Maxsine

EP3 E Series

EtherCAT bus
AC servo drive
Operating Instructions

(10th Edition)

Driver GL1A0/GL1A8/GL3A0/GL5A5/GL7A5/GL120/GL160
GL190/GL240/GH2A0/GH3A5/GH5A4/GH8A5/GH130
GH170/GH210/GH260/GH320/GH390

Wuhan Maxsine Electric Technology Co., Ltd

DECLARATION

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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, operation, inspection or maintenance for the product.

⚠ **Danger**	Indicates a disoperation possibly can cause danger and physical injure 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 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. ● Referring to wire selection guide, please install all wires with an adequate cross-section. Otherwise 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 servo 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 driver and motor while the equipment is operating, otherwise can result in an electric shock or scald. ● Do not move any connection cables while the equipment is operating, otherwise can result in physical injure or equipment damage.

5. Maintenance and inspection

⊘ Stop
● Do not touch the 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 ranges

⚠ 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 various safety devices. If you need the above, please contact our company.

CONTENTS

Chapter 1 Product inspection and installation

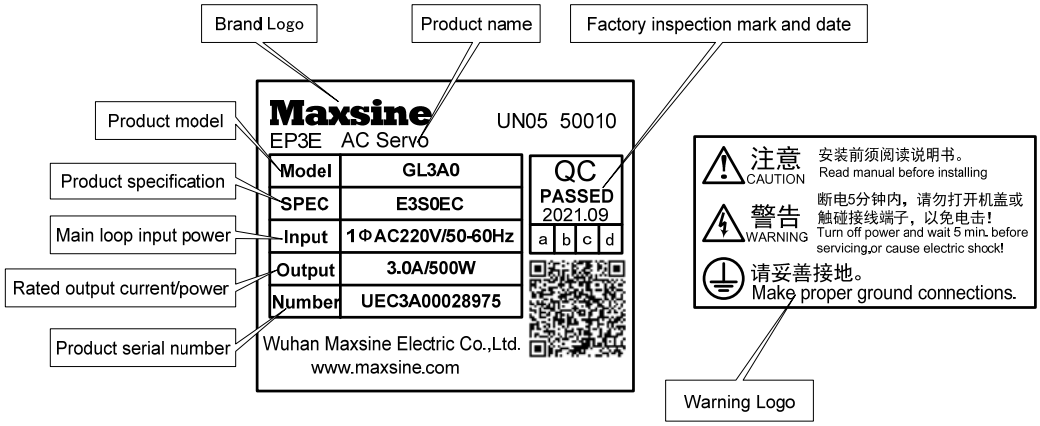
1.1 Product inspection

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.

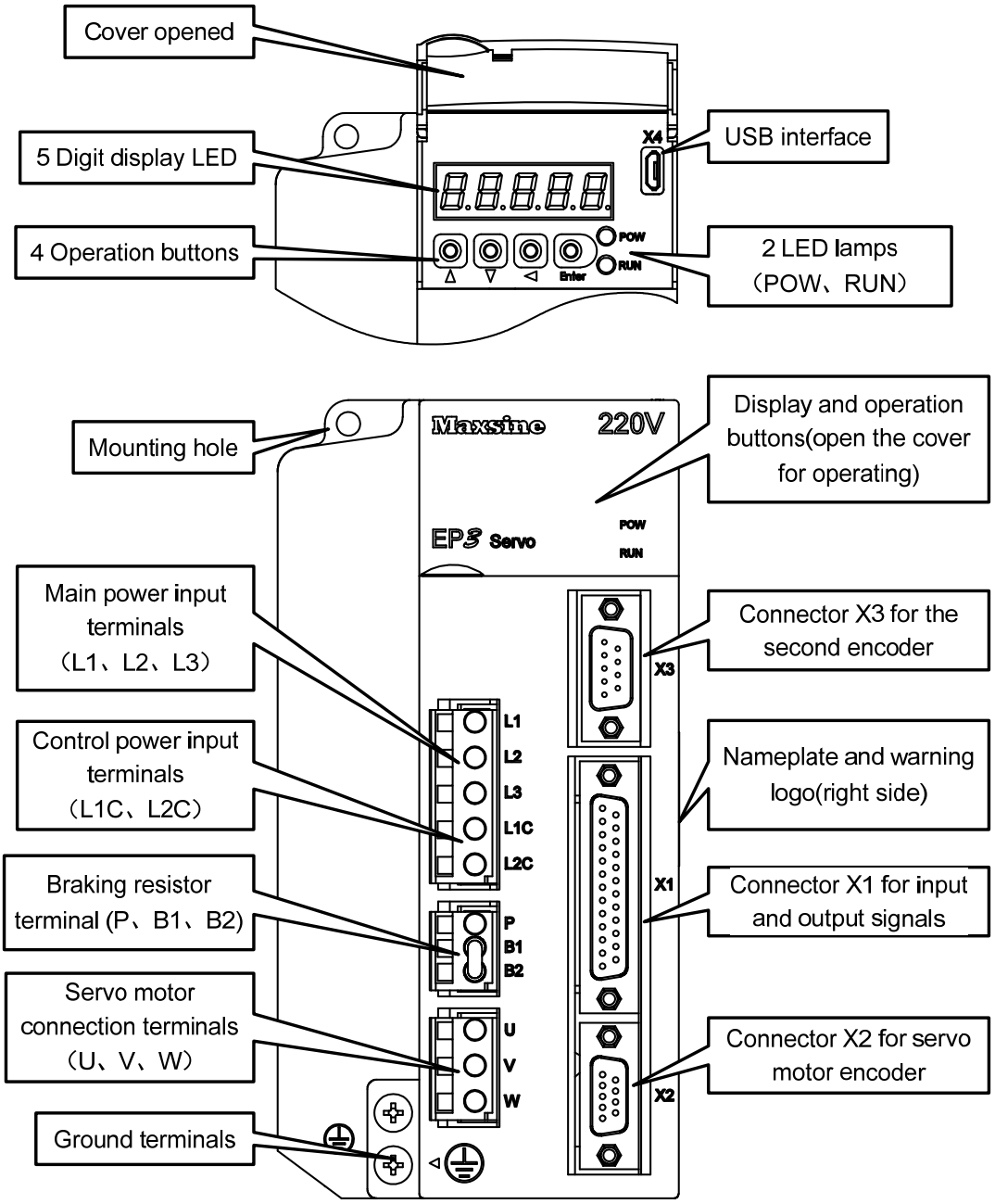
  If the above items have faults or abnormal phenomena, please contact the dealer immediately.

1.2 Product nameplate

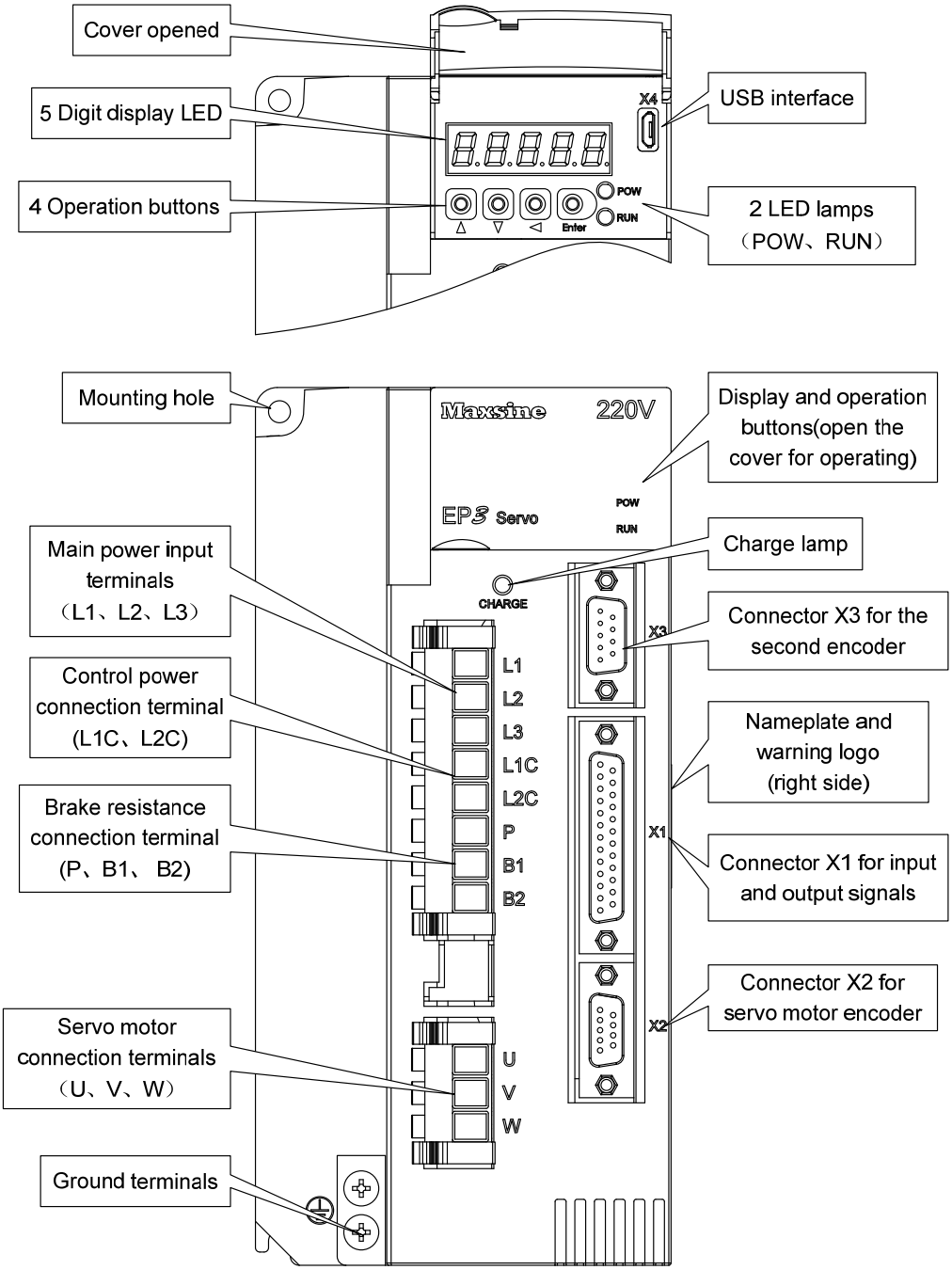


1.3 Product front panel

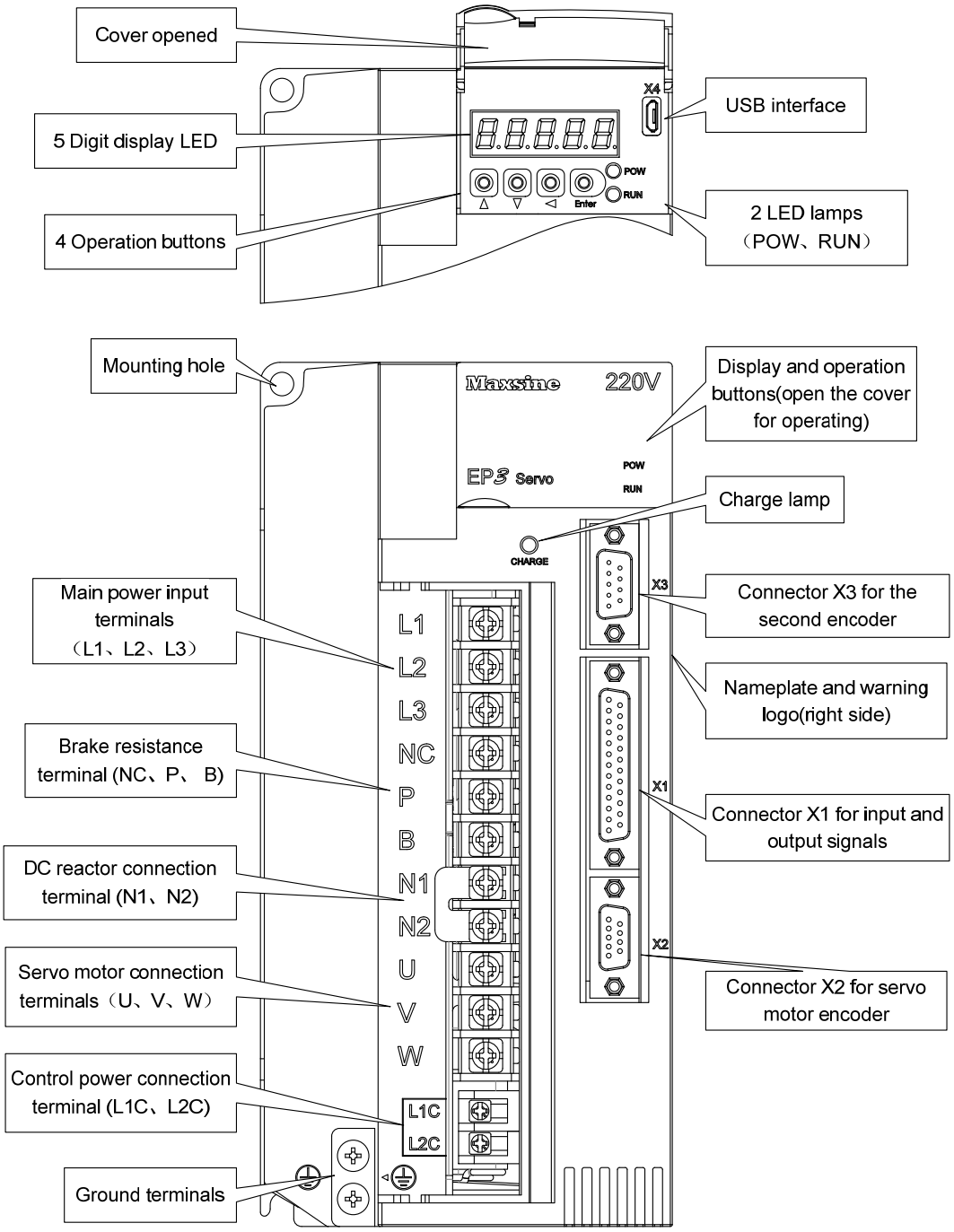
Applicable models：GL1A0、GL1A8、GL3A0、GL5A5、GL7A5、GL120



