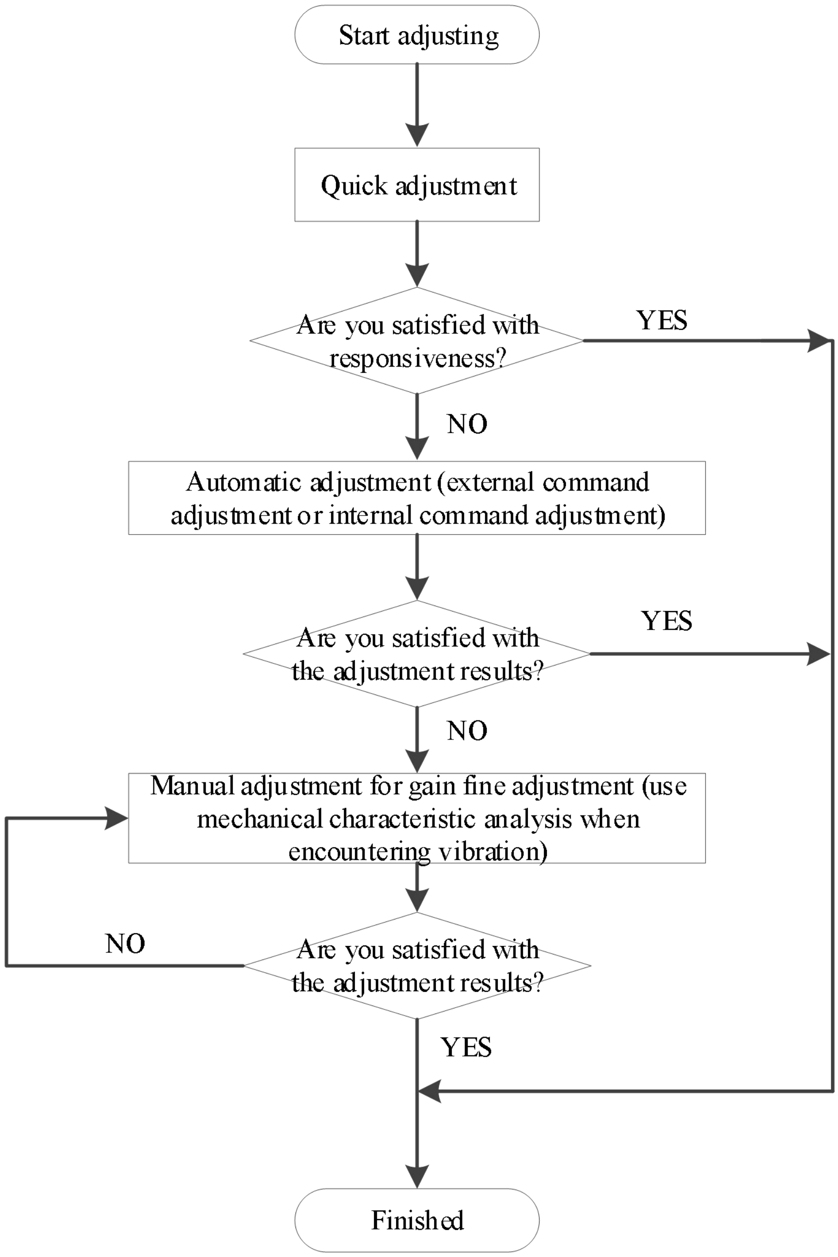
9 Servo gain adjustment

9.1 Overview of servo gain adjustment

9.1.1 Overview and process

Linear servo drives require high precision and high response to drive linear motors, in order to track instructions from the upper computer or internal settings. To meet this requirement, it is necessary to adjust the servo gain reasonably. Due to the special nature of linear motors, motor settings must be made before adjusting the gain, otherwise the linear motor cannot be controlled normally. The motor setting steps are detailed in Appendix 4 Motor Settings.

Servo gain factory value is adaptive mode, but different machines have different requirements for servo responsiveness; the following figure is the basic process of gain adjustment, please adjust according to the current machine status and operation conditions.



9.1.2 Differences between these adjustment modes

Adjustment modes are divided into adaptive and auto-tuning, and their control algorithms and parameters are independent. Among them, the auto-tuning mode is divided into three functions: fast adjustment, automatic adjustment and manual adjustment. The three functions are the same in essence but different in implementation. Refer to the corresponding chapters of each function.

Mode	Type	Parameters	Rigidity	Responsiveness	Related parameters
Adaptive	Automatic adaptation	P2-01.0=1	Middle	150ms	P2-05 adaptive speed loop gain P2-10 adaptive speed loop integral P2-11 adaptive position loop gain P2-07 adaptive inertia ratio P2-08 adaptive speed observer gain P2-12 adaptive stable max inertia ratio

<table>
<tr><td rowspan="3">Auto-tuning</td><td>Fast adjustment</td><td rowspan="3">P2-01.0=0</td><td>High</td><td>10 ~50ms</td><td rowspan="3">P0-07 First inertia ratio
P1-00 Speed loop gain
P1-01 Speed loop integral
P1-02 Position loop gain
P2-35 Torque instruction filtering time constant 1
P2-49 Model loop gain</td></tr>
<tr><td>Automatic adjustment</td><td>High</td><td>10ms</td></tr>
<tr><td>Manual adjusting</td><td>High</td><td>Determined by parameters</td></tr>
</table>

9.2 Rotary inertia presumption

9.2.1 Overview

Rotational inertia estimation is the function of automatic operation (forward and reverse) in the driver and estimate the load inertia in operation.

Rotational inertia ratio (the ratio of load inertia to motor rotor inertia) is a benchmark parameter for gain adjustment, and it must be set to the correct value as far as possible.

Parameter	Meaning	Default setting	Unit	Setting range	Modification	Effective
P0-07	First inertia ratio	500	%	0～50000	anytime	At once

9.2.2 Notes

Occasions where inertia cannot be presumed

- Mechanical systems can only operate in one direction

The occasion where inertia presumption is easy to fail

- Excessive load moment of inertia
- The running range is narrow and the travel is within one polar distance.
- The moment of inertia varies greatly during operation.
- Mechanical rigidity is low and vibration occurs when inertia is presumed.

Notes of inertia presumption

- Since both directions are rotatable within the set range of movement, please confirm the range or direction of movement; and ensure that the load runs in a safe journey.
- If the presumed inertia under default parameters runs jitter, indicating that the present load inertia is too large. It is also possible to set the initial inertia to about twice the current one and execute again under larger loads.
- Driver inertia ratio recognition upper limit is 500 times (parameter upper limit is 20000). If the estimated inertia ratio is exactly 20000, it means that the inertia ratio has reached the upper limit and can not be used, please replace the motor with larger rotor inertia.

Other notes

- At present, the inertia switching function is not supported, and the second inertia ratio is invalid.
- The inertia ratio upper limit changes to 500 times (parameter upper limit value is 50000).

9.2.3 Operation tool

The presumptive tools of load moment of inertia are driver panel and XinjeServo software.

Operation tool	Description
Driver panel	Driver firmware needs version 4600
XinjeServo software	Linear drive upper computer software

Note: driver firmware version can be checked through U2-07.

9.2.4 Operation steps

Estimate the inertia through the driver panel

1. Parameter setting

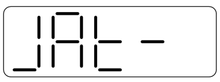
Parameter	Setting	Default setting	Unit	Range	Modification	Effective
P2-15	Inertia configured trip	100	0.01 polar distance (N-N)	1～300	Anytime	At once
P2-17	Inertia identification and internal instruction auto-tuning max speed	0	mm/s	0～65535	Anytime	At once
P2-18	Inertia identification initial inertia ratio	500	%	1～20000	Anytime	At once

The recommended parameters of P2-17 are 500mm/s or more. Low instruction speed will lead to inaccurate identification of inertia ratio. The default is 1/3 of the rated speed, this parameter will be calculated based on the rated speed in the motor parameters.

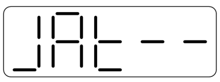
2. Execute the inertia identification

Before inertia identification, please confirm the direction of servo rotation by using F1-00 jog motion function. Initial direction of servo operation is determined by INC or DEC at the beginning of inertia identification.

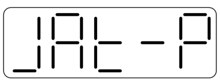
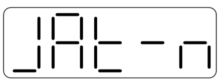
Servo entering parameter F0-07 in BB state:



Press ENTER, servo is enabled:



Press INC or DEC to run forward or reverse (select one of them):

 or 

At this point, start action, under the condition of P0-05 = 0 (initial positive direction), if press INC, then turn forward and then reverse; if press DEC, turn reverse and then forward. If the inertia identification is successful, the load inertia ratio is prompted and written to P0-07 automatically after several forward and reverse operations. If the inertia identification error occurs, the error code will be displayed. Press STA/ESC key to exit the panel inertia identification operation.

- Alarm for inertia identification of panel

Error code	Meaning	Reasons and solutions	Reasons
Err-1	Motor torque saturation	①Initial inertia is too small; in adaptive mode, switch to large inertia mode P2-03.3=1 or the initial inertia of inertia identification P2-18 set to 2 times of the present value. ②The maximum speed is too high (P2-17), but it is recommended not to be less than 500mm/s. Low instruction speed will lead to inaccurate identification of inertia ratio. ③Torque limit too small（P3-28/29）	Initial inertia too small; Maximum speed too large; Torque limit too small
Err-2	Value error is too large when calculating the inertia	①The maximum speed limit is too small (P2-17), but it is recommended not to be less than 500mm/s. Low instruction speed will lead to inaccurate identification of inertia ratio. ②The presumed inertia trip is too small. It is suggested that the minimum for P2-15 should no be less one polar distance, if the trip is too small, the identification of inertia ratio will be inaccurate. ③mechanism friction too large ④overshoot	The maximum speed limit is too small; the travel is too small; the friction of the mechanism is too large; the overrun occurs
Err-3	Driver internal trip calculation error	①The presumed inertia trip is too small. It is suggested that the minimum for P2-15 should no be less than one polar distance. If the trip is too small, the identification of inertia ratio will be inaccurate.	Contact us
Err-5	Unrestrained Vibration in the Process of Inertia Identification	Unhandled vibration occurs	Unhandled vibration occurs
Err-6	Driver is not currently in BB state	①Enable have been opened. P5-20 can be set to 0 first ②When the driver alarms, it will appear. Press ESC key to exit the auto-tuning interface to see if there is an alarm.	Will occur when enable is turned on or driver has alarm
Err-7	The driver alarms in the process of inertia identification	Driver has alarm, press ESC key to exit the auto-tuning interface, check the alarm code, first solve the alarm and then make inertia estimation.	Driver has alarm

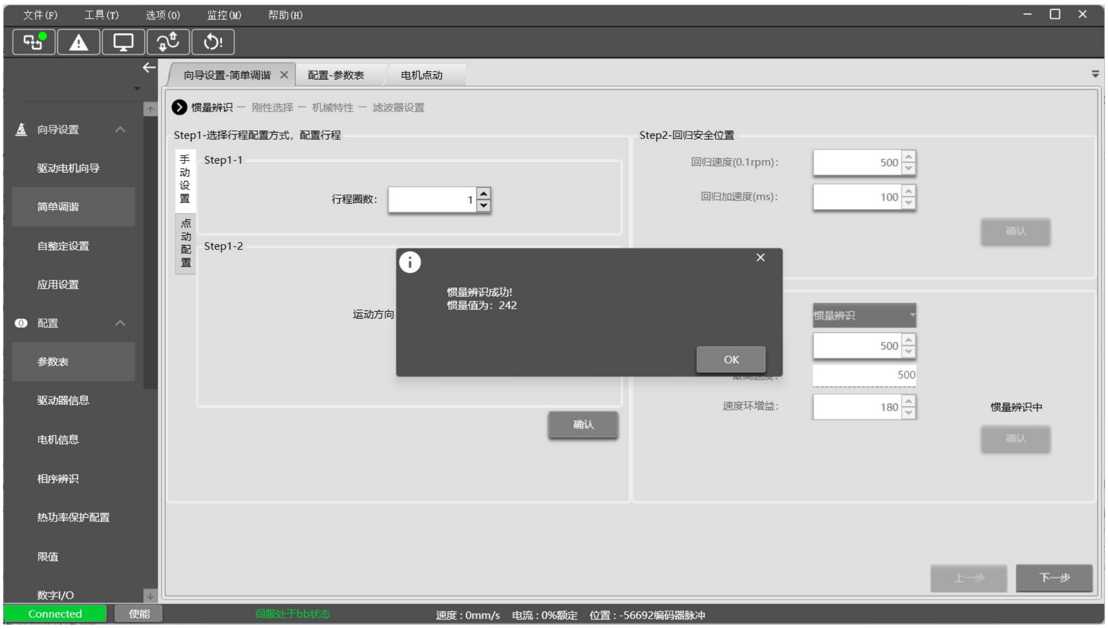
Estimate the inertia through XinJeServo

(1) Click on [Inertia Recognition] on the main menu screen of XinJeServo, or enter [Simple Tuning] after completing the drive motor guide.

(2) Select [jog configuration] or [manual setting] to choose the travel configuration method and configure the travel.

(3) Set the tuning configuration interface

(4) Click [ok] to start estimating the inertia. After the estimation is completed, the interface will display the estimated inertia value, which will be automatically written into P0-07.



- If the self-tuning interface is directly closed at this time, the driver will only be configured with the inertia ratio parameter.
- The detailed steps for using XinJeServo to estimate inertia can be found in XinJeServo's help documentation.

9.3 Fast adjustment

9.3.1 Overview

Fast adjustment needs to set the moment of inertia of load first. If the inertia does not match, it will cause oscillation alarm. Fast adjustment of gain parameters belongs to auto-tuning mode.

9.3.2 Fast adjustment steps

1. Estimate the load inertia through servo driver panel or XinJeServo software, refer to chapter 9.2 Rotary inertia presumption.
2. Set the rigidity level P0-04

Note: P2-01.0 is the first bit of P2-01

P2-01=n. 0 0 1 0
→ P2-01.0

9.3.3 Rigidity level corresponding gain parameters

The rigidity level should be set according to the actual load. The larger the P0-04 value, the greater the servo gain. If there is vibration in the process of increasing the rigidity level, it is not suitable to continue to increase. If vibration suppression is used to eliminate vibration, it can try to continue to increase. The following is the recommended rigidity level of the load for reference.

Supports three types of rigidity levels, selected through P6-00.0:

(1) P6-00.0=0: Standard mode [default]

Rigid level P0-04, associated with 4 parameters, P1-00, P1-01, P1-02, P2-35;

(2) P6-00.0=1: Positioning mode, also known as soft mode

By balancing responsiveness and using gain switching, the overshoot at the end of positioning is minimized, with a rigidity level of P0-04 and associated with 7 parameters, P1-00, P1-01, P1-02, P2-35, P1-05, P1-06, P1-07. Bind to force gain switching, P1-14=0x00A1;

(3) P6-00.0=2: Quick positioning mode

Enable model loop and disturbance observer Dob, rigidity level P0-04, associate 5 parameters, P1-00, P1-01, P1-02, P2-35, P2-49. Forcefully bind P2-00.0 and P2-41 of the disturbance observer Dob, as well as P2-47.0 and P2-49 of the model loop.

Rigid level table for standard mode (P6-00.0=0)

Rigid grade P0-04	Speed loop gain P1-00	Speed loop integral time constant P1-01	Position loop gain P1-02	Torque command filtering time constant 1 P2-35
0	15	50000	24	1326
1	20	39789	32	995

Rigid grade P0-04	Speed loop gain P1-00	Speed loop integral time constant P1-01	Position loop gain P1-02	Torque command filtering time constant 1 P2-35
2	25	31831	40	796
3	30	26526	48	663
4	35	22736	56	568
5	45	17684	72	442
6	60	13263	96	332
7	75	10610	120	265
8	90	8842	144	221
9	110	7234	176	181
10	140	5684	224	142
11	180	4421	288	111
12	250	3183	400	80
13	300	2653	480	66
14	350	2274	560	57
15	400	1989	640	50
16	500	1592	800	40
17	600	1326	960	33
18	750	1061	1200	27
19	900	884	1440	22
20	1150	692	1840	17
21	1400	568	2240	14
22	1700	468	2720	12
23	2100	379	3360	9
24	2500	318	4000	8
25	2800	284	4480	7
26	3100	257	4960	6
27	3400	234	5440	6
28	3700	215	5920	5
29	4000	199	6400	5
30	4500	177	7200	5
31	5000	159	8000	5
32	5500	145	8800	3
33	6000	133	9600	3
34	6500	123	10400	3
35	7000	114	11200	0
36	7500	106	12000	0
37	8000	100	12800	0
38	8500	94	13600	0
39	9000	88	14400	0
40	9500	84	15200	0
41	10000	80	16000	0

Rigid level table for positioning mode (P6-00.0=1)

Rigid grade P0-04	Speed loop gain P1-00	Speed loop integral time constant P1-01	Position loop gain P1-02	Torque command filtering time constant 1 P2-35	Second speed loop gain P1-05	Second speed loop integral time constant P1-06	Second position loop gain P1-07
0	15	50000	24	1326	15	51200	40
1	20	39789	32	995	20	51200	48
2	25	31831	40	796	25	51200	56
3	30	26526	48	663	30	51200	72
4	35	22736	56	568	35	51200	96
5	45	17684	72	442	45	51200	120
6	60	13263	96	332	60	51200	144
7	75	10610	120	265	75	51200	176
8	90	8842	144	221	90	51200	224
9	110	7234	176	181	110	51200	288
10	140	5684	224	142	140	51200	400
11	180	4421	288	111	180	51200	480
12	250	3183	400	80	250	51200	560
13	300	2653	480	66	300	51200	640
14	350	2274	560	57	350	51200	800
15	400	1989	640	50	400	51200	960
16	500	1592	800	40	500	51200	1200
17	600	1326	960	33	600	51200	1440
18	750	1061	1200	27	750	51200	1840
19	900	884	1440	22	900	51200	2240
20	1150	692	1840	17	1150	51200	2720
21	1400	568	2240	14	1400	51200	3360
22	1700	468	2720	12	1700	51200	4000
23	2100	379	3360	9	2100	51200	4480
24	2500	318	4000	8	2500	51200	4960
25	2800	284	4480	7	2800	51200	5440
26	3100	257	4960	6	3100	51200	5920
27	3400	234	5440	6	3400	51200	6400
28	3700	215	5920	5	3700	51200	7200
29	4000	199	6400	5	4000	51200	8000
30	4500	177	7200	5	4500	51200	8000
31	5000	160	8000	5	5000	51200	8000
32	5500	145	8800	3	5500	51200	8000
33	6000	133	9600	3	6000	51200	8000
34	6500	123	10400	3	6500	51200	8000
35	7000	114	11200	0	7000	51200	8000
36	7500	106	12000	0	7500	51200	8000
37	8000	100	12800	0	8000	51200	8000
38	8500	94	13600	0	8500	51200	8000
39	9000	88	14400	0	9000	51200	8000

Rigid grade P0-04	Speed loop gain P1-00	Speed loop integral time constant P1-01	Position loop gain P1-02	Torque command filtering time constant 1 P2-35	Second speed loop gain P1-05	Second speed loop integral time constant P1-06	Second position loop gain P1-07
40	9500	84	15200	0	9500	51200	8000
41	10000	80	16000	0	10000	51200	8000

Fast positioning mode rigidity level table (P6-00.0=2)

Rigid grade P0-04	Speed loop gain P1-00	Speed loop integral time constant P1-01	Position loop gain P1-02	Torque command filtering time constant 1 P2-35	Model loop gain P2-49
0	71	50000	24	20	24
1	80	39789	32	20	32
2	89	31831	40	20	40
3	100	26526	48	20	48
4	112	22736	56	20	56
5	125	17684	72	20	72
6	140	13263	96	20	96
7	157	10610	120	20	120
8	176	8842	144	20	144
9	198	7234	176	20	176
10	221	5684	224	20	224
11	248	4421	288	20	288
12	278	3183	400	20	400
13	311	2653	480	20	480
14	349	2274	560	20	560
15	390	1989	640	20	640
16	437	1592	800	20	800
17	490	1326	960	20	960
18	549	1061	1200	20	1200
19	615	884	1440	20	1440
20	689	692	1840	20	1840
21	771	568	2240	20	2240
22	864	468	2720	20	2720
23	968	379	3360	20	3360
24	1084	318	4000	8	4000
25	1214	284	4480	7	4480
26	1360	257	4960	6	4960
27	1523	234	5440	6	5440
28	1705	215	5920	5	5920
29	1910	199	6400	5	6400
30	2139	177	7200	5	7200

Rigid grade P0-04	Speed loop gain P1-00	Speed loop integral time constant P1-01	Position loop gain P1-02	Torque command filtering time constant 1 P2-35	Model loop gain P2-49
31	2396	160	8000	5	8000
32	2684	145	8800	3	-
33	3006	133	9600	3	-
34	3367	211	10400	3	-
35	3771	189	11200	0	-
36	4223	168	12000	0	-
37	4730	150	12800	0	-
38	5298	134	13600	0	-
39	5934	107	14400	0	-
40	6646	95	15200	0	-
41	6646	95	16000	0	-

9.3.4 Notes

- In the fast adjustment mode, the gain parameters corresponding to the rigidity level can be independently fine tuned.
- The quick adjustment mode will be configured with a rigid level by default. If the gain does not meet the mechanical requirements, please gradually increase or decrease the setting.
- To ensure stability, the model loop gain is given relatively small at low rigidity levels. When there are high response requirements, this parameter value can be increased separately.
- When vibration occurs during rapid adjustment, the torque command filter P2-35 can be modified. If there is no effect, mechanical characteristic analysis can be used to set relevant notch parameters (refer to 9.7 Vibration Suppression).

9.4 Auto-tuning

9.4.1 Overview

Auto-tuning is divided into internal instruction auto-tuning and external instruction auto-tuning.

Auto-tuning (internal instruction) refers to the function of automatic operation (forward and reverse reciprocating motion) of servo unit without instructions from the upper device and adjusting according to the mechanical characteristics in operation.

Auto-tuning (external instruction) is the function of automatically optimizing the operation according to the instructions from the upper device.

The automatic adjustments are as follows:

- Load moment of inertia
- Gain parameters (speed loop, position loop, model loop gain)
- Filter (notch filter, torque instruction filter)

9.4.2 Notes

Untunable occasions

- Mechanical systems can only operate in one direction.

Setting the occasion prone to failure

- Excessive load moment of inertia
- The moment of inertia varies greatly during operation.
- Low mechanical rigidity, vibration during operation and failure of detection positioning.
- The running distance is less one polar distance.

Preparations before auto-tuning

- Use position mode;
- Driver in bb status;
- Driver without alarm;
- The matching of the number of pulses per rotation and the width of positioning completion should be reasonable.

9.4.3 Operation tools

Internal instruction auto-tuning and external instruction auto-tuning can be executed by driver panel and XinJeServo software.

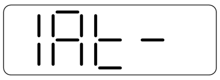
Auto-tuning mode	Operation tools	Limit item
Internal instruction auto-tuning external instruction auto-tuning	XinJeServo software	Linear servo drive upper computer software
	Driver panel	Driver firmware needs 4600 and higher versions

Note: please check the driver firmware version through U2-07.

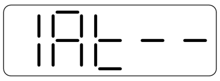
9.4.4 Internal instruction auto-tuning steps

Driver panel auto-tuning steps

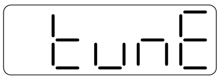
1. The inertia identification is carried out, and the inertia estimation steps please refer to chapter 9.2.4.
2. Enter F0-09, panel display iat-;



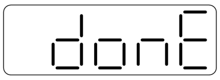
3. Press ENTER, panel display iat--; servo is in enabled status right now;



4. Press INC or DEC, panel display is tune and flashing, enter auto-tuning status.



5. Driver will automatically send pulse instructions, if the auto-tuning is successful, the panel shows done and flashing.



6. Press STA/ESC to exit internal instruction auto-tuning.

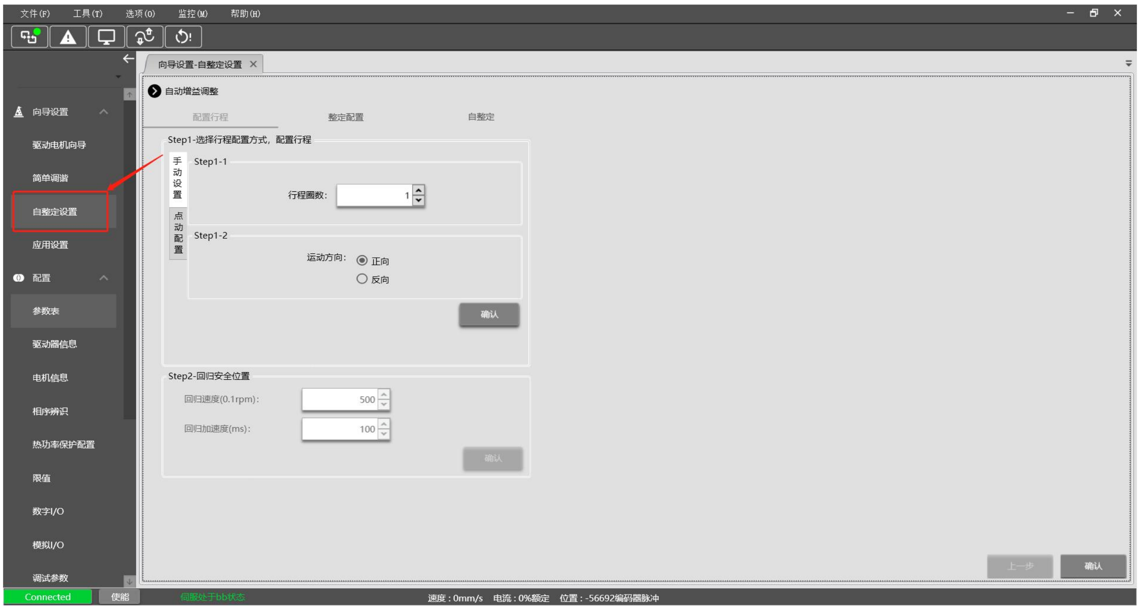
Note: In the process of auto-tuning, press STA/ESC will exit the auto-tuning operation and use the gain parameters at the exit time. If auto-tuning fails, it is necessary to initialize the driver before auto-tuning again.

- Panel alarm in auto-tuning process

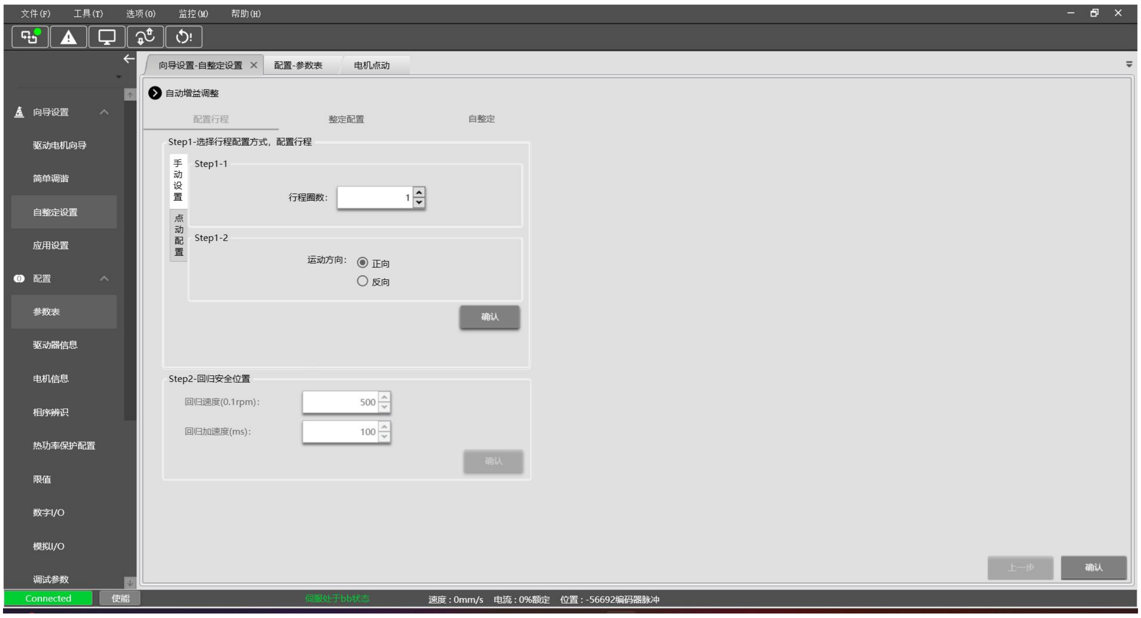
Error code	Meaning	Reasons
Err-1	Failure to search for optimal gain	Too large inertia ratio; too weak rigidity of mechanism
Err-2	Overtrip alarm in auto-tuning process	Please make sure that there is no overrun and alarm before auto-tuning.
Err-6	Driver is not in "bb" state at the time of operation	Please make sure the present status of driver.
Err-7	Driver alarmed in auto-tuning process	The driver alarm occurs.

XinJeServo auto-tuning steps:

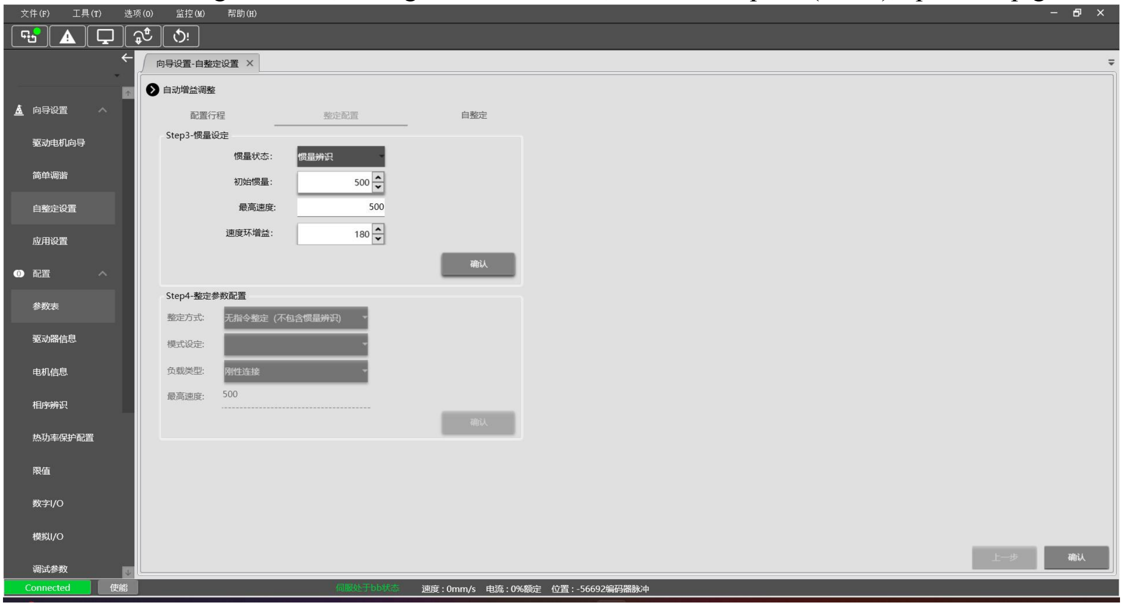
(1) Click on [Self tuning] on the main menu screen of XinJeServo.



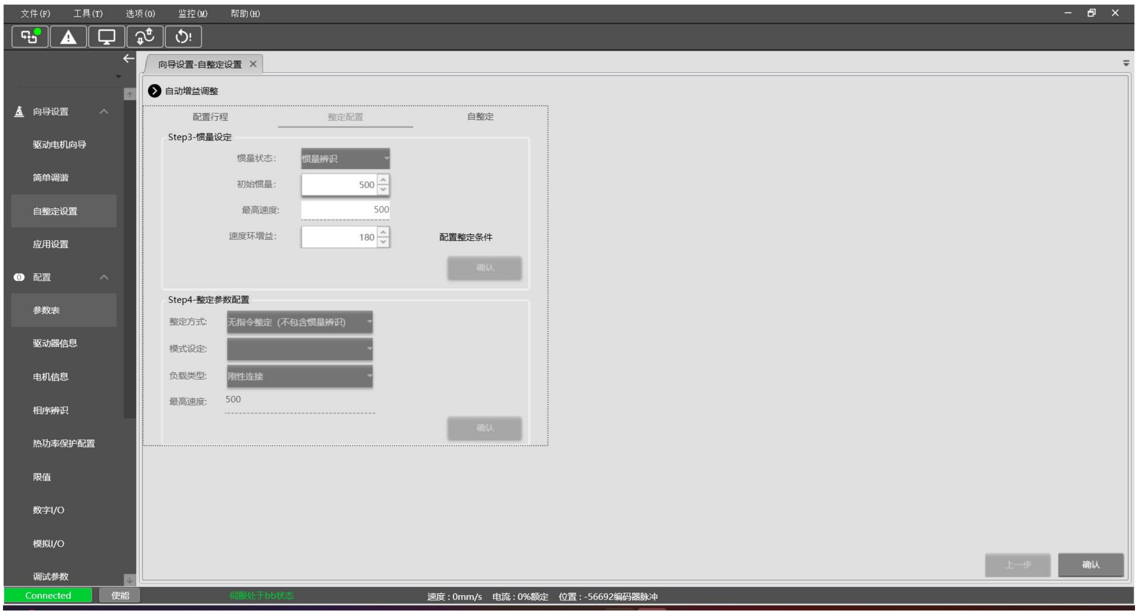
(2) Configure Travel Interface: Configure Inertia Estimation Travel.

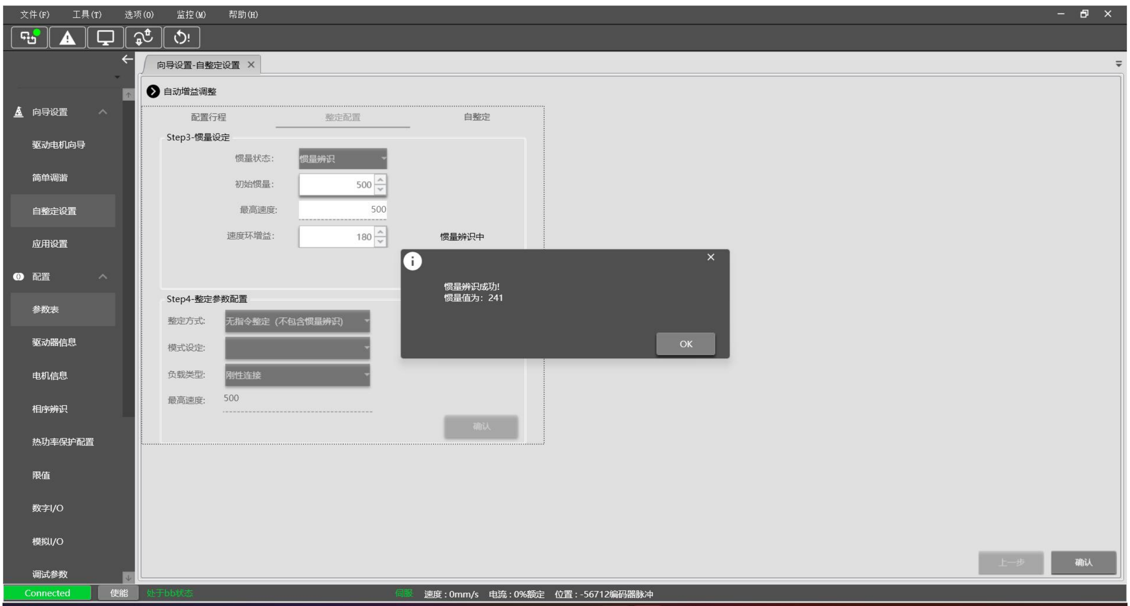


(3) Set the auto-tuning interface, configure initial inertia, maximum speed (mm/s), speed loop gain.

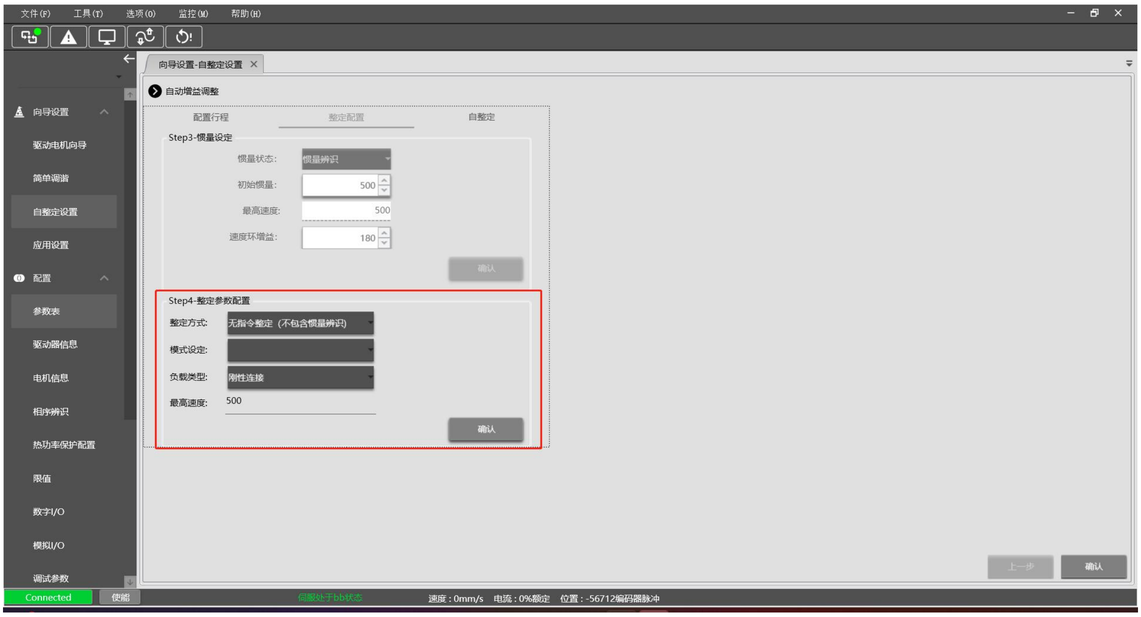


(4) Click [ok] to start estimating inertia.





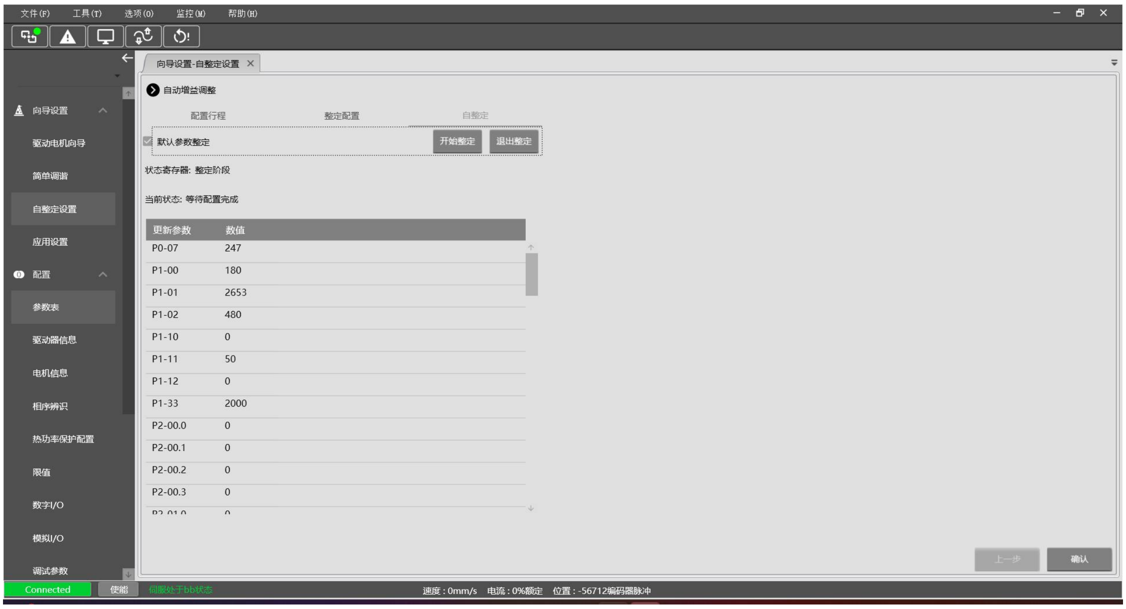
(5) Set the tuning parameters.

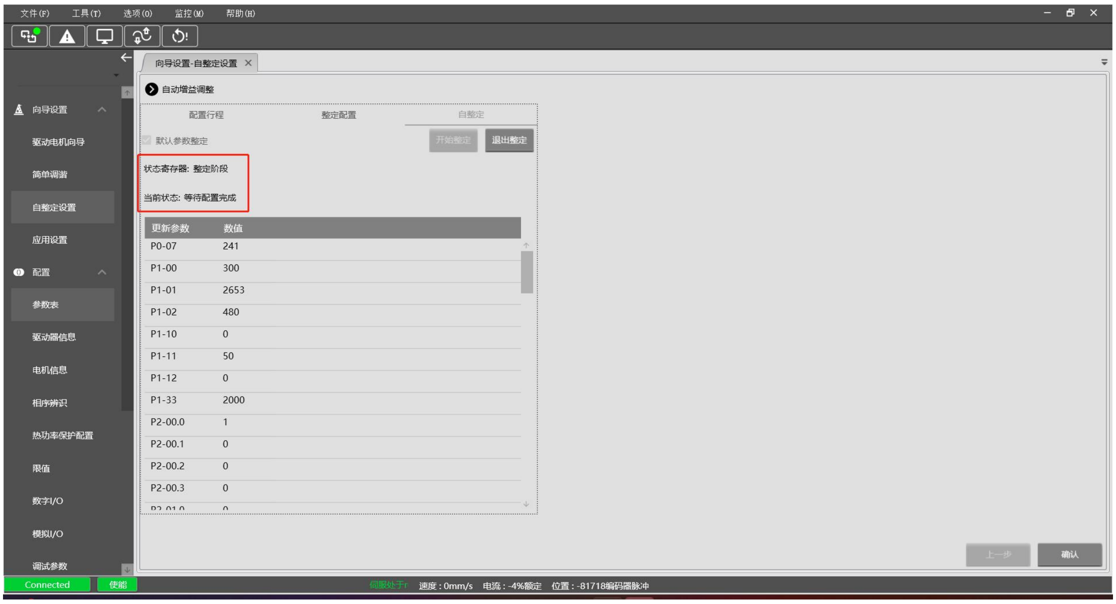


Auto-tuning mode	Description
Soft	Make a soft gain adjustment. Besides gain adjustment, notch filter is automatically adjusted.
Fast positioning	Make special adjustment for positioning purpose. Besides gain adjustment, the model loop gain and notch filter are automatically adjusted.
Fast positioning (control overshoot)	In the use of positioning, we should pay attention to adjusting without overshoot. Besides gain adjustment, the model loop gain and notch filter are automatically adjusted.

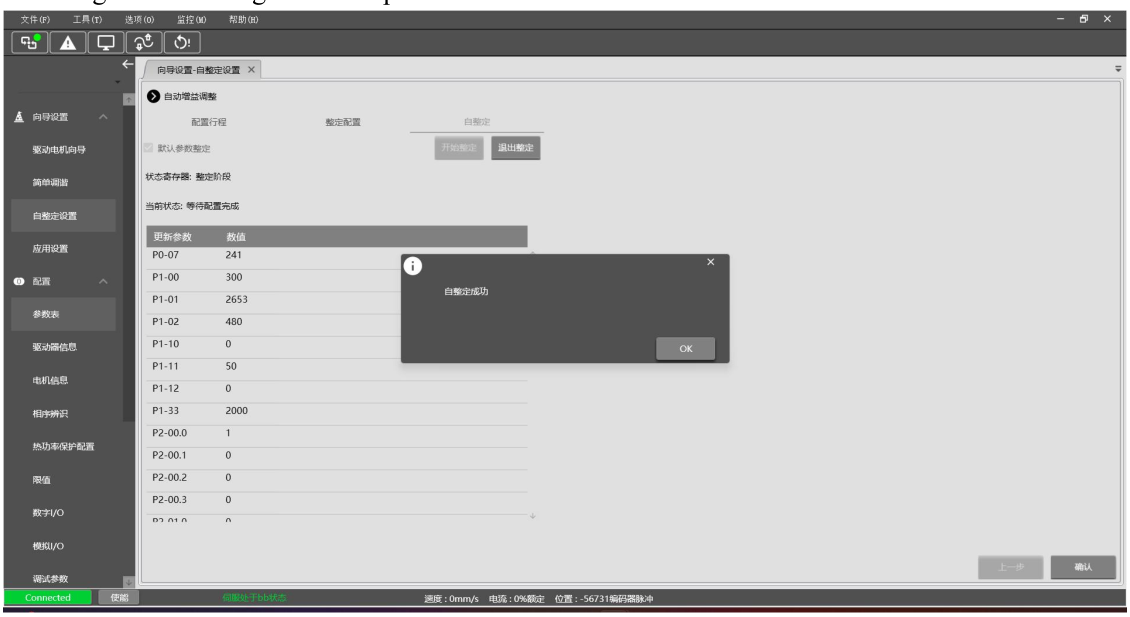
Load type	Description
Synchronous belt	Fit for the adjustment of lower rigidity mechanism such as synchronous belt mechanism.
Screw rod	It is suitable for adjustment of higher rigidity mechanism such as ball screw mechanism. If there is no corresponding mechanism, please choose this type.
Rigid connection	It is suitable for the adjustment of rigid body system and other mechanisms with higher rigidity.

(6) Start tuning.





(7) Waiting for the tuning to be completed



9.4.5 Related parameters

The following parameters may be modified during auto-tuning. Do not change them manually during auto-tuning.

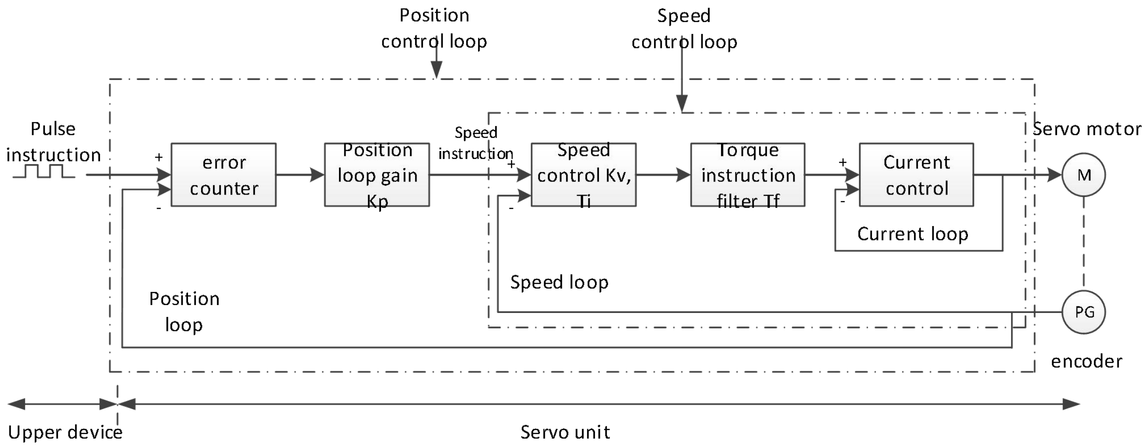
Parameter	Name	Property	Effect of value on gain after setting
P0-07	First inertia ratio	Gain performance parameters	Yes
P1-00	First speed loop gain		
P1-01	Integral time constant of the first speed loop		
P1-02	First position loop gain		
P2-00.0	Disturbance observer switch		
P2-01.0	Adaptive mode switch		
P2-35	Torque command filter time constant 1		
P2-41	Disturbance observer gain		
P2-47.0	model loop switch		
P2-49	model loop gain		
P2-55	model speed feedforward gain		
P2-60.0	Active vibration suppression switch		
P2-61	Active vibration suppression frequency		
P2-62	Active vibration suppression gain		
P2-63	Active vibration suppression damping		
P2-64	Active vibration suppression filtering time 1		
P2-65	Active vibration suppression filter time 2		
P2-66	The second group of active vibration damping		
P2-67	The second group of active vibration suppression frequencies		
P2-69.0	First notch switch		
P2-69.1	Second notch switch		
P2-71	First notch frequency		
P2-72	First notch attenuation		
P2-73	First notch band width		
P2-74	Second notch frequency		
P2-75	Second notch attenuation		
P2-76	Second notch band width		
P2-17	Inertia identification and internal instruction auto-tuning max speed	Auto-tuning setting parameters	No
P2-86	auto-tuning jog mode		
P2-87	auto-tuning min limit position		
P2-88	auto-tuning max limit position		
P2-89	auto-tuning max speed		

Parameter	Name	Property	Effect of value on gain after setting
P2-90	auto-tuning acceleration/deceleration time		

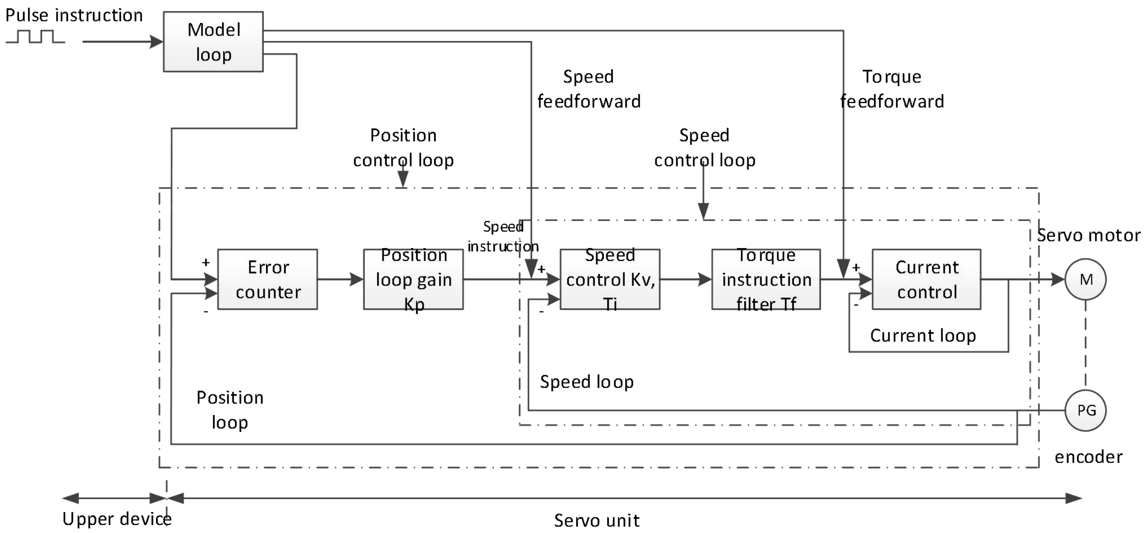
Note: P2-60~P2-63 are automatically modified in auto-tuning process. Users are not allowed to modify them manually. Manual modification may lead to the risk of system runaway.

9.5 Manual adjustment

9.5.1 Overview



Position control loop diagram (shut down the model loop)



Position control loop diagram (turn on the model loop)

Servo unit consists of three feedback loops (current loop, speed loop and position loop) from inside to outside. The more inner loop, the more responsive it is. Failure to comply with this principle will result in poor response or vibration. Among them, the current loop parameters are fixed values to ensure adequate responsiveness, and users do not need to adjust.

Please use manual adjustment in the following occasions:

- When the expected effect can not be achieved by fast adjusting the gain
- When the expected effect is not achieved by automatically adjusting the gain

9.5.2 Adjustment steps

In position mode, if the soft mode (P2-02.0=1) is selected by auto-tuning, the function of model loop will be turned off; in speed mode, the gain of position loop will be invalid.

Increasing response time

1. Reducing the filter time constant of torque instruction (P2-35)
2. Increasing Speed Loop Gain (P1-00)
3. Reducing Integral Time Parameter of Speed Loop (P1-01)
4. Increasing the gain of position loop (P1-02)
5. Improving Model Loop Gain (P2-49)

Reduce response, prevent vibration and overshoot

1. Reduce the Speed Loop Gain (P1-00)
2. Increase Integral Time Constant of Speed Loop (P1-01)
3. Reduce the gain of position loop (P1-02)
4. Increase the filter time constant of the torque instruction (P2-35)
5. Reduce Model Loop Gain (P2-49)

9.5.3 Gain parameter for adjustment

The gain parameters that need to be adjusted:

P1-00 Speed loop gain
P1-01 Integral Time Constant of Speed Loop
P1-02 Position loop gain
P2-35 Torque instruction filter time constant
P2-49 Model loop gain

- **Speed loop gain**

Because the response of the speed loop is low, it will become the delay factor of the outer position loop, so overshoot or vibration of the speed command will occur. Therefore, in the range of no vibration of mechanical system, the larger the setting value, the more stable the servo system and the better the responsiveness.

Parameter	Name	Default setting	Unit	Range	Modification	Effective
P1-00	Speed loop gain	<=20P7: 300 >=21P0: 180	0.1Hz	10～20000	Anytime	At once

- **Speed loop integration time constant**

In order to respond to small inputs, the speed loop contains integral elements. Because this integral element is a delay element for the servo system, when the time constant is set too large, overshoot will occur, or the positioning time will be prolonged, resulting in poor responsiveness.
The gain of the speed loop and the integral time constant of the speed loop roughly meet the following relationship: P1-00 × P1-01 = 636620.

Parameter	Name	Default setting	Unit	Range	Modify	Effective
P1-01	Speed loop integration time constant	<=20P7: 2653 >=21P0: 4421	0.01ms	15～51200	Anytime	At once

- **Position loop gain**

When the model loop is invalid (P2-47.0=0), the responsiveness of the position loop of the servo unit is determined by the gain of the position loop. The higher the position loop gain is, the higher the responsiveness is and the shorter the positioning time is. Generally speaking, the gain of position loop cannot be increased beyond the natural vibration number of mechanical system. Therefore, in order to set the position loop gain to a larger value, it is necessary to improve the rigidity of the machine and increase the number of inherent vibration of the machine.

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P1-02	Position loop gain	<=20P7: 480 >=21P0: 288	0.1/s	10～20000	Anytime	At once

- **Torque command filtering time constant**

When machine vibration may be caused by servo drive, it is possible to eliminate vibration by adjusting the filtering time parameters of the following torque instructions. The smaller the numerical value, the better the response control can be, but it is restricted by the machine conditions. When vibration occurs, the parameter is generally reduced, and the adjustment range is suggested to be 10-150.

Parameter	Name	Default setting	Unit	Range	Modify	Effective
P2-35	Torque command filtering time constant	66	0.01ms	0～65535	Anytime	At once

- **Model loop gain**

When the model loop is valid (P2-47.0=1), the response of the servo system is determined by the gain of the model loop. If the gain of the model loop is increased, the responsiveness is increased and the positioning time is shortened. At this time, the response of the servo system depends on this parameter, not P1-02 (position loop gain). The gain of the model loop is only valid in position mode.

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P2-49	Model loop gain	480	0.1Hz	10～20000	Anytime	At once

9.6 Adaptive

9.6.1 Overview

Adaptive function means that no matter what kind of machine and load fluctuation, it can obtain stable response through automatic adjustment. It starts to automatically adjust when servo is ON.

9.6.2 Notes

- ◆ When the servo unit is installed on the machine, it may produce instantaneous sound when the servo is ON. This is the sound when the automatic notch filter is set, not the fault. For the next time the servo is ON, no sound will be emitted.
- ◆ When the inertia of the motor exceeds the allowable load, the motor may produce vibration. At this time, please modify the adaptive parameters to match the present load inertia.
- ◆ In adaptive operation, in order to ensure safety, the adaptive function should be executed at any time when the servo enablement can be stopped or turned off urgently.

9.6.3 Operation steps

The factory settings are self-adaptive effective without modifying other parameters. The effectiveness of self-adaptation is controlled by the following parameters.

Parameter		Meaning	Default setting	Modify	Effective
P2-01	n.□□□0	Adaptive shutdown	n.□□□1	Servo bb	Re-power on
	n.□□□1	Adaptive open			

9.6.4 Inertia mode and related parameters

The adaptive default parameter is defined as small inertia mode. If the load inertia far exceeds the allowable load inertia of the motor (such as 60 times inertia of the 60 motor), the adaptive large inertia mode can be turned on.

Parameter		Meaning	Default setting	Modify	Effective
P2-03	n.0□□□	Adaptive small inertia mode	n.0□□□	Servo bb	Re-power on
	n.1□□□	Adaptive large inertia mode			

Parameter	Meaning	Default	Modify	Effective

		setting		
P2-05	Adaptive speed loop gain	400	Servo bb	Re-power on
P2-10	Adaptive speed loop integral	500	Servo bb	Re-power on
P2-11	Adaptive position loop gain	100	Servo bb	Re-power on
P2-07	Adaptive inertia ratio	0	Servo bb	Re-power on
P2-08	Adaptive speed observer gain	60	Servo bb	Re-power on
P2-12	Adaptive stable max inertia ratio	30	Servo bb	Re-power on
P2-16	Adaptive motor rotor inertia coefficient	100	Servo bb	Re-power on
P2-19	Adaptive bandwidth	50	Anytime	At once
P6-05	Adaptive large inertia mode speed loop gain	200	Servo bb	Re-power on
P6-07	Adaptive large inertia mode inertia ratio	50	Servo bb	Re-power on
P6-08	Adaptive large inertia mode speed observer gain	40	Servo bb	Re-power on
P6-12	Adaptive large inertia mode max inertia ratio	50	Servo bb	Re-power on

9.6.5 Adaptive parameter effect

Parameter small /large inertia	Name	Default value	Range	Effect
P2-05/P6-05	Adaptive speed loop gain	400/200	200～400	Decreasing can improve the inertia capacity, but will reduce the responsiveness, which has a great impact on the responsiveness
P2-07/P6-07	Adaptive load inertia ratio	0/50	0～200	Increase can greatly improve the inertia capacity, and will not affect the responsiveness. Too large will cause oscillation
P2-08/P6-08	Speed observer gain	60/40	30～60	Decreasing P2-08 and increasing P2-12 can greatly improve the inertia capability, but will reduce the responsiveness, which has a great impact on the responsiveness
P2-12/P6-12	Adaptive stable max inertia ratio	30/50	30～60	
P2-10	Adaptive speed loop integral time coefficient	500	200～larger	Adjust according to need, generally increase
P2-11	Adaptive position loop gain coefficient	100	50～200	Adjust according to the need, increasing will make the response fast, reducing will make the response slow
P2-16	Adaptive motor rotor inertia coefficient	100	100～200	Increasing can improve the servo rigidity, enhance the anti-interference ability, and solve the running jitter
P2-19	Adaptive bandwidth	50～70	40～80	Increasing will slightly improve the inertia capacity of the belt, which has little

				impact on the responsiveness, as an auxiliary parameter

9.6.6 Invalid parameters when adaptive effective

When the adaptive function is effective (P2-01.0=1), the invalid parameters are shown as below:

Item	Parameters	Name
Gain	P1-00 P1-05	First speed loop gain Second speed loop gain
	P1-01 P1-06	First speed loop integral time constant Second speed loop integral time constant
	P1-02 P1-07	First position loop gain Second position loop gain
	P2-49	Model loop gain
	P0-07 P0-08	First inertia ratio Second inertia ratio
	P5-36	/I-SEL inertia ratio switch

9.7 Vibration suppression

9.7.1 Overview

The mechanical system has a certain resonance frequency. When the servo gain is increased, the continuous vibration may occur near the resonance frequency of the mechanical system. Generally in the range of 400Hz to 1000Hz, it caused the gain can not continue to increase. Vibration can be eliminated by automatically detecting or manually setting the vibration frequency. After the vibration is eliminated, if the responsiveness needs to be improved, the gain can be further improved.

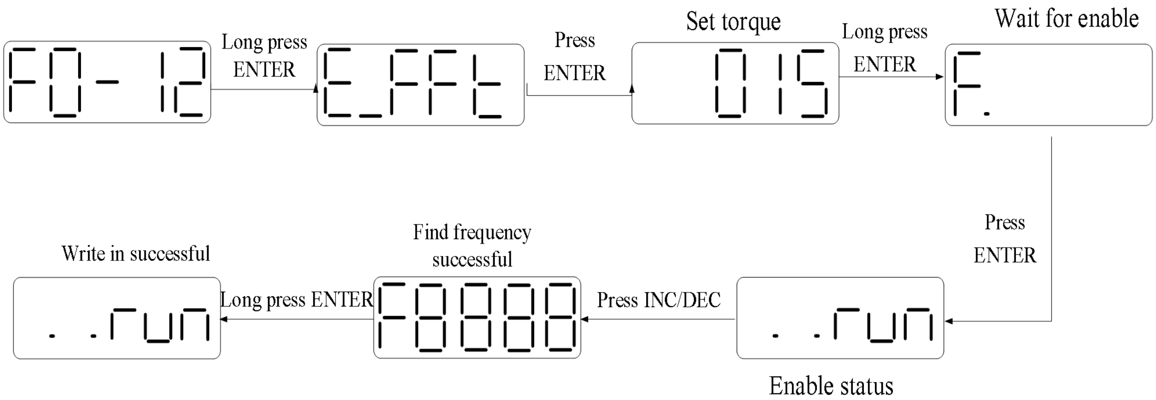
Note:
(1) Servo responsiveness will change after vibration suppression operation.
(2) Please set the inertia ratio and gain parameters correctly before performing the vibration suppression operation, otherwise it can not be controlled properly.

9.7.2 Operation tools

<table>
<tr><th>Adjustment mode</th><th>Operation tools</th><th>Control mode</th><th>Operation steps</th><th>Limitation</th></tr>
<tr><td>Adaptive mode</td><td>XinJeServo Mechanical Characteristic Analysis</td><td rowspan="4">Position mode</td><td>9.7.4Vibration Suppression (PC Software)</td><td>All software versions support</td></tr>
<tr><td rowspan="2">Auto-tuning mode</td><td>Panel vibration suppression</td><td>9.7.3 Vibration Suppression (fast FFT)</td><td>None</td></tr>
<tr><td>XinJeServo Mechanical Characteristic Analysis</td><td>9.7.4 Vibration Suppression (PC Software)</td><td>All software versions support</td></tr>
<tr><td>Auto-tuning /adaptive mode</td><td>Panel vibration suppression</td><td>9.7.3 Vibration suppression (fast FFT)</td><td>None</td></tr>
</table>

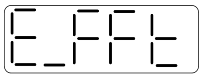
9.7.3 Vibration suppression (fast FFT)

The function can analyze the mechanical characteristics through the parameter F0-12 on the servo operate panel, find out the mechanical resonance frequency and realize the vibration suppression.
The complete operation process is shown in the figure below:

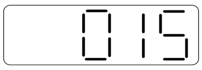


The operation steps are described as follows:

1. F0-12, long press【ENTER】to enter quick FFT function, it will show “E_FFt”.

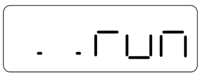


2. Press 【ENT】 to enter torque setting interface, it will show the current setting torque, which is the value of P6-89. Press【▲】,【▼】to increase or decrease torque command. When increasing the torque command, it is recommended to increase it a little bit to avoid severe vibration of the equipment.

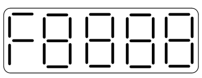


3. After setting the torque command, long press【ENT】, enter “read to enable” status, it will show ‘F”.

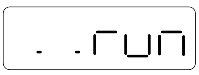
4. Press【ENT】, enable, it will show “..run”.



5. Press【▲】,【▼】 to run forward or reverse and find the resonance frequency. “E_FFt” will shining on the panel when operation. If the resonance frequency is found, it will show “Fxxxx”, “xxxx” is the resonance frequency. If failed, it will show “F----”.



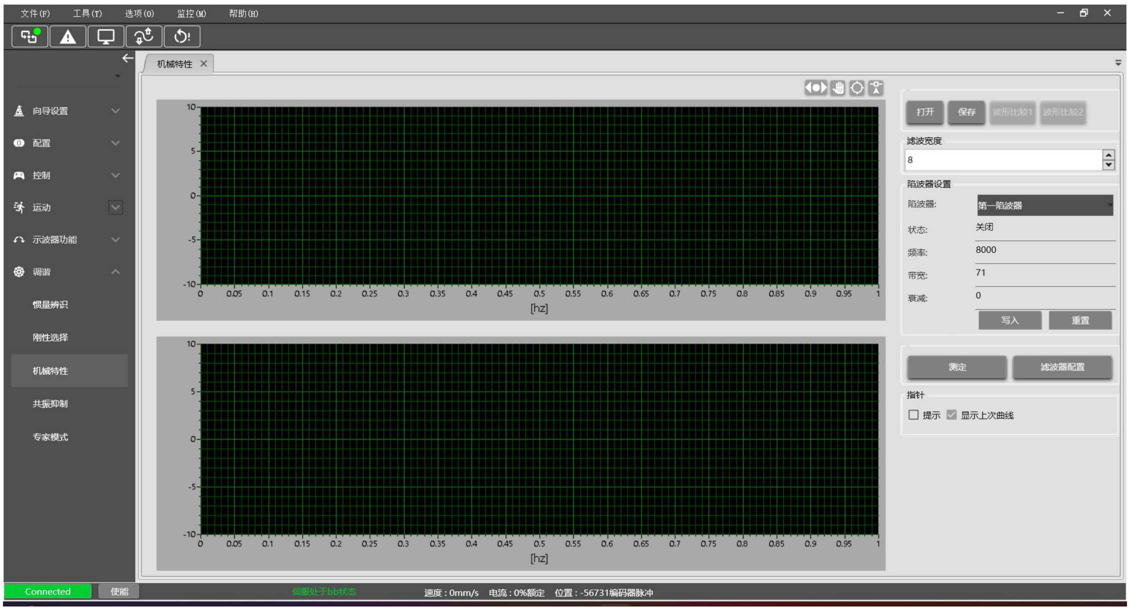
6. Whatever it shown “Fxxxx” or “F----”, press【▲】,【▼】 can find the resonance frequency again. If the resonance frequency is found, long press【EN】to set the resonance frequency in the notch filter of servo driver.



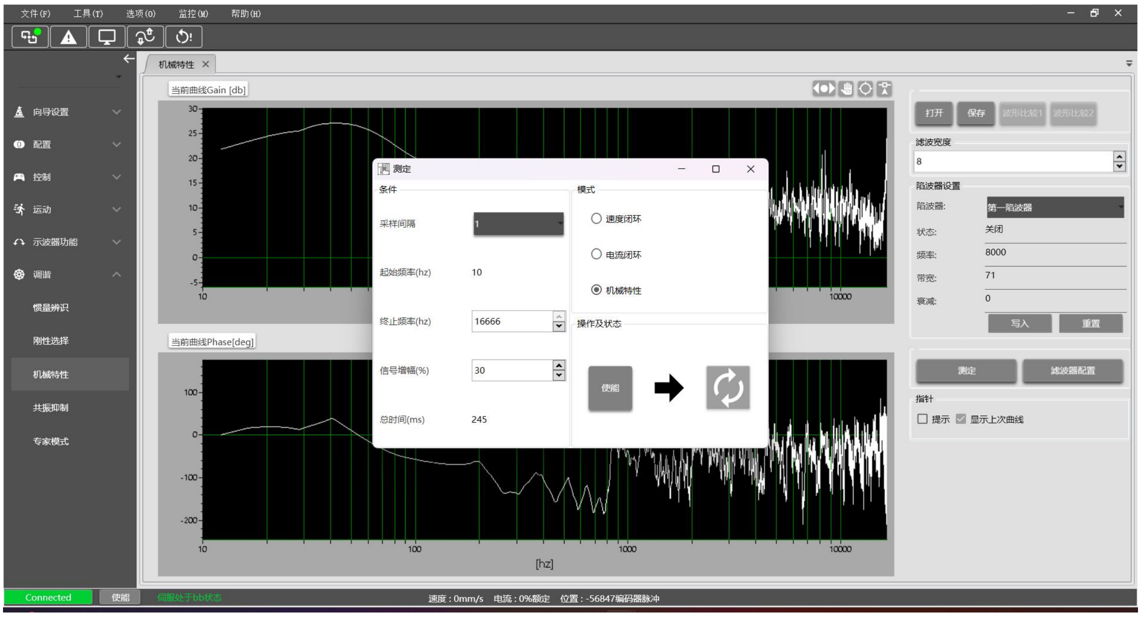
Note: for above each step, press STA/ESC can return to the last step, press STA to exit.

9.7.4 Vibration suppression (software)

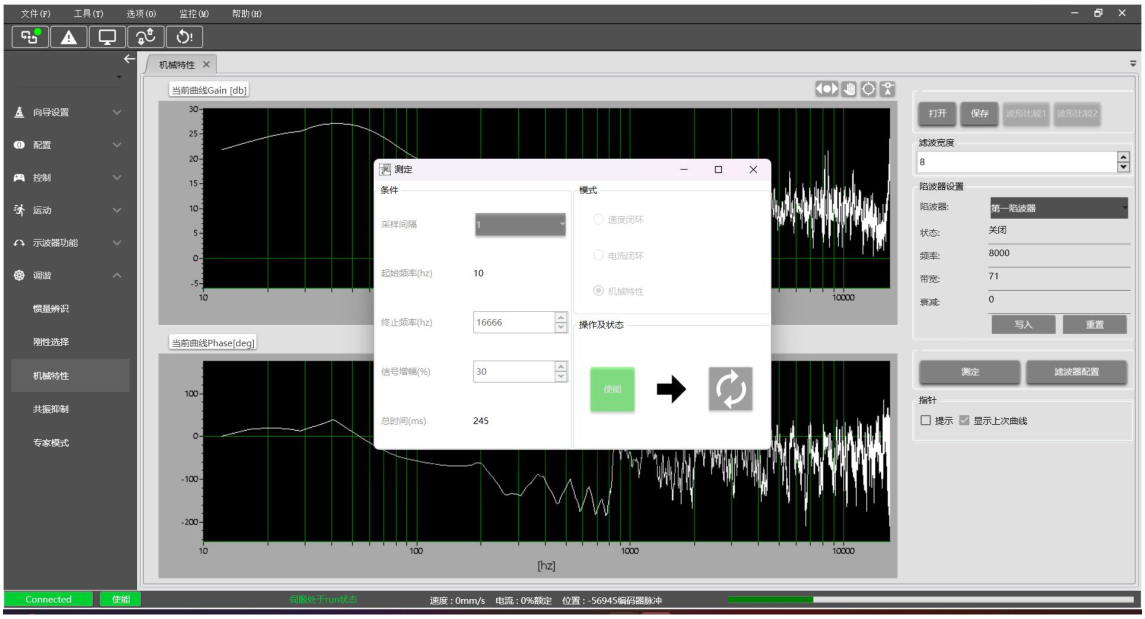
(1) Open the XinJeServo upper computer software and select mechanical characteristics.

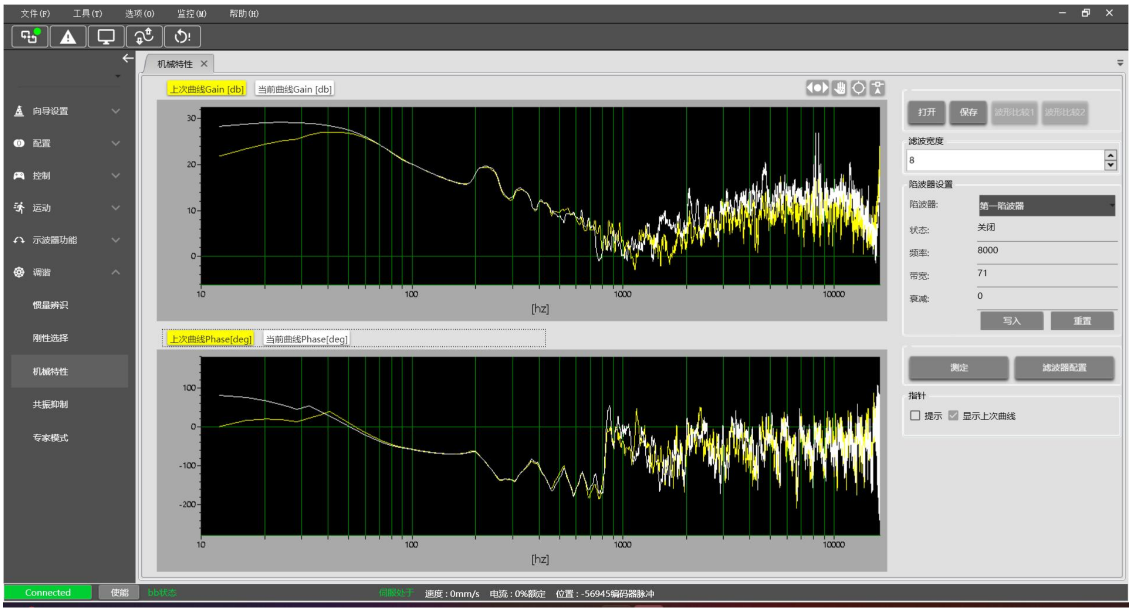


(2) Click [measure].



