Maxsine

EP5 series

EtherCAT bus

AC servo driver

Operating Instructions

(2nd edition)

Driver TL04/TL08/TL10/TL15/TL25/TL35/TL55/TH15
TH20/TH30/TH50/TH75/TH90/TH110/TH150

Wuhan Maxsine Electric Co., Ltd

DECLARATION

There will not be extra notice if the specification or size of products is changed because of improvement etc.

Safety Precautions

In order to ensure proper use of this product safely, the user should be familiar with and observes the following important items before proceeding with storage, installation, wiring, running, inspection or maintenance for the product.

⚠ Danger	Indicates a disoperation possibly can cause danger and physical injury or death.
⚠ Caution	Indicates a disoperation possibly can cause danger and physical injure, and may result in damage to the product.
⊘ Stop	Indicates a prohibited actions, otherwise can cause damage, malfunction to the product.

1. Use occasions

⚠ Danger
● Do not expose the product in moisture, caustic gas, and ignitable gas situation. Otherwise can cause an electric shock or fire. ● Do not use the product in direct-sunlight, dust, salinity and metal powder places. ● Do not use the product in the places that has water, oil and drugs drops.

2. Wiring

⚠ Danger
● Connect the earth terminal (PE) to earth reliably, otherwise can cause an electric shock or fire. ● Do not connect the 220V driver to 380V power supply. Otherwise it will cause equipment damage, electric shock or fire. ● Do not connect the servo motor output terminals (U, V, W) to 3 phase AC power supply, otherwise can cause personnel casualty or fire. ● The output terminals (U, V, W) must be connected with the servo motor connections (U, V, W) correspondently, otherwise can result in the motor flying speed that may cause equipment damage and the personnel casualty ● Please fasten the input power terminals (L1, L2, and L3) and the output terminals (U, V, W). Otherwise may cause fire. ● Please refer to the wire material to select the wiring, otherwise it may cause fire.

3. Operation

⚠ Caution
● Before operating the mechanical device, it is necessary to set the parameters with appropriate values. Otherwise, can cause the mechanical device to out of control or break down. ● Before running the mechanical device, make sure the emergency stop switch can work at any time. ● Performing trial run without load, make sure that the motor is in normal operation. Afterwards joins again the load. ● Please do not turn on and off the main power supply more frequently, otherwise can cause the servo driver overheat.

4. Running

⊘ Stop
● Do not touch any moving parts of the mechanical device while the motor is running, otherwise can cause personnel casualty. ● Do not touch the driver or motor when the device is running, otherwise it may cause electric shock or burn. ● Do not move the cables when the device is running. Otherwise, personnel may be injured or the device may be damaged.

5. Maintenance and inspection

⊘ Stop
● Do not touch any portion inside of the driver and motor, otherwise it will cause electric shock. ● Do not remove the front cover of the servo driver while power is on, otherwise can cause an electric shock. ● Please wait at least 5 minutes after power has been removed before touching any terminal, otherwise the remaining high voltage possibly can cause an electric shock. ● Do not change the wiring while the power is on, otherwise can cause an electric shock. ● Do not disassemble the motor, otherwise can cause an electric shock.

6. Service range

⚠ Caution
The products involved in this manual are for general industrial use. Do not use them on devices that may directly endanger personal safety, such as nuclear power devices, aerospace equipment, life support and maintenance equipment, and other safety equipment. If you need the above, please contact our company.

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Chapter 1 Product inspection and installation

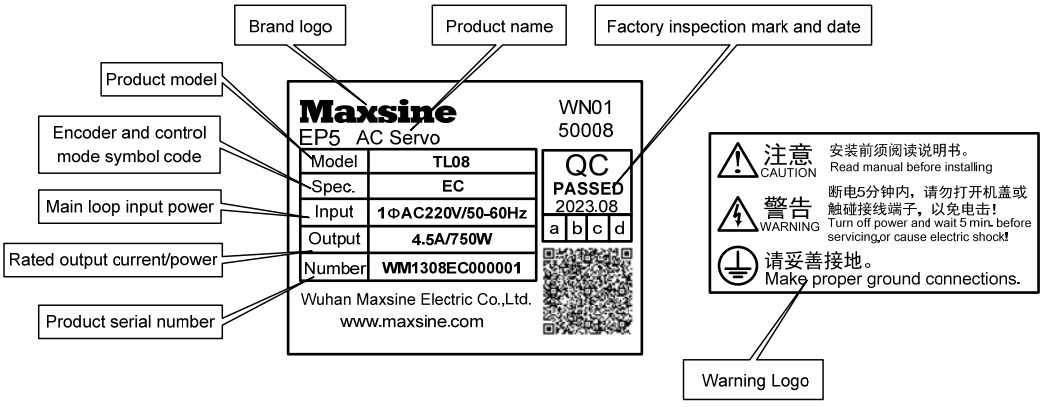
1.1 Product inspection

This product has undergone a complete functional test before delivery. In order to prevent the product from being abnormal due to negligence during the delivery process, please inspect the following items in detail after unpacking:

- Inspect whether the models of the servo driver and servo motor are the same as those ordered.
- Inspect whether the appearance of the servo driver and servo motor is damaged or scratched. When damage is caused during transportation, please do not connect wires for power transmission.
- Inspect whether the servo driver and servo motor are loose. Whether there are loose screws, whether the screws are not locked or fall off.
- Inspect whether the rotor shaft of the servo motor can rotate smoothly by hand. The motor with brake cannot rotate directly.

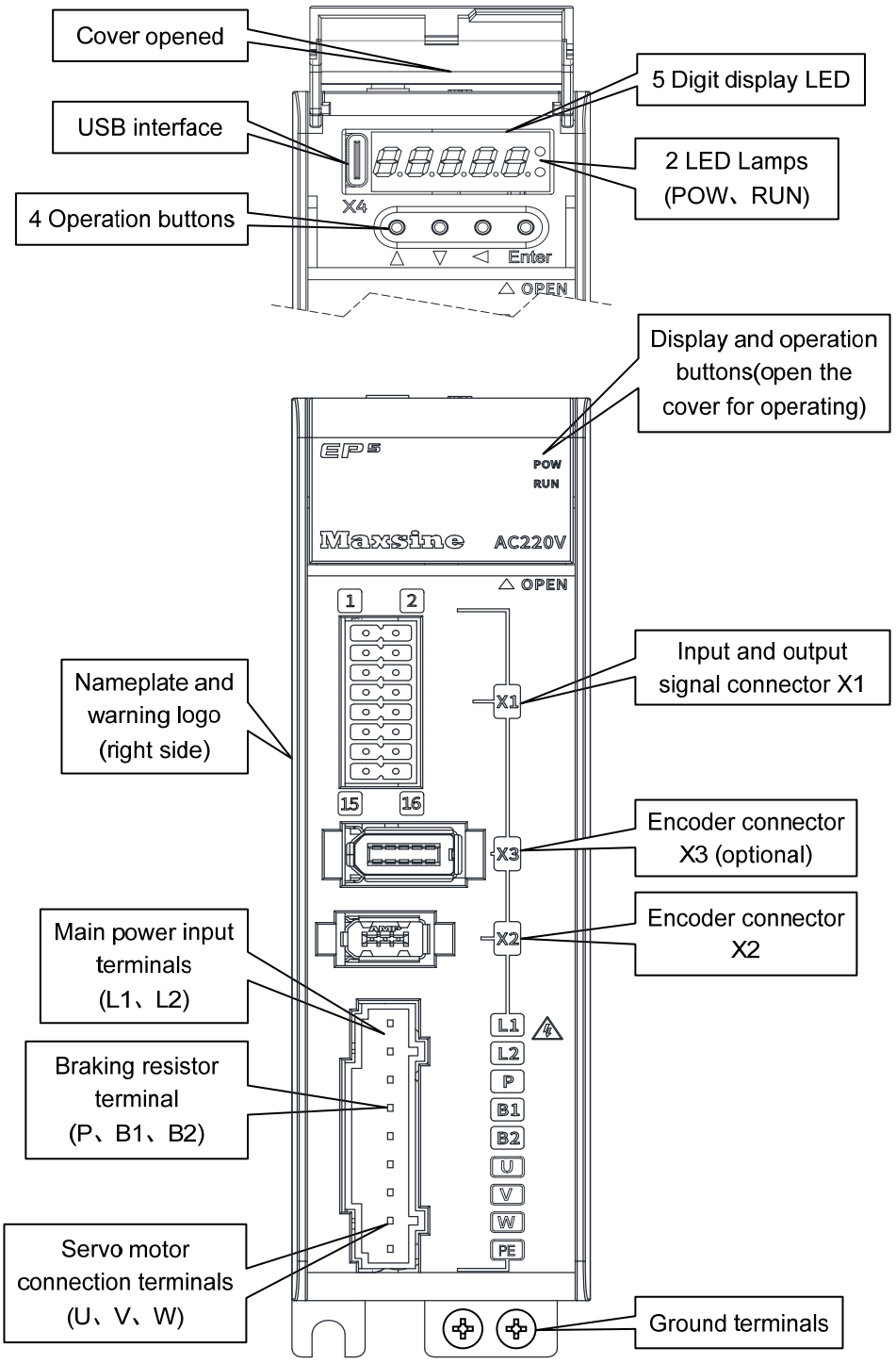
  If the above items have faults or abnormal phenomena, please contact the dealer immediately.

1.2 Product nameplate

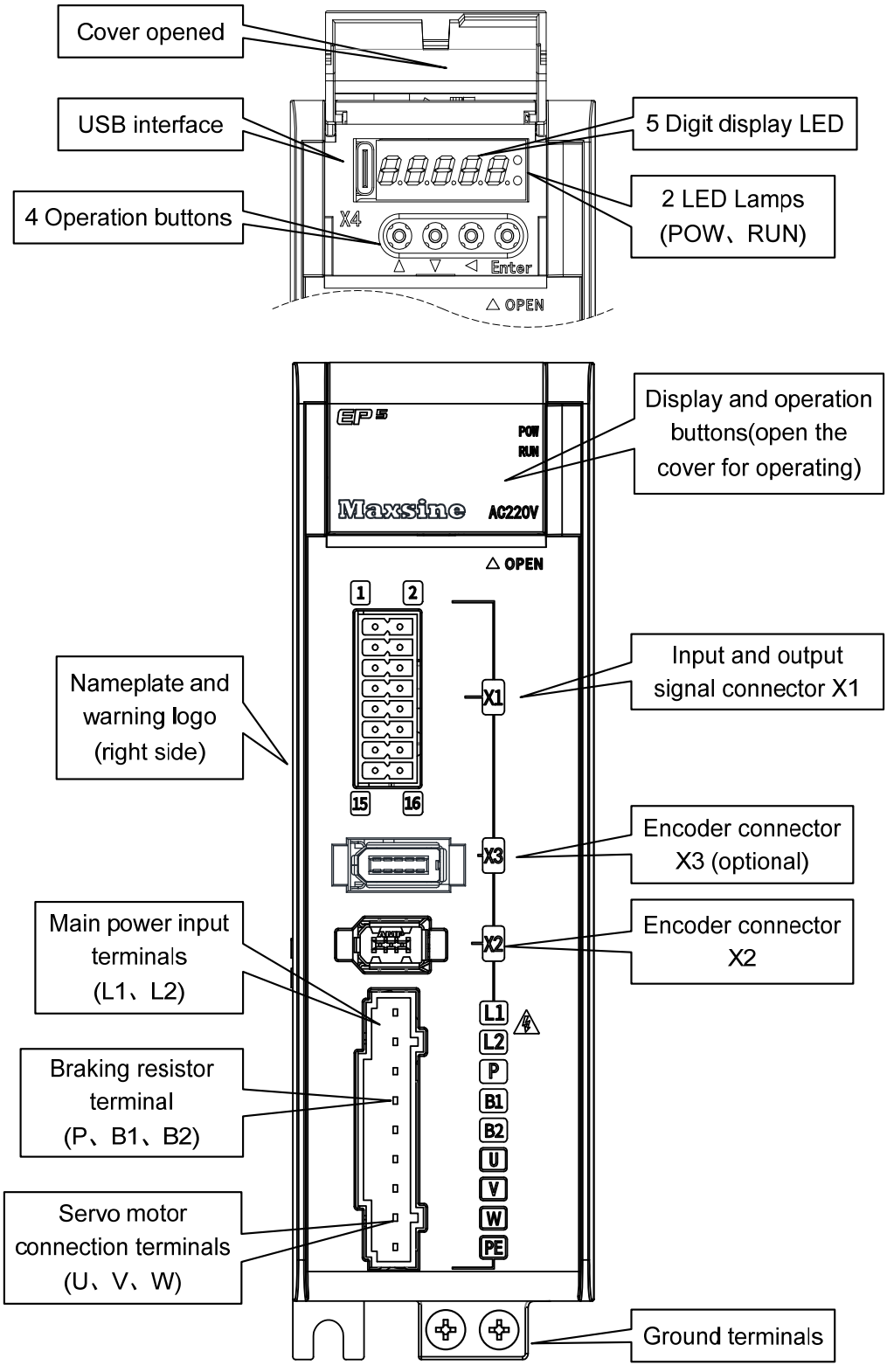


1.3 Product front panel

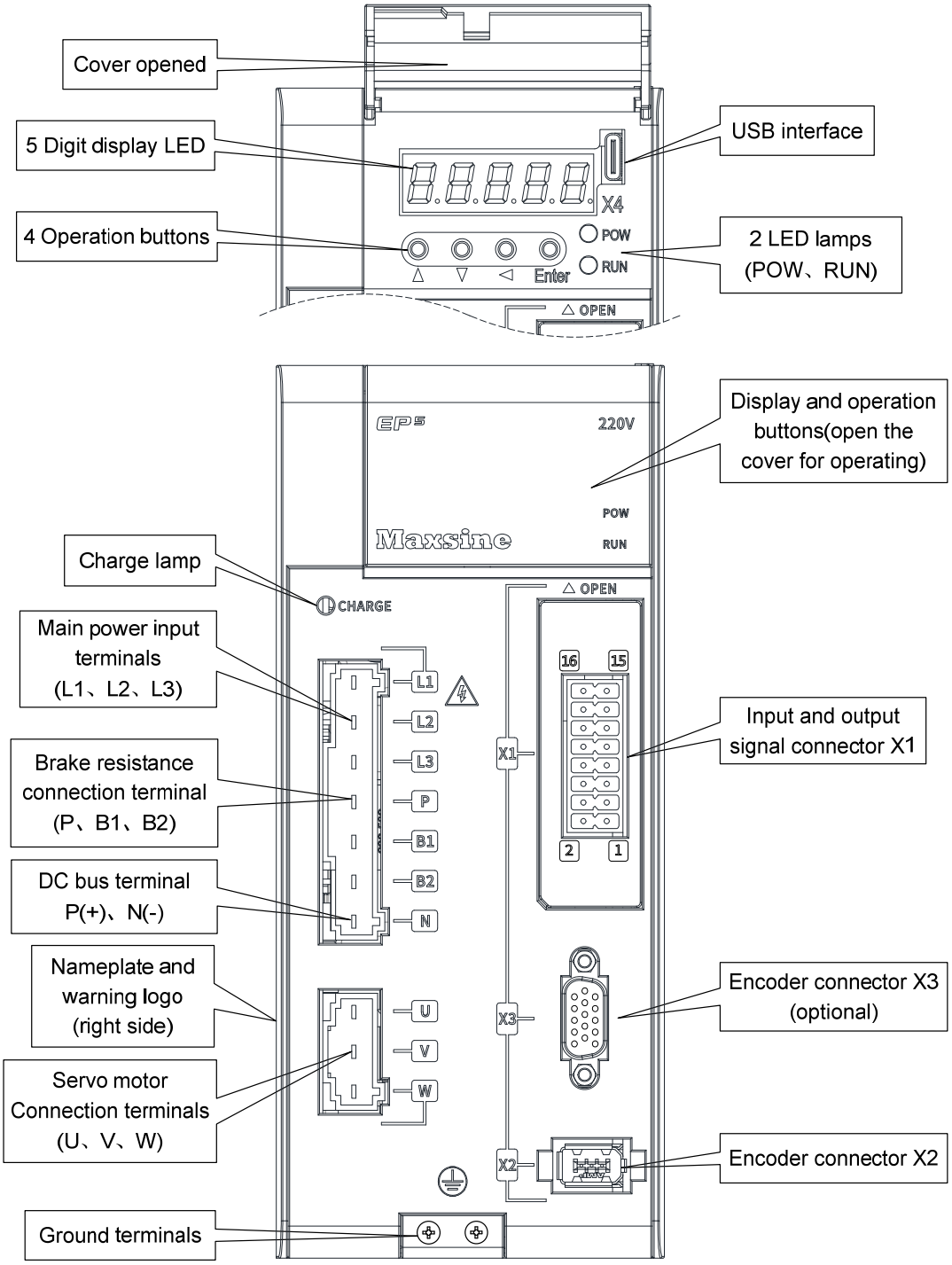
Applicable models: TL04、TL08



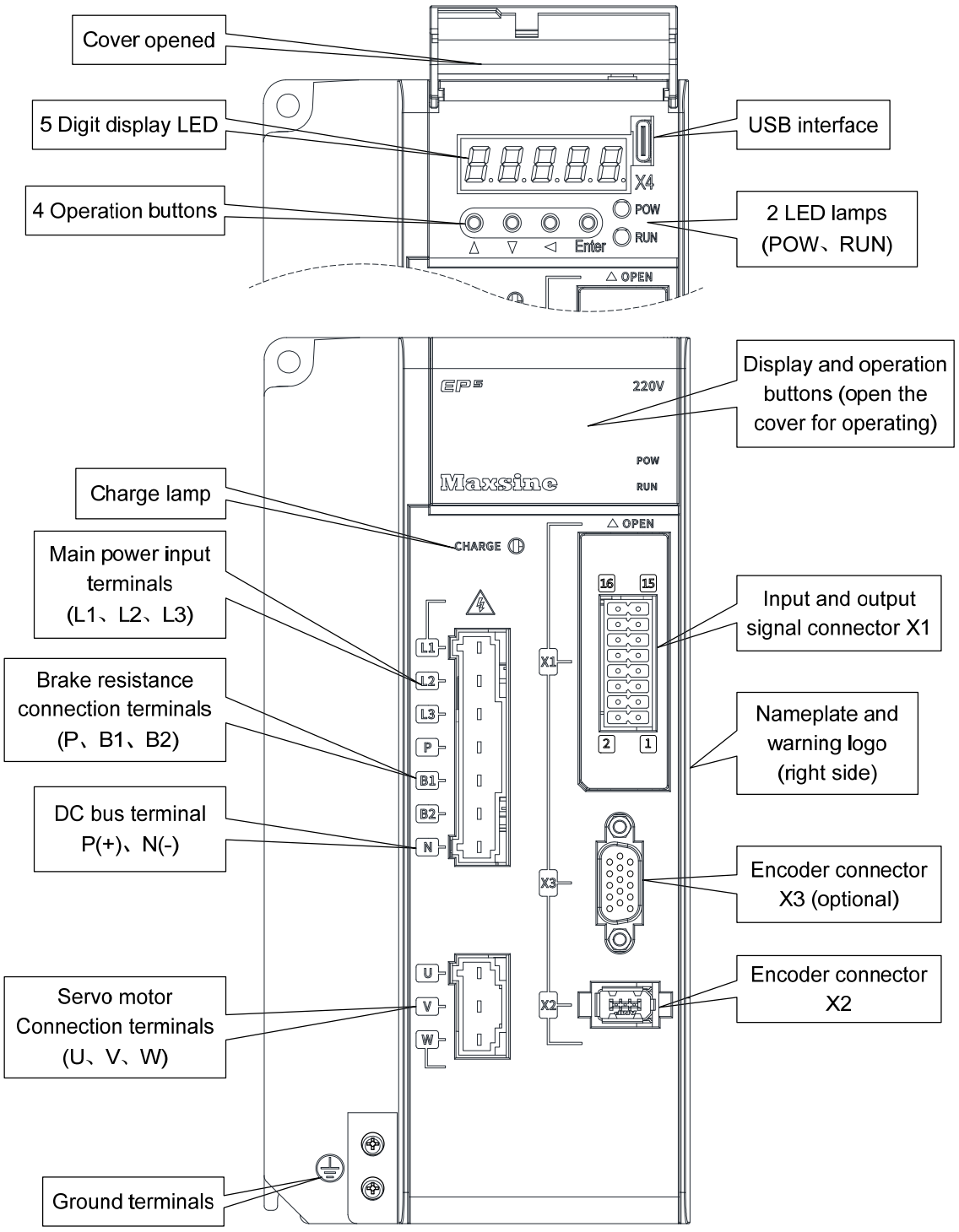
Applicable model: TL10



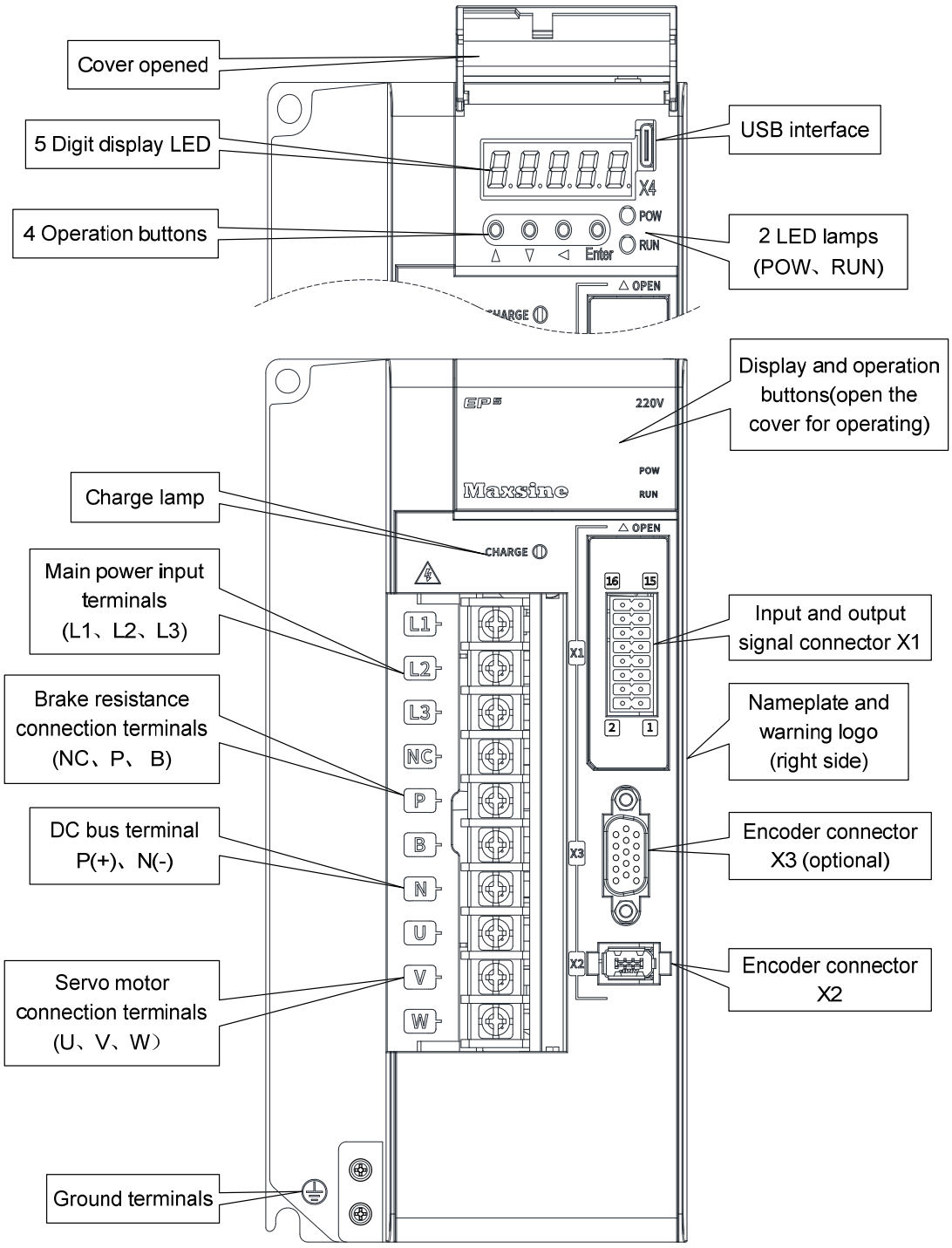
Applicable model: TL15



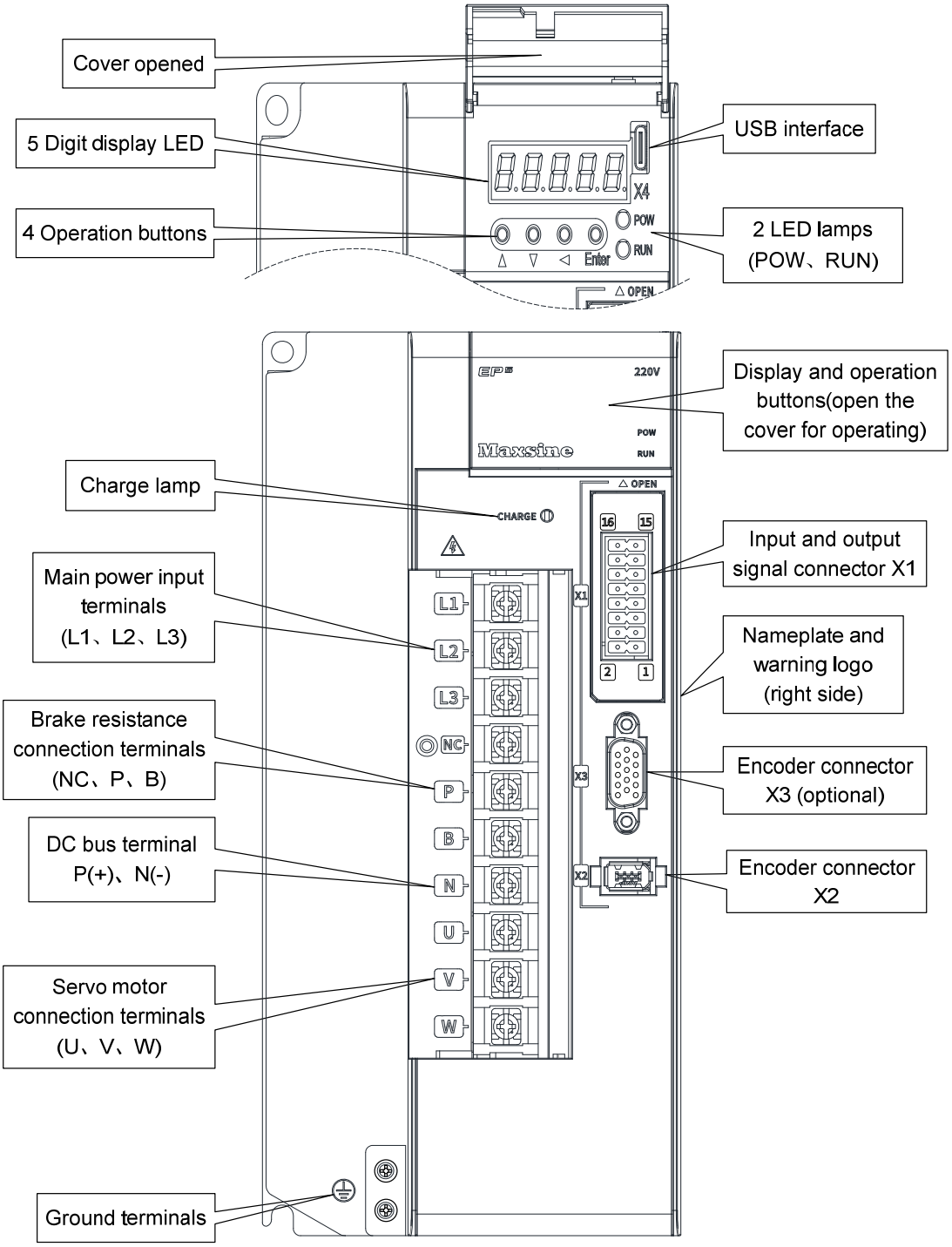
Applicable model: TL25



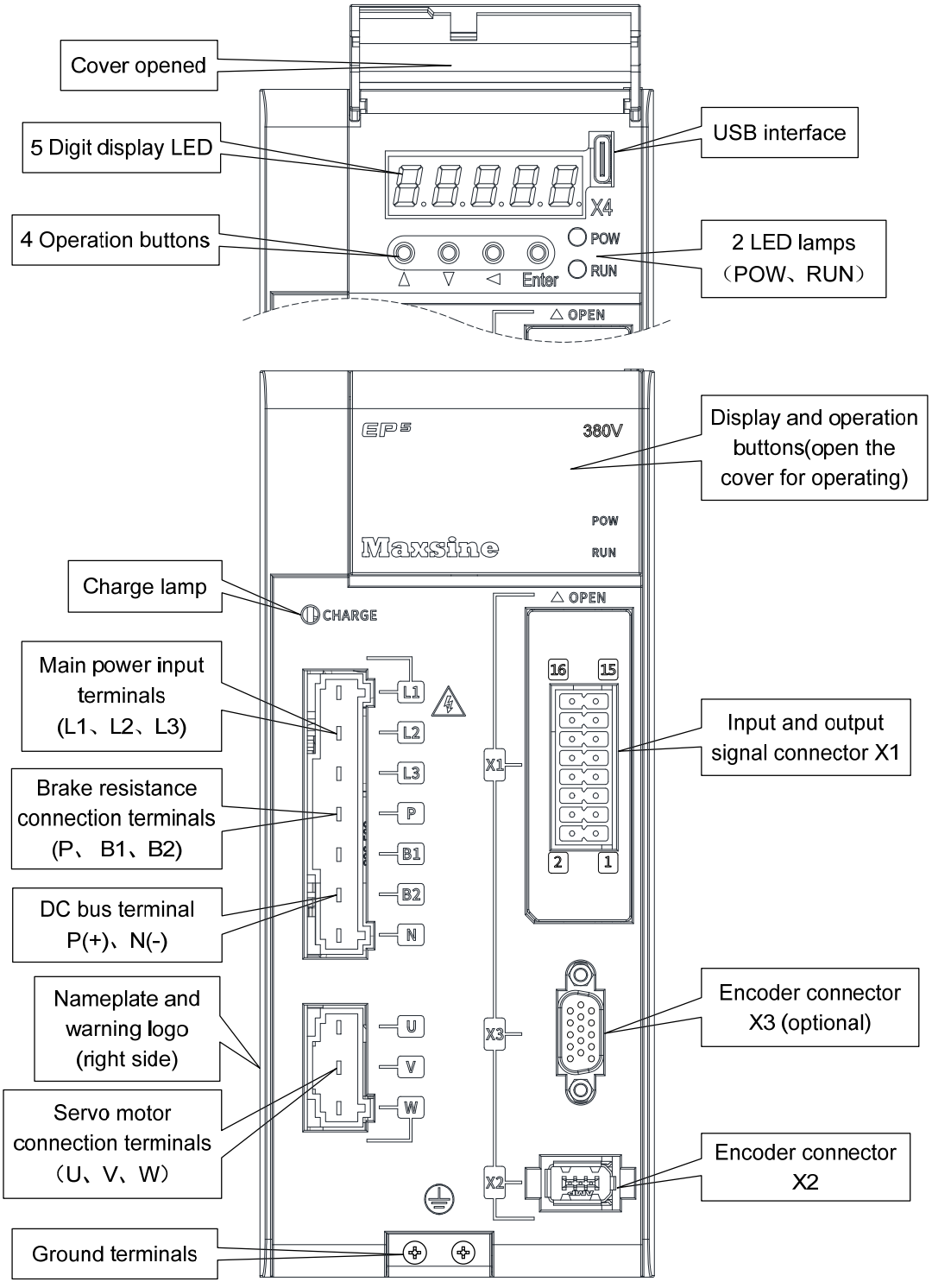
Applicable model: TL35



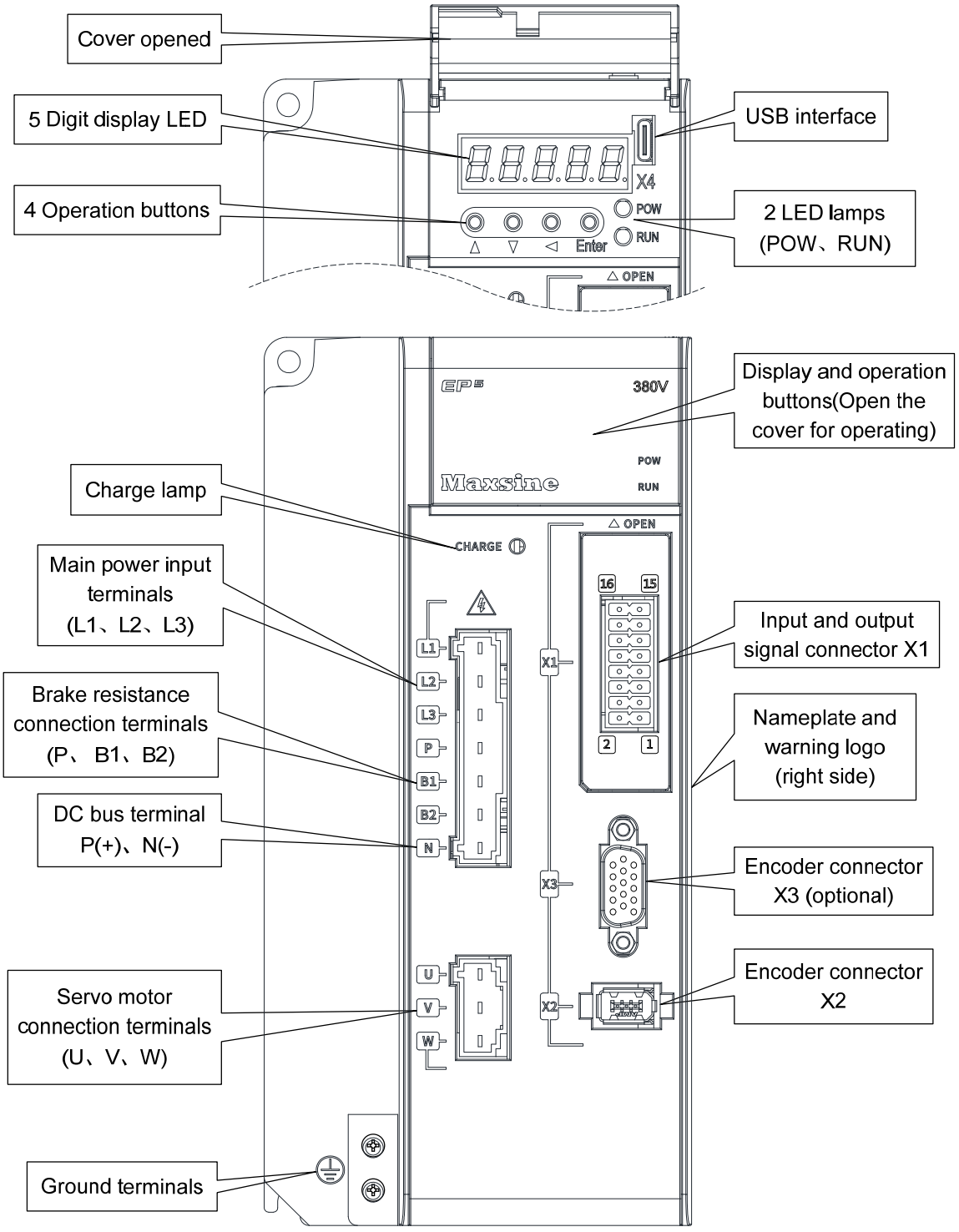
Applicable model: TL55



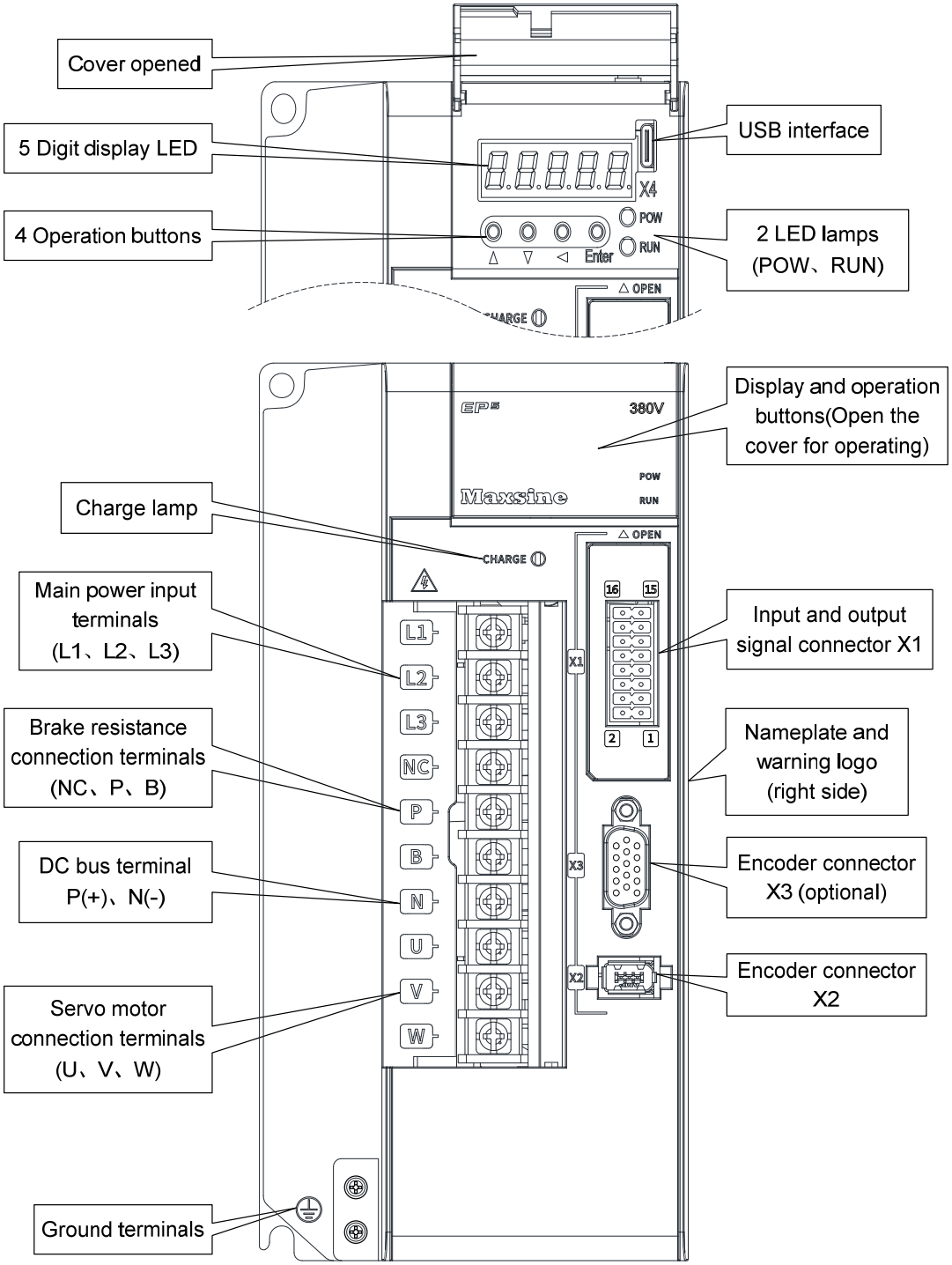
Applicable model: TH15



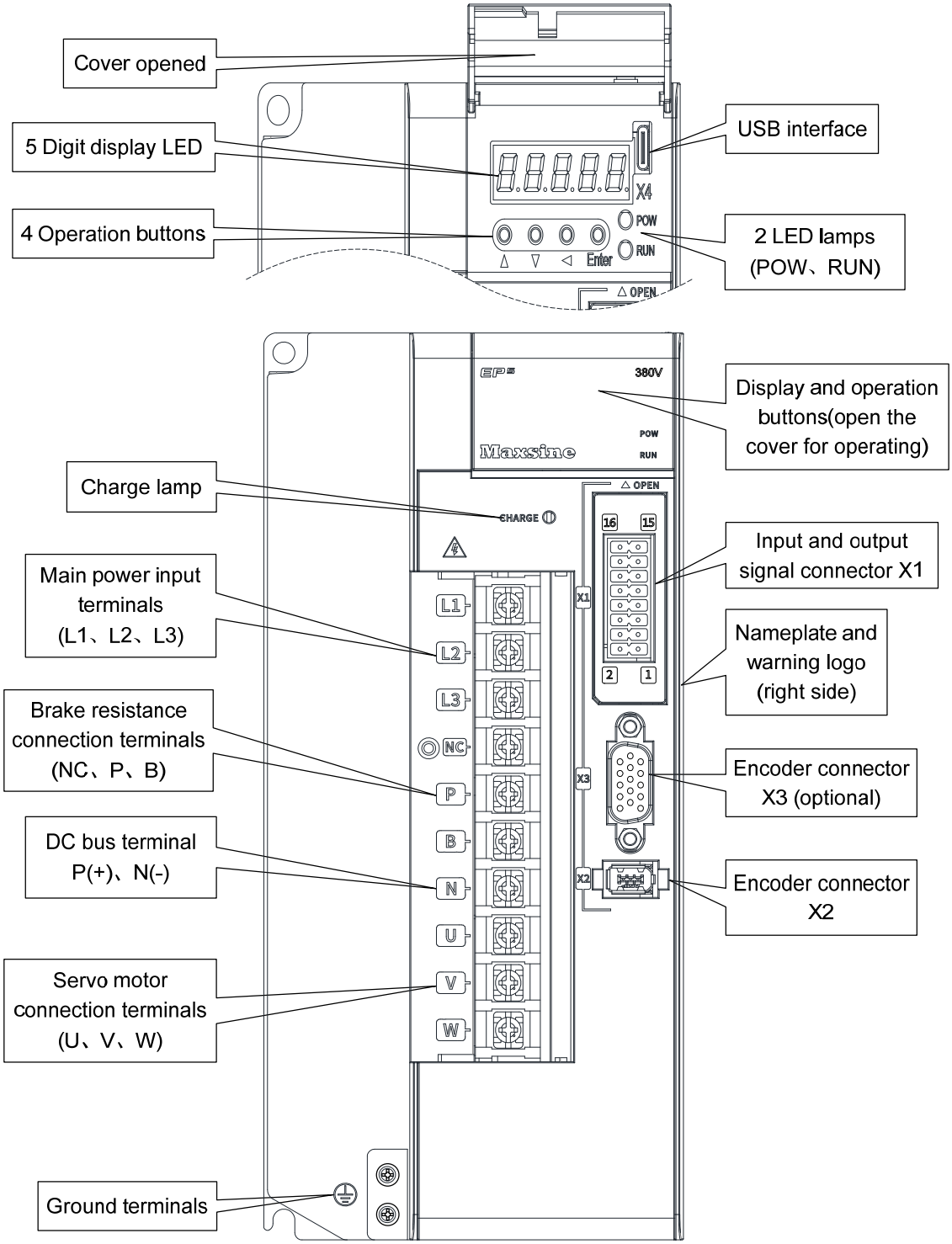
Applicable model: TH20



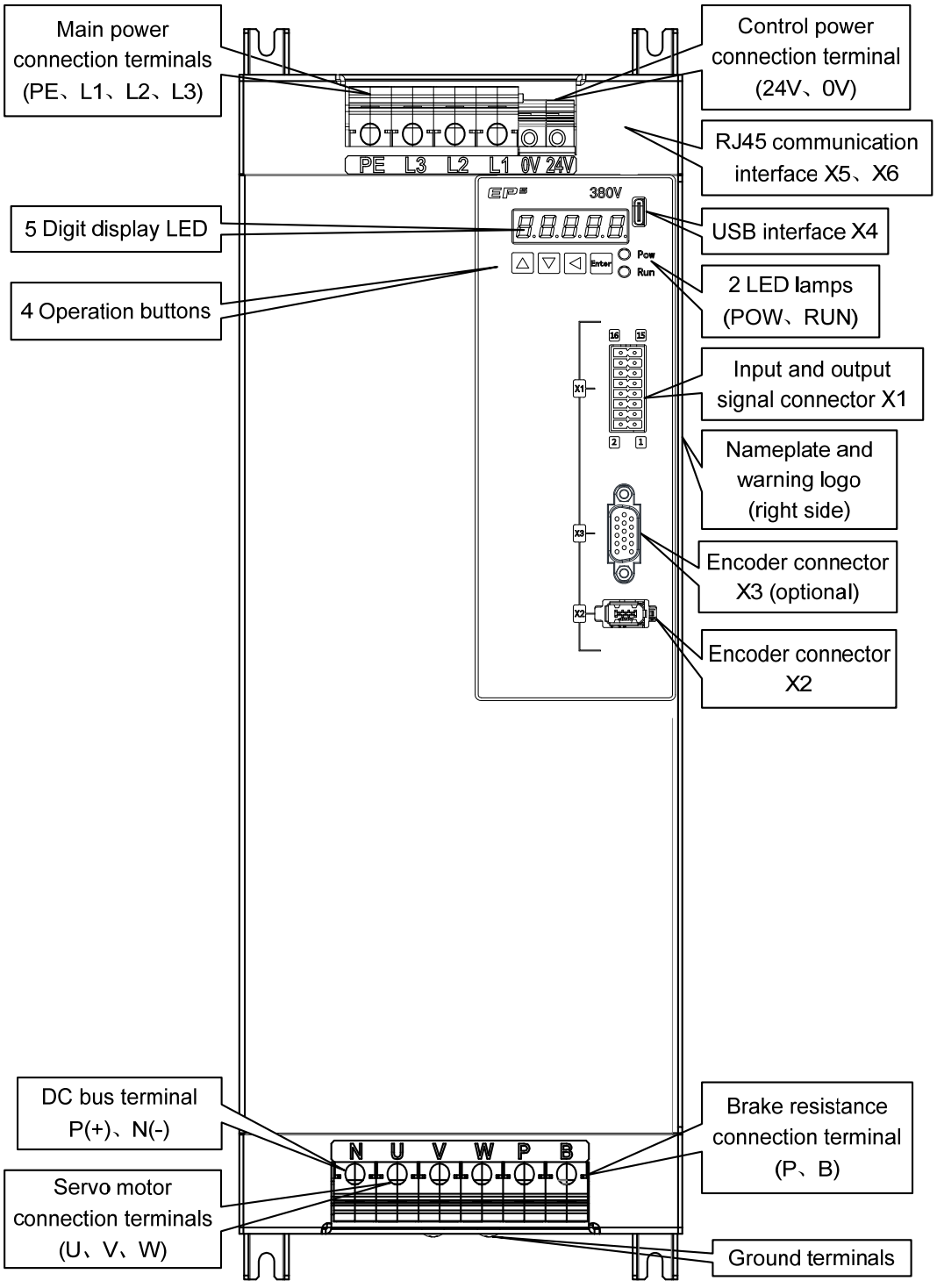
Applicable model: TH30



Applicable models: TH50、TH75



Applicable model: TH90、TH110、TH150



1.4 Servo driver installation

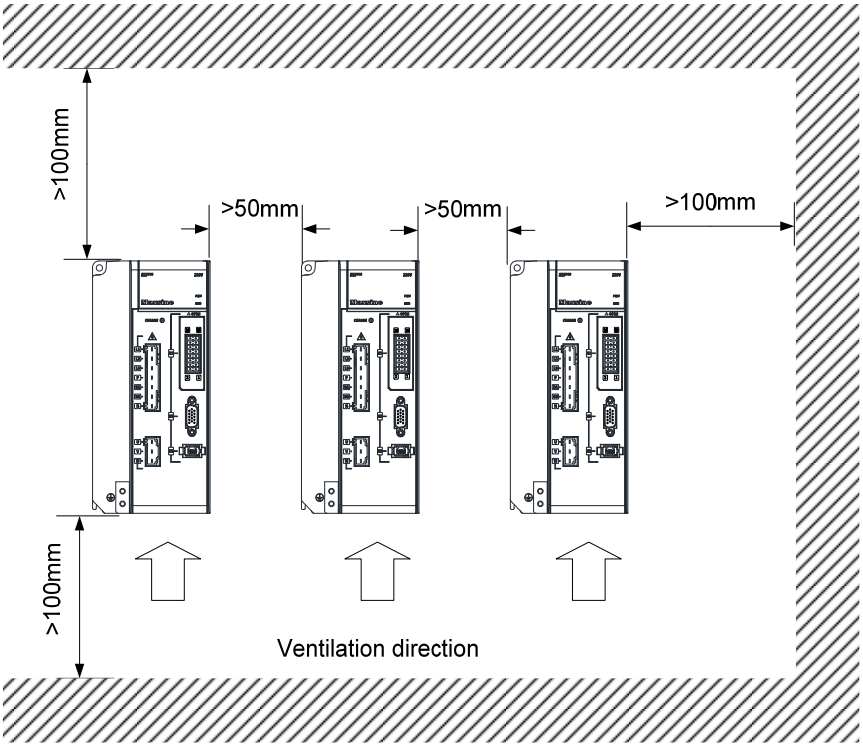
1.4.1 Installation environmental conditions

Since the environment conditions for servo driver installation have the direct influence to the normal function and service life of the servo driver, therefore the environment conditions must be conformed to the following conditions:

- Ambient temperature: 0～40℃; Ambient humidity: below 40%～80% (no dew).
- Storage temperature: -40～50℃; Storage humidity: below 93% (no dew).
- Vibration: below 0.5G.
- Prevent rain dripping or humid environment.
- Avoid direct sunlight.
- Prevent oil mist and salt erosion.
- Prevent corrosive liquid and gas erosion.
- Prevent dust, cotton wadding and metal debris from invading.
- Keep away from radioactive substances and combustibles.
- When several drivers are installed in the control cabinet, please note that enough space should be reserved for placement to facilitate air flow and heat dissipation. Please additionally configure a cooling fan to reduce the temperature around the servo driver. The long-term safe working temperature is below 40℃.
- When there is a vibration source nearby (such as a punch press), if it is unavoidable, please use a vibration absorber or install anti vibration rubber gaskets.
- When there is interference equipment nearby, there is interference to the power line and control line of the servo driver, which may cause the driver to malfunction. Noise filter and other anti-interference measures can be added to ensure the normal operation of the driver. However, the noise filter will increase the leakage current, so it is necessary to install an isolation transformer on the power input end of the driver.

1.4.2 Installation method

- The normal installation direction of servo driver is vertical and upright, with the top facing up to facilitate heat dissipation.
- During installation, tighten the M5 fixing screws at the rear of the servo driver.
- The installation intervals between servo drivers and other equipment are shown in the figure. In order to ensure the service performance and service life of the driver, please leave sufficient installation intervals as far as possible.
- A cooling fan must be installed in the electrical control cabinet to ensure that the vertical wind dissipates heat to the radiator of the servo driver.
- When installing the electrical control cabinet, prevent dust or iron filings from entering the servo driver.



1.5 Servo motor installation

1.5.1 Installation environmental conditions

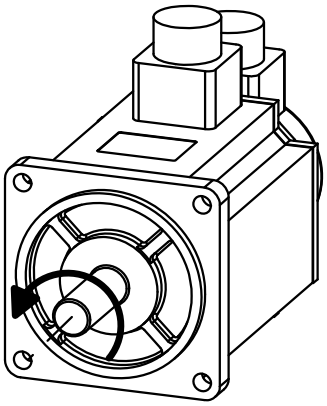
- Ambient temperature: 0～40℃; Ambient humidity: below 80 %(no dew).
- Storage temperature: -40～50℃; Storage humidity: below 80 %(no dew).
- Vibration: below 0.5G.
- Places with good ventilation and less moisture and dust.
- No corrosive, igniting gas, oil and gas, cutting fluid, cutting powder, iron powder and other environments.
- Places without water vapor and direct sunlight.

1.5.2 Installation method

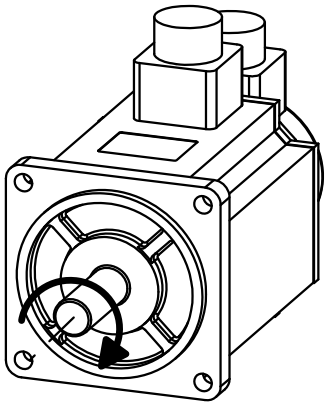
- Horizontal installation: to prevent water, oil and other liquids from flowing into the motor from the outlet end of the motor, please place the cable outlet below.
- Vertical installation: if the motor shaft is installed upward and the reducer is attached, pay attention to and prevent oil stains in the reducer from penetrating into the motor through the motor shaft.
- The extension of the motor shaft should be sufficient. If the extension is insufficient, it will easily cause vibration when the motor moves.
- When installing and disassembling the motor, do not knock the motor with a hammer, otherwise it is easy to cause damage to the motor shaft and encoder.

1.6 Motor rotation direction definition

The definition of rotation direction of the motor described in this manual: facing the motor shaft extension, counterclockwise rotation of the rotating shaft (CCW) is positive rotation, and clockwise rotation of the rotating shaft (CW) is reverse rotation.