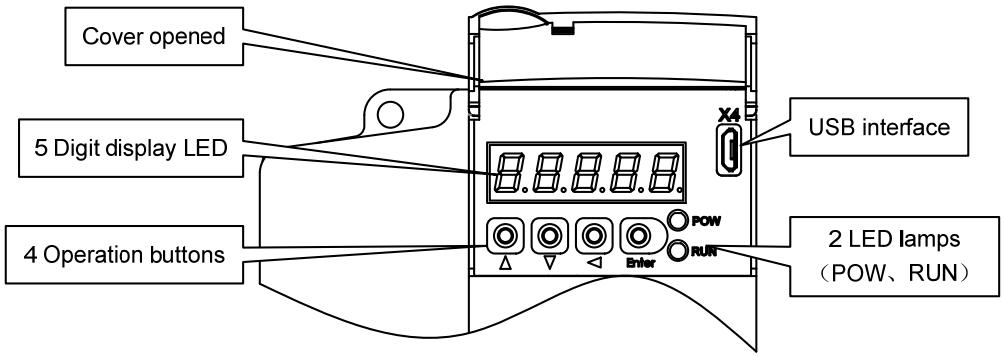
Applicable models：GL160

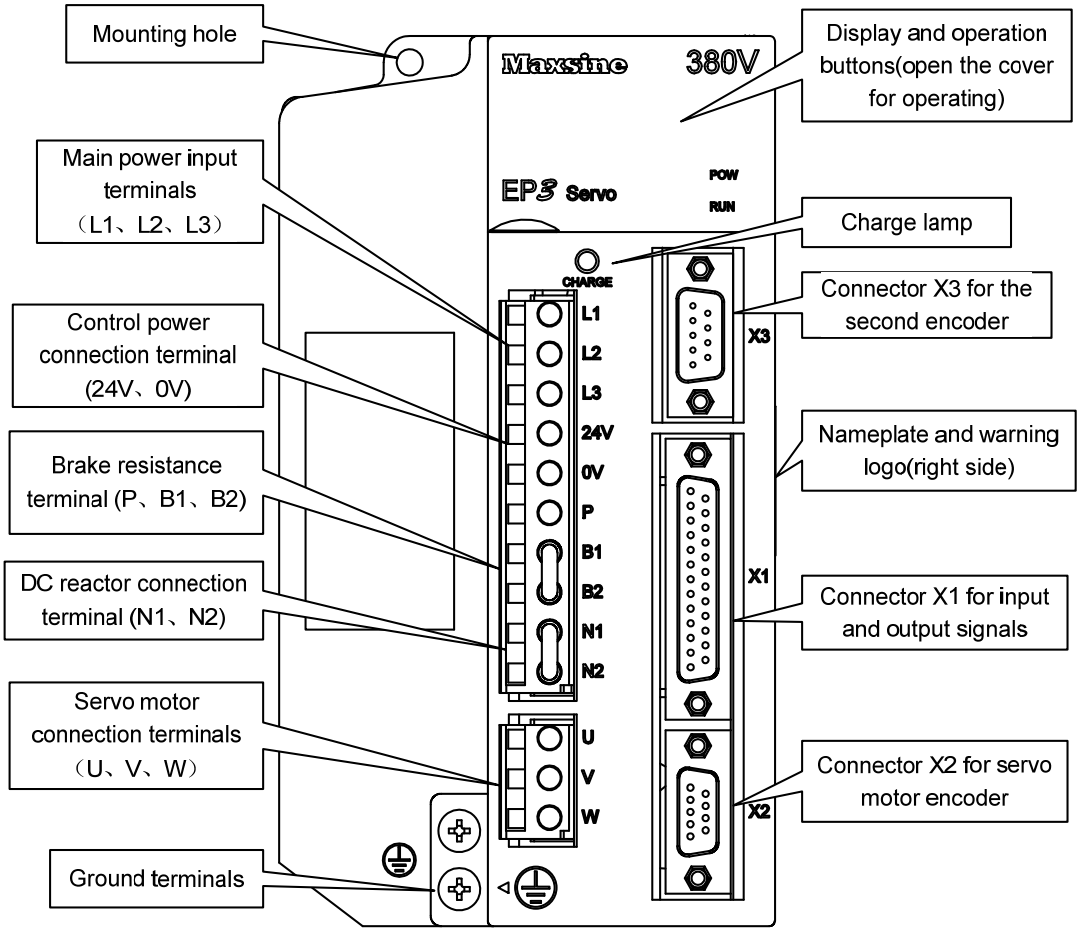


Applicable models：GL190、GL240

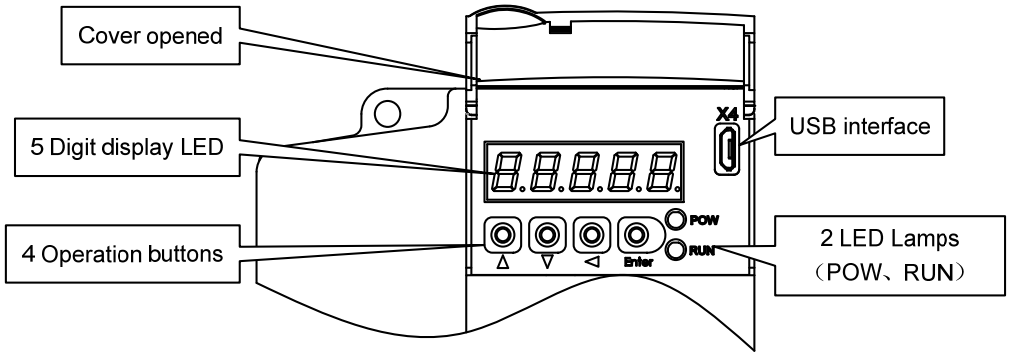


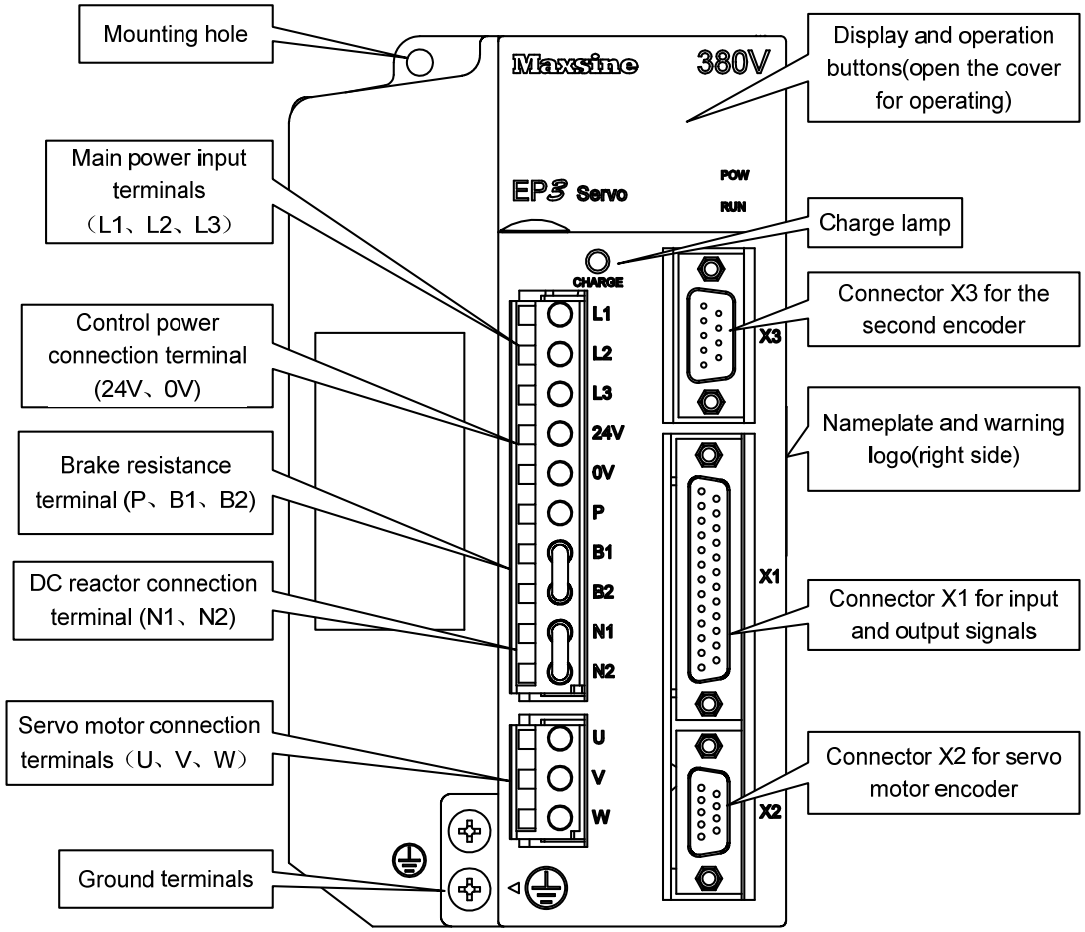
Applicable models：GH2A0、GH3A5、GH5A4



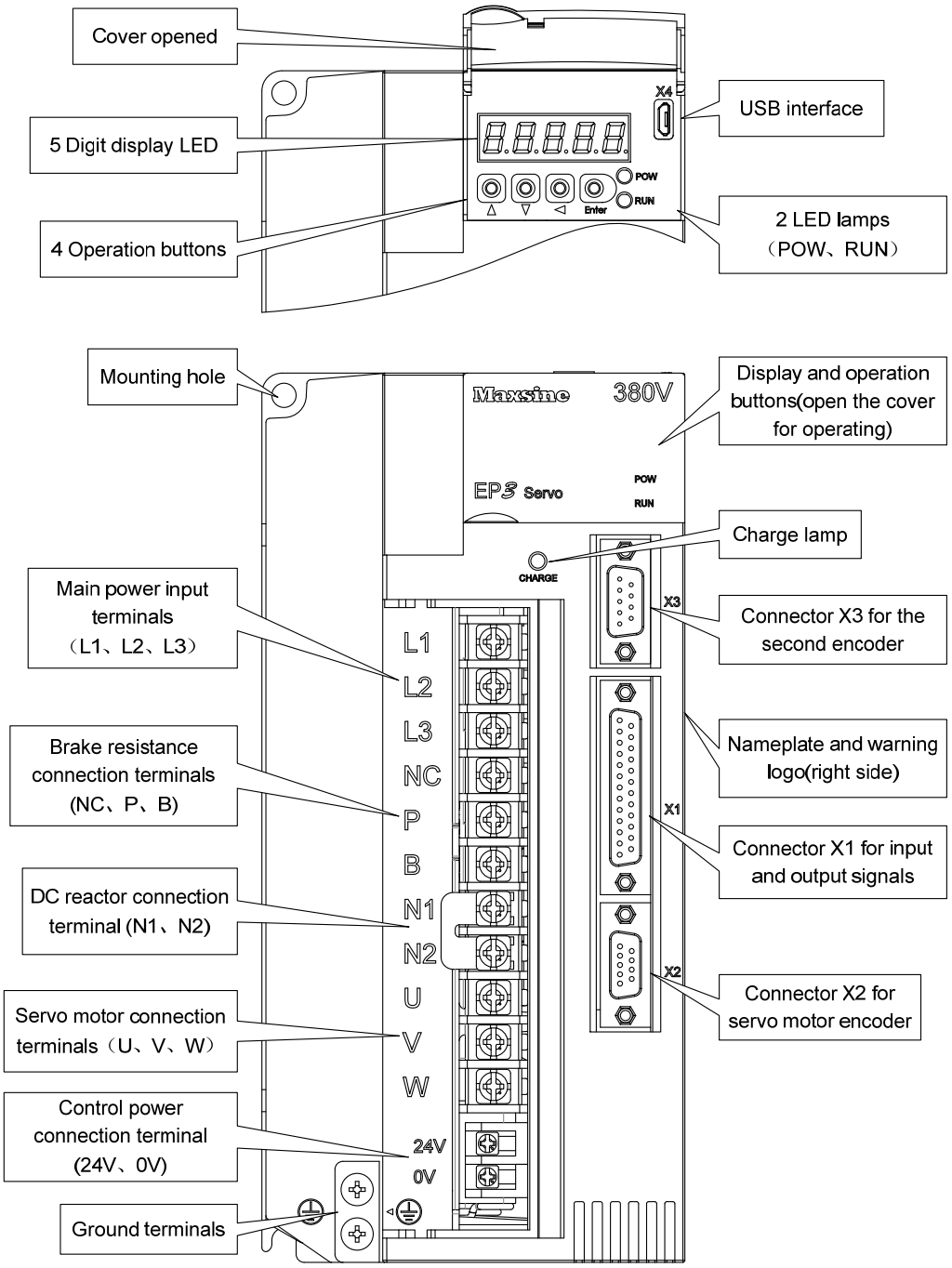


Applicable models：GH8A5

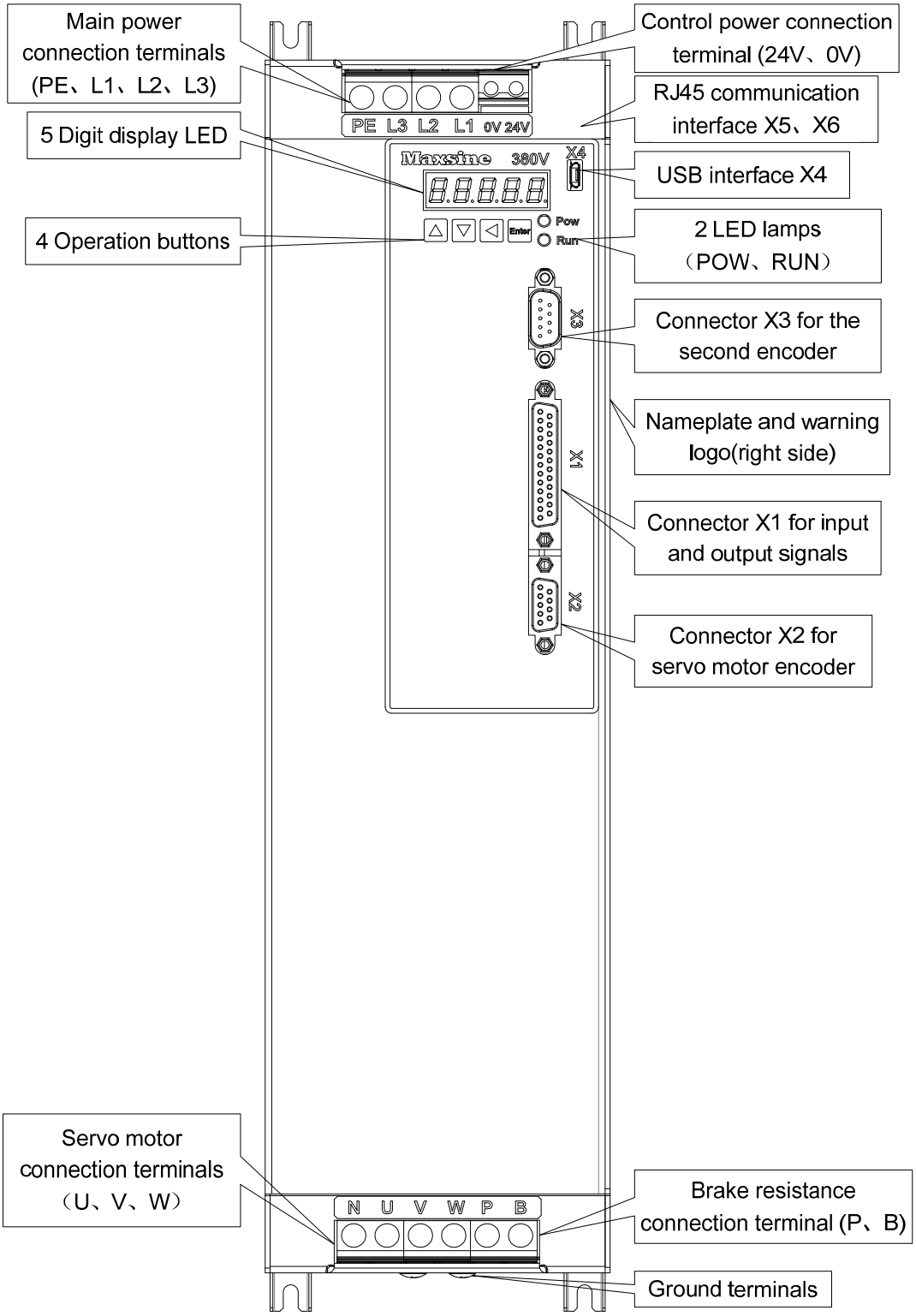




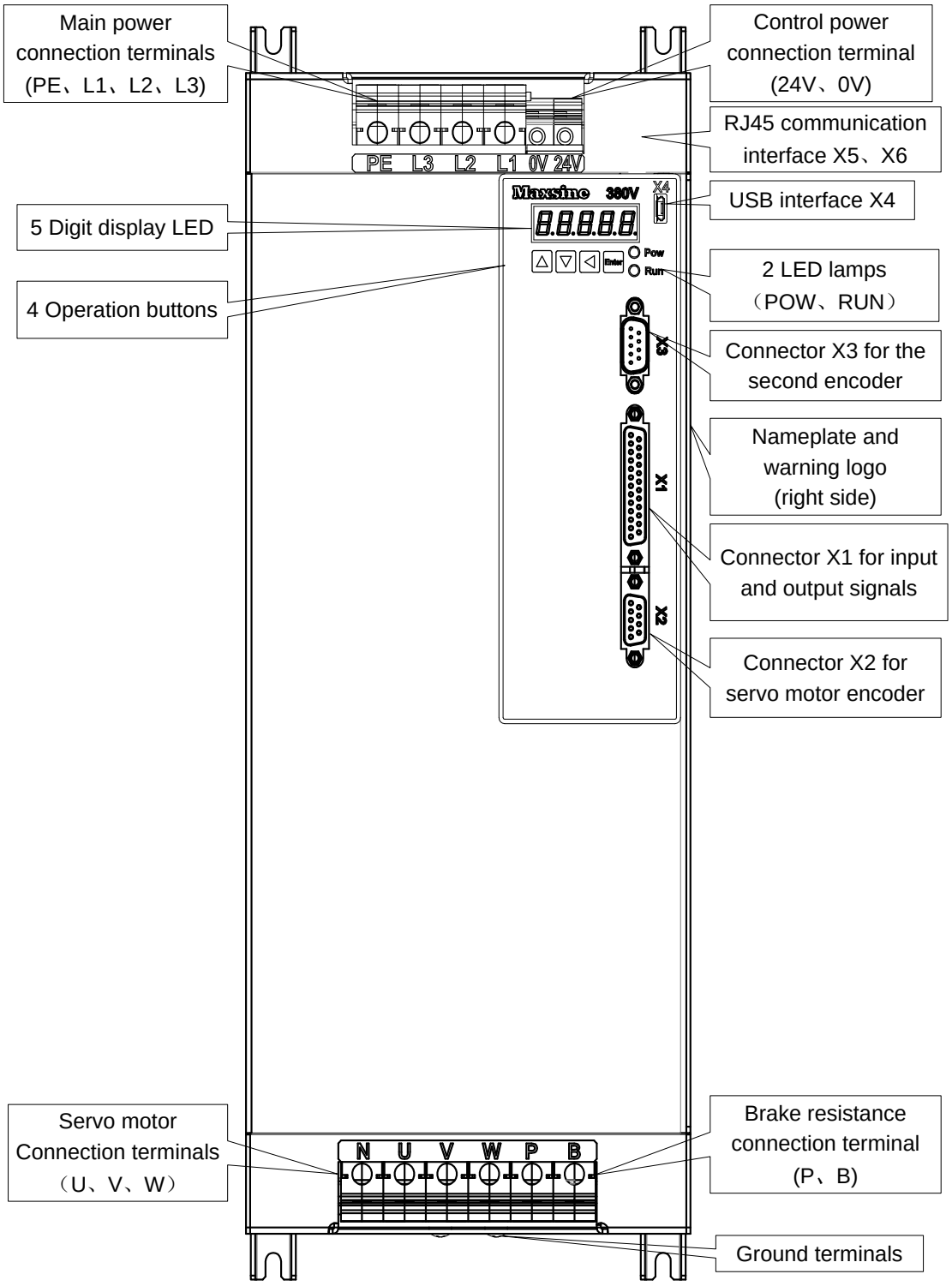
Applicable models：GH130、GH170、GH210



Applicable models：GH260



Applicable models：GH320、GH390



1.4 Servo driver installation

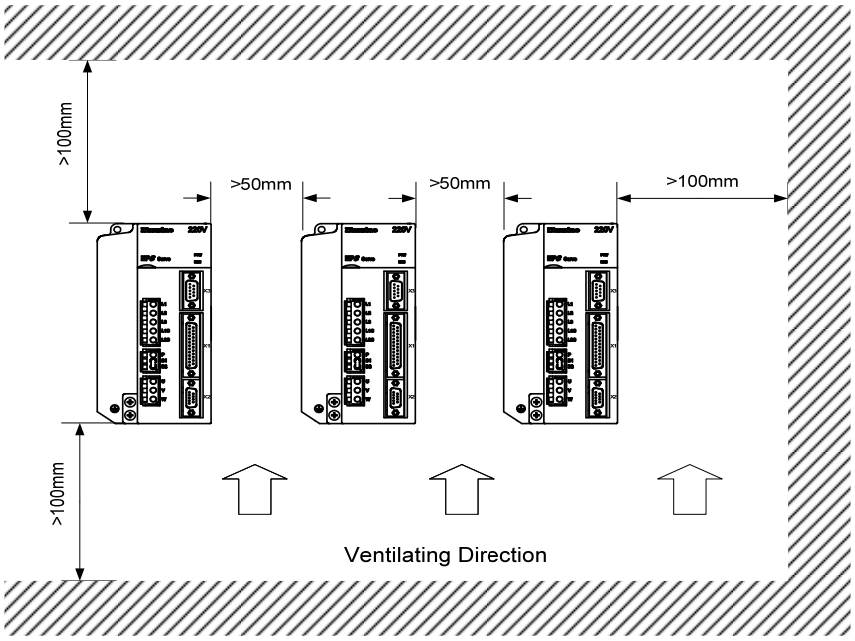
1.4.1 Installation environmental conditions

The installation environment of the servo driver has a direct impact on the normal function and service life of the driver, so the installation environment of the driver must meet 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 drives are installed in the control cabinet, please note that enough space should be reserved in the placement position to facilitate air flow and heat dissipation. Please add a cooling fan to reduce the temperature around the servo drive. 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 drives and other equipment are shown in the figure. In order to ensure the service performance and service life of the drive, 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 drive.
- 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

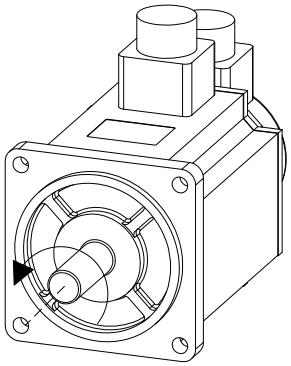
- Ambient temperature: 0～40℃; Ambient humidity: below 80 %(no dew).
- Storage temperature: -40～50℃; Storage humidity: below 80 %(no dew).
- Vibration: below 0.5G.
- Places with good ventilation and less moisture and dust.
- No corrosive, igniting gas, oil and gas, cutting fluid, cutting powder, iron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

1.5.2 Installation method

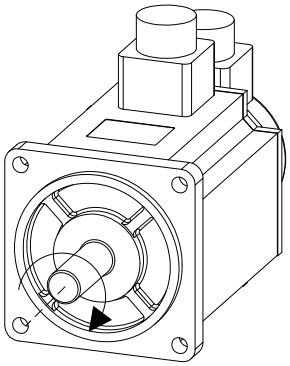
- Horizontal installation: to prevent water, oil and other liquids from flowing into the motor from the outlet end of the motor, please place the cable outlet below.
- Vertical installation: if the motor shaft is installed upward and the reducer is attached, pay attention to and prevent oil stains in 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 motor rotating direction description in this handbook is defined as facing the shaft of the servo motor, if the rotating shaft is in counterclockwise direction will be called as positive direction, or in clockwise as reversal direction



Positive Rotation
(CCW)



Reversal Rotation
(CW)

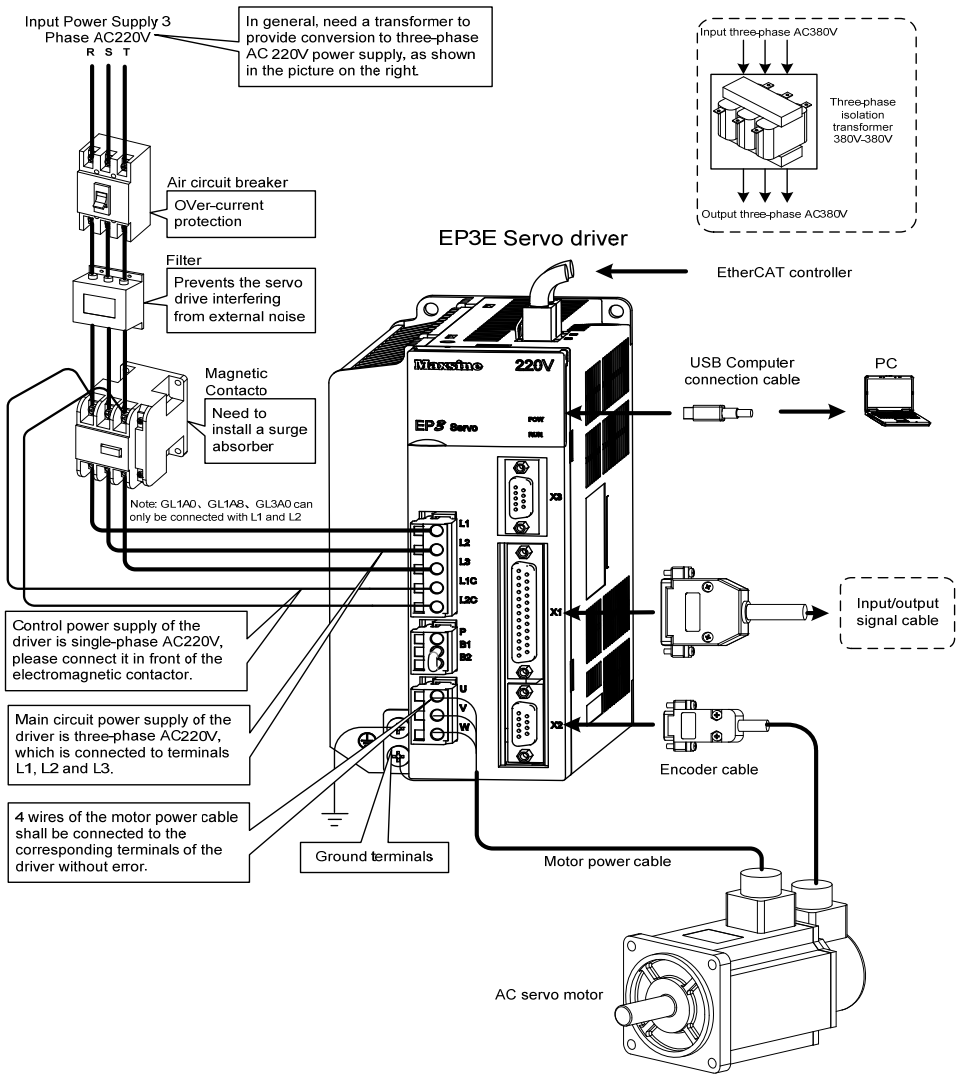
Chapter 2 Wiring

2.1 System composition and wiring

2.1.1 Servo driver wiring diagram

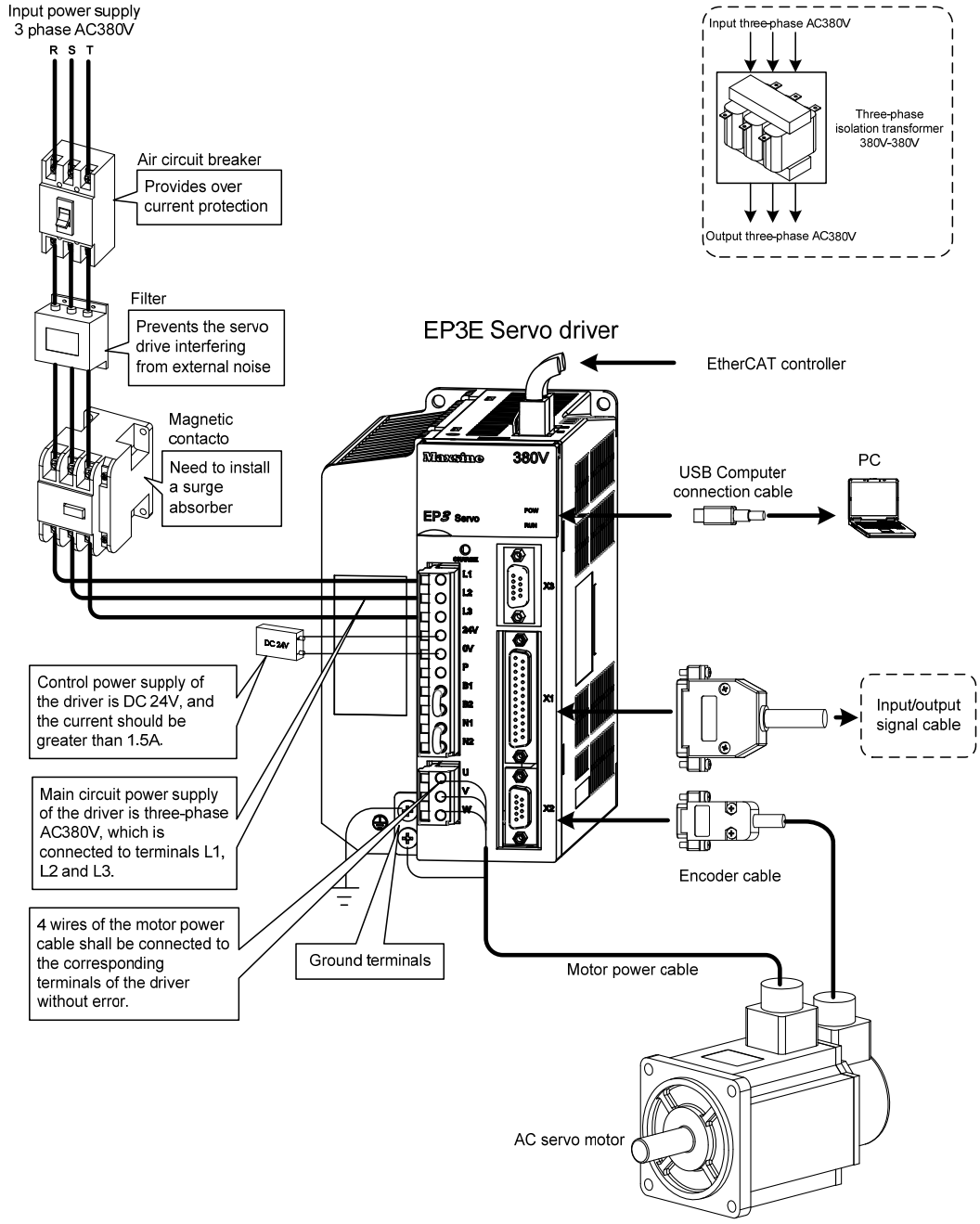
1. EP3E-GL series servo driver wiring diagram

Applicable models：GL1A0、GL1A8、GL3A0、GL5A5、GL7A5、GL120、GL160



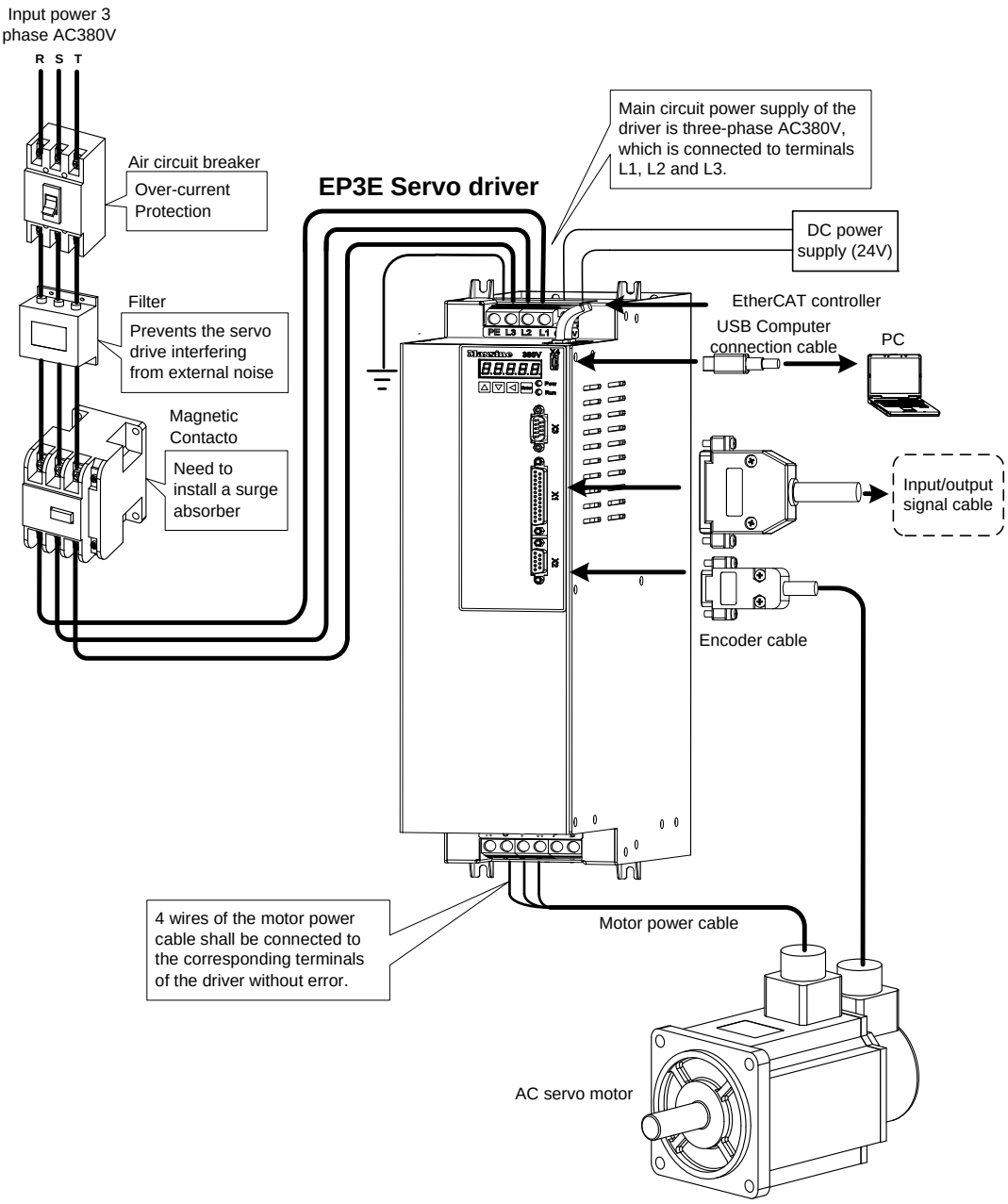
Note: Please refer to section 2.1.5 for details of GL190 and GL240.

2. EP3E-GH series servo driver wiring diagram



Note: This wiring method is only applicable to GH2A0, GH3A5 and GH5A4. Please refer to section 2.1.5 for details of GH8A5, GH130, GH170 and GH210.

Applicable models：GH260、GH320、GH390



2.1.2 Wiring explanations

Wiring notice:

- Wiring materials shall be used according to wire specifications.
- Cable length, command cable within 3m, encoder cable within 20m.
- GL series: check whether the power supply and wiring of L1, L2, L3, L1C and L2C are correct. Do not connect to 380V power supply.
- GH series: check whether the power supply and wiring of L1, L2, L3, 0V and 24V are correct.
- 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 grounded at a single point.
- For the relay installed in the output signal, the direction of the diode used for absorption should be connected correctly. Otherwise it will cause failure and fail to output the signal.
- In order to prevent the wrong action caused by noise, please add insulation 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 a non fusible circuit breaker to cut off the 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	0.75～10mm^2
Control power supply	GL series	L1C、L2C	0.75～1.0mm^2
	GH series	24V、0V	0.75～1.0mm^2
Servo motor connection terminal		U、V、W	0.75～10mm^2
Ground terminal		⏚	0.75～4mm^2
Control signals		X1	≥0.14mm^2(AWG26),shielded
Encoder signals		X2	≥0.14mm^2(AWG26),shielded
Brake resistor terminal		P、B1/P、B	1.5～4mm^2

Must use a twisted pair wire cable for the encoder signal wiring. If the encoder signal cable is too long (>20m), in which the encoder power supply can be insufficient, may use multi-wire or thick wire for the power supply wiring.

2.1.4 Main circuit terminal explanation

Name	Symbol	Model	Detailed explanation
Main power supply	L1 L2	GL1A0、GL1A8、GL3A0	Single-phase 220VAC -15%～+ 10% 50/60 Hz
	L1 L2 L3	GL5A5、GL7A5、GL120、GL160、GL190、GL240	Three-phase 220VAC -15%～+10% 50/60Hz
		GH series	Three-phase 380VAC - 15%～+ 10% 50/60 Hz
Control power supply	L1C L2C	GL series	Single-phase 220VAC - 15%～+ 10% 50/60 Hz
	24V、0V	GH series	External DC24V
Brake resistor terminal	P B1 B2	GL1A0[Note1] 、 GL1A8 、GL3A0、GL5A5、GL7A5、GL120、GL160、GH2A0、GH3A5、GH5A4	When the external braking resistance is needed, disconnect B1、B2[Note 2], and the external braking resistance is connected to the P and B1 ends to make B2 suspended.
	NC P B	GL190、GL240[Note1] GH8A5、GH130、GH170 GH210、GH260、GH320 GH390	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 reactor connection terminal for high harmonic suppression of power supply	N1 N2	GL190、GL240、GH series	DC reactor is connected between N1 and N2 [Note 2] when high-order harmonics of power supply need to be suppressed.
Servo motor connector	U	EP3E series	U phase output to motor
	V		V phase output to motor
	W		W phase output to motor
Ground terminal	⏚	EP3E series	Ground terminal of motor
	⏚		Ground terminal of servo drive

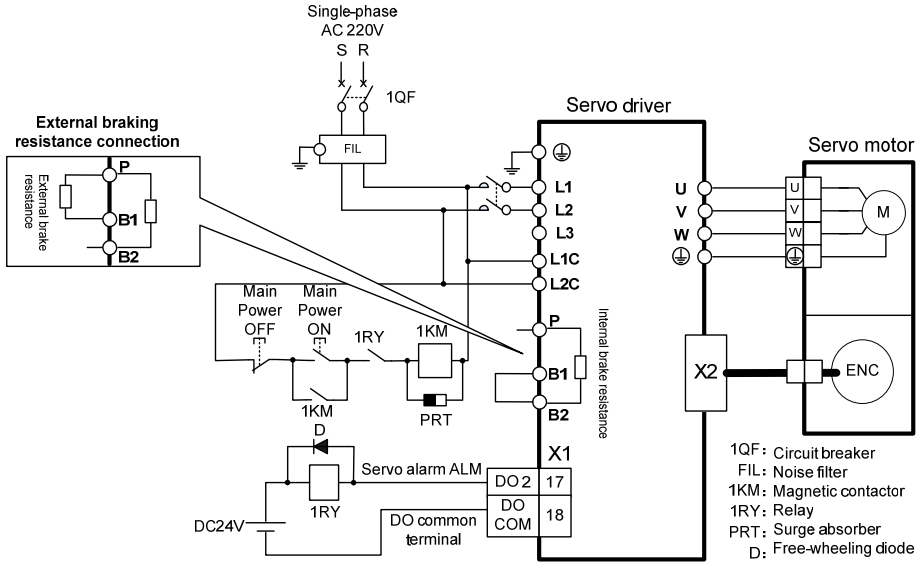
Note 1.GL1A0, GL240, GH260, GH320 and GH390 do not have internal brake resistance. Generally, GL1A0 does not need to connect brake resistance.

Note 2.When leaving the factory, it is the default internal braking resistance connection method: B1 and B2 are in short circuit state, and N1 and N2 are in short circuit state.

2.1.5 Main circuit wiring diagram

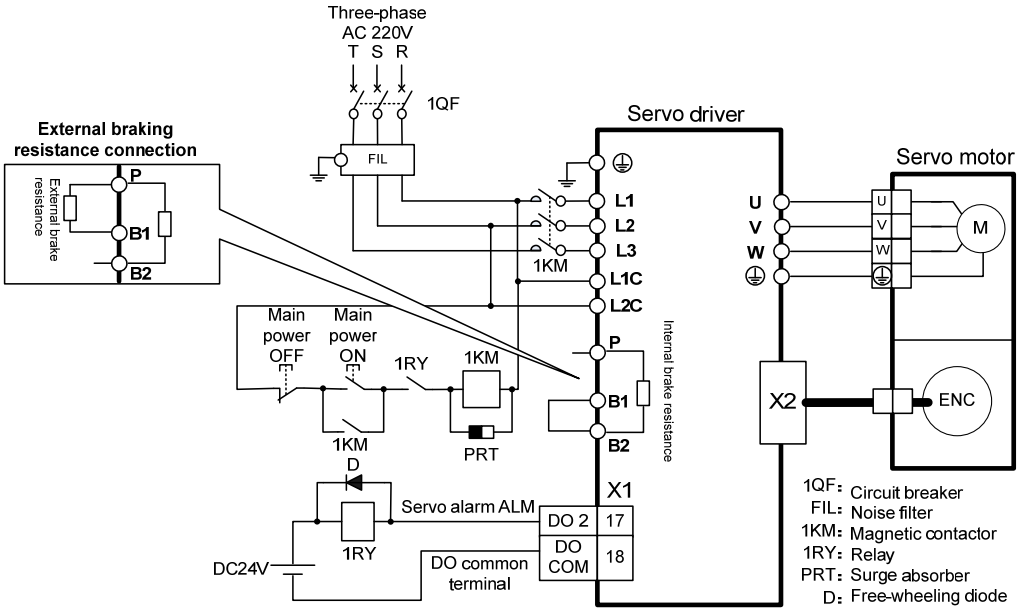
1. GL series servo driver power supply adopts three-phase AC 220V, generally obtained from three-phase AC 380V through transformer.

Applicable models：GL1A0、GL1A8、GL3A0

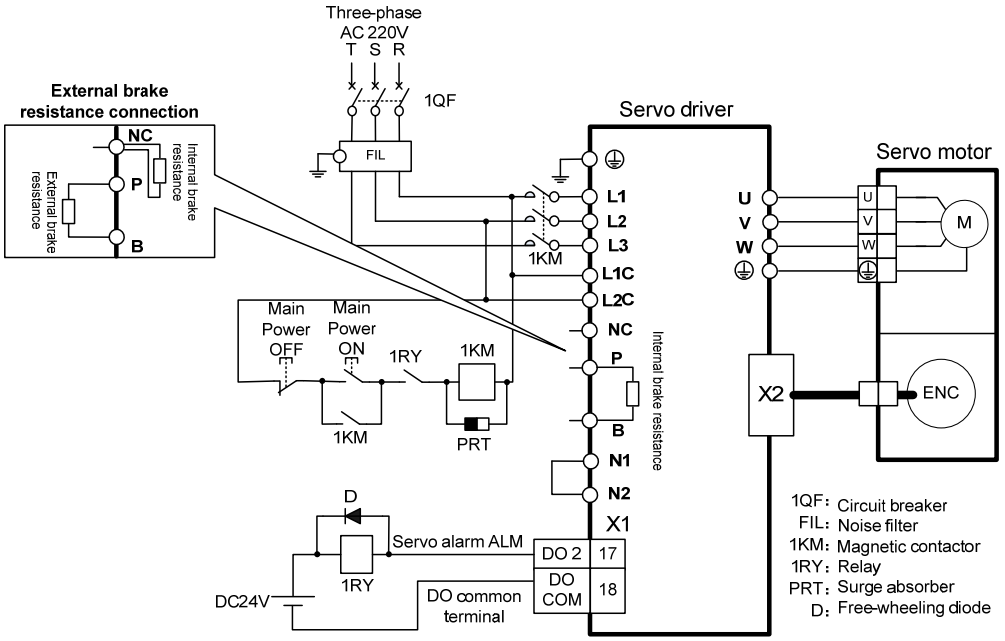


Note: GL1A0 has no internal braking resistor, so it is generally unnecessary to connect the braking resistor.