(3) Configure the testing conditions, then click [Enable] - [Execute]. After execution, the progress will be displayed in the lower right corner. After the progress is completed, the curve and the last recognized curve will be displayed.





(4) Set the filter width (to clearly view the resonance frequency), find the resonance frequency, and if there are multiple resonance points, write the frequency and bandwidth into multiple notch filters.

(5) To manually set the notch parameters, you can click on resonance suppression on the main interface and write the notch parameters into multiple resonance suppression filters. For detailed parameters, please refer to 9.7.7 notch filter.

> In both adaptive and auto-tuning modes, if mechanical characteristic analysis is used, the notch can be set manually. If there are multiple resonance points, the third to fifth notch can be configured in turn.

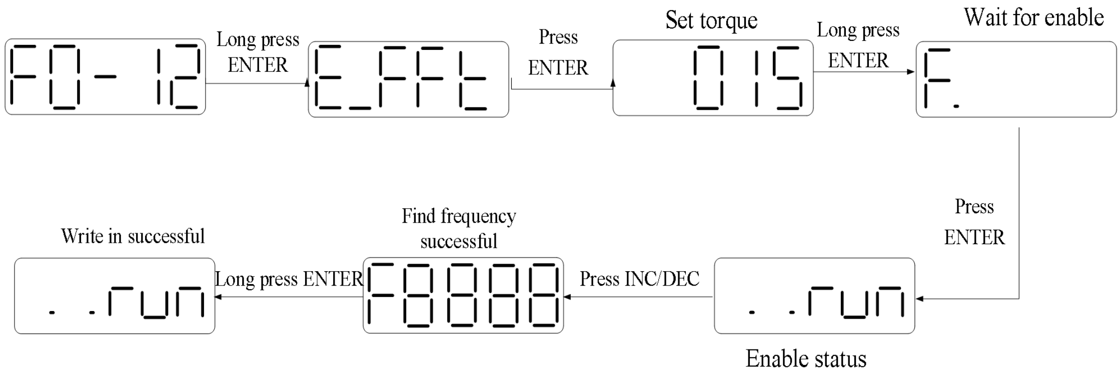
9.7.5 Vibration suppression(manual setting)

If the resonance frequency of the mechanical system is known, the vibration can be eliminated by setting the vibration frequency manually. Please configure the third to fifth notches. The related parameters are detailed in 9.7.6 notch filter.

9.7.6 Vibration suppression (easy FFT)

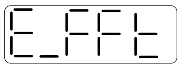
This function can analyze the mechanical characteristics through the parameter F0-12 on the servo operate panel, find out the mechanical resonance frequency and realize the vibration suppression.

The complete operation process is shown in the figure below:

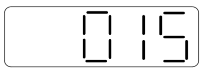


The operation steps are described as follows:

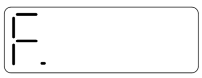
1. F0-12, long press【ENTER】to enter EasyFFT function, it will show “E_FFt”.



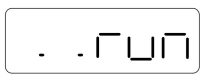
2. Press【ENTER】 to enter torque setting interface, it will show the current setting torque, which is the value of P6-89. Press【INC】,【DEC】to increase or decrease torque instruction. When increasing the torque instruction, it is recommended to increase it a little bit to avoid severe vibration of the equipment.



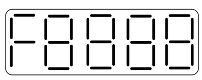
3. After setting the torque instruction, long press【ENTER】, enter “read to enable” status, it will show ‘F”.



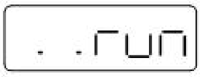
4. Press【ENTER】, enable, it will show “..run”.



5. Press【INC】,【DEC】 to run forward or reverse and find the resonance frequency. “E_FFt” will shining on the panel when operation. If the resonance frequency is found, it will show “Fxxxx”, “xxxx” is the resonance frequency. If failed, it will show “F----”.



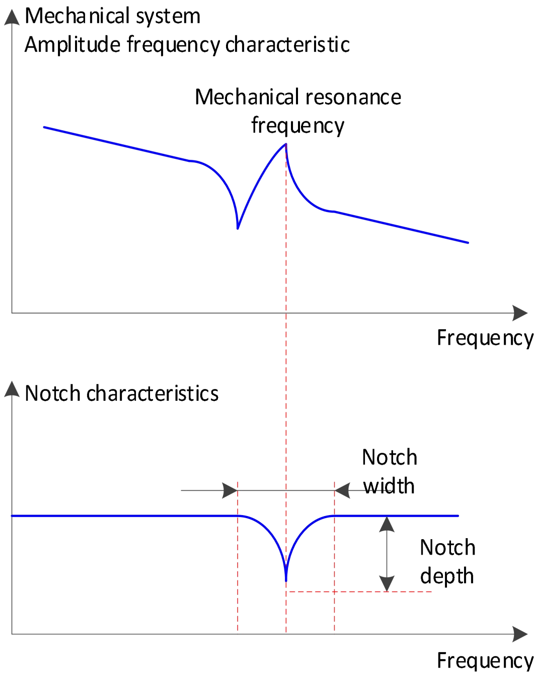
6. Whatever it shown “Fxxxx” or “F----”, press【INC】,【DEC】 can find the resonance frequency again. If the resonance frequency is found, long press【ENTER】to set the resonance frequency in the notch filter of servo driver.



Note: for above each step, short press STA/ESC can return to the last step or exit.

9.7.7 Notch filter

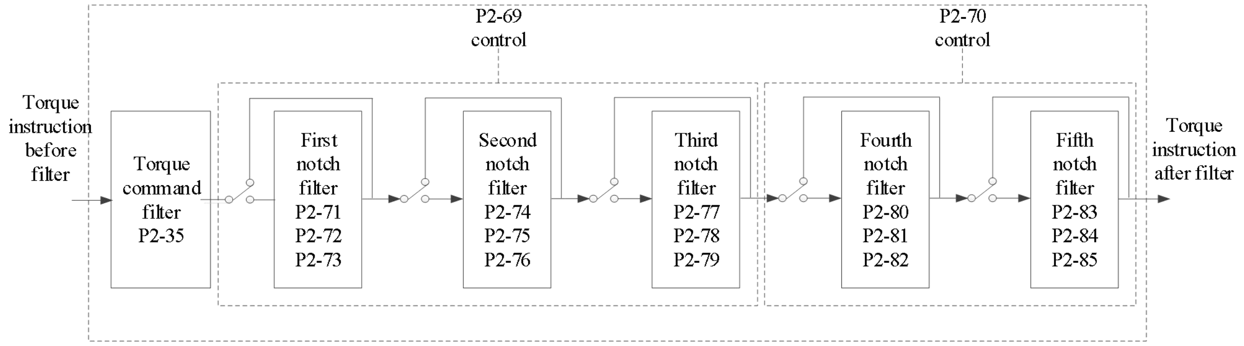
Notch filter can suppress mechanical resonance by reducing the gain at a specific frequency. After the notch filter is set correctly, the vibration can be effectively suppressed and the servo gain can be continuously increased.
The principle diagram of notch filter is as follows:



Principle diagram of notch filter

The servo driver has five sets of notch filters, each with three parameters, notch frequency, notch attenuation and notch bandwidth. The first and second notches are set automatically, and the third, fourth and fifth are set manually.

The torque instruction filter and notch filter are in series in the system. As shown in the figure below, the switch of the notch filter is controlled by P2-69 and P2-70.



Parameter		Meaning	Default setting	Modify	Effective
P2-69	n.□□□0	First notch off	n.□□□0	Anytime	At once
	n.□□□1	First notch on			
	n.□□0□	Second notch off	n.□□0□	Anytime	At once
	n.□□1□	Second notch on			
	n.0□□□	Third notch off	n.0□□□	Anytime	At once
	n.1□□□	Third notch on			
P2-70	n.□□□0	Fourth notch off	n.□□□0	Anytime	At once
	n.□□□1	Fourth notch on			
	n.□□0□	Fifth notch off	n.□□0□	Anytime	At once
	n.□□1□	Fifth notch on			

Parameter	Meaning	Default setting	Unit	Range	Modify	Effective
P2-71	First notch frequency	8000	Hz	50～8000	Anytime	At once
P2-72	First notch attenuation	71	0.01dB	50～1600	Anytime	At once
P2-73	First notch bandwidth	0	0.001Hz	0～1000	Anytime	At once
P2-74	Second notch frequency	8000	Hz	50～8000	Anytime	At once
P2-75	Second notch attenuation	71	0.01dB	50～1600	Anytime	At once
P2-76	Second notch bandwidth	0	0.001Hz	0～1000	Anytime	At once
P2-77	Third notch frequency	8000	Hz	50～8000	Anytime	At once
P2-78	Third notch attenuation	71	0.01dB	50～1600	Anytime	At once
P2-79	Third notch bandwidth	0	0.001Hz	0～1000	Anytime	At once
P2-80	Fourth notch frequency	8000	Hz	50～8000	Anytime	At once
P2-81	Fourth notch attenuation	71	0.01dB	50～1600	Anytime	At once
P2-82	Fourth notch bandwidth	0	0.001Hz	0～1000	Anytime	At once
P2-83	Fifth notch frequency	8000	Hz	50～8000	Anytime	At once
P2-84	Fifth notch attenuation	71	0.01dB	50～1600	Anytime	At once
P2-85	Fifth notch bandwidth	0	0.001Hz	0～1000	Anytime	At once

- In the adaptive mode, if the vibration is detected, the second notch filter will be automatically configured.
- In the auto-tuning mode, the second and first notches will be automatically configured if the vibration is detected (the second notches will be preferentially opened when there is only one vibration point).
- Whether in self-adaptive or auto-tuning mode, if the mechanical characteristic analysis is sued, it belongs to manual setting of notches, please configure the third to fifth notches.

9.8 Gain adjustment application

9.8.1 Model loop control

In the self-tuning mode, in addition to the gain of speed loop and position loop, there is also the gain of model loop, which has a great influence on the servo response. When the model loop is not open, the servo responsiveness is determined by the position loop gain. When the model ring is open, the servo responsiveness is determined by the model loop gain. The model loop is equivalent to the feedforward function in the driver control loop.

When the self-tuning mode is soft, the model loop function will be automatically off. When the self-tuning mode selects fast positioning or fast positioning (control overshoot), the model loop function will be automatically turned on.

Self-tuning mode

Parameter		Meaning	Defult setting	Modify	Effective
P2-02	n.□□□1	Soft	n.□□□3	Anytime	At once
	n.□□□2	Fast positioning			
	n.□□□3	Quick positioning (control overshoot)			

Selection of self-tuning mode:
(1) Soft(P2-02.0=1)
This mode does not turn on the gain of the model loop, and the operation is soft. It is suitable for occasions with insufficient mechanical rigidity and low response requirements.
(2) Quick positioning (P2-02.0 = 2)
This method has the fastest response to setting parameters, but has no special suppression on overshoot.
(3) Quick positioning (control overshoot) (P2-02.0 = 3):
In this way, the setting parameter response is fast, which will inhibit the overshoot.

Load type	Explanation
Synchronous belt	The adjustment is suitable for the mechanism with lower rigidity such as synchronous belt mechanism.
Lead screw	It is suitable for the adjustment of high rigidity mechanism such as ball screw mechanism. Please select this type when there is no corresponding structure.
Rigid connection	The adjustment is suitable for rigid body system and other mechanisms with high rigidity.

Self-tuning mode	Explanation
Soft	Soft gain adjustment. In addition to gain adjustment, the notch filter is also adjusted Automatically.
Fast positioning	Make special adjustment for positioning purpose. In addition to gain adjustment, the model loop gain and notch filter are also adjusted automatically

Fast positioning (control overshoot)	Pay attention to the adjustment of no overshoot in the positioning purpose. In addition to gain adjustment, the model loop gain and notch filter are also adjusted automatically.

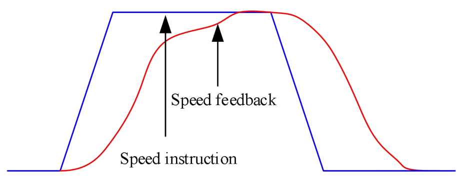
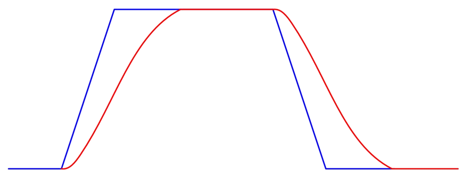
Parameter		Meaning	Default setting	Modify	Effective
P2-02	n.□□□1	Soft	n.□□□3	Anytime	At once
	n.□□□2	Fast positioning			
	n.□□□3	Fast positioning(control overshoot)			

Model loop function

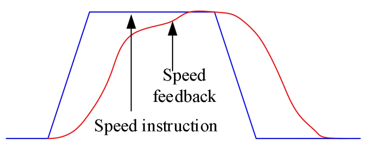
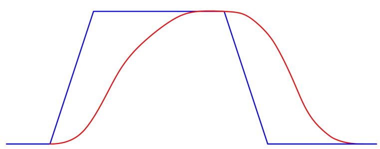
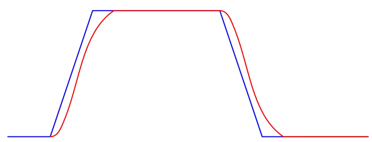
Parameter		Meaning	Default setting	Modify	Effective
P2-47	n.□□□0	Model loop turn off	n.□□□0	Anytime	At once
	n.□□□1	Model loop turn on			

Taking the DL6 series servo self-tuning mode and using a 400w servo with 5 times the load inertia as an example:

- Model loop function turns off (soft mode)

Low rigidity and low response	High rigidity and medium response
	
Load inertia ratio P0-07:500%	
Speed loop gain P1-00:200	Speed loop gain P1-00:800
Speed loop integral P1-01:3300	Speed loop integral P1-01:825
Position loop gain P1-02:200	Position loop gain P1-02:700
Phenomenon: Running jitter, slow response	Phenomenon: smooth operation and fast response

- Model loop function turns on (fast positioning or fast position(control overshoot))

Low rigidity and low response	High rigidity and low response	High rigidity and high response
		
Load inertia ratio P0-07:500%		
Speed loop gain P1-00:200	Speed loop gain P1-00:800	Speed loop gain P1-00:800
Speed loop integral P1-01:3300	Speed loop integral P1-01:825	Speed loop integral P1-01:825
Position loop gain P1-02:200	Position loop gain P1-02:700	Position loop gain P1-02:700
Model loop gain P2-49:300	Model loop gain P2-49:300	Model loop gain P2-49:4000

Phenomenon: Running jitter, slow response	Phenomenon: smooth operation and slow response	Phenomenon: smooth operation And fast response

Note: The above curves only show the effect of the parameters, not the real running curves.

9.8.2 Torque disturbance observation

Disturbance observer can reduce the influence of external disturbance on servo system and improve the anti-disturbance ability by detecting and estimating the external disturbance torque of the system and compensating the torque command.

If the soft mode is selected in the auto-tuning mode, the disturbance observer will be closed automatically, and the gain of the disturbance observer will not change. If the fast positioning or fast positioning (control overshoot) is selected, the disturbance observer will be opened automatically, and the gain of the disturbance observer will be modified to 85. The relevant parameters of this function no need to be set manually by users.

Parameter		Meaning	Default setting	Modify	Effective
P2-00	n.□□□0	Turn off disturbance observer	n.□□□0	Servo bb	At once
	n.□□□1	Turn on disturbance observer			

Parameter	Meaning	Default setting	Unit	Setting range	Modify	Effective
P2-41	Disturbance observer gain	85	%	0～100	Anytime	At once

9.8.3 Gain adjust parameters

Parameter	Meaning	Default setting	Unit	Setting range	Modify	Effective
P1-00	First speed loop gain	<=20P7: 300 >=21P0: 180	0.1Hz	10~20000	Servo bb	At once
P1-01	Integral time constant of the first velocity loop	<=20P7: 2653 >=21P0: 4421	0.01ms	15~51200	Servo bb	At once
P1-02	First position loop gain	<=20P7: 480 >=21P0: 288	0.1/s	10~20000	Servo bb	At once
P1-05	Second speed loop gain	200	0.1Hz	10~20000	Servo bb	At once
P1-06	Second velocity loop integral constant	3300	0.01ms	15~51200	Servo bb	At once
P1-07	Second position loop gain	200	0.1/s	10~20000	Servo bb	At once

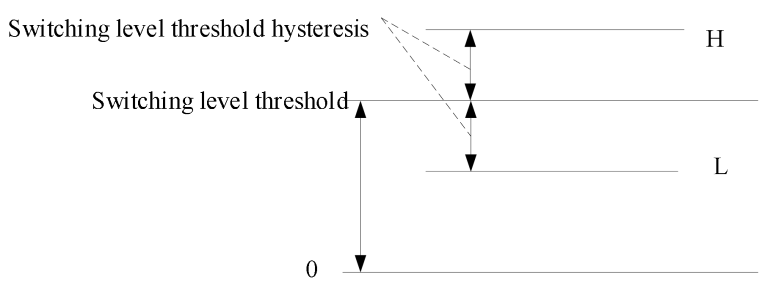
9.8.4 Gain switch

Parameter		Meaning	Default setting	Unit	Modify	Effective
P1-14.0	n.□□□X	n.□□□X: gain switching function switch 0-SI terminal switching gain is valid(the gain switching condition parameter is not valid) 1-Perform gain switching according to gain switching conditions 2-Reserved	0	-	Anytime	At once
P1-14.1	n.□□X□	n.□□X□: Gain switching condition selection 0- First gain fixed 1- Switching by external SI terminals 2- Large torque command 3- Large speed command 4 - Speed command changes greatly 5 - [Reserved] 6 - Large position deviation 7 - Position command 8 - Positioning completed 9 - Large actual speed A - Position command + actual speed				
P1-15		Gain switching waiting time	5	ms	Servo bb	At once
P1-16		Gain switching level threshold	50	-	Servo bb	At once
P1-17		Hysteresis of gain switching level threshold	30	-	Servo bb	At once
P1-18		Position loop gain switching time	3	ms	Servo bb	At once

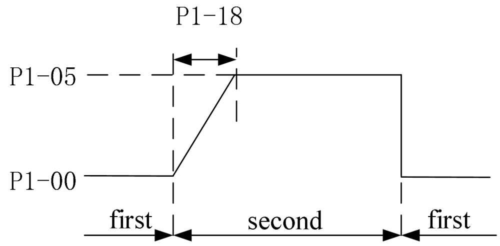
Note:

(1) The gain switching waiting time is effective only when the second gain is switched back to the first gain.

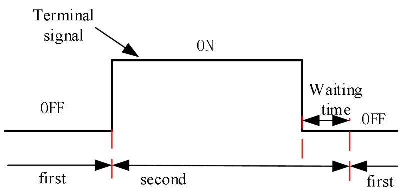
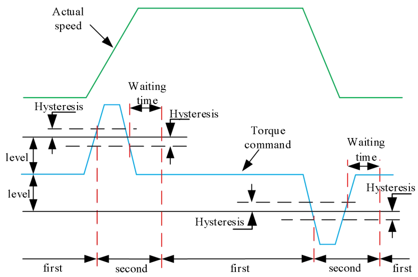
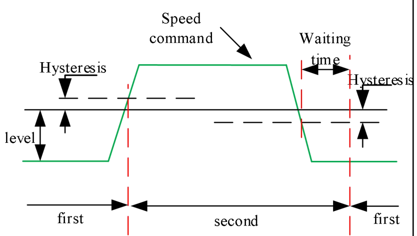
(2) The definition of gain switching level threshold hysteresis:

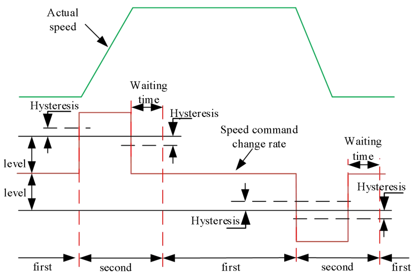
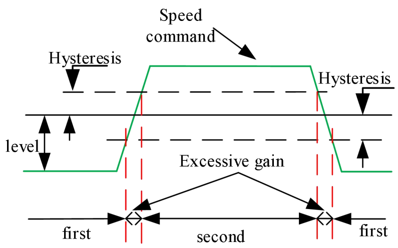
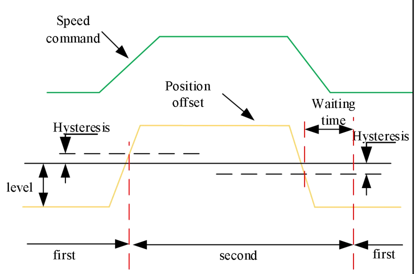


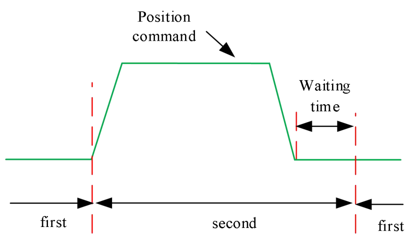
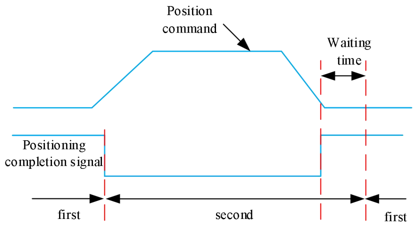
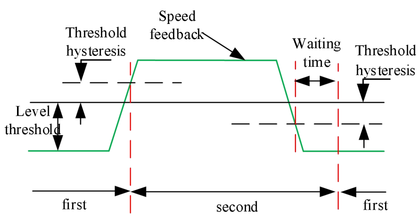
(3) The definition of position gain switching time:

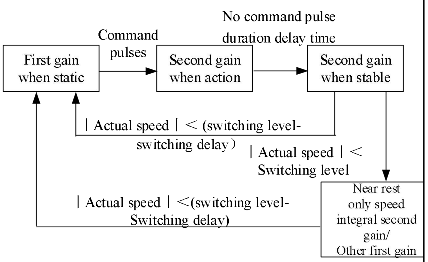


(4) Gain switching conditions:

Gain switching condition				Related parameters		
P1-14.1	Condition	Diagram	Notes	P1-15	P1-16	P1-17
0	The first gain fixed	-	-	Invalid	Invalid	Invalid
1	Terminal switching		Switch the gain through G-SEL signal: G-SEL invalid, first group of gain, G-SEL valid, second group of gain	Valid	Invalid	Invalid
2	Torque command		When the absolute value of torque command exceeds (level + hysteresis) [%] at the last first gain, switch to the second gain. At the last second gain, the absolute value of the torque command is less than (level - hysteresis) [%], and then wait until P1-15 remain in this state, return to the first gain.	Valid	Valid (%)	Valid (%)
3	Speed command		When the absolute value of the speed command exceeds (level + hysteresis) [mm/s] at the last first gain, switch to the second gain. At the last second gain, when the absolute value of the speed command is less than (level - hysteresis) [mm/s], wait until P1-15 remain in this state, and return to the first gain.	Valid	Valid	Valid

Gain switching condition				Related parameters		
4	Speed command change rate		At the last first gain, when the absolute value of the speed command change rate exceeds (level + hysteresis) [10mm/s^2], switch to the second gain. At the last second gain, when the absolute value of the speed command change rate is less than (level-hysteresis) [10mm/s^2], wait until P1-15 remain in this state, and return to the first gain.	Valid	Valid (10mm/s^2)	Valid (10mm /s^2)
5	Speed command high and low speed threshold [not supported]		At the last first gain, when the absolute value of the speed command exceeds (level-hysteresis) [mm/s], switch to the second gain, and the gain gradually changes. When the absolute value of the speed command reaches (level + hysteresis) [mm/s], the gain completely changes to the second gain. At the last second gain, when the absolute value of the speed command is lower than (level + hysteresis) [mm/s], it starts to return to the first gain, and the gain changes gradually. When the absolute value of the speed command reaches (level-hysteresis) [mm/s], the gain completely returns to the first gain.	Invalid	Valid (mm/s)	Valid (mm/s)
6	Position offset		Valid only in position mode (other modes are fixed as the first gain) When the absolute value of position deviation exceeds (level + hysteresis) [encoder unit] at the last	Valid	Valid (Encoder unit)	Valid (Encod er unit)

Gain switching condition				Related parameters		
			first gain, switch to the second gain. When the absolute value of the position deviation is less than (level-hysteresis) [encoder unit] at the last second gain, wait until P1-15 remain in this state, and return to the first gain.			
7	Position command		Valid only in position mode (other modes are fixed as the first gain) At the last first gain, if the position command is not 0, switch to the second gain. At the last second gain, if the position command is in the state of 0 which remains in the waiting time P1-15, it returns to the first gain.	Valid	Invalid	Invalid
8	Positioning completion		Valid only in position mode (other modes are fixed as the first gain) At the last first gain, if the positioning is not completed, switch to the second gain. At the last second gain, if the state of positioning completion remains in this state for the waiting time P1-15, the first gain is returned. Note: it is necessary to set the positioning completion detection mode according to P5-01.	Valid	Invalid	Invalid
9	Actual speed		Valid only in position mode (other modes are fixed as the first gain): At the last first gain, the absolute value of the actual speed exceeds (level + hysteresis)	Valid	Valid (mm/s)	Valid (mm/s)

Gain switching condition				Related parameters		
			[mm/s], switching to the second gain. At the last second gain, when the absolute value of the inter speed is less than (level-hysteresis) [mm/s], wait until P1-15 remain in this state, and return to the first gain.			
A	Position command+ actual speed		Valid only in position mode (other modes are fixed as the first gain): At the last first gain, if the position command is not 0, switch to the second gain. At the last second gain, the state in which the position command is 0 within the waiting time P1-15, maintains the second gain. When the position command is 0 and the waiting time P1-15 reached, if the absolute value of the actual speed is less than (level) [mm/s], the speed integral time constant is fixed at the second speed loop integral time constant (P1-07), and the others return to the first gain. If the absolute value of the actual speed is less than (level-hysteresis) [mm/s], the speed integral also returns to the integral time constant of the first speed loop (P1-02).	Valid	Valid (mm/s)	Valid (mm/s)

9.8.5 Speed loop P-PI mode switching

(1) Speed control mode switching

Parameter		Meaning	Default setting	Modify	Effective
P1-26	n.□□□X	0: Do not use mode switching 1: Switching condition based on internal torque command 2: Switching condition based on speed command 3: Switching condition based on acceleration 4: Switching condition based on position deviation	1	Servo bb	At once
	n.□□X□	0: Clear the integral of 0asr 1: Keep the speed loop integral unchanged and no longer accumulate	1		
P1-27		Mode Switching - Torque command threshold	200	Servo bb	At once
P1-28		Mode Switching - Speed command threshold	0	Servo bb	At once
P1-29		Mode Switching - Acceleration threshold	0	Servo bb	At once
P1-30		Mode switching - Position deviation threshold	0	Servo bb	At once

Asr P/PI mode switching is enabled by default, i.e. P1-26.0=1, and Asr P/PI mode switching is performed based on P1-27 torque command exceeding 200%.

(2) IP control selection

Parameter		Meaning	Default setting	Modify	Effective
P2-03	n.□X□□	0: PI control 1: IP control	0	Servo bb	At once
P1-31		I-P control switching threshold	100	Servo bb	At once

Note: P1-31=0, the speed loop is equivalent to PI control; P1-31=100, the speed loop is equivalent to IP control.

9.9 Gain adjustment

9.9.1 Load shaking

The following reasons cause load to shake

1. The instruction is not smooth enough when the load inertia is too large.

Solutions:

(1) Use position instruction smoothing filter P1-25;

(2) Optimizing the instructions of the upper device to reduce the acceleration of the instructions;

(3) Replace the motor with greater inertia.

2. Servo gain is too small, resulting in insufficient rigidity

Solutions:

(1) Increase the gain parameters and rigidity to enhance the anti-disturbance ability.

3. Insufficient rigidity of mechanism and equipment sloshing

Solutions:

(1) Reducing gain parameters;

(2) Optimize the instructions of the upper device and reduce the acceleration of the instructions.

9.9.2 Vibration

The following causes cause machine vibration:

(1) Vibration due to inappropriate servo gain

Solutions: Reduce gain

(2) Mechanical resonance point

Solutions: Setting notch parameters manually or through mechanical characteristic analysis

9.9.3 Noise

In adaptive mode:

(1) Inappropriate servo gain

Solutions: Reduce the adaptive control bandwidth (P2-19).

In auto-tuning mode:

(1) Inappropriate servo gain

Solutions: Under the mode of rapid adjustment, reduce the rigidity level.

Automatic Adjustment Mode: Reducing Model Loop Gain P2-49

(1) Noise due to mechanical resonance

Solutions: Refer to 9.9.2 vibration.

10 Alarm

10.1 EtherCAT related communication alarm code

Alarm code	Reasons		Solution
E-800	Inaccurate ESM demand error protection	The change state demand which cannot change from the present state was received. Init→Safeop Init→OP PreOP→OP - When the present state is other then OP: It remains in the present ESM state. - When the present state is OP: SafeOP ESC register AL Status Code:0011h	Check the change state request of host controller. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-801	ESM undefined request error protection	The change state request which does not have a definition (except the following) was received. 1:Request Init State 2:Request Pre-Operational State 3:Request Bootstrap State 4:Reauest Safe-operational State 8:Request Operational State - When the present state is other then OP: It remains in the present ESM state. - When the present state is OP: SafeOP ESC register AL Status Code:0012h	Check the change state request of host controller. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-802	Bootstrap requests error protection *1)	The following change state request was received. 3:Request Bootstrap State ESM state after alarm: Init ESC register AL Status Code:0013h	Check the change state request of host controller. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-803	Incomplete PLL error protection	Phasing servo and communication(PLL lock) could not be completed even after the lapse of 1s after the start of the synchronization process. ESM state after alarm:PreOP ESC register AL Status Code:002Dh	- Check setting of DC mode. -Check whether propagation delay compensation or drift compensation is correct. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-804	PDO watchdog error protection	Bit10 of AL Event Request(0220h) did not turn on within the time set by the ESC register	 1. Check whether the transmitting

Alarm code	Reasons		Solution
		addresses 0400h(Watchdog Divider) and 0420h (Watchdog Time Process Data) during PDO communication (SafeOP or OP). ESM state after alarm: Safe OP ESC register AL Status Code:001Bh PDO communication disconnection	timing of PDO from host controller is constant(not stop). 2. Check whether the PDO watchdog detection delay value is too large; 3. Check whether there is a problem with the wiring of the EtherCAT communication cable and whether there is excessive noise on the cable. Replace the high-quality network cable; 4. The communication cable is reconnected, and the network cable is suspended and separated from the power cable; 5. Turn off the interfering equipment such as welding machine and then run it again, To eliminate interference problems; Cross test to determine the fault point; The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-806	PLL error protection	Servo phasing and communication(PLL lock) separated during operation in the state of SafeOP or OP. ESM state after alarm: SafeOP ESC register AL Status Code:0032h	- Check setting of DC mode. - Check whether propagation delay compensation or drift compensation is correct. The alarm can be cleared through the servo panel F0-00=1 or the control power can be disconnected for reset.
E-807	Synchronization signal error protection	After the synchronization processing is completed, the SYNC0 or IRQ interrupt processing occurs above the set threshold ESM state after alarm:SafeOP ESC register AL Status Code:002Ch	- Check setting of DC mode. - Check whether propagation delay compensation or drift compensation is correct. The alarm can be cleared through the servo panel F0-00=1 or the control power can be disconnected for reset.
E-810	Synchronization cycle error	If set to cycle synchronization(SYNC0 cycle) is not supported	Set up a synchronous period correctly.

Alarm code	Reasons		Solution
	protection	Set synchronization cycle except 500us,1ms, 2ms, 4ms ESM state after alarm: PreOP ESC register AL Status Code: 0035h	The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.(Supported after 3770)
E-811	Mailbox error protection	A setup of SM0/1 was set as the unjust value. The sending and receiving area of the mailbox overlaps with SM2/3, and the address of the sending and receiving area is odd; Start address of mailbox: SyncManager0:1000h~10FFh, SyncManager1:other than 1200h~12FFh Length (ESC register:0802h, 0803h/080Ah, 080Bh) set up of SyncManager0/1 is inaccurate SyncManager0:other than 32~256byte SyncManager1:other than 40~256byte Control Register(ESC register:0804h/080Ch) set up of SyncManager0/1is inaccurate Set code other than 0110b in 0804h: bit5-0 Set code other than 0110b in 080Ch:bit5-0 ESM state after alarm: Init ESC register AL Status Code:0016h	Set the Sync manager correctly in accordance with the ESI file descriptions. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-814	PDO watchdog error protection	A setup of the watchdog timer of PDO is wrong. Although PDO watch dog trigger is effective (SyncManager: Bit6 which is the register 0804h set to 1), when the detection timeout value of PDO watchdog timer cycle setup (registers 0400h and 0420h) was less than "communication cycle *2". ESM state after alarm: PreOP ESC register AL Status Code:001Fh	Set up detection timeout value of watchdog timer correctly The servo alarm can be cleared by setting SM2013+20* (N-1) or by servo panel F0-00=1.
E-815	DC error protection	DC setting is wrong. A value other than the following was set to bit 2-0 of 0981h (Activation) of the ESC register: bit2-0=000b; bit2-0=011b ESM state after alarm: PreOP ESC register AL Status Code:0030h	Check setting of DC mode. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-816	SM event mode	SM event mode which is not supported was	- 1C32h-01h(Sync mode) should set

Alarm code	Reasons		Solution
	error protection	set up. 1C32/1C33-01 Set values other than 00, 01 and 02. - When 000b was set to bit 2-0 of 0981h of the ESC register, SM2 setting was set to only either 1C32h-01h or 1C33h-01h. ESM state after alarm:PreOP ESC register AL Status Code:0028h	up 00h(FreeRun), 01h(SM2), or 02h(DC SYNC0). - 1C33h-01h(Sync mode) should set up 00h(FreeRun), 02h(DC SYNC0), or 22h (SM2). - Set same value to 1C32h-01h and 1C33h-01h. The servo alarm can be cleared by setting SM2013+20*(N-1) or by servo panel F0-00=1.
E-817	SyncManager2/3 error protection	A setup of SyncManager3 was set as the unjust value. - A Physical Start Address (ESC register 0818h) setup of SyncManager3 is inaccurate. -Receiving area overlaps with the area for the transmission. - The area for transmission/reception of Mailbox overlaps the area for transmission/reception of SyncManager2/3 - Addressing transmission and reception area is an odd number. - Start addresses is out of range. - A Length (ESC register 0812h/081Ah) setup of SyncManager2 is inaccurate. - Different from RxPDO size. - A Control Register (ESC register 0814h/081Ch) setup of SyncManager2 is inaccurate. Set other than 100110b to bit5-0 ESM state after alarm: PreOP ESC register AL Status Code:001Dh/001Eh	The servo alarm can be cleared by setting SM2013+20*(N-1) or by servo panel F0-00=1.
E-850	TxPDO assignment error protection	The data size of TxPDO map is set up exceeding 24 bytes ESM state after alarm: PreOP ESC register AL Status Code: 0024h	TxPDO data size is set up within 24 bytes. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-851	RxPDO assignment error protection	The data size of RxPDO map is set up exceeding 24 bytes. ESM state after alarm: PreOP ESC register AL Status Code:0025h	RxPDO data size is set up within 32 bytes. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-881	Control mode	- The PDS state was changed to "Operation	Check preset value of 6060h(Modes

Alarm code	Reasons		Solution
	setting error protection	enabled" when the value set to 6060h (Modes of operation) is 0 and the value set to 6061h (Modes of operation display) is 0. Unsupported control mode is set to 6060h (Modes of operation). A control mode other than position control is set to 6060h (Modes of operation) in full-closed control. ESM state after alarm: It remains in the present ESM state. ESC register AL Status Code:0000h	of operation). The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-882	ESM requirements during operation error protection	- When a PDS state was "Operation enabled" or "Quick stop active", the transition command to other ESM state was received. ESM state after alarm: A state transition request from host contoller is followed. ESC register AL Status Code: 0000h	Check the state transition request from higher rank equipment. The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.
E-883	Improper operation error protection	- When EXT1/EXT2 is not assigned to input signal, EXT1/EXT2 was selected in trigger selection of a touch probe (60B8h (Touch probe function)). The calculation result of electronic gear ratio fell outside the range of 1/1000 to 1000 times; - In the calculation process of electronic gear ratio, the denominator or numerator exceeds an unsigned 64-bit size. - In the final calculation result of electronic gear ratio, the denominator or numerator exceeds an unsigned 32-bit size. - When Z-phase is chosen by trigger selection of a touch probe (60B8h(Touch probe function)) at the time of absolute mode of full closed. - When the software limit function is enabled, a wraparound occurred to the actual position or command position. ESM state after alarm: It remains in the present ESM state.	The servo alarm can be cleared by setting SM2013+20 * (N-1) or by servo panel F0-00=1.

Alarm code	Reasons		Solution
		ESC register AL Status Code:0000h	
E-899	The program cannot access the bus peripherals correctly	The EEPROM of the bus is not updated correctly (updated at the factory) Bus driver related hardware error	1. Update the EEPROM of the bus 2.Contact the agent or manufacturer

10.2 EtherCAT communication unrelated alarm

10.2.1 List of common alarm parameters

Historical record: "√" means that historical alarms can be recorded. "○" is not recorded.

The column that can be cleared: "√" represents the alarm that can be cleared. "○" represents the alarm that cannot be cleared.

<table>
<tr><th colspan="2" rowspan="2">Alarm code</th><th rowspan="2">Code</th><th rowspan="2">Explanation</th><th colspan="3">Property</th><th rowspan="2">Servo status when alarming</th></tr>
<tr><th>Historical records</th><th>Can be cleared</th><th>Whether power on is needed to clear the alarm</th></tr>
<tr><td rowspan="4">EEEE</td><td>1</td><td>EEEE1</td><td rowspan="4">Communication error between panel and CPU</td><td rowspan="4">○</td><td>○</td><td>No</td><td>Servo run</td></tr>
<tr><td>2</td><td>EEEE2</td><td>○</td><td>No</td><td>Servo run</td></tr>
<tr><td>3</td><td>EEEE3</td><td>○</td><td>No</td><td>Servo run</td></tr>
<tr><td>4</td><td>EEEE4</td><td>○</td><td>No</td><td>Servo run</td></tr>
<tr><td rowspan="6">01</td><td>0</td><td>E-010</td><td>Firmware version mismatch</td><td>○</td><td>○</td><td>Yes</td><td>Servo run</td></tr>
<tr><td>3</td><td>E-013</td><td>FPGA Loading Error</td><td>○</td><td>○</td><td>Yes</td><td>Servo run</td></tr>
<tr><td>5</td><td>E-015</td><td>Program running error</td><td>○</td><td>○</td><td>Yes</td><td>Servo run</td></tr>
<tr><td>6</td><td>E-016</td><td>Processor Running Error</td><td>○</td><td>○</td><td>No</td><td>Servo run</td></tr>
<tr><td>7</td><td>E-017</td><td>Processor Running Timeout</td><td>○</td><td>○</td><td>Yes</td><td>Servo run</td></tr>
<tr><td>9</td><td>E-019</td><td>System password error</td><td>○</td><td>○</td><td>Yes</td><td>Servo run</td></tr>
<tr><td rowspan="9">02</td><td>0</td><td>E-020</td><td>Parameter loading error</td><td>○</td><td>○</td><td>Yes</td><td>Servo run</td></tr>
<tr><td>1</td><td>E-021</td><td>Parameter range beyond limit</td><td>○</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>2</td><td>E-022</td><td>Parameter conflict</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>3</td><td>E-023</td><td>Sampling channel setting error</td><td>○</td><td>○</td><td>Yes</td><td>Servo run</td></tr>
<tr><td>4</td><td>E-024</td><td>Parameter lost</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>5</td><td>E-025</td><td>Erase FLASH error</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>6</td><td>E-026</td><td>Initialization FLASH error</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>8</td><td>E-028</td><td>EEPROM write in error</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>9</td><td>E-029</td><td>EEPROM write frequent alarm</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>03</td><td>0</td><td>E-030</td><td>Bus voltage overvoltage</td><td>√</td><td>√</td><td>No</td><td>Servo off</td></tr>
<tr><td rowspan="5">04</td><td rowspan="2">0</td><td rowspan="2">E-040</td><td>Bus voltage under voltage
①Low grid voltage</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>Bus voltage under voltage
② Bus voltage undervoltage caused by power failure of driver</td><td>○</td><td>√</td><td>No</td><td>Servo off</td></tr>
<tr><td>1</td><td>E-041</td><td>Driver power down</td><td>○</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>3</td><td>E-043</td><td>Bus Voltage Charging Failure</td><td>√</td><td>√</td><td>No</td><td>Servo off</td></tr>
<tr><td>4</td><td>E-044</td><td>Three phase voltage input phase loss</td><td>√</td><td>√</td><td>No</td><td>Servo off</td></tr>
<tr><td rowspan="2">06</td><td>0</td><td>E-060</td><td>Module temperature too high</td><td>√</td><td>√</td><td>No</td><td>Servo run</td></tr>
<tr><td>1</td><td>E-061</td><td>Motor overheating</td><td>√</td><td>√</td><td>Yes</td><td>Servo run</td></tr>
</table>

Alarm code		Code	Explanation	Property			Servo status when alarming
				Historical records	Can be cleared	Whether power on is needed to clear the alarm	
	3	E-063	Thermocouple disconnection alarm	√	√	No	Servo run
08	0	E-080	Overspeed alarm	√	√	No	Servo off
	2	E-082	Encoder zero position deviation protection 1	√	√	No	Servo off
	3	E-083	Speed command exceeds the limit	√	√	No	Servo run
10	0	E-100	Excessive position deviation	√	√	No	Servo run
	1	E-101	Sudden change in position instruction deviation	√	√	No	Servo run
11	0	E-110	External UVW Short Circuit Discovered in Self-Inspection	√	√	No	Servo off
	2	E-112	U phase current overcurrent protection	√	√	No	Servo off
	3	E-113	Vphase current overcurrent protection	√	√	No	Servo off
13	0	E-150	Power cable disconnection	√	√	No	Servo off
16	1	E-161	Driver thermal power overload	√	√	No	Servo run
	5	E-165	Anti-blocking alarm	√	√	No	Servo run
20	0	E-200	Regenerative resistance overload	√	√	No	Servo run
22	0	E-220	Communication error of absolute servo encoder	√	√	No	Servo off
	1	E-221	Too many CRC errors in encoder communication	√	√	No	Servo off
	3	E-223	Absolute value servo encoder data access alarm	√	√	No	Servo off
	7	E-227	Power on encoder multi-turn signal data error	√	√	No	Servo off
	8	E-228	Absolute Servo Encoder Value Overflow	√	√	No	Servo off
	9	E-229	Encoder electrical angle deviation protection	√	√	No	Servo off
24	0	E-240	Timing error in fetching encoder position data	√	√	No	Servo off
	1	E-241	Encoder reponse data is error code	√	√	No	Servo off
	2	E-242	Phase searching failed	√	√	No	Servo run
	3	E-243	HALL status abnormal	√	√	No	Servo off
	4	E-244	BISS-C encoder abnormality	√	√	Yes	Servo off
25	0	E-250	Homing error alarm	√	√	No	Servo off
26	0	E-260	Over range alarm	√	√	No	Servo run
	1	E-261	Overrun signal connection error	√	√	No	Servo run
	2	E-262	Control stop timeout	√	√	No	Servo off
	4	E-264	Excessive vibration	√	√	No	Servo run

Alarm code		Code	Explanation	Property: Historical records	Property: Can be cleared	Property: Whether power on is needed to clear the alarm	Servo status when alarming
	5	E-265	Motor vibration too large	√	√	No	Servo run
28	0	E-280	Fail to access motor parameters	√	○	Yes	Servo off
	1	E-281	Error writing data to encoder EEPROM	√	○	Yes	Servo off
31	1	E-311	Motor code missing (linear motor doesn't have this alarm)	√	○	Yes	Servo off
	5	E-315	Unable to read valid motor parameters (linear motor doesn't have this alarm)	√	○	Yes	Servo off
32	0	E-320	External terminal emergency alarm	√	√	No	Servo off
34	0	E-340	STO status is not synchronized	√	√	No	Servo off
	2	E-342	STO buffer circuit abnormal alarm	√	√	No	Servo off
	3	E-343	EDM circuit error	√	√	No	Servo off

10.2.2 Analysis of common alarm types

DL6 alarm code format is E-XX□,“XX”means main type, “□” means sub-type.

Type		Code	Description	Reasons	Solutions
EEEE	1	EEEE1	Communication error between panel and CPU	① The power supply voltage fluctuates greatly, and the panel refresh fails due to the low voltage ② The panel program is damaged ③ Communication enters into an endless loop	① Stable power supply to ensure the stability of power supply voltage; ② Power off and power on again. If the alarm cannot be removed, please contact the agent or manufacturer; ③ Check the operation after unplugging the communication terminal
	2	EEEE2			
	3	EEEE3			
	4	EEEE4			
01	0	E-010	Firmware version mismatch	Downloaded firmware version error	Please contact the agent or the manufacturer
	3	E-013	FPGA loading error	①Program damaged ②Device damaged	Please contact the agent or the manufacturer
	4	E-014	FPGA Access error	①Program damage ②Device damage ③Serious external interference	Please contact the agent or the manufacturer
	5	E-015	Program running error	Program damage	Please contact the agent or the manufacturer
	7	E-017	Processor	Program damage	Please contact the agent or the

Type		Code	Description	Reasons	Solutions
			Running Timeout		manufacturer
	9	E-019	System password error	Program damage	Please contact the agent or the manufacturer
02	0	E-020	Parameter loading error	Faliure of parameter self-checking	Re-energizing can restore default parameters, if there are repeated problems, please contact the agent or manufacturer.
	1	E-021	Parameter range beyond limit	Setting values are not within the prescribed range	Check parameters and reset them
	2	E-022	Parameter conflict	Conflict of TREF or VREF Function Settings	① Check whether the parameter settings meet the requirements; ② Under P0-01=4 mode, P3-00 will alarm when set to 1
	3	E-023	Sampling channel setting error	Error setting of custom output trigger channel or data monitoring channel	Check that the settings are correct
	4	E-024	Parameter conflict	Low voltage of power grid	(1) If it is single-phase 220V power supply, please connect L1 and L3. (2) show E-024 immediately after power failure (3) Resetting parameters
	5	E-025	Erase FLASH error	Abnormal parameter preservation during power failure	Please contact the agent or the manufacturer
	6	E-026	Initialization FLASH error	Power supply instability of FLASH chip	Please contact the agent or the manufacturer
	8	E-028	EEPROM write in error	Voltage instability or chip abnormality	Please contact the agent or the manufacturer
03	0	E-030	Bus voltage U0-05 is higher than the actual preset threshold, 220V Power Supply Machine (U0-05≥402V) 380V Power Supply Machine (U0-05≥780V)	High voltage of power grid	Check the fluctuation of power grid, 220V driver normal voltage range 200V ~ 240V, 380V driver normal voltage range 360V ~ 420V. If the voltage fluctuation is large, it is recommended to use the correct voltage source and regulator.
				Excessive load moment of inertia (insufficient regeneration capacity)	(1) Connect external regenerative resistor, (220V: bus voltage U0-05 = 392 discharge starts, U-05 = 377 discharge ends; 380V: U-05 = 750 discharge starts, U-05 = 720 discharge ends;) (2) Increase Acceleration and Deceleration Time (3) Reduce load inertia

Type		Code	Description	Reasons	Solutions
					(4) Reduce start-stop frequency (5) Replacement of larger power drivers and motors
				Brake resistance damage or excessive resistance value	Check the regenerative resistor and replace the external resistor with the appropriate resistance value.
				Acceleration and deceleration time is too short	Extending Acceleration and Deceleration Time
				Hardware Fault of Driver Internal Sampling Circuit	The AC gear of the multimeter measures the input value of the servo LN (R/S/T), which is 220V ± 10% of the normal value. If the power supply voltage is more than 220V+10% (380V+10%), check the power supply voltage; if the power supply voltage is normal, then the servo BB state, monitor U0-05, the voltage measured by the multimeter * 1.414 < U0-05 (within 10V error), then the servo driver is faulty and needs to be sent back for repair.
04	0	E-040	Bus voltage U0-05 is lower than the actual preset threshold. 220V power supply machine (U0-05 ≤ 150V) 380V power supply machine (U0-05 ≤ 300V)	Low voltage of power grid when normal power on	(1) Check the fluctuation of power grid. The normal voltage range of 220V driver is 200V~240V. If the voltage fluctuation is large, the voltage regulator is recommended. (2) Replacement of larger capacity transformers
				Instantaneous power failure	Re-energize after voltage stabilization
				Hardware Fault of Driver Internal Sampling Circuit	The AC gear of the multimeter measures the input value of the servo LN (R/S/T), which is 220V ± 10% of the normal value. If < 220V + 10% (380V + 10%), then check the supply voltage; if the supply voltage is normal, then servo BB state, monitoring U0-05, multimeter measurement voltage * 1.414 > U0-05 (error within 10V), then the servo driver is faulty and needs to be sent back for repair
	1	E-041	Driver power down	Driver power off	Check the power supply

Type		Code	Description	Reasons	Solutions
	3	E-043	Bus Voltage Charging Failure	low voltage of power grid when normal power on	low voltage of power grid when normal power on
				Hardware damage	When the driver is on, please pay attention to whether there is relay actuation sound
	4	E-044	Three phase voltage input phase loss	Three phase input power supply is lack of phase	Check the power supply
06	0	E-060	The temperature is too high (The temperature alarm of the linear drive motor is related to the thermistor and only supports PT100 thermistor. Other types of thermistor are shielded from this alarm on the upper computer.)	Running under heavy load for a long time	Re-consider the capacity of the motor, monitor the U0-02 torque during operation, whether it is in the value of more than 100 for a long time, if yes, please chose the large-capacity motor or load reduction.
				Excessive ambient temperature	① Enhance ventilation measures and reduce environmental temperature; ② Check if the fan rotates when the servo is enabled; PT100 thermistor detects high temperature, fan turned on
				Fan damage	Change the fan
	1	E-061	Motor overheat	Alarm for motor temperature exceeding 140 ℃	① Check whether the motor fan is abnormal ② Contact the manufacturer
	3	E-063	Thermocouple disconnection alarm	Motor thermocouple breakage	Check the connection status of external thermocouples; Can be disabled when setting motor parameters in the upper computer wizard;
	0	E-080	Overspeed (actual speed ≥ P3-21/P3-22) The maximum forward speed is P3-21 and the maximum reverse speed is P3-22.	Motor speed too fast	(1) The maximum speed limit value P3-21/P3-22 was reduced. (2) To confirm whether the external force makes the motor rotate too fast, whether the pulse input frequency is too high, and whether the electronic gear ratio is too large.
				Encoder fault	(1) Check the encoder cable or change a new one (2) Set the servo driver to BB state and the driver to U-10. Rotate the motor shaft slowly by hand to see if the value of U-10 changes normally, increasing in one direction and decreasing in one direction (0-9999 cycle display).

Type		Code	Description	Reasons	Solutions
				Parameter setting	When the actual speed is greater than the P3-21/P3-22 value, an alarm will be given
		E-082	Encoder zero position deviation protection 1	Zero position deviation of motor encoder	① Check whether the three phases of the power line are connected according to the phase sequence of UVW ② Check the encoder zero position, please contact the manufacturer's technical support
	3	E-083	Speed command exceeds the limit	The speed command in position mode exceeds the set value of 13 * P3-21/P3-22	① Check the set values of P3-21/P3-22 ② Abnormal position command
10	0	E-100	Position offset too large	In position control, the difference between the given position and the actual position exceeds the limit value	(1) Observe whether the motor is blocked or not. (2) Reducing the given speed of position; (3) Increase the deviation pulse limit P0-23.
	1	E-101	Sudden change of position command	The instruction difference for cycle position is too large	① Check the given position command to confirm if any errors have caused excessive changes in the position command; ② Confirm whether the electronic gear ratio setting is too large, causing a sudden change in position command; ③ Confirm that the target position is consistent with the position feedback before mode switching or when the servo is enabled.
11	0	E-110	External UVW Short Circuit Discovered in Self-Inspection	Driver UVW output short circuit or motor failure	① Measure whether the UVW phase to phase resistance of the motor is balanced. If the phase to phase resistance is unbalanced, replace the motor; ② Measure whether there is a short circuit between the UVW and PE of the motor. If there is a short circuit, replace the motor; ③ Measure the UVW output on the driver side using a multimeter (diode gear) with a black probe P+and a red probe to measure UVW; Red probe P -, black probe for measuring UVW; If any of the 6 pressure drop values is 0, replace the driver

Type		Code	Description	Reasons	Solutions
				There is a blockage in the load section	Suggest running the motor on an empty shaft to eliminate load issues
				alarm at the moment of high-speed start stop	Increase acceleration and deceleration time
				Encoder problem	① Check the encoder cable or replace it with a new one; ② Set the servo driver to the bb state and the driver to U0-10. Slowly push the motor shaft by hand and check if the value of U0-10 changes normally, increasing in one direction and decreasing in the other direction (displayed in a loop from 0 to 9999)
	2	E-112	U-phase current overcurrent protection	There is a blockage in the load section	Suggest running the motor on an empty shaft to eliminate load issues
				alarm at the moment of high-speed start stop	Increase acceleration and deceleration time
				Encoder problem	① Check the encoder cable or replace it with a new one; ② Set the servo driver to the bb state and the driver to U0-10. Slowly push the motor shaft by hand and check if the value of U0-10 changes normally, increasing in one direction and decreasing in the other direction (displayed in a loop from 0 to 9999)
	3	E-113	V-phase current overcurrent protection	There is a blockage in the load section	Suggest running the motor on an empty shaft to eliminate load issues
				alarm at the moment of high-speed start stop	Increase acceleration and deceleration time
				Encoder problem	① Check the encoder cable or replace it with a new one; ② Set the servo driver to the bb state and the driver to U0-10. Slowly push the motor shaft by hand and check if the value of U0-10 changes normally, increasing in one direction and decreasing in the other direction (displayed in a loop from 0 to 9999)
15	0	E-150	Power cable disconnection	Any phase in UVW of driver, cable or motor broken	Disconnect the power supply of the driver and check the connection of the power cable. It is suggested that the multimeter be used to test the condition. After clearing the errors, the driver should be re-energized.

Type		Code	Description	Reasons	Solutions
16	1	E-161	Driver thermal power overload	Overload, the actual operating torque exceeds the rated torque, and continuous operation for a long time. (Monitor U0-02 to check the actual operating torque. If the motor is in normal operation, it will not jam or jitter. If the U0-02 is longer than 100, it will be considered improper selection of the motor.)	Increase the capacity of drivers and motors. Extend the acceleration and deceleration time and reduce the load. Monitor the U-00, whether it is running over speed.
				Mechanisms are impacted, suddenly weighted and distorted.	Eliminate mechanical distortion. Reduce load
				Wrong wiring of encoder cable, power cable or broken wire or loose pin of connector plug	Check the UVW connection of power cable to see if there is any phase sequence error. The multimeter is used to measure whether all the encoder cable are on. Check whether the plug is loose, for machine vibration, whether the plug has shrinkage pin, virtual welding, damage.
				In multiple mechanical wirings, incorrect connection of motor cable to other shafts leads to incorrect wiring.	Detection of servo wiring, the motor cable, encoder cable are correctly connected to the corresponding shaft.
				Poor gain adjustment results in motor vibration, back and forth swing and abnormal noise.	Readjustment of gain parameters
				Driver or motor hardware failure	There are servo cross test or motor empty shaft on site, F1-01 trial operation, F1-00 jog run can not rotate uniformly; Replace the new driver or motor
	5	E-165	Anti-blocking alarm Judging that the	(1) Machinery is impacted, suddenly becomes heavier and	① Eliminate the factors of mechanical distortion. Reduce load ② Monitor the actual output torque

Type		Code	Description	Reasons	Solutions
			current motor output torque is greater than P3-28/P3-29 (internal forward/reverse torque limit), and the time reaches P0-74 (unit ms), and the speed is lower than P0-75 (unit 1mm/s).	distorted; (2) The parameter setting is unreasonable.	range of U0-02 and check if the torque limit value is set reasonably.
20	0	E-200	Regenerative resistance overload	High Voltage Fluctuation in Power Grid	Stable the input voltage
				Selection of regenerative resistance is too small	Replacement of higher power regenerative resistors
				Acceleration and deceleration time is too short	Extending Acceleration and Deceleration Time
				Hardware damage	The AC gear of the multimeter measures the input value of the servo LN (R/S/T), which is 220V ± 10% of the normal value. If the power supply voltage is more than 220V+10% (380V+10%), check the power supply voltage; if the power supply voltage is normal, then in servo BB state, monitor U0-05, the voltage measured by the multimeter * 1.414 < U0-05 (within 10V error), then the servo driver is faulty and needs to be sent back for repair.
22	0	E-220	Communication error of absolute servo encoder	Unconnected encoder cable or poor contact	Check whether the value of U0-54 increases rapidly. If yes, the encoder circuit is disconnected.Disconnect the power supply of the driver, check the connection of the encoder cable, if there is cable loosening, it is recommended to use the multimeter to test the conduction condition; after eliminating errors, power on again Hot plugging is strictly prohibited, and special cables are required for tank chains.

Type		Code	Description	Reasons	Solutions
				Received encoder data errors, and the number of errors exceeds the number of error retries of encoder registers P0-56	Check whether the value of U0-79 and U0-54 increase. If yes, the encoder is interfered. Encoder wire and strong power do not have the same pipeline wiring; install filter on servo driver power input side; encoder wire sleeves magnetic ring; shut down welding machine type of equipment with large interference
	1	E-221	Too many CRC errors in encoder communication	Encoder is interfered with noise	Need to check if the cable uses twisted pair shielded wire, etc, strong and weak electricity should be separated, and power cables and encoder cables should not be tied up. The motor and driver should be well grounded. Encoder cable sleeve magnetic ring. Turn off equipment with high interference such as welding machines to determine the source of interference. Isolate the interference source.
	9	E-229	Encoder electrical angle zero position deviation protection	Encoder zero offset	Check the zero position of the encoder, please contact the manufacturer's technical support.
24	0	E-240	Timing error in fetching encoder position data	① Communication abnormality of servo drive encoder; ② Encoder signal is interfered; ③ Encoder malfunction	① Restart the drive; ② Check the wiring of the transmission cables to ensure that strong and weak electricity are separated and wired separately; ③ Separate power supply for high current equipment; ④ Good grounding
	1	E-241	Encoder responding data scrambling	① Received encoder data error; ② Encoder signal is interfered ③ Encoder malfunction	① Check the wiring of the transmission cables to ensure that strong and weak electricity are separated and wired separately; ② Separate power supply for high current equipment; ③ Good grounding
	2	E-242	Phase search failed	ABZ encoder phase finding failed	① Check for blockage; ② Is the encoder resolution set correctly;
	3	E-243	HALL status	HALL sensor error	Check if the installation and wiring of

Type		Code	Description	Reasons	Solutions
			error		the HALL sensor are normal
	4	E-244	BISS-C encoder reading head abnormality	BISS-C encoder abnormality	Check if the BISS-C reading head is functioning properly
25	0	E-250	Homing error	① P9-15 is not zero and the total homing time exceeds the time set by P9-15; ② New homing function parameter setting error	① Increase P9-15; ② Ensure that the direction of the mechanical offset (P9-19, P9-20) is opposite to the homing direction; ③ Check if there is a problem with the origin signal; ④ Check the parameter settings of the new homing function
26	0	E-260	Over range alarm	Overrun signal was detected and the overrun processing mode was configured to alarm	If you do not want to alarm immediately when the overrun occurs, you can change the overrun signal processing mode.
	1	E-261	Overrun signal connection error	(1) When the motor is in forward rotation, it encounters reverse overrun signal. (2) When the motor is in reverse rotation, it encounters forward overrun signal.	Check over-run signal connection and over-run terminal allocation.
	2	E-262	Control stop timeout	(1) Excessive inertia (2) Stop timeouts too short	(1) Reduce inertia or use brake motor; (2) Increase the stop timeout time P0-30
	4	E-264	Excessive vibration	(1) Oscillation caused by external forces (2) Load inertia is large and the setting of load inertia ratio is wrong or the gain is too small, which leads to the oscillation of positioning.	(1) Check the source of external force to see if there are any problems in mechanical installation; (2) Increase the servo gain to improve the anti-disturbance ability; (3) Acquisition speed curve analysis; When the first three peaks are convergenced after pulse instruction completed (0.8* | first peak | > | second peak | and 0.8* | second peak | > | third peak |), the driver should not alarm, which can adjust the relevant threshold. When the first three peaks speed are not less than 300mm/s for three consecutive times after the completion of the pulse instruction, the driver will alarm.

Type		Code	Description	Reasons	Solutions
	5	E-265	Excessive motor vibration	Mechanical vibration	Check the motor installation
28	0	E-280	Failed to read motor parameters	① Motor matching error; ② The encoder cable is not connected or wired incorrectly, or the cable is loose	① After professional personnel confirm that the driver and motor are compatible and can be used together. ② Check the connection of the encoder cable, measure the continuity of the encoder cable, or replace the encoder cable to check. ③ Check whether the driver and motor are normal. You can determine whether it is a problem with the driver or motor body by replacing it with a new one. It needs to be sent back to the manufacturer for inspection.
	1	E-281	Error writing data to encoder EEPROM	Request to write EEPROM failed	On the premise that the driver and motor are matched and can be used together, read the alarm shielding position of motor parameters through P0-53, and set the motor code of P0-33 correctly
32	0	E-320	Driver cascading alarm	Terminal emergency alarm function	Check if there are alarm output signals from other drivers connected to the SI input terminal of the driver, and prioritize processing this alarm. Correctly setting parameters P5-68
34	0	E-340	STO status is not synchronized	STO1 and STO2 input states are inconsistent	① Ensure that STO1 and STO2 are disconnected simultaneously; ② If a certain STO is still in a high level state after disconnecting the 24V power supply, please contact the original factory technical support.
	2	E-342	STO buffer circuit abnormal alarm	STO buffer circuit abnormality	Please contact the original factory technical support.
	3	E-343	EDM circuit error	EDM output signal error	Please contact the original factory technical support.

10.3 Alarm read

0000H ~ FEFFh is defined according to IEC61800-7-201.
FF00h ~ FFFFh can be defined according to users, as follows.
The lower 8 bits of the defined value (FF00h ～ FFFFh) shown in the following table indicates the main code of the alarm number of the servo abnormal (alarm). (the secondary code of the alarm number is not read.)
In addition, the main code of alarm number is represented by hexadecimal number.

Index	Sub-Index	Name/Description	Range	DateType	Access	PDO	Op-mode
603Fh	00h	Error code	0~65535	U16	ro	TxPDO	All
		Now the alarm of the servo driver (only the main number). When the alarm does not occur, it will display 0000H. When an alarm occurs, an alarm is displayed. FF**h Alarm (main) No. (00h ～ FFH) (Example) FF03h … 03h = 3d E-030 (overvoltage protection) occurs FF55h … 55h = 85d E-850 (TxPDO configuration error protection), E-851 (RxPDO configuration error protection) any one of them occurs As an exception, A000h is displayed in the case of E-817 (Syncmanager 2/3 setting error).					

Alarm code can also be read through SDO instruction. U1-00 corresponding object dictionary is 0x3100. The command is as follows:

Read the value in slave object dictionary 0x3100: 00 (current alarm code) with station number 0 to register D0. (Refer to *XDH/XLH motion control manual* for the specific use of this instruction)

10.4 Alarm clear

Reset method of protection function associated with EtherCAT that can be cleared in case of abnormal (alarm)
The following methods ①②③④ can be used for abnormal (alarm) clearing no matter which method.
In addition, for protection functions other than EtherCAT association, please refer to the basic function specifications of technical manual.

Method ①: bit4 (Error Ind ACK) of AL control is set to "1".
After that, bit7 of 6040h (control word) is cleared by setting 0→1 (sending Fault result command).
After the alarm is cleared, the PDS status is converted from Fault to Switch on disabled.

Method ②: carry out abnormal (alarm) clearing by servo driver (panel F0-00, upper computer software).
After the alarm is cleared, the PDS status is transferred from Fault to Switch on disabled.

Method ③: the external alarm clear input (A-CLR) of servo driver changes from OFF state to ON state.
After the alarm is cleared, the PDS status is migrated from Fault to Switch on disabled.

Method ④: Clear the alarm through SDO instruction. The object dictionary corresponding to F0-00 is 0x4000. The command is as follows:

When an alarm occurs, write 1 to D0 to clear the alarm.
(Refer to *XDH/XLH motion control manual* for the specific use of this instruction)

11 Applications

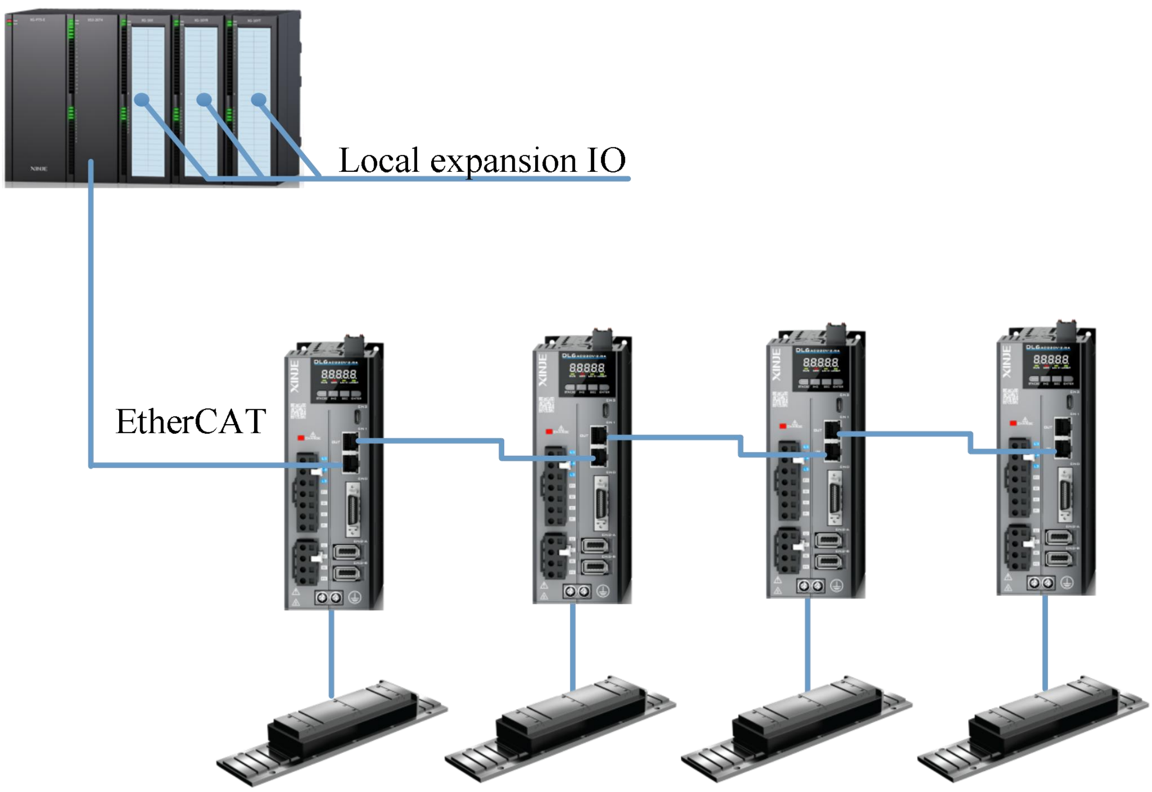
11.1 XINJE XG2/XDH and DL6 EtherCAT communication

This communication case takes DS5C1-20P4-PTA as an example, and the bus configuration of DL6-2003/2006 (- GS) is the same as DS5C1.

11.1.1 System configuration

Name	Model	Quantity	Note
Software	Xinje PLC software	1	
Xinje servo	DL6-2003(-GS)	1	
Cable	JC-CB-3	some	Connect servo and PC

11.1.2 System topology

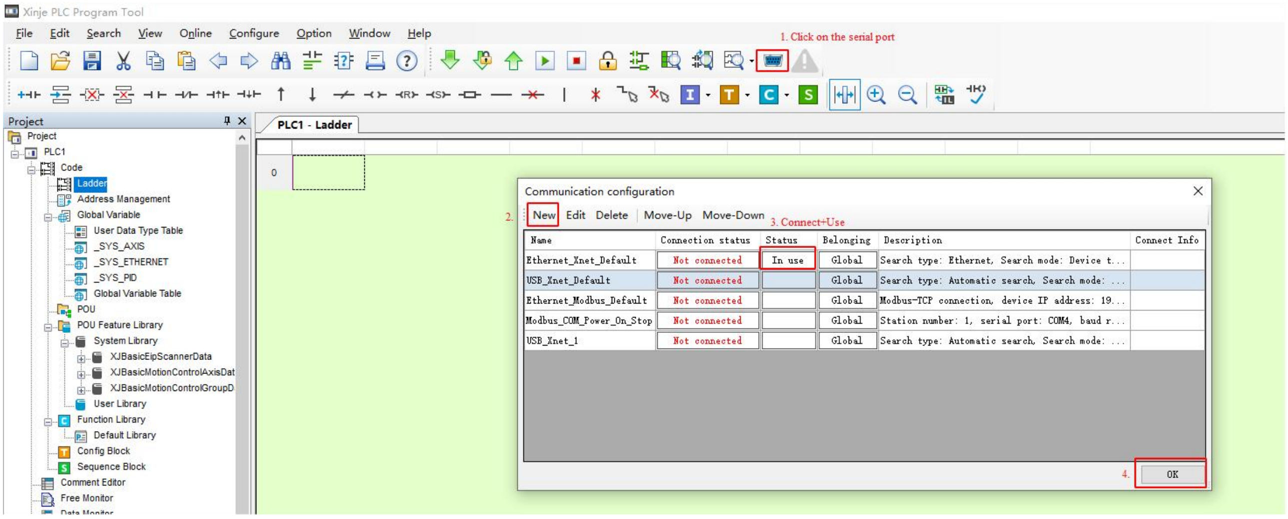


The DL6 drive network port plug follows the bottom in and top out standard, for example: the main station leads out the network cable and connects it to the IN network port of the first drive, leads out the network cable from the OUT network port of the first drive and then connects it to the IN network port of the second drive, and so on.

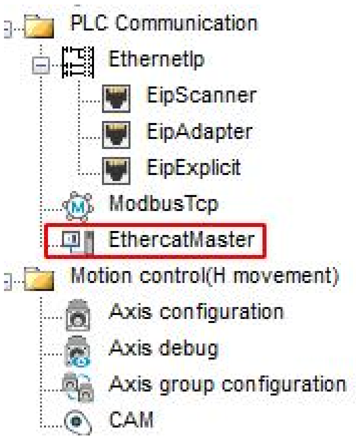
11.1.3 Debugging steps

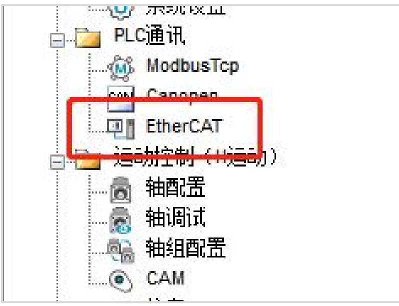
Debugging various EtherCAT bus control modes, taking H motion as an example (in PLC programming software versions 3.7.14 and above, H motion is default), SFD811=1).