Positive Rotation
(CCW)



Reversal Rotation
(CW)

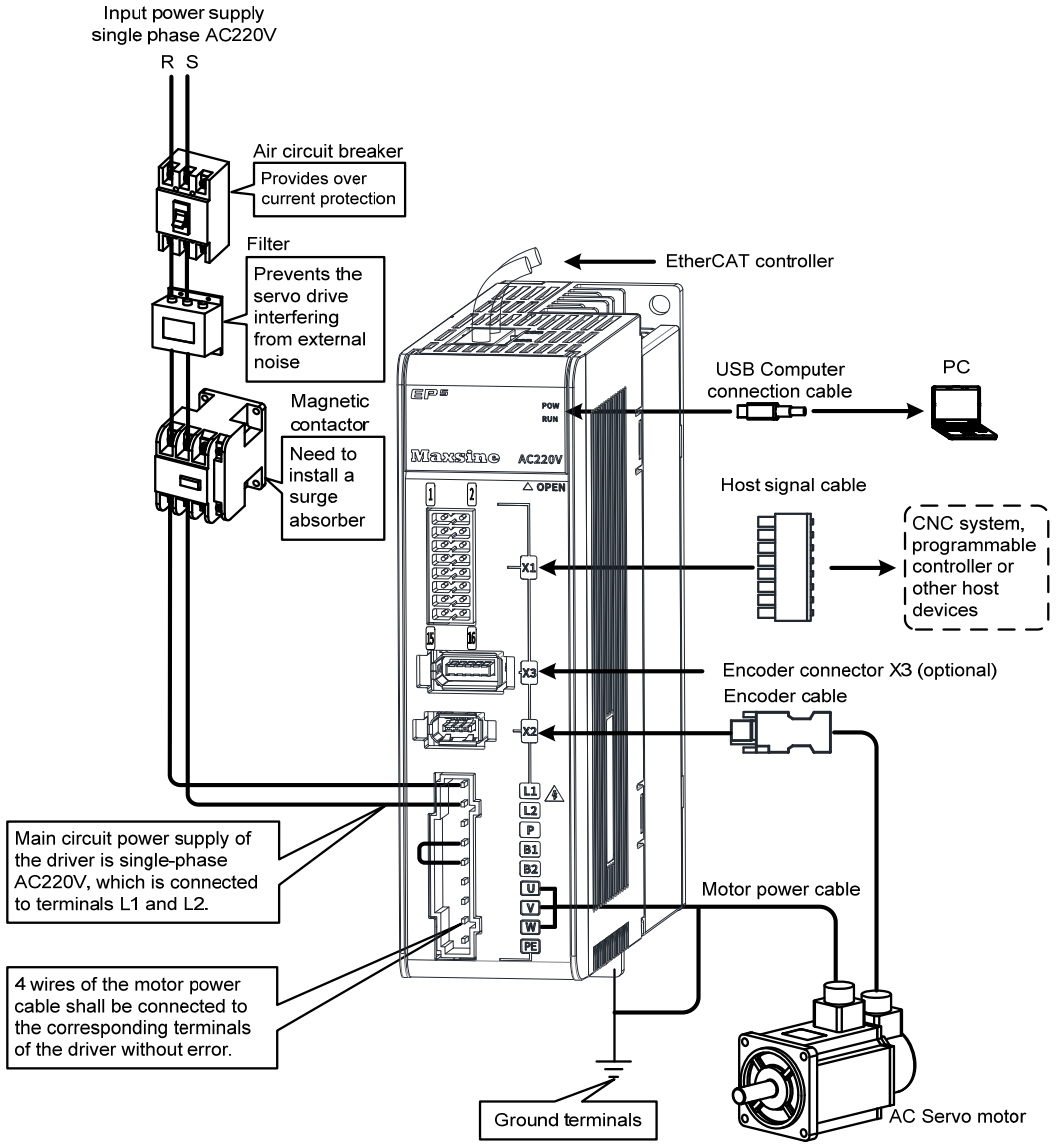
Chapter 2 Wiring

2.1 System construction and wiring

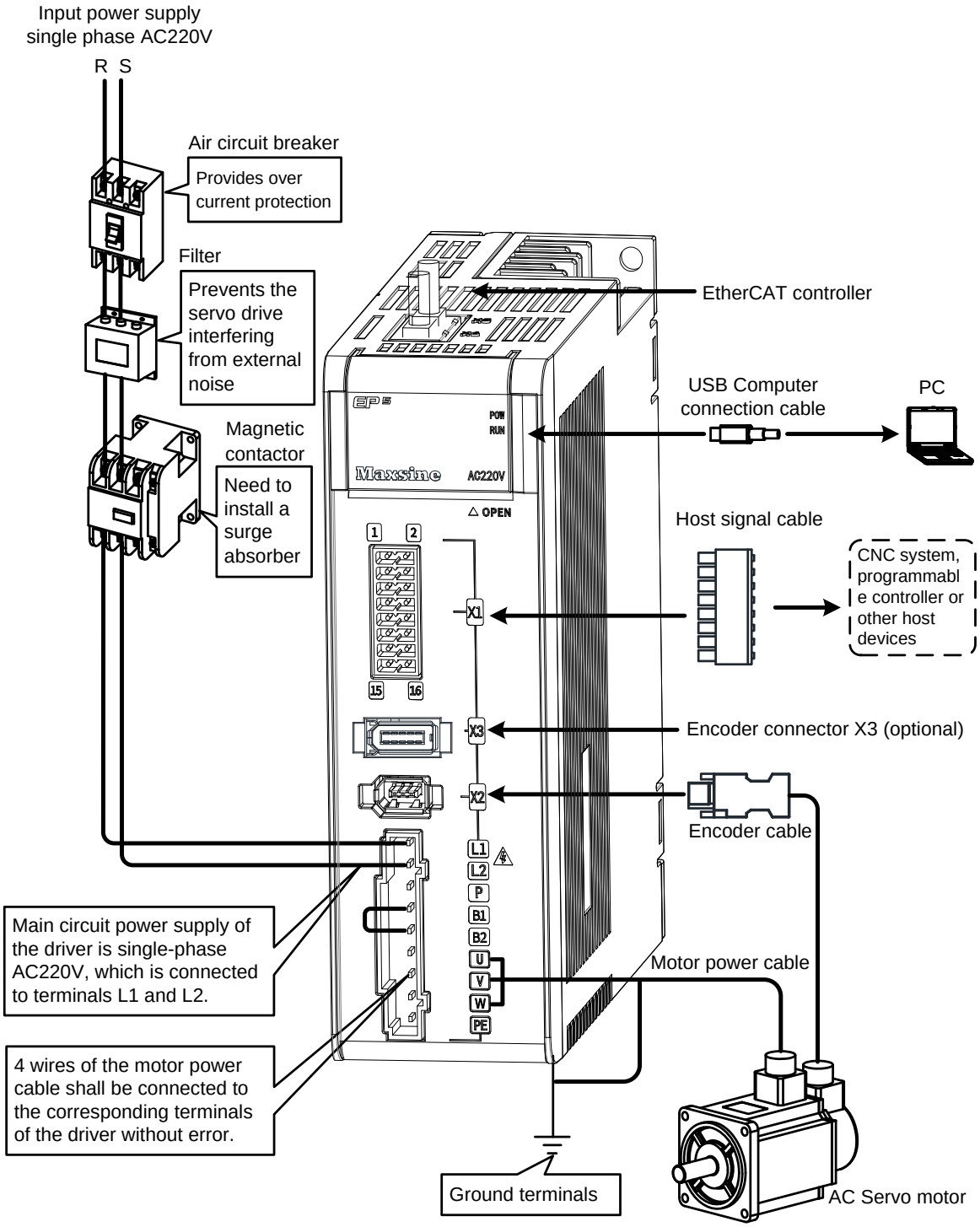
2.1.1 Servo driver wiring diagram

1. EP5-TL series servo driver wiring diagram

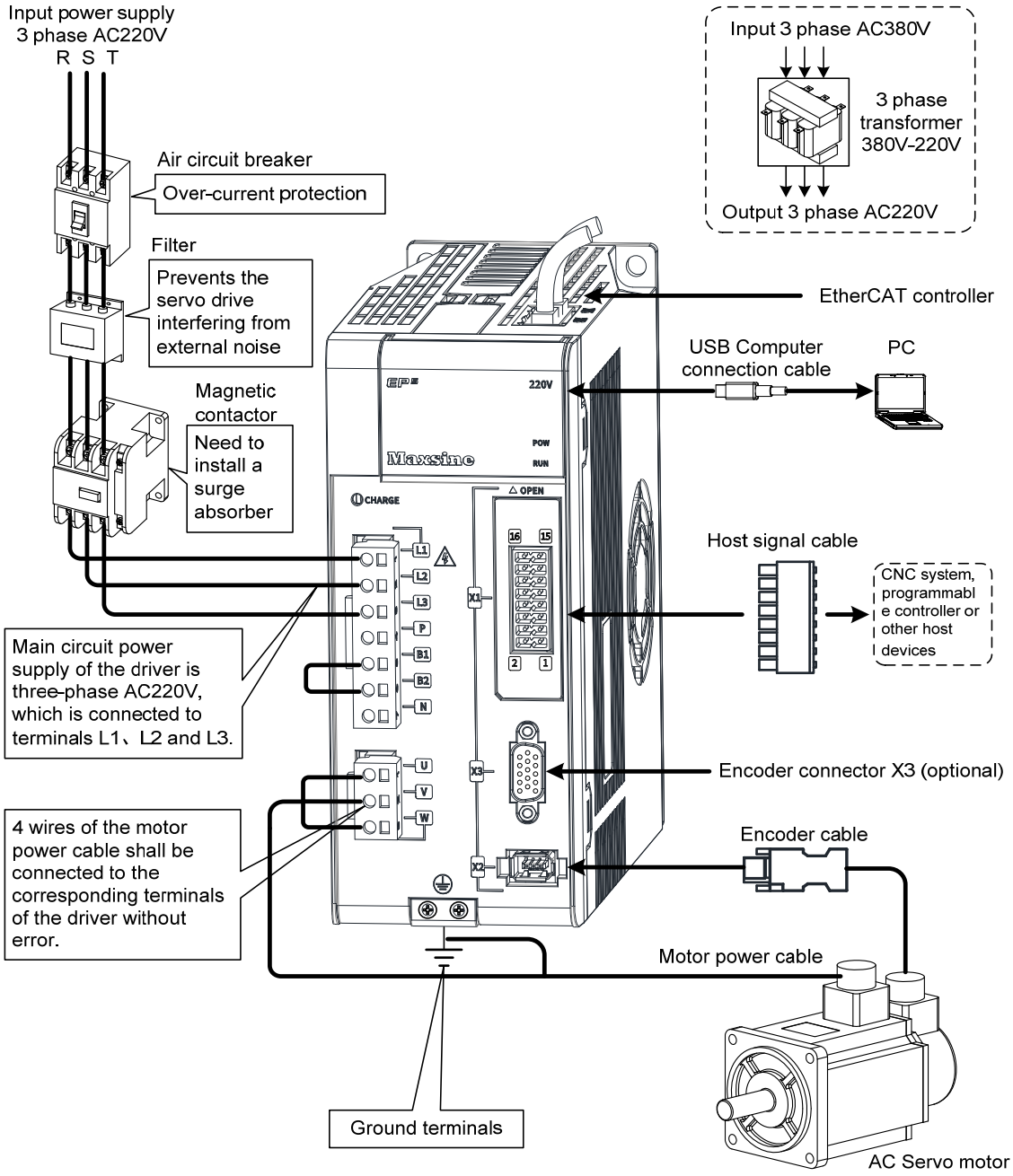
Applicable models: TL04、TL08



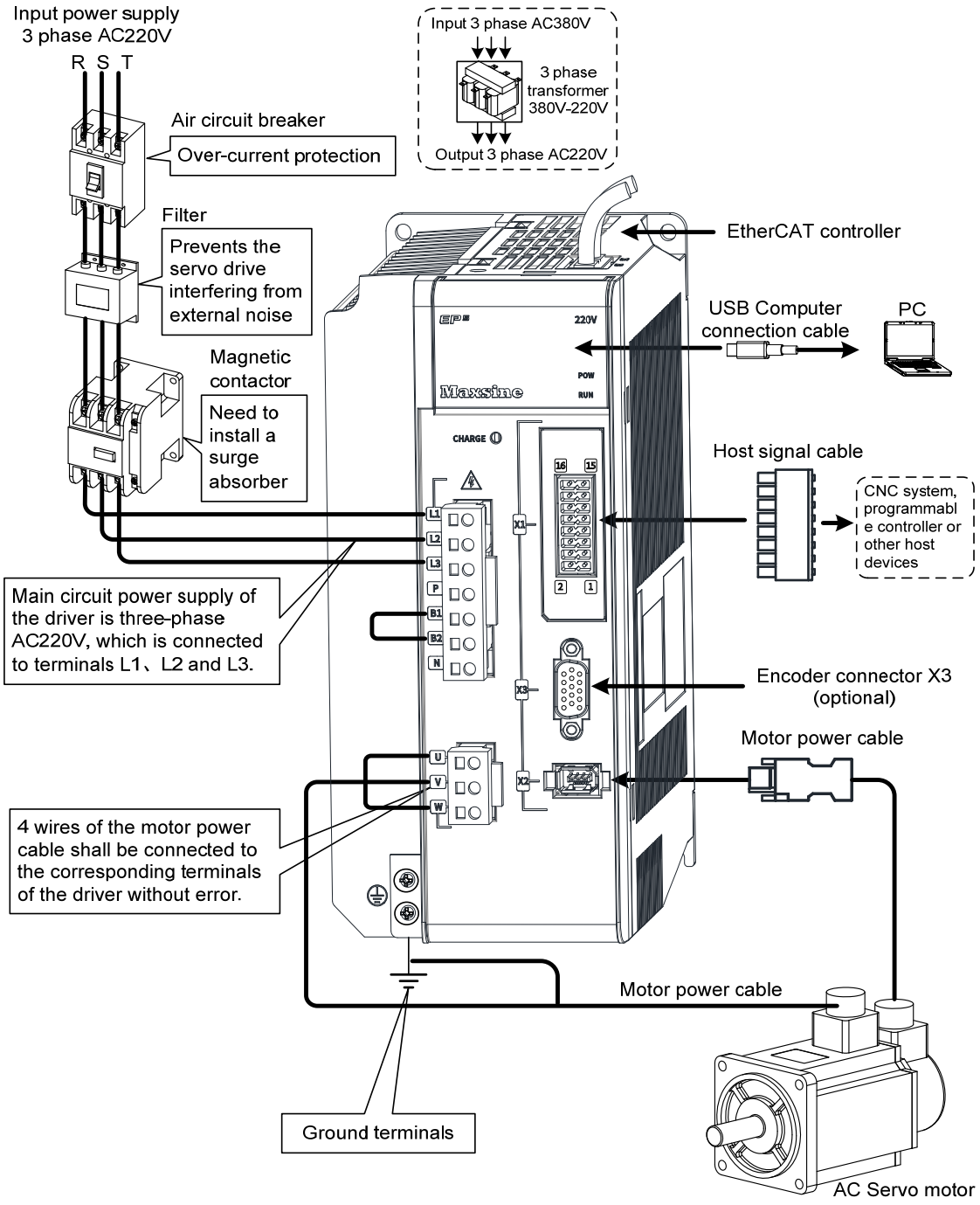
Applicable model: TL10



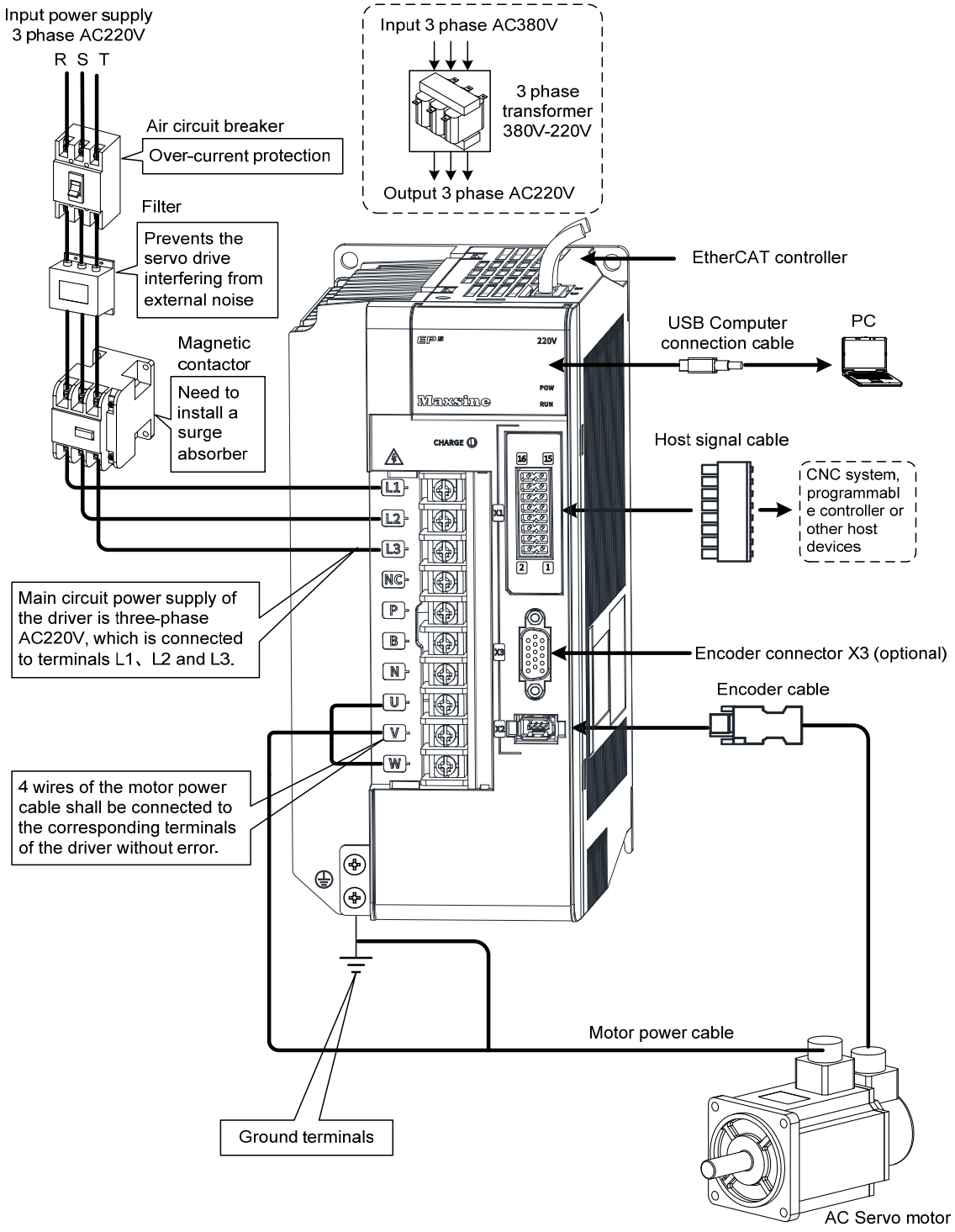
Applicable model: TL15



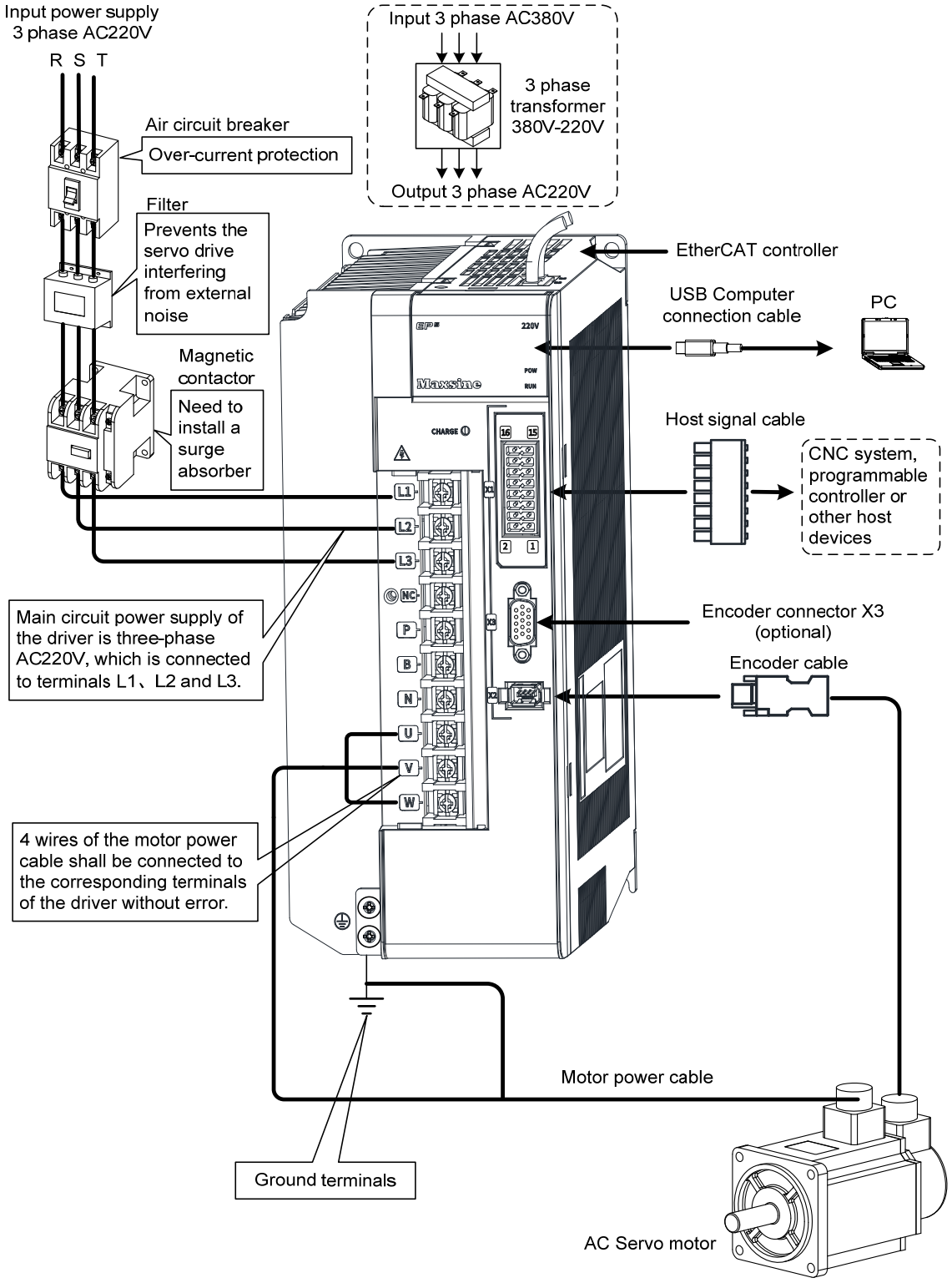
Applicable model: TL25



Applicable model: TL35

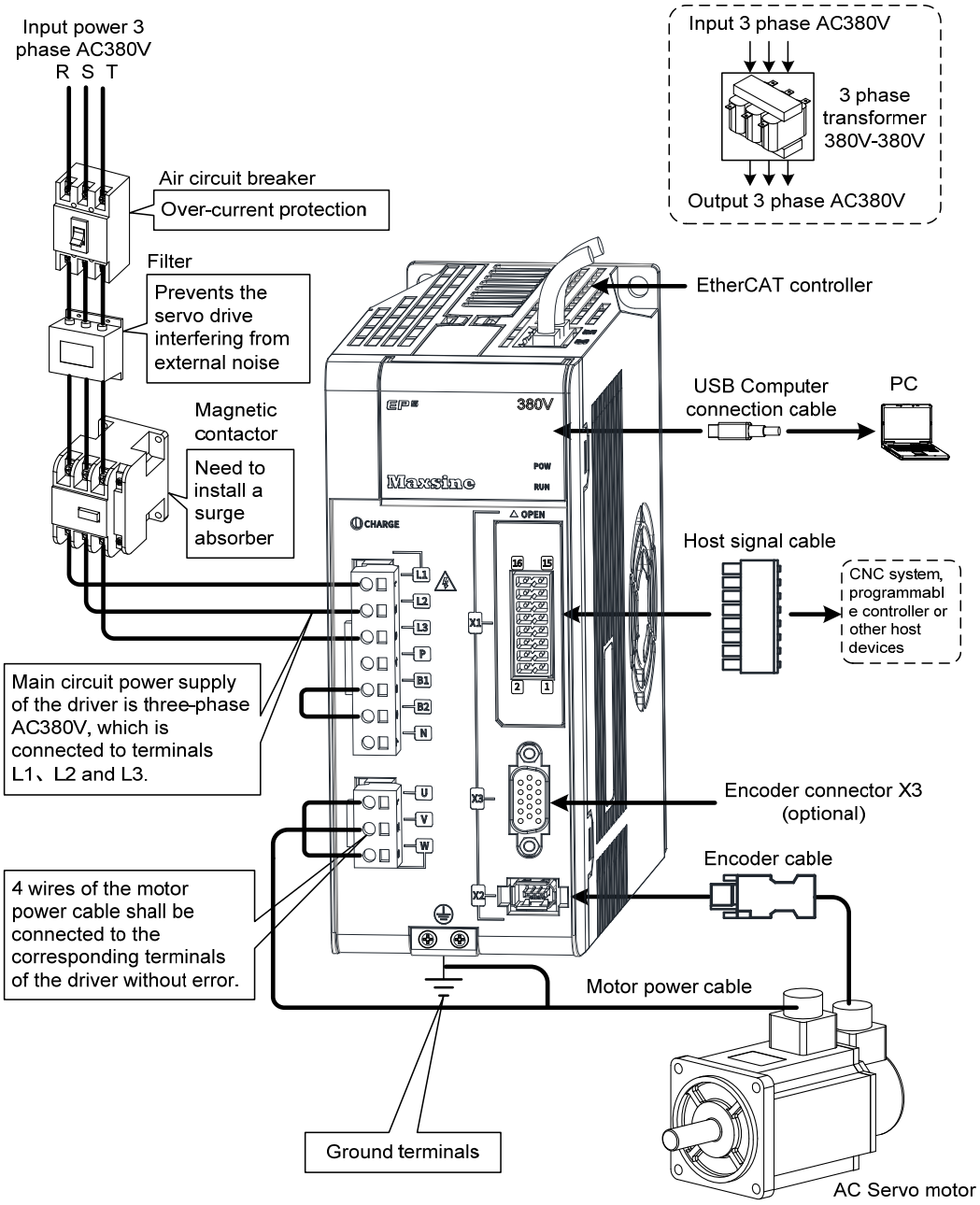


Applicable model: TL55

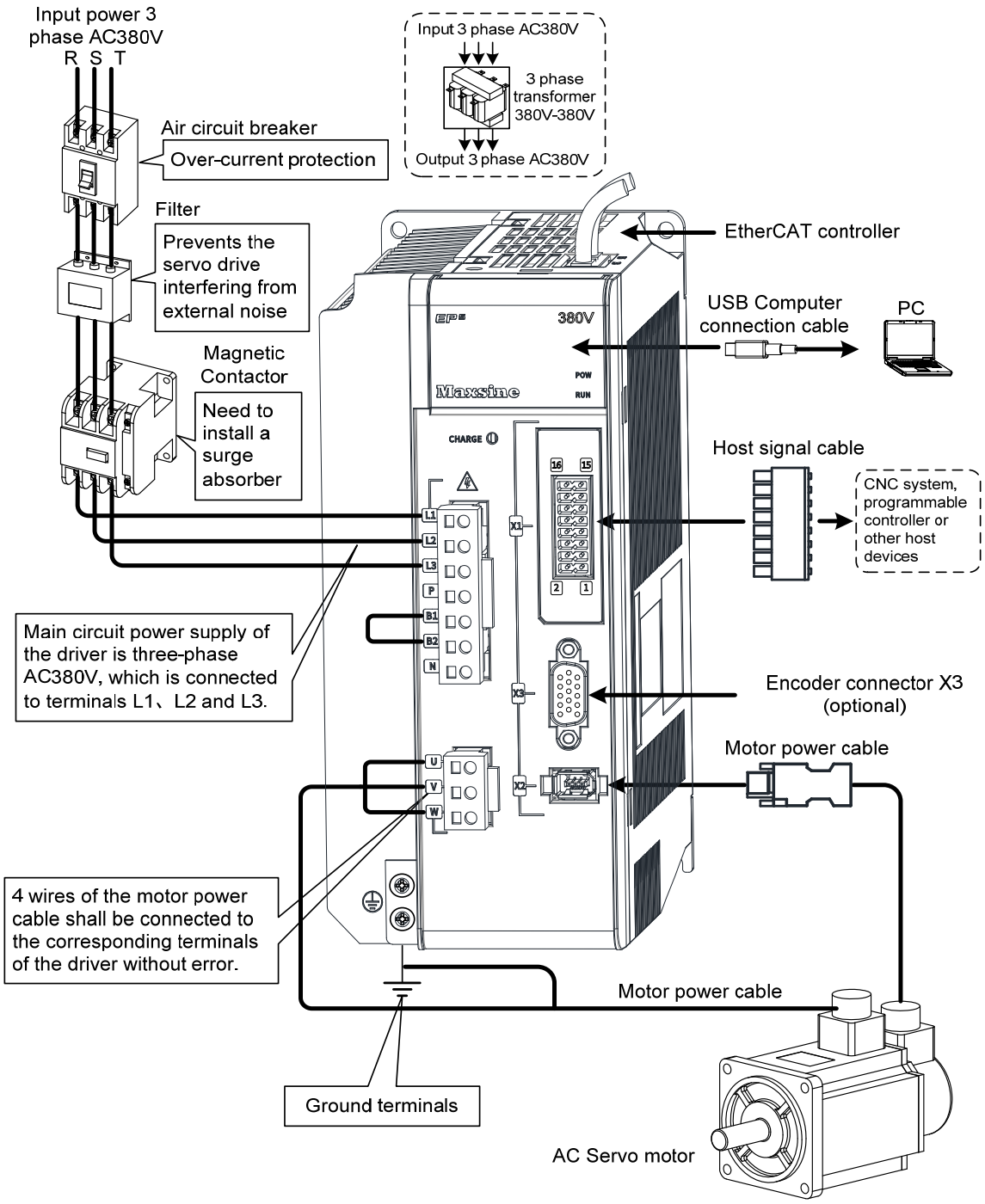


2. EP5-TH series servo driver wiring diagram

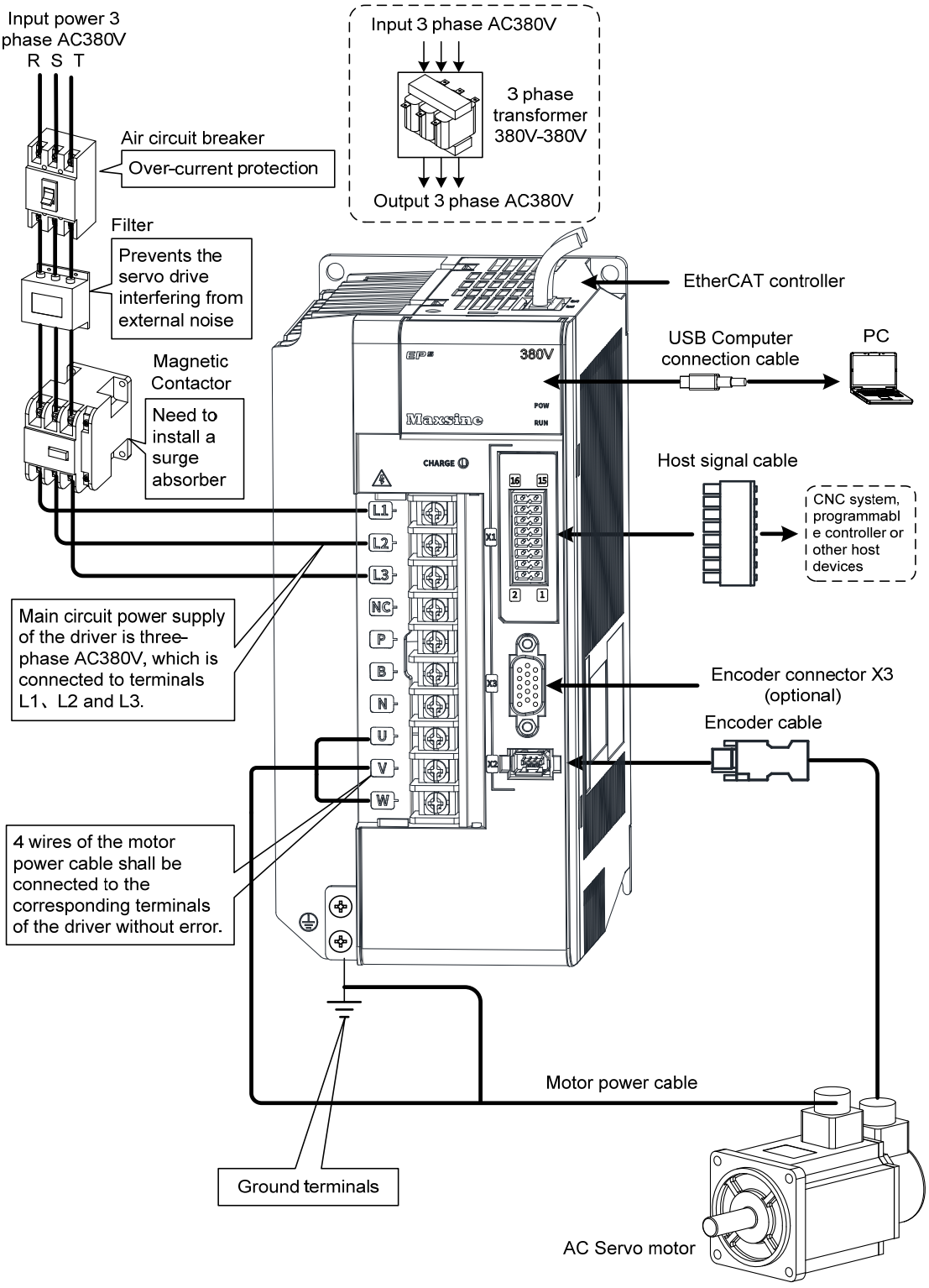
Applicable model: TH15



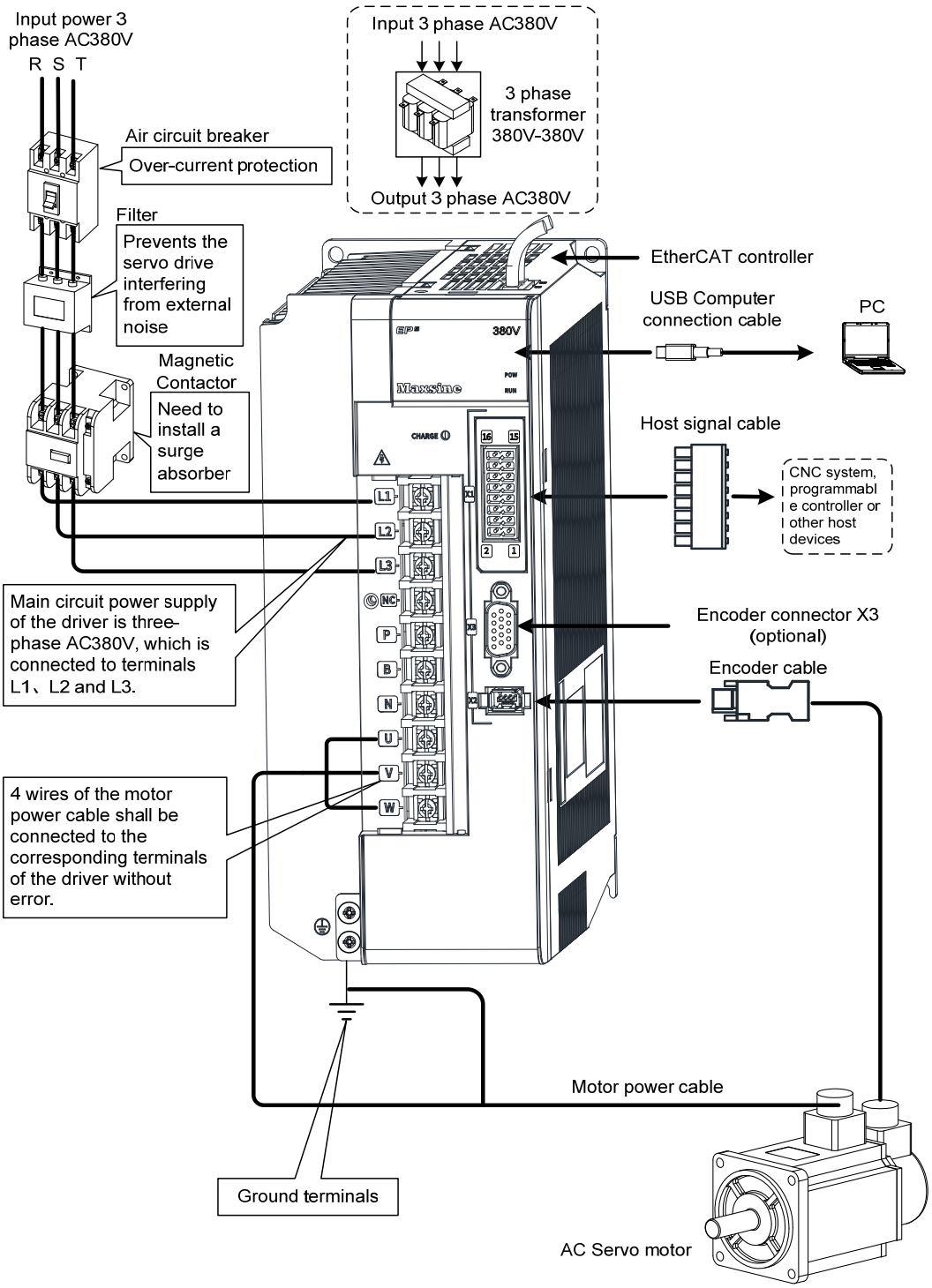
Applicable model: TH20



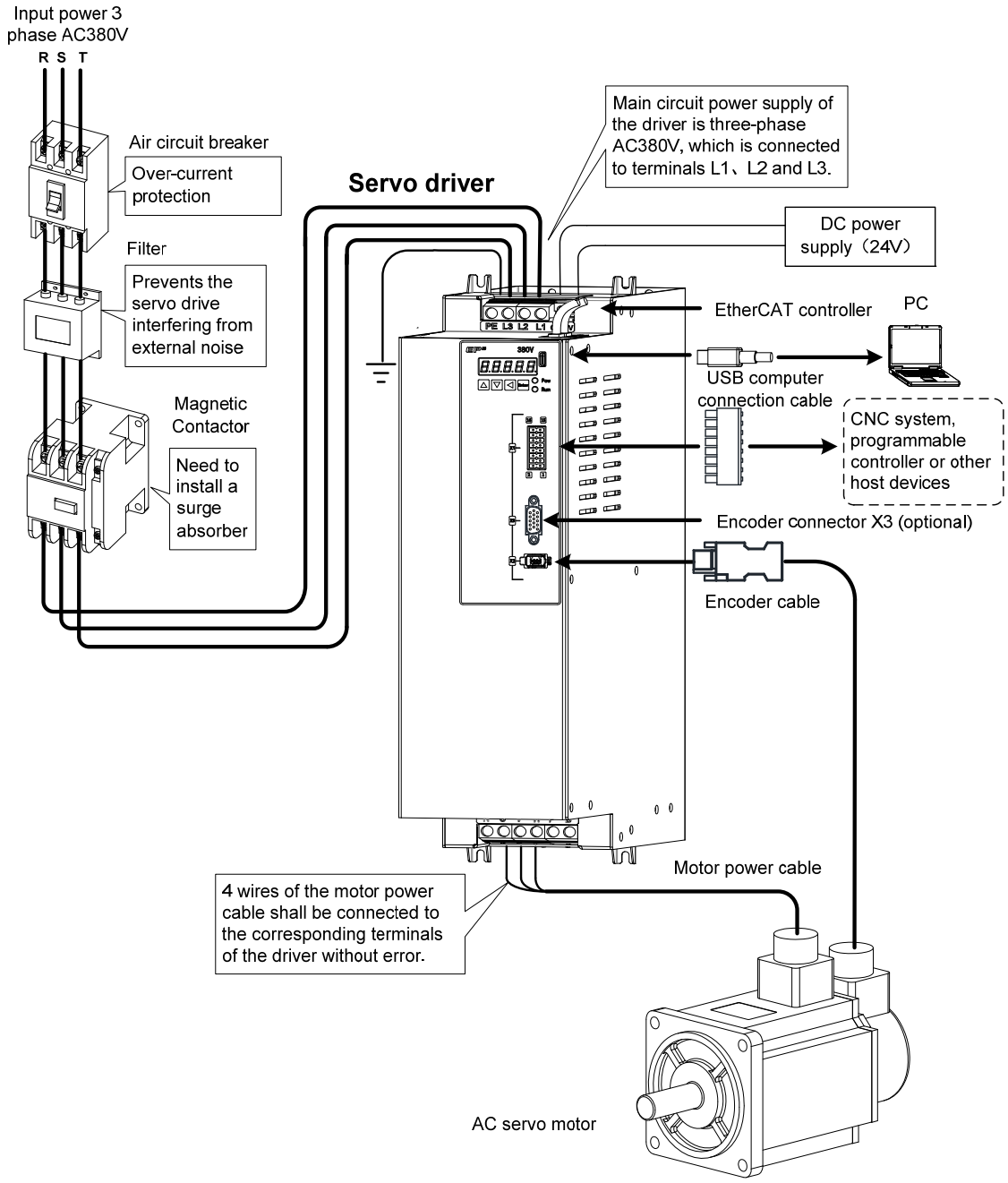
Applicable model: TH30



Applicable models: TH50、TH75



Applicable models: TH90、TH110、TH150



2.1.2 Wiring instruction

Wiring notice:

- Please use according to the wire specifications.
- Cable length, command cable within 3m, encoder cable within 20m.
- Check whether the power supply and wiring of L1, L2 and L3 are correct. Do not connect the low-voltage servo driver (TL series) to the 380V power supply.
- The output terminals(U、V、W) must be connected with the servo motor connections(U、V、W) correspondently, otherwise the servo motor will stop or over speed. However, by exchanging three-phase terminal cannot cause the motor to reverse; this point is different from an asynchronous motor.
- It must be reliably grounded and single point grounded.
- To control the output of the relay coil, a protective diode needs to be installed, and the direction of the diode should be connected correctly, otherwise it may cause a malfunction and prevent the output of the signal.
- In order to prevent wrong action caused by electromagnetic noise, please add isolation transformer, noise filter and other devices to the power supply.
- Please wire the power line (power supply line, main circuit lines, etc.) more than 30cm away from the signal line, and do not place it in the same wiring pipe.
- Please install non fusible circuit breaker to cut off external power supply in time when the driver fails.

2.1.3 Electric wire specification

Connect terminal	Symbol	Wire specification	
Main power supply	L1、L2、L3	400W～1.5kW	0.75～1.5mm^2
		1.5kW～3.5kW	1.5～2.5mm^2
		3.5kW～5.5kW	2.5～4mm^2
		5.5kW～7.5kW	4～6mm^2
		7.5kW～11kW	6～10mm^2
		11kW～15kW	10mm^2
Motor connection terminal	U、V、W	400W～1.5kW	0.75～1.5mm^2
		1.5kW～3.5kW	1.5～2.5mm^2
		3.5kW～5.5kW	2.5～4mm^2
		5.5kW～7.5kW	4～6mm2
		7.5kW～11kW	6～10mm^2
		11kW～15kW	10mm^2
Ground terminal	⏚	1.5～4mm^2	
Control signals	X1	≥0.14mm^2(AWG26), shielded	
Encoder signals	X2	≥0.14mm^2(AWG26), shielded	
USB communication	X4	≥0.14mm^2(AWG26)	
RJ45 communication	X5、X6	Class 5 (CAT 5) or above shielded network cables	
Brake resistor terminal	P、B、B1、B2	1.5～4mm^2	

Encoder cables must use shielded twisted pair cables. If the encoder cable is too long (>20m), it will cause insufficient power supply to the encoder. The power and ground wires can be connected using multiple wires or thick wires.

2.1.4 Main circuit terminal explanation

Name	Terminal symbol	model	Detailed instructions
Main power supply	L1 L2	TL04、TL08、TL10	Connect external AC power supply: single-phase 220VAC - 15%～+ 10% 50/60 Hz
	L1 L2 L3	TL15、TL25、TL35、TL55	Connect external AC power supply: three-phase 220VAC -15%～+10% 50/60Hz
	L1 L2 L3	TH series	Connect external AC power supply: three-phase 380VAC - 15%～+ 10% 50/60 Hz
Brake resistor terminal	P B1 B2	TL04、TL08、TL10、TL15、TL25、TH15、TH20	When external brake resistance is needed, disconnect B1、B2[Note 2], and the external brake resistance is connected to the P and B1 ends to make B2 suspended.
	NC P B	TL35、TL55、TH30、TH50、TH75、TH90、TH110、TH150	When using external braking resistor, must first be open between P and B in braking resistance line, at the same time the two braking resistor inside thread on NC, then the external braking resistor jumper on the P、B.
DC bus terminal	P（+） N（-）	TL15、TL25、TL35、TL55、TH15、TH20、TH30、TH50、TH75、TH90、TH110、TH150	DC bus terminal, used for multiple servo common DC bus.
Motor connection terminal	U	EP5 series	Output to motor U phase power supply
	V		Output to motor V phase power supply
	W		Output to motor W phase power supply
Ground terminal	⏚	EP5 series	Grounding terminal of motor housing
	⏚		Driver grounding terminal

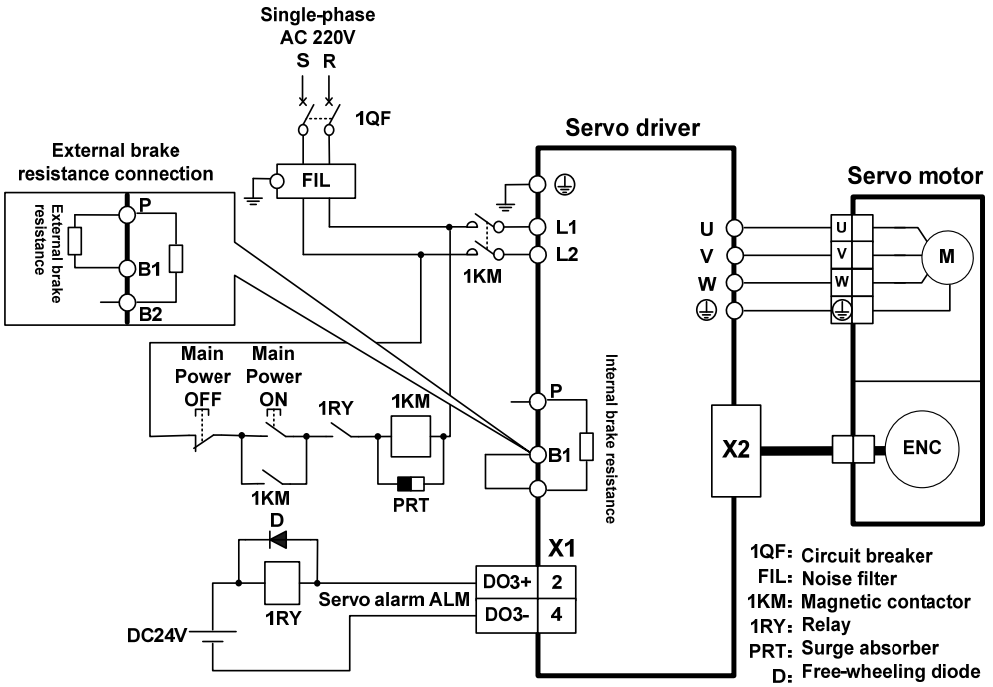
Note 1: TL55、TH50、TH75、TH90、TH110 and TH150 have no internal braking resistance. When TL55、TH50、TH75, TH90、TH110 and TH150 need to be connected with external braking resistance, the external braking resistance should be bridged at the P and B ends.

Note 2: Except for TL55、TH50、TH75、TH90、TH110 and TH150, the manufacturer defaults to the internal braking resistor connection when leaving the factory, and B1 and B2 are in short circuit. It is recommended that TL55、TH50、TH75、TH90、TH110 and TH150 drivers be equipped with dynamic resistors.

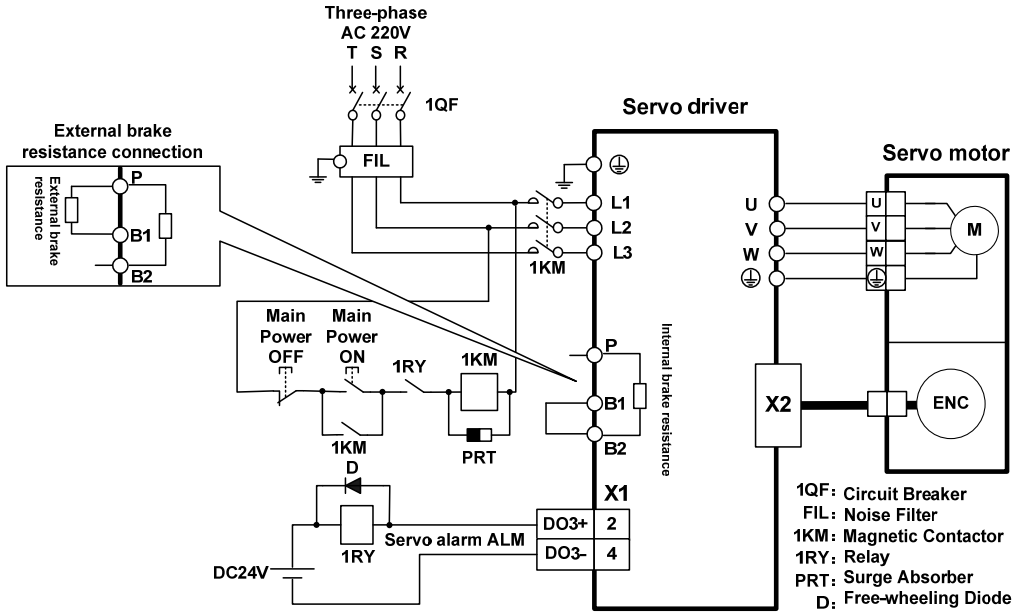
2.1.5 Motor and power wiring diagram

1. TL series servo driver power supply adopts three-phase AC 220V, generally obtained from three-phase AC 380V through transformer. In special cases, motors less than 750W can use single-phase 220V.

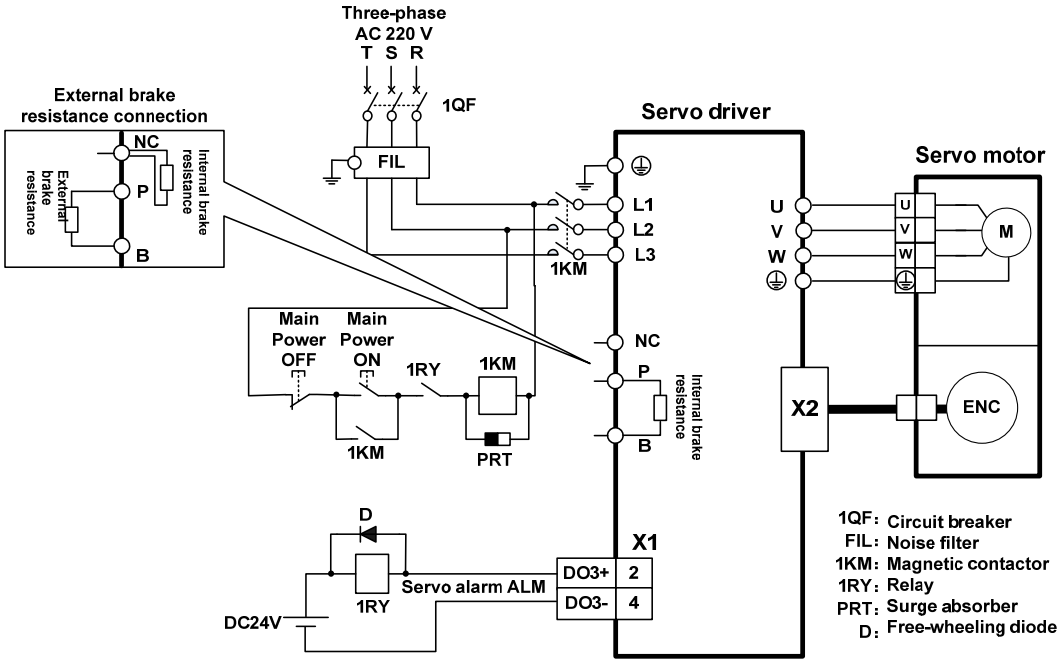
Applicable models: TL04、TL08、TL10



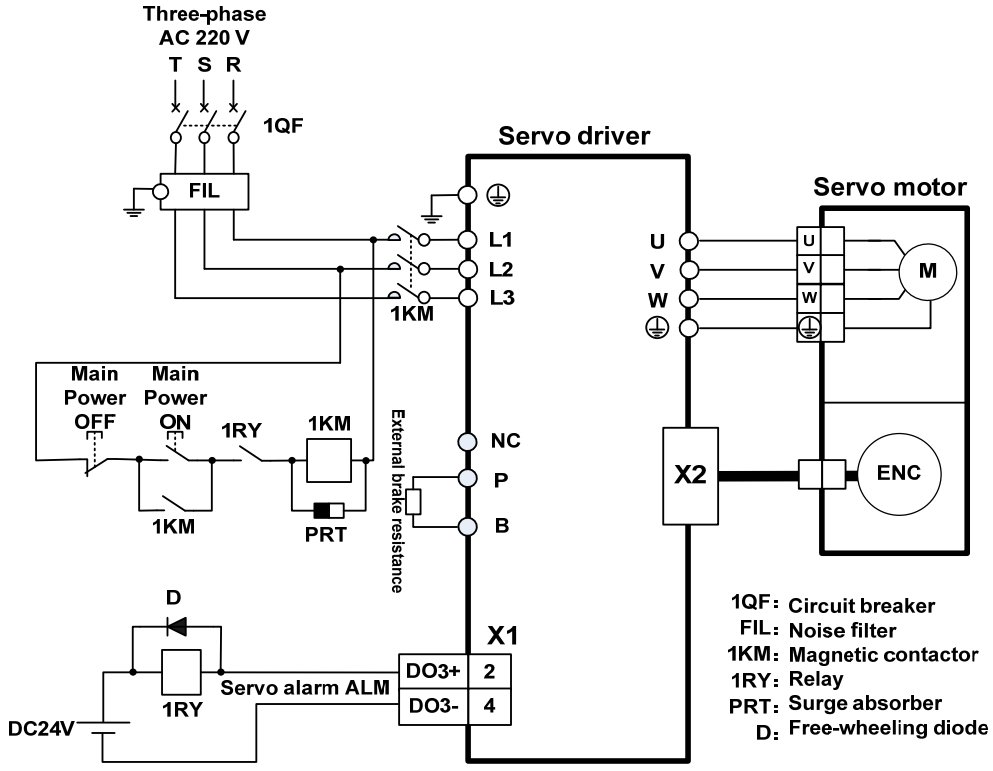
Applicable models: TL15、TL25



Applicable model: TL35



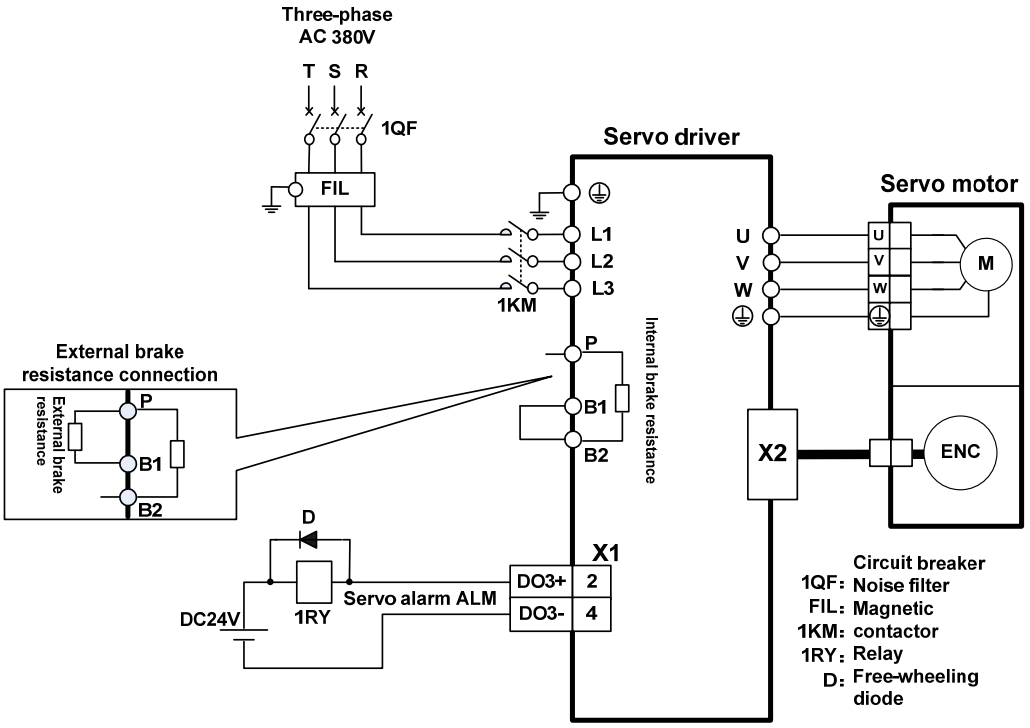
Applicable model: TL55 [Note]



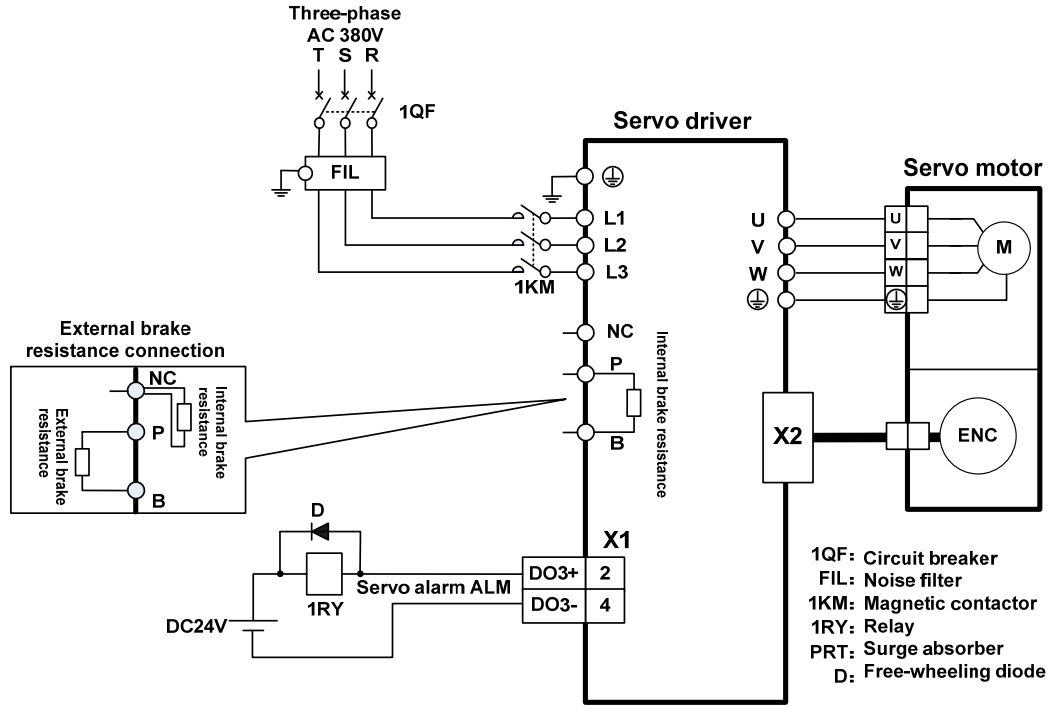
Note: TL55 has no internal brake resistance, so it needs to be connected to external brake resistance.