Applicable models：GL5A5、GL7A5、GL120、GL160



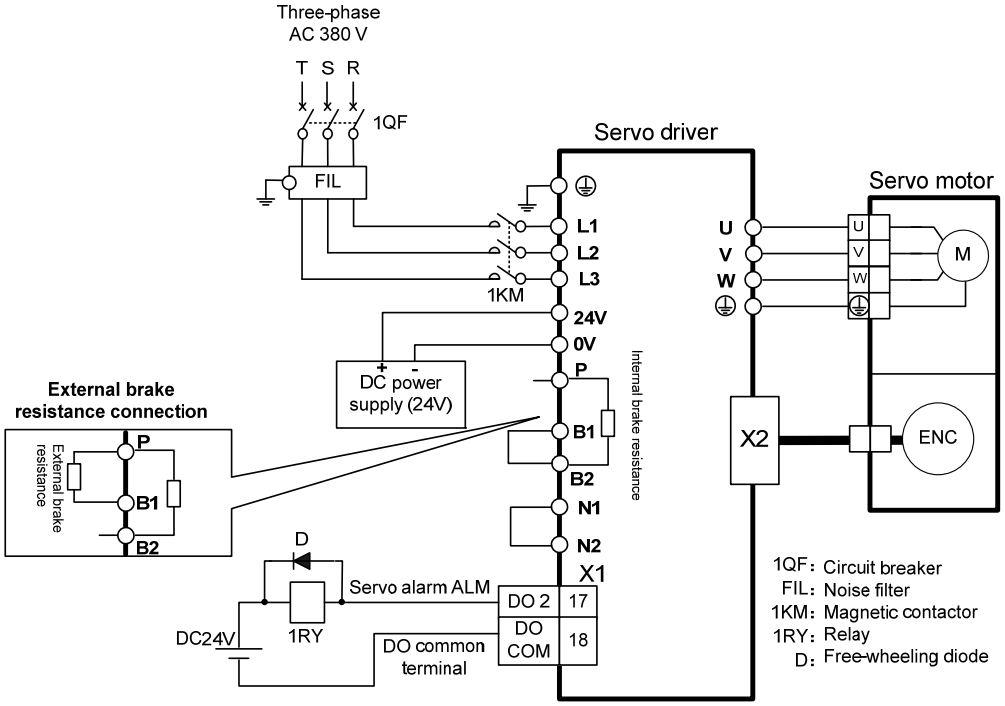
Applicable models：GL190、GL240



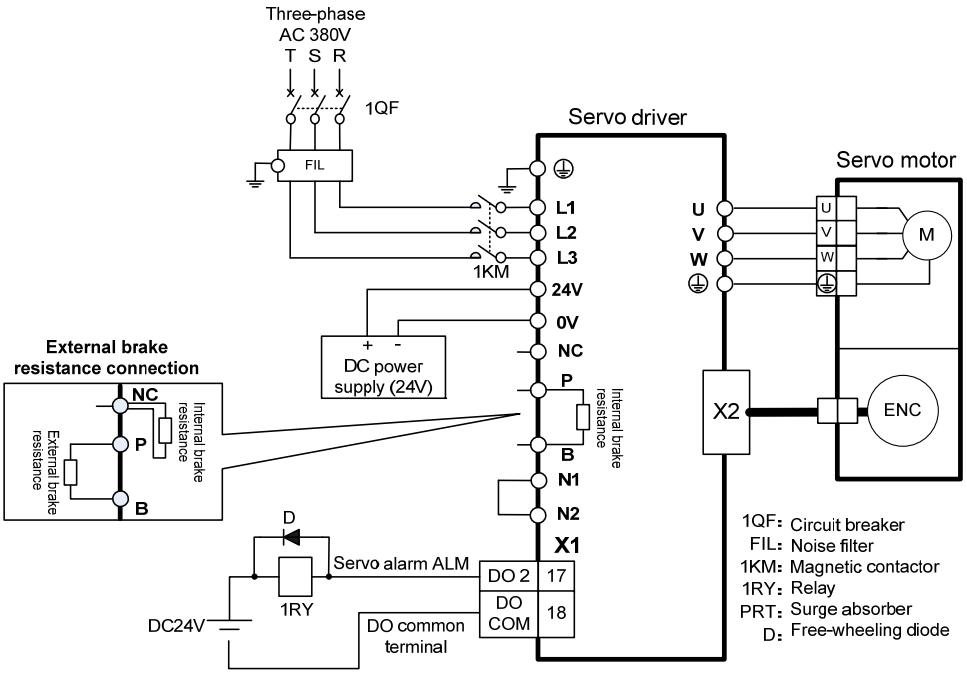
Note: GL240 has no internal brake resistance and needs to be connected to external brake resistance.

2. GH series:

Applicable models：GH2A0、GH3A5、GH5A4、GH8A5



Applicable models：GH130、GH170、GH210、GH260、GH320、GH390[Note]



Note 1: GH130 is a built-in braking resistor, which can meet the general situation.

Note 2: GH170、GH210、GH260、GH320、GH390 have no internal brake resistors, so they need to be connected to external brake resistors for use.

Note 3: GH260、GH320、GH390 have no N1 and N2, but only N terminal, so they are not short circuited.

2.2 Brake resistance adaptation

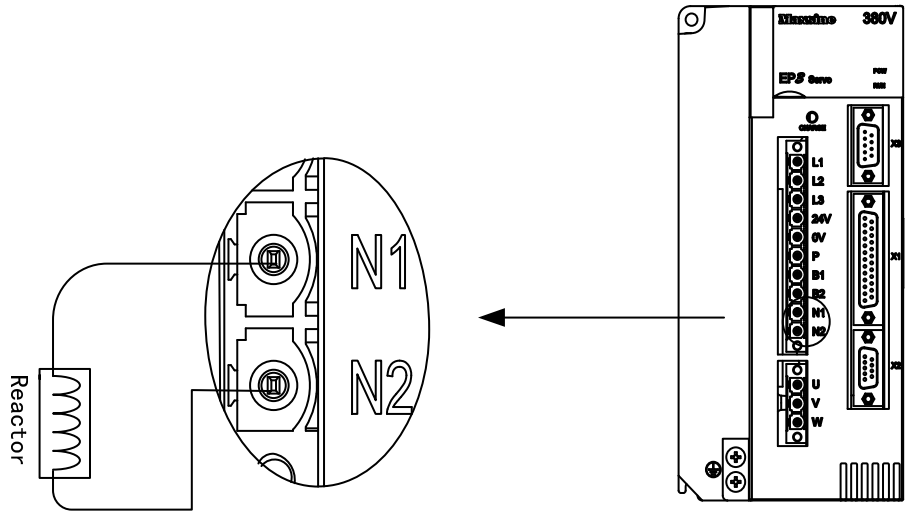
Drive series		Internal brake resistance specification	Recommended specification of external brake resistance	Minimum external brake resistance
AC220V	GL1A0	None	47Ω/100W	30Ω
	GL1A8	47Ω/100W	36Ω/200W	30Ω
	GL3A0	47Ω/100W	36Ω/200W	30Ω
	GL5A5	47Ω/100W	36Ω/200W	25Ω
	GL7A5	47Ω/100W	36Ω/200W	25Ω
	GL120	47Ω/100W	25Ω/200W	20Ω
	GL160	47Ω/100W	25Ω/200W	20Ω
	GL190	47Ω/100W	20Ω/500W	12Ω
	GL240	None	20Ω/500W	12Ω
AC380V	GH2A0	110Ω/100W	50Ω/500W	45Ω
	GH3A5	110Ω/100W	50Ω/500W	45Ω
	GH5A4	110Ω/100W	50Ω/500W	45Ω
	GH8A5	47Ω/100W	50Ω/500W	40Ω
	GH130	47Ω/100W	36Ω/750W	30Ω
	GH170	None	36Ω/750W	30Ω
	GH210	None	20Ω/1000W	15Ω
	GH260	None	20Ω/1000W	15Ω
	GH320	None	20Ω/1000W	15Ω
	GH390	None	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 Connection of reactor

When it is necessary to suppress the higher harmonics of the power supply, connect the DC reactor between N1 and N2; when it is not necessary to suppress the higher harmonics of the power supply, it is directly connected between N1 and N2.



Note: Only GL190, GL240, GH2A0, GH3A5, GH5A4, GH8A5, GH130, GH170 and GH210 servo drivers have the function of connecting external reactors.

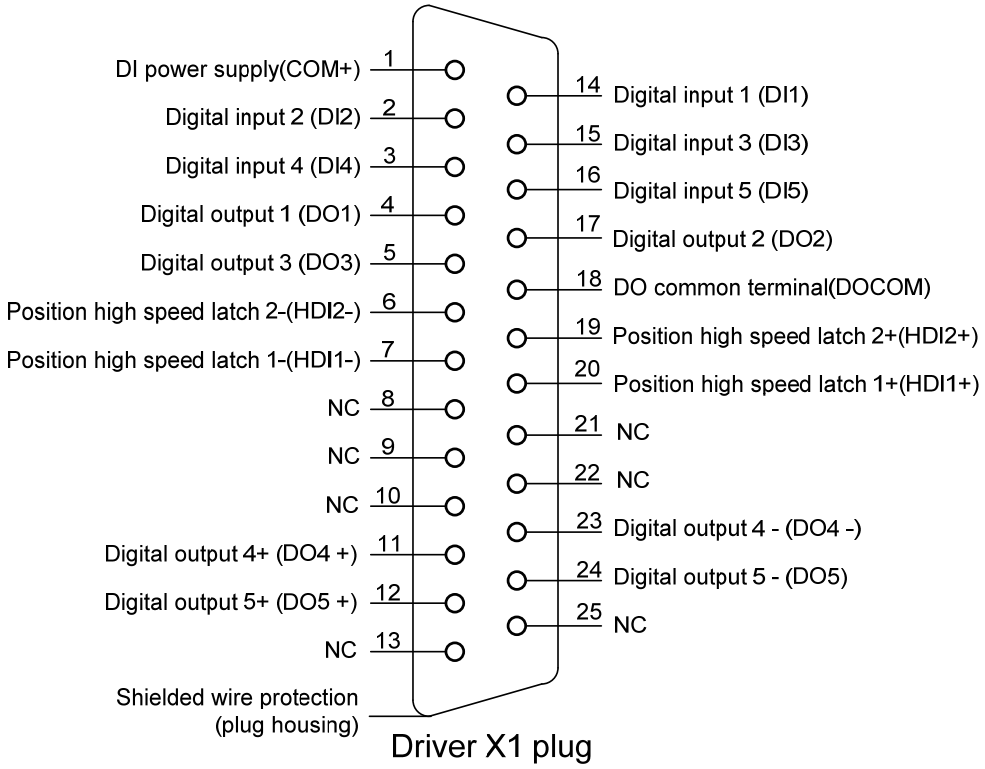
2.4 X1 control signal terminal

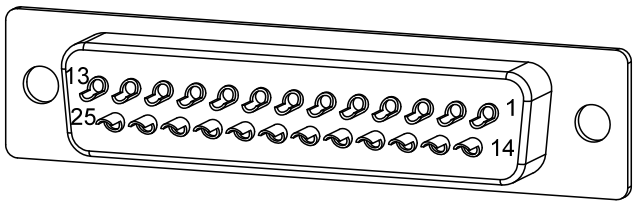
X1 control signal terminals for connected to the host controller signals, use DB25 socket, signs include:

- 5 programmable inputs;
- 5 programmable outputs;
- 2 high-speed color code latch input.

2.4.1 X1 terminal plug

X1 terminal plug adopts DB25 male head, and its shape and pin distribution are:





X1 plug welding pin distribution

2.4.2 X1 terminal signal description

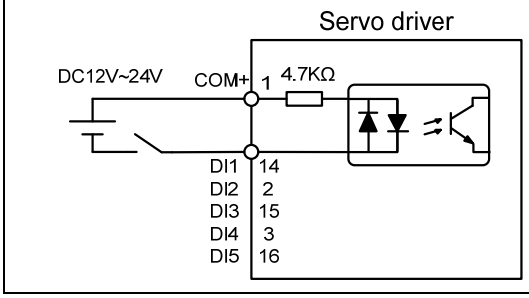
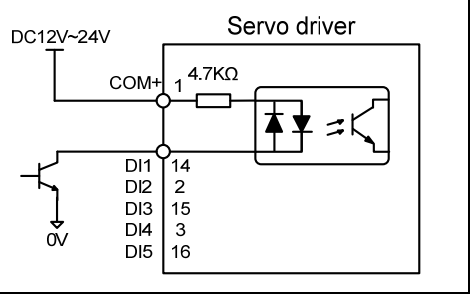
Signal name		Pin number	Functions	Inter face
Digital input	DI1 DI2 DI3 DI4 DI5	14 2 15 3 16	Photoelectric isolation input, programmable function, defined by parameters P100 ~ P104.	C1
	COM+	1	DI power supply (DC12V ~ 24V)	
Digital output	DO1 DO2 DO3	4 17 5	Photoelectric isolation output, maximum output capacity 50mA/25V, programmable function, defined by parameters P130~P132.	C2
	DOCOM	18	DO common terminal	
	DO4+ DO4- DO5+ DO5-	11 23 12 24	Photoelectric isolation output, maximum output capacity of 50mA/25V, programmable function, digital difference output defined by parameters	
Position high speed latch	HDI1+ HDI1- HDI2+ HDI2-	20 7 19 6	High speed photoelectric isolation input	C3
Shielded wire protection ground	Metal case of connector		Connecting the shielded cable shielded wire	

2.4.3 X1 terminal interface type

The following will introduce the interface circuits of X1 and the wiring mode with the host control device.

1. Digital input interfaces (C1)

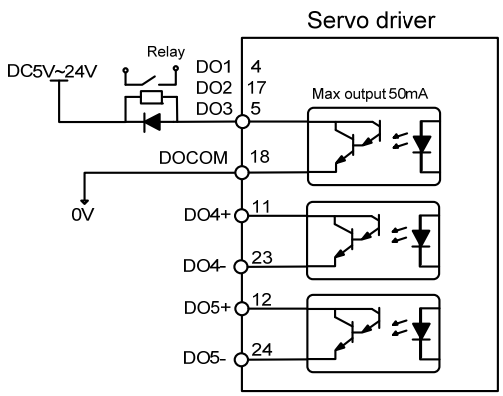
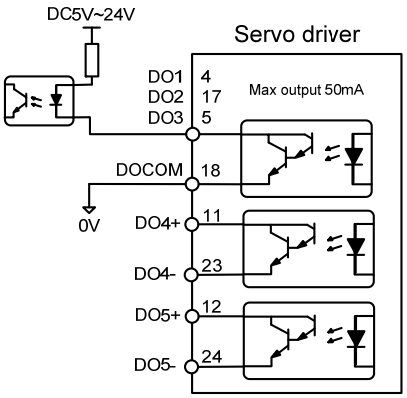
Digital input interface circuit can be controlled by switches, relays, open collector triodes, optocouplers, etc. Low current relay shall be selected for the relay to avoid poor contact. External voltage range is DC12V~24V.

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

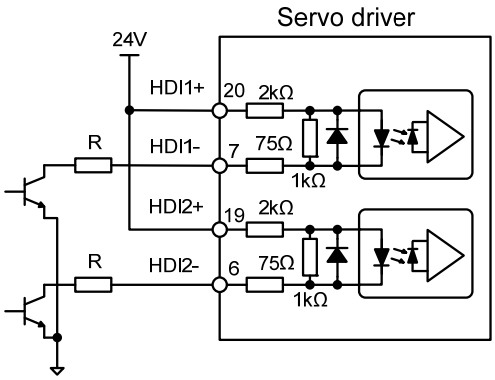
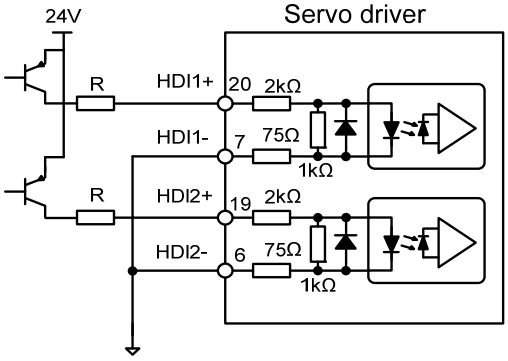
2. Digital output interfaces (C2)

The output circuit adopts Darlington optocoupler, which can be connected with relay and optocoupler. Precautions:

- The power supply is provided by the user. If the power supply is connected reversely, 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 100mA.
- 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 with TTL circuit.

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

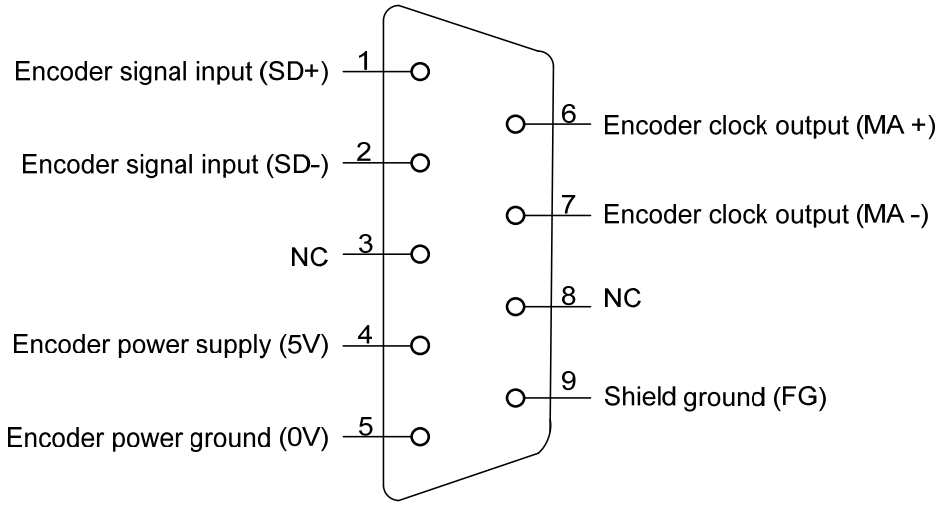
3. Position command pulse interfaces (C3)

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

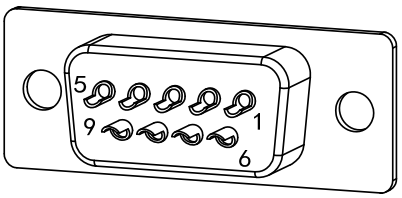
2.5 X2、X3 encoder signal terminals

2.5.1 X2 terminal plug

The following figure shows the connection between X2 encoder signal terminal and motor encoder. Double row DB9 sockets are used. The shape and pin distribution is as follows:



Driver X2 plug (absolute value communication encoder)



X2 plug welding pin distribution

2.5.2 X2 terminal signal description

Absolute value communication encoder definition:

Signal name		Pin number Absolute type （6 core）	Function
Encoder power supply	5V	4	Encoder uses 5V power supply (provided by driver). When the cable is above 20m, in order to prevent the voltage of encoder from decreasing, the power supply and ground wire can be connected by multi-wire or thick wire.
	0V	5	
Signal input	SD+	1	Connect with absolute encoder signal output.
	SD-	2	
Clock output	MA+	6	Connect to the absolute encoder clock input.
	MA-	7	
Shielding wire protected area	FG	9	Connect with cable shield wire.

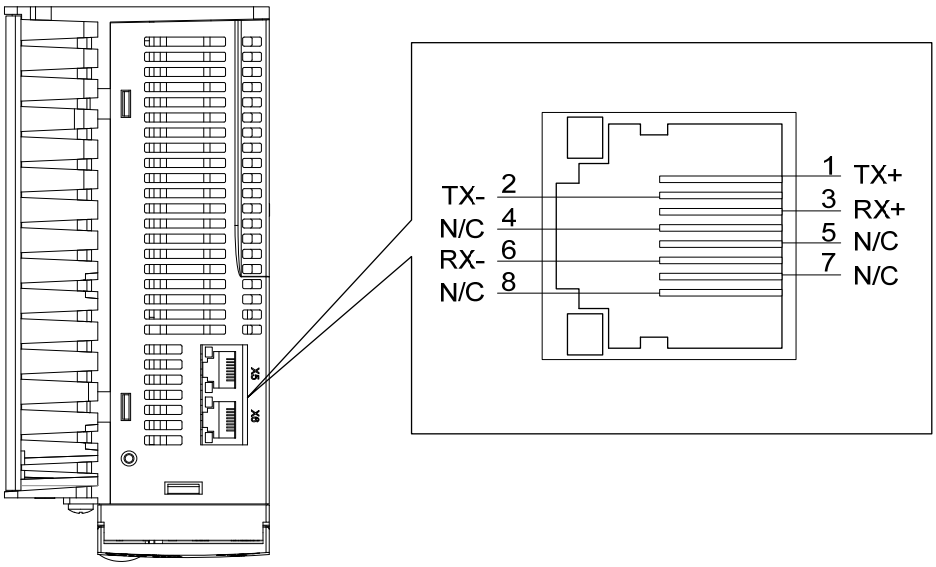
2.5.3 X3 terminal

Reserved

2.6 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.

2.6.1 X5、X6 terminals interface

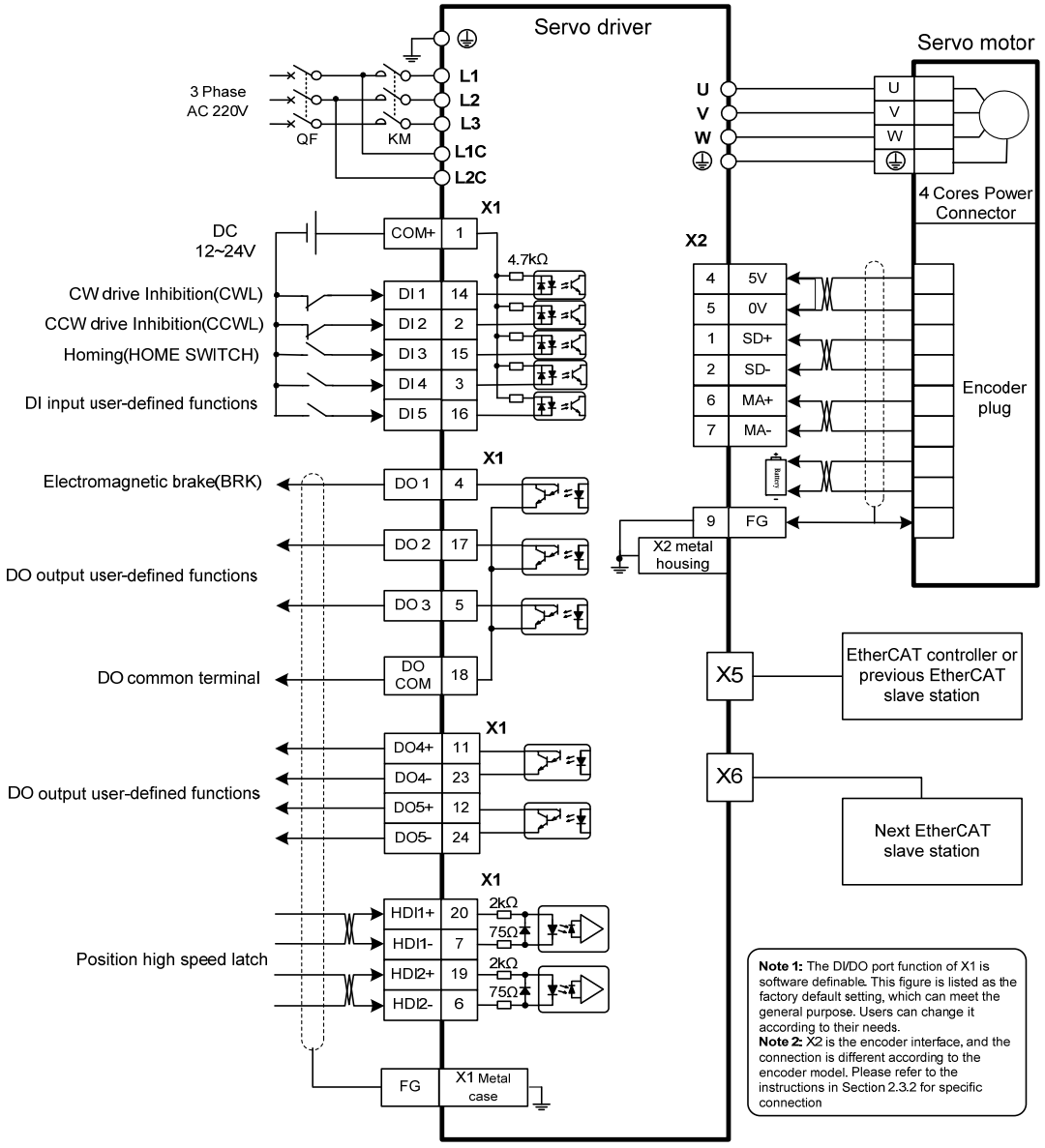


2.6.2 X5、X6 terminal signal description

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

2.7 Standard wiring diagram

2.7.1 Control wiring



Note:

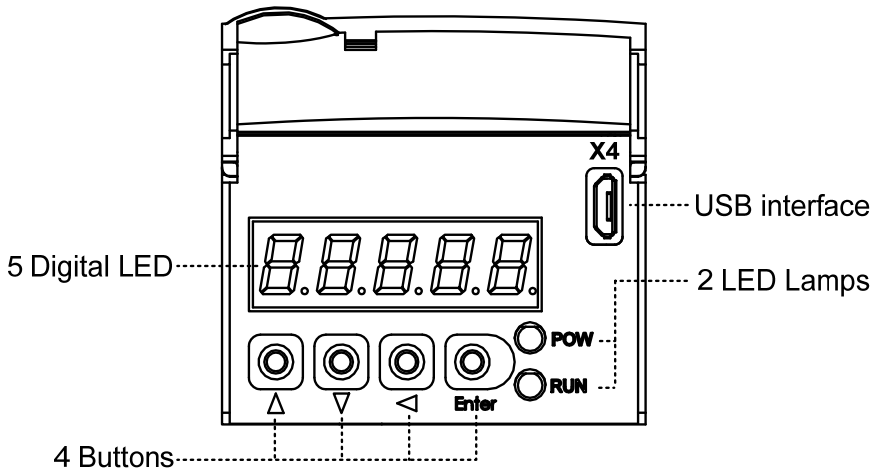
The wiring diagram above takes GL7A5 as an example.

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.

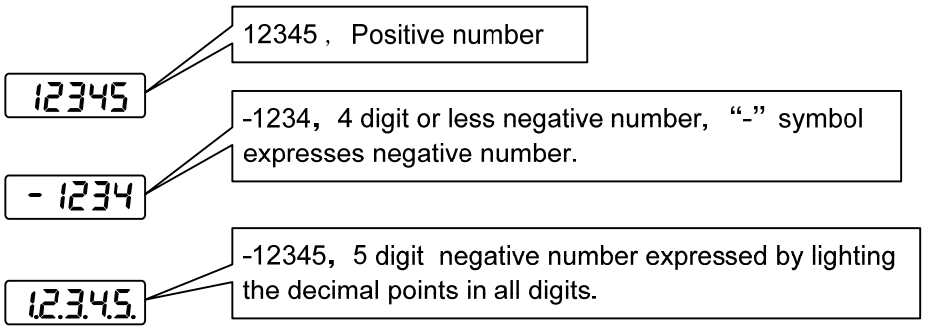


3.1.2 Front panel explanations

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; Press down and hold to repeat increasing.
▼	Decreasing button	Decrease sequence number or value; Press down and hold to repeat decreasing.
◄	Exit button	Menu exit; cancel the operation.
Enter	Confirm button	Menu entered; the operation confirmed.
	USB interface	Equipment connected to the computer interface.