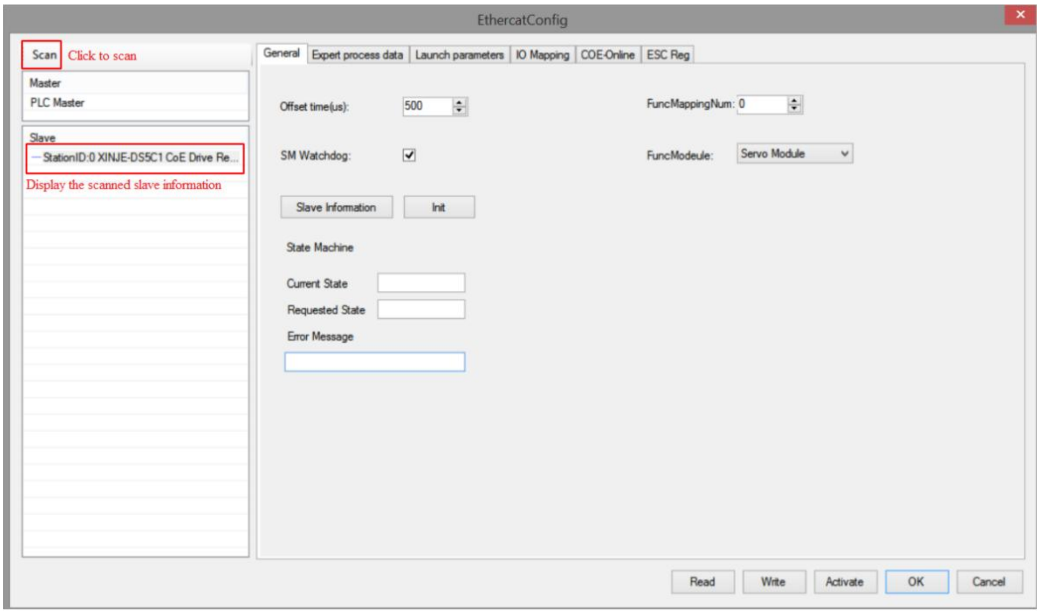
1. Connect PLC.



2. Configure EtherCAT.







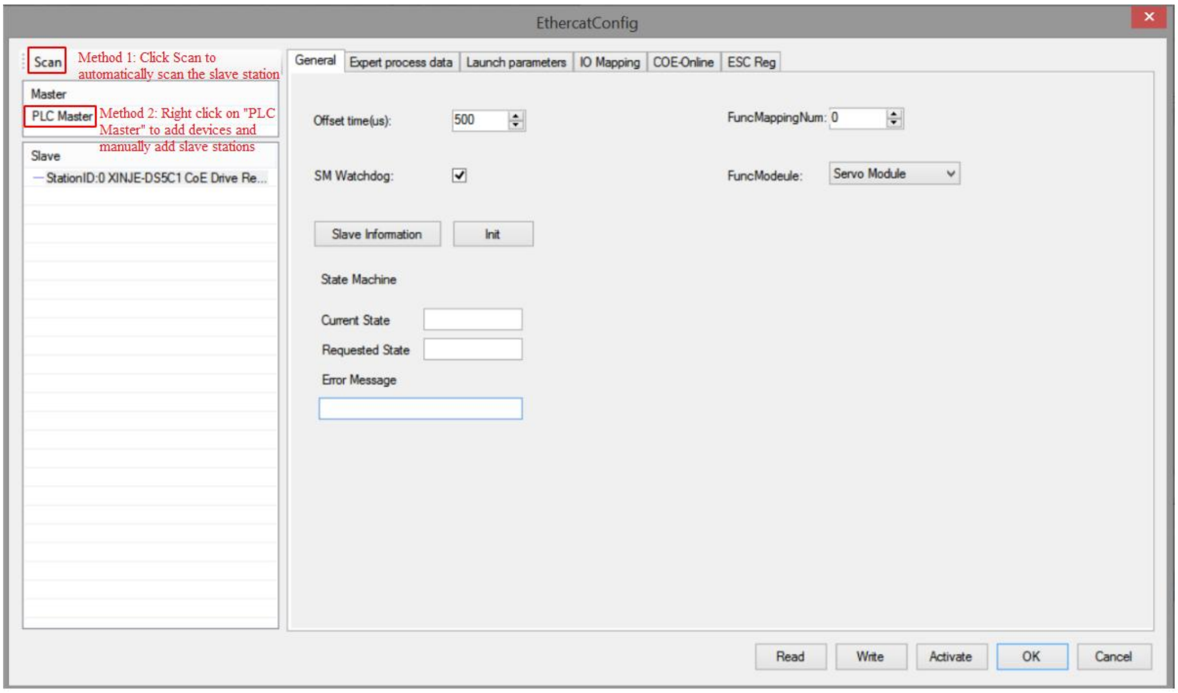
3. Confirm the PDO that needs to be configured in this mode in the [Expert Engineering Data].

1)CSP mode operation example

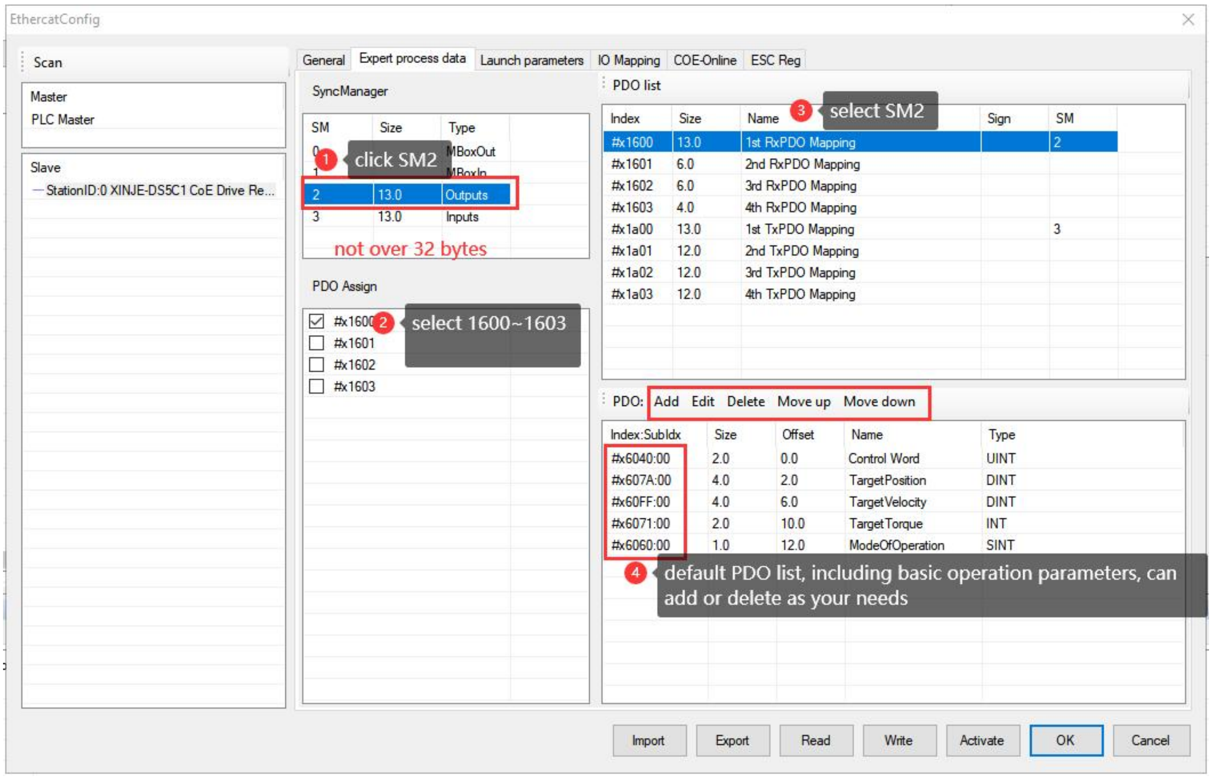
CSP control mode associated object

Register	Note	Unit
RXPDO[0x607A]	Position setting, Modification via IO mapping in CSP mode is invalid, which is controlled by NC module	Command unit
TXPDO[0x6064]	Position feedback (motor actual position)	Command unit
TXPDO[0x606C]	Speed feedback	Command unit/s
RXPDO[0x6060]	Control mode is CSP (Periodic Synchronization Position mode), set its Value to 8	-

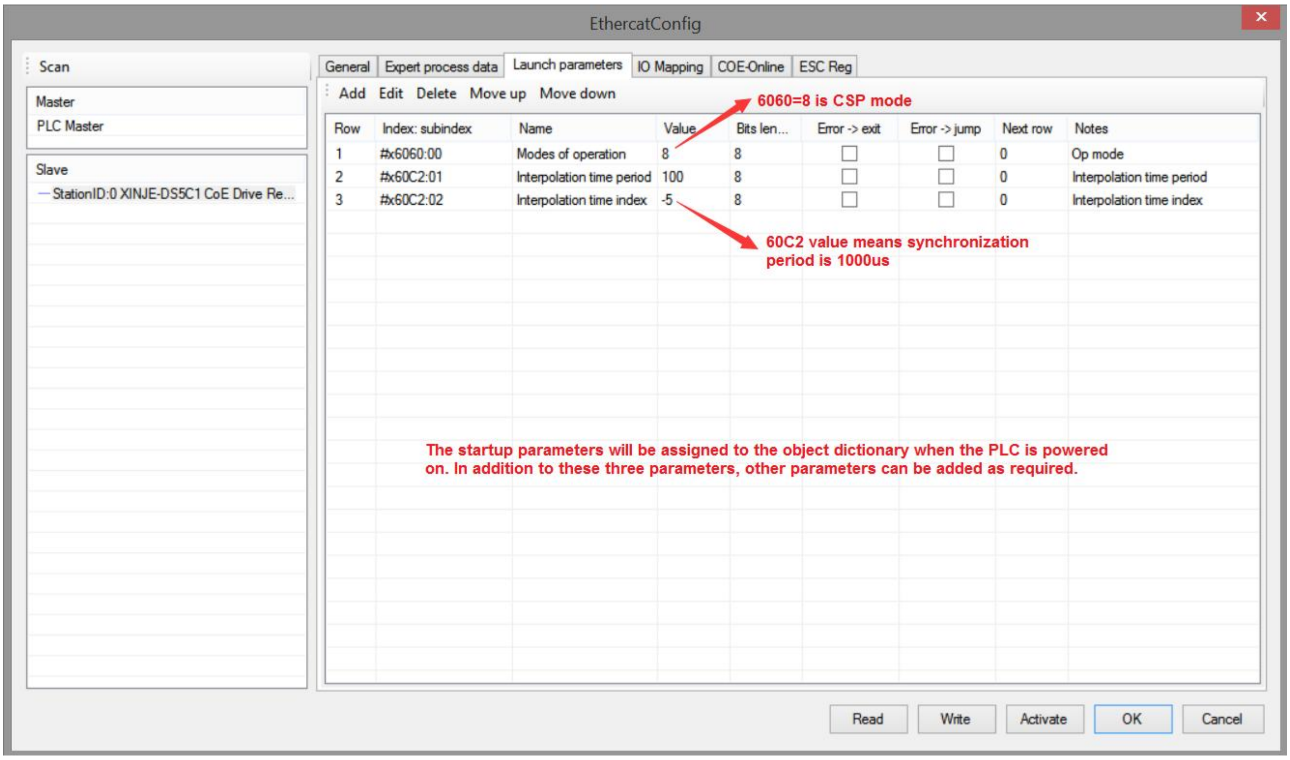
① Click【scan】or【add】in the EtherCAT interface,【general】interface please use default settings.



②Click【Expert process data】→【PDO assign】, select 1600, 1A00. (The default configuration can meet the basic use of CSP. If necessary, other PDO parameters can be added.)



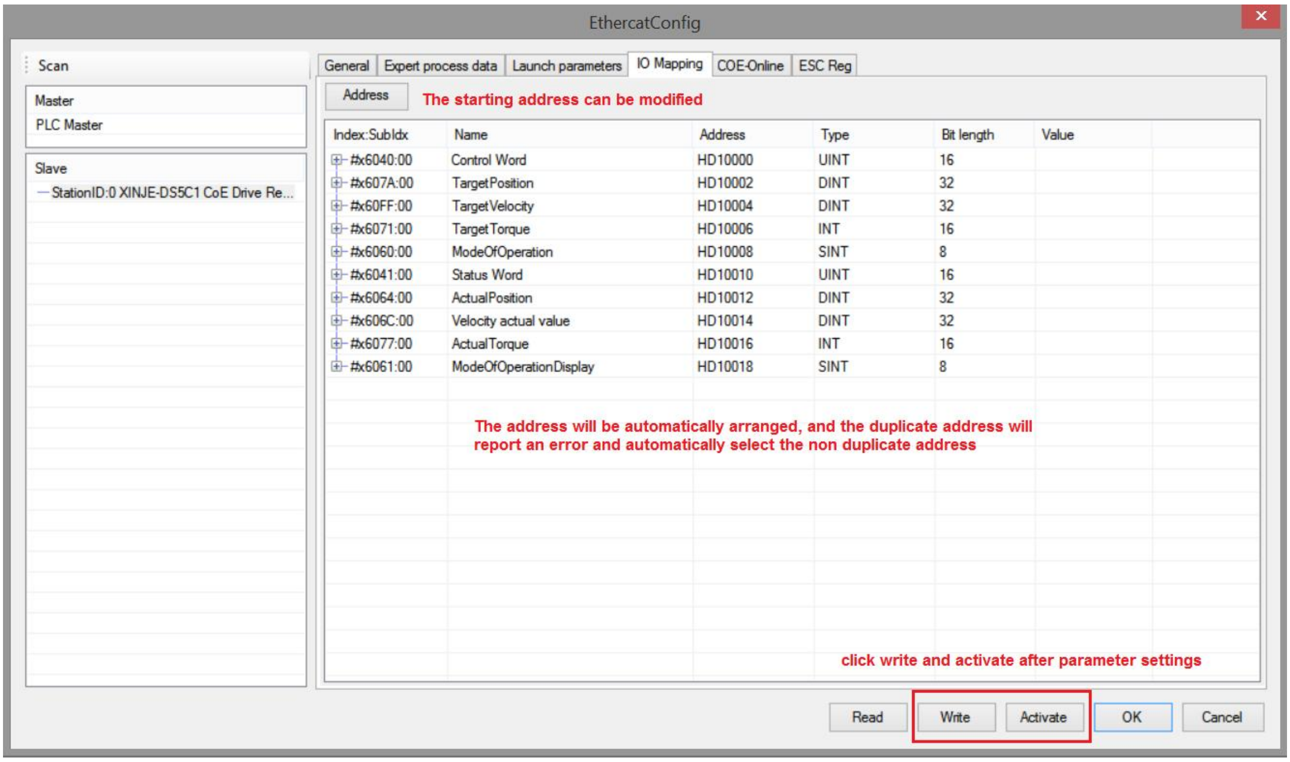
③Confirm 6060h value is 8 in【Lauch parameters】



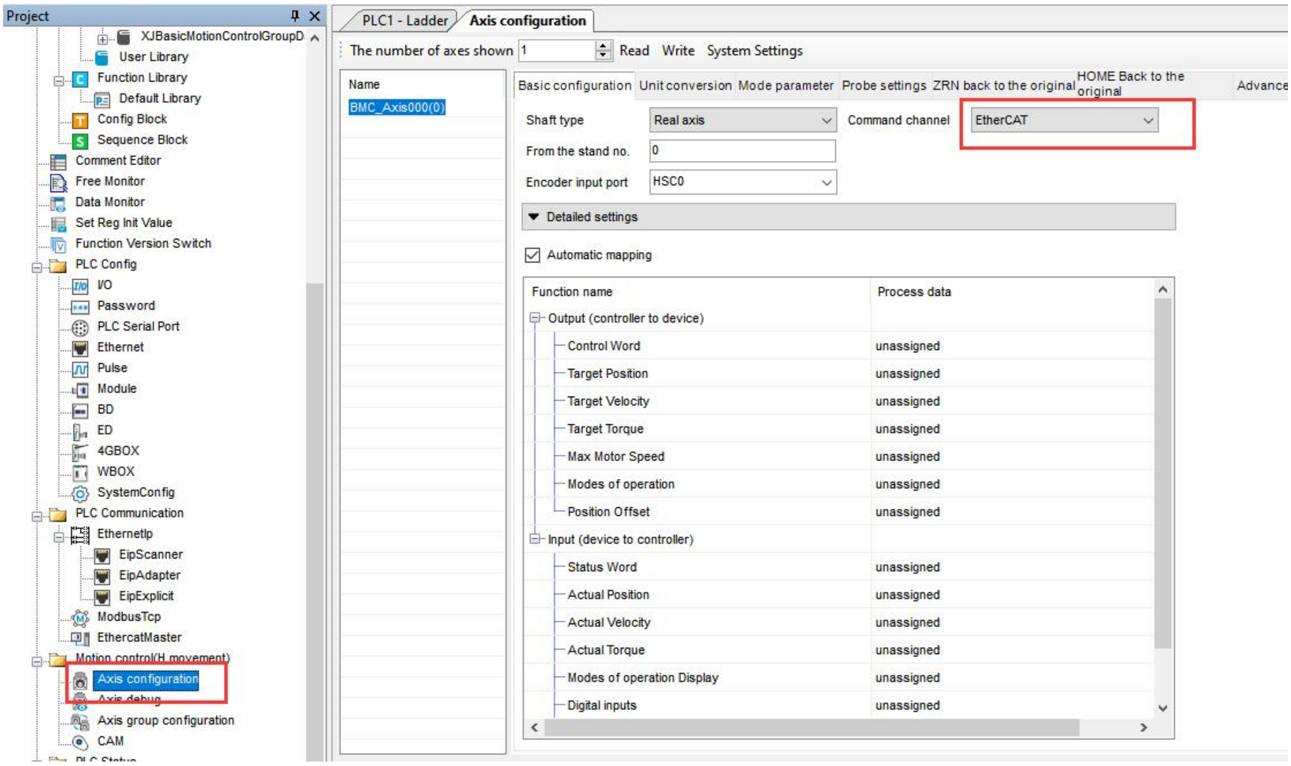
There are three default configurations in the startup parameters, among which 6060h is the slave operation mode, with a default value of 8 (CSP mode); 60C2-1 and 60C2-2 are synchronization unit cycles, 60C2-1 is the value of synchronization unit cycle, and 60C2-2 is the unit of synchronization unit cycle. For example, the default synchronization unit cycle is 100×10^{-5}s, which is 1000us. (This parameter will automatically change with the synchronization cycle of the main station configuration and does not require manual modification).

④【IO mapping】default start address is HD10000, which can be changed if necessary.

⑤ After setting all the parameters, click【write】→【activate】→【OK】. The parameters will take effect after the activation is successful.



The register can be selected as either D power-off hold or HD power-off hold, with HD being the default.
The offset starting point can be modified, with a default of 10000.
⑥ After the activation is completed, the slave station state machine (SD8021) will change state from 1 → 2 → 4 → 8, 8 means OP state. At this time, both SDO and PDO can receive and send messages.
⑦ Confirm that the instruction channel (SFD8001+300*N) in the axis configuration parameters is Ethercat (register value is 0).



⑧ In CSP mode, the current given position can be monitored through HD10002 (mapping of 607Ah), the current actual position of the motor can be monitored through HD10012 (mapping of 6064h), and the current actual speed can be monitored through HD10014 (mapping of 606Ch).


PLC1-自由监控1

监控窗口 ▾ | 添加 修改 删除 全部删除 | 上移 下移 置顶 置底

名称	监控值	类型	映射地址/字长	注释
M0	ON	BIT	位	使能
M20	OFF	BIT	位	周期位置运行
HD300	131072	LREAL	四字	周期位置
HD10002	131072	DINT	双字	Station ID:0,#x607A:0,Target position
HD10008	8	INT	单字	Station ID:0,#x6060:0,Modes of operation
HD10012	131072	DINT	双字	Station ID:0,#x6064:0,Position actual value
HD10004	0	DINT	双字	Station ID:0,#x60FF:0,Target velocity
SFD811	1	INT	单字	运动控制功能：0-简单型；1-入门实用型；

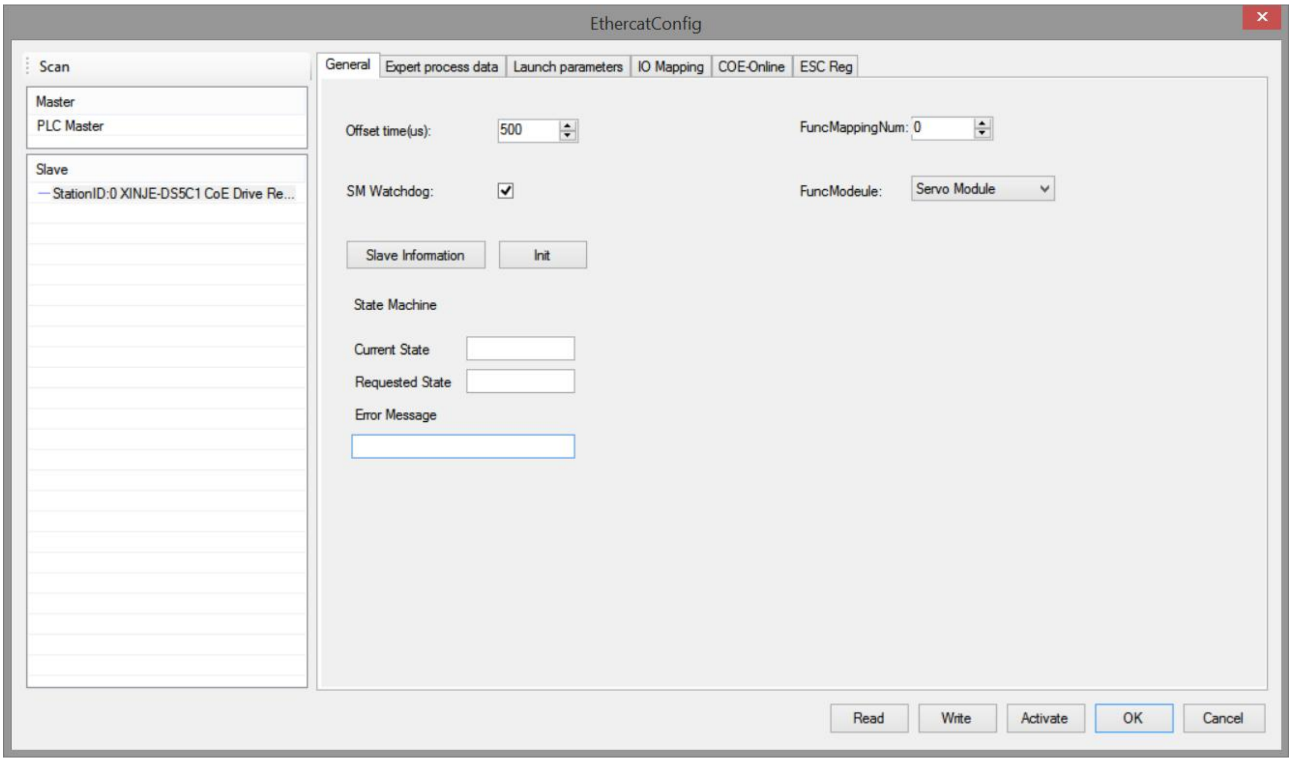
- When M20 goes from OFF to ON, perform periodic position control on the axis specified by HD300. After successful execution, M21 is set to ON to indicate that the axis is in a periodic control state. By periodically assigning values to HD300, control of the axis is achieved.
- Before triggering the command, please ensure that the value of HD300 is the same as the current position, otherwise the position will generate a step.
- Periodic position control requires periodic writing of the target position value into the register, with no significant changes in position, to avoid causing the axis to fly due to a large difference between the given cycle position and the previous cycle position.

2)CSV mode operation example

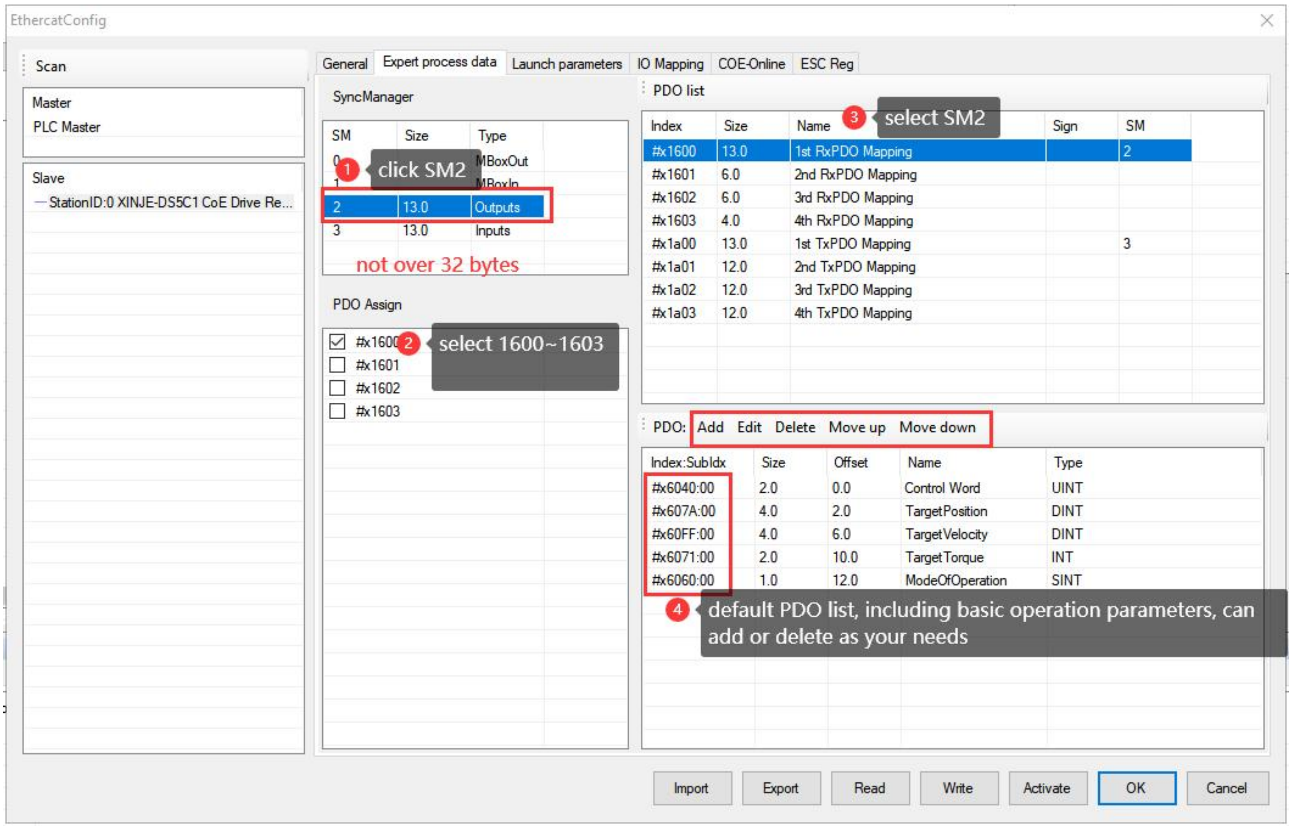
CSV control mode associated objects

Register	Note	Unit
RXPDO[0x60FF]	Target velocity	Command unit/s
TXPDO[0x6064]	Position actual value	Command unit
TXPDO[0x606C]	Velocity actual value	Command unit/s
RXPDO[0x6080]	Max motor speed ,can be modified online through COE-Online	r/min
RXPDO[0x6060]	Control mode is CSV (Periodic Synchronous Speed Mode), set its Value to 9	-

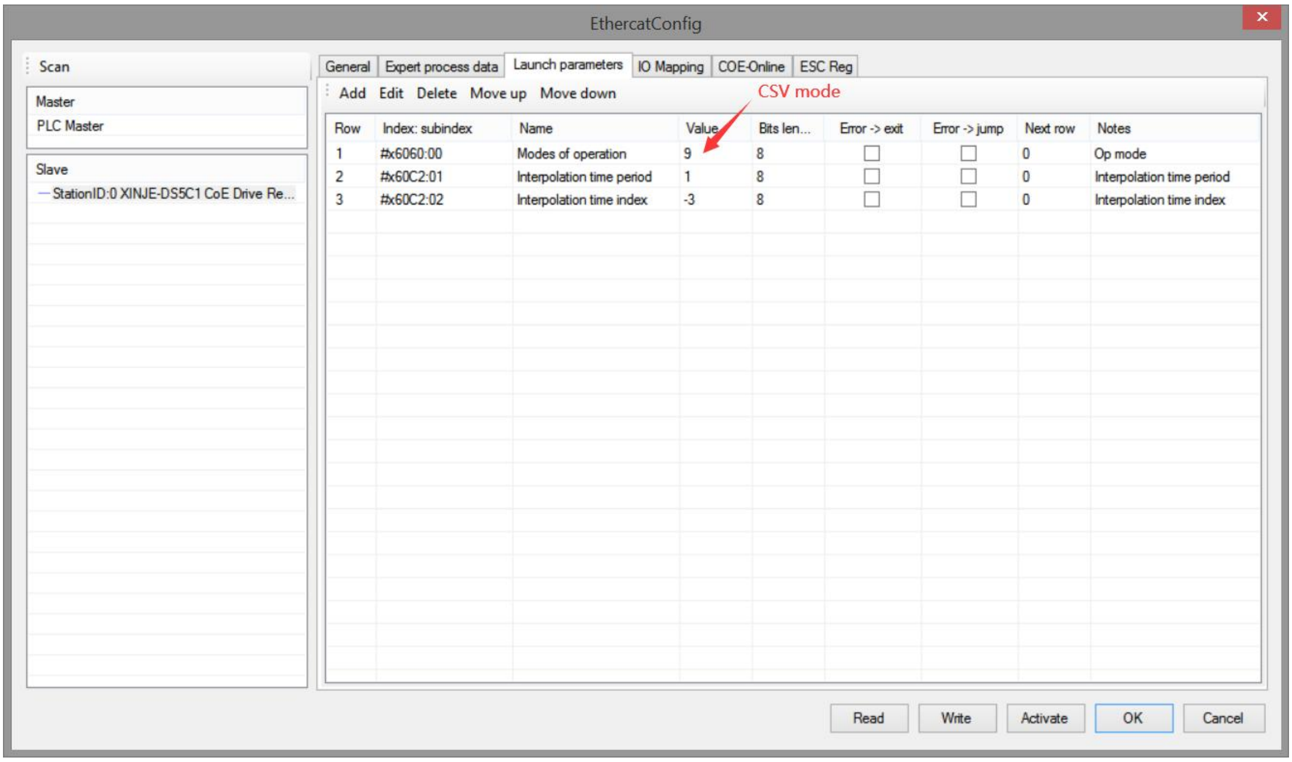
① Click【scan】or【add】in the EtherCAT interface,【general】interface please use default settings.



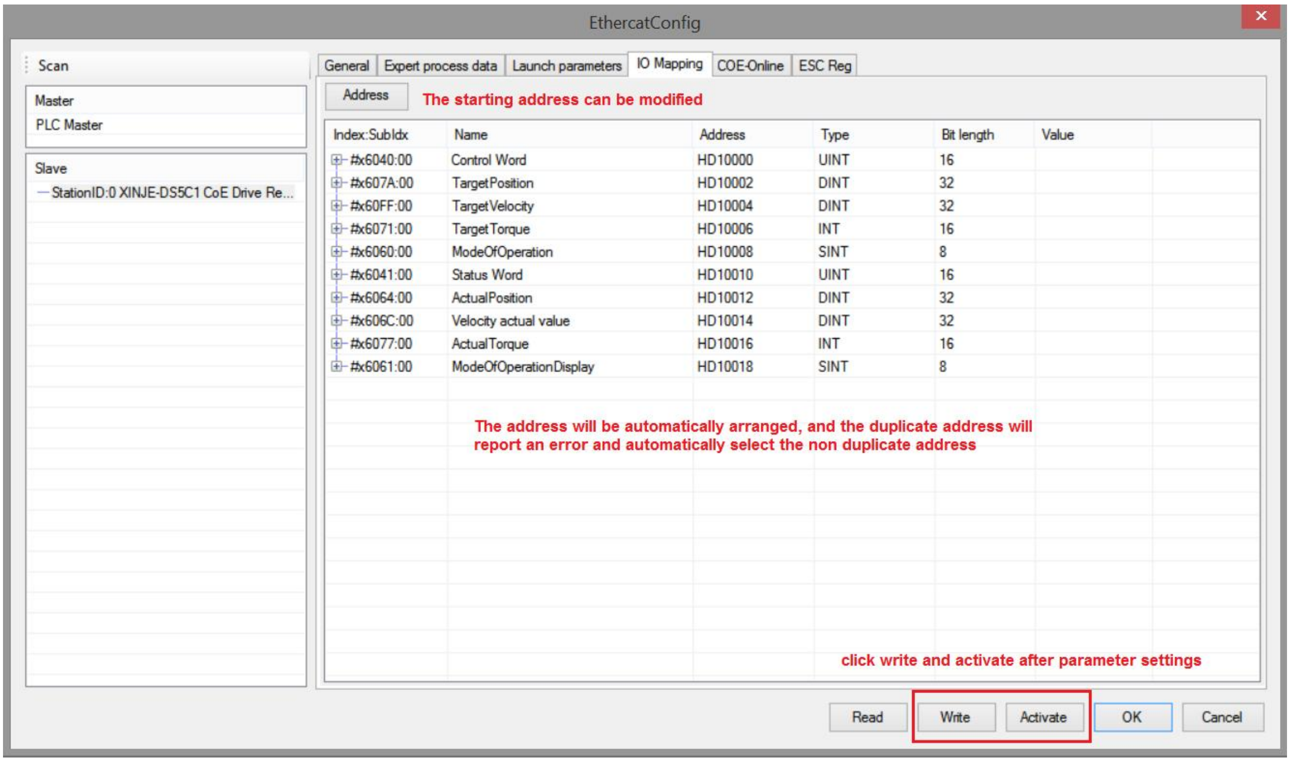
② Click 【Expert process data】→【PDO list】, select 1600, 1A00. (The default configuration can meet the basic use of CSV. If necessary, other PDO parameters can be added.)



③Confirm 6060h value in【Launch parameters】is 9.

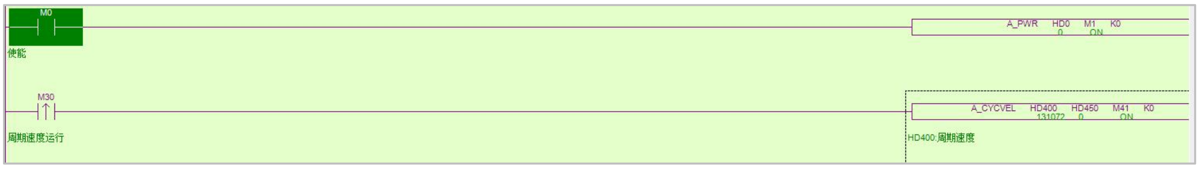


④ 【IO mapping】default start address is HD10000, which can be changed if necessary.
⑤ After setting all the parameters, click【write】→【activate】→【OK】. The parameters will take effect after the activation is successful.



⑥ After the activation is completed, the slave station state machine (SD8021) will change state from 1 → 2 → 4 → 8, 8 means OP state. At this time, both SDO and PDO can receive and send messages. After the state is switched to OP, 6080h (maximum motor speed) can be modified through COE-Online.
⑦After enabling ON, HD10000 (mapping of 6040h) will indicate the slave enable status from 6 → 7 → 15, which can be assigned a value to HD10004 (mapping of 60FFh) as the given speed in CSV mode (real-time speed interpolation can be achieved by modifying HD1004 in I9900 interrupt).

⑧ In CSV mode, the current given speed can be monitored through HD10004 (mapping of 60FFh), the current actual position of the motor can be monitored through HD10012 (mapping of 6064h), and the current actual speed can be monitored through HD10014 (mapping of 606Ch).

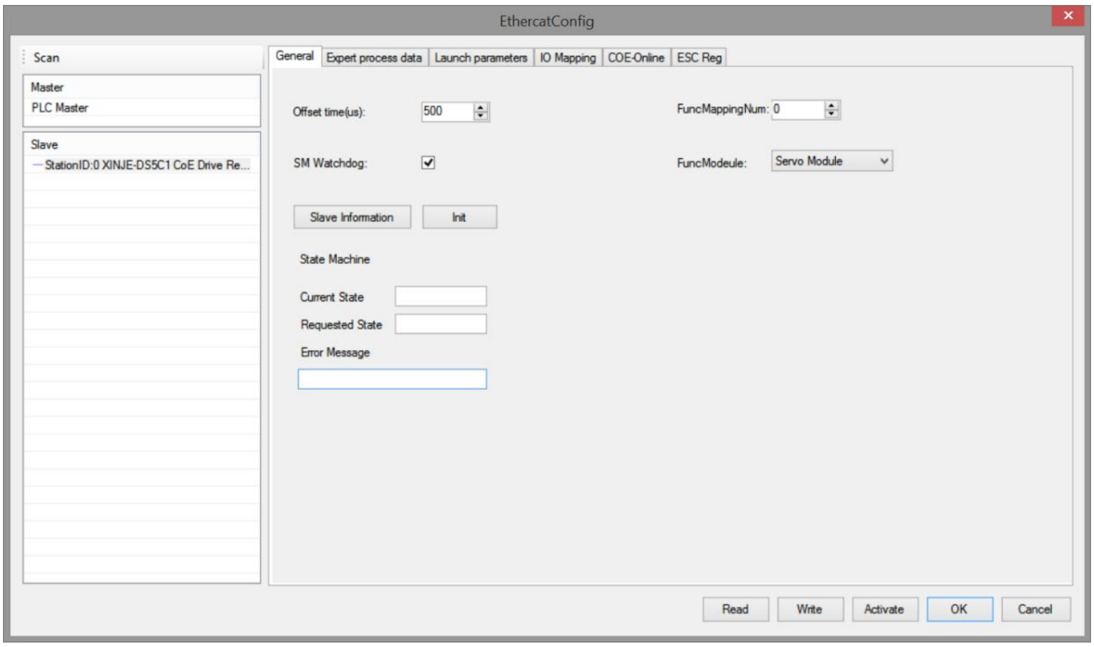


3)CST mode operation example

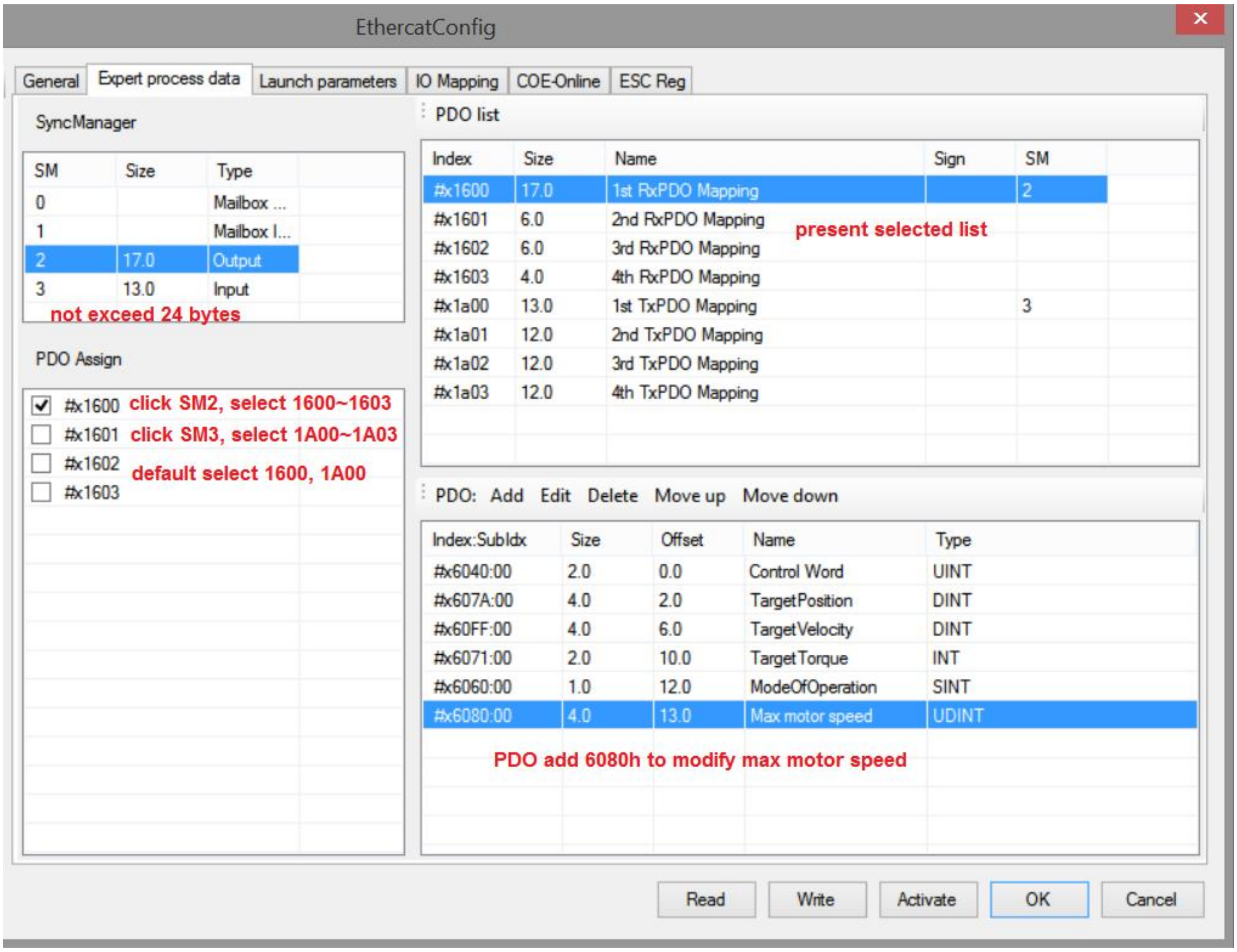
CST control mode associated object

Register	Note	Unit
RXPDO[0x6071]	Target torque	0.1%
TXPDO[0x6064]	Position actual value	Command unit
TXPDO[0x606C]	Velocity actual value	Command unit/s
TXPDO[0x6077]	Torque actual value	0.1%
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6060]	Control mode is CST (Periodic Synchronous Torque Mode), set its Value to 10	-

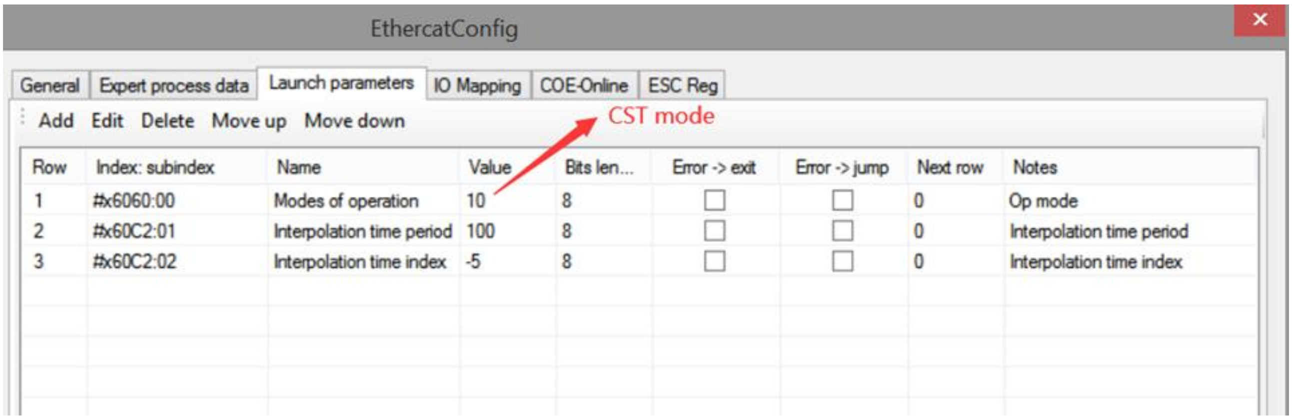
① Click【scan】or【add】in the EtherCAT interface,【general】interface please use default settings.



② Click【Expert process data】→【PDO list】, select 1600, 1A00. The default configuration can meet the basic use of CST. If necessary, other PDO parameters can be added. For example, add 6080h to modify max motor speed and limit the torque.

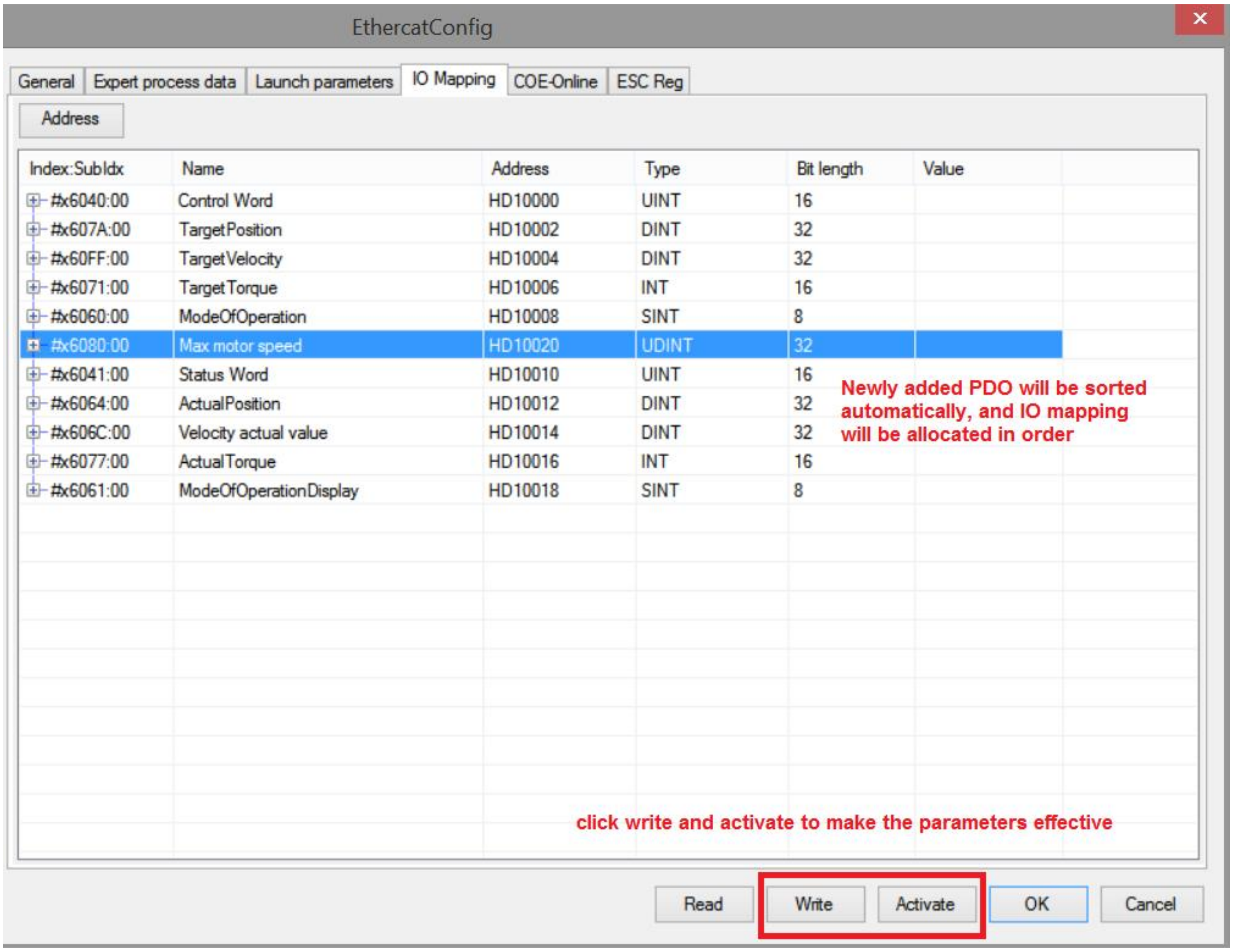


③ Confirm 6060h value in【Launch parameters】is 10.

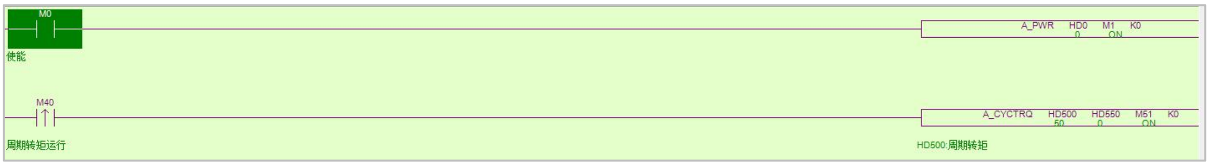


④【IO mapping】default start address is HD10000, which can be changed if necessary.

⑤ After setting all the parameters, click【write】→【activate】→【OK】. The parameters will take effect after the activation is successful.



⑥ After the activation is completed, the slave station state machine (SD8021) will change state from 1 → 2 → 4 → 8, 8 means OP state. At this time, both SDO and PDO can receive and send messages.
⑦ After enabling ON, HD10000 (mapping for 6040h) will indicate the slave enable state from 6 → 7 → 15, which can be assigned a value to HD10006 (mapping for 6071h) as the given torque in CST mode.
⑧ In CST mode, the current given torque can be monitored through HD10006 (mapping of 6071h), the current actual position can be monitored through HD10012 (mapping of 6064h), the current actual speed can be monitored through HD10014 (mapping of 606Ch), the current actual torque can be monitored through HD10016 (mapping of 6077h), and the maximum motor speed can be limited through 6080h.
Note: After adding the speed limit parameter, ensure that the speed limit is within the appropriate range during operation.



名称	监控值	类型	映射地址/字长	注释
M0	ON	BIT	位	使能
M40	OFF	BIT	位	周期转矩运行
HD500	50	LREAL	四字	周期转矩
HD10020	10	DINT	双字	Station ID:0,#x6080:0,Max motor speed
HD10002	3150984	DINT	双字	Station ID:0,#x607A:0,TargetPosition
HD10004	0	DINT	双字	Station ID:0,#x60FF:0,TargetVelocity
HD10008	10	INT	单字	Station ID:0,#x6060:0,ModeOfOperation
HD10014	21816	DINT	双字	Station ID:0,#x606C:0,Velocity actual value
HD10012	3150939	DINT	双字	Station ID:0,#x6064:0,ActualPosition
SFD811	1	INT	单字	运动控制功能：0-简单型；1-入门实用型；

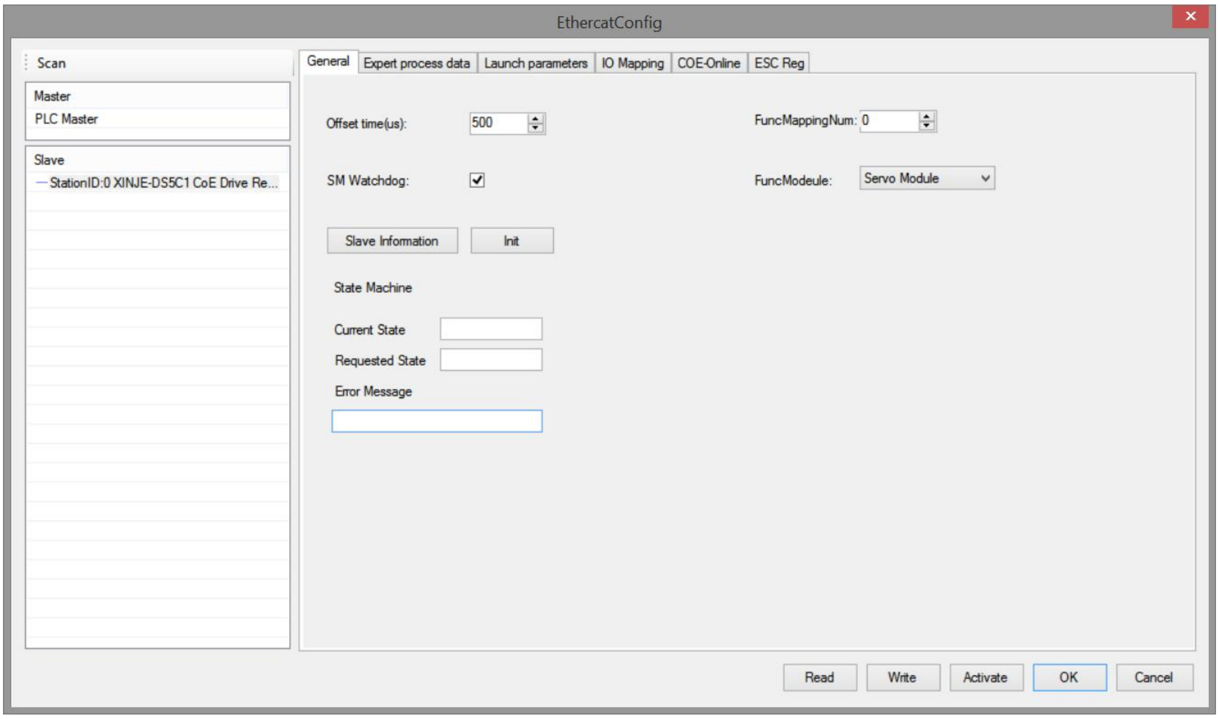
4)HM mode operation example

HM control mode related objects

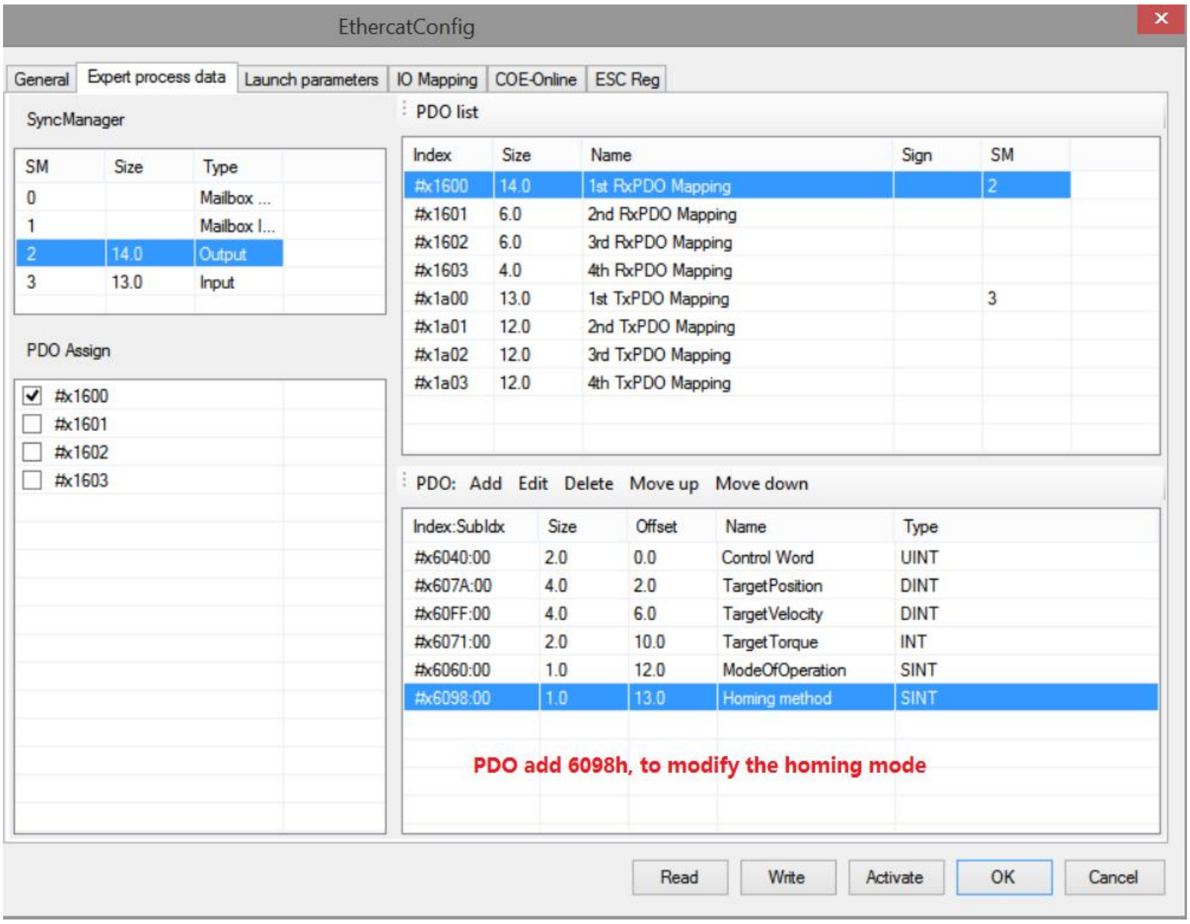
Register	Note	Unit
RXPDO[0x6040]	Control word, modify control word to enable homing	-
RXPDO[0x6098]	Homing mode	-
RXPDO[0x609A]	Homing acceleration speed	Command unit/s²
RXPDO[0x6060]	The control mode is HM mode (i.e. homing mode), and its value is set to 6 when the motor is not enabled	-
SDO[0x6099]	Homing speed, modify online through COE-Online	Command unit/s

① Terminal assignment is performed. P5-22 is the positive limit setting address, and the default value is 1, related to servo terminal SI1. P5-23 is the setting address of the reverse limit, and the default value is 2, related to servo terminal SI2, P5-27 is the origin setting address, and the default value is 3, related to servo terminal SI3.

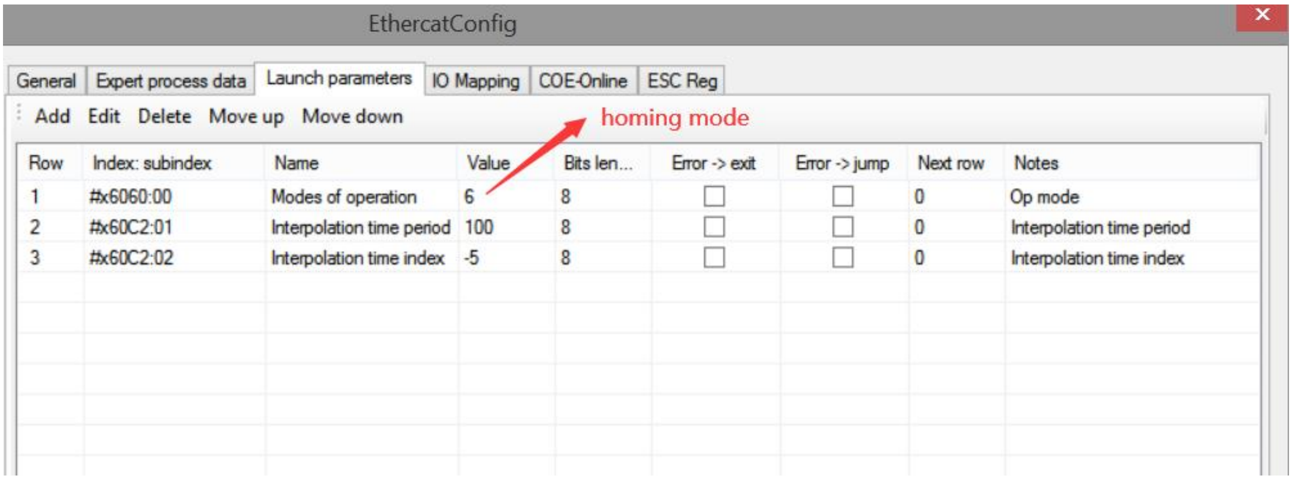
②Click【scan】or【add】in the EtherCAT interface,【general】interface please use default settings.



③【Expert process data】→【PDO list】select 1600, 1A00, add 6098h in 1600.

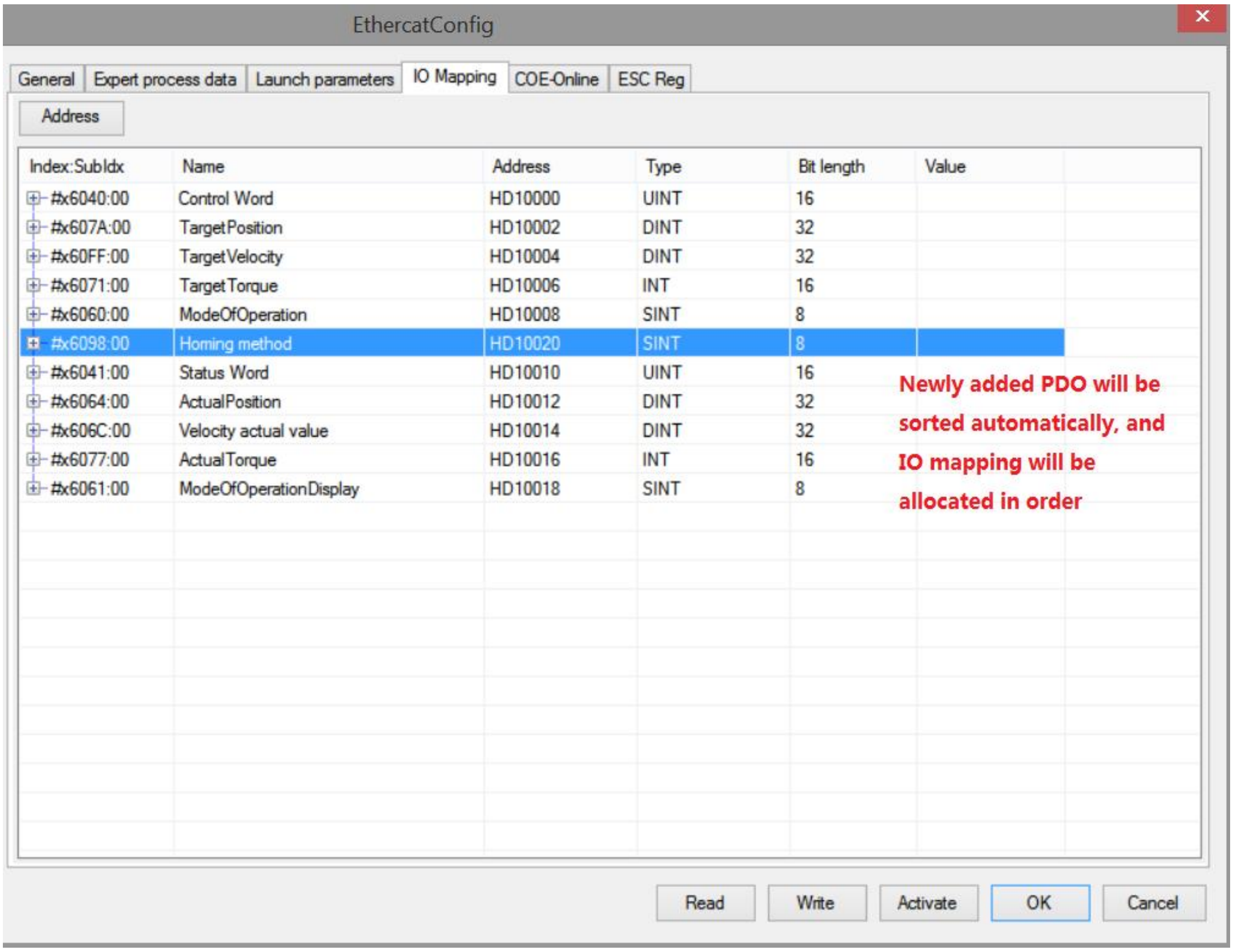


④ Confirm 6060h value in【Launch parameters】is 6.



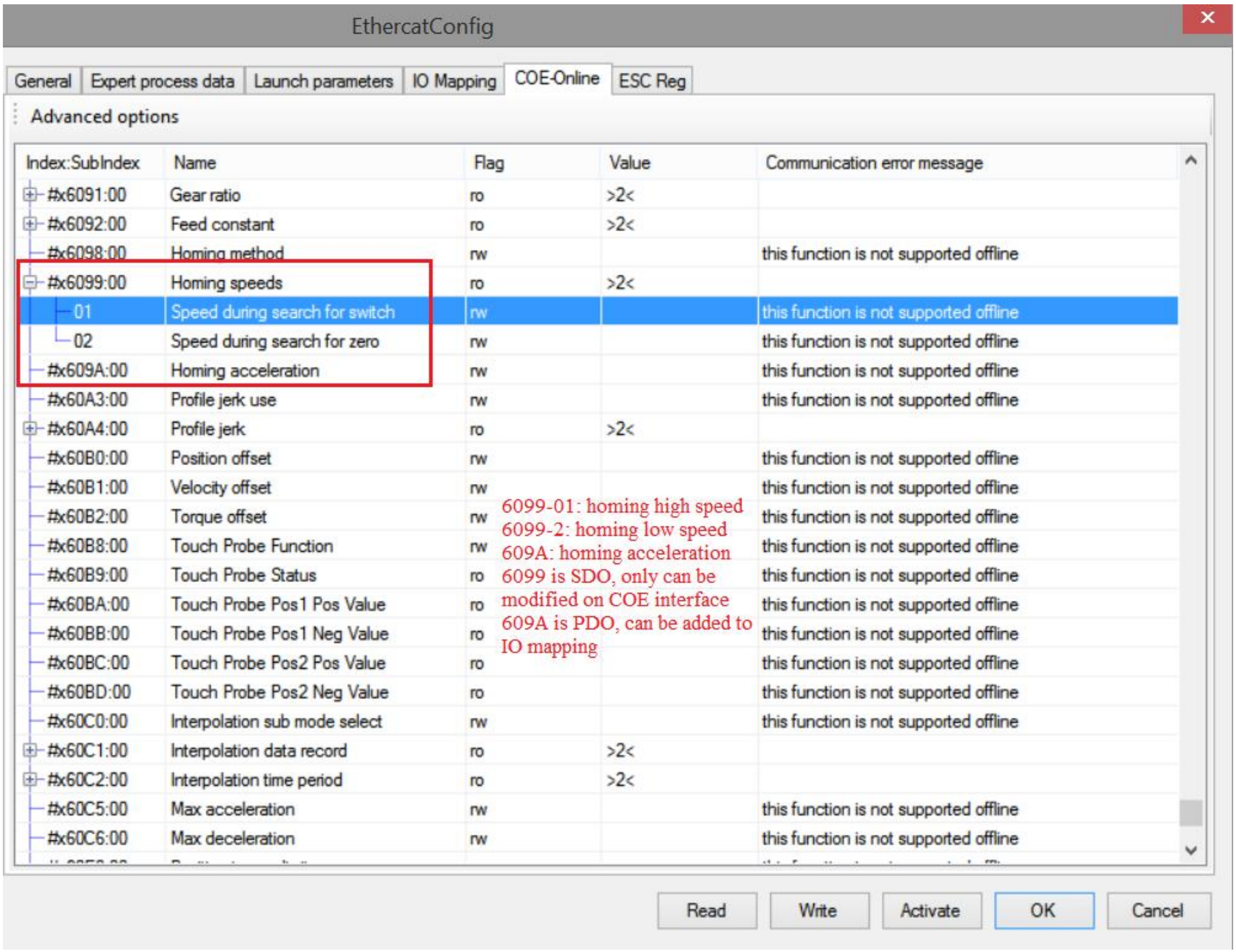
⑤【IO mapping】default start address is HD10000, which can be changed if necessary.

⑥ After setting all the parameters, click【write】→【activate】→【OK】. The parameters will take effect after the activation is successful.



⑦ After the activation is completed, the slave station state machine (SD8021) will be from 1 → 2 → 4 → 8, 8 means OP status. At this time, both SDO and PDO can receive and send messages.

⑧ After the state is switched to OP, the homing speed and acceleration can be modified through COE-Online.



⑨ Set the homing mode(6098h)。

This setting range is -2~37 (currently supports methods -2~14, 17~30, 33, 34, 35, 37)

⑩ After enabling ON, HD10000 (6040h mapping) will go from 6 → 7 → 15 to indicate the slave station's enabled state, and then HD10000 (6040h mapping) will go from 15 → 31 to enable the homing. During the homing process, if the origin signal is triggered, it will slow down and stop according to the corresponding way of homing. To homing again, first change 6040h to 15, and then HD10000 (mapping of 6040h) 15 → 31.

5)PP mode operation example

PP control mode related object (command・setting)

Register	Note	Unit
RXPDO[0x6040]	Control word	-
RXPDO[0x6060]	Set to 1	-
RXPDO[0x607A]	Target position	Command unit
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x607F]	Max Profile velocity	Command unit/s
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6081]	Profile velocity	Command unit/s
RXPDO[0x6083]	Profile acceleration	Command unit/s²
RXPDO[0x6084]	Profile deceleration	Command unit/s²

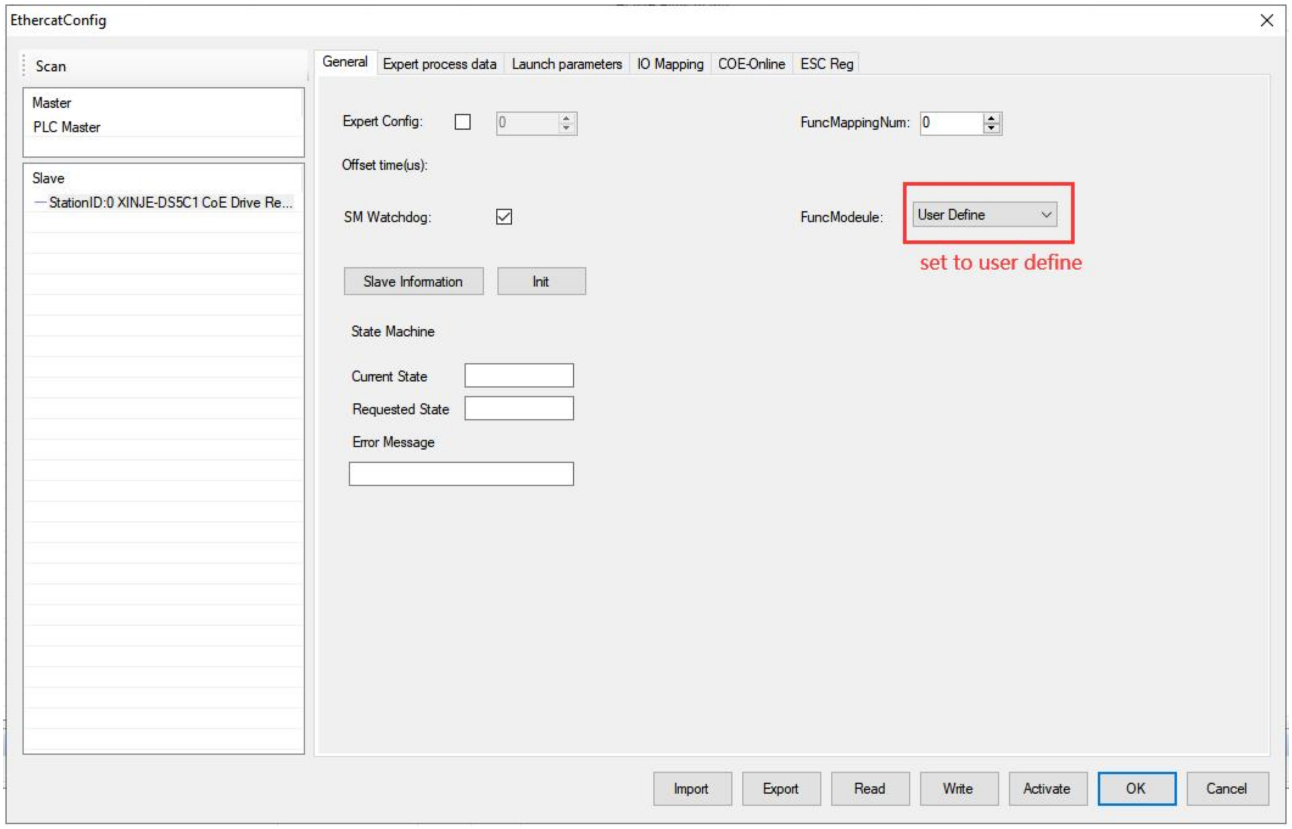
RXPDO[0x60C5]	Max acceleration	Command unit/s²
RXPDO[0x60C6]	Max deceleration	Command unit/s²
RXPDO[0x6065]	Following error window	Command unit
RXPDO[0x6066]	Following error time out	ms
RXPDO[0x6067]	Position windows	Command unit
RXPDO[0x6068]	Position window time	ms

- 6081h (profile speed) is limited by the smaller one of 607Fh (maximum internal speed) and 6080h (maximum motor speed).
- Changing the set value of 607Fh (maximum internal speed) or 6080h (maximum motor speed) during the operation is not reflected in the operation.