2. TH series two different wiring modes:

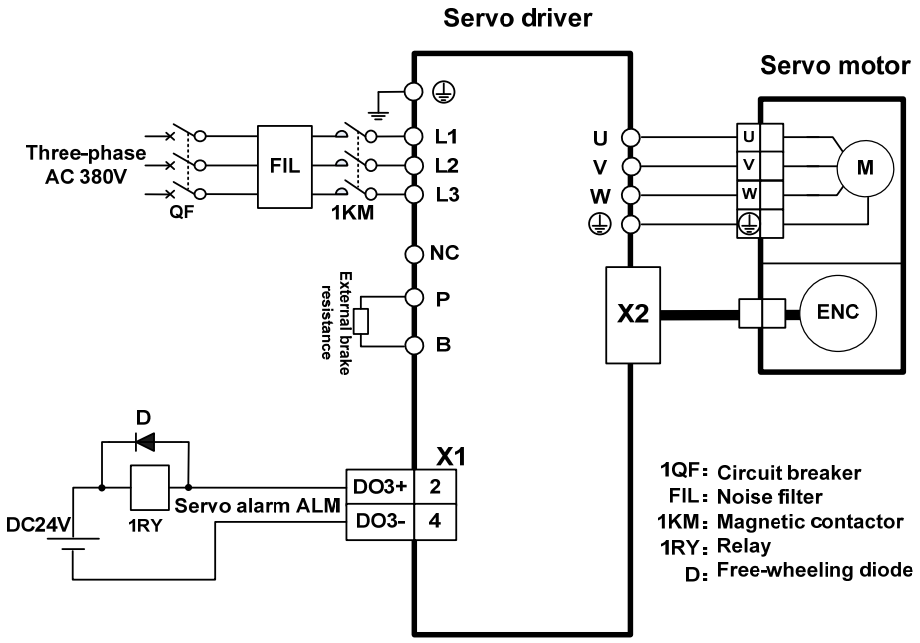
Applicable models: TH15、TH20



Applicable model: TH30

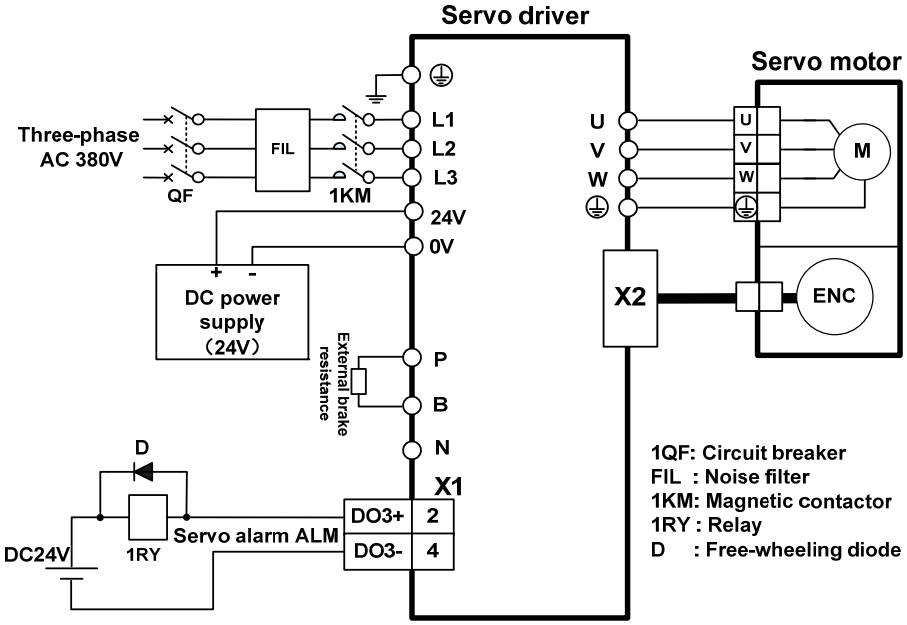


Applicable models: TH50、TH75 [Note]



Note: TH50、TH75 have no internal brake resistance and need to be connected with external brake resistance.

Applicable models: TH90、TH110、TH150 [Note]



Note: TH90、TH110、TH150 have no internal brake resistance, and need to be connected with external brake resistance for use.

2.2 Brake resistance adaptation

Drive series		Internal brake resistance specification	Recommended specification for external brake resistance	Minimum external brake resistance
AC220V	TL04	47Ω/50W	36Ω/200W	25Ω
	TL08	47Ω50W	36Ω/200W	25Ω
	TL10	47Ω50W	36Ω/200W	25Ω
	TL15	47Ω/100W	25Ω/200W	20Ω
	TL25	47Ω/100W	25Ω/200W	20Ω
	TL35	47Ω/100W	20Ω/500W	12Ω
	TL55	无	20Ω/500W	12Ω
AC380V	TH15	117Ω/100W	50Ω/500W	45Ω
	TH20	47Ω/100W	50Ω/500W	40Ω
	TH30	47Ω/100W	36Ω/750W	30Ω
	TH50	无	36Ω/750W	30Ω
	TH75	无	20Ω/1000W	15Ω
	TH90	无	20Ω/1000W	15Ω
	TH110	无	20Ω/1000W	15Ω
	TH150	无	20Ω/1000W	12Ω

Note 1: The resistances recommended in the table can be used in most applications. In practical application, if the demand cannot be met, please contact the manufacturer.

Note 2: When all drivers are changed to external brake resistance, parameters P084/P085/P086 should be modified accordingly. Refer to the corresponding parameter description in chapter 5.4.1 for specific modification.

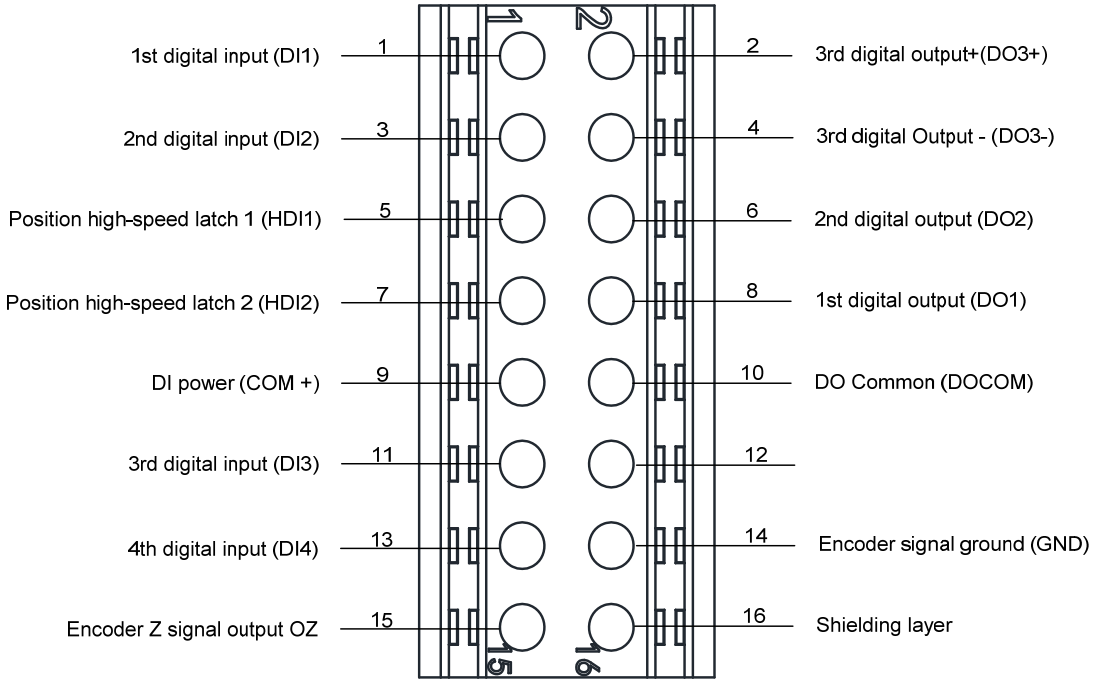
2.3 X1 control signal terminal

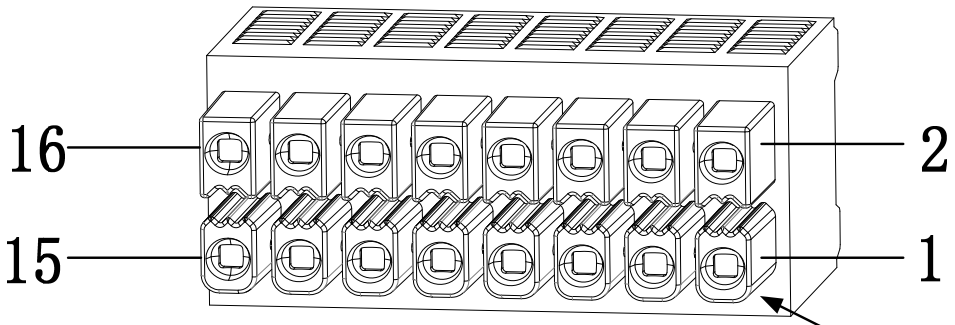
The X1 control signal terminal provides the signals required for external IO connection, using a 15EDGRHC-3.5-16P socket. The signals include:

- 4 programmable inputs;
- 3 programmable outputs;
- 2 high-speed latch inputs.

2.3.1 X1 terminal plug

The X1 terminal plug adopts a 15EDGKNH-3.5-16P male connector, with the following appearance and pin distribution:





X1 plug pin schematic diagram, pay careful attention to the wire hole number when wiring

Determine the hole sequence number based on the shape of the pins

2.3.2 X1 terminal signal explanation

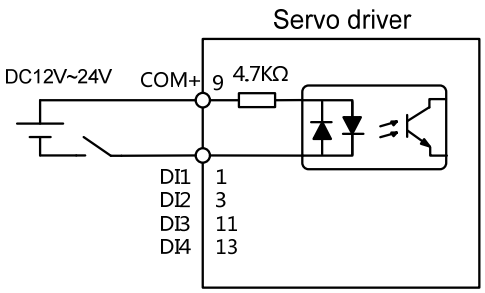
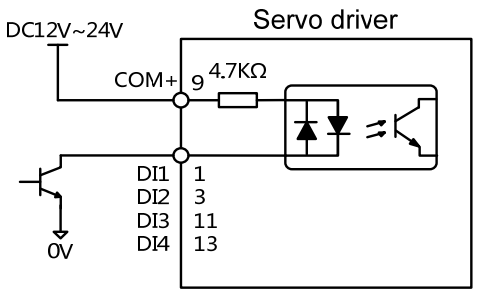
Signal name		Pin number	Functions	Inter face
Digital inputs	DI1 DI2 DI3 DI4	1 3 11 13	Photoelectric isolation input, programmable function, defined by parameters P100～P103	C1
	COM+	9	DI power supply (DC12V～24V)	
Digital outputs	DO1 DO2 DO3+ DO3-	8 6 2 4	Photoelectric isolation output, maximum output capacity of 50mA/25V, programmable function, defined by parameters P130～P132.	C2
	DOCOM	10	DO common terminal	
Position high-speed latch	HDI1 HDI2	5 7	High speed optoelectronic isolation input	C3
Encoder signal differential output	OZ	15	Encoder Z signal open collector output	C4
	GND	14	Encoder signal ground	
Shielding layer	Plug metal case	16	Shielded wire connecting shielded cable	

2.3.3 X1 terminal interface type

The following describes the interface circuits of X1 and how to connect to the host control device.

1. Digital input interfaces (C1)

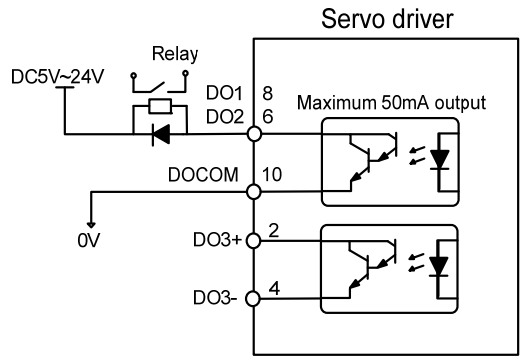
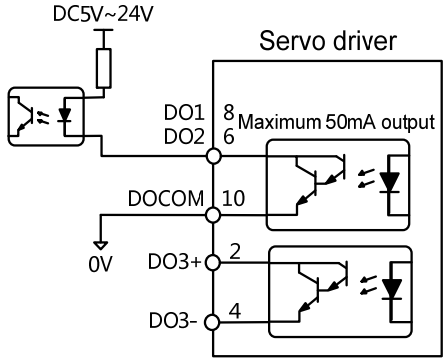
Digital input interface circuit can be controlled by switch, relay, open collector triode, photoelectric coupler, etc. Low current relay shall be selected to avoid poor contact. The external voltage range is DC12V～24V.

C1-1: Switch input	C1-2: Open collector triode
	

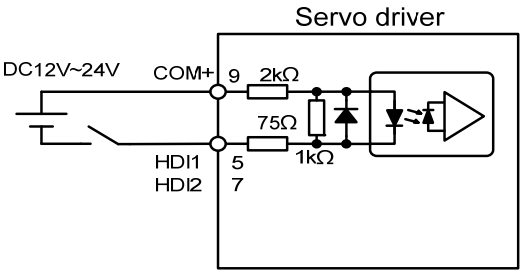
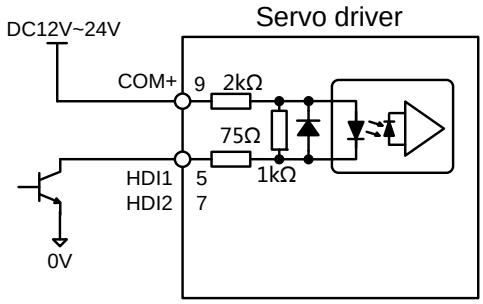
2. Digital output interfaces (C2)

Output circuit adopts Darlington photoelectric coupler, which can be connected with relay and photoelectric coupler. Precautions:

- The power supply is provided by the user. If the power supply is reversed, the drive will be damaged.
- The maximum external power supply is 25V, the maximum output current is 50mA, and the sum of the three currents does not exceed 200mA.
- When using inductive loads such as relays, add diodes in parallel with inductive loads. If the polarity of diodes is opposite, the driver will be damaged.
- When conducting, there is a voltage drop of about 1V, which cannot meet the low level requirements of TTL, so it cannot be directly connected to the TTL circuit.

C2-1: Relay	C2-2: Photoelectric coupler
	
● Freewheel diode must be connected.	

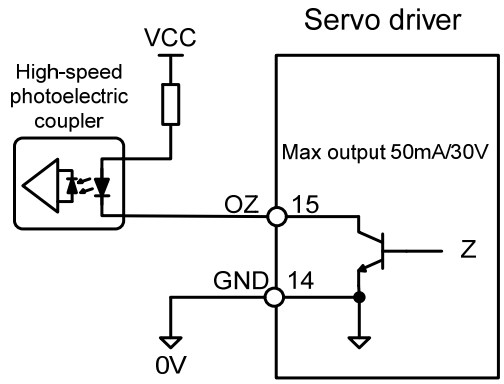
3. Position high-speed latch interfaces (C3)

C3：Position high-speed latch interface	
	
● Maximum pulse frequency 200kHz;	

4. Encoder signal open collector output (C4)

Output the encoder Z signal to the host controller through an open collector circuit. Due to the narrow pulse width of the encoder signal, please use a high-speed photoelectric coupler for reception.

C4: Encoder Z signal open collector output

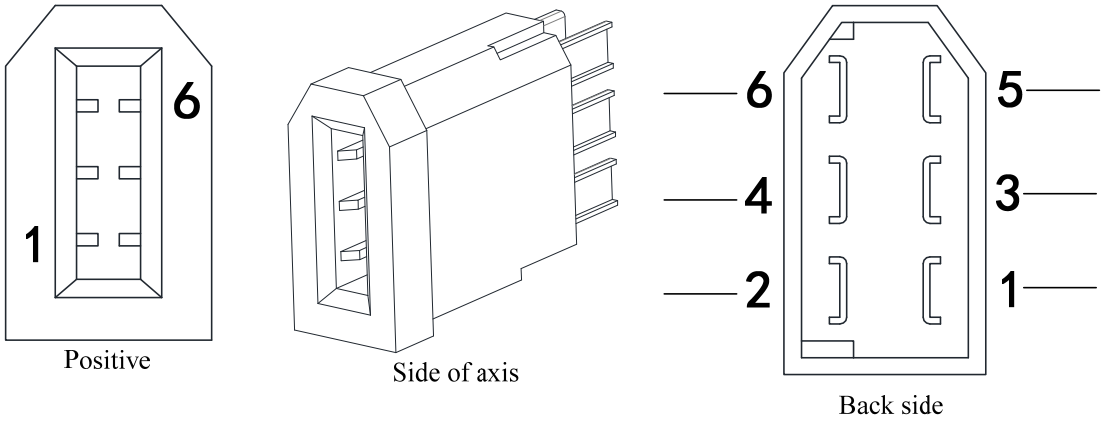


- The maximum external power supply is 30V, and the maximum output current is 50mA.

2.4 X2 encoder signal terminal

2.4.1 X2 terminal connector

X2 encoder signal terminals connected to the motor encoder diagram:



X2 connector core pin diagram

Driver X2 plug

2.4.2 X2 terminal signal description

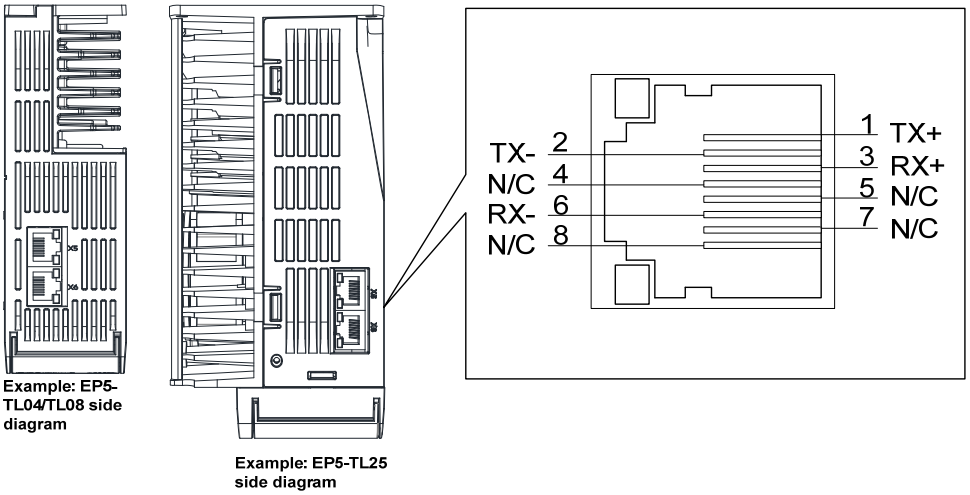
Signal name		Pin number Absolute type （6 core）	Functions
Encoder power supply	5V	1	Use 5VDC power supply (provided by servo driver).If the cable is longer than 20m, in order to prevent encoder from voltage drop down, it is better to use multi wire or thick wire for power line and ground line.
	0V	2	
Signal input	SD+	5	Connect with absolute encoder signal output.
	SD-	6	
Shielding layer	FG	Metal shell	Connect with signal cable shield wire.

Note: Maxsine supplies finished cables, including model E□□□-1394□□A09 (for 60mm and 80mm motor) and model E□□□-1394□□H15(for motor whose seat size is over 110mm).

2.5 X5、X6 EtherCAT network port

X5 for EtherCAT port input, X6 for EtherCAT port output, be sure to connect as required, otherwise it will lead to abnormal communication.

2.5.1 X5、X6 terminal sockets

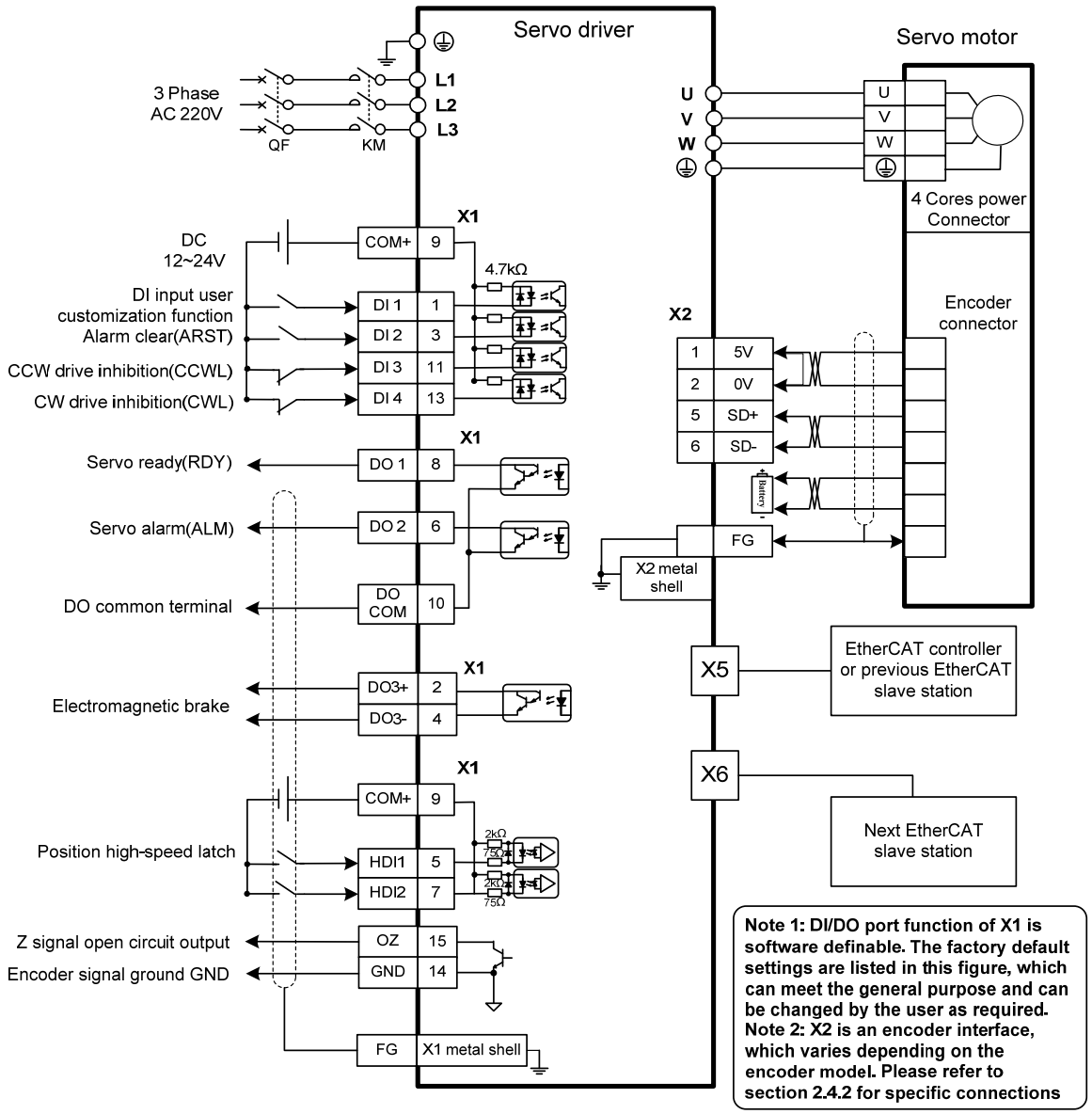


2.5.2 X5、X6 terminal signal description

Signal name	Pin number	Function
TX+	1	Sending signal +
TX-	2	Sending signal-
RX+	3	Receiving signal+
RX-	6	Receiving signal-

2.6 Standard wiring diagram

2.6.1 Control wiring



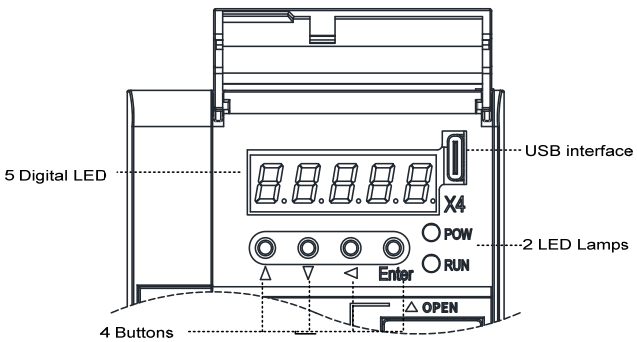
Note: The above wiring diagram takes TL15 as an example.

Chapter 3 Front panel operation

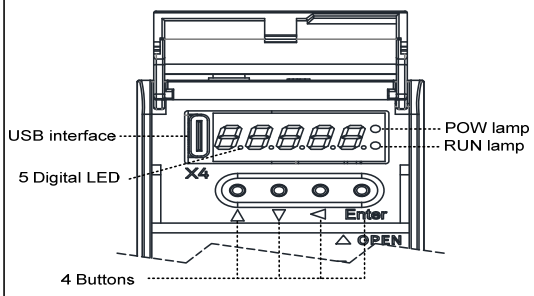
3.1 Driver front panel description

3.1.1 Front panel compositions

The front panel is composed of 5 LED digital tube displays, 4 buttons ▲、▼、◄、Enter and one USB interface, which are used to display various states of the system and set parameters. Operation is a hierarchical operation, which is expanded layer by layer from the main menu.



Panel applicable model：TL15、TL25、TL35、TL55、TH15、TH20、TH30、TH50、TH75、TH90、TH110、TH150



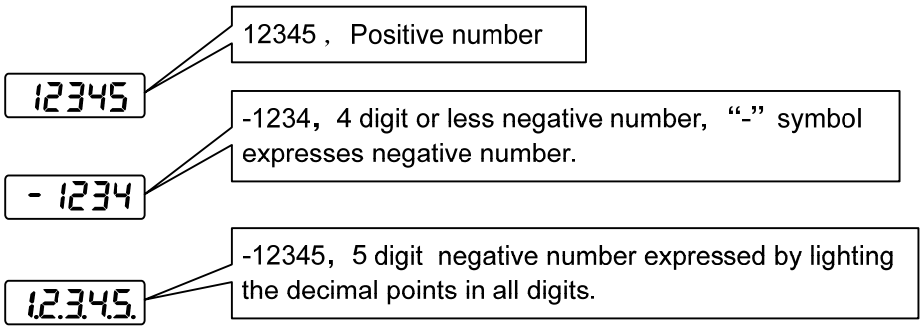
Panel applicable model：TL04、TL08、TL10

3.1.2 Front panel explanation

Symbol	Name	Functions
POW	Main power lamp	Lit: Main power supply already turn on; Go out: Main power supply did not turn on.
RUN	Running lamp	Lit: Motor is active; Go out: Motor is not active.
▲	Increasing button	Increase sequence number or value; Long press has repetitive effect.
▼	Decreasing button	Decrease sequence number or value; Long press has repetitive effect.
◄	Exit button	Menu exit; cancel the operation.
Enter	Confirm button	Menu entered; the operation confirmed.
	USB interface	Equipment connected to the computer interface.

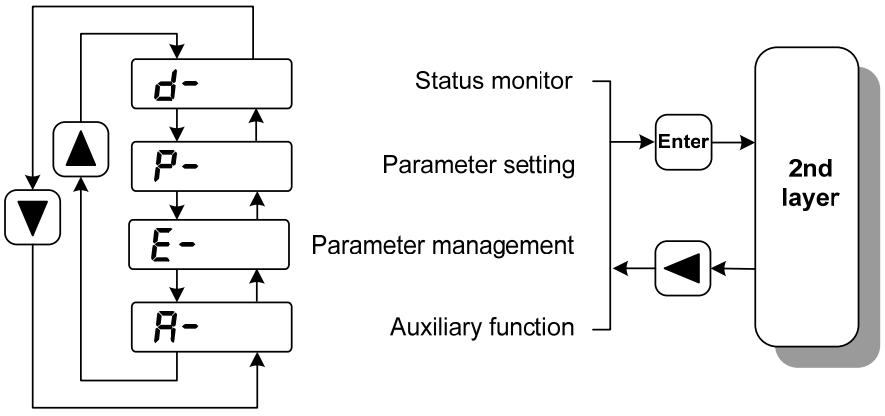
3.1.3 Data display

A number is shown by five digital displays; a minus symbol in front of the value represents a negative value; the lit decimal points in all the digits indicate a negative 5-digit value. Some displays have a prefix character. If the value is full-scale, then the prefix character can be omitted.



3.2 Main menu

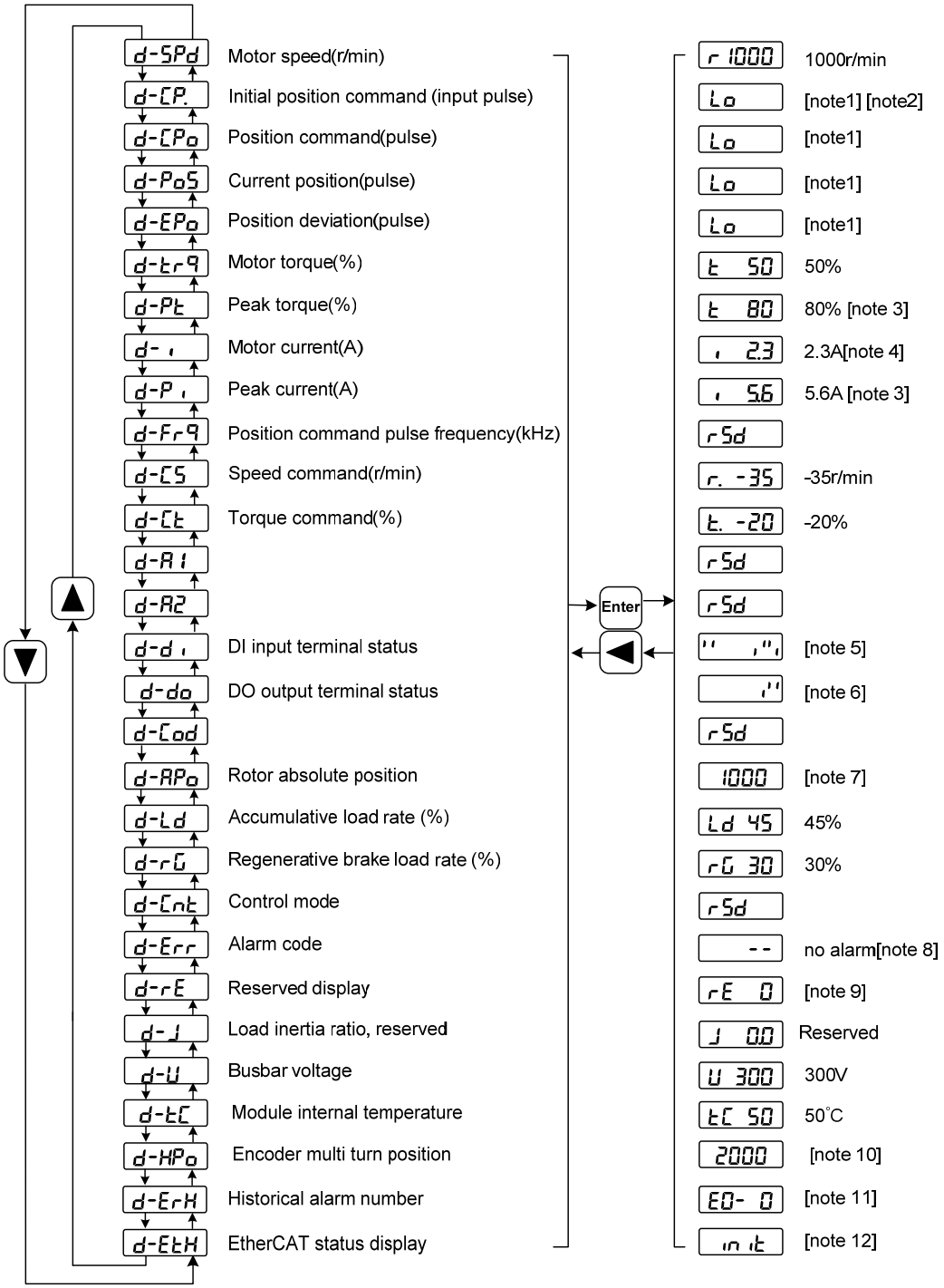
The first layer is the main menu and has four operating modes. Pressing ▲、▼ button changes the operation mode. Pressing the Enter button enters the second layer and then executes a concrete operation. Pressing ◄ button returns to the main menu from the second layer.



1st layer（Main menu）

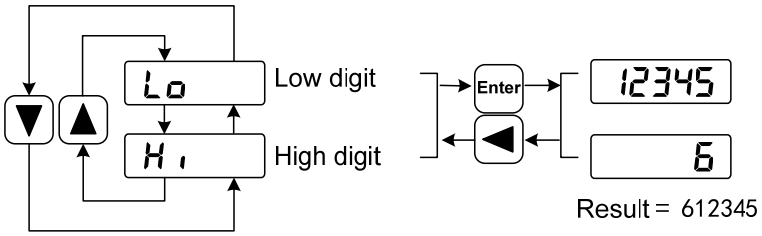
3.3 Status monitor

Choose status monitor "d- " under the main menu. Pressing the Enter button enters the monitor mode. There are many kinds of monitor's project; Use ▲、▼ button to select the needing project. Pressing the Enter button again enters the concrete status display.



1. 32 binary bits value display [note1]

The range of 32-bit binary number is -2147483648～2147483647, which is represented by the combination of low and high digit. Select low digit and high digit through the menu, and use the formula in the figure to synthesize the complete value.



32bit number=High digit number×100000+Low digit number

2. Pulse unit [note2]

The pulses of the initial position command refer to the number of pulses input without electronic gear transformation.

Other items of the pulse (position command, current position, position deviation, rotor absolute position) are uniform pulse units.

$$\text{Uniform pulse unit} = 65536(\mathit{pulse}/\mathit{rev})$$

Uniform pulse unit indicates that the encoder rotates one cycle and the number of pulses increases by 65536. The driver panel display and the host software of the driver all use this unit.

3. Peak torque and peak current [note3]

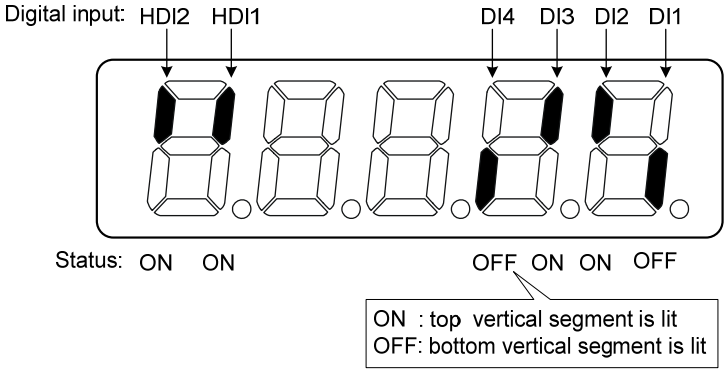
Maximum torque and maximum effective phase current of the motor in the past 10 seconds.

4. Motor current [note4]

Motor phase current effective value.

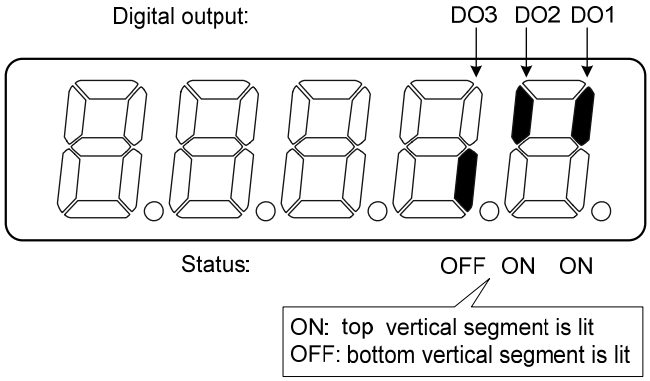
5. Input terminals DI [note5]

A vertical segment of LED shows an input status. The lit top vertical segment shows the DI input to be “ON” and the lit bottom vertical segment to be “OFF”.



6. Output terminals DO [note6]

A vertical segment of LED shows an output status. The lit top vertical segment shows the DO output to be “ON” and the lit bottom vertical segment to be “OFF”.

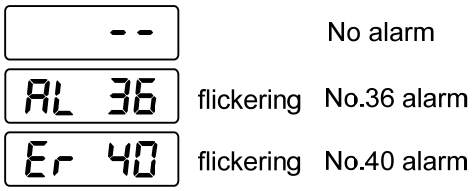


7. Rotor absolute position [note7]

Represents the position of the rotor relative to the stator in a revolution, and turns one into a period. Uniform pulse unit, and encoder Z pulse as the origin. Its range is 0～65535, and the value when Z pulse appears is 0.

8. Alarm code [note8]

No alarm shows two minus signs " --". When there is an alarm, it will display the alarm number and blink at the interval of on 0.3s and off 0.3s; if there is a warning, it will display the warning number and blink at the interval of on for 1.8s and off for 0.6s. When the alarm or warning appears, the error code number displays automatically on the front panel LED. During the error status, the monitor mode can be changed to other mode by pressing buttons, but the decimal point of the last LED is still flickering and shows existence of an alarm.



9. RE reserved display [note9]

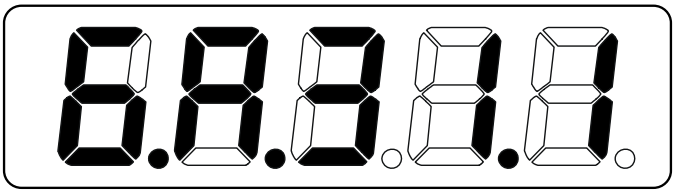
(1) re-0 menu displays the date information of the software version:

The 1st digital tube shows the last digit of the year, such as: 2016 shows 6, 2017 shows 7, and so on;

The 2nd digital tube displays the month (note: October is indicated by "A", November by "b", December by "c");

The 3rd-4th digital tube display day;

The 5th digital tube manufacturer retains the display, which is generally the serial number of the internal control version.



For example, the above icon indicates: October 31, 2016, Internal Control Version 1.

10. Encoder multi turn position [note10]

This status display is only valid for absolute value drives. Record the multi turn position of the encoder. The range is 0～65535. Combined with the absolute position of the APo rotor single turn, the absolute position of the rotor can be obtained:

Absolute position=multi turn position $\times 2^{16}$+single turn position

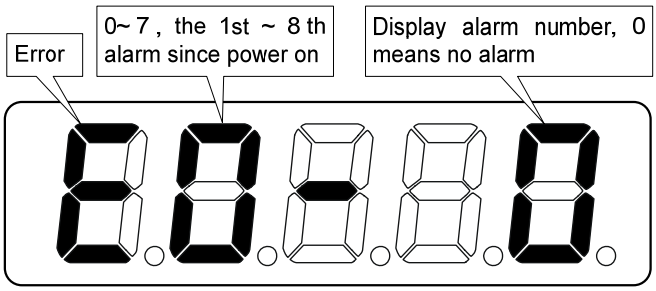
For example, the multi turn position displays 2000, and the single turn position displays 1000, both of which are decimal numbers

The absolute position of the encoder is (2000 $\times 2^{16}$+1000) (decimal)=131073000

When the absolute encoder is set to single turn mode (P090=0), the multi turn position is displayed as 0 and does not change with the position of the rotor.

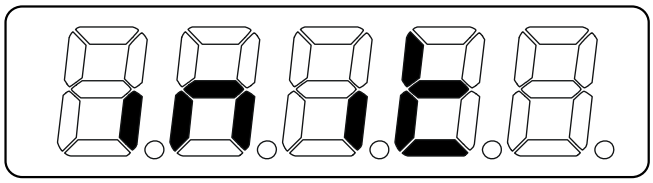
11. Historical alarm number [note11]

Display alarm number, use ▲、▼ button to view the historical alarm number. After the servo is powered off and restarted, only the first four alarm numbers from E0 to E3 are recorded.

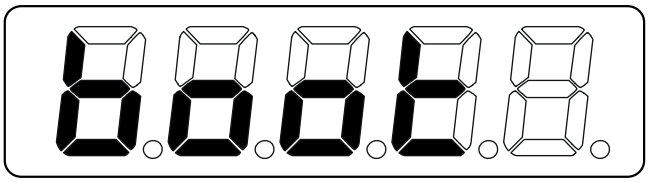


12. EtherCAT status display [note12]

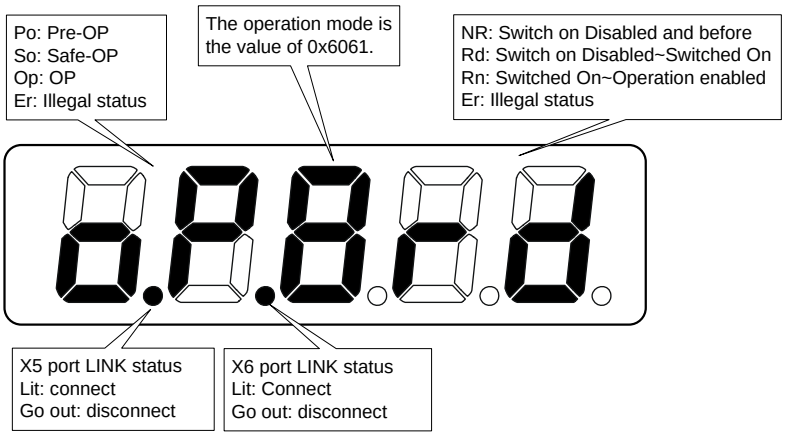
(1) When EtherCAT network status is Init, display：



(2) When EtherCAT network status is boot, display：



(3) When other EtherCAT network status is displayed：



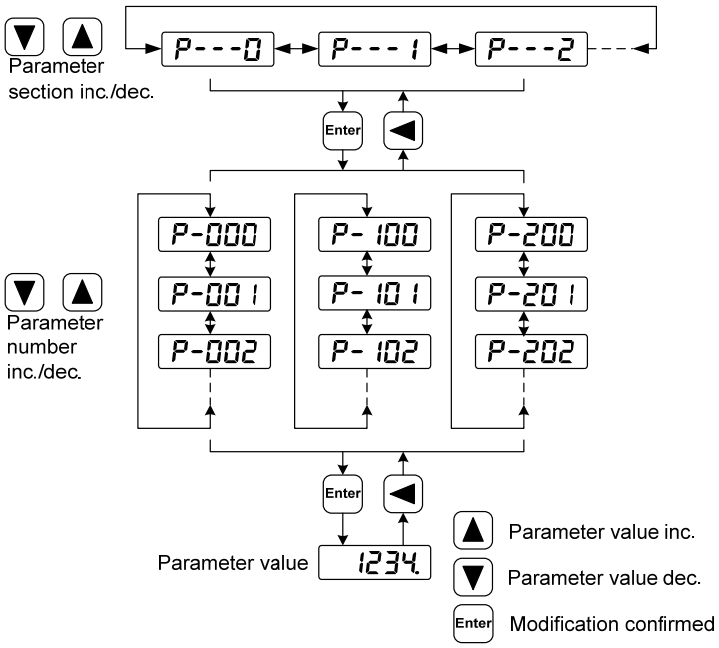
3.4 Parameters setting

The parameter number expression uses a parameter section name combined with a parameter name. The three figures are the section name and two figures and one figure are the parameter name. Take P102 parameter as an example, '**1**' is the section name and '**02**' the parameter name. "P- 102" displays on the front panel LED.

Choose the parameter mode under the main menu "P- ". Pressing the Enter button enters the parameter-setting mode. First use ▲、▼ button to select the parameter section name and then pressing Enter button enters the parameter name selection. Again, use ▲、 ▼ button to select the parameter name and then pressing Enter button shows the parameter value.

Use ▲、 ▼ button to alter a parameter value. Pressing ▲ or ▼ button once to increase or decrease the parameter value by one. Pressing down and hold the ▲ or ▼ button, the parameter value can increase or decrease continuously. When the parameter value is modified, the decimal point on the most right sides LED is lit. Press the Enter button to confirm the parameter value to be effective, meanwhile the decimal point turns off. The modified parameter value is immediately active to influence on the control action (but some parameters needs to preserve firstly and then turn off and on the power supply). Hereafter pressing ◄ button returns to the parameter number selection and can continue to modify a parameter. If the value is not satisfied, do not press the Enter button and can press the ◄ button to cancel it for resuming the original parameter value.

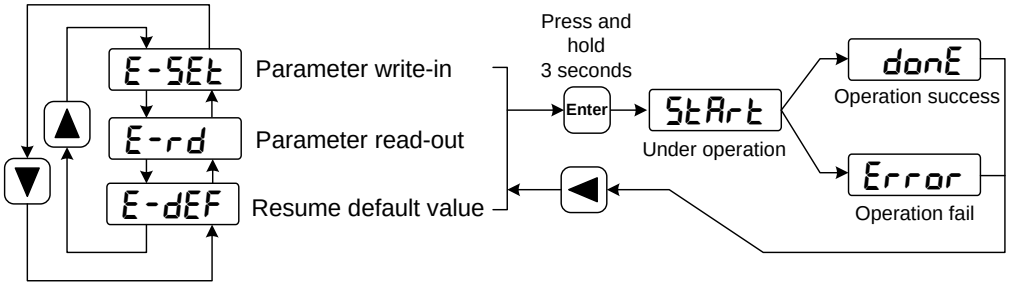
The modified parameter is not saved to EEPROM. If it needs to be saved permanently, please use the parameter write operation in parameter management. Parameter segments and numbers are not necessarily contiguous, and unused segments and numbers are skipped and cannot be selected.



3.5 Parameter management

Choose the parameter management mode under the main menu "E- ". Pressing the Enter button enters the parameter management mode. The operation is performed between parameter list and the EEPROM.

There are three operation modes. Use ▲、▼ button to select an operation mode and then pressing down and hold the Enter button at least three seconds to active the operation mode. After finished the operation and then pressing ◄ button returns to the operation mode selection.



- **Parameter write-in**

  This operation indicates that the parameter in parameter list will write to the EEPROM. When user has made change to a parameter, it only change the parameter value in parameter list, but for the next time when the power supply is on the parameter value will restore its original value. Making permanent change to a parameter value, it is the need to carry out the parameter write operation and write the parameter value to the EEPROM. Hereafter, when the power supply is on again will be able to use the new parameter value.

- **Parameter read-out**

  This operation indicates that the data in EEPROM is read into the parameter list. This process will be automatically executed once when the power is turned on. At the beginning, the parameter values of the parameter list are the same as those in the EEPROM. However, if the user modifies the parameters, the parameter values in the parameter list will be changed. When the user is not satisfied with the modified parameters or the parameters are scrambled, the parameter read-out operation will be executed, and the data in the EEPROM can be read into the parameter list again to restore to the parameters just powered on.

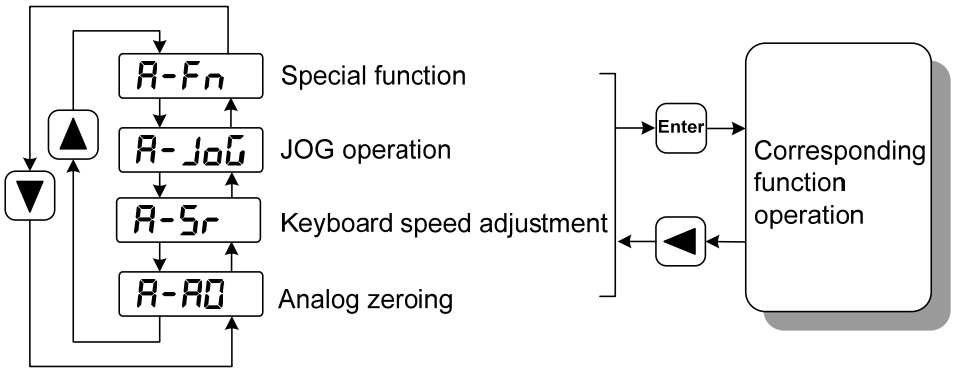
- **Resume default value**

  This operation indicates that the default values (factory values) of all parameters are read out in the parameter list and written in the EEPROM, and the default parameters will be used for the next power on. When the user adjusts the parameters disorderly and cannot work normally, use this operation to restore all parameters to the factory state. Because the default values of parameters corresponding to different driver models and motor models are different, the correctness of the motor code (parameter P002) must be ensured before using the default parameters to restore.

E-SEt	Parameter write-in：	Parameter list	⇨	EEPROM
E-rd	Parameter read-out：	Parameter list	⇦	EEPROM
E-dEF	Resume default value：	Ex-factory default value	⇨	Parameter list、EEPROM

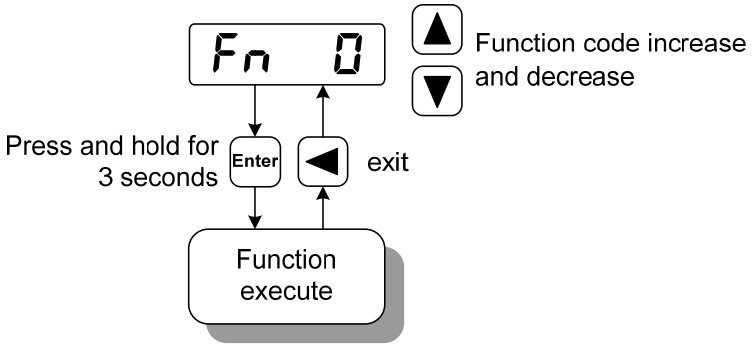
3.6 Auxiliary functions

Select the auxiliary function "A- " in the main menu, and press the Enter button to enter the auxiliary function mode. Select the operation mode with ▲、▼ button. After selecting the operation, press the Enter button to enter the corresponding function, and then press the ◄ button to return to the operation mode selection state.



