SINEE

Technical Manual

EA350 Analog Pulse Type Servo Driver
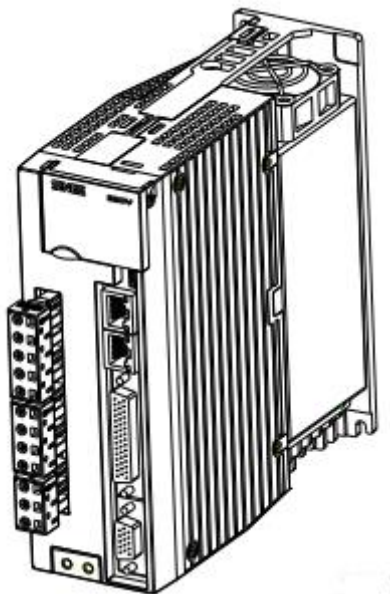
Product services and more information

Version: V101

Release time: October 2022

Reliable drives & Solutions by technology

Preface

Thank you for selecting the EA350 pulse type servo driver!

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This EA350 series servo driver is a high-performance medium and small power AC servo unit researched and manufactured by Sine Electric. This series of products have advanced motor-controlled special CPU, large-scale programmable gate array FPGA and PIM power modules, featuring high integration, small volume, complete protection and high reliability. They have a current loop refresh rate up to 512 k and optimized PID control algorithm to realize precise and full digital control over torque, position and speed with quick response, providing rigidity selection, real-time automatic gain rectification, automatic resonance suppression and other advanced functions. This product series also has various digital and analog interfaces, optional with models of 16-bit high-precision analog input, and comes with standard support to MODBUD communication protocol for easy networking. Its built-in 16-segment position that is flexibly configurable allows realization of simple PLC functions. The EA350 series is widely applicable for machining centers, laser cutting, high-speed die cutting, printing machinery and other fields that impose high requirements on performance.

Due to our efforts in constant improvement of product functions, descriptions in this manual may not be fully consistent with your driving system. Any such inconsistency will be subject to no further notification.

For the latest changes and contents, please visit www.sinee.cn.

Safety precautions

Safety definition: Safety precautions are divided into the following two categories in this manual:

⚡	Danger: The dangers caused by nonconforming operations may include serious injuries and even deaths;
⚠	Note: The danger caused by nonconforming operations, including moderate or minor injuries and equipment damage;

During the installation, commissioning and maintenance, please read this chapter carefully, and follow the safety precautions herein. Our company will not be liable for any injury or loss arising from nonconforming operations.

Precautions

Before installation:

⚡ **Danger**
1. Do not install the product in the case of water in the package or missing or damaged components found in unpacking!
2. Do not install the product in the case of inconsistency between the actual product name and identification on the outer package.

| ⚠ **Attention** |
|---|
| 1. Handle with care; or the product may be damaged! |
| 2. Do not use the servo driver if it is damaged or has some parts missing; otherwise injuries may be caused! |
| 3. Do not touch the components of the control system with your hands; otherwise, there is a danger of static damage! |

During installation:

⚡ **Danger**
1. Please install the inverter on a metal retardant object (e.g. metal) and keep it away from combustibles; otherwise, a fire may be caused!

⚠ **Attention**
1. Never allow wire connectors or screws to fall into the servo driver; otherwise the servo driver may be damaged!
2. Install the servo driver in a place where it is subject to low vibration and no exposure to direct sunlight.
3. When the servo driver is placed in a relatively closed cabinet or space, reserve some installation clearance for sound heat dissipation.

During wiring:

⚡ **Danger**
1. Wiring shall be performed by a professional electrical engineer following instructions provided in this manual; otherwise unexpected danger may be caused!
2. Install a circuit breaker between the servo driver and the power supply for fire protection!
3. Before wiring, make sure that the power supply is in the zero energy status; otherwise, electric shock may be caused! Ground the servo driver correctly for protection against electric shock!
4. Connect the ground terminal reliably; otherwise electric shock and fire may be caused!

⚠ **Attention**
1. Never connect the input power to an output terminal (U, V, W) of the servo driver. Pay attention to the marks of wiring terminals, and connect wires correctly! Otherwise the servo driver may be damaged!
2. Make sure that the lines meet the EMC requirements and local safety standards. For wire diameters, refer to the recommendations. Otherwise, an accident may occur!
3. Never connect the braking resistor directly between the P+ and - terminals of a DC bus. Otherwise, a fire may be caused!
4. Tighten the terminals with a screwdriver of specified torque; otherwise, there is a risk of fire.
5. Never connect the phase-shifting capacitor and LC/RC noise filter to the output circuit.
6. Do not connect the electromagnetic switch and electromagnetic contactor to the output circuit. Otherwise action of the overcurrent protection circuit of the servo driver may cause internal damage to the servo driver in severe cases.
7. Never disassemble connecting cables inside the servo driver; otherwise damage may be caused to the inside of the servo driver.

Before power-on:

⚠ **Attention**
1. Make sure that the supply voltage of the input power is consistent with the rated voltage of the servo driver, and that the power input terminals (L1, L2, L3) and output terminals (U, V, W) are correctly wired. Check to ensure there is no short circuit in peripheral circuits connected to the servo driver and all connecting lines are tightened; otherwise damage may be caused to the servo driver. 2. No withstand voltage test needs to be performed on any part of the servo driver, as the test has been performed in the factory. Otherwise, an accident may be caused!

⚠ **Attention**
1. The servo driver shall not be powered on until its cover is installed correctly; otherwise electric shock may occur! 2. The wiring of all peripheral accessories must be in line with the instructions in this manual. All wires should be connected correctly according to the circuit connections in this manual. Otherwise, an accident may occur!

After power-on:

⚡ **Danger**
1. Never touch the servo driver and its surrounding circuits with wet hands; otherwise electric shock may occur! 2. If the indicator does not get ON or the keyboard has no response after power-on, immediately turn off the power supply. Never touch the servo driver terminals (L1, L2, L3) and any terminal on the terminal block with your hands or a screwdriver; otherwise electric shock may be caused. Upon turning off the power supply, contact our customer service personnel. 3. Immediately after power-on, the servo driver automatically performs a safety test on external high-voltage circuits. Do not touch the servo driver terminals (U, V, W) or motor terminals; otherwise electric shock may be caused!

⚠ **Attention**
1. When parameter identification is required, please pay attention to the danger of injury during motor rotation; otherwise, an accident may occur! 2. Do not change the parameters set by the servo driver manufacturer; otherwise damage may be caused to the equipment!

During operation:

⚡ **Danger**
1. Do not touch the cooling fan, radiator, servo motor or discharge resistor to feel the temperature; otherwise burns may be caused! 2. Non-professional technicians must not test signals when the controller is in operation; otherwise, personal injury or equipment damage may be caused!

⚠ **Attention**
1. The servo driver in operation should be protected against falling objects; otherwise damage may be caused to the equipment! 2. Do not start or stop the servo driver by turning on or off the contactor; otherwise damage may be caused to the equipment! 3. Do not touch the rotary shaft of the motor during operation; otherwise injury may be caused!

During maintenance:

⚡ **Danger**
1. Never carry out repair and maintenance in the live state; otherwise, electric shock may be caused! 2. Cut off power of the main circuit, and perform maintenance and repair of the servo driver after the CHARGE indicator goes off; otherwise residual charges of the capacitor may cause injuries! 3. No repair or maintenance of the servo driver shall be performed by any individual who has not been professionally trained on such repair or maintenance; otherwise personal injury or equipment damage may be caused! 4. The servo driver, after replacement, shall have parameters set; all plug connections and disconnections shall be handled in the power-off status!

Precautions

- **When a voltage-dependent device or power factor-improving capacitor is present on output side**

  The servo driver outputs PWM waves. Installation of a power factor-improving capacitor or a voltage-dependent resistor for lightning protection on the output side may cause instantaneous overcurrent or even damage to the servo driver; therefore, such installation shall not be used.

- **Lightning impulse protection**

  The servo driver of this series is equipped with a lightning overcurrent protector for protection against induced lightning. Yet if the product is installed in a place subject to frequent lightning, installation of an additional lightning protection device before the servo driver is required.

- **Altitude and derating**

At places with the altitude exceeding 1,000 m where heat dissipation and safety insulation reduce due to thin air, the servo driver shall be subject to derated use. For specific details, please contact us for technical advice.

- **Precautions for scraping of the servo driver**

Burning of the electrolytic capacitors on the main circuit and printed circuit board may result in explosion, and burning of plastic parts may generate toxic gases. Please dispose of the controller as a kind of industrial waste.

Maintenance and inspection

Please regularly maintain and check the driver and motor for safe use

Precautions for maintenance and inspection

1) The operator shall cut off the power source. Do not get close to the motor or any machine driven by the motor when any malfunction occurs during electrification.

2) Within a short time after disconnection from the power source, the internal circuit remains in the high-voltage charged status. Before performance of inspection, it is required to cut off the power first, wait for 10 minutes and make sure the charge indicator is fully off.

3) If an insulation resistance test of the servo driver is required, all connections to the driver shall be cut off. Performance of an insulation resistance test on the driver when it is connected to a motor with wire may cause damage to the driver.

4) Do not use gasoline, diluents, acidic or alkali detergents that may cause discoloration or damage to the housing.

Inspection items and cycle

Normal use conditions

Annual average temperature of 30°C, average load rate of less than 80%, and daily operation of less than 20h

Daily inspection and regular inspection shall be implemented with respect to the following items

Inspection	Cycle	Check Item
Daily inspection	Daily	• Check the operating environment (temperature, humidity, dust, debris) • Check against abnormal vibration and noise • Check to ensure the voltage is in the normal range • Check against abnormal smell • Check to ensure there is no fiber attachment at the air vent • Check to ensure connections are clean and tightened • Check against damage of wires • Check against loose or eccentric connections of the equipment • Check to ensure no entry of debris into the mechanical transmission part
Regular inspection	1 year	• Check against loosening of tightened parts • Check against overheat • Check the transmission mechanism against leakage and the motor shaft extension against contamination • Check the wiring terminal for soundness • Check wire connections of the driver for tightness

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Chapter 1 Product information

1.1 Open-box confirmation

To prevent negligence during purchase and transport of the product, please check the items listed in the table below:

Check Item	Content
Is it the model ordered by you?	Check the product model on respective nameplate of the motor and the driver. If cables are ordered, check the model and length on the cable label
Is there any damage caused during transport?	Visually check if there is any external damage or scratch
Does the motor shaft operate smoothly?	Turn the motor shaft manually. If it can operate smoothly, it means the motor shaft is normal. However, motors with a holding brake (braking) can't be turned manually!

If any abnormality occurs, please contact the agency for a proper solution.

1.1.1 Complete operable servo components shall include:

1) Servo driver and corresponding servo motor.

2) A signal cable for encoder, connecting the motor encoder jack and the CN5 terminal of the driver.

3) A motor power line, including four core wires, i.e. U (red), V (white or blue), W (black or brown) and PE (yellow-green) (in case of a motor with a brake, there shall be two additional brake power cables). U, V and W wires shall be connected in sequence to corresponding terminals of the driver; PE line shall be connected to the ground terminal of the driver.

4) For the DB44 connector used for CN4, a control line shall be made according to the actual need.

Note: 1) It is strongly recommended to purchase the encoder signal cable provided by our company.

2) If motor power cable is purchased, the core wires of the power cable may differ from those described above. For this reason, do not distinguish the wires by color but by the letters indicated on the wires.