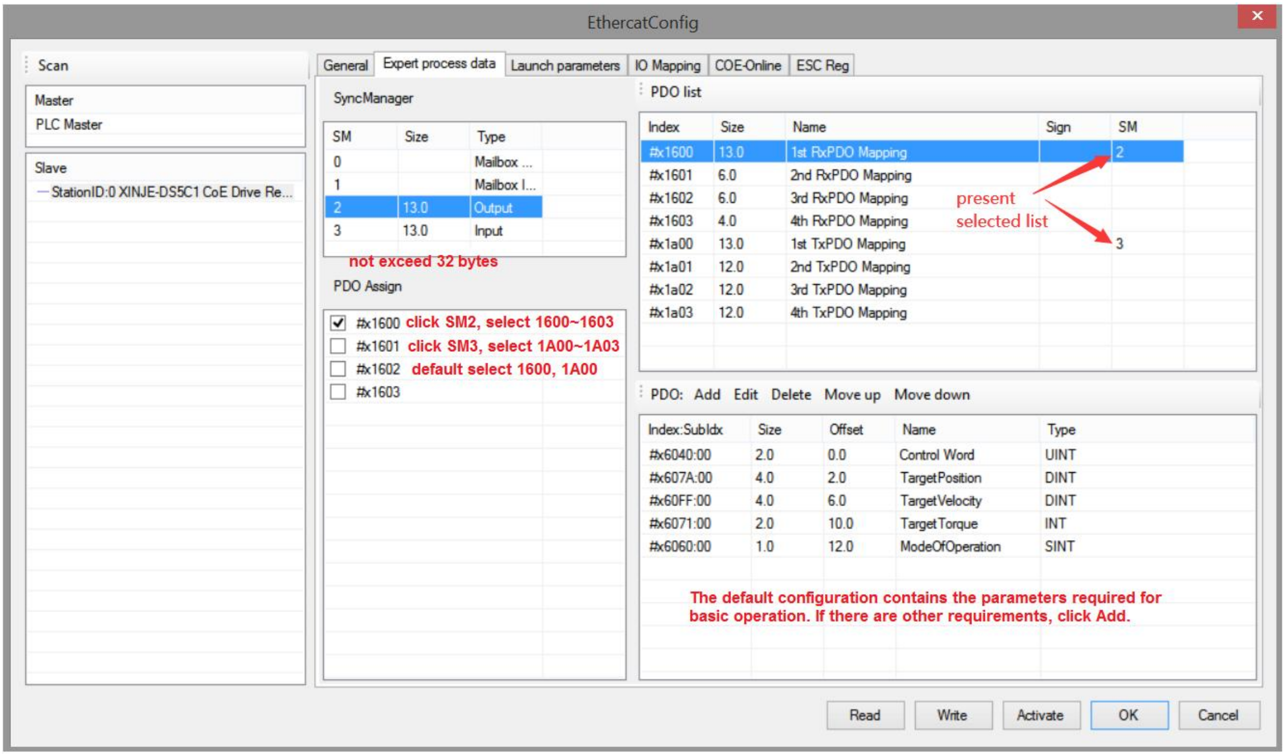
pp control mode related object (command・monitor)

Register	Note	Unit
TXPDO[0x6041]	Status word	-
TXPDO[0x6063]	Position actual internal value	Command unit
TXPDO[0x6064]	Position actual value	Command unit
TXPDO[0x606C]	Speed feedback	Command unit/s
TXPDO[0x6077]	Actual torque	0.1%
TXPDO[0x60F4]	Following error actual value	Command unit

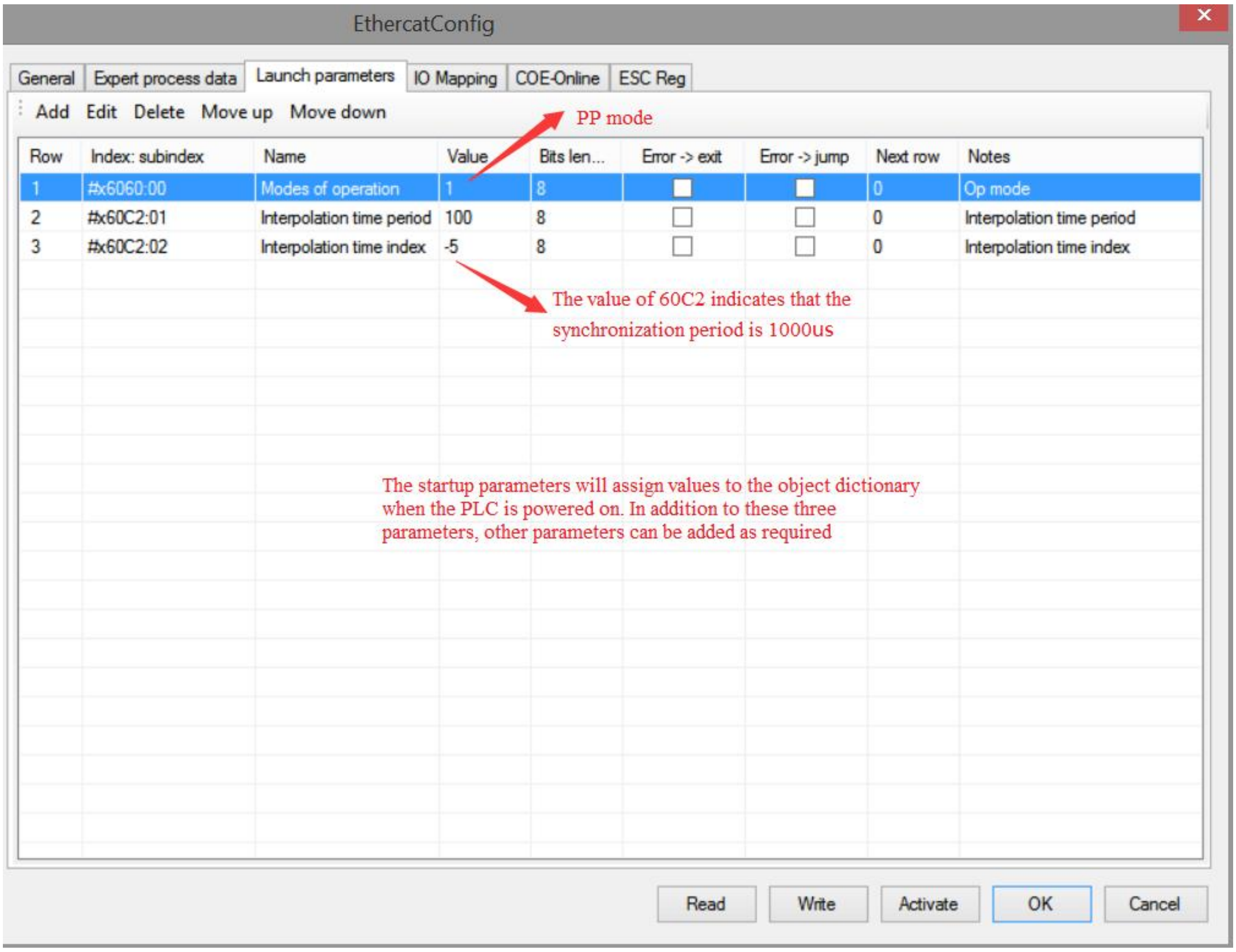
① Click【scan】or【add】in the EtherCAT interface, function module please set to user define in【general】interface.



②Click【Expert process data】→【PDO list】, select 1600, 1A00. PDO parameters associated with the mode can be added (1600 and 1A00 can not add more than 32 bytes respectively).

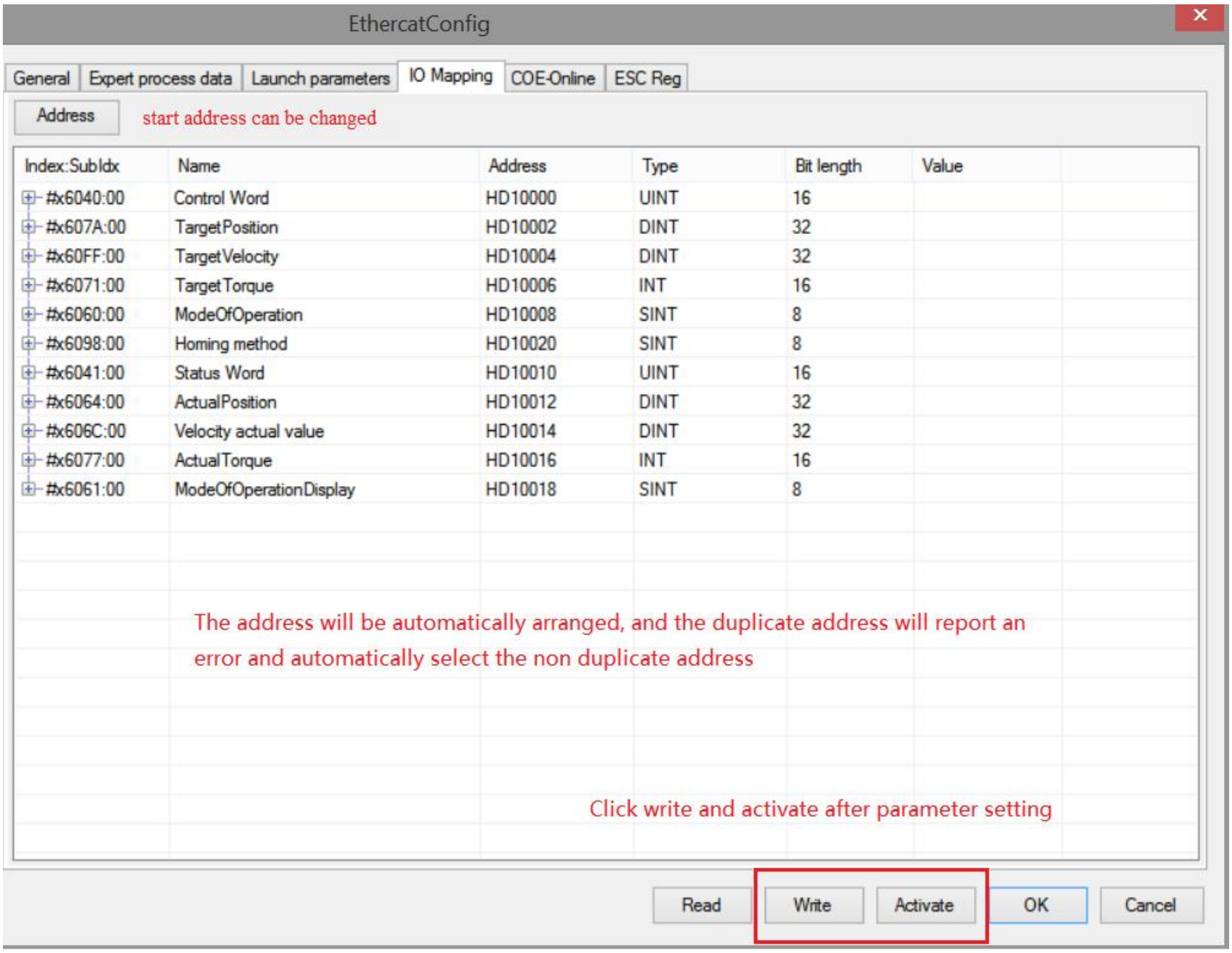


③Confirm 6060h value【launch parameters】is 1.



④ 【IO mapping】default start address is HD10000, which can be changed if necessary.

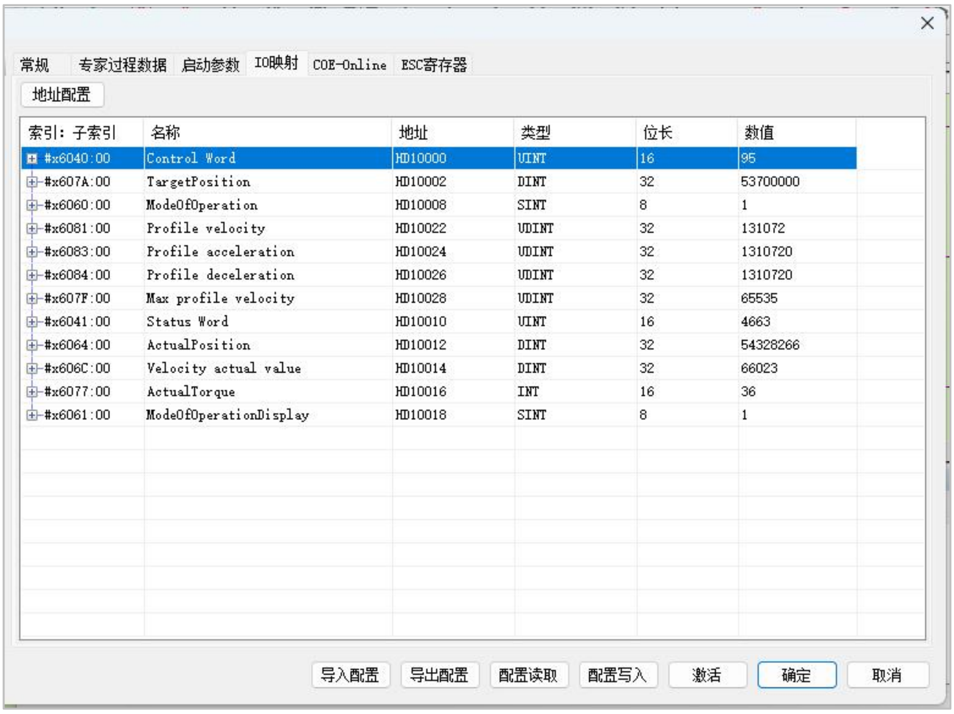
⑤ After parameter configuration is completed, click 【write】→【activate】→【OK】. After activation, the parameters will take effect.



⑥ After the activation is completed, the slave station state machine (SD8021) will from 1 → 2 → 4 → 8, 8 means OP status. At this time, both SDO and PDO can receive and send messages.

⑦ Modify the control word 6040 (absolute mode: 6 → 15 → 31, relative mode: 6 → 79 → 95) to enable the slave station to move the motor by setting the target position, target speed, acceleration and deceleration and other parameters.

⑧ In PP mode, data can be monitored through I/O mapping address setting. For example, the control word of axis1 can be modified through HD10000 (mapping of 6040h), the motor can be enabled or disabled, and the given position of current axis 1 can be monitored through HD10004 (mapping of 607Ah).



6) PV mode operation example

PV control mode associated object (instruction/setting)

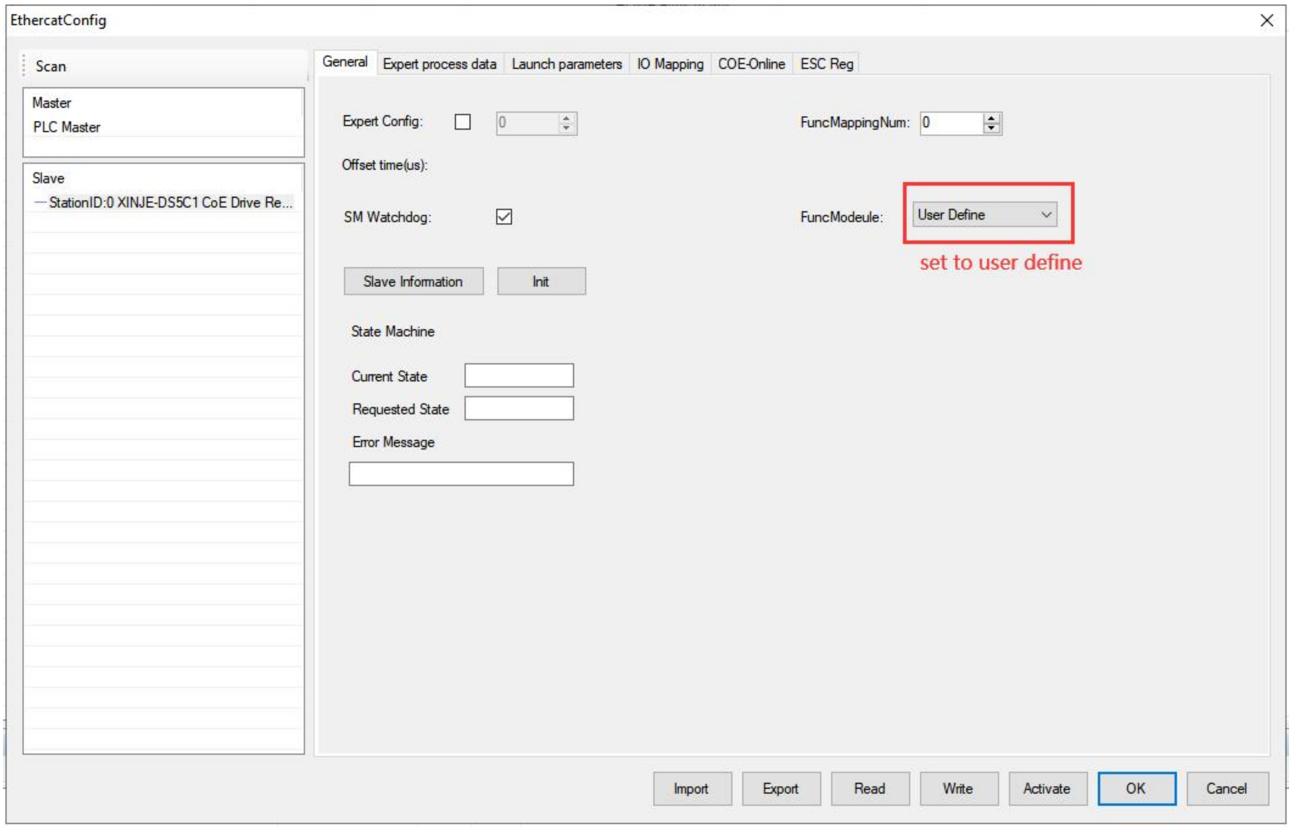
Register	Note	Unit
RXPDO[0x6040]	Control word	-
RXPDO[0x6060]	Set to 3	-
RXPDO[0x60FF]	Target velocity	Command unit/s
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x607F]	Max Profile velocity	Command unit/s
RXPDO[0x6080]	Max motor speed	r/min
RXPDO[0x6083]	Profile acceleration	Command unit/s^2
RXPDO[0x6084]	Profile deceleration	Command unit/s^2
RXPDO[0x60C5]	Max acceleration	Command unit/s^2
RXPDO[0x60C6]	Max deceleration	Command unit/s^2

RXPDO[0x606D]	Velocity window	Command unit/s
RXPDO[0x606E]	Velocity window time	ms
RXPDO[0x606F]	Velocity threshold	Command unit/s
RXPDO[0x6070]	Velocity threshold time	ms

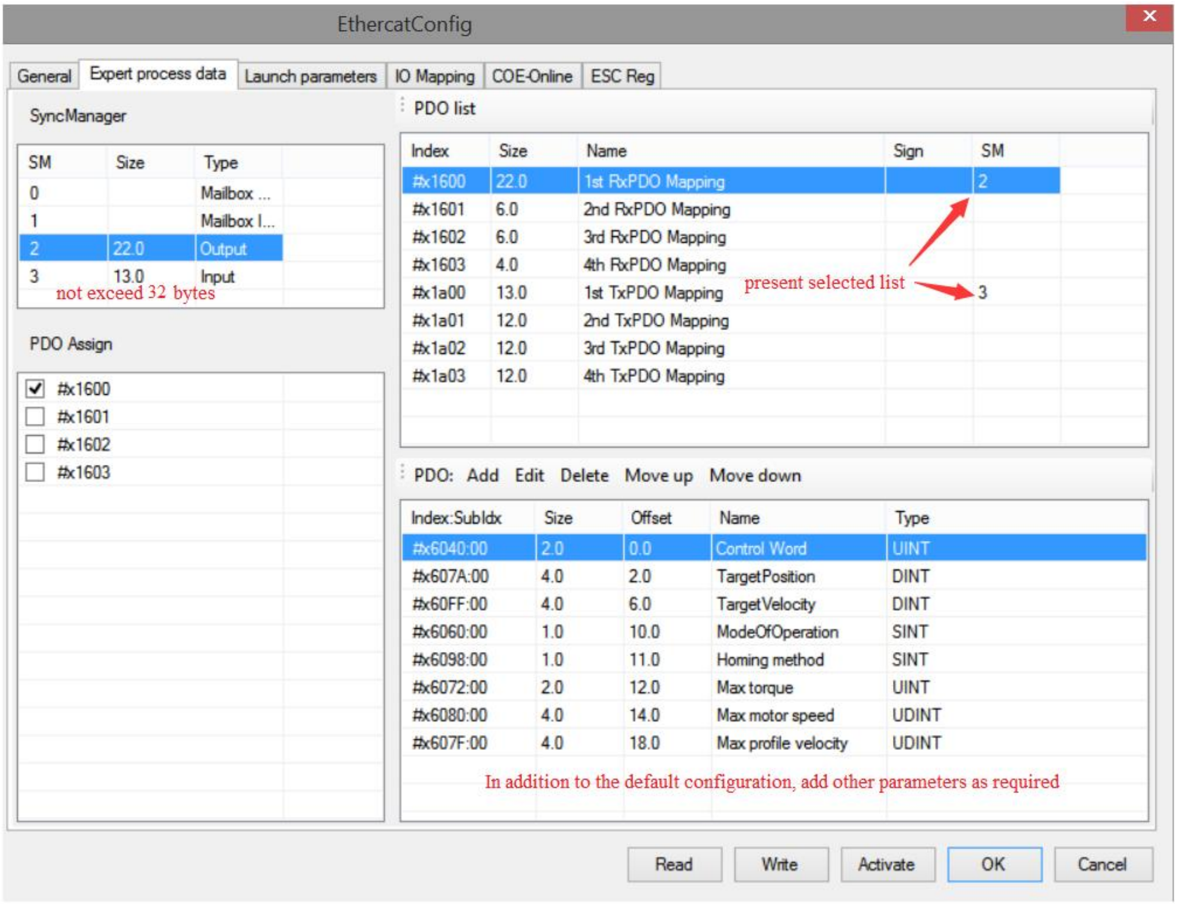
pv control mode related object (command・monitor)

Register	Note	Unit
TXPDO[0x6041]	Status word	-
TXPDO[0x6064]	Position actual value	Command unit
TXPDO[0x606C]	Velocity actual value	Command unit/s
TXPDO[0x6077]	Torque actual value	0.1%

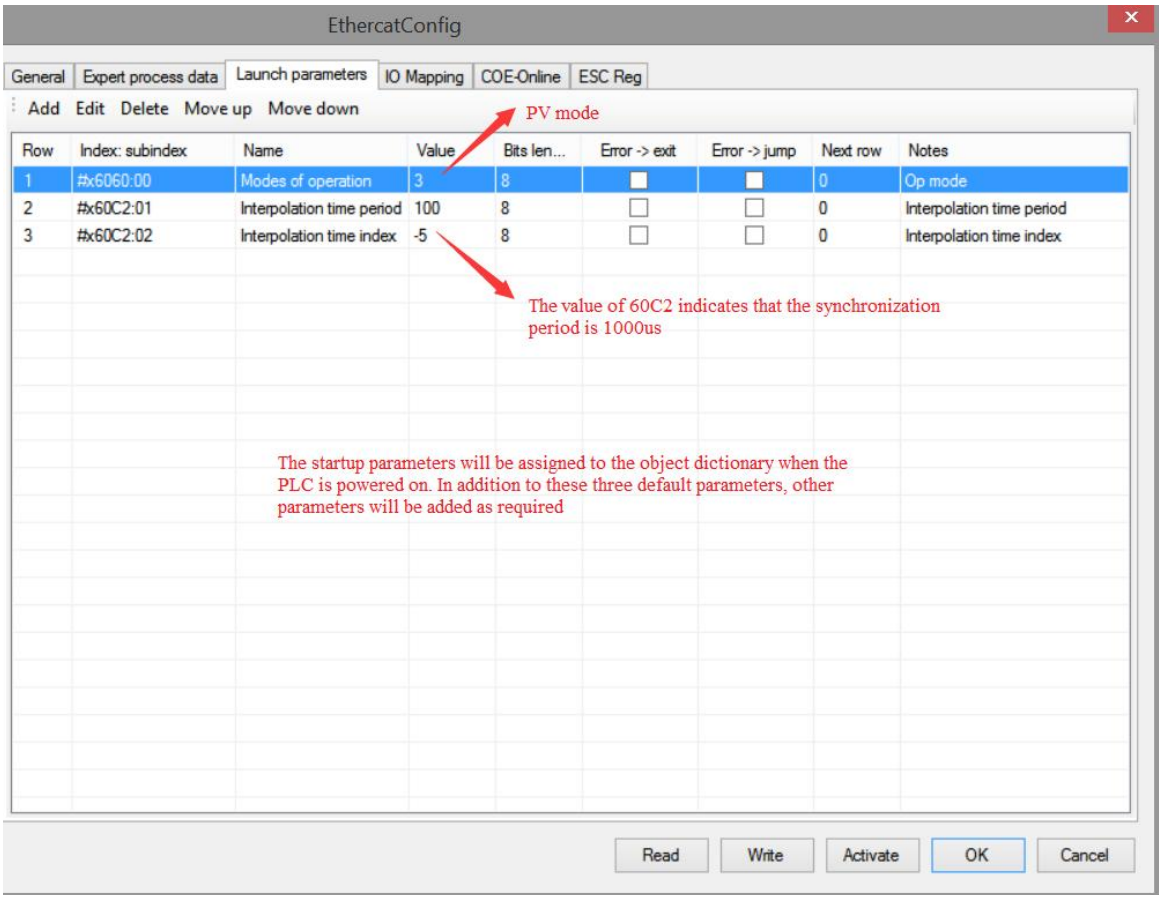
① Click【scan】or【add】in the EtherCAT interface, function module please set to user define in【general】interface.



② Click【Expert process data】→【PDO list】, select 1600, 1A00. PDO parameters associated with the mode can be added (1600 and 1A00 can not add more than 32 bytes respectively)

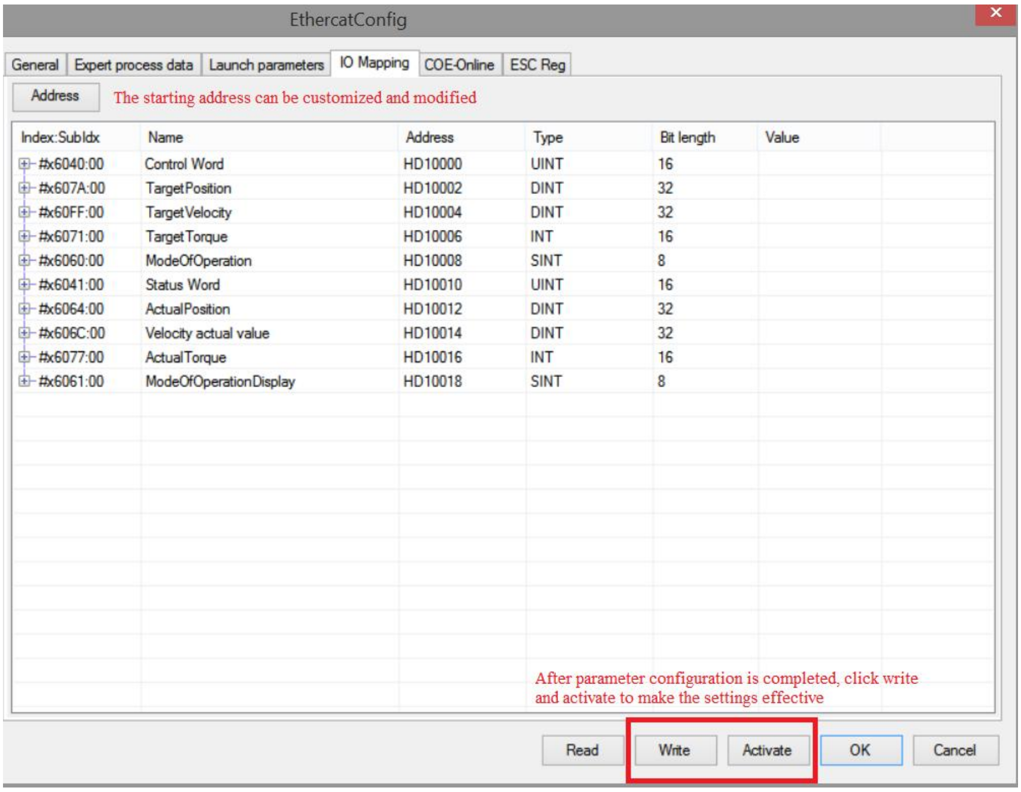


③ Confirm the 6060h value in【Lanuch parameter】is 3.



④【IO mapping】The starting address can be customized and modified.

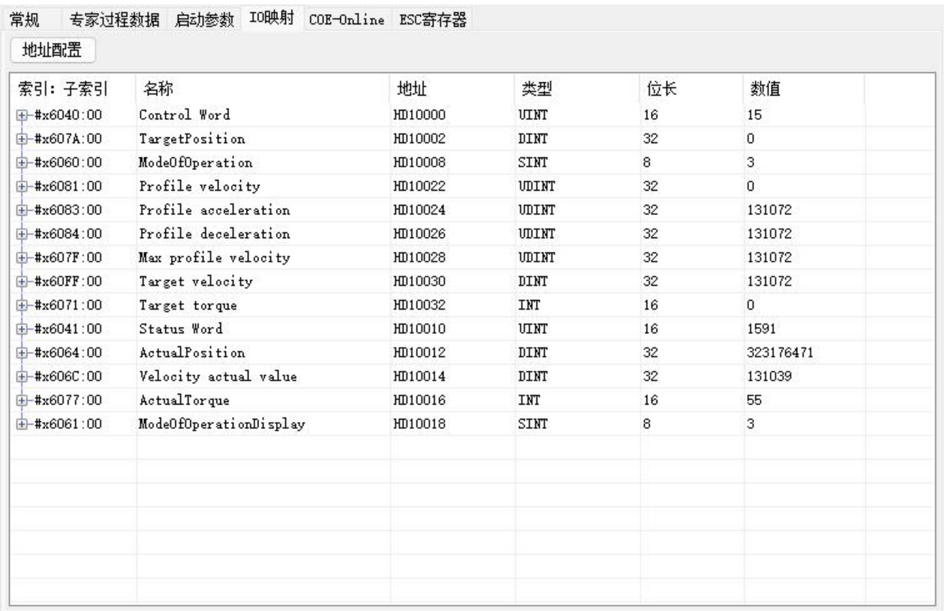
⑤ After configuring the parameters, click【write】→【activate】→【OK】, the parameters will take effect after the activation is successful.



⑥ After the activation is completed, the slave station state machine (SD8021) will from 1 → 2 → 4 → 8, 8 means the OP status. At this time, SDO and PDO can receive and send messages.

⑦ Modify the control word 6040 (6 → 15) to enable the slave station and move the motor by setting the target speed, acceleration and deceleration and other parameters.

⑧ In PV mode, data can be set and monitored through I/O mapping addresses. For example, the control word of axis 1 can be modified through HD10000 (6040h mapping) to enable or disable the motor. The actual position of the current motor on axis 1 can be monitored through HD10012 (6064h mapping), and the actual speed of axis 1 can be monitored through HD10014 (606Ch mapping).



7)TQ mode operation example

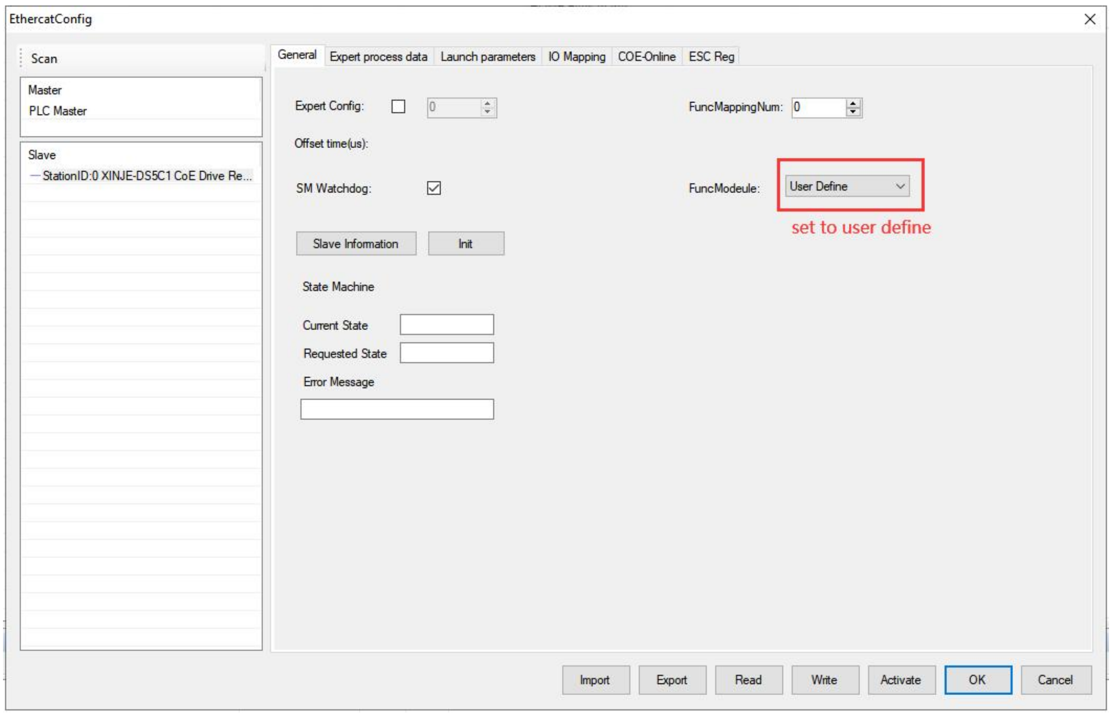
TQ control mode related objects (command・setting)

Register	Note	Unit
RXPDO[0x6040]	Control word	-
RXPDO[0x6060]	Control mode is tq (Profile torque control mode), set its value to 4	-
RXPDO[0x6071]	Target torque given	0.1%
RXPDO[0x6072]	Max torque	0.1%
RXPDO[0x6080]	Maximum motor speed	r/min
RXPDO[0x6087]	Set torque slope	0.1%/S
RXPDO[0x6088]	Set the type of torque profile to use	-

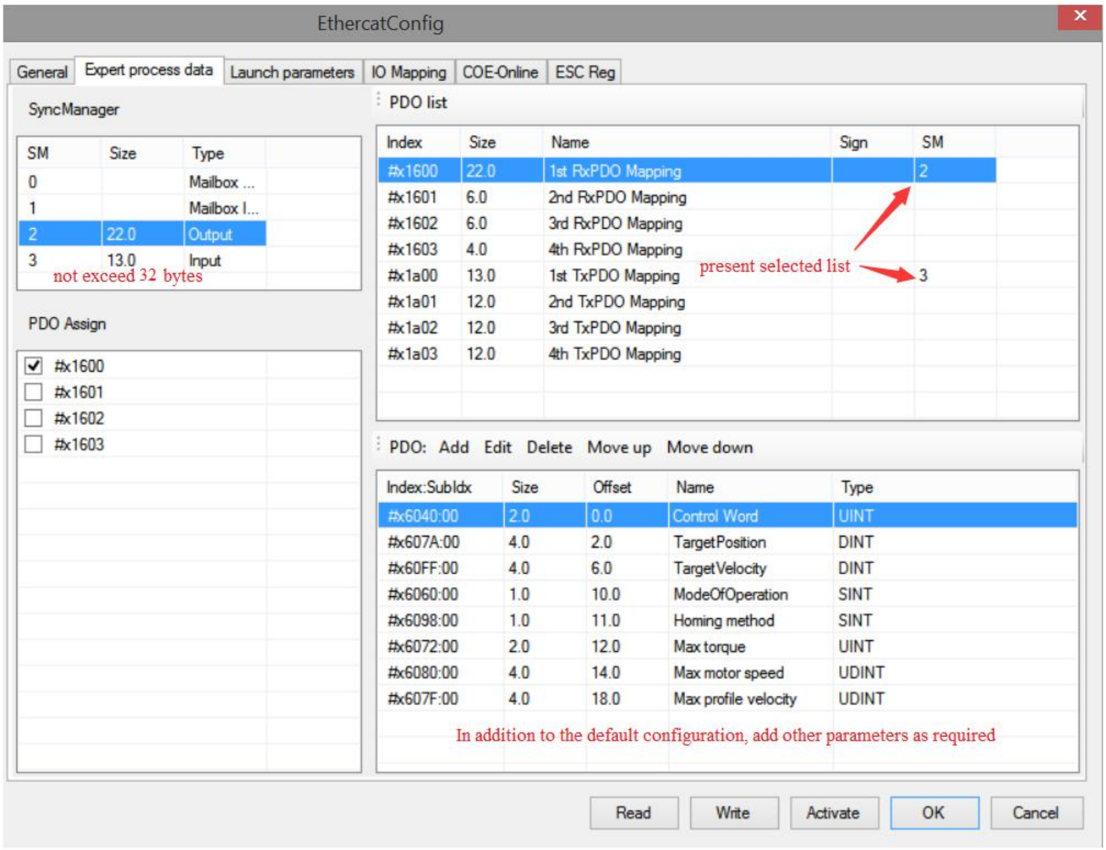
TQ control mode related objects (command・monitoring)

Register	Note	Unit
TXPDO[0x6041]	Status word	-
TXPDO[0x6064]	Position feedback (actual motor position)	Command unit
TXPDO[0x606C]	Speed feedback	Command unit/s
TXPDO[0x6077]	Actual torque	0.1%

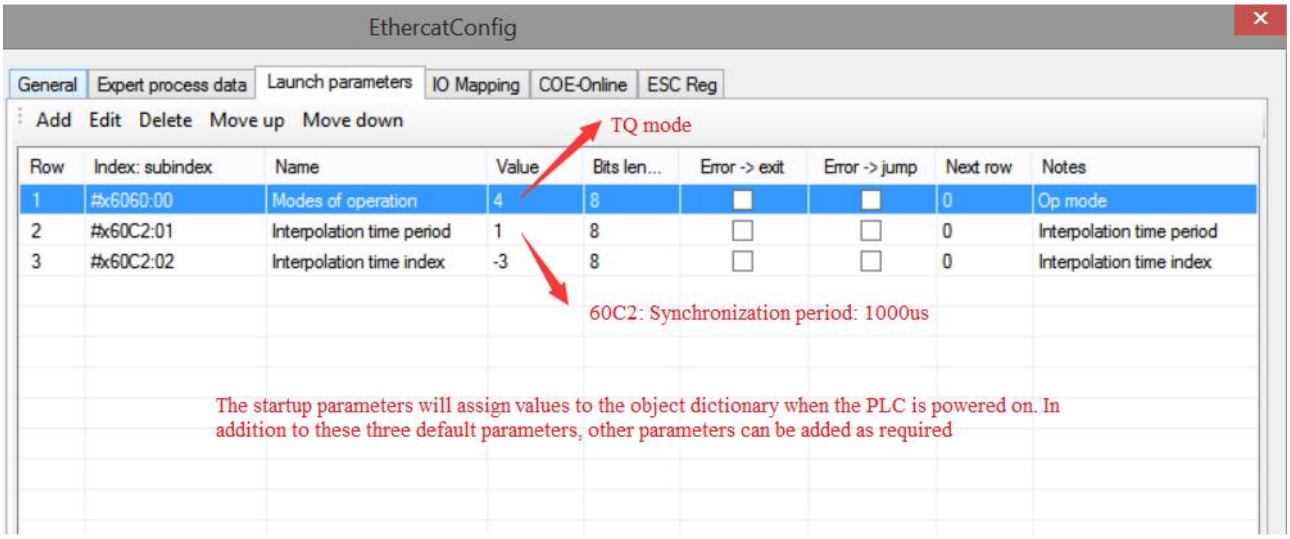
① Click 【scan】 or【add】 slave on EtherCATconfig interface, function module please set to user define in【general】 interface.



② Select 1600, 1A00 in【expert process data】→【PDO list】, PDO parameters associated with the mode can be added (1600 and 1A00 cannot add more than 32 bytes respectively).

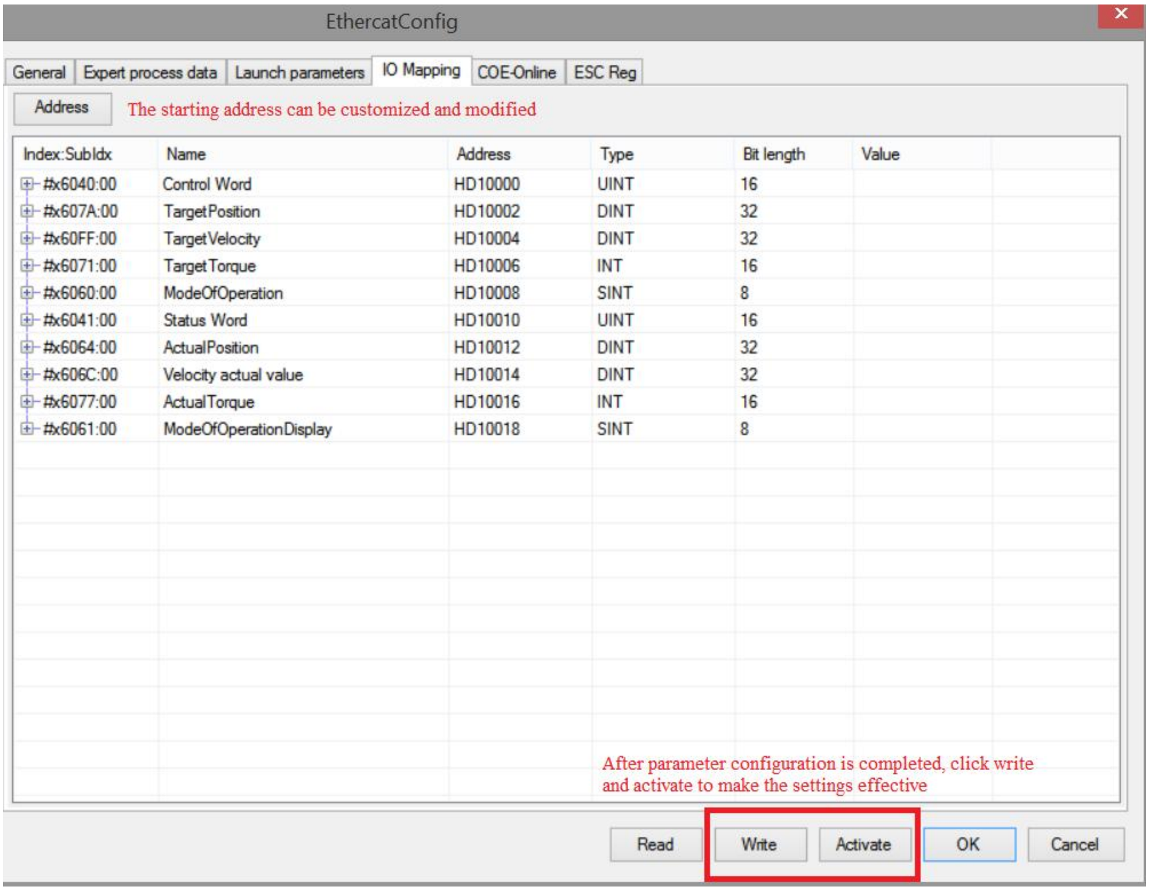


③ Confirm 6060h value in【Launch parameter】is 4.



④【IO mapping】the starting address can be customized and modified.

⑤ After configuring the parameters, click【write】→【activate】→【OK】, the parameters will take effect after the activation is successful.



⑥ After activation, the slave station state machine (SD8021) will change from 1 → 2 → 4 → 8, 8 indicating the OP state. At this time, both SDO and PDO can receive and send messages.
⑦ Modify the control word 6040 (6 → 15) to enable the slave station to move the motor by setting the target torque, torque slope and other parameters.
⑧ In TQ mode, data can be set and monitored through I/O mapping addresses. For example, the control word of axis 1 can be modified through HD10000 (6040h mapping) to enable or disable the motor. The actual torque of the current motor on axis 1 can be monitored through HD10016 (6077h mapping), and the torque slope of axis 1 can be set through HD10038 (6087h mapping).

8)Probe function example(take DS5C1-20P4-PTA as an example，DL6 is the same as DS5C1)

Probe function related object

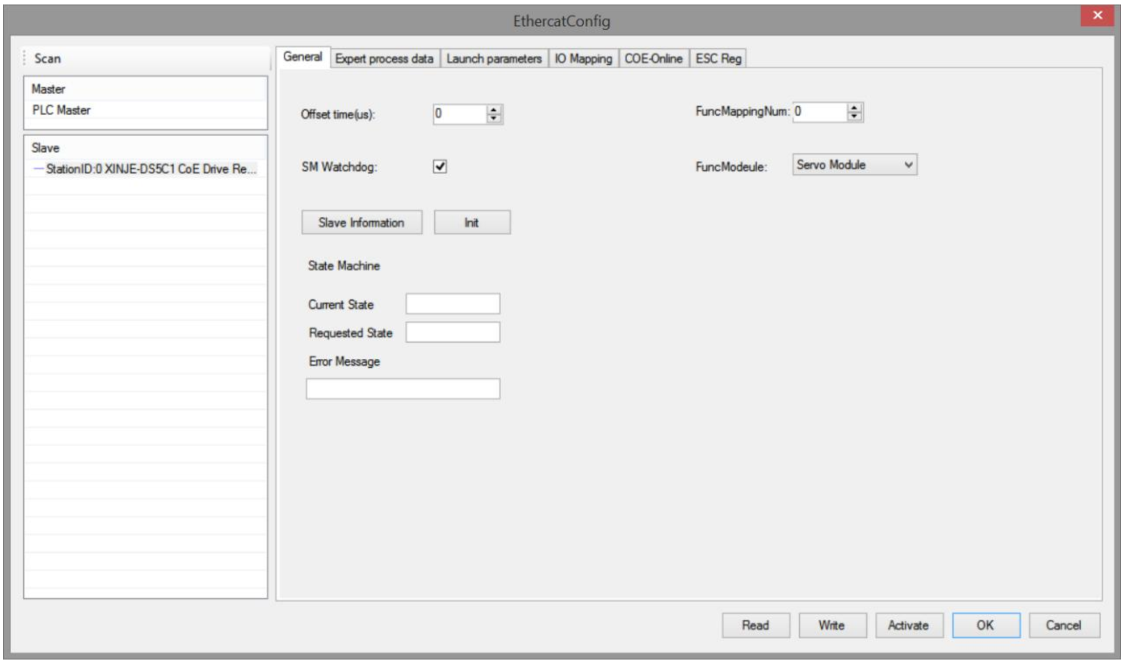
Index	Sub index	Name	Unit
60B8h	00h	Probe function settings	-
60B9h	00h	Indicates the status of the Touch probe function	-
60BAh	00h	Indicates the clamping position of the rising edge of Touch	Command

		probe1	unit
60BBh	00h	Indicates the clamping position of the falling edge of Touch probe1	Command unit
60BCh	00h	Indicates the clamping position of the rising edge of Touch probe2	Command unit
60BDh	00h	Indicates the clamping position of the falling edge of Touch probe2	Command unit

① External wiring and probe terminal assignment: P5-62 and P5-63 are used for terminal assignment of probe function, probe 1 is assigned to SI1, probe 2 is assigned to SI2, 1 is written in P5-62 when SI1 is assigned, and 2 is written in P5-63 when SI2 is assigned.

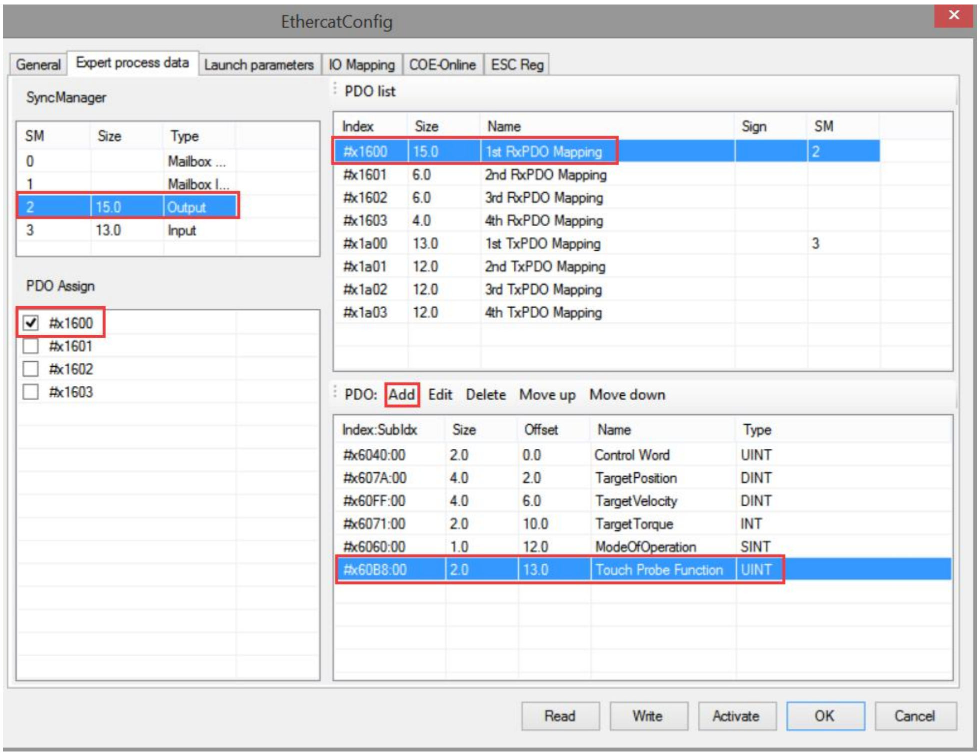
Model	Factory Default		Set when using probe function	
	P5-62	P5-63	P5-62(terminal)	P5-63(terminal)
DL6(1kw and below)	0	0	1(SI1)	2(SI2)

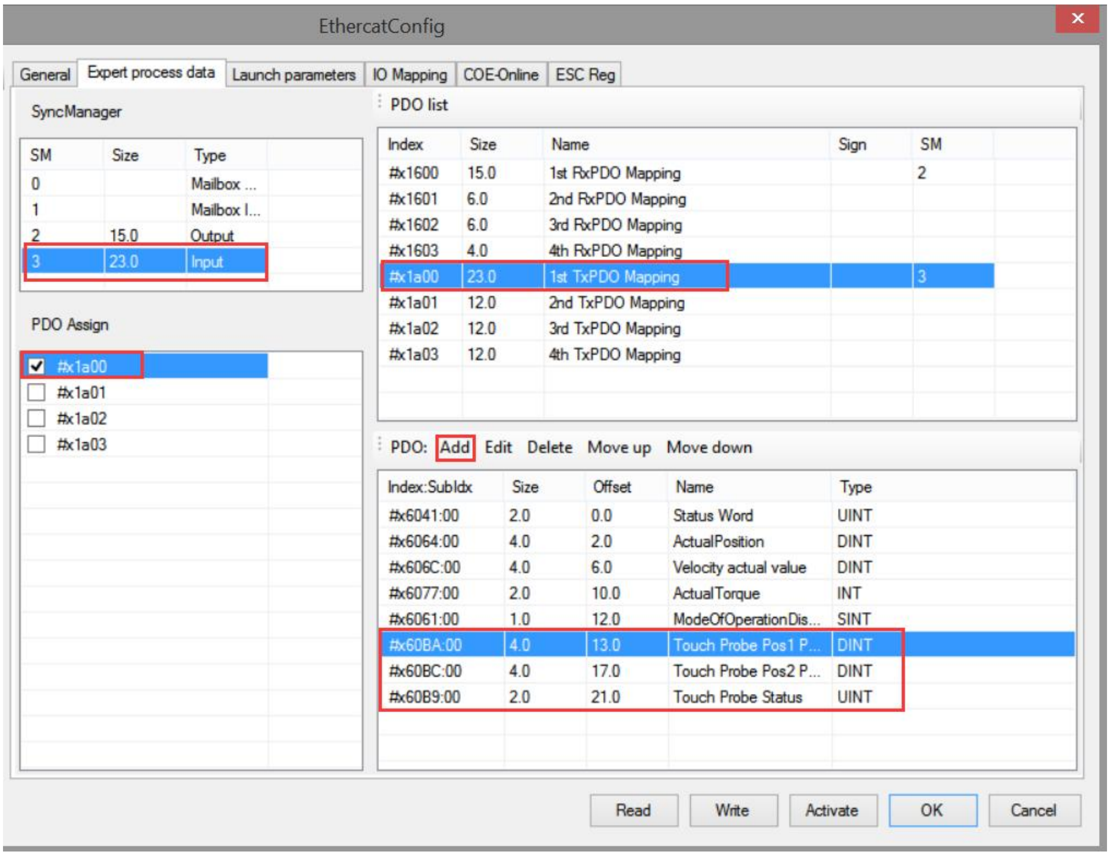
② Click【scan】or【add】slave on EtherCATconfig interface, use default settings for【general】interface.



③ When the level signal connected to the driver SI1 or SI2 jumps, the probe function is triggered, and the probe value is locked in the corresponding COE object words 0x60BA to 0x60BD. When reading the probe value, you need to add the corresponding probe value object (0x60BA-0x60BD) to TxPDO to facilitate data collection.

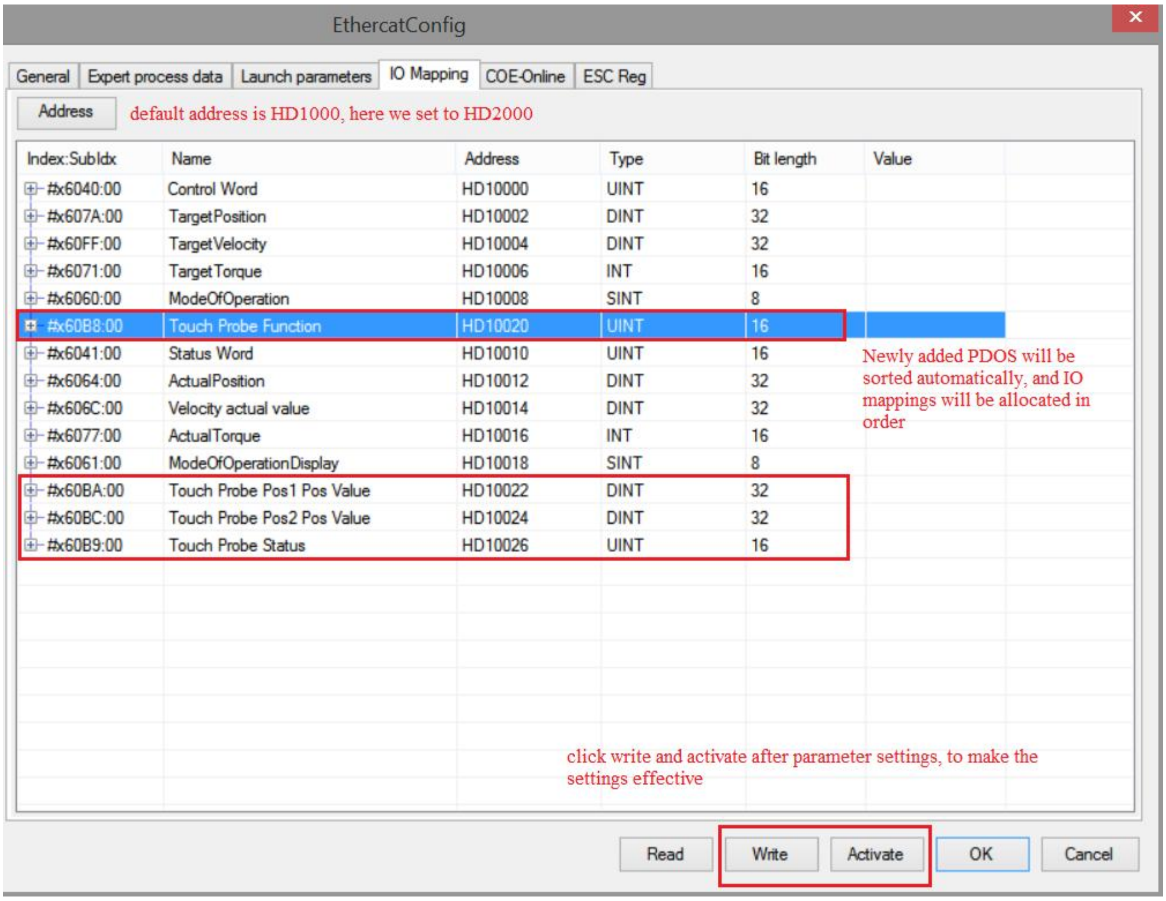
Select 1600, 1A00 in【Expert process data】→【PDO list】, add 60B8h in 1600, add 60BAh in 1A00, 60BCh (take the rising edge of the two probe signals as an example. If the falling edge is collected, 60BBh and 60BDh can be added).

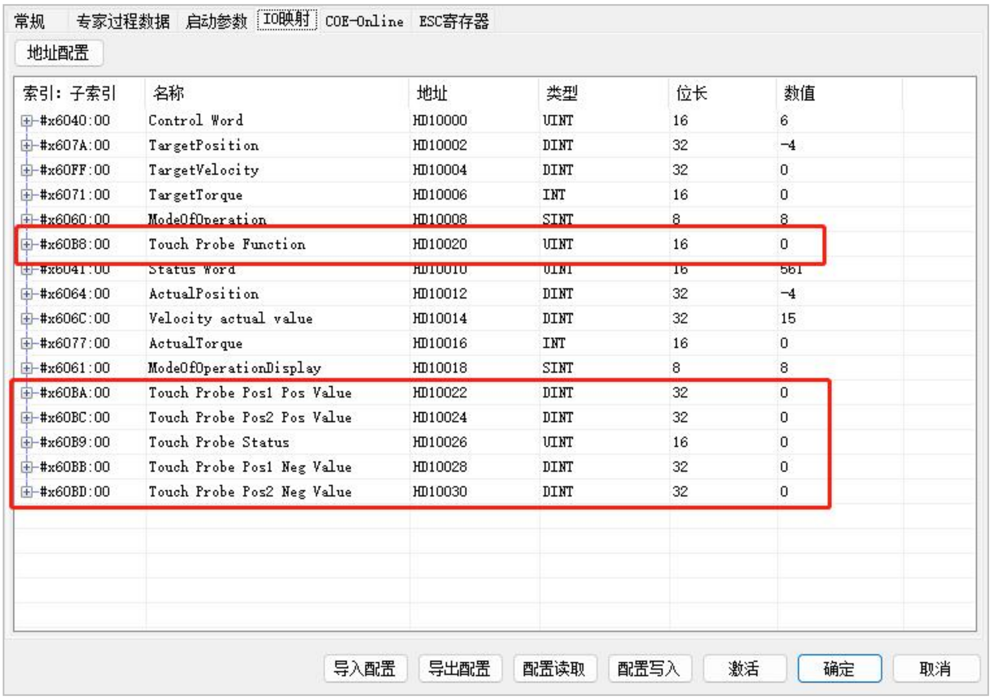




④【IO mapping】The default starting address is HD10000, which can be changed if necessary.

⑤ After configuring the parameters, click【write】→【activate】→【OK】, the parameters will take effect after the activation is successful.

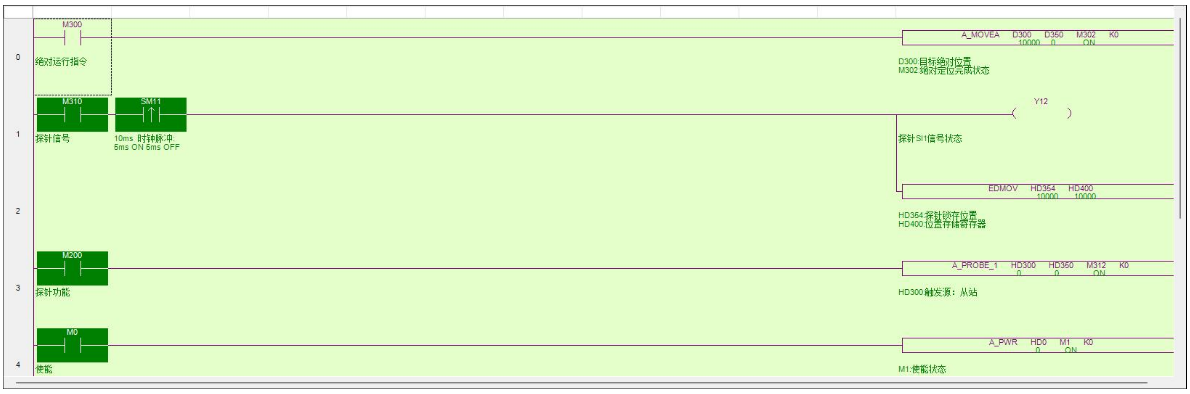




⑥ After activation, the slave station state machine (SD8021) will change from 1 → 2 → 4 → 8, 8 indicating the OP state. At this time, both SDO and PDO can receive and send messages.

⑦ After enabling the slave station, the probe function can be activated by modifying HD10024 (60B8h mapping).

⑧ After activating the probe function, the rising edge clamping value of probe 1 can be monitored through HD10022 (60BAh mapping), the rising edge clamping value of probe 2 can be monitored through HD10024 (60BCh mapping), the current probe status can be monitored through HD10026 (60B9h mapping), the current actual position of the motor can be monitored through HD10012 (6064h), and the current actual speed can be monitored through HD10014 (606Ch mapping).



PLC1-自由监控1

监控窗口 ▾ | 添加 修改 删除 全部删除 | 上移 下移 置顶 置底

名称	监控值	类型	映射地址/字长	注释
M0	ON	BIT	位	使能
M1	ON	BIT	位	使能状态
D10	0	UINT	单字	控制模式
M300	OFF	BIT	位	绝对运行指令
D300	1000000000	LREAL	四字	目标绝对位置
D304	10000	LREAL	四字	目标速度
D308	5000	LREAL	四字	加速度
D312	5000	LREAL	四字	减速度
D316	100	LREAL	四字	加加速度
M302	OFF	BIT	位	绝对定位完成状态
M200	ON	BIT	位	探针功能
M310	ON	BIT	位	探针信号
Y12	OFF	BIT	位	探针SI1信号状态
SM11	ON	BIT	位	10ms 时钟脉冲: 5ms ON 5m...
M310	ON	BIT	位	探针信号
HD354	99140	LREAL	四字	探针锁存位置
HD358	9965	LREAL	四字	探针锁存速度
HD400	99140	LREAL	四字	位置存储寄存器
HD10012	466533	DINT	双字	Station ID:0,#x6064:0,Actual...

11.2 Beckhoff TWINCAT and Xinje DL6

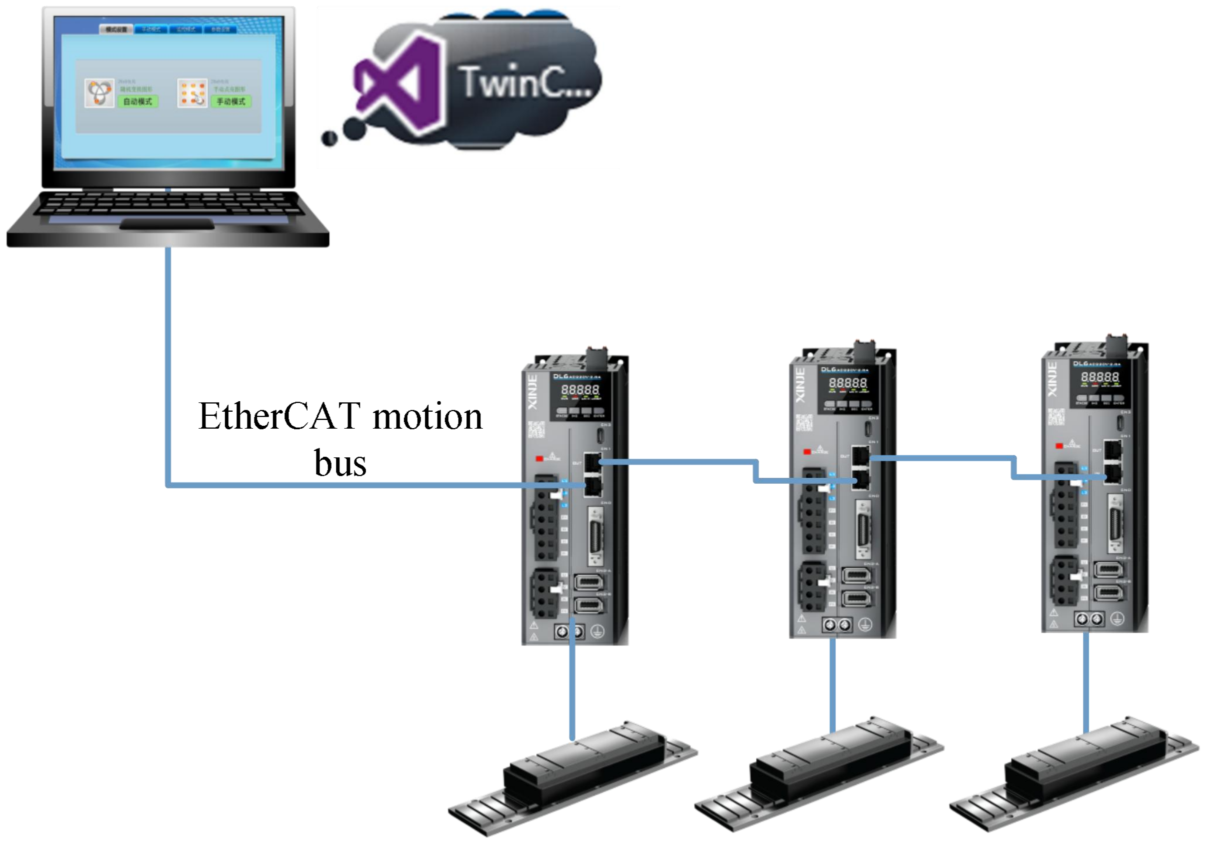
Beckhoff TwinCAT control software is used as the master station and Xinje servo is used as the slave station to realize EtherCAT motion control.

This communication case takes DS5C1-20P4-PTA as an example, and the bus configuration of DL6-2003/2006 (- GS) is the same as DS5C1.

11.2.1 System configuration

Name	Model	Quantity	Note
Servo software	TWINCAT XAE(VS 2013)	1	TC31-FULL-Setup.3.14022.27
XINJE servo	DL6-2003(-GS)	1	
Ethernet cable	JC-CA-3	Some	Used for connecting computer and servos

11.2.2 System configuration



DL6 servo driver has two communication network ports, which follow the principle of "bottom in and top out" shall be followed when connecting. The master station must be connected with the network port under the CN1 port of the first servo, and then the network port above the first servo is connected with the network port below the second servo, and so on.

11.2.3 Commissioning steps

1. Add XML file

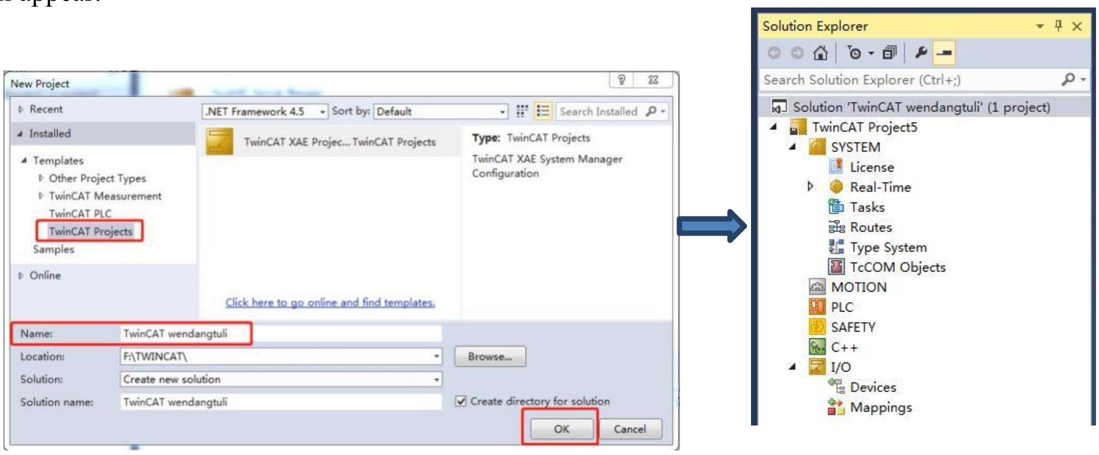
Before opening the software operation, we need to copy the DS5C2 XML file to the TwinCAT installation directory, and the default path is C:\TwinCAT\3.1\Config\Io\EtherCAT.

2. New project

Open the TwinCAT XAE(VS 2013) software and new a project:

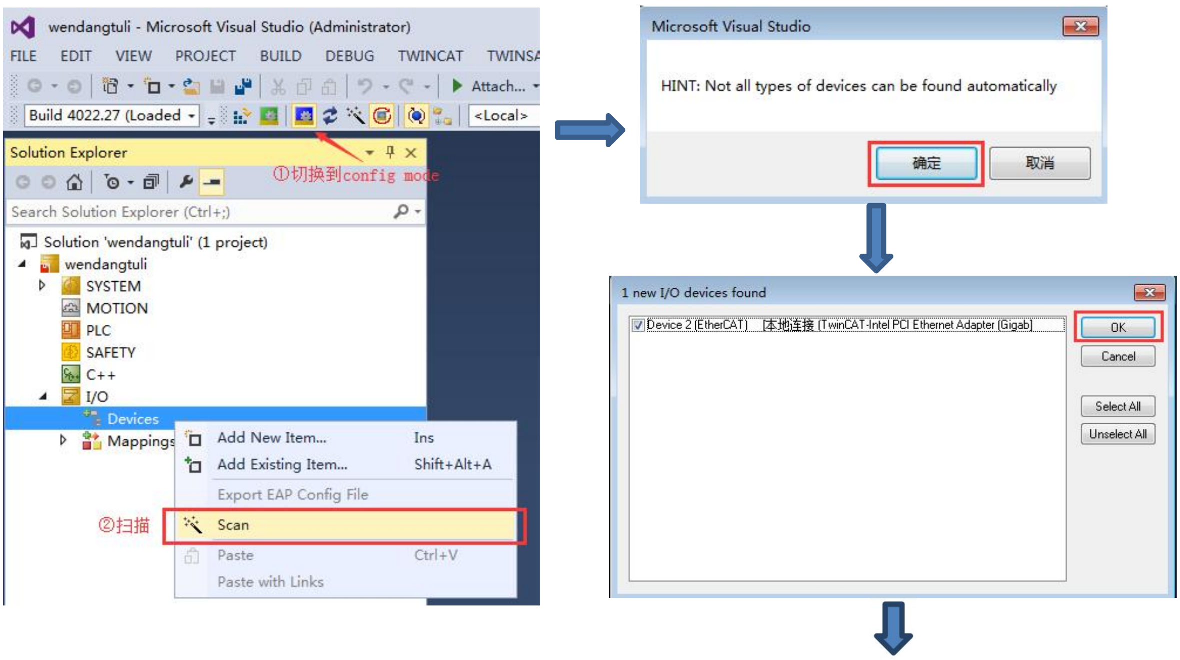
(1) FILE—NEW—Project;

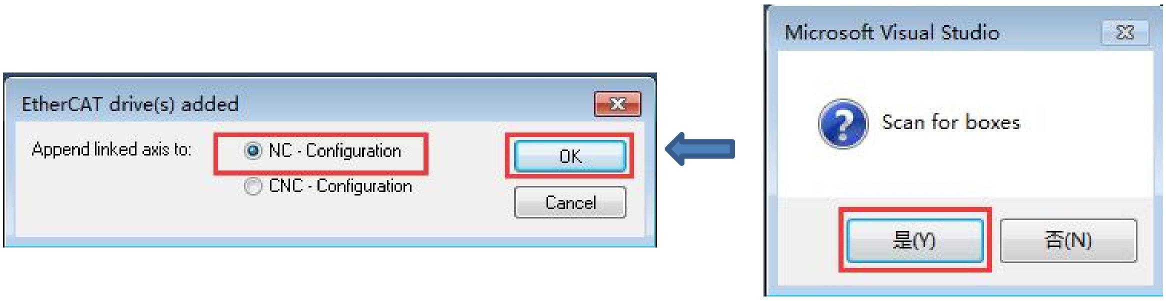
(2)Select TwinCAT Project, enter the project name and the project saving path, and click OK. The following interface will appear:



3. Hardware scanning

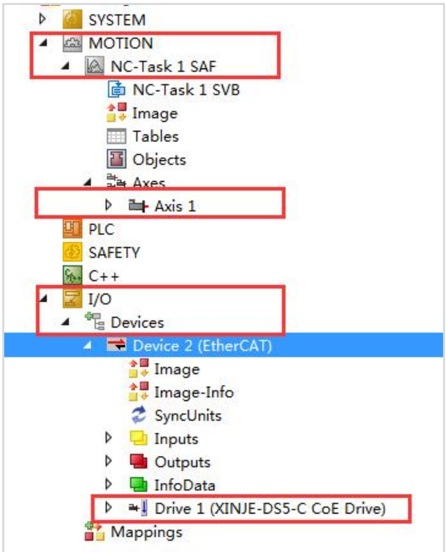
If the controller is not in config mode,click  to switch the controller to config mode first. Then right click "Device" and click "Scan" to scan the slave station of EtherCAT.