3.6.1 Special function

Select special functions and press the Enter button to enter. Set the function code with ▲、▼ button, press the Enter button and hold it for more than 3 seconds to activate the operation. After that, press the ◄ button to exit. **Note: The Fn function should be executed when the drive is not enabled.**



Fn number	functions	explanation
Fn36	reset the encoder (multi-turn absolute encoder is valid)	Encoder RESET command, is used for encoder initialization, encoder alarm reset, and multi-turn information to zero. Perform this function after replacing the battery.
Fn37	Encoder alarm clearing	Encoder alarm clearing command is used to clear various encoder alarms. Executing this command will not clear the encoder multi turn information. Perform this function after replacing the battery.
Fn -2	Enter normal mode	The 999 warning is displayed on the screen, and the function can run normally
Fn -1	Exit normal mode	Exit normal mode and enter network mode

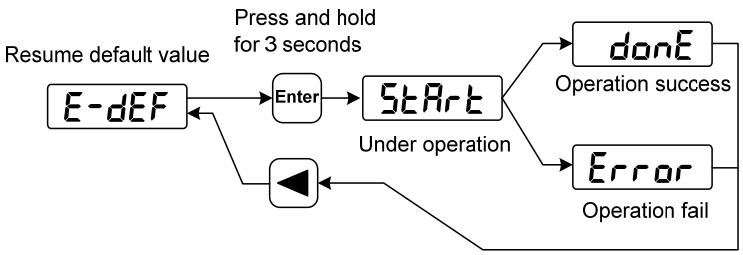
3.7 Resume the parameter default value

Please use the restore default parameters (factory parameters) function in the following cases:

- The parameters are scrambled, and the system cannot work normally.
- Replace the motor. The new motor is different from the original motor.

Resume all of the parameter default value

1. All parameters are restored to their default values, and all user-modified parameters are restored to their factory defaults. Restore the default values in parameter management.



Resume all of the parameter default value

2. Turn off and on the power supply, then an operation can be performed again.

Chapter 4 Running

4.1 Trial running with no load

The purpose of the trial run is to confirm whether the following matters are correct:

- Driver power wiring;
- Servo motor power wiring;
- Encoder wiring;
- Servo motor running direction and speed.

4.1.1 Wiring and inspection

Before turn on the power supply, confirms the motor:

- When the motor is unloaded, do not add load to the motor shaft, and disconnect the connector if it has been installed on the machine.
- Since the acceleration and deceleration of the motor have impact, the motor must be fixed.

Inspect the following items before turn on power supply:

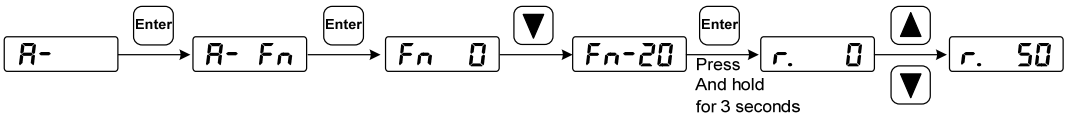
- Is the connection correct? In particular, whether the driver U, V, W is one-to-one corresponding to the motor U, V, W wiring and whether the driver L1, L2, L3 wiring.
- Is the input voltage correct?
- Is the encoder cable connected correctly?

4.1.2 Trial running in speed adjustment with keyboard

Note: The keyboard speed control trial run requires setting A-Fn→Fn -2 to enter normal mode before it can run! Fn -2 is on time for a long time, and the drive displays AL999 warning number 999, indicating normal operation.

When the driver is not enabled, long press Fn -2, and the panel displays "done". The driver switches to normal mode, which can be used for keyboard speed adjustment and trial operation functions; When the driver is not enabled, press and hold Fn-1, and the panel displays "done". The driver switches to EtherCAT mode, and the control mode and instructions are sourced from the EtherCAT bus.

1. Before performing this operation, confirm that the motor has been disconnected from the load.
2. Turn on the power supply (AC three-phase 220V or AC single-phase 220V). The front panel display is lit and the POWER indicating LED is lit. If any error alarm, please inspect the wiring.
3. After confirming that there is no alarm or abnormality, perform the following operations as shown below:



Change the speed command by ▲、▼ button, and the motor runs at the given speed. Positive number indicates forward rotation (CCW), negative number indicates reverse rotation (CW), and the minimum given speed is 0.1r/min.

Note: After the Fn function is executed, the E-SET saving operation cannot be performed, and the power must be turned off and restarted, otherwise the state of Fn will be saved.

4.2 Position control mode

Refer to "6.4.1 cyclic synchronous position mode".

The position control mode is applied to the systems requiring precise positioning, such as CNC machine tools, textile machinery, etc.

4.2.1 Parameter setting of position control mode

Parameter setting:

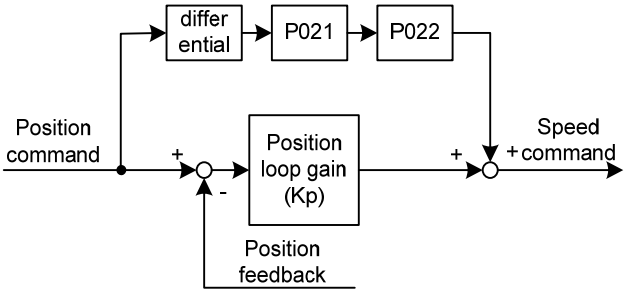
Para meter	Name	Setting value	Default value	Parameter explanation
P097	Ignore drive inhibit	3	3	Use forward drive inhibit (CCWL) and reverse drive inhibit (CWL). If set to ignore, did not connect CCWL、CWL.

4.2.2 Position control mode related gain

Para meter	Name	Range	Default value	Unit
P009	1st position loop gain	1～1000	40	1/s
P021	Position loop feedforward gain	0～100	0	%
P022	Position loop feedforward filter time constant	0.20～50.00	1.00	ms

Because the position loop includes the speed loop, first set the load moment of inertia ratio, then adjust the speed loop gain, speed loop integration time constant, and finally adjust the position loop gain according to the order of inner loop to outer loop.

The following is the position controller of the system. Increasing the gain K_p of the position loop can improve the bandwidth of the position loop, but it is limited by the bandwidth of the speed loop. To increase the gain of position loop, the bandwidth of speed loop must be increased first.



Feedforward can reduce the phase lag of position loop control, reduce the position tracking error and shorten the positioning time. With the increase of feedforward, the tracking error of position control is reduced, but if it is too large, the system will be unstable and overshoot. If the electronic gear ratio is greater than 10, it is also easy to generate noise. In general applications, P021 can be set to 0%. When high response and low tracking error are required, they can be increased appropriately, and should not exceed 80%. At the same time, it may be necessary to adjust the position loop feedforward filter time constant (parameter P022).

4.3 Speed control mode

Refer to "6.4.2 cyclic synchronous velocity mode".

Speed control mode is applied to the occasions requiring precise speed control, such as braider, drill, CNC machine. Position control can also be formed by host device.

4.3.1 Parameter setting of speed control mode

Parameter setting:

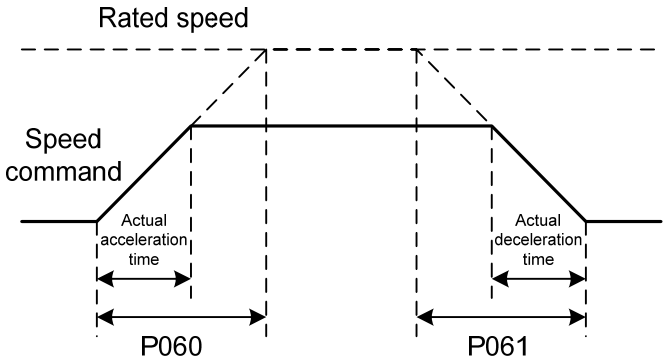
Para meter	Name	Setting value	Default value	Parameter explanation
P060	Speed command acceleration time	suitable	0	
P061	Speed command deceleration time	suitable	0	
P097	Ignore drive inhibit	3	3	Use forward drive inhibit (CCWL) and reverse drive inhibit (CWL). If set to ignore, did not connect CCWL、CWL.

4.3.2 Acceleration and deceleration

Acceleration and deceleration are related to the following parameters:

Para meter	Name	Range	Default value	Unit
P060	Speed command acceleration time	0～30000	0	ms
P061	Speed command deceleration time	0～30000	0	ms

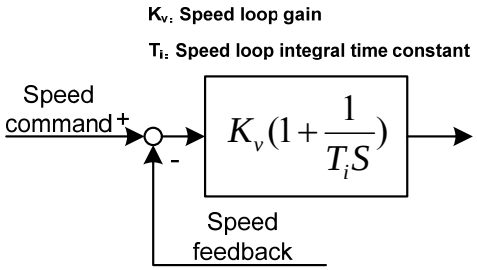
Acceleration and deceleration can slow down the sudden change of speed and make the motor run smoothly. As shown in the figure below, parameter P060 sets the acceleration time of the motor from zero speed to rated speed, and P061 sets the deceleration time of the motor from rated speed to zero speed. If the command speed is lower than the rated speed, the required acceleration and deceleration time will also be shortened accordingly. If the driver is operating in speed mode and the host (PLC, etc.) performs position closed-loop control, the parameter should be set to 0.



4.3.3 Speed control mode related gain

Para meter	Name	Range	Default value	Unit
P005	1st speed loop gain	1～3000	40	Hz
P006	1st speed loop integral time constant	1.0～1000.0	20.0	ms
P017	Load moment of inertia ratio	0.0～200.0	1.0	times
P018	Speed loop PDFF control coefficient	0～100	100	%

First, set the load moment of inertia ratio, and then adjust the speed loop gain and speed loop integration time constant. The following is the speed controller of the system. Increasing the speed loop gain K_V can improve the speed response bandwidth, and decreasing the speed loop integration time constant T_i can increase the system rigidity and reduce the steady-state error.



P018 can choose the speed controller structure. 0 is the IP regulator, 100 is the PI regulator, 1～99 is the PDFF regulator. If the parameter value of P018 is too large, the system has high frequency response; if the parameter value is too small, the system has high stiffness (resistance to deviation); if the parameter value is too small, both frequency response and stiffness are considered.

4.4 Torque control mode

Refer to "6.4.3 cyclic synchronous torque mode".

Torque control mode is used for printing machines, winding machines, injection molding machines and other occasions. The motor output torque is proportional to the input command.

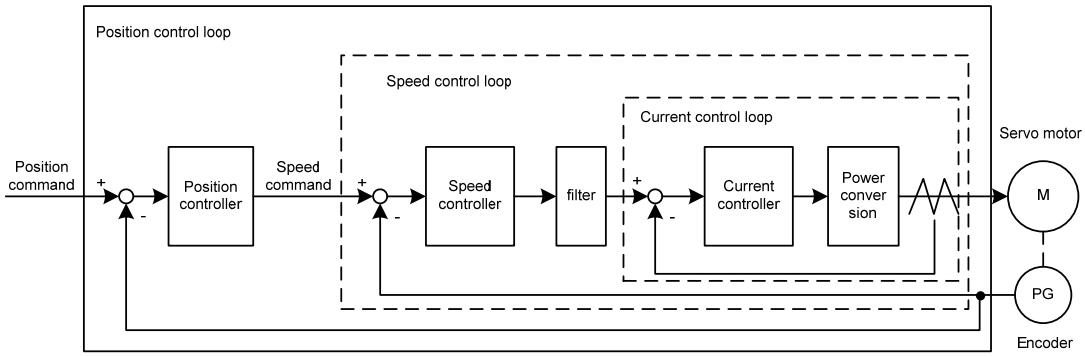
4.4.1 Speed limit of torque control mode

In the torque control mode, the motor torque output is controlled by the command, but the motor speed is not controlled. Therefore, over-speed may occur under light load. In order to protect the machinery, the speed must be limited. The parameters related to speed limit are:

Para meter	Name	Range	Default value	Unit	Usage
P078	Speed limit in torque control mode	0～5000	3000	r/min	T

4.5 Gain adjustment

The driver includes three control loops: current control loop, speed control loop and position control loop. The control block diagram is as follows:



Theoretically, the bandwidth of the inner control loop must be higher than that of the outer control loop. Otherwise the whole control system will be unstable and cause vibration or poor response. Therefore, the relationship between the bandwidth of the three control loops is as follows:

Current loop bandwidth>speed loop bandwidth>position loop bandwidth

Since the driver has adjusted the current control loop to the best state, the user only needs to adjust the parameters of the speed control loop and the position control loop.

4.5.1 Gain parameters

Parameters related to the gain are:

Para meter	Name	Range	Default value	Unit
P005	1st speed loop gain	1～3000	40	Hz
P006	1st speed loop integral time constant	1.0～1000.0	20.0	ms
P009	1st position loop gain	1～1000	40	1/s
P017	Load moment of inertia ratio	0.0～200.0	1.0	times

Symbols are defined as follows:

K_v: Speed loop gain;

T_i : Speed loop integral time constant;

K_p: Position loop gain;

G : Load moment of inertia ratio (P017);

J_L : Load moment of inertia converted to motor shaft;

J_M: Moment of inertia of motor rotor

1. Speed loop gain K_v

The speed loop gain K_v directly determines the response bandwidth of the speed loop. On the premise that the mechanical system does not produce vibration or noise, increasing the gain value of the speed loop will accelerate the speed response and the better the following of the speed command. However, excessive settings are easy to cause mechanical resonance. The bandwidth of the speed loop is expressed as:

$$\text{Speed loop bandwidth(Hz)} = \frac{1+G}{1+J_L/J_M} \times K_v(\text{Hz})$$

If the load moment of inertia ratio G is set correctly ($G=J_L/J_M$), the speed loop bandwidth is equal to the speed loop gain K_v.

2. Speed loop integral time constant T_i

Speed loop integration can effectively eliminate the steady-state error of speed and quickly respond to subtle speed changes. On the premise that the mechanical system does not produce vibration or noise, reduce the integral time constant T_i of the speed loop to increase the system rigidity and reduce the steady-state error. If the load inertia ratio is large or the mechanical system has resonance factors, it must be confirmed that the integral time constant of the speed loop is large enough. Otherwise the mechanical system is easy to produce resonance. If the load moment of inertia ratio G is set correctly ($G=J_L/J_M$), use the following formula to obtain the speed loop integral time constant T_i:

$$T_i(ms) \geq \frac{4000}{2\pi \times K_V(Hz)}$$

3. Position loop gain K_p

The position loop gain directly determines the reaction speed of the position loop. On the premise that the mechanical system does not produce vibration or noise, increase the position loop gain value to speed up the reaction speed, reduce the position tracking error and shorten the positioning time. However, too large setting will cause mechanical system jitter or positioning overshoot. The bandwidth of the position loop cannot be higher than that of the speed loop, generally:

$$\text{Position loop bandwidth}(Hz) \le \frac{\text{Speed loop bandwidth(Hz)}}{4}$$

If the load moment of inertia ratio G is set correctly ($G=J_L/J_M$), the position loop gain K_p is calculated as follows:

$$K_p(1/s) \le 2\pi \times \frac{K_v(Hz)}{4}$$

4.5.2 Gain adjustment steps

The choice of position and speed bandwidth must be determined by the rigidity of the machinery and the application situation. The conveying machinery connected by the belt has low rigidity and can be set to a lower frequency bandwidth; The mechanical stiffness of the ball screw driven by the reducer is medium, which can be set to medium bandwidth; Direct drive ball screw or linear motor has high rigidity and can be set as high frequency bandwidth. If the mechanical characteristics are unknown, gradually increase the gain to increase the bandwidth until resonance, and then lower the gain.

In servo gain, if one parameter is changed, other parameters also need to be readjusted. Please do not make major changes to only one parameter. For the change steps of servo parameters, please generally follow the following principles:

Increase response	Decrease response，restrain vibration and overshoot
1.Increase speed loop gain K_v 2.Decrease the speed loop integration time constant T_i 3.Increase position loop gain K_p	1.Decrease position loop gain K_p 2.Increase the speed loop integration time constant T_i 3.Decrease speed loop gain K_v

Speed control gain adjustment steps:

1. Set the load moment of inertia ratio.
2. Set the speed loop integration time constant to a larger value.
3. Increase the speed loop gain in the range without vibration and abnormal sound, and slightly decrease if vibration occurs.
4. The speed loop integration time constant should be decrease in the range without vibration, and slightly increased if vibration occurs.
5. If the gain cannot be increased due to resonance of the mechanical system or other reasons, and the desired responsiveness cannot be obtained, adjust the torque low-pass filter or notch filter to

suppress resonance, and then repeat the above steps to improve responsiveness. First, use torque low-pass filter, and then consider using notch filter if the effect is not good. Please refer to section 4.6.

Position control gain adjustment steps:

1. Set the load moment of inertia ratio.
2. Set the speed loop integration time constant to a larger value.
3. Increase the speed loop gain in the range without vibration and abnormal sound, and slightly decrease if vibration occurs.
4. Speed loop integration time constant should be reduced in the range without vibration, and slightly increased if vibration occurs.
5. Increase the position loop gain and slightly decrease the vibration if it occurs.
6. If the gain cannot be increased due to resonance of the mechanical system and the desired responsiveness cannot be obtained, adjust the torque low-pass filter or notch filter to suppress the resonance, and then repeat the above steps to improve responsiveness. First, use torque low-pass filter, and then consider using notch filter if the effect is not good. Please refer to section 4.6.
7. If shorter positioning time and smaller position tracking error are required, the position feedforward can be adjusted appropriately.

4.5.3 Parameter self-tuning

The self-tuning mode used is selected by parameter P296: 0 is the manual setting mode, 1 is the automatic setting mode, and 3 is the feedforward setting mode. The parameters set in the manual setting mode and automatic setting mode in the auto-tuning process include five parameters: P005、P006、P007、P009 and P019. The feedforward setting mode is used to set P021 feedforward gain. The relevant parameters of the motion path configuration in the self-tuning process are as follows:

Para meter	Name	Range	Default value	Unit
P472	Number of forward turns of round-trip motion	1～32767	3	
P473	Number of reverse turns of round-trip motion	1～32767	3	
P474	Round-trip speed	1～32767	1000	rpm
P475	Round-trip acceleration time	0～32767	100	ms
P476	Round-trip deceleration time	0～32767	100	ms

In addition, if it is necessary to have the automatic suppression function of vibration points in the parameter self-tuning process, it is necessary to turn on the automatic notch filter or enable the automatic intermediate frequency vibration suppression function. The automatic trap function can be turned on by setting P213 parameter to 1, and the automatic IF suppression function can be turned on by setting P229 parameter to 2.

Before the parameter self-tuning process, it is necessary to ensure that the entire motion path has enough available displacement to avoid equipment damage and other problems. After setting the self-tuning mode through parameter P296, use the Fn2 function to enter the parameter self-tuning process.

In the manual setting mode, adjust the set gain level through the up and down keys on the keyboard. Each gain level corresponds to a set of speed loop and position loop parameters. The last two digits of the screen display the current gain level. Exit the Fn2 mode through the back key. At this time, you can view the relevant parameters after setting. If you need to save, you need E-SET operation;

In the automatic setting mode, the gain level of the speed loop and the position loop is automatically set. The sequence is to set the speed loop parameters first, and then the position loop parameters. The last two digits of the same screen display the current gain level. After all settings are completed, "--" is displayed in the middle of the screen, which means the automatic setting process is over. Exit the Fn2 mode by pressing the Back key. At this time, you can view the relevant parameters after setting. If you need to save, you need E-SET operation;

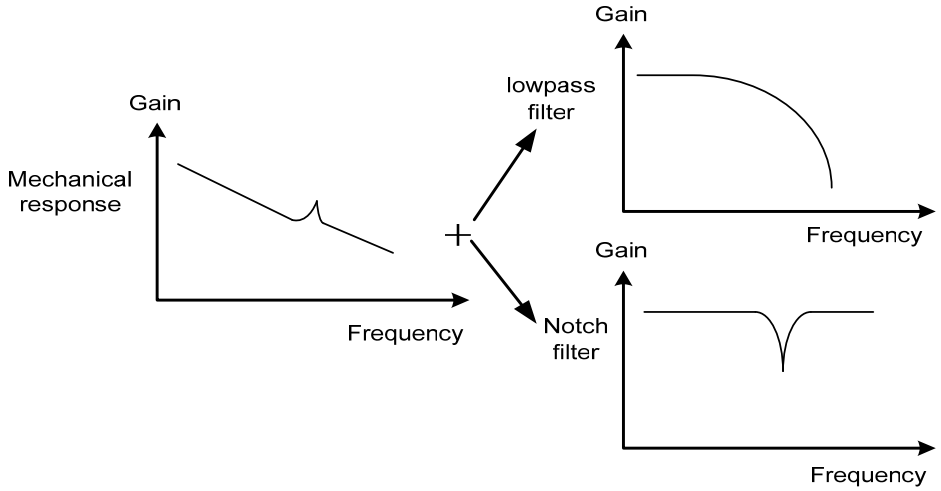
In the feedforward setting mode, set the feedforward percentage parameter P021. The last two digits of the screen display the current feedforward percentage. After setting, the middle two digits of the screen display "--", indicating the end of automatic setting. Exit the Fn2 mode by pressing the Back key. At this time, you can view the relevant parameters after setting. If you need to save, you need E-SET operation.

4.6 Resonance suppression

When resonance occurs in the mechanical system, it may be caused by the servo system being too large and responding too fast. Reducing the gain may improve it. The driver provides a low-pass filter and a notch filter to suppress resonance without changing the gain. Parameters related to resonance suppression are as follows:

Para meter	Name	Range	Default value	Unit
P007	1st torque filter time constant	0.01～50.00	1.00	ms
P200	1st notch filter frequency	50～5000	5000	Hz
P201	1st notch filter quality factor	1～100	7	
P202	1st notch filter depth	0～60	0	dB
P203	2nd notch filter frequency	50～5000	5000	Hz
P204	2nd notch filter quality factor	1～100	7	
P205	2nd notch filter depth	0～60	0	dB

The principle of resonance suppression is to use a filter to suppress the formant of the mechanical response. The schematic diagram is as follows:



The characteristics of the two filters are:

Filter type	Suitable case	Advantage	Disadvantage
Low pass filter	High frequency resonance	Do not need to know the exact resonance frequency	Bring phase delay; reduce bandwidth of the system. Do not suitable for the case of medium and low frequency resonance.
Notch filters	Medium and low frequency resonance	Do not affect the bandwidth of the system.	It is important to know the exact resonance frequency. If make mistake of frequency setting, will affect the performance. It is not suitable that if the resonance frequency drifts all the time.

4.6.1 Low pass filter

Set by parameter P007. The low-pass filter is valid by default. Low pass filter has good attenuation to high frequency, and can better suppress high frequency resonance and noise. For example, when using ball screw machinery to improve the driver gain, sometimes high-frequency resonance will occur, and the use of low-pass filter has a better effect. However, the system response bandwidth and phase margin are also reduced, and the system may become unstable. If the system is medium low frequency resonance, the low-pass filter cannot suppress it.

When the high frequency vibration of the machine is caused by the servo drive, adjust the time constant T_f of the torque filter. This may eliminate the vibration. The smaller the numerical value, the more responsive the control can be, but it is limited by mechanical conditions; the larger the value is, the more high-frequency vibration can be suppressed. If the value is too large, the phase margin will be reduced, causing oscillation. If the load moment of inertia ratio G is set correctly ($G=J_L/J_M$), it shall meet the following requirements:

$$T_f\,(ms) \le \frac{1000}{2\pi \times 2 \times K_v\,(Hz)}$$

4.6.2 Notch filter

Set by parameters P200～P205, two notch filters can be used at the same time to suppress two different frequency resonances. By default, both notch filters are turned off. If the resonance frequency can be known, the notch filter can directly eliminate the resonance. Generally, if the resonant frequency is determined, the notch filter is better than the low-pass filter. When the resonance frequency is unknown, the suppression frequency can be reduced gradually from high to low, and the suppression frequency at the minimum vibration point is the optimal setting value. However, if the resonance frequency shifts with time or other factors and the shift is too large, the notch filter is not suitable for use.

In addition to frequency, the notch depth and quality factor can also be adjusted, but pay attention to the appropriate settings. The notch depth is deep, and the effect of mechanical resonance suppression may be very good, but it will cause a large phase change, and sometimes it will strengthen the vibration. Small quality factor, wide notch width, mechanical resonance suppression may be very good, but it will cause large phase change area, sometimes it will strengthen the vibration.

4.6.3 Automatic notch filter

Select whether to enable the automatic notch filter function by parameter P213: 0 indicates disabled, 1 indicates enabled. The function of automatic notch filter is applicable to the vibration of frequency above 300Hz bandwidth, and can realize the vibration suppression function of this frequency range.

When the parameter P213 is set to 1, the automatic notch filter function will be turned on. When mechanical vibration above 300Hz occurs, the driver will automatically detect the vibration frequency point and set the parameters of the notch filter, and complete the suppression of the vibration point. There is no need to manually set the relevant parameters of the notch filter. The frequency of the detected vibration point is stored in parameter P200.

4.6.4 Notch filter automatic medium frequency vibration suppression

When the parameter P229 medium frequency vibration suppression switch parameter is set to 2, the automatic medium frequency vibration suppression function is enabled. The vibration judgment level can be modified through parameter P289, which is 10rpm by default. When the automatic medium frequency vibration suppression function is enabled, the vibration frequency of 100Hz～1500Hz mechanical vibration can be detected and suppressed. And the detected vibration point frequency value will be stored in P226.

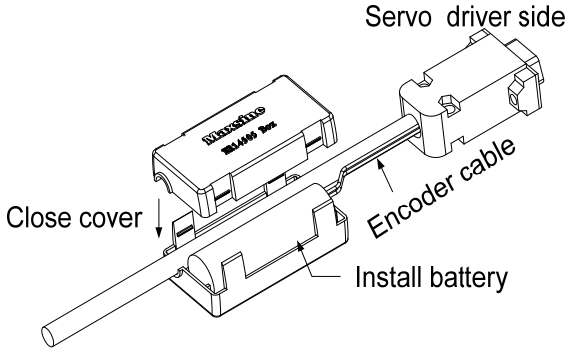
4.7 Absolute value encoder setting

4.7.1 Absolute value encoder multi turn information backup

Absolute value encoder defaults to single turn absolute value. If the user needs multi turn position value, set parameter P090 to 1, save and restart the drive.

In order to save the multi turn position data of the absolute value encoder, a battery unit needs to be installed.

Signal input SD+、SD- (wire color is brown, brown and white), encoder power supply 0V、5V (wire color is black + black and white, red + red and white) are connected to the DB head, and the external battery pins E+、E- (wire color is yellow, yellow and white) are connected to the battery box.



Note: Please set the battery unit on the servo driver side. Please set the battery unit on either side of the servo driver.

Battery voltage requirements: 3.2VDC～4.8VDC

When the battery voltage exceeds the range, the servo driver will give an alarm (Er 48) when it is turned on. At this time, please replace the battery. After replacing the battery, in order to remove the display of "Encoder battery alarm (Er 48)", please ensure that the servo driver is not enabled. Connect the power supply of the servo driver control part and initialize the absolute encoder. After initialization, the multi turn value is 0. Confirm that the error display disappears and the servo driver can work normally.

4.7.2 Initialization of the absolute value encoder

In the following cases, the absolute encoder must be initialized through Fn36. For details, please refer to Section 3.6.1.

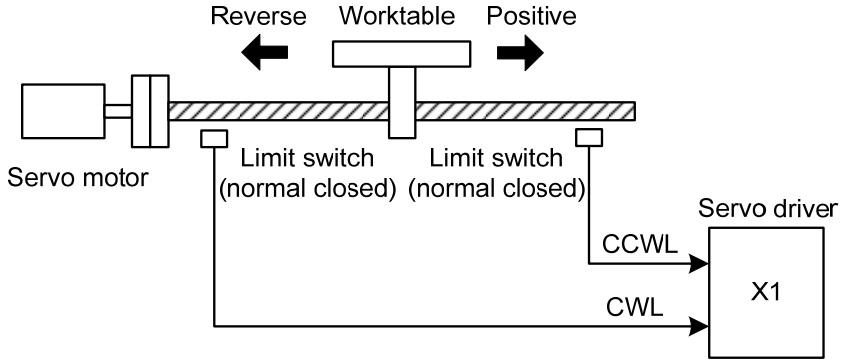
- When the machine is initially started;
- When the rotation amount data of the absolute encoder is to be set to 0.

In the following cases, the encoder alarm must be cleared through Fn37. Please refer to Section 3.6.1 for details.

- When "Encoder battery alarm (Er 48)" occurs;
- When "encoder internal fault alarm (Er 41)" occurs.

4.8 Over-travel protection

Over-travel protection function refers to the safety function that the limit switch acts to force the motor to stop when the moving part of the machine exceeds the designed safe movement range. The diagram of over travel protection is as follows:



It is recommended to use the normally closed contact for the limit switch, which is closed within the safety range, and open if it is over-travel. Connected to forward drive inhibit (CCWL) and reverse drive inhibit (CWL), it can also be set to use and ignore through parameter P097. If it is set to use, the limit signal must be connected; set to ignore, the signal is not required. The default value of the parameter is that CCWL and CWL are ignored. If it needs to be used, the parameter P097 must be modified. Even in the over-travel state, it is still allowed to exit the over-travel state by entering the reverse command.

P097	Reverse drive inhibit (CWL)	Forward drive inhibit (CCWL)
0	Use	Use
1	Use	Ignore
2	Ignore	Use
3(Default)	Ignore	Ignore

4.9 Torque limit

For the purpose of protecting machinery, the output torque can be limited.

4.9.1 Torque limit parameters

Parameters related to torque limit are:

Para meter	Name	Range	Default value	Unit
P065	Internal torque limit in CCW direction	0～500	300	%
P066	Internal torque limit in CW direction	-500～0	-300	%

Torque limits related to CiA402 parameters are:

Index	Name	Units	Range	Data Type	Access	PDO
6072h	Max torque	0.1%	0-65535	U16	rw	RxPDO
60E0h	Positive torque limit value	0.1%	0-65535	U16	rw	RxPDO
60E1h	Negative torque limit value	0.1%	0-65535	U16	rw	RxPDO

4.9.2 Torque limit mode

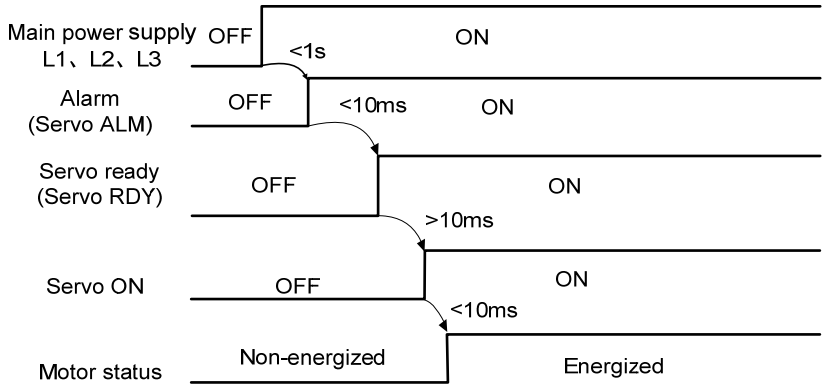
CCW	CW
It is determined by P065、6072h and 60E0h.	It is determined by P066、 6072h and 60E1h.

Note: If multiple limits occur, the final limit value is the value with smaller absolute value.

4.10 Timing chart of operation

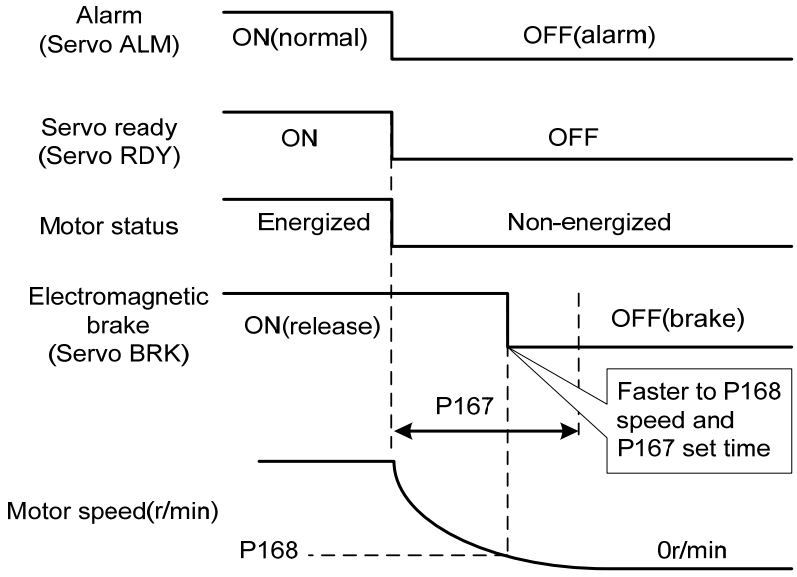
4.10.1 Timing chart when power supply switch on

- After the main power supply turn on, the delay is about 1.5 seconds, and the servo ready signal (RDY) is ON. At this time, the servo enable (SON) signal can be received. The servo enable signal is detected to be effective, the power circuit is turned on, and the motor is excited, and it is in the running state. The servo enable is invalid or there is an alarm, the power circuit is shut down, and the motor is in a free state.



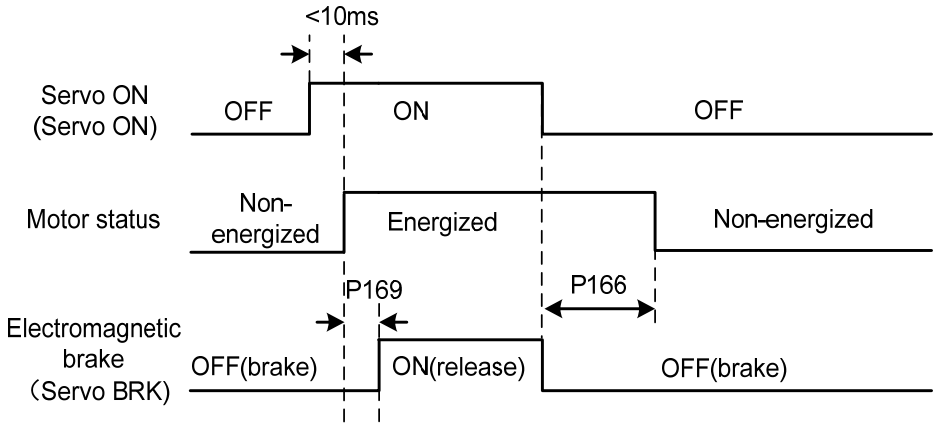
4.10.2 Alarm timing chart while servo-ON is executed

When the electromagnetic brake is servo controlled:



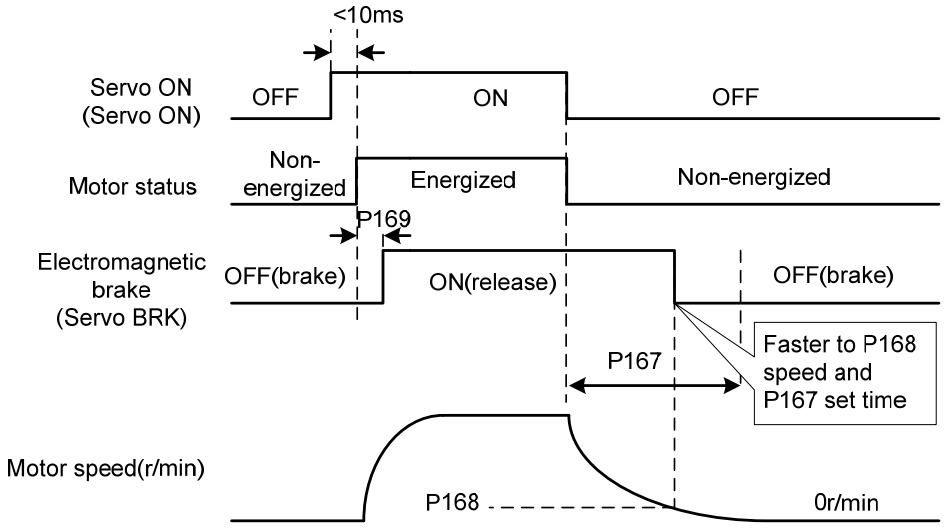
4.10.3 Servo ON/OFF action timing when the motor is stationary

When the motor speed is lower than parameter P165, the action-timing chart is:



4.10.4 Servo ON/OFF action timing when the motor is running

When the motor speed is higher than parameter P165, the action-timing chart is:



4.11 Electromagnetic brake

Electromagnetic brake related parameters:

Para meter	Name	Range	Default value	Unit
P165	Motor static speed detection point	0～1000	5	r/min
P166	Electromagnetic brake delay time when motor is stationary	0～2000	150	ms
P167	Waiting time of electromagnetic brake when motor is running	0～2000	0	ms
P168	Action speed of electromagnetic brake when motor is running	0～3000	100	r/min
P169	Delay time of electromagnetic brake opening	0～1000	0	ms

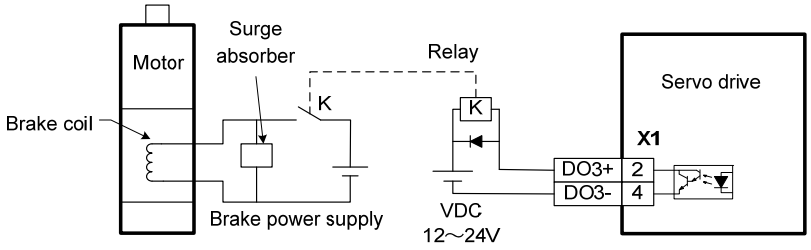
4.11.1 Use of electromagnetic brake

The following figure is the brake wiring diagram. The brake release signal BRK of the driver is connected to the relay coil. And the relay contact is connected to the brake power supply. The brake power supply is provided by the user and has sufficient capacity. It is recommended to install a surge absorber to suppress the surge voltage caused by the on/off action of the relay. Diodes can also be used as surge absorbers, which may cause a little braking delay.

After the motor stops stationary (speed is less than P165) and the servo is OFF. At this time, the motor continues to be turned on to maintain the position. The brake is released to brake. After a period of stability (the time is determined by parameter P166), remove the motor power supply.

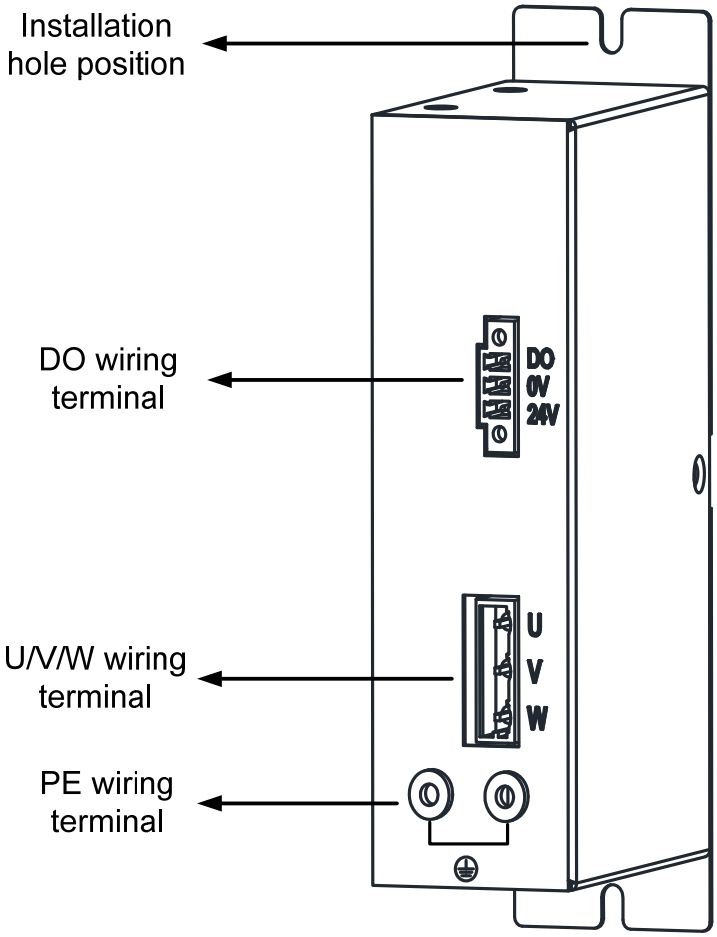
When the motor changes from the non-enable state to the enable state, the delay time from the motor current opening to the electromagnetic brake release (DO output terminal BRK ON) is determined by parameter P169.

When the motor is running (speed is greater than P165), the servo is OFF. At this time, the motor current is cut off, and the brake continues to be released. After a period of delay, the brake is brake. This is to make the motor decelerate from high speed to low speed, and then make the mechanical brake act to avoid damage to the brake. The delay time is the minimum value of parameter P167 or the time required for the motor speed to decelerate to the speed of parameter P168.



4.12 DB servo dynamic brake

Servo dynamic brake is a servo system shutdown auxiliary device. It realizes the quick stop of the servo motor by shorting the electrical circuit of the servo motor, so as to achieve the safety purpose of fast stop and shortening the stop stroke.



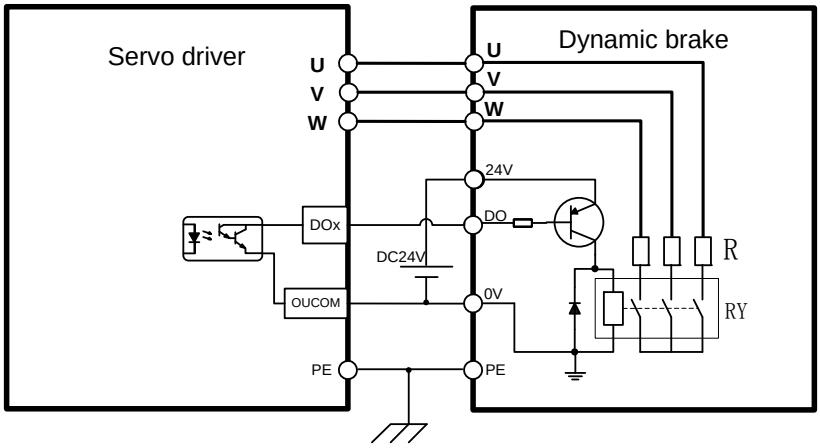
DB - XX

Mark	Mark description
DB	Dynamic brake

Mark	Mark description
L1	Applicable to AC220V servo products
H1	Applicable to AC380V servo products

4.12.1 Wiring diagram

Dynamic brake is internally composed of a normally closed contact relay, which short-circuits the three-phase UVW phase line of the servo motor; When the servo motor works normally, the closed contact will be disconnected. The servo end needs to plan a DO port as a dynamic braking function, which is used to control the opening and closing of the relay; the connection between dynamic brake and servo is shown in the figure below, where DC24V is external DC24V ± 5%.



4.12.2 Application principle and software setting

When the dynamic brake is effective (DB ON), the relay is closed, and the three-phase winding of the servo motor UVW is short-connected through the brake resistor. At this time, if the rotor rotates, the torque will be generated to stop the motor.

Since this resistance torque is generated due to the rotation of the motor rotor, when the rotor does not move, it will not generate resistance torque. Therefore, when the motor shaft is continuously subjected to external force, the dynamic brake cannot keep the motor stopped, so the dynamic brake cannot be used to replace the motor holding brake function.

When using the dynamic brake function, you need to set the software as follows:

Para meter	Name	Range	Default value	Setting value	Unit
P130	Digital output DO1 function	-30～30	2	30	

P130=30, set digital output DO1 as dynamic brake function; If you want to use other DO ports to achieve dynamic brake, you need to plan the corresponding DO ports as dynamic brake functions. See the "5.4 Parameter details" section in the description for details.

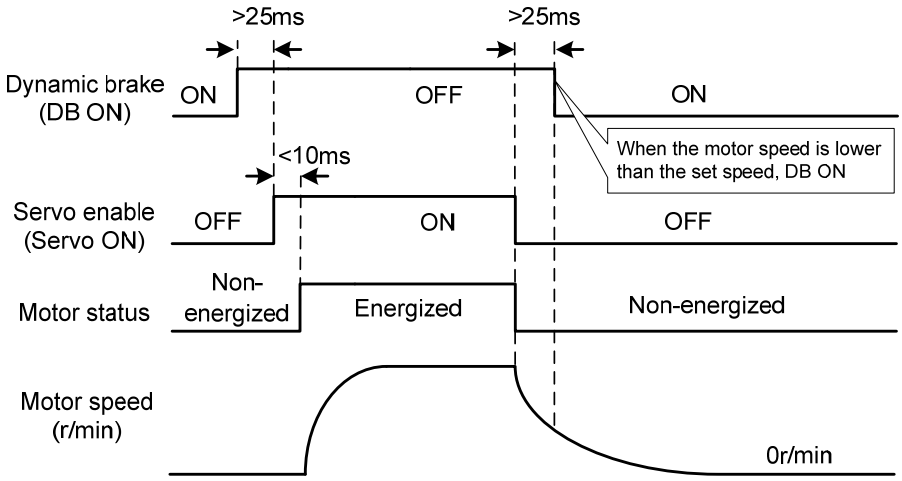
The servo driver has planned the dynamic brake function, and has correctly connected the dynamic brake. If the control power is not cut off, the motor will enter the dynamic brake deceleration process after the enable is cut off, and the dynamic brake will stop after the stop.

When the control power supply is interrupted during operation, whether the dynamic brake function is planned or not, the servo motor will enter the dynamic brake deceleration process. After the motor

stops, it will enter the dynamic brake stop state.

When the servo system is in the power off state, the dynamic brake function state is always effective.

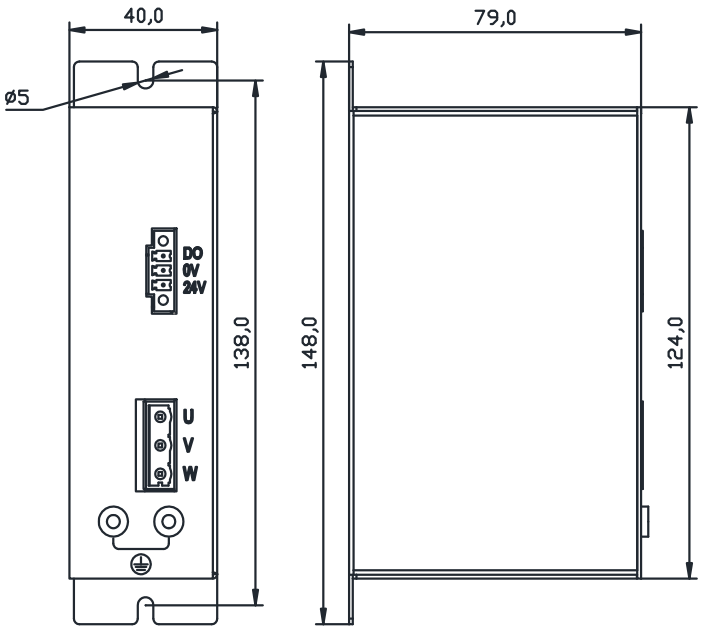
The dynamic brake function timing chart is as follows:



Matters needing attention:

1. This product is a general industrial product and is not intended for the use of machines and systems that affect human life.
2. Do not start and stop the motor rotation through the ON/OFF operation of the SERVO ON signal, otherwise the dynamic brake may be damaged.
3. Do not drive the motor continuously from outside. When the motor is driven externally, it is a generator, which is not affected by the power on/off state. When the dynamic brake works, it passes the short-circuit current. Therefore, if the motor is continuously driven externally, the dynamic brake may smoke or catch fire;
4. Dynamic brake is divided into L1 and H1 models, which are used for AC220V servo products and AC380V servo products respectively. The two cannot be mixed, otherwise the brake may be damaged or the purpose of fast shutdown may not be achieved.

4.12.3 Dynamic brake mounting dimensions



4.13 DB dynamic brake function

Dynamic brake related parameters:

Para meter	Name	Range	Default value	Setting value	Unit
P083	Dynamic braking mode	0～1	0		

The dynamic brake function refers to the quick stop of the servo motor by shorting the electrical circuit of the servo motor. When the dynamic brake is effective (DB ON), the rotation of the servo motor rotor will produce a resistance moment that prevents the rotor from rotating. When the speed of the servo motor is not 0, the dynamic brake can make the motor stop quickly; When the motor is stopped and the motor shaft rotates due to external force, the servo motor will also stop quickly due to the resistance torque.

However, this resistance torque is generated due to the rotation of the motor rotor. If the rotor does not move, no resistance torque will be generated. Therefore, when the motor shaft is continuously subjected to external forces, the dynamic brake cannot keep the motor stopped, so the dynamic brake cannot be used to replace the motor holding brake function.

When the dynamic brake function is invalid (P083=0), and the control power supply is not cut off, decelerate freely when decelerating, and stop freely after stopping.

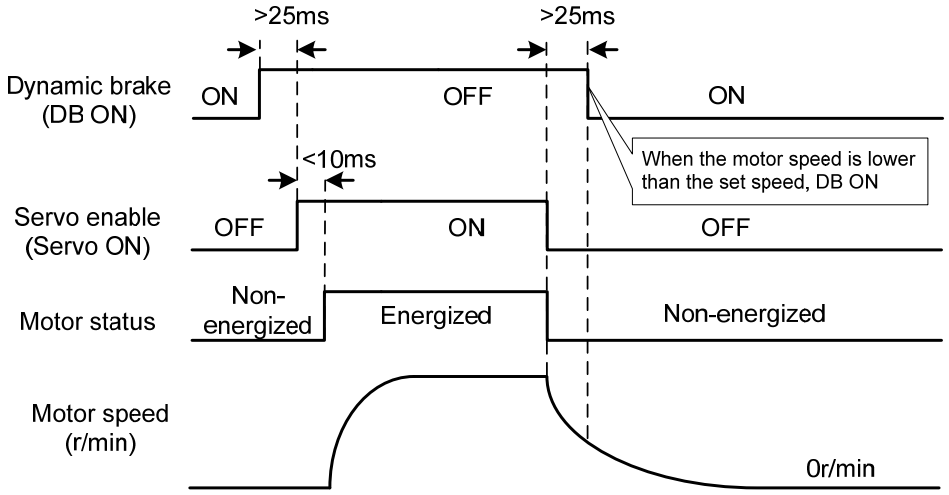
When the dynamic brake function is effective (P083=1), and the control power supply is not cut off, the dynamic brake decelerates when decelerating, and the dynamic brake stops after stopping.

When the control power supply is interrupted during operation, whether the dynamic brake function

is effective or not, the servo motor will enter the dynamic brake deceleration process. After the motor stops, it will enter the dynamic brake stop state.

When the servo system is in the power off state, the dynamic brake function state is always effective.

The dynamic brake function timing chart is as follows:



Note: Model TL04/TL08/TL10 comes with an onboard dynamic braking relay, which only supports internal dynamic braking function and is controlled by P083, without external dynamic braking function; Other models do not have onboard dynamic brake relays, only external dynamic brake functions.

Chapter 5 Parameter

5.1 Parameter overview

The parameter Data Type used in this manual is INT16, and the INT16 range is shown in the following table.

Name	Describe	Range
INT16	Signed 16bit	-32768～32767

Format description of parameters that can be written and read by SDO communication:

The parameters read and written must be decimal integer. The parameters with a decimal point are marked in the display panel of the drive and the instruction manual. During the reading and writing operation, they are magnified by the corresponding multiple, making them become decimal integer. Displays arguments in binary format, the actual decimal integer of their equivalent used during read and write operations.

