Maxsine

EP3 E series

PROFINET
AC servo drive
User Manual

(The fourth edition)

Servo drive

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

Wuhan Maxsine Electric Co., Ltd

DECLARATION

Because improves and so on the reasons, the product specification or dimension has the change, not separate informs even slightly.

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. Service conditions

⚠ 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. ● Never connect the input power terminals (L1, L2, L3) to 380V power supply, otherwise can result in the equipment damage and an 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 servomotor 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. Operations

⚠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 servomotor 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 servomotor is running, otherwise can cause personnel casualty. ● Do not touch servo driver and servomotor while the equipment is operating, otherwise can result in an electric shock or in burn. ● 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 any portion inside of the servo driver and servomotor, otherwise can cause an 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 servomotor, otherwise can cause an electric shock.

6. Service ranges

⚠CAUTION
This handbook involves the product for the general industry use, please do not use in some equipment which may directly harm the personal safety, such as nuclear energy, spaceflight, aeronautic equipment, and life safeguard, life-support equipment and each kind of safety equipment. Please make contact with the company if have the need of use mentioned above.

CONTENTS

Chapter 1 Product inspection and installment

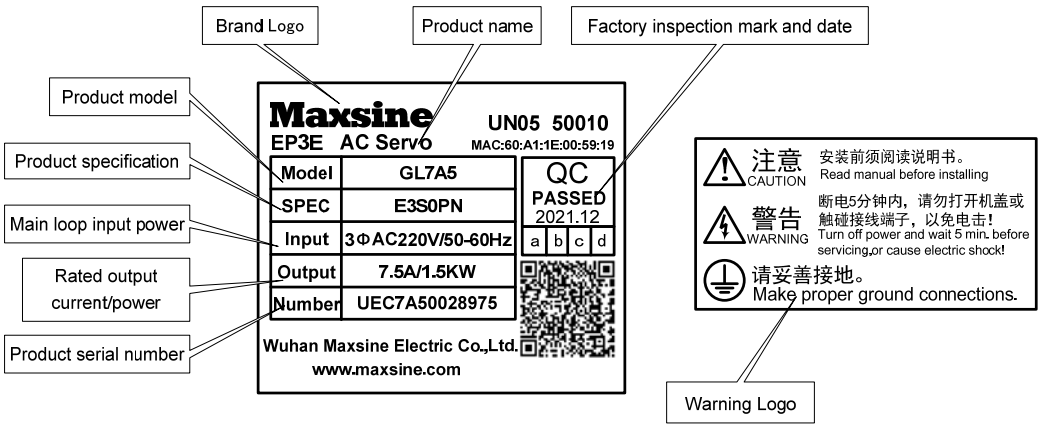
1.1 Product inspection

This product has made the complete function test before delivery, for prevented the product to be abnormal owing to shipping process, please make detail inspection as the following items after breaking the seal:

- Inspect the types of servo driver and servomotor and ensure that are the same types in the order form.
- Inspect the outward appearance of servo driver and servomotor to see any abrasion or damage; if so please do not wire to the power supply.
- Inspect the parts of servo driver and servomotor to see any loosen parts such as loosened or fallen off screw.
- Rotate the servomotor shaft by hand and should be smooth rotation. However, the servomotor with holding brake is unable to rotate directly.

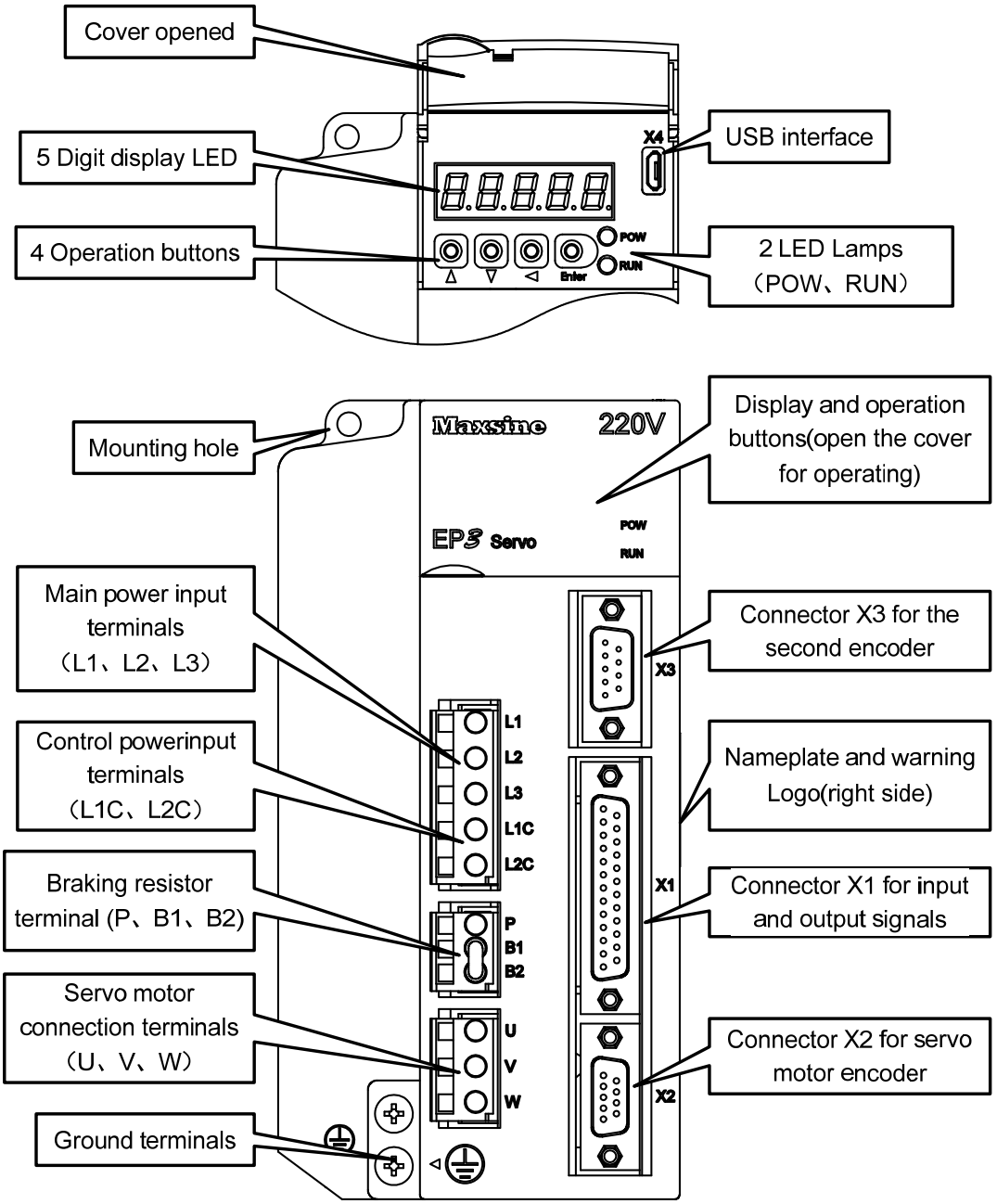
If there is any break down item or abnormal phenomenon mentioned above, please contact with the dealer immediately.

1.2 Product nameplate

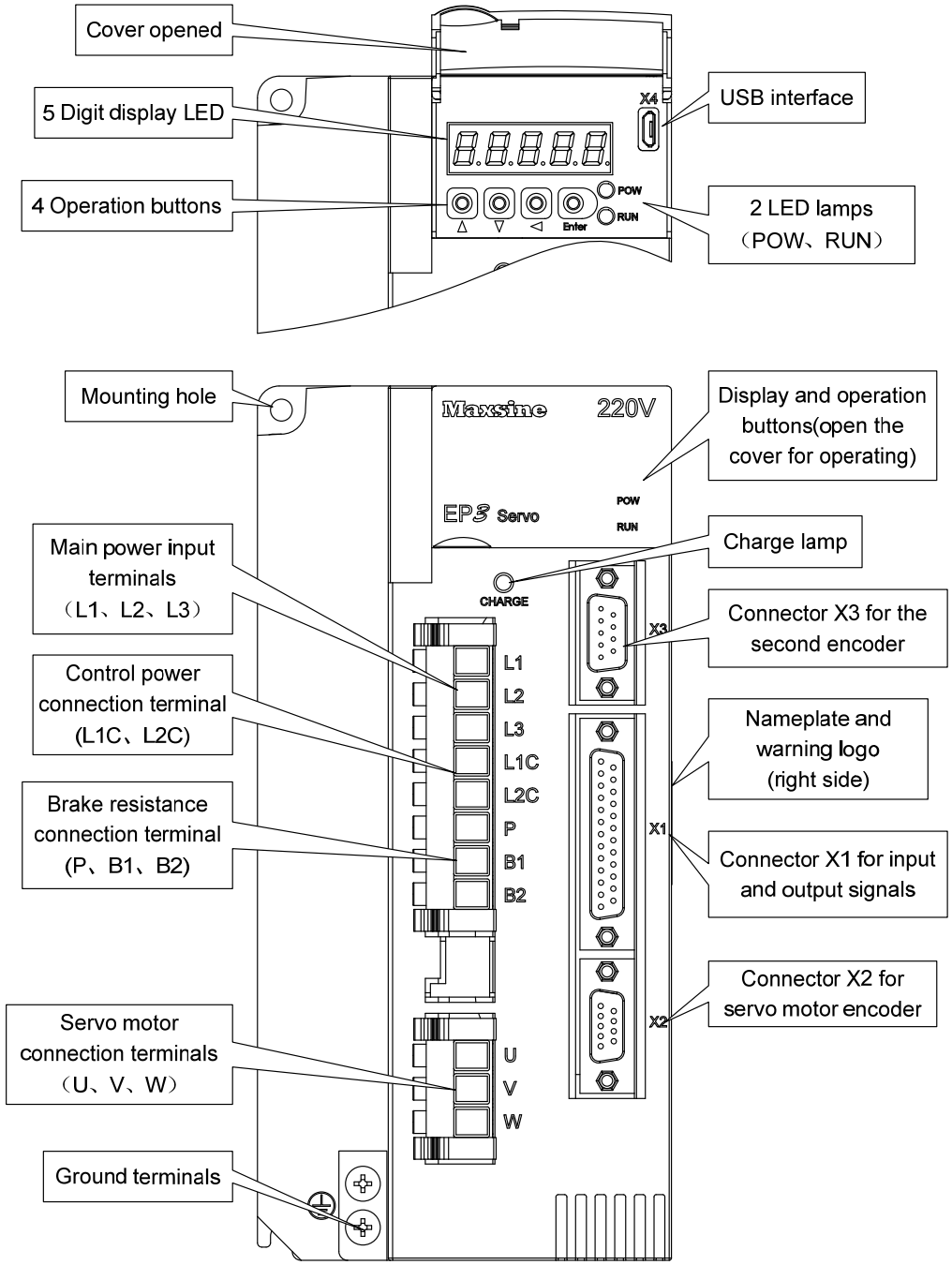


1.3 Product front panel

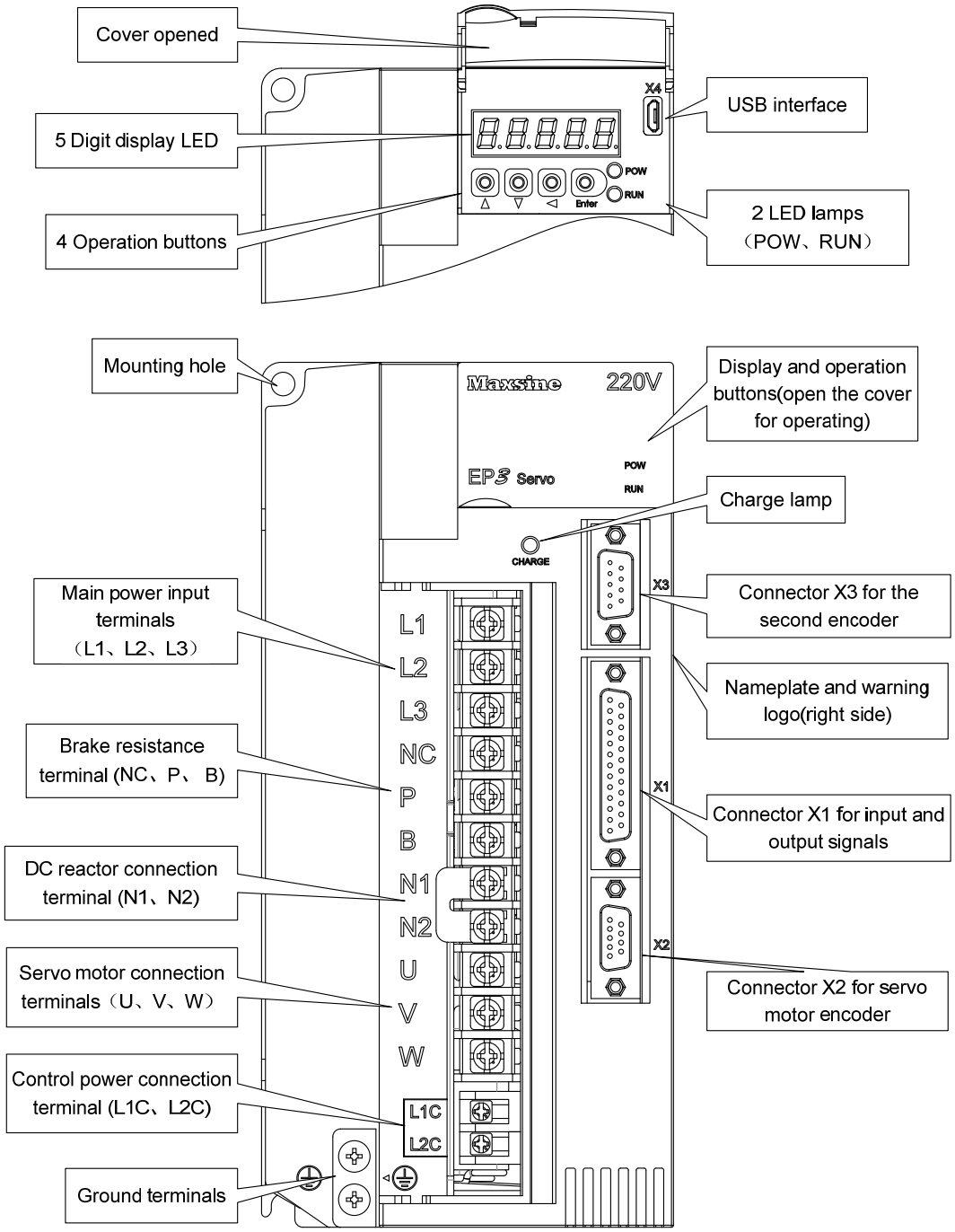
Applicable models：GL1A0、GL1A8、GL3A0、GL5A5、GL7A5、GL120



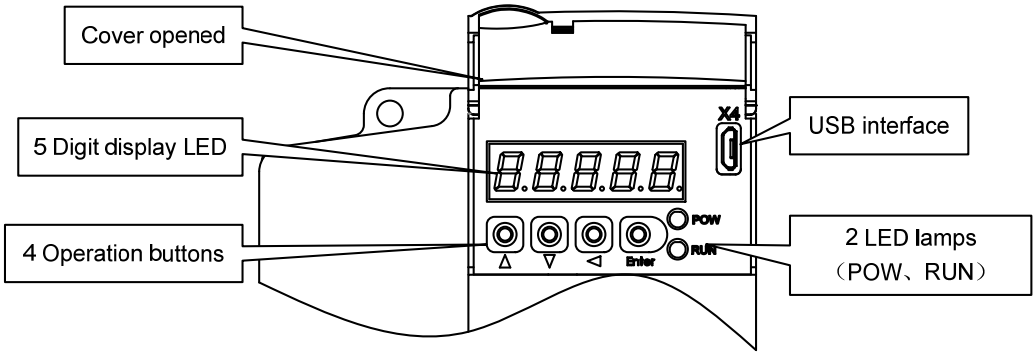
Applicable models：GL160

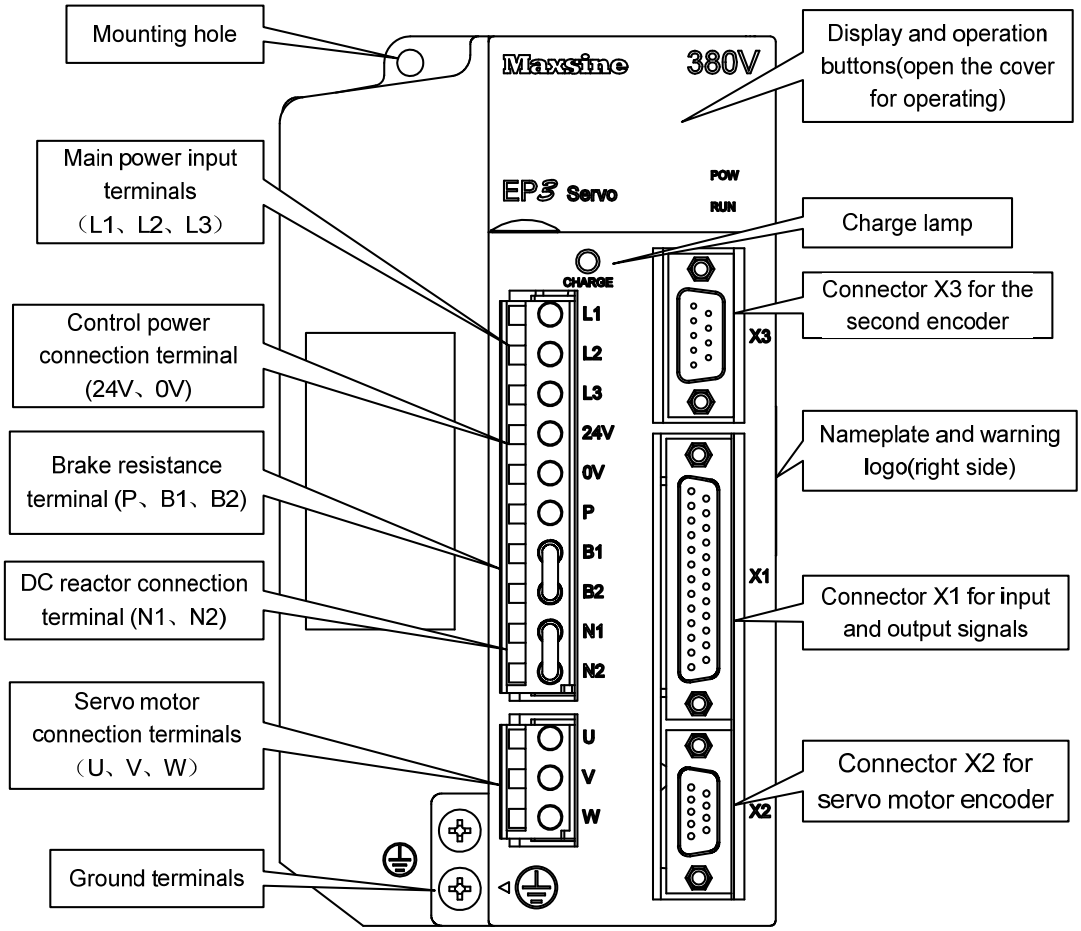


Applicable models：GL190、GL240

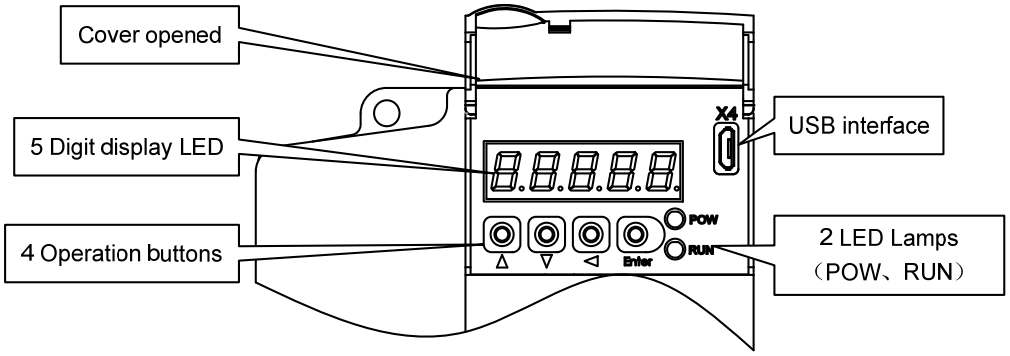


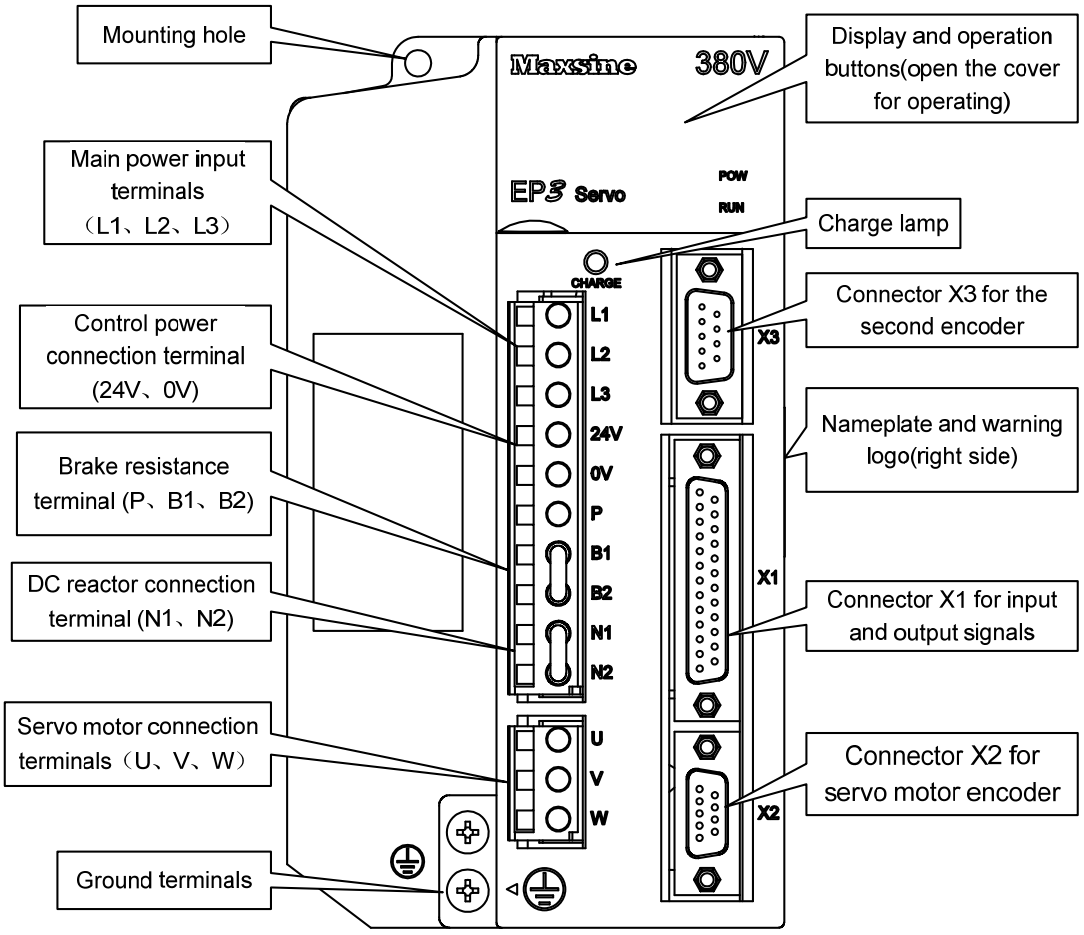
Applicable models：GH2A0、GH3A5、GH5A4



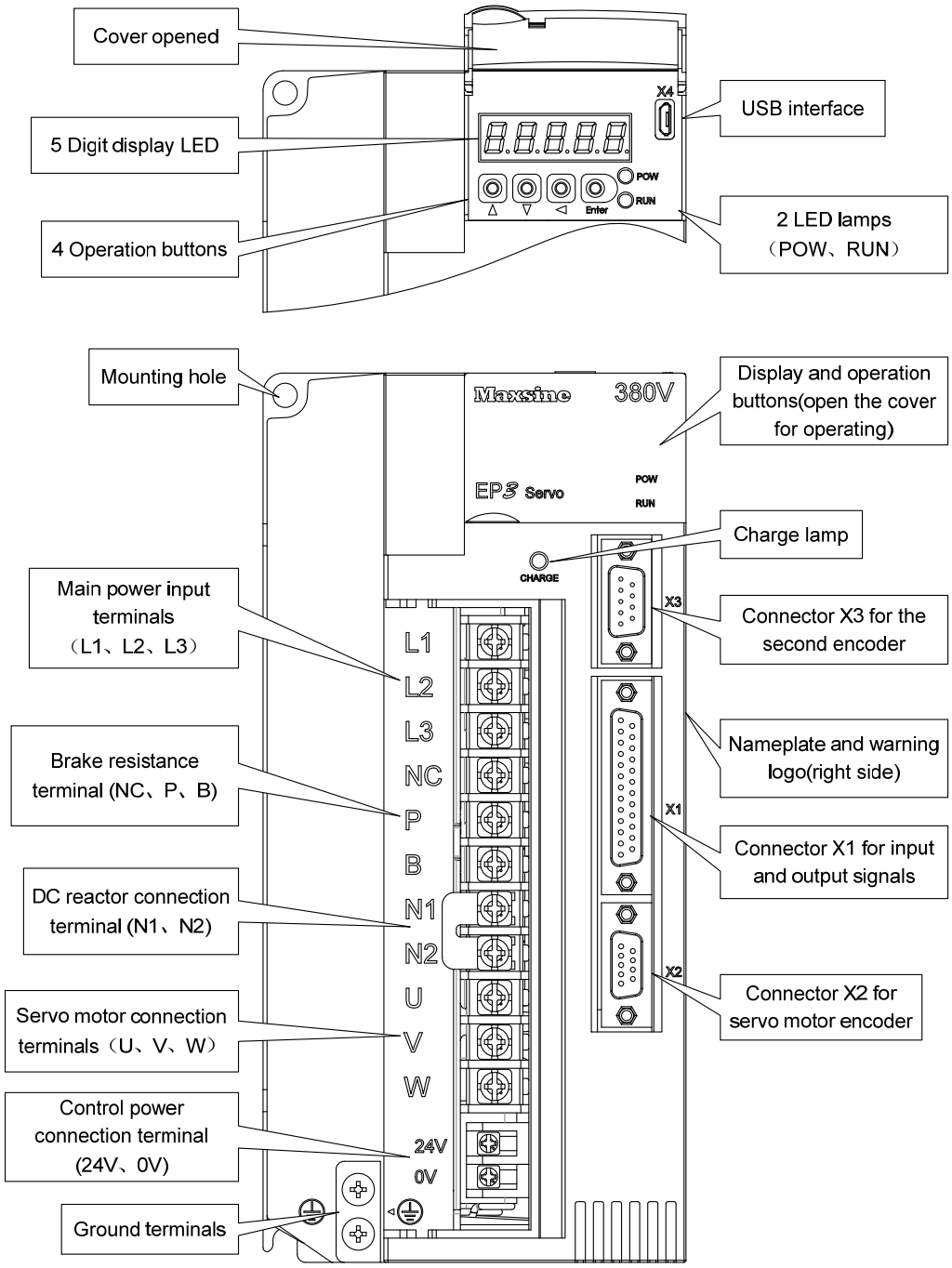


Applicable models：GH8A5

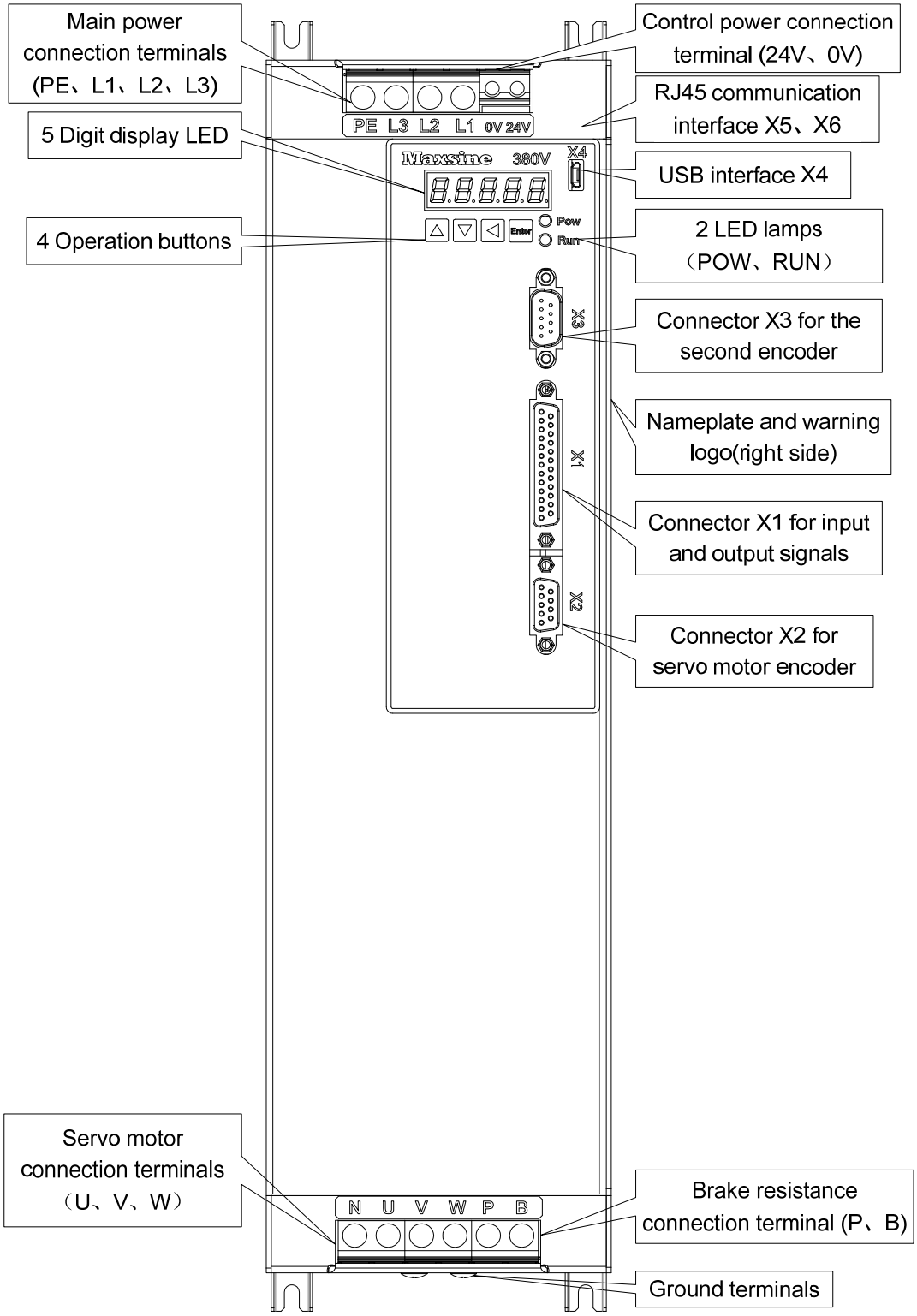




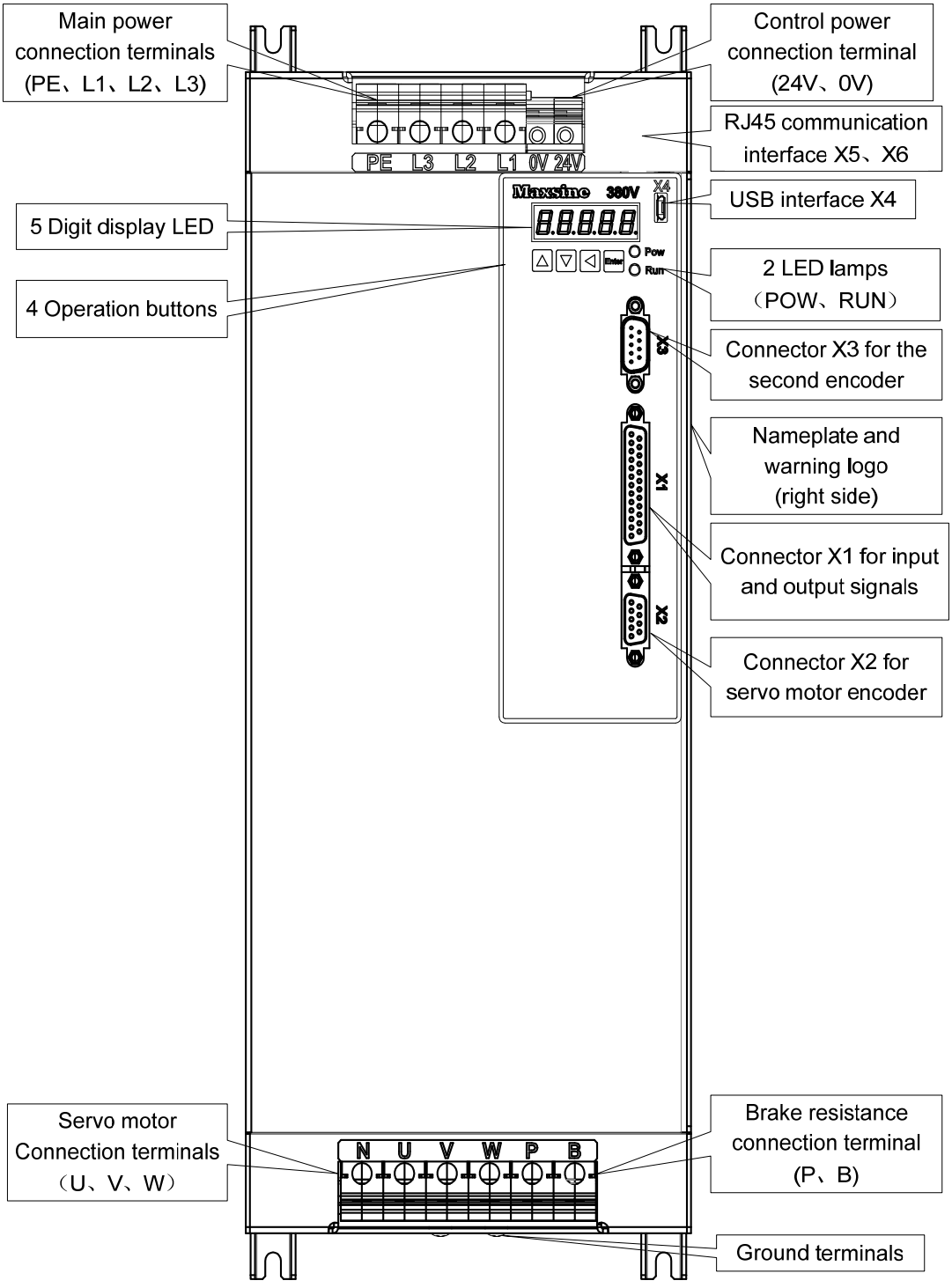
Applicable models：GH130、GH170、GH210



Applicable models：GH260



Applicable models：GH320、GH390



1.4 Servo driver installation

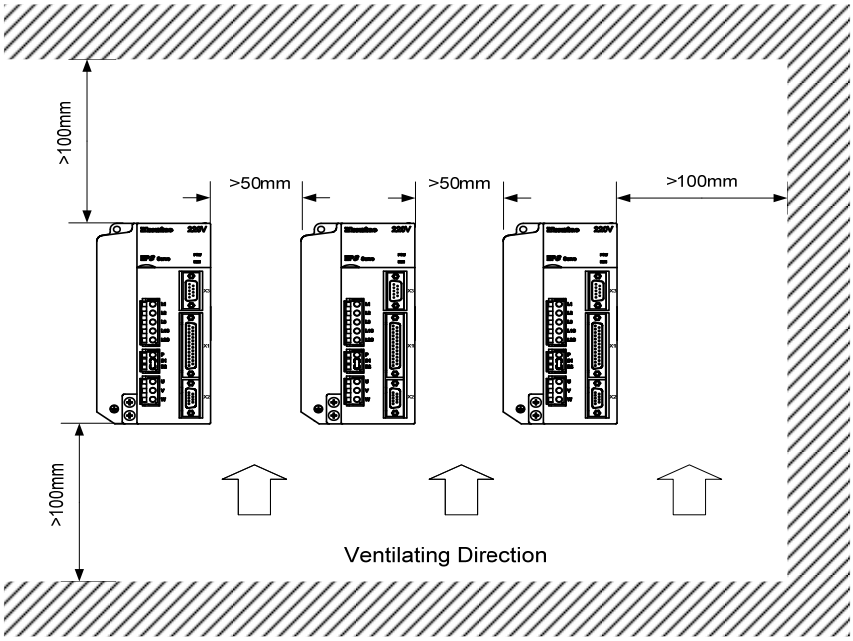
1.4.1 Installation environmental conditions

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

- Ambient temperature: 0～40℃; Ambient humidity: less than 40% ~ 80% (no dew).
- Storage temperature: -40～50℃; Storage humidity: less than 93% (no dew).
- Vibration: less than 0.5G.
- Preventive measure shall be taken against raindrop or moist environment.
- Avoid direct sunlight.
- Preventive measure shall be taken against corrosion by oil mist and salinity.
- Free from corrosive liquid and gas.
- Preventive measure shall be taken against entering the servo driver by dust, cotton fiber and metal tiny particle.
- Keep away from radioactive and inflammable substances.
- When several driver installments in a control cubicle, for good ventilation please reserve enough space around each driver, install fans to provide effective cooling, keep less than 40℃ for long-term trouble-free service.
- If there are vibration sources nearby (punch press for example) and no way to avoid it, please use absorber or antivibration rubber filling piece.
- If there is disturbance from interferential equipment nearby along the wirings to the servo driver can make the servo driver misoperation. Using noise filters as well as other antijamming measure guarantee normal work of the servo driver.However, the noise filter can increase current leakage, therefore should install an insulating transformer in the input terminals of power supply.