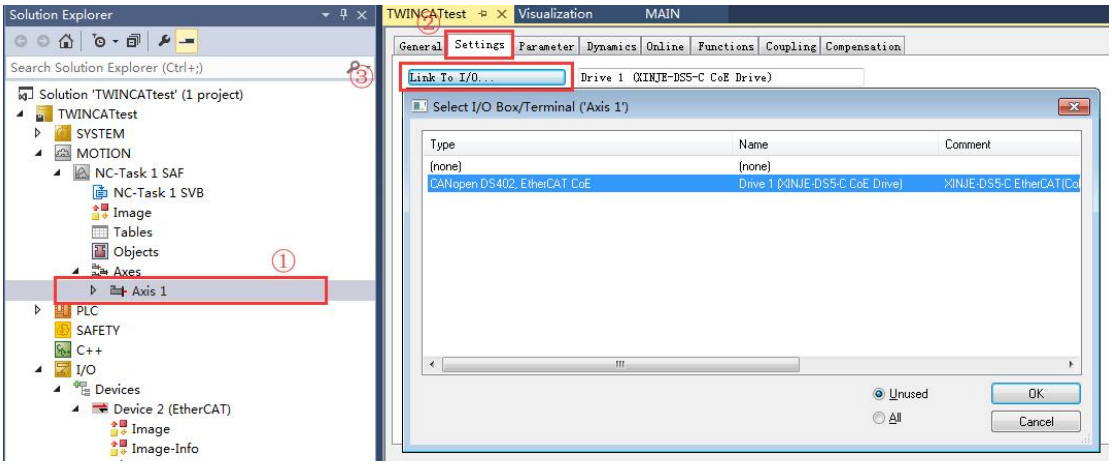
Click “NC Configuration”.

After the scanning is completed, Axis1 can be seen in “Motion-NC axis”, corresponding to the servo motor connected to the servo driver, and DS5C2 can be seen in the “Device”.



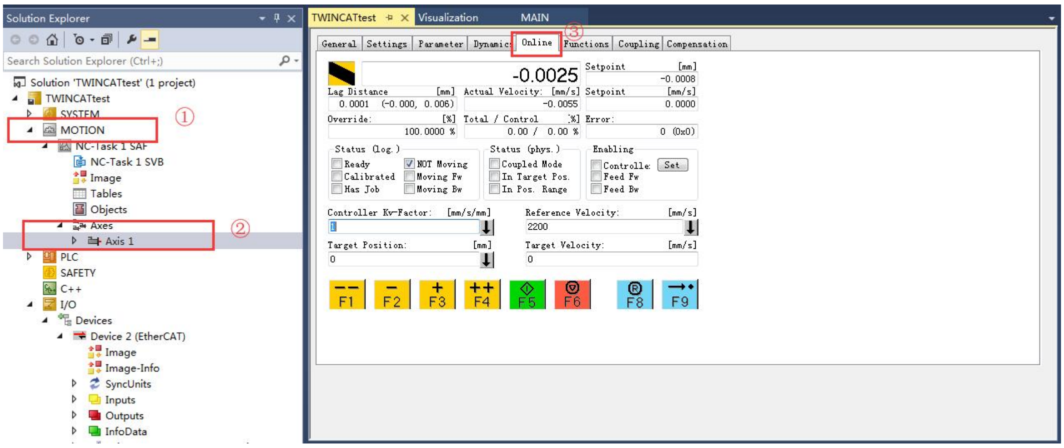
4. Connect NC axis and physical axis

Can select the physical axis associated with the NC axis through Axis1 Settings Link to, and this link will be automatically added when scanning hardware. Alternatively, you can manually right-click on the axis, click Append axis to add the axis, and manually link the NC axis to the physical axis. This window displays the correspondence between the NC axis and the physical axis.



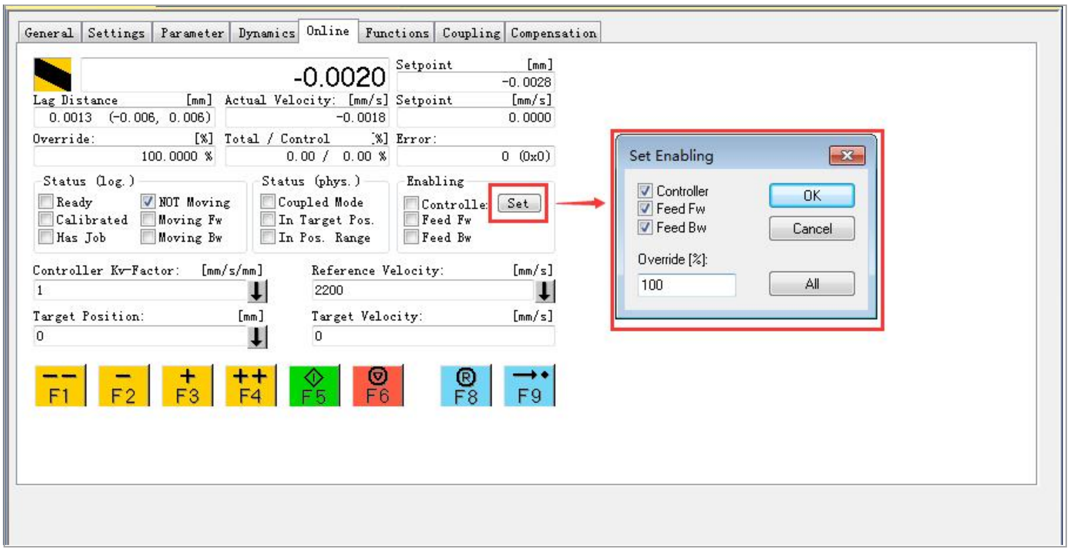
5. Debugging through NC-Online interface

(1) Switch TwinCAT to the running mode, and then click “MOTION- Axis1- Online” to debug the servo axis.

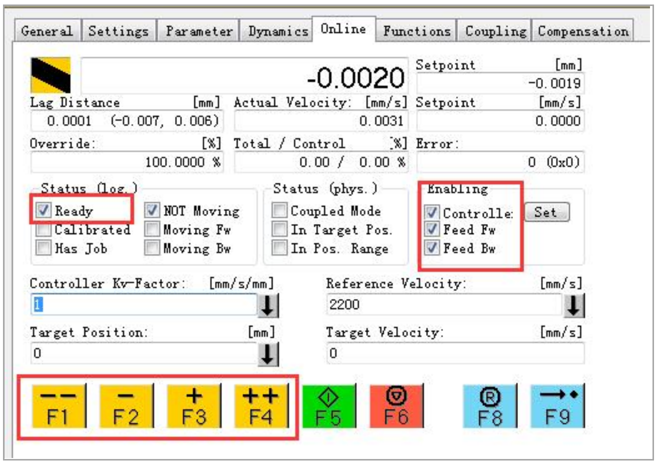


If you don't see the current position of the shaft in the "Online", please make sure that the motor model addition and activation configuration are completed normally.

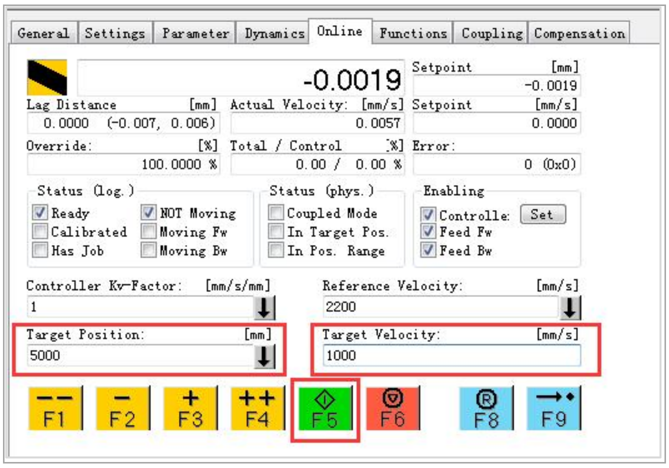
(2)Click Set, manually check Controller, Feed Fw, Feed Bw and set Override(%), then click OK. Or directly click "All" to enable the axis, and automatically set the Override to 100%.



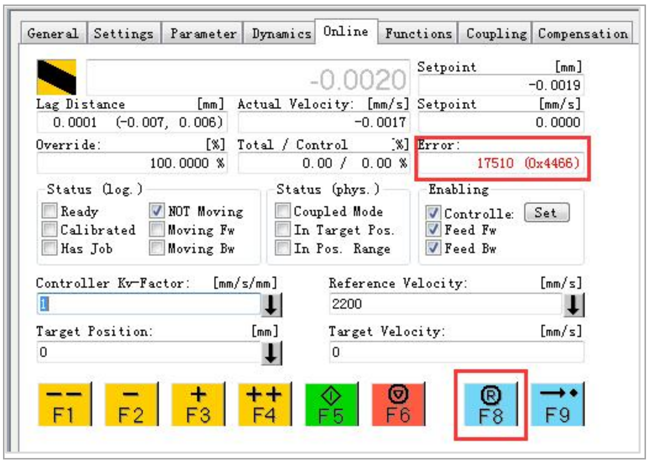
(3)If the Ready status is checked, it means that the motor is enabled. Then the axis can be inched through F1 ~ F4. The inching speed is set in the "Manual Velocity" in the "Parameter". The default speed is 100mm/s and 600mm/s, respectively corresponding to slow inching and fast inching.



(4) After setting “Target position” and “Target Velocity”, press F5 to realize position control. The motor will move to the target position with the set target. This positioning is absolute position positioning, and F6 can be used to stop during positioning.



(5) When the NC reports an error, there will be an error code in the “Error”. F8 is the reset button. Press F8 to reset the error. F9 is the origin finding button. After pressing F9, the axis position will change to 99999... And move slowly. However, the origin signal requires external hardware signal, which cannot be captured in the Online window. Therefore, F9 is not used to return to the origin generally, but realized through programming in the program.

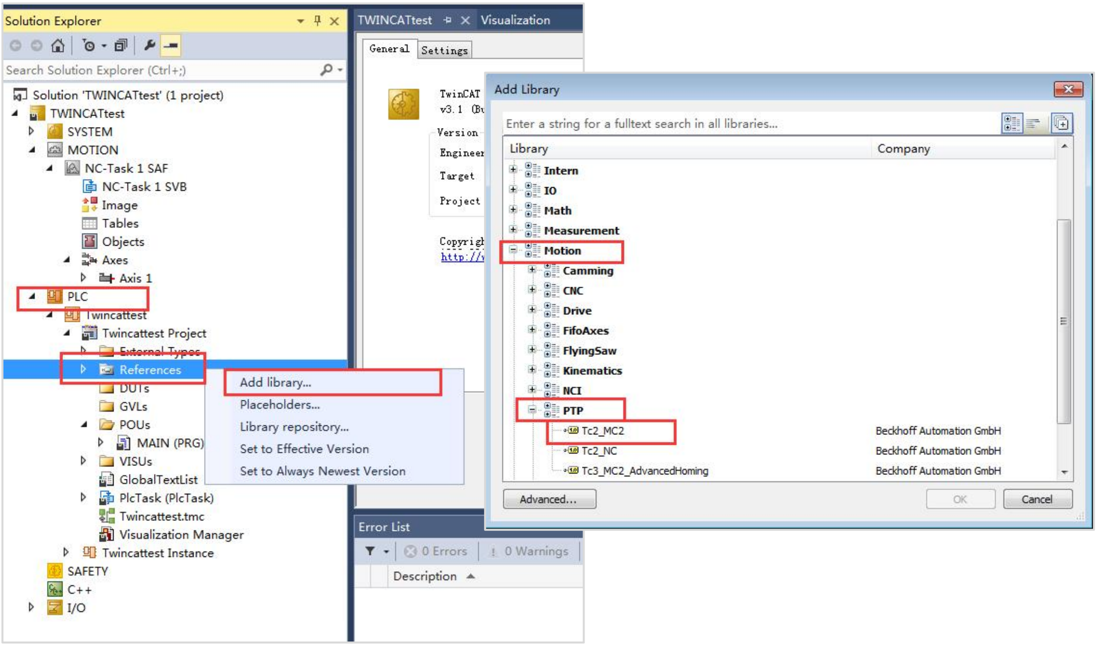


ⓘ	Refer to "TC3 training material V1.1.0" for more single axis debugging functions.

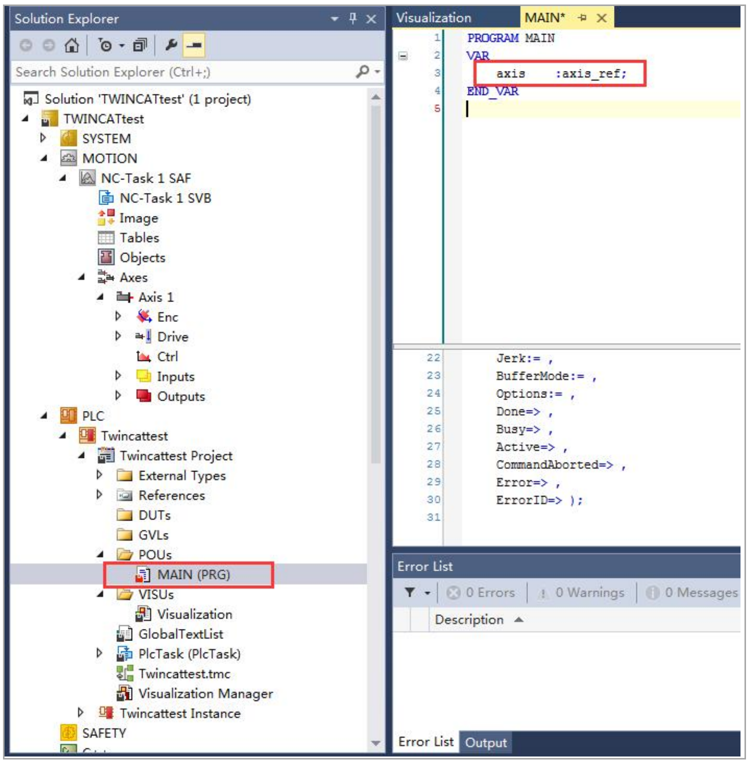
6. Control DL6 servo motor by PLC control programming

(1) Add motion control library files and axis type variables

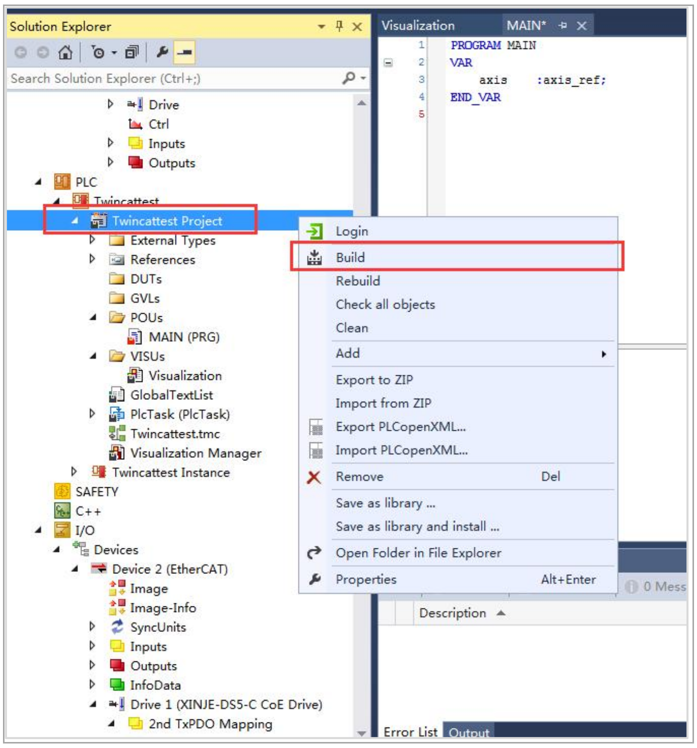
Create a new project under PLC and click “PLC-References-Add library...”. In the pop-up dialog box, find “Motion -- PTP -- TC2_MC2” and select Add.



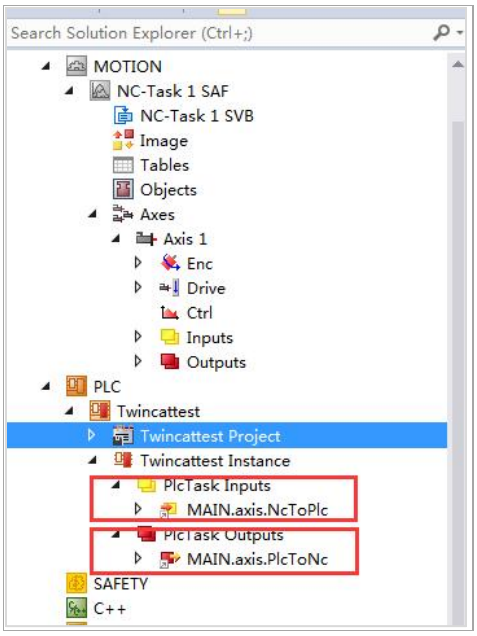
Click POUs -MAIN(PRG) ,create an Axis_ref type at the main program. Axis_ Ref is a structure, mainly used for data exchange between NC and PLC. It also contains some other structures. We call this Axis_ref variable the axis variable.



After the program is written, compile it to see if it is wrong. The project of this instance is named Twincattest, so find Twincattest project, right-click it, and then select “Build” and click it.

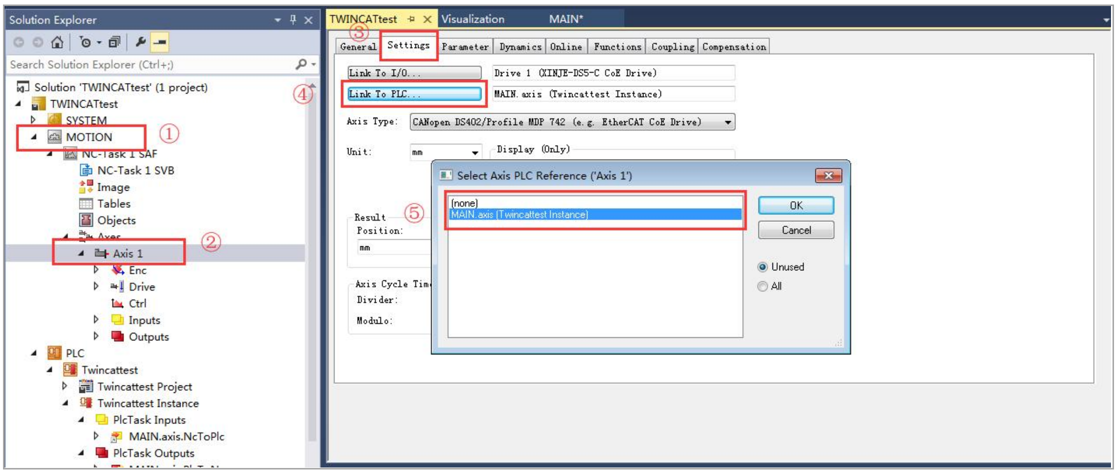


After successful compilation, you will see the Correspond variable in the Instanc directory of the project. After the Build compilation is successful, you can bind two variables separately under PlcTask Input and PlcTask Output in Twincattest Instance.



(2)Connect variable between NC and PLC

Click “Motion-Axes”,double click Axis 1, find “Settings-Link to PLC...” from the interface on the right. Link Axis1 to the corresponding PLC, and then NC and PLC can interact with each other through this link.

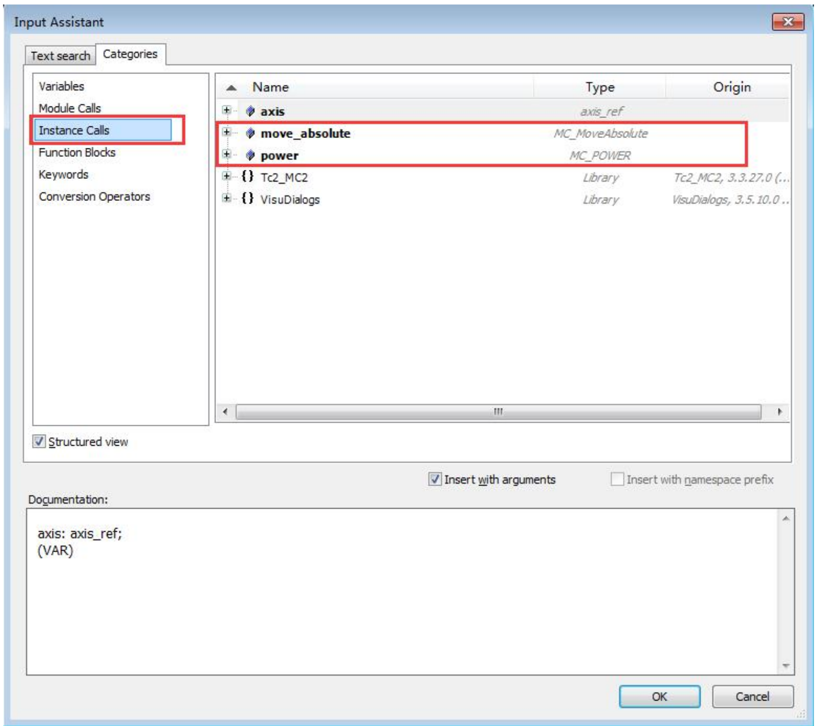


(3) Call function block to control the axis motion

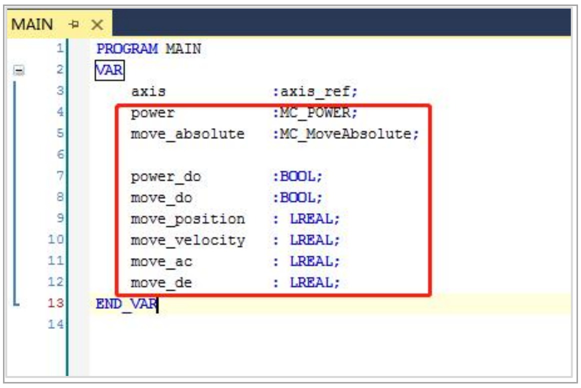
On the POUs-MAIN (PRG) interface, declare one MC_POWER function block and one MC_MoveAbsolute function block, where MC_Power is used to control shaft enable, MC_ Moveabsolute is used to control the absolute position of the axis.

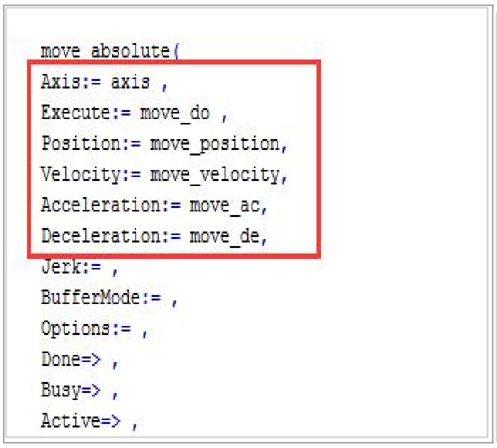
```
PROGRAM MAIN
VAR
    axis            :axis_ref;
    power           :MC_POWER;
    move_absolute   :MC_MoveAbsolute;
```

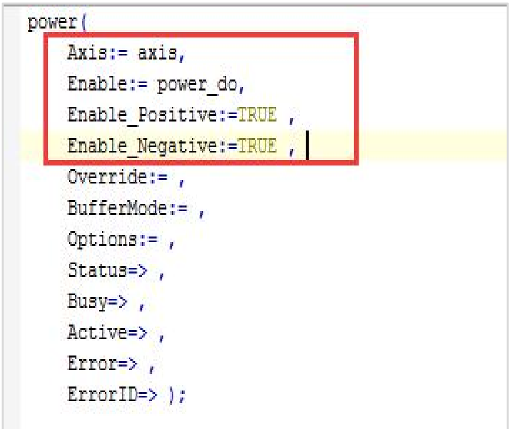
Press F2 in the program writing window and select power and move_absolute in “Categories——Instance Calls” to call the defined function block into the program.



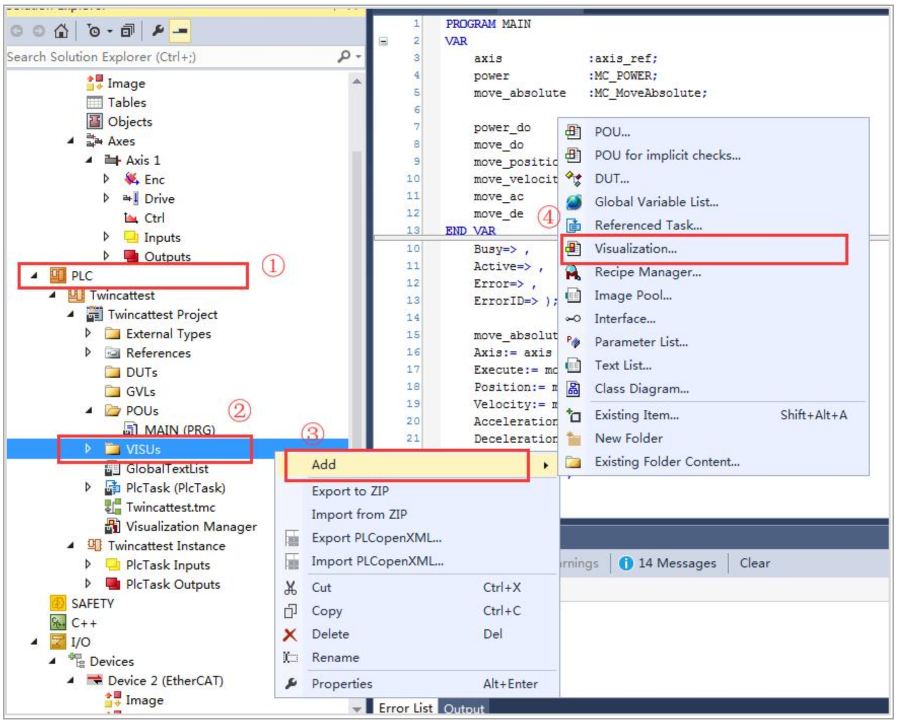
Fill in all the parameters in the function block. Enable represents the enable position, Enabled_Positive represents allowing forward rotation, Enabled_Negative represents allowing reverse rotation, Override represents the speed ratio, Axis represents the corresponding axis, Position represents the positioning position, Velocity represents the positioning speed, Acceleration represents acceleration, and Deceleration represents deceleration. Additionally, declare two boolean type variables power_do and move_do as trigger bits for the enable and absolute position motion function blocks, and declare an Lreal type variable as the position, velocity, and acceleration/deceleration for absolute position motion.



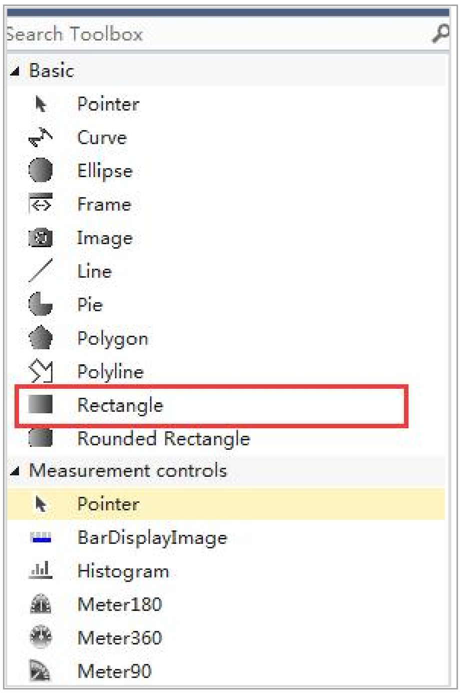




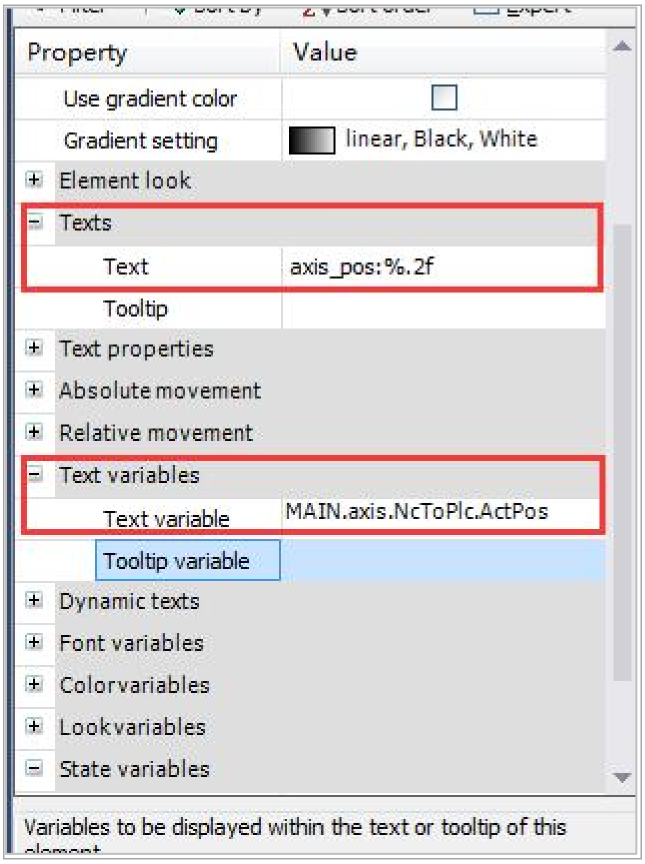
Right click “PLC-VISUs”, click Add from the pop-up menu, and then select Visualization from the new menu to create a visual interface.



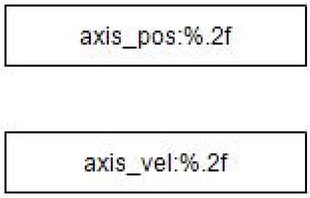
Select the rectangle in the toolbar of the added VISU interface and drag a control.   Double click the rectangle box control to set.



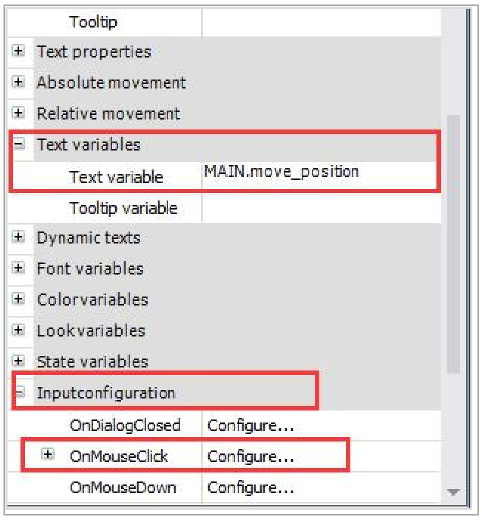
Double click the control, and set parameters in Property as shown in the figure. Set Texts——Text-axis_ pos: %.2f, %.2f represents the data type of floating-point number, display the value of the associated variable (that is, the variable pointed to by "Text variables——Text variable", and only two decimal places are reserved. Enter MAIN.axis.NcToPlc.ActPos in Text variable, indicating that the control points to the actual position in the axis variable.

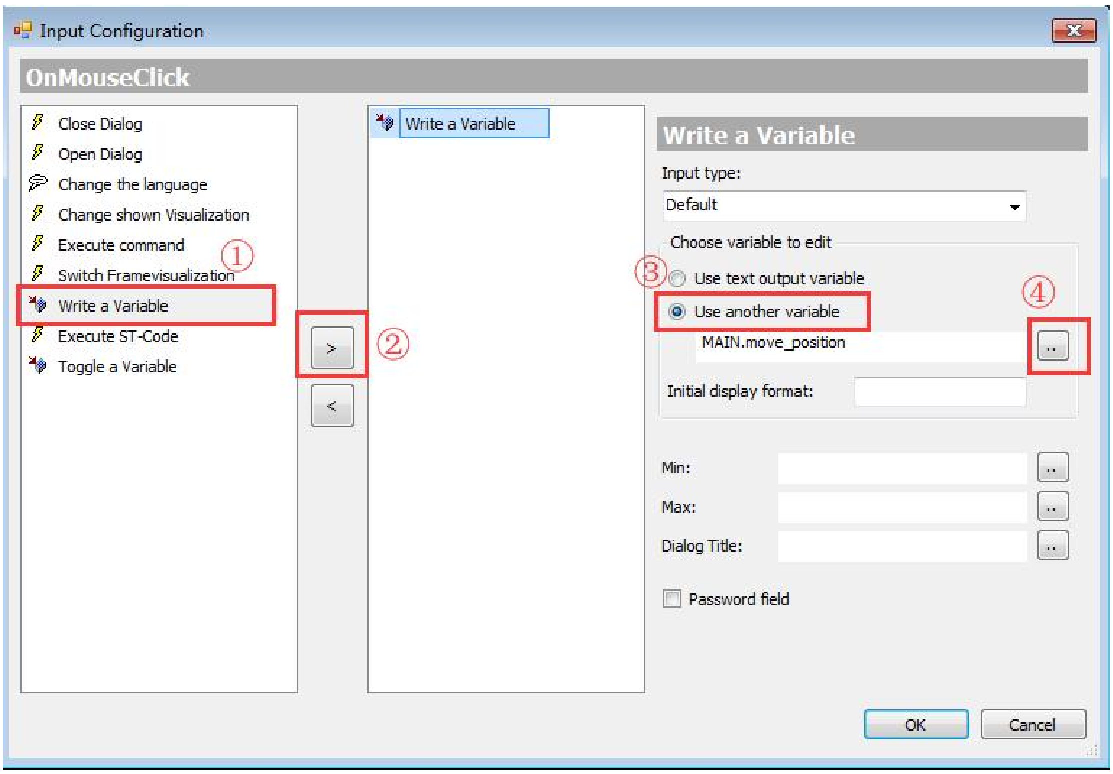


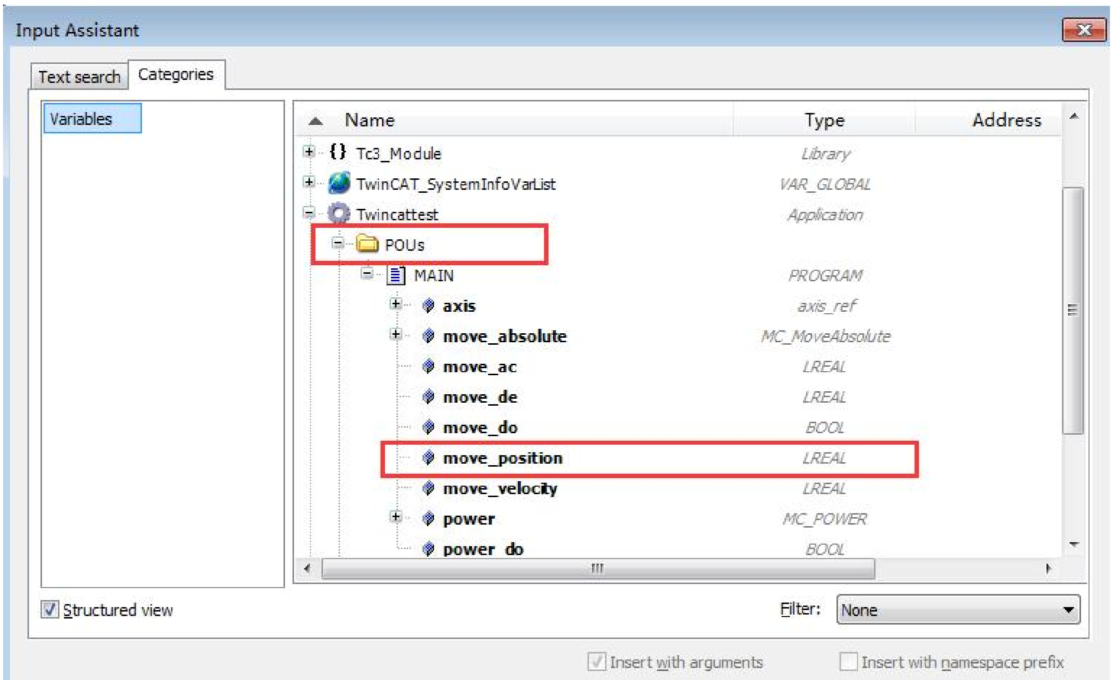
Make another control to represent the current speed of the shaft, enter MAIN.axis.NcToPlc.ActVelo in Text variable.



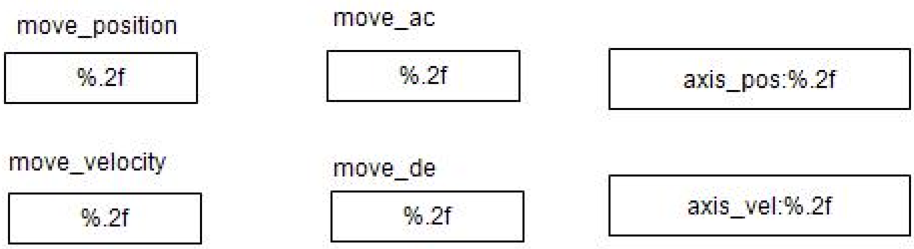
Add a rectangular control to input the target position value of the absolute position movement. The specific operations are as follows: create a rectangular control, and enter MAIN.move_position in Text variable(lreal type variable added in the program), click “Inputconfiguration - OnMouseClick”, select “Write a Variable” in the pop-up interface, click “>” to add the function, and select “Use another variable” on the right to point to the variable MAIN.move_position.



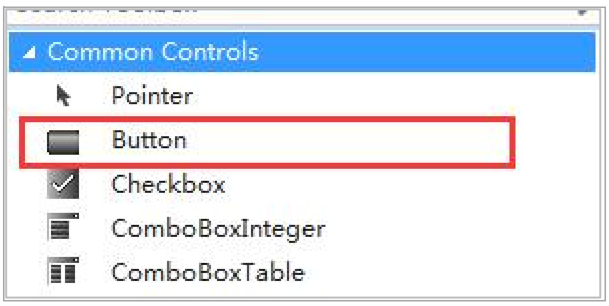


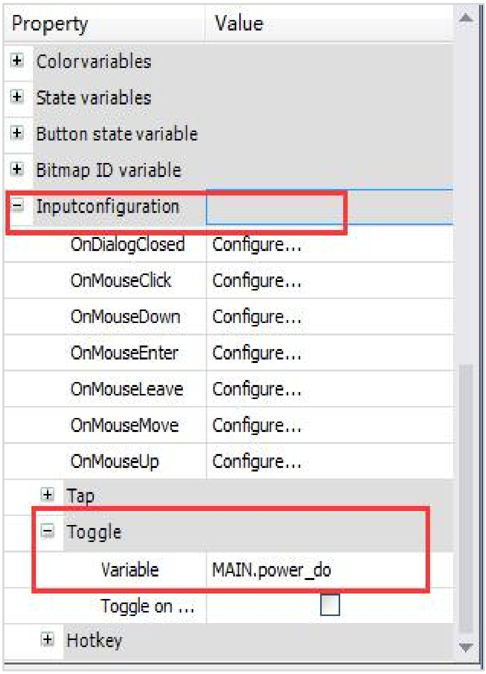


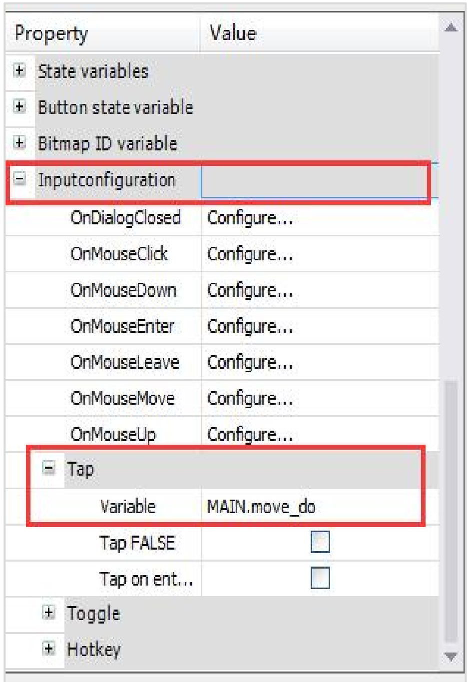
In the same way, create the controls of speed, acceleration and deceleration pointing to the absolute position.



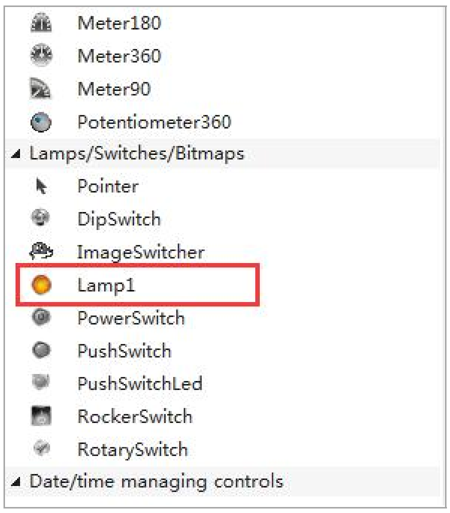
Enter “MAIN.power_do” in “Inputconfiguration——Toggle——Variable”, click once to set 1, and click again to set 0. Enter “MAIN.move_do” in “Inputconfiguration——Tap——Variable” of the trigger control of axis motion_ Do, set 1 only when clicked, and 0 when released.

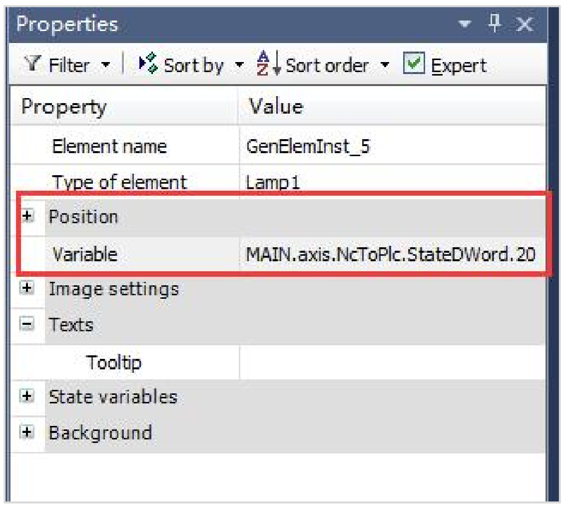






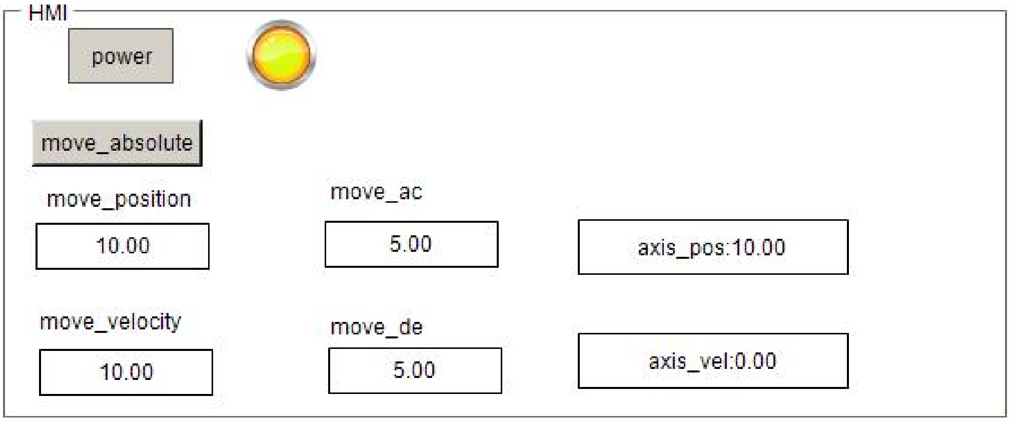
Create an indicator control to show whether the power function block is enabled successfully. First, drag an LED icon from the Toolbox on the right, and then bind the "Position——Variable" to the MAIN.axis.NcToPlc.StateDWord.20 variable, where StateDWord ".20" represents the enabled state of the axis variable.



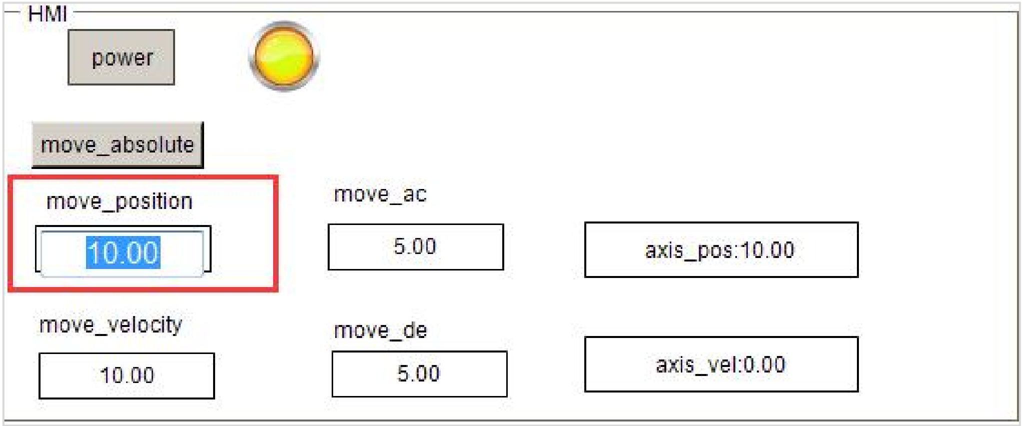


After the program is written, it needs to be activated, and then click Login  to run the program. Click the run

 button to see the value of the specified variable in the visual interface.



Click move_ Position and other input type controls can modify the value of the variable in real time.



11.3 CODESYS and XINJE DL6 Ethercat communication example

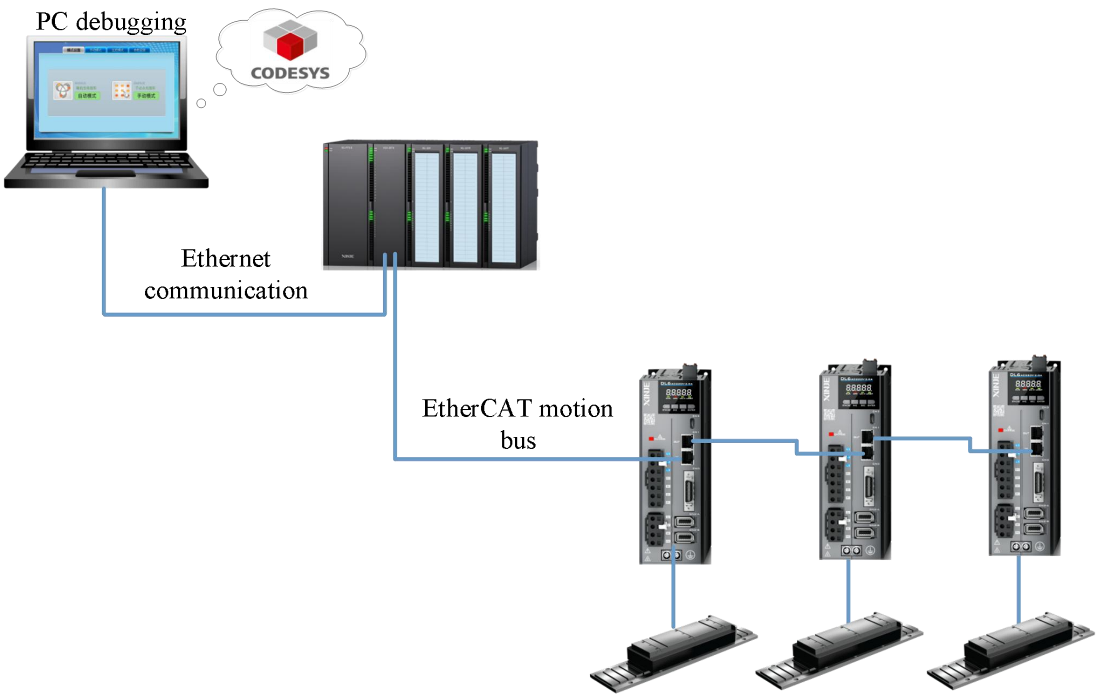
This example will explain how Codesys motion control software realizes EtherCAT motion control when it is used as EtherCAT master station (Xinje XS3 series PLC is only used as a hardware platform) and Xinje DL6 series servo is used as slave station.

Note: This communication case takes DS5C1-20P4-PTA as an example, and the bus configuration of DL6-2003/2006 (- GS) is the same as DS5C1.

11.3.1 System topology

Name	Model	Quantity	**Note**
Software	CODESYS	1	Software version: V3.5 SP13 Patch 1
Hardware	XS3 series PLC	1	
Servo	DL6-2003(-GS)	3	
Network cable	JC-CA-3	Some	Connect PC and servo

11.3.2 System topology

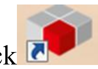


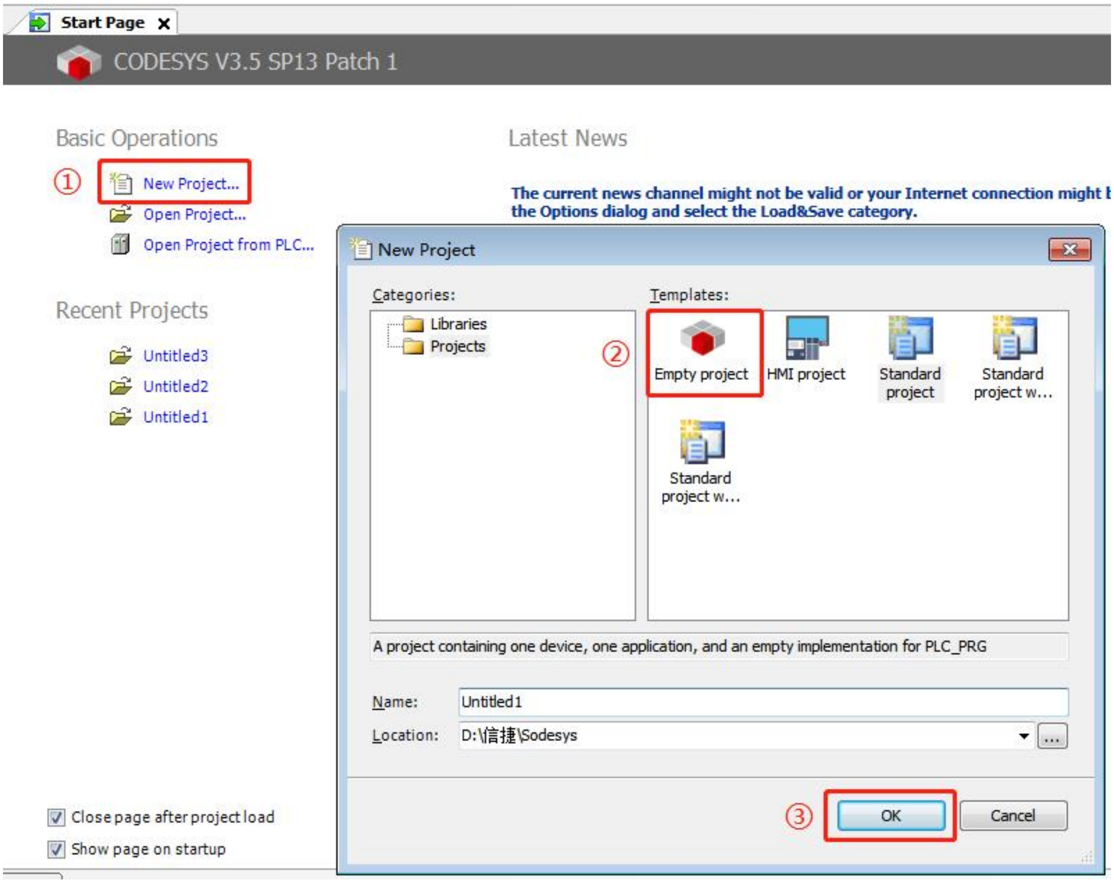
This is a Codesys control system based on traditional hard PLC. In this scheme, the PLC development system generally runs on an ordinary PC, while the traditional hard PLC only serves as a hardware platform. The real-time core of the soft PLC is installed in the traditional hard PLC, and the system program compiled by the development system is downloaded into the hard PLC. The control system diagram is shown in the above figure.

XS3 series PLC has upper and lower network ports. The upper network port is Ethernet/IP, which is used to connect the Codesys upper computer. The lower network port is an EtherCAT connection port, which is used to connect Xinje DL6 series servo to realize EtherCAT communication. The two communication network ports of Xinje DL6 series servo drivers should follow the principle of "bottom in and top out".

11.3.3 Debugging steps

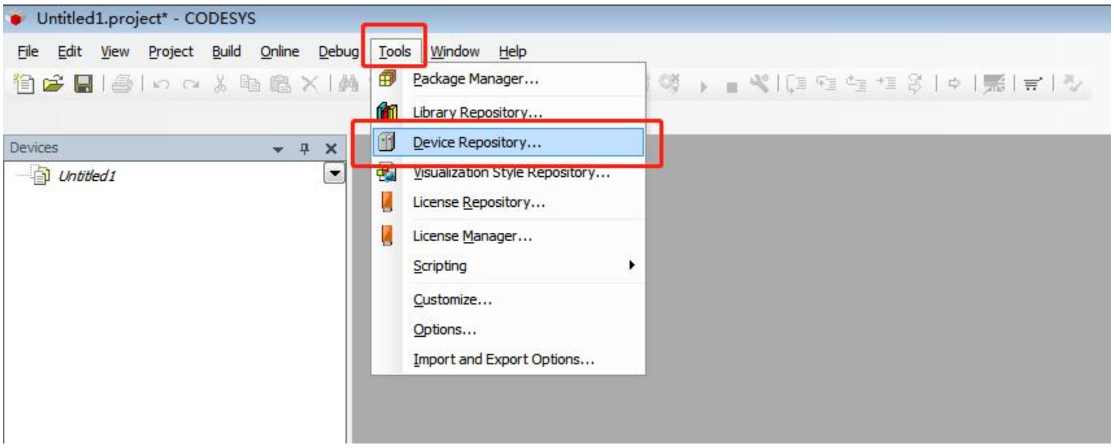
1)New project

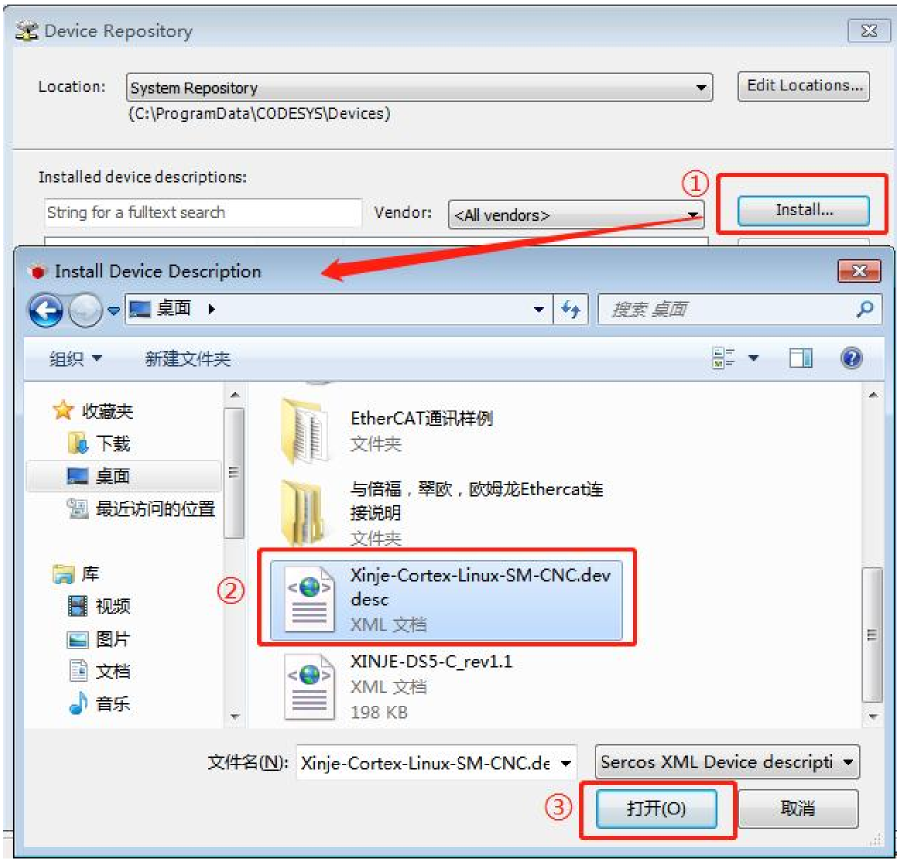
Double click  to open Codesys. Click New Project, input project name and save path.



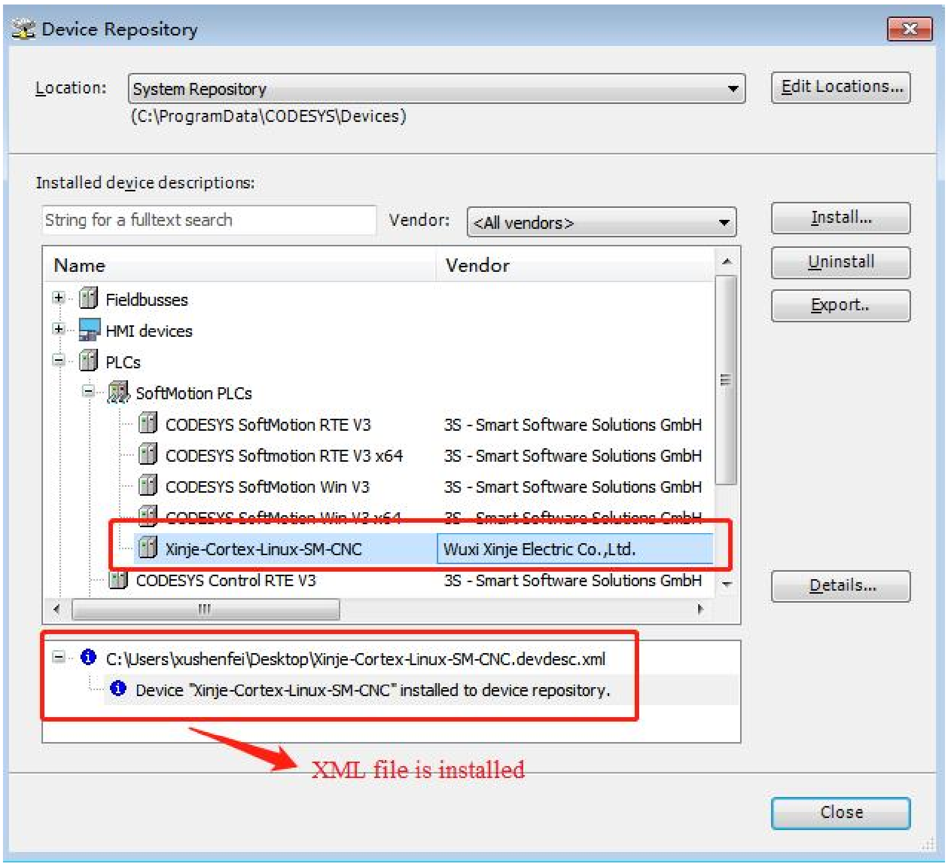
2)Add XML file

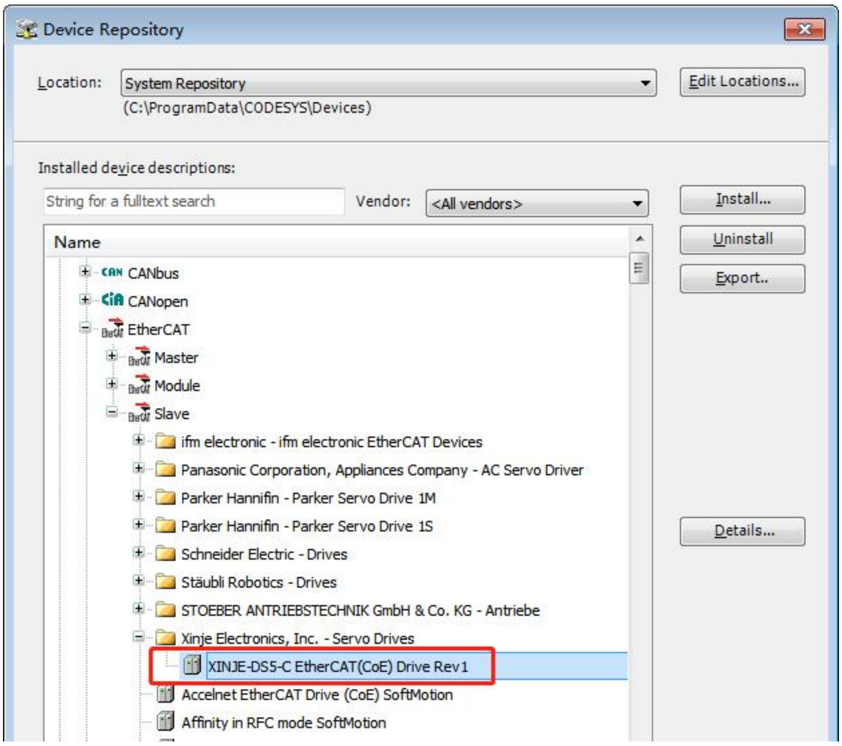
Open Tools/device repository, add XML file of master and slave station. First, add the XML file of the master station device. Click Tools -- device repository in turn, click install in the pop-up dialog box, select the path where the XML file is located, find the XML file, select it, and click open.





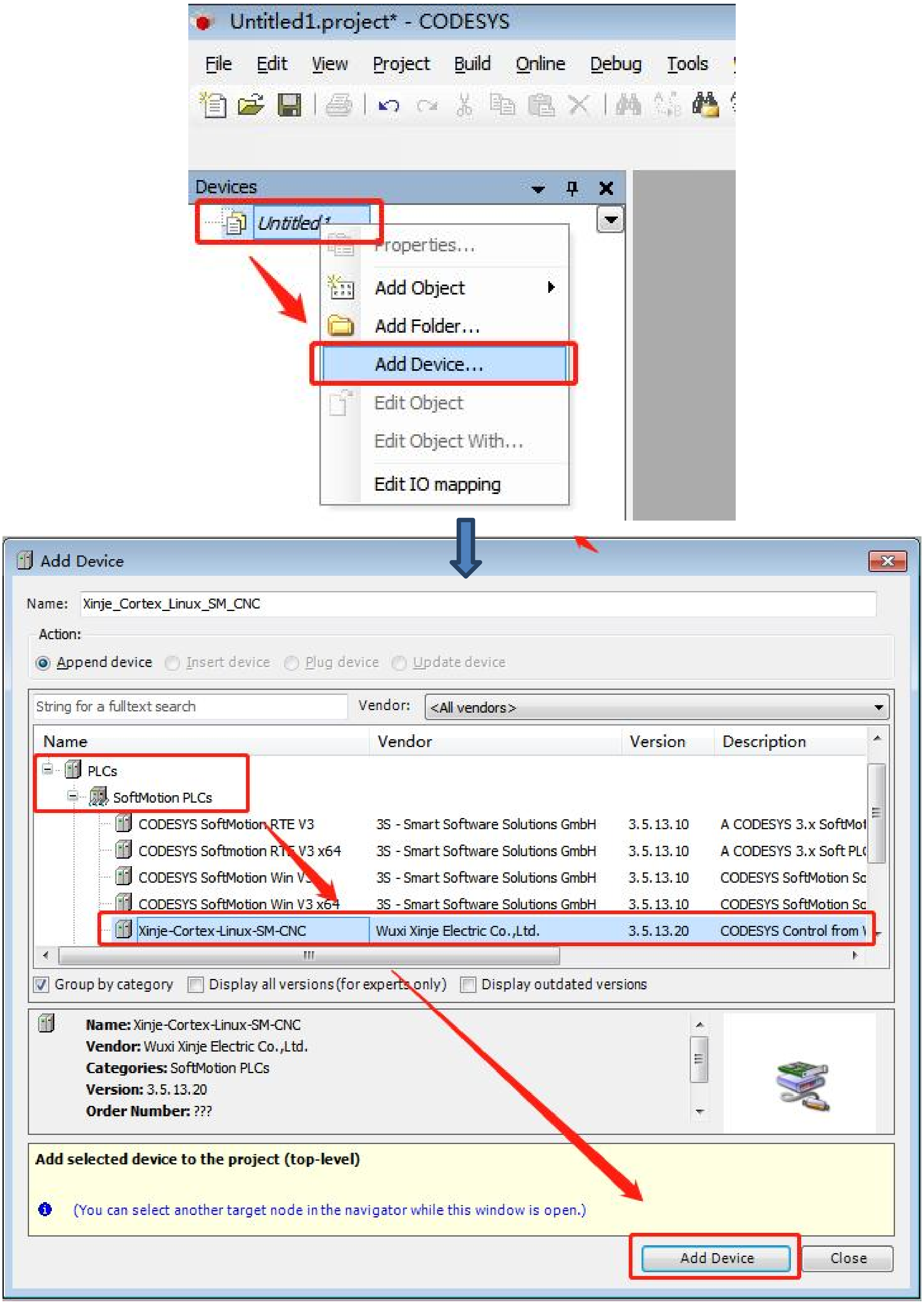
After opening, the installation is completed, as shown in the following figure. Similarly, install the slave XML file (XINJE-DL6-ECT(V1.2)) in the same way.



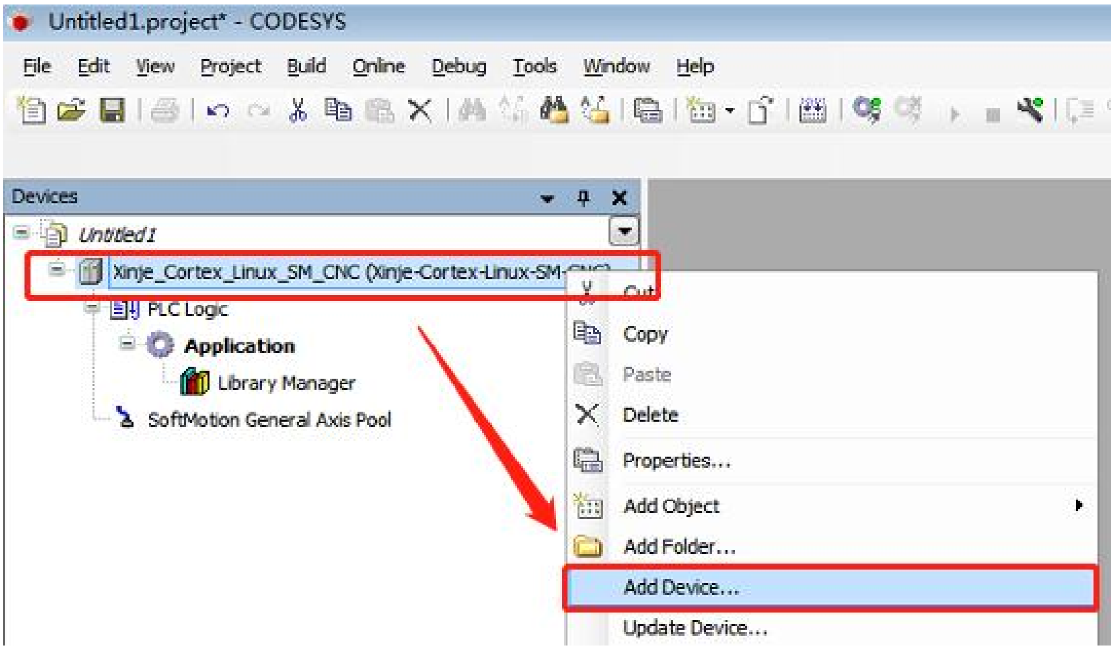


3)Add master station device

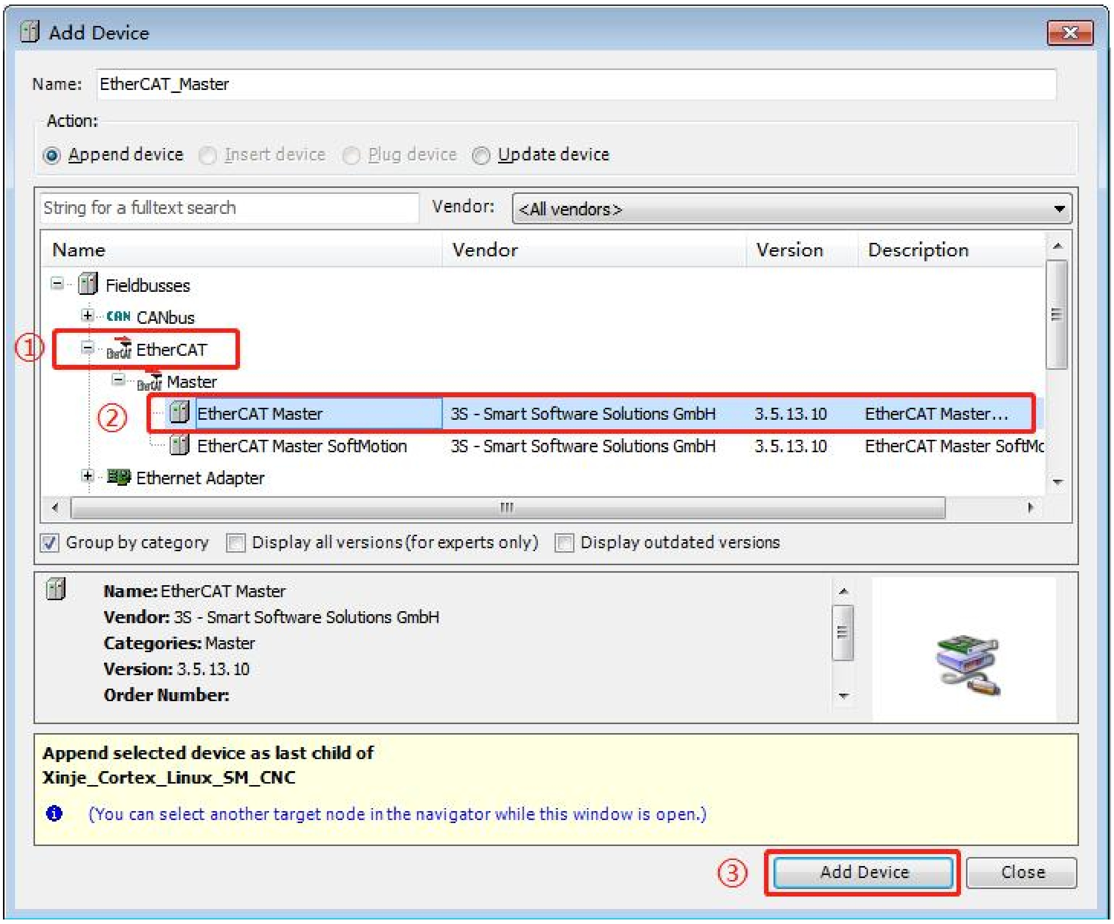
Right click Untitled, click Add Device, select PLCs--SoftMotion PLCs--Xinje –Cortex-Linux-SM-CNC, click Add Device to add the PLC.



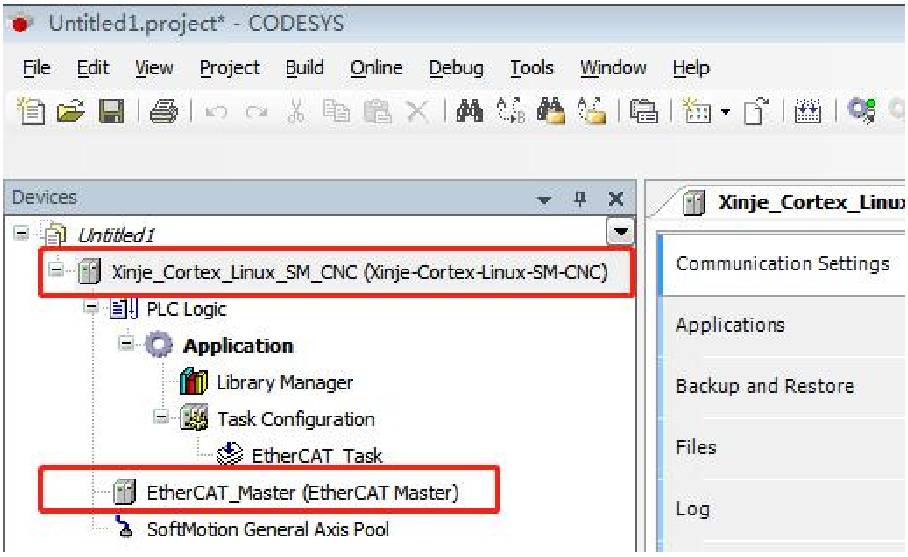
After adding a PLC, the device manager will appear on the right side of the interface. Select Xinje – Cortex Linux SM CNC, right-click, and click Add device.



Select "EtherCAT / master/ EtherCAT master" in the "add device" dialog box, and finally click Add device.