The details are as follows:

Parameter number	Instruction display value	Communication operation value	Transformation mode
P005	40	40	invariability
P006	20.0	200	We have one decimal point, 10 times
P007	1.00	100	We have two decimal points, 100 times
P120	00000(binary)	0(decimal)	Binary to decimal

5.1.1 Parameters of section 0

Para meter	Name	Range	Default value	Effective mode	Unit
P000	Password	0～9999	315	Immedia tely	
P001	Driver code	*	*		
P003	Software version	*	*		
P004	Control mode	0～5	0	Immedia tely	
P005	1st speed loop gain	1～3000	40		Hz
P006	1st speed loop integral time constant	1.0～1000.0	20.0		ms
P007	1st torque filter time constant	0.01～50.00	1.00		ms
P008	Rigidity class	0～21	0		
P009	1st position loop gain	1～1000	40		l/s
P010	2nd speed loop gain	1～3000	40		Hz
P011	2nd speed loop integral time constant	1.0～1000.0	20.0		ms

Para meter	Name	Range	Default value	Effective mode	Unit
P012	2nd torque filter time constant	0.01～50.00	1.00	Immedia tely	ms
P013	2nd position loop gain	1～1000	40		1/s
P017	Load moment of inertia ratio	0.0～200.0	1.0	Save restart	times
P018	Speed loop PDFF control coefficient	0～100	100	Immedia tely	%
P019	Speed detection filter time constant	0.01～50.00	2.00		ms
P021	Position loop feedforward gain	0～100	0		%
P022	Position loop feedforward filter time constant	0.20～50.00	1.00		ms
P023	Speed loop feedforward gain	0～100	0		%
P024	Speed loop feedforward filtering time constant	0.20～50.00	1.00		ms
P040	Position command exponential smoothing filtering time	0～1000	0	Save restart	ms
P041	Position command exponential linear filtering time	0～256	0		ms
P042	CWL,CCWL direction prohibited mode	0～1	0	Immedia tely	
P060	Speed command acceleration time	0～30000	0		ms
P061	Speed command deceleration time	0～30000	0		ms
P063	EMG(emergency shutdown) deceleration time	0～10000	1000		ms
P064	Torque limit selection	0～3	3		
P065	Internal torque limit in CCW direction	0～500	300		%
P066	Internal torque limit in CW direction	-500～0	-300		%
P067	External torque limit in CCW direction	0～500	100		%
P068	External torque limit in CW direction	-500～0	-100		%
P069	Torque limit in trial running	0～300	100		%
P070	Positive (CCW) torque overload alarm level	0～300	300	Save restart	%
P071	Reverse (CW) torque overload alarm level	-300～0	-300		%
P072	Torque overload alarm detection time	0～10000	0		10ms
P075	Maximum speed limit	0～7500	5000	Immedia tely	r/min
P076	JOG running speed	0～7500	100		r/min
P078	Speed limit in torque control mode	0～5000	3000		r/min
P080	Position deviation detection	0.00～ 327.67	4.00	Save restart	circle
P083	Dynamic braking mode	0～1	0		
P084	Brake resistance selector switch	0～1	0		
P085	Resistance value of external brake resistor	1～750	50		Ω
P086	Power of external brake resistor	1～10000	60		W

Para meter	Name	Range	Default value	Effective mode	Unit
P088	Main encoder manufacturer	0～31	0	Save restart	
P089	Secondary encoder manufacturer	1～31	11		
P090	Main absolute position encoder type	0～2	0		
P091	Sub absolute position encoder type	0～2	0		
P094	Fan on temperature point	25～125	50	Immedia tely	℃
P096	Initial display item	0～29	29		
P097	Ignore drive inhibit	0～3	3		
P098	Forced enable	0～1	0		

5.1.2 Parameters of section 1

Para meter	Name	Range	Default value	Effective mode	Unit
P100	Digital input DI1 function	-37～37	24	Immedia tely	
P101	Digital input DI2 function	-37～37	2		
P102	Digital input DI3 function	-37～37	3		
P103	Digital input DI4 function	-37～37	4		
P110	Digital input DI1 filtering	0.1～100.0	2.0		ms
P111	Digital input DI2 filtering	0.1～100.0	2.0		ms
P112	Digital input DI3 filtering	0.1～100.0	2.0		ms
P113	Digital input DI4 filtering	0.1～100.0	2.0		ms
P118	Digital high-speed input HDI1 filtering	1～8	4	Save restart	
P119	Digital high-speed input HDI2 filtering	1～8	4		
P120	Digital input DI forced valid 1	00000～11111	00000	Immedia tely	
P121	Digital input DI forced valid 2	00000～11111	00000		
P122	Digital input DI forced valid 3	00000～11111	00000		
P123	Digital input DI forced valid 4	00000～11111	00000		
P124	Digital input DI forced valid 5	00000～11111	00000		
P125	Digital input DI forced valid 6	00000～11111	00000		
P126	Digital input DI forced valid 7	00000～11111	00000		
P127	Digital input DI forced valid 8	00000～11111	00000		
P130	Digital output DO1 function	-30～30	2		
P131	Digital output DO2 function	-30～30	3		
P132	Digital output DO3 function	-30～30	8		
P138	Digital output DO forced selection 1	0～7	0		

Para meter	Name	Range	Default value	Effective mode	Unit
P139	Digital output DO forced content 1	0～7	0	Immedia tely	
P149	Dynamic braking delay time	30～1000	100		ms
P150	Positioning completion range	0～32767	10		pulse
P151	Positioning completion hysteresis	0～32767	5		pulse
P152	Positioning approach range	0～32767	500		pulse
P153	Positioning approach hysteresis	0～32767	50		pulse
P154	Arrival speed	-5000～5000	500		r/min
P155	Arrival speed hysteresis	0～5000	30		r/min
P156	Arrival speed polarity	0～1	0		
P157	Arrival torque	-300～300	100		%
P158	Arrival torque hysteresis	0～300	5		%
P159	Arrival torque polarity	0～1	0		
P160	Zero speed detection point	0～1000	10		r/min
P161	Zero speed detection hysteresis	0～1000	5		r/min
P162	Zero speed clamp mode	0～1	0		
P163	Position deviation clearing mode	0～1	0		
P164	Emergency shutdown mode	0～2	0		
P165	Motor static speed detection point	0～1000	5		r/min
P166	Electromagnetic brake delay time when motor is stationary	0～2000	150		ms
P167	Waiting time of electromagnetic brake when motor is running	0～2000	0		ms
P168	Action speed of electromagnetic brake when motor is running	0～3000	100		r/min
P169	Delay time of electromagnetic brake opening	0～1000	0		ms
P172	Encoder output lines	1～16384	2500	Save restart	
P173	Encoder outputs B pulse phase	0～1	0		
P174	Encoder outputs Z pulse phase	0～1	0		
P175	Encoder outputs Z pulse width	0～1	0		
P195	Encoder multi turn overflow alarm shielding	0～1	1		

5.1.3 Parameters of section 2

Para meter	Name	Range	Default value	Effective mode	Unit
P200	1st notch filter frequency	50～5000	5000	Immediately	Hz
P201	1st notch filter quality factor	1～100	7		
P202	1st notch filter depth	0～60	0		dB
P203	2nd notch filter frequency	50～5000	5000		Hz
P204	2nd notch filter quality factor	1～100	7		
P205	2nd notch filter depth	0～60	0		dB
P206	2nd torque filter frequency	100～5000	5000		Hz
P207	2nd torque filter quality factor	1～100	50		
P208	Gain switching selection	0～15	0		
P209	Gain switching level	0～32767	100		
P210	Gain switching level hysteresis	0～32767	5		
P211	Gain switching delay time	0～3000	5		ms
P212	Gain switching time	0～3000	5		ms
P213	Automatic notch filter on	0～FFFF	0		
P214	3rd notch filter frequency	50～5000	5000		Hz
P215	3rd notch filter quality factor	1～100	7		
P216	3rd notch filter depth	0～60	0		dB
P217	4th notch filter frequency	50～5000	5000		Hz
P218	4th notch filter quality factor	1～100	7		
P219	4th notch filter depth	0～60	0		dB
P220	End vibration detection filter frequency	10～2000	200		Hz
P221	Minimum detection amplitude of end vibration	3～32767	5		pulse
P222	Compensation coefficient of end vibration suppression	1.0～100.0	1.0		
P223	End vibration suppression switch	0～3	0		
P224	Manual setting of end vibration suppression period	0～1000	0		ms
P225	Reserved by the manufacturer	0～1	0		
P226	Medium frequency vibration 1 frequency	50～2000	100		Hz
P227	Compensation coefficient of medium frequency vibration suppression 1	1～1000	100		%
P228	Damping coefficient of medium frequency vibration suppression 1	0～300	100		%

Para meter	Name	Range	Default value	Effective mode	Unit
P229	Medium frequency vibration suppression 1 switch	0～2	0		
P231	Medium frequency vibration 2 frequency	50～2000	100		Hz
P232	Compensation coefficient of medium frequency vibration suppression 2	1～1000	100		%
P233	Damping coefficient of medium frequency vibration suppression 2	0～300	100		%
P234	Medium frequency vibration suppression 2 switch	0～2	0		
P236	Speed feedback source	0～1	0		
P237	Medium frequency vibration suppression mode in high response mode	0～1	1		
P238	High immunity mode gain percentage in high response mode	0～1000	50		%
P239	High immunity mode switch in high response mode	0～2	0		
P240	High response mode tracking gain	10～1000	100		%
P241	Friction compensation gain percentage	10～1000	100	Immedia	%
P242	Friction compensation ratio	0～1000	0	tely	%
P243	Friction compensation observer gain	0～1200	400		Hz
P244	Current loop mode selection in high response mode	0～3	0		
P245	High response mode speed observer nonlinear mode	0～1	1		
P246	High response mode speed feedback source	0～1	0		
P247	High response mode enable	0～2	0		
P248	High response mode speed observer bandwidth	100～2000	150		Hz
P249	High response mode speed observer bandwidth parameter setting is valid	0～1	1		
P250	High response mode current observer bandwidth	50～400	180		10Hz
P251	High response mode current observer bandwidth parameter setting is valid	0～1	0		
P252	High response mode 1st torque filtering time constant	0.05～5.00	0.10		ms

Para meter	Name	Range	Default value	Effective mode	Unit
P253	High response mode speed observer type	0～5	0	Immediately	
P254	High response mode speed observer non exponential gain multiple	0.0～10.0	1.5		times
P255	Speed observer gain	10～1000	120		Hz
P256	Speed observer compensation coefficient	0～1000	150		%
P258	Inertia identification	0～9	0		
P269	Inertia estimation mode	0～10	0		
P270	Model tracking control switch	0～3	0		
P271	Model tracking control gain	10～2000	40		Hz
P272	Model tracking damping ratio	50～200	100		
P273	Model tracking positive direction output ratio	0～1000	100		%
P274	Model tracking reverse direction output ratio	0～1000	100		%
P277	Model tracking speed compensation feedforward	0～100	100		%
P280	Model tracking speed compensates feedforward filtering time	0.10～50.00	0.50		ms
P281	Model tracking speed loop gain	1～3000	40		Hz
P282	Model tracking speed loop integral time constant	1.0～1000.0	20.0		ms
P283	Inertia estimation gain level	0～2	0		
P285	Vibration alarm time	0～100	0		s
P289	Vibration detection level	0～2000	60		Hz
P296	Self tuning mode	0～3	0		

5.1.4 Parameters of section 3

Parameter	Name	Range	Default value	Effective mode	Unit
P300	Device address	0～239	0	Save restart	
P305	Speed return filtering time constant	0.1～300.0	0.1		ms
P306	Path segment interpolation type	0～2	2		
P377	PP path Halt recovery mode	0～1	0	Immediately	

5.1.5 Parameters of section 4

Parameter	Name	Range	Default value	Effective mode	Unit
P472	Number of forward turns of round-trip motion	1～32767	3	Immediately	
P473	Number of reverse turns of round-trip motion	1～32767	3		
P474	Round-trip speed	1～32767	1000		rpm
P475	Round-trip acceleration time	0～32767	100		ms
P476	Round-trip deceleration time	0～32767	100		ms

5.2 DI function list

Ordinal	Symbol	DI Function
0	NULL	No function
2	ARST	Clear alarm
3	CCWL	CCW drive inhibit
4	CWL	CW drive inhibit
15	EMG	Emergency shutdown
24	REF	Homing reference point

5.3 DO function list

Ordinal	Symbol	DO Function
0	OFF	Always invalid
1	ON	Always valid
2	RDY	Servo ready
3	ALM	Alarm
8	BRK	Electromagnetic brake
9	RUN	Servo running
11	TRQL	In torque limit
12	SPL	In speed limit
13	HOME	Homing complete
23	BRKNET	Electromagnetic Brake (EtherCAT Object Control)
24	NETIO1	EtherCAT corresponding control word control IO
25	NETIO2	
26	NETIO3	
27	NETIO4	
28	NETIO5	
30	DBC	Dynamic Braking

5.4 Parameter details

5.4.1 Parameters of section 0

P000	Index None	Password					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	0～9999	315	

- Hierarchical parameter management can guarantee the parameters cannot modify by mistake.
- Setting this parameter as 315 can examine, modify the parameters of the 0、1、2 and 3 sections. For other setting only can examine, but cannot modify parameters.
- Some special operations need to set a suitable password.

P001	Index None	Driver code					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	*	*	

- The drive model currently in use. It has been set in the factory and cannot be modified by the user.

P003	Index 2003h	Software version					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	*	*	

- The software version number cannot be modified.

P004	Index None	Control mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	0～5	0	

- Parameter meaning:
  0: Position control mode;
  1: Speed control mode;
  2: Torque control mode;
  3～5: Reserved.

P005	Index 2005h	1st speed loop gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～3000	40	Hz

- The proportional gain of the speed regulator can accelerate the speed response by increasing the parameter value. If it is too large, it is easy to cause vibration and noise.

- If P017 (moment of inertia ratio) is set correctly, the parameter value is equal to the speed response bandwidth.

P006	Index 2006h	1st speed loop integral time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1.0～1000.0	20.0	ms

- The integral time constant of the speed regulator can reduce the speed control error and increase the rigidity by reducing the parameter value. If it is too small, it is easy to cause vibration and noise.
- Setting to the maximum value (1000.0) means canceling integration, and the speed regulator is a P controller.

P007	Index 2007h	1st torque filter time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.01～50.00	1.00	ms

- Torque low-pass filter can suppress mechanical vibration.
- The larger the value is, the better the vibration suppression effect will be. If the value is too large, the response will become slower, which may cause oscillation; the smaller the value, the faster the response, but limited by mechanical conditions.
- When the load inertia is small, a smaller value can be set; when the load inertia is large, a larger value can be set.

P008	Index None	Rigidity class					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～21	0	

- Parameter meaning:
  0: The rigidity level setting is not effective
  1-21: The higher the level setting, the faster the system response, but excessive rigidity may cause vibration

P009	Index 2009h	1st position loop gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～1000	40	1/s

- Proportional gain of position regulator; Increasing the parameter value can reduce the position tracking error and improve the response. Overshoot or oscillation may occur if the parameter value is too large.

P010	Index None	2nd speed loop gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	1～3000	40	Hz

- Refer to the description of parameter P005. Only when the gain switching function is enabled, it

needs to be set.

P011	Index None	2nd speed loop integral time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	1.0～1000.0	20.0	ms

- Refer to the description of parameter P006. Only when the gain switching function is enabled, it needs to be set.

P012	Index None	2nd torque filter time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	0.01～50.00	1.00	ms

- Refer to the description of parameter P007. Only when the gain switching function is enabled, it needs to be set.

P013	Index None	2nd position loop gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	1～1000	40	1/s

- Refer to the description of parameter P009. Only when the gain switching function is enabled, it needs to be set.

P017	Index 2011h	Load moment of inertia ratio					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～200.0	1.0	times

- The ratio of the moment of inertia of a mechanical load (converted to the motor shaft) to the moment of inertia of the motor rotor.

P018	Index 2012h	Speed loop PDFF control coefficient					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～100	100	%

- For the PDFF coefficient of the speed regulator, the speed controller structure can be selected. 0 is the IP regulator, 100 is the PI regulator. And 1 ～ 99 is the PDFF regulator.
- If the parameter value is too large, the system will have high frequency response; if the parameter value is too small, the system will have high stiffness (resistance to deviation); if the parameter value is too small, both frequency response and stiffness will be considered.

P019	Index 2013h	Speed detection filter time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.01～50.00	2.00	ms

- The larger the parameter value, the smoother the detection, the smaller the parameter value, the

faster the detection response, too small may lead to noise; Too large can cause oscillation.

P021	Index 2015h	Position loop feed forward gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～100	0	%

- Feed forward can reduce the position tracking error in position control mode. When set to 100, the position tracking error is always 0 at any frequency of command pulse.
- When the parameter value increases, the position control response will be improved. If the parameter value is too large, the system will be unstable and easy to oscillate.

P022	Index 2016h	Position loop feed forward filter time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.20～50.00	1.00	ms

- The function of filtering the feed forward of position loop is to increase the stability of feed forward control.

P023	Index None	Speed loop feedforward gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～100	0	%

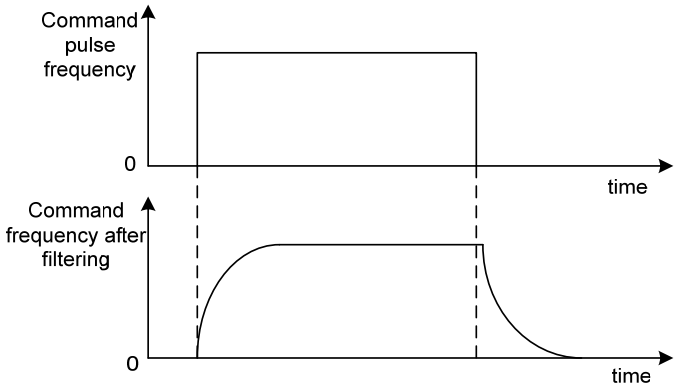
- When the parameter value increases, the speed control response will be improved. If the parameter value is too large, the system will be unstable and easy to oscillate.

P024	Index None	Speed loop feedforward filtering time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.20～50.00	1.00	ms

- The filtering of the speed loop feedforward is used to increase the stability of the feedforward control.

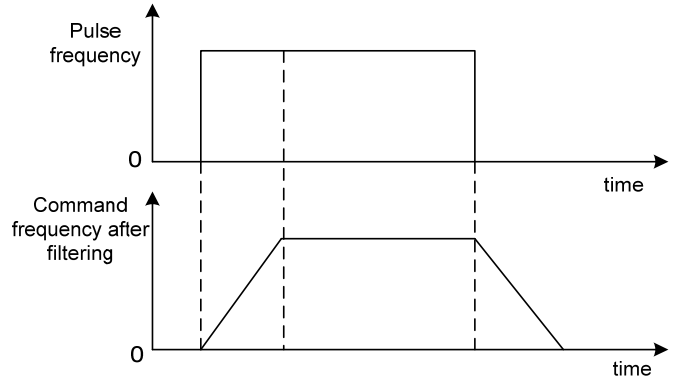
P040	Index None	Position command exponential smoothing filtering time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	0	ms

- The command pulse is smoothed and filtered with exponential acceleration and deceleration. The filter will not lose the input pulse, but the command delay will occur. When it is set to 0, the filter will not work.
- This filter is used to:
  1. The host controller has no acceleration and deceleration function;
  2. The electronic gear ratio is large (N/M>10);
  3. The command frequency is low;
  4. When the motor is running, the phenomenon of step jumping and instability occurs.



P041 Index None	Position command exponential linear filtering time					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	0～256	0	ms

- The command pulse is smoothed and filtered with linear acceleration and deceleration. The filter will not lose the input pulse, but the command delay will occur. When it is set to 0, the filter will not work. The parameter value represents the time from 0 frequency to 100% of the position command frequency.
- This filter is used to:
  1. The host controller has no acceleration and deceleration function;
  2. The electronic gear ratio is large (N/M>10);
  3. The command frequency is low;
  4. When the motor is running, the phenomenon of step jumping and instability occurs.



P042 Index None	CWL,CCWL direction prohibited mode					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	0～1	0	

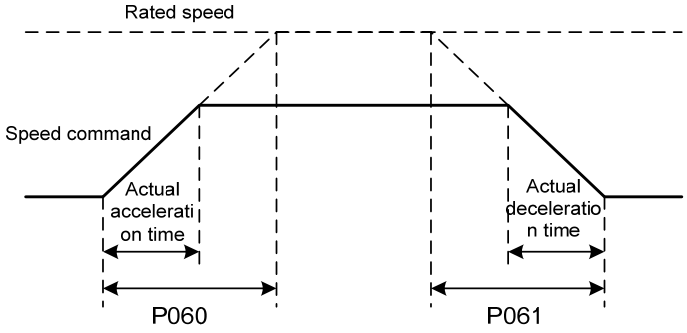
- When the machine touches the mechanical limit switch and triggers CWL and CCWL limits, this parameter is used to select the prohibited mode.
- Parameter meaning:

0: Limit the torque in this direction to 0

1: Pulse input in this direction is prohibited

P060	Index 203Ch	Speed command acceleration time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～30000	0	ms

- Set the acceleration time of motor from zero speed to rated speed.
- If the command speed is lower than the rated speed, the required acceleration time will be reduced accordingly.
- Only for speed control mode, position control mode is invalid.
- If the driver is operating in speed mode and the host (PLC, etc.) performs position closed-loop control, this parameter should be set to 0, otherwise it will affect position control performance.



P061	Index 203Dh	Speed command deceleration time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～30000	0	ms

- Set the deceleration time of motor from rated speed to zero speed.
- If the command speed is lower than the rated speed, the deceleration time required will be reduced accordingly.
- Only for speed control mode, position control mode is invalid.
- If the driver is used in combination with the external position loop, this parameter should be set to 0, otherwise the position control performance will be affected

P063	Index None	EMG(emergency shutdown) deceleration time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～10000	1000	ms

- It works when EMG (emergency shutdown) mode is deceleration stop (P164=2).
- Set the deceleration time of EMG (emergency shutdown) motor from current speed to zero speed.

P064	Index None	Torque limit selection					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	3	

- Set torque limit mode:

P064	Explanation	CCW	CW
0	Basic limit	Determined by DI input TCCW: TCCW =OFF: parameter P065 TCCW =ON : parameter P067	Determined by DI input TCW: TCW =OFF: parameter P066 TCW =ON : parameter P068
1			
2			
3	0x60 Object Control	In addition to basic control, it is also limited by objects 0x6072, 0x60E0, and 0x60E2.	

Note: 1. If multiple restrictions occur, the final limit value is the value with the smaller absolute value.

2. The limitations of P065 and P066 are valid at all times.

3. Even if the set value exceeds the maximum torque allowed by the system, the actual torque will be limited to within the maximum torque.

P065	Index 2041h	Internal torque limit in CCW direction					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～500	300	%

- Set the internal torque limit value in the CCW direction of the motor.
- This limit is valid at any time.
- If the set value exceeds the maximum overload capacity allowed by the system, the actual limit is the maximum overload capacity allowed by the system.

P066	Index 2042h	Internal torque limit in CW direction					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-500～0	-300	%

- Set the internal torque limit in the CW direction of the motor.
- This limit is valid at any time.
- If the set value exceeds the maximum overload capacity allowed by the system, the actual limit is the maximum overload capacity allowed by the system.

P067	Index 2043h	External torque limit in CCW direction					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～500	100	%

- Set the external torque limit value in the CCW direction of the servo motor.
- This limit is only valid when the TCCW (positive torque limit) of the DI input is ON.
- When the limit is effective, the actual torque limit is the minimum of the maximum overload

capacity allowed by the system, internal positive torque limit, and external positive torque limit.

P068	Index 2044h	External torque limit in CW direction					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-500～0	-100	%

- Set the external torque limit value in the CCW direction of the servo motor.
- This limit is only valid when the TCW (reverse torque limit) of the DI input is ON.
- When the limit is effective, the actual torque limit is the minimum of the maximum overload capacity allowed by the system, internal reverse torque limit, and external reverse torque limit.

P069	Index None	Torque limit in trial running					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～300	100	%

- Set the torque limit value for trial running mode (speed JOG operation, keyboard speed adjustment, demonstration mode).
- Regardless of the direction of rotation, both CCW and reverse CW are limited.
- The internal and external torque limits are still valid.

P070	Index 2046h	Positive (CCW) torque overload alarm level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～300	300	%

- Set CCW torque overload value, which is the percentage of rated torque.
- When the CCW torque of the motor exceeds P070 and the duration is greater than P072, the driver alarms with the alarm number of Er 29 and the motor stops.

P071	Index 2047h	Reverse (CW) torque overload alarm level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-300～0	-300	%

- Set CW torque overload value, which is the percentage of rated torque.
- When the CW torque of the motor exceeds P071 and the duration is greater than P072, the driver alarms with the alarm number of Er 29 and the motor stops.

P072	Index 2048h	Torque overload alarm detection time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～10000	0	10ms

- Refer to the description of parameters P070 and P071.
- When set to 0, shield the torque overload alarm.

P075	Index 204Bh	Maximum speed limit					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～7500	5000	r/min

- Set the allowable maximum speed limit of the servo motor.
- Independent of the direction of rotation.
- If the setting value exceeds the maximum speed allowed by the system, the actual speed will also be limited within the maximum speed.

P076	Index None	JOG running speed					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	No	0～7500	100	r/min

- Set the running speed of JOG operation.

P078	Index 204Eh	Speed limit in torque control mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～5000	3000	r/min

- In torque control mode, the motor running speed is limited within this parameter.
- It can prevent overspeed under light load.
- In case of overspeed, speed negative feedback is connected to reduce the actual torque, but the actual speed will be slightly higher than the speed limit.

P080	Index 2050h	Position deviation detection					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.00～327.67	4.00	circle

- Set the position deviation alarm detection range.
- In the position control mode, when the count value of the position deviation counter exceeds the pulse corresponding to this parameter value, the servo driver gives a position deviation alarm (Er 4).
- The unit is circle. Multiply the resolution of each cycle of the encoder to obtain the number of pulses. If a 2500 lines encoder is used, the resolution of each turn of the encoder is 10000. When the parameter value is 4.00, it corresponds to 40000 encoder pulses.

P083	Index None	Dynamic braking mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:

  0: Do not use dynamic braking;

1: Using dynamic braking;

P084	Index 2054h	Brake resistance selector switch					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:

  0: Adopting internal brake resistance.

  1: Adopting external brake resistance.

P085	Index 2055h	Resistance value of external brake resistor					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～750	50	Ω

- Set this parameter according to the resistance value of the actual external brake resistor.
- If the internal brake resistor (P084=0) is used, this parameter is invalid.

P086	Index 2056h	Power of external brake resistor					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～10000	60	W

- Set this parameter according to the resistance value of the actual external brake resistor.
- If the internal brake resistor (P084=0) is used, this parameter is invalid.

P088	Index None	Main encoder manufacturer					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～31	0	

- Parameter meaning:

  0: Automatic recognition

  1: Tamagawa 2.5M, 17/23Bit

  6: Magnetic encoder

P089	Index None	Secondary encoder manufacturer					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～31	11	

- Parameter meaning:

  1: Tamagawa 2.5M, 17/23Bit

  6: Magnetic encoder

- The secondary encoder cannot be set to automatic recognition.
- This parameter is invalid in the TL04, TL08, and TL10 series, and is valid in all other series.

P090	Index 205Ah	Main absolute position encoder type					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- Parameter meaning:
  0: Single turn absolute encoder.
  1: Multi turn absolute encoder.
  2: Absolute value encoders are used incrementally.
- When the encoder does not have an external battery, the encoder cannot save multi turn information. Please set this parameter to 0.

P091	Index None	Sub absolute position encoder type					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- Parameter meaning:
  0: Single turn absolute encoder.
  1: Multi turn absolute encoder.
  2: Absolute value encoders are used incrementally.
- This parameter is invalid in the TL04, TL08, and TL10 series, and is valid in all other series.

P094	Index 205Eh	Fan on temperature point					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	25～125	50	℃

- When the power module temperature is ＞P094, the driver cooling fan starts to work.
- When the power module temperature is ＜P094, the driver cooling fan stops working.
- When P094=25℃, the driver cooling fan will work all the time.

P096	Index None	Initial display item					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～29	29	

- Set the display status on the front panel after turn on the power supply.
- Parameter meaning:

P096	Display item	P096	Display item
0	Motor speed	15	Digital output DO
1	Initial position command	16	Reserved
2	Position command	17	Absolute position in one turn
3	Motor position	18	Cumulative load rate
4	Position deviation	19	Braking load rate
5	Torque	20	Control mode
6	Peak torque	21	Alarm code
7	Current	22	Reserved display
8	Peak current	23	Load inertia ratio, reserved
9	Pulse input frequency	24	Bus voltage
10	Speed command	25	Reserved display
11	Torque command	26	Module internal temperature
12	Reserved	27	Encoder multi-turn position
13	Reserved	28	History alarm code display
14	Digital input DI	29	EtherCAT status display

P097	Index 2061h	Ignore drive inhibit					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	3	

- The forward drive inhibit (CCWL) and reverse drive inhibit (CWL) in DI input are used for limit travel protection. The normally closed switch is adopted. When the input is ON, the motor can run in this direction, and when it is OFF, it cannot run in this direction. If the limit travel protection is not used, it can be ignored through this parameter, so it can operate without connecting the drive inhibit signal.
- The default value is to ignore the drive inhibit. If you need to use the drive inhibit function, please modify this value first.
- Parameter meaning:

P097	Reverse drive inhibit (CWL)	forward drive inhibit (CCWL)
0	Use	Use
1	Use	Ignore
2	Ignore	Use
3	Ignore	Ignore

Use: When the input signal is ON, the motor can run in this direction; When OFF, the motor cannot run to this side.

Ignore: The motor can run in this direction, and the drive inhibit signal has no effect, so it cannot be connected.

P098 Index None	Force enable					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RO	Yes	0～1	0	

- P098 parameter is invalid in network mode. Press and hold Fn-2 to enter normal mode.
- Parameter meaning:

  0: Enable to be controlled by SON input by DI;

  1: Software forced enable.

5.4.2 Parameters of section 1

P100	Index 2064h	Digital input DI1 function					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-37～37	24	

- Digital input DI1 function planning, parameter absolute value represents function, and symbol represents logic. Please refer to chapter 5.5 for functions.
- Symbols indicate input logic, positive numbers indicate positive logic, negative numbers indicate negative logic, ON is valid, OFF is invalid:

Parameter value	DI input signal	DI result
Positive number	Turn off	OFF
	Turn on	ON
Negative number	Turn off	ON
	Turn on	OFF

- When multiple input channels have the same function selection, the function result is logic or relationship. For example, if both P100 and P101 are set to 1 (SON function), then SON is valid when either DI1 or DI2 is ON.
- If there is no input function selected by parameters P100～P103, that is, the function is not planned, the result is OFF (invalid). However, there are exceptions. Setting parameters P120～P127 can force the input function ON (valid), regardless of whether the function is planned or not.

P101	Index 2065h	Digital input DI2 function					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-37～37	2	

- Digital input DI2 function planning, refer to parameter P100 description.

P102	Index 2066h	Digital input DI3 function					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-37～37	3	

- Digital input DI3 function planning, refer to parameter P100 description.

P103	Index 2067h	Digital input DI4 function					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-37～37	4	

- Digital input DI4 function planning, refer to parameter P100 description.

P110	Index 206Eh	Digital input DI1 filtering					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.1～100.0	2.0	ms

- DI1 input digital filtering time constant.
- The smaller the parameter value, the faster the signal response speed. The larger the parameter value is, the slower the signal response speed is, but the stronger the noise filtering ability is.

P111	Index 206Fh	Digital input DI2 filtering					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.1～100.0	2.0	ms

- DI2 input digital filtering time constant. Refer to the description of parameter P110.

P112	Index 2070h	Digital input DI3 filtering					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.1～100.0	2.0	ms

- DI3 input digital filtering time constant. Refer to the description of parameter P110.

P113	Index 2071h	Digital input DI4 filtering					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.1～100.0	2.0	ms

- DI4 input digital filtering time constant. Refer to the description of parameter P110.

P118	Index None	Digital high-speed input HDI1 filtering					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～8	4	

- Parameter meaning:
  1～8: Enhanced filtering ability from low to high

P119	Index None	Digital high-speed input HDI2 filtering					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～8	4	

- Parameter meaning:
  1～8: Enhanced filtering ability from low to high

P120 Index 2078h	Digital input DI forced valid 1					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	CWL	CCWL	ARST	SON	NULL

- The function used to force DI input is valid. If the function corresponding bit is set to 1, the function is forced ON (valid).
- Refer to chapter 5.5 for the meaning of DI symbols. Parameter meaning:

A bit in this parameter	Function[note]	Function result
0	Not planned	OFF
	Planned	Determined by input signal
1	Not planned or planned	ON

Note: Planned refers to the function selected by parameters P100～P103;
Not planned refers to the function not selected by parameters P100～P103.

P121 Index 2079h	Digital input DI forced valid 2					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	CINV	CZERO	ZCLAMP	TCW	TCCW

- Description of other reference parameter P120.

P122 Index 207Ah	Digital input DI forced valid 3					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	TRQ2	TRQ1	SP3	SP2	SP1

- Description of other reference parameter P120.

P123 Index 207Bh	Digital input DI forced valid 4					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	GEAR2	GEAR1	GAIN	CMODE	EMG

- Description of other reference parameter P120.

P124	Index 207Ch	Digital input DI forced valid 5					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	REF	GOH	PC	INH	CLR

- Description of other reference parameter P120.

P125	Index None	Digital input DI forced valid 6					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	Reserved	Reserved	Reserved	Reserved	Reserved

- Description of other reference parameter P120.

P126	Index None	Digital input DI forced valid 7					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	Reserved	Reserved	Reserved	Reserved	Reserved

- Description of other reference parameter P120.

P127	Index None	Digital input DI forced valid 8					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	00000～11111	00000	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	Reserved	Reserved	Reserved	Reserved	Reserved

- Description of other reference parameter P120.

P130 Index 2082h	Digital output DO1 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-30～30	2	

- Digital output DO1 function planning, parameter absolute value represents function, and symbol represents logic. Please refer to chapter 5.6 for functions.
- 0 is forced OFF and 1 is forced ON.
- Symbols represent output logic, positive numbers represent positive logic, and negative numbers represent negative logic:

Parameter value	Function	DO output signal
Positive number	ON	Turn on
	OFF	Turn off
Negative number	ON	Turn off
	OFF	Turn on

P131 Index 2083h	Digital output DO2 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-30～30	3	

- Digital output DO2 function planning, refer to parameter P130 description.

P132 Index 2084h	Digital output DO3 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-30～30	8	

- Digital output DO3 function planning, refer to parameter P130 description.

P138 Index None	Digital output DO forced selection 1					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	0～7	0	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	Reserved	Reserved	DO3	DO2	DO1

- The force used to select DO output is valid.

  1: The DO output force ON and force OFF are set by P139.

  0: This DO outputs normally.

P139	Index None	Digital output DO forced content 1					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～7	0	

- Corresponding functions are represented by 5-bit binary:

Bit number	bit4	bit3	bit2	bit1	bit0
Function	Reserved	Reserved	DO3	DO2	DO1

1: Indicates that the corresponding DO output is forced ON (valid), and the P138 parameter takes effect when the bit is set to 1.

0: Indicates that the corresponding DO output is forced to be OFF (invalid), and takes effect when the bit corresponding to the P138 parameter is set to 1.

P149	Index None	Dynamic braking delay time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	30～1000	100	ms

- Parameter meaning:

  When the dynamic braking delay time is set to 0, the dynamic braking function is invalid.

P150	Index None	Positioning completion range					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～32767	10	pulse

- Set the positioning completion pulse range in the position control mode.
- When the number of remaining pulses in the position deviation counter is less than or equal to the set value of this parameter, the COIN (positioning completion) of the digital output DO is ON, otherwise it is OFF.
- The comparator has the function of hysteresis, which is set by parameter P151.

P151	Index None	Positioning completion hysteresis					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～32767	5	pulse

- Refer to the description of parameter P150.

P152	Index None	Positioning approach range					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～32767	500	pulse

- Set the positioning approach pulse range in the position control mode.
- When the number of remaining pulses in the position deviation counter is less than or equal to the

set value of this parameter, the NEAR of the digital output DO NEAR (near positioning) is ON, otherwise it is OFF.

- The comparator has the function of hysteresis, which is set by parameter P153.
- When the positioning is about to be completed, the host receives the NEAR signal to prepare for the next step. Generally, the parameter value should be greater than P150.

P153	Index None	Positioning approach hysteresis					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～32767	50	pulse

- Refer to the description of parameter P152.

P154	Index None	Arrival speed					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-5000～5000	500	r/min

- When the motor speed exceeds this parameter, the ASP (arrival speed) of the digital output DO is ON, otherwise it is OFF.
- The comparator has the hysteresis function, which is set by parameter P155.
- With polarity setting function:

P156	P154	Comparator
0	>0	detect CCW or CW speed
1	>0	Only detect CCW speed
	<0	Only detect CW speed

P155	Index None	Arrival speed hysteresis					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～5000	30	r/min

- Refer to the description of parameter P154.

P156	Index None	Arrival speed polarity					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Refer to the description of parameter P154.

P157	Index None	Arrival torque					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-300～300	100	%

- When the motor torque exceeds this parameter, the ATRQ (arrival torque) of the digital output DO is ON, otherwise it is OFF.
- The comparator has the hysteresis function, which is set by parameter P158.
- With polarity setting function:

P159	P157	Comparator
0	>0	detect CCW or CW torque
1	>0	Only detect CCW torque
	<0	Only detect CW torque

P158	Index None	Arrival torque hysteresis					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～300	5	%

- Refer to the description of parameter P157.

P159	Index None	Arrival torque polarity					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Refer to the description of parameter P157.

P160	Index 20A0h	Zero speed detection point					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	10	r/min

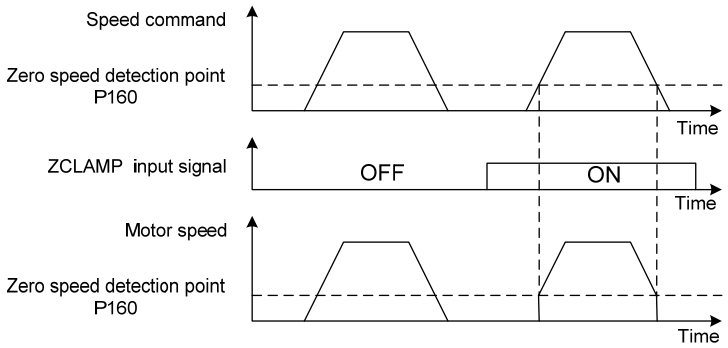
- When the motor speed is lower than this parameter, the ZSP (zero speed) of the digital output DO is ON, otherwise it is OFF.
- The comparator has the hysteresis function, which is set by parameter P161.

P161	Index 20A1h	Zero speed detection hysteresis					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	5	r/min

- Refer to the description of parameter P160.

P162	Index 20A2h	Zero speed clamp mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- When the following conditions are met, the zero speed clamping function is turned on:
  Condition 1: Speed control mode
  Condition 2: ZCLAMP (Zero Speed clamp) in DI is ON
  Condition 3: Speed command is lower than parameter P160
- When any of the above conditions is not met, the normal speed control is executed.
- When the zero speed clamping function is turned on, the meaning of this parameter is:
  0: The motor position is fixed at the moment when the function is turned on. At this time, the internal access position control will return to the zero fixed point even if it rotates due to external force.
  1: When the function is turned on, the speed command is forced to zero speed. The internal control is still speed control, which may rotate due to external forces.



P163	Index 20A3h	Position deviation clearing mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- In position control mode, clear the position deviation counter and use CLR (position deviation clear) in DI.
- Parameter meaning, position deviation clearing occurs in:
  0: CLR ON level
  1: CLR rising edge (when OFF changes to ON)

P164	Index 20A4h	Emergency shutdown mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- When EMG(emergency shutdown) in DI is ON, the meaning of this parameter is:
  0: The driver turns off the motor current directly, and the motor stops freely;

1: The driver remains enabled, and the control motor stops at the acceleration and deceleration defined by 6085h (Quick stop deceleration).

2: Decelerate the machine for shutdown, and the deceleration time is determined by P063.

P165	Index 20A5h	Motor static speed detection point					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	5	r/min

- Motor static detection: if the motor speed is lower than the parameter value, the motor is considered to be static.
- It is only used for timing judgment of electromagnetic brake.

P166	Index 20A6h	Electromagnetic brake delay time when motor is stationary					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2000	150	ms

- When the SON of the servo driver is from ON go to OFF or an alarm occurs, define the delay time from electromagnetic brake braking (DO output terminal BRK OFF) to motor current turn off during motor standstill.
- This parameter enables the brake to turn off the current after reliable braking to avoid small displacement of the motor or work piece drop. The parameter shall not be less than the delay time of mechanical braking.
- Refer to chapter 4.10.3 for corresponding timing.

P167	Index 20A7h	Waiting time of electromagnetic brake when motor is running					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2000	0	ms

- When the SON of the servo driver is from ON go to OFF or an alarm occurs, define the delay time from the motor current turn off to the electromagnetic brake braking (DO output terminal BRK OFF) during motor operation.
- This parameter is used to make the motor decelerate from high speed rotating state to low speed, and then let the brake braking to avoid damaging the brake.
- The actual action time is P167 or the time required for the motor to decelerate to P168, whichever is the minimum.
- Refer to chapter 4.10.4 for corresponding timing.

P168	Index 20A8h	Action speed of electromagnetic brake when motor is running					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3000	100	r/min

- Refer to the description of parameter P167.

P169	Index 20A9h	Delay time of electromagnetic brake opening					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	0	ms

- When the SON of the servo driver is from OFF to ON, define the delay time from the motor current turn on to the electromagnetic brake release (DO output terminal BRK ON).
- Refer to chapter 4.10 for corresponding timing.

P172	Index None	Encoder output lines					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～16384	2500	

- Parameter meaning set parameters to determine the resolution of driver output pulse.
- The default value is 2500, which means that per revolution of the motor shaft, the output is 2500 × 4=10000 pulses.

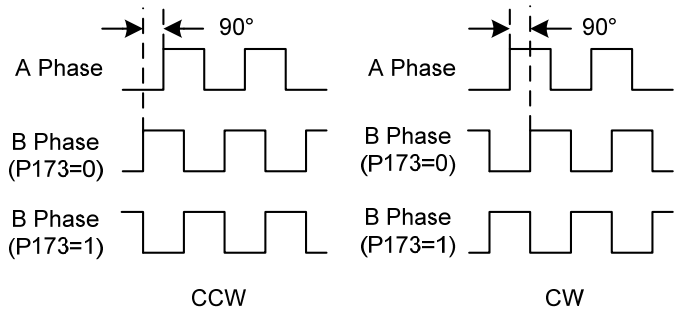
P173	Index None	Encoder outputs B pulse phase					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:

  0: In-phase

  1: Reverse phase
- This parameter can adjust the phase relationship between B-phase signal and A-phase signal.

P173	CCW	CW
0	A phase lags B phase for 90 degree	A phase advances B phase for 90 degree
1	A phase advances B phase 90 degree	A phase lags B phase 90 degree



P174	Index None	Encoder outputs Z pulse phase					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:
  0: In-phase;
  1: Reverse phase

P175	Index None	Encoder outputs Z pulse width					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:
  0: Width is the parameter value multiplied by 1 times the width of the output A (or B) signal;
  1: Width is the parameter value multiplied by 4 times the width of the output A (or B) signal.
- Expand the Z pulse. When the host device cannot capture a narrow Z pulse, it can be widened. Note that it is best to use the leading edge of Z pulse.

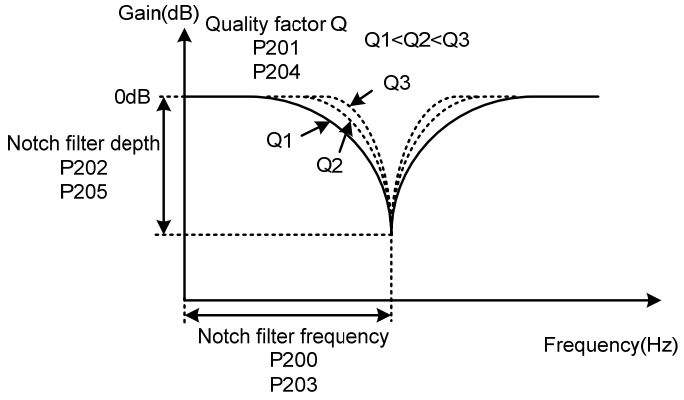
P195	Index None	Encoder multi turn overflow alarm shielding					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	1	

- Parameter meaning:
  0: When the encoder multi turn counting overflow alarm occurs, the servo will handle it according to the alarm.
  1: When the encoder multi turn counting overflow alarm occurs, the servo operates normally.

5.4.3 Parameters of section 2

P200	Index 20C8h	1st notch filter frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	50～5000	5000	Hz

- Notch filter is a filter used to eliminate the resonance of specific frequency caused by machinery.
- If parameter P202 is set to 0, this notch filter will be turned off.



P201	Index 20C9h	1st notch filter quality factor					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～100	7	

- The quality factor Q indicates the shape of notch filter. The larger the Q, the sharper the shape of notch filter and the narrower the width (-3dB) of notch filter.

$$\text{Quality factor Q} = \frac{\text{Notch filter frequency}}{\text{Notch filter width}}$$

P202	Index 20CAh	1st notch filter depth					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～60	0	dB

- Set the notch depth of the notch filter. The greater the parameter value, the greater the notch depth, that is, the greater the filter gain attenuation. Set to 0 to turn off the notch filter.
- Notch depth D expressed in dB units is:

$$D = -20\log(1 - \frac{P202}{100})(dB)$$

dB	Input /output ratio	dB	Input /output ratio	dB	Input /output ratio	dB	Input /output ratio	dB	Input /output ratio
0	1	-13	0.224	-26	0.050	-39	0.011	-52	0.003
-1	0.891	-14	0.200	-27	0.045	-40	0.010	-53	0.002
-2	0.794	-15	0.178	-28	0.040	-41	0.009	-54	0.002
-3	0.708	-16	0.158	-29	0.035	-42	0.008	-55	0.002
-4	0.631	-17	0.141	-30	0.032	-43	0.007	-56	0.002
-5	0.562	-18	0.126	-31	0.028	-44	0.006	-57	0.001
-6	0.501	-19	0.112	-32	0.025	-45	0.006	-58	0.001
-7	0.447	-20	0.10	-33	0.022	-46	0.005	-59	0.001
-8	0.398	-21	0.089	-34	0.020	-47	0.004	-60	0.001
-9	0.355	-22	0.079	-35	0.018	-48	0.004		
-10	0.316	-23	0.71	-36	0.016	-49	0.004		
-11	0.282	-24	0.063	-37	0.014	-50	0.003		
-12	0.251	-25	0.056	-38	0.013	-51	0.003		

P203	Index 20CBh	2nd notch filter frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	50～5000	5000	Hz

- Notch filter is a filter used to eliminate specific frequency resonance caused by machinery.
- If P205 is set to 0, this notch filter will be turned off.

P204	Index 20CCh	2nd notch filter quality factor					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～100	7	

- Refer to the specification of parameter P201.

P205	Index 20CDh	2nd notch filter depth					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～60	0	dB

- Set the notch depth of the notch filter. Setting it to 0 means turn off the notch filter. Refer to the explanation of parameter P202 for others.

P206	Index None	2nd torque filter frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	100～5000	5000	Hz

- The cut-off frequency of 2nd torque filter (2nd order type) acts as the 1st torque command filter.

P207	Index None	2nd torque filter quality factor					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～100	50	

- The quality factor of the 2nd torque filter quality factor (2nd order type) acts as the 1st torque command filter.

P208	Index None	Gain switching selection					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～15	0	

- Parameter meaning:
  0: Fixed 1st gain.
  1: Fixed 2nd gain.
  2～3: Reserved.
  4: Pulse deviation control: switch to 2nd gain when the position pulse deviation exceeds P209.
  5: Motor speed control, switch to 2nd gain when the motor speed exceeds P209.
- The 1st gain and the 2nd gain are combined, with 4 parameters for each group and switching at the same time.

First gain		Second gain	
Para meter	Name	Para meter	Name
P005	1st speed loop gain	P010	2nd speed loop gain
P006	1st speed loop integral time constant	P011	2nd speed loop integral time constant
P007	1st torque filtering time constant	P012	2nd torque filtering time constant
P009	1st position loop gain	P013	2nd position loop gain

P209	Index None	Gain switching level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～32767	100	

- According to the setting of parameter P208, the switching conditions and units are different.
- Parameter P210 and P209 have the same unit.

- The comparator has the function of hysteresis, which is set by parameter P210.

P208	Gain switching condition	Unit
3	Command pulse frequency	0.1kHz(kpps)
4	Pulse deviation	pulse
5	Motor speed	r/min

P210	Index None	Gain switching level hysteresis					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～32767	5	

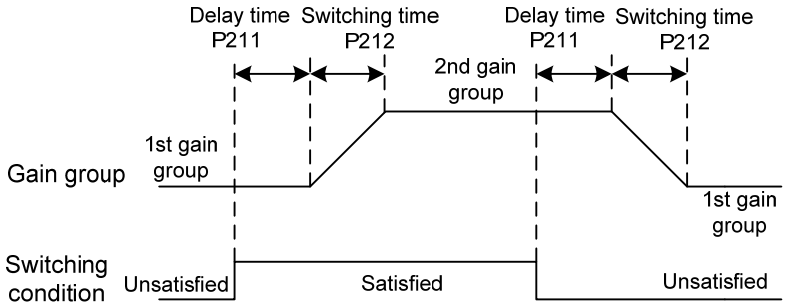
- Refer to the description of parameter P209.

P211	Index None	Gain switching delay time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3000	5	ms

- The delay time from when the gain switching condition is satisfied to when the switching is started.
- Cancel the handover if it is detected that the handover condition is not satisfied in the delay phase.

P212	Index None	Gain switching time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3000	5	ms

- During gain switching, the current gain combination will linearly and smoothly change to the target gain combination within this time, and all parameters in the combination will change at the same time.
- It can avoid impact caused by sudden change of parameters.



P213	Index None	Automatic notch filter on					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～FFFF	0	

- Parameter description:

Bit	Explanation
Bit0	1st notch filter is automatically set, 0: OFF; 1: ON
Bit1	2nd notch filter is automatically set, as above
Bit2	3rd notch filter is automatically set, as above
Bit3	4th notch filter is automatically set, as above
Bit4	1st notch filter is automatically set mode, 0: Turn off the automatic setting function after the automatic setting is successful; 1: Always working
Bit5	2nd notch filter automatic setting mode is the same as above
Bit6	3rd notch filter automatic setting mode is the same as above
Bit7	4th notch filter automatic setting mode is the same as above
Bit8～Bit15	Reserved

P214	Index None	3rd notch filter frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	50～5000	5000	Hz

- Notch filter is a filter used to eliminate specific frequency resonance caused by machinery.
- If P205 is set to 0, this notch filter will be turned off.

P215	Index None	3rd notch filter quality factor					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～100	7	

- Refer to the description of parameter P201.

P216	Index None	3rd notch filter depth					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～60	0	dB

- Set the notch depth of the notch filter. Setting it to 0 means turn off the notch filter. Refer to the explanation of parameter P202 for others.

P217	Index None	4th notch filter frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	50～5000	5000	Hz

- Notch filter is a filter used to eliminate specific frequency resonance caused by machinery.
- If P205 is set to 0, this notch filter will be turned off.

P218	Index None	4th notch filter quality factor					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～100	7	

- Refer to the description of parameter P201.

P219	Index None	4th notch filter depth					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～60	0	dB

- Set the notch depth of the notch filter. Setting it to 0 means turn off the notch filter. Refer to the explanation of parameter P202 for others.

P220	Index None	End vibration detection filter frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～2000	200	Hz

- Parameter meaning:
  Set the filtering bandwidth frequency of the filter used for the end vibration detection function.

P221	Index None	Minimum detection amplitude of end vibration					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	3～32767	5	pulse

- Minimum detection value of low frequency vibration suppression.

P222	Index 20DEh	Compensation coefficient of end vibration suppression					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1.0～100.0	1.0	

- Valid when the vibration suppression switch is turned on.
- The larger the value is, the more obvious the suppression effect is. However, too large a value is likely to bring mechanical noise.

P223	Index 20DFh	End vibration suppression switch					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	0	

- Parameter meaning:
  0: Vibration suppression function is invalid.
  1: Vibration suppression mode 1, which automatically detects vibration frequency, is suitable for

occasions where inertia changes little.

2: Vibration suppression mode 2, which automatically detects vibration frequency, is suitable for occasions where inertia always changes.

3: Vibration suppression mode 3, manually set the vibration frequency, suitable for vibration frequency known occasions.

P224	Index 20E0h	Manual setting of end vibration suppression period					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	0	ms

- When the vibration suppression mode (P223) is set to 3, this parameter is used to set the vibration cycle to be suppressed.

P225	Index None	Reserved by the manufacturer					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

P226	Index None	Medium frequency vibration 1 frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	50～2000	100	Hz

- It is valid when the IF vibration suppression 1 switch is turned on (P229≠0).
- The frequency point manual setting mode (P229=1) requires searching for intermediate frequency vibration points through the servo host software recording function.

P227	Index None	Compensation coefficient of medium frequency vibration suppression 1					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～1000	100	%

- It is recommended to use the Fn1 function to estimate the load inertia first.
- If the servo inertia (P017) is set properly, it is recommended to set this parameter to 100.
- If the inertia cannot be estimated, the value is inversely proportional to the actual load inertia.

P228	Index None	Damping coefficient of medium frequency vibration suppression 1					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～300	100	%

- Increasing the damping coefficient can improve the anti vibration effect, but excessive damping coefficient will increase the vibration.

P229	Index None	Medium frequency vibration suppression 1 switch					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- Parameter meaning:
  0: Invalid
  1: Manual setting
  2: Automatic setting

P231	Index None	Medium frequency vibration 2 frequency					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	50～2000	100	Hz

- It is valid when the IF vibration suppression 1 switch is turned on (P234≠0).
- The frequency point manual setting mode (P234=1) requires searching for intermediate frequency vibration points through the servo host software recording function.

P232	Index None	Compensation coefficient of medium frequency vibration suppression 2					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～1000	100	%

- It is recommended to use the Fn1 function to estimate the load inertia first.
- If the servo inertia (P017) is set properly, it is recommended to set this parameter to 100.
- If the inertia cannot be estimated, the value is inversely proportional to the actual load inertia.

P233	Index None	Damping coefficient of medium frequency vibration suppression 2					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～300	100	%

- Increasing the damping coefficient can improve the anti vibration effect, but excessive damping coefficient will increase the vibration.

P234	Index None	Medium frequency vibration suppression 2 switch					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- Parameter meaning:
  0: Invalid
  1: Valid
  2: Automatic setting

P236	Index None	Speed feedback source					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:
  0: Speed feedback comes from filter
  1: Speed feedback comes from the observer

P237	Index None	Medium frequency vibration suppression mode in high response mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	1	

- Parameter meaning:
  0: External compensation
  1: Internal compensation

P238	Index None	High immunity mode gain percentage in high response mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	50	%

- This parameter only takes effect when the high immunity mode is enabled (P239=2) in the high response mode. It is used to adjust the gain percentage of the advanced control high response mode, and is generally set to 20～80 to meet the needs. Setting the value too high can easily cause mechanical vibration.

P239	Index None	High immunity mode switch in high response mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- This parameter is used to enable high immunity mode in high response mode.
- Parameter meaning:
  0: Turn off this mode
  1: Turn on this mode and maintain the default gain
  2: Gain percentage adjustable

P240	Index None	High response mode tracking gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～1000	100	%

- The recommended value is 75～150.

P241	Index None	Friction compensation gain percentage					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～1000	100	%

- It is suggested to use Fn1 function to infer load inertia first.
- If the servo inertia (P017) is set properly, it is recommended to set this parameter to 100.
- If the inertia cannot be deduced, the value is inversely proportional to the actual load inertia.

P242	Index None	Friction compensation ratio					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	0	%

- Increasing the damping coefficient can improve the anti-vibration effect, but excessive damping coefficient will increase the vibration. When the parameter is set to 0, the friction compensation function is turned off.

P243	Index None	Friction compensation observer gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1200	400	Hz

- Increasing the observer gain can compensate the external disturbance more quickly, but if the gain is too large, vibration will occur when the machinery has a resonant frequency.

P244	Index None	Current loop mode selection in high response mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	0	

- This parameter only takes effect when P247=1.
  0: Current loop does not adopt high response mode
  1: Current loop adopts a high response mode
  2: The current loop uses a high response current observer
  3: The current loop uses a standard current observer

P245	Index None	High response mode speed observer nonlinear mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	1	

- Parameter meaning:
  0: The nonlinear function type in high response mode adopts structure 0
  1: The nonlinear function type in high response mode adopts structure 1

P246 Index None	High response mode speed feedback source					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	0～1	0	

- Parameter meaning:
  0: In high response mode, the feedback speed source is the original speed
  1: In high response mode, the feedback speed source is the filtered speed

P247 Index None	High response mode enable					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	0～1	0	

- Parameter meaning:
  0: Servo loop controller adopts traditional control mode
  1: Servo loop controller adopts high response mode
  2: Servo loop controller adopts disturbance observer for disturbance compensation

P248 Index None	High response mode speed observer bandwidth					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	100～2000	150	Hz

- High response mode speed observer bandwidth, increasing the parameter value can enhance the speed following ability and anti-interference ability, and being too large is prone to noise interference.