1.2 About the driver

1.2.1 Nameplate description
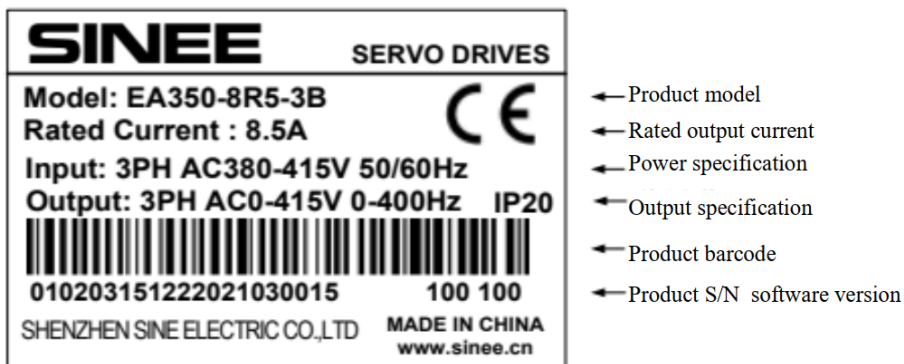
1.2.2 Product model description
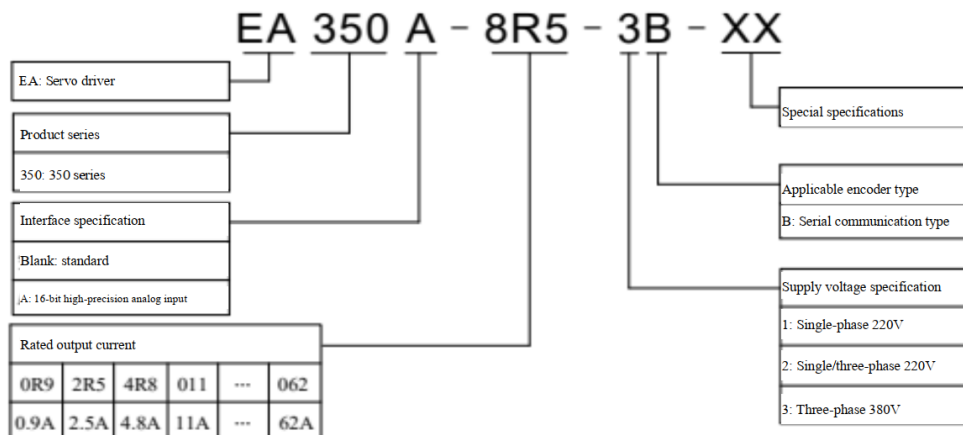
Note: 1): Products of AC220V and 4.8A~6.2A apply single-phase and three-phase AC220V power supply; no such product applies separate single-phase AC220V power supply.

2: Products of AC220V and 11A or above apply only three-phase AC220V power supply.

3: Products of AC220V and 2.5A or below apply only single-phase AC220V power supply.

1.2.3 Components of the servo driver

- EA350-0R9, 1R6, 2R5, 4R8 and 6R2 models

Digital tube display	Operating status of servo with 5-bit seven-segment LED digital tube display
Key operator	Parameter setting

Power source of L1C and L2C control circuits	With reference to the rated voltage on the nameplate, enter the power source of the control circuit
Power source of L1, L2 and L3 main circuits	With reference to the rated voltage on the nameplate, enter the power source of the main circuit (cabinet A, i.e. 0R9, 1R6 and 2R5 model without L3 terminal)
P+, ⊖	The DC bus voltage terminal is used for the driver to share the DC bus
P+, D or C to an external braking resistor	A short-circuiting piece is installed between P+ and D in default; upon connection of an external braking resistor, remove the short-circuit piece, leave P+ and D open, and connect the external resistor between P+ and C (Size A cabinet, i.e. 0R9, 1R6 and 2R5 models without terminal D)
U, V and W servo motor	Connecting the three phases, i.e. U, V and W of the servo motor

PE ground terminal	To ground of power source and servo motor
CHARGE Bus voltage indicator light	It is used to indicate whether the bus capacitor is in the charged status. When it is on, charge is present with the capacitor in the driver even if the main circuit is powered off.

Connection terminal of CN5 encoder	Encoder connecting to the servo motor

- EA350-011, 5R6, 8R5, 013, 017, 022, and 028 models

Digital tube display	Operating status of servo with 5-bit seven-segment LED digital tube display
Key operator	Parameter setting

Power source of L1C and L2C control circuits	With reference to the rated voltage on the nameplate, enter the power source of the control circuit
Power source of L1, L2 and L3 main circuits	With reference to the rated voltage on the nameplate, enter the power source of the main circuit
P+, ⊖	P+ and ⊖ The DC bus voltage terminal is used for the driver to share the DC bus
P+, D or C to an external braking resistor	A short-circuiting piece is installed between P+ and D in default; upon connection of an external braking resistor, remove the short-circuit piece, leave P+ and D open, and connect the external resistor between P+ and C (Size D cabinet, i.e. 017, 022, and 028 models without terminal D)
U, V and W servo motor	Connecting the three phases, i.e. U, V and W of the servo motor

PE ground terminal	To ground of power source and servo motor (PE terminal of Size D cabinet in the same row as other terminals)
CHARGE Bus voltage indicator light	It is used to indicate whether the bus capacitor is in the charged status. When it is on, charge is present with the capacitor in the driver even if the main circuit is powered off.

Connection terminal of CN5 encoder	Encoder connecting to the servo motor

• EA350-038, 052 and 062 models

C braking resistor terminal	External braking resistor connected to P+
L1, L2, L3 power sources	With reference to the rated voltage on the nameplate, enter the power source of the main circuit
P+ Positive DC bus terminal	The positive DC bus terminal of the drive, used for the driver to share the DC bus and connect the external braking resistor with C terminal.
CN1 analog monitoring signal terminal	Two channels of analog output
Digital tube display	Operating status of servo with 5-bit seven-segment LED digital tube display
Key operator	Parameter setting

CN6USB communication terminal	MICRO USB communication terminal
CN2 and CN3 communication terminals	The two terminals are connected internally in parallel, with RS232, RS485 and CAN communication interfaces
CN4 control terminal	Connection to upper controller

PE ground terminal	To ground of power source and servo motor

CHARGE Bus voltage indicator light	It is used to indicate whether the bus capacitor is in the charged status. When it is on, charge is present with the capacitor in the driver even if the main circuit is powered off.

U, V and W servo motor	Connecting the three phases, i.e. U, V and W of the servo motor

⊖ Negative DC bus terminal	The negative DC bus terminal of the drive, used for the driver to share the DC bus

PE ground terminal	To ground of power source and servo motor
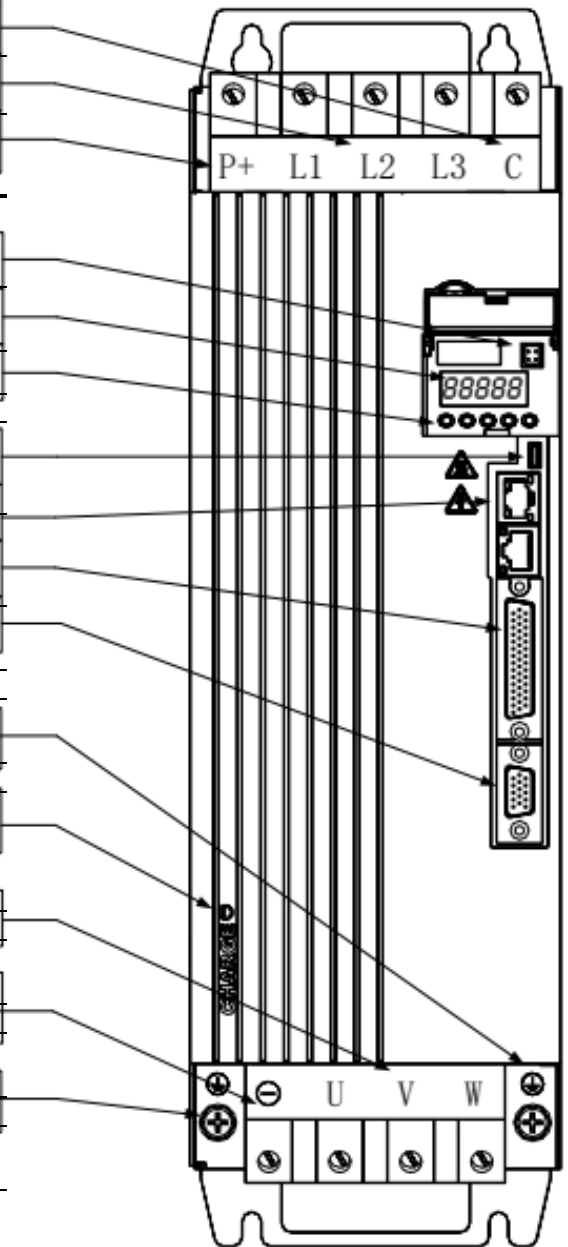
1.2.4 Block diagram of EA350-028-3B or below servo drivers
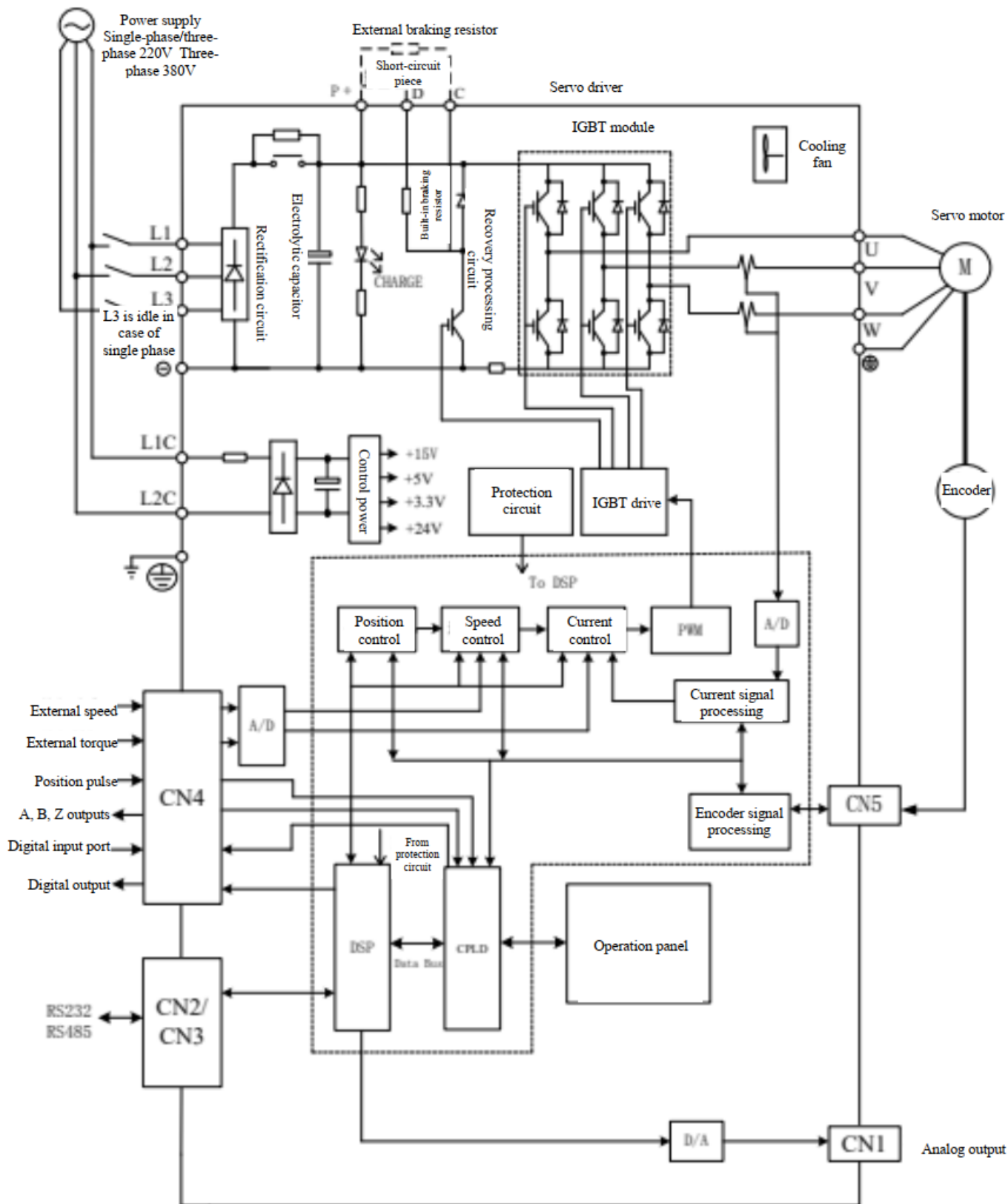
Caution☞	1. EA350-1R6/2R5/4R8/6R2 models are of AC220V power supply and have no L3 terminal.
	2. EA350-1R6/2R5/017/022/028, without built-in braking resistor, terminal D and short-circuiting piece.