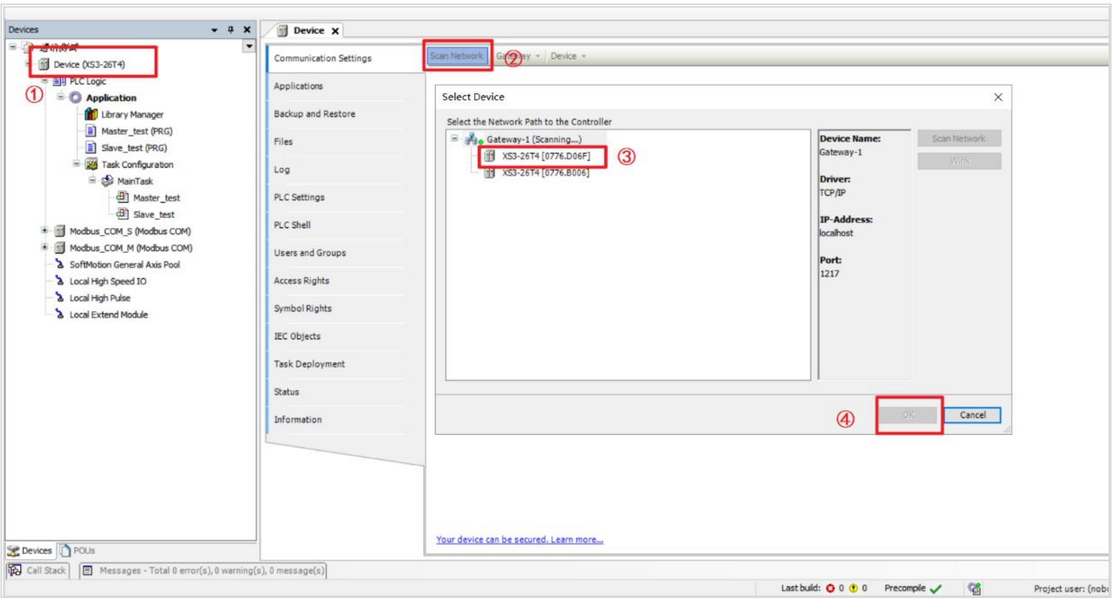
Add the device, as shown in the following figure:



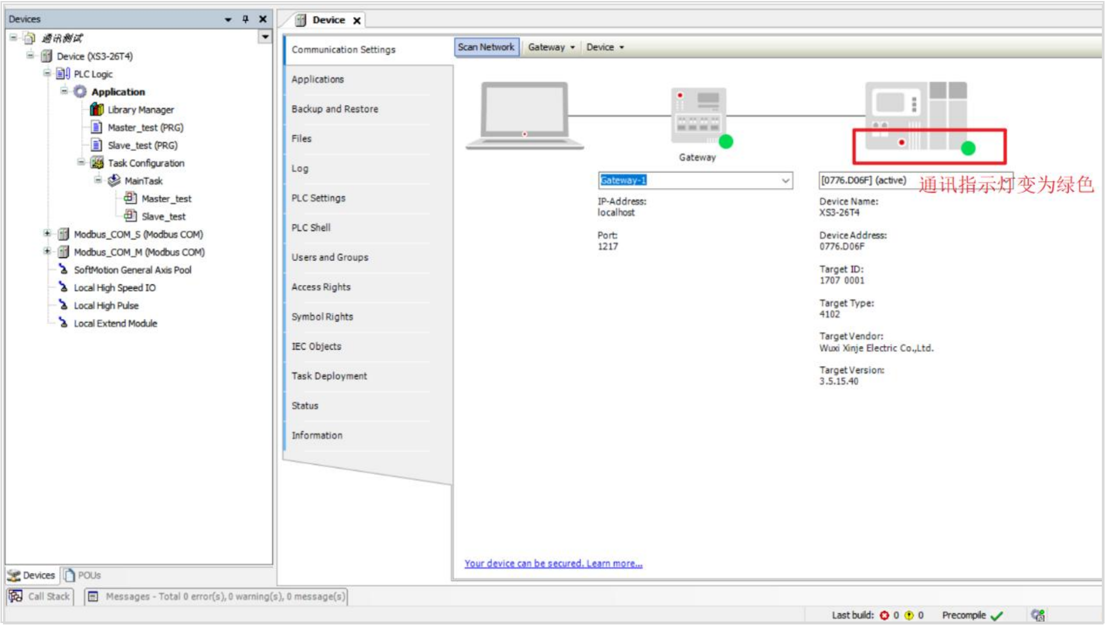
4)Gateway communication settings

Double click Xinje_ Cortex_ Linux_ SM_ CNC, click Scan netwook in the communication settings tab, search for PLCs in the same network segment, and click OK after finding them. As shown in the figure below, the equipment name of the PLC is XINJE-XS3.

Note: Ethernet connection requires that the IP address of the connected device (PC) and the IP address of the PLC are in the same network segment, so confirm whether the IP address setting of the PC meets the requirements before connecting.

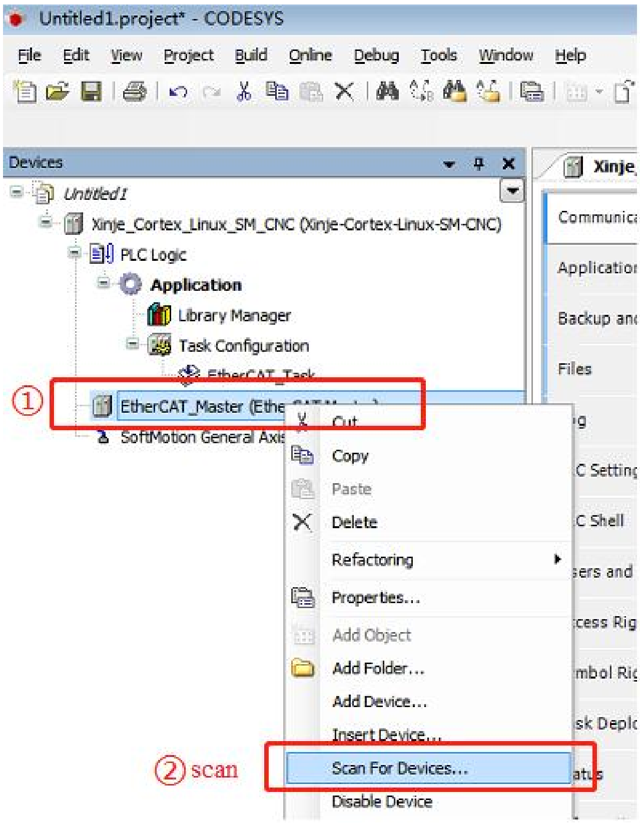


After successful communication, see the following figure:

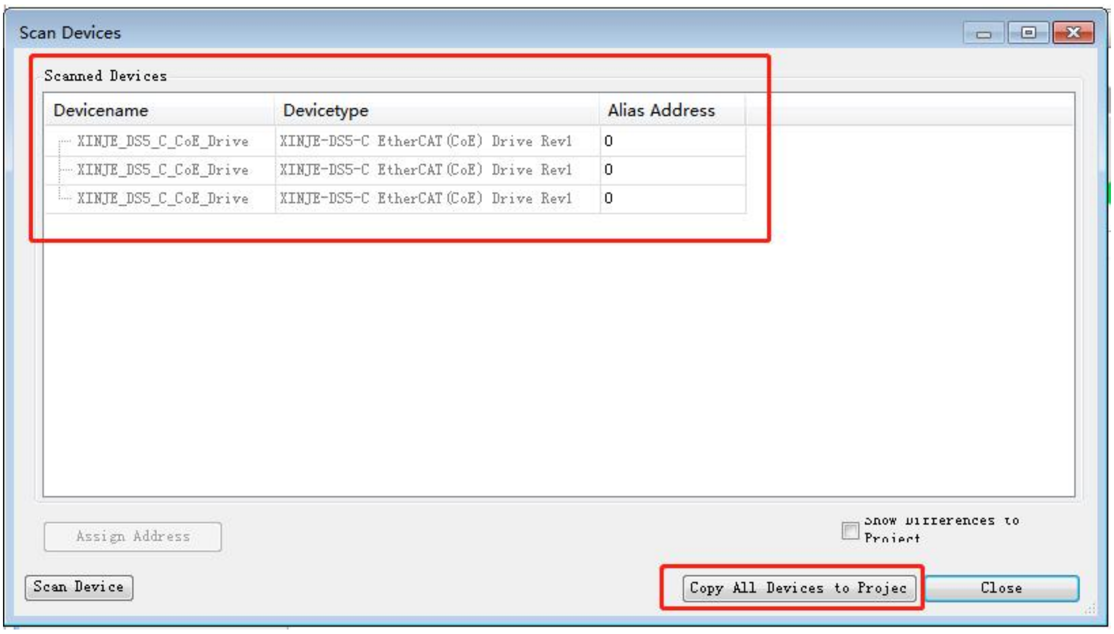


5)Scan the slave station device

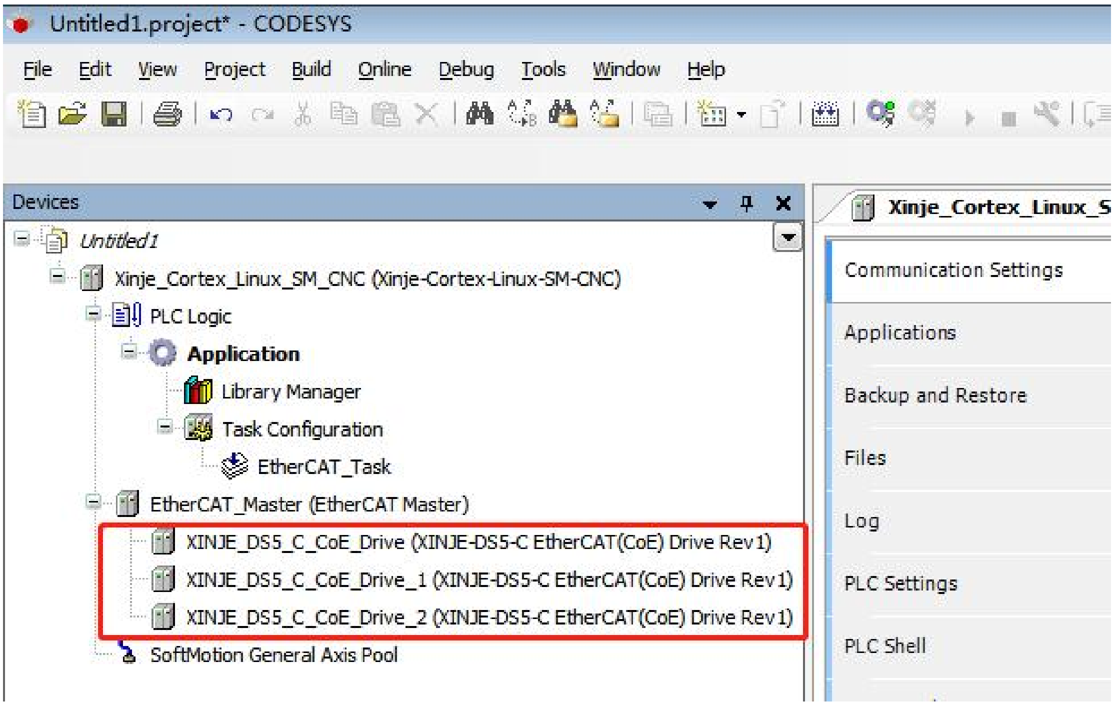
In the device engineering bar, right-click EtherCAT_ Master, click Scan for devices.



In this example, three DL6 series servos are connected. The scanning results are shown in the figure below. Click Copy All to Project to add all the slave stations scanned to the project.

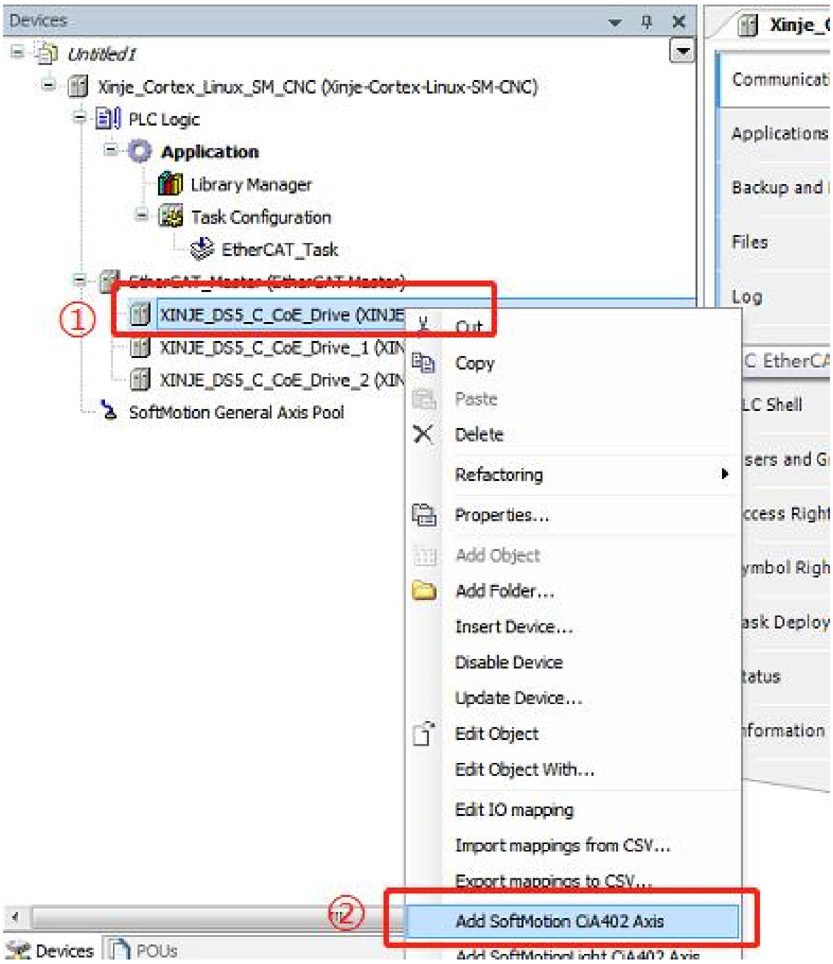


After the slave station equipment is successfully added, the "devices" is shown in the following figure.

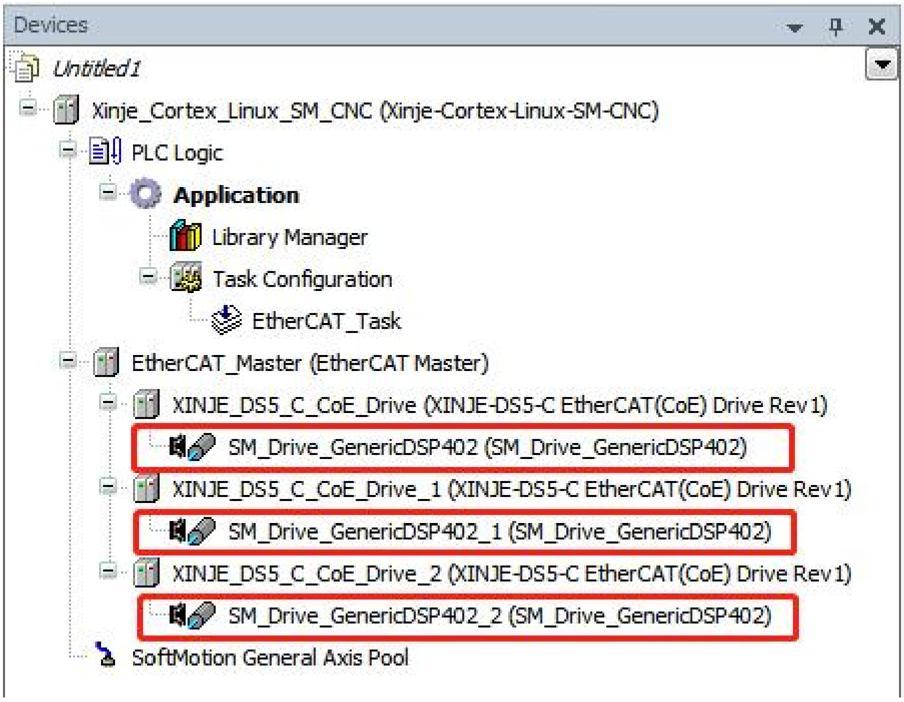


6)Add motion control axis

Select slave axis device XINJE_DS5_C_CoE_Drive, right-click, click Add SoftMotion CiA 402 Axis.

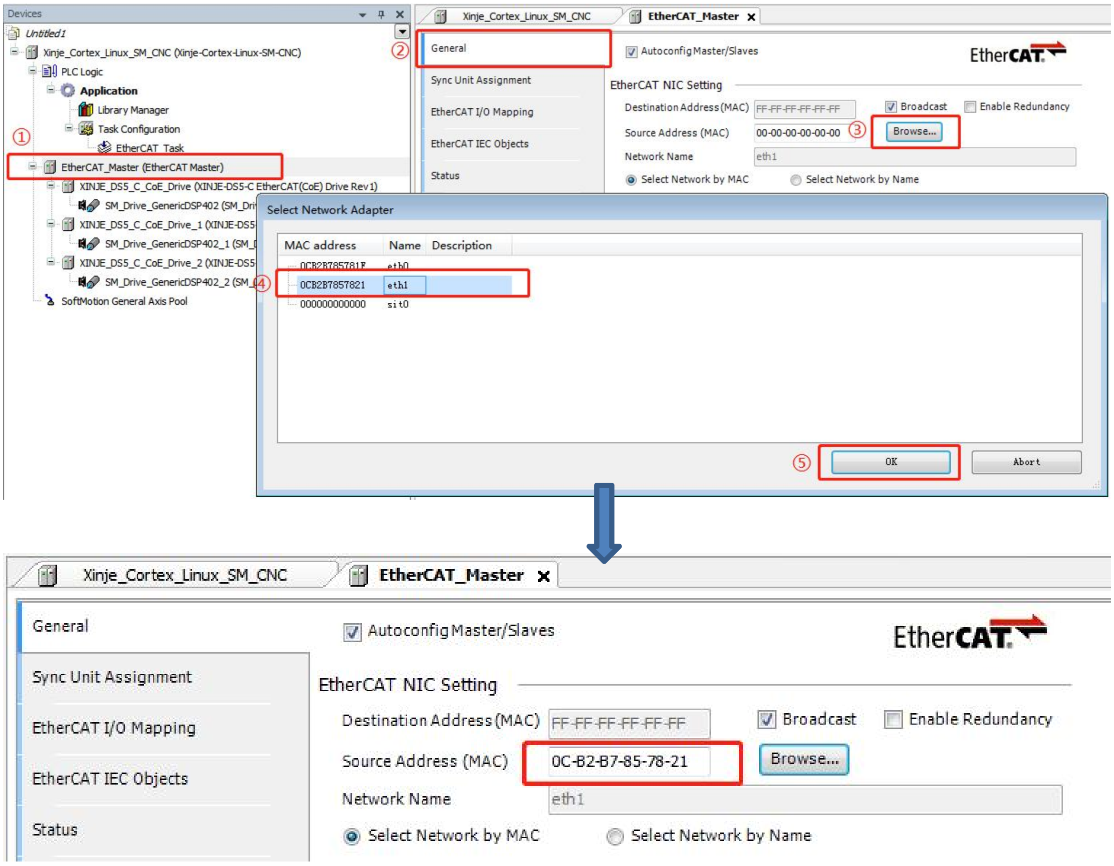


Similarly, add an axis for each slave station. After adding, it is shown in the following figure:



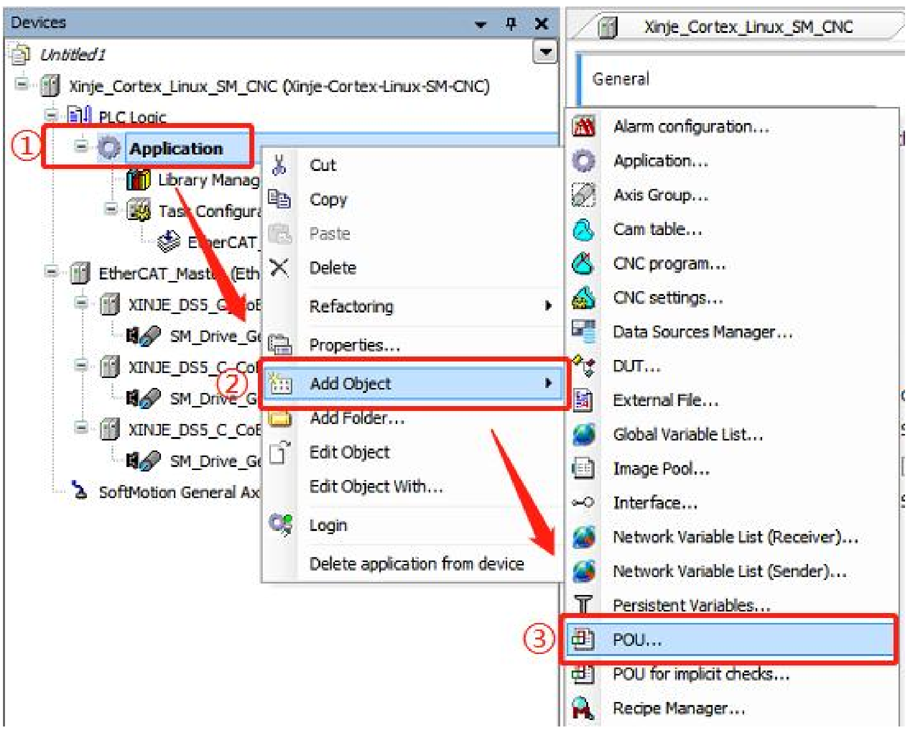
7)Master station device select source address

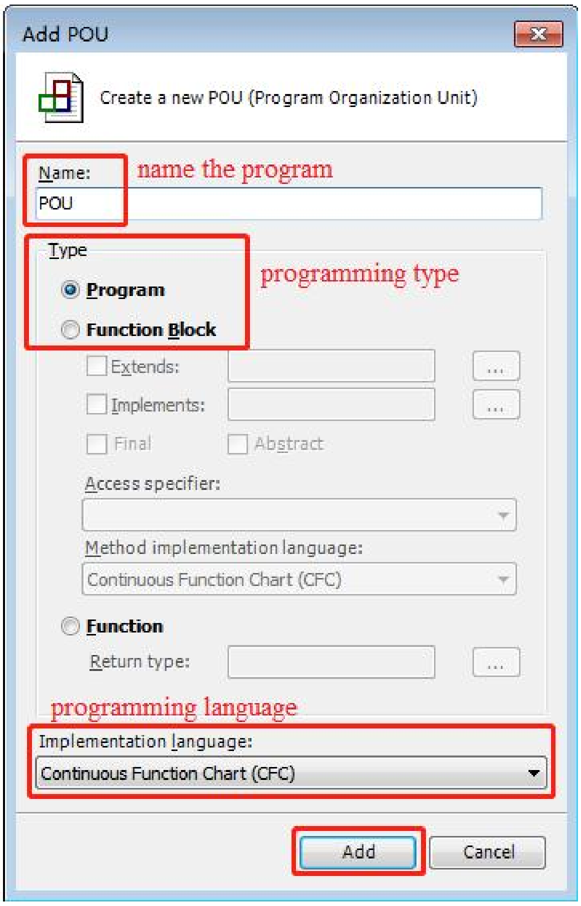
Double click "EtherCAT_Master", click Browse… in general tab, select corresponding MAC address, click OK, now the source address is selected.



8) Make the program

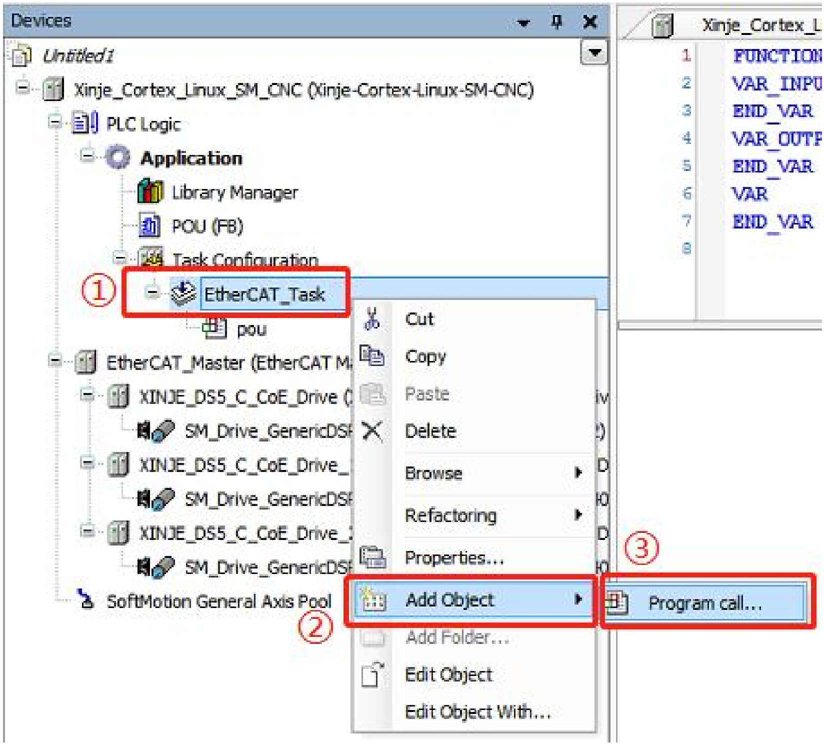
Add POU. Right click application in the devices column and select Add object -- POU. Name the POU to be added and select the programming method, then click Add. In this example, the form of continuous function diagram (CFC) is selected for programming.

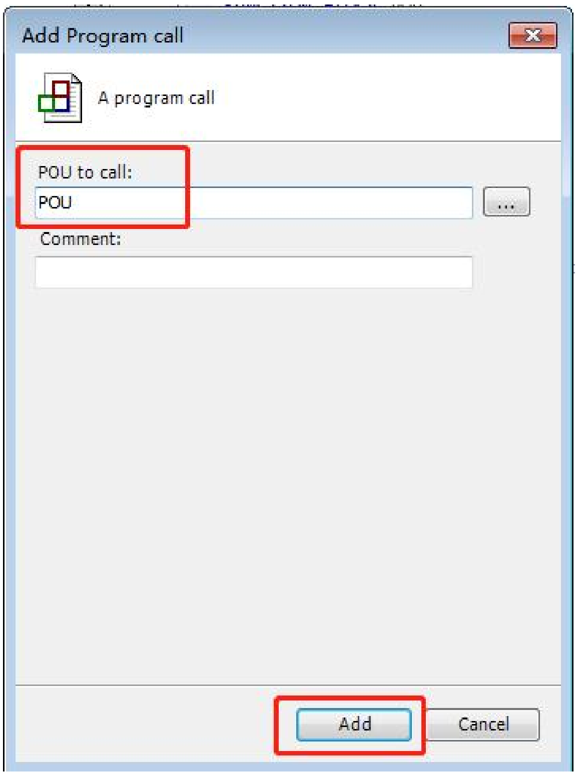




Double click the added POU to program in the POU interface.

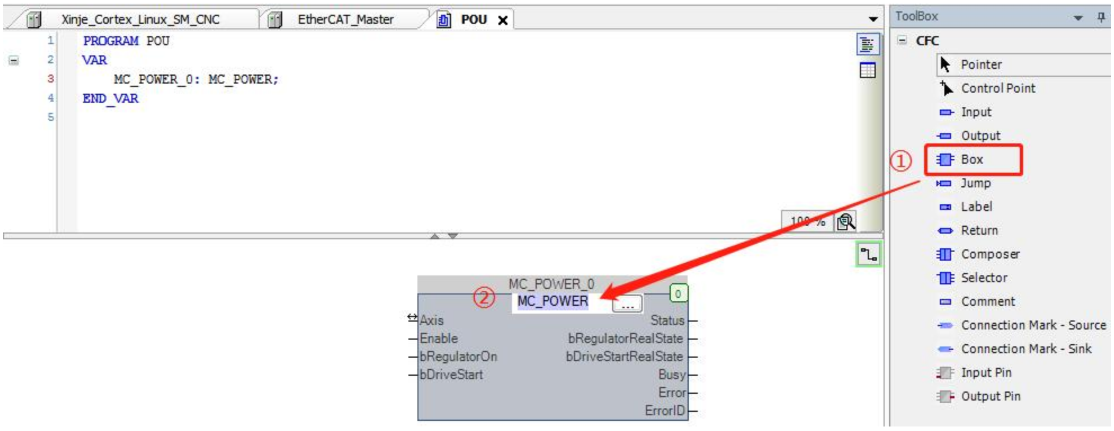
Note: POU should be added to the task, because subsequent compilation commands only compile the programs added to the task. If the created POU is not added to the task, the compile command does not perform syntax check for the POU. Right click EtherCAT_ Task, select Add object -- Program call, fill in "POU" in the dialog box “Add Program Call”, and finally click Add.



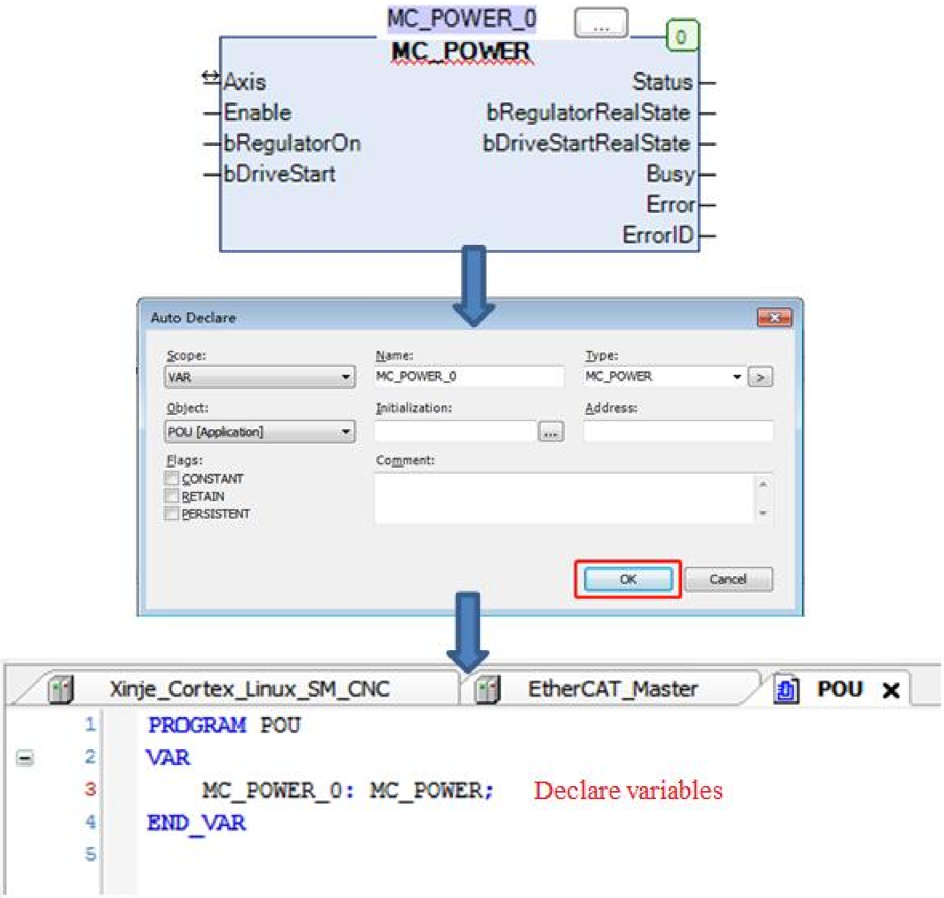


Call the function block

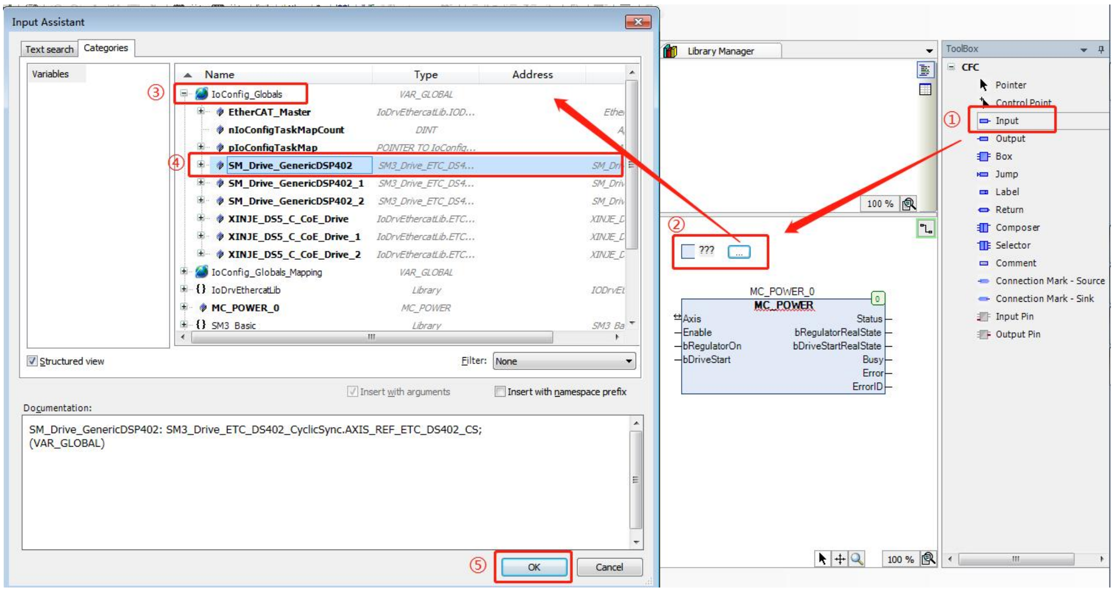
On the POU interface, calling an MC_POWER function block to control the axis enable. Select the box in the toolbar, drag it into the programming interface, and enter MC_ POWER.



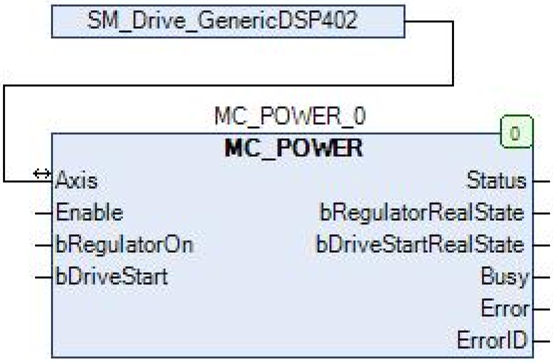
Link this function block to the variable of the first slave station axis, as shown in the figure, enter MC_ POWER_ 0, the programming interface will automatically generate variables to be declared.



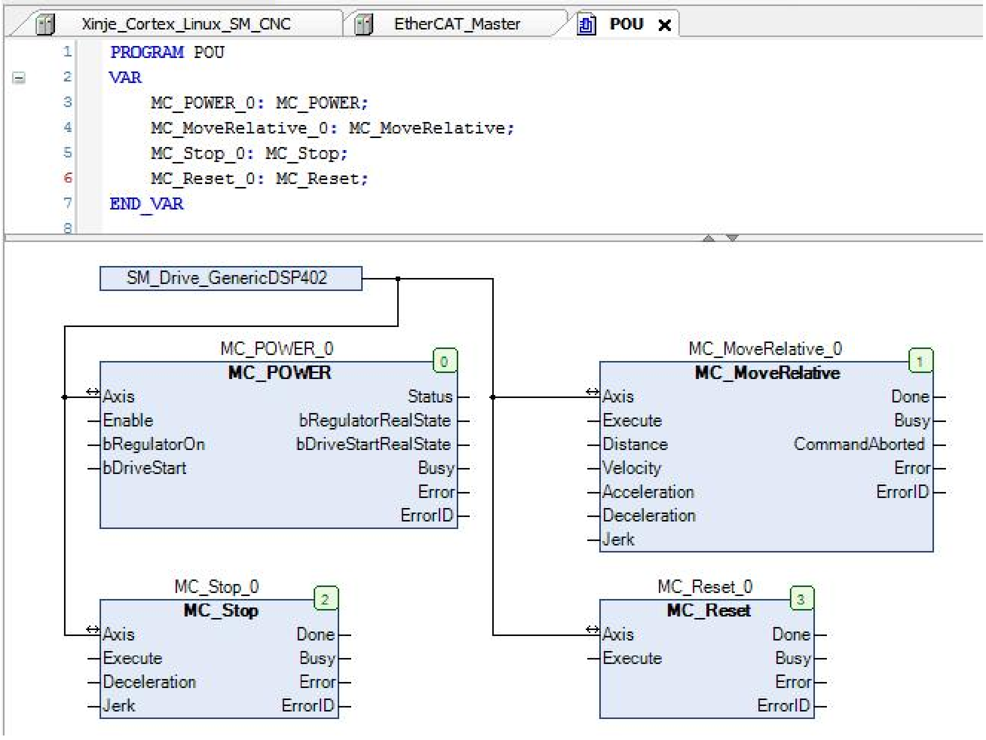
Add input and link the function block to the first slave station axis. Select Input, drag it in the programming interface, double click this object, click  , select IoConfig_Globals-- SM_Drive_GenericDSP402 in the Input Assistant, click OK.



Connect the added input function block and the enable function block with wires.

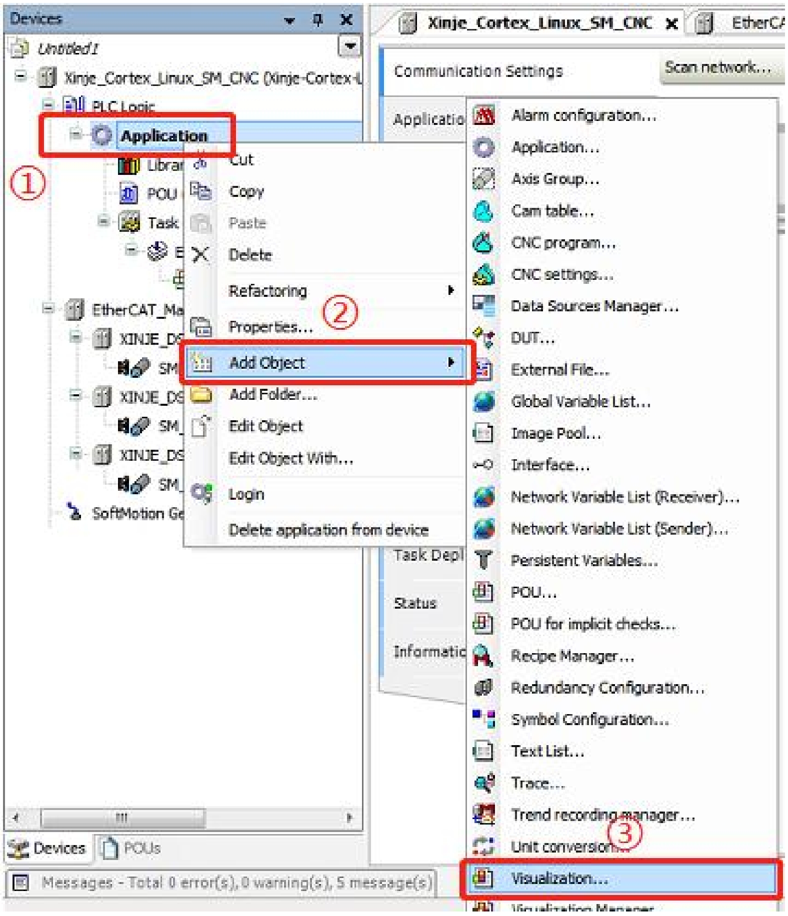


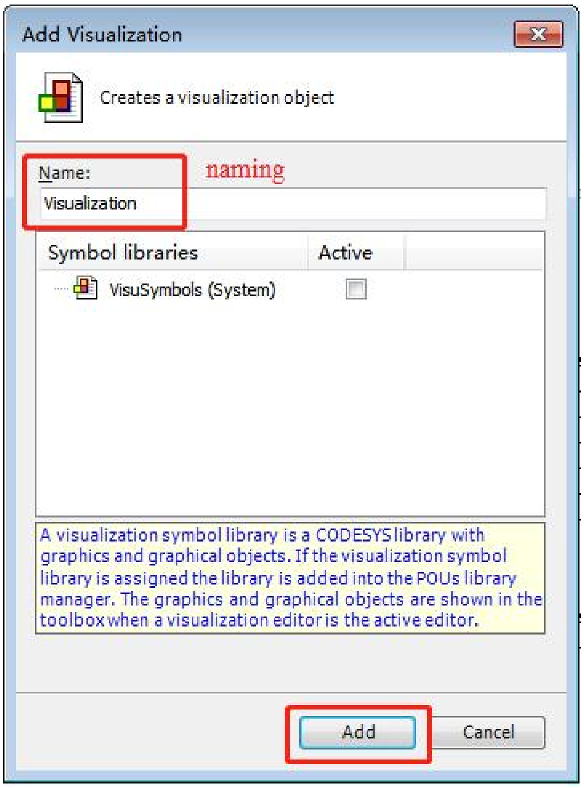
Similarly, continue to add the relative movement function block MC_ MoveRelative, Stop function block MC_ Stop, Reset function block MC_Reset. The procedure is shown in the figure below.



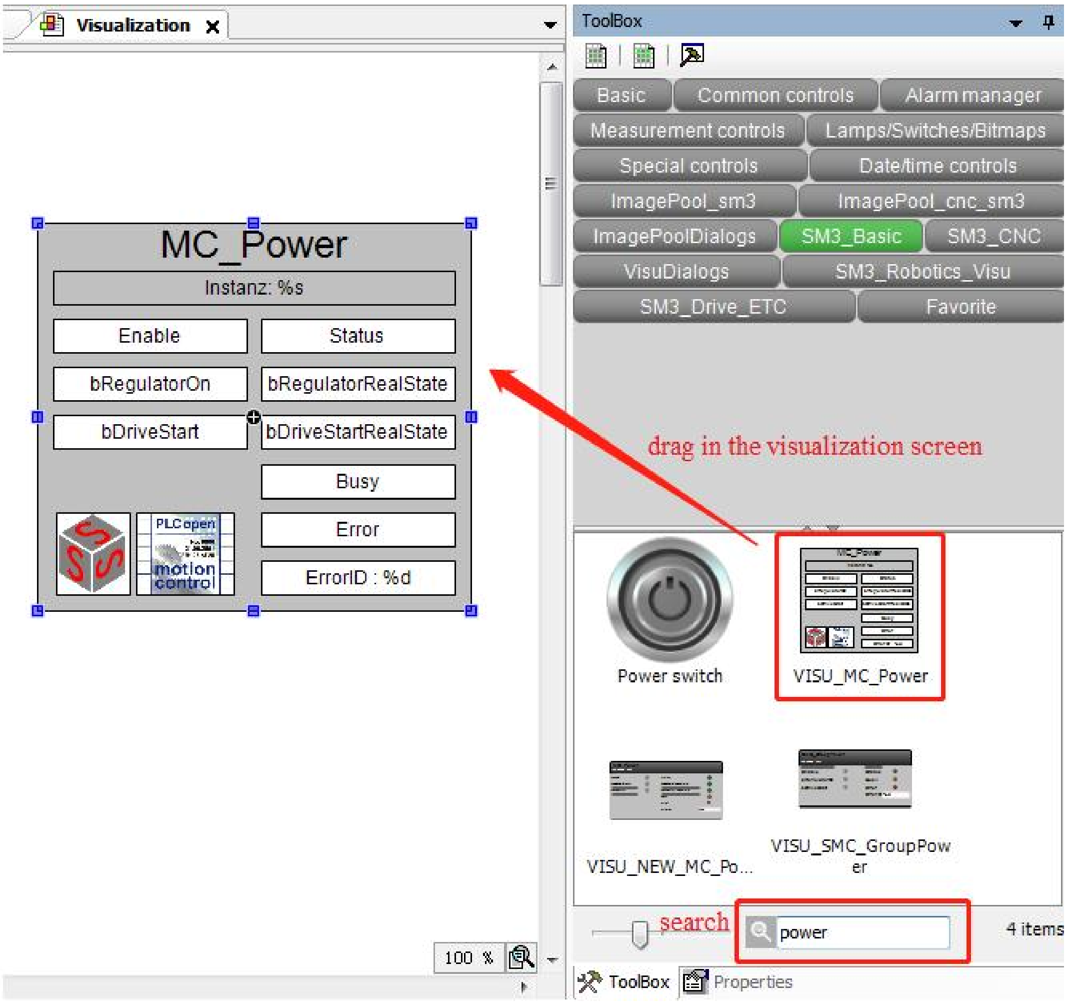
8) Add visualization

Right click application in the devices column and select Add object - visualization. After naming and selecting the programming method, click Add.

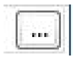


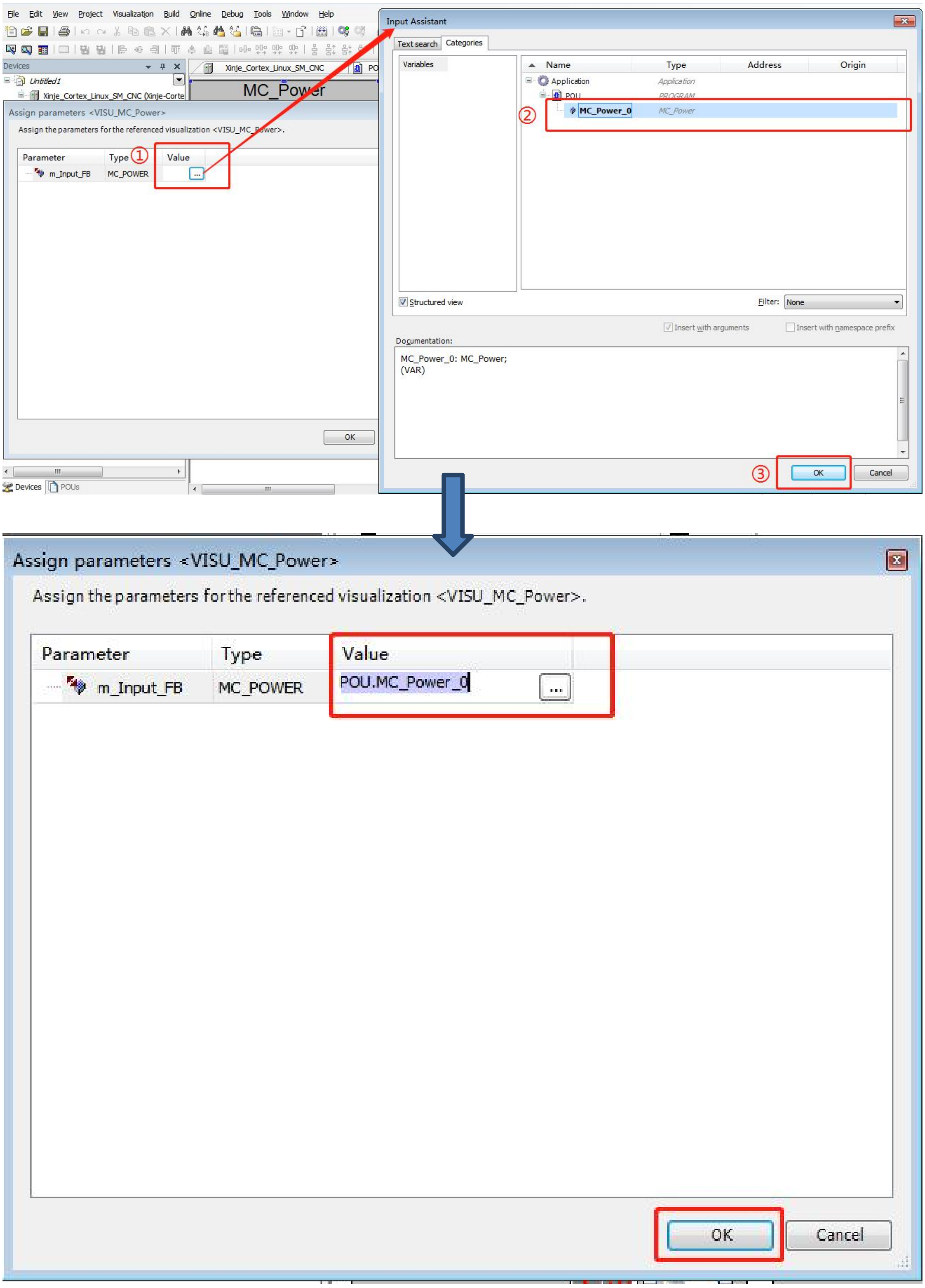


Double click visualization in the devices column to add the required visualization. For example, you can search for power in the toolbar and drag the visualization object into the screen.

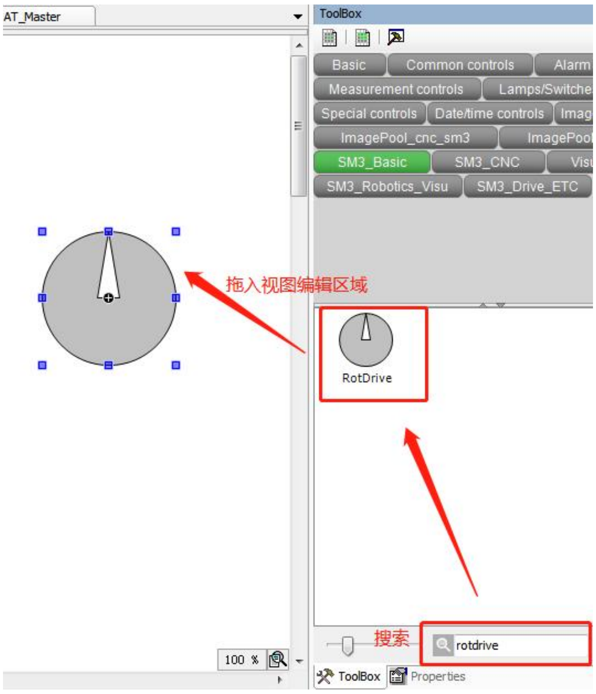


When you drag the control object into the editing area, the dialog box Assign parameters < VISU_MC_Power> will pop up automatically, link the control object to the corresponding declared variable. Double click the value column.

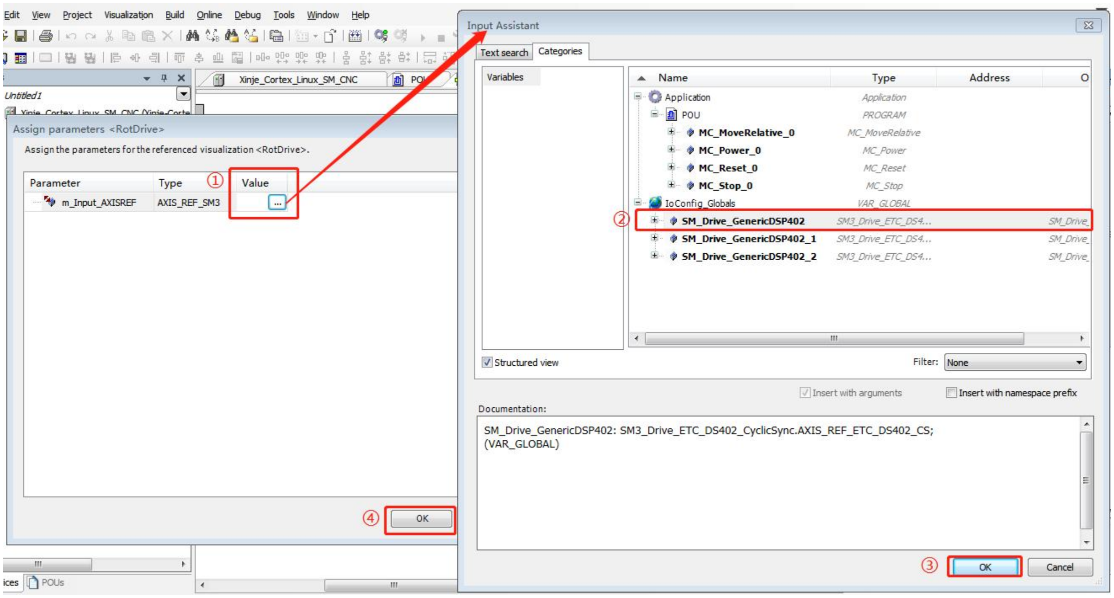
Click , at this time, select the declared variable in the newly pop-up dialog box, and then click OK. The linked variable name will appear in the value column. Finally, click OK, that is, the variable linking is completed. Similarly, other control object follow suit.

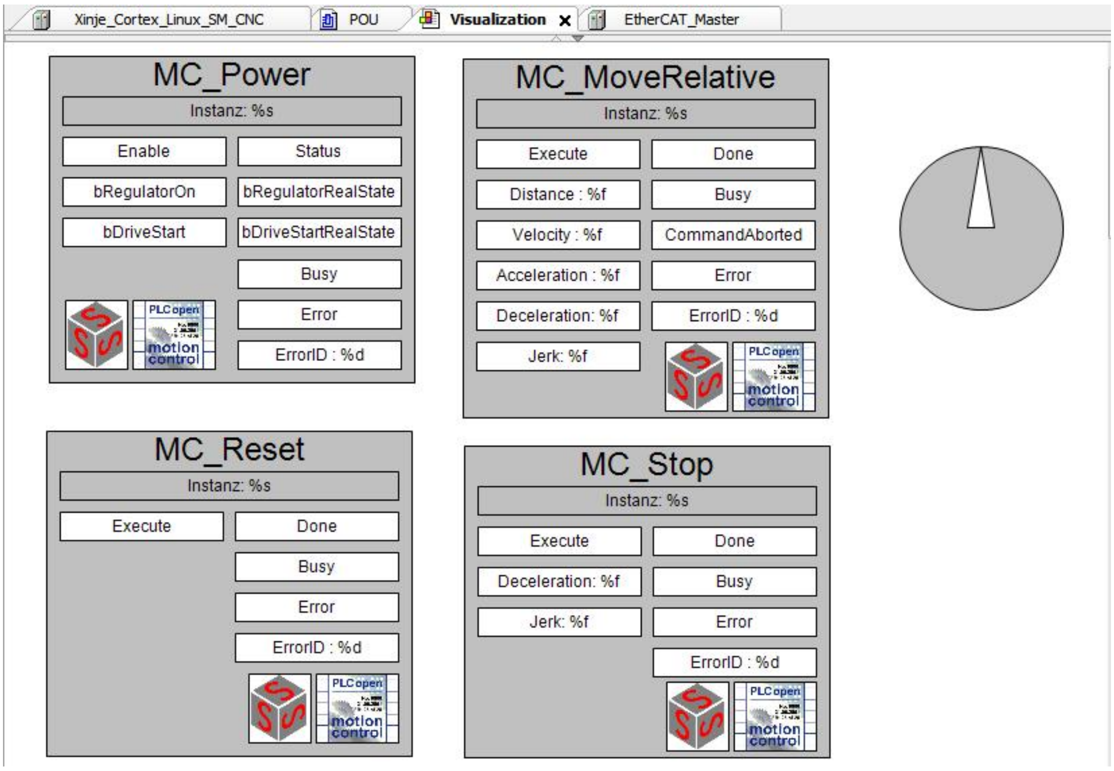


Add an object that simulates the rotation of the motor and link it to the motor axis. Add it in the same way as above.



The created view is as follows:

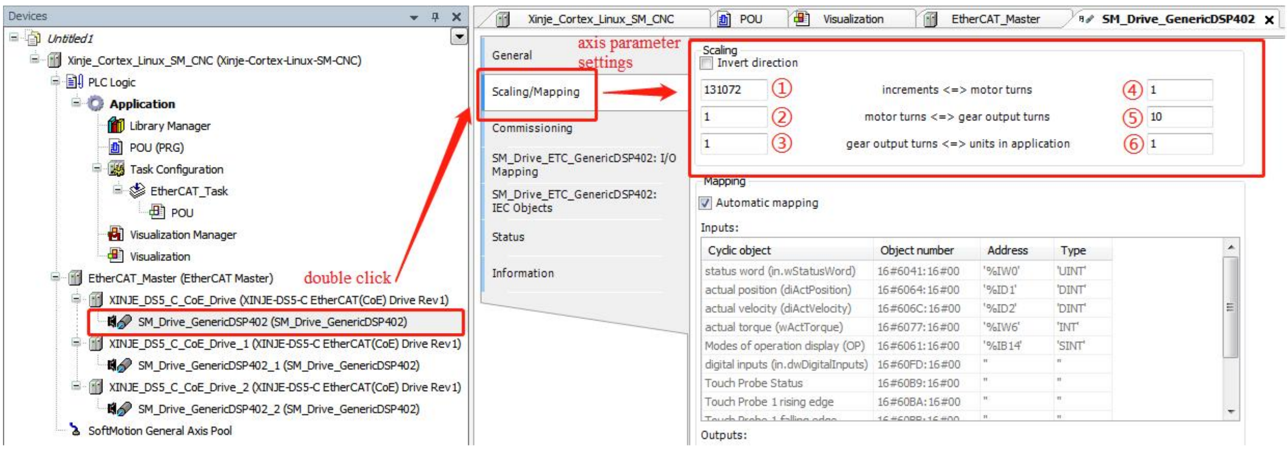




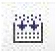
10) Online control

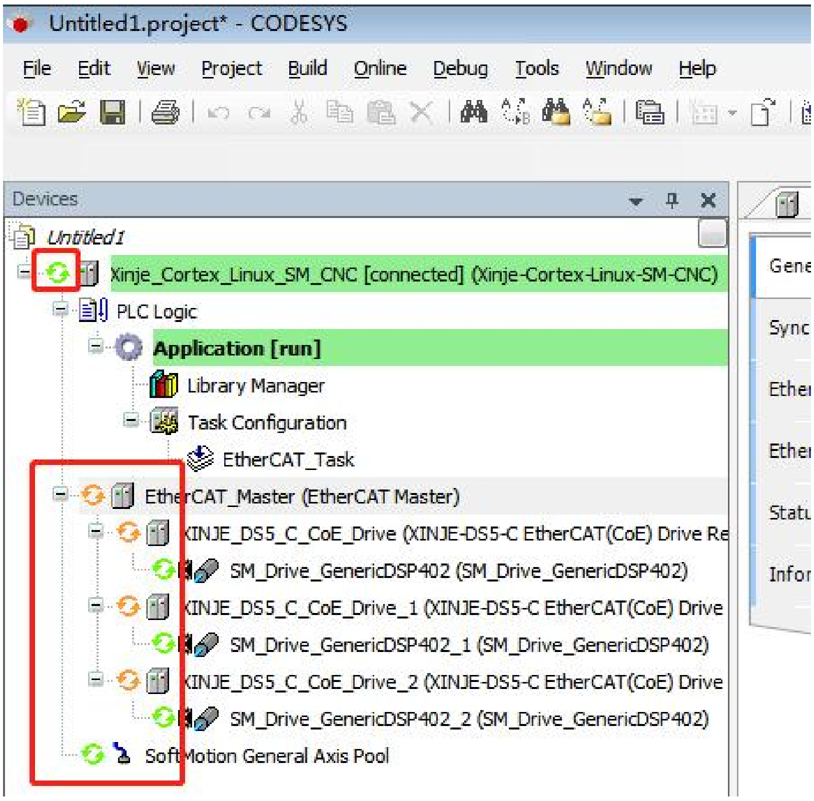
Parameter setting of axis. Double click axis 1 to set axis parameters in the Scaling/Mapping tab. ① To set the encoder accuracy, a 19-bit encoder is connected in this example, so 524288 is filled in.
The relationship between settings and output: coefficient =(④*⑤*⑥)/(②*③)

Example: when the input-output relationship coefficient is 10, the distance in the MC_MoveRelative function block is set to 100, then 100/10*524288 = 5242880, that is, the set operating distance is 5242880 pulses, and the motor will rotate for 10 polar distance.
At this time, set the velocity value in the function block to 10, then 10/10* 524288 = 524288, that is, the motor will run at the speed of 524288/s.
Set the acceleration value to 1000, then 1000/10*524288 = 52428800, that is, the acceleration of the motor is 52428800/s², the deceleration setting is the same.

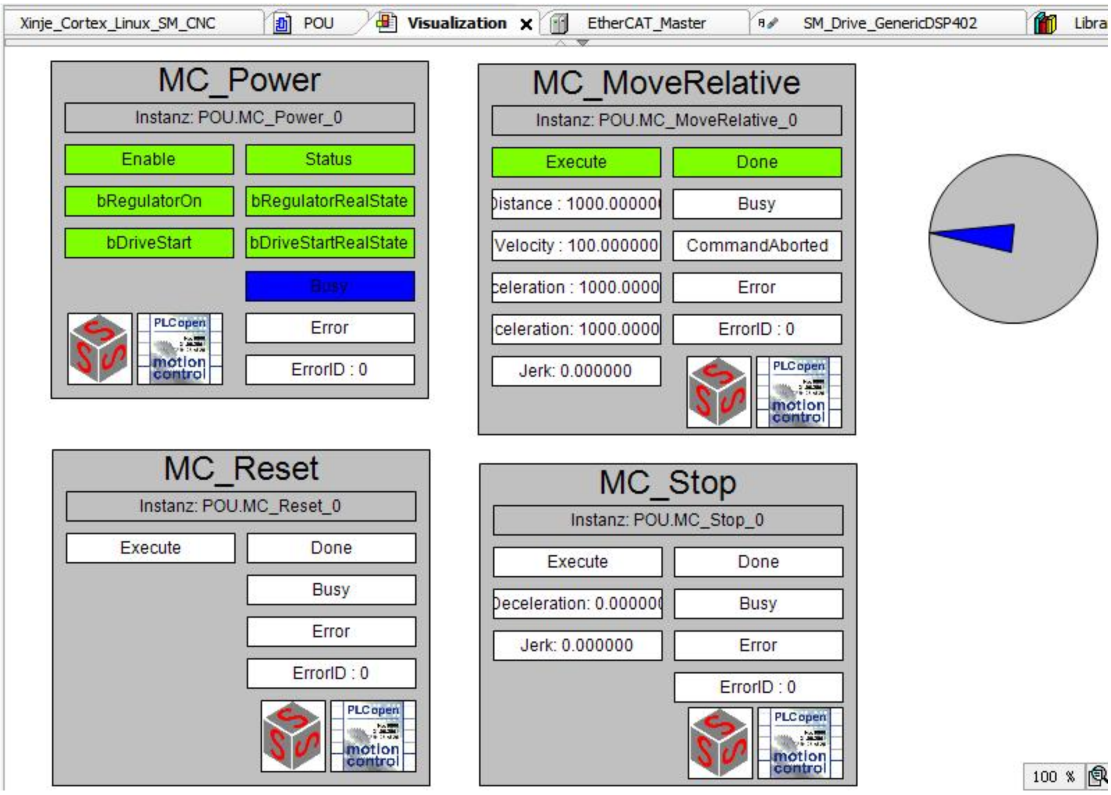


After setting parameters, compile the program for syntax check, and log in and run the program after no error is reported. Login enables the application to establish a connection with the target device and enter the online state. The precondition for correct login is to correctly configure the communication settings of the device and the application must be free of compilation errors.

Execute  compile,  login,  run, the normal operation status is shown in the figure below:



At this time, the distance, speed and other parameters that the motor needs to move can be set in the visualization. Click bDriveStart—bRegulatorOn—Enable in turn in the MC_Power function block to enable the motor normally. Finally, click Execute in MC_MoveRelative function block to start relative position movement.



11.4 OMRON and DL6 servo Ethercat communication example

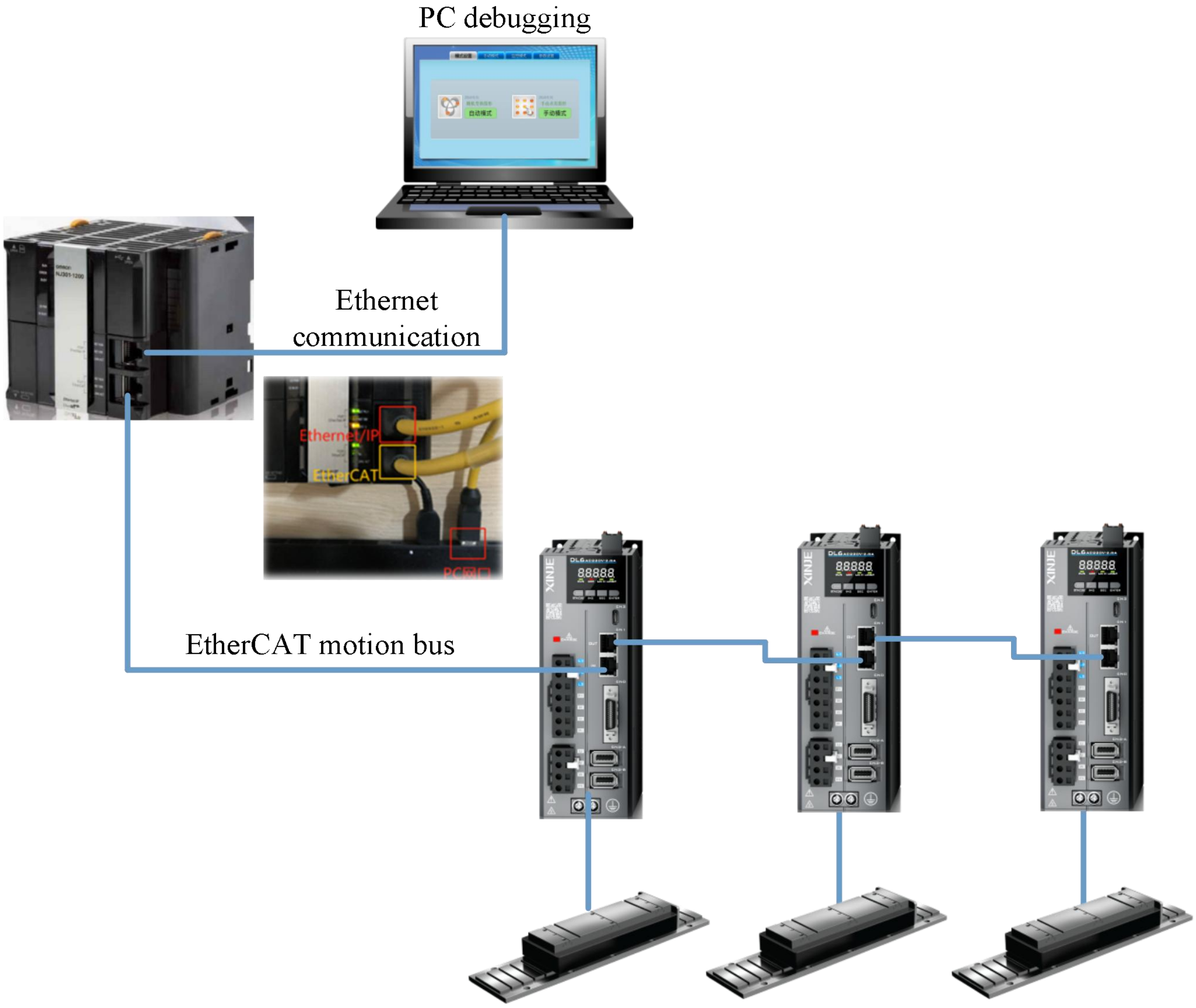
This example will explain how Omron PLC is used as EtherCAT master station and Xinje servo is used as slave station to realize EtherCAT motion control.

Note: This communication case takes DS5C1-20P7-PTA as an example, and the bus configuration of DL6-2003/2006 (- GS) is the same as DS5C1.

11.4.1 System configuration

Name	Model	Quantity	Note
Upper computer	Sysmac Studio	1	Omron software
Controller	OMRON NJ501-1500 series	1	
Xinje servo	DL6-2003(-GS)	1	
Network cable	JC-CA-3	Some	Used for connection between computer and PLC or between PLC and servo

11.4.2 System topology



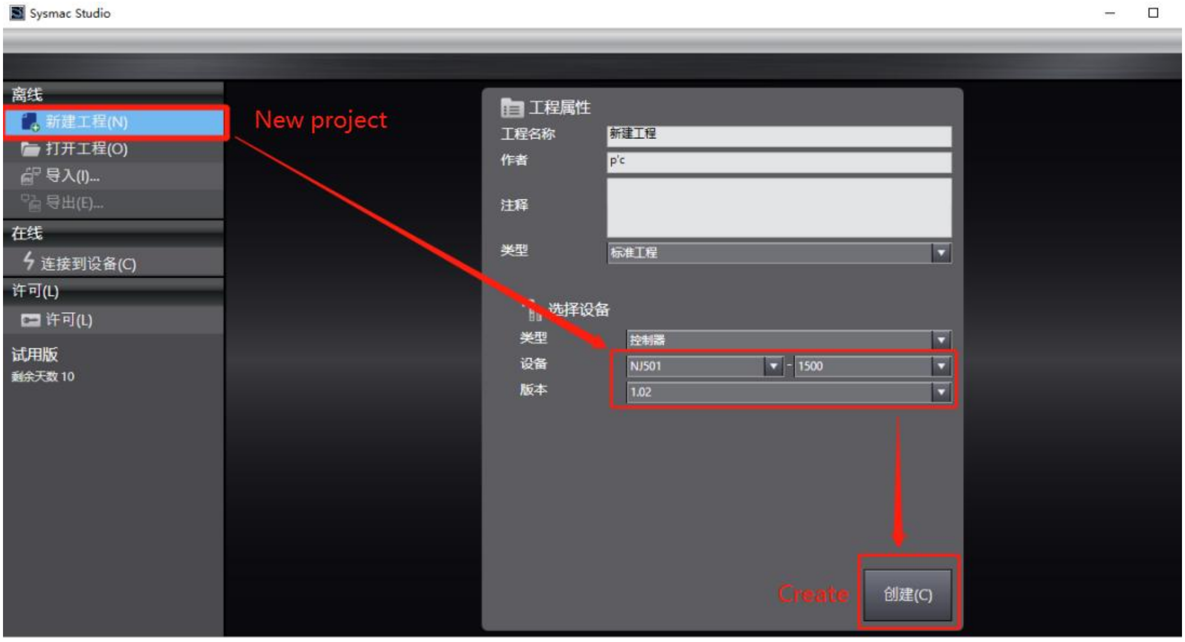
The NJ501 CPU module has two network ports, the red marked is Ethernet/IP, which are used to connect the Omron host computer SYSMAC studio to monitor and write data to the PLC. The yellow marked is EtherCAT, and the other end is connected to Xinje DL6 series servo to realize EtherCAT communication.

Each network port is equipped with three indicators, RUN/ERROR/ACT. After the network cable is correctly connected, RUN should be on and ACT should be on. When the communication is established and there is data interaction at the network interface, ACT flashes. Error will not light up unless it is abnormal.

11.4.3 Debugging steps

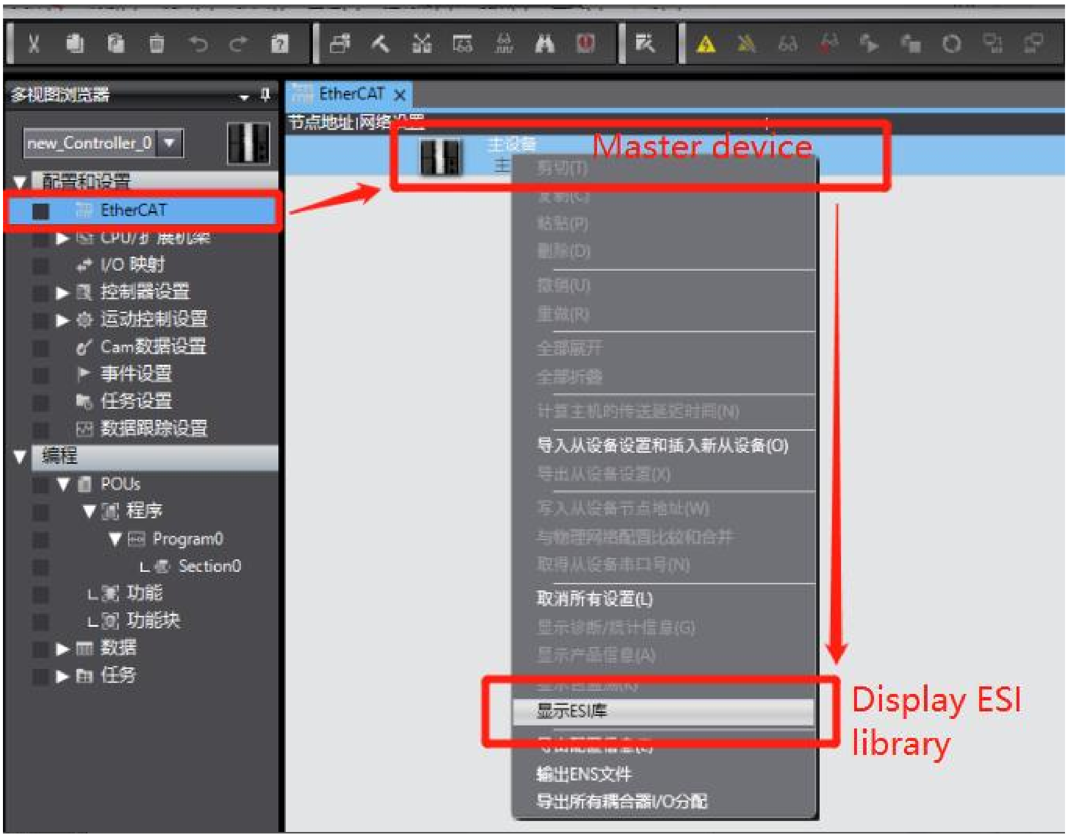
1)New project

If "new project" is selected for the first time, select model: NJ501-1500, version 1.02 in the project attribute interface, and click "create" to generate the programming interface.