1.4.2 Installation method

- In order to get good cooling the servo driver should normally mount in vertical direction with the topside upward.
- For installing the servo driver, fasten the backboard of the servo driver with M5 screw bolt.
- Reserve enough space around the servo drivers as shown in the reference diagram. In order to guarantee the performance of the servo driver and the lifetime, please make the space as full as possible.
- To provide vertical wind to the heat sink of the servo driver should install ventilating fans in the control cubicle.
- Prevent the dust or the iron filings entering the servo driver when install the control cubicle.



1.5 Servo motor installation

1.5.1 Installation environmental conditions

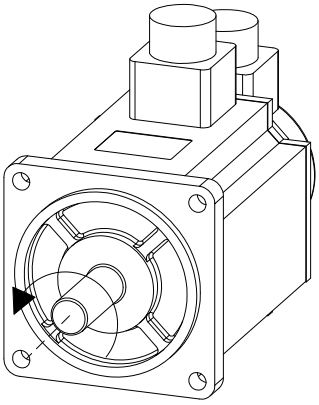
- Ambient temperature: 0～40℃; Ambient humidity: less than 80 %(no dew).
- Storage temperature: -40～50℃; Storage humidity: less than 80 %(no dew).
- Vibration: less than 0.5G.
- Install the servomotor in well-ventilated place with less moisture and a few dusts.
- Install the servomotor in a place without corrosive liquid, flammable gas, oil vapor, cutting cooling liquid, cutting chips, iron powder and so on.
- Install the servomotor in a place without water vapor and direct sunlight.

1.5.2 Installation method

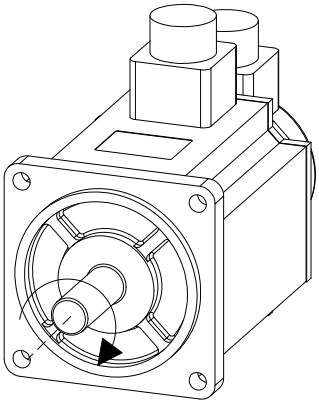
- For horizontal installation: In order to prevent water, oil, etc. from entering inside of the servomotor, please put the cable connector downward.
- For vertical installation: if the shaft of the servo motor is in upward direction with a speed reducer, some prevention measure shall be taken against entering inside of the servomotor by oil come from the speed reducer.
- Motor shaft extension should be long enough, or may cause vibration while motor is in running.
- In case of installation or removing the servomotor, please do not hit the servomotor with a hammer, otherwise the shaft and the encoder can be damaged.

1.6 Motor rotation direction definition

The motor rotating direction description in this handbook is defined as facing the shaft of the servomotor, if the rotating shaft is in counterclockwise direction will be called as positive direction, or in clockwise as reversal direction



Positive Rotation
Counterclockwise (CCW)



Reversal Rotation
Clockwise(CW)

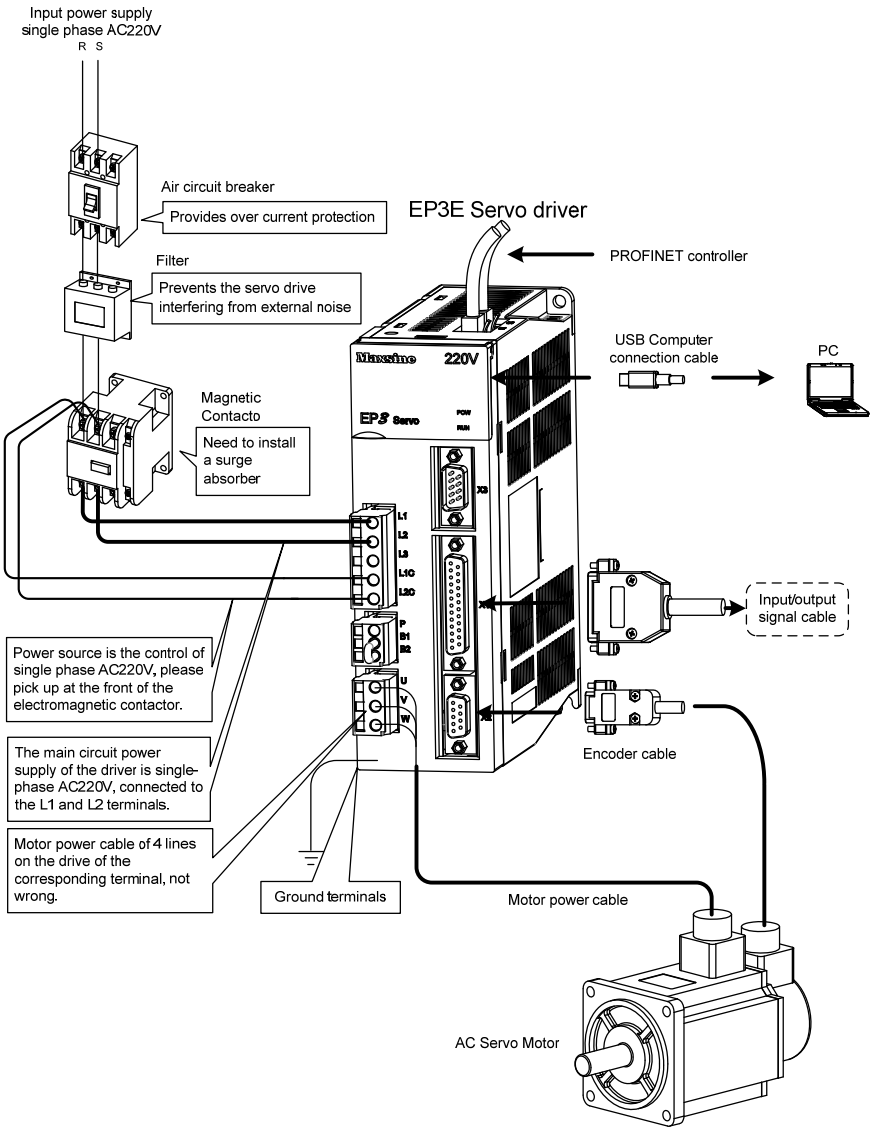
Chapter 2 Wiring

2.1 System construction and wiring

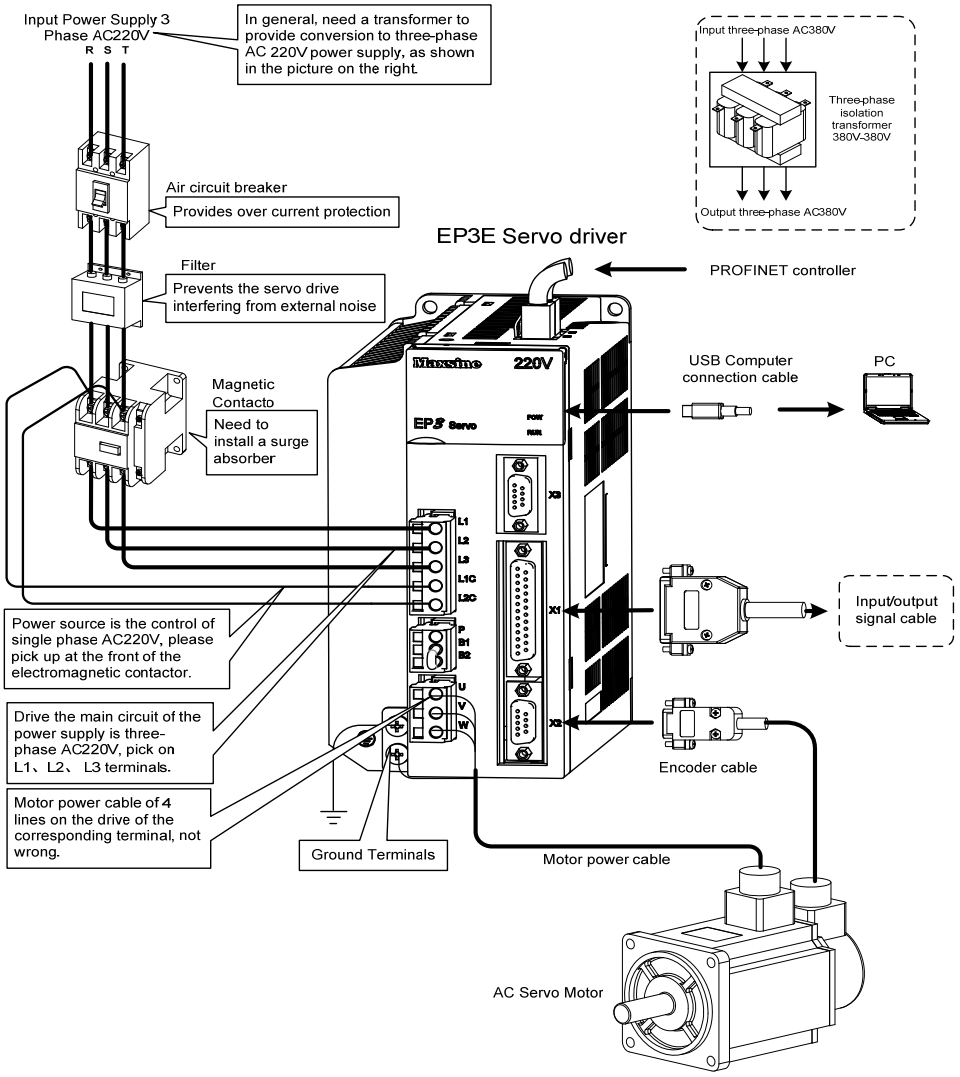
2.1.1 Servo driver wiring diagram

1. EP3E-GL series servo driver wiring diagram

Applicable models：GL1A0、GL1A8、GL3A0

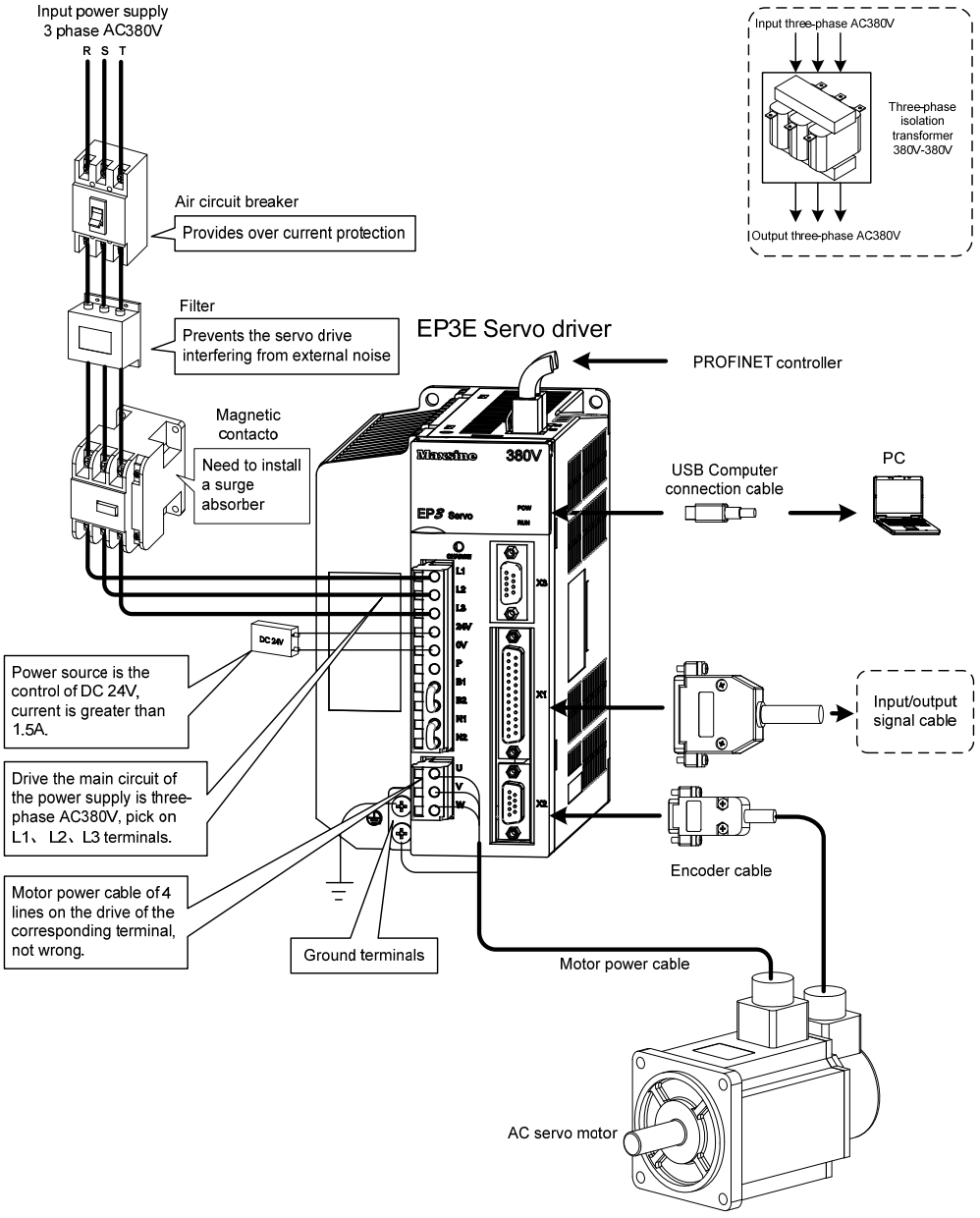


Applicable models：GL5A5、GL7A5、GL120、GL160



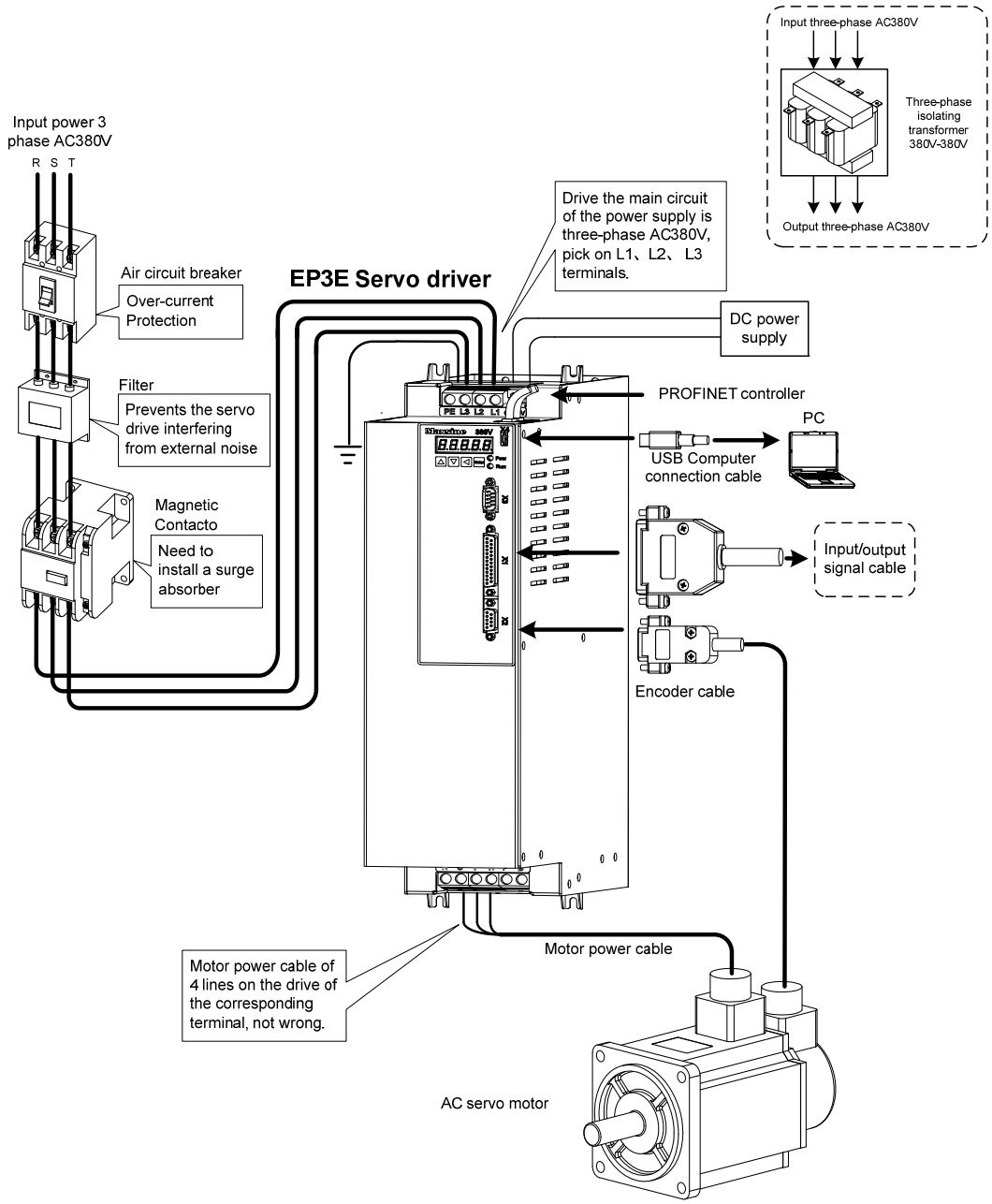
Note: Please refer to section 2.1.5 for details of GL190 and GL240.

2. EP3E-GH series servo driver wiring diagram

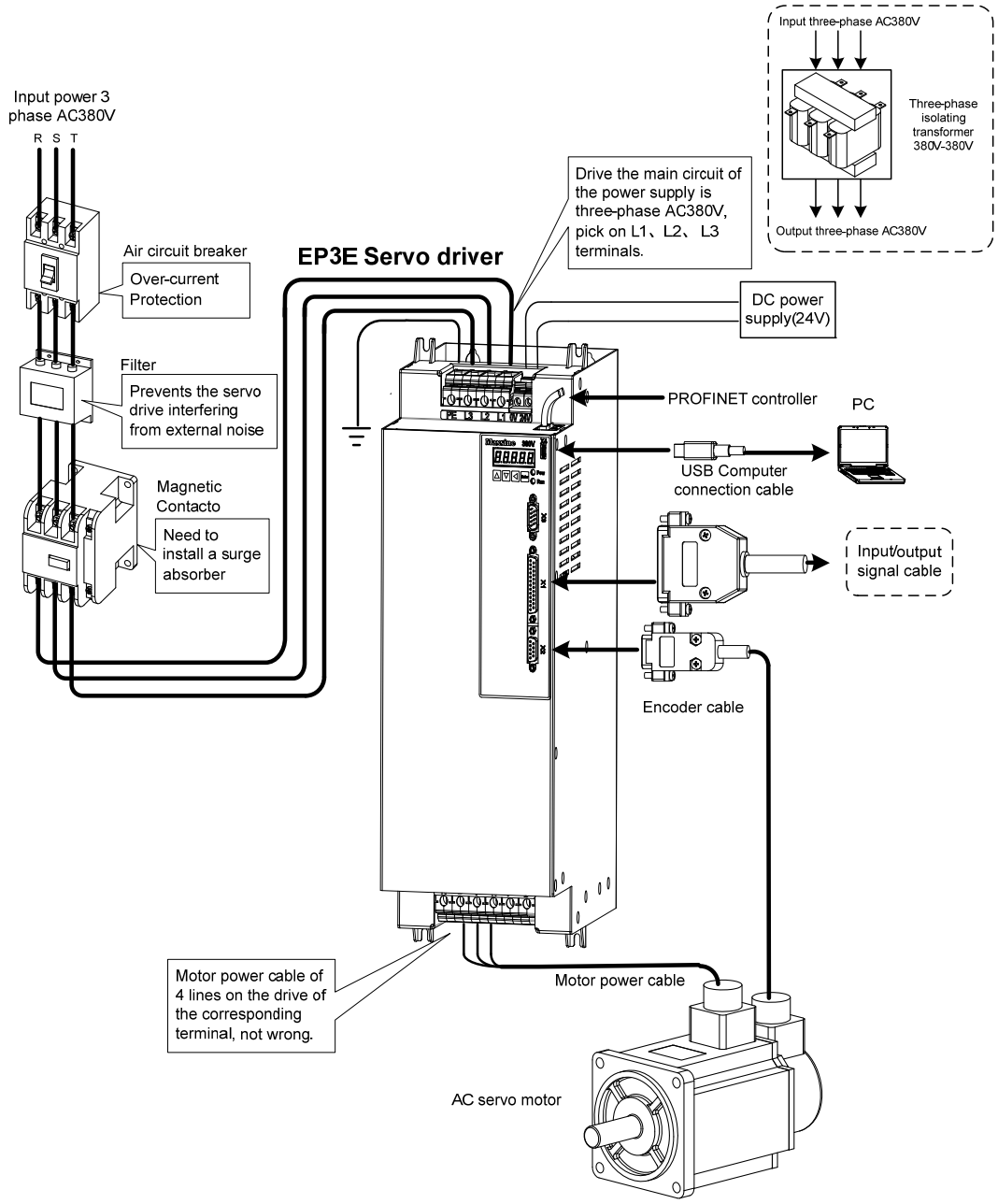


Note: This wiring method is only applicable to GH2A0, GH3A5 and GH5A4. Please refer to section 2.1.5 for details of GH8A5, GH130, GH170 and GH210.

Applicable models：GH260



Applicable models：GH320、GH390



2.1.2 Wiring instructions

Wiring Notes:

- According to electric wire specification, use the wiring materials.
- The control cable length should be less than 3 meters and the encoder cable length 20 meters.
- GL series: Check that the power supply and wiring of L1、L2、L3 and L1C、L2C terminals are correct. Please do not connect to 380V power supply.
- GH series: Check L1、L2、L3 and 0V、24V power supply and connection 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.
- Earthed wiring must be reliable with a single-point connection.
- Pay attention to the correct direction of freewheel diode which is connected with the relay at the output terminal, otherwise can cause the output circuit breakdown.
- In order to protect the servo driver from noise interference that can cause malfunction, please use an insulation transformer and noise filter on the power lines.
- Wiring the power lines (power supply line, main circuit lines, etc.) at a distance above 30cm from the control signal wires, do not lay them in one conduit.
- Install a non-fuse circuit breaker that can shut off the external power supply immediately for in case of the servo driver fault.

2.1.3 Electric wire specifications

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
Servomotor		U、V、W	0.75～10mm^2
Ground		⏚	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 Strong terminal specification

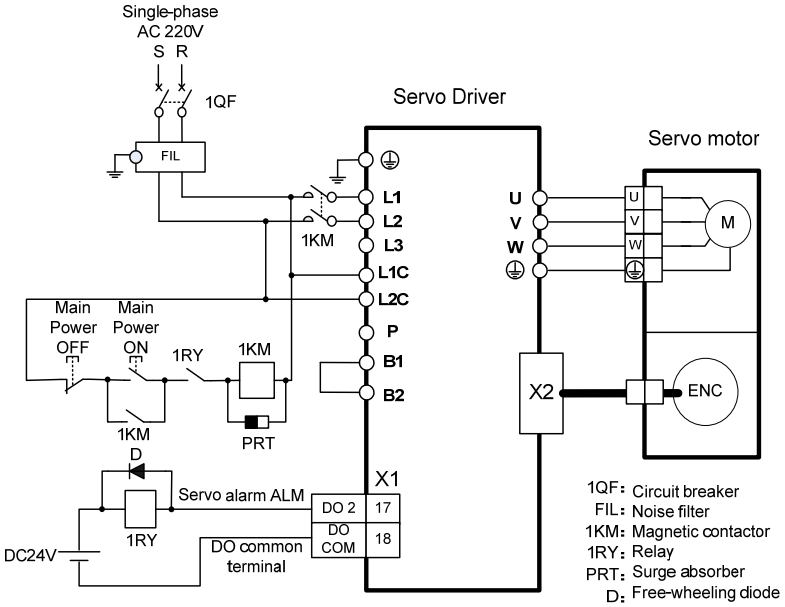
Name	Terminal symbol	model	Detailed instructions
Main circuit power input terminal	L1 L2	GL1A0、GL1A8、GL3A0	Single-phase 220VAC - 15% ~ + 10% 50/60 Hz
	L1 L2 L3	GL5A5、GL7A5、GL120、GL160、GL190、GL240	Three-phase 220VAC -15%～+10% 50/60Hz
		GH series	Three-phase 380VAC - 15% ~ + 10% 50/60 Hz
Control circuit power terminal	L1C L2C	GL series	Single-phase 220VAC - 15% ~ + 10% 50/60 Hz
	24V、0V	GH series	External DC24V
Brake resistance terminal	P B1 B2	GL1A0[Note1]、GL1A8、GL3A0、GL5A5、GL7A5、GL120、GL160、GH2A0、GH3A5、GH5A4	When external brake resistance is needed, disconnect B1、B2[Note 2], and the external brake resistance is bonded to P、B1, so that B2 is 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.
Power higher harmonic suppression with DC reactor connection terminals	N1 N2	GL190、GL240、GH series	Need for power to suppress high order harmonic, the connection between the N1, and N2 [Note 2] DC reactor.
Motor connection terminal	U	EP3E series	Output to motor U phase power supply
	V		Output to motor V phase power supply
	W		Output to the motor W phase power supply
Earth terminal	⏚	EP3E series	Grounding terminal of motor housing
	⏚		Driver grounding terminal

Note 1. GL1A0, GL240, GH260, GH320, GH390 have no internal brake resistor: GL1A0 generally does not need to connect the brake resistor; However, when GL240 needs to connect the external brake resistor, the external brake resistor should be straddled at the P and B ends, and the NC is suspended; GH260, GH320, GH390 braking resistor in P and B side directly.

Note 2. It is the default internal brake resistance connection when delivered: B1 and B2 are short-connected, N1 and N2 are short-connected.

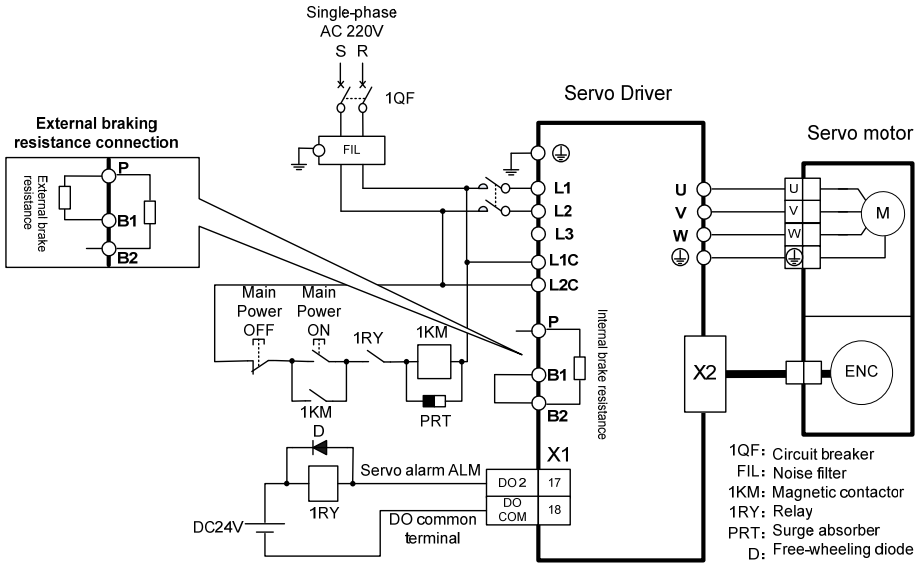
2.1.5 Main circuit wiring diagram

1. GL series servo driver power supply adopts three-phase AC 220V, generally obtained from three-phase AC 380V through transformer.
   Applicable models：GL1A0 [Note]

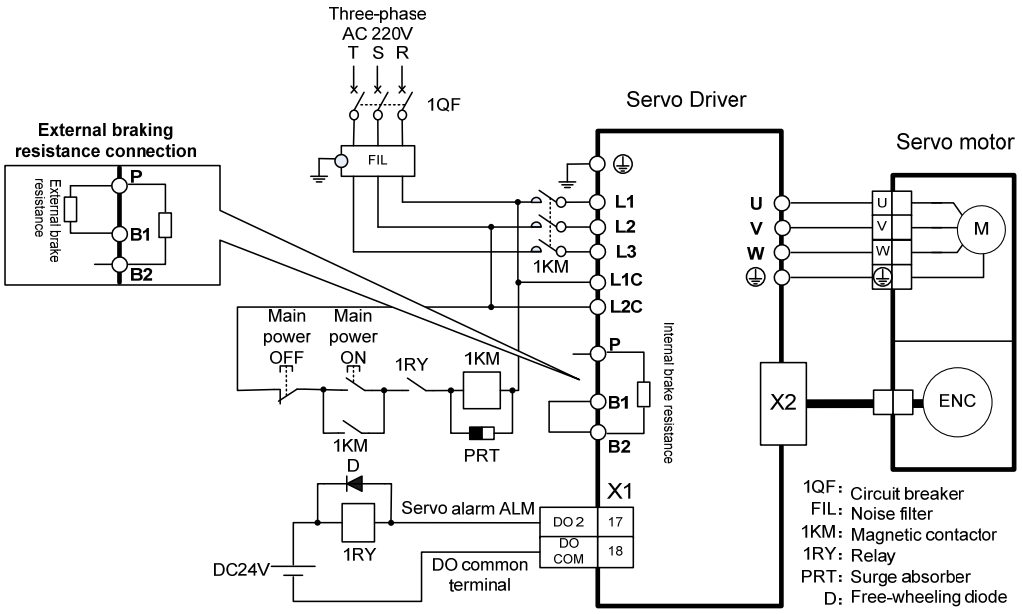


Note: GL1A0 has no internal brake resistor, so it is generally not necessary to connect the brake resistor.

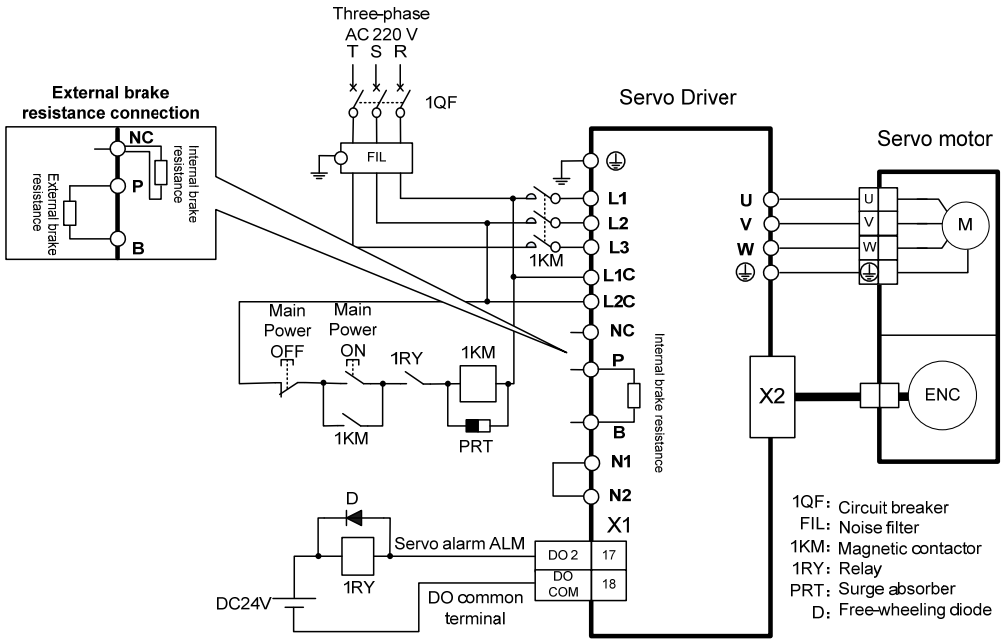
Applicable models: GL1A8、GL3A0



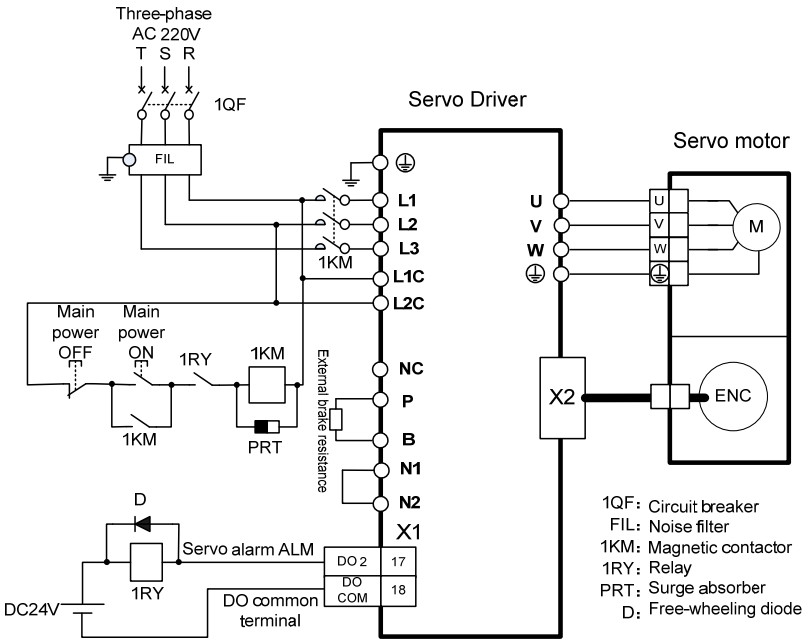
Applicable models：GL5A5、GL7A5、GL120、GL160



Applicable models：GL190



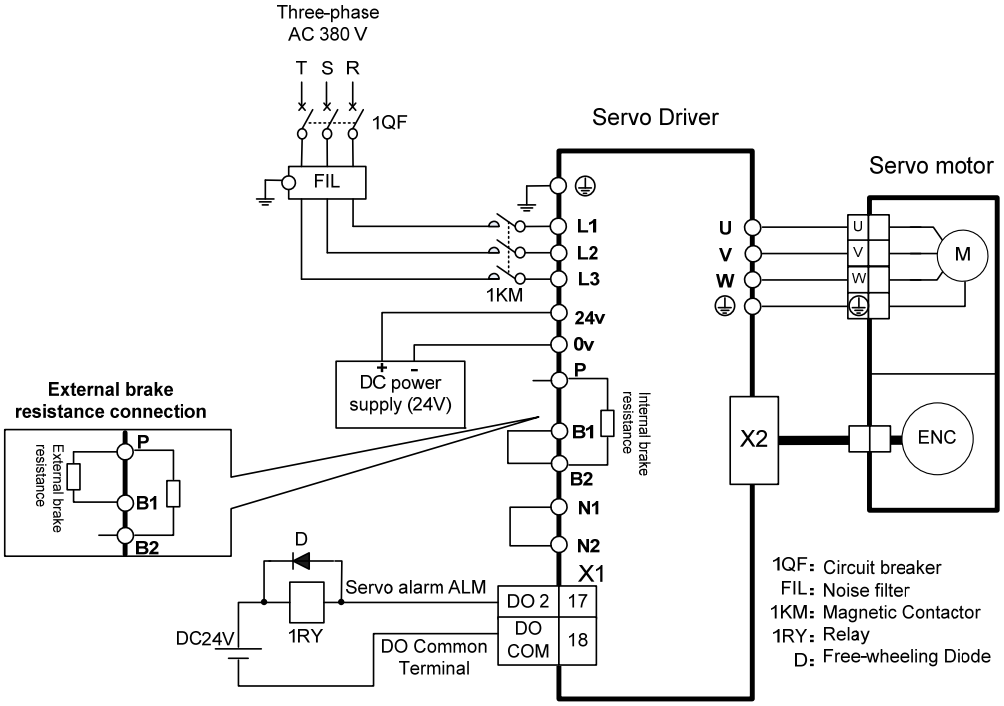
Applicable models：GL240 [Note]



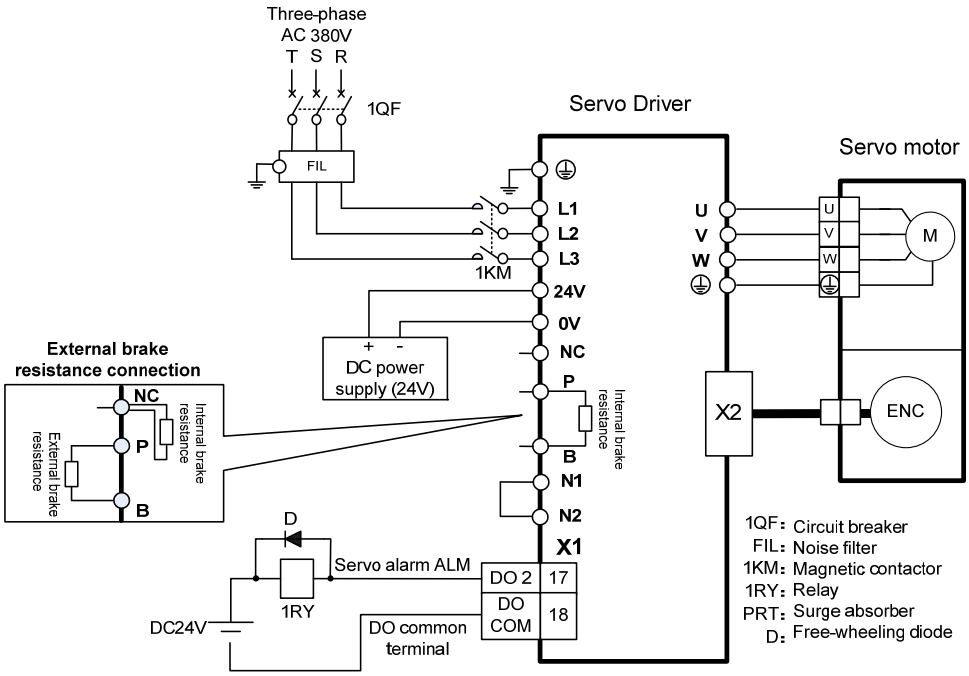
Note: GL240 has no internal brake resistor, so it needs to be connected with external brake resistor.