P249 Index None	High response mode speed observer bandwidth parameter setting is valid					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	0～1	1	

- Parameter meaning:
  0: High response mode speed observer bandwidth parameter setting is invalid
  1: High response mode speed observer bandwidth parameter setting is valid

P250 Index None	High response mode current observer bandwidth					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	50～400	180	10Hz

- High response mode current observer bandwidth, increasing the parameter value can enhance the current following ability and anti-interference ability, and being too large is prone to noise interference.

P251	Index None	High response mode current observer bandwidth parameter setting is valid					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:
  0: High response mode current observer bandwidth parameter setting is invalid
  1: High response mode current observer bandwidth parameter setting is valid

P252	Index None	High response mode 1st torque filtering time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.05～5.00	0.10	ms

- Low pass filter of torque can suppress mechanical vibration and reduce torque current fluctuation.
- The larger the value is, the better the vibration suppression effect is, and the smaller the torque current fluctuation is. If it is too large, the response will become slower, which may cause oscillation; the smaller the value, the faster the response, but limited by mechanical conditions.
- It is recommended that the setting range is 0.05～0.15. If it exceeds this range, it will easily cause system oscillation.

P253	Index None	High response mode speed observer type					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～5	0	

- Parameter meaning:
  0: Linear
  1: Low-level nonlinearity
  2: Intermediate nonlinearity
  3: Medium to advanced nonlinearity
  4: Advanced nonlinearity
  5: Super advanced nonlinearity

P254	Index None	High response mode speed observer non exponential gain multiple					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～10.0	1.5	times

- High response mode speed observer non exponential gain multiple, the higher the value, the stronger the speed following and anti-interference ability.

P255	Index None	Speed observer gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～1000	120	Hz

- The improvement of the speed observer gain can make the observer output track the actual speed

feedback faster.

P256	Index None	Speed observer compensation coefficient					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	150	%

- The default value is not recommended to be modified.

P258	Index None	Inertia identification					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～9	0	

- Parameter meaning:
  0: Turn off
  1: Reserved, used by the manufacturer
  2: Online mode

P269	Index None	Inertia estimation mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～10	0	

- Set the inertia estimation mode. The larger the presumptive inertia value, the larger the default inertia setting value.

P270	Index None	Model tracking control switch					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	0	

- It is suggested to use Fn1 function to infer load inertia first.
- Suitable for position control mode, according to different load to choose the appropriate parameters, can improve the response of the system.
- Parameter meaning:
  0: Model tracing is invalid
  1: Suitable for rigid load
  2: Suitable for flexible load
  3: Universal type

P271	Index None	Model tracking control gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～2000	40	Hz

- Model tracking control gain, mode 1～3 are valid.
- The higher the value, the faster the response. If it is too large, it may cause noise.

P272	Index None	Model tracking damping ratio					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	50～200	100	

P273	Index None	Model tracking positive direction output ratio					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	100	%

- Model tracking positive direction control deviation, mode 1～3 are effective.
- By adjusting this parameter, the response speed of forward and reverse can be adjusted separately.
- The greater the value, the greater the torque loop feed forward effect, too much noise may be caused.

P274	Index None	Model tracking reverse direction output ratio					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	100	%

- The description is the same as P273.

P277	Index None	Model tracking speed compensation feedforward					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～100	100	%

- Model tracking speed compensation feed forward, the larger the value, the greater the feed-forward effect of the speed loop, too large may cause noise.
- Modes 1～3 are valid.

P280	Index None	Model tracking speed compensates feedforward filtering time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.10～50.00	0.50	ms

- Parameter meaning:
  The higher the value is, the lower the noise will be. If the value is too large, the compensation will be delayed.

P281	Index None	Model tracking speed loop gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～3000	40	Hz

- Parameter meaning:

Model tracking speed loop gain, the unit is Hz.

P282	Index None	Model tracking speed loop integral time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1.0～1000.0	20.0	ms

- Parameter meaning:

  Model tracking speed loop integral constant, the unit is ms.

P283	Index None	Inertia estimation gain level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- Parameter meaning:

  0: Low rigidity

  1: Medium rigidity

  2: High rigidity

P285	Index None	Vibration alarm time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～100	0	s

- It does not take effect when it is set to 100, and every 3 corresponds to 1s.

P289	Index None	Vibration detection level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2000	60	Hz

- When the maximum and minimum speed error reaches the set value, it is determined as vibration.

P296	Index None	Self tuning mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	0	

- Parameter meaning:

  0: Manual mode;

  1: Automatic mode;

  2: Setting completed;

  3: Feedforward mode.

5.4.4 Parameters of section 3

Parameter	Name	Range	Default value	Unit
P300	Device address	0～239	0	

- Set the site alias through this parameter. After the parameter is changed, the parameter must be stored in EEPROM, and the driver must be turned off and then turned on again for operation to take effect!
- The use of EtherCAT sites depends on the EtherCAT master station. When using sequential addressing, the site number of the slave station is assigned sequentially by the EtherCAT master station, and this site alias setting is invalid. When setting addressing, the EtherCAT master reads the slave site alias to set the slave address. This site alias needs to be set to a non-zero value, and in the same network, each drive needs to be set to a different site alias.

Parameter	Name	Range	Default value	Unit
P305	Speed return filtering time constant	0.1～300.0	0.1	ms

- Set the filtering time constant for feedback speed. The larger the value, the better the filtering effect.

Parameter	Name	Range	Default value	Unit
P306	Path segment interpolation type	0～2	2	

- Select the connection mode between displacement segments in CSP mode through this parameter. When the value is 0, select two displacement segments to complete the connection in the way of continuous acceleration to avoid sudden acceleration change; When the value is 1, select two displacement segments to complete the connection in the way of continuous speed to avoid sudden change of speed; When the value is 2, it does not consider whether the acceleration and speed between two line segments are continuous, and each line segment is interpolated by linear averaging.
- Parameter meaning:
  0: Acceleration continuous mode transition;
  1: Speed continuous mode transition;
  2: Direct transition, linear division between line segments.

Parameter	Name	Range	Default value	Unit
P377	PP path Halt recovery mode	0～1	0	

- Parameter meaning:
  1: After the Halt command is revoked, the PP mode restores the operation of the path segment before the Halt command.
  0: PP mode aborts the operation of all subsequent path segments after Halt.

5.4.5 Parameters of section 4

Para meter	Name	Range	Default value	Unit
P472	Number of forward turns of round-trip motion	1～32767	3	
P473	Number of reverse turns of round-trip motion	1～32767	3	
P474	Round-trip speed	1～32767	1000	rpm
P475	Round-trip acceleration time	0～32767	100	ms
P476	Round-trip deceleration time	0～32767	100	ms

- When using the parameter self-tuning function, you can set P472 and P473 to limit the total displacement of the motor, but it is not recommended that the number of turns be less than 3. Too small turns are not conducive to the result of parameter self-tuning.
- In addition, when the mechanical connection stiffness is not enough, or the load inertia ratio is too large, the values of P475 and P476 can be appropriately increased, and the value of P474 can be reduced to achieve the purpose of making the acceleration, deceleration, and uniform motion process smoother, reducing potential damage to the machinery.

5.5 DI function details

Please refer to "6.5.3 Digital input/digital output" for details. The following table describes the functions of IO.

<table>
<tr><th>Ordinal</th><th>Symbol</th><th>DI Function</th><th>Functional explanation</th></tr>
<tr><td>0</td><td>NULL</td><td>No function</td><td>Input state had no effect on the system.</td></tr>
<tr><td>2</td><td>ARST</td><td>Clear alarm</td><td>When there is an alarm, if the alarm is allowed to be cleared, input the rising edge (OFF to ON moment) to clear the alarm. Note that only some alarms are allowed to be cleared.</td></tr>
<tr><td>3</td><td>CCWL</td><td>CCW drive inhibit</td><td>OFF: CCW rotation is prohibited;
ON: CCW rotation is allowed.
It is used for mechanical limit travel protection and its function is controlled by parameter P097. Note that the default value of P097 is to ignore this function. If you need to use this function, you need to modify P097.
<table>
<tr><th>P097</th><th>Explanation</th></tr>
<tr><td>0</td><td rowspan="2">To use the CCW drive inhibit function, the normally closed contact of the travel switch must be connected.</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td><td rowspan="2">Ignore the CCW drive inhibit function, the motor can run in the positive direction. This signal has no effect and does not need to be connected.</td></tr>
<tr><td>3 (default)</td></tr>
</table></td></tr>
<tr><td>4</td><td>CWL</td><td>CW drive inhibit</td><td>OFF: CW rotation is prohibited;
ON: CW rotation is allowed.
It is used for mechanical limit travel protection, and the function is controlled by parameter P097. Note that the default value of P097 is to ignore this function. If you need to use this function, you need to modify P097.
<table>
<tr><th>P097</th><th>explain</th></tr>
<tr><td>0</td><td rowspan="2">To use the CW drive inhibit function, the normally closed contact of the travel switch must be connected.</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td><td rowspan="2">Ignoring the CW drive inhibit function, the motor can run in the opposite direction. This signal has no effect and does not need to be connected.</td></tr>
<tr><td>3 (default)</td></tr>
</table></td></tr>
</table>

Ordinal	Symbol	DI Function	Functional explanation
15	EMG	Emergency shutdown	OFF: Allows the servo driver to work; ON: Stop the motor according to the mode set by parameter P164.
24	REF	Homing reference point	Homing external reference point

5.6 DO function details

Please refer to "6.5.3 Digital input/digital output" for details. The following table describes the functions of IO.

Ordinal	Symbol	DO Function	Functional explanation
0	OFF	Always invalid	Force output OFF.
1	ON	Always valid	Force output ON.
2	RDY	Servo ready	OFF: Servo main power supply is off, or alarm occurs; ON: Servo main power supply is normal, no alarm occurs.
3	ALM	Alarm	OFF: Alarm occurs; ON: No alarm occurs.
8	BRK	Electromagnetic brake	OFF: Electromagnetic brake braking; ON: Electromagnetic brake is released. The output state is determined by the servo, see "4.11 Electromagnetic brake" for details
9	RUN	Servo running	OFF: Servo motor is not turned on for operation; ON: Servo motor is turned on and running.
11	TRQL	In torque limit	OFF: Motor torque does not reach the limit value; ON: Motor torque reaches the limit value.
12	SPL	In speed limit	In torque control mode OFF: Motor speed does not reach the limit value; ON: Motor speed reaches the limit value.
13	HOME	Homing complete	When homing is complete, output ON
23	BRKNET	Electromagnetic Brake (EtherCAT Object Control)	OFF: Electromagnetic brake braking; ON: Electromagnetic brake is released. The output state is determined by bit0 in 60FE.
24	NETIO1	EtherCAT corresponding control word control IO	See "6.5.3 Digital input/digital output" for details
25	NETIO2		
26	NETIO3		
27	NETIO4		
28	NETIO5		
30	DBC	Dynamic braking	OFF: External dynamic brake is invalid; ON: External dynamic brake takes effect.

Chapter 6 Communication functions

6.1 Common object description

1. **6040h Control Word:** See "6.3.2 Control word 6040h" section description.

2. **6041h Status Word:** See "6.3.3 Status word 6041h" section description.

3. **6060h Modes of Operation**

Currently, only the following four operating modes are supported, as described below:

6. Homing mode; 8: Synchronous position mode;

9: Synchronous velocity mode; 10: Synchronous torque mode.

Before sending the enable command, you need to determine the object value. The running mode after enabling is subject to the object value when the enable command is received.

4. **607Ah Target Position**

Target Position, which takes effect in the CSP position mode, the position command received in the current cycle represents the absolute position that the servo needs to run to in the current cycle. The unit is User Unit.

User Unit: represents the minimum resolution set by the user for the position.

5. **60FFh Target Velocity**

Target Velocity description, which takes effect in CSV velocity mode. The speed command received in the current cycle represents the target speed of the servo running in the current cycle, and the unit is User Unit/s.

6. **6071h Target Torque**

Target Torque, which takes effect in CST torque mode, the torque command received in the current cycle represents the target torque of the servo running in the current cycle, and the unit is 0.1% of the rated torque.

7. **6064h Position Actual Value**

Position Actual Value, the Unit is User Unit.

The original data of the encoder's single turn value can be read out through 0x2703.0x03,, and the highest bit of the read data is aligned. If the encoder bit is less than 32 bits, the low bit is supplemented by 0. For example, when the encoder resolution is 17 bits, bit31 to bit15 is the encoder's 17 bit single turn value, and bit14 to bit0 is supplemented by 0.

The original data of the multi turn value of the encoder can be read out through 0x2703.0x04.

8. 606Ch Velocity Actual Value

Velocity Actual Value, the unit is User Unit/s.

9. 6077h Torque Actual Value

Torque Actual Value, unit: 0.1%.

10. 2700h Sub Index 1：Pos Loop Command

The position command value received by the servo, the unit is User Unit/s.

11. 2700h Sub Index 2：Pos Loop Feedback

Motor position feedback value, unit: User Unit/s.

12. 2700h Sub Index 3：Pos Loop Error

Servo position tracking error, unit: User Unit/s.

13. 2701h Sub Index 1：Velocity Loop Motor Speed

Servo velocity loop motor speed, unit: rpm.

14. 2702h Sub Index 1：Torque Loop Motor Actual Torque

Servo torque loop motor actual torque, unit: %.

15. 2702h Sub Index 2：Torque Loop Motor Actual Peak Torque

Servo torque loop motor actual peak torque, unit: %.

16. 2702h Sub Index 3：Torque Loop Motor Actual Current

Servo torque loop motor actual current, unit: 0.1A.

17. 2702h Sub Index 4：Torque Loop Motor Actual Peak Current

Servo torque loop motor actual peak current, unit: 0.1A.

18. 2703h Sub Index 1：StartUp Single Position

When the servo is powered on, the single turn position is aligned with the 32-bit high position, and the lowest position is supplemented with 0.

19. 2703h Sub Index 2：StartUp Multi Turn

Count multi-turn when the servo is powered on.

20. 2703h Sub Index 3：Current Single Position

At the current time, the single turn position is aligned with 32-bit high bits, and the lowest bit is filled with 0.

21. 2703h Sub Index 4：Current Multi Turn

Multi turn counting at the current moment.

22. 2707h Sub Index 1

Motor rated current, unit: 0.1A.

23. 2707h Sub Index 2

Motor rated torque, unit: 0.1Nm.

24. 2707h Sub Index 3

Motor rated speed, unit: rpm.

25. 27FEh Operation Command

Internal operation instructions, reserved.

26. 27FFh Operation Status：

Internal operation status, reserved.

6.2 EtherCAT communication

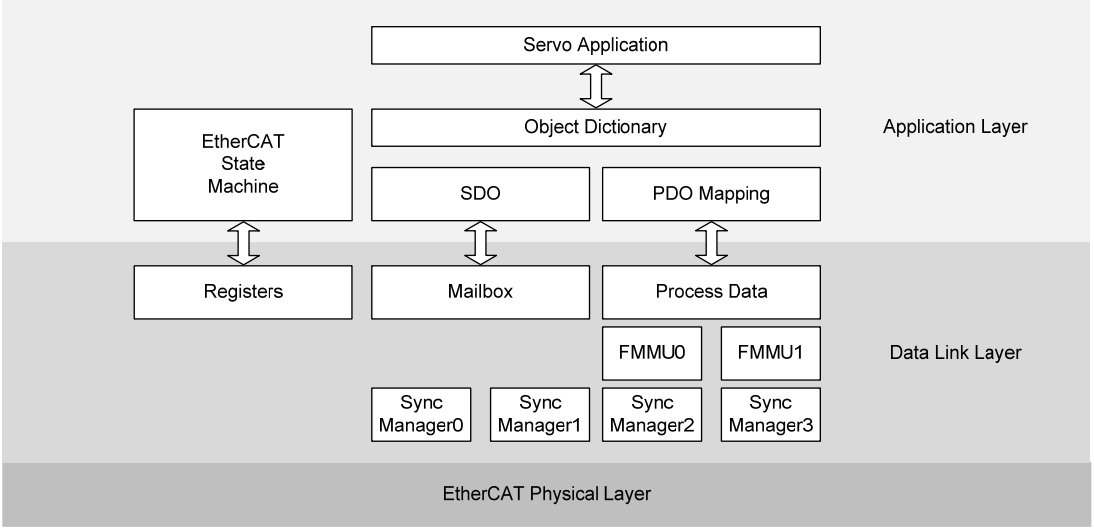
EtherCAT is the abbreviation of Ethernet for Control Automation Technology. It is a communication mode between master and slave computers using Real-Time Ethernet developed by BECKHOFF, Germany. It is managed by the ETG (EtherCAT Technology Group).

The basic concept of EtherCAT communication is that when the DataFrame sent through the host passes through the slave station, the slave station sends and receives data to the DataFrame while receiving the sent data.

EtherCAT uses the Ethernet framework based on IEEE802.3 as the standard.

When using 100BASE-TX Ethernet as the base, the maximum cable length is 100m, and the maximum number of slave stations that can be received is 65535, thus forming an unlimited network. In the case of using the Ethernet Switch alone, it can also receive each other with the commonly used TCP/IP.

6.2.1 Construction of CANopen over EtherCAT

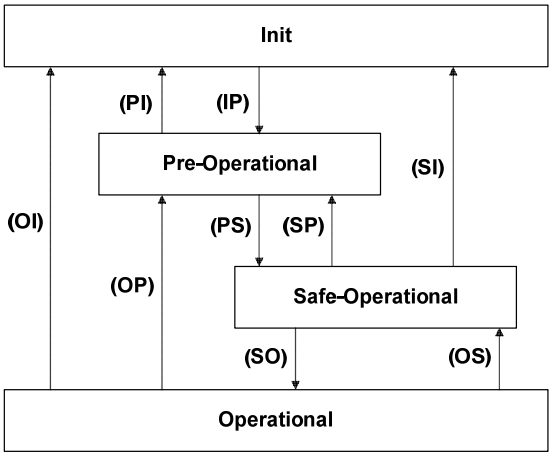


The drive adopts the shape of the CiA 402 drive. The Object Dictionary of the application layer includes the application data and process data interface, as well as the PDO mapping information between application data.

PDO (Process Data Object) is composed of Object Dictionary that can be mapped in PDO. The content of process data is defined according to PDO mapping.

Process data communication will have periodic read/write PDO, while mailbox communication is non periodic communication, which can read/write all Object Dictionary.

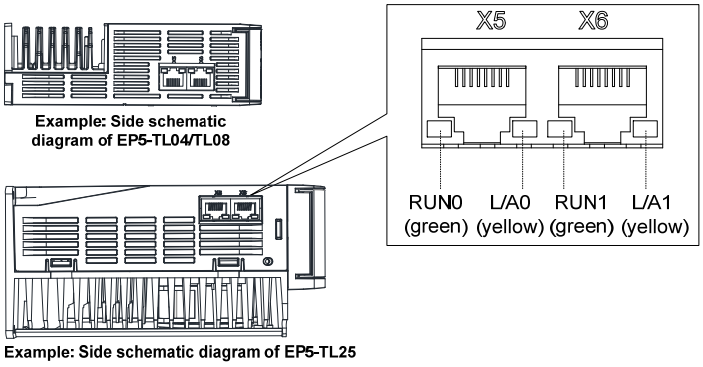
6.2.2 EtherCAT state machine



State	Description
Init	Device initialization. Unable to use mailbox communication and process data communication.
Pre-Operational	The current status can use mailbox communication.
Safe-Operational	PDO input data (TxPDO) can be read. Cannot receive PDO output data (RxPDO).
Operational	Periodic I/O communication can process PDO output data (RxPDO).
State transition	**Description**
IP	Start mailbox communication.
PI	Interrupt mailbox communication.
PS	Start updating input data.
SP	Terminates updating input data.
SO	Start updating output data.
OS	Terminates updating output data.
OP	Terminates updating input/output data.
SI	Terminate updating input data and mailbox communication.
OI	Terminate all I/O data updates and mailbox communications.

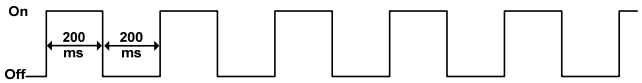
6.2.3 Status LED

The status LED of the EP5 driver is located on the X5 (IN) and X6 (OUT) sockets, as shown in the following figure.



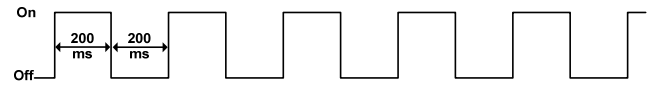
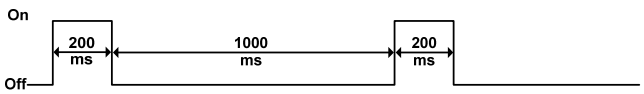
1. L/A0，L/A1（Link Activity）LED（YELLOW LED）

L/A0 LED displays the status of X5 communication interface, and L/A1 LED displays the status of X6 communication interface. The contents displayed by each LED are shown in the following table.

Link/Activity LED	Description
Off	Communication is not connected.
Flickering	Communication connected, communication activated. 
On	Communication is connected. Communication has not been activated.

2. RUN0，RUN1（Run）LED（GREEN LED）

Display the state of the EtherCAT State Machine.

RUN LED	Description
Off	In the INIT state.
Blinking	In Pre-Operational state. 
Single Flash	In Safe-Operational state. 
On	In Operational state.

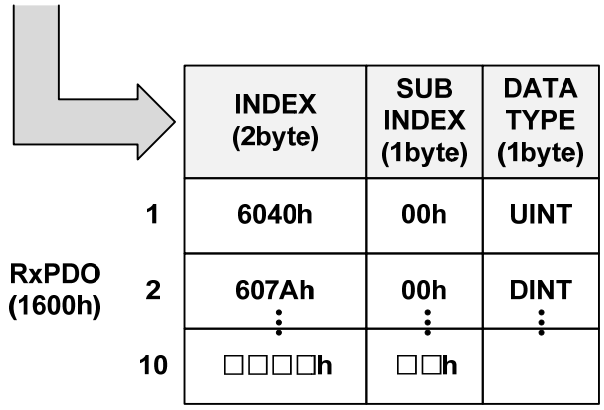
6.2.4 Data Type

The content and scope of the Data Type used in this instruction book are shown in the following table.

Name	Description	Range
SINT	Signed 8bit	-128～127
USINT	Unsigned 8bit	0～255
INT	Signed 16bit	-32768～32767
UINT	Unsigned 16bit	0～65535
DINT	Signed 32bit	-21247483648～21247483647
UDINT	Unsigned 32bit	0～4294967295
STRING	String Value	

6.2.5 PDO mapping

Index	Sub-Index	**Name**	**Data Type**
6040h	-	Controlword	UINT
607Ah	-	Target Position	DINT

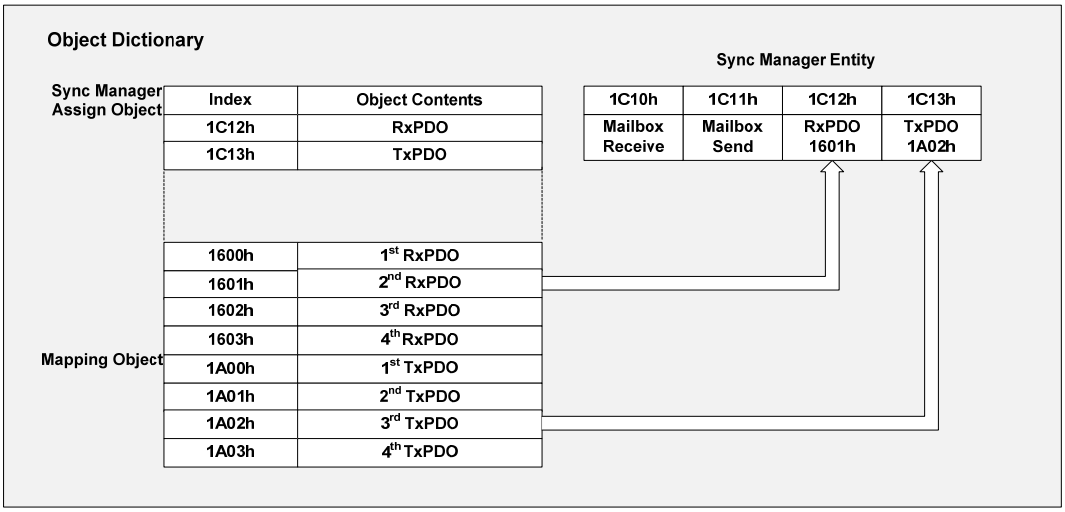


ndex	**Sub-**Index	**Name**	**Data Type**
6041h	-	StatusWord	UINT
6064h	-	Position Actual Value	DINT
606Ch	-	Velocity Actual Value	DINT

		INDEX (2byte)	SUB INDEX (1byte)	DATA TYPE (1byte)
TxPDO (1A00h)	1	6041h	00h	UINT
	2	6040h	00h	DINT
	3	606Ch	00h	DINT
	⋮	⋮	⋮	⋮
	10	□□□□h	□□h	

SyncManager can consist of several PDOs. SyncManagerPDO Assign Object (RxPDO: 1C12h, TxPDO: 1C13h) displays the relationship between SyncManger and PDO.

The following figure shows the SyncManager PDO mapping.



PDO mapping

The following table is the PDO mapping that has been basically set up. This setting is defined in EtherCAT Slave Information file (XML file).

1. PDO Mapping

RxPDO (1600h)	Control Word (6040h)	Mode of Operation (6060h)	Target position (607Ah)	Target Velocity (60FFh)	Target Torque (6071h)

TxPDO (1A00h)	Status Word (6041h)	Mode of Operation Display (6061h)	Position Actual Value (6064h)	Veloctiy Actual Value (606Ch)	Torque Actual Value (6077h)

2. PDO Mapping

RxPDO (1601h)	Control Word (6040h)	Target position (607Ah)

TxPDO (1A01h)	Status Word (6041h)	Position Actual Value (6064h)

3. PDO Mapping

RxPDO (1602h)	Control Word (6040h)	Target Velocity (60FFh)

TxPDO (1A02h)	Status Word (6041h)	Position Actual Value (6064h)	Velocity Actual Value (606Ch)

4. PDO Mapping

RxPDO (1603h)	Control Word (6040h)	Target Torque (6071h)

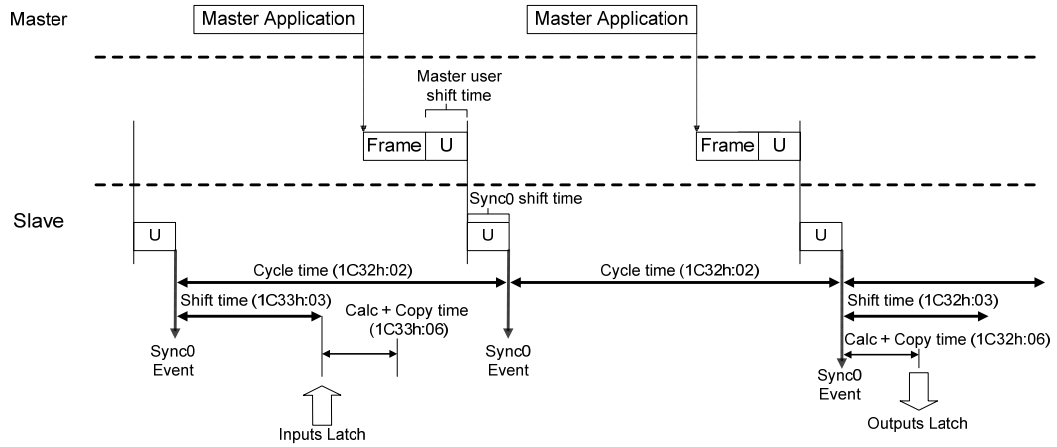
TxPDO (1A03h)	Status Word (6041h)	Position Actual Value (6064h)	Torque Actual Value (6077h)

6.2.6 According to the synchronization of DC (Distributed Clock)

In EtherCAT communication, DC (Distributed Clock) is used for synchronization. The master and slave stations share the Reference Clock (System time) for synchronization. The slave stations synchronizes according to the Sync0 event caused by the Reference Clock.

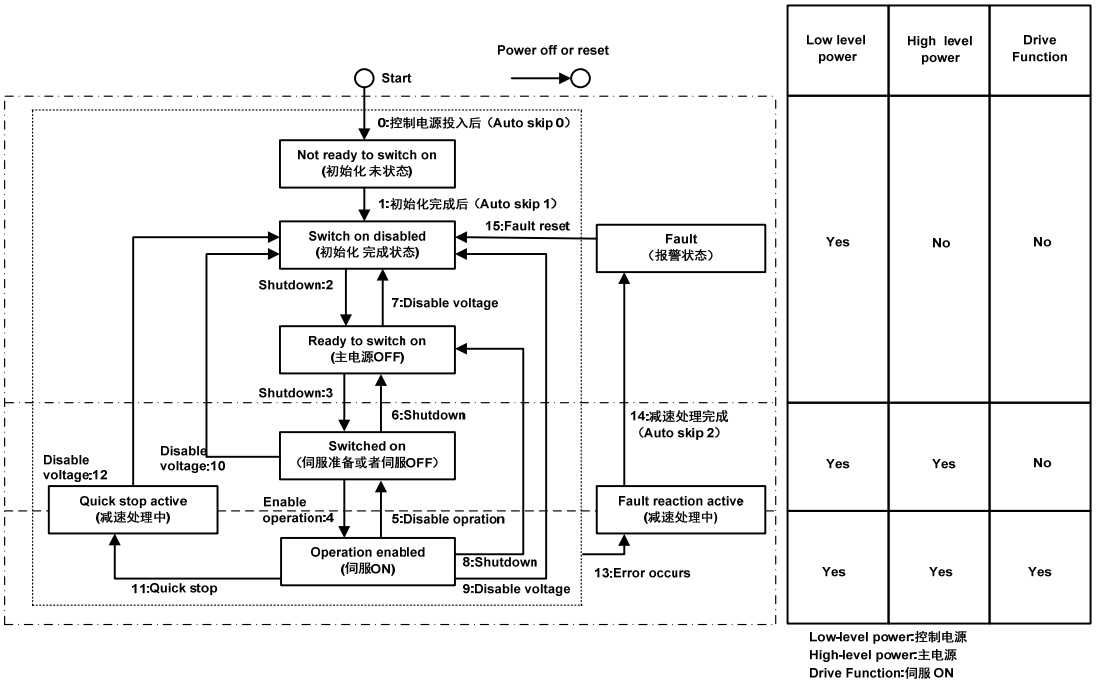
There are the following synchronization modes, which can be changed through Sync Control registration.

In DC Synchronous mode, the drive is synchronized through the Sync0 event of the EtherCAT master station.



6.3 Drive mode

6.3.1 Servo state machine



State	Instructions
Not ready to switch on	Turn on control power. Initializing.
Switch on disabled	After initialization, servo parameters can be set. The main power supply cannot be supplied in the current state.
Ready to switch on	In the current state, the main power supply can be turned on and the servo parameters can be set. The drive is inactive.
Switched on	The main power supply is On state, and servo parameters can be set. The drive is inactive.
Operation enabled	In the non-Fault state, start the driver function to apply torque to the motor. Servo parameters can also be set.
Quick Stop active	Quick stop function has been executed. Servo parameters can be set.
Fault reaction active	Fault status due to Quick Stop or servo. Servo parameters can be set.
Fault	Fault reaction processing is completed, and the drive function is inactive. Servo parameters can be set.

Control command and state switching

Operation mode can be changed by 6060h (Modes of operation). On the server, the selection of the operation mode is made at the same time as the change of the associated target. If the master server switches to the new operation mode, it will switch to the same mode immediately.

CiA402 state switch		Control word 6040h	Status word 6041h bit0～bit9
0	Start →Not ready to switch on	Natural transition without control command	0000h
1	Not ready to switch on →Switch on disabled	Natural transition without control command If an error occurs during initialization, go directly to 13	0270h
2	Switch on disabled→Ready to switch on	0006h	0231h
3	Ready to switch on→Switched on	0007h	0233h
4	Switched on →Operation enabled	000Fh	0237h
5	Operation enabled→Switched on	0007h	0233h
6	Switched on →Ready to switch on	0006h	0231h
7	Ready to switch on→Switch on disabled	0000h	0270h
8	Operation enabled→Ready to switch on	0006h	0231h
9	Operation enabled→ Switch on disabled	0000h	0270h
10	Switched on→Switch on disabled	0000h	0270h
11	Operation enabled→Quick stop active	0002h	0217h
12	Quick stop active→Switch on disabled	Quick stop mode 605A is set to 0～3. After the shutdown is completed, there is a natural transition without control command.	0270h
13	→Fault reaction active	In any state other than "fault", once the servo driver fails, it will automatically switch to the fault shutdown state without control command	02B6h
15	Fault → Switch on disabled	0080h bit7 rising edge is valid; bit7 remains 1, and other control commands are invalid.	0270h

Note: The bit10～bit15 (bit14 meaningless) of the status word 6041h is related to the operating status of each servo mode, which is represented by "0" in the above table. Please refer to each servo operating mode for specific status.

6.3.2 Control word 6040h

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
6040h	00h	Control Word	-	0～65535	UINT	RW	Yes	ALL	Yes

Instructions:

bit	name	describe
0	Switch On	1: valid, 0: invalid
1	Enable Voltage	1: valid, 0: invalid
2	Quick Stop	1: invalid, 0: valid
3	Enable Operation	1: valid, 0: invalid
4～6		Related to each servo operation mode
7	Fault Reset	Fault reset For resettable faults and warnings, execute the fault reset function; bit7 rising edge is valid; bit7 remains 1, and other control commands are invalid
8	Halt	Please query the object dictionary 605Dh for the pause mode in each mode
9		Related to each servo operation mode
10～15		Reserved, customized by the manufacturer

Note:

1. bit0～bit3 and bit7 have the same meaning in each servo mode. It is meaningless to assign each bit separately. They must form a control command together with other bits. Each command corresponds to a determined state, and the servo driver guides to the expected state according to the CiA402 state machine switching process.

Command	Bits of the control word					Transitions
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	
Shut Down	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（NOTE）
Disable Voltage	0	×	×	0	×	7，9，10，12
Quick Stop	0	×	0	1	×	7，10，11
Disable Operation	0	0	1	1	1	5
Enable Operation	0	1	1	1	1	4，16
Fault Reset		×	×	×	×	15
NOTE: After executing the Switch on status function, it automatically jumps to the Enable Operation status.						

2. bit4～bit6 are related to each servo mode (please check the control commands under different modes).

Op-mode	Bit 9	Bit 6	Bit 5	Bit 4
hm	-	-	-	Start homing
csp	-	-	-	
csv	-	-	-	
cst	-	-	-	

6.3.3 Status word 6041h

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc -ess	PDO	Op-mode	EEP-ROM
6041h	00h	Status Word	-	0～65535	UINT	RO	TPDO	ALL	Yes

Set the control instruction:

bit	name	describe
0	Ready to Switch On	
1	Switch On	
2	Operation Enable	
3	Fault	
4	Voltage Enable	
5	Quick Stop	
6	Switch On Disable	
7	Warning	
8		Reserved, customized by the manufacturer
9	Remote	0: Non remote control mode. EP3E series products only support remote control mode 1: Remote control mode
10	Target Reached	0: Target position or speed not reached 1: Target position or speed reached
11	Internal Limit Active	0: The position command or feedback does not reach the internal position limit of the software 1: The position command reaches the internal position limit of the software. After the absolute position limit of the software takes effect, the servo will run at the position limit value as the target position and stop when the limit value is reached. Entering the reverse displacement command can make the motor exit the position over-limit state and clear the position.

bit	name	describe
12～13		Related to each servo mode
14		Reserved, customized by the manufacturer
15	Homing complete	0: Homing is not in progress or completed 1: Homing has been completed, and the reference point has been found

Note:

1. bit0～bit3、bit5 and bit6 have the same meaning in each servo mode. It is meaningless to read each bit separately. They must be combined with other bits to feed back the current state of the servo. After the control word 6040h sends commands in sequence, the servo will feed back a determined state.

Status word	State	
xxxx xxxx x0xx 0000 b	Not Ready to Switch on	Initialization incomplete status
xxxx xxxx x1xx 0000 b	Switch on disabled	Initialization completion status
xxxx xxxx x01x 0001 b	Ready to switch on	Main circuit power supply is OFF
xxxx xxxx x01x 0011 b	Switched on	SERVO OFF/ SERVO READY
xxxx xxxx x01x 0111 b	Operation enabled	Servo ON
xxxx xxxx x00x 0111 b	Quick stop active	Stop
xxxx xxxx x0xx 1111 b	Fault reaction active	Abnormal (alarm) judgment
xxxx xxxx x0xx 1000 b	Fault	Abnormal (alarm) status

2. bit10、bit12～bit13 are related to each servo mode (please check the control commands under different modes).

Op-mode	Bit 13	Bit 12	Bit 10
hm	Homing error	Homing attained	target reached
csp	Following error	Drive follows command value	-
csv	-	Drive follows command value	-
cst	-	Drive follows command value	-

3. bit4、bit7、bit9、bit11 have the same meaning in each servo mode, and feedback the state after the servo executes a certain servo mode.
   bit4 (main supply turned on): 1 indicates that the main circuit relay is closed.
   bit7 (alarm): 1 indicates that the alarm occurs. Whether the motor moves during alarm depends on the type of alarm.
   bit9 (remote): EtherCAT application layer state transition to PreOP above into 1.

6.4 Modes of operation

EP5 only supports the following modes of operation (6060h) temporarily.

- Cyclic synchronous position mode
- Cyclic synchronous velocity mode
- Cyclic synchronous torque mode
- hm mode

1. Associate object

Index	Sub-Index	Name/ Description	Units	Range	DataType	Acc-ess	PDO	Op-mode	EEP-ROM
6502h	00h	Supported Drive Modes	-	0～4294967295	UD-INT	RO	Tx-PDO	ALL	No

- Represents the supported control mode (mode of operation).
- Represents this mode is supported when the value is 1.

bit	31…16	16…10	9	8	7	6	5	4	3	2	1	0
Op-mode	ms	r	cst	csv	csp	ip	hm	r	tq	pv	vl	pp
Value	0…0	0…0	1	1	1	0	1	0	0	0	0	0

- ms: manufacturer-specific
- r: reserved

bit	name	Abbreviation	Corresponding
0	Profile position mode	pp	No
1	Velocity mode	vl	No
2	Profile velocity mode	pv	No
3	Torque profile mode	tq	No
5	Homing mode	hm	Yes
6	Interpolated position mode	ip	No
7	Cyclic synchronous position mode	csp	Yes
8	Cyclic synchronous velocity mode	csv	Yes
9	Cyclic synchronous torque mode	cst	Yes

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
6060h	00h	Modes of Operation	-	-128～127	SINT	RW	RxPDO	ALL	Yes

- Set the control mode of the servo driver.
- Non corresponding control modes are prohibited from setting.

Value	Operational display mode	Abbreviation	Corresponding
-128～1	Reserved		
0	No mode change /no mode assigned		Yes
1	Profile position mode	pp	No
2	Velocity mode	vl	No
3	Profile velocity mode	pv	No
4	Torque profile mode	tq	No
6	Homing mode	hm	Yes
7	Interpolated position mode	ip	No
8	Cyclic synchronous position mode	csp	Yes
9	Cyclic synchronous velocity mode	csv	Yes
10	Cyclic synchronous torque mode	cst	Yes
11～127	Reserved		

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
6061h	00h	Modes of Operation Display	-	-128～127	SINT	RO	TxPDO	ALL	No

- Represents the current control mode.
- Definition is the same as the 6060h (Modes of Operation).

Value	Operational display mode	Abbreviation	Corresponding * 1
-128～1	Reserved		
0	No mode change /no mode assigned		Yes
1	Profile position mode	pp	Yes
2	Velocity mode	vl	No
3	Profile velocity mode	pv	Yes
4	Torque profile mode	tq	Yes
6	Homing mode	hm	Yes
7	Interpolated position mode	ip	No
8	Cyclic synchronous position mode	csp	Yes
9	Cyclic synchronous velocity mode	csv	Yes
10	Cyclic synchronous torque mode	cst	Yes
11～127	Reserved		

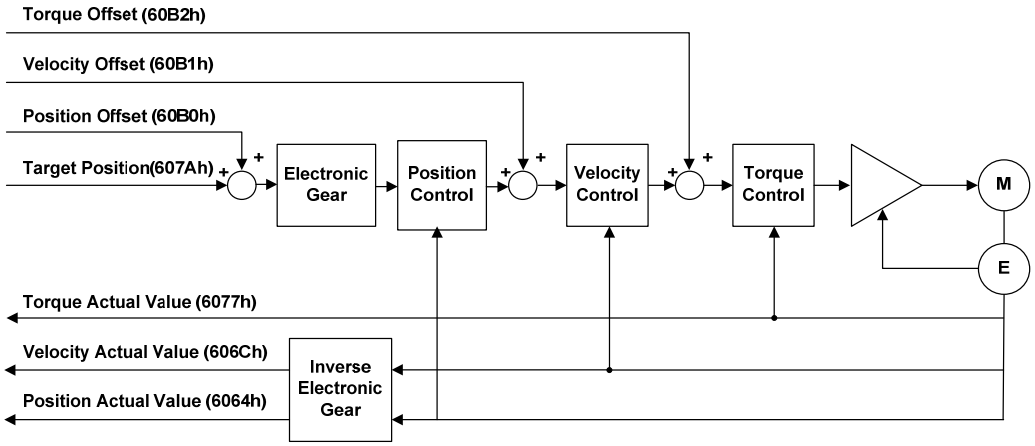
2. Note when switching control mode

- The control mode can be switched by changing the value of 6060h (Modes of Operation).
- Please confirm the control mode of the current servo driver at 6061h (Modes of Operation Display).
- When switching the control mode, please update the RxPDO objects related to the 6060h synchronized control mode.
- In the changed control mode, the value of unsupported objects is variable.
- It takes 2ms from the time of control mode change to the completion of switching. During this period, the object value of 6061h TxPDO related to control mode is uncertain.
- Please switch the control mode for more than 20ms. If the interval is shorter than 20ms and the control mode is switched continuously, an exception will occur.
- The control mode must be switched when the motor is stopped. It is impossible to guarantee the action of control mode switching in motor action (including homing action and deceleration stop). The mode cannot be switched immediately, or an exception will occur.
- In the state of 6060h=0 and 6061h=0, if the drive state is converted to "Operation enabled", abnormal actions will occur.
- After setting a value other than 0 for 6060h, if you set 6060h=0, the previous control mode will be maintained.
- If there is no corresponding control mode for 6060h, abnormal protection will occur.

6.4.1 Cyclic synchronous position mode

Cyclic Synchronous Position Mode is a mode of receiving target position (607Ah) operation through periodic PDO updates from the master station. In this mode, the master station can add position offset (Position Offset 60B0h), torque offset (60B2h), and velocity offset (60B1h).

1. Structural drawing



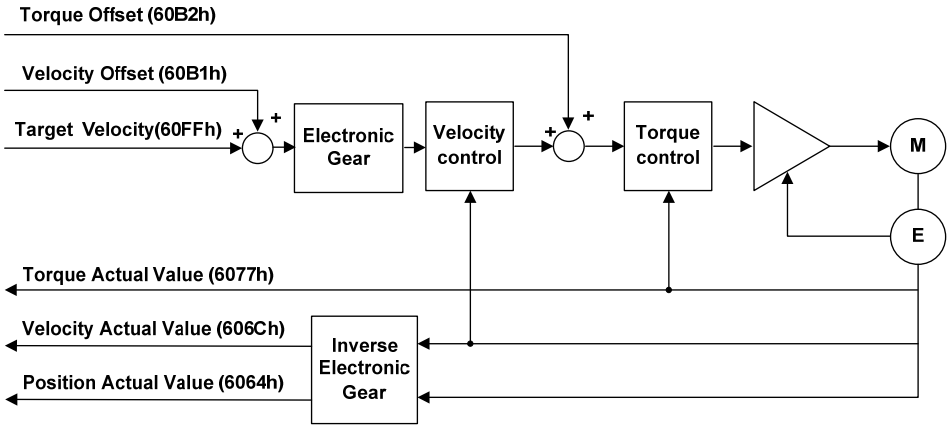
2. Associate object

Index	Sub-Index	Name	Data Type	Access	PDO Mapping	Units
607Ah	-	Target Position	DINT	RW	Yes	User Unit
60B0h	-	Position Offset	DINT	RW	Yes	User Unit
60B1h	-	Velocity Offset	DINT	RW	Yes	User Unit/s
60B2h	-	Torque Offset	INT	RW	Yes	0.1%
6077h	-	Torque Actual Value	INT	RO	Yes	0.1%
606Ch	-	Velocity Actual Value	DINT	RO	Yes	User Unit/s
6064h	-	Position Actual Value	DINT	RO	Yes	User Unit

6.4.2 Cyclic synchronous velocity mode

In Cyclic Synchronous Velocity Mode, the master station sends a target velocity (60FFh) to the driver to control speed. In this mode, the master station can add velocity offset (60B1h) and torque offset (60B2h).

1. Structural drawing



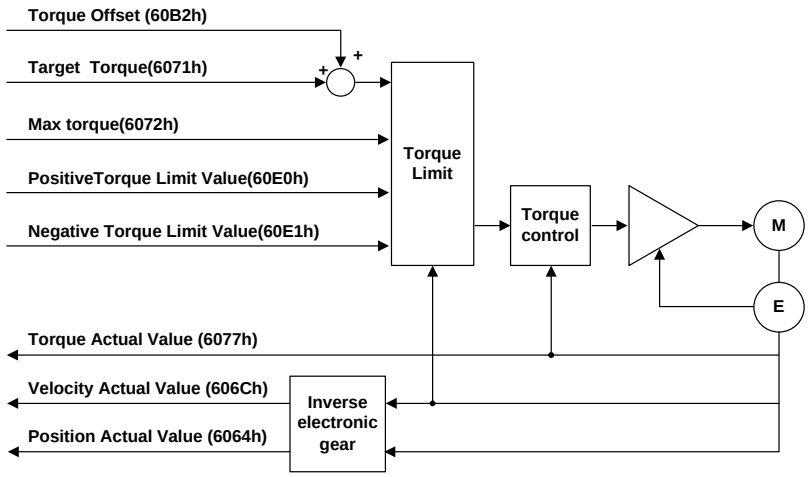
2. Associate object

Index	Sub-Index	Name	Data Type	Access	PDO Mapping	Units
60FFh	-	Target Velocity	DNIT	RW	Yes	User Unit/s
60B1h	-	Velocity Offset	DINT	RW	Yes	User Unit/s
60B2h	-	Torque Offset	INT	RW	Yes	0.1%
6077h	-	Torque Actual Value	INT	RO	Yes	0.1%
606Ch	-	Velocity Actual Value	DINT	RO	Yes	User Unit/s
6064h	-	Position Actual Value	DINT	RO	Yes	User Unit

6.4.3 Cyclic synchronous torque mode

In Cyclic Synchronous Torque Mode, the master station assigns a target torque (6071h) to the driver to control the torque. In this mode, the master station can add torque offset (60B2h).

1. Structural drawing



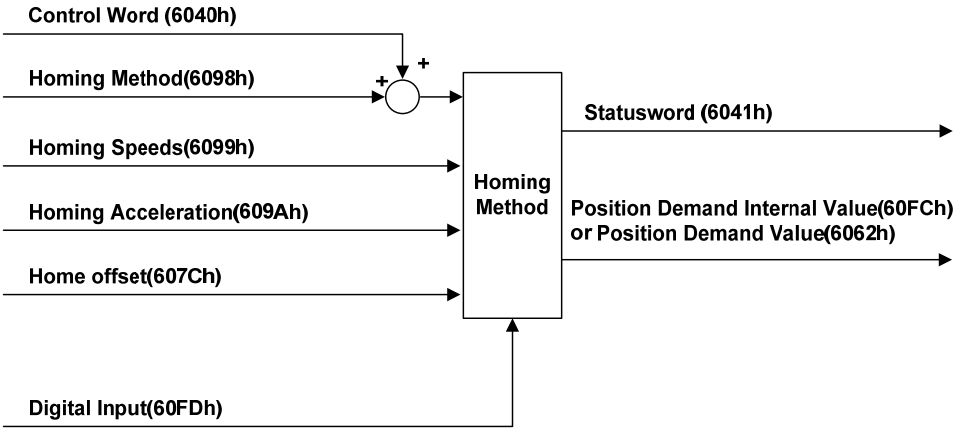
2. Associate object

Index	Sub-Index	Name	Data Type	Access	PDO Mapping	Units
6071h	-	Target Torque	INT	RW	Yes	0.1%
6077h	-	Torque Actual Value	INT	RO	Yes	0.1%
60B2h	-	Torque Offset	INT	RW	Yes	0.1%
606Ch	-	Velocity Actual Value	DINT	RO	Yes	User Unit/s
6064h	-	Position Actual Value	DINT	RO	Yes	User Unit
6072h	-	Max Torque	DINT	RW	Yes	0.1%
60E0h	-	Positive Torque Limit Value	DINT	RW	Yes	0.1%
60E1h	-	Negative Torque Limit Value	DINT	RW	Yes	0.1%

6.4.4 Homing mode（hm mode）

The master station sends a homing method to the driver, specifies the motion speed, and generates a position command within the servo driver to execute the homing action position control mode. If the motor is equipped with an incremental encoder (or an absolute encoder that requires batteries but is not installed) and requires absolute position positioning, it is necessary to perform a homing action before performing position positioning work after power on.

1. Structural drawing



2. Associate object

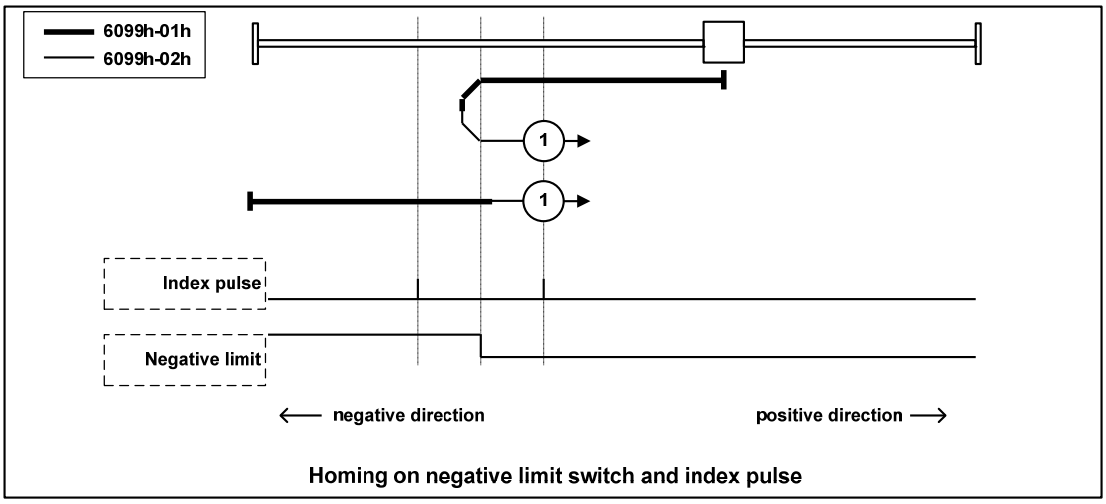
Index	Sub-Index	Name	Data Type	Access	PDO Mapping	Units
6040h	00h	Controlword	UNIT	RW	Yes	-
6041h	00h	Statusword	UINT	RO	Yes	-
607Ch	00h-	Home Offset	DINT	RW	No	User Unit
6098h	00h-	Homing Method	SINT	RW	Yes	-
6099h	-	Homing speed	-	-	-	-
	00h	Number of entries	USINT	RO	No	-
	01h	Speed During Search for Switch	U32	RW	RxPDO	User Unit/s
	02h	Speed During Search for zero	U32	RW	RxPDO	User Unit/s

Index	Sub-Index	Name	Data Type	Access	PDO Mapping	Units
607Dh	-	Software Position Limit	-	-	-	-
	00h	Number of entries	USINT	RO	No	-
	01h	Min position limit	DINT	RW	No	User Unit
	02h	Max position limit	DINT	RW	No	User Unit
609Ah	-	Homing Acceleration	UDINT	RW	Yes	User Unit/s^2

Index	Sub-Index	Name	Units	Range	Data Type	Access	PDO
6040h	00h	Control word		0～65535	U16	RW	RxPDO
6098h	00h	Homing method		-128～127	I8	RW	RxPDO
6099h	-	Homing speeds		-	-	-	-
	00h	Number of entries		2	U8	RO	No
	01h	Speed during search for switch	User unit/s	0～4294967295	U32	RW	RxPDO
	02h	Speed during search for zero	User unit/s	0～4294967295	U32	RW	RxPDO
609Ah	00h	Homing acceleration	User unit/s^2	0～4294967295	U32	RW	RxPDO

Method 1

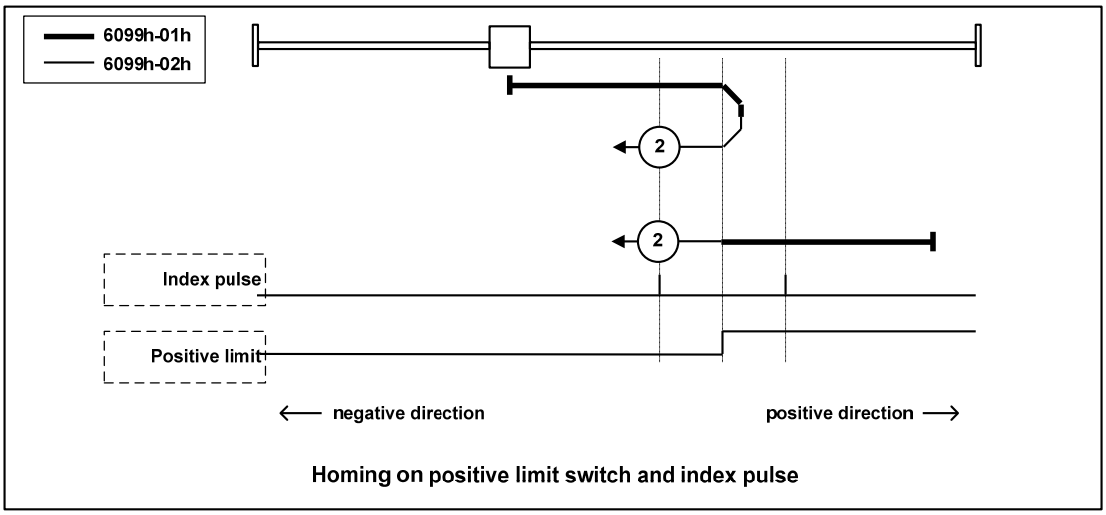
- This method is that if the negative limit switch is not activated, the initial action direction is negative detection. (The figure shows the inactive state under the low level state)
- The home detection position is the initial index pulse detection position in the positive direction after the negative limit signal is inactive.