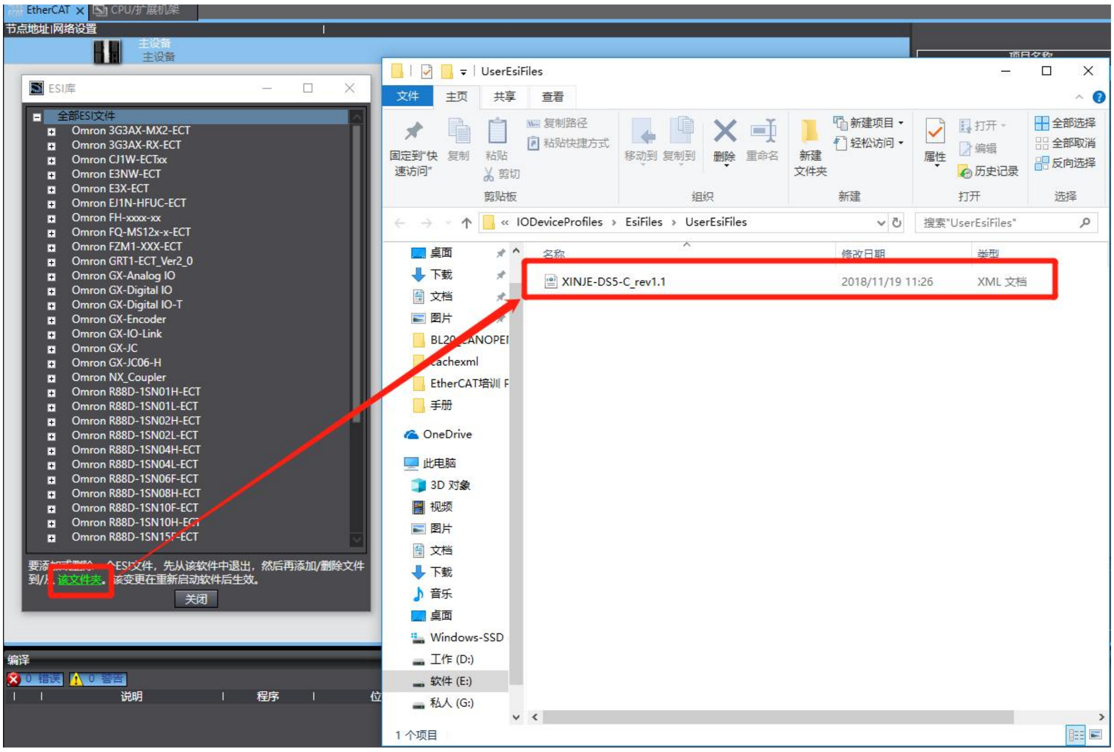


2)Add XML file

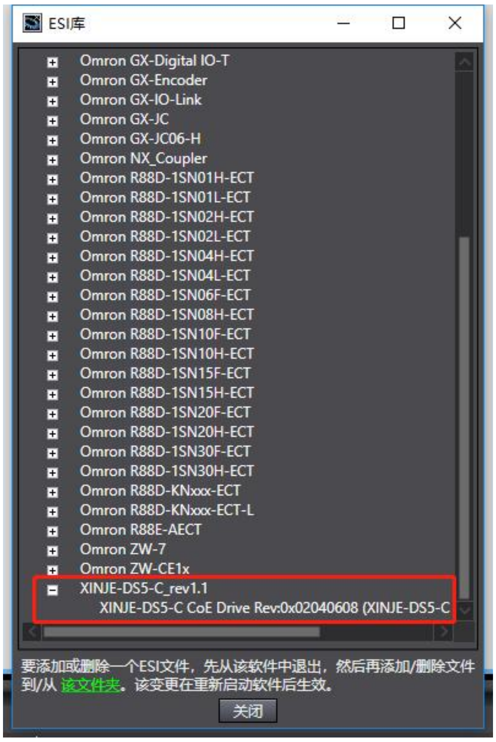
Double click "EtherCAT" on the main interface to call up the EtherCAT configuration interface. For the first time, you need to add XML files to the library. Right click "master device" and select "display ESI library".



Then we need to add the XML file of DL6 to the pop-up ESI library. Select "this folder" to display the path of the storage folder, and put the "XINJE-DL6-ECT(V1.2)" XML type file in the path folder.

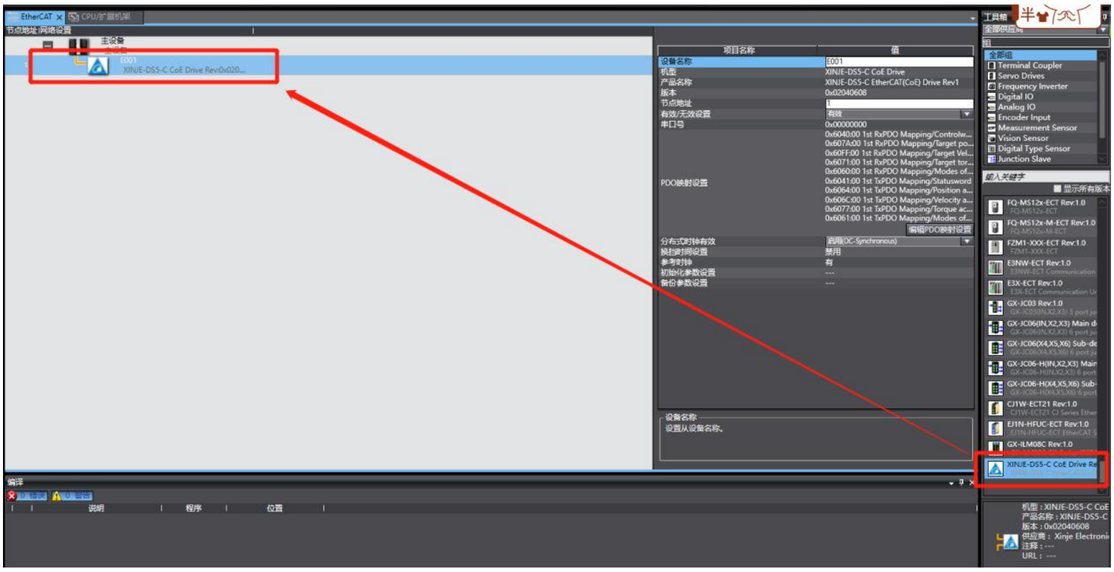


Finally, close SYSMAC studio and restart the software, browse the "ESI library" again, and the XINJE-DL6 slave station description file already exists in the library.



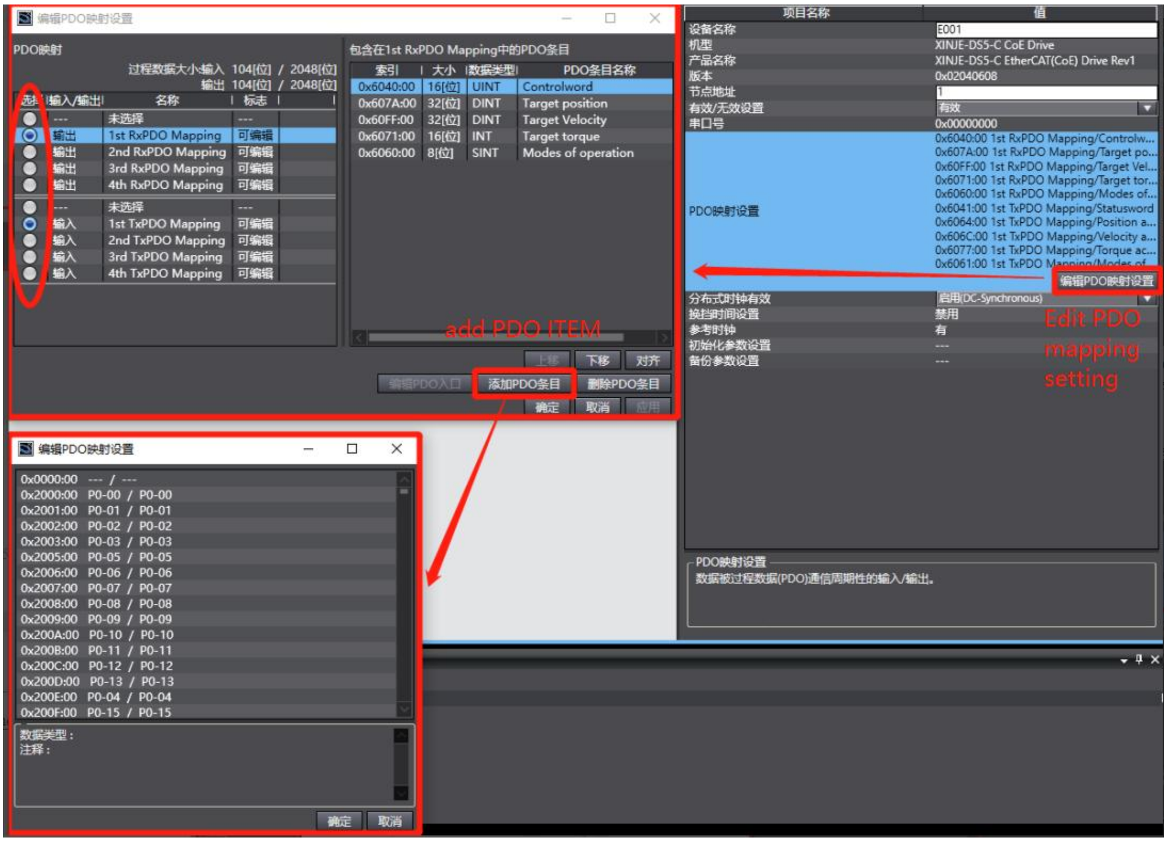
3)Add device

Find “XINJE-DL6 CoE Drive Rev” on the right side of the interface, double click it to add to the node under master device.

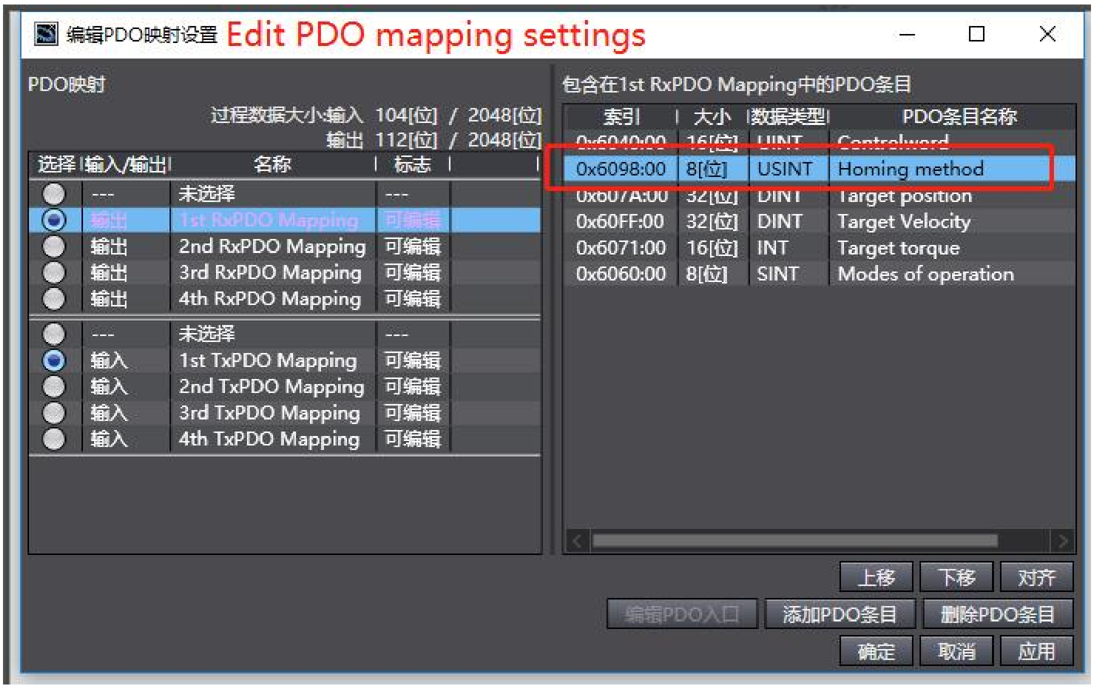


After adding a node, select the node with the cursor to display the PDO configuration of the current node. Select Edit PDO mapping settings. The pop-up interface will display the current output PDO mapping on the left and the PDO items on the right. You can add or delete PDO as required.

Select "add PDO item" to add PDO, and the pop-up window will show the PDO objects that can be added. After selecting, click "OK", and then click "apply", and the addition is successful.

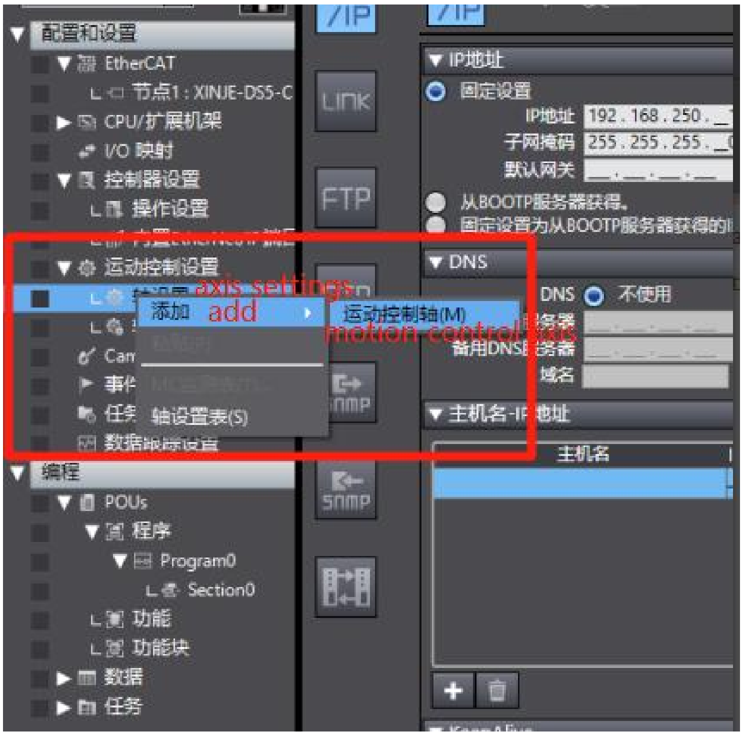


After adding, it is shown in the following figure:



4)Motion control axis settings

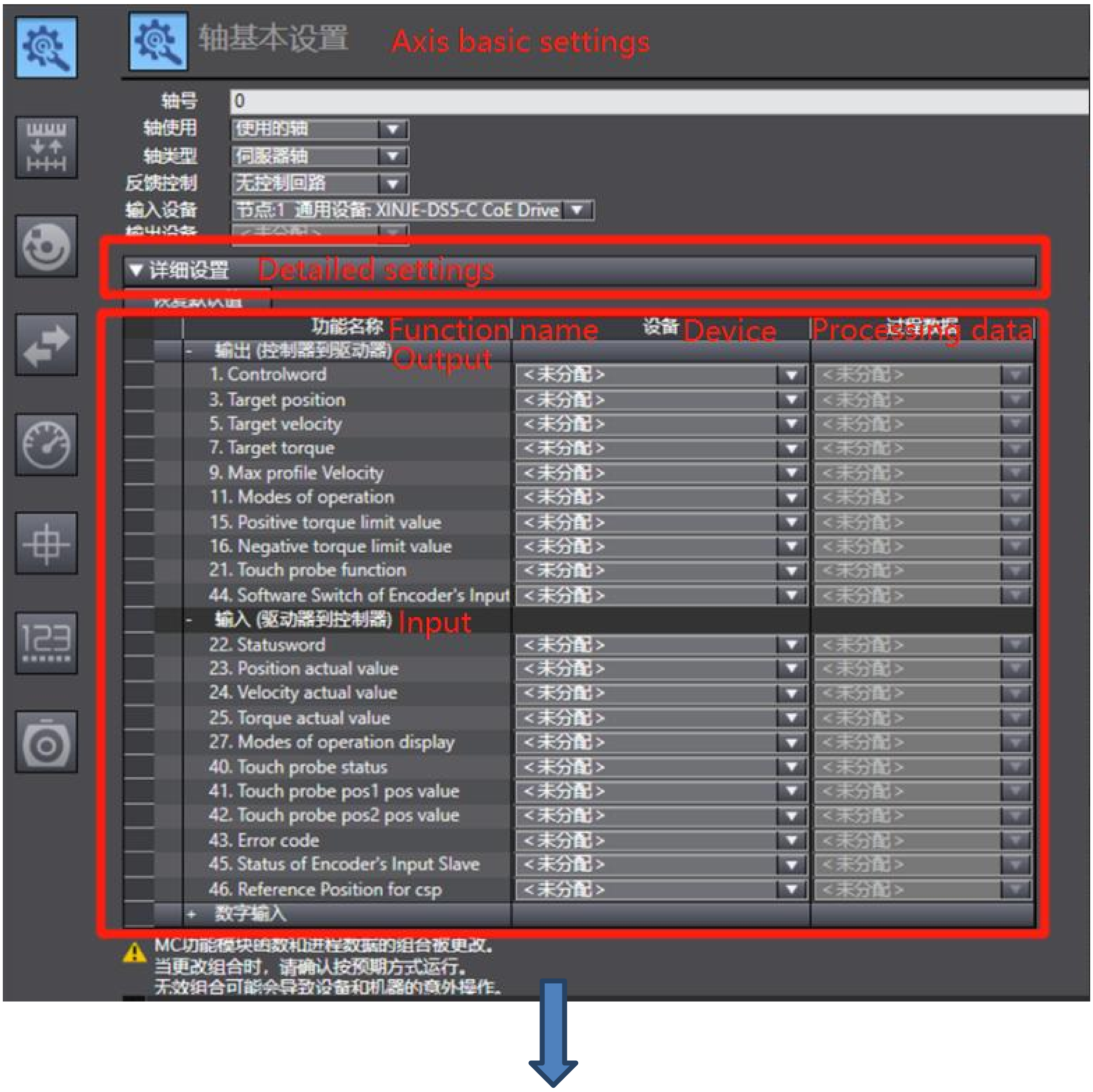
Double click "motion control settings", right-click "axis settings", and select "add - motion control axis".

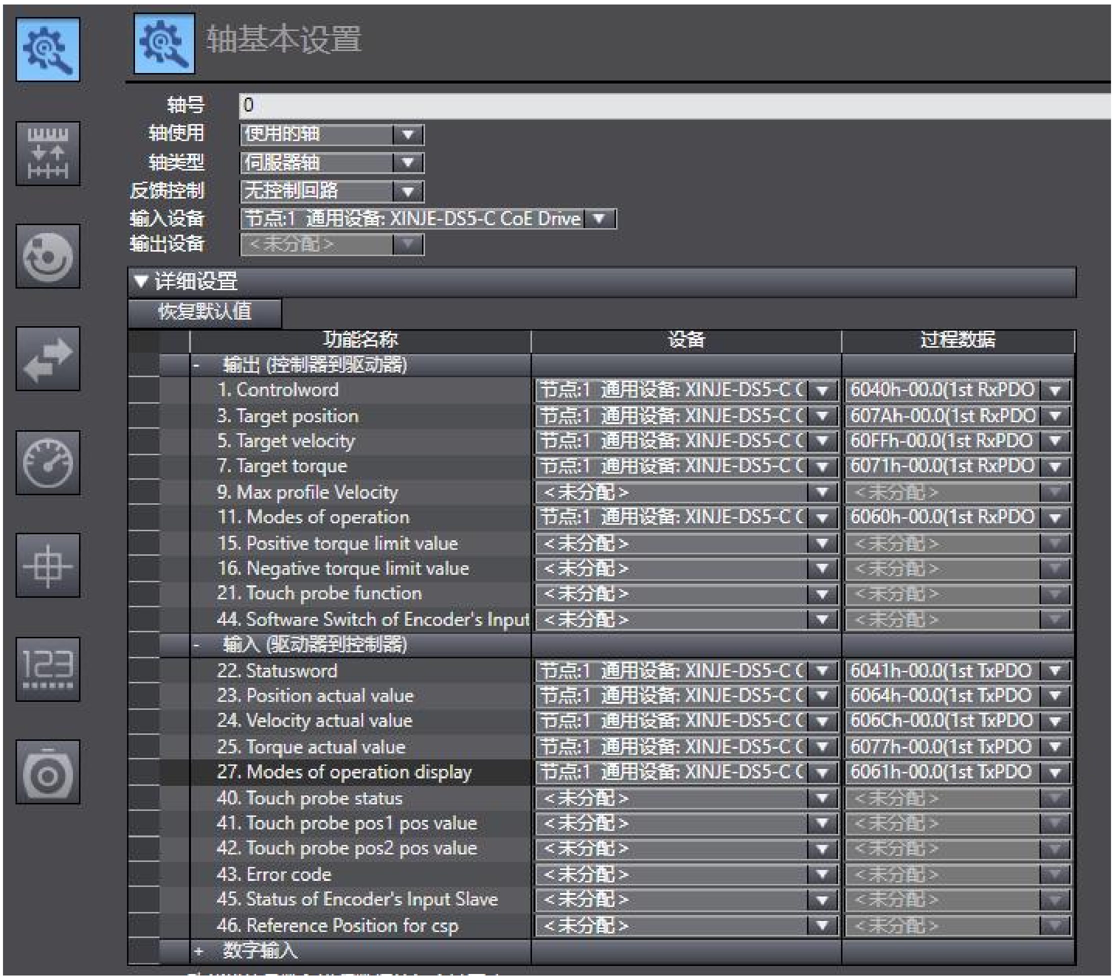


Double click " MC_Axis000" to display the axis setting interface. The interface is divided into multiple sub interfaces.

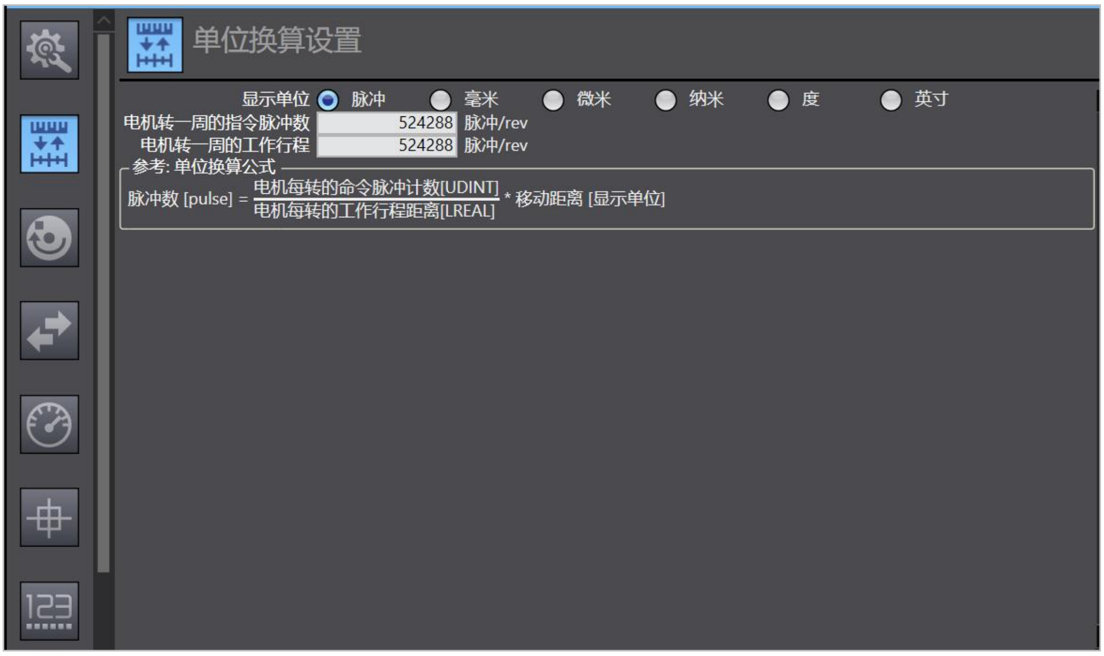
Select "axis type - servo axis" in the "axis basic settings" interface, and select "node 1: DL6" in the "input device".

Click detailed settings, expand the configuration module. The function name needs to be mapped to the PDO mapping item on the device. It needs to be added manually here. Missing or wrong addition will affect the subsequent use of this parameter.



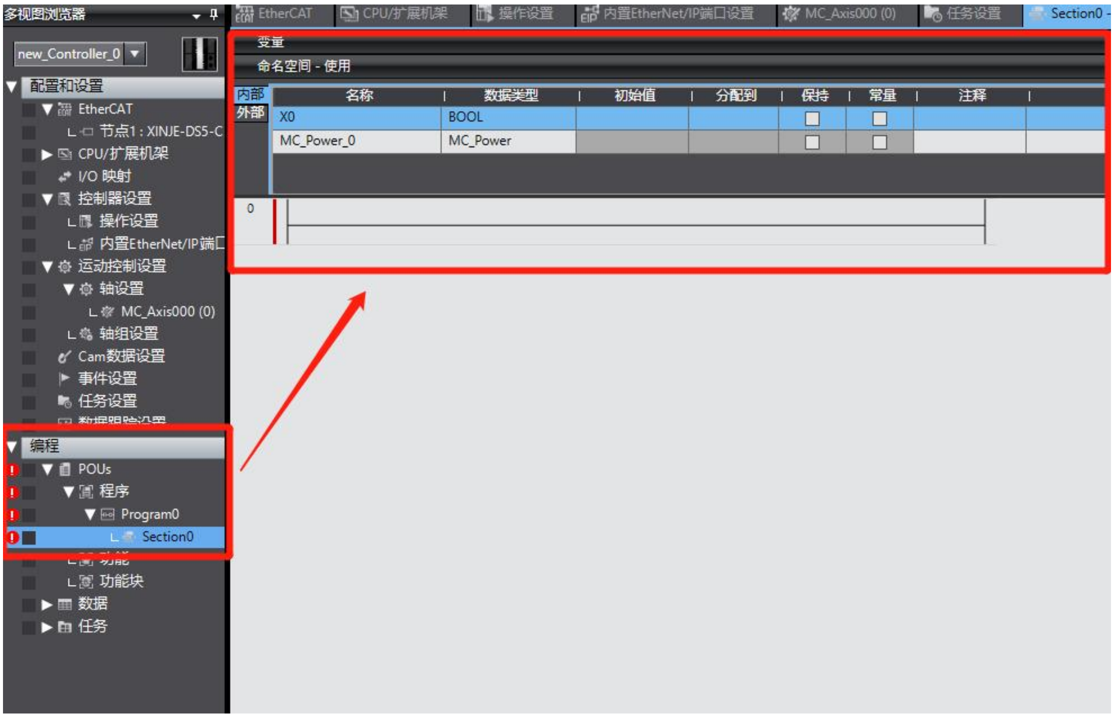


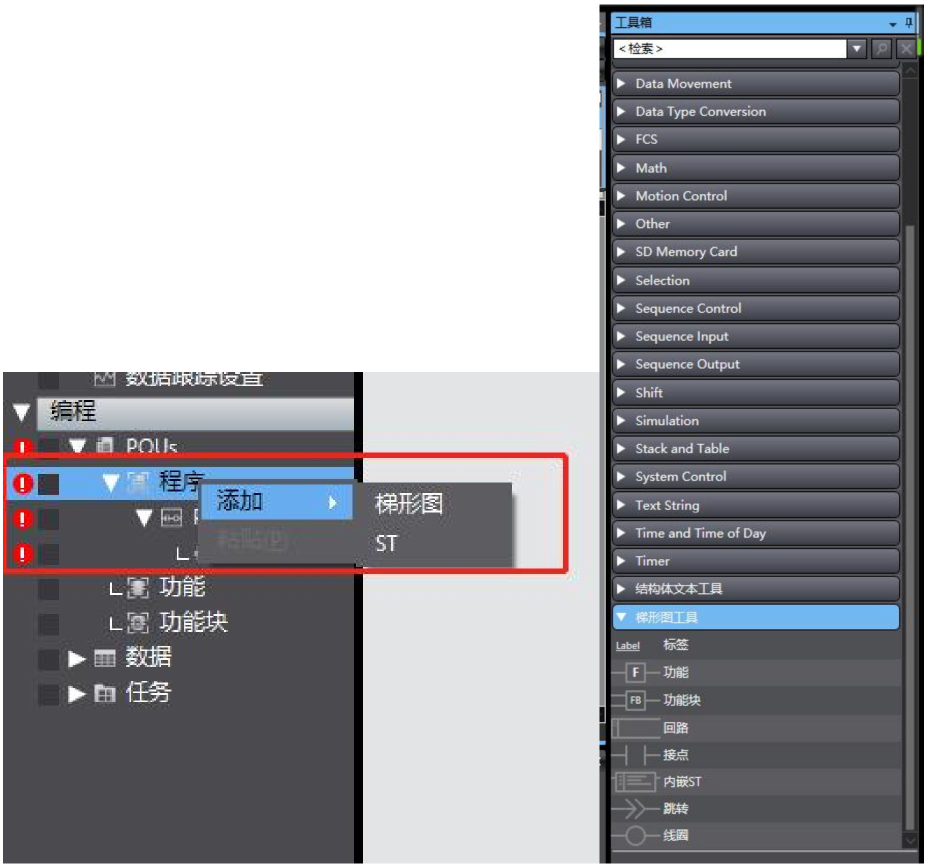
In "unit conversion setting", the number of motor encoder lines is correctly filled in the "number of command pulses per motor revolution". If 19-bit encoder is used in this example, it is modified to 524288. "Working stroke of motor for one revolution" is the equivalent stroke of motor for one revolution. The example here is modified to 524288, and the default gear ratio is 1:1.



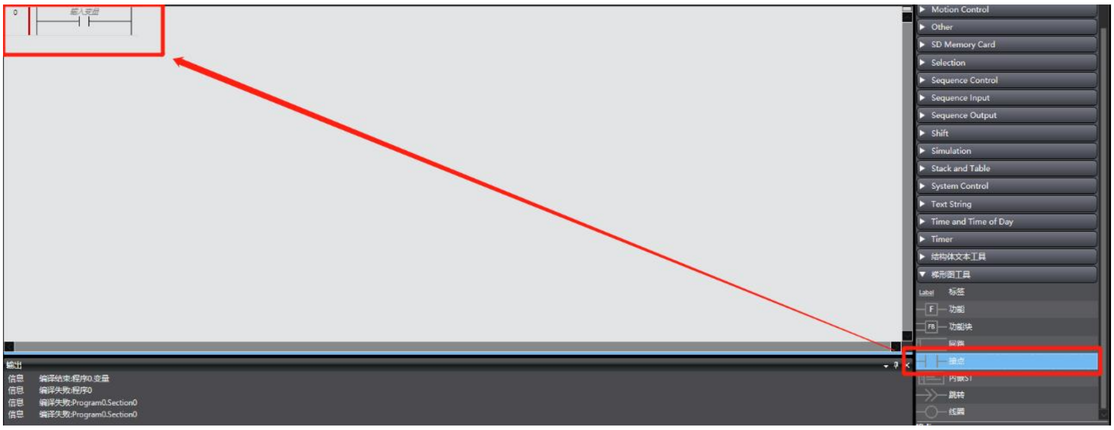
5)Write "round trip" program

Description of programming interface: select "programming / POUs / program / program0/ section0" and double-click "section0" to show the programming interface. By default, program0 is ladder programming. If ST programming is selected, right click "program / add / ST". The "toolbox" allows you to add various ladder elements.

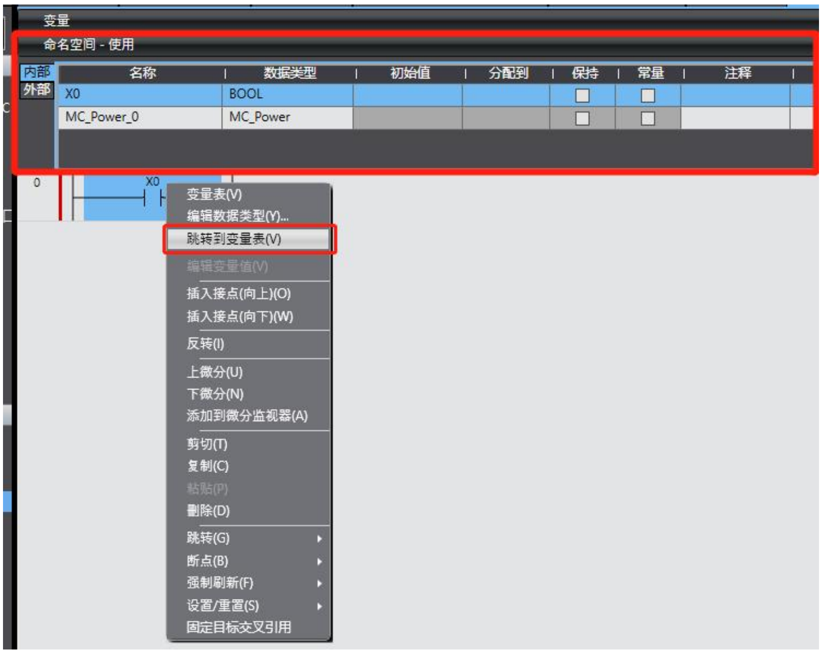




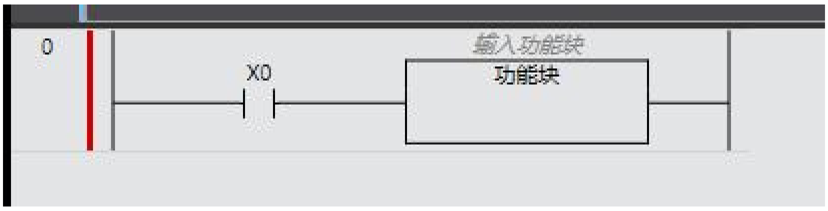
Select "contact" and drag it directly into the ladder node.



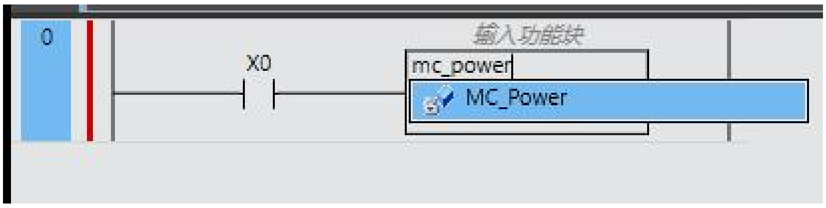
Click "input variable" to write the variable name. If it is a new variable name, a new variable will be generated. If it is an existing variable, you can directly select a variable to fill in. New variables can be viewed in the variable table. Right click variable X0 and select "jump to variable table" to expand the variable table. In the variable table, you can create variables of various data types for calling, or view all variables that have been defined.

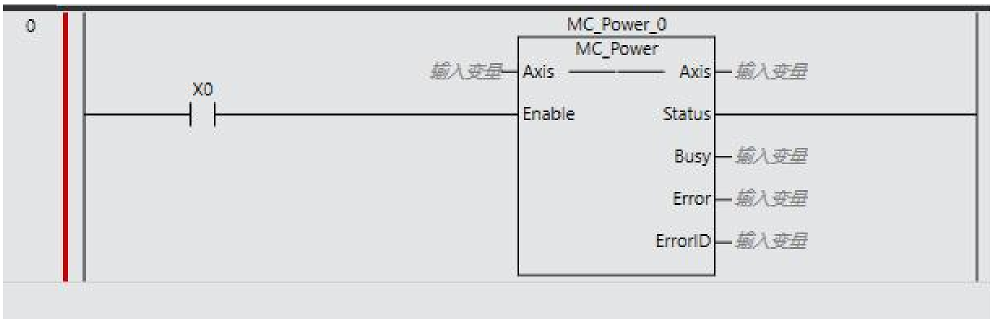


Add a "function block" in the same way as in the ladder diagram.



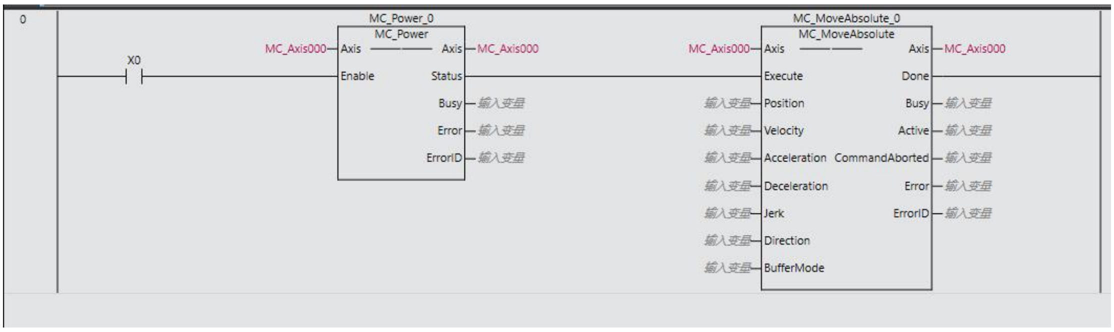
Enter a function block name to call this function block parameter. If "MC_Power" is input, the calling function block is declared as MC_ Power.



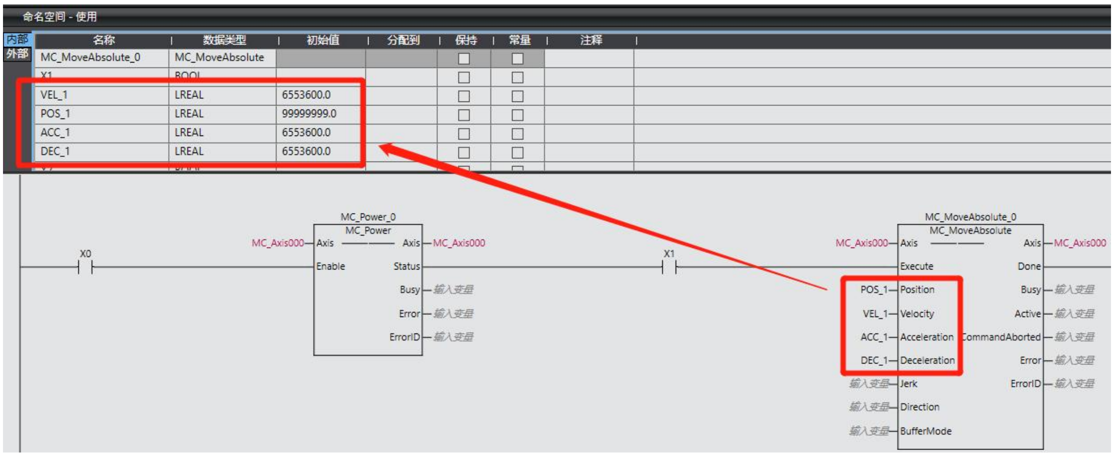


Function block "Axis" pin connected variable, input MC_ Axis000 indicates that the function block is applied to the axis "MC_Axis000".

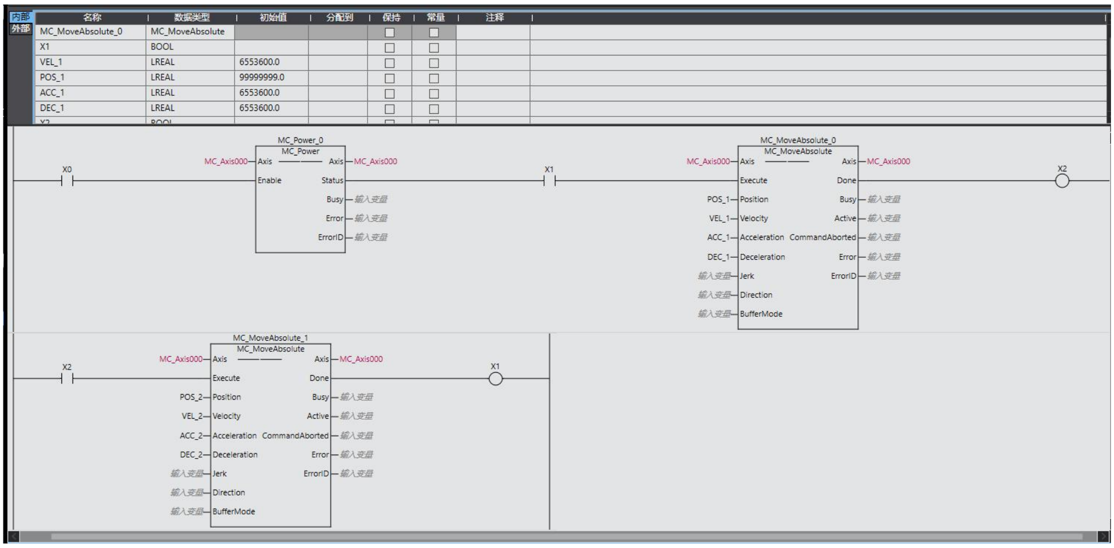
Add function block “MC_MoveAbsolute” in the same way, and define the variable name for the pins “Position”“Velocity”“Acceleration”“Deceleration” to “Pos_1”“Vel_1”“Acc_1”“Dec_1”.



The defined variables can be written with initial values in the variable table, and the initial values take effect when the PLC is running.



The same way to write a complete round-trip motion ladder program.



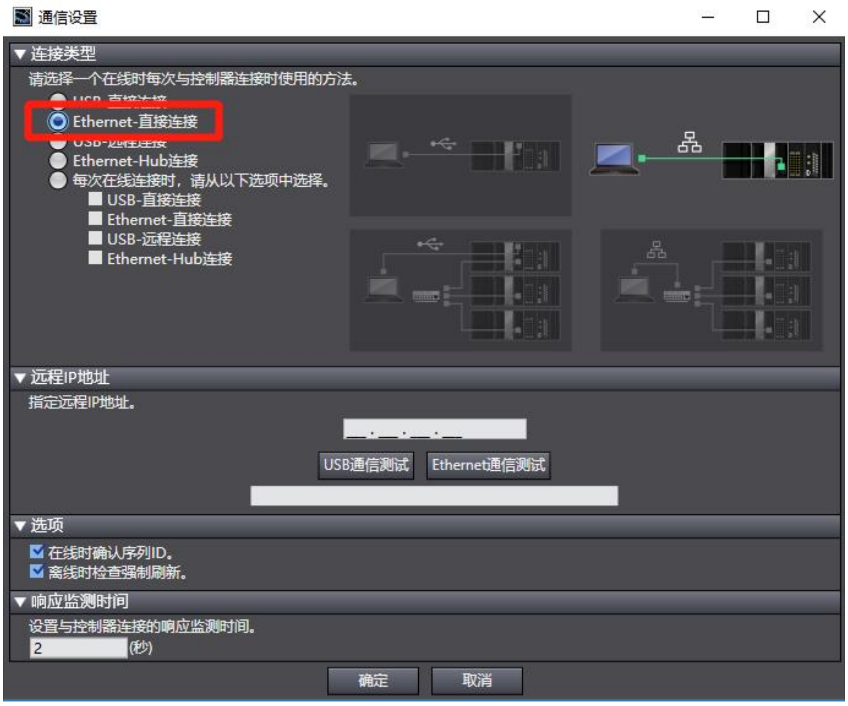
6)Gateway communication settings

First, check the IP address of the PLC: in the multiview browser, select "controller settings - built-in Ethernet / IP port settings" to show the "TCP / IP settings" interface on the right. The fixed IP address setting of the current project can be viewed in the configuration interface. For a new program, the default IP address is 192.168.250.1.

Communication configuration path: "controller - communication settings".

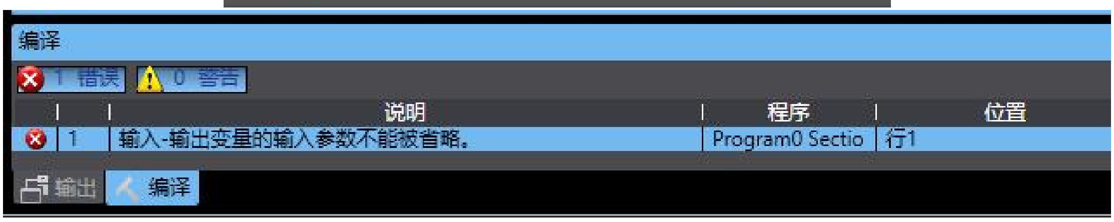
Select "Ethernet - direct connection" in the "communication setting" interface, and then click "OK" to close the interface.

Note: Ethernet connection requires that the IP address of the connected device (PC) is automatically obtained or in the PLC IP address network segment. Therefore, before connecting, confirm whether the IP address setting of the PC meets the requirements.

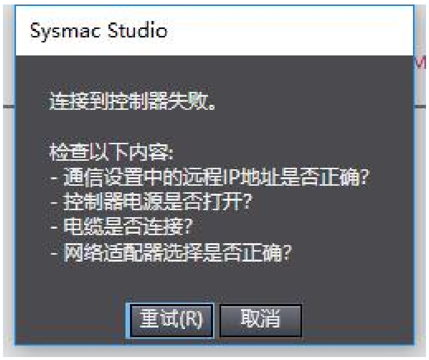


7)Compile program and prepare connection

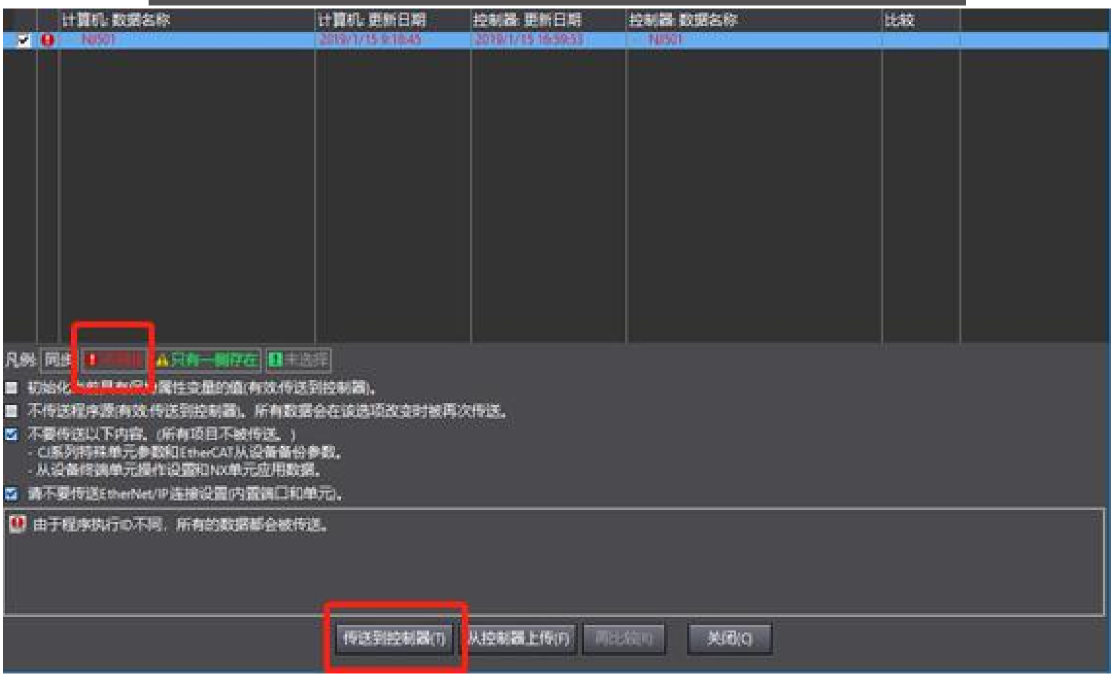
Find "compile controller" in the toolbar to compile the project. If there is any error, check the cause of the error.

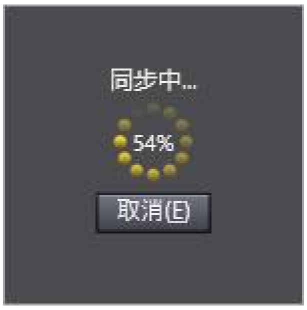


After the compilation is passed, find "online" in the toolbar and click it. If the pop-up window "failed to connect to the controller" appears, check whether the communication configuration is correct. After successful online, the upper computer switches to online status.

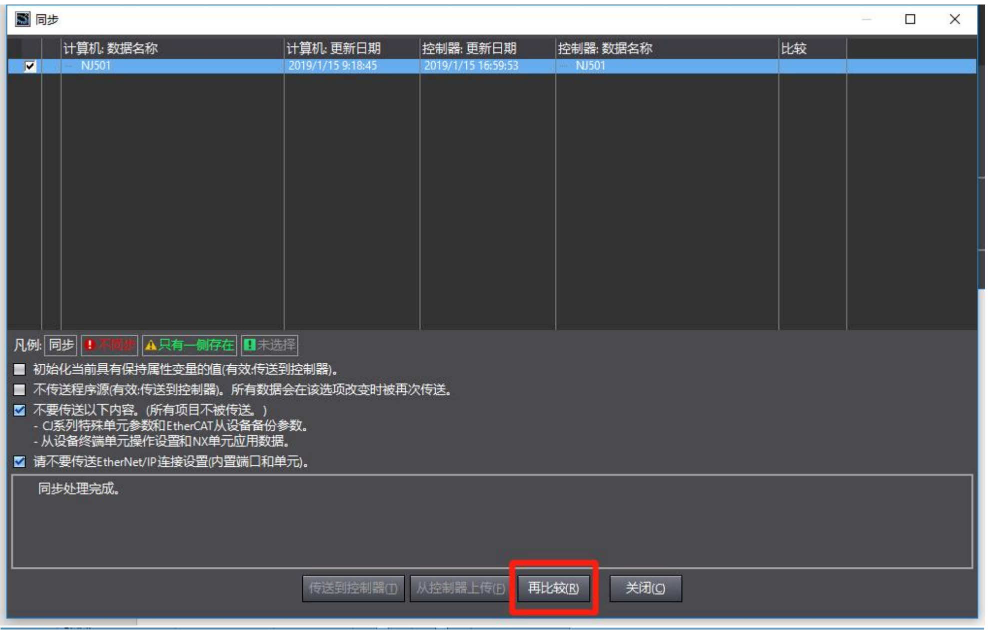


Select "synchronize" in the toolbar, and the pop-up window compares the local project with the project in the controller. The local project and the project in the controller display "out of sync". Click "transfer to controller" to download the local project and overwrite the original project of the controller.





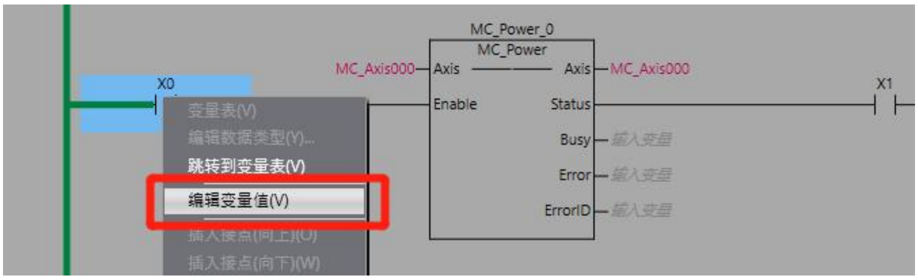
After synchronization, click "recompare" to view the synchronization items of each local project and the controller project. When the subsequent modified project is synchronized again, the different items from the controller project will be marked in detail.

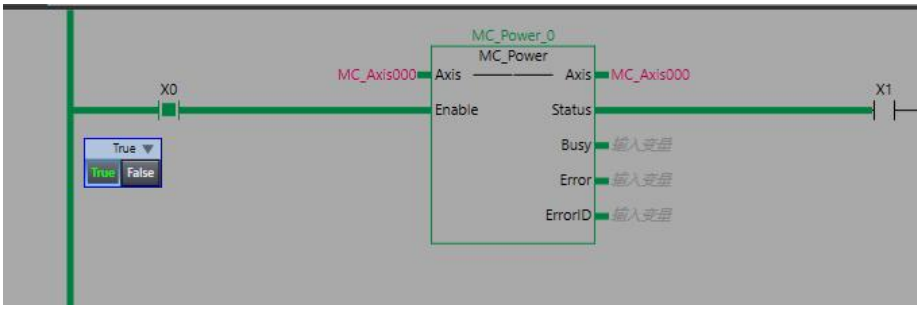


8)Online control

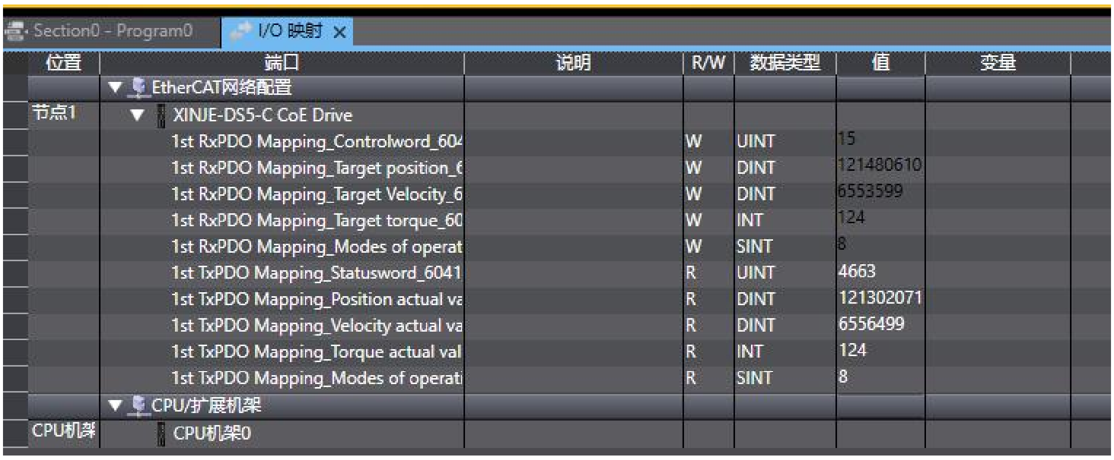
On the "section0" interface, right-click the variable "X0", select "Edit variable value", switch BOOL to the state

"True", the function block "MC_Power" takes effect, and the servo enable is turned on. Change the state of the variable "X1" to "True" in the same way to realize the round-trip movement of the program.





PDO object data can be monitored by "IO mapping".


Section0 - Program0　I/O 映射

位置	端口	说明	R/W	数据类型	值	变量
	EtherCAT网络配置					
节点1	XINJE-DS5-C CoE Drive					
	1st RxPDO Mapping_Controlword_604		W	UINT	15	
	1st RxPDO Mapping_Target position_6		W	DINT	121480610	
	1st RxPDO Mapping_Target Velocity_6		W	DINT	6553599	
	1st RxPDO Mapping_Target torque_60		W	INT	124	
	1st RxPDO Mapping_Modes of operat		W	SINT	8	
	1st TxPDO Mapping_Statusword_6041		R	UINT	4663	
	1st TxPDO Mapping_Position actual va		R	DINT	121302071	
	1st TxPDO Mapping_Velocity actual va		R	DINT	6556499	
	1st TxPDO Mapping_Torque actual val		R	INT	124	
	1st TxPDO Mapping_Modes of operati		R	SINT	8	
	CPU/扩展机架					
CPU机架	CPU机架0					

Appendix

Appendix 1 Driver parameters

Appendix 1.1 PX-XX

Modification and effective:

"○" means modifying when servo OFF and take effect at once.

"√" means modifying anytime and take effect at once.

"●" means modifying when servo OFF and take effect when power on again.

"△" means modifying anytime and take effect when the motor doesn't rotate.

For parameters set in hexadecimal system, the prefix "n." is added to the setting value to indicate that the current setting value is hexadecimal number.

PX-XX=n. x x x x

PX-XX.0
PX-XX.1
PX-XX.2
PX-XX.3

(1) P0-XX

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P0-00	Driver type 0:General type 1:EtherCAT type	-	1	0～1	●	All
P0-01	P0-00=0:General type 1-Internal Torque Mode 3-Internal speed Model 5-Internal Location Mode 6: External pulse position mode 7: External pulse speed mode P0-00=1:EtherCat type 1-Profile position control mode(PP) 3-Profile speed control mode(PV) 4-Profile torque control mode(TQ) 6-Homing mode(HM) 8-Cyclic synchronous position control mode(CSP) 9-Cyclic synchronous velocity control mode(CSV) 10-Cyclic synchronous torque control mode(CST)	-	0	1～10	○	All
P0-02	**Control mode 2** (ditto)	-	0	1～10	○	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	When the/C-SEL signal is valid, the servo system will switch to the mode selected by P0-02 for operation					
P0-03	Enabling mode 0:not enabled 1:IO /SON enable 2:Software enable(Panel/Modbus) Write 1 to panel F1-05; 3:Bus Enable	-	3	0~3	○	All
P0-04	Rigidity grade	-	400w: 13 1kw: 11	0~41	△	All
P0-05	Definition of rotation direction 0- positive mode 1- negative mode	-	0	0~1	●	All
P0-07	First inertia ratio	1%	200	0~5000	√	All
P0-09.0	Input pulse command positive direction 0: Positive pulse counting 1: Reverse pulse counting	-	0	0~1	●	6, 7
P0-09.2	Input pulse command filtering time	-	0	0~F	●	6, 7
P0-10.0 xxx□	0: CW/CCW 1: AB 2: P+D	-	2	0~2	○	6, 7
P0-11	Low bit of pulses per cycle ×1	-	0	0~9999	○	5, 6
P0-12	High bit of pulses per cycle × 10000	-	0	0~65535	○	5, 6
P0-13	Electronic Gear Numerator	-	1	1~65535	√	5, 6
P0-14	Denominator of Electronic Gear	-	1	1~65535	○	5, 6
P0-15	Pulse frequency corresponding to rated speed in speed mode	100Hz	1000	0~10000	○	7
P0-16	Speed command pulse filtering time	0.01ms	100	0~10000	○	7
P0-23	Pulse offset limit	0.01 polar distance	2000	0~65535	√	5, 6
P0-24	0 - cumulative discharge time 1 - average power mode 1 2-average power mode 2	-	0	0~2	○	All
P0-25	Power Value of Discharge Resistance	W	Related to the driver	0~65535	○	All
P0-26	Discharge resistance value	Ω		1~500	○	All
P0-27	Servo shutdown the enable stop mode 0: Free stop, maintain free running state after stopping 1: Free stop, maintain DB state after stopping 2: Slow down and stop, maintain free running state after stopping 3: Slow down and stop, maintain DB status after stopping 4: DB stops and maintains a free running	-	0	0~5	○	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	state after stopping 5: DB stops, maintains DB state after stopping					
P0-28	Servo Overrun Stop Mode (P0-28.0) 0-Deceleration stop 1 1-Inertial Stop 2-Deceleration stop 2 3-Alarm Stop Overtravel alarm shield switch (P0-28.1) 0-Not shield the alarm 1-Shield the alarm	-	2	0~3	○	All
	EC bus overtravel stop mode (P0-28.0) 0: Direct alarm, using servo deceleration shutdown method 1: Alarm after decelerating and stopping as 605Ah mode 2: Do not use overtravel	-	2	0~3	○	1|3|4|8|9|10
P0-29	Servo alarm stop mode 0: Free stop, maintain free running state after stopping 1: Free stop, maintain DB state after stopping 2: DB/deceleration stop, maintain free running state after stopping 3: DB/deceleration stop, maintain DB state after stopping 4: DB stops and maintains a free running state after stopping 5: DB stops, maintains DB state after stopping	-	2	0~5	○	All
P0-30	Stop timeout time	1ms	20000	0~65535	○	All
P0-31	Deceleration stop time	1ms	25	0~5000	○	All
P0-33	Set the motor code	-	0000	0~65535	●	All
P0-42	Automatic reading of motor parameters alarm shielding switch 0: Do not block alarms 1: Block alarm for not reading valid motor parameters	AD	100	0~500	○	All
P0-53	Servo alarm stop mode 0: Free stop, maintain free running state after stopping 1: Free stop, maintain DB state after stopping 2: DB/deceleration stop, maintain free running state after stopping 3: DB/deceleration stop, maintain DB state after stopping 4: DB stops and maintains a free running state after stopping 5: DB stops, maintains DB state after stopping	-	0	0/1	●	All
P0-63.0	Selection of encoder speed measurement algorithm 0: K-type speed measurement (default)	-	0	0~3	○	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	1: Speed measurement method 1, S method (Used in conjunction with P0-63.1) 2: Speed measurement method 2, P method (Used in conjunction with P0-63.2) 3: Speed measurement method 3, T method (parameter configuration P0-76,%)					
P0-63.1	Original position differential right shift bit numbers in S method	-	0	0~f	○	All
P0-63.2~3	Speed measurement zone total length L in P method	-	0	4~17	○	All
P0-68.0~P0-68.1 xx□□	Number of consecutive error alarms in the update sequence of coded data	-	0x05	0x01~0xFF	●	All
P0-68.2~P0-68.3 □□xx	E-241 Alarm filtering times	-	0	0~0xFF	●	All
P0-69	Fan switch (P0-69.0) 0- Turn on the fan when the temperature greater than 45℃ and turn off the fan when less than 42℃ (hysteresis 3℃) 1 - Turn on the fan after enabling, turn off the fan when not enabling Large motor thermocouple break alarm shield switch (P0-69.1) 0-not shield thermocouple disconnection alarm 1-shield thermocouple disconnection alarm	-	1	0/1	√	All
P0-70	Pulse command offset limit value	0.01 polar distance	200	0~65535	√	8
P0-71	Selection of bus CSP position interpolation mode 0: Advanced interpolation 1: Normal interpolation	-	1	0~1	√	8
P0-72	Bus Sync0 offset time After setting the parameters, the upper computer needs to be reactivated to take effect, and the modification effect can be observed through U5-19	[%]	30	0~60	√	All
P0-74	Blocking alarm time	1ms	Set as model	0-65535	√	All
P0-75	Blocking alarm speed	1mm/s	50	5~9999	√	All
P0-79	Absolute encoder setting (Linear motors do not have this setting) 0 - Used as absolute encoder 1 - Used as incremental encoder 2 - Used as absolute value encoder,	-	1	0~2	●	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	ignoring multi turn overflow alarm					
P0-80	Motor thermal power protection mode 0- Current protection 1- Average thermal power protection 2 - Analog thermal power protection	-	2	0~2	●	All
P0-92～ P0-93	32-bit electronic gear ratio numerator. take effect when P0-11~P0-14 is 0. P0-92*1 + P0-93 *10000	-	1 1	1~9999 0~65535	○(mode 5) √(mode 6)	5, 6
P0-94～ P0-95	32-bit electronic gear ratio denominator. P0-11~P0-14 is 0. P0-94*1 + P0-95 *10000	-	1	1~9999	○	5, 6

(2) P1-XX

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P1-00	First speed loop gain	0.1Hz	<=20P7: 300 >=21P0: 180	10~20000	√	All
P1-01	Integral Time Constant of the First Speed Loop	0.01ms	<=20P7: 2653 >=21P0: 4421	15~51200	√	All
P1-02	First position loop gain	0.1/s	<=20P7: 480 >=21P0: 288	10~20000	√	All
P1-05	Second speed loop gain	0.1Hz	200	10~20000	√	1|3|5|6|7|
P1-06	Integral Time Constant of the second Speed Loop	0.01ms	3300	15~51200	√	1|3|5|6|7|
P1-07	Second position loop gain	0.1/s	200	10~20000	√	1|3|5|6|7|
P1-10	Speed feedforward gain	1%	0	0~300	√	5|6|7
P1-11	Speed feedforward filter time	0.01ms	50	0~10000	√	5|6|7
P1-14	Gain switching mode setting	-	0	0~0x00A2	√	All
P1-15	Gain switching waiting time	-	5	0~1000	√	All
P1-16	Gain switching level threshold	-	50	0~20000	√	All
P1-17	Gain switching level hysteresis	-	30	0~20000	√	All
P1-18	Position loop gain switching time	-	3	0~1000	√	All
P1-19.0	Gap compensation function direction 0: Positive direction 1: Reverse direction	-	0	0~1	√	All
P1-19.1	Gap compensation function switch	-	0	0~1	√	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	0: Close 1: Open					
P1-20	Gap compensation quantity	0.1Pref	0	0~65535	√	All
P1-21	Gap compensation filtering time	0.01ms	0	0~65535	√	All
P1-23	Speed instruction filter time	0.1ms	0	0~65535	○	3
P1-24	Position command acceleration and deceleration filtering time	0.1ms	0	0~65535	△	5|6
P1-25	Position instruction smooth filter time	0.1ms	0	0~65535	△	5|6
P1-26.0	Switching conditions for speed control mode [P-PI switching] 0: Do not use mode switching 1: Switching condition based on internal torque command 2: Switching condition based on speed command 3: Switching condition based on acceleration 4: Switching condition based on position deviation	-	1	0~4	△	All
P1-26.1	Speed control mode switching integral holding selection 0: Clear the integral of 0 Asr 1: Keep the points unchanged and no longer accumulate	-	1	0~1	△	All
P1-27	Mode Switching - Torque Command Threshold	%	200	0~800	△	All
P1-28	Mode Switching - Speed Command Threshold	mm/s	0	0~10000	△	All
P1-29	Mode Switching - Acceleration Threshold	mm/s^2	0	0~30000	△	All
P1-30	Mode switching - Position deviation threshold	Command unit	0	0~10000	△	All
P1-31	I-P control switching threshold	%	100	0~100	△	All
P1-65	Overload warning threshold	%	20	1~100	√	-
P1-66	Percentage of overload alarm baseline value	%	100	10~100	●	-

(3) P2-XX

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P2-00.0	Disturbance observer switch 0- OFF 1- ON	-	0	0~1	○	All
P2-00.1	Selection of speed observer 0: Close 1: EhVobs 2: Vobs	-	0	0~2	○	All
P2-00.3	Electric angle compensation switch 0: Close 1: Open	-	0	0~1	○	All
P2-01.0	Adaptive mode switch 0- OFF 1- ON	-	0	0~1	●	All
P2-01.1	Adaptive level 0-High response 1-Low noise	-	Set as model	0~1	●	All
P2-02.0	Auto-tuning mode 1-Soft 2-Fast positioning 3-Fast positioning, control the overshoot	-	3	1~3	√	All
P2-02.2	Load type (valid only during auto-tuning) 1-Synchronous belt 2-Screw rod 3-Rigid Connection	-	2	1~3	√	All
P2-03.2	Enable speed loop IP control 0: Close 1: Open	-	0	0~1	√	All
P2-03.3	Adaptive load type 0-Small Inertia Mode 1-Large Inertia Mode	-	0	0~1	√	All
P2-05	Adaptive mode speed loop gain (standard)	0.1Hz	200	1~65535	○	All
P2-07	Adaptive mode inertia ratio (standard)	%	0	0~10000	○	All
P2-08	Gain of adaptive mode speed observer (standard)	Hz	40	10~1000	○	All
P2-12	Maximum Inertia Ratio of Adaptive Mode (Standard)	-	30	1~10000	○	All
P2-15	Inertia identification and internal instruction self-tuning maximum travel	0.01 polar distance	100	1~3000	√	All
P2-17	Inertia identification and internal instruction self-tuning maximum speed	-	0	0~65535	√	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P2-18	Initial inertia ratio of inertia identification	%	500	1~20000	√	All
P2-19	Adaptive mode bandwidth	%	50	1~100	○	All
P2-31	Torque command filtering time constant 1	0.01ms	15	0~65535	√	All
P2-35	Torque command filtering time constant 2	0.01ms	66	0~65535	√	All
P2-36	Adaptive load type 0-Small Inertia Mode 1-Large Inertia Mode	0.01ms	100	0~65535	√	All
P2-39	Disturbance observer gain 1	-	10	10~1000	√	All
P2-40	Disturbance observer gain 2	-	100	10~1000	√	All
P2-41	Model Loop Switch 0-OFF 1-ON	%	85	0~100	√	All
P2-42	Model loop gain	0.1Hz	0	-1000~1000	√	All
P2-43	Active Vibration Suppression Switch 0-OFF 1-ON	%	100	1~1000	√	All
P2-47.0	Active Suppression Auto-tuning Switch 0-Active Vibration Suppression is not Configured in auto-tuning 1- Configure the Active Vibration Suppression when auto-tuning	-	0	0~f	√	All
P2-49	Model Loop Switch 0-OFF 1-ON	0.1Hz	480	10~20000	√	3|4|5|6|7
P2-60.0	Model loop gain	-	0	0~1	√	3|4|5|6|7
P2-60.1	Active Vibration Suppression Switch 0-OFF 1-ON	-	1	0~1	√	3|4|5|6|7
P2-61	Active Vibration Suppression frequency	0.1Hz	10000	10~20000	√	All
P2-62	Active Vibration Suppression gain	%	100	1~1000	√	All
P2-63	Active Vibration Suppression damping	%	100	0~300	√	All
P2-64	Filtering time of active vibration suppression 1	-	0	-10000~10000	√	All
P2-65	Filtering time of active vibration suppression 2	-	0	-10000~10000	√	All
P2-69.0	Notch filter 1 switch	-	0	0~1	√	All
P2-69.1	Notch filter 2 switch	-	0	0~1	√	All
P2-69.3	Notch filter 3 switch	-	0	0~1	√	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P2-70.0	Notch filter 4 switch	-	0	0~1	√	All
P2-70.1	Notch filter 5 switch	-	0	0~1	√	All
P2-71	First notch frequency	Hz	8000	50～8000	√	All
P2-72	First notch attenuation	0.01dB	71	50～1600	√	All
P2-73	First notch band width	0.001Hz	0	0～1000	√	All
P2-74	Second notch frequency	Hz	8000	50～8000	√	All
P2-75	Second notch attenuation	0.01dB	71	50～1600	√	All
P2-76	Second notch band width	0.001Hz	0	0～1000	√	All
P2-77	Third notch frequency	Hz	8000	50～8000	√	All
P2-78	Third notch attenuation	0.01dB	71	50～1600	√	All
P2-79	Third notch band width	0.001Hz	0	0～1000	√	All
P2-80	Fourth notch frequency	Hz	8000	50～8000	√	All
P2-81	Fourth notch attenuation	0.01dB	71	50～1600	√	All
P2-82	Fourth notch band width	0.001Hz	0	0～1000	√	All
P2-83	Fifth notch frequency	Hz	8000	50～8000	√	All
P2-84	Fifth notch attenuation	0.01dB	71	50～1600	√	All
P2-85	Fifth notch band width	0.001Hz	0	0～1000	√	All

(4) P3-XX Speed control parameters

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P3-05	Preset speed 1	mm/s	0	-9999~9999	√	3
P3-06	Preset speed 2	mm/s	0	-9999~9999	√	3
P3-07	Preset speed 3	mm/s	0	-9999~9999	√	3
P3-09	Acceleration time	ms	0	0~65535	○	3|4|7
P3-10	Deceleration time	ms	0	0~65535	○	3|4|7
P3-12	Zero-speed clamping mode	-	0	0~3	○	3|4|7
P3-13	Zero-speed clamping speed	mm/s	10	0~300	○	3|4|7
P3-14	Forward Maximum Speed Instruction Limit	mm/s	4000	0~10000	○	All
P3-15	Reverse Maximum Speed Instruction Limit	mm/s	4000	0~10000	○	All
P3-16	Internal Forward Speed Limitation in	mm/s	2000	5~10000	√	1|2

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	Torque Control					
P3-17	Internal Reverse Speed Limitation in Torque Control	mm/s	2000	5~10000	√	1|2
P3-18	Jogging speed	mm/s	100	0~1000	○	All
P3-19	Forward warning speed	mm/s	3000	0~10000	○	All
P3-20	Reverse warning speed	mm/s	3000	0~10000	○	All
P3-21	Forward alarming speed	mm/s	4000	0~10000	○	All
P3-22	Reverse alarming speed	mm/s	4000	0~10000	○	All
P3-28	Internal forward torque limit	%	Set as model	0~Motor overload multiple	√	All
P3-29	Internal reverse torque limit	%	Set as model	0~Motor overload multiple	√	All
P3-30	External forward torque limit	%	Set as model	0~Motor overload multiple	√	All
P3-31	External reverse torque limit	%	Set as model	0~Motor overload multiple	√	All
P3-33	Preset torque	%	0	-1000~1000	√	1
P3-37	Delay in switching torque mode	ms	40	0~9999	√	1|2
P3-38	Anti blockage forward torque limit	%	Set as model	0~Motor overload multiple	√	All
P3-39	Anti blockage reverse torque limit	%	Set as model	0~Motor overload multiple	√	All
P3-40.0	Friction compensation switch	-	0	0~1	√	All
P3-40.1	Selection of Friction Compensation Speed Source	-	0	0~2	√	All
P3-45	Friction compensation speed threshold	0.1mm/s	20	0~200	√	All

(5) P4-XX Internal position parameters

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P4-00.0	Z phase signal numbers The Z phase signal numbers after leaving the limit switch (note: stop when N+1 Z phase signal reached)	-	2	0~f	○	5|6
P4-00.1	Search the origin function 0-OFF 1-ON	-	0	0~1	○	5|6
P4-00.2	Return to zero overrun prohibition	-	0	0~1	○	5|6

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	0-not prohibit 1-prohibit					
P4-01	Speed of hitting the proximity switch	mm/s	600	0~65535	○	5|6
P4-02	Speed of leaving proximity switch	mm/s	100	0~65535	○	5|6
P4-03.0	Internal Location Given Mode Sets Location Monm,de 0-Relative positioning 1-Absolute positioning	-	0	0~1	○	5
P4-03.1	Internal position setting mode Set step change mode 0 - Step change when signal is ON, recyclable 1 - Step change on the rising edge of the signal, single step execution 2 - The rising edge of the signal is started, and all the signals are executed in sequence without circulation 3 - Communication setting section number 4 -/CHSTP bilateral edge trigger Terminal/PREFA (P5-57),/PREFB 5-(P5-58),/PREFC (P5-59) select segment number, and 1~3 segments can be selected 6-Terminal/PREFA (P5-57), PREFB (P5-58), PREFC (P5-59),/PREFD (P5-60) Terminal selection segment number, optional 1-16 segments	-	0	0~5	○	5
P4-03.2	Internal position mode sets waiting mode 0-wait positioning completion 1-not wait positioning completion	-	0	0~1	○	5
P4-04	Valid segment number	-	0	0~35	○	5
P4-10~P4-11	First segment pulse	1pul	0	-327689999~327679999	√	5
P4-12	First segment speed	0.1mm/s	0	0~65535	√	5
P4-13	First segment acceleration time	1ms	0	0~65535	√	5
P4-14	First segment deceleration time	1ms	0	0~65535	√	5
P4-16	Adjusting time	1ms	0	0~65535	√	5
P4-10+(n-1)*7 ~ P4-16+(n-1)*7	Segment 1 to 35 pulse parameters (n is segment number)	-	-	-	√	5

- Set pulse number=pulse number (high bit) × 10000+pulses (low order)
- 35 sections in total. The parameters of sections 1 to 12 can be set through the panel, and the parameters of sections 13 to 35 need to be written through communication (RS232 and RS485).