2. GH series:

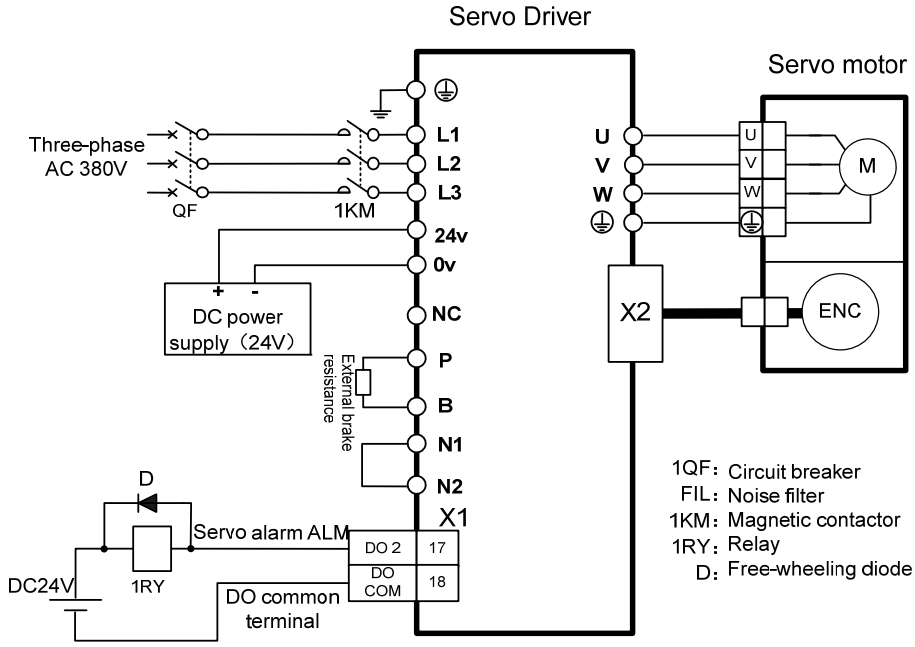
Applicable models：GH2A0、GH3A5、GH5A4、GH8A5



Applicable models：GH130



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



Note: GH170, GH210, GH260, GH320 and GH390 have no internal brake resistors. They need to be connected with external brake resistors for use.

2.2 Brake resistance adaptation

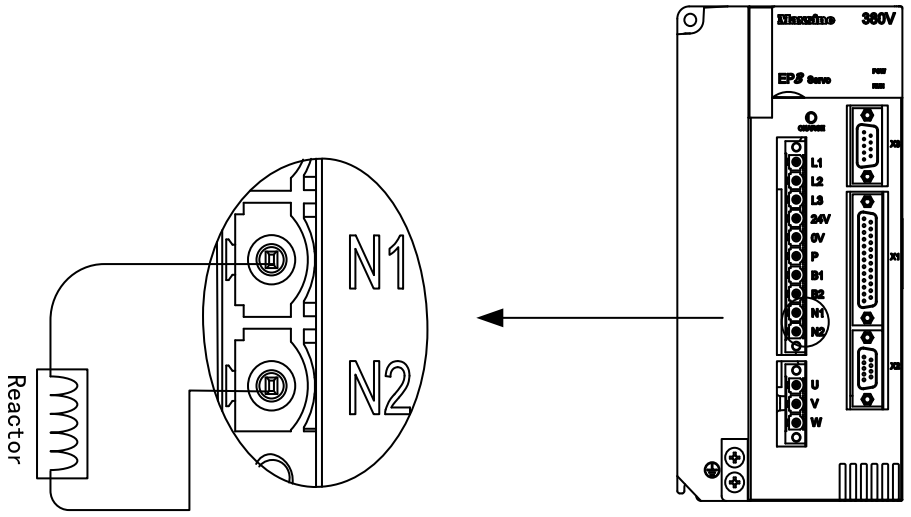
Drive series		Internal brake resistance specification	Recommended specification for external brake resistance	Minimum resistance of external brake resistance
AC220V	GL1A0	None	47Ω/100W	30Ω
	GL1A8	47Ω/100W	36Ω/200W	30Ω
	GL3A0	47Ω/100W	36Ω/200W	30Ω
	GL5A5	47Ω/100W	36Ω/200W	25Ω
	GL7A5	47Ω/100W	36Ω/200W	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 section 5.4.1 for specific modification.

2.3 Connection of reactor

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



Note: only GL190、GL240、GH2A0、GH3A5、GH5A4、GH8A5、GH130、GH170、GH210 servo drivers have external reactor connection function.

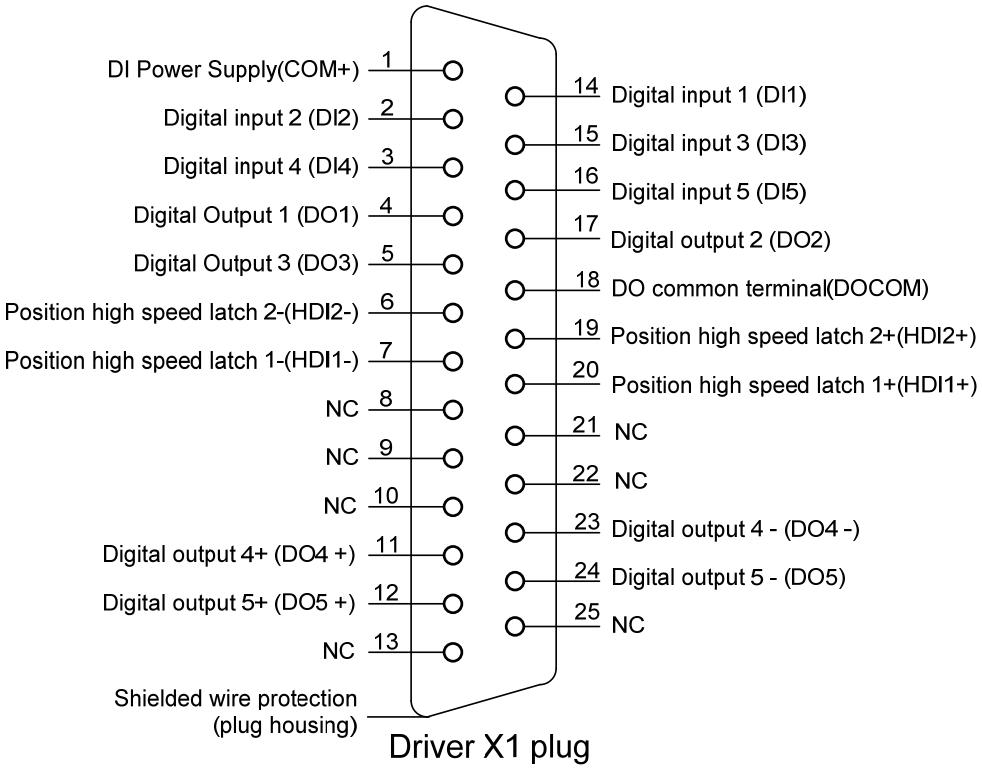
2.4 X1 control signal terminal

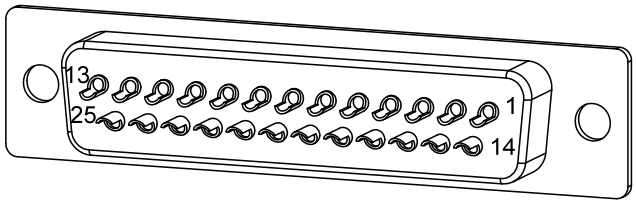
X1 control signal terminals for connected to the host controller signals, use DB25 socket, signs include:

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

2.4.1 X1 terminal plug

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





X1 plug welding pin distribution

2.4.2 X1 terminal signal description

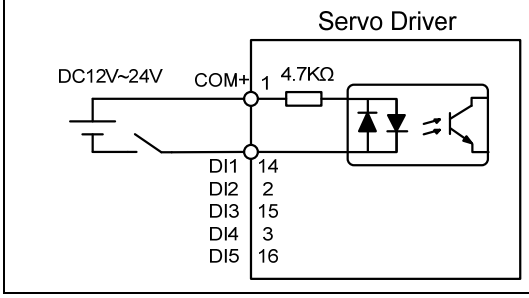
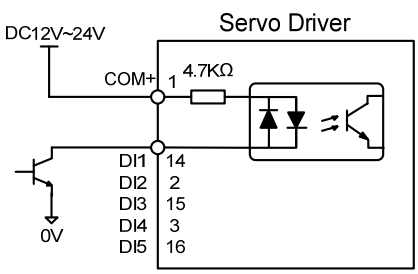
Signal name		Pin number	Functions	Connector
Digital inputs	DI1 DI2 DI3 DI4 DI5	14 2 15 3 16	Photoelectric isolation input, programmable function, defined by parameters P100 ~ P104.	C1
	COM+	1	DI power supply (DC12V ~ 24V)	
Digital outputs	DO1 DO2 DO3	4 17 5	Photoelectric isolation and output, the maximum output capacity 50mA/25V, programmable function, defined by the parameter 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
Shielding wire protected area	Plug metal housing		Connecting the shielded cable shielded wire	

2.4.3 X1 terminal interface type

The following will introduce the X1 interface circuit and the connection mode with the upper control device.

1. Digital input interfaces (C1)

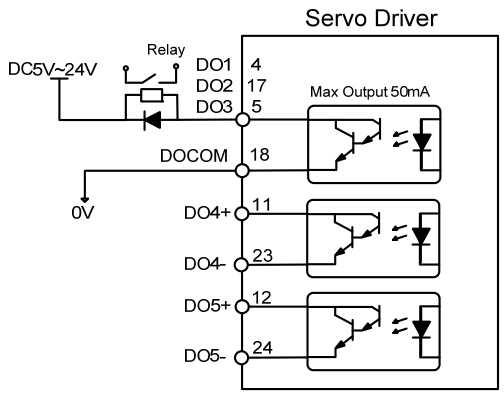
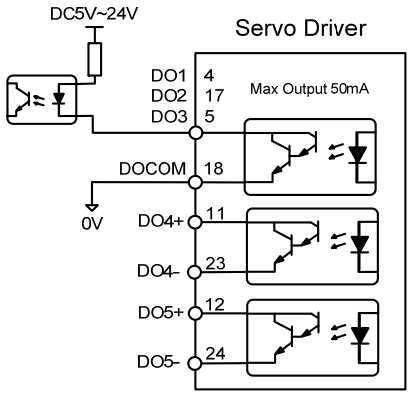
For carrying on a control, the digital input interface circuit can be constructed by switch, relay, open-collector triode, and photo-coupler and so on. To avoid contacting problem the relay must be chosen with low current operation. External voltage is in the range of DC12V~24V.

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

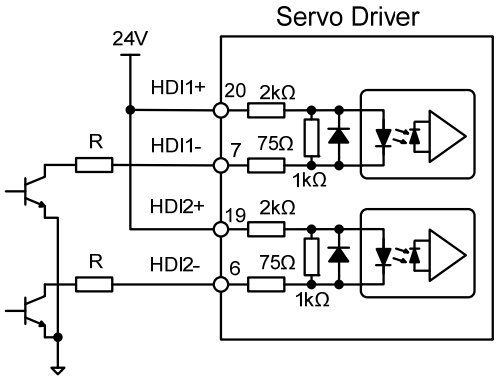
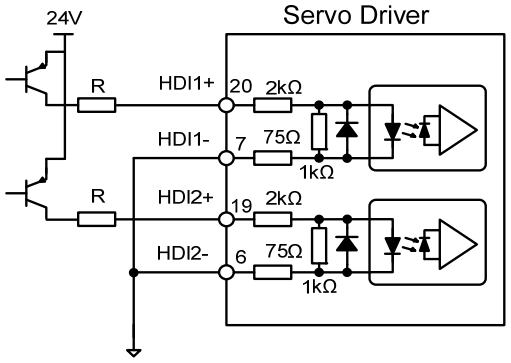
2. Digital output interfaces (C2)

The digital outputs use Darlington photo-coupler. It can be connected with relay, photo-coupler. Matters of note are:

- Inverting the polarity of DC power source, which is provided by the user, can cause the servo driver damage.
- The maximum voltage of external DC power supply is 25V, the maximum output current is 50mA, and the total current for three channels is not in excess of 100mA.
- When using relay like inductive loads, a free-wheel diode must be connected with the inductive load in parallel. If the diode connects in wrong direction can cause damage to the output circuit.
- Owing to the low level of output is approximately 1V and cannot satisfy the TTL low-level request, therefore cannot directly connect with the TTL circuit.

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

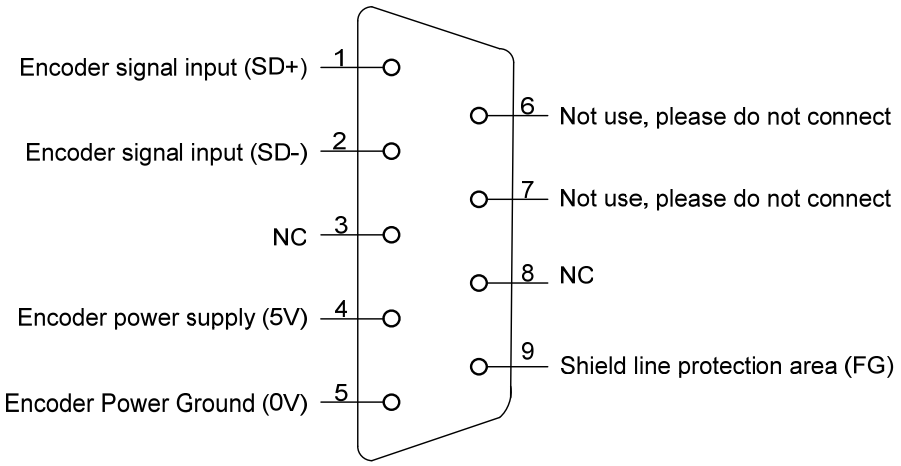
3. Position command pulse interfaces (C3)

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

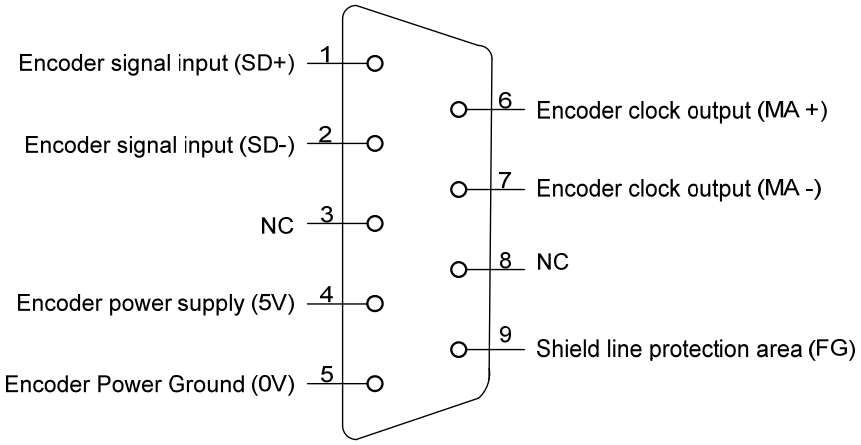
2.5 X2、X3 encoder signal terminals

2.5.1 X2 terminal plug

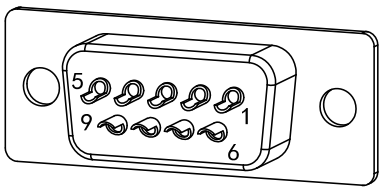
The following figure shows the connection between the signal terminal of the X2 encoder and the motor encoder. The double-row DB9 socket is used. The shape and pin distribution are as follows:



Driver X2 plug (absolute value serial communication encoder)



Driver X2 plug (absolute value for BISSC communication encoder)



X2 plug welding pin distribution

2.5.2 X2 terminal signal description

Absolute value serial communication encoder definition:

Signal name		Pin number	Function
		10 core	
Encoder power supply	5V	4	Use 5VDC power supply (provided by servo driver).If the cable is longer than 20m, in order to prevent encoder from voltage drop down, it is better to use multi wire or thick wire for power line and ground line.
	0V	5	
Signal input	SD+	1	Connect with absolute encoder signal output.
	SD-	2	
Shielding wire protected area	FG	9	Connect with cable shield wire.

Absolute value BISSC communication encoder definition:

Signal name		Pin number	Function
		Absolute （10 core）	
Encoder power supply	5V	4	Use 5VDC power supply (provided by servo driver).If the cable is longer than 20m, in order to prevent encoder from voltage drop down, it is better to use multi wire or thick wire for power line and ground line.
	0V	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

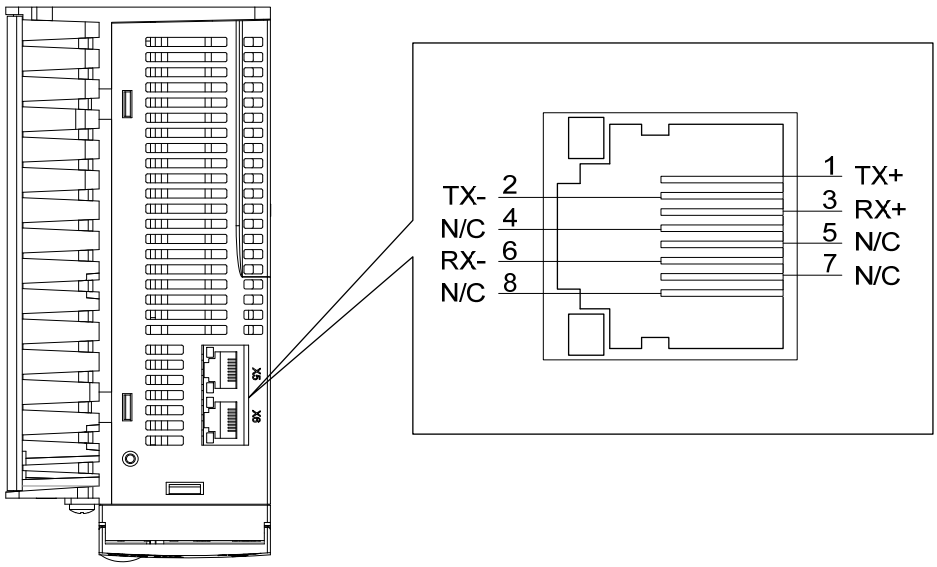
Reserved

2.6 X5、X6 PROFINET network port

The PROFINET interface of the EP3E PN servo drive has two ports that can be physically connected, X5 for PN Port.PN X5 and X6 for PN Port.PN X6. PROFINET devices are uniquely identified on the network by their PROFINET interfaces, each of which has a unique MAC address, a device name, and an IP address.

When using X5 and X6 ports, you need to ensure that the physical connections of the inputs and outputs are consistent with the topology in the configuration.

2.6.1 X5、X6 terminals interface

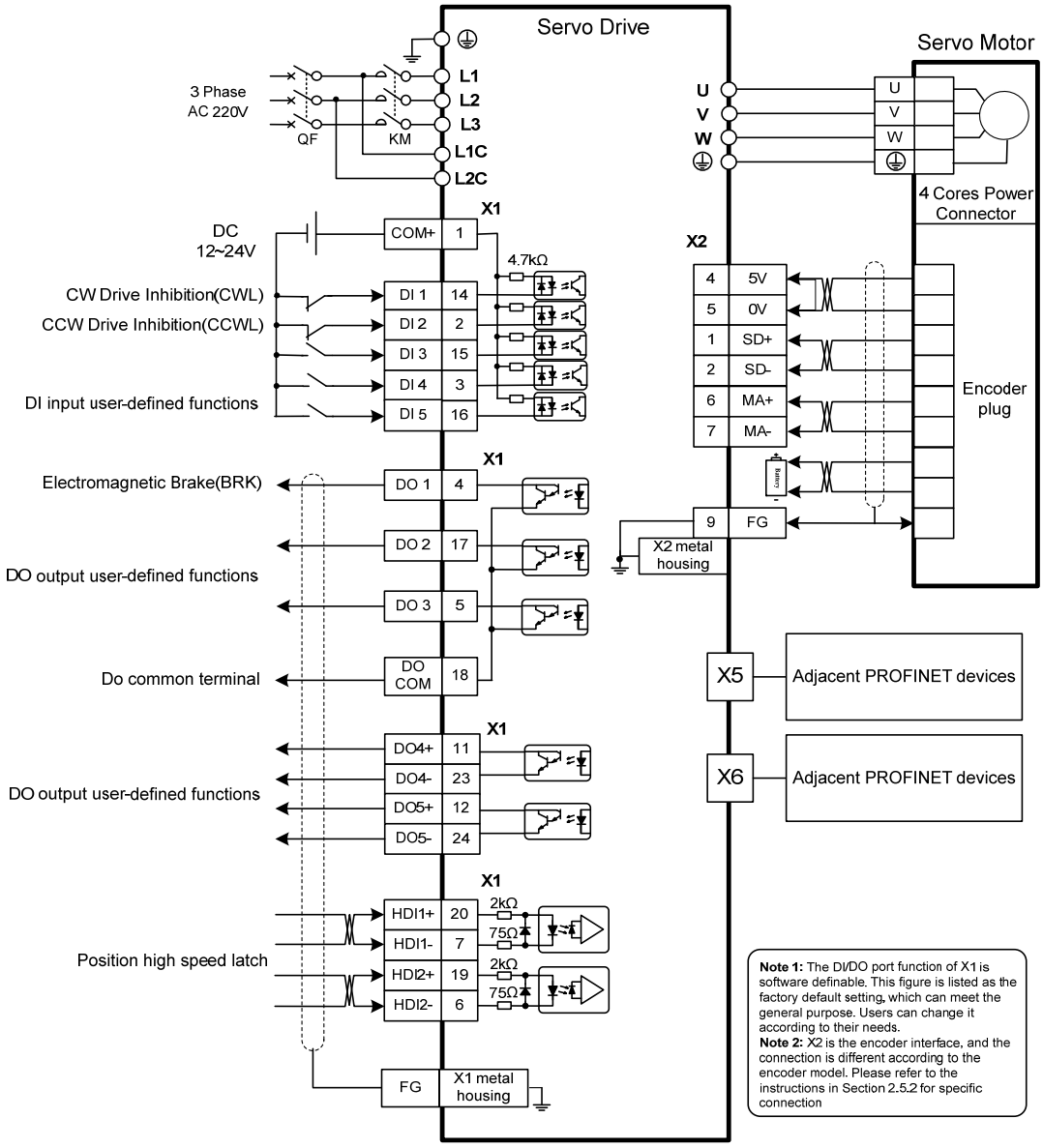


2.6.2 X5、X6 terminal signal description

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



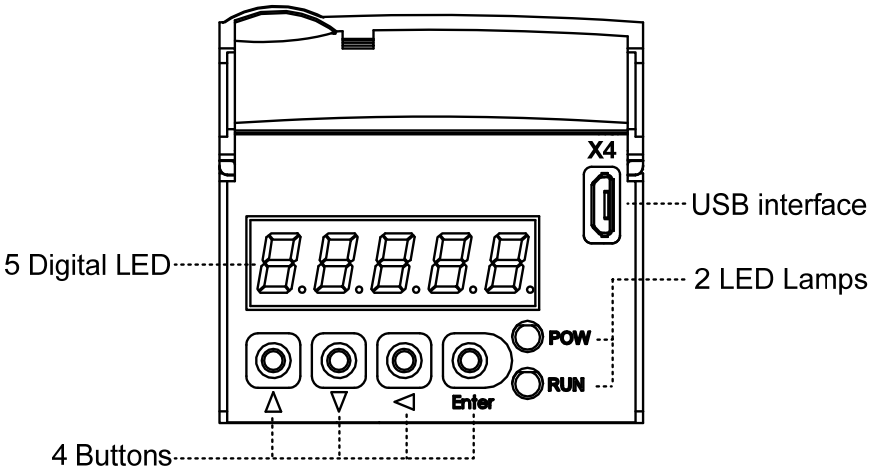
Note: The wiring diagram above takes GL7A5 as an example.

Chapter 3 Front panel operation

3.1 Driver panel description

3.1.1 Front panel compositions

The panel is composed of 5 LED digital tube displays and 4 keys ▲、▼、◄、Enter and 1 USB interface to display various states of the system and set parameters. Operations are layered operations, which are expanded by the main menu layer by layer.

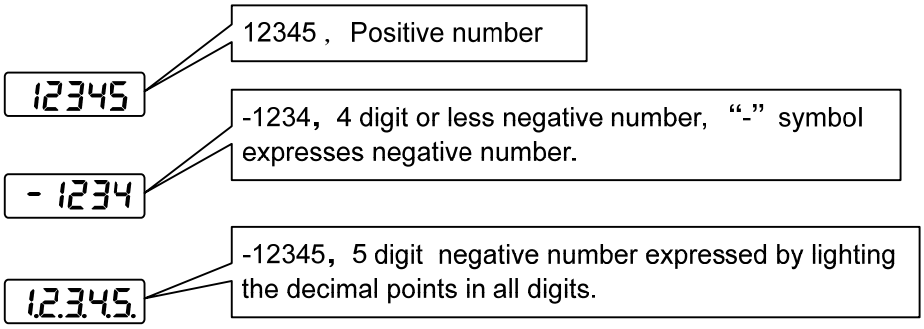


3.1.2 Front panel explanations

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: Servomotor is active; Go out: Servomotor is not active.
▲	Increasing button	Increase sequence number or value; Long press has repetitive effect.
▼	Decreasing button	Decrease sequence number or value; Long press has repetitive effect.
◄	Exit button	Menu exit; cancel the operation.
Enter	Confirm button	Menu entered; the operation confirmed.
	USB interface	Equipment connected to the computer interface.

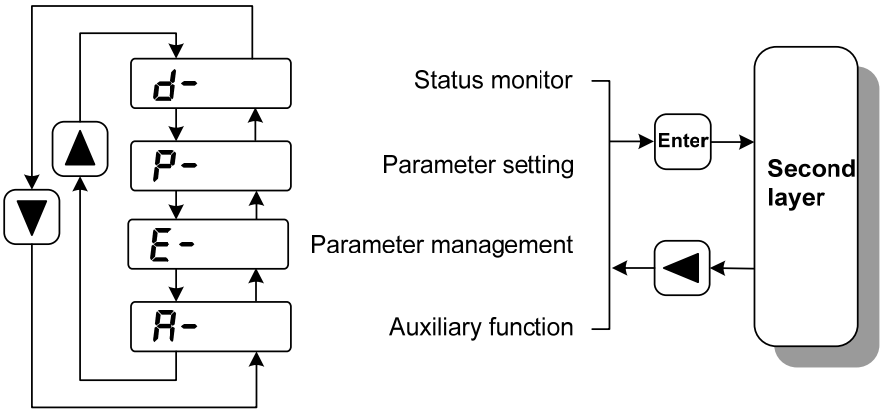
3.1.3 Data display

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



3.2 Main menu

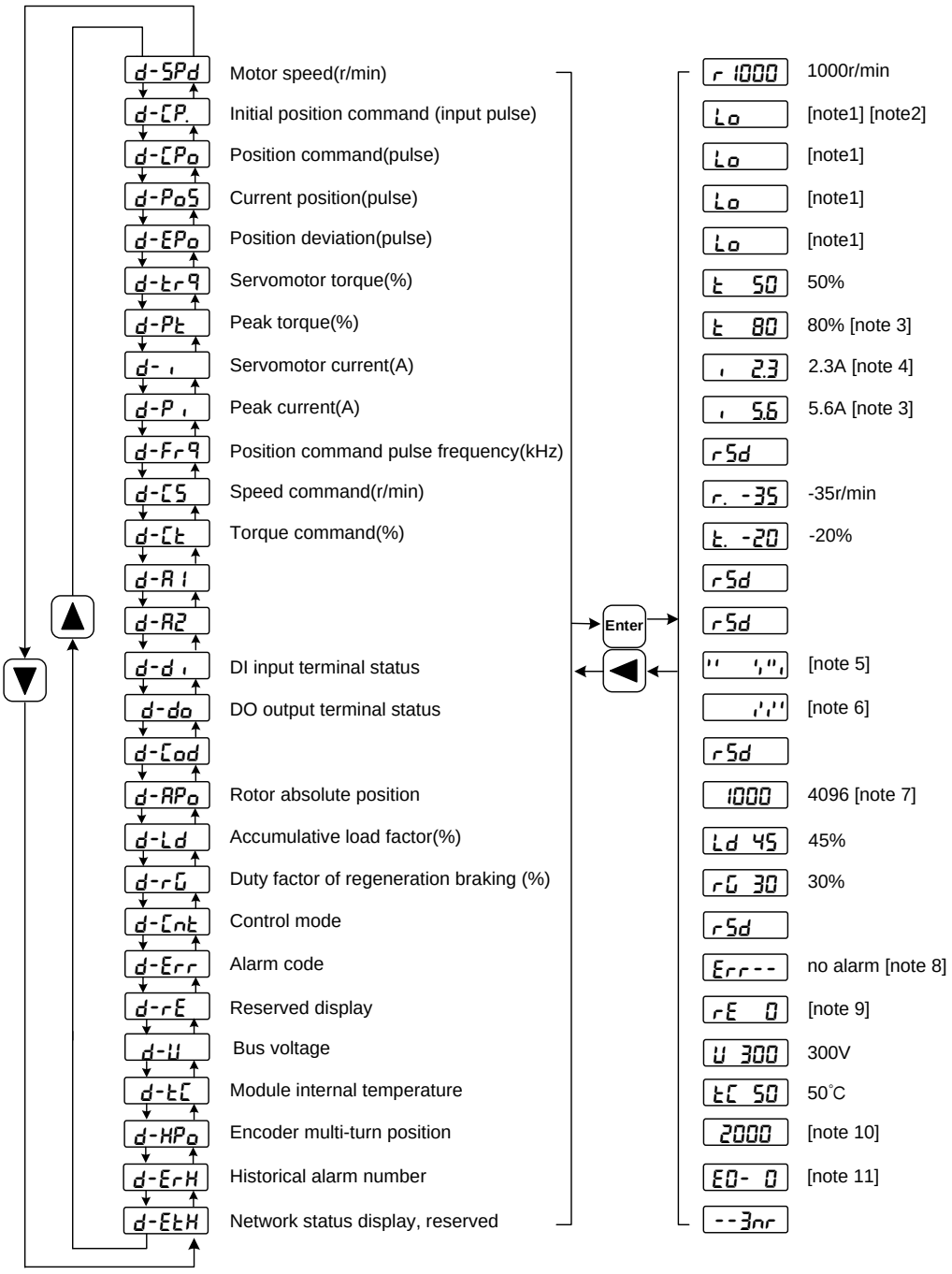
The first layer is the main menu and has four operating modes. Pressing ▲、▼ button changes the operation mode. Pressing the Enter button enters the second layer and then executes a concrete operation. Pressing ◄ button returns to the main menu from the second layer.



First layer（Main menu）

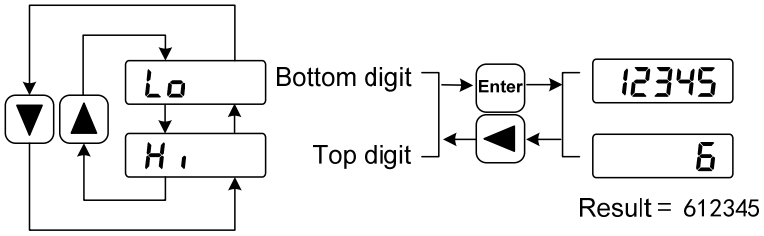
3.3 Status monitor

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-bit binary numeric display [note1]

The 32-bit binary number ranges from -2147483648 to 2147483647, which is represented by the combination of low and high values. The low and high values are selected through the menu, and the complete values are synthesized by the formula in the figure.



32bit number=top digit number×100000+bottom digit number

2. Pulse unit [note2]

The pulse of the original position instruction refers to the number of input pulses without electronic gear transformation.

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

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

3. Peak torque and peak current [note 3]

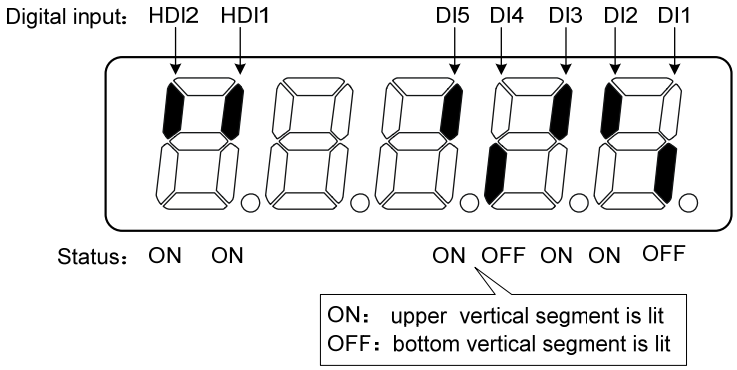
Maximum torque and maximum phase current of the motor in the last 10 seconds.

4. Servomotor current [note 4]

Effective value of motor phase current.

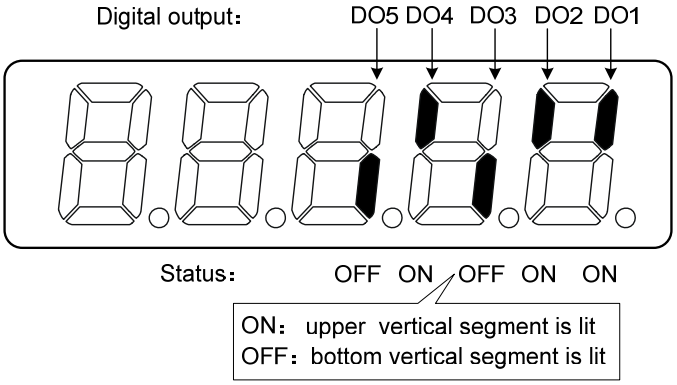
5. Input terminal DI [note 5]

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”



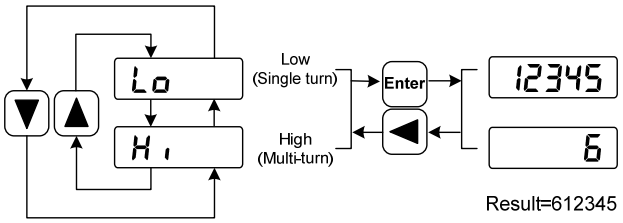
6. Output terminal DO [note 6]

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]

The rotor absolute value position is represented by the combination of low and high position, which are selected from the menu.

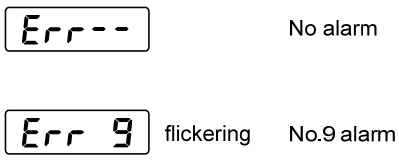


Single turn represents the position of the rotor relative to the stator in a revolution, and turns one into a period. The unified pulse unit takes the encoder Z pulse as the origin. The range is 0 to 65535, and the value is 0 when the Z pulse appears.