1.2.5 Block diagram of EA350-038-3B or above servo drivers
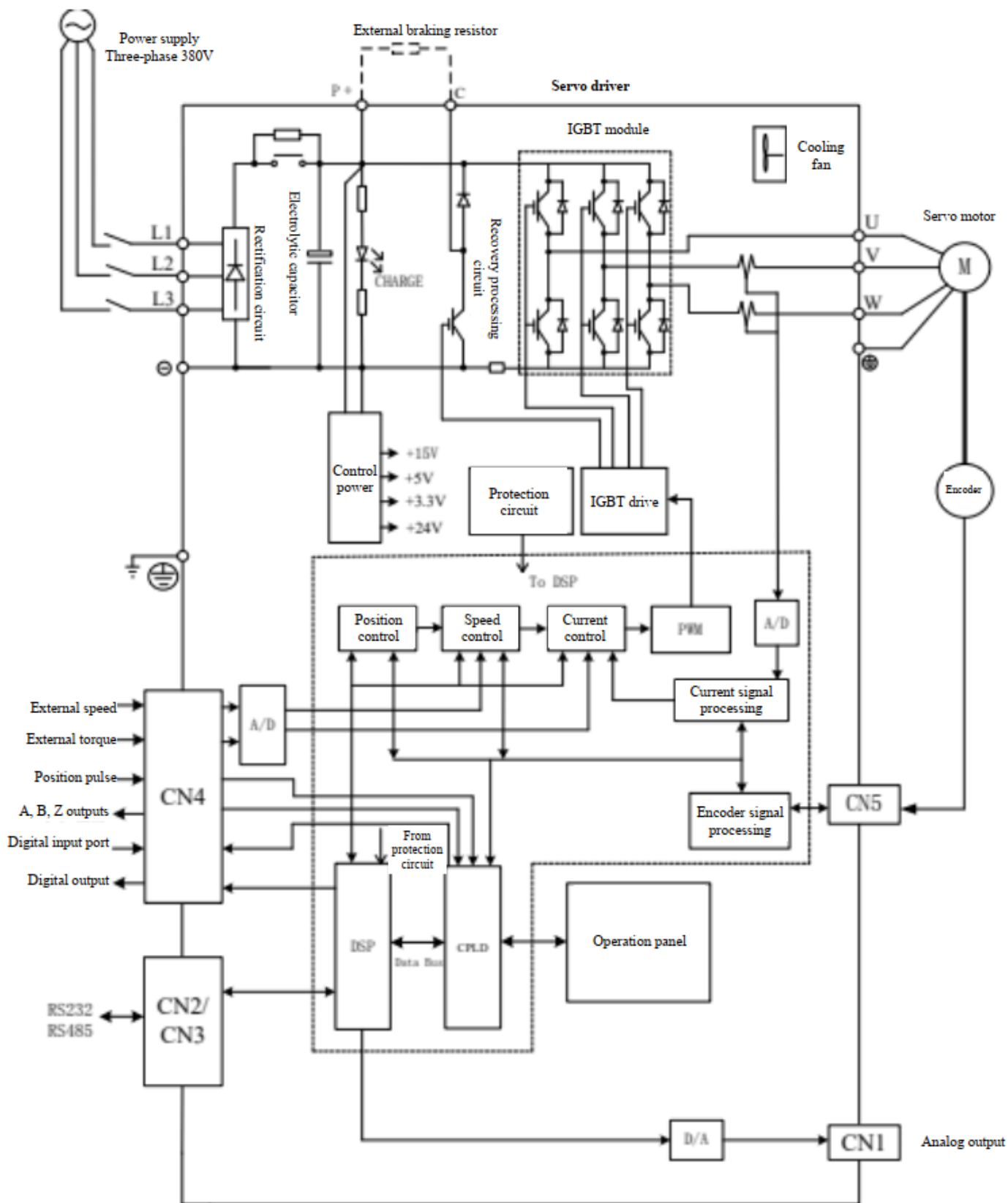
Caution☞	1. EA350-038/052/062 models are of AC380V power supply without built-in braking resistor, terminal D and short-circuiting piece.
	2. EA350-038/052/062 models have no auxiliary power interface and do not support power supply from an auxiliary source.

1.3 About the servo motor

1.3.1 Nameplate description

Note: Texts on the actual product nameplate may differ from those shown in the figure in respect of layout and content.

1.3.1 Model description

$$\underline{SES}\ \underline{08}\ -\ \underline{0R7}\text{-}\ \underline{30}\text{-}\ \underline{2}\ \underline{F}\ \underline{B}\ \underline{Y}\ \underline{1}\ \text{-}\underline{XX}$$
$$\textcircled{1}\ \ \textcircled{2}\ \ \ \ \textcircled{3}\ \ \ \textcircled{4}\ \ \textcircled{5}\ \textcircled{6}\ \textcircled{7}\ \textcircled{8}\ \textcircled{9}\ \ \textcircled{10}$$

The **1st place** represents the series	**2nd place:** size of motor flange	**3rd place:** rated output power of motor
SER: Standard servo motor SES: High-performance servo motor SEC: Large-power servo motor	04: 40mm 06: 60mm 08: 80mm 09: 86mm 11: 110mm 13: 130mm 18: 180mm 20: 200mm 23: 230mm 26: 266mm	005: 50W 0R1: 100W 0R2: 200W 0R4: 400W 0R7: 750W 1R0: 1000W 1R5: 1500W 2R0: 2000W 3R0: 3000W 4R4: 4400W 5R5: 5500W 7R5: 7500W 011: 11kW 029: 29kW
4th place: rated speed of motor 10: 1000rpm 15: 1500rpm 20: 2000rpm 25: 2500rpm 30: 3000rpm	**7th place:** inertia type A: Low inertia B: Medium inertia C: High inertia	
5th place: voltage level 2: 220V 3: 380V		**9th place:** optional accessory Null: No optional accessory 1: With holding brake (DC24V) 2: With oil seal 3: With holding brake and oil seal 4: With fans[4] 5: with fan and brake[4]
6th place: encoder type B: 17-bit incremental encoder[3] F: 23-bit absolute type encoder	**8th place:** output shaft type X: Optical axis, without key slot [1] Y: With U-shaped key slot and screw hole [2] Z: With double-circular key slot and screw hole	**Tenth place:** special specification

*1: It is not recommended to choose any non-standard variety.

*2: Partial varieties can be of double-circular key slots; except for motors with flange 130, the key width and height are the same with the U-shaped key slots; for details, refer to Chapter 12.

*3: Only provided for motors with flanges of specification 80 or below.

*4: Only provided for motors with flanges of specification 130 or above. To be customized, not an off-the-shelf product.

Elements of the 10 servo motor models are not subject to causal combination. For details, refer to the selection guide or consult us.

1.4 Confirm the matching model of the driver and the motor

1.4.1 Correspondence of servo drivers to common motor specifications

Servo driver			Servo motor			
Driver model	Supply voltage	Size	Motor model	Motor power	Rated speed	Rated torque
EA350-0R9-1B	Single-phase AC220V	SIZE A	SES04-005-30-2□AY□	50W	3000rpm	0.16Nm
EA350-1R6-1B			SES04-0R1-30-2□AY□	100W	3000rpm	0.32Nm
			SES06-0R2-30-2□BY□	200W	3000rpm	0.64Nm
EA350-2R5-1B			SES06-0R4-30-2□BY□	400W	3000rpm	1.27Nm
EA350-4R8-2B	Single-phase or three-phase AC220V	SIZE B	SES08-0R7-30-2□BY□	750W	3000rpm	2.38Nm
EA350-6R2-2B			SES08-1R0-30-2□BY□	1000W	3000rpm	3.18Nm
			SER13-1R0-10-2□BY□	1000W	1000rpm	9.55Nm
			SER13-1R0-20-2□BY□	1000W	2000rpm	4.77Nm
			SER13-1R0-30-2□BY□	1000W	3000rpm	3.18Nm
EA350-011-2B	Three-phase AC220V	SIZE C	SER13-1R5-10-2□BY□	1500W	1000rpm	14.32Nm
			SER13-1R5-20-2□BY□	1500W	2000rpm	7.16Nm
			SER13-1R5-30-2□BY□	1500W	3000rpm	4.77Nm
EA350-5R6-3B	Three-phase AC380V		SER13-1R5-10-3□BY□	1500W	1000rpm	14.32Nm
			SER13-1R5-20-3□BY□	1500W	2000rpm	7.16Nm
			SER13-1R5-30-3□BY□	1500W	3000rpm	4.77Nm
			SES13-0R8-15-3□BY□	850W	1500rpm	5.4Nm
			SES13-1R3-15-3□BY□	1300W	1500rpm	8.3Nm
EA350-8R5-3B			SER13-2R0-20-3□BY□	2000W	2000rpm	9.55Nm
			SES13-1R8-15-3□BY□	1800W	1500rpm	11.4Nm
EA350-013-3B			SER13-3R0-20-3□BY□	3000W	2000rpm	14.32Nm
			SER13-3R0-30-3□BY□	3000W	3000rpm	9.55Nm
			SES18-2R9-15-3FBY□	2900W	1500rpm	19Nm
EA350-017-3B		SIZE D	SES18-4R4-15-3FBY□	4400W	1500rpm	28Nm
EA350-022-3B			SES18-5R5-15-3FBY□	5500W	1500rpm	35Nm
EA350-028-3B			SES18-7R5-15-3FBY□	7500W	1500rpm	48Nm
EA350-038-3B		SIZE E	SEC23-015-15-3FBY	15KW	1500rpm	95.5Nm
EA350-052-3B			SEC23-022-15-3FBY	22kW	1500rpm	140Nm
EA350-062-3B			SEC23-029-15-3FBY	29kW	1500rpm	185Nm

Note that the type of encoder used for the servo motor must be supported by the servo motor.

The table shows only common servo motors. For more specifications, please consult us.

1.4.2 Cable for encoder

Motor flange size	Encoder type	Cable model
40~80	Serial incremental encoder	A10-LS-A000-m[*1]
	Absolute type encoder	A10-LA-A000-m[*2]
110~230	Serial incremental encoder	A10-LS-H100-m/ A10-LS-H400-m
	Absolute type encoder	A10-LA-H100-m/ A10-LA-H400-m [*2]

Note *1: m represents the cable length, in m.

Note *2: The battery for the absolute type encoder is installed on the cable. When the absolute encoder is used for incremental purpose, cable for serial incremental encoder may be used.

1.4.3 Motor power cable/brake cable

Motor flange size	Motor power cable		Brake cable (band brake)
	Motor power cable	Motor power with brake (band brake) cable	
40~80	A18-LM-A010-m[*1]	-	A10-LZ-A005-m
110~130	A10-LM-H120-m/A18-LM-H115-m	A10-LB-H120-m/A18-LB-H115-m	-
180(2.9~4.4KW)	A18-LM-M525-m[*2]	-	A18-LZ-H405-m
180(5.5~7.5KW)	A10-LM-M240-m	-	A18-LZ-H405-m

Note *1: m represents the cable length, in m.

Note *2: For 2.9 and 4.4 kW motors with a 180 flange, the power cable of the motor should be A10-LM-M220-m if a brake is provided.

- **The cable above is only available from us in odd number of meters.**
- **For motors with a flange of 200 or above, we don't provide the power cable of the motor.**
- **If you wish to make it on your own, please read instructions in Chapter 3 of this manual.**

Chapter 2 Installation

2.1 Precautions for installation

Please be cautioned about the following:

■ The cable between the servo driver and the servo motor shall keep relaxed and may not be tensioned.

■ If the cable connecting the servo driver and the servo motor extends for over 20m, larger cables shall be used for UVW connection and encoder connection.

■ The servo motor shall be fixed in the installation direction specified, and each fixing screw shall be tightly locked.

■ Make sure the servo motor shaft is concentric with the equipment shaft to prevent occurrence of radial stress upon operation.

■ **Knocking is absolutely forbidden when dismantling/installing couplers and etc. on motor shaft. Please use shrinkage fittings and appropriate tools.**

■ The four fixing screws of the servo motor must be locked by the specified torque.

■ To ensure good circulating cooling effect, sufficient space shall be reserved between the AC servo driver and objects/baffles (walls) around it; otherwise fault may be incurred.

■ Upon installation, the servo motor may not be placed in an inverted manner, and its vents may not be blocked; otherwise fault may be incurred.