Homing on negative limit switch and index pulse

Method 2

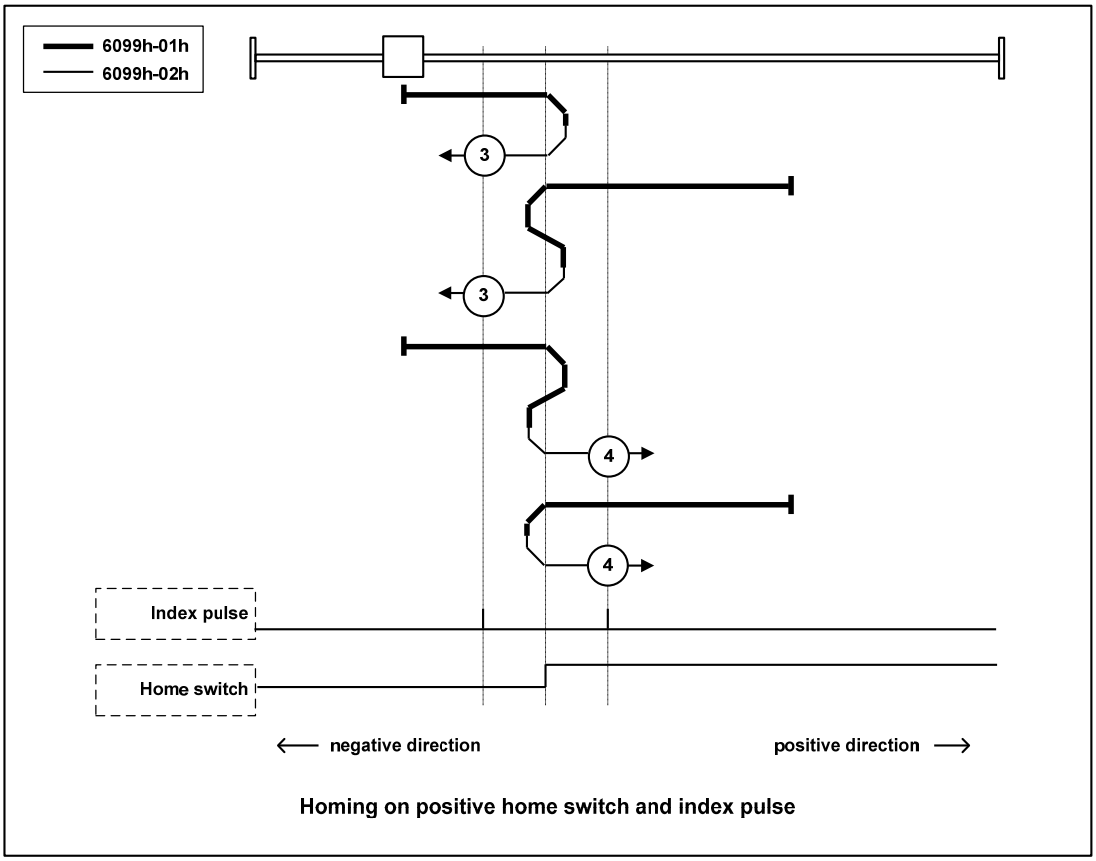
- This method is that if the positive limit switch is not activated, the initial action direction is the positive direction. (The figure shows the inactive state under the low level state)
- The home detection position is the initial index pulse detection position in the negative direction after the positive limit signal is inactive. (Please refer to the following figure)



Homing on positive limit switch and index pulse

Method 3，4

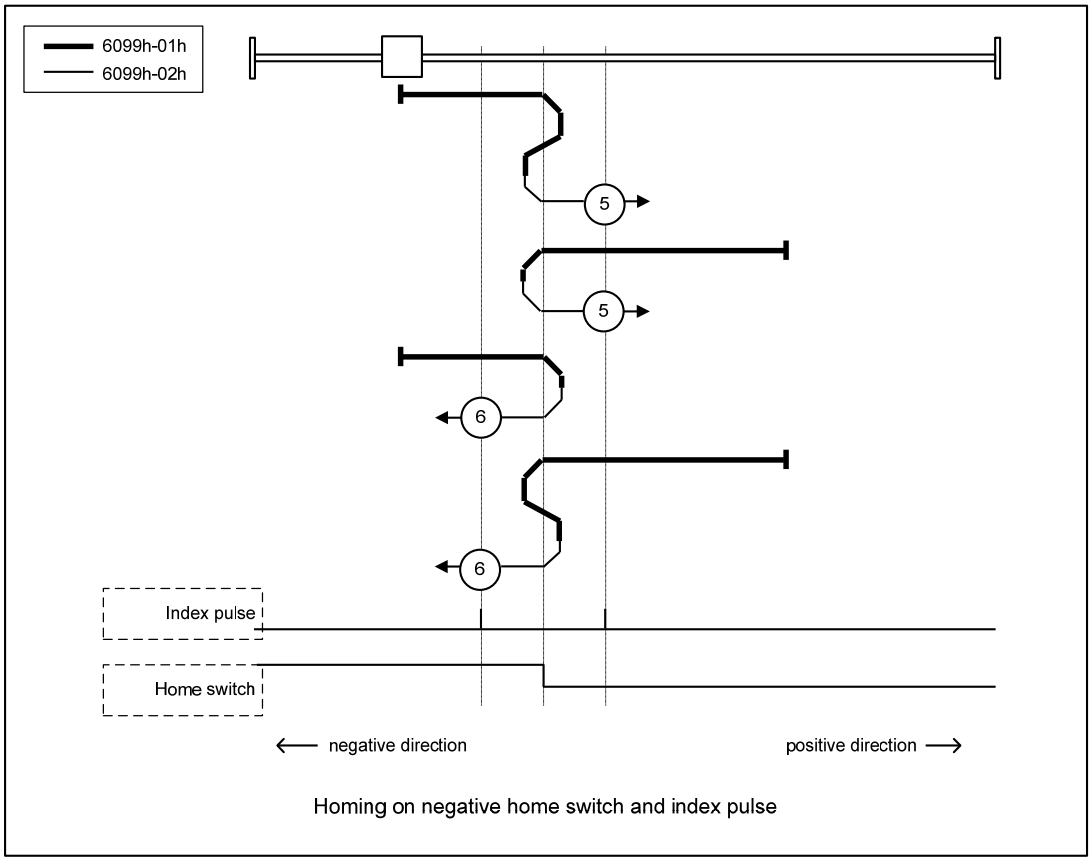
- This method is to initialize the action direction change based on the state of the home switch at startup.
- The home detection position is the negative direction side after the state of the home switch changes, or the initial index pulse detection position on the negative direction side. (Please refer to the following figure)



Homing on positive home switch and index pulse

Method 5，6

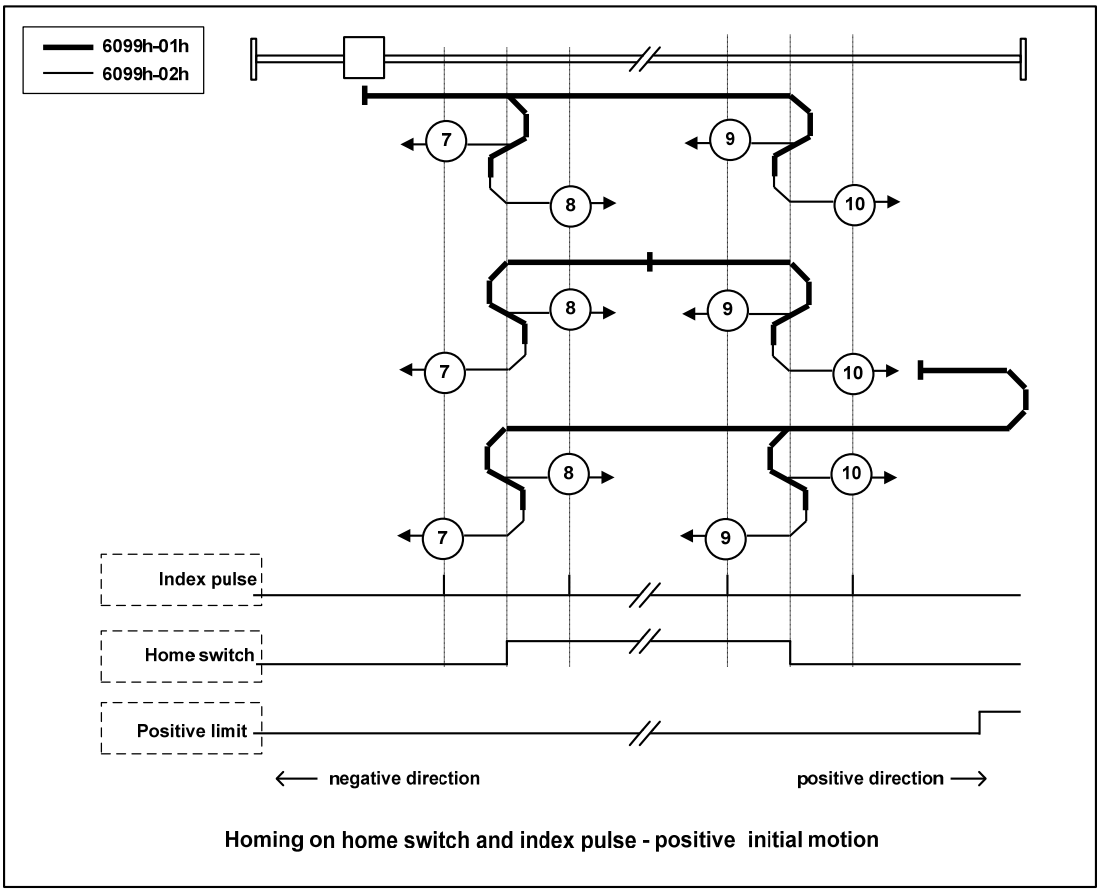
- This method is to initialize the action direction change based on the state of the home switch at startup.
- The home detection position is the initial index pulse detection position on the negative direction side or the positive direction side after the state of the home switch changes. (Please refer to the following figure)



Homing on negative home switch and index pulse

Method 7，8，9，10

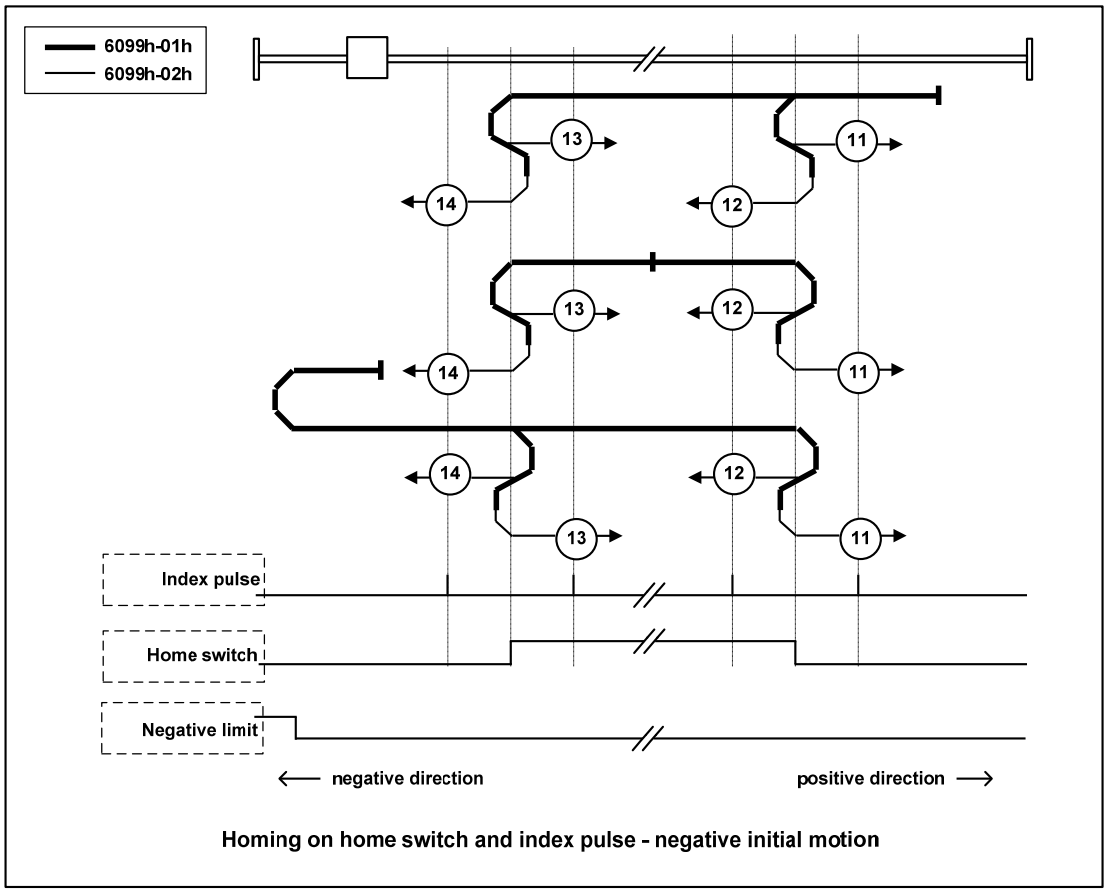
- This method is to use the home switch and index pulse.
- The initial action direction of methods 7 and 8 is the home switch. If it has been activated at the beginning of the action, it is a negative direction.
- The initialization action direction of methods 9 and 10 is the home switch. If it has been activated at the beginning of the action, it is the positive direction.
- The home detection position is the index pulse near the rising or falling edge of the home switch. (Please refer to the following figure)



Homing on home switch and index pulse - positive initial motion

Method 11，12，13，14

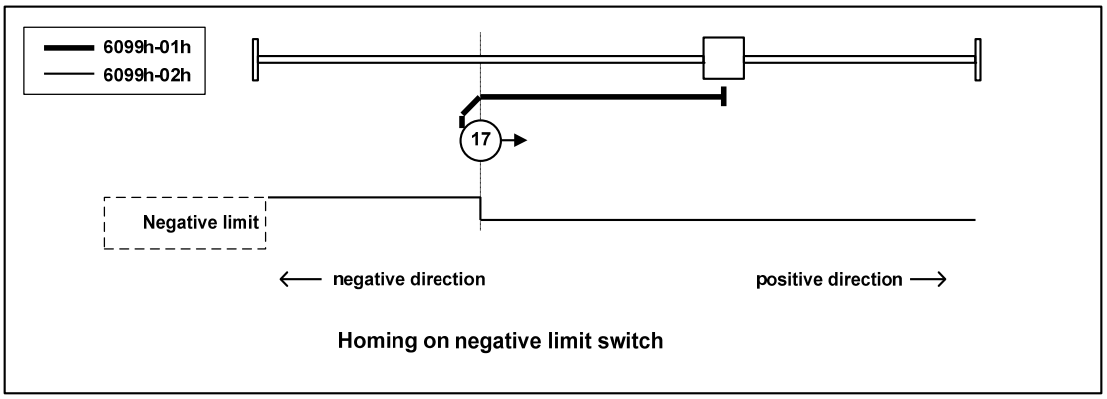
- This method is to use the home switch and index pulse.
- The initialization action direction of methods 11 and 12 is the home switch. If it has been activated at the beginning of the action, it is the positive direction.
- The initialization action direction of methods 13 and 14 is the home switch. If it has been activated at the beginning of the action, it is a negative direction.
- The home detection position is the index pulse near the rising or falling edge of the home switch. (Please refer to the following figure)



Homing on home switch and index pulse - negative initial motion

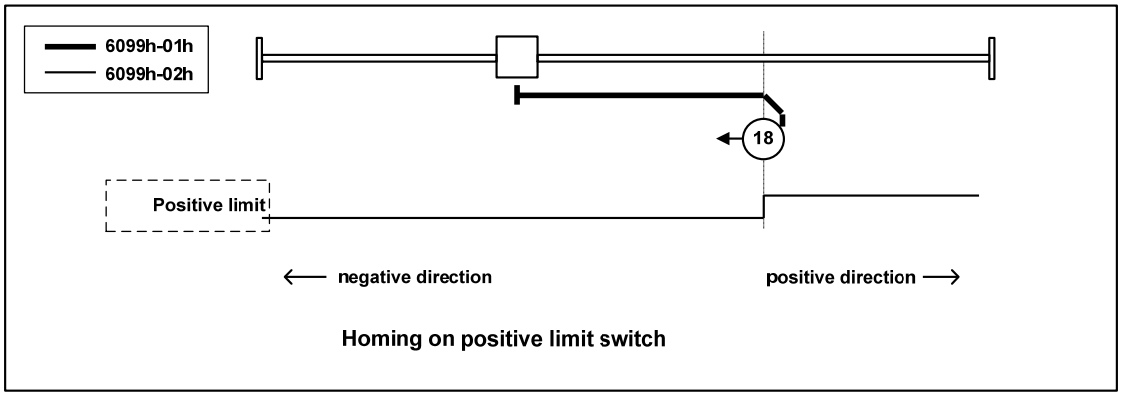
Method 17

- This method is similar to method 1. The difference is that the home detection position is not the index pulse, but the position where the limit switch changes. (Please refer to the following figure)



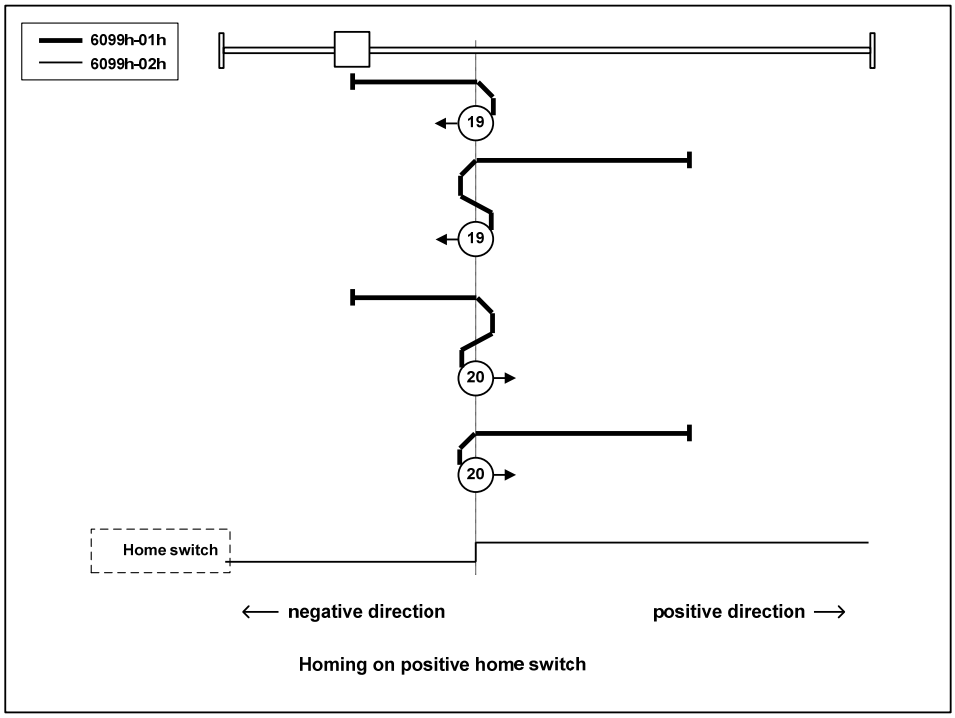
Method 18

- This method is similar to method 2. The difference is that the home detection position is not the index pulse, but the position where the limit switch changes. (Please refer to the following figure)



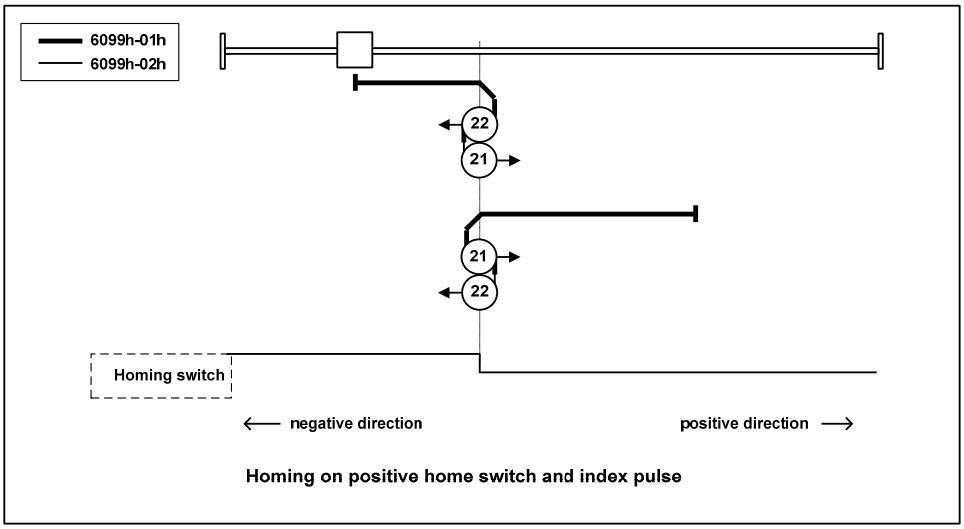
Method 19，20

- This method is similar to methods 3 and 4. The difference is that the home detection position is not the index pulse, but the position where the home switch changes. (Please refer to the following figure)



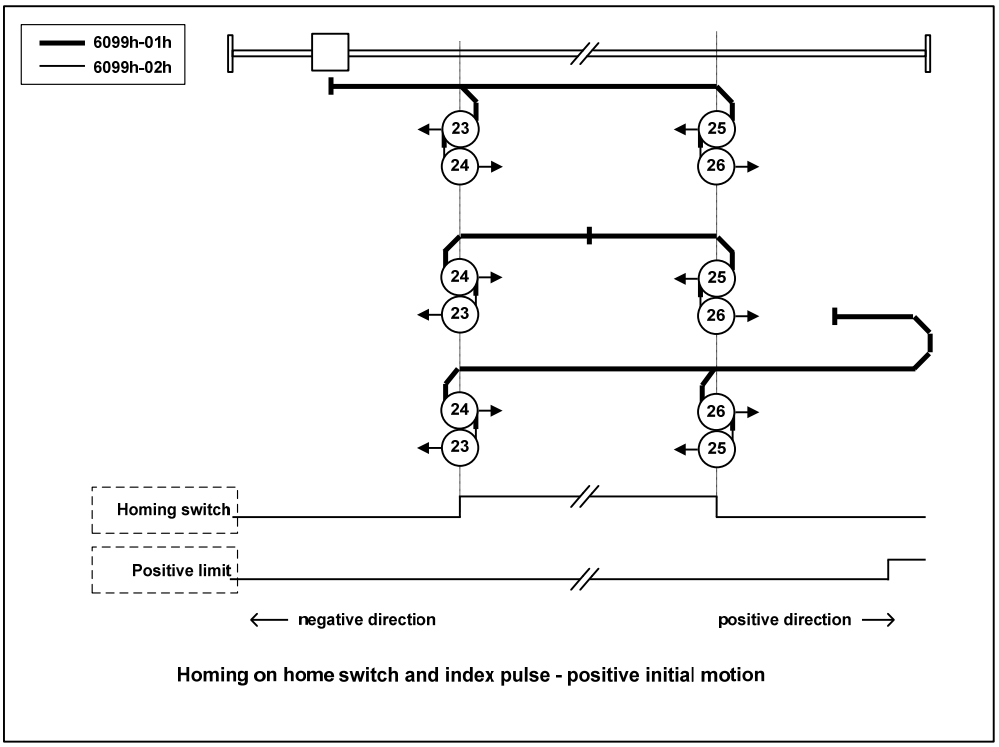
Method 21，22

- This method is similar to methods 5 and 6. The difference is that the home detection position is not the index pulse, but the position where the home switch changes. (Please refer to the following figure)



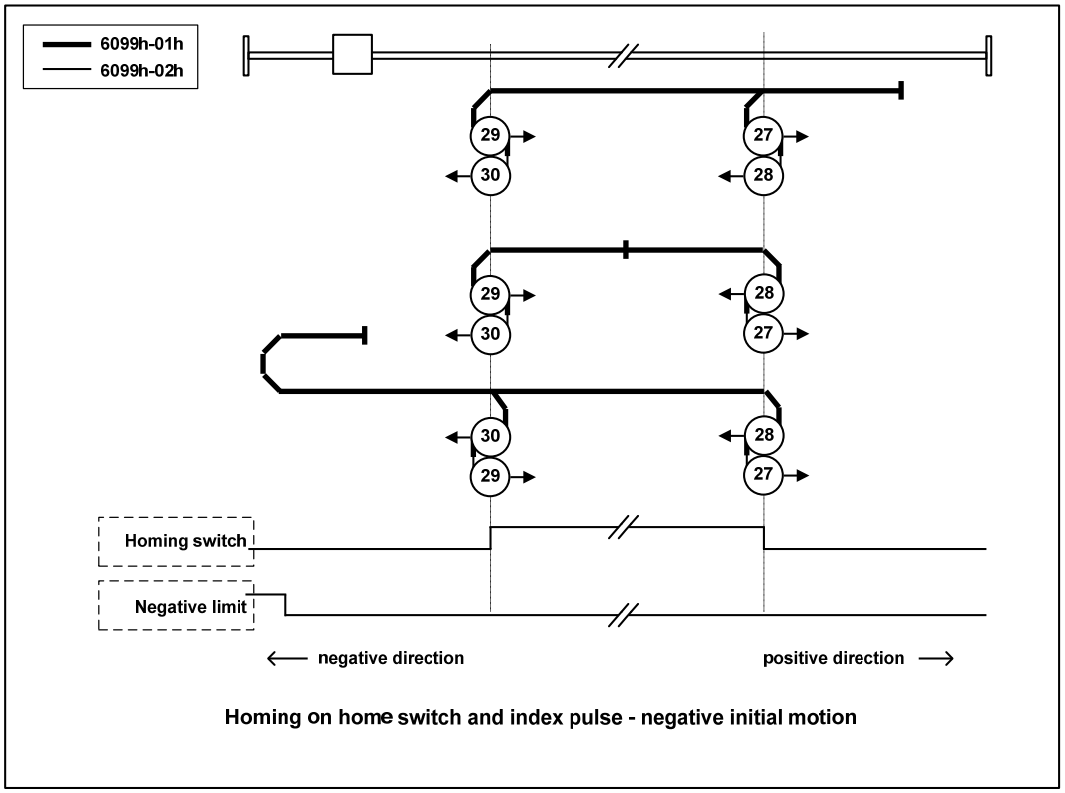
Method 23，24，25，26

- This method is similar to methods 7, 8, 9 and 10. The difference is that the home detection position is not the index pulse, but the position where the home switch changes. (Please refer to the following figure)



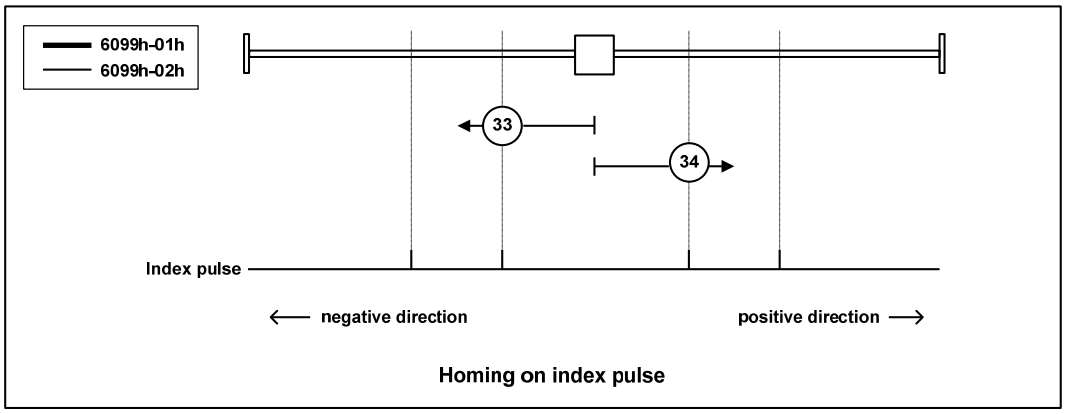
Method 27，28，29，30

- This method is similar to methods 11, 12, 13 and 14. The difference is that the home detection position is not the index pulse, but the position where the home switch changes. (Please refer to the following figure)



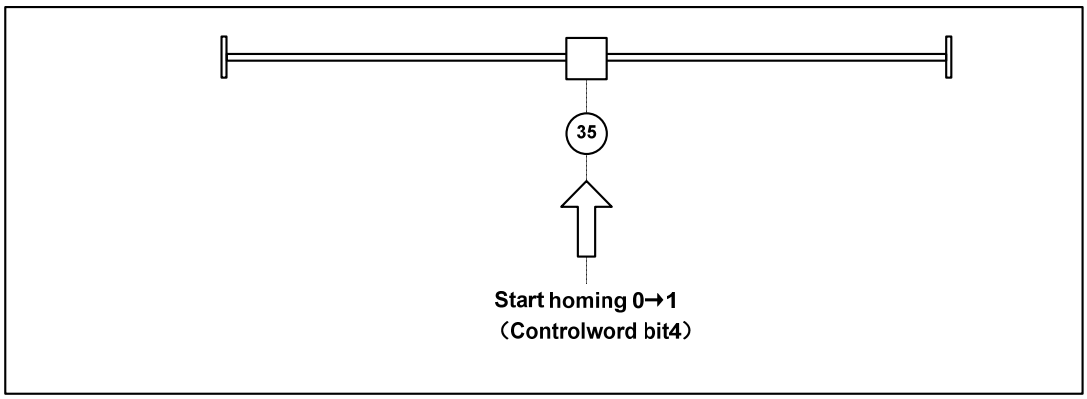
Method 33，34

- This method uses only index pulses.
- After the operation in the direction shown in the figure, the index pulse is detected as the home detection position.



Method 35

- Used when setting the coordinate system of the servo driver (setting the position information).
- At the point when homing starts, initialize (preset) the following objects based on this position.
  6062h（Position Demand Value）=6064h（Position Actual Value）=607Ch（Home Offset）
  6063h（Position Actual Internal Value）=60FCh（Position Demand Internal Value）= 0
  Note: 607Ch (Home Offset) is added to 6062h and 6064h.
- The drive state is not an operational enable state and can also be executed.



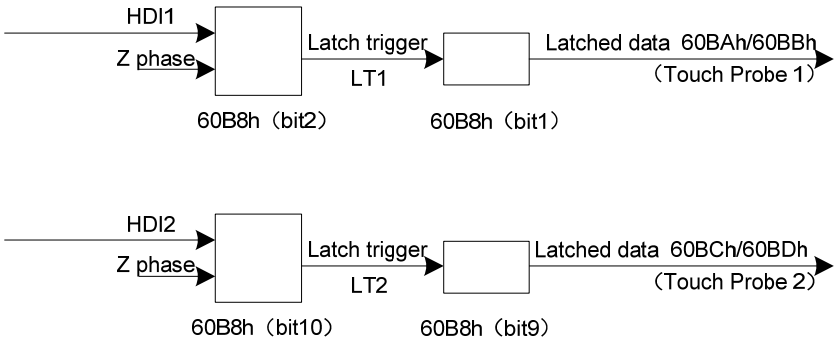
6.5 Common functions of modes

6.5.1 Touch Probe function

This function is to select trigger signal from external input (HDI1, HDI2) or Z-phase (in case of semi closed loop control, it is the position where the single turn data of rotary encoder is 0) to lock the feedback position.

- The input ON width and OFF width of the trigger signal shall be kept above 2ms respectively.
- If the trigger is selected as Z phase, do not select the falling edge.
- Please do not set both the rising and falling edges for the same Touch probe.
- When the drive status is Init and working in hm mode, the Touch probe function is invalid.

1. Composition of Touch Probe function



- 60B8h：Touch Probe Function

60B8h（Touch Probe Function）			
bit10	LT2	Bit2	LT1
0	HDI2	0	HDI1
1	Z phase	1	Z phase

- 60BAh：Touch Probe Pos1 Pos Value
- 60BBh：Touch Probe Pos1 Neg Value
- 60BCh：Touch Probe Pos2 Pos Value
- 60BDh：Touch Probe Pos2 Neg Value

2. Touch Probe associated objects

Index	Sub-Index	Name	Unit	Range	Date 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	Touch Probe Pos1Pos Value	User unit	-2147483648 ～2147483647	I32	RO	TxPDO
60BBh	00h	Touch Probe Pos1 Neg Value	User unit	-2147483648 ～2147483647	I32	RO	TxPDO
60BCh	00h	Touch Probe Pos2 Pos Value	User unit	-2147483648 ～2147483647	I32	RO	TxPDO
60BDh	00h	Touch Probe Pos2 Neg Value	User unit	-2147483648 ～2147483647	I32	RO	TxPDO

（1）Touch probe function （60B8h）

Touch Probe action start, various settings use the basic object

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
60B8h	00h	Touch Probe Function	-	0～65535	U16	RW	RxPDO	ALL	No
		Execute the settings for the Touch Probe function							

Corresponding Bit description

bit	value	Note	
0	0	Switch off touch probe 1	Touch Probe 1 Execution/Stop
	1	Enable touch probe 1	
1	0	Trigger first event	Touch Probe 1 Event mode selection (single shot/continuous)
	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	unused
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	unused
8	0	Switch off touch probe 2	Touch Probe 2 Execution/Stop
	1	Enable touch probe 2	
9	0	Trigger first event	Touch Probe 2 Event mode selection (single shot/continuous)
	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	unused
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	unused

- If the Z phase is selected according to the trigger setting, do not select the falling edge. It is impossible to guarantee the implementation of the above settings.
- The so-called rising edge represents the theoretical state of the object signal from OFF (inactive state) to ON (active state), and the so-called falling edge represents the time when the theoretical state of the object signal changes from ON to OFF.

（2）Touch probe status （60B9h）

Represents the status of the Touch Probe action

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
60B9h	00h	Touch Probe Status	-	0～65535	U16	RO	TxPDO	ALL	No
		Represents the status of the Touch Probe function							

Corresponding Bit description

bit	value	Note	
0	0	Touch probe 1 is switch off	Touch Probe 1 action stopped
	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 uncompleted state
	1	Touch probe 1 positive edge value stored	Rising edge Touch Probe 1 completion status
2	0	Touch probe 1 no negative edge value stored	Rising edge Touch Probe 1 uncompleted state
	1	Touch probe 1 negative edge value stored	Falling edge Touch Probe 1 completion status
3～5	-	Reserved	unused
6～7	-	Not Supported	unused
8	0	Touch probe 2 is switch off	Touch Probe 2 action stopped
	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 uncompleted state
	1	Touch probe 2 positive edge value stored	Rising edge Touch Probe 2 completion status
10	0	Touch probe 2 no negative edge value stored	Rising edge Touch Probe 2 uncompleted state
	1	Touch probe 2 negative edge value stored	Falling edge Touch Probe 2 completion status
11～13	-	Reserved	unused
14～15	-	Not Supported	unused

（3）Touch Probe Position 1/2 Positive Value （60BAh～60BDh）

Represents the obtained latch position.

Index	Sub-Index	Name/ Description	U-nits	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
60BAh	00h	Touch Probe Pos1 Pos Value	User unit	-2147483648 ～2147483647	I32	RO	Tx-PDO	ALL	No
		Represents the rising edge latch position of the Touch Probe 1.							
60BBh	00h	Touch Probe Pos1 Neg Value	User unit	-2147483648 ～2147483647	I32	RO	Tx-PDO	ALL	No
		Represents the landing edge latch position of the Touch Probe 1.							
60BCh	00h	Touch Probe Pos2 Pos Value	User unit	-2147483648 ～2147483647	I32	RO	Tx-PDO	ALL	No
		Represents the rising edge latch position of the Touch Probe 2.							
60BDh	00h	Touch Probe Pos2 Neg Value	User unit	-2147483648 ～2147483647	I32	RO	Tx-PDO	ALL	No
		Represents the landing edge latch position of the Touch Probe 2.							

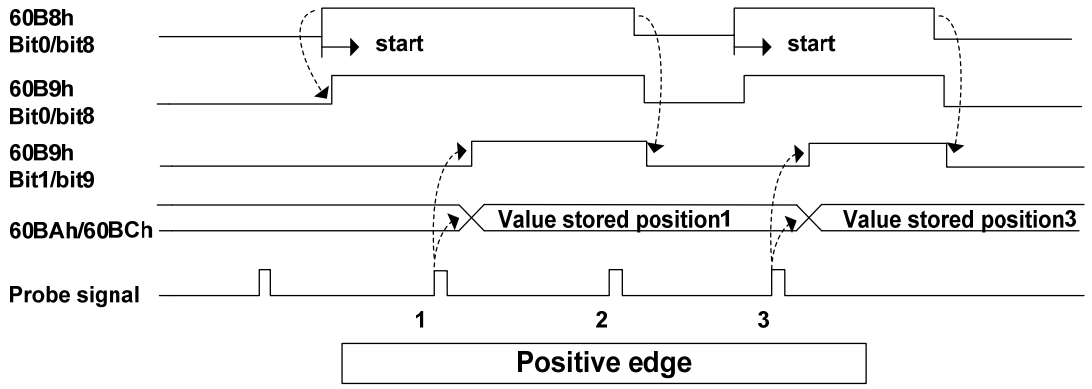
3. Start of Touch Probe action

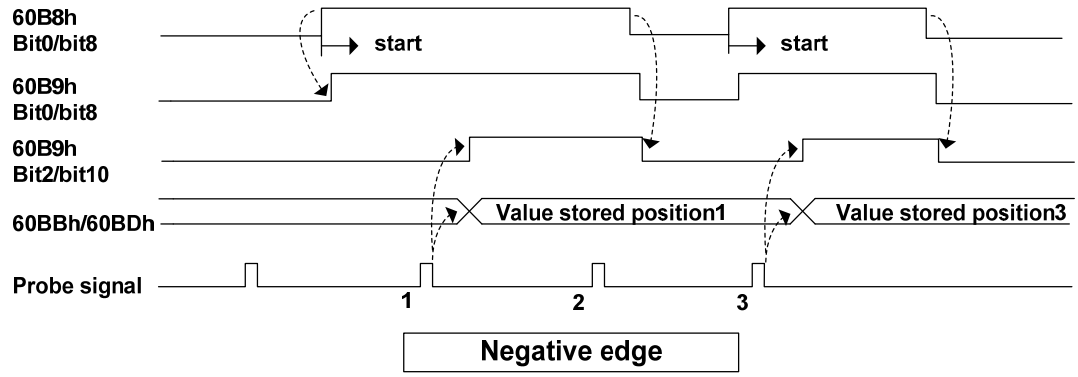
60B8h (Touch Probe Function) bit0/bit8 (Touch Probe execute/stop) changes from "0 (stop) → 1 (start)" to obtain various setting conditions (60B8h: bit1～7/bit9～15) and start the Touch Probe action. The changes of various setting conditions are valid. Please return to "0 (stop)" once for bit0/bit8, and then go to "1 (start)" again.

"0 (Trigger First event mode)" and "1 (Continuous mode)" can be selected according to bit 1/bit 9 (event mode selection) of 60B8h (Touch Probe Function).

- Trigger First Event mode (60B8h: bit1=0/bit9=0)

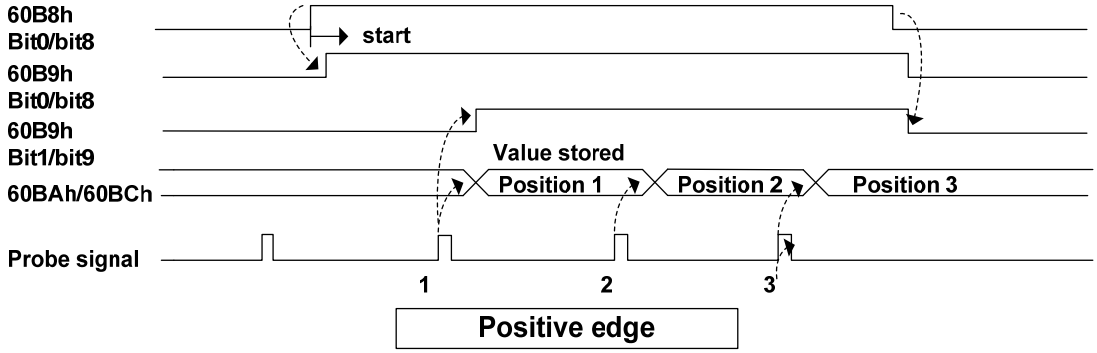
After starting, the mode is embedded only under the first trigger signal. In order to get it again, it is necessary to start the Touch Probe again.

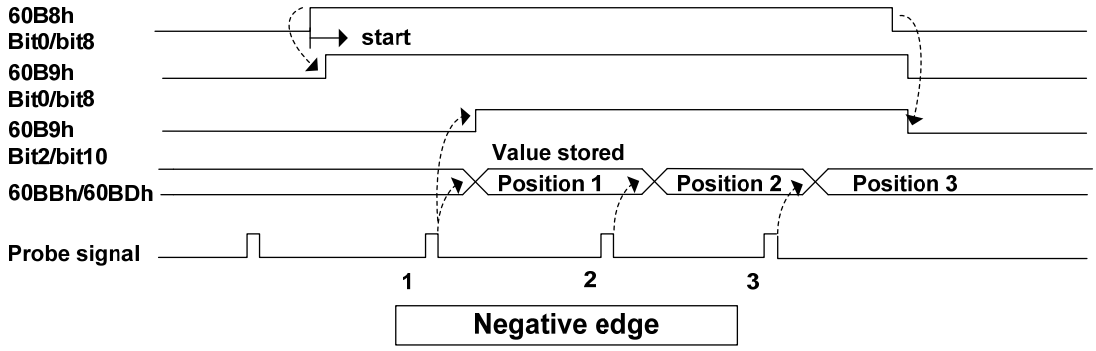




- Continuous mode (60B8H: bit1=1 / bit9=1)

After starting, detect the mode of trigger signal embedding every time. The obtained value is kept until the next Probe latch signal is valid.





6.5.2 Shutdown function

The deceleration function (option code) defined by CoE (CiA402) and the deceleration function of servo (EMG, dynamic brake stop, free running stop, instant stop, etc.) are combined to realize the "shutdown function".

1. PDS selection code list

Index	Sub Index	Name	Units	Range	Date Type	Access	PDO
6007h	00h	Abort Connection Option Code	-	0-3	I16	rw	No
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
605Eh	00h	Fault Reaction Option Code	-	0-2	I16	rw	No

2. Associated object list

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
6084h	00h	Profile Deceleration	User unit /s^2	0～ 4294967295	U32	RW	Rx-PDO	pp/ ip/pv	Yes

- Set the profile deceleration.
- If it is set to 0, the internal processing is operated as 1.

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP ROM
6085h	00h	Quick Stop Deceleration	User unit /s^2	0～ 4294967295	U32	RW	Rx-PDO	pp/ip/pv/hm/csp/csv	Yes

- If 605Ah (Quick stop option code) ="2" or "6", set the deceleration parameters used for motor deceleration stop during Quick stop.
- 605Dh (Halt option code) and 605Eh (Fault reaction option code) ="2" are also used.
- If it is set to 0, the internal processing is operated as 1.

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
6087h	00h	Torque Slope	0.1%/s	0～ 4294967295	U32	RW	Rx-PDO	cst	Yes

- Set the parameter value of the given inclination torque command.
- Only the deceleration stop time is valid in the cyclic synchronous torque mode (cst).
- If it is set to 0, the internal processing is operated as 1.

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
60C6h	00h	Max Deceleration	User unit /s^2	0～ 4294967295	U32	RW	Rx-PDO	pp/hm /pv/ip	Yes

- Set the maximum deceleration.
- If it is set to 0, the internal processing is operated as 1.

（1） EMG emergency shutdown

When EMG (emergency shutdown) in DI is ON, execute emergency stop according to the setting of parameter P164 (emergency shutdown mode).

- When P164=0, the driver turns off the motor current directly and the motor stops freely.
- When P164=1, the driver remains enabled, and the control motor stops at the acceleration and deceleration defined by 6085h (Quick stop deceleration).
- When P164=2, decelerate and shut down, and the deceleration time is determined by P063.

（2） Quick Stop Option Code（605Ah）

Set motor deceleration stop method

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Access	PDO	Op-mode	EEP-ROM
605Ah	00h	Quick Stop Option Code	-	0～7	I16	RW	No	ALL	Yes

- Set the timing of Quick stop. It varies according to the control mode definition.
- Setting other than the following values is prohibited.

  csp，csv，hm

  0: After the motor stops freely, migrate to Switch on Disabled.

  1: After 6084h (Profile Deceleration) motor stops, migrate to Switch on disabled.

  2: After 6085h (Quick Stop Deceleration) motor stops, migrate to Switch on disabled.

  3: After 60C6h (Max Deceleration) motor stops, migrate to Switch on disabled.

  5: After 6084h (Profile Deceleration) motor stops, migrate to Quick stop active.

  6: After 6085h (Quick Stop Deceleration) motor stops, migrate to Quick stop active.

  7: After 60C6h (Max Deceleration) motor stops, migrate to Quick stop active.

  cst

  0: After the motor stops freely, migrate to Switch on disabled.

  1, 2: After 6087h (Torque Slope) motor stops. Migrate to Switch on disabled.

  5, 6: After 6087h (Torque Slope) motor stops. Migrate to Quick stop active.

（3） Shutdown Option Code（605Bh）

Set the method of motor deceleration stop when receiving "Shutdown" and "Disable voltage" commands.

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Access	PDO	Op-mode	EEP-ROM
605Bh	00h	Shutdown option code	-	0～1	I16	RW	No	ALL	Yes

- Set the timing when PDS commands "Shutdown" and "Disable voltage" are received. It varies according to the control mode definition.
- Setting other than the following values is prohibited.

  When PDS command "Shutdown" is received:

  csp，csv，hm

  0: After the motor stops freely, switch to Ready to switch on.

  1: After 6084h (Profile cancellation) motor stops, switch to Ready to switch on.

  cst

  0: After the motor stops freely, switch to Ready to switch on.

  1: After 6087h (Torque slope) motor stops, switch to Ready to switch on.

（4） Disable Operation Option Code（605Ch）

Set the method of motor deceleration stop when receiving the "Disable operation" command.

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acce ss	PDO	Op-mode	EEP-ROM
605Ch	00h	Disable operation option code	-	0～1	I16	RW	No	ALL	Yes

- Set the timing when receiving the PDS command "Disable operation". It varies according to the control mode definition.
- Setting other than the following values is prohibited.

  csp，csv，hm

  0: After the motor stops freely, it switches to switched on.

  1: After 6084h (Profile cancellation) motor stops, switch to switched on.

  cst

  0: After the motor stops freely, it switches to switched on.

  1: After 6087h (Torque slope) motor stops, switch to switched on.

（5） Fault Reaction Option Code（605Eh）

Set the motor stop method when the alarm occurs.

When the fault occurs, the brake acts immediately and turns off the PWM to enter the fault state.

6.5.3 Digital input/digital output

1. Digital input（60FDh）

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
60FDh	00h	Digital nputs	-	0～ 4294967295	U32	RO	Tx-PDO	ALL	No

- Represents the theoretical input state of an external input signal.

bit	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**
function	HDI2	HDI1	（reserved）					
bit	23	22	21	20	19	18	17	16
function	DI5	DI4	DI3	DI2	DI1	（reserved）		
bit	15	14	13	12	11	10	9	8
function	（reserved）							
bit	7	6	5	4	3	2	1	0
function	（reserved）				（Not Supported）	home switch [HOME]	positive limit switch[POT]	negative limit switch [NOT]

Note that to use the following functions, DI must be configured to the appropriate IO function, otherwise unpredictable results may occur.

bit 19-23 reflects the original IO states of DI1 to DI5, and the details of each Bit are as follows:

Value	Definition
0	Switched off (theoretical input state OFF)
1	Switched On (theoretical input state ON)

60FDh (Digital Inputs) bit2 (home switch), bit1 (positive limit switch), and bit0 (negative limit switch) parallel I/O connectors near homing input (HOME), positive drive prohibited input (POT), negative drive prohibited input (NOT) signal state.

2. Digital output（60FEh）

If you perform a set brake signal control, be sure to use it through PDO.

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name/ Description</th><th>Units</th><th>Range</th><th>Data Type</th><th>Acc ess</th><th>PDO</th><th>Op-mode</th><th>EEP-ROM</th></tr>
<tr><td rowspan="11">60FEh</td><td>-</td><td>Digital Outputs</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2"></td><td colspan="8">● Used when the output triode of the external output signal acts.
<table>
<tr><td>bit</td><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>function</td><td colspan="8">（Not Supported）</td></tr>
<tr><td>bit</td><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>function</td><td colspan="3">（reserved）</td><td>NET IO5</td><td>NET IO4</td><td>NET IO3</td><td>NET IO2</td><td>NET IO1</td></tr>
<tr><td>bit</td><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>function</td><td colspan="8">（reserved）</td></tr>
<tr><td>bit</td><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>function</td><td colspan="7">（reserved）</td><td>set brake</td></tr>
</table></td></tr>
<tr><td rowspan="2">00h</td><td>Number of entries</td><td>-</td><td>2</td><td>U8</td><td>RO</td><td>No</td><td>ALL</td><td>No</td></tr>
<tr><td colspan="8">● Represents the number of the Sub-Index of 60FEh.</td></tr>
<tr><td rowspan="2">01h</td><td>Physical outputs</td><td>-</td><td>0～ 4294967295</td><td>U32</td><td>RW</td><td>Rx-PDO</td><td>ALL</td><td>Yes</td></tr>
<tr><td colspan="8">● Operates the output of an external output signal.</td></tr>
<tr><td rowspan="2">02h</td><td>Bit mask</td><td>-</td><td>0～ 4294967295</td><td>U32</td><td>RW</td><td>Rx-PDO</td><td>ALL</td><td>Yes</td></tr>
<tr><td colspan="8">● When it is set to "1", the corresponding physical output is normally output; when it is "0", the corresponding physical output is invalid level.</td></tr>
<tr><td colspan="9">bit 16-20 can control the output state of DO1-5. Note that DOx should be configured as NETIOx, and bit mask is not supported.
When bit 0=1, it means the brake is engaged; When bit 0=0, it means that the brake is released and bit mask is supported.</td></tr>
</table>

6.5.4 Position information

1. Initialization time of position information

Servo driver in the building of a communication (ESM state Init → PreOP transformation), initialize the position information of the following objects.

- 6062h（Position Demand Value）
- 6063h（Position Actual Internal Value）
- 6064h（Position Actual Value）
- 60FCh（Position Demand Internal Value）

Therefore, the electronic gear function, polarity, home offset and other contents are implemented when the communication is established.

2. Electronic gear function

The electronic gear is a function that converts the movement amount set by the user through the command unit into the number of pulses required for actual movement servo. With the use of this function, the motor rotation movement of each command unit can be set arbitrarily. EP5 EtherCAT series does not set the electronic gear ratio according to the parameters P027, P028 (number of command pulses per motor rotation), P029 (electronic gear numerator), P030 (electronic gear denominator), but according to the object 608Fh (Position Encoder Resolution), 6091h (Gear Ratio), 6092h (Feed Constant) specified by CiA402.

The relationship between user-defined units (user units) and internal units (pulse) is calculated according to the following equation.

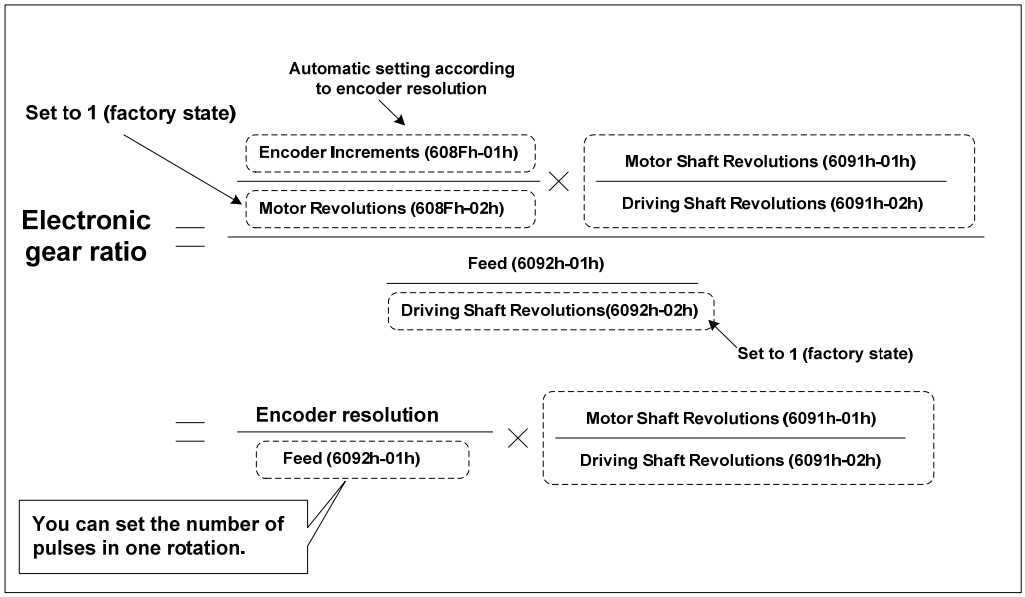
$$\text{Electronic gear ratio} = \frac{\text{Position Encoder Resolution} \times \text{Gear Ratio}}{\text{Feed Constant}}$$

$$\text{Position Demand Value} \times \text{Electronic gear ratio} = \text{Position Demand Internal Value}$$

Note: The electronic gear ratio is valid in the range of 1000 times～1/1000 times. If the range is exceeded, abnormal protection will occur.