Multiple turns indicate the number of rotor turns, the range of which is 0 ~ 65535.

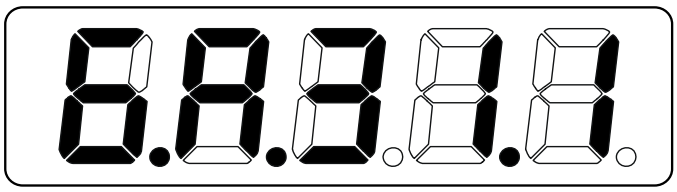
8. Alarm code [note 8]

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.



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 menu displays the date information of ERTEC200P software version. See re-0 for detailed description.

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

(4) re-3 under the menu display driver detection of communication cycle and set at a standard deviation of the communication cycle time, the unit for us, display 2 decimal places.

(5) re-4 menu displays the negative maximum 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 lost times of PROFINET 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

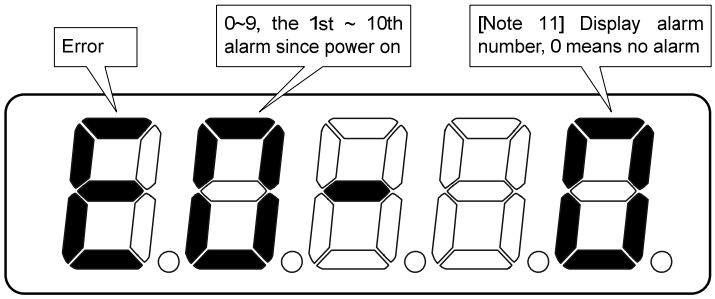
For example, the multi-turn position shows 2000, and the single-turn position shows 1000, both of which are base 10 numbers

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 ▲、▼ keys to view the history of the alarm number.



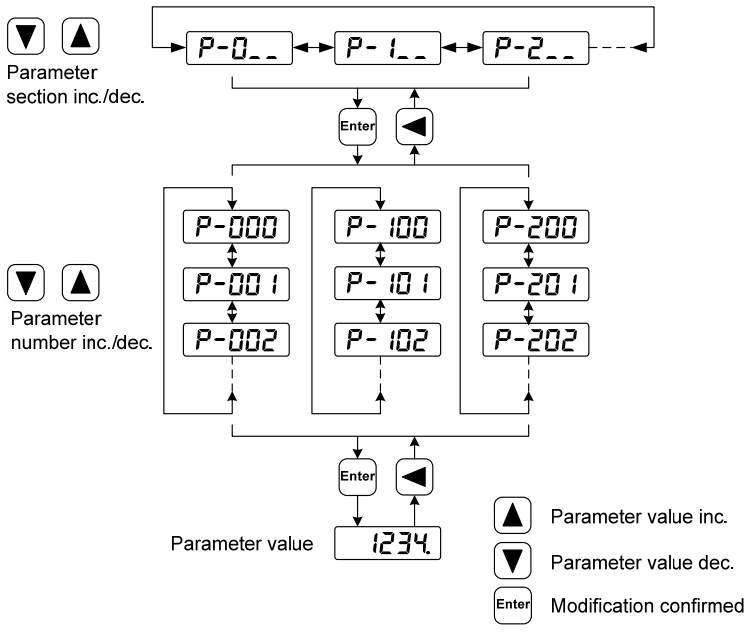
3.4 Parameters setting

Parameters are represented by parameter segment + parameter number. The hundreds digit is the segment number, and the tens digit and the ones digit are the parameter number. For example, parameter P102, segment number is "1", parameter number is "02", display is "P- 102".

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 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 ◄ button to cancel it for resuming the original parameter value.

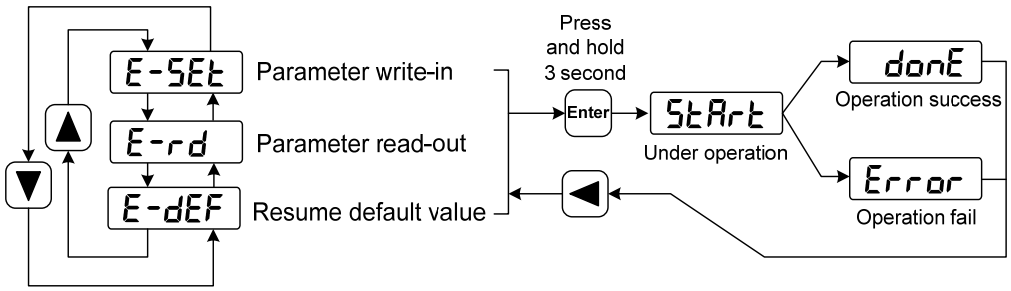
The modified parameter is not saved to EEPROM. If it needs to be saved permanently, please use the parameter write operation in parameter management. Parameter segments and Numbers are not necessarily contiguous, and unused segments and Numbers are skipped and cannot be selected.



3.5 Parameter management

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

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



- **Parameter write-in**

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

- **Parameter read-out**

  This operation indicates that all the parameters will be read from the EEPROM to the parameter list. This process will carry out automatically one time when power supply is on. At the beginning, the value of each parameter in the parameter list is the same as the parameter in the EEPROM. After making change to a parameter value, the value in the parameter list will also change. When the parameter value is not satisfied or comes to confusion, carries out the parameter read operation to read back the original parameter value from the EEPROM to the parameter list.

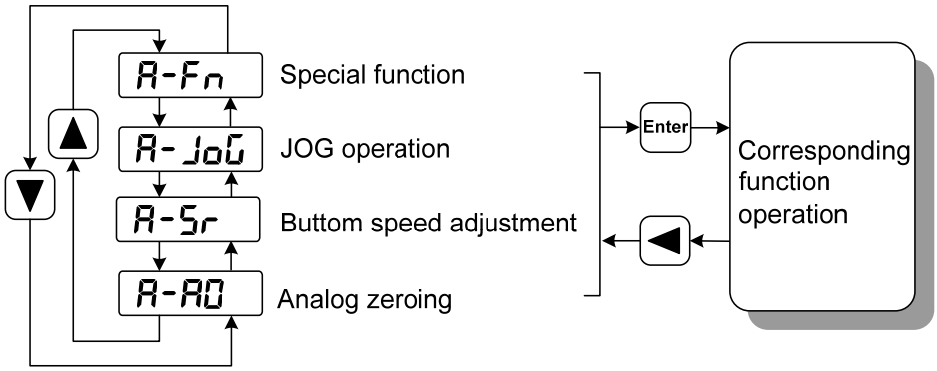
- **Resume default value**

  This operation indicates that each default value of all the parameters will read from EEPROM and write to the parameter list and EEPROM. For the next time when power supply is on the default parameters will be used by now. When many parameters become confusion and cause abnormal operation, it is necessary to carry out this operation for resuming the default parameters. There are different default parameters for different servo driver model and the servomotor model. Therefore, before doing this operation the servomotor code (Parameter P002) must be selected correctly.

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

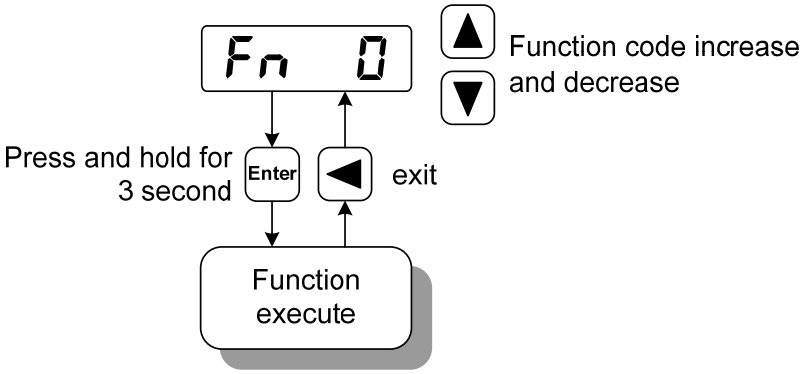
3.6 Auxiliary functions

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



3.6.1 Special functions☆

Select a special function and press Enter to enter. Set the function code with keys ▲、▼, press down key Enter and hold for more than 3 seconds to activate the operation. After finishing, you can press ◄ key to exit.



Fn number	functions	explanation
Fn36	reset the encoder (Multi-turn absolute encoder is valid)	The RESET command of encoder is used for encoder initialization, encoder alarm reset and multi-turn information return-to-zero. This function should be executed when the battery is replaced.
Fn37	Encoder alarm clearance	Encoder alarm clearing instructions are used for various alarms cleaning of encoders. Executing this command does not eliminate encoder multi loop information. This function should be executed when the battery is replaced.

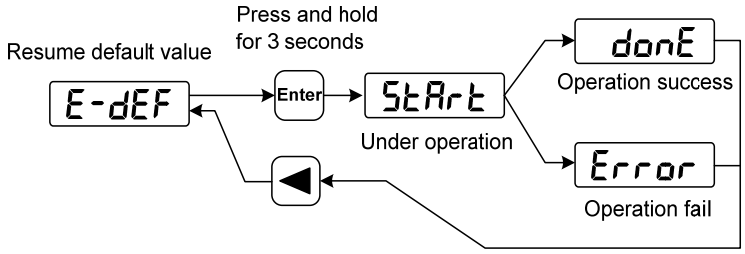
3.7 Parameter default value recovery

In the case of the following, please use the restore default parameters (factory parameters) function:

- The system cannot work properly because the parameters are out of order.
- Replace the motor. The new motor is different from the original motor.

The steps to restore the default parameters are as follows:

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



Resume all of the parameter default value

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

Chapter 4 Running

4.1 Trial running with no load

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

- Driver power wiring;
- Servo motor power wiring;
- Encoder wiring;
- Direction and speed of servo motor.

4.1.1 Wiring and inspection

Before energizing, verify that the motor:

- Motor no load, do not add load on the motor shaft, has been installed on the machine, please remove the connector.
- The motor must be fixed because of the impact of motor acceleration and deceleration.

Check the following before turning on the power:

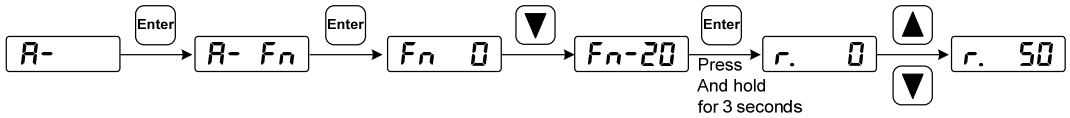
- Is the connection correct? In particular, whether the drive U, V, W and motor U, V, W wiring one to one corresponding to the drive L1, L2, L3, L1C, L2C, 24V, 0V wiring.
- Is the input voltage correct?
- Is the encoder cable connected correctly?

4.1.2 Trial running in JOG mode

Note: keyboard speed test run, need to set parameter P304 (PROFINET mode switch) to 0 to run!

When parameter P304 is 0, the driver is in normal mode, which can be used for keyboard speed control trial operation and other functions; When parameter P304 is 1, the driver is in PROFINET mode, and the control mode and instructions are all from PROFINET bus. After changing parameter P304, the parameters must be stored in EEPROM, and the drive power off, and then re-energized to run, can take effect!

1. Before performing this operation, verify that the motor is unloaded.
2. Switch on the POWER supply (AC three-phase 220V or AC single-phase 220V), the display of the driver will be on, and the POWER indicator will be on. If there is an alarm, please check the connection.
3. After confirming that there is no alarm or abnormity, and when the parameter P304 of EP3E is 0, perform the following operations as shown in the figure below:



Change the speed command with keys ▲ and ▼ and the motor will run at the given speed. A positive number means forward rotation (CCW), a negative number means reverse (CW), and the minimum given speed is 0.1r/min.

Note: after the Fn function is completed, the E-SET saving operation cannot be carried out, and the power must be turned off and restarted, otherwise the state of Fn will be saved.

4.2 Position control mode

See the section "6.3.1 AC3: Single axis positioning driver with local motion control" for instructions.

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

4.2.1 Parameter setting of position control mode

Parameter setting:

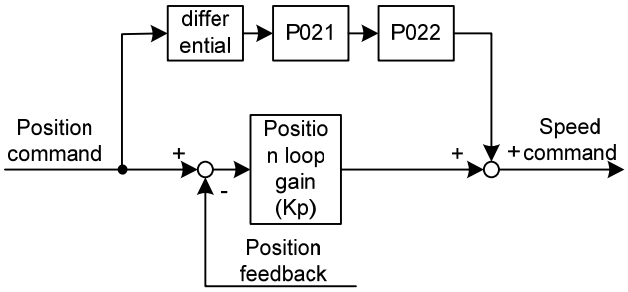
Para meter	Name	Setting value	Default value	Parameter explanation
P097	Ignore driver prohibition	3	3	Forward Drive Prohibition (CCWL) and Anti-rotational Prohibition (CWL) are used. If set to ignore, can not connect to CCWL、CWL.
P304	PROFINET mode switch	1	1	0: Normal mode; 1: PROFINET mode.

4.2.2 Gain related to position control mode

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

Since the position loop includes the speed loop, the load moment of inertia ratio is set firstly, then the gain of the speed loop and the integral time constant of the speed loop are adjusted, and finally the gain of the position loop is adjusted.

The following is the position controller of the system. The increase of the position loop gain Kp can improve the position loop bandwidth, but it is limited by the speed loop bandwidth. In order to increase the position loop gain, the velocity loop bandwidth must be increased first.



The 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

See the section "6.3.2 AC4: Motion control with central interpolation and speed setting interface" for instructions.

The speed control mode is used in applications where precise speed control is required, such as weaving machines, drilling machines, CNC machines. The position control can also be constituted by the upper device.

4.3.1 Speed control mode parameter setting

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 driver prohibition	3	3	Use Forward Drive Inhibition (CCWL) and Reverse Drive Inhibition (CWL). If set to ignore, can not connect to CCWL, CWL.
P304	PROFINET mode switch	1	1	0: Normal mode; 1: PROFINET mode.

4.3.2 Speed command source

The speed command has several different sources and is set by parameter P025:

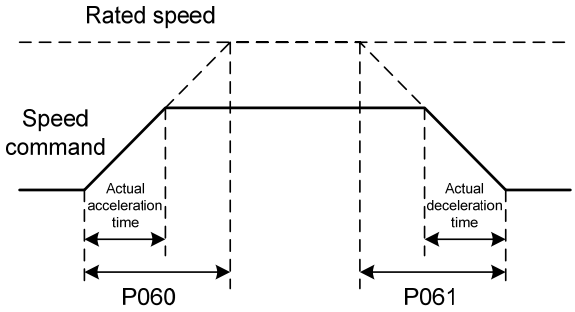
P025	Instruction	Explication
3	JOG speed command	Set when doing a JOG operation
4	Keyboard speed command	Set for keyboard speed regulation (Sr) operation
5	Demonstrate speed command	Setting for speed control demonstration

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

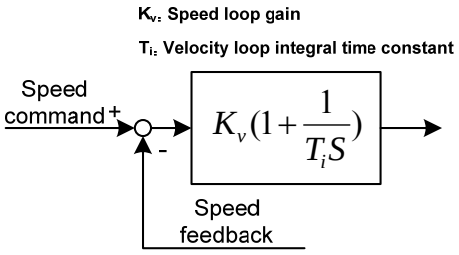
Acceleration and deceleration can slow down the sudden change of speed, so that the motor runs smoothly. As shown in the figure below, parameter P060 sets the acceleration time of the motor from zero speed to rated speed, while parameter P061 sets the deceleration time of the motor from rated speed to zero speed. If the command speed is lower than the rated speed, the required acceleration and deceleration time is also shortened. If the driver and the upper device form position control, the parameter should be set to 0.



4.3.4 Gain related to speed control mode

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

Firstly, the ratio of load's moment of inertia is set, and then the gain of velocity loop and the time constant of velocity loop integration are adjusted. 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 integral time constant T_i can increase the system rigidity and reduce the steady-state error.



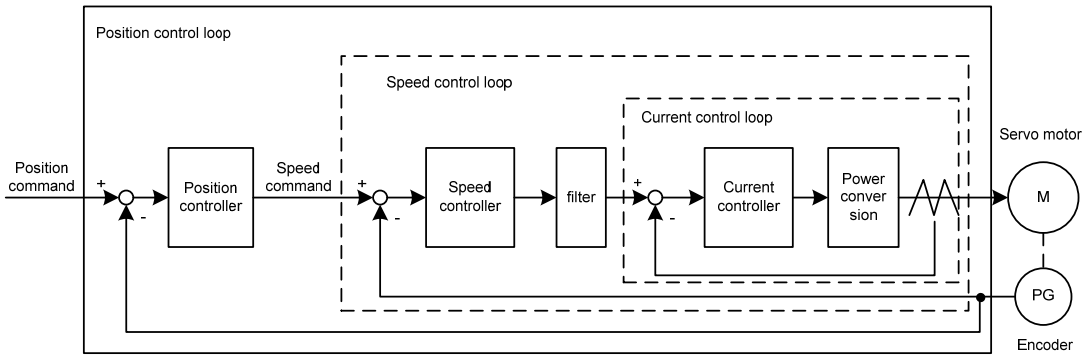
The P018 has a selectable speed controller structure, with 0 for IP regulator, 100 for PI regulator, and 1～99 for PDFF regulator. If the parameter value of P018 is large, the system has a high frequency response; if the parameter value is small, the system has a high stiffness (deviation resistance ability); and if the parameter value is medium, both frequency response and stiffness are considered.

4.4 Torque control mode

This part of the function needs to be improved.

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:



In theory, the bandwidth of the control loop of the inner layer must be higher than that of the outer layer, 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 already adjusted the current control loop to the optimum condition, the user only needs to adjust the speed control loop and position control loop parameters.

4.5.1 Gain parameters

The parameters related to the gain are:

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

The definition of symbol as follows:

K_v：Speed loop gain Kv;

T_i ： Speed loop integral time constant;

K_p：Position loop gain;

G ： Ratio of load moment of inertia (P017);

J_L ： Load moment of inertia converted to motor shaft;

J_M：Rotational inertia of motor rotor.

1. Speed loop gain Kv

The speed loop gain K_V directly determines the response bandwidth of the speed loop. Under the premise that the mechanical system does not produce vibration or noise, increase the gain value of the speed loop, the speed response will be accelerated, and the better the following of the speed command will be. However, too large setting is easy to cause mechanical resonance. Velocity loop bandwidth 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 ($G=J_L/J_M$), then the speed loop bandwidth is equal to the speed loop gain K_V.

2. Speed loop integral time constant T_i

Speed loop integral can effectively eliminate the steady-state error, and a minor change the speed of the quick response. In mechanical system under the premise of vibration or noise, reduce the speed loop integral time constant T_i, to increase the system rigidity, reduce the steady-state error. If the load inertia than large or mechanical system resonance factors are must confirm the speed loop integral time constant is enough big, otherwise the mechanical system is easy to produce resonance. If the load moment of inertia than G set ($G=J_L/J_M$) right, the speed loop integral time constant T_i are obtained by the following formula:

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

3. Position loop gain Kp

The position loop gain directly determines the reaction speed of the position loop. Under the premise that the mechanical system does not produce vibration or noise, the position loop gain value is increased to accelerate the reaction speed, reduce the position tracking error, and shorten the positioning time. However, too large a setting will cause mechanical system jitter or positioning overshoot. Position loop bandwidth shall not be higher than speed loop bandwidth, 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 ($G=J_L/J_M$), then the position loop gain Kp is calculated as follows:

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

4.5.2 Gain adjustment steps

The bandwidth selections of the position and the speed loop depend on the machinery rigidity and the application situation. A leather belt conveyer has low rigidity and may set low bandwidth. Machinery with reducer and ball bearing screw has medium rigidity and may set medium bandwidth. Machinery with ball bearing screw or linear motor has higher rigidity and may set high bandwidth. If mechanical characteristics are unknown, may gradually increase the bandwidth until resonating, and then decreases the gain

In the servo system, if changes a parameter, then other parameters also need to readjust. Therefore, do not change a parameter far from its original value. About the steps for changing the servo parameter, please observe the following principle generally:

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

Gain adjustment procedure for speed control loop:

1. Set the moment of inertia ratio of the load.
2. Set the speed loop integral time constant for larger values..
3. The gain of the speed loop is increased within the range of no vibration and abnormal sound, and slightly reduced if vibration occurs.
4. The integral time constant of the speed loop is smaller in the range of no vibration, and if the vibration is slightly increased..

5. If the gain cannot be increased due to the resonance of the mechanical system and the desired responsiveness cannot be obtained, the torque low-pass filter or notch filter can be adjusted to suppress the resonance, and then the above steps can be repeated to improve the responsiveness. First, use a torque low-pass filter, and then use a notch filter if the effect is not good. Refer to Section 4.6.

Gain adjustment procedure for position control loop:

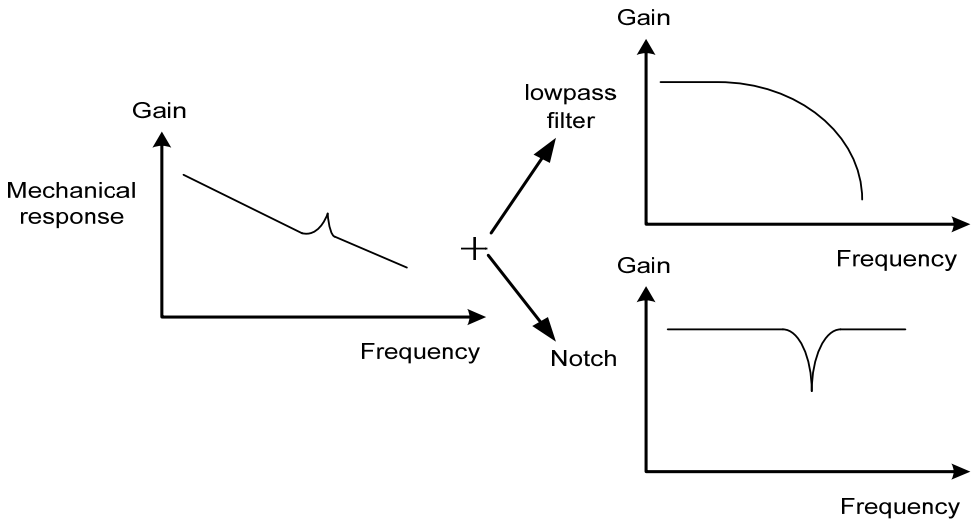
1. Set the moment of inertia ratio of the load.
2. The time constant of velocity loop integration is set to a higher value.
3. The gain of the speed loop is increased within the range of no vibration and abnormal sound, and slightly reduced if vibration occurs.
4. The integral time constant of the speed loop is smaller in the range of no vibration, and if the vibration is slightly increased..
5. Increase the position loop gain and slightly reduce it if vibration occurs.
6. If the gain cannot be increased due to the resonance of the mechanical system and the desired responsiveness cannot be obtained, the torque low-pass filter or notch filter can be adjusted to suppress the resonance, and then the above steps can be repeated to improve the responsiveness. First, use a torque low-pass filter, and then use a notch filter if the effect is not good. Refer to Section 4.6.
7. If shorter positioning time and smaller position tracking error are needed, the position feedforward can be adjusted appropriately.

4.6 Resonance suppressions

When the mechanical system resonates, it may be caused by the excessive stiffness and fast response of the servo system, and the gain reduction may be improved. The driver provides a low-pass filter and a notch to suppress resonance without changing the gain. The parameters related to resonance suppression are as follows:

Para meter	Name	Range	Default value	Unit	Usage
P007	First torque filtering time constant	0.10～50.00	1.00	ms	ALL
P200	First resonant trap frequency	50～1500	1500	Hz	ALL
P201	First quality factor of resonant trap	1～100	7		ALL
P202	First resonant trap depth	0～100	0	%	ALL
P203	Second resonant trap frequency	50～1500	1500	Hz	ALL
P204	Second quality factor of resonant trap	1～100	7		ALL
P205	Second resonant trap depth	0～100	0	%	ALL

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



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

When high frequency vibration of the machine is caused by servo drive, the time constant T_f of the torque filter is adjusted. This may eliminate the vibration. The smaller the value is, the more responsive the control can be, but it is limited by mechanical conditions. The higher the value is, the more it can suppress the high frequency vibration, and the higher the value is, the less the phase margin will be, and the oscillation will be caused. 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 the resonance of two different frequencies. By default both notch filters are turned off. If the resonant frequency can be known, the notch device can eliminate the resonant amount directly. In general, 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 gradually reduced in order from high to low, and the suppression frequency at the minimum vibration point is the optimal set value. However, if the resonance frequency deviates from time to time or other factors, and the deviation is too large, it is not suitable for the use of notch device.

In addition to the frequency, you can also adjust the notch depth and quality factor, but pay attention to the appropriate Settings. With the depth of the notch wave, the effect of mechanical resonance suppression may be very good, but it will cause great phase change, and sometimes it will strengthen the vibration. Small quality factor, wide notch width, the effect of mechanical resonance suppression may be very good, but it will cause a large phase change area, sometimes it will strengthen the vibration.

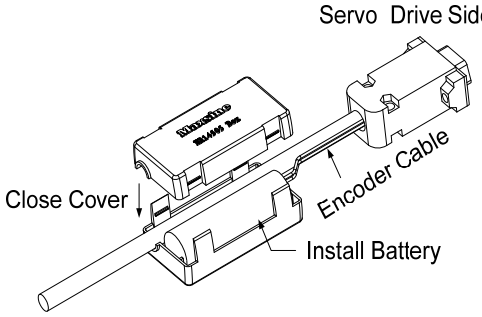
4.7 Absolute value encoder setting

4.7.1 Absolute value encoder multi-turn information saving

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

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

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



Note: Do not install battery units on both sides of the servo drive. Please set the battery unit on either side of the servo drive.

Battery voltage requirement: 3.2VDC ~ 4.8VDC

When the battery voltage is out of range, the servo driver will alarm (Err48) when the power is on. Please replace the battery at this time. After replacing the battery, in order to remove the display of "Encoder battery alarm (Err48)", please ensure that the servo drive is in the unenabled state. Connect the power supply of the servo drive control part, and initialize the absolute value encoder. After initializing, the multi-turn value is 0. Confirm error display disappears, servo drive can work normally.

4.7.2 Initialization of the absolute value encoder

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

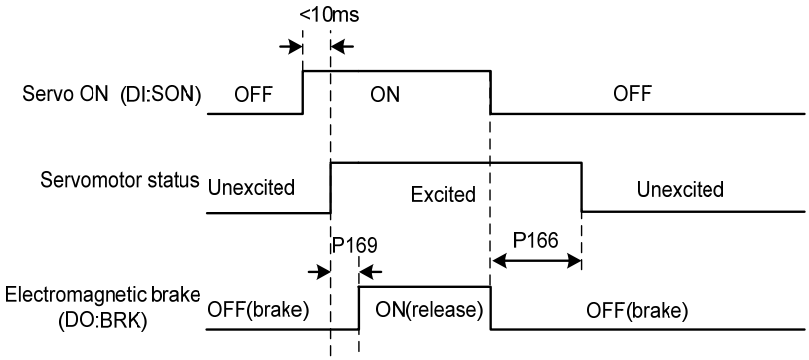
- When the machine is initially started;
- To set the absolute value of the encoder's rotation data to 0.

In the following situations, the encoder alarm must be cleared by Fn37, please refer to Section 3.6.1 for details.

- When "Encoder Battery Alarm (Err48)" occurs;
- When "Encoder Internal Fault Alert (Err41)" occurs.

4.8 Over travel protection

Over-range protection function refers to the safety function that the motor is forced to stop when the moving part of the machine exceeds the designed safe moving range and the limit switch moves. Schematic diagram of over-range protection is as follows:



Limit switches are recommended to use normally closed contacts, in the safe range is closed, over-range is disconnected. Connect to Forward Drive Prohibit (CCWL) and Reverse Drive Prohibit (CWL), which can also be set to use or ignore via the parameter P097. Set to use, must access limit signal; Set to Ignore, the signal is not needed. The default value of the parameter is that both CCWL and CWL are ignored. If it is needed, the parameter P097 must be modified. Even in the overrun state, it is allowed to exit the overrun state by entering a reverse instruction.

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

4.9 Torque limit

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

4.9.1 Torque limit parameters

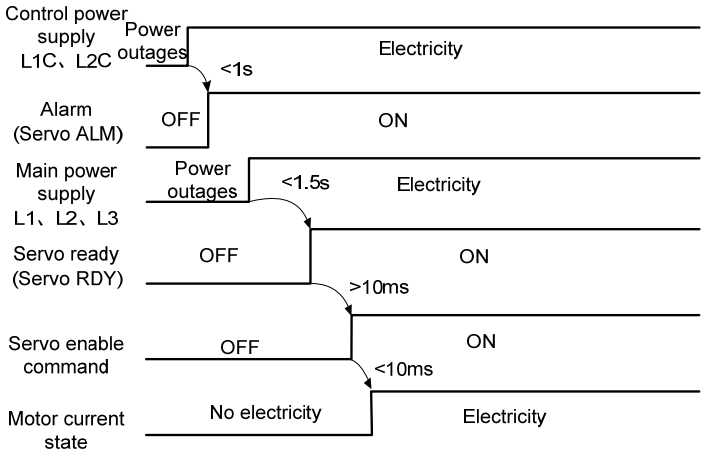
Torque limit related parameters are:

Para meter	Name	Range	Default value	Unit	Usage
P065	Internal forward (CCW) torque limit	0～300	300	%	ALL
P066	Internal reversal (CW) torque limit	-300～0	-300	%	ALL

4.10 Timing chart of operation

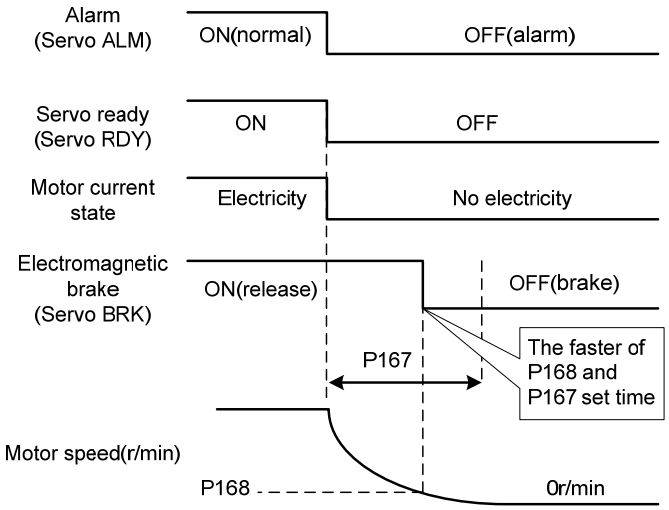
4.10.1 Timing chart when power supply switch on

- Control power supply L1C, L2C and 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 connected, the servo is ready to signal (RDY) OFF.
- After the main power is switched ON, the delay is about 1.5 seconds, and the servo signal is ready (RDY) ON. At this time, the servo enabling command can be accepted, and it is detected that the servo enabling is effective, the power circuit is turned ON, the motor is excited, and it is in the running state. Servo enabled or alarm is detected. Power circuit is closed and motor is in free state.



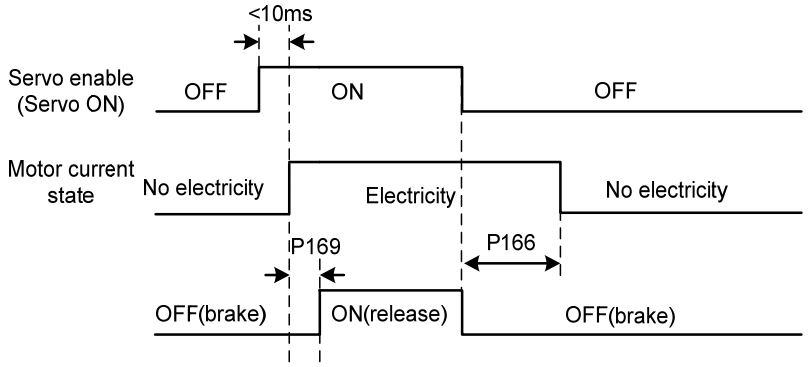
4.10.2 Alarm timing chart while servo-ON is executed

When the electromagnetic brake is controlled by servo:



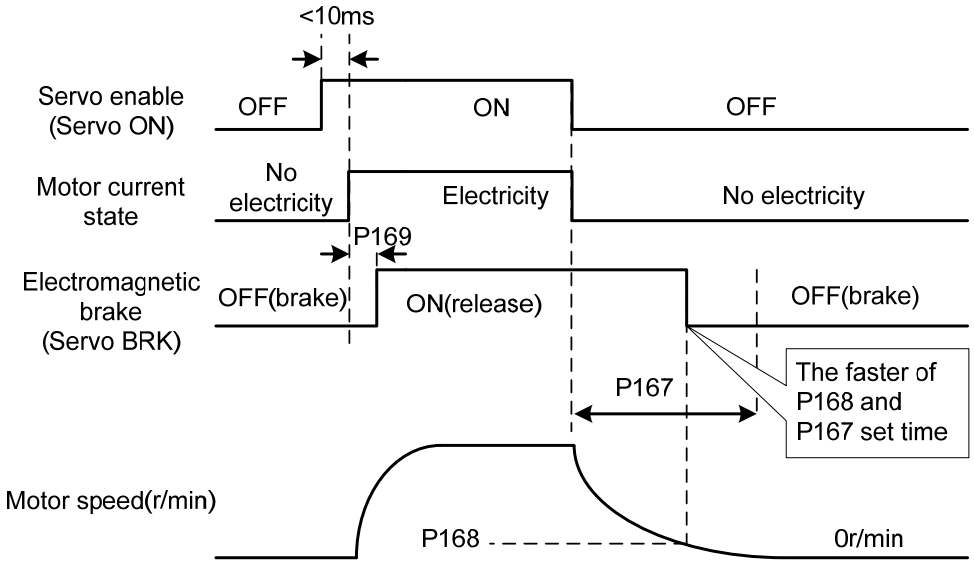
4.10.3 Servo ON/OFF action timing when the motor is stationary

When the electromagnetic brake is controlled by servo, when the motor speed is lower than the parameter P165, the action timing sequence is as follows:



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	Motor static electromagnetic brake delay time	0～2000	150	ms	ALL
P167	Electromagnetic brake waiting time when the motor is running	0～2000	500	ms	ALL
P168	Speed of action 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

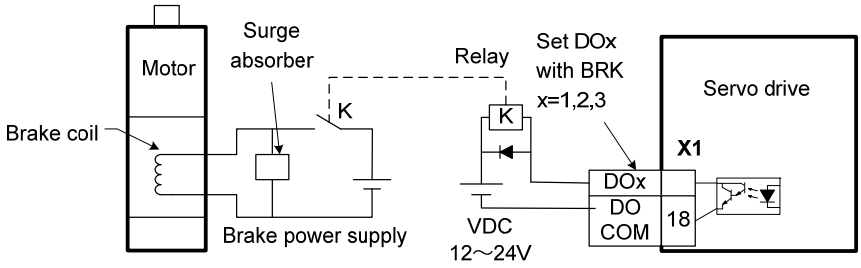
4.11.1 Electromagnetic brake use

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

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

When the motor changes from the unenabled state to the enabled state, the delay time between the motor current opening and the electromagnetic brake loosening (DO output terminal BRK ON) is determined by parameter P169.