2.2 Environmental conditions of storage

Before installation, the product shall be placed in its packing box. If the servo is left unused, it shall be stored following the precautions below to ensure conformity to conditions of our warranty and subsequent maintenance services:

Item	Description
Storage temperature	-20°C~+65°C
Storage humidity	RH 0%~95%, without dew condensation
Vibration	Below 49m/s²
Impact	Below 490m/s²

2.3 Environmental conditions of installation

2.3.1 Environmental conditions for operation of the EA350 servo driver:

Item	Description
Dust and gas	It shall be located free from dust and corrosive gas or liquid.
Ambient humidity	RH 20%~90% (without dew condensation)
Environment temperature	0°C~+45°C
Vibration	Below 4.9m/s²
Impact	Below 49m/s²
Altitude	Below 1,000m; it shall be derated for use in case of above 1,000m

2.3.2 Environmental conditions for operation of the servo motor

Item	Description
Ambient humidity	RH 20%~80%, without dew condensation
Environment temperature	0°C~+40°C
Vibration	Below 4.9m/s²
Impact	Below 49m/s²
Altitude	Below 1,000m; it shall be derated for use in case of above 1,000m

■ Do not use the motor in an enclosed space. Enclosed space may result in high temperature of the motor and shorten its service life.

2.3.3 Other precautions

Apart from the environmental conditions above, the following precautions shall be observed upon selection of the installation location for the driver or the motor; otherwise the product will be rendered incompliant with conditions of our warranty and subsequent maintenance services:

• Location without any excessively hot equipment

• Location without water drops, steam, dust and oily dust

• Location without corrosive or flammable gas or liquid

• Location without floating dust and metal particles

• Location with firm foundation and subject to no vibration or disturbance of electromagnetic disturbance and noise.

2.4 Installation direction and space of the servo driver

For external size and weight of the servo driver and servo motor, please refer to Chapter 12.

2.4.1 Method

Make sure the installation direction is perpendicular to the wall. Use natural convection or a fan to cool the servo driver. Fix the servo driver through the installation hole firmly to the installation surface.

Upon installation, direct the front of the servo driver to the operator, and make it perpendicular to the wall.

2.4.2 Cooling

To ensure air convection, do reserve sufficient space around the servo driver, with reference to Fig. 2-1.

To prevent local high ambient temperature of the servo driver, it is required to keep the temperature in the electric cabinet uniform; for this purpose, do install a cooling fan above the servo driver within the electric cabinet.
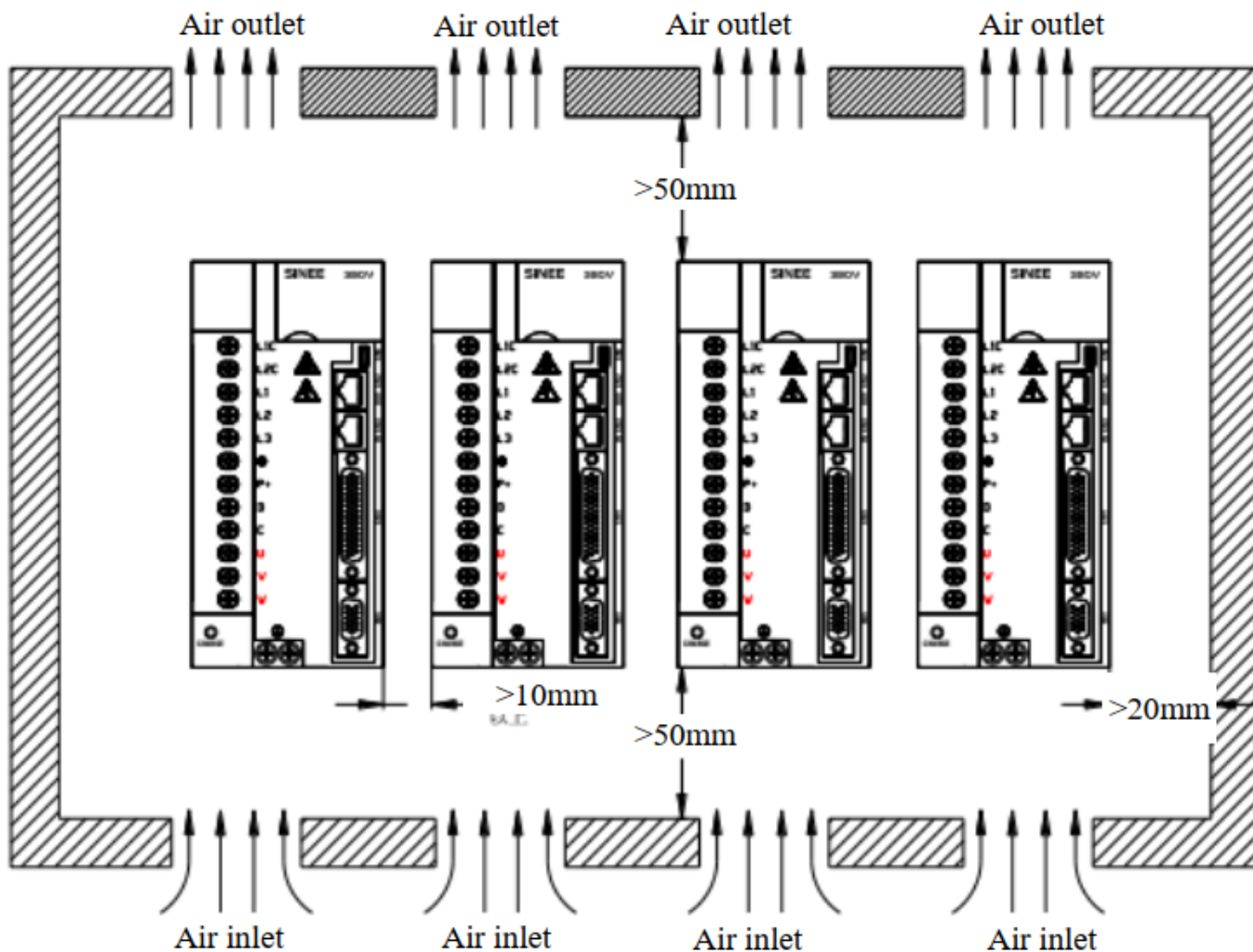
Fig. 2-1 Installation space of the servo driver

2.4.3 Grounding

Do ground the ground terminal; otherwise electric shock or danger may be incurred by disturbance.

Please refer to description in Section 2.8
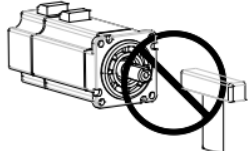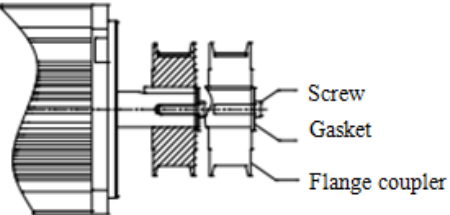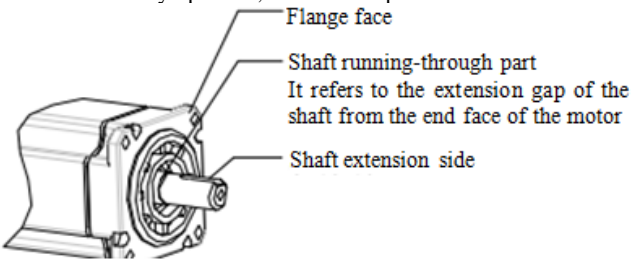
2.5 Installation direction and space of the servo motor

2.5.1 Installation of motor

The servo motor must be properly installed on a dry and firm platform; upon installation, it is required to consider sound ventilation and heat dissipation, as well as sound grounding.

For external size and weight of the motor, please refer to the rated values and specifications in Chapter 12.

2.5.2 Installation diagram

Item	Description
Anti-rusting treatment	Before installation, wipe off "anti-rust agent" on the extended part of the servo motor shaft, and treat it against trusting
Precautions for the encoder	• Upon installation, collision of the shaft extension end shall be avoided; or otherwise the encoder inside may break
Pulley installation	• Upon installation of a pulley on a servo motor shaft with key slots, a screw hole shall be used on the shaft end. To install the pulley, first insert a double-headed nail into the screw hole of the shaft, and then use a nut to lock the pulley in place; a washer shall be used on the coupling interface. • For a servo motor shaft with key slots, a screw hole on the shaft end shall be used for installation. For a bare shaft without key slots, wear coupling or a similar method is adopted. • Upon removal of the pulley, it is required to use a pulley remover to prevent impact on the bearing. • For safety, a protective cover or other similar device shall be installed in the rotation area.
Centering	• Upon connection to a machine, do use a coupler and keep the servo motor axis in line with the mechanical axis; the radial runout on the circumference of the coupler shall not exceed 0.03mm. If centering is insufficient, vibration may occur to cause damage to the bearing, the encoder and other components.
Installation direction	• The servo motor can be installed horizontally or vertically; it may not be installed in an inclined manner; otherwise wear of the motor bearing may be accelerated.
Countermeasures against oily water	When the servo motor is intended for use in a place with dripping water, such use shall be based on the protection grade of the servo motor (excluding the shaft running-through part). A servo motor with oil seal shall be used if the location of the motor may expose the shaft running-through part to dripping oil. Use conditions of a servo motor with oil seal: • Make sure the oil level is below the oil seal lip during use. • Use the servo motor when the oil seal can keep oil splashes to a certain extent. • When the servo motor is installed vertically upwards, take care to prevent oil accumulation at the oil seal lip.
Cable stress condition	Do not excessively bend or tension cables, particularly the encoder signal cable with fine core wires of $0.14mm^2$ or $0.2mm^2$, during wiring or use. Upon installation of a drag chain, it is required to select a highly flexible drag chain cable.
Treatment of connectors	**For connectors, the following precautions shall be observed:** • Upon connection of a connector, make sure there is no foreign matters in the connector. • Upon connecting the connector to the servo motor, make sure connection is started from the main circuit cable side of the servo motor, and the ground line of the main cable must be reliably connected. If the encoder cable side is connected first, the encoder may fail due to the potential difference with the PE. • Upon wiring, make sure the pins are arranged correctly. • The connector is made of resin. Do not apply impact on the connector; otherwise it may be damaged. • Upon handling the equipment with cables connected, do hold the main body of the servo motor. If the motor is handled by holding the cables, the connector may be damaged or the cable may break. • If bending a cable is needed, take care during wiring not to cause any stress or tension to the connector; otherwise damage or poor contact of the connector may be caused.

2.6 Suggestions regarding circuit breaker and fuse

If the driver is provided with a residual-current circuit breaker, to prevent malfunction of the circuit breaker, do select a model with the induced current of above 200mA and the actuation time of above 0.1s.

For fuse, a fast-acting fuse shall be used, and its rated current shall be around 1.5 times the driver capacity.

It is highly recommended:	to use a UL/CSA-accepted fuse and circuit breaker.

2.7 Braking resistor selection

When the motor has an output torque in opposite direction of its rotating speed, energy will be transferred from the load end back to the driver. The energy will be charged into the bus capacitor to increase the bus voltage inside the driver; the amount of energy so charged depends on the motor rotor and the load inertia. If the system has low inertia, the energy transferred back may be fully absorbed by the capacitor inside of the driver; if the system has high inertia and the energy transferred back exceeds the absorbing capacity of the capacitor, excessive rise of the voltage may cause shutdown or even damage of the driver. For this reason, when the voltage rises to a certain value, the energy transferred back needs to be consumed by a braking resistor.

Table 2-1 below gives rotor inertia of common servo motors and absorbing capacity of the capacitor inside the EA350 driver, as well as the calculating formula of the recoverable energy.

Table 2-1 Rotor inertia of common servo motors and recoverable energy-absorbing capacity of their capacitors

Driver model	Motor	Rotor inertia $J (\times 10^{-4} kg \cdot m^2)$	Recoverable energy from the rated speed without load to stop Eo (J)	Maximum amount of recoverable energy to be absorbed by the capacitor Ec (J)
EA350-0R9-1B	SES04-005-30-2□AY	0.02	0.1	9.5
EA350-1R6-1B	SES04-0R1-30-2□AY	0.04	0.2	9.5
	SES06-0R2-30-2□BY	0.29	1.43	9.5
EA350-2R5-1B	SES06-0R4-30-2□BY	0.58	2.87	19
EA350-4R8-2B	SES08-0R7-30-2□BY	1.56	7.71	20.2
EA350-6R2-2B	SER13-1R0-20-2□BY	8.71	19.1	24
EA350-011-2B	SES13-0R8-15-2FBY	13.95	17.25	45.7
EA350-5R6-3B	SES13-1R3-15-3FBY	19.95	24.66	31.4
EA350-8R5-3B	SES13-1R8-15-3FBY	26.1	32.27	51.7
EA350-013-3B	SES18-2R9-15-3FBY	46.0	56.87	51.7
EA350-017-3B	SES18-4R4-15-3FBY	67.5	83.45	110.7
EA350-022-3B	SES18-5R5-15-3FBY	89	110.0	110.7
EA350-028-3B	SES18-7R5-15-3FBY	125	154.53	138.4
EA350-038-3B	SEC23-015-15-3FBY	380	469.78	207.6
EA350-052-3B	SEC23-022-15-3FBY	500	618.13	276.8
EA350-062-3B	SEC23-029-15-3FBY	620	766.48	276.8
• **Calculation formula for recoverable energy:** $Eo= J \cdot v^2 /182$(joules) ; v: rpm, generally referring to the rated speed of the motor				
A servo motor with holding brake may be deemed to have the same rotor inertia as a servo motor without brake due to negligible difference in the rotor inertia.				