(6)P5-XX Signal parameter setting

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P5-00	Positioning completion width/COIN	Command unit	144	1~65535	√	5|6
P5-01	Location Completion Detection Mode	-	0	0~3	√	5|6
P5-02	Location completion retention time	ms	0	0~65535	√	5|6
P5-03	Rotation Detection Speed	mm/s	50	0~10000	√	All
P5-04	Same speed detection speed	mm/s	50	0~10000	√	All
P5-05	Reached detection speed	mm/s	1000	0~10000	√	All
P5-06	Positioning near output width	Command unit	655	0~65535	√	5|6
P5-07	Servo OFF delay time	ms	500	-500-9999	○	All
P5-08	Brake instruction output speed	mm/s	30	20~10000	○	All
P5-09	Brake instruction waiting time	ms	500	0~65535	○	All
P5-10	User-defined output 1 trigger condition	-	0	0~ffff	√	All
P5-11	Set a value that compares with the trigger condition of custom output 1	Related to the triggering condition	0	-9999~9999	√	All
P5-12	Select custom output 1 mode	-	0	0~3	√	All
P5-13	Setting custom output 1 hysteresis	Related to the triggering condition	0	0~65535	√	All
P5-14	Custom Output 2 Trigger Condition	-	0	0~ffff	√	All
P5-15	Set a value that compares with the trigger condition of custom output 2	Related to the triggering condition	0	-9999~9999	√	All
P5-16	Select custom output 2 mode	-	0	0~3	√	All
P5-17	Setting custom output 2 hysteresis	Related to the triggering condition	0	0~65535	√	All
P5-18	IO filter time multiple	-	1	0~10000	√	All
P5-19	Z-phase output holding time	ms	2	1~65535	√	All
P5-20.0~1	/S-ON: servo signal	-	00	0~ff	√	1|3|5

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	00: Set the signal to be invalid all the time. 01: Input positive signal from SI1 terminal. 02: Input positive signal from SI2 terminal. 03: Input positive signal from SI3 terminal. 04: Input positive signal from SI4 terminal. 05: Input positive signal from SI5 terminal. 06: Input positive signal from SI6 terminal. 07: Input positive signal from SI7 terminal. 10: Set the signal to always be "valid". 11: Inverse signal is input from SI1 terminal. 12: Inverse signal is input from SI2 terminal. 13: Inverse signal is input from SI3 terminal. 14: Inverse signal is input from SI4 terminal. 15: Inverse signal is input from SI5 terminal. 16: Inverse signal is input from SI6 terminal. 17: Inverse signal is input from SI7 terminal.					
P5-20.2	SI terminal filtering time	ms	0	0~f	√	All
P5-21.0~1	/P-CON proportion action instruction	-	00	0~ff	√	All
P5-21.2	SI terminal filtering time	ms	0	0~f	√	All
P5-22.0~1	In non EtherCAT mode: /P-OT: Forward drive prohibited EtherCAT mode: Control mode 6 (return to zero mode), POT inhibit signal	-	01	0~ff	√	All
P5-22.2	SI terminal filtering time	ms	0	0~f	√	All
P5-23.0~1	In non EtherCAT mode: /N-OT: Reverse drive prohibited EtherCAT mode: Control mode 6 (return to zero mode), NOT inhibit signal	-	02	0~ff	√	All
P5-23.2	SI terminal filtering time	ms	0	0~f	√	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P5-24.0~1	/ALM-RST: alarm clear	-	0	0~ff	√	All
P5-24.2	SI terminal filtering time	ms	0	0~f	√	All
P5-25.0~1	/P-CL: External Torque Limitation at Forward Rotation Side	-	00	0~ff	√	All
P5-25.2	SI terminal filtering time	ms	0	0~f	√	All
P5-26.0~1	/N-CL： External Torque Limitation at Reverse Rotation Side	-	00	0~ff	√	All
P5-26.2	SI terminal filtering time	ms	0	0~f	√	All
P5-27.0~1	In non EtherCAT mode: /SPD-D: Internal Speed Direction Selection In EtherCAT mode: Control mode 6 (return to zero mode), Home Origin signal	-	03	0~ff	√	1|2|3|4|7
P5-27.2	SI terminal filtering time	ms	0	0~f	√	1|2|3|4|7
P5-28.0~1	In non EtherCAT mode: Speed mode: /SPD-A: Internal setting speed selection New Return to Original Mode: /SPD-A: Trigger the return to original action Old Return Mode: /SPD-A: Find the origin in the forward direction	-	00	0~ff	√	3|5
P5-28.2	SI terminal filtering time	ms	0	0~f	√	3|5
P5-29.0~1	In non EtherCAT mode: Speed mode: /SPD-B: Internal setting speed selection Old Return Mode: /SPD-B: Reverse direction to find the origin	-	00	0~ff	√	3|5
P5-29.2	SI terminal filtering time	ms	0	0~f	√	3|5
P5-30.0~1	/C-SEL: control mode selection	-	00	0~ff	√	All
P5-30.2	SI terminal filtering time	ms	0	0~f	√	All
P5-31.0~1	/ZCLAMP: zero position clamping	-	00	0~ff	√	3
P5-31.2	SI terminal filtering time	ms	0	0~f	√	3
P5-32.0~1	/INHIBIT: Instruction pulse prohibition	-	00	0~ff	√	5
P5-32.2	SI terminal filtering time	ms	0	0~f	√	5
P5-33.0~1	/G-SEL: gain switching	-	00	0~ff	√	All
P5-33.2	Filtering time of SI terminal	ms	0	0~f	√	All
P5-34.0~1	/CLR: pulse offset clear	-	00	0~ff	√	5|6
P5-34.2	SI terminal filtering time	ms	0	0~f	√	5|6
P5-35.0~1	/CHGSTP:internal position	-	00	0~ff	√	5

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	mode change step signal					
P5-35.2	SI terminal filtering time	ms	0	0~f	√	5
P5-36.0~1	/I-SEL:Inertia ratio switching	-	00	0~ff	√	All
P5-36.2	SI terminal filtering time	ms	0	0~f	√	All
P5-37	/COIN_HD: Location Completion Maintenance 00: No output to terminal 01: Output positive signal from SO1 terminal 02: Output positive signal from SO2 terminal 03: Output positive signal from SO3 terminal 11: Output reverse signal from SO1 terminal 12: Output reverse signal from SO2 terminal. 13: Output reverse Signal from SO3 terminal 14: Output reverse Signal from SO4 terminal	-	0000	0~ffff	√	5|6
P5-38	/COIN: positioning completion	-	0000	0~ffff	√	5|6
P5-39	/V-CMP: same speed detection	-	0000	0~ffff	√	3|4|7
P5-40	/TGON: rotation detection	-	0000	0~ffff	√	All
P5-41	/S-RDY: ready	-	0000	0~ffff	√	All
P5-42	/CLT: torque limit	-	0000	0~ffff	√	All
P5-43	/VLT: speed limit detection	-	0000	0~ffff	√	1|2
P5-44	/BK: brake locking	-	0000	0~ffff	○	All
P5-45	/WARN: warning	-	0000	0~ffff	√	All
P5-46	/NEAR: near	-	0000	0~ffff	√	5|6
P5-47	/ALM: alarm	-	0002	0~ffff	√	All
P5-48	/Z: encoder Z phase signal output	-	0000	0~ffff	√	All
P5-50	/MRUN: internal position mode motion starting signal	-	0000	0~ffff	√	5
P5-51	/V-RDY: speed reached	-	0000	0~ffff	√	3|4|7
P5-52	/USER1: User-defined output 1	-	0000	0~ffff	√	All
P5-53	/USER2: User-defined output 2	-	0000	0~ffff	√	All
P5-54	Return to origin to complete signal					
P5-56	Phase search successful output		0	0~ffff		
P5-57	/PREFA: Intenral position selection signal A	-	0	※1	√	5
P5-58	/PREFB: Intenral position selection signal B	-	0	※1	√	5
P5-59	/PREFC: Internal position selection signal C	-	0	※1	√	5
P5-60	/PREFC: Internal position selection signal D	-	0	※1	√	5

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P5-61.0~1	/TRAJ-START: Motion start trigger signal	-	00	0~ff	√	5
P5-62	Probe function 1	-	0	0000~0006	○	EtherCAT mode
P5-63	Probe function 2	-	0	0000~0007	○	EtherCAT mode
P5-64	Origin switch signal	-	0	0000~ffff	√	1|3|5|6|7
P5-68.0~1	Terminal emergency alarm function	-	00	0~ff	√	All
P5-68.2	SI terminal filtering time	ms	0	0~f	√	All
P5-70	/SRDY: Output Conditions Selection 0: This terminal is turned on after initialization of the driver is completed 1: This terminal will not turn on until enabled.	-	0	0~1	√	All
P5-71	Function Selection of Directional Terminal of Pulse Speed Mode	-	0	0~1	√	7
P5-72	Remote input of SI input 1	-	0	0~ff	√	EtherCAT mode
P5-73	Remote input of SI input 2	-	0	0~ff	√	EtherCAT mode
P5-74	Remote input of SI input 3	-	0	0~ff	√	EtherCAT mode
P5-75	Remote input of SI input 4	-	0	0~ff	√	EtherCAT mode
P5-76	Remote input of SO output 1	-	0	0~ff	√	EtherCAT mode
P5-77	Remote input of SO output 2	-	0	0~ff	√	EtherCAT mode
P5-78	Remote input of SO output 3	-	0	0~ff	√	EtherCAT mode
P5-79	/OCMP1: Flying Photography	-	1	0-65535	√	Position mode
P5-80	Flybeat pulse output width	0.1ms	5	0-20000	√	Position mode

Table 1 Input signal allocation

Input terminal parameter	Servo model	Setting range
P5-20~P5-36 P5-57~P5-59 P5-72~P5-75	DL6series	n.0000~n.0007 n.0010~n.0017

Table 2 Output signal allocation

Output terminal parameter	Servo model	Setting range
P5-37~P5-53 P5-76~P5-79	DL6series	n.0000~n.0004 n.0010~n.0014

(7)P6-XX Signal parameter settings(Some parameters are reserved)

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P6-00	Rigid setting mode 0: Standard mode 1: Positioning mode 2: Quick positioning mode	-	0	0~2	○	All
P6-05	Adaptive Mode Speed Loop Gain (Large Inertia)	0.1Hz	200	1~65535	○	1|3|5|6|7
P6-07	Adaptive mode inertia ratio (Large inertia)	%	50	0~10000	○	1|3|5|6|7
P6-08	Gain of adaptive mode speed observer (large inertia)	Hz	40	10~1000	○	1|3|5|6|7
P6-12	Maximum Inertia Ratio of Adaptive Mode (Large Inertia)	-	50	1~10000	○	1|3|5|6|7

(8)P7-XX Communication parameter setting(485 communication is not supported temporarily)

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P7-00	Slave station no.	-	0	0~100	○	EtherCAT mode
P7-10	RS232 station no.	-	1	0~100	√	1|3|5
P7-11.0~1	RS232 baud rate 00:300 01:600 02:1200 03:2400 04:4800 05:9600 06:19200 07:38400 08:57600 09:115200 0A:192000 0B:256000 0C:288000 0D:384000 0E:512000 0F:576000 10:768000 11:1M 12:2M 13:3M 14:4M 15:5M 16:6M	Baud rate	09	0~16	√	1|3|5
P7-11.2	RS232 stop bit 0:2 bit	Stop bit	2	0~2	√	1|3|5

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
	2:1 bit					
P7-11.3	RS232 stop bit 0: no parity 1: odd parity 2: even parity	Parity bit	2	0~2	√	1|3|5
P7-20	Ethercat homing find Z phase numbers	-	1	-9999~9999	○	EtherCAT mode
P7-21	Filter time after homing	Scan period	400	1~65535	○	EtherCAT mode
P7-22	Communication clock frequency P7-22=x: BISS-CBaud rate=10M /(1+x)	MHz	2	0-9	●	All
P7-26	Single cycle data bits	-	26	1-99	●	All
P7-27	Multi cycle data bits When connecting a linear motor, the number of data bits for multiple turns should be set to 0, and the number of data bits for a single turn should be set according to the actual number of bits in the encoder	-	0	0-99	●	All

(9) P8-XX

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P8-17	Sampling interval	-	25	1~65535	▲	1|3|5
P8-25	Panel display selection	-	0	0~2	▲	1|3|5

(10) P9-XX

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P9-11.0	Find the number of Z phases when returning to the origin	-	0	0-15	○	New Return to Origin Mode
P9-11.1	New return to origin triggering method	-	0	0-2	○	New Return to Origin Mode
P9-11.2	New Return to Origin Mode	-	0	0-7	○	New Return to Origin Mode
P9-11.3	Deceleration method when encountering overtravel signal	-	0	0-1	○	New Return to Origin Mode
P9-12	Return to origin high-speed speed	mm/s	200	0-3000	○	New Return to Origin Mode
P9-13	Return to origin at low speed	mm/s	20	0-1000	○	New Return to Origin Mode

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
P9-14	Return to origin acceleration and deceleration time	ms	1000	0-12000	○	New Return to Origin Mode
P9-15	Return to origin timeout	10ms	0	0-1000	○	New Return to Origin Mode
P9-16	Touch stop homing speed threshold	mm/s	2	0~1000	○	EtherCAT mode
P9-17	Touch stop homing torque threshold	%	100	0~300	○	EtherCAT mode
P9-18	Touch stop homing time threshold	ms	500	10~1500	○	EtherCAT mode
P9-19	Quantitative pulse number low bit	-	0	-9999~9999	○	EtherCAT mode
P9-20	Quantitative pulse number high bit	-	0	-9999~9999	○	EtherCAT mode
P9-21	Return to Origin Selection	-	2	0-2	○	CIA402 returns to original mode
P9-41.1	402 Return to Origin Trigger Method	-	0	0-3	○	CIA402 returns to original mode
P9-42	402 Return to Origin Method	-	1	-2~37	○	CIA402 returns to original mode
P9-43~ P9-44	402 Return to Origin Search for Switch Signal Speed	Command unit/s	0	0-65535	○	CIA402 returns to original mode
P9-45~ P9-46	P9-43*1+P9-44*65535	Command unit/s	0	0-65535	○	CIA402 returns to original mode
P9-47~ P9-48	402 Return to Origin Search for Origin Speed	Command unit/s^2	0	0-65535	○	CIA402 returns to original mode

(11) PA-XX

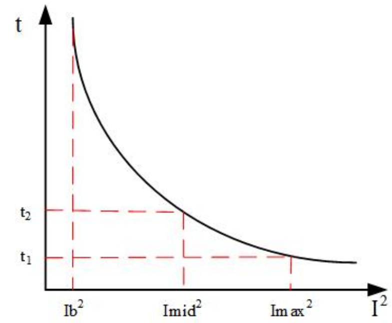
Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
PA-00.0	Motor type selection	-	1	0~1	●	All
PA-01.0	Encoder type selection	-	0	0~3	●	All
PA-01.1	Encoder polarity	-	0	0~1	●	All
PA-01.2	HALL polarity	-	0	0~1	●	All
PA-02.1	Phase finding mode 0: Pre positioning and phase finding 1: Binary micro motion phase search	-	1	0-3	○	All
PA-02.2	Enhanced phase finding function switch	-	0	0-1	○	All

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
PA-04	Maximum current for phase finding	%	100	0-100	○	All
PA-05	Time for phase finding to reach maximum current	ms	200	100-10000	○	All
PA-06	Maximum movement distance of micro motion phase finding	1 pulse	30000	1000-65535	○	All
PA-07	Micro motion phase finding motion threshold	nm	200	0-65535	○	All
PA-08	Time limit for phase finding	0.01s	500	200-65535	○	All
PA-09	Enhance the threshold of phase finding electrical angle error	0.1 electrical angle	300	0-600	○	All
PA-43	Number of pole pairs: If motor type PA-00.0=1, the number of pole pairs defaults to 1. No modifications allowed	-	1	1	●	All
PA-44	Rated speed	mm/s	1000	0-65535	●	All
PA-45	Maximum speed	mm/s	2000	0-65535	●	All
PA-46	Rated current	mA	2100	0-65535	●	All
PA-47	Maximum current	mA	6300	0-65535	●	All
PA-48	Rated torque	0.1N	1050	0-65535	●	All
PA-49	Resistance (phase)	mΩ	4800	0-65535	●	All
PA-50	Q-axis inductance (phase)	0.01mH	1800	0-65535	●	All
PA-51	D-axis inductance (phase)	0.01mH	1800	0-65535	●	All
PA-52	Motor mass: Linear motor motor motor mass, excluding slider	Kg*10^-3	700	0-65535	●	All
PA-53	Coefficient of back electromotive force	mVPeak/mm/s L-L	41	0-65535	●	All
PA-54	Motor rated power: Motor power, if unclear, can be set to 1KW	W	800	0-65535	●	All
PA-55	Grating/magnetic grating resolution: Grating/magnetic grating resolution accuracy, please carefully check	nm	1000	0-65535	●	All
PA-56	Pole distance (N-N): N-N pole distance	0.01mm	3000	0-65535	●	All
PA-57	Motor thermal power	W	50	0-65535	○	All
PA-58	Overload reference current	mA	2415	0-65535	○	All
PA-59	Overload intermediate current 1	mA	4200	0-65535	○	All
PA-60	Overload intermediate time 1	0.1s	300	0-65535	○	All
PA-61	Overload intermediate current 2	mA	6300	0-65535	○	All
PA-62	Overload intermediate time 2	0.1s	30	0-65535	○	All
PA-70	Error correction switch	-	0	0-1	○	-

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
PA-71	Error correction starting position low Error correction starting position=high position * 10000+low position	-	0	0-65535	○	
PA-72	Error correction starting position high position Starting position=high position * 10000+low position	-	0	0-65535	○	-
PA-73	Low error correction interval Error correction interval=high bit * 10000+low bit	-	0	0-65535	○	-
PA-74	Error correction interval high bit Error correction interval=high bit * 10000+low bit	-	1	0-65535	○	-
PA-75	Error correction length Can be set to be less than the length of the error correction table	-	10	0-65535	○	-
PA-76	Error correction unit 0: um 1: mm	-	0	0-1	○	-
PA-77	Error correction instruction direction 0: Forward, the direction of operation when generating the error correction table is consistent with the incremental direction of the encoder 1: Reverse, the direction of operation when generating the error correction table is not consistent with the incremental direction of the encoder	-	0	0-1	○	-
PA-78-PA-177	Error correction array [100] Error correction data, maximum 1mm	-	0	-32768-32767	○	-

- The default values of linear motor parameters have no reference value. Please configure according to the actual motor parameters.
- The inverse time characteristic curve of overload alarm is recommended to be 115% (∞), 200% (10s), and 300% (3s) of the rated current.

Plan a curve according to the inverse time limit new curve, as shown in the following figure:



(12) PE-XX

Parameter	Function	Unit	Default value	Range	Effective	Suitable mode
PE-18	Driver power	W	400/1000	0-65535	√	All
PE-20	Rated current of the driver	0.01A	280/600	0-65535	√	All
PE-21	Maximum current of the driver	0.01A	1386/2545	0-65535	√	All
PE-22	Vibration alarm speed threshold	mm/s	300	0-10000	√	All
PE-23	Vibration alarm speed detection hysteresis loop	mm/s	100	0-1000	√	All
PE-24	Maximum frequency of oscillation alarm	0.1Hz	300	0-1000	√	All
PE-25	Maximum attenuation ratio of oscillation alarm	0.1%	800	0-1000	√	All

Appendix 1.2 FX-XX

Code	Contents
F0-00	Clear the alarm
F0-01	Restore to out of factory settings
F0-02	clear the position offset
F1-00	Jog run
F1-01	Test run
F1-02	Current sampling zero calibration
F1-05	Panel enable
F2-08	Trigger return to original (set 1 to start return to original, set 2 to stop return to original), only supports communication settings

Appendix 1.3 UX-XX

U0-XX:

Parameter	Content		Unit
U0-00	Current speed of servo motor		mm/s
U0-01	Input speed instruction		mm/s
U0-02	Torque instruction		% rated
U0-03	Mechanical angle		1°
U0-04	Electric angle		1°
U0-05	Bus voltage		V
U0-06	IPM temperature		0.1℃
U0-07	Torque feedback		% rated
U0-08	Pulse offset	(-9999～9999)*1	Instruction pulse
U0-09		(-65536～65535)*10000	
U0-10	Encoder feedback	(0000～9999)*1	Encoder pulse
U0-11		(0000～65535)*10000	
U0-12	Input instruction pulse numbers	(-9999～9999)*1	Instruction pulse
U0-13		(-32768~32767)*10000	
U0-14	Position feedback	(-9999～9999)*1	Instruction pulse
U0-15		(-32768~32767)*10000	
U0-18	Torque current		0.01A
U0-21	Input signal status 1		
U0-22	Input signal status 2		
U0-23	Output signal status 1		
U0-24	Output signal status 2		
U0-25	Input pulse frequency	(0000～9999)*1	Hz
U0-26		(0000～65535)*10000	
U0-41	Instantaneous output power		1W
U0-42	Average output power		1W
U0-43	Instantaneous thermal power		1W
U0-44	Average thermal power		1W
U0-49	Position feedforward		1Command unit
U0-50	Speed feedforward		mm/s
U0-51	Torque feedforward		% rated
U0-52	Instantaneous Bus Capacitor Power		1W
U0-53	Average Bus Capacitor Power		1W
U0-55	Encoder error count		1W
U0-56	Instantaneous regenerative braking discharge power		1W
U0-57	Average regenerative braking discharge power		Encoder pulse
U0-58			
U0-59	Absolute encoder present position feedback low 32-bit		Encoder pulse
U0-60			

Parameter	Content	Unit
(Direction sign)		
U0-89	Position command end flag	
U0-91	Multi-turn absolute motor circles	
U0-94 U0-95 U0-96 U0-97 (Direction sign)	Calibrate the absolute value encoder position low 32 bits	Encoder pulse
U0-98	Calibrate the absolute value encoder position high 32 bits	0.1℃

U1-XX:

Parameter	Contents	Unit
U1-00	Current alarm code	
U1-01	Current warning code	
U1-02	U phase current when alarming	0.01A
U1-03	V phase current when alarming	0.01A
U1-04	Bus voltage when alarming	V
U1-05	IGBT temperature when alarming	0.1℃
U1-06	Torque current when alarming	0.01A
U1-07	Excitation current when alarming	A
U1-08	Position offset when alarming	Instruction pulse
U1-09	Speed value when alarm occurs	mm/s
U1-10	Seconds(low 16-bit) when alarming, cumulated seconds from the first time power-on	s
U1-11	Seconds(high 16-bit) when alarming, cumulated seconds from the first time power-on	s
U1-12	The number of errors in this operation is calculated after this power on	
U1-13	The number of warnings for this operation is calculated after this power on	
U1-14	Historical alarm amounts	
U1-15	Historical warning amounts	
U1-16	Recent 1st alarm code	
U1-17	Recent 2nd alarm code	
U1-18	Recent 3rd alarm code	
U1-19	Recent 4th alarm code	
U1-20	Recent 5th alarm code	
U1-21	Recent 6th alarm code	
U1-22	Recent 7th alarm code	
U1-23	Recent 8th alarm code	
U1-24	Recent 9th alarm code	
U1-25	Recent 10th alarm code	

U2-XX:

Parameter	Contents		Unit
U2-00	Power on times		-
U2-01	Series		-
U2-02	Model (low 16-bit)		-
U2-03	Model (high 16-bit)		-
U2-04	out of factory date: year		-
U2-05	out of factory date: month		-
U2-06	out of factory date: day		-
U2-07	Firmware version		-
U2-08	Hardware version		-
U2-09	Total running time (from the first time power on)		hour
U2-10	Total running time (from the first time power on)		minute
U2-11	Total running time (from the first time power on)		second
U2-12	This time running time (from this time power on)		hour
U2-13	This time running time (from this time power on)		minute
U2-14	This time running time (from this time power on)		second
U2-15	Average output power (from the first time enabled, average power in the process of enabling)		1W
U2-16	Average thermal power (from the first time enabled, average power in the process of enabling)		1W
U2-17	Average bus capacitor filter power (from the first time power on, average power in the process of power on)		1W
U2-18	Accumulated motor turns	(0000～9999)*1	turn
U2-19		(0000～9999)*10000	turn
U2-20	Device serial no.: low 16-bit		-
U2-21	Device serial no.: high 16-bit		-
U2-22	Firmware generation date: year		-
U2-23	Firmware generation date: month/day		-
U2-24	Firmware generation date: hour/minute		-

U3-XX:

Parameter	Contents	Unit
U3-00	Motor code automatically read by drive (including thermal power parameters)	-
U3-01	Motor version	-
U3-02	Encoder version	-
U3-03	Extreme logarithm	-
U3-04	Encoder direction	
U3-05	Rated speed	
U3-06	top speed	
U3-07	Encoder accuracy	

Parameter	Contents	Unit
U3-09	Rated current	
U3-10	Maximum current	
U3-11	Overcurrent detection threshold	
U3-17	Motor inertia	
U3-19	Rated output power	
U3-21	Maximum output power	
U3-22	Maximum heat dissipation power	

U4-XX:

Parameter	Contents	Unit
U4-10	Resonance frequency detected by fast FFT	Hz
U4-20	Online inertia identification results	%
U4-21	Initial phase state	-
U4-22	Motor calibration results	-
U4-23	HALL status	-
U4-24	Low resolution identified by motor calibration	Enco
U4-25	High resolution identified by motor calibration	Enco
U4-26	Resistance identification value	mΩ
U4-27	Inductance identification value Ld	0.01mH
U4-28	Inductance identification value Lq	0.01mH
U4-29	Error correction index: displays the correction index position where the current position of the linear motor is located after the error correction function takes effect, and is also used for the correction position cursor in the upper computer.	-
U4-30	Error correction to return to the original state High 8 digits: 1: Error correction takes effect 0: Error correction not effective Lower 8 digits: 0: Return to original unfinished 1: Return to original completion	-

U5-XX:

Parameter	Contents	Unit
U5-00	Sync0 period time	us
U5-05	Port0 RX Error Count (Stop counting until 255)	
U5-07	Port1 RX Error Count (Stop counting until 255)	
U5-12	Port0 Link loss count (stop counting until 255)	
U5-13	Port1 Link loss count (stop counting until 255)	
U5-19	Synchronous offset time	us

Appendix 2 Object dictionary

All objects are configured in the object dictionary of each group through 4 digits 16-bit index configuration address.

The object dictionary of CoE (CANopen over EtherCAT) specified by CiA402 and the object dictionary of DS5C2 series are as follows:

Object dictionary specified by CiA402		DL 6series object dictionary	
Index	Content	Index	Contents
0000h～0FFFh	Data type area	Index	Content
1000h～1FFFh	COE communication area	0000h～0FFFh	Data type area
2000h～5FFFh	Factory custom area	1000h～1FFFh	COE communication area
		2000h～2FFFh	Servo parameter area
		3000h～3FFFh	Reserved
		4000h～4FFFh	Reserved
6000h～9FFFh	Profile area	5000h～5FFFh	Reserved
		6000h～6FFFh	Driver Profile area
A000h～FFFFh	Reserved	7000h～9FFFh	Reserved

Appendix 2.1 COE communication area(0x1000-0x1FFF)

Index	subindex	Name	Unit	Data range	Data type	Flag	PDO
1000h	00h	Device type	-	0~429496795	U32	RO	NO
1001h	00h	Error register	-	0~65535	U16	RO	NO
1008h	00h	Device	-	-	-	RO	NO
1009h	00h	Hardware version	-	-	-	RO	NO
100Ah	00h	software version	-	-	-	RO	NO
1018h	00h	Identity	-	-	-	RO	-
	01h	vendor ID	-	0~255	U8	RO	NO
	02h	product code	-	0~429496795	U32	RO	NO
	03h	Revision	-	0~429496795	U32	RO	NO
	04h	Serial number	-	0~429496795	U32	RO	NO
1600h	00h	1st RxPDO mapping Enter the number of mapping objects supported by RxPDO1	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO
1601h	00h	2nd RxPDO mapping RxPDO2 number of supported mapping objects	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO

Index	subindex	Name	Unit	Data range	Data type	Flag	PDO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO
1602h	00h	3rd RxPDO mapping RxPDO3 number of supported mapping objects	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO
1603h	00h	4th RxPDO mapping RxPDO4 number of supported mapping objects	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO
1A00h	00h	1st TxPDO mapping Output TxPDO1 number of supported mapping objects	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO
1A01h	00h	2nd TxPDO mapping TxPDO2 number of supported mapping objects	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO
1A02h	00h	3rd TxPDO mapping TxPDO3 number of supported mapping objects	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO

Index	subindex	Name	Unit	Data range	Data type	Flag	PDO
1A03h	00h	4th TxPDO mapping TxPDO3 number of supported mapping objects	-	0~24	U8	RW	NO
	01h	1st mapping object	-	0~4294967295	U32	RW	NO
	02h	2nd mapping object	-	0~4294967295	U32	RW	NO
	03h	3rd mapping object	-	0~4294967295	U32	RW	NO
	...	...	-	0~4294967295	U32	RW	NO
	18h	24th mapping object	-	0~4294967295	U32	RW	NO
1C00h	00h	Sync mangager communication type	-	0~255	U8	RO	NO
	01h	Subindex 001	-	0~4	U8	RO	NO
	02h	Subindex 002	-	0~4	U8	RO	NO
	03h	Subindex 003	-	0~4	U8	RO	NO
	04h	Subindex 004	-	0~4	U8	RO	NO
1C12h	00h	RxPDO assign	-	0~4	U8	RW	NO
	01h	Subindex 001	-	1600h~1603h	U16	RW	NO
	02h	Subindex 002	-	1600h~1603h	U16	RW	NO
	03h	Subindex 003	-	1600h~1603h	U16	RW	NO
	04h	Subindex 004	-	1600h~1603h	U16	RW	NO
1C13h	00h	TxPDO assign	-	0~4	U8	RW	NO
	01h	Subindex 001	-	1A00h~1A03h	U16	RW	NO
	02h	Subindex 002	-	1A00h~1A03h	U16	RW	NO
	03h	Subindex 003	-	1A00h~1A03h	U16	RW	NO
	04h	Subindex 004	-	1A00h~1A03h	U16	RW	NO
1C32h	00h	Sync manager 2 synchronization	-	0~20h	U8	RO	NO
	01h	Number of sub-objects	-	0~65535	U16	RW	NO
	02h	Sync mode	ns	0~4294967295	U32	RW	NO
	03h	Cycle time	ns	0~4294967295	U32	RW	NO
	04h	Shift time	-	0~65535	U16	RO	NO
	05h	Sync modes supported	ns	0~4294967295	U32	RO	NO
	06h	Minimum cycle time	ns	0~4294967295	U32	RO	NO
	08h	Calc and copy time	ns	0~65535	U16	RO	NO
	09h	Command (cannot support)	ns	0~4294967295	U32	RO	NO
	0Ah	Delay time (cannot support)	-	0~4294967295	U32	RO	NO
	0Bh	Sync0 cycle time When DC SYNC0 (1C32h-01h=02h), ESC register 09A0h is set. Except DC SYNC0, set to 0	-	0~65535	U16	RO	NO
	0Ch	Cycle time too small (cannot support)	-	0~65535	U16	RO	NO
	0Dh	SM-event missed (cannot support)	-	0~65535	U16	RO	NO
	0Eh	Shift time too short (cannot support)	-	0~65535	U16	RW	NO
	20h	RxPDO toggle failed (cannot support)	-	0~1	BOOL	RO	NO

Index	subindex	Name	Unit	Data range	Data type	Flag	PDO
1C33h	00h	Sync manager 3 synchronization	-	0~20h	U8	RO	NO
	01h	Number of sub-objects	-	0~65535	U16	RW	NO
	02h	Sync mode	ns	0~4294967295	U32	RW	NO
	03h	Cycle time	ns	0~4294967295	U32	RW	NO
	04h	Shift time	-	0~65535	U16	RO	NO
	05h	Sync modes supported	ns	0~4294967295	U32	RO	NO
	06h	Minimum cycle time	ns	0~4294967295	U32	RO	NO
	08h	Calc and copy time	ns	0~65535	U16	RO	NO
	09h	Command (cannot support)	ns	0~4294967295	U32	RO	NO
	0Ah	Delay time (cannot support)	-	0~4294967295	U32	RO	NO
	0Bh	Sync0 cycle time When DC SYNC0 (1C32h-01h=02h), ESC register 09A0h is set. Except DC SYNC0, set to 0	-	0~65535	U16	RO	NO
	0Ch	Cycle time too small (cannot support)	-	0~65535	U16	RO	NO
	0Dh	SM-event missed (cannot support)	-	0~65535	U16	RO	NO
	0Eh	Shift time too short (cannot support)	-	0~65535	U16	RW	NO
	20h	RxPDO toggle failed (cannot support)	-	0~1	BOOL	RO	NO

Appendix 2.2 Servo parameter area

Index	Sub-index	Name
2000h	00h	P0-00
2001h	00h	P0-01
2002h	00h	P0-02
2003h	00h	P0-03
...	...	...
205Fh	00h	P0-95
2100h	00h	P1-00
2101h	00h	P1-01
2102h	00h	P1-02
2103h	00h	P1-03
...	...	...
214Ah	00h	P1-74
2200h	00h	P2-00
2201h	00h	P2-01
2202h	00h	P2-02
2203h	00h	P2-03
...	...	...
2263h	00h	P2-99
2300h	00h	P3-00

Index	Sub-index	Name
2500h	00h	P5-00
2501h	00h	P5-01
2502h	00h	P5-02
2503h	00h	P5-03
...	...	...
2547h	00h	P5-71
2700h	00h	P7-00
2701h	00h	P7-01
2702h	00h	P7-02
2703h	00h	P7-03
...	...	...
2715h	00h	P7-21
2800h	00h	P8-00
2801h	00h	P8-01
2802h	00h	P8-02
2803h	00h	P8-03
...	...	...
281Ah	00h	P8-26

Index	Sub-index	Name
2301h	00h	P3-01
2302h	00h	P3-02
2303h	00h	P3-03
...	...	...
232Eh	00h	P3-46

Index	Sub-index	Name

Appendix 2.3 Driver Profile area(0x6000~0x6FFF)

Error code (603Fh)

Index	Sub index	Name	Range	Data type	Accessibility	PDO	Suitable mode
603Fh	00h	Error code	0~65535	U16	ro	TxPDO	ALL
		Display the main number of alarms that are occurring in the servo drive. (for 3791 and later versions, universal alarm displays complete error codes)					

Control word (6040h)

Index	Sub index	Name	Range	Data type	Accessibility	PDO	Suitable mode
6040h	00h	Controlword	0~65535	U16	rw	RxPDO	ALL
		Set control commands for servo drivers such as PDS state transitions.					

Bit information of 6040h:

Bit	Name		Note
0	switch on	Servo ready	-
1	enable voltage	Connect the main circuit power supply	-
2	quick stop	Quick stop	The logic is valid under 0. Please note to execute other bit logic and reverse actions
3	enable operation	Servo running	-
4	operation mode specific	Control mode dependency bit	PP：new set-point HM：start homing In other modes: this bit is undefined
5	operation mode specific	Control mode dependency bit	PP：change set immediately In other modes: this bit is undefined
6	operation mode specific	Control mode dependency bit	PP：absolute /elative In other modes: this bit is undefined
7	fault reset	fault reset	-
8	halt	halt	When bit8=1, execute motor deceleration pause through 605Dh (Halt selection code). After pausing, the enable must be turned off to restart the action
9	operation mode specific	Control mode	In other modes: this bit is undefined

Bit	Name		Note
		dependency bit	
10~15	Reserved	Reserved	-

6040h 的 bit0~3, bit7Note :

Command	6040h的bit					PDS conversion
	bit7	bit3	bit2	bit1	bit0	
	Fault reset	Servo running	Quick stop	Connect main circuit power supply	Servo ready	
Shutdown	0	-	1	1	0	2，6，8
Switch on	0	0	1	1	1	3
Switch on + Enable operation	0	1	1	1	1	3+4
Enable operation	0	1	1	1	1	4，16
Disable voltage	0	-	-	0	-	7，9，10，12
Quick stop	0	-	0	1	-	7，10，11
Disable operation	0	0	1	1	1	5
Fault reset	0→1	-	-	-	-	13

Status word(6041h)

The commands for PDS state migration and control of the slave station are set through 6040h (control word).

Index	Sub index	Name	Range	Data type	Accessibility	PDO	Suitable mode
6041h	00h	Statusword	0~65535	U16	ro	TxPDO	ALL

6041h bit information ：

Bit	Name		Note
0	ready to switch on	Main circuit power off status	-
1	switched on	Servo ready status	-
2	operation enabled	Servo running	-
3	fault	Fault	-
4	voltage enabled	Main circuit power on status	1: Indicates that the power supply voltage is printed onto the PDS
5	quick stop	quick stop	0: Indicates that PDS receives a quick stop request. The bit logic of quick stop is valid at 0. Please note to execute other bit logic and reverse actions
6	switch on disabled	Servo cannot run	-
7	warning	warning	1: Indicates that a warning is occurring. When warned, the PDS status remains unchanged and the motor continues to operate.

Bit	Name		Note
8	reserved	reserved	-
9	remote	Remote control	0: Indicates that 6040h is in an unprocessed state. 1: Indicates that 6040h is in a manageable state. The ESM state changes to 1 when transitioning above PreOP.
10	operation mode specific	Control mode dependency bit	PP, PV, TQ, HM：target reached In other modes: this bit is undefined
11	internal limit active	The internal position of the software exceeds the limit	The main reason for internal limitations is that the bit11 of 6041h becomes 1 when it occurs
12	operation mode specific	Control mode dependency bit	PP：set-point acknowledge PV：speed HM：homing attained CSP, CSV, CST：drive follows command value TQ：this bit no definition
13	operation mode specific	Control mode dependency bit	PP：following error HM：homing error CSP：following error In other modes: this bit is undefined
14~15	reserved	reserved	Value fixed to 0

6041h bit6~5, bit3~0 information:

6041h	PDS status	
xxxx xxxx x0xx 0000 b	Not ready to switch on	Incomplete initialization status
xxxx xxxx x1xx 0000 b	Switch on disabled	Initialization completion status
xxxx xxxx x01x 0001 b	Ready to switch on	Initialization completion status
xxxx xxxx x01x 0011 b	Switched on	Servo enable off/servo ready
xxxx xxxx x01x 0111 b	Operation enabled	Servo enable on
xxxx xxxx x00x 0111 b	Quick stop active	Stop immediately
xxxx xxxx x0xx 1111 b	Fault reaction active	Abnormal (alarm) judgment
xxxx xxxx x0xx 1000 b	Fault	Abnormal (alarm) state

Quick stop mode(605Ah)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
605Ah	00h	Quick stop option code	-	0~7	I16	rw	NO	ALL

605Ah information:

Control mode	Value	Effective deceleration	PDS status after stop
pp，csp，csv，pv mode	0	Free stop on servo side	Switch on disabled
	1	6084h	
	2	6085h	

Control mode	Value	Effective deceleration	PDS status after stop
	3	60C6h	
	5	6084h	Quick stop active
	6	6085h	
	7	60C6h	
Hm mode	0	Free stop on servo side	Switch on disabled
	1	609Ah	
	2	6085h	
	3	60C6h	
	5	609Ah	Quick stop active
	6	6085h	
	7	60C6h	
cst， tq mode	0	Free stop on servo side	Switch on disabled
	1, 2	6087h	
	3	Torque set to 0	
	5, 6	6087h	Quick stop active
	7	Torque set to 0	

Example of deceleration stop action based on Quick stop command:

A: If 6040h: bit2 (Controlword: quick stop) changes from 1 to 0, start decelerating stop.

The PDS status during deceleration changes to Quick stop active.

B: The motor stops when the actual speed is detected to be below 10r/min.

The PDS status after stopping is Switch on disabled or changed to Quick stop active.

Stop mode selection (605Bh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
605Bh	00h	Shutdown option code	-	0~1	I8	rw	RxPDO	ALL

605Bh information:

(1)When PDS command「Shutdown」is receiving

Control mode	Value	Effective deceleration	PDS status after stop
pp, csp, csv, pv mode	0	Free stop on servo side	Ready to switch on
	1	6084h	
Hm mode	0	Free stop on servo side	
	1	609Ah	
cst, tq mode	0	Free stop on servo side	
	1	6087h	

(2)When PDS command「Disable voltage」is receiving

Control mode	value	Effective deceleration	PDS status after stop
pp, csp, csv, pv mode	0	Free stop on servo side	Switch on disabled
	1	6084h	
Hm mode	0	Free stop on servo side	
	1	609Ah	
cst, tq mode	0	Free stop on servo side	

	1	6087h	

An example of slowing down and stop based on the Shutdown command:
A: If you receive the PDS command "Shutdown" to start deceleration and stop.
The PDS status during deceleration remains Operation enabled.
B: The motor stops when the actual speed is detected to be below 10r/min.
The PDS status after stopping is Ready to switch on.

Servo OFF shutdown mode selection(605Ch)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
605Ch	00h	Servo OFF shutdown mode	-	0~1	I8	rw	RxPDO	ALL

605Ch information:

Current control mode	Value	Effective deceleration	PDS status after shutdown
pp, csp, csv, pv mode	0	Servo side free stop	Switched on
	1	6084h	
Hm mode	0	Servo side free stop	
	1	609Ah	
cst, tq mode	0	Servo side free stop	
	1	6087h	

An example of slowing down and stop based on the Disable operation command.
A: If you receive the PDS command "Disable operation", start deceleration and stop.
The PDS status during deceleration remains Operation enabled.
B: Motor stops when the actual speed is below 10 r/min.
The PDS status bit after stop is Switched on.

Pause shutdown mode selection(605Dh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
605Dh	00h	Pause shutdown mode selection	-	1~3	I16	rw	NO	ALL

605Dh information:

Current control mode	Value	Effective deceleration	PDS status after shutdown
pp, csp, csv, pv mode	1	6084h	Operation enabled
	2	6085h	
	3	6072h, 60C6h	
Hm mode	1	609Ah	
	2	6085h	
	3	6072h, 60C6h	
cst, tq mode	1, 2	6087h	
	3	Torque set to 0	

Examples of deceleration and stop based on the Halt function
A: If 6040h: bit8 (Controlword: halt) changes from 0 to 1, start decelerating and stop. The PDS status during

deceleration remains Operation enabled.
B: the motor stops when the actual speed is below 10 r/min. After stopping, the PDS status remains in Operation enabled.

Alarm shutdown mode selection(605Eh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
605Eh	00h	Fault reaction option code	-	0~2	I16	rw	NO	ALL

605Eh information:

(1)When EtherCAT communication association abnormal alarm occurs (E-800~E-899):

Current control mode	Value	Effective deceleration	PDS status after shutdown
pp, csp, csv, pv mode	0	Servo side free stop	Fault
	1	6084h	
	2	6085h	
Hm mode	0	Servo side free stop	
	1	609Ah	
	2	6085h	
cst, tq mode	0	Servo side free stop	
	1, 2	6087h	

(2)When EtherCAT communication is not associated with abnormal alarms (not E-800~E-899):

Current control mode	Value	Effective deceleration	PDS status after shutdown
pp, csp, csv, pv hm, cst, tq	0, 2, 3	Servo side free stop	Fault

Examples of deceleration and stop based on alarms.
A: If an alarm occurs, start decelerating and stop. The PDS status during deceleration is Fault reaction active.
B: the motor stops when the actual speed is below 10 r/min. The PDS status after stopping is Fault.

Control mode setting(6060h)

The control mode is set through 6060h.

Index	Sub index	Name	Range	Data type	Accessibility	PDO	Suitable mode
6060h	00h	Mode of operation	-128~127	I8	rw	RxPDO	All

6060h bit information:

bit	Definition		abbr	correspond
-128~-1	-	Retain	-	-
0	No mode changed/No mode assigned	No control mode change/No control mode allocation	-	-
1	Profile position mode	Contour position control mode	pp	YES
3	Profile velocity mode	Contour speed control mode	pv	YES
4	Torque profile mode	Contour torque control mode	tq	YES
6	Homing mode	Origin reset Position mode	hm	YES
8	Cyclic synchronous position	Periodic synchronous position control	csp	YES

	mode	mode		
9	Cyclic synchronous velocity mode	Periodic synchronous speed control mode	csv	YES
10	Cyclic synchronous torque mode	Periodic synchronous torque control mode	cst	YES
11~127	-	Retain	-	-

Since 6060h is the default = (no mode change/no mode assigned), be sure to set the control mode value used after power input. When the set value for 6060h is 0 and the set value for 6061h is 0, an E-881(Control Mode Set Exception Protection) occurs if the PDS state migrates to Operation enabled.
After the initial state is converted from 0 to the supported control mode (pp, pv, tq, hm, csp, csv, cst), set 6060h to 0 again, the previous control mode will be maintained as "No mode changed", and the switch of control mode cannot be performed.

Control mode display(6061h)

The confirmation of the internal control mode of the servo drive is performed according to 6061h. After setting 6060h, please confirm whether it is feasible to set this object action by detection.

Index	Sub index	Name	Range	Data type	Accessibility	PDO	Suitable mode
6061h	00h	Mode of operation display	-128~127	I8	ro	TxPDO	All

6061h bit information:

bit	Definition	abbr	Correspond
-128~ -1	-	-	-
0	No mode changed/No mode assigned	-	-
1	Profile position mode	pp	YES
3	Profile velocity mode	pv	YES
4	Torque profile mode	tq	YES
6	Homing mode	hm	YES
8	Cyclic synchronous position mode	csp	YES
9	Cyclic synchronous velocity mode	csv	YES
10	Cyclic synchronous torque mode	cst	YES
11~127	-	-	-

Position command(6062h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6062h	00h	Position demand value [PUU]	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	PP CSP HM

Internal actual position feedback(6063h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6063h	00h	Position actual internal value	Command unit	-2147483648 ~	I32	ro	TxPDO	ALL

				2147483647				

Position feedback(6064h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6064h	00h	Position actual value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL

Position deviation too large threshold (6065h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6065h	00h	Position deviation too large threshold	Command unit	0~ 4294967295	U32	rw	RxPDO	PP CSP
		When the difference between the position instruction 6062h and the position feedback 6064h exceeds 6065h and the time reaches 6066h, the bit 13 of 6041h will be set to 1.						

Excessive position deviation timeout (6066h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6066h	00h	Excessive position deviation timeout	1ms	0~65535	U16	rw	RxPDO	PP CSP
		When the difference between the position instruction 6062h and the position feedback 6064h exceeds 6065h and the time reaches 6066h, the bit 13 of 6041h will be set to 1.						

Position reach threshold (6067h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6067h	00h	Position reach threshold	Command unit	0~4294967295	U32	rw	RxPDO	PP
			When the difference between the position instruction 6062h and the position feedback 6064h is within the set range of 6067h, and the time reaches 6068h, the bit 10 of 6041h will be set to 1.					

Position command reached threshold time (6068h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6068h	00h	Position command reached threshold time	1ms	0~65535	U16	rw	RxPDO	PP
		When the difference between the position instruction 6062h and the position feedback 6064h is within the set range of 6067h, and the time reaches 6068h, the bit 10 of 6041h will be set to 1.						

Speed command (606Bh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode

606Bh	00h	Speed command	Command unit /s	-2147483648~ 2147483647	I32	RO	TxPDO	PV CSV

Speed feedback (606Ch)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
606Ch	00h	Speed feedback	Command unit /s	-2147483648~ 2147483647	I32	ro	TxPDO	ALL

Speed reached threshold (606Dh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
606Dh	00h	Speed reached threshold	command unit	0~4294967295	U32	rw	RxPDO	PV
		When the difference between the speed command 606Bh and the speed feedback 606Ch is within the set range of 606Dh, and the time reaches 606Eh, the bit 10 of 6041h will be set to 1.						

Speed reached threshold time (606Eh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
606Eh	00h	Speed reached threshold time	1ms	0~65535	U16	rw	RxPDO	PV
		When the difference between the speed command 606Bh and the speed feedback 606Ch is within the set range of 606Dh, and the time reaches 606Eh, the bit 10 of 6041h will be set to 1.						

Speed threshold (606Fh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
606Fh	00h	Velocity threshold	Command unit	0~4294967295	U32	rw	RxPDO	PV
		When the value of speed feedback 606Ch exceeds the set value of 606Fh and the time reaches 6070h, the threshold value of bit 12 for 6041h is set to 0. If the speed is below the set value of this parameter, the bit12 of 6041h becomes 1.						

Speed threshold time (6070h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6070h	00h	Velocity threshold time	1ms	0~65535	U16	rw	RxPDO	PV
		When 606Ch exceeds the set value of 606Fh, set the time for bit12 of 6041h to become 0.						

Target torque (6071h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6071h	00h	Target torque	0.1%	-32768~32767	I16	rw	RxPDO	TQ

Max torque (6072h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6072h	00h	Max torque	0.1%	0~65535	U16	rw	RxPDO	ALL

Max current (6073h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6073h	00h	Max current	0.1%	0~65535	U16	ro	NO	ALL

Torque command (6074h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6074h	00h	Torque command	0.1%	-32768~32767	I16	ro	TxPDO	ALL

Motor rated torque (6076h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6076h	00h	Motor rated torque	Mn·m	0 ~ 4294967295	U32	RO	TxPDO	ALL

Torque feedback (6077h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6077h	00h	Torque feedback	0.1%	-32768~32767	I16	ro	TxPDO	ALL

Current feedback (6078h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6078h	00h	Current feedback	0.10%	-32768~32767	I16	RO	TxPDO	ALL

Bus voltage (6079h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6079h	00h	DC link circuit voltage	mV	0~4294967295	U32	RO	TxPDO	ALL

Target position (607Ah)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
607Ah	00h	Target position	Command unit	-2147483648~ 2147483647	I32	rw	RxPDO	PP CSP

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
								HM

Position range limit (607Bh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
607Bh	01h	Min position range limit	command unit	-2147483648~ 2147483647	I32	rw	RxPDO	ALL
	02h	Max position range limit	command unit	-2147483648~ 2147483647	I32	rw	RxPDO	ALL

This parameter modification has no effect.

Home offset (607Ch)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
607Ch	00h	Home Offset	command unit	-2147483648~ 2147483647	I32	rw	RxPDO	NO

Soft limit (607Dh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
607Dh	01h	Min position limit	command unit	-2147483648~ 2147483647	I32	rw	RxPDO	NO
	02h	Max position limit	command unit	-2147483648~ 2147483647	I32	rw	RxPDO	NO

Command polarity (607Eh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
607Eh	00h	Command Polarity	-	0~255	U8	rw	NO	ALL

607Eh bit information

bit	Name	value	note	note
0-4	-	0	-	Reserved, please set to 0
5	Torque polarity	0	Symbol without inversion	0: No inversion of symbols 1: The symbol has inversion
		1	Symbol has inversion	
6	Speed polarity	0	Symbol without inversion	0: No inversion of symbols 1: The symbol has inversion
		1	Symbol has inversion	
7	Position polarity	0	Symbol without inversion	0: No inversion of symbols 1: The symbol has inversion
		1	Symbol has inversion	

The position, speed, and torque polarity must be exactly the same, that is, bit7-5 must all be set to 0 or bit7-5 must all be set to 1.

Max profile speed(607Fh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
607Fh	00h	Max profile velocity	command unit/s	0~4294967295	U32	rw	RxPDO	PP PV HM
		Speed limit values in pp, hm, and pv mode. The maximum value is limited by 6080h through internal processing.						

Max motor speed(6080h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6080h	00h	Max motor speed	r/min	0~4294967295	U32	rw	RxPDO	PV TQ CSV CST
		Set the maximum speed of the motor. When power supply input, the maximum speed read from the motor is set. The maximum value is limited by the maximum speed read from the motor based on internal processing. During tq and cst, the speed is limited by the set value of this object.						

Profile speed(6081h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6081h	00h	Profile velocity	Command unit/s	0~4294967295	U32	rw	RxPDO	PP

Profile acceleration(6083h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6083h	00h	Profile deceleration	command unit/s^2	0~4294967295	U32	rw	RxPDO	PP PV HM CSP CSV
		Set the profile deceleration. When set to 0, internal processing is processed as 1.						

Profile deceleration(6084h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6084h	00h	Profile deceleration	command unit/s^2	0~4294967295	U32	rw	RxPDO	PP PV HM CSP

								CSV
		Set the profile deceleration. When set to 0, internal processing is processed as 1.						

Fast stop deceleration(6085h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6085h	00h	Fast stop deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV HM CSP CSV

Motor rated current(6075h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6075h	00h	Motor rated current	1mA	0 ~4294967295	U32	RO	TxPDO	PP PV HM CSP CSV

Position trajectory planning type(6086h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6086h	00h	Motion profile type	-	-32768~32767	I16	rw	RxPDO	HM

This parameter 0: Step type; 1: Slope type.

This parameter is only applicable to HM mode. In PP and PV modes, slope types are directly used within trajectory planning.

In CSP and CSV modes, this parameter is not required and trajectory planning is completed at the main station.

Torque slope (6087h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6087h	00h	Torque slope	0.1%	0~4294967295	U32	rw	RxPDO	TQ CST
		Set the parameter values to give a bias torque command. In CST mode, it is only effective in deceleration stop time.						

Torque planning type (6088h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6088h	00h	Torque planning type	-	0~65535	I16	rw	RxPDO	TQ

This parameter 0: Step type; 1: Slope type.

In TQ mode, the slope type directly used for torque planning, modifying this parameter has no effect.

Electronic gear ratio (6091h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6091h	01h	Motor revolutions	Turns (motor)	1~4294967295	U32	rw	NO	ALL
	02h	Shaft revolutions	Turns (shaft)	1~4294967295	U32	rw	NO	ALL

This object defines the content related to the motor turns and the shaft turns after the gearbox output.

Gear ratio = 6091h-01h/ 6091h-02h

Encoder division ratio (6092h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6092h	01h	Feed	command unit	1~4294967295	U32	rw	NO	ALL
		Set feed quantity						
	02h	Shaft revolutions	Turns (shaft)	1~4294967295	U32	rw	NO	ALL
		Set shaft turns						

This object represents the amount of action for each rotation of the shaft after the gearbox output.

Feed constant =6092h-01h/ 6092h-02h

Homing mode (6098h)

Index	Sub index	Name	Range	Data type	Accessibility	PDO	Suitable mode
6098h	00h	Homing method	-128~127	I8	rw	RxPDO	All

6098h information:

Value	Definition
-2	Searching for reverse limits
-1	Searching for positive limits
0	Not specify the homing method
1	Reverse homing, the deceleration point is the reverse limit switch, and the origin is the motor Z signal. Before encountering the Z signal, the descending edge of the reverse limit must be encountered first
2	Forward homing, deceleration point is the forward limit switch, origin is the motor Z signal, and the falling edge of the forward limit must be encountered before encountering the Z signal
3	Positive homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the falling edge on the same side of the origin switch
4	Positive homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the rising edge on the same side of the origin switch
5	Reverse homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the falling edge on the same

Value	Definition
	side of the origin switch
6	Reverse homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the rising edge on the same side of the origin switch
7	Positive homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the falling edge on the same side of the origin switch
8	Positive homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the rising edge on the same side of the origin switch
9	Positive homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, you must first encounter the rising edge on the other side of the origin switch
10	Positive homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the falling edge on the other side of the origin switch
11	Reverse homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the falling edge on the same side of the origin switch
12	Reverse homing, deceleration point is the origin switch, and the origin is the motor Z signal. Before encountering the Z signal, it is necessary to first encounter the rising edge on the same side of the origin switch
13	Reverse homing, deceleration point is the origin switch, and the origin is the motor Z signal on the other side of the origin switch. Before encountering the Z signal, the rising edge on the other side of the origin switch must be encountered first
14	Reverse homing, deceleration point is the origin switch, and the origin is the Z signal of the motor on the other side of the origin switch. Before encountering the Z signal, the falling edge on the other side of the origin switch must be encountered first
15	No meaning
16	No meaning
17	Homing action is the same as 1, but the origin is at the reverse limit position
18	Homing action is the same as 2, but the origin is at the forward limit position
19	Homing action is the same as 3, but the origin is at the origin switch
20	Homing action is the same as 4, but the origin is at the origin switch
21	Homing action is the same as 5, but the origin is at the origin switch
22	Homing action is the same as 6, but the origin is at the origin switch
23	Homing action is the same as 7, but the origin is at the origin switch
24	Homing action is the same as 8, but the origin is at the origin switch
25	Homing action is the same as 9, but the origin is at the origin switch
26	Homing action is the same as 10, but the origin is at the origin switch
27	Homing action is the same as 11, but the origin is at the origin switch
28	Homing action is the same as 12, but the origin is at the origin switch
29	Homing action is the same as 13, but the origin is at the origin switch
30	Homing action is the same as 14, but the origin is at the origin switch

Value	Definition
31	No meaning
32	No meaning
33	Reverse homing, with the origin at the Z-phase signal of the motor
34	Forward homing, with the origin at the Z-phase signal of the motor
35	Take the current position as the origin
37	Take the current position as the origin

Homing speed (6099h)

<table>
<tr><th>Index</th><th>Sub index</th><th>Name</th><th>Unit</th><th>Range</th><th>Data type</th><th>Accessibility</th><th>PDO</th><th>Suitable mode</th></tr>
<tr><td rowspan="3">6099h</td><td>01h</td><td>Speed during search for deceleration point</td><td>command unit/s</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>HM</td></tr>
<tr><td rowspan="2">02h</td><td>Speed during search for zero</td><td>command unit/s</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>NO</td><td>HM</td></tr>
<tr><td colspan="7">If the edge of the Switch signal is used as the origin detection position, please set a value as small as possible to reduce detection error.</td></tr>
</table>

The speeds of 6099-01h and 6099-02h are limited by the minimum values of 6080h and 607Fh.

Homing acceleration(609Ah)

<table>
<tr><th>Index</th><th>Sub index</th><th>Name</th><th>Unit</th><th>Range</th><th>Data type</th><th>Accessibility</th><th>PDO</th><th>Suitable mode</th></tr>
<tr><td rowspan="2">609Ah</td><td rowspan="2">00h</td><td>Homing acceleration</td><td>command unit/s²</td><td>0~4294967295</td><td>U32</td><td>rw</td><td>RxPDO</td><td>HM</td></tr>
<tr><td colspan="7">Set the acceleration and deceleration during HM mode.
At the final stop of each homing mode (when the origin position is detected), there is no need to use the set value of this object, and the servo lock stops.</td></tr>
</table>

Position offset(60B0h)

<table>
<tr><th>Index</th><th>Sub index</th><th>Name</th><th>Unit</th><th>Range</th><th>Data type</th><th>Accessibility</th><th>PDO</th><th>Suitable mode</th></tr>
<tr><td rowspan="2">60B0h</td><td rowspan="2">00h</td><td>Position offset</td><td>Command unit</td><td>-2147483648 ~ 2147483647</td><td>I32</td><td>rw</td><td>RxPDO</td><td>ALL</td></tr>
<tr><td colspan="7">This parameter is used for the position loop control of the drive. As the servo underlying algorithm does not support feedforward control, this parameter is temporarily not used. Modifying it does not affect the effect.</td></tr>
</table>

Velocity offset(60B1h)

<table>
<tr><th>Index</th><th>Sub index</th><th>Name</th><th>Unit</th><th>Range</th><th>Data type</th><th>Accessibility</th><th>PDO</th><th>Suitable mode</th></tr>
<tr><td rowspan="2">60B1h</td><td rowspan="2">00h</td><td>Velocity offset</td><td>Command unit/s</td><td>-2147483648~ 2147483647</td><td>I32</td><td>rw</td><td>RxPDO</td><td>ALL</td></tr>
<tr><td colspan="7">This parameter is used for the speed loop control of the drive. As the servo underlying algorithm does not support feedforward control, this parameter is temporarily not used. Modifying it does not affect the effect.</td></tr>
</table>

Torque offset(60B2h)

<table>
<tr><th>Index</th><th>Sub index</th><th>Name</th><th>Unit</th><th>Range</th><th>Data type</th><th>Accessibility</th><th>PDO</th><th>Suitable mode</th></tr>
<tr><td rowspan="2">60B2h</td><td rowspan="2">00h</td><td>Torque offset</td><td>0.1%</td><td>-2147483648 ~ 2147483647</td><td>I32</td><td>rw</td><td>RxPDO</td><td>ALL</td></tr>
<tr><td colspan="7">This parameter is used for the current loop control of the drive. As the servo underlying algorithm does not support feedforward control, this parameter is temporarily not used. Modifying it does not affect the effect</td></tr>
</table>

Touch Probe function(60B8h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60B8h	00h	Touch probe function	-	0~65535	U16	rw	RxPDO	ALL

60B8h bit information ：

<table>
<tr><th>bit</th><th>Value</th><th colspan="2">Note</th></tr>
<tr><td rowspan="2">0</td><td>0</td><td>Probe 1 not enabled</td><td rowspan="2">Probe 1 enabled</td></tr>
<tr><td>1</td><td>Probe 1 enabled</td></tr>
<tr><td rowspan="2">1</td><td>0</td><td>Single triggering</td><td rowspan="2">Probe 1 trigger mode selection</td></tr>
<tr><td>1</td><td>Continuous triggering</td></tr>
<tr><td rowspan="2">2</td><td>0</td><td>External input signal</td><td rowspan="2">Probe 1 trigger method selection</td></tr>
<tr><td>1</td><td>Z phase signal (not support)</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">4</td><td>0</td><td>Rising edge not latched</td><td rowspan="2">Probe 1 rising edge selection</td></tr>
<tr><td>1</td><td>Rising edge latched</td></tr>
<tr><td rowspan="2">5</td><td>0</td><td>Falling edge not latched</td><td rowspan="2">Probe 1 falling edge selection</td></tr>
<tr><td>1</td><td>Falling edge latched</td></tr>
<tr><td>6-7</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">8</td><td>0</td><td>Probe 2 not enabled</td><td rowspan="2">Probe 2 enabled</td></tr>
<tr><td>1</td><td>Probe 2 enabled</td></tr>
<tr><td rowspan="2">9</td><td>0</td><td>Single triggering</td><td rowspan="2">Probe 2 trigger mode selection</td></tr>
<tr><td>1</td><td>Continuous triggering</td></tr>
<tr><td rowspan="2">10</td><td>0</td><td>External input signal</td><td rowspan="2">Probe 2 trigger method selection</td></tr>
<tr><td>1</td><td>Z phase signal (not support)</td></tr>
</table>

bit	Value	Note	
11	-	-	-
12	0	Rising edge not latched	Probe 2 rising edge selection
	1	Rising edge latched	
13	0	Falling edge not latched	Probe 2 falling edge selection
	1	Falling edge latched	
14-15	-	-	-

- At present, Z-phase triggering mode is not supported, only external signals are supported as triggering sources
- Do not set the rising and falling edges simultaneously under the same probe.

Touch probe status(60B9h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60B9h	00h	Touch probe status	-	0~65535	U16	ro	TxPDO	ALL

60B9h bit information:

bit	Value	Note	
0	0	Probe 1 not executed	Probe 1 execution status
	1	Probe 1 is executing	
1	0	Probe 1 rising edge latch not completed	Probe 1 rising edge latch state
	1	Probe 1 rising edge latch completed	
2	0	Probe 1 falling edge latch not completed	Probe 1 falling edge latch state
	1	Probe 1 falling edge latch completed	
3-7	-	-	-
8	0	Probe 2 not executed	Probe 2 execution status
	1	Probe 2 is executing	
9	0	Probe 2 rising edge latch not completed	Probe 2 rising edge latch state
	1	Probe 2 rising edge latch completed	
10	0	Probe 2 falling edge latch not completed	Probe 2 falling edge latch state
	1	Probe 2 falling edge latch completed	
11-15	-	-	-

Probe 1 rising edge latch position value(60BAh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60BAh	00h	probe 1 rising edge latch position value	Command Unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL

Probe 1 falling edge latch position value(60BBh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60BBh	00h	Touch probe pos1 neg	Command	-2147483648~	I32	ro	TxPDO	ALL

		value	unit	2147483647				

Probe 2 rising edge latch position value(60BCh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60BCh	00h	Touch probe pos2 pos value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL

Probe 2 falling edge latch position value(60BDh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60BDh	00h	Touch probe pos2 neg value	Command unit	-2147483648~ 2147483647	I32	ro	TxPDO	ALL

Max acceleration(60C5h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60C5h	00h	Max acceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV HM
		Set the min deceleration. When set to 0, internal processing is processed as 1.						

Min deceleration(60C6h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60C6h	00h	Min deceleration	Command unit/s²	0~4294967295	U32	rw	RxPDO	PP PV HM
		Set the min deceleration. When set to 0, internal processing is processed as 1.						

Positive torque limited(60E0h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60E0h	00h	Positive torque limited	0.1%	0~65535	U16	rw	RxPDO	ALL

Negtive torque limited(60E1h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60E1h	00h	Negtive torque limited	0.1%	0~65535	U16	rw	RxPDO	ALL

Position offset(60F4h)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60F4h	00h	Following error actual value	Command unit	-2147483648 ~2147483647	I32	RO	TxPDO	PP CSP HM

Internal instruction speed(60FAh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60FAh	00h	Control effort internal command speed (position output)	Command unit/s	-2147483648~ 2147483647	I32	RO	TxPDO	ALL

Internal command position(60FCh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60FCh	00h	Position demand value	Command unit	-2147483648~ 2147483647	I32	RO	TxPDO	PP CSP HM

Digital inputs(60FDh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60FDh	00h	Digital inputs	-	0~4294967 295	U32	ro	TxPDO	ALL

60FDh bit information ：

bit	Name	Value	Note
0	negative limit switch	0	No reverse overtravel switch signal detected
		1	Reverse overtravel switch signal detected
1	positive limit switch	0	No forward overtravel switch signal detected
		1	Forward overtravel switch signal detected
2	home switch	0	No origin switch signal detected
		1	Origin switch signal detected
3	EXT1 probe1	0	No input signal detected for probe 1
		1	Detected input signal from probe 1
4	EXT1 probe2	0	No input signal detected for probe 2
		1	Detected input signal from probe 2
5	Z phase signal output	0	No Z-phase output signal detected
		1	Z-phase output signal detected
6-15	Reserved	-	-
16	Remote input SI1	0	Remote SI1 input signal not detected
		1	Remote SI1 input signal detected

bit	Name	Value	Note
17	Remote input SI2	0	Remote SI2 input signal not detected
		1	Remote SI2 input signal detected
18	Remote input SI3	0	Remote SI3 input signal not detected
		1	Remote SI3 input signal detected
19	Remote input SI4	0	Remote SI4 input signal not detected
		1	Remote SI4 input signal detected
19-31	Reserved		

Digital outputs(60FEh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60FEh	-	Digital outputs	-	-	-	-	-	-
	01h	Output of operating the external output signal	-	-	-	-	-	-
	02h	Set output operation host machine function of external output signal	-	-	-	-	-	-

60FEh bit information ：

Index	Bit	Name	Value	Note
01h	0-15	Reserved	-	-
	16	Remote SO1 output status	0	Remote SO1 output signal not detected
			1	Remote SO1 output signal detected
	17	Remote SO2 output status	0	Remote SO2 output signal not detected
			1	Remote SO2 output signal detected
	18	Remote SO3 output status	0	Remote SO3 output signal not detected
			1	Remote SO3 output signal detected
02h	0-15	Reserved	-	-
	16	Remote SO1 output enable	0	Turn off remote SO1 output
			1	Turn on remote SO1 output
	17	Remote SO2 output enable	0	Turn off remote SO2 output
			1	Turn on remote SO2 output
	18	Remote SO3 output enable	0	Turn off remote SO3 output
			1	Turn on remote SO3 output

Target velocity(60FFh)

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
60FFh	00h	Target velocity	Command unit/s	-4294967296~4294967295	U32	RW	RxPDO	PV

Supported drive mode(6502h)

This servo driver can confirm the supported control mode based on 6502h.

Index	Sub index	Name	Unit	Range	Data type	Accessibility	PDO	Suitable mode
6502h	00h	Supported drive modes	-	-2147483648	I32	ro	TxP	ALL

				~2147483647			DO	

6502h bit information:

bit	Definition	abbr	Correspond
0	Profile position mode	pp	YES
2	Profile velocity mode	pv	YES
3	Torque profile mode	tq	YES
5	Homing mode	hm	YES
7	Cyclic synchronous position mode	csp	YES
8	Cyclic synchronous velocity mode	csv	YES
9	Cyclic synchronous torque mode	cst	YES
10~31	-	-	-

Appendix 3 Glossary of Terms

Abbreviation	Full name	Note
EtherCAT	Ethernet for Control Automation Technology	Using Ethernet for communication functions in automation control technology
COE	CANopen Over EtherCAT	CAN Application Protocol Based on EtherCAT
FMMU	Fieldbus Memory Management Unit	Fieldbus Memory Management Unit
SM	Sync Manager	Sync Manager
pp	Profile position	Contour position control mode
pv	Profile velocity	Contour speed control mode
tq	Torque profile	Contour torque control mode
csp	Cyclic synchronous position mode	Cyclic position control mode
hm	Homing mode	Origin reset position control mode
csv	Cyclic synchronous velocity mode	Cyclic speed control mode
cst	Cyclic synchronous torque mode	Cyclic torque control mode
DC	Distributed Clock	Distributed clock
SDO	Service Data Object	Service data object, used to transmit non periodic communication data
PDO	Process Data Object	Process data object, used to transmit periodic communication data
TxPDO	-	PDO transmitted from the station to the main station
RxPDO	-	PDO transmitted from the master station to the slave station
ESM	EtherCAT State Machine	EtherCAT state machine
ESC	EtherCAT Salve Controller	Slave station controller
PHY	Physical layer device that converts data from the Ethernet controller to electric or optical signals.	Physical layer devices that convert data from Ethernet controllers into electrical or optical signals
PDI	Process Data Interface or Physical Device Interface	Process data interface
EEPROM	Electrically Erasable Programmable Read Only Memory	Programmable read-only memory, a non-volatile memory used to store ESC configurations and device descriptions. Connect to ESI interface
ESI	EtherCAT Slave Information, stored in ESI EEPROM(formerly known as SII)	EtherCAT secondary information, stored in ESI EEPROM (formerly known as SII)

In TQ mode, the slope type directly used for torque planning does not work when modifying this parameter.

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