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


Motor
Surge
absorber
Relay
Set DOx
with BRK
x=1,2,3
Servo drive
Brake coil
K
K
X1
DOx
DO
COM
18
Brake power supply
VDC
12～24V

Chapter 5 Parameters

5.1 Parameter list

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

Name	Describe	Range
INT16	Signed 16bit	-32768 ~ 32767

5.1.1 Parameters of section 0

Para meter	Name	Range	Default value	Unit
P000	Password	0～9999	315	
P001	Driver code	*	*	
P002	Motor code	0～8	*	
P003	Software version	*	*	
P004	Control mode	0~5	0	
P005	First speed loop gain	1～3000	40	Hz
P006	First speed loop integral time constant	1.0～1000.0	20.0	ms
P007	First torque filtering time constant	0.10～50.00	1.00	ms
P009	First position loop gain	1～1000	40	1/s
P010	Second speed loop gain	1~3000	40	Hz
P011	Second speed loop integral time constant	1.0~1000.0	10.0	ms
P012	Second torque filtering time constant	0.10~50.00	1.00	ms
P013	Second position loop gain	1~1000	80	1/s
P017	Load inertia ratio	0.0～200.0	1.0	times
P018	Speed loop PDFF control coefficient	0～100	100	%
P019	Speed detection filter time constant	0.01～50.00	2.00	ms
P021	Position loop feed forward gain	0～100	0	%
P022	Position loop feedforward filter time constant	0.20～50.00	1.00	ms
P025	Speed command source	0~5	0	
P040	Position instruction exponential smoothing filtering time	0~1000	0	ms
P041	Linear smoothing filtering time for position instruction	0~256	0	ms
P060	Speed command acceleration time	0～30000	0	ms

Para meter	Name	Range	Default value	Unit
P061	Speed command deceleration time	0～30000	0	ms
P064	Torque limit selection	0～3	0	
P065	Internal forward (CCW) torque limit	0～300	300	%
P066	Internal reversal (CW) torque limit	-300～0	-300	%
P070	Forward (CCW) torque overload alarm level	0～300	300	%
P071	Reverse (CW) torque overload alarm level	-300～0	-300	%
P072	Torque overload alarm detection time	0～10000	0	10ms
P075	Maximum speed limit	0～7500	5000	r/min
P076	JOG running speed	0～7500	100	r/min
P078	Speed limit in torque control	0～5000	3000	r/min
P080	Position out of tolerance detection	0.00～327.67	4.00	circle
P084	Brake resistance selector switch	0～1	0	
P085	Resistance value of external brake resistor	10～750	50	Ω
P086	Power of external brake resistor	10～10000	60	W
P088	Encoder type	0~31	0	
P090	Absolute position encoder type	0～2	0	
P093	Enable fan alarm	0～1	1	
P094	Fan on temperature point	25~125	50	℃
P096	Initial display item	0～29	0	
P097	Ignore driver prohibition	0～3	3	
P098	Force enable	0~1	0	

5.1.2 Parameters of section 1

Para meter	Name	Range	Default value	Unit
P100	Digital input DI1 function	-37～37	4	
P101	Digital input DI2 function	-37～37	3	
P102	Digital input DI3 function	-37～37	23	
P103	Digital input DI4 function	-37～37	0	
P104	Digital input DI5 function	-37～37	0	
P108	Digital High Speed Input 1 (HDI1) Filter Enable	0~1	0	
P109	Digital High Speed Input 2 (HDI2) Filter Enable	0~1	0	

Para meter	Name	Range	Default value	Unit
P110	Digital input DI1 filter	0.1～100.0	2.0	ms
P111	Digital input DI2 filter	0.1～100.0	2.0	ms
P112	Digital input DI3 filter	0.1～100.0	2.0	ms
P113	Digital input DI4 filter	0.1～100.0	2.0	ms
P114	Digital input DI5 filter	0.1～100.0	2.0	ms
P118	Digital high speed input 1 (HDI1) filter level	1~8	4	
P119	Digital high speed input 2 (HDI2) filter level	1~8	4	
P120	Digital input DI forced valid 1	00000～11111	00000	
P121	Digital input DI forced valid 2	00000～11111	00000	
P122	Digital input DI forced valid 3	00000～11111	00000	
P123	Digital input DI forced valid 4	00000～11111	00000	
P124	Digital input DI forced valid 5	00000～11111	00000	
P130	Digital output DO1 function	-28～28	8	
P131	Digital output DO2 function	-28～28	0	
P132	Digital output DO3 function	-28～28	0	
P133	Digital output DO4 function	-28～28	0	
P134	Digital output DO5 function	-28～28	0	
P149	Delay time of dynamic braking	0～1000	0	ms
P164	Emergency shutdown mode	0～1	0	
P165	Motor static speed detection point	0～1000	5	r/min
P166	Motor static electromagnetic brake delay time	0～2000	150	ms
P167	Electromagnetic brake waiting time when the motor is running	0～2000	500	ms
P168	Speed of action of electromagnetic brake when the motor is running	0～3000	100	r/min
P169	Delay time of electromagnetic brake opening	0～1000	0	ms

5.1.3 Parameters of section 2

Para meter	Name	Range	Default value	Unit
P200	First resonant trap frequency	50～1500	1500	Hz
P201	First quality factor of resonant trap	1～100	7	
P202	First resonant trap depth	0～100	0	%
P203	Second resonant trap frequency	50～1500	1500	Hz
P204	Second quality factor of resonant trap	1～100	7	
P205	Second resonant trap depth	0～100	0	%
P208	Gain switching selection	0~6	0	
P209	Gain switching level	0~32767	100	
P210	Gain switching horizontal backlash	0~32767	5	
P211	Gain switching delay time	0~3000	5	ms
P212	Gain switching time	0~3000	5	ms
P222	Compensation coefficient of vibration suppression	1.0～100.0	1.0	
P223	Vibration suppression mode	0～3	0	
P224	Manual setting of vibration period	0～1000	0	ms
P226	Intermediate frequency vibration frequency	50～1500	100	Hz
P227	Compensation coefficient of IF suppression	1～1000	100	%
P228	Intermediate frequency suppression of damping coefficient	0～300	0	%
P229	Intermediate frequency vibration suppression switch	0～2	0	
P270	Model tracking control switch	0～3	0	
P271	Model tracking control gain	10～2000	40	Hz
P273	Model tracking positive direction proportional control	0～1000	100	%
P274	Model tracking reverse proportional control	0～1000	100	%
P277	Model tracking velocity compensation feedforward	0～1000	100	%

5.1.4 Parameters of section 3

Para meter	Name	Range	Default value	Unit
P302	Message selection	*	3	
P304	PROFINET mode switch	0～1	1	
P310	Reference speed	10～X	3000	rpm
P312	Reference torque	1～X	4000	0.1nm
P315	User-defined PZD receiving word	0～2	0	
P316	User-defined PZD sending word	0～3	0	
P320	Ramp acceleration time	0～30000	1000	ms
P321	Ramp deceleration time	0～30000	1000	ms
P322	Rapid deceleration time	0～30000	100	ms
P360	Maximum number of lost SOL counts	0～32767	5	
P362	Additional packet selection	*	0	

5.2 DI Function List

Ordinal	Symbol	DI Function
0	NULL	No function
2	ARST	Clear alarm
3	CCWL	Forward driving ban
4	CWL	Reverse driving ban
15	EMG	Emergency shutdown
23	HOME SWITCH	Homing reference point

5.3 DO Function List

Ordinal	Symbol	DI Function	Ordinal	Symbol	DI Function
0	OFF	Always invalid	9	RUN	Servo in operation
1	ON	Always valid	11	TRQL	Torque under limitation
2	RDY	Servo ready	12	SPL	Speed under limitation
3	ALM	Alarm	13	HOME	Homing complete
8	BRK	Electromagnetic brake	16	DBC	Dynamic braking

5.4 Parameter description

5.4.1 Parameters of section 0

P000	Password	Range	Default value	Unit	Usage
		0~9999	315		ALL

- Classifying 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	Driver code	Range	Default value	Unit	Usage
		*	*		ALL

- The driver model currently in use. Factory has been set, the user can not modify.

P002	Motor code	Range	Default value	Unit	Usage
		0~8	*		ALL

- Current motor model in use, only valid when using panasonic motor. Factory set.
- You need to modify this parameter when changing different types of motors. Please refer to the Panasonic Motor Adaptation table for details.

P003	Software version	Range	Default value	Unit	Usage
		*	*		ALL

- Software version number, cannot be modified.

P004	Control mode	Range	Default value	Unit	Usage
		0～5	0		ALL

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

P005	First speed loop gain	Range	Default value	Unit	Usage
		1～3000	40	Hz	P,S

- The proportional gain of the speed regulator, increase the parameter value, can make the speed response faster, too large easy to cause vibration and noise.
- If P017 (Load inertia ratio) is set correctly, the parameter value is equivalent to the

velocity response bandwidth.

P006	First speed loop integral time constant	Range	Default value	Unit	Usage
		1.0～1000.0	20.0	ms	P,S

- The integral time constant of the speed regulator reduces the parameter value, which can reduce the speed control error and increase the rigidity. Too small is easy to cause vibration and noise.
- Set to the maximum value (1000.0) to cancel the integration, and the speed regulator is the P controller.

P007	First torque filtering time constant	Range	Default value	Unit	Usage
		0.10～50.00	1.00	ms	ALL

- Low pass filter with torque, can suppress mechanical vibration.
- The higher the value is, the better the vibration suppression effect will be, and too large the response will be slow and may cause oscillation. The smaller the value is, the faster the response is, but it is 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	First position loop gain	Range	Default value	Unit	Usage
		1～1000	40	1/s	P

- Proportional gain of position regulator; Increasing the parameter value can reduce the position tracking error and improve the response. Excessive parameter value may lead to overshoot or oscillation.

P010	Second speed loop gain	Range	Default value	Unit	Usage
		1～3000	40	Hz	P,S

- Refer to parameter P005 to enable the gain switch function before setting.

P011	Second speed loop integral time constant	Range	Default value	Unit	Usage
		1.0～1000.0	10.0	ms	P,S

- Refer to parameter P006 to enable the gain switch function before setting it.

P012	Second torque filtering time constant	Range	Default value	Unit	Usage
		0.10～50.00	1.00	ms	ALL

- Refer to parameter P007 to enable the gain switch function before setting it.

P013	Second position loop gain	Range	Default value	Unit	Usage
		1～1000	80	1/s	ALL

- Refer to parameter P009 to enable the gain switch function before setting it.

P017	Load inertia ratio	Range	Default value	Unit	Usage
		0.0～200.0	1.0	times	P,S

- The load inertia ratio is that the inertia of mechanical load (refers to servomotor shaft) divides by the rotor inertia of the servomotor.

P018	Speed loop PDFF control coefficient	Range	Default value	Unit	Usage
		0～100	100	%	P,S

- The PDFF coefficient of the speed regulator can be selected as the speed controller structure. 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 has a high frequency response; if the parameter value is too small, the system has a high stiffness (deviation resistance ability); if the parameter value is medium, both the frequency response and the stiffness are considered.

P019	Speed detection filter time constant	Range	Default value	Unit	Usage
		0.01～50.00	2.00	ms	P,S

- 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	Position loop feed forward gain	Range	Default value	Unit	Usage
		0～100	0	%	P

- Feed-forward can reduce the position tracking error in position control. When set to 100, the position tracking error is always 0 at any frequency of instruction 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	Position loop feedforward filter time constant	Range	Default value	Unit	Usage
		0.20～50.00	1.00	ms	P

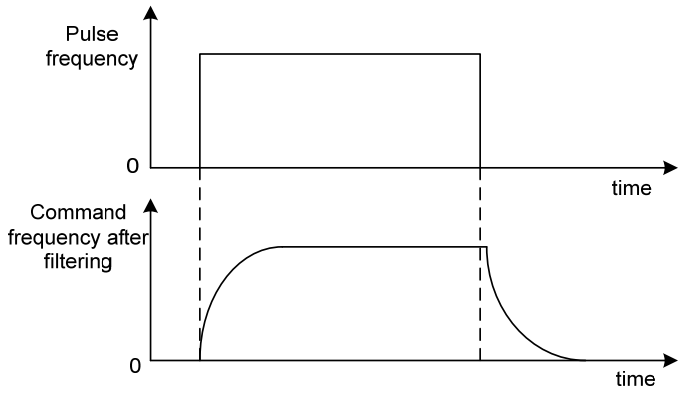
- The function of filtering the position loop feedforward is to increase the stability of feedforward control.

P025	Speed command source	Range	Default value	Unit	Usage
		0～5	0		S

- When speed control, set the source of the speed instruction. Parameter meaning:
  0, 1, 2: Reserved
  3: JOG speed command, JOG (JOG) operation, need to set.
  4: Keyboard speed command, keyboard speed regulation (SR) operation,need to set.
  5: Demonstrate speed command, speed control demonstration, need to be set, the speed command will automatically change.

P040	Position instruction exponential smoothing filtering time	Range	Default value	Unit	Usage
		0～1000	0	ms	P

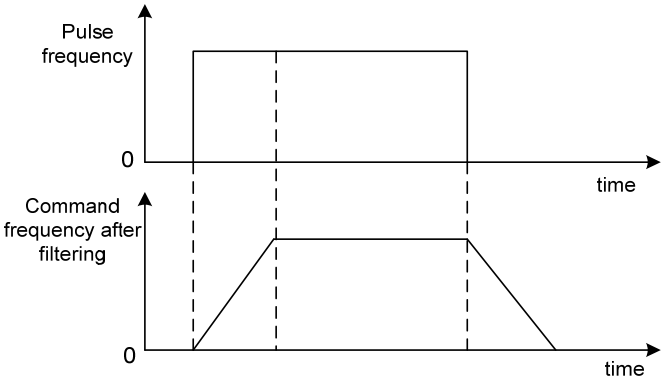
- The command pulse is smoothed and has exponential acceleration and deceleration. The filter will not lose the input pulse, but will show the instruction delay phenomenon, when set to 0, the filter is not effective.
- This filter is used for:
  1. The upper controller has no acceleration and deceleration function;
  2. The electronic gear is large (N/M>10);
  3. Low instruction frequency;
  4. Stepping and jumping and unstable phenomenon occur when the motor is running.



P041	Linear smoothing filtering time for position instruction	Range	Default value	Unit	Usage
		0～256	0	ms	P

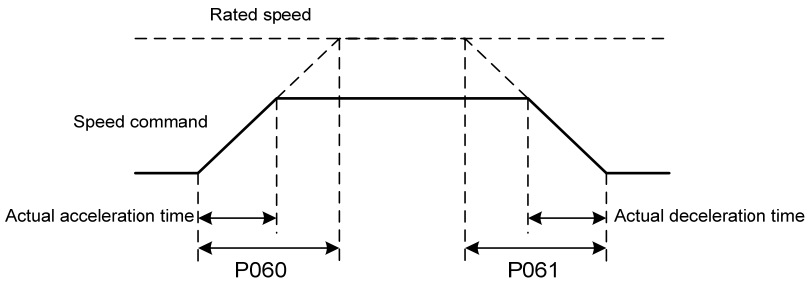
- The command pulse is smoothed and has linear acceleration and deceleration. The filter will not lose the input pulse, but will show the instruction delay phenomenon, when set to 0, the filter is not effective. The parameter value represents the time to rise from 0 frequency to 100 % of the position instruction frequency.
- This filter is used for:
  1. The upper controller has no acceleration and deceleration function;

2. The electronic gear is large (N/M>10);
3. Low instruction frequency;
4. Stepping and jumping and unstable phenomenon occur when the motor is running.



P060	Speed command acceleration time	Range	Default value	Unit	Usage
		0～30000	0	ms	S

- Set the acceleration time of the motor from zero speed to the rated speed.
- If the command speed is lower than the rated speed, the required acceleration time is correspondingly shortened.
- For speed control mode only, not position control mode.
- If the driver and the upper device constitute position control, this parameter should be set to 0, otherwise the position control performance will be affected.



P061	Speed command deceleration time	Range	Default value	Unit	Usage
		0～30000	0	ms	S

- Sets the motor deceleration time from rated speed to zero speed.
- If the command speed is lower than the rated speed, the required deceleration time is correspondingly shortened.
- For speed control mode only, not position control mode.
- If the driver is used in combination with an external position ring, this parameter should be set to 0, otherwise position control performance will be affected.

P064	Torque limit selection	Range	Default value	Unit	Usage
		0～3	0		ALL

- Set torque limit mode:
  0: internal torque limit;
  1~2: reserved;
  3: Torque limit comes from network

P065	Internal forward (CCW) torque limit	Range	Default value	Unit	Usage
		0～300	300	%	ALL

- Set the internal torque limit in the CCW direction of the motor.
- At any time, this restriction is in effect.
- If the setting value exceeds the maximum allowable system overload capacity, the actual limit is the maximum allowable system overload capacity.

P066	Internal reversal (CW) torque limit	Range	Default value	Unit	Usage
		-300～0	-300	%	ALL

- Set the internal torque limit in the CW direction of the motor.
- This restriction is in effect at all times.
- If the value exceeds the maximum overload capacity allowed by the system, the actual limit is the maximum overload capacity allowed by the system.

P070	Forward (CCW) torque overload alarm level	Range	Default value	Unit	Usage
		0～300	300	%	ALL

- Set forward torque (CCW) overload value, which is a percentage of the rated torque.
- When the positive torque of the motor exceeds P070 and the duration is longer than P072, the driver will alarm with the alarm number of Err29 and the motor will stop running.

P071	Reverse (CW) torque overload alarm level	Range	Default value	Unit	Usage
		-300～0	-300	%	ALL

- Set the reverse torque (CW) overload value, which is a percentage of the rated torque.
- When the motor reverse rotation torque exceeds P071 and the duration is longer than P072, the driver will alarm with the alarm number of Err29 and the motor will stop running.

P072	Torque overload alarm detection time	Range	Default value	Unit	Usage
		0～10000	0	10ms	ALL

- Refer to the description of parameters P070 and P071.

- When set to 0, shielding torque overload alarm.

P075	Maximum speed limit	Range	Default value	Unit	Usage
		0～7500	5000	r/min	ALL

- Set the maximum allowable speed limit of the servo motor.
- It doesn't depend on the direction of rotation.
- If the setting value exceeds the maximum speed allowed by the system, the actual speed will also be limited to the maximum speed.

P076	JOG running speed	Range	Default value	Unit	Usage
		0～7500	100	r/min	S

- Sets the speed of the JOG operation.

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

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

P080	Position out of tolerance detection	Range	Default value	Unit	Usage
		0.00～327.67	4.00	circle	P

- Set the detection range of position out of tolerance alarm.
- In the position control mode, when the value of the position deviation counter exceeds the pulse corresponding to this parameter value, the servo driver will give a position deviation alarm (Err 4).
- The unit is cycles, multiplied by the resolution per turn of the encoder to obtain the number of pulses. If 2500 line encoder is used, the resolution of encoder per turn is 10000, and the parameter value is 4.00, corresponding to 40,000 encoder pulses.

P084	Brake resistance selector switch	Range	Default value	Unit	Usage
		0～1	0		ALL

- Parameter meaning:
  0: Adopt internal brake resistance. 1: Use external brake resistance.

P085	Resistance value of external brake resistor	Range	Default value	Unit	Usage
		10～750	50	Ω	ALL

- This parameter is set according to the resistance value of the actual external brake

resistance.

- If internal brake resistance (P084=0) is used, this parameter is invalid.

P086	Power of external brake resistor	Range	Default value	Unit	Usage
		10～10000	60	W	ALL

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

P088	Encoder type	Range	Default value	Unit	Usage
		0~31	0		ALL

- Parameter meaning:
  0: Automatic recognition.
  1: Tamagawa.
  2: Panasonic.
  3: Nikon.
  6: Decoding box
- Note: when P088 is 2 (Panasonic), you need to select motor code by P002.

P090	Absolute position encoder type (absolute only)	Range	Default value	Unit	Usage
		0～2	0		ALL

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

P093	Enable fan alarm	Range	Default value	Unit	Usage
		0～1	1		ALL

- Parameter meaning:
  0: Shielded fan fault alarm (except for special reasons, customers are not recommended to shield this bit).
  1: Allow fan failure alarm.

P094	Fan on temperature point	Range	Default value	Unit	Usage
		25～125	50	℃	ALL

- When the module temperature is higher than this temperature, the drive cooling fan begins to operate.
- When the module temperature falls below this temperature, the drive cooling fan stops

working.

P096	Initial display item	Range	Default value	Unit	Usage
		0～29	0		ALL

- The display state of the monitor after the drive is powered on. Parameter meaning:

P096	Display item	P096	Display item
0	Servomotor speed	15	Digital output DO
1	Original Position command	16	Encoder signal
2	Position command	17	Absolute position in a turn
3	Servomotor position	18	Cumulative load rate
4	Position deviation	19	Brake load ratio
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	PROFINET status display

P097	Ignore driver prohibition	Range	Default value	Unit	Usage
		0～3	3		ALL

- Forward drive prohibition (CCWL) and reverse drive prohibition (CWL) in DI input are used for limit travel protection. Normally closed switch is adopted. When the input is ON, the motor can run in this direction, and when OFF, it cannot run in this direction. If the limit travel protection is not used, it can be ignored by this parameter, so it can be run without access to the driver stop signal.
- The default value is to ignore driver disabling. If you want to use driver disabling, please modify this value first.
- Parameter meaning:

P097	Reverse Drive Prohibition (CWL)	Forward Drive Prohibition (CCWL)
0	Use	Use
1	Use	Neglect
2	Neglect	Use
3	Neglect	Neglect

Usage: When the input signal is ON, the motor can run in this direction; The motor

cannot run in this direction when OFF.

Neglect: the motor can run in this direction, the driver forbid signal has no effect, can not access the signal.

P098	Force enable	Range	Default value	Unit	Usage
		0～1	0		ALL

- P098 parameter is invalid when P304 = 1, effective P304 = 0.
- Parameter meaning:

  0: Enable by DI input SON control;

  1: Software enablement.

5.4.2 Parameters of section 1

P100	Digital input DI1 function	Range	Default value	Unit	Usage
		-37～37	4		ALL

- Input DI1 function planning by number. Absolute value of parameter represents function and symbol represents logic. Please refer to Section 5.5 for function.
- Symbol denotes input logic, positive numbers denote positive logic, negative numbers denote negative logic, ON is valid, OFF is invalid:

Parameter value	DI input signal	DI result
Positive number	Open circuit	OFF
	Conduction	ON
Negative number	Open circuit	ON
	Conduction	OFF

- When multiple input channels have the same function choice, the function result is logical or relational. For example, P100 and P101 are both set to 1 (SON function), then DI1, DI2 any ON, SON is valid.
- Input functions that are not selected by parameters P100 ~ P104, i.e. unplanned functions, result in OFF (invalid). With exceptions, setting parameters P120 ~ P124 can force the function ON (valid), whether the function is planned or not.

P101	Digital input DI2 function	Range	Default value	Unit	Usage
		-37～37	3		ALL

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

P102	Digital input DI3 function	Range	Default value	Unit	Usage
		-37～37	23		ALL

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

P103	Digital input DI4 function	Range	Default value	Unit	Usage
		-37～37	0		ALL

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

P104	Digital input DI5 function	Range	Default value	Unit	Usage
		-37～37	0		ALL

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

P108	Digital High Speed Input 1 (HDI1) Filter Enable	Range	Default value	Unit	Usage
		0～1	0		ALL

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

P109	Digital High Speed Input 2 (HDI2) Filter Enable	Range	Default value	Unit	Usage
		0～1	0		ALL

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

P110	Digital input DI1 filter	Range	Default value	Unit	Usage
		0.1～100.0	2.0	ms	ALL

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

P111	Digital input DI2 filter	Range	Default value	Unit	Usage
		0.1～100.0	2.0	ms	ALL

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

P112	Digital input DI3 filter	Range	Default value	Unit	Usage
		0.1～100.0	2.0	ms	ALL

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

P113	Digital input DI4 filter	Range	Default value	Unit	Usage
		0.1～100.0	2.0	ms	ALL

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

P114	Digital input DI5 filter	Range	Default value	Unit	Usage
		0.1～100.0	2.0	ms	ALL

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

P118	Digital high speed input 1 (HDI1) filter level	Range	Default value	Unit	Usage
		1~8	4		ALL

- Parameter meaning:
  1~8: From low to high, the filtering ability is enhanced

P119	Digital high speed input 2 (HDI2) filter level	Range	Default value	Unit	Usage
		1~8	4		ALL

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

P120	Digital input DI forced valid 1	Range	Default value	Unit	Usage
		00000～11111	00000		ALL

- Corresponding functions are represented by 5-bit binary:

Digital	bit4	Bit3	Bit2	Bit1	bit0
Corresponding function	CWL	CCWL	ARST	SON	NULL

- The function used to force DI input is valid. If the corresponding bit of the function is set to 1, the function enforces ON (valid).
- The meaning of the DI symbol is referred to Section 5.2. Parameter meaning:

One of the parameters	Corresponding functions [Note]	Functional results
0	Not planned	OFF
	planned	It depends on the input signal
1	Not planned or planned	ON

Note: Planned refers to the function selected by parameters P100 ~ P104;
Unplanned is a function that is not selected by parameters P100 to P104.

P121	Digital input DI force valid 2	Range	Default value	Unit	Usage
		00000～11111	00000		ALL

- Corresponding functions are represented by 5-bit binary:

Digital	bit4	bit3	bit2	bit1	bit0
Corresponding function	CINV	CZERO	ZCLAMP	TCW	TCCW

- Description of other reference parameter P120.

P122	Digital input DI force valid 3	Range	Default value	Unit	Usage
		00000～11111	00000		ALL

- Corresponding functions are represented by 5-bit binary:

Digital	bit4	bit3	bit2	bit1	bit0
Corresponding function	TRQ2	TRQ1	SP3	SP2	SP1

- Description of other reference parameter P120.

P123	Digital input DI force valid 4	Range	Default value	Unit	Usage
		00000～11111	00000		ALL

- Corresponding functions are represented by 5-bit binary:

Digital	bit4	bit3	bit2	bit1	bit0
Corresponding function	GEAR2	GEAR1	GAIN	CMODE	EMG

- Description of other reference parameter P120.

P124	Digital input DI force valid 5	Range	Default value	Unit	Usage
		00000～11111	00000		ALL

- Corresponding functions are represented by 5-bit binary:

Digital	bit4	bit3	bit2	bit1	bit0
Corresponding function	REF	GOH	PC	INH	CLR

- Description of other reference parameter P120.

P130	Digital output DO1 function	Range	Default value	Unit	Usage
		-28～28	8		ALL

- Digital output DO1 function planning, absolute value of parameter represents function, symbol represents logic, please refer to Section 5.3 for function.
- 0 forces OFF and 1 forces ON.
- Signs represent output logic, positive numbers represent positive logic, and negative numbers represent negative logic:

Parameter value	Corresponding function	DO output signal
Positive number	ON	Conduction
	OFF	Cut-off
Negative number	ON	Cut-off
	OFF	Conduction

P131	Digital output DO2 function	Range	Default value	Unit	Usage
		-28～28	0		ALL

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

P132	Digital output DO3 function	Range	Default value	Unit	Usage
		-28～28	0		ALL

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

P133	Digital output DO4 function	Range	Default value	Unit	Usage
		-28～28	0		ALL

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

P134	Digital output DO5 function	Range	Default value	Unit	Usage
		-28～28	0		ALL

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

P149	Delay time of dynamic braking	Range	Default value	Unit	Usage
		0～1000	0	ms	ALL

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

P164	Delay time of dynamic braking	Range	Default value	Unit	Usage
		0～1	0		ALL

- When EMG (emergency shutdown) in DI is ON, the meaning of this parameter is:
  0: Drive directly cut off the motor current, motor free stop;
  1: the driver can keep status, control motor to 6085 h (Quick stop deceleration) defined by the deceleration to stop.

P165	Motor static speed detection point	Range	Default value	Unit	Usage
		0～1000	5	r/min	ALL

- Motor static detection, motor speed is lower than the parameter value is considered to be static motor.
- Used only for timing judgment of electromagnetic brakes.

P166	Motor static electromagnetic brake delay time	Range	Default value	Unit	Usage
		0～2000	150	ms	ALL

- Define the delay time from the electromagnetic brake braking (DO output terminal BRK OFF) to the motor current cut OFF during the motor rest period when the system changes from the enabled state to the deactivated state or when an alarm occurs.
- This parameter is to make the brake reliable after braking and then cut off the current, to avoid the small displacement of the motor or workpiece drop. The parameter should not be less than the delay time of mechanical braking. See Section 4.10.3 for corresponding chronology.

P167	Electromagnetic brake waiting time when the motor is running	Range	Default value	Unit	Usage
		0～2000	500	ms	ALL

- Define the delay time between the motor current cut OFF and the electromagnetic brake (DO output terminal BRK OFF) during the motor operation when the system changes from the enabled state to the deactivated state or when an alarm occurs.
- This parameter is to make the motor slow down from high speed to low speed, and then let the brake brake, to avoid damage to the brake.
- The actual action time is P167 or the time required for the motor to decelerate to the value of P168, and the minimum value of the two is chosen.
- See Section 4.10.4 for the corresponding chronology.

P168	Speed of action of electromagnetic brake when the motor is running	Range	Default value	Unit	Usage
		0～3000	100	r/min	ALL

- Refer to the description of parameter P167.

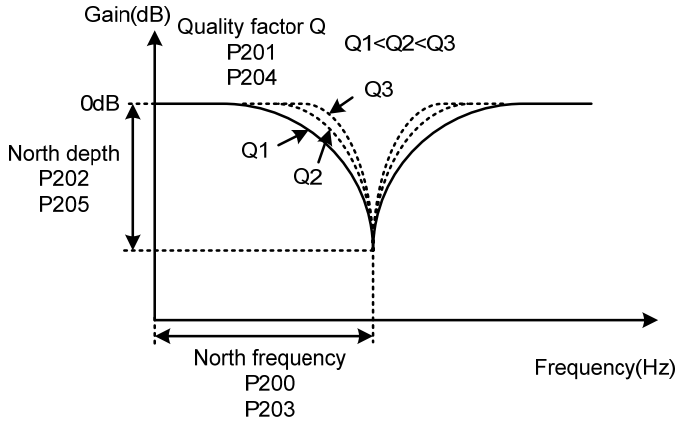
P169	Delay time of electromagnetic brake opening	Range	Default value	Unit	Usage
		0～1000	0	ms	ALL

- When the system changes from the disenabled state to the enabled state, define the delay time between the motor current turning ON and the electromagnetic brake releasing (DO output terminal BRK ON).
- See Section 4.10 for corresponding chronology.

5.4.3 Parameters of section 2

P200	First resonant trap frequency	Range	Default value	Unit	Usage
		50～1500	1500	Hz	ALL

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



P201	First quality factor of resonant trap	Range	Default value	Unit	Usage
		1～100	7		ALL

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

$$\text{Quality factor Q} = \frac{\text{North frequency}}{\text{North Width}}$$

P202	First resonant trap depth	Range	Default value	Unit	Usage
		0～100	0	%	ALL

- The notch depth of the notch filter is set, and the greater the parameter, the larger the notch depth is, that is, the larger the filter gain attenuation. Set to 0 to turn off the notch filter.
- The notch depth D in dB unit is:

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

P203	Second resonant trap frequency	Range	Default value	Unit	Usage
		50～1500	1500	Hz	ALL

- Notch filter is a kind of filter used to eliminate the special frequency resonance caused by

machinery.

- If P205 is set to 0, the notch filter is turned off.

P204	Second quality factor of resonant trap	Range	Default value	Unit	Usage
		1～100	7		ALL

- Refer to the specification of parameter P201.

P205	Second resonant trap depth	Range	Default value	Unit	Usage
		0～100	0	%	ALL

- Set the notch depth of the notch filter, and set it to 0 to turn off the notch filter. Refer to P202 for other information.

P208	Gain switching selection	Range	Default value	Unit	Usage
		0～6	0		ALL

- Parameter meaning:

  0: Fixed the first gain.

  1: Fixed the second gain.

  2 ~ 3: Reservation.

  4: Pulse deviation control, switch to the second gain when the position pulse deviation exceeds P209.

  5: Motor speed control, switch to the second gain when the motor speed exceeds P209.

  6：Reserved.

- The first gain and the second gain are combined, with 4 parameters in each group, switching at the same time.

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

P209	Gain switching level	Range	Default value	Unit	Usage
		0～32767	100		ALL

- Switching conditions and units vary according to the setting of parameter P208.
- Parameter P210 and P209 are in the same unit.

- The comparator has a return function, set by parameter P210.

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

P210	Gain switching level	Range	Default value	Unit	Usage
		0～32767	5		ALL

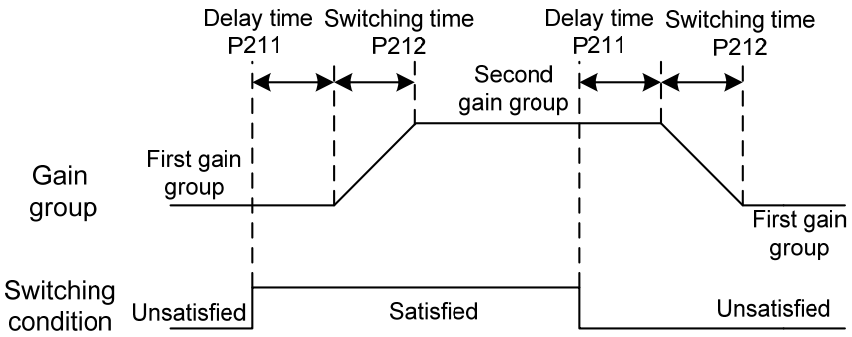
- Refer to the description of parameter P209.

P211	Gain switching delay time	Range	Default value	Unit	Usage
		0～3000	5	ms	ALL

- The gain switching condition satisfies the delay time from the start of switching.
- If the handover condition is not met in the delay phase, the handover is canceled.

P212	Gain switching time	Range	Default value	Unit	Usage
		0～3000	5	ms	ALL

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



P222	Compensation coefficient of vibration suppression	Range	Default value	Unit	Usage
		1.0～100.0	1.0		P

- The vibration suppression switch is effective when turned on.
- The larger the value, the more obvious the inhibition effect, but too large the value is easy to bring mechanical noise.

P223	Vibration suppression mode	Range	Default value	Unit	Usage
		0～3	0		P

- Parameter meaning:
  0: The vibration suppression function is invalid.
  1: Vibration suppression mode 1, automatic detection of vibration frequency, suitable for the inertia of little change occasions.
  2: Vibration suppression mode 2, automatic detection of vibration frequency, suitable for the occasion of inertia is always changing.
  3: Vibration suppression mode 3, manually set the vibration frequency, suitable for known vibration frequency occasions.

P224	Manual setting of vibration period	Range	Default value	Unit	Usage
		0～1000	0	ms	P

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

P226	Intermediate frequency vibration frequency	Range	Default value	Unit	Usage
		50～1500	100	Hz	P

- Effective when the intermediate frequency vibration suppression switch is turned on (P229 is not 0).
- The mode of frequency point is set manually (P229=1), and the intermediate frequency vibration point needs to be found through the FFT function of the servo upper computer software.

P227	Compensation coefficient of IF suppression	Range	Default value	Unit	Usage
		1～1000	100	%	P

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

P228	Intermediate frequency suppression of damping coefficient	Range	Default value	Unit	Usage
		0～300	0	%	P

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

P229	Intermediate frequency vibration suppression switch	Range	Default value	Unit	Usage
		0～2	0		P

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

P270	Model tracking control switch	Range	Default value	Unit	Usage
		0～3	0		P

- It is suggested that Fn1 function should be used to deduce the load inertia first.
- Suitable for position control, select appropriate parameters according to different loads, can improve the response of the system.
- Parameter meaning:
  0: Model tracking is invalid 1: Applicable to rigid load
  2: Suitable for flexible load 3: General purpose

P271	Model tracking control gain	Range	Default value	Unit	Usage
		10～2000	40	Hz	P

- Model tracking control gain, modes 1 ~ 3 are valid.
- The higher the value, the faster the response, too much may bring noise.

P273	Model tracking positive direction proportional control	Range	Default value	Unit	Usage
		0～1000	100	%	P

- Model to trace the positive direction control deviation, mode 1 ~ 3 are valid.
- By adjusting this parameter, the forward and reverse response speed can be adjusted separately.
- The larger the value is, the greater the feedforward effect of the torque ring will be.

P274	Model tracking reverse proportional control	Range	Default value	Unit	Usage
		0～1000	100	%	P

- Instructions are the same as P273.

P277	Model tracking velocity compensation feedforward	Range	Default value	Unit	Usage
		0～1000	100	%	P

- Model to trace the speed feedforward compensation, the value, the greater the speed loop feedforward action, the greater the too much may lead to noise.
- Modes 1 to 3 are valid.

5.4.4 Parameters of section 3

P302	Message selection	Range	Default value	Unit	Usage
		*	3		ALL

- This parameter is used to set the drive letter. After parameters are changed, the parameters must be stored in EEPROM, power off the drive, and then power on the drive to take effect.
- The packet type must be the same as that configured in the configuration.

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

- Use this parameter to select PROFINET mode or common mode. If the value is 0, select common mode. Users can conduct test operation in this mode to detect hardware problems. If the value is 1, the PROFINET mode is selected. In this mode, the PROFINET master station performs corresponding operations.
- Parameter meaning:
  0: normal mode.
  1: PROFINET mode.

P310	Reference speed	Range	Default value	Unit	Usage
		10～X	3000	rpm	ALL

- This parameter is used as a normalized reference variable for the speed set value in AC4.
- After the driver is initialized, the maximum value of this parameter is limited to the rated speed of the connected motor. The reference speed can be set freely within the rated speed range. If the current set value exceeds the rated speed of the motor, the current set value will be limited to the rated speed of the motor.

P312	Reference torque	Range	Default value	Unit	Usage
		1～X	4000	0.1nm	ALL

- This parameter is used as a normalized reference variable for torch-related set values.
- After drive initialization, the maximum value X of this parameter is limited to 3 times the rated torque of the connected motor. When 102 and 105 messages are used, the reference torque can be set freely within the range of 3 times the rated torque. If the current set value exceeds 3 times the rated torque of the motor, the current set value will be limited to 3 times the rated torque of the motor. When using other messages, the reference torque is automatically set internally at the maximum torque of the motor.