2.7.1 Built-in braking resistor

Drivers of certain specifications under the EA350 series contain an internal braking resistor, applicable to circumstances of average load inertia. Table 2-2 shows specifications of the built-in braking resistor for EA350 series.

Table 2-2 Built-in braking resistor of EA350 driver and the minimum allowable resistance of an external braking resistor

Driver model	Specification of the built-in braking resistor		Recovering capacity of the built-in braking resistor	Allowable minimum resistance of external braking resistor
	Resistance (P8-10)	Capacity (P8-11)		
EA350-0R9-1B	None	None	None	50Ω
EA350-1R6-1B	None	None	None	50Ω
EA350-2R5-1B	None	None	None	50Ω
EA350-4R8-2B	50Ω	100W	50W	40Ω
EA350-6R2-2B	50Ω	100W	50W	40Ω
EA350-011-2B	50Ω	100W	50W	40Ω
EA350-5R6-3B	50Ω	100W	50W	50Ω
EA350-8R5-3B	50Ω	100W	50W	50Ω
EA350-013-3B	50Ω	100W	50W	45Ω
EA350-017-3B	None	None	None	30Ω
EA350-022-3B	None	None	None	30Ω
EA350-028-3B	None	None	None	25Ω
EA350-038-3B	None	None	None	10Ω
EA350-052-3B	None	None	None	10Ω
EA350-062-3B	None	None	None	10Ω

2.7.2 Resistance capacity calculation of external braking resistor

■ When the recovering capacity exceeds the recovering capacity of the built-in braking resistor (say an $AL.017$ warning occurs), an external braking resistor shall be used.

■ According to the calculation formula of recoverable energy, if the total inertia of load is N multiples of the motor's rotor inertia, then the recoverable energy of the motor braking from the rated speed to 0 is N*Eo, and the actuation cycle is T(s).

Power of the braking resistor $= \dfrac{2(N \times E_0 - E_c)}{T}$ For E_0 and E_c, please see Table 2-1.

2.7.3 Precautions for use of an external braking resistor

■ When an external braking resistor is used, the resistor is connected to terminals P+ and C of the driver; at the same time, the short-circuiting piece installed on terminals P+ and D shall be removed to leave the circuit between terminals P and D open.

■ The resistance of the external braking resistance shall be no less than that provided in Table 2-2; otherwise damage may be caused to the driver.

■ Please set the resistance and capacity of the external braking resistor correctly to the functional parameters of the driver; otherwise execution of the function will be executed.

• P8-10 (resistance of the braking resistor), P8-11 (power of the braking resistor), P8-13 (derated percentage of the braking resistor).

■ In the natural environment, when the recoverable capacity (average value) that can be handled by the braking resistor is used at the rated capacity, the resistor temperature will rise to above 120°C (under the condition of constant braking). For the sake of safety, forced cooling shall be performed to lower the temperature of the braking resistor; alternatively, it is recommended to use a braking resistor with a thermoswitch. For load characteristic of the braking resistor, please consult the manufacturer.

Caution☞	1. The resistance of the external braking resistance shall be no less than that provided in Table 2-2; otherwise damage may be caused to the driver. 2. When an external brake resistor is used, failure to remove the short-circuiting piece between P+ and D may cause damage to the driver.

2.8 Measures against disturbance

Important	• The servo unit is an industrial device, and thus no measure against radio disturbance is adopted. • The servo unit has a high-speed switching element in its main circuit, and electromagnetic noise produced by the switching element may affect peripheral devices of the servo unit. When it used near a residence, or in any other place where radio disturbance is a problem of concern, measures against noise disturbance shall be taken.

The servo unit has a built-in micro-processor that may be affected by electromagnetic noise produced by peripheral devices of the driver. To suppress noise disturbance between the servo driver and peripheral devices, measures for protection against electromagnetic noise may be taken as necessary.

• It is advisable to place the input command device and the electromagnetic noise filter near the servo driver wherever possible.

• Do install surge absorbers on the coil of the relay, the solenoid and the electromagnetic contactor.

• Do not set the following cables into the same sleeve or trunking, nor bind them together. Besides, it is required to keep an interval of above 30cm upon wiring.

■ Main circuit cable and input/output signal cable.

■ Main circuit cable and encoder cable.

• Do not use the same power source with an electric discharge machine, an electric welder or a high-frequency induced furnace. It is required to connect a noise filter on the input side of the main circuit power cable and the control power cable when a high frequency generator is present nearby, even if not the same power source is used. For connection of the noise filter, refer to Section 2.8.1.

• Proper grounding is required.

2.8.1 Noise filter (EMI Filters)

All electronic devices (including the servo driver) will, during normal operation, produce some high- or low-frequency noise that will transmitted or radiated to disturb peripheral devices. Use and proper installation of an EMI filter can minimize such disturbance. If the servo driver and EMI filter can be installed and wired in accordance with this Manual, we can assure that they conform to the following specifications:

1. EN61000-6-4 (2001)

2. EN61800-3 (2004) PDS of category C2

3. EN55011+A2 (2007) Class A Group 1

An example of wiring is shown below
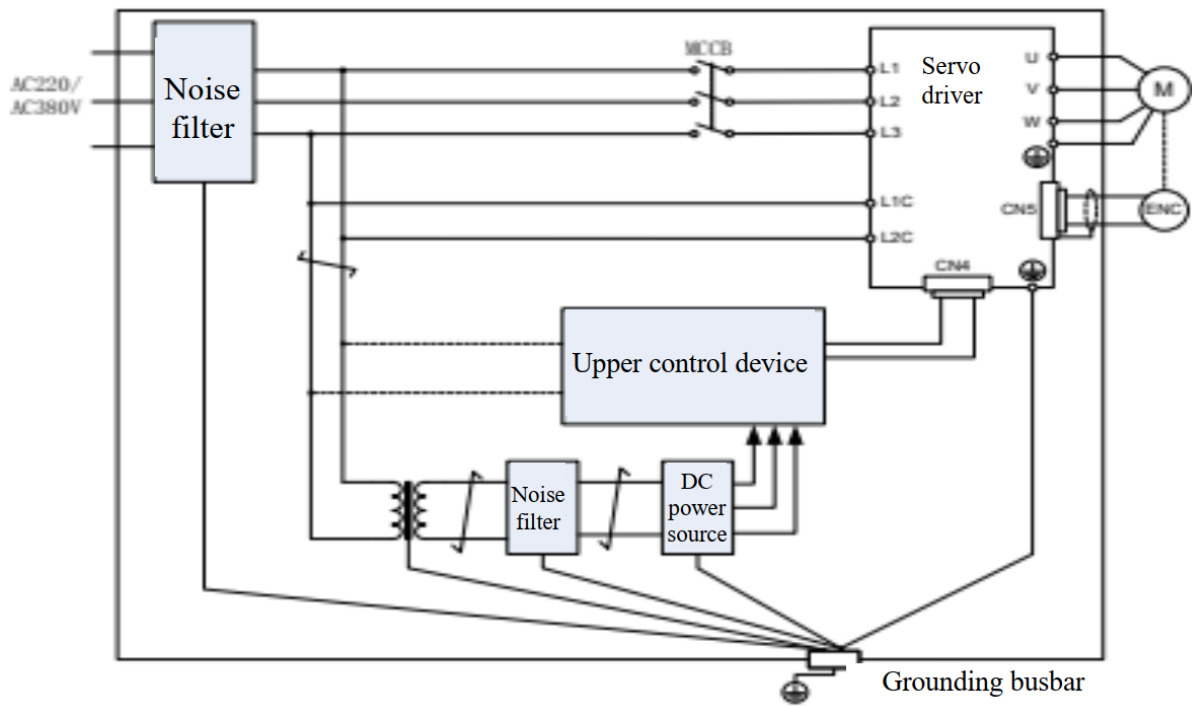
Note: For grounding, wire of 1.5mm^2 or above shall be used as far as possible (most preferably copper braided wire)

2.8.2 Precautions for installation of an EMI filter

To maximize the effect of the EMI filter suppressing disturbance of the servo driver, in addition to installation and wiring of the servo driver in accordance with the Manual, the following precautions shall be observed:

1) The servo driver and the EMI filter must be installed on the same well-grounded metal plane.

2) All wiring cables shall be as short as possible.

3) The metal housing of the servo driver and the EMI filter must be reliably connected to the metal plane, and the contact area between the two shall be as large as possible.

4) The input and output wiring cables of the noise filter shall be laid separately, and may not be put into the same sleeve or trunking, nor be bound together.

5) The ground wire and output wire of the noise filter shall be separately arranged.

6) The noise filter shall have a ground wire separately connected to the ground busbar and shall not be shared with other ground wires.

2.8.3 Motor cable selection and installation precautions

Whether motor cable is properly selected and installed matters to whether the EMI filter can render the maximum disturbance suppression effect. Attention shall be paid to the following points:

1) Cable with isolating copper mesh (double isolating layers more preferred) shall be used.

2) Isolating copper meshes at both ends of the motor cable shall be grounded with the shortest distance and the maximum contact area.

3) The isolating copper meshes of the motor cable shall be correctly connected to the metal plane, with U-shaped metal piping brackets used to fix the copper meshes on both ends onto the metal plane.

2.8.4 Grounding

Grounding shall be done following the requirements below. Proper grounding may prevent misoperation resulted from electromagnetic disturbance.

- Single-point grounding is required.
- The grounding resistance shall be less than 100Ω.
- When the servo motor is mutually isolated from the machine, directly ground the servo motor.
- The PE terminal of the servo motor must be connected to the ground terminal of the servo driver ⏚.
- The ground terminal "⏚" of the servo driver must be grounded.