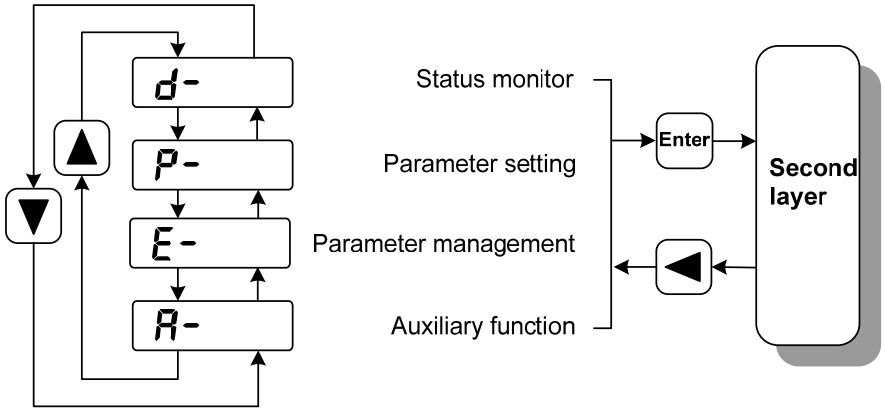
3.1.3 Data display

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

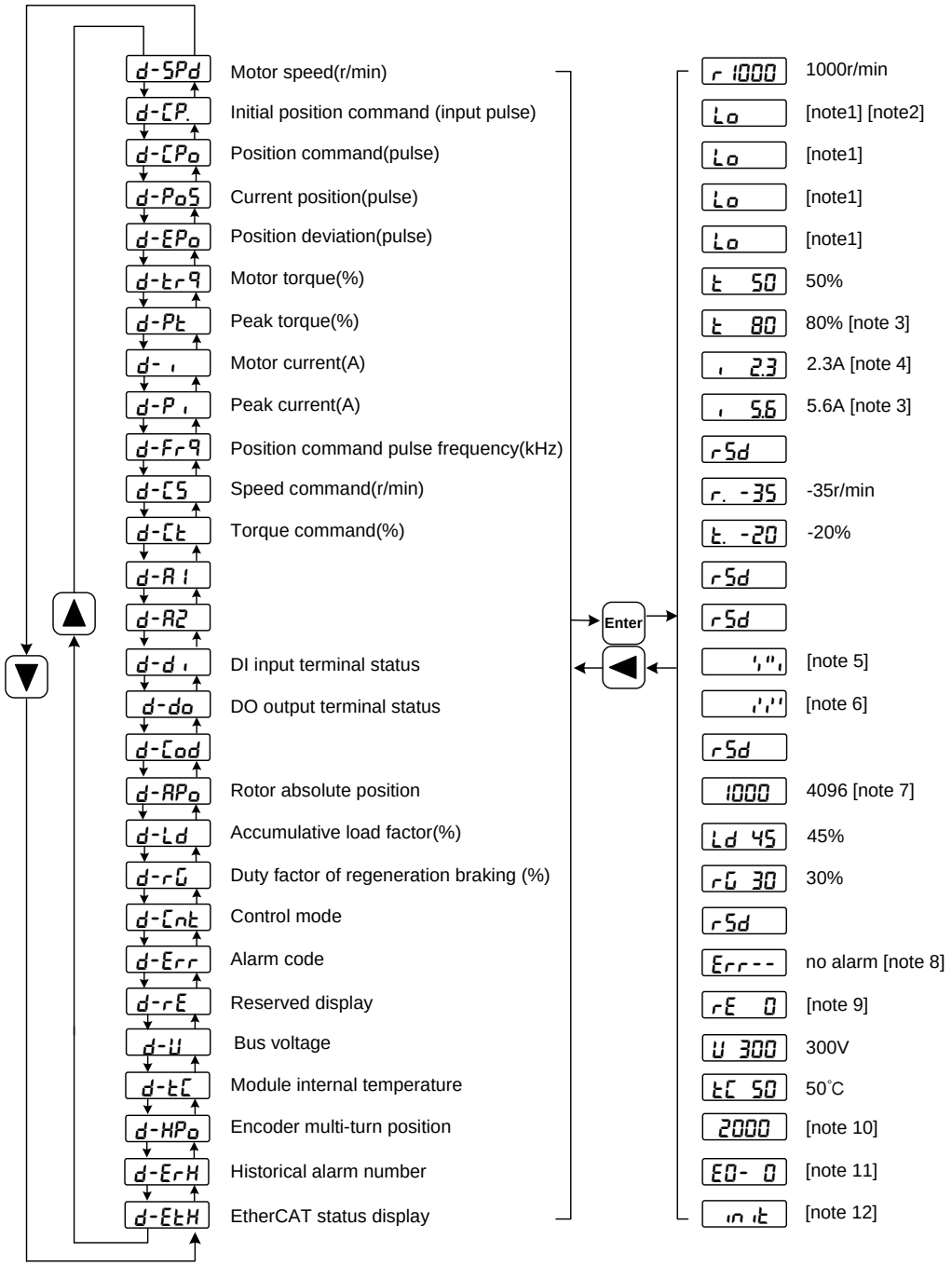
The first layer is the main menu and has four operating modes. Pressing ▲、▼ button changes the operation mode. Pressing the Enter button enters the second layer and then executes a concrete operation. Pressing ◄ button returns to the main menu from the second layer.



First layer（Main menu）

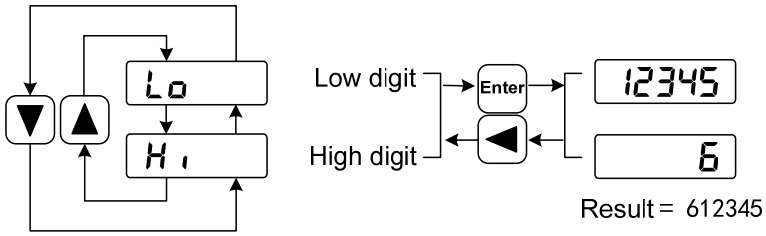
3.3 Status monitor

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 [note 1]

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



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

2. Pulse unit [note2]

The original position command pulse is the input pulse count that has not transformed through the electronic gear.

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

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

3. Peak torque and peak current [note 3]

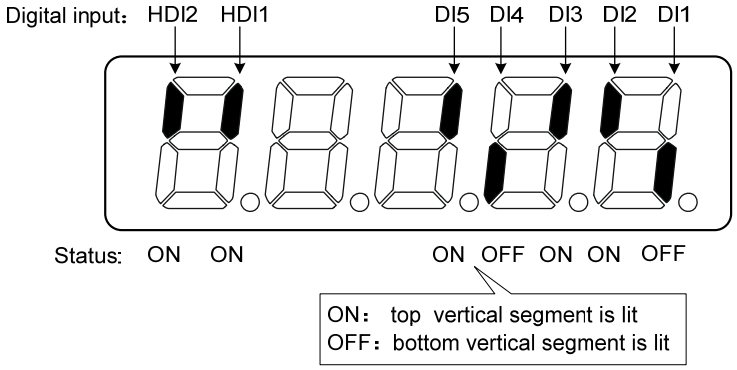
Maximum torque and maximum effective phase current of the motor in the past 10 seconds.

4. Motor current [note 4]

Motor phase current effective value.

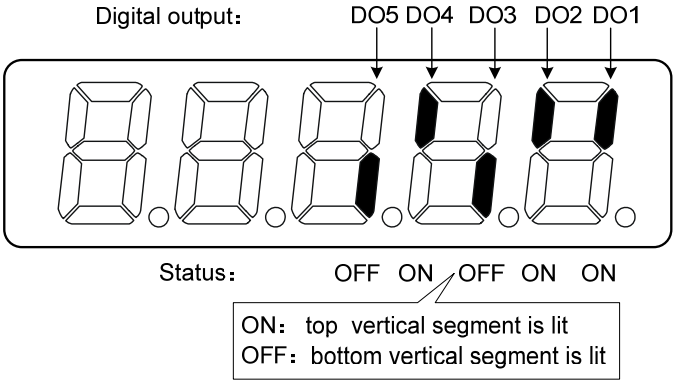
5. Input terminals DI [note 5]

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 [note 6]

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”

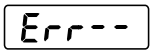


7. Rotor absolute position [note7]

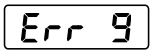
Represents the position of the rotor relative to the stator in a revolution, and turns one into a period. The unified pulse unit takes the encoder Z pulse as the home. The range is 0～65535, and the value is 0 when the Z pulse appears.

8. Alarm code [note 8]

The "Err" followed by two minus symbols indicates no alarm and by digital number indicates an error code number that is flickering. When alarm 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.



No alarm



flickering No.9 alarm

9. RE reserved display [note 9]

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

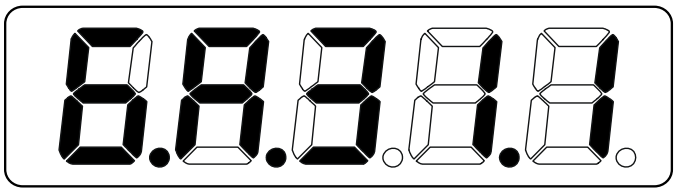
The first digital tube shows the last digit of the year, such as: 2016 shows 6, 2017 shows 7, and so on;

The second digital tube display month (note: October is indicated by "A", November by "B", December by "C");

3-4 digital tube display day;

The fifth 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.

(2) re-1 under the menu displays the current site.

According to each main controller is not the same, the site number setting method is different. Refer to the P300 parameter description for details.

This value is convenient for the field engineer to diagnose whether the station number is set correctly.

(3) re-2 under the menu display the real-time communication cycle time, the current connection unit is us, according to 1 decimal places.

(4) re-3 menu displays the positive maximum value of time deviation between the communication cycle detected by the driver and the set standard communication cycle, unit is us, and displays 2 decimal places.

(5) re-4 menu displays the negative maximum value of the time deviation between the communication cycle detected by the driver and the set standard communication cycle, unit is us, and displays 2 decimal places.

(6) re-5 menu displays the servo cycle compensation value, unit is us, accurate to 2 decimal places.

(7) re-6 menu displays the cumulative value of the number of lost EtherCAT synchronization interrupts.

10. Encoder multi-turn position [note10]

This status shows that only absolute value drives are valid. The multi-turn position of the encoder is recorded in the range of 0 ~ 65535. With the absolute position of APo rotor in a single-turn, the absolute position of the rotor can be obtained as follows:

Absolute position = multi-turn position × absolute encoder digit + single-turn position

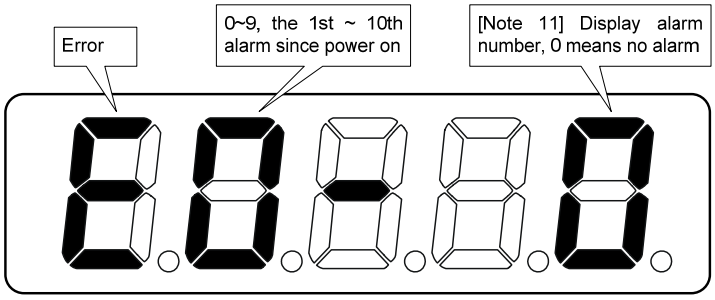
For example, the multi-turn position shows 2000, and the single-turn position shows 1000, both of which are base 10 numbers

The absolute position of the encoder is $(2000\times2^{16}+1000)$ (decimal) =131073000

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

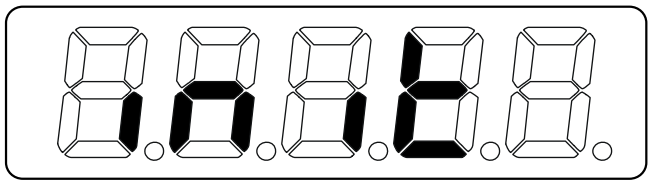
11. Historical alarm number [note11]

Display alarm number, can be used ▲、▼ button to view the history of the alarm number.

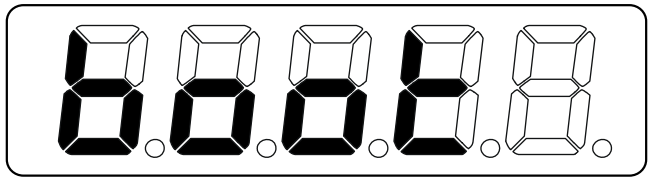


12. EtherCAT status display [note12]

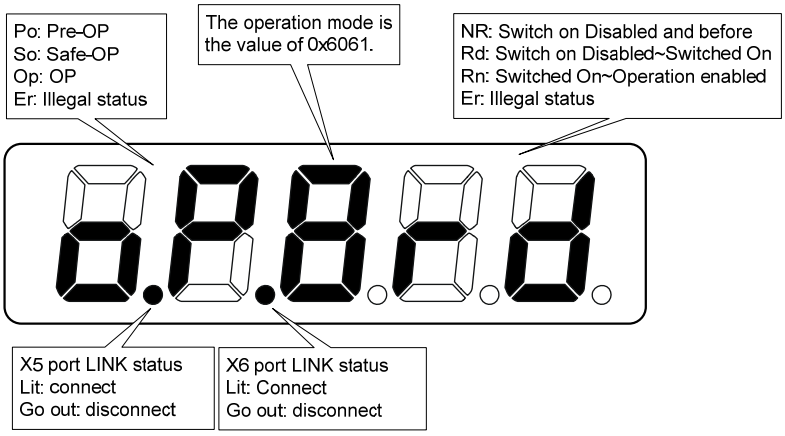
(1) When EtherCAT network status is init, display：



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



(3) When other EtherCAT network status is displayed：



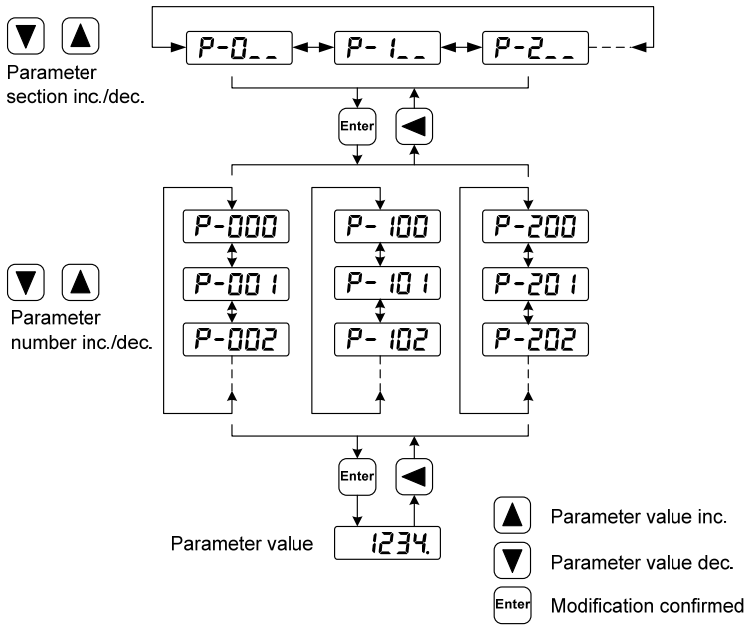
3.4 Parameters setting

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 ▲、▼ button once to increase or decrease the parameter value by one. Pressing down and hold the ▲、 ▼ 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.

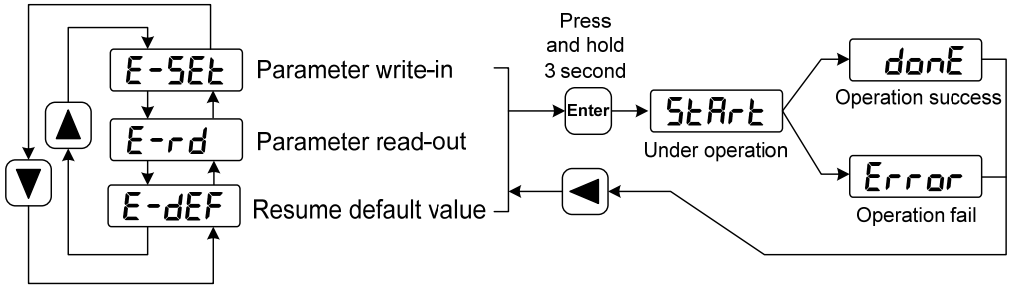
The modified parameter is not saved to EEPROM. If it needs to be saved permanently, please use the parameter write operation in parameter management. Parameter segments and Numbers are not necessarily contiguous, and unused segments and Numbers are skipped and cannot be selected.



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 the parameter list is written in EEPROM. The user modified the parameters, only changing the parameter values in the parameter list, and the original values will be restored when the power is turned on next time. If you want to permanently change the parameter value, you need to execute the parameter write in operation, and insert the parameter write in the parameter list into the EEPROM. After power on, the modified parameters will be used.

- **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.

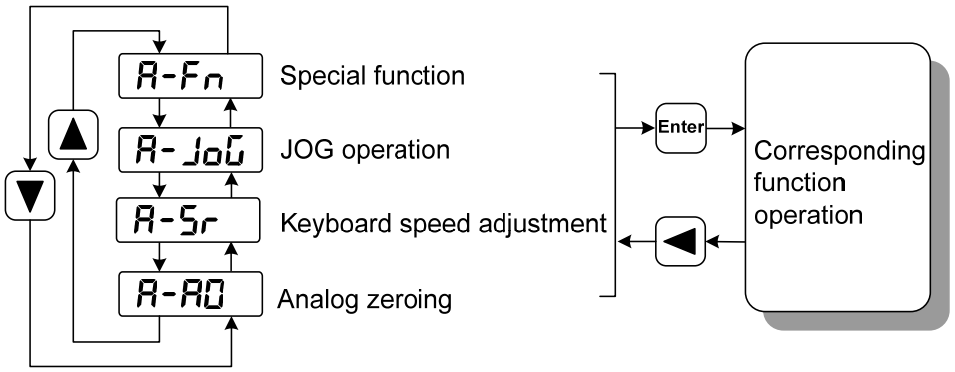
- **Resume default value**

  This operation indicates that the default values (factory values) of all parameters are read into the parameter list and written into 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

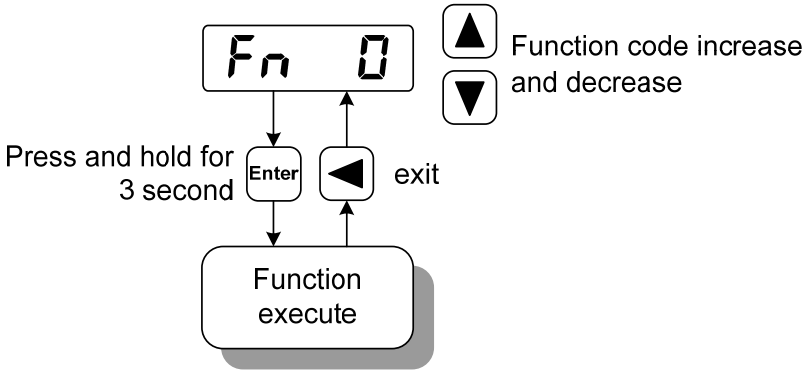
3.6 Auxiliary function

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.



Fn number	functions	explanation
Fn36	Encoder reset (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.

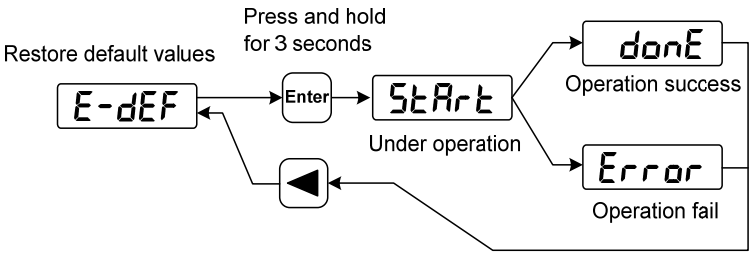
3.7 Resume the parameter default values

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.

The steps to restore the default parameters are as follows:

1. Restore all parameters to the default values, and the parameters modified by the user will also be restored to the factory default values. Perform the operation of restoring default values in parameter management.



Restore the default values of all parameters

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;
- Running direction and speed of servo motor.

4.1.1 Wiring and inspection

Before turn on power supply, confirm that 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:

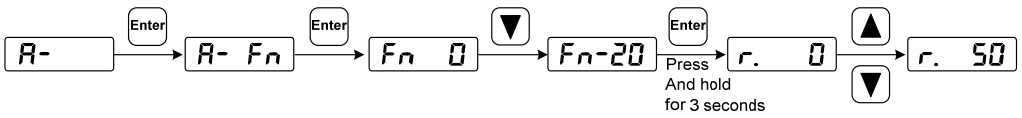
- Is the connection correct? In particular, whether the driver U, V, W is one-to-one corresponding to the motor U, V, W wiring and whether the driver L1, L2, L3, L1C, L2C, 24V, 0V wiring.
- Is the input voltage correct?
- Is the encoder cable connected correctly?

4.1.2 Trial running in speed adjustment with keyboard

Note: trial running in speed adjustment with keyboard, you need to set parameter P304 (EtherCAT mode switch) to 0 to run!

When parameter P304=0, the driver is in normal mode and can be used for trial running in speed adjustment with keyboard and other functions; When parameter P304=1, the driver is in EtherCAT mode, and the control mode and commands are from the EtherCAT bus. After parameter P304 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!

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, the POWER indicator LED lit. If any error alarm, please inspect the wiring.
3. After confirming that there is no alarm or abnormality, confirm that parameter P304 of EP3E is 0, and then 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:

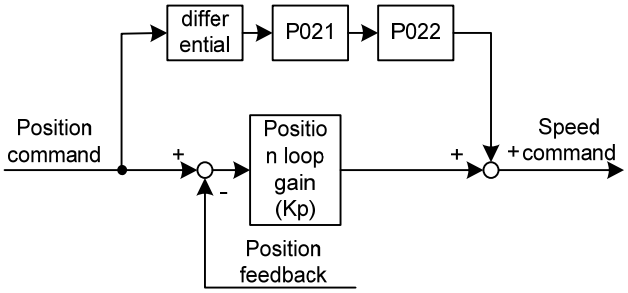
Para meter	Name	Setting value	Default value	Parameter explanation
P097	Ignore drive inhibit	3	3	Use forward drive inhibit (CCWL) and reverse drive inhibit (CWL). If set to ignore, did not connect CCWL、CWL.
P304	EtherCAT mode switch	1	1	0: Normal mode; 1: EtherCAT mode.

4.2.2 Position control mode related gain

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

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 decreases, but too much will make the system unstable and overshoot. If the electronic gear ratio is greater than 10, it is easy to produce noise. In general applications, P021 can be set to 0%. If high response and low tracking error are needed, it can be increased appropriately and should not exceed 80%. At the same time, the time constant of position loop feedforward filtering (parameter P022) may need to be adjusted.

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
P025	Speed command source	0	0	Reserved
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 Speed command source

The speed command has several different sources, which are set by parameter P025:

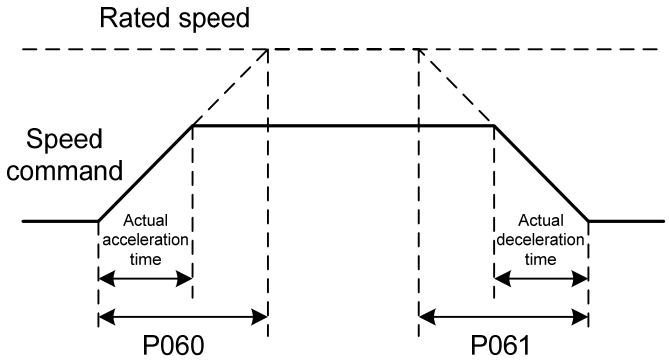
P025	Instruction	Explication
3	JOG speed command	Set for JOG operation
4	Keyboard speed command	Set for keyboard speed regulation (Sr) operation
5	Demonstrate speed command	Setting for speed regulation demonstration

4.3.3 Acceleration and deceleration

Acceleration and deceleration are related to the following parameters:

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

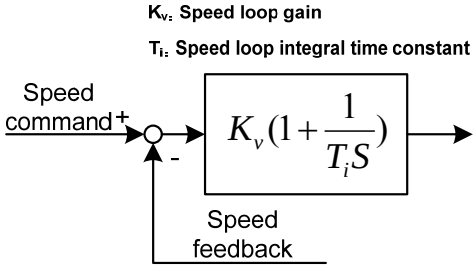
Acceleration and deceleration can slow down the sudden change of speed and make the motor run smoothly. As shown in the figure below, parameter P060 sets the acceleration time of the motor from zero speed to rated speed, and P061 sets the deceleration time of the motor from rated speed to zero speed. If the command speed is lower than the rated speed, the required acceleration and deceleration time will be shortened accordingly. If the driver and host device constitute position control, the parameter should be set to 0.



4.3.4 Speed control mode related gain

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

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.

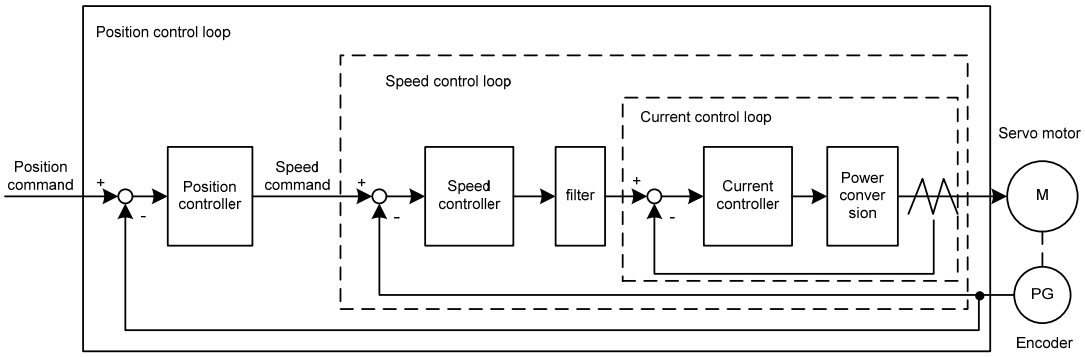
4.4.1 Speed limit of torque control mode

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	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:

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

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:

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

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:

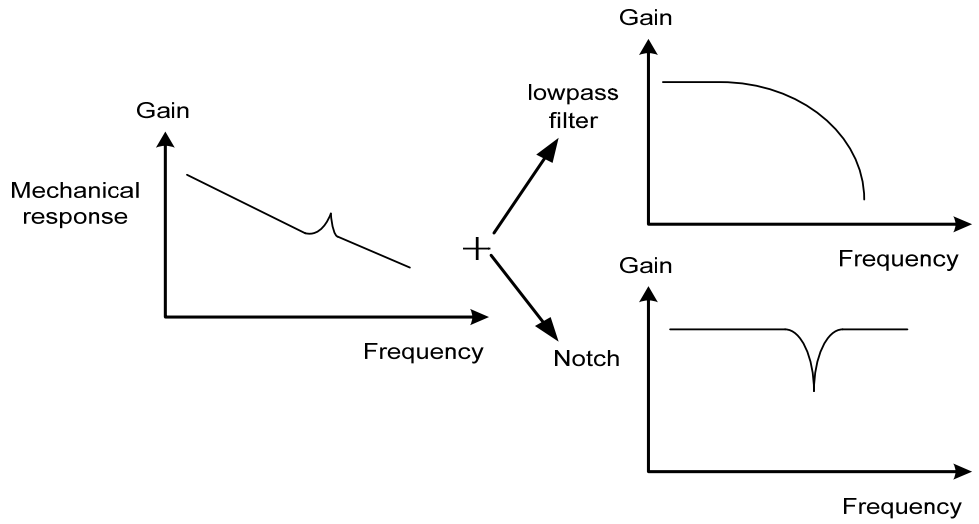
1. Set the load moment of inertia ratio.
2. Set the speed loop integration time constant to a larger value.
3. Increase the speed loop gain in the range without vibration and abnormal sound, and slightly decrease if vibration occurs.
4. The speed loop integration time constant should be reduced in the 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.

4.6 Resonance suppressions

When the mechanical system resonates, it may be caused by the servo system being too large and responding too fast. Reducing the gain may improve. 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	Usage
P007	1st torque filter time constant	0.10～50.00	1.00	ms	ALL
P200	1st notch filter frequency	50～5000	5000	Hz	ALL
P201	1st notch filter quality factor	1～100	7		ALL
P202	1st notch filter depth	0～60	0	dB	ALL
P203	2nd notch filter frequency	50～5000	5000	Hz	ALL
P204	2nd notch filter quality factor	1～100	7		ALL
P205	2nd notch filter depth	0～60	0	dB	ALL

The principle of resonance suppression is to use a filter to suppress the formant of 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.

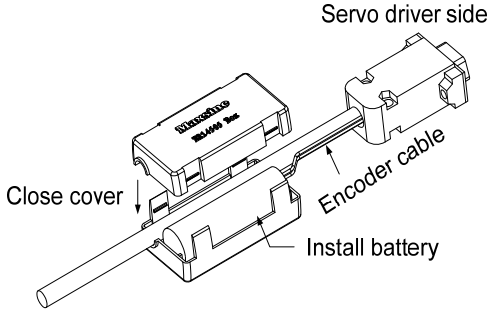
4.7 Absolute value encoder setting

4.7.1 Absolute value encoder multi-turn information saving

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, the 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: Do not set the battery unit on both sides of the servo drive. 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 (Err48) 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 (Err48)", 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.

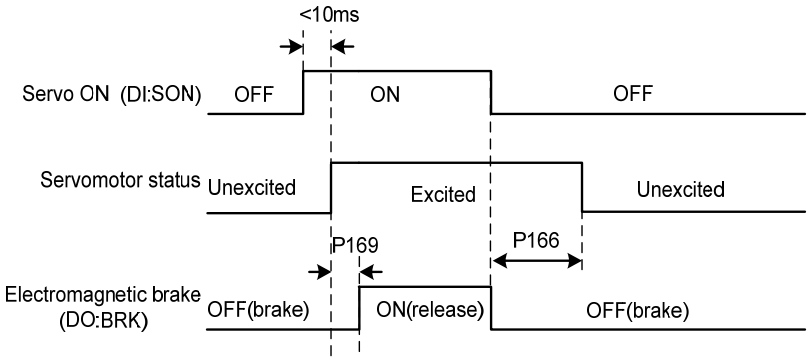
- When the machine is initially started;
- When the rotation amount data of the absolute encoder is to be set to 0.

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 (Err48)" occurs;
- When "encoder internal fault alarm (Err41)" 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

The parameters related to torque limit are:

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

Torque limits related to 402 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

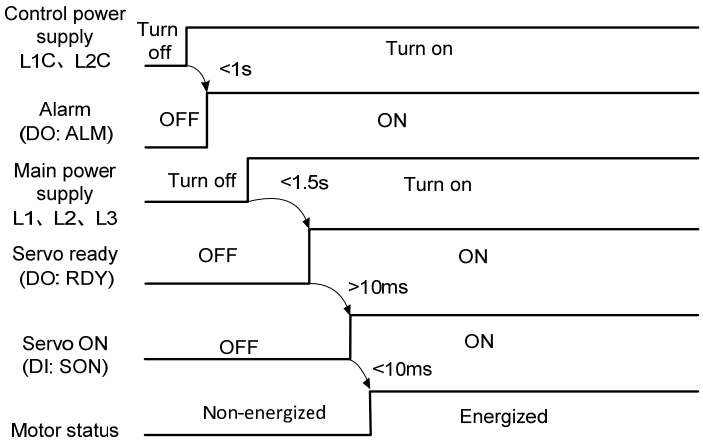
CCW	CW
It is determined by P065、6072H and 60E0h.	It is determined by P066、6072H and 60E1h.