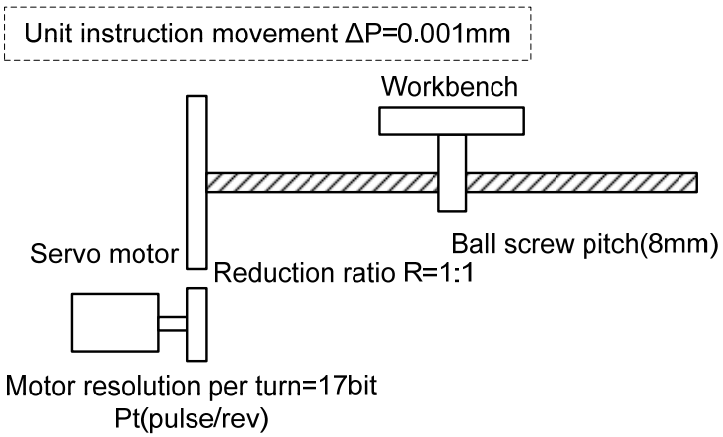
- The setting of electronic gear ratio takes effect at the moment when Init is converted to PreOP.
- Please set the value of electronic gear ratio within the range of -2^{31}（-2147483648）～$+2^{31}-1$（2147483647）. If it exceeds the range, an exception will occur.

3. Electronic gear calculation formula



4. Example of electronic gear

（1）Application of electronic gear in ball screw



- Mechanical specifications: ball screw Pitch is 8mm; Reduction ratio 1/1
- Encoder resolution: 131072 (17bit)
- User unit ΔP is 0.001mm
- Number of instruction pulses for one turn of the load shaft

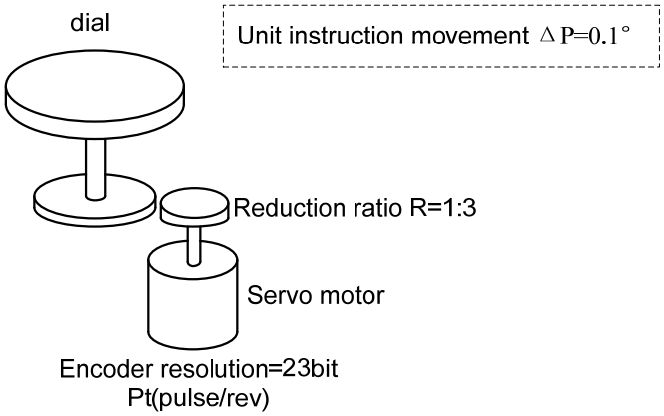
$$Feed\,(6092h-01h)=\frac{Pitch}{\Delta P}=\frac{8mm}{0.001mm}=8000$$

- Calculate the electronic gear ratio

$$\text{Electronic gear ratio} = \frac{\text{Encoder resolution}}{\text{Feed}(6092h-01h)} \times \frac{\text{Motor Shaft Revolutions}(6091h-01h)}{\text{Driving Shaft Revolutions}(6091h-02h)}$$
$$= \frac{131072}{8000} \times \frac{1}{1}$$

- Setting parameters: Feed (6092h-01h) is set to 8000, Motor Shaft Revolutions (6091h-01h) is set to 1, and Driving Shaft Revolutions (6091h-02h) is set to 1.

（2）Application of electronic gear in indexing dial



- Mechanical specifications: one turn of rotation Angle 360°; 1/3 reduction ratio
- Encoder resolution 8388608 (23bit)
- User unit ΔP is 0.1°
- Calculate the number of instruction pulses at one turn of the load axis

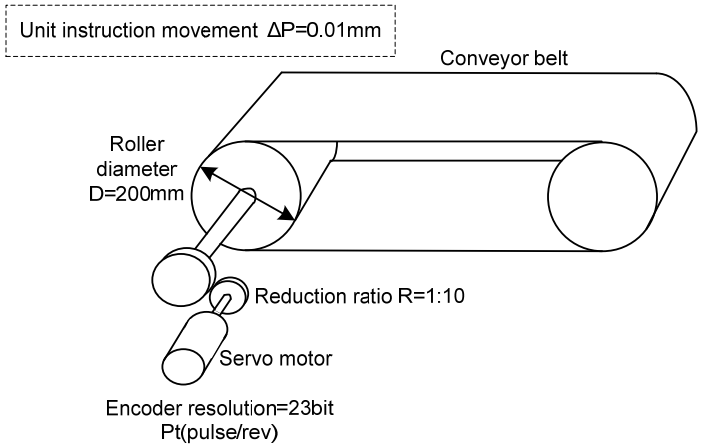
$$Feed(6092h-01h) = \frac{360°}{\Delta P} = \frac{360°}{0.1°} = 3600$$

- Calculate the electronic gear ratio

$$\text{Electronic gear ratio} = \frac{\text{Encoder resolution}}{\text{Feed}(6092h-01h)} \times \frac{\text{Motor Shaft Revolutions}(6091h-01h)}{\text{Driving Shaft Revolutions}(6091h-02h)}$$
$$= \frac{8388608}{3600} \times \frac{3}{1}$$

- Setting parameters: Feed (6092h-01h) is set to 3600, Motor Shaft Revolutions (6091h-01h) is set to 3, and Driving Shaft Revolutions (6091h-02h) is set to 1.

（3）Application of electronic gear in conveyor belt



- Mechanical specifications: roller diameter 200mm; Reduction ratio 1/10
- Encoder resolution 8388608 (23bit)
- User unit ΔP is 0.01mm
- Number of instruction pulses for one turn of the load shaft

$$Feed\,(6092h-01h)=\frac{\pi D}{\Delta P}=\frac{3.14\times 200\,\text{mm}}{0.01mm}=62800$$

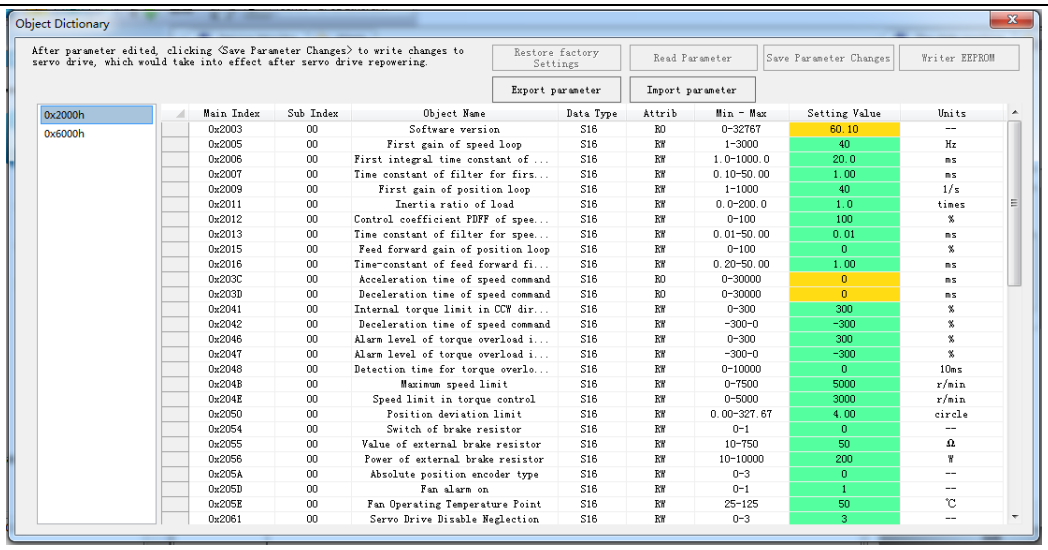
- Calculate the electronic gear ratio

$$\text{Electronic gear ratio}=\frac{\text{Encoder resolution}}{Feed(6092h-01h)}\times\frac{Motor\ \text{Shaft Revolutions(6091h - 01h)}}{Driving\ \text{Shaft Revolutions(6091h - 02h)}}$$
$$=\frac{8388608}{62800}\times\frac{10}{1}$$

- Setting parameters: Feed (6092h-01h) is set to 62800, Motor Shaft Revolutions (6091h-01h) is set to 10, and Driving Shaft Revolutions (6091h-02h) is set to 1.

5. Saving of electronic gear settings

The associated objects of electronic gears (6091h-01h, 6091h-02h, 6092h-01h, 6092h-02h) are saved objects. After the change, it is recommended to perform the save operation (write to EEPROM). Use the object editor of the host software to set and save objects.



（1）Position Encoder Resolution（608Fh）

Index	Sub-Index	Name/ Description	Units	Range	Date Type	Acc-ess	PDO	Op-mode	EEP-ROM
608Fh	-	Position Encoder Resolution	-	-	-	-	-	-	-
		● The resolution of the encoder is automatically set.							
	00h	Highest Sub-Index Supported	-	2	U8	RO	No	ALL	No
		● Represents the number of Sub-Index of 608Fh.							
	01h	Encoder increments	pulse	0～4294967295	U32	RO	No	ALL	No
		● Represents the encoder movement. Value is the automatic setting of encoder resolution.							
	02h	Motor Revolutions	R (motor)	0～4294967295	U32	RO	No	ALL	No
		● Represents the number of motor rotation. The value is fixed at 1.							

This object defines the encoder resolution for each revolution of the motor, which is automatically set according to the information read from the motor connected to the servo driver.

$$\text{Position Encoder Resolution} = \frac{\text{Encoder Increments (608Fh - 01h)}}{\text{Motor Revolutions (608Fh - 02h)}}$$

Example: 17bit/ r encoder connection

608Fh-01h（Encoder Increments）=131072

608Fh-02h（Motor Revolutions）=1

Position Encoder Resolution =131072 / 1=131072

（2）Gear ratio（6091h）

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
6091h	-	Gear Ratio	-						
		● Set the gear ratio.							
	00h	Number of Entries	-	2	U8	RO	No	ALL	No
		● Represents the number of Sub-Index number of 6091h.							
	01h	Motor Revolutions	R (motor)	1～32767	U32	RW	No	ALL	Yes
		● Set motor rotation number.							
	02h	Shaft Revolutions	r(axis)	1～32767	U32	RW	No	ALL	Yes
		● Set the number of axis rotations.							

This object defines the motor revolution and the shaft revolution after the electronic gear output.

$$\text{Gear ratio} = \frac{\text{Motor Shaft Revolutions (6091h-01h)}}{\text{Driving Shaft Revolutions (6091h-02h)}}$$

（3）Feed Constant（6092h）

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Acc-ess	PDO	Op-mode	EEP-ROM
6092h	-	Feed Constant	-	-	-	-	-	-	-
		● Set the feed constant.							
	00h	Highest Sub-index Supported	-	2	U8	RO	No	ALL	No
		● Represents the number of Sub-Index of 6092h.							
	01h	Feed	User unit	0-4294967295	U32	RW	No	ALL	Yes
		● Set the feed size.							
	02h	Shaft Revolutions	r (axis)	0-4294967295	U32	RW	No	ALL	Yes
		● Set the number of axis rotations.							

This object represents the amount of action per 1 turn of shaft rotation after electronic gear output.

$$\text{Feed Constant} = \frac{\text{Feed (6092h-01h)}}{\text{Driving Shaft Revolutions (6092h-02h)}}$$

（4）Polarity (607Eh)

For position command/speed command/torque command and each offset, the polarity (motor rotation direction) can be set.

Index	Sub-Index	Name/ Description	Units	Range	Data Type	Access	PDO	Op-mode	EEP-ROM
607Eh	00h	Polarity	-	0-255	U8	RW	No	ALL	Yes

Set the polarity when transmitting position command, speed command, torque command and position offset, speed offset (speed addition), torque offset (torque addition) values from the object to internal processing, and the polarity when transmitting position feedback, speed feedback, torque feedback values from internal processing to the object. The specific objects involved are as follows:

- Instruction set class object
  607Ah（Target Position）、60B0h（Position Offset）、60FFh（Target Velocity）、
  60B1h（Velocity Offset）、6071h（Target Torque）、60B2h（Torque Offset）
- Monitor class object
  6062h（Position Demand Value）、6064h（Position Actual Value）、
  606Bh（Velocity Demand Value）、606Ch（Velocity Actual Value）、6074h（Torque Demand）、
  6077h（Torque Actual Value）
- External input class objects
  bit1(positive Limit Switch(POT)) of 60FDh-00h(Digital Input)、
  bit0(Negative Limit Switch(NOT)) of 60FDh-00h(Digital Input)、
  POT, NOT for external input signals

Set value	Content
0	Signs of position、peed、torque are not reversed
224	Signs reversal of position、speed、torque
Beyond the above	Not supported（Please do not set, no effect）

For example, when using a 17bit absolute encoder, the settings and effects of 607Eh are shown in the following table:

607E（Set value）	Position information
0 (CCW is positive direction)	6063h = M×2^{17}+S
	6064h =(6063h×Electronic gear inverse transformation)+607Ch
224 (CW is positive direction)	6063h =-(M×2^{17}+S)
	6064h =(6063h×Electronic gear inverse transformation)+607Ch

Among them, 6063h (Position Actual Internal Value), 6064h (Position Actual Value), 607Ch (Home Offset), M are multi turn data, and S are single turn data.

6.5.5 EEPROM operation of object

Object 1010h is used to manipulate the EEPROM of the slave station.

Index	Sub-Index	Name /Description	Units	Range	Data Type	Access	PDO	Op-mode	EEP-ROM
1010h		Store Parameters	-	-	-	-	-	-	-
	-	Object data is written to EEPROM. The object as a standby object is the object with "Yes" recorded in the EEPROM column of the object list.							
	00h	Number of Entries	-	0-255	U8	RO	No	All	No
		Fixed value of 1							
	01h	Save All Parameters	-	0～4294967295	U32	RW	No	All	No
		● Object 1010h.01h is initialized with a value of 0x01. ● When the parameter needs to be saved, the value of 1010h.01h written through SDO is (65766173h). ● When it is necessary to restore the default value of the parameter, write the value of 1010h.01h to (64616f6ch) through SDO. ● When object 1010h.01h is detected to have a value of (65766173h), an EEPROM operation (E-SET) for saving driver parameters will be triggered. During the save operation, the SDO function needs to be temporarily suspended until the save operation is completed, otherwise an error will result. ● When object 1010h.01h is detected to have a value of (64616f6ch), a default drive parameter EEPROM operation (E-DEF) will be triggered. During the default operation, SDO functions are temporarily suspended until the default operation is completed, otherwise an error will result ● After writing 1010h.01h to trigger EEPROM operation (E-SET or E-DEF), if the operation is successful, read the value of 1010h.01h and return it to 0; If the operation fails, read the value of 1010h.01h and return it as 1.							

- The number of EEPROM writes is limited.
- The EEPROM write time can take up to 10 seconds (when all objects are changed).

Chapter 7 Alarm

7.1 Alarm list

Alarm code	Serial no.	603Fh value	Alarm name	Alarm content	Alarm clear
--	0	FF00h	No alarm	Normal operation	
Er 1	1	FF01h	Over speed	Motor speed exceeds the maximum limit	Can
Er 2	2	FF02h	Main circuit over-voltage	The main circuit supply voltage exceeds the specified value	Can
Er 3	3	FF03h	Main circuit undervoltage	The main circuit supply voltage is below the specified value	Can
Er 4	4	FF04h	Position deviation	Position deviation counter value exceeds the set value	Can
Er 7	7	FF07h	Drive inhibition abnormal	CCWL, CWL driver prohibited input are invalid	Can
Er 8	8	FF08h	Position deviation counter overflow	The absolute value of position deviation counter exceeds 2^{30}	Can
Er 9	9	FF09h	Pulse encoder signal failure	Pulse encoder signal failure	No
Er 11	11	FF0Bh	Power module over-current	Power module failure	No
Er 12	12	FF0Ch	Over-current	Excessive motor current	No
Er 13	13	FF0Dh	Over-load	Motor overload	No
Er 14	14	FF0Eh	Brake peak power overload	Brake instantaneous short time load is too large	No
Er 15	15	FF0Fh	Pulse encoder count error	Pulse encoder count error	No
Er 16	16	FF10h	Motor thermal overload	Motor calorific value exceeds the set value (I^2t detection)	No
Er 17	17	FF11h	Average braking power overload	Excessive average load after braking for a long time	No
Er 18	18	FF12h	IGBT model over-load	Average output load of power model is too big	No
Er 20	20	FF14h	EEPROM error	EEPROM read/write error	No
Er 21	21	FF15h	Logic circuit error	Logic circuit fault outside DSP	No
Er 22	22	FF16h	Mismatch between power board and control board	Replace the power board or control board	No
Er 23	23	FF17h	AD conversion error	Circuit or current sensor fault	No
Er 25	25	FF19h	FPGA verification error	FPGA verification error	No

Alarm code	Serial no.	603Fh value	Alarm name	Alarm content	Alarm clear
Er 27	27	FF1Bh	Phase loss alarm	Check whether the power line is three-phase input	No
Er 29	29	FF1Dh	Torque overload alarm	Motor load exceeds user set value and duration	No
Er 30	30	FF1Eh	Pulse encoder Z signal loss	Pulse encoder Z signal loss	No
Er 35	35	FF23h	Connection failure between boards	Drive internal connection path failure	No
AL 36	36	FF24h	Fan alarm	Fan fault	No
Er 40	40	FF28h	Absolute value encoder communication error	Drive and encoder cannot communicate	No
Er 41	41	FF29h	Absolute value encoder handshake error	Absolute value encoder handshake error	No
Er 42	42	FF2Ah	Absolute value encoder internal count error	Absolute value encoder count exception	No
Er 43	43	FF2Bh	Absolute value encoder communication response error	Absolute value encoder communication response abnormal	No
Er 44	44	FF2Ch	Absolute value encoder verification error	Absolute value encoder communication content error	No
Er 45	45	FF2Dh	Absolute value encoder EEPROM error	EEPROM fault of absolute value encoder	No
Er 46	46	FF2Eh	Absolute value encoder parameter error	Absolute value encoder parameters are damaged	No
Er 47	47	FF2Fh	Absolute value encoder external battery error	Battery voltage is too low	No
Er 48	48	FF30h	Absolute value encoder external battery alarm	Low battery voltage	No
Er 49	49	FF31h	Encoder overheating	Encoder overheating	No
Er 50	50	FF32h	Motor parameters do not match the driver	Power mismatch between motor and drive	No
Er 51	51	FF33h	Encoder automatic recognition failed	Encoder automatic recognition failed	No
Er 55	55	FF37h	Encoder function not supported	Encoder function not supported	Can
Er 56	56	FF38h	Encoder position value is invalid	Encoder position value is invalid	Can
Er 57	57	FF39h	Encoder multi turn fault	Encoder multi turn fault	No
Er 61	61	FF3Dh	Ethernet communication cycle deviation too large	Ethernet communication cycle deviation too large	No

Alarm code	Serial no.	603Fh value	Alarm name	Alarm content	Alarm clear
Er 62	62	FF3Eh	Ethernet command data out of range	Ethernet command data out of range	No
Er 63	63	FF3Fh	Internal error	Internal error	No
Er 65	65	FF41h	SYNC signal initialization error	SYNC signal initialization error	No
Er 66	66	FF42h	SYNC signal and data receiving beat error	Sync signal and data receiving phase error	No
Er 68	68	FF44h	EtherCAT operation EEPROM failed	EtherCAT operation EEPROM failed	No
Er 70	70	FF46h	Ethernet bus interface hardware error	Ethernet bus interface hardware error	No
Er 71	71	FF47h	Ethernet bus message setting error	Ethernet bus message setting error	No
Er 75	75	FF4Bh	Ethernet bus interface data exchange error	Ethernet bus interface data exchange error	No
Er 80	80	FF50h	Internal error 1	Internal calculation error, illegal electronic gear setting	No
Er 81	81	FF51h	Internal error 2	Internal calculation error, parameter setting to 0 is abnormal	No
Er 82	82	FF52h	Internal error 3	Internal calculation error, homing parameter setting illegal	No
Er 88	88	FF58h	Operation mode error 1	Operating mode is not set when enabling	Can
Er 89	89	FF59h	Operation mode error 2	Set invalid operation mode	Can
Er 90	90	FF5Ah	Dynamic braking fault	Dynamic braking fault	Can
Er 91	91	FF5Bh	Vibration fault	Vibration fault	Can
Er 92	92	FF5Ch	Power module temperature warning	Power module temperature warning	Can
Er 93	93	FF5Dh	Power module temperature alarm	Power module temperature alarm	No
Er100	100	FF64h	Auxiliary encoder setting is abnormal	Auxiliary encoder setting is abnormal	No
Er998	998		Authorization exception	Authorization exception	No
AL 999	999		Local command validation warning	Local command validation warning	No

7.2 Alarm causes and handling

In this user manual, "☆" represents the unique function of the multi turn absolute value code disk, and "★" represents the unique function of the incremental code disk.

Er 1 (Over speed)

Potential cause	Check	Handle
Motor U、V、W connection is not correct	Check U、V、W wiring	Connect the U、V、W wires correctly and correspond to the U、V、W marks of the driver plug one by one
Motor speed overshoot	Check the operation status and parameters	Adjust the servo gain to reduce the overshoot; In speed control mode can increase acceleration/deceleration time
Encoder wiring error	Check encoder wiring	Correct wiring.

Er 2 (Main circuit over-voltage)

Potential cause	Check	Handle
Input AC power supply is too high	Check the power supply voltage	Make the voltage meet the product specification
Regenerative braking failure	Whether regenerative braking resistance and brake pipe fail or wiring is disconnected	Repair.
Excessive regenerative braking energy	Check the brake load rate	● Reduce start and stop frequency ● Increase acceleration/deceleration time ● Reduce torque limit ● Reduce load inertia ● Replace higher power driver and motor ● Replace the larger brake resistance

Er 3 (Main circuit undervoltage)

Potential cause	Check	Handle
Main power supply is abnormal	Check the main power supply	Make the voltage meet the product specification
Drive hardware issues	Check drive hardware	Repair.

Er 4 (Position deviation)

Potential cause	Check	Handle
Motor U、V、W connection is not correct	Check U、V、W wiring	Connect the U、V、W wiring of the motor correctly and correspond to the U、V、W marks of the driver plug one by one
Encoder zero point variation	Check encoder zero point	Reinstall the encoder and adjust the zero point
Encoder wiring error	Check encoder wiring	Correct wiring
Motor stuck	Check the motor and mechanical connection	Repair
Command pulse frequency too high	Check input frequency and pulse division and multiplication parameters	● Reduce input frequency ● Adjust pulse frequency division and multiplication parameters
Position loop gain is too small	Check parameter P009、P013	Increase position loop gain
Insufficient torque	Check torque	● Increase torque limit ● Increase position command smoothing filter time ● Reduce load ● Replace higher power drive and motor

Er 7 (Drive inhibition abnormal)

Potential cause	Check	Handle
When the servo enable, CCWL、CWL drive inhibit inputs are invalid	Check CCWL、CWL wiring	● Correctly input CCWL、CWL signal ● If CCWL、CWL signal are not used, set parameter P097 to shield

Er 8 (Position deviation counter overflow)

Potential cause	Check	Handle
Motor stuck	Check the motor and mechanical connection	Repair.
Abnormal command pulse	Check pulse command	

Er 9 (Pulse encoder signal failure)

Potential cause	Check	Handle
Encoder wiring error	Check encoder wiring	Correct wiring
Poor encoder cable and connector	Check cables and connectors	Replace cables and connectors
Motor model is not set correctly	Check the motor model	Reset the motor model
Encoder damaged	Check encoder	Replace encoder

Er 11 (Power module over-current)

Potential cause	Check	Handle
Motor wiring U、V、W short circuit	Check U、V、W wiring	Correctly connect U、V、W wiring
Motor winding insulation damage	Check the motor	Replace the motor
Driver damaged	Check driver	Motor no problem, turn on again or alarm, may be the driver damage
Poor grounding	Check the grounding wire	Correct grounding
Disturbed	Check interference source	Add line filter to keep away from interference source

Er 12 (Over-current)

Potential cause	Check	Handle
Motor wiring U、V、W short circuit	Check U、V、W wiring	Correctly connect U、V、W wiring
Motor winding insulation damage	Check the motor	Replace the motor
Driver damaged	Check driver	Motor no problem, turn on again or alarm, may be the driver damage

Er 13 (Over-load)

Potential cause	Check	Handle
Continuous operation over rated load	Check load rate	Reduce the load or replace with a higher power driver
System instability	Check whether the motor is oscillating	Reduce system gain
Acceleration and deceleration are too fast	Check whether the motor runs smoothly	Increase acceleration and deceleration time
Encoder zero point variation	Check encoder zero point	Reinstall the encoder and adjust the zero point

Er 14 (Brake peak power overload)

Potential cause	Check	Handle
High input AC power	Check the power supply voltage	Make the voltage meet the product specification
Regenerative braking fault	Whether regenerative braking resistance and brake pipe fail or wiring is disconnected	Repair
Excessive regenerative braking energy	Check the brake load rate	● Reduce start and stop frequency ● Increase acceleration and deceleration time ● Replace higher power driver and motor ● Replace the larger brake resistance
Wiring error	Is B1 and B2 not short circuited Check the driver model and whether it is necessary to connect an external braking resistor for use	Short circuit B1 and B2 Connecting external braking resistors for use

Er 15 (Pulse encoder count error)

Potential cause	Check	Handle
Encoder wiring error	Check encoder wiring	Correct wiring, including shielded wires
Poor grounding	Check the grounding wire	Correct grounding
Disturbed	Check interference source	Stay away from interference
Encoder problem	● Wrong number of wires and poles ● Encoder Z signal error ● Encoder damaged	Replace encoder

Er 16 (Motor thermal overload)

Potential cause	Check	Handle
Long time operation over rated load	Check load rate and motor temperature rise	Reduce the load or replace with a higher power driver
Encoder zero point variation	Check encoder zero point	Reinstall the encoder and adjust the zero point

Er 17 (Average braking power overload)

Potential cause	Check	Handle
High input AC power	Check the power supply voltage	Make the voltage meet the product specification
Excessive regenerative braking energy	Check the brake load rate	● Reduce start and stop frequency ● Increase acceleration and deceleration time ● Reduce torque limit ● Reduce load inertia ● Replace higher power driver and motor ● Replace the larger brake resistance

Er 18 (IGBT model over-load)

Potential cause	Check	Handle
Long time operation over rated load	Check current	Reduce the load or replace with a higher power driver
Encoder zero point variation	Check encoder zero point	Reinstall the encoder and adjust the zero point

Er 20 (EEPROM Error)

Potential cause	Check	Handle
EEPROM chip damaged	Power on again for inspection	If the fault persists, replace the driver

Er 21 (Logic circuit error)

Potential cause	Check	Handle
Control circuit fault	Power on again for inspection	If the fault persists, replace the driver

Er 22 (Mismatch between power board and control board)

Potential cause	Check	Handle
Control board and power board does not match	Whether the control panel has been replaced by itself	Use a control board that matches the power board

Er 23 (AD conversion error)

Potential cause	Check	Handle
Current sensor and connector problems	Check the main circuit	If the fault persists, replace the driver
AD converter and analog amplifier circuit problems	Check the control circuit	If the fault persists, replace the driver

Er 25 (FPGA verification error)

Potential cause	Check	Handle
FPGA verification error	Power on again for inspection	If the fault persists, replace the driver

Er 27 (Phase loss alarm)

Potential cause	Check	Handle
Phase loss of power supply	Check L1、L2、L3 wiring	Correct wiring
Power supply undervoltage	Check supply power voltage	Ensure correct voltage input
Phase loss checking return circuit error	Check optocoupler, power on again	If the fault persists, replace the driver

Er 29 (Torque overload alarm)

Potential cause	Check	Handle
Unexpected large load occurs	Check load condition	Adjust the load
Parameters P070、P071、P072 are set unreasonably	Check parameters	Adjust the parameters

Er 30 (Pulse encoder Z signal loss)

Potential cause	Check	Handle
Encoder problem	Encoder Z signal error	Replace encoder
Encoder cable and connector problems	Check cables and connectors	Replace cable and connector
Driver interface circuit failure	Check the control circuit	Replace driver

Er 35 (Connection failure between boards)

Potential cause	Check	Handle
Flat cable failure of inter board connection	Check the flat wire and its terminals	If the fault persists, replace the driver
Connection path failure	Check the optocoupler	If the fault persists, replace the driver

AL 36 (Fan alarm)

Potential cause	Check	Handle
Cooling fan failure	Check the fan	Replace the fan
Fan detection circuit fault	Check wiring	Correct wiring
Fan detection circuit fault	Check the optocoupler	If the fault persists, replace the driver

Er 40 (Absolute value encoder communication error) ☆

Potential cause	Check	Handle
Different types of motors have been replaced	Whether the replaced motor encoder is of the same type	Set P088=0 to automatically identify the encoder
Encoder wiring error	Check encoder wiring	Correct wiring
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder damaged	Check encoder	Replace encoder

Er 41 (Absolute value encoder handshake error) ☆

Potential cause	Check	Handle
Encoder wiring error	Check encoder wiring	Correct wiring
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder damaged	Check encoder	Replace encoder

Er 42 (Absolute value encoder internal count error) ☆

Potential cause	Check	Handle
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder damaged	Check encoder	Replace encoder

Er 43 (Absolute value encoder communication response error) ☆

Potential cause	Check	Handle
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder damaged	Check encoder	Replace encoder

Er 44 (Absolute value encoder verification error) ☆

Potential cause	Check	Handle
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder damaged	Check encoder	Replace encoder

Er 45 (Absolute value encoder EEPROM error) ☆

Potential cause	Check	Handle
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder EEPROM is damaged	Check encoder	Replace encoder

Er 46 (Absolute value encoder parameter error) ☆

Potential cause	Check	Handle
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder EEPROM is damaged	Check encoder	Replace encoder

Er 47 (Absolute value encoder external battery error) ☆

Potential cause	Check	Handle
External battery out of power	External battery voltage	Replace the battery
Power on for the first time after replacing the battery	Battery voltage	If the voltage is normal, please restart the encoder, refer to chapter 3.6.1

Er 48 (Absolute value encoder external battery alarm) ☆

Potential cause	Check	Handle
External battery out of power	External battery voltage	Replace the battery
Power on for the first time after replacing the battery	Battery voltage	If the voltage is normal, please restart the encoder, refer to chapter 3.6.1

Er 49 (Encoder overheating)

Potential cause	Check	Handle
Encoder overheating	Whether the motor power is too small or the ambient temperature is too high	● Replace the motor with a suitable power or temperature rating ● Reduce ambient temperature

Er 50 (Motor parameters do not match with driver)

Potential cause	Check	Handle
Motor and driver power mismatch	Check the motor adaptation table of the driver	Replace the appropriate driver or motor

Er 51 (Encoder automatic recognition failed)

Potential cause	Check	Handle
Encoder wiring error	Check the encoder wiring	Correct wiring
Encoder automatic recognition failed	Confirm whether the encoder type is supported by the driver	Replace the type of encoder supported by the driver

Er 55 (Encoder function not supported)

Potential cause	Check	Handle
The requested encoder function is not supported	Check encoder function settings	Check encoder function settings

Er 56 (Encoder position value is invalid)

Potential cause	Check	Handle
Encoder status abnormal	Check encoder error codes	Clear encoder error

Er 57 (Encoder multi turn fault)

Potential cause	Check	Handle
Abnormal multi turn reading of encoder	Check encoder settings	Change encoder settings

Er 61 (Ethernet communication cycle deviation too large)

Potential cause	Check	Handle
Industrial Ethernet communication interruption	Check the Ethernet cable	Replacing the Ethernet cable
Ethernet communication cycle jitter is too large	● Increase communication cycle time ● Reduce the load on the master station	● Increase communication cycle time ● Reduce the load on the master station

Er 62 (Ethernet command data out of range)

Potential cause	Check	Handle
The current communication cycle command data exceeds the limit	● Check user unit settings ● Check electronic gear settings	● Change user unit settings ● Change electronic gear settings

Er 63 (Internal error)

Potential cause	Check	Handle
Internal error	Whether the servo firmware is a test version or an incompatible version	Perform firmware upgrade operation and refresh servo firmware

Er 65 (SYNC signal initialization error)

Potential cause	Check	Handle
No SYNC signal received after entering OP state	Check host configuration	Check host configuration

Er 66 (SYNC signal and data receiving beat error)

Potential cause	Check	Handle
No SYNC signal received after entering OP state	Check host configuration	Check host configuration

Er 68 (EtherCAT operation EEPROM failed)

Potential cause	Check	Handle
EtherCAT operation EEPROM failed	Power on again for inspection	If the fault persists, replace the driver

Er 70 (Ethernet bus interface hardware error)

Potential cause	Check	Handle
Ethernet bus interface hardware error	Power on again for inspection	If the fault persists, replace the driver

Er 71 (Ethernet bus message setting errorr)

Potential cause	Check	Handle
Ethernet bus message setting error	Check message settings	Change message settings

Er 75 (Ethernet bus interface data exchange error)

Potential cause	Check	Handle
Ethernet bus interface data exchange error	Power on again for inspection	If the fault persists, replace the driver

Er 80 (Internal error 1)

Potential cause	Check	Handle
Relevant parameters of electronic gear are set illegally	Setting of relevant parameters of electronic gear	Set legal electronic gear parameters

Er 81 (Internal error 2)

Potential cause	Check	Handle
Division "0" occurs in internal operation	Relevant parameter settings, such as rated current, rated voltage, rated speed, etc	Set the parameter value of "legal" (not "0")

Er 82 (Internal error 3)

Potential cause	Check	Handle
Illegal setting of "homing" related parameters	Setting of "homing" related parameters	Set legal "homing" parameters

Er 88 (Operation mode error 1)

Potential cause	Check	Handle
Operating mode is not set when enabling	Setting of operating mode when enabled	Enable after setting the operation mode

Er 89 (Operation mode error 2)

Potential cause	Check	Handle
Set invalid operation mode	Operating mode settings	Set valid operation mode according to 6502h

Er 90 (Dynamic braking fault)

Potential cause	Check	Handle
Abnormal status of dynamic brake relay	Power on again for inspection	If the fault persists, replace the driver

Er 91 (Vibration fault)

Potential cause	Check	Handle
Mechanical vibration occurs	Check mechanical structure or gain related parameters	Reduce gain related parameters

Er 92 (Power module temperature warning)

Potential cause	Check	Handle
Power module problem exceeds the parameter setting value	● Check the heat dissipation of the cabinet ● Check the load condition of the equipment	● Improve cabinet heat dissipation conditions ● Troubleshooting abnormal load issues

Er 93 (Power module temperature alarm)

Potential cause	Check	Handle
Power module temperature greater than 125 ℃	● Check the heat dissipation of the cabinet ● Check the load condition of the equipment	● Improve cabinet heat dissipation conditions ● Troubleshooting abnormal load issues

Er 100 (Auxiliary encoder setting is abnormal)

Potential cause	Check	Handle
Auxiliary encoder setting is abnormal	● Check whether the device is configured with an auxiliary encoder ● Check the auxiliary encoder settings	Change the auxiliary encoder settings

Er 998 (Authorization exception)

Potential cause	Check	Handle
Authorization exception	Authorization exception	Contact the manufacturer

AL 999 (Local command validation warning)

Potential cause	Check	Handle
Set invalid operation mode	Setting of operating mode	Set the valid operating mode according to 6502h

Chapter 8 Specifications

8.1 Driver model

EP5 - T L 15 EC X

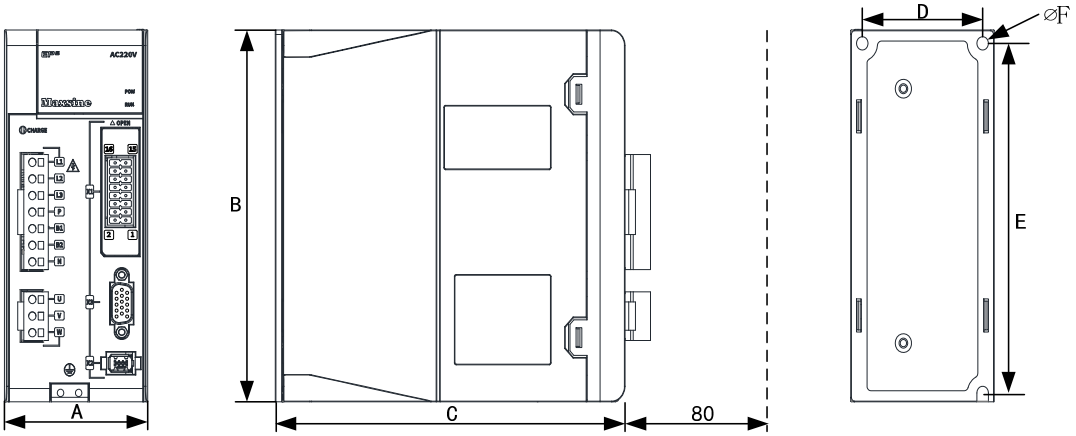
Mark	Main circuit supply voltage
L	AC220V
H	AC380V

Mark	Output Power	Mark	Output Power
TL04	0.4kW	TH20	2.0kW
TL08	0.75kW	TH30	3.0kW
TL10	1.0kW	TH50	5.0kW
TL15	1.5kW	TH75	7.5kW
TL25	2.5kW	TH90	9.0kW
TL35	3.5kW	TH110	11.0kW
TL55	5.5kW	TH150	15.0kW
TH15	1.5kW		

Mark	Encoder type
Blank	Standard machine
***	Other customized models

Mark	Communication protocol
P	Pulse type
M	Support MODBUS
C	Support CANopen
EC	Support EtherCAT bus
PN	Support PROFINET bus

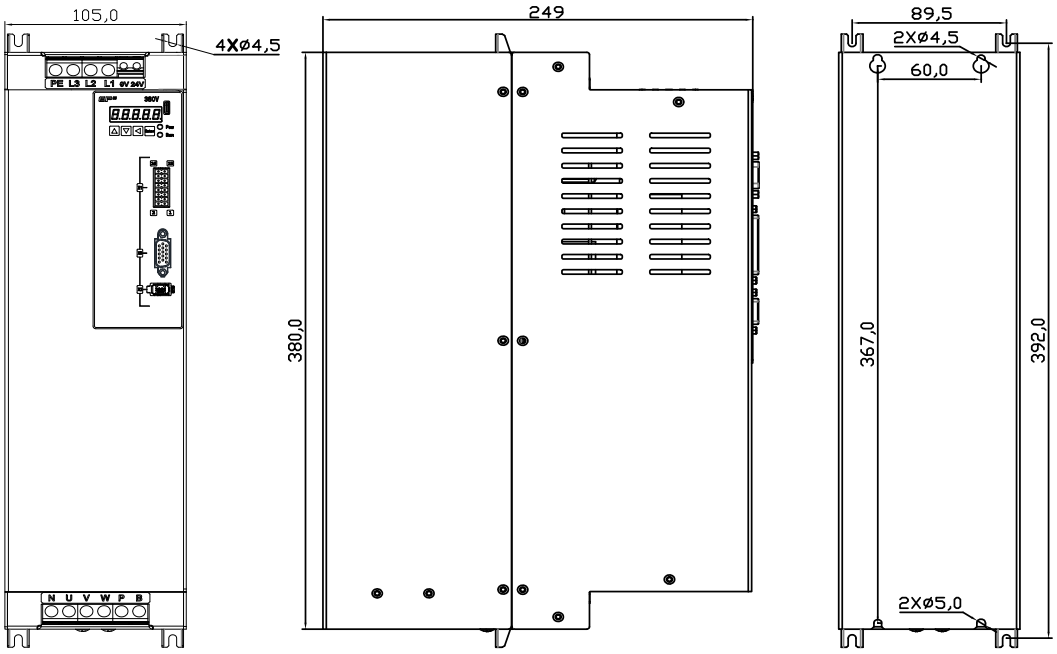
8.2 Driver size



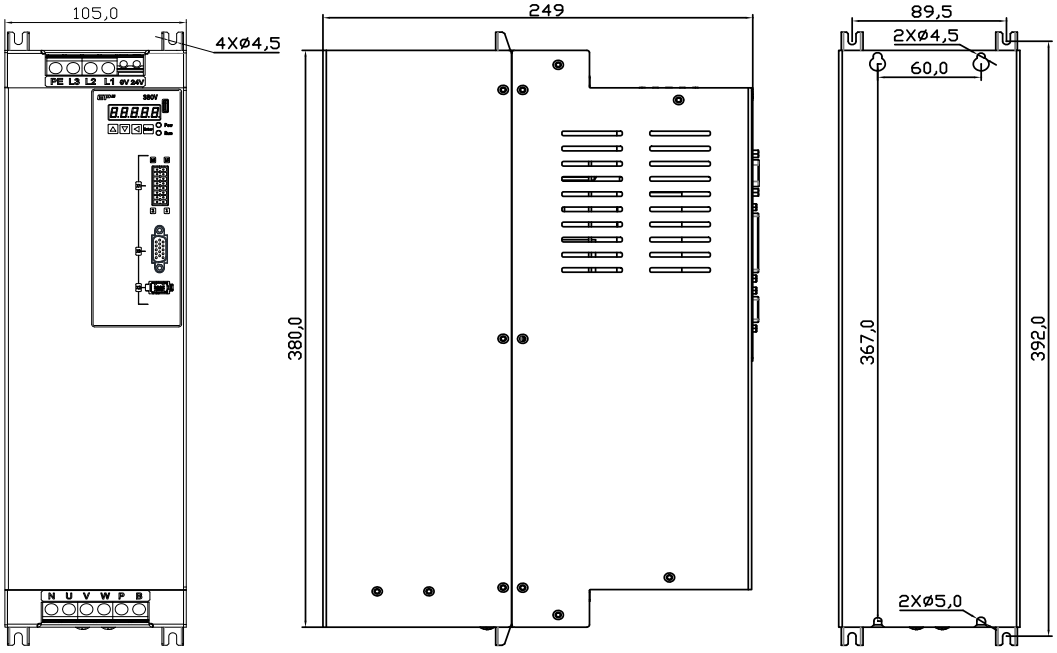
Model / Size (mm)	TL04	TL08	TL10	TL15	TL25	TL35	TL55
A	45	45	55	75	95	105	115
B	170	170	170	168	200	220	250
C	156	156	171	183	182	182	212
D	34.5	34.5	43	63	84	94	104
E	161	161	161	158	189	209	239
F	5.2	5.2	5.2	5.2	5.2	5.2	5.2

Model / Size (mm)	TH15	TH20	TH30	TH50	TH75
A	75	95	105	115	115
B	168	200	220	250	250
C	183	182	182	212	212
D	63	84	94	104	104
E	158	189	209	239	239
F	5.2	5.2	5.2	5.2	5.2

TH90 installation dimension drawing



TH110、TH150 installation dimension drawing



8.3 Driver specifications

Model		TL04	TL08	TL10	TL15	TL25	TL35	TL55	TH15	TH20	TH30	TH50	TH75	TH90	TH110	TH150
Rated output current (A)		3.0	4.5	5.5	7.5	12.0	19.0	24.0	5.4	8.5	13.0	17.0	21.0	25.5	32.0	39.0
Maximum output current (A)		9.0	11.3	12.0	16.9	26.0	31.0	43.0	12.7	17.0	28.0	35.0	39.6	44.0	55.0	78.0
Input power	Main power supply	Single phase AC220V -15% ～ +10% 50/60Hz			Three-phaseAC220V -15%～+10% 50/60Hz				Three-phaseAC380V -15%～+10% 50/60Hz							
Environment	Temperature	Operation：0℃～40℃ Storage：-40℃～50℃														
	Humidity	Operation：40%～80%(non-condensing) Storage：93% or less(non-condensing)														
	Atmospheric pressure	86kPa～106kPa														
IP rating		IP20														
Control mode		Vector control														
Regenerative braking		Built-in/built-out						built-out	Built-in/built-out			built-out				
Feedback mode		Standard 23 bit/multi turn absolute encoder, optional with other specifications														
Control mode		Cyclic Synchronous Position Mode （CSP）、Cyclic Synchronous Velocity Mode （CSV）、Cyclic Synchronous Torque Mode （CST）……														
Digital input		4 programmable input terminals (photoelectric isolation), 2 high-speed optocoupler inputs														
Digital output		3 programmable output terminals (photoelectric isolation)														
Special function		Mechanical resonance notch filter, vibration suppression, optional with STO														
Monitoring function		Speed, current position, position deviation, motor torque, motor current, command pulse frequency, etc														
Protection function		Overspeed, overvoltage, overcurrent, overload, abnormal braking, abnormal encoder, position deviation, etc														
Characteristic	Speed frequency response	1.2kHz														
	Speed fluctuation rate	＜±0.03%（负载 0～100%）；＜±0.02%（电源-15%～+10%）														
	Speed regulation ratio	1:5000														

8.4 Motor adaptation table of the driver

Motor model (220V series)		Rated power KW	Rated torque N·m	Rated speed/ Maximum speed r/min	Rated current A	Recommend adaptation	Adaptable
BSL series	060BSL00630	0.20	0.64	3000/6000	1.6	TL04	
	060BSL01330	0.40	1.27	3000/6000	2.8	TL04	
	080BSL02430	0.75	2.39	3000/6000	4.4	TL08	
	080BSL03230	1.0	3.18	3000/6000	6.3	TL15	
GSL series	060GSL00630	0.20	0.64	3000/6000	1.6	TL04	
	060GSL01330	0.40	1.27	3000/6000	2.8	TL04	
	080GSL01330	0.40	1.27	3000/6000	2.5	TL04	
	080GSL02430	0.75	2.39	3000/6000	4.4	TL08	
	110GSL04030	1.26	4.00	3000/4000	6.0	TL15	TL10
	110GSL06025	1.57	6.00	2500/4000	8.7	TL15	
	130GSL04025	1.00	4.00	2500/4000	5.8	TL15	TL08
	130GSL04820	1.00	4.77	2000/4000	6.6	TL15	TL10
	130GSL05025	1.30	5.00	2500/4000	6.9	TL15	TL10
	130GSL05415	0.85	5.39	1500/3000	6.7	TL15	TL10
	130GSL06025	1.57	6.00	2500/4000	7.7	TL15	
	130GSL07725	2.00	7.70	2500/4000	10.1	TL25	TL15
	130GSL08315	1.30	8.34	1500/3000	9.9	TL25	TL15
	130GSL10025	2.60	10.00	2500/4000	15	TL25	
	130GSL11515	1.80	11.50	1500/3000	12	TL25	
	130GSL15015	2.36	15.00	1500/3000	14.7	TL25	
GAL series	110GAL04020	0.84	4.00	2000/3000	4.4	TL08	
	110GAL06020	1.26	6.00	2000/3000	6.4	TL15	TL10
	130GAL05415	0.85	5.39	1500/2000	5.1	TL08	
	130GAL08315	1.30	8.34	1500/2000	6.4	TL15	TL10
	130GAL10015	1.57	10.00	1500/2000	6.4	TL15	TL10
	130GAL11515	1.80	11.50	1500/2000	7.4	TL25	TL15
	130GAL15015	2.36	15.00	1500/2000	9.5	TL25	

Motor model（380V series）		Rated power KW	Rated torque N·m	Rated speed/ Maximum speed r/min	Rated current A	Recommend adaptation	Adaptable
GSH series	110GSH04025	1.05	4.00	2500/4000	3.3	TH15	
	110GSH06025	1.57	6.00	2500/4000	4.5	TH15	
GAH series	130GAH04025	1.00	4.00	2500/3000	2.4	TH15	
	130GAH04820	1.00	4.77	2000/3000	2.8	TH15	
	130GAH05025	1.30	5.00	2500/3000	2.9	TH15	
	130GAH05415	0.85	5.39	1500/3000	3.1	TH15	
	130GAH06025	1.57	6.00	2500/3000	4.1	TH15	
	130GAH07725	2.02	7.70	2500/3000	5.0	TH20	TH15
	130GAH08315	1.30	8.34	1500/3000	4.9	TH15	
	130GAH10015	1.57	10.00	1500/2000	3.9	TH15	
	130GAH10025	2.62	10.00	2500/3000	5.4	TH20	TH15
	130GAH11515	1.80	11.50	1500/2000	4.3	TH15	
	130GAH15015	2.36	15.00	1500/2000	6.6	TH20	
BAH series	180BAH19015	3.00	19.00	1500/2000	7.1	TH30	TH20
	180BAH27015	4.30	27.00	1500/2000	10.7	TH50	TH30
	180BAH35015	5.50	35.00	1500/2000	13.3	TH50	
	180BAH48015	7.50	48.00	1500/2000	17.5	TH75	
BSH series	180BSH19015	3.00	19.00	1500/3000	10.7	TH30	
	180BSH27015	4.30	27.00	1500/3000	14.8	TH50	
	180BSH35015	5.50	35.00	1500/3000	19.0	TH75	TH50
	180BSH48015	7.50	48.00	1500/3000	25.7	TH75	

8.5 Servo motor model

060 BS L 006 30 M N C 1 MC
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

①

Mark	Seat No.
040	40mm
060	60mm
080	80mm
110	110mm
130	130mm
180	180mm

②

Mark	Series
BS	B series high speed
BA	B-series medium and low speed
GS	G series high speed
GA	G series medium and low speed
MS	M series high speed
MA	M series medium and low speed

③

Mark	Voltage
L	220V
H	380V

④

Mark	Rated torque	Mark	Rated torque
003	0.32 N.m	100	10.00 N.m
006	0.64 N.m	115	11.50 N.m
013	1.27 N.m	143	14.30 N.m
024	2.39 N.m	150	15.00 N.m
032	3.18 N.m	170	17.20 N.m
040	4.00 N.m	190	19.00 N.m
048	4.77 N.m	220	21.50 N.m
050	5.00 N.m	260	26.30 N.m
054	5.39 N.m	270	27.00 N.m
060	6.00 N.m	350	35.00 N.m
077	7.70 N.m	480	48.00 N.m
083	8.34 N.m		

⑤

Mark	Rated speed
15	1500rpm
20	2000rpm
25	2500rpm
30	3000rpm

⑦

Mark	Brake
N	Not configured
Z	Configure power loss brake

⑧

Mark	Keyway specifications
O	Circular axis
A	Closed key
C	Open key(standard configuration)

⑨

Mark	Specifications
1	Default value
2	Customer customization

⑩ B series model description:

Mark	Interface description	Notes
MC	Direct connected	(omitted) Standard
MCA	MC to A Amp	(Optional) Amp
MC1	MC to Y1	(Optional) 4-core metal circular plug
MC2	MC to Y2	(Optional) 4-core waterproof round plug
MC3	MC to Y3	(Optional) 6-core waterproof round plug
MC4	MC to Y4	(Optional) 6-core metal circular plug

⑩ M/G series model description:

Mark	Plug type	
Y3	G series 60/80	(Optional) Waterproof round plug
Y4		(Optional) Metal round plug
A[Note]		Standard Amp plug
H[Note]	All series 110/130/180	Standard aviation plug

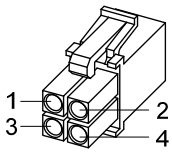
⑥

Mark	Encoder	Mark	Pulse count	Number of wires
C	Magnetic multi turn absolute value	17bit	131072	7
D	Magnetic single turn absolute value	17bit	4,096	5
M	Optical multi turn absolute value	23bit	8,388,608	7
B	Optical single turn absolute value	23bit	8,388,608	5
F	Standard incremental	2500ppr	10, 000	15
R	Rotating transformer	12bit	4,096	7
P	Multi turn absolute value	23bit	33,554,432	7

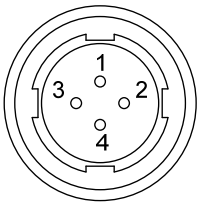
Note: "G" is standard for all series motors of 40/60/80, "H" is standard for all series motors of 110/130/180. The symbol of standard configuration is omitted when ordering.

8.6 Servo motor wiring

8.6.1 Winding wiring



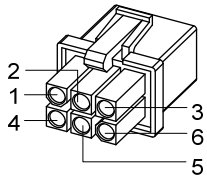
40/60/80 motor power supply plug



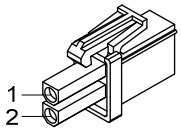
110/130/180 motor power supply plug

Terminal symbol	Terminal number		Terminal description
	40/60/80 motor	110/130/180 motor	
U	1	2	Motor U phase power input
V	2	3	Motor V phase power input
W	3	4	Motor W phase power input
⏚	4	1	Motor housing grounding terminal

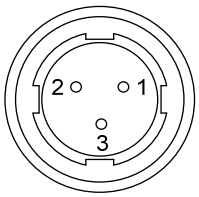
8.6.2 Brake wiring



40 motor with brake power plug



60/80 motor brake plug



110/130 motor brake plug

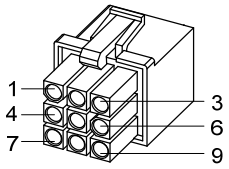
40 motor with brake power supply wiring:

Terminal symbol	Terminal number	Terminal description
U	1	Motor U phase power input
V	2	Motor V phase power input
W	3	Motor W phase power input
PE	4	Grounding terminal
BK+	5	Brake terminal
BK-	6	

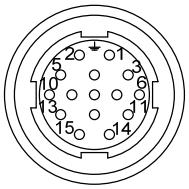
60、80、110、130、180 motor brake wiring:

Terminal symbol	Terminal number		Terminal description
	60/80 series motors	110/130/180 series motors	
DC+	1	1	Brake power supply is DC power supply with no polarity connection requirements
DC-	2	2	
PE	——	3	

8.6.3 Encoder



40/60/80 motor encoder plug



110/130/180 motor encoder plug

40、60、80、110、130、180 motor encoder wiring:

Terminal symbol	Terminal number					Terminal description
	40motor	60/80motor		110/130/180motor		
	Absolute value	Absolute value	Incremental	Absolute value	Incremental	
SD+	1	1	1	6	6	Encoder signal wire
SD-	2	2	2	7	7	
VCC	6	6	6	2	2	Encoder 5V power input
GND	7	7	7	3	3	
Battery+ ☆	3	3	——	4	——	3.6V battery powered
Battery - ☆	8	8	——	5	——	
PE	9	9	9	1	1	Ground terminal

In this user manual, "☆" represents the unique function of the multi turn absolute value code disk, and "★" represents the unique function of the incremental code disk.

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