Chapter 3 Connection

3.1 Connection of Peripheral Device
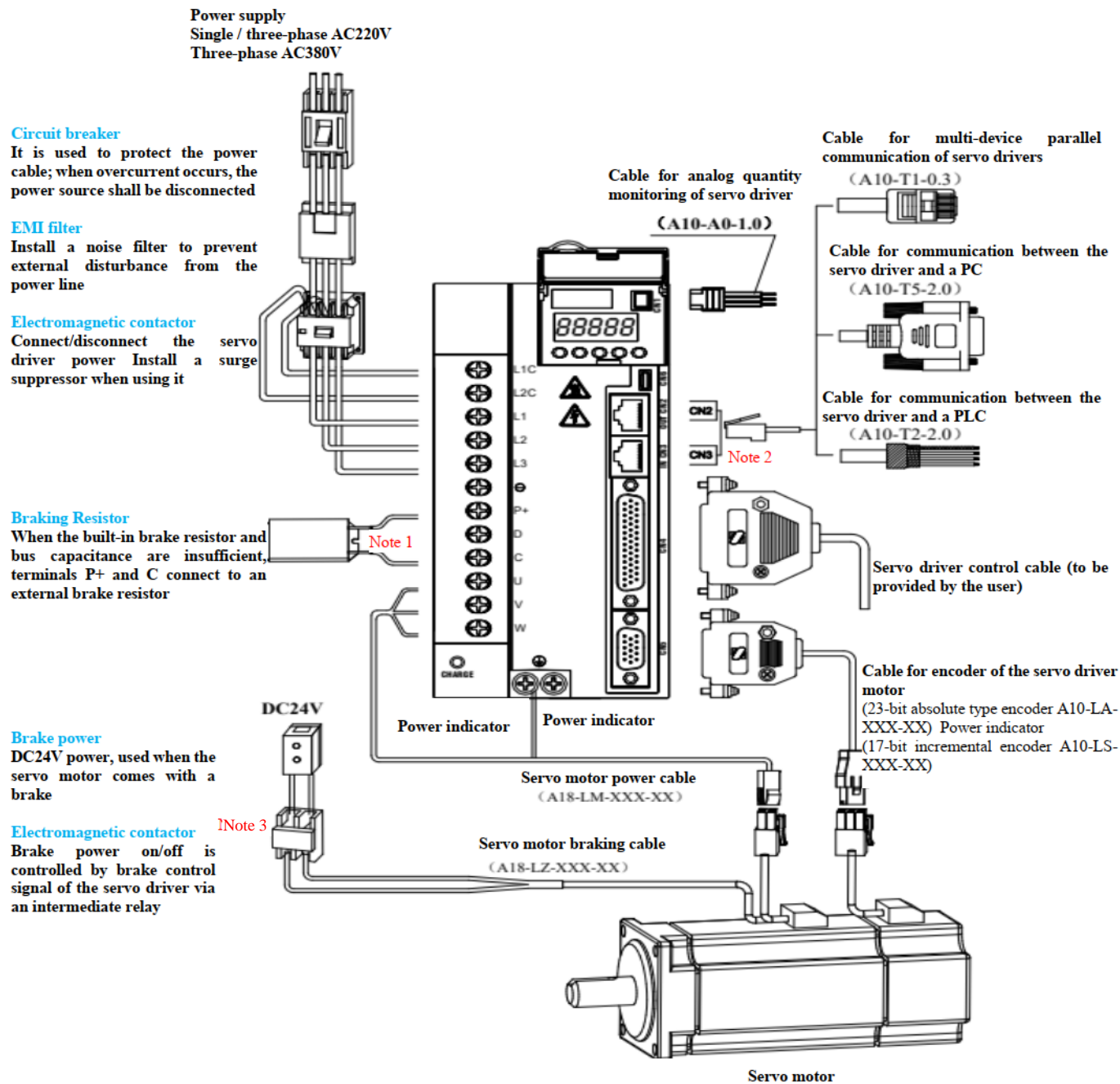
Precautions:

1) The servo driver is directly connected to an industrial power source, without use of a transformer or other device for power isolation. To prevent cross electric shock of the servo system, a fuse or circuit breaker for wiring may be used on the input power.

2) It is strictly forbidden to install an electromagnetic contactor between the driver and the motor; otherwise damage may be caused to the driver.

3) When an external control power and 24V power is connected, attention shall be paid to the power capacity; particularly when power is supplied to several drivers or brakes, insufficient power capacity may cause insufficient current, resulting in damage to the drivers or brakes.

4) Note that if a brake uses a 24V DC power source, the capacity of the power source shall conform to the power requirement of the brake. For brake power, refer to introduction to the servo motor.

5) Check to make sure the output terminals U, V and W of the servo motor are correctly wired in the phase sequence; incorrect wiring may cause a rotation failure or error of the motor to trigger a warning, or even cause damage to the motor.

6) When an external braking resistor is used, it is required to have terminals P+ and D open; the external braking resistor shall be connected to terminals P+ and C. If an internal braking resistor is used, it is required to short-circuit terminals P+ and D and leave terminals P+ and C open (refer to Section 2.7).

7) Upon single-phase 220V wiring, the main power terminals are L1 and L2; if there is a terminal L3, it shall not be wired.

8) CN2 and CN3 are communication interfaces with identical pin definition, and either can be selected for use.

3.2 Wiring of Main Circuit Terminals

Terminal layout of the main circuit and screw size are shown below.

Driver specification	Main circuit terminal	
	Screw size	Locking torque
EA350-0R9-1B EA350-1R6-1B EA350-2R5-1B	None	-
EA350-4R8-2B EA350-6R2-2B	None	-
EA350-011-2B EA350-5R6-3B EA350-8R5-3B EA350-013-3B	M4	2.5N.m
EA350-017-3B EA350-022-3B EA350-028-3B	M4	2.5N.m

Driver specification	PE ground terminal	
	Screw size	Locking torque
EA350-0R9-1B EA350-1R6-1B EA350-2R5-1B	M4	2.5N.m
EA350-4R8-2B EA350-6R2-2B	M4	2.5N.m
EA350-011-2B EA350-5R6-3B EA350-8R5-3B EA350-013-3B	M4	2.5N.m
EA350-017-3B EA350-022-3B EA350-028-3B	M4	2.5N.m

EA350-038-3B
EA350-052-3B
EA350-062-3B

Driver specification	Main circuit terminal	
	Screw size	Locking torque
EA350-038-3B EA350-052-3B EA350-062-3B	Wiring frame type	3.5Nm

Driver specification	PE ground terminal	
	Screw size	Locking torque
EA350-038-3B EA350-052-3B EA350-062-3B	M5	3Nm

No cold-pressed terminal is required for main circuit cables. Stripping length: 19mm.

3.2.1 Introduction to the main circuit (high voltage) terminal

Table 3-1 Description of the main circuit terminal of the servo driver

Terminal marking	Terminal name	Terminal Function	
L1C, L2C	Control power input terminal	Output with voltage consistent with power level of the main circuit (EA350-038, 052 and 062 models don't contain this terminal)	
L1, L2, L3	AC power input terminal of main circuit	EA350-0R9-1B EA350-1R6-1B EA350-2R5-1B	Single-phase 220V input of terminals L1 and L2
		EA350-4R8-2B EA350-6R2-2B	Single-phase 220V input of terminals L1 and L2 Or three-phase 220V power input of L1, L2 and L3
		EA350-010-2B	Three-phase 220V power input of L1, L2 and L3
		EA350-5R6-3B EA350-8R5-3B EA350-013-3B EA350-017-3B EA350-022-3B EA350-028-3B EA350-038-3B EA350-052-3B EA350-062-3B	Three-phase 380V power input
P+, D, C	Connecting terminal for an external braking resistor	Shorting wire is used for connection between P+ and D in default When the braking force is insufficient, leave the circuit between P+ and D open, and connect an external braking resistor between P+ and C. External braking resistor should be purchased separately. (EA350-0R9, 1R6, 2R5, 017, 022, 028, 038, 052 and 062 models have neither wiring terminal D nor short-circuit wire.)	
P+, ⊖	Common DC bus terminal	The DC bus terminal of a servo driver can be connected to a common bus in case of multiple units connected in parallel.	
U, V, W	Servo motor connecting terminal	The connecting terminal of a servo motor connects to U, V and W phases of the motor.	
⏚	PE ground	The two ground terminals are connected to the ground terminals of the power source and the motor.	

3.2.2 Power wiring

The servo driver may be subject to single-phase or three-phase power wiring. Single-phase power wiring is only permitted for models with the output current of 6.2A or below.

- Single-phase power wiring (applicable to drivers with a rated output current of 6.2A or below)
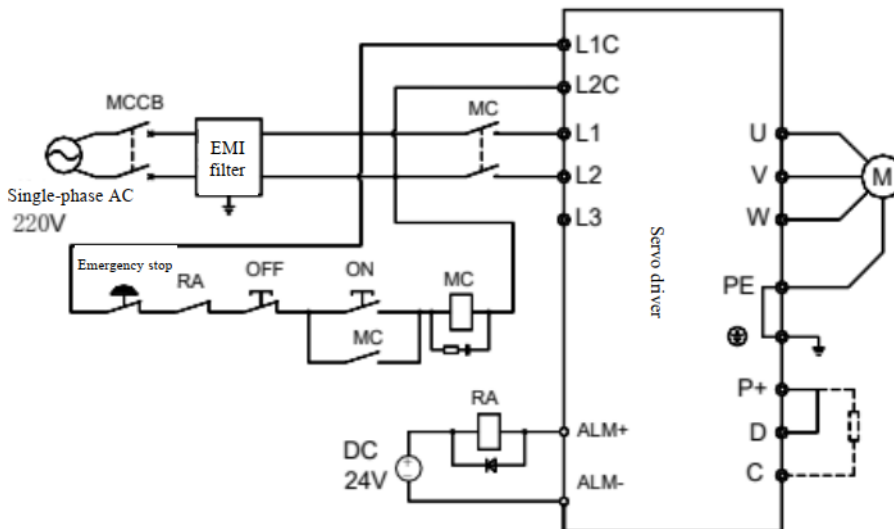
Fig. 3-1 Single-phase power wiring diagram

- Three-phase power wiring (applicable to drivers with a rated output current of 4.8 A to 28 A)
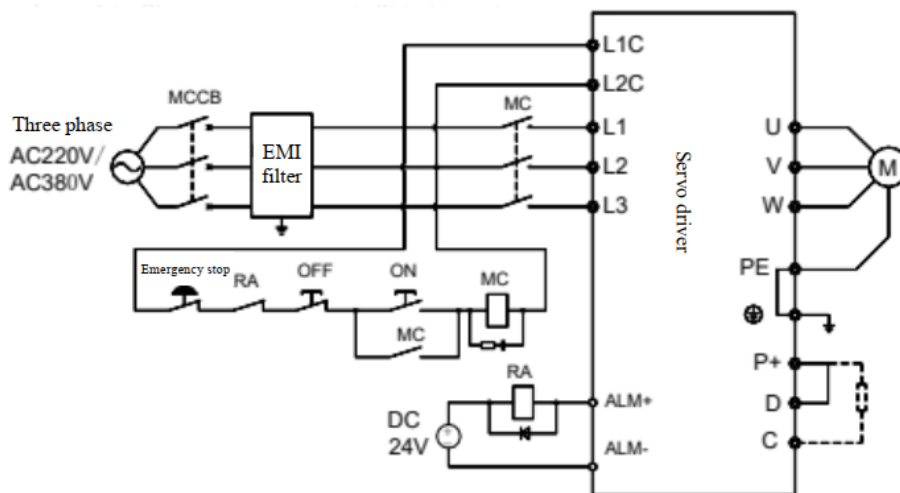
Fig. 3-2 Three-phase power wiring diagram (4.8 - 28 A)

Caution☞	1. If you don't wish to cut off the power of the main circuit upon an alarm, the RA relay is not needed. 2. L1C and L2C may be connected to P+ and - terminals respectively (despite of polarity) instead of an external power supply.

- Three-phase power wiring (applicable to rated output current of 38A or above)
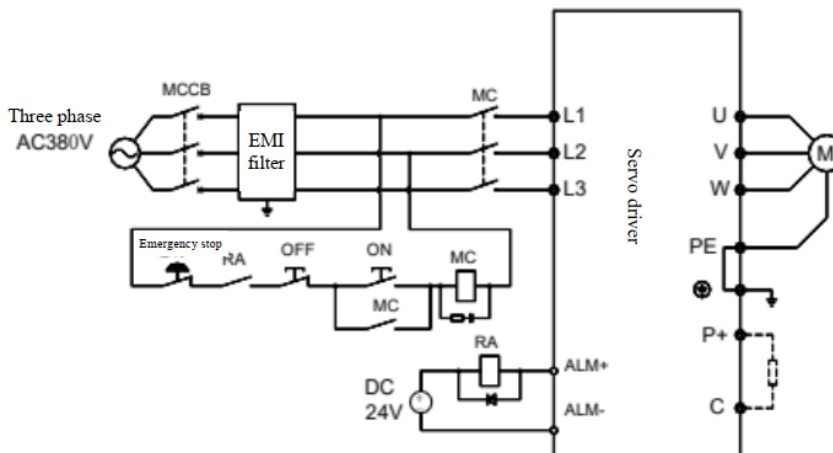
Fig. 3-3 Three-phase power wiring diagram (above 38 A)

3.2.3 Power connection sequence diagram
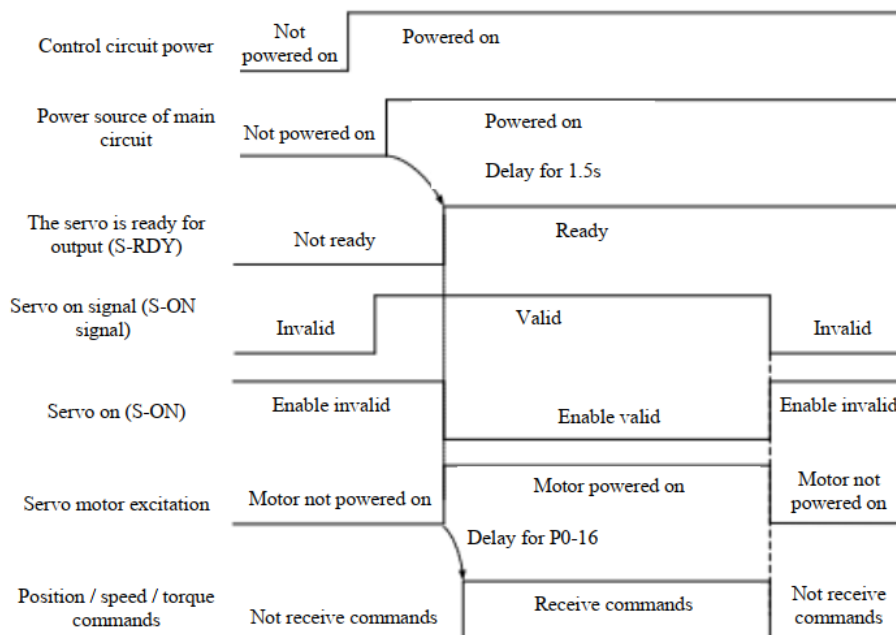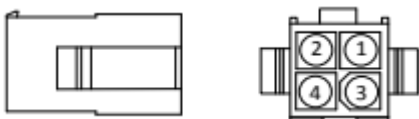
Fig. 3-4 Power connection sequence diagram
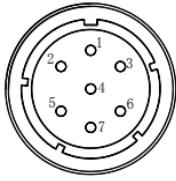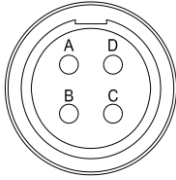
For power connection, refer to Fig. 3-1, Fig. 3-2 and Fig. 3-3, and follow the sequence below:

1) The power L1C and L2C for circuit control must be connected before the main circuit or concurrently with the power of the main circuit. If only the power to control circuit is connected, the S-RDY signal will not be valid.