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

4.10 Timing chart of operation

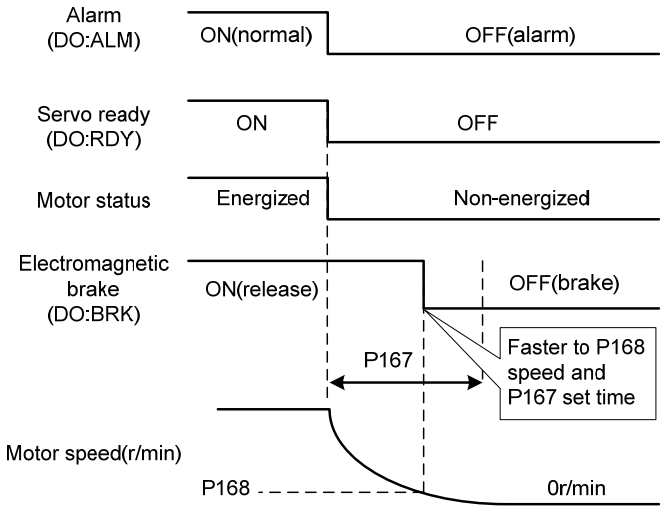
4.10.1 Timing chart when power supply switch on

- Control power supply L1C、L2C are turn on with the main power supply L1、L2、L3 at the same time or before the main circuit power supply. If only the power supply of the control circuit is turn on, the servo ready signal (RDY) is OFF.
- 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 accepted. It is detected that the SON is effective, the power circuit is turned on, and the motor is excited, and it is in the running state. It is detected that the SON is invalid or there is an alarm, the power circuit is closed, and the motor is in a free state.



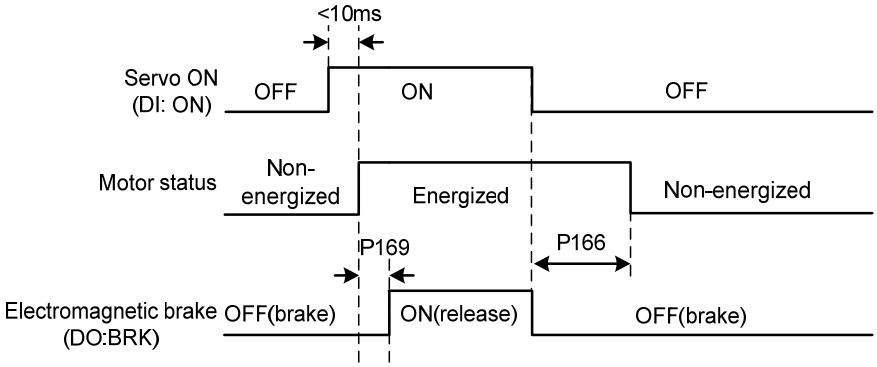
4.10.2 Alarm timing chart while servo-ON is executed

When the electromagnetic brake is servo controlled:



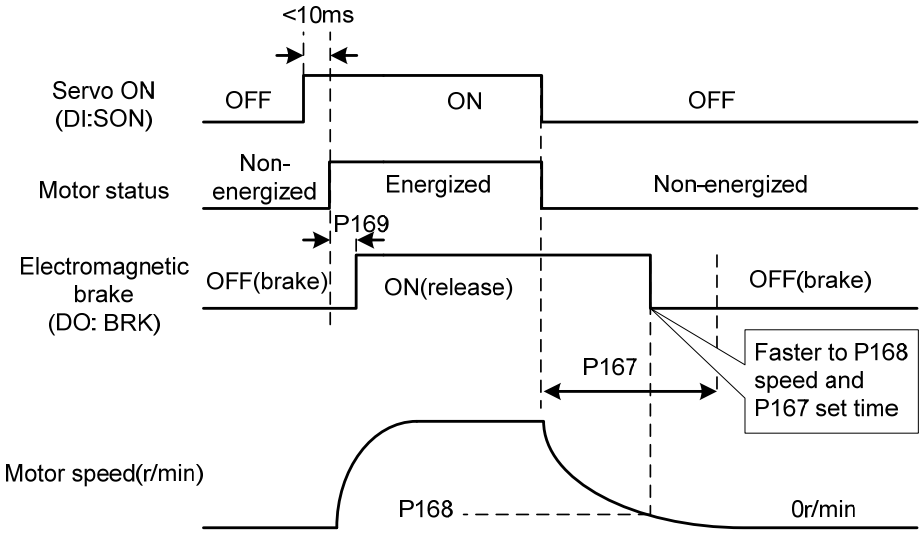
4.10.3 Servo ON/OFF action timing when the motor is stationary

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



4.10.4 Servo ON/OFF action timing during motor operation

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



4.11 Electromagnetic brake

Electromagnetic brake related parameters:

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

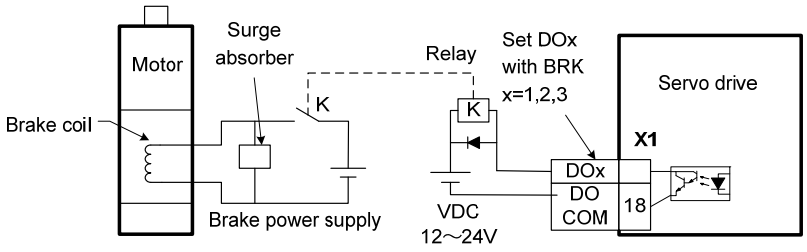
4.11.1 Use of electromagnetic brake

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 surge absorber to suppress surge voltage caused by on/off action of relay. Diodes can also be used as surge absorbers, which may cause a little braking delay.

After the motor is stationary (the speed is less than P165), the SON becomes OFF. At this time, the motor continues to be powered on to maintain the position. After the brake is released to the brake and stabilized for a period of time (the time is determined by parameter P166), the motor power supply is removed.

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

When the motor is running (the speed is greater than P165), the SON becomes OFF. At this time, the motor current is cut OFF, and the brake continues to be released. After a time delay, the brake is brakes. This is to decelerate the motor from the high-speed rotating state to the low-speed state, 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.



Chapter 5 Parameters

5.1 Parameter details

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

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.

P002	Index None	Motor code					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	0~8	*	

- The current motor model is only valid when Panasonic motor is used. Factory set.
- This parameter needs to be modified when replacing different types of motors. Please refer to Panasonic motor adaptation table for details.

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 speed up 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	0.10～50.00	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.

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	10.0	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	0.10～50.00	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	80	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 oscillations.

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

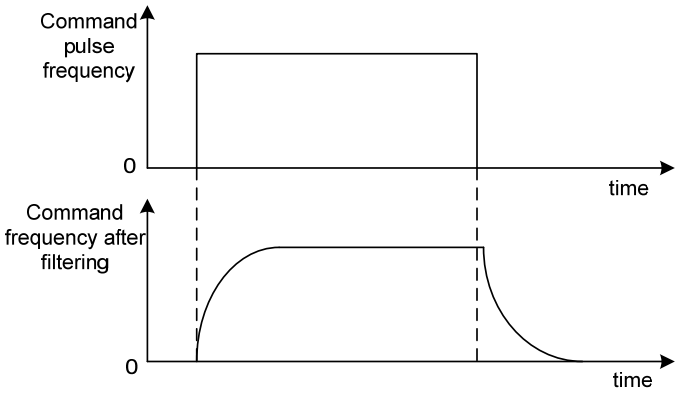
- The function of filtering the feed forward of position loop is to increase the stability of feed forward control.

P025	Index None	Speed command source					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	Yes	0～5	0	

- In speed control mode, set the source of speed command. Parameter meaning:
  0, 1, 2: Reserved
  3: JOG speed command, which needs to be set during JOG operation.
  4: Keyboard speed command, which needs to be set during keyboard speed adjustment (Sr) operation.
  5: Demonstrate speed command. When speed regulation demonstration is carried out, it needs to be set, and the speed command will change automatically.

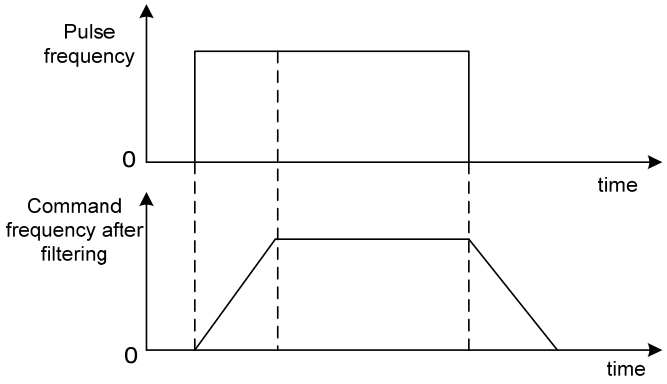
P040	Index None	Position command exponential smoothing filter time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	0	ms

- 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 linear smoothing filter 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

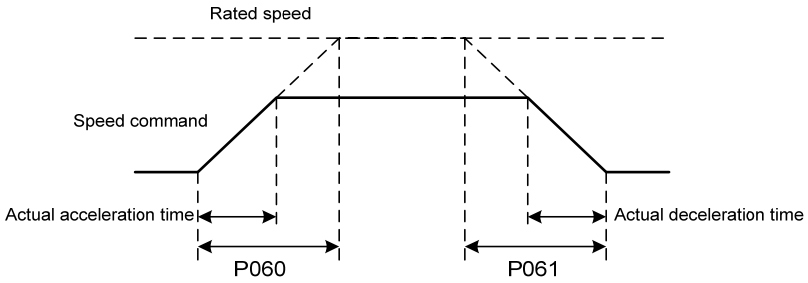
  Note: This parameter is only valid for versions V60.10-0.9.24.3 and above.

P060	Index 203Ch	Speed command acceleration time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	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 drive and host device constitute position control, this parameter should be set to 0, otherwise the performance of position control will be affected.



P061	Index 203Dh	Speed command deceleration time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	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	0.001～10.000	1.000	s

- 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.

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	0～300	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	-300～0	-300	%

- Sets 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.

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	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 Err29 and the motor stops.

P071	Index 2047h	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 Err29 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					
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 (Err 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.

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	10～750	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	10～10000	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	Encoder type					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0~31	1	

- Parameter meaning:
  0: Automatic recognition. 1: Tamagawa. 2: Panasonic. 3: Nikon.
- Note: When P088=2 (Panasonic), you need to select the motor code by P002.

P090	Index 205Ah	Absolute position encoder type (absolute only)					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	0	

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

P093	Index 205Dh	Fan alarm enable					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	1	

- Parameter meaning：
  0: Shield the fan fault alarm (except for special reasons, the customer is not recommended to shield this bit).
  1: Allow fan fault alarm.

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 module temperature is higher than this temperature, the driver cooling fan starts to work.
- When the module temperature is lower than this temperature, the driver cooling fan stops working.

P096	Index None	Initial display items					
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	Encoder signal
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	Reserved display
9	Pulse input frequency	24	Bus voltage
10	Speed command	25	Reserved display
11	Torque command	26	Module internal temperature
12	Speed command analog voltage	27	Encoder multi-turn position
13	Torque command analog voltage	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 the signal can not 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 when P304=1 and valid when P304=0.
- Parameter meaning:

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

  1: Software forced enable.

5.1.2 Parameters of section 1

P100 Index 2100h	Digital input DI1 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-37～37	4	

- Digital input DI1 function planning, parameter absolute value represents function, and symbol represents logic. Please refer to chapter 5.2 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 ~P104, that is, the function is not planned, the result is OFF (invalid). However, there are exceptions. Setting parameters P120 ~ P124 can force the input function ON (valid), regardless of whether the function is planned or not.

P101 Index 2101h	Digital input DI2 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-37～37	3	

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

P102 Index 2102h	Digital input DI3 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-37～37	23	

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

P103 Index 2103h	Digital input DI4 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-37～37	0	

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

P104	Index 2104h	Digital input DI5 function					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-37～37	0	

- Digital input DI5 function planning, refer to parameter P100 description.

P108	Index None	Digital high speed input 1 (HDI1) filtering enable					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	-	Yes	0～1	0	

- Parameter meaning:
  0: Not enabled;
  1: Enable.

P109	Index None	Digital high speed input 2 (HDI2) filtering enable					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	-	Yes	0～1	0	

- Parameter meaning:
  0: Not enabled;
  1: Enable.

P110	Index 210Ah	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 210Bh	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 210Ch	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 210Dh	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.

P114	Index 210Eh	Digital input DI5 filtering					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.1～100.0	2.0	ms

- DI5 input digital filtering time constant. Refer to the description of parameter P110.

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

- Parameter meaning:

  1~8: From low to high, the filtering ability is enhanced.

P119	Index None	Digital high speed input 2 (HDI2) filtering level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	-	Yes	1~8	4	

- Parameter meaning:

  1~8: From low to high, the filtering ability is enhanced.

P120	Index 2114h	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 5.2 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 ~ P104;

Not planned refers to the function not selected by parameters P100 ~ P104.

P121	Index 2115h	Digital input DI force 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 2116h	Digital input DI force 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 2117h	Digital input DI force 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 2118h	Digital input DI force 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.

P130 Index 211Eh	Digital output DO1 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-31～31	8	

- Digital output DO1 function planning, parameter absolute value represents function, and symbol represents logic. Please refer to chapter 5.3 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 211Fh	Digital output DO2 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-31～31	0	

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

P132 Index 2120h	Digital output DO3 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-31～31	0	

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

P133 Index 2121h	Digital output DO4 function					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	-31～31	0	

- Digital output DO4 function planning, refer to parameter P130 description.

P134	Index 2122h	Digital output DO5 function					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	-31～31	0	

- Digital output DO5 function planning, refer to parameter P130 description.

P149	Index None	Delay time of dynamic braking					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	0	ms

- Parameter meaning:
  When the dynamic braking delay time is set to 0, the dynamic braking function is invalid.

P164	Index 2140h	Emergency shutdown mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RO	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 2141h	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 2142h	Electromagnetic brake delay time when the 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 2143h	Waiting time of electromagnetic brake when the 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 2144h	Action speed of electromagnetic brake when the 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.

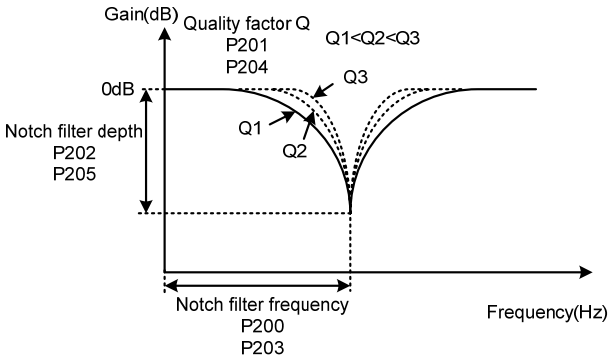
P169	Index 2145h	Delay time for electromagnetic brake opening					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1000	0	ms

- 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.

5.1.3 Parameters of section 2

P200	Index 2200h	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 2201h	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 2202h	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 2203h	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 2204h	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 2205h	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	

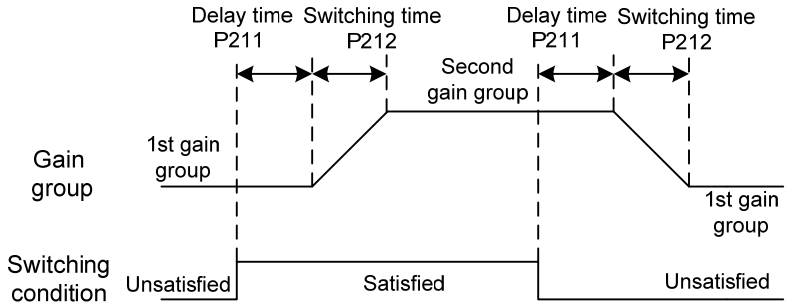
- Refer to the description of parameter P209.

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	Notch filter settings					
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 resonant 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 resonant 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.

P221	Index None	Minimum detection amplitude for low frequency suppression					
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 2216h	Compensation coefficient of 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 2217h	Vibration suppression mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～3	0	

- Parameter meaning:

  0: The 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 2218h	Manually set the vibration 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～FFFF	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).
- In the manual setting mode of frequency point (P229=1), it is necessary to find the intermediate frequency vibration point through the wave recording function of the servo host software.

P227	Index None	Compensation coefficient of IF 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 IF suppression 1					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～300	150	%

- 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).
- In the manual setting mode of frequency point (P234=1), it is necessary to find the IF vibration point through the wave recording function of the servo host software.

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

- 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 IF suppression 2					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～300	150	%

- 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

P235	Index None	Advanced control speed loop over modulation coefficient					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～1000	100	%

- It takes effect in the advanced control mode. The default value is 100%. Increasing this value can improve the convergence speed when approaching the given speed. Decreasing this value can improve the smoothness when approaching the given speed. The recommended value is 75～150. In cases where the convergence speed needs to be improved, it can generally be increased to 120.

P236	Index None	Speed feedback selection					
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	Advanced control speed loop high response mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2	0	

- The high response mode of the advanced control speed loop is used in the situation with high requirements for anti-interference, which can better respond to external disturbances, reduce the instantaneous speed fluctuation and recover the target speed as soon as possible.
  0: Advanced control speed loop high response mode is turned off
  1: Advanced control speed loop high response mode is turned on and the default gain percentage is maintained
  2: Advanced control speed loop high response mode is turned on, and the gain percentage is adjustable.

P238	Index None	Advanced control speed loop high response mode gain percentage					
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 advanced control high response mode is enabled (P237=1). It is used to adjust the gain percentage of the advanced control high response mode. Generally, it can be set to 20~80 to meet the needs. If the value is set too high, it is easy to cause mechanical vibration.

P239	Index None	Speed feed forward gain					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	%

- This parameter is used to set the gain percentage of speed feed forward.

P240	Index None	Speed feed forward filter time constant					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.00～50.00	0.00	ms

P241	Index None	Friction compensation gain					
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 damping coefficient					
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	Selection of current loop mode in advanced control mode					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	1	

- This parameter only takes effect when P247=1.

  0: Only the speed loop adopts the advanced control mode

  1: Speed loop and current loop adopt advanced control mode

P245	Index None	Advanced control nonlinear function structure					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	1	

- Parameter meaning:

  0: The type of nonlinear function in advanced control adopts structure 0

  1: The type of nonlinear function in advanced control adopts structure 1

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

- Parameter meaning:
  0: In advanced control, the source of feedback speed is the original speed
  1: In advanced control, the source of feedback speed is filtered speed

P247	Index None	Advanced control					
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 advanced control mode

P248	Index None	Advanced control speed loop bandwidth					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	100～1000	300	Hz

- Advanced control speed observer bandwidth, increase the parameter value to enhance the speed following ability and anti-interference ability. If it is too large, it is vulnerable to noise interference.

P249	Index None	Advanced control speed observer bandwidth parameter settings are valid					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	

- Parameter meaning:
  0: The bandwidth parameter setting of advanced control speed observer is invalid
  1: Advanced control speed observer bandwidth parameter settings are valid

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

- Advanced control current observer bandwidth, increasing the parameter value can enhance the current following ability and anti-interference ability, and it is easy to be interfered by noise if it is too large.

P251	Index None	Advanced control 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: Advanced control current observer bandwidth parameter setting is invalid
  1: Advanced control current observer bandwidth parameter setting is valid

P252 Index None	Advanced control 1st torque filter time constant					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	5～5000	10	0.01ms

- 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 5~15. If it exceeds this range, it will easily cause system oscillation.

P253 Index None	Advanced control nonlinear function 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: Non linear type 1
  2: Non linear type 2
  3: Non linear type 3
  4: Non linear type 4
  5: Non linear type 5

P254 Index None	Advanced control nonlinear function gain multiple					
Sub Index	Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0	INT16	RW	Yes	0～100	15	0.1

- Advanced control nonlinear function gain multiple, the higher the parameter 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.

P257	Index None	Reserved					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～500	0	

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

P259	Index None	Reserved					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～1000	80	

P260	Index None	Gravity compensation					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	%

- Compensating torque for vertical axis load.

P261	Index None	Positive direction static friction peak value					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	%

- Positive direction position command when compensating friction peak value.

P262	Index None	Reverse direction static friction peak value					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	%

- Reverse direction position command when compensating friction peak value.

P263	Index None	Positive direction static friction low value					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	%

- Positive direction position command when compensating friction low value.

P264	Index None	Reverse direction static friction low value					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	%

- Reverse direction position command when compensating friction low value.

P265	Index None	Rated sliding friction					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	%

- In position mode running, it corresponds to the compensated sliding friction at rated speed.

P266	Index None	Static friction speed switching point					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	2.0	rpm

- Speed switching threshold for static friction compensation to take effect.

P267	Index None	Sliding friction speed switching point					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0.0～100.0	0.0	rpm

- Speed switching threshold at which sliding friction compensation take effect.

P268	Index None	Reserved					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1000～32000	15000	s

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

- Set the inertia presumption 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 proportional control					
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 ring feed forward effect, too much noise may be caused.

P274	Index None	Model tracking reverse direction proportional control					
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 feed forward					
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 velocity 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 for 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 for ms.

P283	Index None	Speed loop integral separation function integral term limit percentage					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～100	0	%

- P284=1 takes effect.

P284	Index None	Speed loop integral separation function enable					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～1	0	%

P285	Index None	Vibration alarm time					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～100	6	s

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

P286	Index None	Vibration detection					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2000	80	Hz

P287	Index None	Vibration detection low pass filter					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～2000	50	Hz

P288	Index None	Vibration detection high pass filter					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	10～2000	100	Hz

P289	Index None	Vibration detection level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	0～2000	30	Hz

P295	Index None	Vibration level					
Sub Index		Data Type	Access	PDO Mapping	Setting Range	Initial Value	Unit
0		INT16	RW	Yes	1～200	100	rpm

5.1.4 Parameters of section 3

P300	Site alias	Range	Default value	Unit	Usage
		0～128	0		ALL

- 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 the EtherCAT site depends on the EtherCAT master. When sequential addressing is used, the station number of the slave station is assigned by the EtherCAT master station in sequence, and this site alias setting is invalid. When addressing is set, 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. In the same network, each driver needs to be set to a different site alias.

P304	EtherCAT mode switch	Range	Default value	Unit	Usage
		0～1	1		ALL

- Select EtherCAT mode or normal mode through this parameter, and select normal mode when the value is 0. The user can test the machine in this mode to detect hardware problems; when the value is 1, select the EtherCAT mode, and cooperate with the EtherCAT master station to perform corresponding operations in this mode.
- Parameter meaning:
  0: Normal mode;
  1: EtherCAT mode.

P306	CSP mode spline type	Range	Default value	Unit	Usage
		0～3	2		ALL

- 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.

5.2 DI function detail

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 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>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">Ignoring 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.
23	HOME SWITCH	Homing reference point	Homing external reference point

5.3 DO function detail

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		

Chapter 6 Communication function

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.

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 by 2601h, 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 by 2602h.

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. 2600h Err Code

Err Code, driver error code. When the servo driver has an error alarm, the driver error code can be read by this object (except ERR60).

ERR60 indicates that the communication between the servo driver and the EtherCAT host (in OP mode) fails. After the communication between the servo driver and the EtherCAT host is successful, ERR60 will automatically clear.

11. 2601h Absolute Position

Absolute Position is the absolute position of the encoder in a single turn. The type is 32 bits, the encoder position is unified into 32 bits, and the low bit is filled with zero. Example:

17 bit absolute encoder. The data range is 0x0000 0000H~0xffff 8000H.

20 bit absolute encoder. The data range is 0x0000 0000H～0xffff f000H.

23 bit absolute encoder. The data range is 0x0000 0000H～0xffff fe00H.

12. 2602h Multi Turn

Multi Turn is the encoder multi turn information. It is only valid for the multi turn absolute encoder. The multi turn display range is 0x0000H~0xffffH.

13. 2603h First Z Event

First Z Event is only valid when the incremental encoder is adapted. The value of z signal is changed to 1 after it appears. At this time, the Absolute Position is corrected to the true value.

14. 2604h Vibration Period: Parameter is not used and is reserved.

15. 2605h DC Bus Voltage: Servo driver DC bus voltage, unit: V.

16. 2606h Power Module Internal Temperature

Module Internal Temperature, unit: ℃.

17. 2670h Accumulative Load Rate: Accumulative Load Rate, unit: %.

18. 2671h Regenerative Load Rate

Regenerative Load Rate, unit: %.

19. 2680h Sub Index 1：Pos Loop Command

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

20. 2680h Sub Index 2：Pos Loop Feedback

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

21. 2680h Sub Index 3：Pos Loop Error

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

22. 2681h Sub Index 1：Velocity Loop Motor Speed

Servo velocity loop motor speed, unit: rpm.

23. 2682h Sub Index 1：Torque Loop Motor Actual Torque

Servo torque loop motor actual torque, unit: %.

24. 2682h Sub Index 2：Torque Loop Motor Actual Peak Torque

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

25. 2682h Sub Index 3：Torque Loop Motor Actual Current

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

26. 2682h Sub Index 4：Torque Loop Motor Actual Peak Current

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

27. 26A0h Para Motor Current RMS Rate

Motor rated current, unit: 0.1A.

28. 26A1h Para Motor Torque rate

Motor rated torque, unit: 0.1Nm.

29. 26A2h Para Motor Speed Rate

Motor rated speed, unit: rpm.

30. 27FEh Operation Command

Internal operation command, reserved.

31. 27FFh Operation Status

Internal operation status, reserved.

6.2 EtherCAT communication

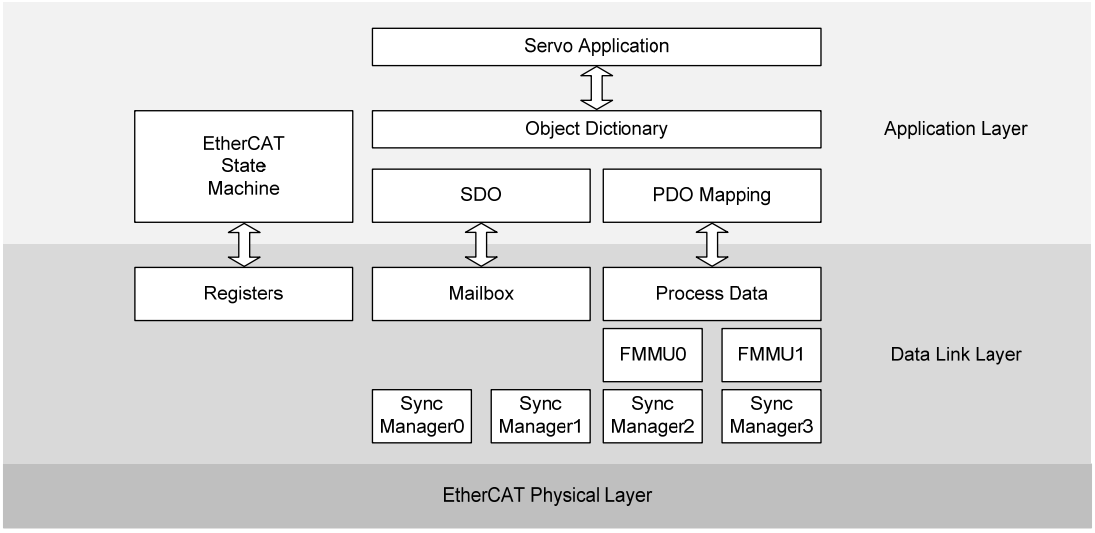
EtherCAT is the abbreviation of Ethernet for Control Automation Technology. It is a communication mode between master and slave computers using Real-Time Ethernet developed by BECKHOFF, Germany. It is managed by the ETG (EtherCAT Technology Group).

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

EtherCAT uses the Ethernet framework based on IEEE802.3.

Similarly, if the Ethernet of 100BASE-TX is used as the base, the maximum cable length is 100m, and the maximum number of slave servers that can be received is 65535, so the network can be formed indefinitely. When Ethernet Switch is used alone, it can also receive TCP/IP.

6.2.1 Construction of CANopen over EtherCAT

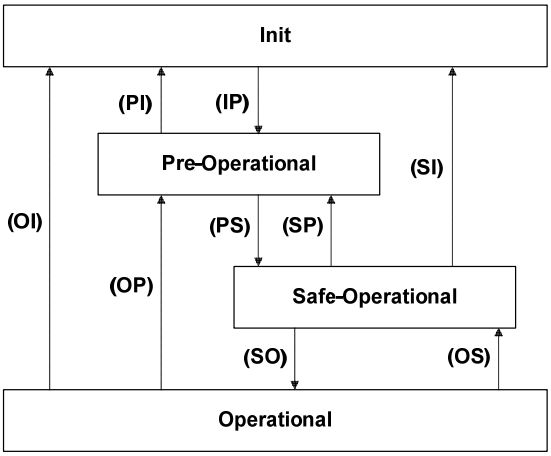


The drive adopts the shape of the CiA 402 drive. The Object Dictionary of the application layer includes the application data and process data interface, as well as the PDO mapping information between application data.

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.

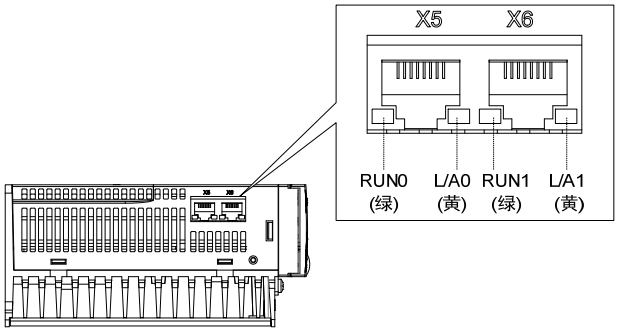
6.2.2 EtherCAT state machine



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.

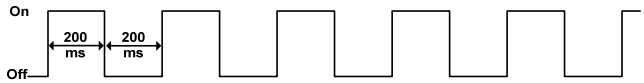
6.2.3 Status LED

The status LED of the EP3E drive is located on the X5 (IN) and X6 (OUT) sockets, as shown in the following figure.



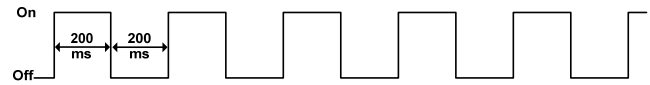
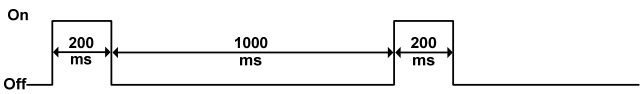
1. L/A0，L/A1（Link Activity）LED（YELLOW LED）

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.