P315	User-defined PZD receiving word	Range	Default value	Unit	Usage
		0～2	0		ALL

- You can set this parameter to select the user-defined PZD content in the received packets.
- Parameter meaning:
  0: meaningless.
  1: Additional torque (function to be improved);
  2: Additional speed (functions to be improved).

P316	User-defined PZD sending word	Range	Default value	Unit	Usage
		0～3	0		ALL

- You can set this parameter to select user-defined PZD content in the sent packet.
- Parameter meaning:
  0: meaningless.
  1: actual torque, unit %;
  2: actual current, unit: 0.1a;
  3: DI state, Bit0 ~ Bit4 said DI1 ~ DI5, respectively.

P320	Ramp acceleration time	Range	Default value	Unit	Usage
		0～30000	1000	ms	ALL

- Sets the acceleration time of the motor from zero speed to rated speed.
- If the command speed is lower than the rated speed, the acceleration time required is correspondingly reduced.
- This parameter has no effect in the application class AC4.

P321	Ramp deceleration time	Range	Default value	Unit	Usage
		0～30000	1000	ms	ALL

- Sets the acceleration time of the motor from zero speed to rated speed.
- If the command speed is lower than the rated speed, the acceleration time required is correspondingly reduced.
- This parameter has no effect in the application class AC4.

P322	Rapid deceleration time	Range	Default value	Unit	Usage
		0～30000	100	ms	ALL

- Set deceleration time of motor from rated speed to zero speed.
- If the current speed is lower than the rated speed, the deceleration time required is correspondingly shortened.
- This parameter is valid only during rapid deceleration.

P360	Maximum number of lost SOL counts	Range	Default value	Unit	Usage
		0～32767	5		ALL

- In periodic synchronization mode, the SOL signals in each period are used to ensure data reliability. If the SOL signals are continuously lost, you need to determine the validity of the data. This parameter is used to set the maximum number of consecutive lost signals.

P362	Additional packet selection	Range	Default value	Unit	Usage
		*	0		ALL

- Select additional through this parameter, parameter changes, must be stored in the EEPROM parameters, and drive power off, and then power on the operation, can take effect!
- P302 Packet Selection After this parameter is changed, the additional packet parameter is reset. Therefore, you need to select this parameter again.
- The packet type must be the same as that configured in the configuration.

5.5 DI function detail

See "6.5.3 Digital input/digital output" for details. The following table shows the function description 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 allows clearing, enter the rising edge (OFF changes ON moment) to clear the alarm. Note that only part of the alarm is allowed to clear.</td></tr>
<tr><td>3</td><td>CCWL</td><td>CCW drive inhibition</td><td>OFF：CCW rotation is prohibited;
ON ： CCW rotation is allowed.
For mechanical limit travel protection, function controlled by parameter P097. Note that the default value of P097 is to ignore this function. If you want 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">Using the forward drive disable function, the normally closed contacts of the travel switch must be connected.</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td><td rowspan="2">Ignore forward drive forbidden function, motor can run in the positive direction, this signal has no effect, no need to access.</td></tr>
<tr><td>3
(default)</td></tr>
</table></td></tr>
<tr><td>4</td><td>CWL</td><td>Reverse drive ban</td><td>OFF：CW rotation is prohibited;
ON ： CW rotation is allowed.
For mechanical limit travel protection, function controlled by parameter P097. Note that the default value of P097 is to ignore this function. If you want 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">Using reverse driving ban function, must answer the normally closed contact of stroke switches.</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td><td rowspan="2">Ignore forward drive forbidden function, motor can run in the positive direction, this signal has no effect, no need to access.</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 drive to work; ON ： Stop the motor according to the way set by parameter P164
23	HOME SWITCH	Homing reference point	Homing external reference point

5.6 DO function detail

See "6.5.3 Digital input/digital output" for details. The following table shows the function description 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：The main servo power supply is not turned OFF or there is an alarm; ON ： The main servo power supply is normal and there is no alarm.
3	ALM	Alarm	OFF：There is an alarm; ON ： No alarm.
8	BRK	Electromagnetic brake	OFF：Electromagnetic brake applies the brake; ON ： Electromagnetic brake releases the brake.
9	RUN	Servo in operation	OFF：The servo motor runs without power on; ON ：The servo motor is energized and running.
11	TRQL	Torque under limitation	OFF：Servomotor torque has not reached the limit value; ON ： Servomotor torque has reached the limit value.
12	SPL	Speed under limitation	In torque control mode OFF：Servomotor speed has not reached the limit value; ON ： Servomotor speed has reached the limit value.
13	HOME	Homing complete	When homing is complete, output ON
16	DBC	Dynamic braking	OFF：External dynamic brake is invalid; ON ： External dynamic brake in effect.

Chapter 6 Communication function

6.1 PROFINET communication

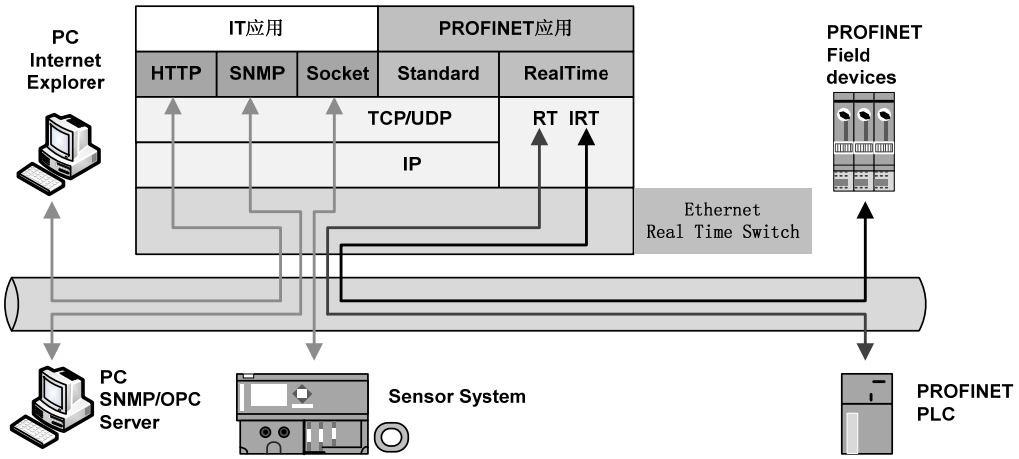
PROFINET communication consists of PROFINET IO and PROFIDrive.

6.1.1 PROFINET IO

PROFINET, launched by PFOFIBUS International (PI), is a new generation automation bus standard based on industrial Ethernet technology.

Communication between the PROFINET network and external devices is realized by PROFINET IO, which defines complete data exchange, parameter setting and diagnostic functions between the master controller and other slave devices, as shown in the figure below. A complete PROFINET IO network includes the following devices:

- IO controller: Used to control the operation of the entire system (for example, PLC).
- IO device: Typically a field device (for example, a driver, encoder, sensor, etc.) that is controlled and monitored by an IO controller. An IO device may consist of several modules or submodules.
- IO monitoring: HMI(Human machine interface) or a PIECE of PC software for diagnosis and debugging.



PROFINET provides two kinds of real-time communication, PROFINET IO RT and PROFINET IO IRT.

- PROFINET IO RT channel priority Ethernet frames for transmission of real-time data, no special hardware requirement, based on the priority level, its cycle can reach 4 ms.
- PROFINET IO IRT channel is suitable for data transmission has a more precise time requirement, the cycle of up to 250 us, but need to have special hardware support IO device and switches.

PROFINET all diagnostic and configuration in the data transmitted through non real-time (NRT) channels, using TCP/IP protocol, no sure cycle.

6.1.2 PROFIDrive

PROFIDrive is a protocol framework of PROFINET for driving technology applications. It is called application industry rules. Application industry rules help openness, interoperability, and interchangeability of devices. End users can determine whether similar devices provided by different manufacturers will have standardized functions and usage modes.

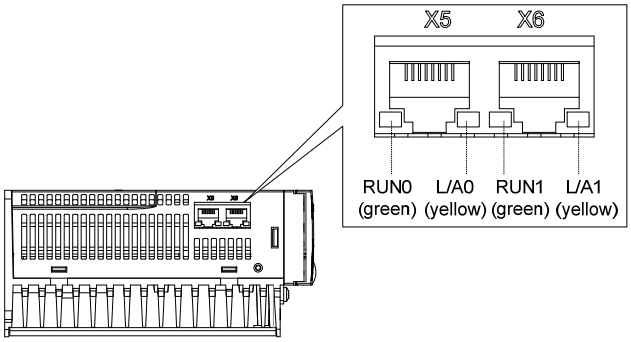
PROFIDrive defines six application classes (AC) based on typical examples in the field of electrical drive engineering:

- AC1: standard driver.
- AC2: Standard driver with distributed process controller.
- AC3: Single axis positioning drive with local motion control.
- AC4: Motion control with central interpolation and speed setting interface.
- AC5: Motion control with centralized interpolation and position setting interface.
- AC6: Motion control with clock handling or distributed angular synchronization.

PROFIDrive AC4 is temporarily supported in the current version of the servo drive.

6.1.3 Status LED

As shown IN the following figure, the Status LEDS of the EP3E drive are located IN the X5 (IN) and X6 (OUT) sockets, and the status information of the PROFINET port can be displayed through the indicators.



Name	Color	State	Meaning
Link	green	Light up	The transfer rate is 100Mbit/s
		Put out	No connection or connection error
Activity	yellow	Light up	Data interchange
		Put out	No data exchange

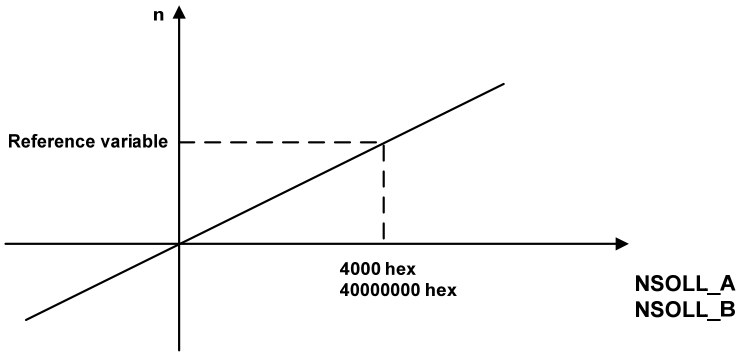
6.1.4 Data type definition

The contents and scope of Data types used in this manual are shown in the following table.

- General data type definitions

Name	Description	Range
I8	Signed 8bit	-128 ~127
U8	Unsigned 8bit	0 ~ 255
I16	Signed 16bit	-32768 ~ 32767
U16	Unsigned 16bit	0 ~ 65535
I32	Signed 32bit	-21247483648 ~ 21247483647
U32	Unsigned 32bit	0 ~ 4294967295

- The normalized data are defined as N2 and N4



As shown in the figure above: Linearly normalized values, 0% corresponds to 0, for N2 type data, 16 bits are used, and 100% corresponds to 214(i.e. 0x4000); For N4 type data, make the 32-bit representation, 100% corresponding to 230(that is, 0x40000000).

As shown in the following example, the base variable is 3000:
N2 data: 0x4000 corresponds to 3000
0x2000 corresponds to 1500
0xE000 corresponds to -1500

N4 type data: 0x20000000 corresponds to 1500
0xE0000000 corresponds to -1500
0xC0000000 corresponds to -3000

6.1.5 PROFINET support message and content explanation

The basic length of a packet field is PZD. A PZD is a word, that is, 16 bits. The sending and receiving words are the data content that the servo driver needs to send and receive.

Description of message 1 contents and fields:

Message 1 is suitable for the application class AC1 speed control mode, the message content as follows:

Message 1	P302=1	
	Receiving word (2 PZD)	Sending word (2 PZD)
PZD1	STW1	ZSW1
PZD2	NSOLL_A	NIST_A

Description of message 3 contents and fields:

Message 3 is suitable for the application class AC4 speed control mode, the message content as follows:

Message 3	P302=3	
	Receiving word (5 PZD)	Sending word (9 PZD)
PZD1	STW1	ZSW1
PZD2	NSOLL_B	NIST_B
PZD3		
PZD4	STW2	ZSW2
PZD5	G1_STW	G1_ZSW
PZD6		G1_XIST1
PZD7		
PZD8		G1_XIST2
PZD9		

Description of message 102 contents and fields:

Message 102 is suitable for the application class message AC4 real-time limit the speed of the positive and negative to the torque control mode, the message content is as follows:

Message 102	P302=102	
	Receiving word (6 PZD)	Sending word (10 PZD)
PZD1	STW1	ZSW1
PZD2	NSOLL_B	NIST_B
PZD3		
PZD4	STW2	ZSW2
PZD5	MOMRED	MELDW
PZD6	G1_STW	G1_ZSW
PZD7		G1_XIST1
PZD8		
PZD9		G1_XIST2
PZD10		

Description of contents and fields of message 5:

Message 5 is suitable for the speed control mode of application CLASS AC4 with DSC dynamic servo control function. The message contents are as follows:

Message 5	P302=5	
	Receiving word (9 PZD)	Sending word (9 PZD)
PZD1	STW1	ZSW1
PZD2	NSOLL_B	NIST_B
PZD3		
PZD4	STW2	ZSW2
PZD5	G1_STW	G1_ZSW
PZD6	XERR	G1_XIST1
PZD7		
PZD8	KPC	G1_XIST2
PZD9		

Description of message 105 contents and fields:

Message 105 is suitable for the speed control mode of AC4 application class with DSC dynamic servo control function and real-time limiting positive and negative torques. The message contents are as follows:

Message 105	P302=105	
	Receiving word (10 PZD)	Sending word (10 PZD)
PZD1	STW1	ZSW1
PZD2	NSOLL_B	NIST_B
PZD3		
PZD4	STW2	ZSW2
PZD5	MOMRED	MELDW
PZD6	G1_STW	G1_ZSW
PZD7		G1_XIST1
PZD8		
PZD9		G1_XIST2
PZD10		

STW1: Control word 1, U16.

	Signal	Describe
STW1	STW1.0	1: The main contact is closed and can be enabled. 0: Brake through ramp function generator, eliminate pulse, ready to be connected.
	STW1.1	1: No inertia stop command, enable. 0: The main contact is disconnected, the inertia deceleration brake, immediately eliminate the pulse and forbid the connection.
	STW1.2	1: The quick stop command is disabled. 0: Fast brake, eliminate pulse and disable connection.
	STW1.3	1: Allows the operation and can be enabled. 0: Disable or disable the operation.
	STW1.4	1: Enable ramp function generator. 0: Disables the ramp function generator and sets the output to zero.
	STW1.5	1: Continue the ramp function generator. 0: Freeze slope function generator, AC4, this bit is invalid.
	STW1.6	1: Set value is valid, ramp function generator input is normal. 0: Set value is invalid, ramp function generator input is 0.
	STW1.7	1: Fault confirmation (0→1 jump). 0: indicates nonsense.
	STW1.8~ STW1.9	Reserved
	STW1.10	1: PLC control. 0: Non-PLC control.
	STW1.11~ STW1.15	Reserved

NSOLL_A: set speed A(16Bit), N2.

Servo parameter P310 is used as the reference variable, and the speed instruction value corresponding to N2 normalized data sent by PLC is used as the speed instruction of the servo driver. See Section 6.1.4 for details.

NSOLL_B: set speed B(32Bit), N4.

Servo parameter P310 is used as the benchmark variable, and the speed instruction value corresponding to N4 type normalized data sent by PLC is used as the speed instruction of the servo driver. See Section 6.1.4 for details.

STW2: Control word 2, U16.

	Signal	Describe
STW2	STW2.0~ STW2.11	Reserved
	STW2.12	Main life symbol, Bit0
	STW2.13	Main life symbol, Bit1
	STW2.14	Main life symbol, Bit2
	STW2.15	Main life symbol, Bit3

G1_STW: Encoder 1 control word, U16.

	Signal	Describe
G1_STW	G1_STW.0~ G1_STW.11	Reserved
	G1_STW.13	1: Request the additional cycle cycle transmission for the absolute position in Gx_XIST2. 0: No request.
	G1_STW.14	1: Requests the resident shaft encoder. 0: No request.
	G1_STW.15	1: Encoder fault confirmation (0→1 hop). 0: Indicates nonsense.

MOMRED: Torque reduction set point, N2.

Servo parameter P312 is used as the reference variable. The torque reduction instruction corresponding to N2 type normalized data sent by PLC takes effect after recalculating the positive and negative torque limit value inside the servo. For details, see Section 6.1.4.

XERR: DSC position deviation, I32.

KPC: DSC position control gain, I32.

ZSW1: status word 1, U16.

	Signal	Describe
ZSW1	ZSW1.0	1: Server is ready. 0: servo is not ready.
	ZSW1.1	1: Servo run in place. 0: server is not running in place.
	ZSW1.2	1: Servo operation is enabled.0: The servo is not running.
	ZSW1.3	1: Server Error. 0: servo without Error.
	ZSW1.4	1: Inertia stop is invalid. 0: Inertial stop activation.
	ZSW1.5	1: Quick stop is invalid. 0: Quick stop activation.
	ZSW1.6	1: Disable the connection. 0: Disables connection.
	ZSW1.7	1: Waring exists for the servo. 0: The servo has no Waring.
	STW1.8	1: Velocity value and actual value deviation in the range of tolerance. 0: Velocity value and actual value deviation outside the tolerance range.
	STW1.9	1: PLC control request. 0: No PLC control request.
	STW1.10	1: Actual speed reaches or is beyond compare. 0: Actual speed did not reach or exceed the comparison value.
	STW1.11~ STW1.15	Reserved

NIST_A: actual rotational speed B(16Bit), N2.

Servo parameter P310 is used as the reference variable, and N2 normalized data corresponding to the current actual speed of the servo driver is used as the return value of the actual speed of PLC. See Section 6.1.4 for details.

NIST_B: actual rotational speed B(32Bit), N4.

Servo parameter P310 as the benchmark variable, servo drive current actual speed corresponding to the N4 type of normalized data, as the actual speed return value of PLC. See Section 6.1.4 for details.

ZSW2: Status word 2, U16.

	Signal	Describe
ZSW2	ZSW2.0~ ZSW2.10	Reserved
	ZSW2.11	1: Pulse is enabled. 0: Pulse disabled.
	ZSW2.12	Slave station life symbol, Bit0
	ZSW2.13	Slave station life symbol, Bit1
	ZSW2.14	Slave station life symbol, Bit2
	ZSW2.15	Slave station life symbol, Bit3

G1_ZSW: Encoder 1 status word, U16.

	Signal	Describe
G1_ZSW	G1_ZSW.0~ G1_ZSW.11	Reserved
	G1_ZSW.13	1: Gx_XIST2 transmission of absolute position data representation in the cycle. 0: Gx_XIST2 of transferring data does not represent cycle in absolute position.
	G1_ZSW.14	1: Reside shaft encoder activation. 0: Inactive reside shaft encoder.
	G1_ZSW.15	1: The data in Gx_XIST2 represents the encoder fault code. 0: Data in Gx_XIST2 does not represent an encoder fault code.

G1_XIST1: Encoder 1 actual position 1, U32.

G1_XIST1 is used to transmit the actual position value of the encoder periodically.

G1_XIST2: Encoder 1 actual position 2, U32.

	Bit state	Numerical significance
G1_XIST2	G1_ZSW.13=1	Transmission cycle of absolute position.
	G1_ZSW.15=1	Encoder failure code
	G1_ZSW. 13 = 0 at the same time G1_ZSW.15=0	0

MELDW：MELDW message word, U16.

	Signal	Describe
MELDW	MELDW.0~ MELDW.10	Reserved
	MELDW.11	1: Enables the driver. 0: Driver is not enabled.
	MELDW.12	1: Drive is ready. 0: Drive not ready.
	MELDW.13	1: Pulse is enabled. 0: Pulse is not enabled.
	MELDW.14~ MELDW.15	Reserved

Description of message 7 content and fields (not supported currently):

Message 7 is suitable for the application class AC3 position control mode, the message content as follows:

Message 7	P302=7	
	Receiving word (2 PZD)	Sending word (2 PZD)
PZD1	STW1	ZSW1
PZD2	SATZANW	AKTSATZ

Description of message 9 content and fields (not supported currently):

Message 9 is suitable for the application class AC3 position control mode, the message content as follows:

Message 9	P302=9	
	Receiving word (10 PZD)	Sending word (5 PZD)
PZD1	STW1	ZSW1
PZD2	SATZANW	AKTSATZ
PZD3	STW2	ZSW2
PZD4	MDI_TARPOS	XIST_A
PZD5		
PZD6	MDI_VELOCITY	
PZD7		
PZD8	MDI_ACC	
PZD9	MDI_DEC	
PZD10	MDI_MOD	

Description of the contents and fields of Message 111:

Message 111 is suitable for the application class AC3 position control mode, the message content as follows:

Message 111	P302=111	
	Receiving word (12 PZD)	Sending word (12 PZD)
PZD1	STW1	ZSW1
PZD2	POS_STW1	POS_ZSW1
PZD3	POS_STW2	POS_ZSW2
PZD4	STW2	ZSW2
PZD5	OVERRIDE	MELDW
PZD6、PZD7	MDI_TARPOS	XIST_A
PZD8、PZD9	MDI_VELOCITY	NIST_B
PZD10	MDI_ACC	FAULT_CODE
PZD11	MDI_DEC	WARN_CODE
PZD12	USER_RX	USER_TX

STW1: Control word 1, U16.

	Signal	Describe
STW1	STW1.0	1: The main contact is closed and can be enabled. 0: Brake through ramp function generator, eliminate pulse, ready to be connected.
	STW1.1	1: No inertia stop command, enable. 0: Main contact disconnect, inertia braking deceleration, eliminate pulse and ban on immediately.
	STW1.2	1: The quick stop command is disabled. 0: Fast brake, eliminate pulse and disable connection.
	STW1.3	1: Allows the operation and can be enabled. 0: Disable or disable the operation.
	STW1.4	1: Do not refuse to perform the task. 0: Refuse to perform the task (at maximum deceleration speed to stop).
	STW1.5	1: The task is not suspended. 0: Suspends the task (slowed to a stop at the set MDI_DEC).
	STW1.6	1: Activates the running task (0→1). 0: The running task is not activated.
	STW1.7	1: Fault confirmation (0→1 jump). 0: Indicates nonsense.
	STW1.8~ STW1.9	00: JOG channel is not activated. 01: JOG1 channel is activated. 10: JOG2 channel is activated. 11: JOG channel is not activated.
	STW1.10	1: PLC control. 0: Non-PLC control.
	STW1.11	1: Starts to return to the reference point (0→1 jump). 0: Stops returning to the reference point.
	STW1.12~ STW1.15	Reserved

POS_STW1: POS control word 1, U16.

	Signal	Describe
POS_STW1	POS_STW1.0	Run segment selection, bit 0.
	POS_STW1.1	Run segment selection, bit 1.
	POS_STW1.2	Run segment selection, bit 2.
	POS_STW1.3	Run segment selection, bit 3.
	POS_STW1.4~ POS_STW1.7	Reserved
	POS_STW1.8	1: Absolute positioning is selected. 0: Relative positioning is selected.
	POS_STW1.9~ POS_STW1.10	00: The shaft is stationary. 01: MDI direction selection, positive. 10: MDI direction selection, negative direction. 11: The shaft is stationary.
	POS_STW1.11~ POS_STW1.13	Reserved
	POS_STW1.14	1: Signal adjustment has been selected. 0: The signal location is selected.
	POS_STW1.15	1: Select MDI. 0: Select the program segment to run.

POS_STW2: POS control word 2, U16.

	Signal	Describe
POS_STW2	POS_STW2.0	Reserved
	POS_STW2.1	1: Sets the reference point. 0: The reference point is not set.
	POS_STW2.2	1: The reference point block is activated. 0: The reference block is not activated.
	POS_STW2.3~ POS_STW2.4	Reserved
	POS_STW2.5	1: JOG incremental mode. 0: JOG speed mode.
	POS_STW2.6~ POS_STW2.8	Reserved
	POS_STW2.9	1: Start searching for reference points in the negative direction. 0: Searches for a reference point in the positive direction.
	POS_STW2.10~ POS_STW2.13	Reserved
	POS_STW2.14	1: Soft limit activation. 0: The soft limit is not activated.
	POS_STW2.15	Reserved

STW2: Control word 2, U16.

	Signal	Describe
STW2	STW2.0~ STW2.11	Reserved
	STW2.12	Main life symbol, Bit0
	STW2.13	Main life symbol, Bit1
	STW2.14	Main life symbol, Bit2
	STW2.15	Main life symbol, Bit3

OVERRIDE: position velocity multiplier (16Bit), N2.

MDI_VELOCITY is used as the reference variable, and the proportional value corresponding to the N2 type normalized data sent by PLC is used as the multiplier of the MDI_VELOCITY velocity instruction. For details, see Section 6.1.4 (4000hex = 100%).

MDI_TARPOS: MDI position, I32.

The position instruction data sent by PLC is input as the position instruction of the servo driver position planning. For details, see section 6.4.3 (1hex = 1LU).

MDI_VELOCITY: MDI velocity, I32.

The velocity instruction data sent by the PLC is used as the velocity instruction input for the position planning of the servo driver. For details, see section 6.4.3 (1hex = 1000LU/min).

MDI_ACC: MDI acceleration multiplier, I16.

The maximum servo acceleration is used as the reference variable, and the proportional value corresponding to the N2 type normalized data sent by PLC is used as the multiplier input of the acceleration instruction for the position planning of the servo driver. For details, see Section 6.1.4 (4000hex= 100%).

MDI_DEC: MDI deceleration multiplier, I16.

The maximum deceleration of the servo is taken as the reference variable, and the proportion value corresponding to the N2 type normalized data sent by the PLC is taken as the multiplier input of the deceleration instruction of the servo driver's position planning. For details, see Section 6.1.4 (4000hex = 100%).

USER_RX: user-defined functions.

This part is being planned.

ZSW1: status word 1, U16.

	Signal	Describe
ZSW1	ZSW1.0	1: Server is ready. 0: Servo is not ready.
	ZSW1.1	1: Servo run in place. 0: Server is not running in place.
	ZSW1.2	1: Servo operation is enabled. 0: Servo is not enabled.
	ZSW1.3	1: Server Error. 0: Servo without Error.
	ZSW1.4	1: Inertia stop is invalid. 0: Inertial stop activation.
	ZSW1.5	1: Quick stop is invalid. 0: Quick stop activation.
	ZSW1.6	1: Disable the connection. 0: Disables connection.
	ZSW1.7	1: Servo Waring. 0: Servo without Waring.
	STW1.8	1: The position following error is within the tolerance range. 0: Position following error is outside the tolerance range.
	STW1.9	1: PLC control request. 0: No PLC control request.
	STW1.10	1: The target position is reached. 0: The target position is not reached.
	STW1.11	1: The reference point has been set. 0: The reference point is not set.
	STW1.12	1: Response activation running program segment (0→1 jump). 0: The running program segment is not activated.
	STW1.13~ STW1.15	Reserved

POS_ZSW1: POS status word 1, U16.

	Signal	Describe
POS_ZSW1	POS_ZSW1.0	Run segment activation, bit 0.
	POS_ZSW1.1	Run segment activation, bit 1.
	POS_ZSW1.2	Run segment activation, bit 2.
	POS_ZSW1.3	Run segment activation, bit 3.
	POS_ZSW1.4~ POS_ZSW1.9	Reserved
	POS_ZSW1.10	1: JOG activation. 0: JOG is not activated.
	POS_ZSW1.11	1: Back to the reference point activation. 0: The backreference point is not activated.
	POS_ZSW1.12~ POS_ZSW1.13	Reserved
	POS_ZSW1.14	1: Adjust the mode activation. 0: The positioning mode is activated.
	POS_ZSW1.15	1: MDI is activated. 0: program segment activation.

POS_ZSW2: POS status word 2, U16.

	Signal	Describe
POS_ZSW2	POS_ZSW2.0~ POS_ZSW2.1	Reserved
	POS_ZSW2.2	1: The set value is available. 0: The set value is unavailable.
	POS_ZSW2.3	Reserved
	POS_ZSW2.4	1: axial forward motion. 0: The axis is not moving forward.
	POS_ZSW2.5	1: The axis moves backward. 0: The axis does not move backward.
	POS_ZSW2.6~ POS_ZSW2.14	Reserved
	POS_ZSW2.15	1: The command is activated. 0: The running command is not activated.

ZSW2: Status word 2, U16.

	Signal	Describe
ZSW2	ZSW2.0~ZSW2.10	Reserved
	ZSW2.11	1: Pulse is enabled. 0: Pulse disabled.
	ZSW2.12	Slave station life symbol, Bit0
	ZSW2.13	Slave station life symbol, Bit1
	ZSW2.14	Slave station life symbol, Bit2
	ZSW2.15	Slave station life symbol, Bit3

MELDW: MELDW message word, U16.

	Signal	Describe
MELDW	MELDW.0~MELDW.10	Reserved
	MELDW.11	1: Drive enable. 0: Drive is not enabled.
	MELDW.12	1: Drive is ready. 0: Drive not ready.
	MELDW.13	1: Pulse is enabled. 0: Pulse is not enabled.
	MELDW.14~MELDW.15	Reserved

XIST_A: actual value A, I32.

XIST_A is used to transmit the actual position value periodically. For details, see section 6.4.3 (1hex = 1LU).

NIST_B: Velocity Actual value B(32Bit), N4.

The servo parameter P310 is used as the reference variable, and the N4 type normalized data corresponding to the current actual velocity of the servo driver is used as the return value of the actual velocity of PLC. For details, see Section 6.1.4.

FAULT_CODE: Servo error code, U16.

The error code for the servo driver is returned to the PLC through this field. When no error occurs, the return value is 0x0000. When an error occurs, the lower 8 bits fill the error code and the higher 8 bits are fixed to fill 0xFF. See Chapter 7 for specific error codes.

WARN_CODE: Servo error code, U16.

This section is reserved.

USER_TX: user-defined functions.

Use parameter P316 to select feedback content. For details, see parameter P316 Definition.

Details of the contents and fields of Message 750:

The message 750 is applicable to torque limit related control, and the message content is as follows:

Message 750	P362 = 750	
	Receiving word (3 PZD)	Sending word (1 PZD)
PZD1	M_ADD1	M_ACT
PZD2	M_LIMIT_POS	
PZD3	M_LIMIT_NEG	

M_ADD1: Additional torque (function to be improved), N2.

M_LIMIT_POS: Positive torque limit, N2.

Servo parameter P312 is used as the benchmark variable. The positive torque limit instruction corresponding to N2 type normalized data sent by PLC is required to be greater than 0, which is used as the internal positive torque limit value of the servo driver. For details, see Section 6.1.4.

M_LIMIT_NEG: negative torque limit, N2.

Servo parameter P312 is used as the benchmark variable. The positive torque limit instruction corresponding to N2 type normalized data sent by PLC is required to be less than 0, which is used as the internal negative torque limit value of the servo driver. For details, see Section 6.1.4.

M_ACT: actual torque feedback value, N2.

The servo parameter P312 is used as the reference variable, and the N2 type normalized data corresponding to the current actual torque of the servo driver is used as the actual torque return value of PLC. For details, see Section 6.1.4.

Details of the contents and fields of Message 860:

Message 860 applies to the probe latch related applications, message content as follows:

Message 860	P362=860	
	Receiving word (1 PZD)	Sending word (9 PZD)
PZD1	TB_FUNCTION	TB_STATUS
PZD2		TB1_POS_VALUE
PZD3		
PZD4		TB1_NEG_VALUE
PZD5		
PZD6		TB2_POS_VALUE
PZD7		
PZD8		TB2_NEG_VALUE
PZD9		

TB_FUNCTION: Touch Probe latch function setting, U16.
For details, see 6.4.1 Touch Probe Functions.

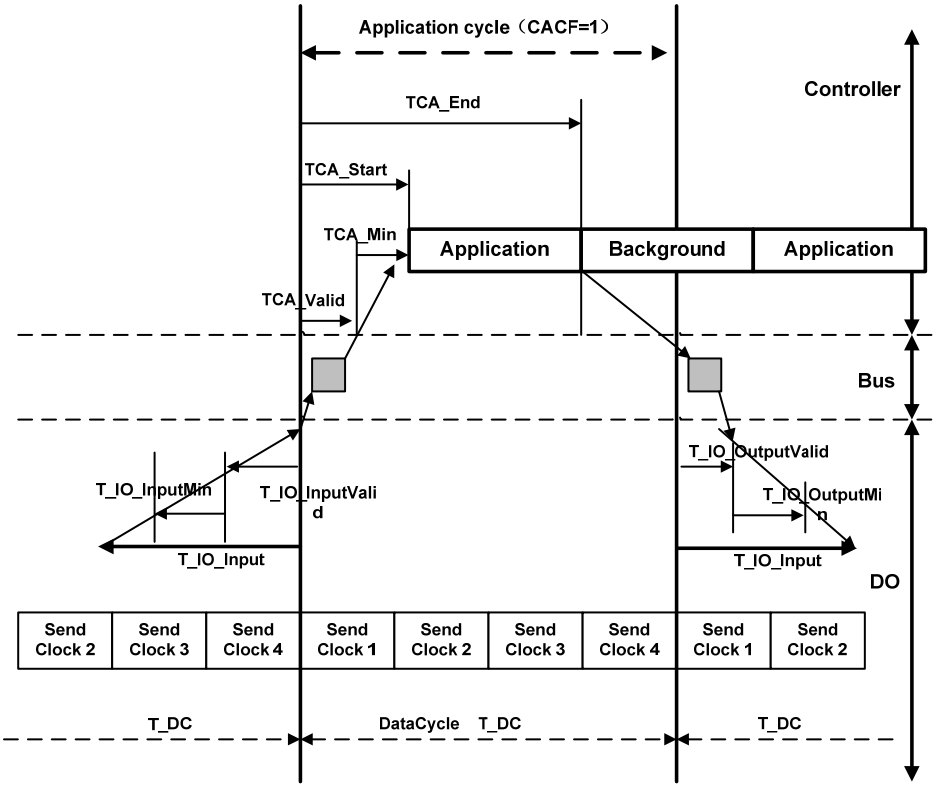
TB_STATUS: Touch Probe latch status, U16.
For details, see 6.4.1 Touch Probe Functions.

TB1_POS_VALUE: Touch Probe 1 Latch position value, U16.
TB1_NEG_VALUE: Touch Probe 1 latch position value, U16.
TB2_POS_VALUE: Touch Probe 2 latch position value, U16.
TB2_NEG_VALUE: latch position value of the falling edge of Touch Probe 2, U16.
For details, see 6.4.1 Touch Probe Functions.

6.1.6 Isochronous Mode

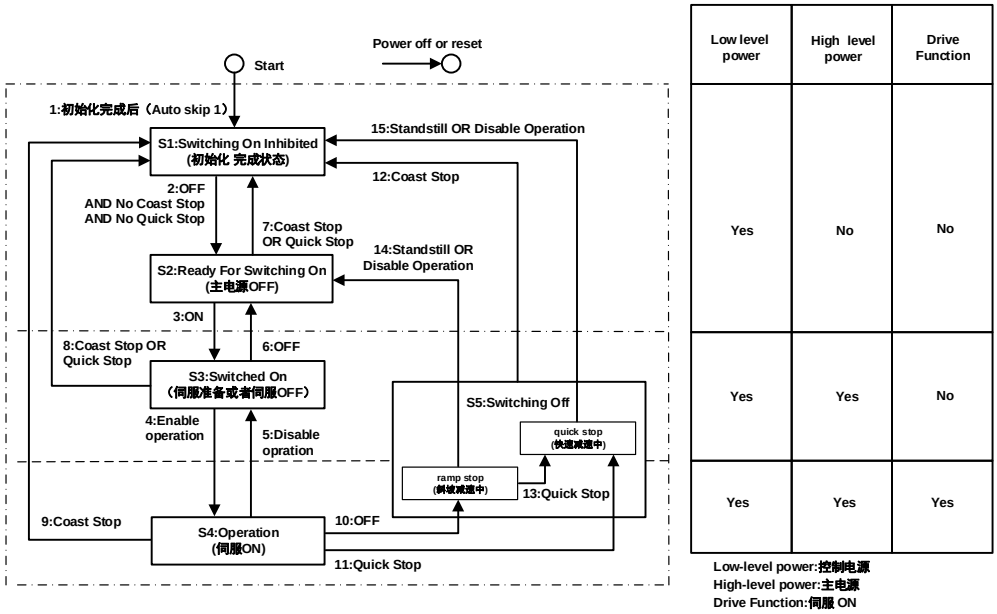
In PROFINET communication, in order to realize isochronic synchronization, each Slave device realizes cycle synchronization according to PNPLL output clock signal, and sets T_IO_Output Time and T_IO_Input Time of each Slave device. Ensure that all Slave devices in the synchronization domain collect data at the same time and set output values at the same time to ensure that all devices are in the same pace.