2) Connect the power source via an electromagnetic contactor to the power input terminal of the main circuit (to L1, L2 and L3 in case of three phases, or to L1 and L2 in case of two phases).

3) Upon the lapse of about 1.5s delay after the main circuit is powered on, the servo ready signal (SRDY) becomes valid; at this time, servo on (S-ON) signal can be received. When valid servo on signal is detected, the motor is excited and enters into the operating status. When invalid servo on signal or a warning is detected, the driver output is turned off, and the motor enters the free status.

4) When the servo on and the power source are connected simultaneously, the motor will be excited upon the lapse of about 1.5s.

5) Frequent power on/off of the main circuit may cause damage to the soft start circuit and the dynamic braking circuit; the power-on/-off frequency shall be preferably limited to 5 times per hour and less than 30 times a day. If the drive unit or the motor become overheated, after elimination of the fault, it is required to leave the unit or motor to cool for 30 minutes before powering on it again.

6) Never connect the input power cable to an output terminal U, V or W; otherwise damage may be caused to the servo driver.

7) Never connect the braking resistor directly between the P+ and ⊖ terminals of a DC bus; otherwise a fire may be caused.

8) When the power is turned off, residual voltage may exist on the internal capacitor of the servo driver; check to confirm the CHARGE indicator light on the servo driver panel is off before conducting inspection.

3.2.4 Specification of the motor power cable connector

Table 3-2 Motor power cable and servo motor connection terminal

Connector appearance and model	Pin distribution of the terminal		Motor flange
Housing model: 172159-1 TE MATE-N-LOCK Insert model: 170362-1 TE MATE-N-LOCK	4-pin AMP connector (excluding brake)		40 60 80 86
	Pin number	Function definition	
	1	U	
	2	V	
	3	W	
	4	PE	
Type: YD28K4TS	Aviation plug (excluding brake)		110 130 (SER series)
	Pin number	Function definition	
	1	PE	
	2	U	
	3	V	
	4	W	

Connector appearance and model	Pin distribution of the terminal		Motor flange
Type: YD28K7TS	Aviation plug (including brake)		110 130 (SER series)
	Pin number	Function definition	
	1	PE	
	2	U	
	3	V	
	4	W	
	5	24V (brake)	
	6	0V (brake)	
	7	Null	
Type: MS3108A32-17S MS3108A18-10S MS3108A22-22S	Aviation plug		130 (SES series) 180 (SES series)
	Pin number	Function definition	
	A	U	
	B	V	
	C	W	
	D	PE	
Barrier terminal			200 220 230 266

Caution☞
1. For a motor with flange 40, 60, 80 or 86 and a brake, it has an independent 2P AMP head for the braking power, which requires no differentiation of the polarity.
2. An SES series motor with a brake comes with a CM10-SP2S-MD plug for braking power, which requires no differentiation of the polarity.
3. The above graphs in this table show the cable ends.

3.2.5 Recommended cable specification for the main circuit

Table 3-3 Recommended cable specification for the main circuit

Driver model	L1C, L2C	L1, L2, L3	U, V, W	P+, C	PE
EA350-0R9-1B	0.5mm²	0.5mm²	0.5mm²	0.5mm²	1.0mm²
EA350-1R6-1B		0.75mm²	0.75mm²	0.75mm²	1.0mm²
EA350-2R5-1B		1.0mm²	1.0mm²	1.0mm²	Above 2.5 mm²
EA350-4R8-2B					
EA350-6R2-2B					
EA350-011-2B		2.5mm²	2.5mm²	2.5mm²	
EA350-5R6-3B		1.5mm²	1.5mm²	1.5mm²	
EA350-8R5-3B		2.5mm²	2.5mm²	2.5mm²	
EA350-013-3B					
EA350-017-3B		4.0mm²	4.0mm²	2.5mm²	
EA350-022-3B					
EA350-028-3B		6.0mm²	6.0mm²	4.0mm²	
EA350-038-3B	None	10.0mm²	10.0mm²	6.0mm²	>10mm²
EA350-052-3B		16.0mm²	16.0mm²	6.0mm²	
EA350-062-3B		25.0mm²	25.0mm²	6.0mm²	

The recommended specification for the wires connecting P+ and D to the braking resistor is calculated based on the 30% utilization of braking. For practical use, please adjust it based on the actual circumstances. For example, a cable with a specification one grade above the recommendation should be selected if reverse dragging under a high speed is a long-term case.

3.3 CN5 encoder signal terminal

CN5 is the encoder signal terminal, a DB15 socket; its position is shown in Fig. 3-5:
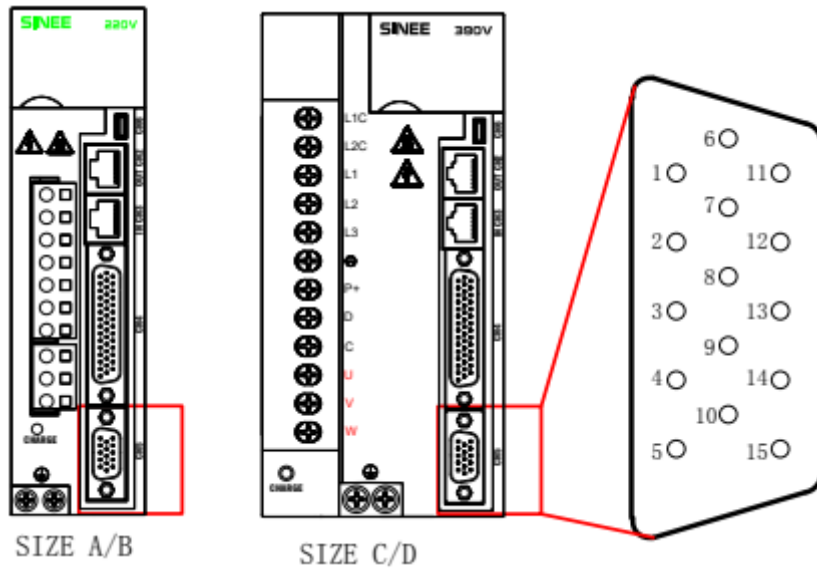
Fig. 3-5 CN5 terminal position

3.3.1 Definition of encoder terminals on the driver side
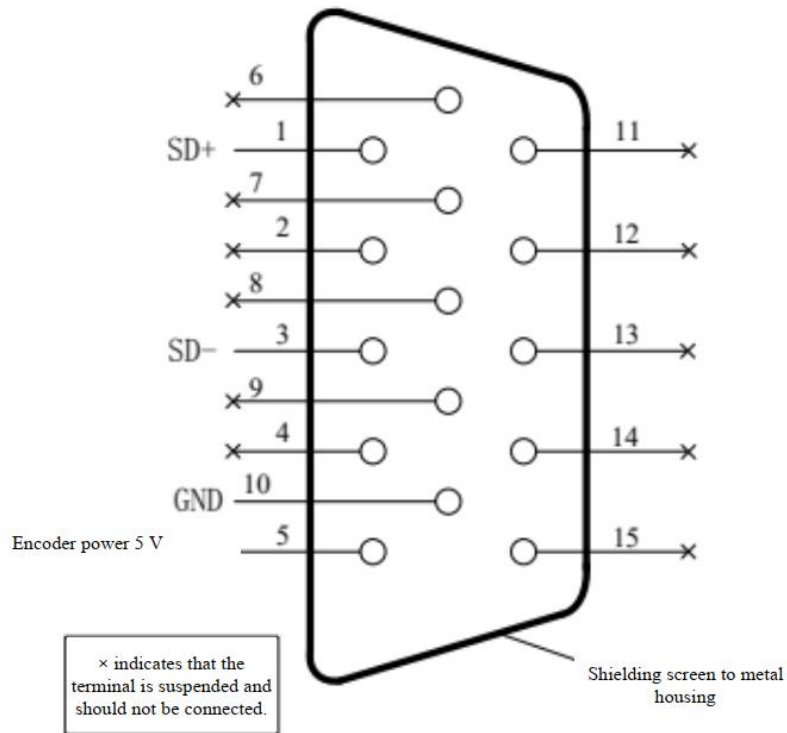
Fig. 3-6 Pin distribution of CN5 terminal
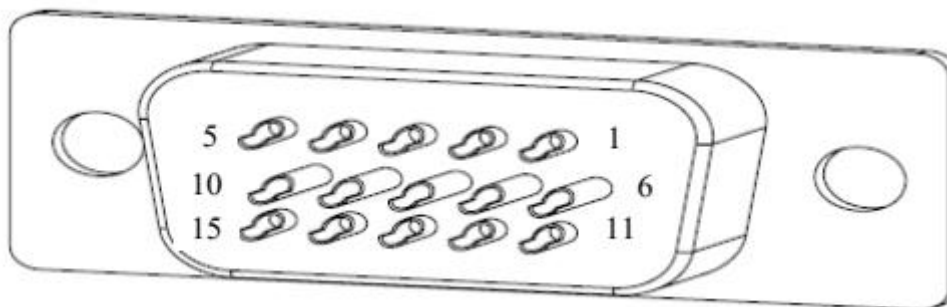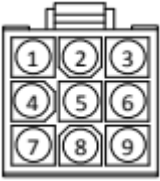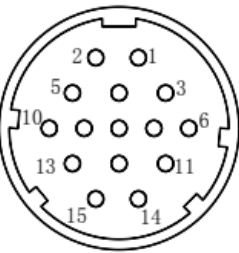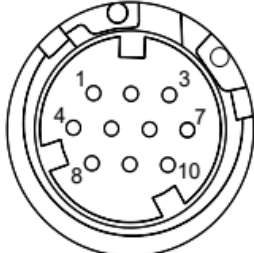
Fig. 3-7 Soldered pin distribution of CN5 terminal

3.3.2 Definition of encoder terminals on the servo motor side

On the servo motor side, there are four forms of encoder terminals

Connector type	TE 172161-1		YD28K15TS		CM10-SP10S-MD	
	Signal	Pin number	Signal	Pin number	Signal	Pin number
17/23-bit serial encoder	+5V	1	+5V	2	+5V	4
	GND	2	GND	3	GND	9
	SD+	5	SD+	4	SD+	1
	SD-	6	SD-	7	SD-	2
	VD+	3	VD+	14	VD+	6
	VD-	4	VD-	15	VD-	5
	PE	9	PE	1	PE	10
Note: Graphs in the table are views from the side of the motor						

Precautions for encoder wiring:

1) Do reliably ground the shielding screens on the driver side and the motor side; otherwise a warning of the driver will be triggered.

2) Make sure the differential signal corresponds to two core wires of the twisted-pair connecting cable. For example, SD+ and SD- forming a differential signal group shall use a twisted-pair cable.

3) When a serial incremental encoder is selected, VD + and VD- signals do not exist (VD+ and VD- are the positive and negative ends of a battery)

4) When a 17/23-bit serial encoder is used with a conductor of less than 5m long, a cable with the cross section area of 0.2mm^2 shall be used. If the conductor exceeds 5m, per each incremental 1 meter, the cross area of the core wire shall increase by 0.05mm^2.