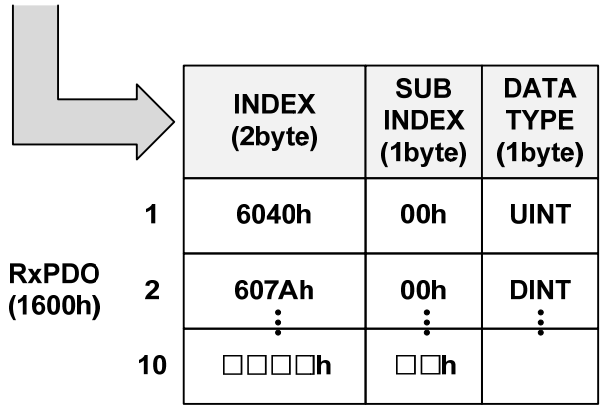
6.2.4 Data Type

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

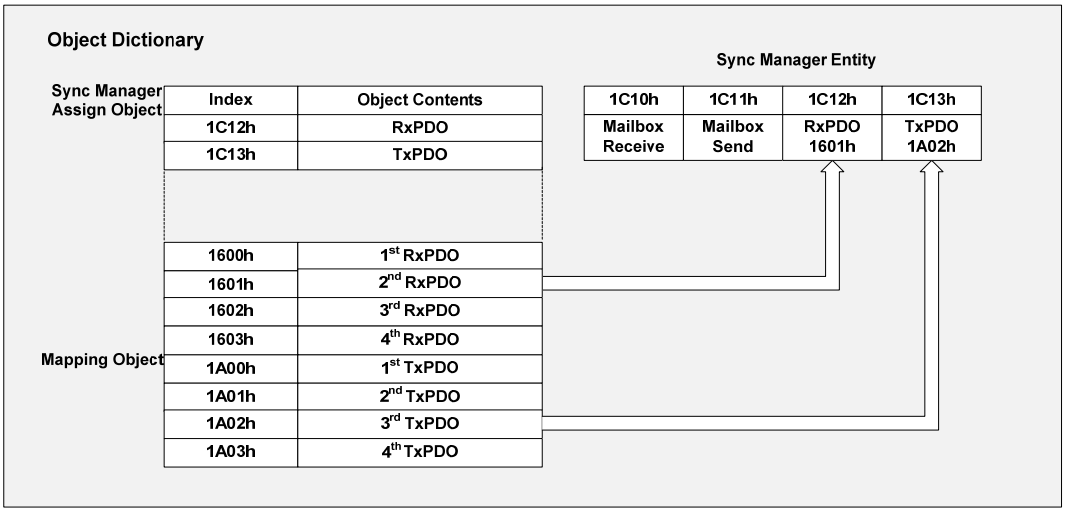


ndex	**Sub-**Index	**Name**	**Data Type**
6041h	-	StatusWord	UINT
6064h	-	Position Actual Value	DINT
606Ch	-	Velocity Actual Value	DINT

		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)	Velocity 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)

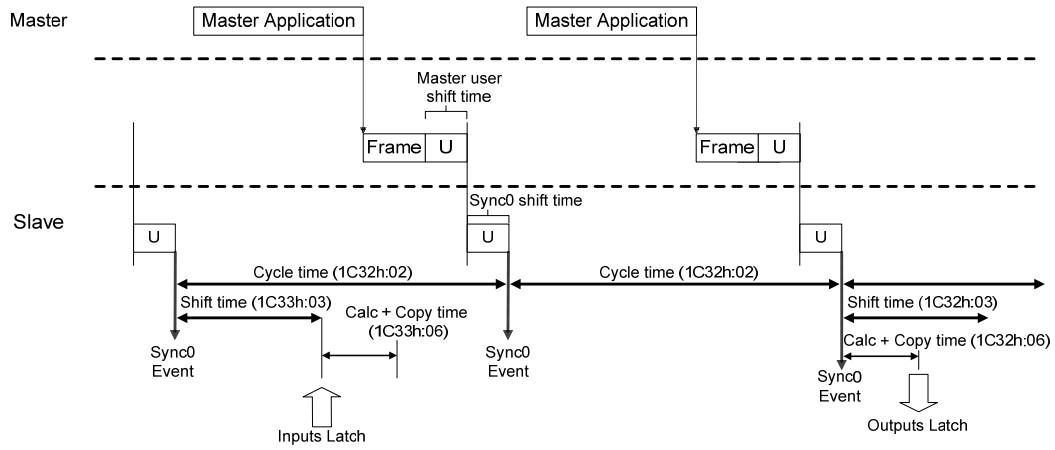
TxPDO (1A03h)	Status Word (6041h)	Position Actual Value (6064h)	Torque Actual Value (6077h)

6.2.6 According to the synchronization of DC (Distributed Clock)

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

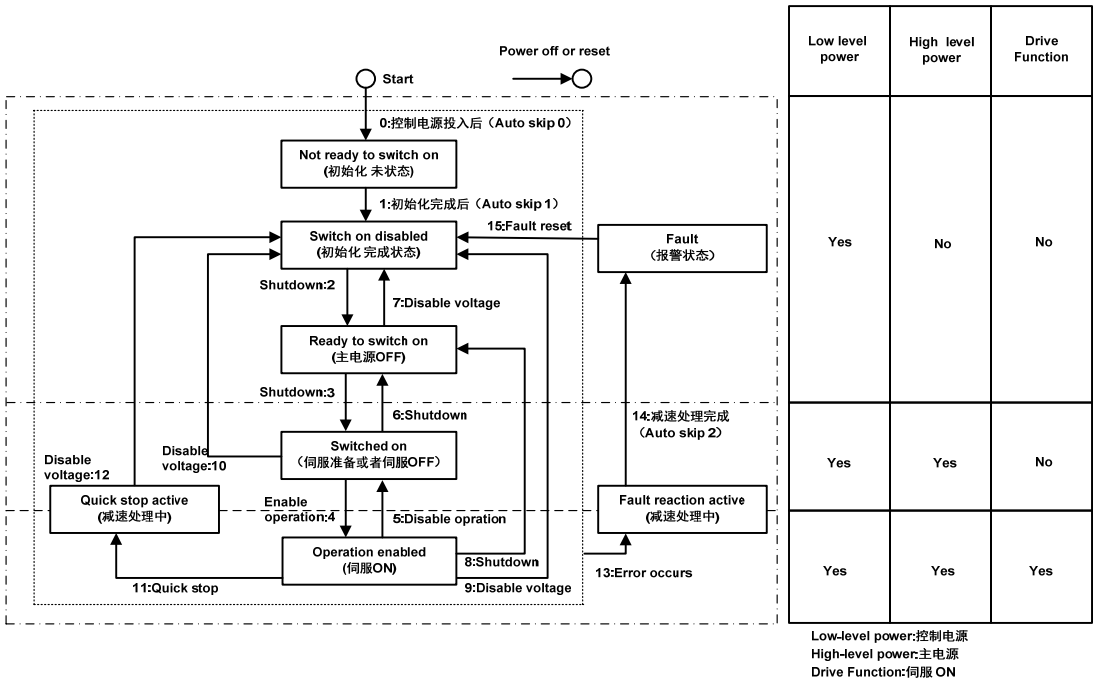
There are the following synchronization modes, which can be changed through Sync Control registration.

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



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*1
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	1237h
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	PDS 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): changes to 1 when the ESM state transitions above PreOP.

6.4 Operating mode

EP3E 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 target

Index	Sub-Index	Name/ Description	Units	Range	Data Type	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		

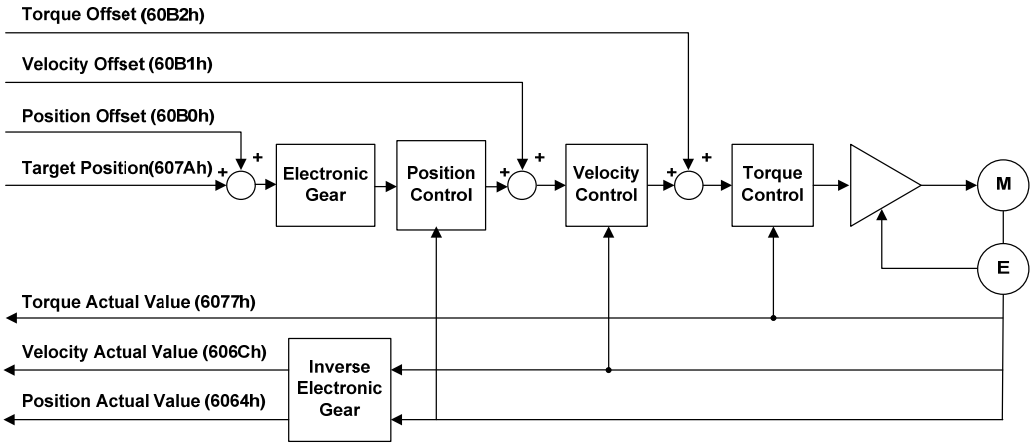
2. Note when switching control mode

- 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.
- When 6060h=0 and 6061h=0, if the PDS state is changed 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 that receives target position (607Ah) operation through periodic PDO updates of the master server. In this mode, the torque offset (60B2h) and velocity offset (60B1h) can be operated additionally.

1. Structural drawing



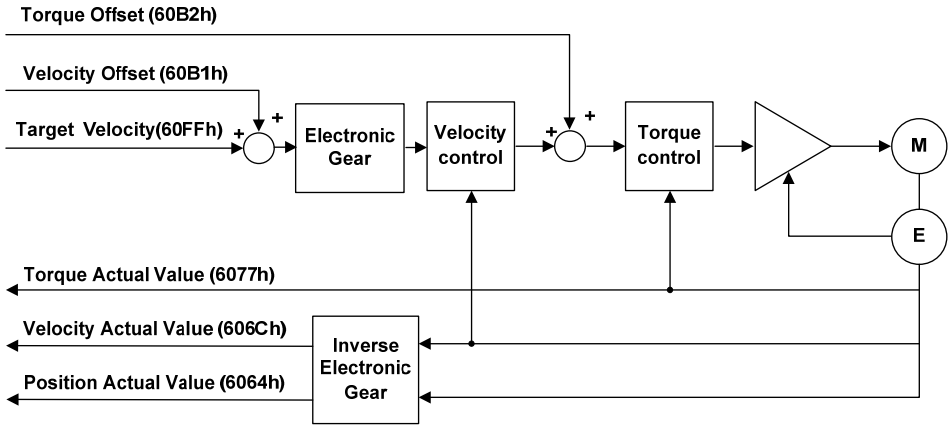
2. Associate target

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

6.4.2 Cyclic synchronous velocity mode

In Cyclic Synchronous Velocity Mode, the master server specifies target velocity (60FFh) to the drive to limit the speed. In this mode, the master server can append torque offset (60B2h).

1. Structural drawing



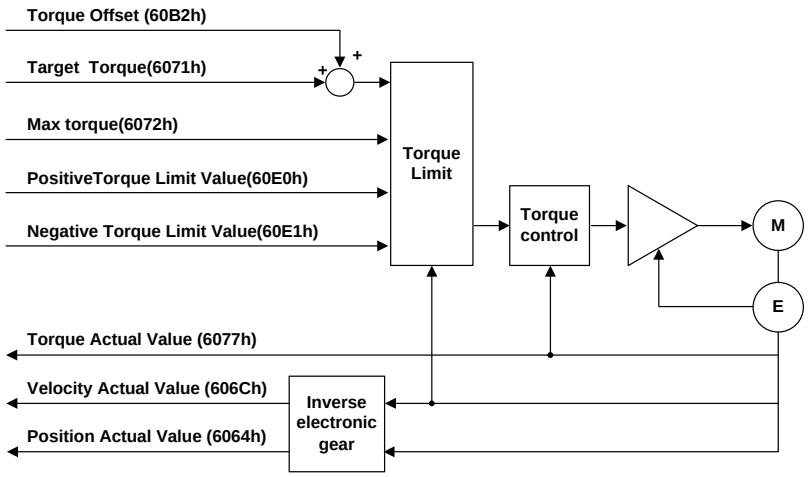
2. Associate target

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

6.4.3 Cyclic synchronous torque mode

In the Cyclic Synchronous Torque Mode, the master server specifies a target torque (6071h) to the drive to control the torque.

1. Structural drawing



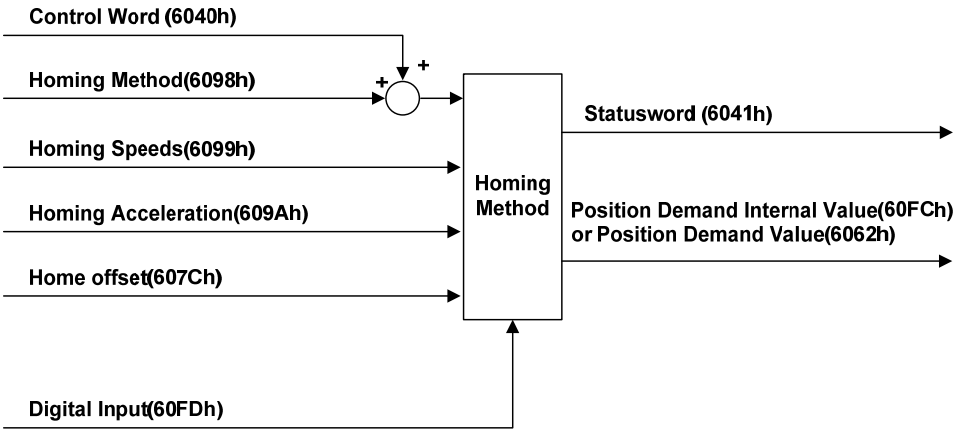
2. Associate target

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	Vel Units
6064h	-	Position Actual Value	DINT	RO	Yes	Pos Units
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 homing method specifies the action speed, and generates the position command inside the servo driver to execute the position control mode of homing action. If it is used in the incremental mode, it is necessary to perform the homing action before performing the position positioning after the power is put into operation.

1. Structural drawing



2. Associate target

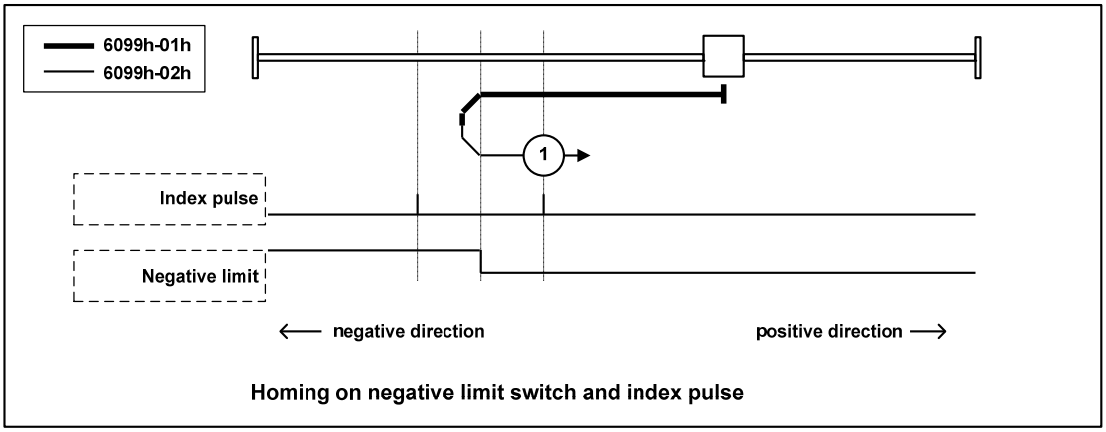
Index	Sub-Index	Name	Data Type	Access	PDO Mapping	Units
6040h	00h	Control word	UNIT	RW	Yes	-
6041h	00h	Status word	UINT	RO	Yes	-
607Ch	00h-	Home offset	DINT	RW	No	Pos Units
6098h	00h-	Homing method	SINT	RW	Yes	-
6099h	-	Homing speed	-	-	-	-
	00h	Number of entries	USINT	RO	No	-

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	Pos Units
	02h	Max position limit	DINT	RW	No	Pos Units
609Ah	-	Homing Acceleration	UDINT	RW	Yes	Acc Units
200Dh	-	Function Select Switch	UINT	RW	No	-
200Eh	-	Position Scale Numerator	INT	RW	No	-
200Fh	-	Position Scale Denominator	INT	RW	No	-

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

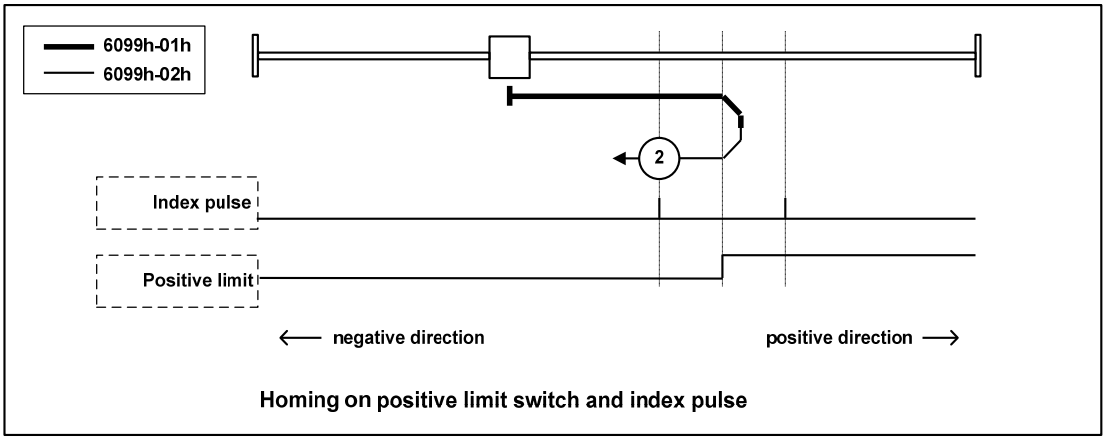
- This method is that if the negative limit switch is not activated, the initial action direction is negative detection. (The figure shows the inactive state under the low level state)
- The home detection position is the initial index pulse detection position in the positive direction after the negative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



Homing on negative limit switch and index pulse

Method 2

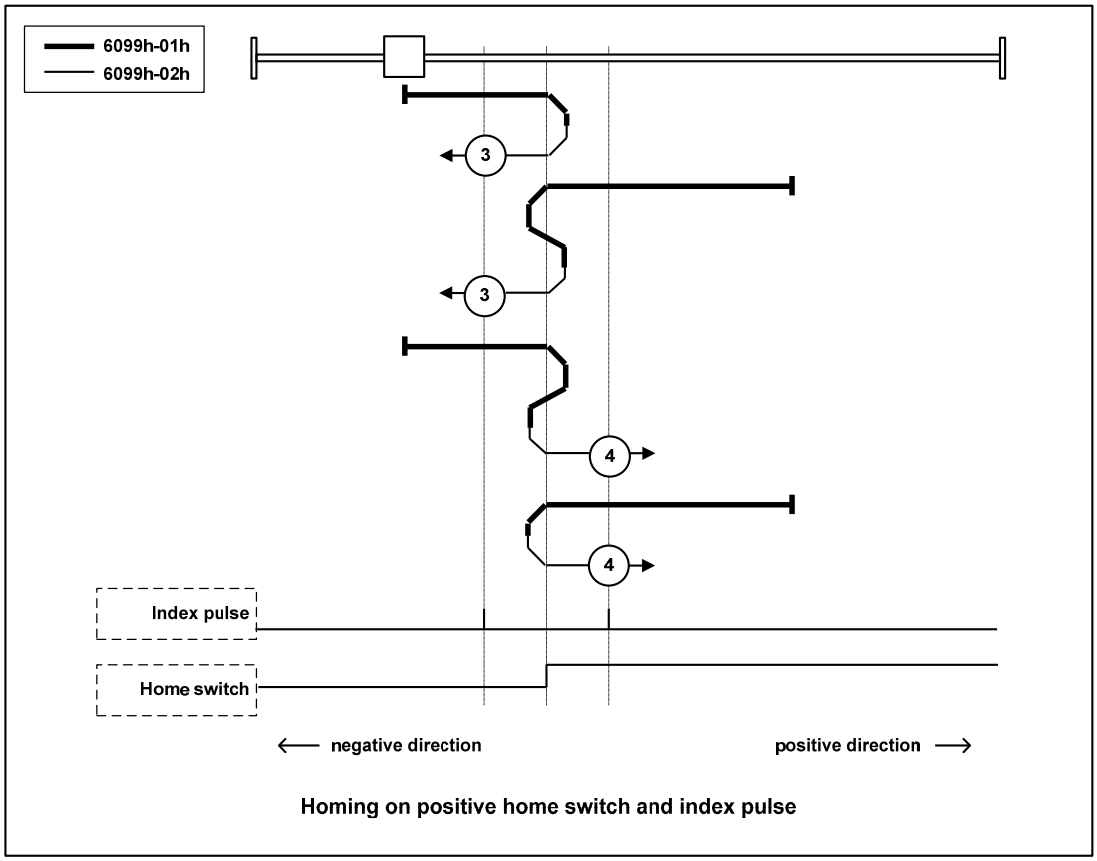
- This method is that if the positive limit switch is not activated, the initial action direction is the positive direction. (The figure shows the inactive state under the low level state)
- The home detection position is the initial index pulse detection position in the negative direction after the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



Homing on positive limit switch and index pulse

Method 3，4

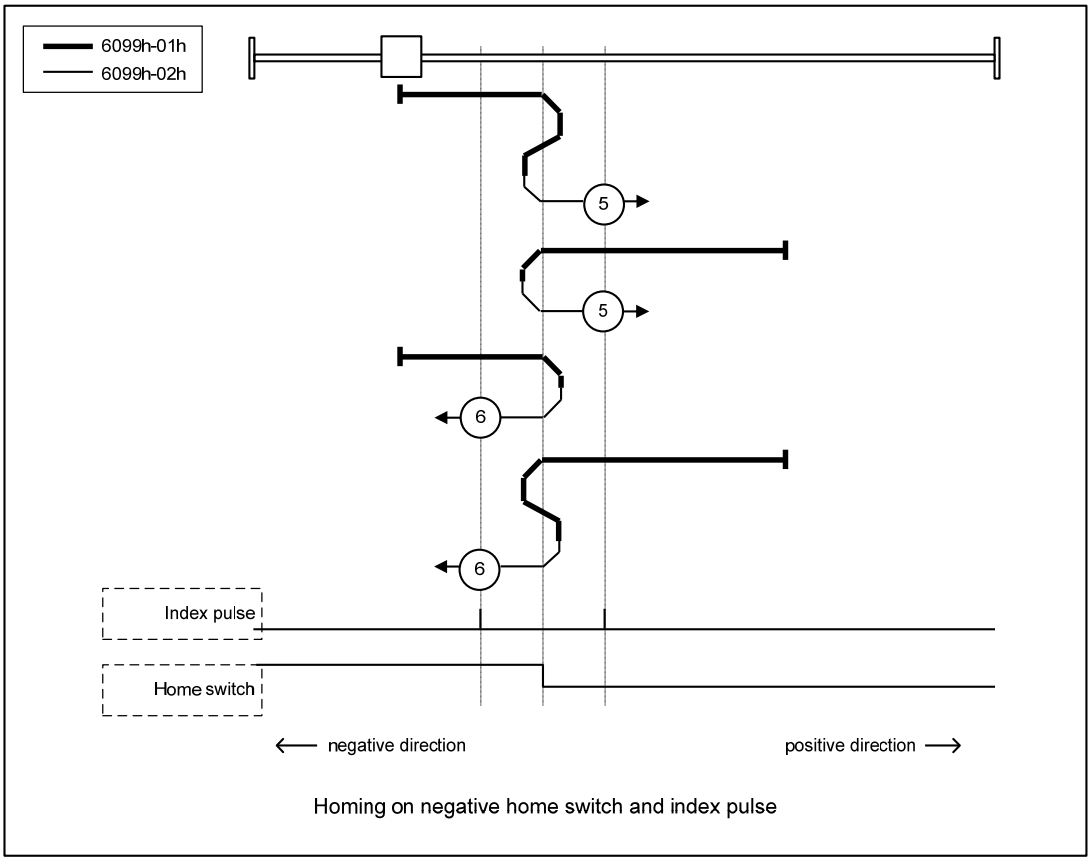
- This method is to initialize the action direction change based on the state of the home switch at startup.
- The home detection position is the negative direction side after the state of the home switch changes, or the initial index pulse detection position on the negative direction side. (Please refer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



Homing on positive home switch and index pulse

Method 5，6

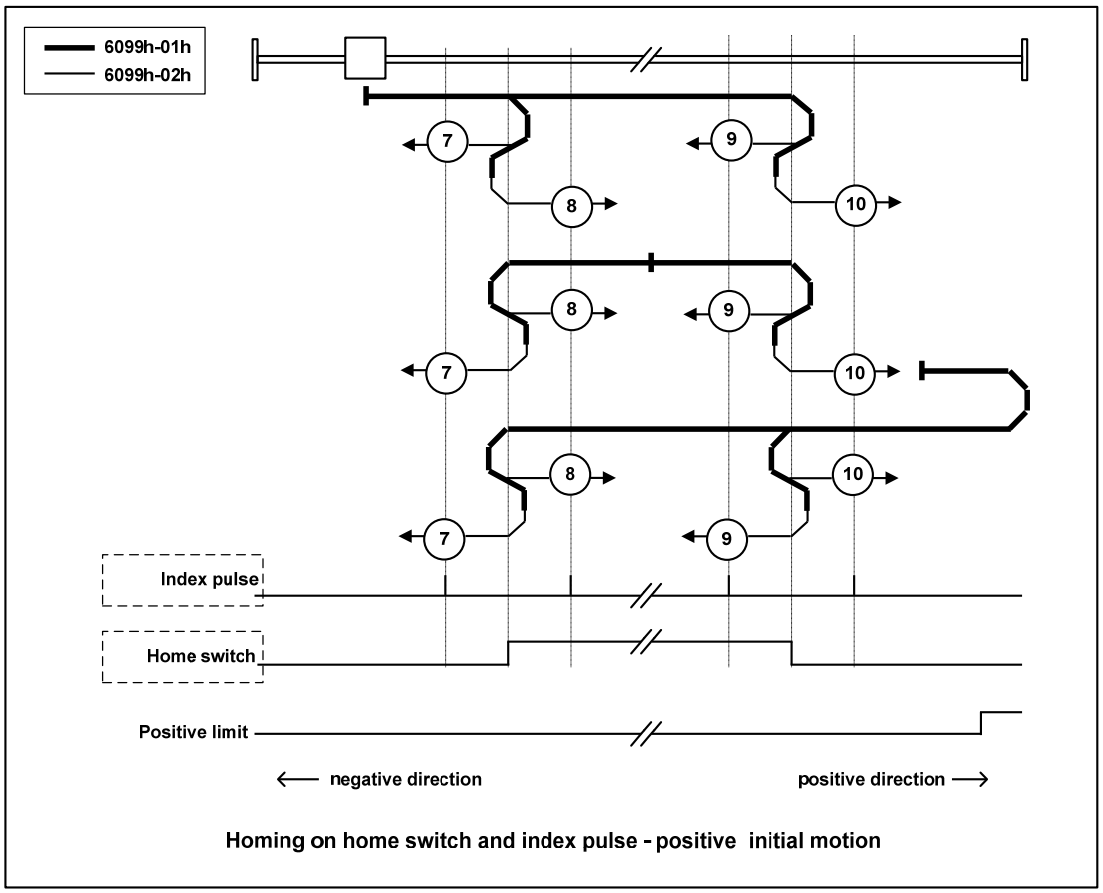
- This method is to initialize the action direction change based on the state of the home switch at startup.
- The home detection position is the initial index pulse detection position on the negative direction side or the positive direction side after the state of the home switch changes. (Please refer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