In the current version of the servo drive, the minimum isochronous synchronization period is 250us. The sequence of isochronous synchronization data cycles for PROFINET IO is shown below.



6.2 Drive mode

6.2.1 Servo state machine



Control command and status switchover

PROFIDrive state switch		STW1
1	Default →SwitchingOn Inhibited	Natural transition, no instructions
2	SwitchingOn Inhibited →Ready ForSwitchingOn	STW1.0 = 0 And STW1.1 = 1 And STW1.2 = 1
3	Ready ForSwitchingOn →Switched On	STW1.0 = 1
4	Switched On →Operation	STW1.3 = 1
5	Operation →Switched On	STW1.3 = 0
6	Switched On →Ready ForSwitchingOn	STW1.0 = 0
7	Ready ForSwitch On →SwitchingOn Inhibited	STW1.1 = 0 Or STW1.2 = 0
8	Switched On →SwitchingOn Inhibited	STW1.1 = 0 Or STW1.2 = 0
9	Operation →SwitchingOn Inhibited	STW1.1 = 0
10	Operation →Ramp Stop Switching Off	STW1.0 = 0
11	Operation →Quick stop Switching Off	STW1.2 = 0
12	Switching Off→SwitchingOn Inhibited	STW1.1 = 0
13	Ramp Stop Switching Off→Quick stop Switching Off	STW1.2 = 0
14	Ramp Stop Switching Off→Ready ForSwitch On	STW1.3 = 0 Or Deceleration completed
15	Quick stop Switching Off→SwitchingOn Inhibited	STW1.3 = 0 Or Deceleration completed

Status switchover and description

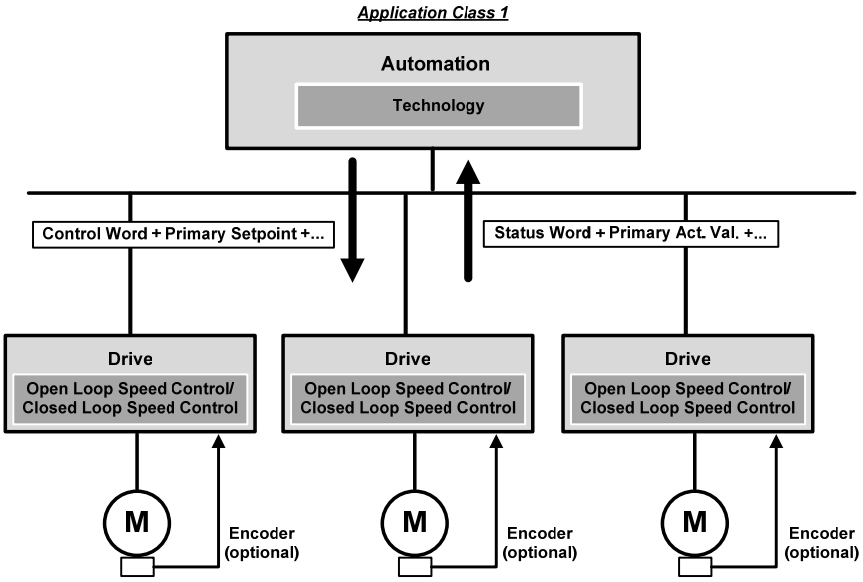
State	Explanation	ZSW1、ZSW2
SwitchingOn Inhibited	● After initialization, you can set servo parameters. ● The main power supply cannot be supplied in the current state.	ZSW1.0 = 0ZSW1.1 = 0 ZSW1.2 = 0ZSW1.6 = 1 ZSW2.11 = 0
Ready For Switching On	● In the current state, the main power can be turned on and servo parameters can be set. ● The drive is inactive.	ZSW1.0 = 1ZSW1.1 = 0 ZSW1.2 = 0ZSW1.6 = 0 ZSW2.11 = 0
Switched On	● The main power supply is On, and servo parameters can be set. ● The drive is inactive.	ZSW1.0 = 1ZSW1.1 = 1 ZSW1.2 = 0ZSW1.6 = 0 ZSW2.11 = 0
Operation	● In a non-fault state, start the driver function to apply torque to the motor. Servo parameters can also be set.	ZSW1.0 = 1ZSW1.1 = 1 ZSW1.2 = 1ZSW1.6 = 0 ZSW2.11 = 1
Ramp Stop Switching Off	● The Ramp stop function has been executed. ● Servo parameters can be set.	ZSW1.0 = 1ZSW1.1 = 1 ZSW1.2 = 0ZSW1.6 = 0 ZSW2.11 = 1
Quick stop Switching Off	● The Quick Stop function has been executed. ● Servo parameters can be set.	ZSW1.0 = 1ZSW1.1 = 1 ZSW1.2 = 0ZSW1.6 = 0 ZSW2.11 = 1

6.3 Operating mode

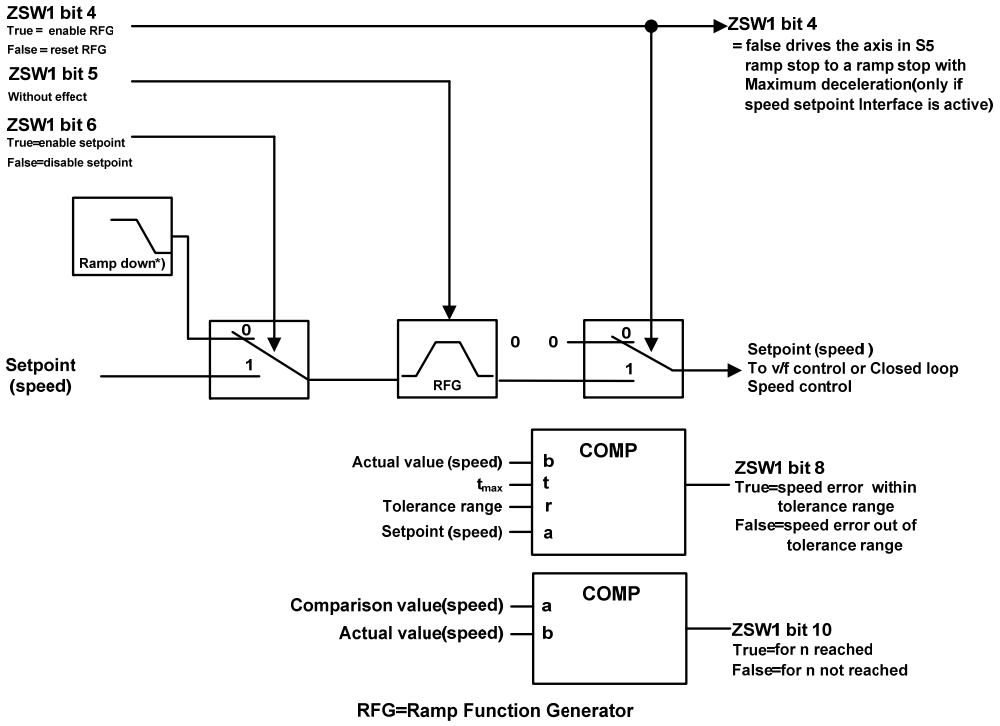
EP3E currently supports:
Application class AC1 message 1;
Application class AC4 message 3、5、102、105;
Application class AC3 message 111;
Auxiliary message 750、860.

6.3.1 AC1: Standard driver

Application class AC1(shown below) shows speed control through a communication system. The speed set value and actual value are transmitted through circular data exchange, and clock synchronization operation is not necessary.

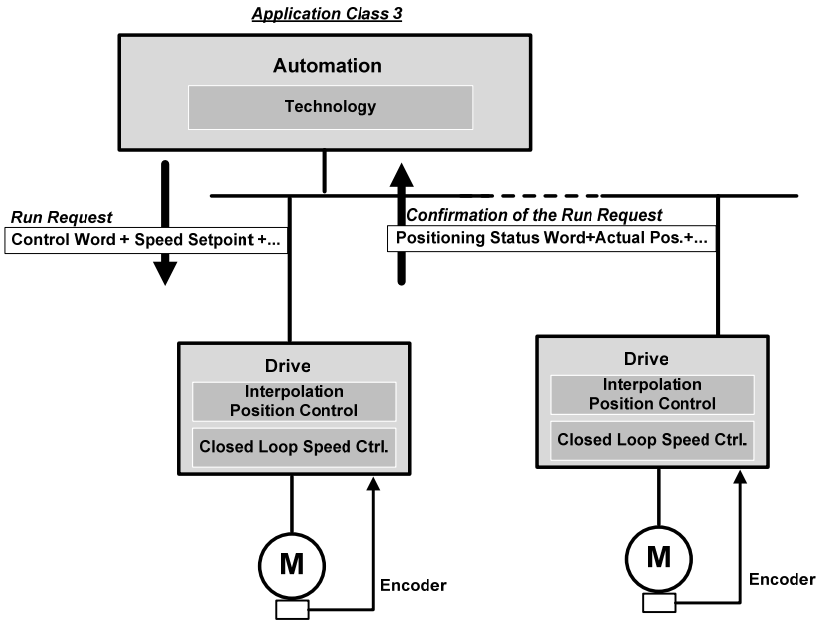


The ramp function generator is required in the speed set channel of application class AC1. The function of the speed set channel module in the slave device is illustrated below. STW1.5 controls the ramp function generator.



6.3.2 AC3: Single axis positioning driver with local motion control

Application class AC3 (as shown in the figure below), the process function of automatic process exists in PLC, positioning parameters and position speed feedback value are transmitted through cyclic data, positioning request is started through the command of the controller. Interpolation, position control and speed control are implemented directly in the driver. Clock synchronization is required only when multiple axes are required to work together.



1. Running program segment

This part of the function is being improved.

2. Value is directly given MDI

The MDI mode is positioned in absolute and relative terms by means of a set value given directly by the PLC, or adjusted in a position ring. In addition, the motion parameters are modified in real time during operation, and the "absolute positioning", "relative positioning" and "adjustment" modes can be switched quickly.

Activate the set value given function

When using Message 111, the function is given directly with the control word POS_STW1.15 set value:

Control word	Set up	Describe
POS_STW1.15	1	Choose the MDI
	0	Choose to run the program segment

When using Message 9, the function is given directly with the control word SATZANW.15 set value:

Control word	Set up	Describe
SATZANW.15	1	Choose the MDI
	0	Choose to run the program segment

Choose work mode

In the "positioning" mode, absolute and relative positioning of the servo axis is achieved according to the parameters (position、speed、acceleration、deceleration).
In the "adjustment" mode, the servo axis can realize closed-loop position control according to the parameters (speed、acceleration、deceleration).

When using Message 111, use the control word POS_STW1.14 to select the working mode:

Control word	Set up	Describe
POS_STW1.14	1	Signal adjustment selected
	0	Signal location has been selected [1)]

[1)] Message 9 works in signal location mode.

Select a location mode in location mode

If Message 111 is used, use POS_STW1.8 to select the location mode:

Control word	Set up	Describe
POS_STW1.8	1	Absolute positioning selected
	0	Relative positioning has chosen

When using Message 9, select the location mode using MDI_MOD.0:

Control word	Set up	Describe
MDI_MOD.0	1	Absolute positioning selected
	0	Relative positioning has chosen

Select direction in Adjustment mode (Message 111 only)

The direction of operation in location mode is determined by MDI_TARPOS.

Control word	Set up	Describe
POS_STW1.9 POS_STW1.10	1	MDI direction selection, positive
	0	MDI direction selection, negative

Pause and reject MDI tasks

When using Message 9、111, the MDI task is rejected by STW1.4, and the servo decelerates the ramp at maximum deceleration.

Control word	Set up	Describe
STW1.4	1	Do not refuse to perform tasks
	0	Refuse to perform the task (perform slope descent at maximum deceleration)

When Message 9 and 111 are applicable, the task is suspended through STW1.5, and the servo decelerates the slope at the current set deceleration speed

When the task pause signal is cancelled, the task that is waiting for execution or being suspended is resumed.

Control word	Set up	Describe
STW1.5	1	Do not suspend the task
	0	The task is suspended by the set deceleration MDI_DEC (Message9, 10, and 111) or P2693 (Message7)

3. Back to the reference point

When using Message 9 and 111, use the STW1.11 setting to start the operation back to the reference point. There are three modes for returning to the reference point.

Control word	Set up	Describe
STW1.1	1	Start back to the reference point
	0	Stop back to the reference point

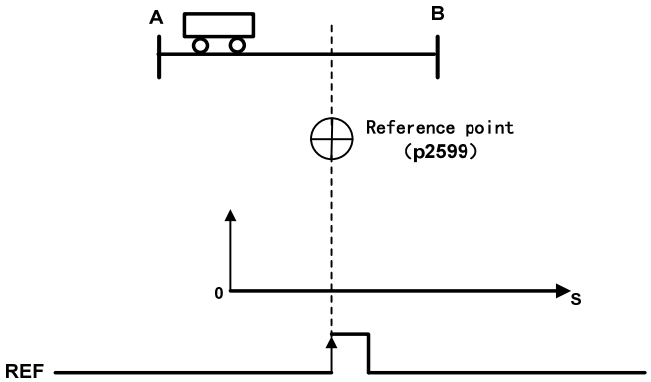
Parameter	Value	Describe
Return to reference point mode	0	REF back to reference point by external signal
	1 (default)	Zero pulses back to the reference point through an external reference block (signal REF) and the encoder
	2	Return to reference point through zero pulse only

REF back to reference point by external signal (mode 0)

If Message 111 is used, set external input signal to POS_STW2.1 and REF(0->1) :

Control word	Set up	Describe
POS_STW2.1	1	Setting reference Points
	0	No reference point is set

At the rising edge of signal REF, the current position is set to 0, and the servo drives back to the reference point.



External reference point block (signal REF) and encoder zero pulse (Mode 1)

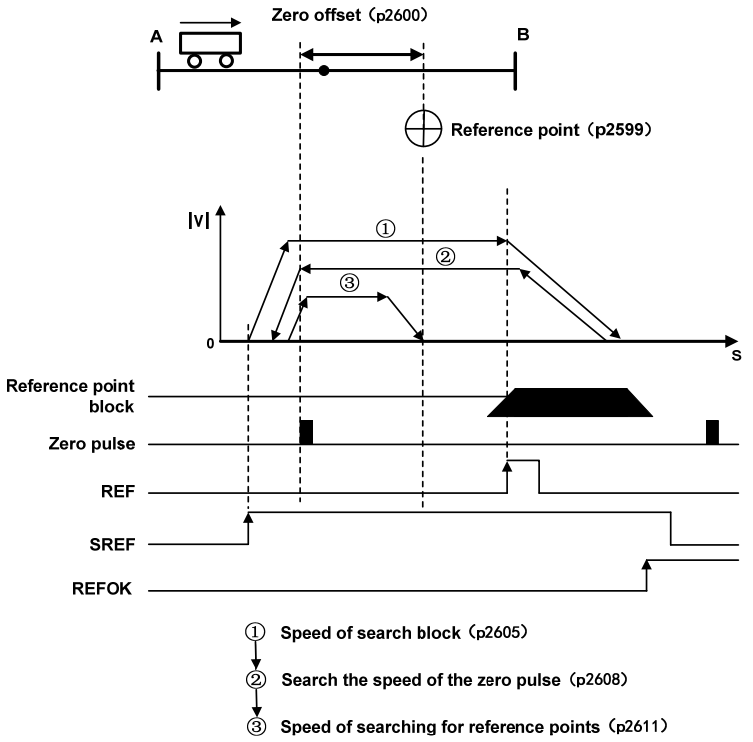
When using Message 111, set the external input signal REF via POS_STW2.1:

Control word	Set up	Describe
POS_STW2.2	1	Reference point block activation
	0	The reference point block is not activated

The back to reference process is triggered by STW1.11(0->1). Servo drive to find the reference point block by accelerating to the speed specified by the parameter "back to reference Search block speed", the direction of the search reference point block is specified by the parameter "back to reference direction"; When the reference point block is searched (signal REF: 0->1), the servo motor is slowed to the static state; Then, the servo drive is accelerated again to the speed specified in the parameter "return to reference search zero speed", and the direction is opposite to the direction specified in the parameter "return to reference direction", when leaving the reference block (signal REF: 1->0); When the first zero pulse is reached, the servo drive starts to run to the reference point defined by the parameter "back reference point offset value" at the speed specified by the parameter "back reference point approaching the reference point speed". When the servo drive reaches the reference point, the REFOK signal is output. Setting STW1.11 to 0 succeeds in returning to the reference point.

The whole process is shown as follows. The parameter "maximum distance back to the reference point block" is set to search the travel of the reference point block of path 1 in the figure. If the REF signal (0->1) is not found in the travel, the servo driver appears Err77 alarm; The parameter "maximum distance back to the reference point zero" is set to search the zero stroke after leaving the reference point block (signal REF: 1->0) in path 2 in the figure. If no zero pulse signal is found in the stroke, the servo driver will alarm Err78.

In the process of returning to the reference point, acceleration and deceleration are carried out with maximum acceleration and maximum deceleration.



Back to the reference point in the process of related parameters as shown below

Parameter	Range	Factory Settings	Unit	Describe
Back to the reference point offset value	-2147482648 ~2147482647	0	LU	Sets the position value of the reference axis
Return to reference point direction[1)]	0~1	0	-	Set the signal source for the start direction of the search block: 0: Starts in the positive direction 1: Starts in a negative direction
Search block speed back to reference point	1~40000000	5000	1000 LU/min	Speed of search block
Return to reference point block maximum distance	0~2147482647	2147482647	LU	Maximum distance to search blocks
Return to reference point to search for zero speed	1~40000000	300	1000 LU/min	Search the speed of the zero pulse
Maximum distance back to reference point zero	0~2147482647	20000	LU	Search the maximum distance of the zero pulse
Back to the reference point approach speed reference point	1~40000000	300	1000 LU/min	Speed of searching for reference points

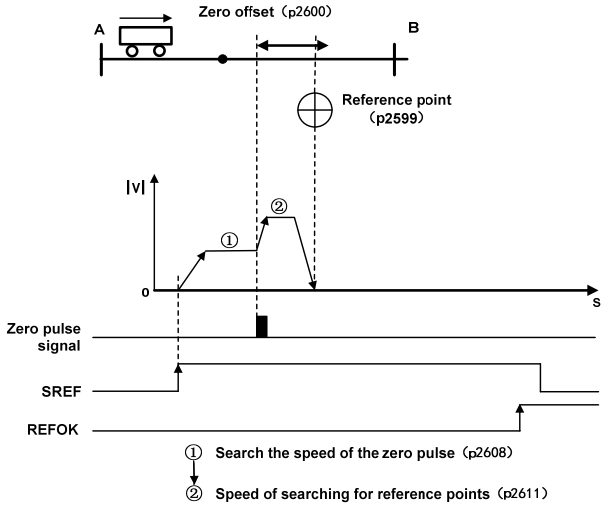
[1)] When Message 111 is used, the direction back to the reference point is assigned by the control value POS_STW2.9

Encoder only zero pulse (Mode 2)

In this mode, the REF signal is not available and the return to the reference point process is triggered by STW1.11(0->1). The servo drive is accelerated to the speed specified by the parameter "return to reference search zero speed", and the running direction is specified by the parameter "return to reference direction"; When the first zero pulse is reached, the servo drive begins to run towards the reference point defined by the parameter "back reference offset value" at the speed specified by the parameter "back reference point approaching reference point speed"; When the servo drive reaches the reference point, the REFOK signal is output. Setting STW1.11 to 0 succeeds in returning to the reference point.

The whole process is shown as follows. The parameter "maximum distance back to the reference point zero" sets the travel of path 1 in the figure to search for zero. No zero pulse signal is found in the travel, and the servo driver generates an Err78 alarm.

In the process of returning to the reference point, acceleration and deceleration are carried out with maximum acceleration and maximum deceleration.



Back to the reference point in the process of related parameters as shown below:

Parameter	Range	Factory Settings	Unit	Describe
Back to the reference point offset value	-2147482648 ~2147482647	0	LU	Offset of the reference point
Return to reference point direction [1)]	0~1	0	-	Set the signal source for the start direction of the search block: 0: starts in the positive direction 1: Starts in a negative direction
Return to reference point to search for zero speed	1~40000000	300	1000 LU/min	Search the speed of the zero pulse
Maximum distance back to reference point zero	0~2147482647	20000	LU	Search the maximum distance of the zero pulse
Return to the reference point approaching the reference point velocity	1~40000000	300	1000 LU/min	Speed of searching for reference points

[1)] When Message 111 is used, the direction back to the reference point is assigned by the control value POS_STW2.9.

4. EJOG

When using Message 9, 111, select JOG channel through STW1.8 and STW1.9, corresponding to through is activated, the axis is accelerated to the specified JOG speed at the maximum acceleration; When deactivated, the axis slopes down from its current speed at maximum acceleration:

Control word	Set up	Describe
STW1.8 STW1.9	0	JOG channel is not active
	1	JOG1 source rise along has been activated
	2	JOG2 source rise along has been activated
	3	Reserved

Select JOG Mode

If Message 111 is used, select JOG mode via pos_STW2.5. Message 9 supports only continuous JOG mode:

Control word	Set up	Describe
POS_STW2.5	1	JOG, incremental activation
	0	JOG, speed activation

Setting JOG parameters can be modified through the EPOS parameter editor in the upper computer software.

When using Message 9, the following JOG Settings are set with the parameter:
JOG1 speed: the unit is 1000LU/min.
JOG2 speed: the unit is 1000LU/min.
When using Message 111, set the following JOG Settings as a parameter
JOG1 speed: the unit is 1000LU/min.
JOG1 Stroke: unit LU.
JOG2 speed: the unit is 1000LU/min.
JOG2 Travel: Unit: LU.

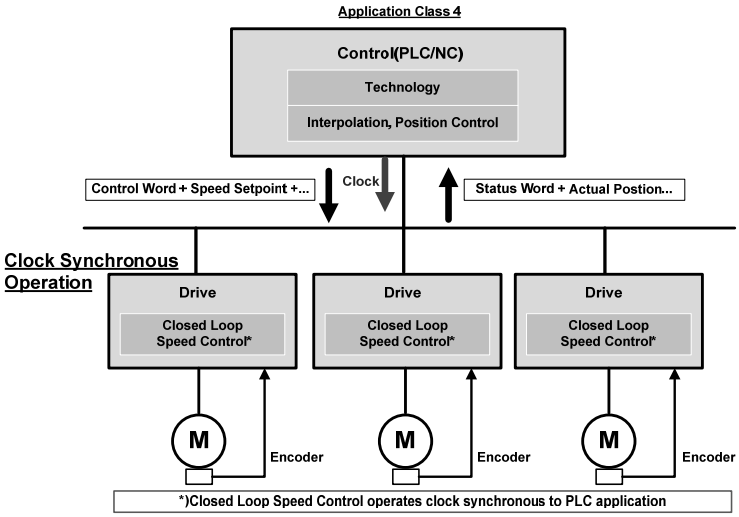
5. Software limit

When EJOG and MDI are running in position mode, run POS_STW2.5 or edit EPOS to enable the software limit function. When the actual position of the axis exceeds the position point of the software limit in the running direction, the axis decelerates the slope with the maximum acceleration of the corresponding mode, and Err75 (negative soft limit exceeds the limit) and Err76 (positive soft limit exceeds the limit) are reported. This error can be cleared by STW1.7. After the clearance, the servo can only receive the instructions in the opposite direction of the limit and run to the software limit range. Receiving the instructions in the same direction of the limit will trigger the limit alarm again.

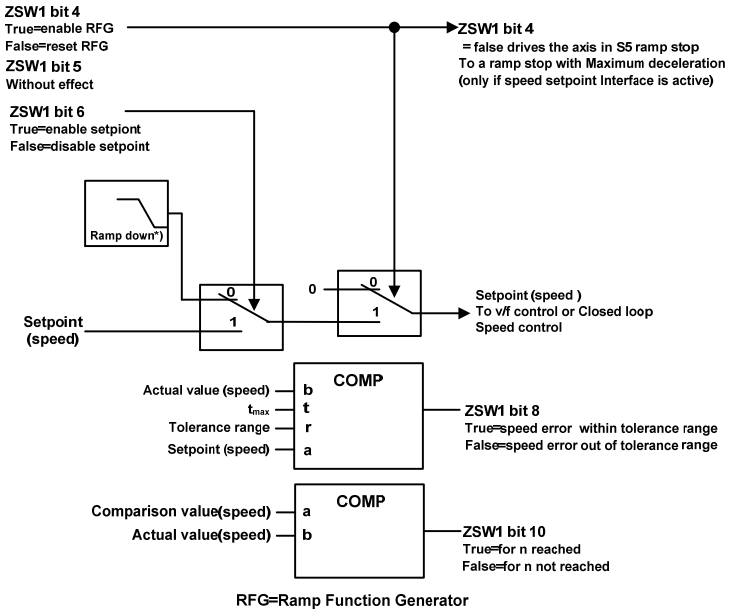
Set the soft limit parameters, which can be modified through the EPOS parameter editor in the upper computer software.

6.3.3 AC4: Motion control with central interpolation and speed setting interface

Application class AC4(shown below) shows closed-loop position control through a communication system. The speed set and actual values as well as the actual position values are transmitted through a cyclic data exchange. The servo driver contains only closed-loop speed control and actual position sampling algorithms. Because position is controlled through the bus system, clock synchronization operations are necessary and should be precise.



Application class generally do not need the speed setting of the AC4 channel slope function generator, the following chart from out of the station equipment the speed setting of the simplified channel module function, to the speed set point STW1.5 channel has no effect.



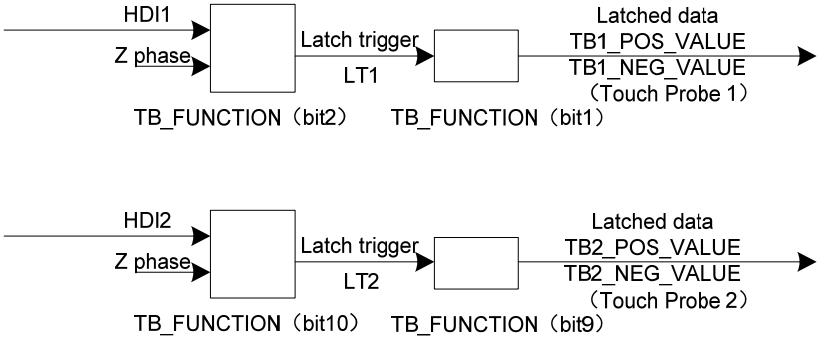
6.4 Pattern common function

6.4.1 Touch Probe Function

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

- The width of the trigger signal input ON and OFF should be kept above 2ms respectively.
- If the trigger selection is Z phase, do not select the falling edge.
- The Touch Probe function is only effective when the motor is enabled.

1. Composition of the Touch Probe function



- TB_FUNCTION

TB_FUNCTION			
bit10	LT2	Bit2	LT1
0	HDI2	0	HDI1
1	Z phase	1	Z phase

- TB1_POS_VALUE
- TB1_NEG_VALUE
- TB2_POS_VALUE
- TB2_NEG_VALUE

2. Touch Probe Associated object

Name	Unit	Range	Date Type	Access
TB_FUNCTION	-	0~65535	U16	RW
TB_STATUS	-	0~65535	U16	RO
TB1_POS_VALUE	Instruction unit	-2147483648~2147483647	I32	RO
TB1_NEG_VALUE	Instruction unit	-2147483648~2147483647	I32	RO
TB2_POS_VALUE	Instruction unit	-2147483648~2147483647	I32	RO
TB2_NEG_VALUE	Instruction unit	-2147483648~2147483647	I32	RO

（1）TB_FUNCTION

Start the Touch Probe action, the basic object used for various Settings, and the corresponding Bit description

bit	value	Note
0	0	Switch off touch probe 1
	1	Enable touch probe 1
1	0	Trigger first event
	1	Continuous
2	0	Trigger with touch probe 1 input
	1	Trigger with zero impulse signal of position encoder
3	-	Reserved
4	0	Switch off sampling at positive edge of touch probe 1
	1	Enable sampling at positive edge of touch probe 1
5	0	Switch off sampling at negative edge of touch probe 1
	1	Enable sampling at negative edge of touch probe 1
6~7	-	Not Supported
8	0	Switch off touch probe 2
	1	Enable touch probe 2
9	0	Trigger first event
	1	Continuous
10	0	Trigger with touch probe 2 input
	1	Trigger with zero impulse signal of position encoder
11	-	Reserved
12	0	Switch off sampling at positive edge of touch probe 2
	1	Enable sampling at positive edge of touch probe 2
13	0	Switch off sampling at negative edge of touch probe 2
	1	Enable sampling at negative edge of touch probe 2
14~15	-	Not Supported

- If the Z phase is selected according to the trigger setting, do not select the falling edge. There is no guarantee that the actions set above will be performed.
- The rising edge represents the time when the theoretical state of the object signal changes from OFF (inactive state) to ON (active state), and the falling edge represents the time when the theoretical state of the object signal changes from ON to OFF.

（2）TB_STATUS

Indicates the status of the Touch Probe action. The corresponding Bit is described

bit	value	Note
0	0	Touch probe 1 is switch off
	1	Touch probe 1 is enabled
1	0	Touch probe 1 no positive edge value stored
	1	Touch probe 1 positive edge value stored
2	0	Touch probe 1 no negative edge value stored
	1	Touch probe 1 negative edge value stored
3~5	-	Reserved
6~7	-	Not Supported
8	0	Touch probe 2 is switch off
	1	Touch probe 2 is enabled
9	0	Touch probe 2 no positive edge value stored
	1	Touch probe 2 positive edge value stored
10	0	Touch probe 2 no negative edge value stored
	1	Touch probe 2 negative edge value stored
11~13	-	Reserved
14~15	-	Not Supported

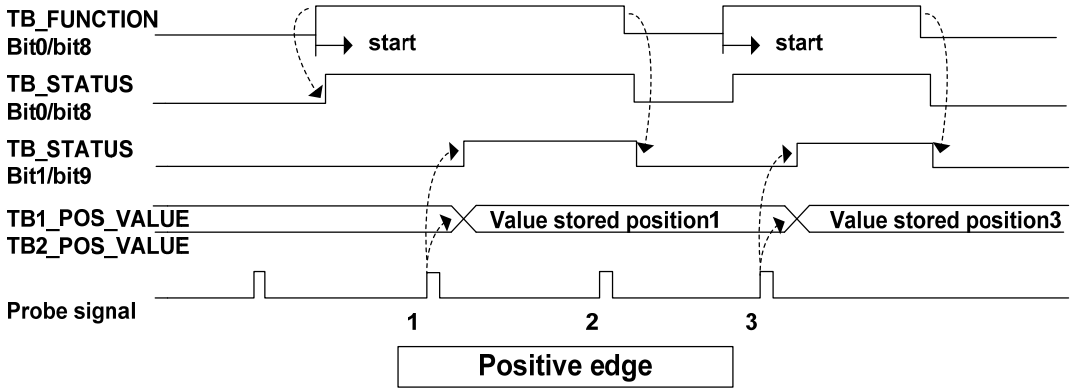
3. Start the Touch probe action

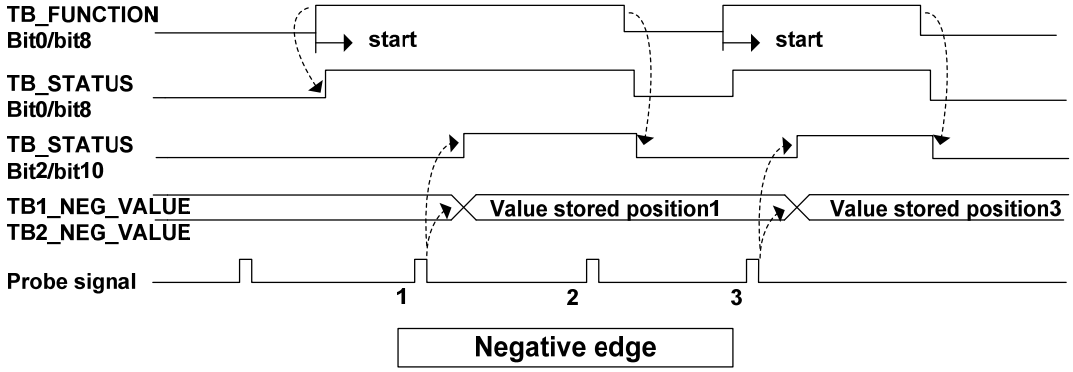
Bit0 /bit8 (Touch Probe execution/stop) of the TB_FUNCTION changes from 0 (stop) to 1 (start), obtains the set conditions (TB_FUNCTION: bit1-7 / BIT9-15), and starts the Touch Probe. Changes to various Settings are valid, please bit0/bit8 return once to "0 (stop)", and then again to "1 (start)".

According to the bit1 TB_FUNCTION/combination mode selection (events), you can choose to "0 (the Trigger First event mode)", "1" (Continuous mode).

- Trigger First Event mode (TB_FUNCTION: bit1=0 / bit9=0).

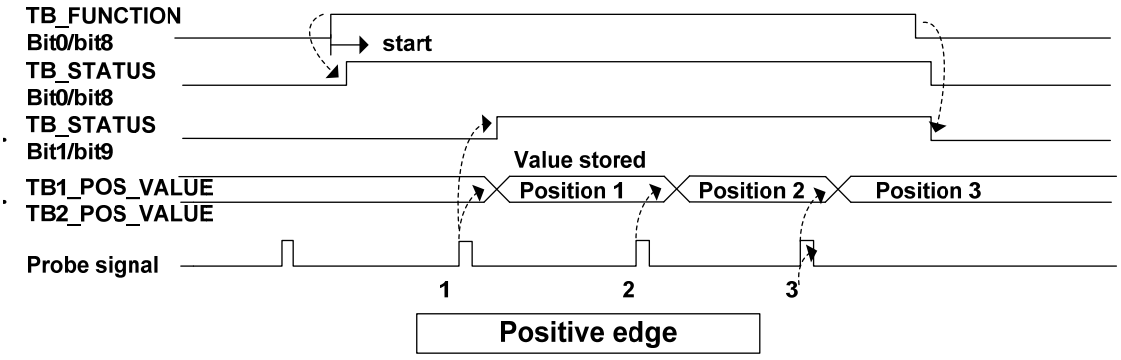
After starting, only under the trigger signal of the first clamping mode. In order to obtain it again, it is necessary to start the Touch Probe again.

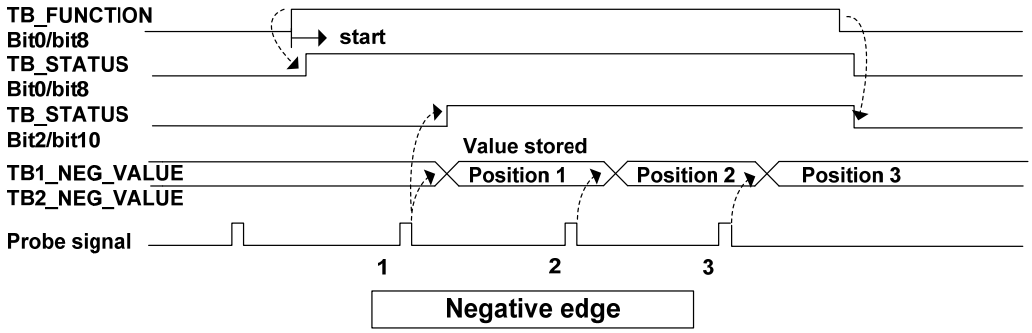




- Continuous mode（TB_FUNCTION：bit1=1 / bit9=1）

After starting, each time the trigger signal nesting mode is checked out. The obtained value is held until the next Probe latch signal is valid.





6.4.2 Stop function

When the servo driver needs to be stopped due to motion control or servo driver failure, the PROFIDrive defined deceleration function can be combined with servo deceleration function (EMG, dynamic brake stop, free running stop, instant stop, etc.) to achieve the "stop function".

1. EMG emergency stop

When EMG(emergency shutdown) in DI is ON, the driver directly cuts off the motor current, and the motor stops freely. After the motor stops, it switches to a Switching On Inhibited state.

2. OFF1 ramp parking

When STW1.0 goes from 1 to 0, the deceleration stop is performed according to the setting of parameter P321(ramp deceleration time).

P321	Ramp deceleration time	Range	Default value	Unit	Usage
		1～30000	1000	ms	ALL

P321 parameter sets the deceleration time of the motor from rated speed to zero speed. If the current speed is lower than the rated speed, the deceleration time required is correspondingly shortened.