Homing on negative home switch and index pulse

Method 7，8，9，10

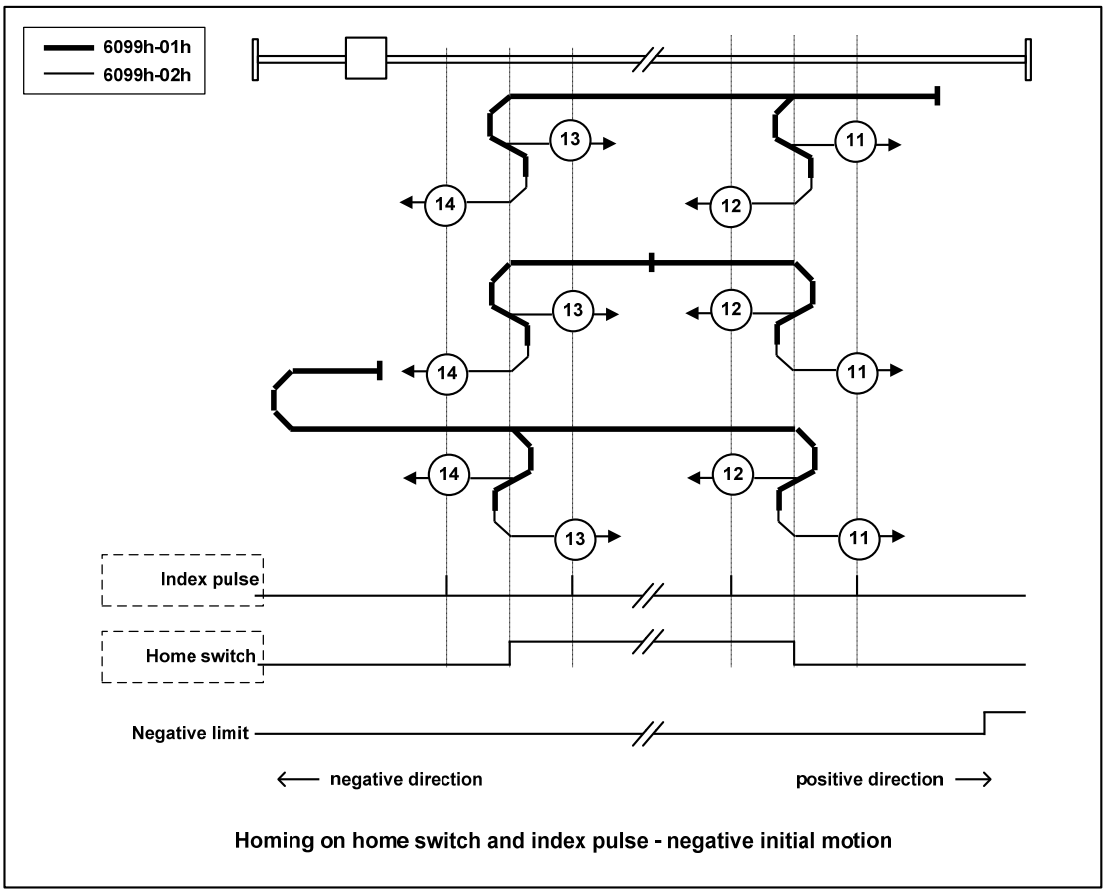
- This method is to use the home switch and index pulse.
- The initial action direction of methods 7 and 8 is the home switch. If it has been activated at the beginning of the action, it is a negative direction.
- The initialization action direction of methods 9 and 10 is the home switch. If it has been 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

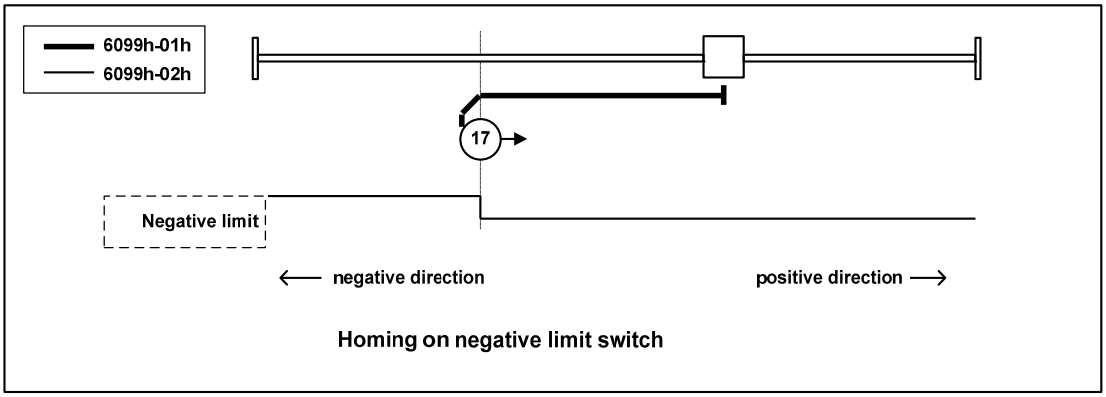
- This method is to use the home switch and index pulse.
- The initialization action direction of methods 11 and 12 is the home switch. If it has been activated at the beginning of the action, it is the positive direction.
- The initialization action direction of methods 13 and 14 is the home switch. 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

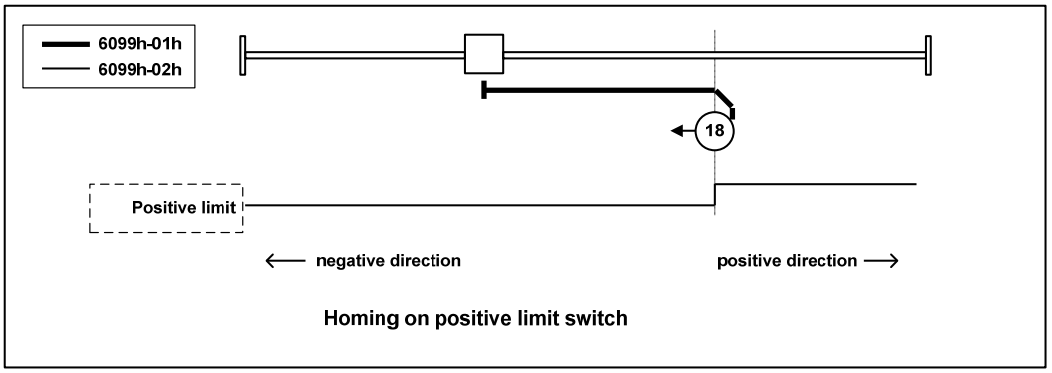
- This method is similar to method 1. The difference is that the home detection position is not the index pulse, but the position where the limit switch changes. (Please refer to the following figure)



Homing on negative limit switch

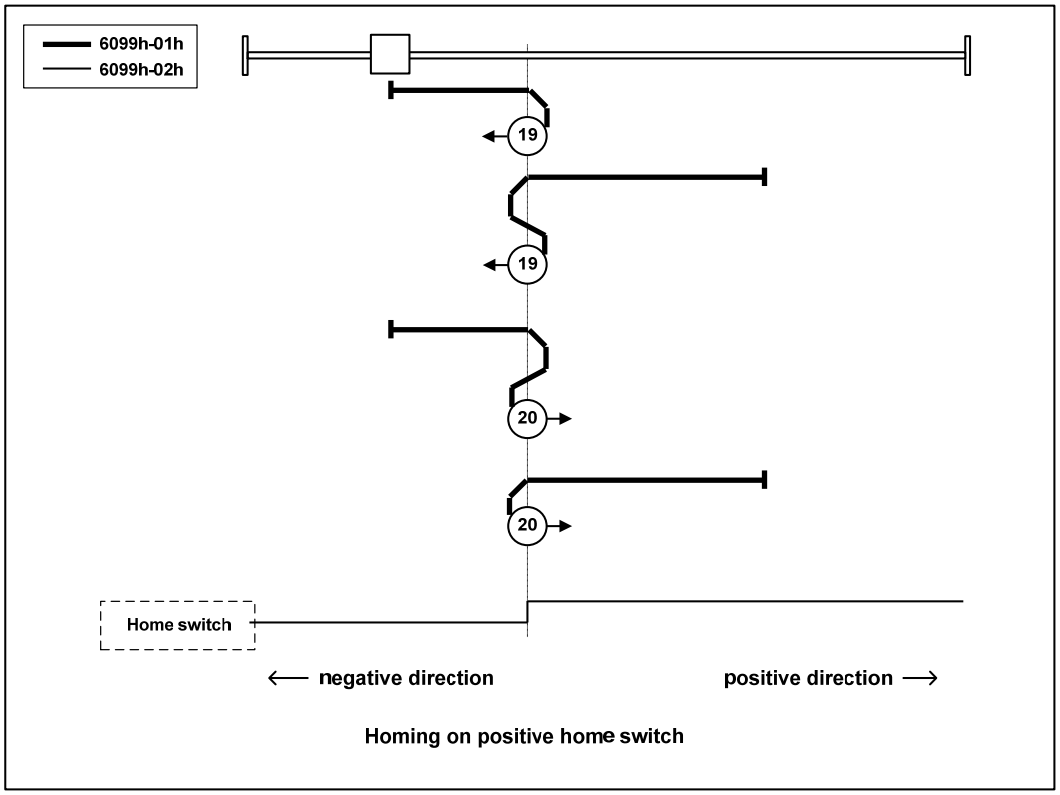
Method 18

- 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)



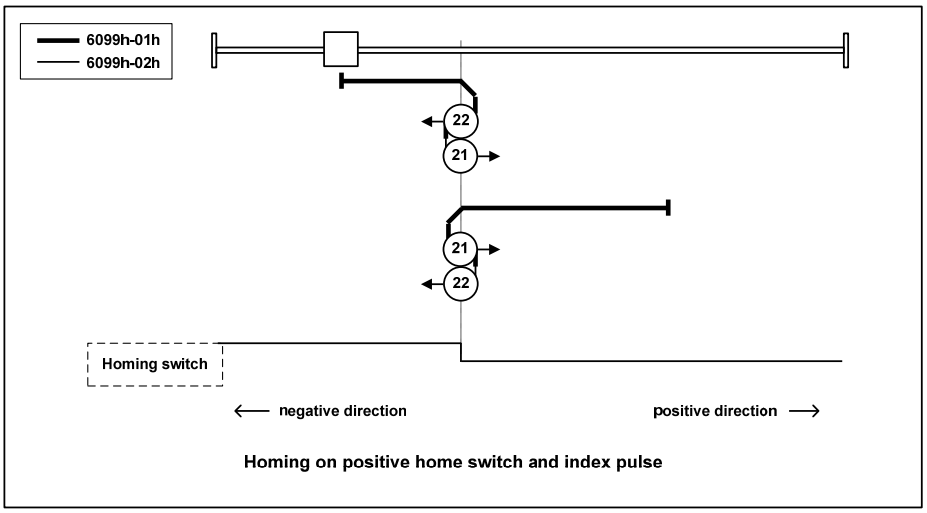
Method 19，20

- 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)



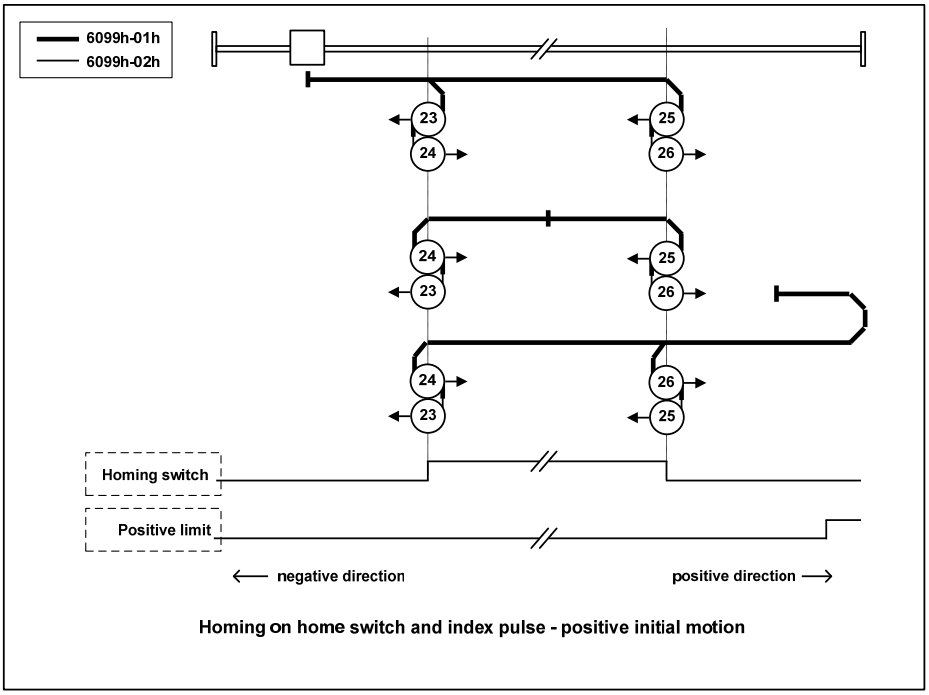
Method 21，22

- 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)



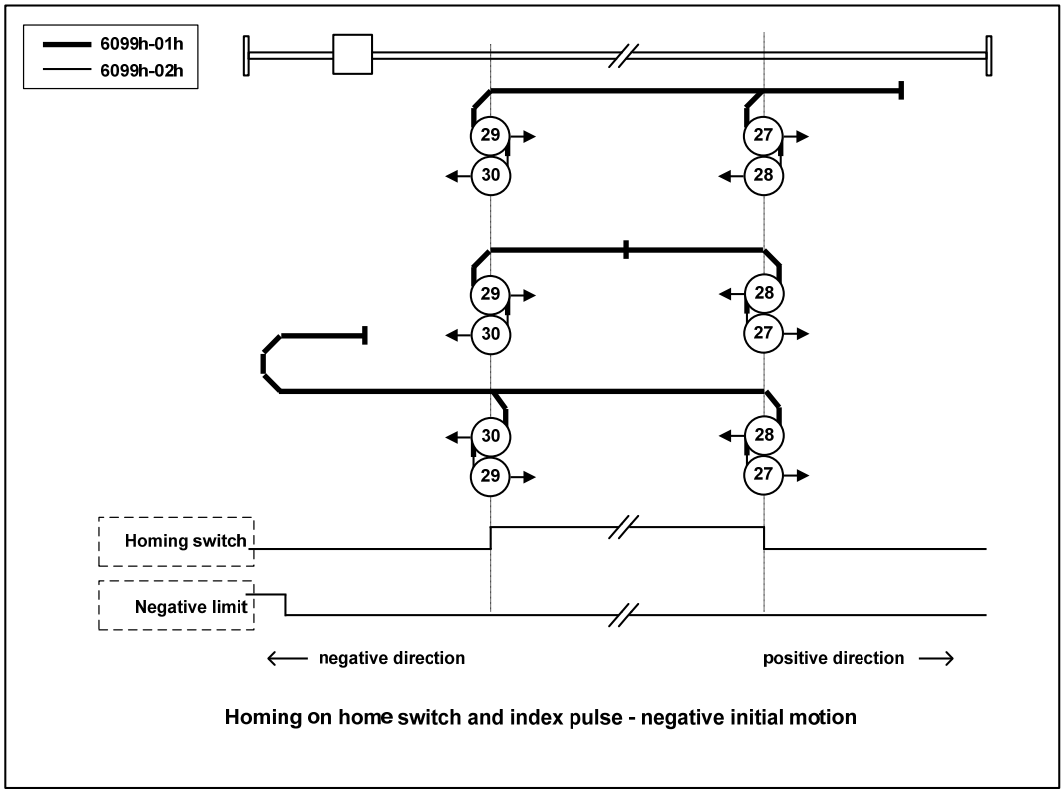
Method 23，24，25，26

- 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)



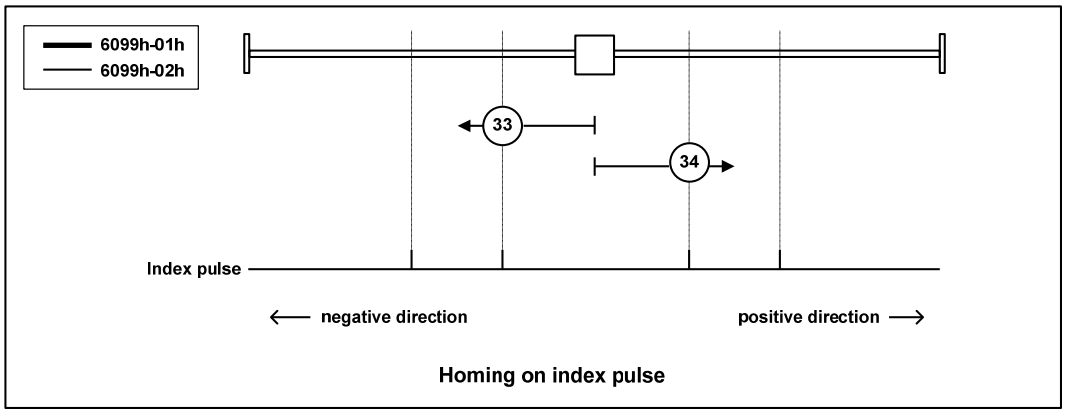
Method 27，28，29，30

- 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)



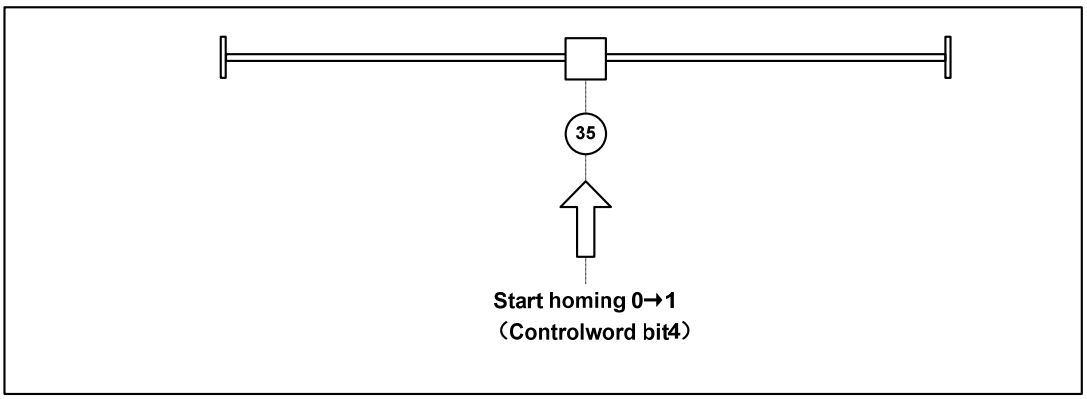
Method 33，34

- 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 PDS status is not the operation enabling status, but can also be executed.



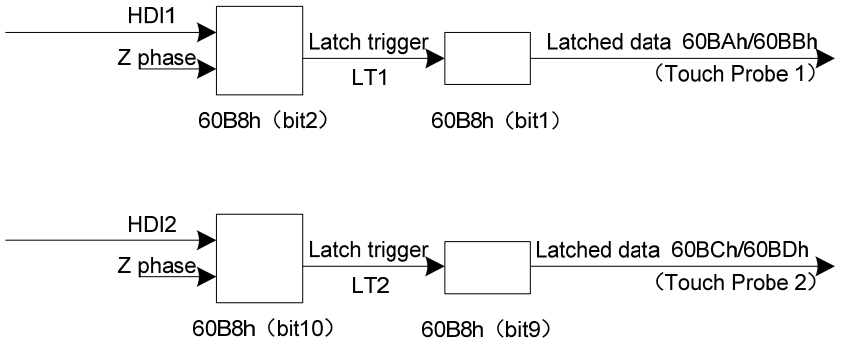
6.5 Common functions of modes

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.
- When the ESM status is Init and the ESM is 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	

bit	value	Note	
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

bit	value	Note	
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 acquired 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

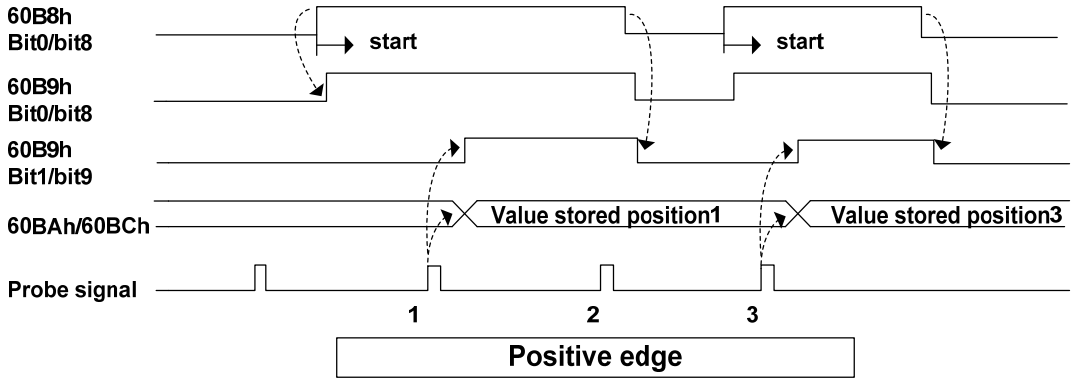
60B8h (Touch Probe Function) bit0/bit8 (Touch Probe execute/stop) changes from "0

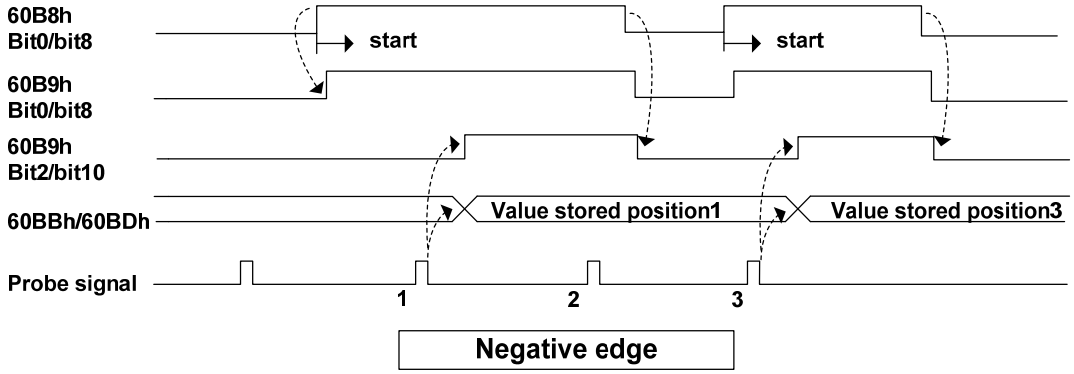
(stop) → 1 (start)" to obtain various setting conditions (60B8h: bit1~7/bit9~15) and start the Touch Probe action. The changes of various setting conditions are valid. Please return to "0 (stop)" once for bit0/bit8, and then go to "1 (start)" again.

"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)

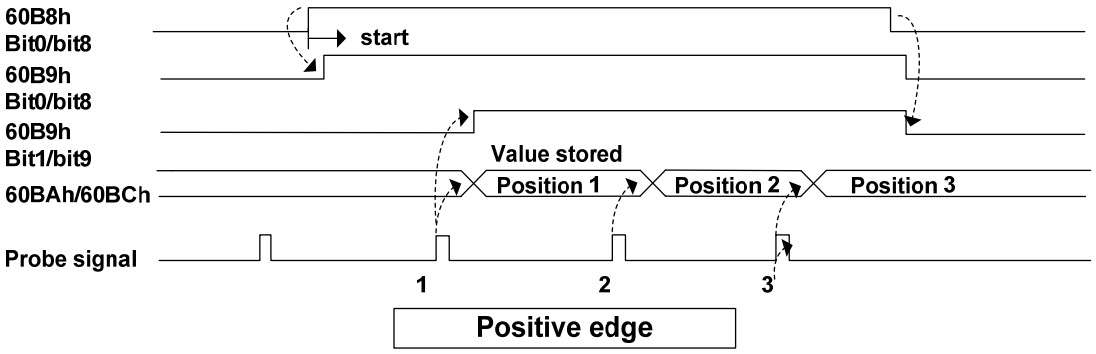
After starting, the mode is embedded only under the first trigger signal. In order to get it again, it is necessary to start the Touch Probe again.

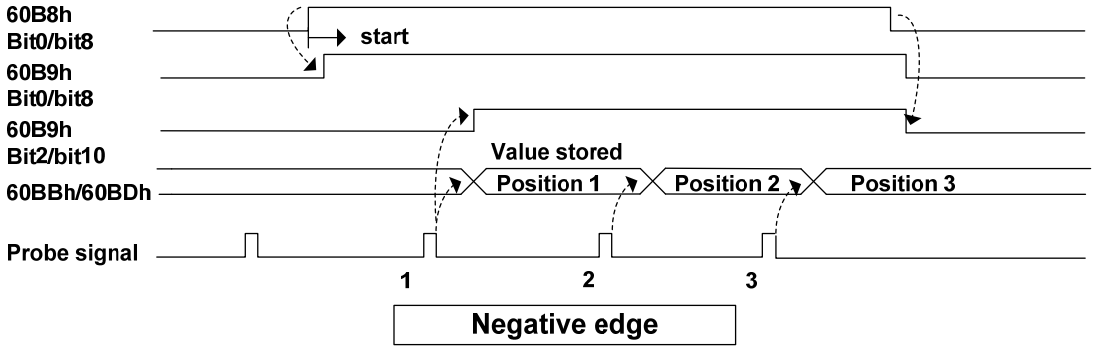




- Continuous mode (60B8H: bit1=1 / bit9=1)

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


60B8h
Bit0/bit8
start
60B9h
Bit0/bit8
60B9h
Bit1/bit9
Value stored
60BAh/60BCh
Position 1
Position 2
Position 3
Probe signal
1
2
3
Positive edge


60B8h
Bit0/bit8
start
60B9h
Bit0/bit8
60B9h
Bit2/bit10
Value stored
60BBh/60BDh
Position 1
Position 2
Position 3
Probe signal
1
2
3
Negative edge

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	User unit 0.1%/s	0~ 4294967295	U32	RW	Rx-PDO	tq/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	Acc ess	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 Inputs	-	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="8">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（Positon 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. EP3E 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 CoE (CiA402).

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

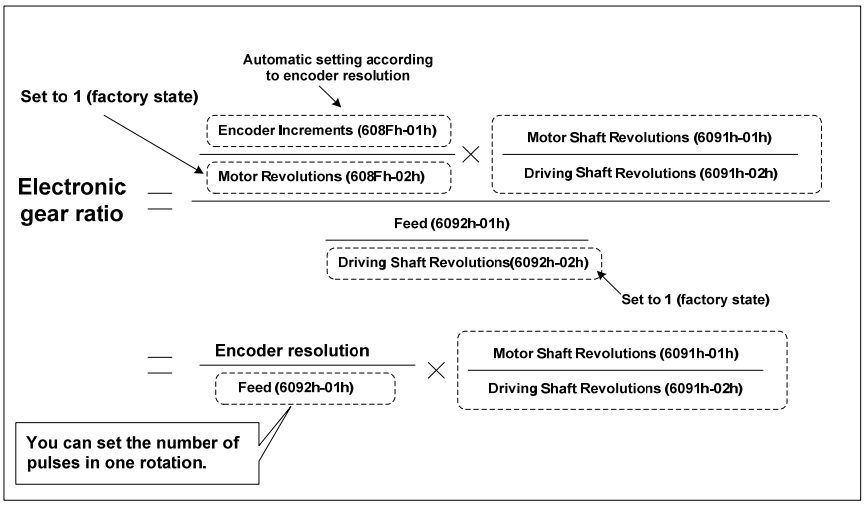
$$\text{Electronic gear ratio} = \frac{\text{Position Encoder Resolution} \times \text{Gear Ratio}}{\text{Feed Constant}}$$

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

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.

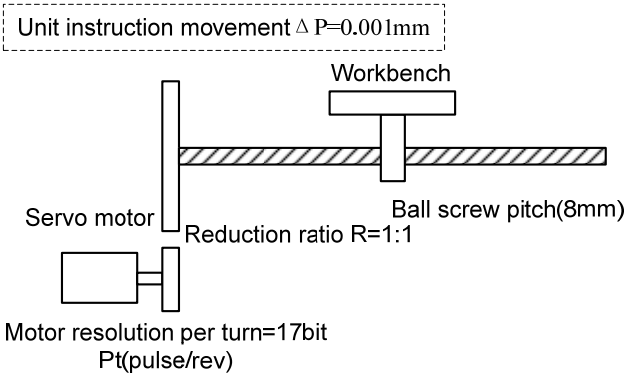
- The setting of electronic gear ratio takes effect at the moment when Init is converted to PreOP.
- Please set the value of electronic gear ratio within the range of -2^{31}（-2147483648）～ $+2^{31}-1$（2147483647）. If it exceeds the range, an exception will occur.

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)
- The instruction unit is 0.001mm
- Number of instruction pulses for one turn of the load shaft

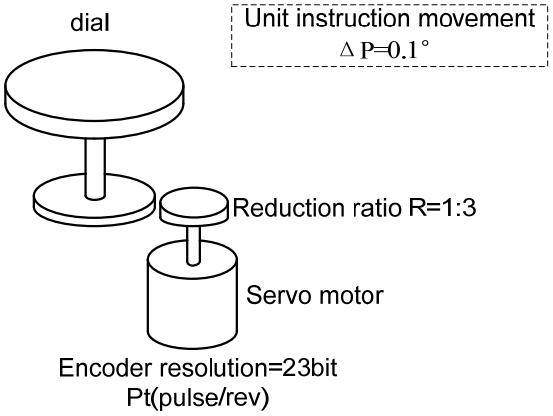
$$Feed\ (6092\,h-01h)=\frac{Pitch}{\Delta P}=\frac{8mm}{0.001\,mm}=8000$$

- Calculate the electronic gear ratio

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

- 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)
- The instruction ΔP unit is 0.1°
- Calculate the number of instruction pulses at one turn of the load axis

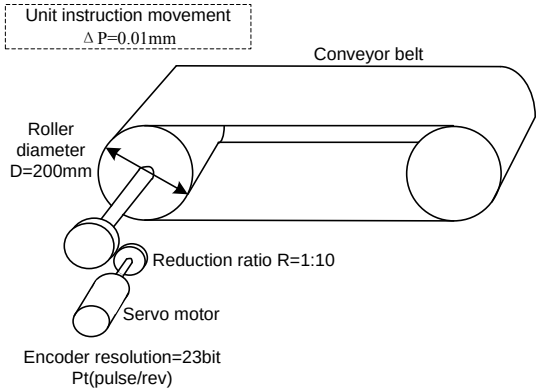
$$Feed\ (6092h-01h)=\frac{360°}{\Delta P}=\frac{360°}{0.1°}=3600$$

- Calculate the electronic gear ratio

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

- 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)
- The instruction unit ΔP is 0.01mm
- Number of instruction pulses for one turn of the load shaft

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

- Calculate the electronic gear ratio

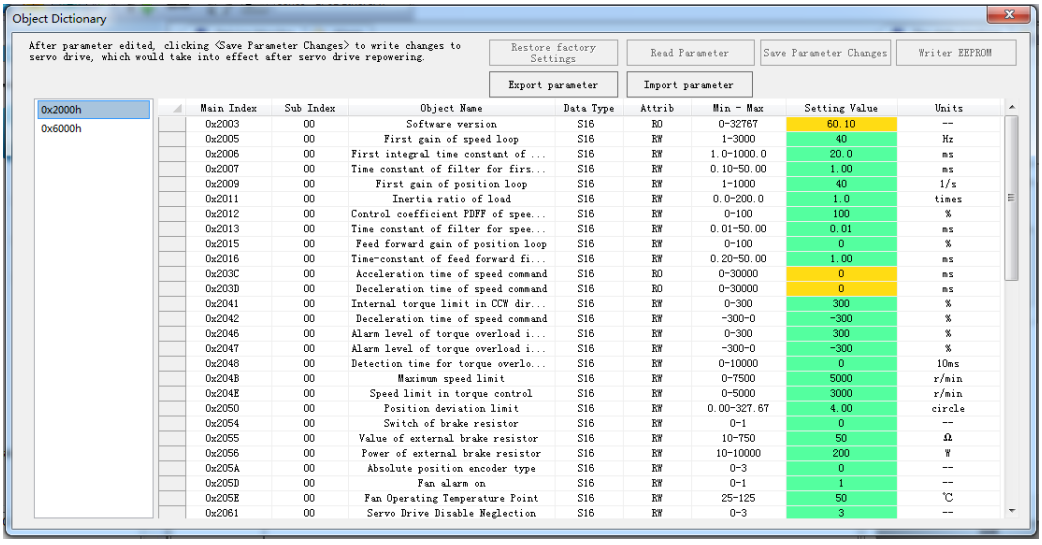
$$\text{Electronic gear ratio}=\frac{\text{Encoder resolution}}{Feed(6092h-01h)}\times\frac{Motor\ \text{Shaft Revolutions}(6091\text{h - }01\text{h})}{Driving\ \text{Shaft Revolutions}(6091\text{h - }02\text{h})}$$

$$=\frac{8388608}{62800}\times\frac{10}{1}$$

- 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.



Main Index	Sub Index	Object Name	Data Type	Attrib	Min - Max	Setting Value	Units
0x2003	00	Software version	S16	RO	0-32767	60.10	--
0x2005	00	First gain of speed loop	S16	RW	1-3000	40	Hz
0x2006	00	First integral time constant of ...	S16	RW	1.0-1000.0	20.0	ms
0x2007	00	Time constant of filter for firs...	S16	RW	0.10-50.00	1.00	ms
0x2009	00	First gain of position loop	S16	RW	1-1000	40	1/s
0x2011	00	Inertia ratio of load	S16	RW	0.0-200.0	1.0	times
0x2012	00	Control coefficient PDFF of spee...	S16	RW	0-100	100	%
0x2013	00	Time constant of filter for spee...	S16	RW	0.01-50.00	0.01	ms
0x2015	00	Feed forward gain of position loop	S16	RW	0-100	0	%
0x2016	00	Time-constant of feed forward fi...	S16	RW	0.20-50.00	1.00	ms
0x203C	00	Acceleration time of speed command	S16	RO	0-30000	0	ms
0x203D	00	Deceleration time of speed command	S16	RO	0-30000	0	ms
0x2041	00	Internal torque limit in CCW dir...	S16	RW	0-300	300	%
0x2042	00	Deceleration time of speed command	S16	RW	-300-0	-300	%
0x2046	00	Alarm level of torque overload i...	S16	RW	0-300	300	%
0x2047	00	Alarm level of torque overload i...	S16	RW	-300-0	-300	%
0x2048	00	Detection time for torque overlo...	S16	RW	0-10000	0	10ms
0x204B	00	Maximum speed limit	S16	RW	0-7500	5000	r/min
0x204E	00	Speed limit in torque control	S16	RW	0-5000	3000	r/min
0x2050	00	Position deviation limit	S16	RW	0.00-327.67	4.00	circle
0x2054	00	Switch of brake resistor	S16	RW	0-1	0	--
0x2055	00	Value of external brake resistor	S16	RW	10-750	50	Ω
0x2056	00	Power of external brake resistor	S16	RW	10-10000	200	W
0x205A	00	Absolute position encoder type	S16	RW	0-3	0	--
0x205D	00	Fan alarm on	S16	RW	0-1	1	--
0x205E	00	Fan Operating Temperature Point	S16	RW	25-125	50	℃
0x2061	00	Servo Drive Disable Neglection	S16	RW	0-3	3	--

（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	EncoderIncrements	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 motion per turn of the shaft after the output of the electronic gear.

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

（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
  60FDh-00h（Digital Input）的 bit1（positive Limit Switch（POT））、60FDh-00h（Digital Input）的 bit0（Negative Limit Switch（NOT））、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）	Location 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
Err--	0	FF00h	No alarm occurs	Normal operation	
Err 1	1	FF01h	Over speed	Motor speed exceeds maximum limit	Can
Err 2	2	FF02h	Main circuit overvoltage	Main circuit power supply voltage exceeds the specified value	Can
Err 4	4	FF04h	Position deviation	Position deviation counter value exceeds the set value	Can
Err 7	7	FF07h	Drive inhibition abnormal	CCWL、CWL drive inhibit inputs are invalid	Can
Err 8	8	FF08h	Position deviation counter overflow	The absolute value of position deviation counter exceeds 2^{30}	Can
Err11	11	FF0Bh	Power module over-current	Power module failure	No
Err12	12	FF0Ch	Over-current	Excessive motor current	No
Err13	13	FF0Dh	Over-load	Motor overload	No
Err14	14	FF0Eh	Braking peak power overload	Excessive instantaneous load in short braking time	No
Err16	16	FF10h	Motor thermal overload	Motor heating value exceeds the set value (I^2t detection)	No
Err17	17	FF11h	Average braking power overload	Average load of braking for a long time is too large	No
Err18	18	FF12h	Power module overload	Average output load of power module is too large	No
Err20	20	FF14h	EEPROM error	Error in EEPROM reading and writing	No
Err21	21	FF15h	Logic circuit error	Processor peripheral logic circuit fault	No
Err22	22	FF16h	Power version and control board do not match	Replace the power version or control board	No
Err23	23	FF17h	AD conversion error	Circuit or current sensor error	No
Err25	25	FF19h	FPGA verification error	FPGA calibration error	No

Alarm code	Serial no.	603Fh value	Alarm name	Alarm content	Alarm clear
Err27	27	FF1Bh	Phase loss alarm	Check whether the power line is three-phase input	No
Err29	29	FF1Dh	Torque overload alarm	Motor load exceeds user set value and duration	Can
Err35	35	FF23h	Inter board connection failure	Drive internal connection path failure	No
Err36	36	FF24h	Fan alarm	Fan fault	No
Err40	40	FF28h	Absolute value encoder communication error	Drive and encoder cannot communicate	No
Err41	41	FF29h	Absolute value encoder handshake error	Absolute value encoder handshake error	No
Err42	42	FF2Ah	Absolute value encoder internal count error	Absolute value encoder counts abnormally	No
Err43	43	FF2Bh	Absolute value encoder communication response error	Absolute value encoder communication response abnormal	No
Err44	44	FF2Ch	Absolute value encoder verify error	Absolute value encoder communication content error	No
Err45	45	FF2Dh	Absolute value encoder EEPROM error	EEPROM fault of absolute value encoder	No
Err46	46	FF2Eh	Absolute value encoder parameter error	Absolute value encoder parameters are broken	No
Err47	47	FF2Fh	Absolute value encoder external battery failure	Battery voltage is too low	No
Err48	48	FF30h	Absolute value encoder external battery alarm	Low battery voltage	No
Err49	49	FF31h	Encoder overheating	Encoder overheating	No
Err50	50	FF32h	Motor parameters do not match driver	Motor and drive power mismatch	No
Err51	51	FF33h	Encoder automatic recognition failed	Encoder automatic recognition failed	No
Err60	60	FF3Ch	Abnormal data receiving under Op status	Ethernet communication interruption	Can
Err61	61	FF3Dh	Ethernet communication cycle deviation is too large	Ethernet communication cycle deviation is too large	No

Alarm code	Serial no.	603Fh value	Alarm name	Alarm content	Alarm clear
Err62	62	FF3Eh	Ethernet command data out of range	Ethernet command data out of range	No
Err63	63	FF3Fh	Internal error	Internal error	No
Err65	65	FF41h	SYNC signal initialization error	SYNC signal initialization error	No
Err66	66	FF42h	SYNC signal and data receiving beat error	Sync signal and data receiving phase error	No
Err68	68	FF44h	EtherCAT operation EEPROM failed	EtherCAT operation EEPROM failed	No
Err80	80	FF50h	Internal error 1	Internal calculation error, illegal electronic gear setting	No
Err81	81	FF51h	Internal error 2	Internal calculation error, parameter setting to 0 is abnormal	No
Err82	82	FF52h	Internal error 3	Internal calculation error, illegal homing parameter setting	No
Err88	88	FF58h	Operation mode error 1	Operating mode is not set when enabling	Can
Err89	89	FF59h	Operation mode error 2	Set invalid operation mode	Can

7.2 Alarm causes and handling

In this operating instructions, "☆" means the special function of the multi-turn absolute value encoder, and "★" means the special function of the incremental encoder.

Err 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.

Err 2 (Main circuit overvoltage)

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

Err 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 the parameters P009 and 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

Err 7 (Drive inhibition abnormal)

Potential cause	Check	Handle
When servo is enabled, CCWL and 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

Err 8 (Position deviation counter overflowed)

Potential cause	Check	Handle
Motor stuck	Check the motor and mechanical connection	Repair.
Abnormal command pulse	Check pulse command	

Err11 (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	There is no problem with the motor. If the motor is powered on again or the alarm is given, the driver may be damaged.
Poor grounding	Check the grounding wire	Correct grounding
Disturbed	Check interference source	Add line filter to keep away from interference source

Err12 (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	There is no problem with the motor. If the motor is powered on again or the alarm is given, the driver may be damaged.

Err13 (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

Err14 (Braking 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	● Whether B1 and B2 are not short circuited ● Check whether the driver model needs to be connected with external braking resistor	● Short circuit B1 and B2 ● Use for connecting external braking resistor

Err16 (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

Err17 (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

Err18 (Power module overload)

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

Err20 (EEPROM Error)

Potential cause	Check	Handle
EEPROM chip damaged	Power on again for inspection	If the fault persists, replace the driver

Err21 (Logic circuit error)

Potential cause	Check	Handle
Control circuit fault	Power on again for inspection	If the fault persists, replace the driver

Err22 (Power version and control board do not match)

Potential cause	Check	Handle
Control board and power version do not match	Have you replaced the control board yourself	Use the control board matching the power version

Err23 (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

Err25 (FPGA verification error)

Potential cause	Check	Handle
FPGA verification error	Power on again for inspection	If the fault persists, replace the driver

Err27 (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

Err29 (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

Err35 (Inter board connection failure)

Potential cause	Check	Handle
Connection wire error between boards	Check wire and connectors	If the fault persists, replace the driver
Connection path failure	Check the optocoupler	If the fault persists, replace the driver

Err36 (Fan alarm)

Potential cause	Check	Handle
Cooling fan fault	Check fan	Replace fan
Fan detection circuit fault	Check wiring	Correct wiring
Fan detection circuit fault	Check the optocoupler	If the fault persists, replace the driver

Err40 (Absolute value encoder communication 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

Err41 (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

Err42 (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

Err43 (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

Err44 (Absolute value encoder verify error) ☆

Potential cause	Check	Handle
Poor encoder cable and connector	Check cables and connectors	Replace cable and connector
Encoder damaged	Check encoder	Replace encoder

Err45 (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

Err46 (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

Err47 (Absolute value encoder external battery failure) ☆

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 section 3.6.1

Err48 (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 section 3.6.1

Err49 (Encoder overheating)

Potential cause	Check	Handle
Encoder overheating	Whether the power of the adaptive motor is too low or the ambient temperature is too high	● Replace the motor with the appropriate power or temperature class ● Reduce ambient temperature

Err50 (Motor parameters do not match driver)

Potential cause	Check	Handle
Motor and drive power mismatch	Check the motor adaptation table of the driver	Replace the appropriate drive or motor

Err51 (Encoder automatic recognition failed)

Potential cause	Check	Handle
Encoder wiring error	Check encoder wiring	Correct wiring
Encoder automatic recognition failed	Confirm whether the encoder type is supported by the driver	Replace the encoder supported by the driver

Err60（Abnormal data receiving under Op status）

Potential cause	Check	Handle
Abnormal data receiving under Op status	● Check the Ethernet cable ● Check the master station status	● Replace Ethernet cable ● Check host status

Err61（Ethernet communication cycle deviation is too large）

Potential cause	Check	Handle
Industrial Ethernet communication interruption	Check the Ethernet cable	Replace Ethernet cable
Ethernet communication cycle jitter is too large	● Increase communication cycle time ● Reduce the load of the master station	● Increase communication cycle time ● Reduce the load of the master station

Err62（Ethernet command data out of range）

Potential cause	Check	Handle
Current communication cycle command data exceeds the limit	● Check user unit settings ● Check the electronic gear setting	● Change user company settings ● Changing electronic gear settings

Err63（Internal error）

Potential cause	Check	Handle
Internal error 1	Whether the servo firmware is a test version or an incompatible version	Perform firmware upgrade and refresh the servo firmware

Err65（SYNC signal initialization error）

Potential cause	Check	Handle
SYNC signal is not received after entering OP state	Check host configuration	Check host configuration

Err66（SYNC signal and data receiving beat error）

Potential cause	Check	Handle
SYNC signal and SM data receiving beat error	Check host configuration	Check host configuration

Err68（EtherCAT operation EEPROM failed）

Potential cause	Check	Handle
EtherCAT operation EEPROM failed	Power on again for inspection	If the fault persists, replace the driver

Err80（Internal error 1）

Potential cause	Check	Handle
Relevant parameters of electronic gear are set illegally	Electronic gear related parameters setting	Set legal electronic gear parameters

Err81（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")

Err82（Internal error 3）

Potential cause	Check	Handle
Illegal setting of "homing" related parameters	Setting of "homing" related parameters	Set legal "homing" parameters

Err88（Operation mode error 1）

Potential cause	Check	Handle
Operating mode is not set when enabling	Setting of operation mode when enabling	Enable after setting operation mode

Err89（Operation mode error 2）

Potential cause	Check	Handle
Set invalid operation mode	Setting of operation mode	Set valid operation mode according to 6502h

Chapter 8 Specifications

8.1 Driver model

EP3E - G L 3A0 - E3 S0 EC

Mark	Main circuit supply voltage
L	AC220V
H	AC380V

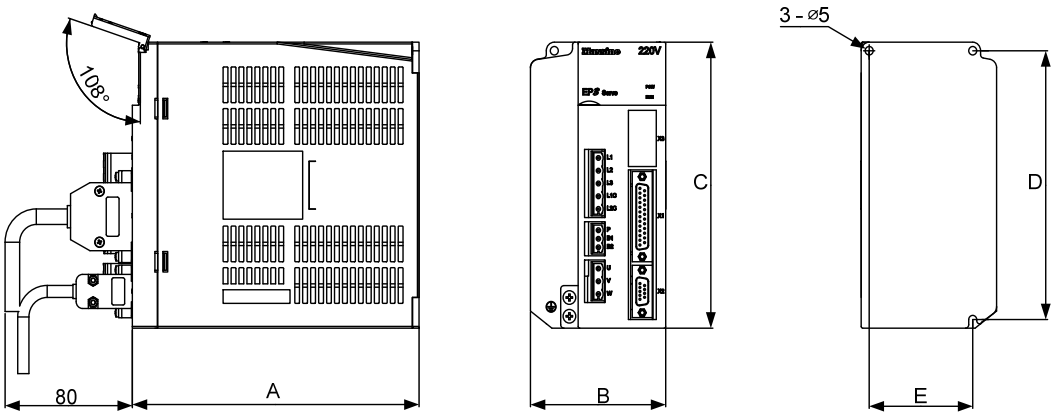
Mark	Power (kW)	Current (A)	Mark	Power (kW)	Current (A)
GL1A0	0.1	1.0	GH3A5	1.0	3.5
GL1A8	0.2	1.8	GH5A4	1.5	5.4
GL3A0	0.5	3.0	GH8A5	2.0	8.5
GL5A5	1.0	5.0	GH130	3.0	13.0
GL7A5	1.5	7.5	GH170	5.0	17.0
GL120	2.0	11.5	GH210	7.5	21.0
GL160	2.5	15.5	GH260	9.0	25.5
GL190	3.5	19.0	GH320	11.0	32.0
GL240	5.5	24.0	GH390	15.0	39.0
GH2A0	0.6	2.0			

Mark	Encoder interface specifications
E3	23bit multi-turn absolute value encoder
E6	Panasonic A5, A6 absolute encoders
B0	23bit incremental encoder

Mark	Control mode
S0	X1 controls terminal DB25

Mark	Specifications
EC	EtherCAT bus protocol

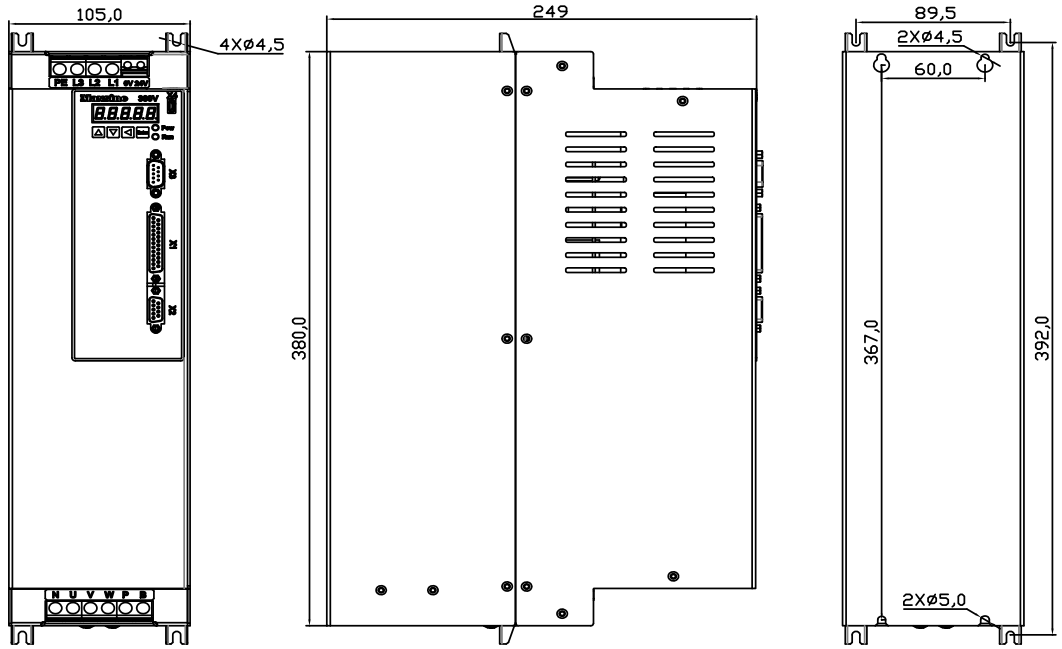
8.2 Driver size



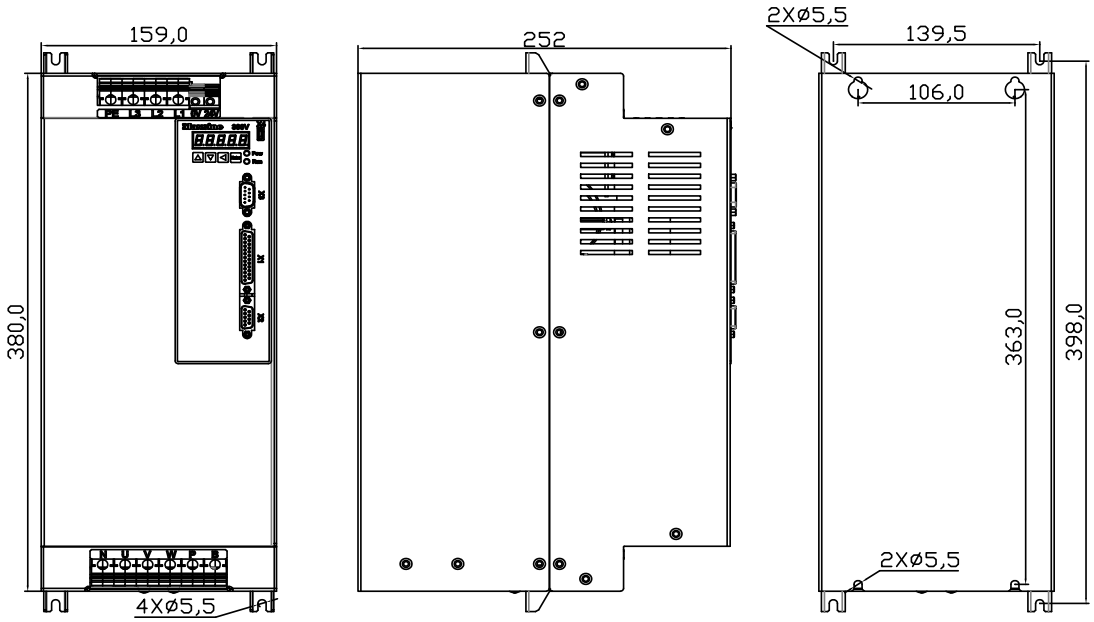
Model / Size (mm)	GL1A0	GL1A8/ GL3A0	GL5A5	GL7A5	GL120	GL160	GL190	GL240
A	150	150	180	180	180	180	180	210
B	55	65	75	85	95	95	105	115
C	168	168	168	168	168	200	220	250
D	158	158	158	158	158	189	209	239
E	-	55	65	65	65	84	94	104

Model / Size (mm)	GH2A0/GH3A5/GH5A4	GH8A5	GH130	GH170/GH210
A	180	180	180	210
B	95	95	105	115
C	168	200	220	250
D	158	189	209	239
E	65	84	94	104

GH260 installation dimension drawing



GH320、GH390 installation dimension drawing



8.3 Driver specifications

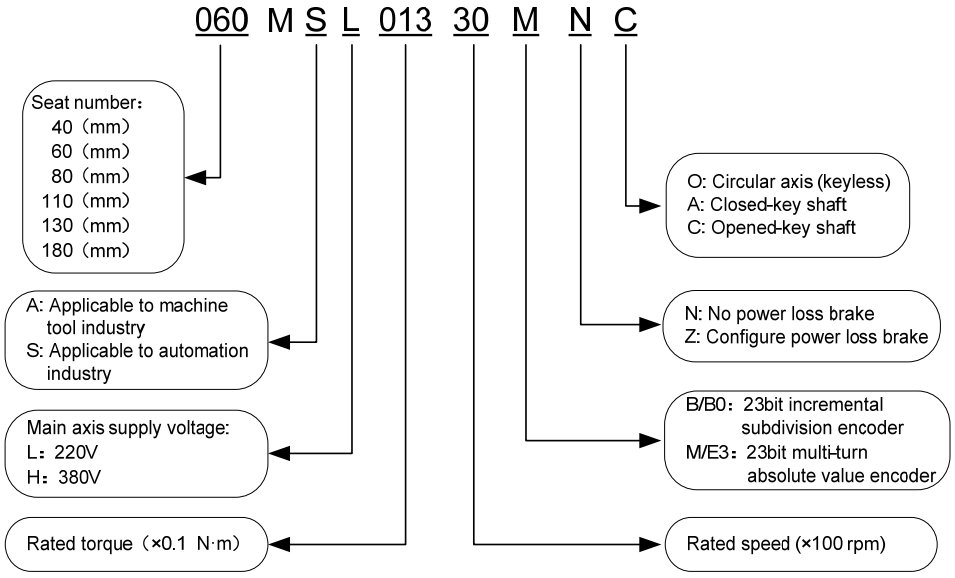
model		GL 1A0	GL 1A8	GL 3A0	GL 5A5	GL 7A5	GL 120	GL 160	GL 190	GL 240	GH 2A0	GH 3A5	GH 5A4	GH 8A5	GH 130	GH 170	GH 210	GH 260	GH 320	GH 390
Rated output power (kW)		0.1	0.2	0.5	1.0	1.5	2.0	2.5	3.5	5.5	0.6	1.0	1.5	2.0	3.0	5.0	7.5	9.0	11.0	15.0
Rated output current (A)		1.0	1.8	3.0	5.0	7.5	11.5	15.5	19.0	24.0	2.0	3.5	5.4	8.5	13.0	17.0	21.0	25.5	32.0	39.0
Maximum output current (A)		3.0	5.4	9.0	11.3	14.9	21.0	24.5	28.5	40.0	6.0	7.1	10.0	12.7	28.3	31.2	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-phaseAC220V -15%～+10% 50/60Hz									
	Control power supply	Single phaseAC220V-15%～+10% 50/60Hz									24V DC ±15% Not less than 1.5 A									
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-out	Built-in/built-out							built-out	Built-in/built-out				built-out					
Feedback method		Standard 23-bit incremental/multi-turn absolute value encoder, other specifications can be selected																		
Control mode		Cyclic Synchronous Position Mode（CSP）、Cyclic Synchronous Velocity Mode（CSV）、Cyclic Synchronous Torque Mode（CST）……																		
Digital input		5 programmable input terminals (photoelectric isolation), 2 high-speed optocoupler input																		
Digital output		5 programmable output terminals (optoelectronic isolation)																		
Special function		Mechanical resonant notch device、vibration suppression																		
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 ratio	< ±0.03% (load 0 ~ 100%); < ±0.02% (power supply -15% ~ +10%)																		
	Speed regulation ratio	1:5000																		

8.4 Motor adaptation table of the driver

Motor model (220V series)		Torque N·m	Speed r/min	Power kW
MSL series	40MSL00330	0.32	3000	0.10
	60MSL00630	0.64	3000	0.20
	60MSL01330	1.27	3000	0.40
	80MSL01330	1.27	3000	0.40
	80MSL02430	2.39	3000	0.75
	80MSL03230	3.18	3000	1.00
	130MSL04025	4.00	2500	1.00
	130MSL04820	4.77	2000	1.00
	130MSL05025	5.00	2500	1.30
	130MSL07220	7.16	2000	1.50
	130MSL09620	9.55	2000	2.00
	130MSL10025	10.00	2500	2.60
	130MSL14320	14.30	2000	3.00
MAL series	110MAL04030	4.00	3000	1.26
	110MAL06030	6.00	3000	1.88
	130MAL06025	6.00	2500	1.57
	130MAL07725	7.70	2500	2.02
	130MAL10015	10.00	1500	1.57
	130MAL15015	15.00	1500	2.36
GSL series	110GSL04030	4.00	3000	1.26
	110GSL06025	6.00	2500	1.57
	130GSL05415	5.39	1500	0.85
	130GSL08315	8.34	1500	1.30
	130GSL11515	11.50	1500	1.80
	130GSL15015	15.0	1500	2.36
GAL series	110GAL04020	4.00	2000	0.84
	110GAL06020	6.00	2000	1.26
	130GAL05415	5.39	1500	0.85
	130GAL08315	8.34	1500	1.30
	130GAL11515	11.50	1500	1.80
	130GAL15010	15.00	1000	1.57
	130GAL15015	15.00	1500	2.36

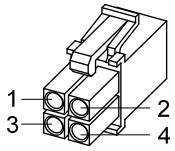
Motor Type (380V series)		Torque N·m	Speed r/min	Power kW
MAH series	110MAH04030	4.00	3000	1.26
	110MAH06030	6.00	3000	1.88
	130MAH04025	4.00	2500	1.00
	130MAH04820	4.77	2000	1.00
	130MAH05025	5.00	2500	1.30
	130MAH06025	6.00	2500	1.57
	130MAH07725	7.70	2500	2.02
	130MAH10015	10.00	1500	1.57
	130MAH15015	15.00	1500	2.36
	180MAH19015	19.00	1500	3.00
	180MAH27015	27.00	1500	4.30
	180MAH35015	35.00	1500	5.50
	180MAH48015	48.00	1500	7.50
GAH series	130GAH05415	5.39	1500	0.85
	130GAH08315	8.34	1500	1.30
	130GAH10025	10.00	2500	2.62
	130GAH11515	11.50	1500	1.80
	130GAH15015	15.00	1500	6.60

8.5 Servo motor model

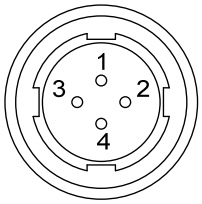


8.6 Servo motor wiring

8.6.1 Winding wiring



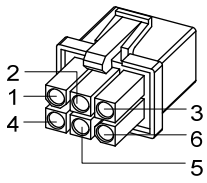
40/60/80 motor power plug



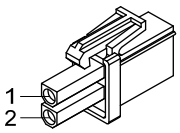
110/130/180 motor power plug

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

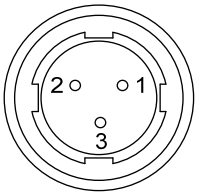
8.6.2 Brake wiring



40 motor with brake power plug



60/80 motor brake plug



110/130 motor brake plug

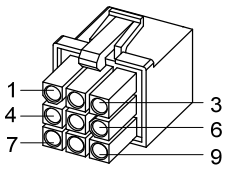
40 Motor with brake power wiring:

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	

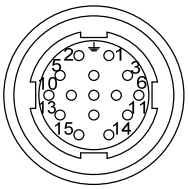
60、80、110、130、180 motor brake wiring:

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 type	Absolute value	Incremental type	
SD+	1	1	1	6	6	Encoder signal wire
SD-	2	2	2	7	7	
MA+	4	4	4	8	8	Clock output
MA-	5	5	5	9	9	
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

Note: In this operating instructions, "☆" means the special function of absolute encoder, and "★" means the special function of incremental encoder.

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