Related actions in the deceleration process are as follows:

- In the deceleration process, when STW1.1 from 1→0, the deceleration process is switched from slope stop to free stop, the driver directly cuts off the motor current, and after the motor stops, converts to Switching On Inhibited state.
- During the deceleration process, when STW1.2 went from 1 to 0, the Ramp Stop Switching Off was switched to Quick Stop Switching Off. The deceleration process started from the current speed, and the setting of deceleration time was switched from Ramp deceleration time to fast deceleration time.
- After the deceleration is complete or STW1.3 goes from 1 to 0, the Ramp Stop Switching Off is switched to Ready For Switching On.

3. OFF2 free parking

Drive directly cut off the motor current, the motor stop freedom. After the motor stops, it switches to a Switching On Inhibited state.

4. OFF3 stop quickly

When STW1.0 goes from 1 to 0, the deceleration stop is performed according to the setting of parameter P321(ramp deceleration time).

P322	Rapid deceleration time	Range	Default value	Unit	Usage
		1～30000	100	ms	ALL

P322 parameter sets the deceleration time of motor from rated speed to zero speed. If the current speed is lower than the rated speed, the deceleration time required is correspondingly shortened.

Related actions in the deceleration process are as follows:

- In the deceleration process, when STW1.1 from 1→0, the deceleration process is switched from slope stop to free stop, the driver directly cuts off the motor current, and after the motor stops, converts to Switching On Inhibited state
- After the deceleration is complete or STW1.3 goes from 1 to 0, the Ramp Stop Switching Off is switched to Ready For Switching On.

6.4.3 Reference speed

Servo parameter P310, as the normalized reference variable of the speed setting value in AC4, is described as follows:

P310	Reference speed	Range	Default value	Unit	Usage
		10～X	3000	rpm	ALL

After drive initialization, the maximum value X of this parameter is limited to the rated speed of the connected motor. The reference speed can be set freely within the rated speed range. If the current set value exceeds the rated speed of the motor, the current set value will be limited to the rated speed of the motor.

6.4.4 Reference torque

Servo parameter P312 is used as a normalized reference variable in the application of torque limit and feedback. The parameter description is as follows:

P312	Reference torque	Range	Default value	Unit	Usage
		1～X	4000	0.1nm	ALL

After drive initialization, the maximum value X of this parameter is limited to 3 times the rated torque of the connected motor. The reference torque can be set freely in the range of 3 times the rated torque. If the current set value exceeds 3 times the rated torque of the motor, the current set value will be limited to 3 times the rated torque of the motor.

6.4.5 Position feedback interface

The position feedback interface is the interface between the axis and higher level control that enables the controller to get position feedback through the PROFIDrive interface. This position feedback comes from a sensor connected to the driver, where the functions described in the position feedback interface are implemented.

In current versions of drives, only rotary absolute value encoders are supported. **And the resolution format of the current position information returned by the encoder is fixed, including 17Bit single-loop data and 15Bit multi-loop data.** PROFIDrive specific parameter P979 (sensor format) structure and set values are described as follows:

subindex	Meaning	Set value
0	Prelude	0x00005111
1	Sensor type	0x80000002
2	Sensor resolution	131072
3	G1_XIST1 shift factor	0
4	G1_XIST2 absolute value of the shift factor	0
5	Determinable resolution	32768
6~N	Reserved	0

Chapter 7 Alarm

7.1 Diagnostic information

PROFIDrive classifies each alarm information of the servo drive. The specific category information is shown in the following table:

Class no.	Error class name	Reason statement
1	Hardware or software malfunction	A hardware or software fault occurs
2	Main power failure	The main power supply is faulty, with phase loss, overvoltage and undervoltage
3	Control power failure	Control power failure, 24V, 5V power supply is abnormal
4	Overvoltage of the DC bus	DC bus voltage threshold above normal
5	Power electronic component failure	Power electronic component failure, such as overheating, overcurrent or IGBT failure
6	Electronic component overheating	Electronic component temperature exceeds normal threshold
7	Grounding, interphase short circuit	Grounding or interphase short circuit found in power cable or motor winding
8	Motor overload	Motor over finite temperature, limit current or limit torque operation
9	Communication failure of upper controller	Between the drive and controller PROFINET communication failure
10	Security monitoring channel failure	Safety operation monitoring detects faults
11	Position feedback interface failure	Status error or signal loss occurs during encoder signal processing
12	Internal communication failure	Drive internal communication between components abnormal or interrupt
13	Power module failure	Power supply module fault or failure
14	Brake module failure	Internal or external brake module is abnormal or overheated
15	Power filter failure	Power filter temperature too high or abnormal state
16	Abnormal external signal	The external input signal exceeds the threshold or is abnormal
17	Failure of application and process function	Driver monitoring position, speed, and torque over set thresholds
18	Parameter setting or configuration fails	Drive parameters are incorrectly configured or incorrectly configured
19	Common Driver Faults	Device component failure
20	Auxiliary device failure	The monitoring of the auxiliary device is abnormal

7.2 Alarm list

Alarm code	Serial no.	Class no.	Alarm name	Alarm content	Alarm clear
Err--	0	0	No alarm	Normal operation	
Err 1	1	17	Over speed	Motor speed exceeds the maximum limit	Can
Err 2	2	4	Main circuit overvoltage	The main circuit supply voltage exceeds the specified value	Can
Err 3	3	1	Main circuit undervoltage	The main circuit supply voltage is below the specified value	Can
Err 4	4	17	Position out of tolerance	Position deviation counter value more than set value	Can
Err 7	7	17	Drive inhibition abnormal	CCWL, CWL driver prohibited input are invalid	Can
Err 8	8	17	Position deviation counter overflowed	The absolute value of position deviation counter exceeds 2^{30}	Can
Err11	11	5	Power module over-current	Power module to malfunction	No
Err12	12	8	Over current	Excessive motor current	No
Err13	13	8	Overload	Motor overload	No
Err14	14	14	Peak Brake Power Overload	Brake instantaneous short time load is too large	No
Err16	16	8	Over-heat of servomotor	The heat load of servomotor exceeds the setting value (I^2t detection)	No
Err17	17	14	Overload of brake average power	Average load is too big in brake time	No
Err18	18	5	Overload of power model	Average output load of power model is too big	No
Err20	20	1	EEPROM error	Error in EEPROM reading and writing	No
Err21	21	1	Logic circuit error	Logic circuit fault outside DSP	No
Err22	22	18	Power panel and control panel does not match	Replace the power panel or control panel	No
Err23	23	1	AD conversion error	Circuit or current sensor fault	No
Err25	25	1	FPGA verification error	FPGA calibration error	No
Err27	27	2	Lack of phase alarm	Check whether the power line is three-phase input	No

Alarm code	Serial no.	Class no.	Alarm name	Alarm content	Alarm clear
Err29	29	5	Torque overload alarm	Motor load exceeds user set value and duration	Can
Err35	35	12	Interplate connection failure	Drive internal connection path failure	No
Err36	36	1	Fan alarm	Fan fault	No
Err40	40	11	Absolute value encoder communication error	The driver and encoder cannot communicate	No
Err41	41	19	Absolute value encoder handshake error	Absolute value encoder handshake error	No
Err42	42	11	Absolute value encoder internal count error	Abnormal absolute encoder count	No
Err43	43	11	Absolute value encoder communication reply wrong	Absolute value encoder communication response abnormal	No
Err44	44	11	Absolute value encoder calibration error	Absolute value encoder communication content error	No
Err45	45	19	Absolute encoder EEPROM error	EEPROM failure of absolute encoder	No
Err46	46	19	Absolute encoder parameter error	Absolute encoder parameters are broken	No
Err47	47	17	Absolute value encoder external battery failure	Battery voltage is too low	No
Err48	48	19	Absolute value encoder external battery alarm	Low battery voltage	No
Err49	49	8	Encoder overheating	Encoder overheating	No
Err50	50	18	Motor parameters do not match with driver	The power of the motor and drive does not match	No
Err51	51	18	Encoder automatic recognition failed	Encoder automatic recognition failed	No
Err60	60	1	Device offline	Ethernet communication interrupt or disconnects	Can
Err61	61	9	Ethernet communication cycle deviation is too large	Ethernet communication cycle deviation is too large	No
Err62	62	9	Ethernet instruction data out of range	Ethernet instruction data out of range	No
Err67	67	9	SOL synchronous counting errors	SOL synchronous counting errors	No

Alarm code	Serial no.	Class no.	Alarm name	Alarm content	Alarm clear
Err75	75	17	Negative soft limit overrun	Axis position exceeds negative soft limit	No
Err76	76	19	Positive soft limit overrun	Axis position beyond positive soft limit point	No
Err77	77	19	Failed to search for reference block	Failed to search for reference block	
Err78	78	19	Search for zero pulse failed	Search for zero pulse failed	No
Err80	80	1	Internal error 1	Internal calculation error, electronic gear setting invalid	No
Err81	81	1	Internal error 2	Internal error calculation, abnormal parameter is set to 0	No
Err82	82	1	Internal error 3	Internal calculation error, invalid home parameter setting	No
Err88	88	1	Operation mode error 1	Operation mode is not set when enabling	Can
Err89	89	1	Operation mode error 2	Set an invalid operation mode	Can

7.3 Alarm cause and handling

In this manual, "☆" indicates the special function of the multi-circle absolute value code disk, and "★" indicates the special function of the incremental code disk.

Err 1 (Over speed)

Potential cause	Check	Handle
Servomotor U、V、W connection is not correct	Check U、V、W wiring	Correct U、V、W wiring. The U、V、W must connect with servo driver terminal U、V、W correspondently.
Speed overshoot	Check the operation status and the parameters	Adjust servo gain to reduce the overshoot; In speed control mode can increase acceleration/deceleration time.
Encoder wiring error	Check the encoder wiring	Correct wiring.

Err 2 (Main circuit over-voltage)

Potential cause	Check	Handle
Input AC power is too high	Check the voltage of power supply	Use correct power supply according with the specifications.
Regeneration fault	Regenerative resistor and/or IGBT damaged; Connection circuit is open.	Repair.
Regeneration energy too large	Check the regeneration load factor	● Decrease the start-stop frequency. ● Increase acceleration / deceleration time ● Reduce the torque limit. ● Reduce the load inertia. ● Replace a bigger power servo driver and servomotor ● Replace a bigger brake resistor

Err 3 (Main circuit undervoltage)

Potential cause	Check	Handle
Input AC power is too low	Check the power supply voltage	Make voltage conform to product specification

Err 4 (Position deviation)

Potential cause	Check	Handle
Servomotor U、V、W connection is not correct	Check U、V、W wiring	Correct U、V、W wiring. The U、V、W must connect with servo driver terminal U、V、W correspondently.
Encoder zero point changes	Check the encoder zero point	Adjust the zero point of encoder again.
Encoder wiring error	Check the encoder wiring	Correct connection
The servomotor is blocked	Check the servomotor shaft and its mechanical connection	Repair.
Command pulse frequency is too high	Check the input frequency and pulse frequency doubling parameters	Lower input frequency Adjust the pulse frequency doubling parameters
The position loop gain is too small	Check parameters P009, P013	Increase the position loop gain
Torque is not enough big	Check torque	● Increase the torque limit. ● Increase smooth filtering time for position command. ● Reduce load. ● Replace the servo driver and servomotor with bigger ones.

Err 7 (Drive inhibition abnormal)

Potential cause	Check	Handle
When the servo enable, CCWL、CWL drive forbidden input are invalid	Check CCWL、CWL wiring	● Correct input CCWL、CWL signal. ● If not use CCWL、CWL signal can shield it by setting parameter P097.

Err 8 (Overflow of position deviation counter)

Potential cause	Check	Handle
The servomotor is blocked	Check the servomotor shaft and its mechanical connection	Repair.
The command pulse is abnormal	Check command pulse	

Err11 (Power module over-current)

Potential cause	Check	Handle
Short circuit between motor connection U、V、W	Check U、V、W wiring	Properly connected U、V、W wiring
Motor winding insulation damage	Check the servomotor	Replace the servo motor
Drive damage	Check driver	No problem with motor, power on again or alarm, may be drive damage
Bad earth	Check the ground wire	Correct grounding
Be disturbed	Check the source of interference	Add line filter, away from interference source

Err12 (Over-current)

Potential cause	Check	Handle
Short circuit between motor connection U、V、W	Check U、V、W wiring	Properly connected U、V、W wiring
Motor winding insulation damage	Check the servomotor	Replace the servo motor
Drive damage	Check driver	No problem with motor, power on again or alarm, may be drive damage

Err13 (Over-load)

Potential cause	Check	Handle
Excess the rated load for continuous duty operation	Check the load factor	Reduce load or replace the servo driver with bigger one.
System unstable	Check the oscillation when servomotor is in running	Reduce the gains of the system
Acceleration/deceleration is too short	Check the smoothness when servomotor is in running	Increase the acceleration and deceleration time
Encoder zero point changes	Check the encoder zero point	Install the encoder again and adjust the zero point.

Err14 (Overload of brake peak power)

Potential cause	Check	Handle
Input AC power is high	Check the supply voltage	Make the voltage conform to the product specification
Regenerative braking fault	Whether the regenerative brake resistance, brake pipe failure or disconnected wiring	Repair.
Regenerative braking energy is too large	Check the brake load factor	● Reduce the start-stop frequency ● Increase acceleration and deceleration time ● Replace the higher power driver and motor ● Replace with larger brake resistance
Wrong wiring	B1, B2 are not short connected Check the type of drive, whether it needs to be connected with external brake resistor	Short-connect B1 and B2 Connect the external brake resistor for use

Err16 (Motor over-heat)

Potential cause	Check	Handle
Long running over rated load	Check load rate and motor temperature rise	Reduce load or replace with a more powerful driver
Zero change of encoder	Check the zero of the encoder	Reinstall the encoder and set it to zero

Err17 (Brake average power overload)

Potential cause	Check	Handle
Input AC power is high	Check the supply voltage	Make the voltage conform to the product specification
Regenerative braking energy is too large	Check the brake load factor	● Reduce the start-stop frequency ● Increase acceleration and deceleration time ● Reduce torque limit ● Reduce the load inertia ● Replace the higher power driver and motor ● Replace with larger brake resistance

Err18 (IGBT model over-load)

Potential cause	Check	Handle
Excess the rated load for continuous duty operation	Check current	Reduce load or replace the servo driver with bigger one.
Encoder zero point changes	Check the encoder zero point	Install the encoder again and adjust the zero point.

Err20 (EEPROM Error)

Potential cause	Check	Handle
EEPROM chip is damaged	Turn on the power again and check	If the error still exists, then replace the servo driver.

Err21 (Logic circuit error)

Potential cause	Check	Handle
Control circuit fault	Turn on the power again and check	If the error still exists, then replace the servo driver.

Err22 (Power panel and control panel does not match)

Potential cause	Check	Handle
Power panel and control panel does not match	Whether to change control board	Use and power board to match the panel

Err23 (AD conversion error)

Potential cause	Check	Handle
Current sensor and connector fault	Check the main circuit	If the error still exists, then replace the servo driver.
AD converter and analog amplifier fault	Check the control circuit	If the error still exists, then replace the servo driver.

Err25 (FPGA verification error)

Potential cause	Check	Handle
FPGA verification error	Re-energize and check	If the error still exists, then replace the servo driver.

Err27 (Phase loss alarm)

Potential cause	Check	Handle
Phase loss of power supply	Check the wiring of L1, L2,L3	Connect wire correctly
Power supply undervoltage	Check supply power voltage	Ensure correct voltage input
Phase loss checking return circuit error	Check optocoupler, power on again	If error still exists, please replace drive

Err29 (Over-torque alarm)

Potential cause	Check	Handle
Unexpected big load occurs	Check load condition	Correctly readjust the load.
Parameter P070、P071、P072 setting is not reasonable	Check the parameters	Correctly readjust parameters.

Err35 (Connection path error between boards)

Potential cause	Check	Handle
Connection wire error between boards	Check wire and connectors	Please change drive if error does not disappear.
Connection route error	Check optocouplers	Please change drive if error does not disappear.

Err36 (Fan alarm)

Potential cause	Check	Handle
Cooling fan fault	Check fan	Replace fan
Fan detection circuit fault	Check wiring	Please wire rightly
Fan detection circuit fault	Check optocouplers	Please change drive if error does not disappear.

Err40 (Encoder communication error) ☆

Potential cause	Check	Handle
Encoder connection wiring error	Check encoder connection wiring	Connect wiring correctly
Encoder cable and connector unsteady	Check cable and connector	Replace cable and connector
Encoder damage	Check encoder	Replace encoder

Err41 (Absolute value encoder handshake error) ☆

Potential cause	Check	Handle
Encoder connection wiring error	Check encoder connection wiring	Connect wiring correctly
Encoder cable and connector unsteady	Check cable and connector	Replace cable and connector
Encoder damage	Check encoder	Replace encoder

Err42 (Encoder interior counting error) ☆

Potential cause	Check	Handle
Encoder cable and connector unsteady	Check cable and connector	Replace cable and connector
Encoder damage	Check encoder	Replace encoder

Err43 (Encoder communication responds error) ☆

Potential cause	Check	Handle
Encoder cable and connector unsteady	Check cable and connector	Replace cable and connector
Encoder damage	Check encoder	Replace encoder

Err44 (Encoder verify error) ☆

Potential cause	Check	Handle
Encoder cable and connector unsteady	Check cable and connector	Replace cable and connector
Encoder damage	Check encoder	Replace encoder

Err45 (Encoder EEPROM error) ☆

Potential cause	Check	Handle
Encoder cable and connector unsteady	Check cable and connector	Replace cable and connector
Encoder EEPROM damage	Check encoder	Replace encoder

Err46 (Encoder parameter error) ☆

Potential cause	Check	Handle
Encoder cable and connector unsteady	Check cable and connector	Replace cable and connector
Encoder EEPROM damage	Check encoder	Replace encoder

Err47 (Absolute encoder external battery error) ☆

Potential cause	Check	Handle
External battery out of power	External battery voltage	Replace battery
Power on for the first time after replacing the battery	Battery voltage	If the voltage is normal, restart the encoder. Refer to section 3.6.1

Err48 (Absolute encoder external battery alarm)☆

Potential cause	Check	Handle
External battery out of power	External battery voltage	Replace battery
Power on for the first time after replacing the battery	Battery voltage	If the voltage is normal, restart the encoder. Refer to section 3.6.1

Err49 (Encoder overheating)

Potential cause	Check	Handle
Encoder overheating	Whether the power of the motor is too small or the ambient temperature is too high	● Replace the motor with the appropriate power or temperature grade ● Lower ambient temperature

Err50 (Motor parameter does not match that of drive)

Potential cause	Check	Handle
The power of motor does not match that of drive	Check the motor match list of drive	Replace suitable drive or motor

Err51 (Encoder automatic recognition failed)

Potential cause	Check	Handle
Encoder wiring error	Check the encoder wiring	Correct connection
Encoder automatic recognition failed	Verify that the encoder type is supported by the driver	Replace the type of encoder supported by the drive

Err60 (Device offline)

Potential cause	Check	Handle
Device offline	● Check the Ethernet cable ● Check the status of the master station	● Replace the Ethernet cable ● Check host status

Err61 (Ethernet communication cycle deviation is too large)

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

Err62 (Ethernet instruction data out of range)

Potential cause	Check	Handle
Current communication cycle instruction data is out of limit	● Check user unit Settings ● Check the electronic gear Settings	● Change user unit Settings ● Change electronic gear Settings

Err67 (SOL synchronous counting errors)

Potential cause	Check	Handle
SOL cycle synchronization count error	● Check the configuration parameter configuration ● Check the Ethernet cable	● Check the configuration parameter configuration ● Check the Ethernet cable

Err75 (Negative soft limit overrun)

Potential cause	Check	Handle
Axis position exceeds negative soft limit	● Clear error, send limit direction opposite instruction.	● Clear error, send limit direction opposite instruction.

Err76 (Positive soft limit overrun)

Potential cause	Check	Handle
Axis position beyond positive soft limit point	● Clear error, send limit direction opposite instruction.	● Clear error, send limit direction opposite instruction.

Err77 (Failed to search for reference block)

Potential cause	Check	Handle
Search found no REF signal reference point tour	● Check the REF signal wiring ● Check the relevant configuration	● Check the REF signal wiring ● Check the relevant configuration

Err78 (Search for zero pulse block failed)

Potential cause	Check	Handle
Electronic gear related parameters are not set legally	● Electronic gear related parameter setting	● Set valid electronic gear parameters

Err80 (Internal error 1)

Potential cause	Check	Handle
Parameter Settings of electronic gear are invalid	Set related parameters of electronic gear	Set valid electronic gear parameters

Err81 (Internal error 2)

Potential cause	Check	Handle
Division by "0" occurs in the internal operation	Related parameter setting values, such as rated current, rated voltage, rated speed, etc	Set the value of Valid (not 0)

Err82 (Internal error 3)

Potential cause	Check	Handle
The home parameters are invalid	Set the parameters related to home	Set a valid home parameter

Err88 (Operation mode error 1)

Potential cause	Check	Handle
Operation mode is not set when enabling	Set the operation mode when enable	Enable the operation mode after the operation mode is set

Err89 (Operation mode error 2)

Potential cause	Check	Handle
Set an invalid operation mode	Setting the operation mode	Set a valid operation mode based on 6502h

Chapter 8 Specifications

8.1 Driver model

EP3E - G L 3A0 - E3 S0 PN

Mark	Main power supply voltage specifications
L	AC220V
H	AC380V

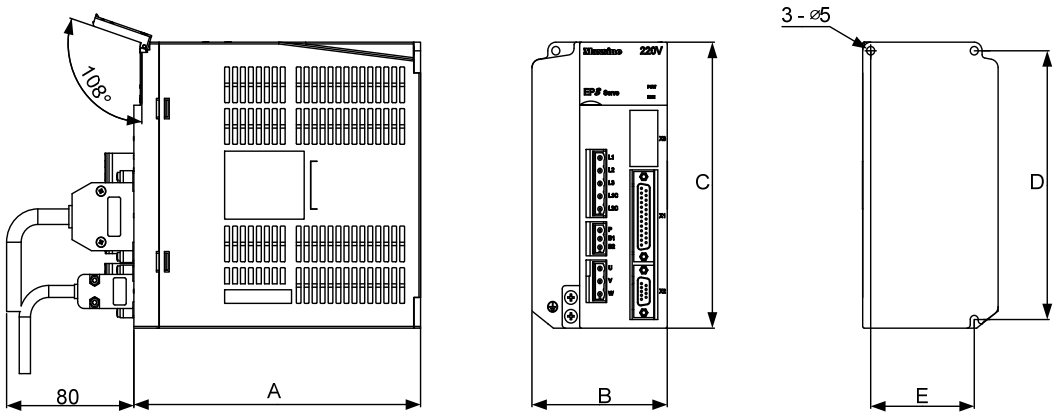
Mark	Power (kW)	Current (A)	Mark	Power (kW)	Current (A)
GL1A0	0.1	1.0	GH3A5	1.0	3.5
GL1A8	0.2	1.8	GH5A4	1.5	5.4
GL3A0	0.5	3.0	GH8A5	2.0	8.5
GL5A5	1.0	5.0	GH130	3.0	13.0
GL7A5	1.5	7.5	GH170	5.0	17.0
GL120	2.0	11.5	GH210	7.5	21.0
GL160	2.5	15.5	GH260	9.0	25.5
GL190	3.5	19.0	GH320	11.0	32.0
GL240	5.5	24.0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

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

Mark	Control mode
S0	X1 control terminal DB25

Mark	Specifications
PN	PROFINET bus protocol

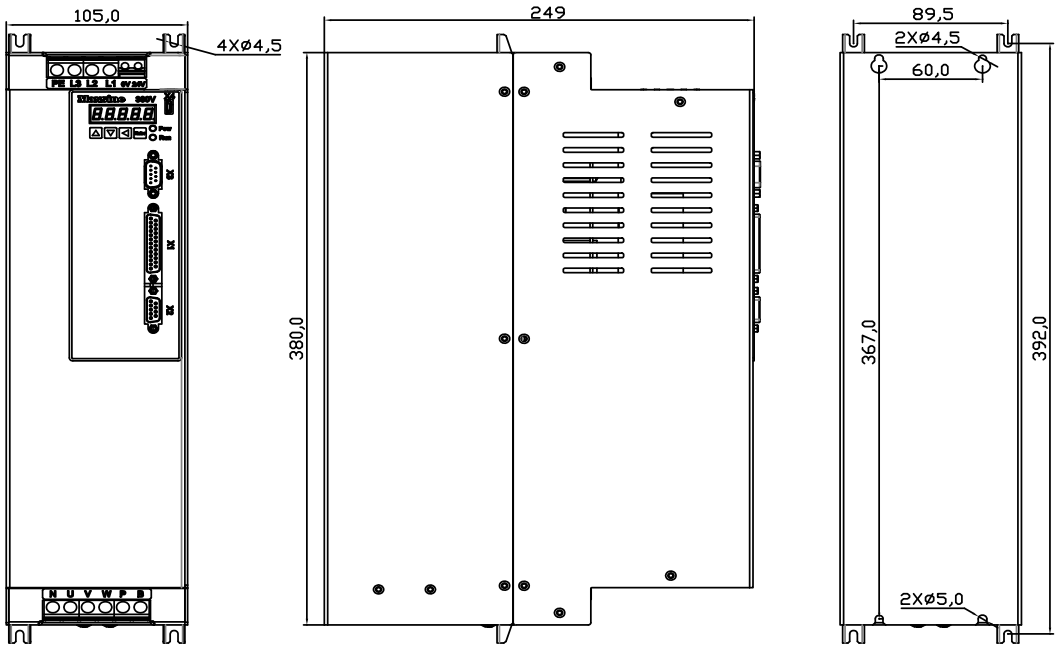
8.2 Drive size



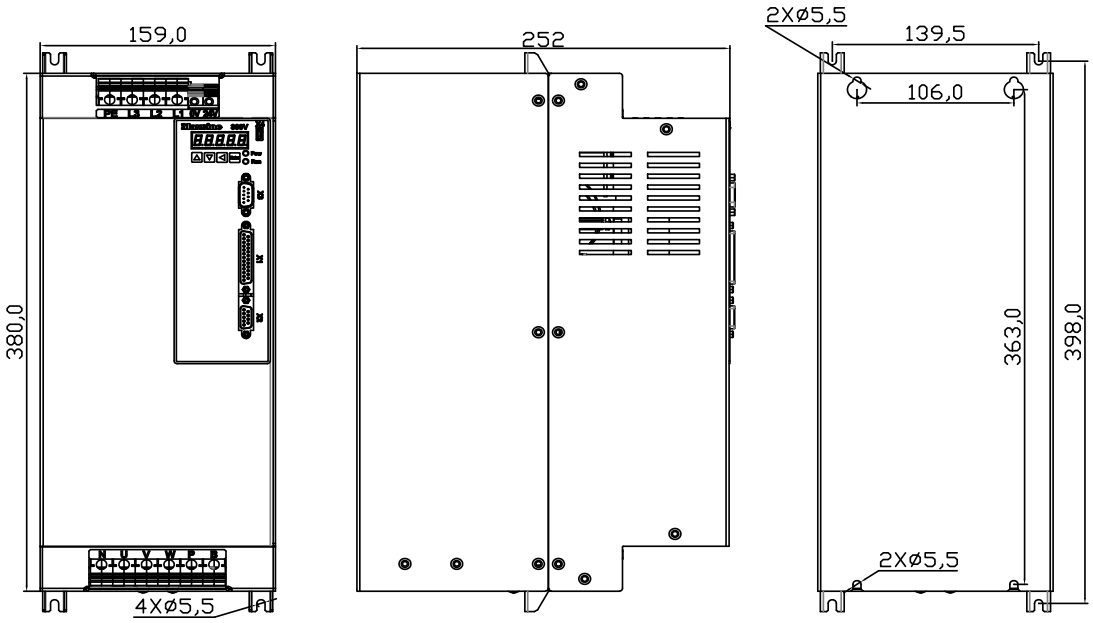
Model / Size (mm)	GL1A0	GL1A8/ GL3A0	GL5A5	GL7A5	GL120	GL160	GL190	GL240
A	150	150	180	180	180	180	180	210
B	55	65	75	85	95	95	105	115
C	168	168	168	168	168	200	220	250
D	158	158	158	158	158	189	209	239
E	-	55	65	65	65	84	94	104

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 size chart



GH320、GH390 Installation size chart



8.3 Drive specification

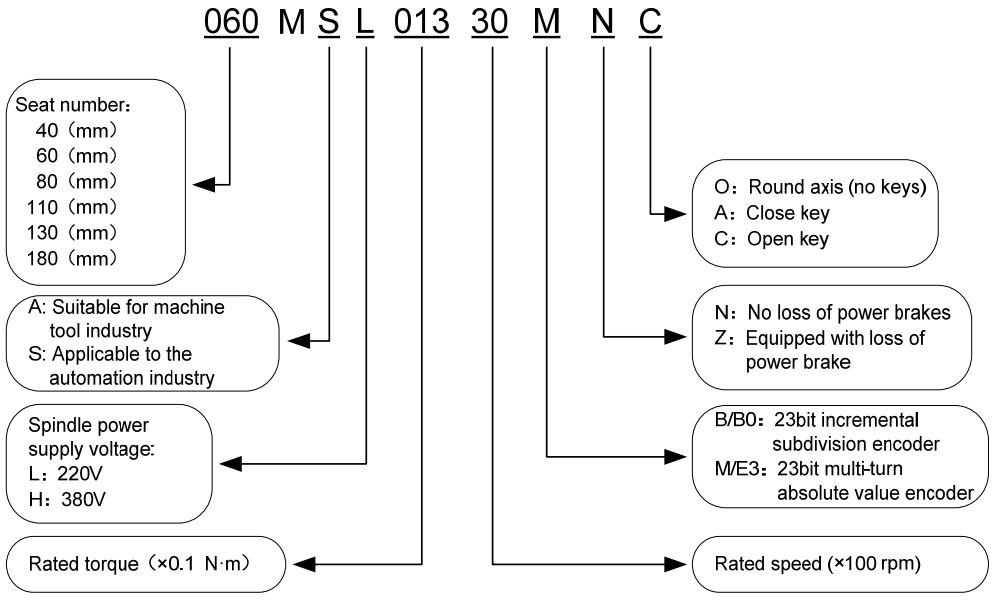
model		GL 1A0	GL 1A8	GL 3A0	GL 5A5	GL 7A5	GL 120	GL 160	GL 190	GL 240	GH 2A0	GH 3A5	GH 5A4	GH 8A5	GH 130	GH 170	GH 210	GH 260	GH 320	GH 390
Rated output power (kW)		0.1	0.2	0.5	1.0	1.5	2.0	2.5	3.5	5.5	0.6	1.0	1.5	2.0	3.0	5.0	7.5	9.0	11.0	15.0
Rated output current (A)		1.0	1.8	3.0	5.0	7.5	11.5	15.5	19.0	24.0	2.0	3.5	5.4	8.5	13.0	17.0	21.0	25.5	32.0	39.0
Instantaneous 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 phaseAC220V -15%～+10% 50/60Hz			Three-phase220VAC -15%～+10% 50/60Hz						Three-phase380VAC -15%～+10% 50/60Hz									
	Control power supply	Single phase220VAC-15%～+10% 50/60Hz									24V DC ±15% Not less than 1.5 A									
环境	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 way		Standard 23-bit/multi-turn absolute encoder, optional other specifications																		
Control mode		Application class AC1 message 1; AC4 message 3, 5, 102, 105; AC3 message 111; Auxiliary message 750, 860																		
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, poor position and so on																		
Characteristic	Velocity frequency response	1.2kHz																		
	Velocity fluctuation	< ±0.03% (load 0 ~ 100%); < ±0.02% (power supply -15% ~ +10%)																		
	Speed ratio	1:5000																		

8.4 Motor adaptation sheet of driver

Motor type （220V series）		Torque N·m	Speed r/min	Power kW	Adapter driver	
					Recommend adaptation	Can be adapted
MSL series	40MSL00330	0.32	3000	0.10	GL1A0	
	60MSL00630	0.64	3000	0.20	GL1A8	
	60MSL01330	1.27	3000	0.40	GL3A0	
	80MSL01330	1.27	3000	0.40	GL3A0	
	80MSL02430	2.39	3000	0.75	GL7A5	GL120
	80MSL03230	3.18	3000	1.00	GL120	GL7A5
	110MSL03225	3.18	2500	0.83	GL7A5	
	110MSL04825	4.77	2500	1.25	GL7A5	GL120
	110MSL06425	6.37	2500	1.67	GL120	GL190
	130MSL04025	4.00	2500	1.00	GL7A5	
	130MSL04820	4.77	2000	1.00	GL7A5	GL120
	130MSL05025	5.00	2500	1.30	GL120	GL7A5
	130MSL07220	7.16	2000	1.50	GL160	GL190
	130MSL09620	9.55	2000	2.00	GL190	GL160
	130MSL10025	10.00	2500	2.60	GL190	GL160
	130MSL14320	14.30	2000	3.00	GL190	GL240
MAL series	110MAL04030	4.00	3000	1.26	GL7A5	GL120
	110MAL05030	5.00	3000	1.57	GL120	
	110MAL06030	6.00	3000	1.88	GL120	
	130MAL06025	6.00	2500	1.57	GL120	GL7A5
	130MAL07725	7.70	2500	2.02	GL160	GL120
	130MAL10015	10.00	1500	1.57	GL120	
	130MAL15015	15.00	1500	2.36	GL160	GL190

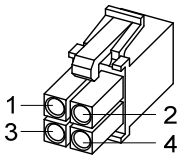
Motor type （380V series）		Torque N·m	Speed r/min	Power kW	Adapter driver	
					Recommend adaptation	Can be adapted
MAH series	110MAH04030	4.00	3000	1.26	GH3A5	GH5A4
	110MAH05030	5.00	3000	1.57	GH5A4	GH8A5
	110MAH06030	6.00	3000	1.88	GH8A5	GH5A4
	130MAH04025	4.00	2500	1.00	GH3A5	
	130MAH04820	4.77	2000	1.00	GH3A5	GH5A4
	130MAH05025	5.00	2500	1.30	GH5A4	GH8A5
	130MAH06025	6.00	2500	1.57	GH5A4	GH8A5
	130MAH07725	7.70	2500	2.02	GH8A5	GH5A4
	130MAH10015	10.00	1500	1.57	GH5A4	GH8A5
	130MAH15015	15.00	1500	2.36	GH8A5	GH130
	180MAH19015	19.00	1500	3.00	GH130	
	180MAH27015	27.00	1500	4.30	GH170	
	180MAH35015	35.00	1500	5.50	GH170	GH210
	180MAH48015	48.00	1500	7.50	GH210	

8.5 Servo motor model

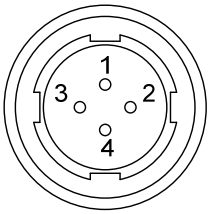


8.6 Servo motor wiring

8.6.1 Winding wiring



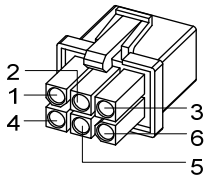
40/60/80 motor power supply plug



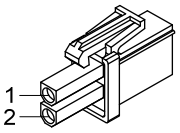
110/130/180 motor power supply plug

Terminal symbol	Terminal number		Terminal explanation
	40/60/80 motor	110/130/180 motor	
U	1	2	U phase drive input
V	2	3	V phase drive input
W	3	4	W phase drive input
⏚	4	1	Ground terminal of motor case

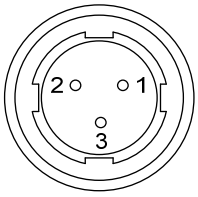
8.6.2 Brake wiring



Power supply plug of 40 motor with brake



60/80 motor brake plug



110/130 motor brake plug

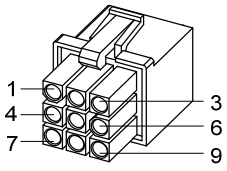
40 Motor with brake power wiring:

Terminal symbol	Terminal number	Terminal explanation
U	1	U phase drive input
V	2	V phase drive input
W	3	W phase drive input
PE	4	Ground terminal
BK+	5	Brake terminal
BK-	6	

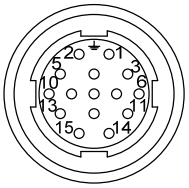
60、80、110、130、180 motor brake wiring:

Terminal symbol	Terminal number		Terminal explanation
	60/80 series motors	110/130/180 series motors	
DC+	1	1	The brake power supply is DC, without polarity insert requirement
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 explanation
	40motor	60/80motor		110/130/180motor		
	Absolute type	Absolute type	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	——	3.6Vbattery-powered
Battery - ☆	8	8	——	5	——	
PE	9	9	9	1	1	Ground terminal

In this manual, "☆" means the typical functions of absolute encoder. "★" means the typical functions of incremental encoder

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Third edition	June, 2021	
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