Caution☞	Please note that for the encoder cable provided by us, the connection method for the shielding layer differ from those mentioned above. When an absolute encoder is used, please choose disposable ER14505 3.6 V lithium batteries.

3.4 CN4 control signal terminal

The CN4 signal terminal provides signal required for connection with the upper controller, and uses a DB44 socket; the pin distribution and signal definition are shown below:
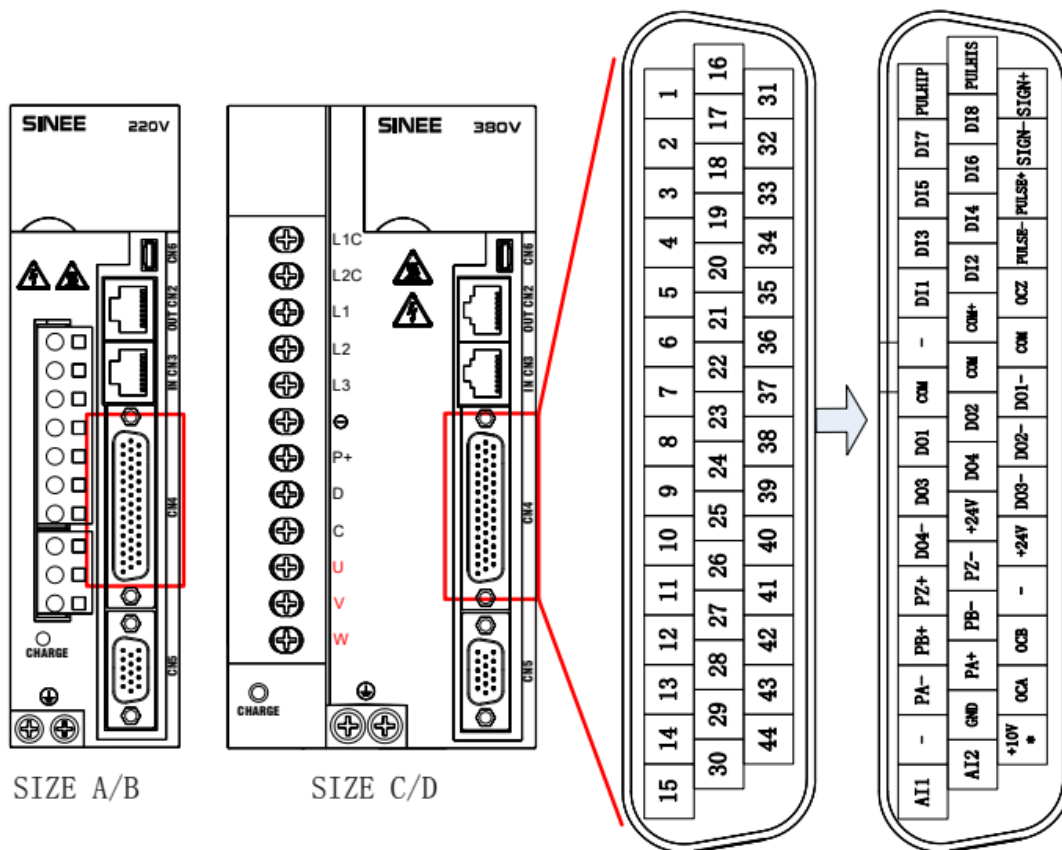
Fig. 3-8 Terminal position and pin distribution diagram of the driver control circuit

3.4.1 Pin distribution of the control signal terminal

Signal name		Pin number	Function description	
Digital input port	DI1	5	Digital input, default function No. 1	Refer to Sections 3.4.2 and 3.4.4
	DI2	20	Digital input, default function No. 2	
	DI3	4	Digital input, default function No. 13	
	DI4	19	Digital input, default function No. 14	
	DI5	3	Digital input, default function No. 3	
	DI6	18	Digital input, default function No. 12	
	DI7	2	Digital input, default function No. 20	
	DI8	17	Digital input, default function No. 21	
	COM+	21	Digital input common positive terminal	
Power supply	+24V	25/40	Internal 24V power source, voltage range +20V~26V, maximum output current 200mA	
	COM	7/22/36	Internal 24V power ground; digital input common ground	
	+10V	44	+10V power, maximum output of 20mA.	
	GND	29	+10V power ground, analog ground	
Digital output	DO1	8	Digital output, default function No. 1	Refer to Sections 3.4.3 and 3.4.5
	DO1-	37		
	DO2	23	Digital output, default function No. 2	
	DO2-	38		
	DO3	9	Digital output, default function No. 8	
	DO3-	39		
	DO4	24	Digital output, fixed function No. 12	
	DO4-	10		

Signal name		Pin number	Function description	
Position pulse input	PULHIP	1	Positive terminal when 24V power source is used for command pulse	Refer to Sections 3.4.7
	PULSE+	33	Position pulse command +	
	PULSE-	34	Position pulse command -	
	SIGN+	31	Position direction command +	
	SIGN-	32	Position direction command -	
Frequency division output	PA+	28	Differential frequency division output of pulse A, maximum allowable current 20mA	Refer to Sections 3.4.8
	PA-	13		
	PB+	12	Differential frequency division output of pulse B, maximum allowable current 20mA	
	PB-	27		
	PZ+	11	Differential frequency division output of pulse B, maximum allowable current 20mA	
	PZ-	26		
	OCZ	35	Z pulse open-collector output, maximum allowable current 40mA.	
	GND	29		
	OCA	43	A pulse open-collector output, maximum allowable current 40mA	
	OCB	42	B pulse open-collector output, maximum allowable current 40mA	
Analog input	AI1	15	Analog input 1	Refer to Sections 3.4.6
	AI2	30	Analog input 2	
	GND	29	Analog input signal ground	

Caution☞ All GND terminals are connected inside the driver; all COM terminals are connected inside the driver

3.4.2 DI function definition table

Settings	Item	Function name	Description		Trigger mode	Running mode
0	Disabled	Terminal inactive				
1	S-ON	Servo on	ON: Servo on	OFF: Servo off	Level	P S T
2	ALM-RST	Warning and warning reset	OFF→ON: Reset warnings and alarms that can be reset		Edge	P S T
3	P-CLR	Position deviation counter clearing	For the trigger mode, see the definition of P1-16		Edge/level	P
4	DIR-SEL	Direction selection for speed command	ON: Reverse direction of speed command	OFF: Set the direction of a speed command	Level	S
5	CMD0	Internal command bit0	In the multi-segment position control mode, the signal corresponds to the multi-segment position switching function; In the multi-segment speed control mode, the signal corresponds to the multi-segment speed switching function;		Level	P S
6	CMD1	Internal command bit1			Level	P S
7	CMD2	Internal command bit2			Level	P S
8	CMD3	Internal command bit3			Level	P S
9	CTRG	Internal command trigger	Multi-segment position trigger		Edge	P
10	MSEL	Control mode switching	For control mode switching, see P0-00 description for the significance of ON/OFF		Level	P S T
11	ZCLAMP	Zero position fixation on for speed command	ON: Zero position fixation function on	OFF: Function invalid	Level	S
12	INHIBIT	Pulse inhibited	ON-Inhibit command pulse input	OFF: Allow pulse input	Level	P
13	P-OT	Inhibit forward drive	ON - Inhibit forward drive	OFF - Allow forward drive	Level	P S T
14	N-OT	Inhibit reverse drive	ON - Inhibit reverse drive	OFF - Allow reverse drive	Level	P S T
15	GAIN_SEL	Gain switching	ON: Use the second gain	OFF: Use the first gain	Level	P S T
16	J_SEL	Inertia switching	ON: Use inertia ratio P4-11	OFF: Use inertia ratio P4-10	Level	P S T
17	JOG_P	Forward jog	ON: Forward jog running	OFF: No function	Level	S
18	JOG_N	Reverse jog	ON: Reverse jog running	OFF: No function	Level	S
19	TDIR-SEL	Direction selection for torque command	ON: Reverse direction of torque command	OFF: Set torque direction	Level	T
20	GNUM0	Numerator selection 0 for electronic gear ratio	GNUM1 / GNUM0 / Code: 0 / 0 / P1-04; 0 / 1 / P1-08		Level	P
21	GNUM1	Numerator selection 1 for electronic gear ratio	1 / 0 / P1-10; 1 / 1 / P1-12		Level	P
22	ORGP	External detector input	Rising edge: External detector active Falling edge: External detector inactive		Edge	P S T
23	SHOM	Homing	OFF→ON: Start the homing function		Edge	P S T
24	TL2	External torque limit	ON: External torque limit enabled OFF: External torque limit disabled		Level	P S T
25	EMGS	Emergency stop	ON: Emergency braking	OFF: No function	Level	P S T
33	PDIR_SEL	Direction selection for position command	ON: Reverse position command	OFF: Given command direction	Level	P

34	GBK	Position probe	ON: Execution position probe	OFF: No action	Edge	P S T
35	PUL-UP	Forward pulse deviation	Rising edge: Forward deviation	Falling edge: No action	Edge	P
36	PUL-DN	Reverse pulse deviation	Rising edge: Reverse deviation	Falling edge: No action	Edge	P

3.4.3 DO function definition table

Settings	Item	Function name	Description	Running mode
0	Disable	Terminal inactive		
1	S-RDY	Servo ready	Active - The servo is ready and can receive S-ON commands Inactive - The servo is not ready and does not receive S-ON commands	P S T
2	BK	Brake control	Active - Release the holding brake (brake powered on) Inactive - Close the holding brake (brake powered off)	P S T
3	TGON	Motor rotation	Active - The motor is rotating (the rotating speed is higher than the P0-04 set value) Inactive - The motor stops rotating (the rotating speed is lower than the P0-04 set value)	P S T
4	ZER0	Zero speed of motor	Active - The motor speed is zero (the speed is lower than the P0-03 set value) Inactive - The motor speed is not zero (the speed is higher than the P0-03 set value)	P S T
5	V-CLS	Speed reached	Valid: The actual motor speed reaches or exceeds the P2-08 set value (regardless of direction)	P S T
6	V-CMP	Speed consistency	Valid: Upon speed control, the absolute value of the difference between the actual motor speed and the speed command value is smaller than the P2-09 set value	S
7	PNEAR	Positioning approach	Valid: In the position control mode, the count of position deviation pulses is smaller than the P1-23 set value of the positioning approach width	P
8	COIN	Positioning completion	Valid: In the position control mode, the count of position deviation pulses is smaller than the P1-24 set value of the positioning completion width, and satisfies the condition defined by P1-22	P
9	C-LT	Torque limit	Valid - Motor torque limited Invalid - Motor torque not limited	P S T
10	V-LT	Rotating speed limit	Valid - Motor speed limited Invalid - Motor speed not limited	T
11	WARN	Warning output	Valid: A warning event occurs	P S T
12	ALM	Alarm output	Valid: An alarm event occurs	P S T
13	Tcmp	Torque consistency	Valid: The motor output torque reaches the set value Invalid: The motor output torque does not reach the set value	T
14	Home	Homing	Valid: Homing completed Invalid: Homing is being executed	P
15	S-RUN	Servo on	Valid - The servo is on Invalid - The servo is off	P S T
27	T_CLS	The torque is reached	Valid: The motor current percentage reaches or exceeds the P3-07 set value (regardless of the direction)	P S T
29	SPD_P	Speed programming comparison output	P8-36 selects the judgment logic; when the condition is satisfied, the output is valid; otherwise when the condition is dissatisfied, the output is invalid; when 10rpm hysteresis is present, the output remains unchanged during the hysteresis.	P S T
30	TRQ_P	Torque programming comparison output	P8-39 selects the judgment logic; when the condition is satisfied, the output is valid; otherwise when the condition is dissatisfied, the output is invalid; when 3.0% hysteresis is present, the output remains unchanged during the hysteresis.	P S T
31	SPD_TRQ	Speed and torque programming comparison output	Valid: Both SPD_P and TRQ_P are valid Invalid: SPD_P or TRQ_P is invalid	P S T

Caution☞	**1. Generally 10rpm speed hysteresis is present; during the hysteresis, the output remains unchanged.** **2. Generally 3.0% hysteresis is present; during the hysteresis, the output remains unchanged.**

3.4.4 Digital input terminal wiring

The digital input (DI) terminal of EA350 series servo driver has a full-bridge rectifier circuit. Through the terminal current can be forward (NPN mode) or reverse (PNP mode).

Take DI1 for example. DI1~DI8 have the same interface circuits.

1) When the higher-level device has relay output:
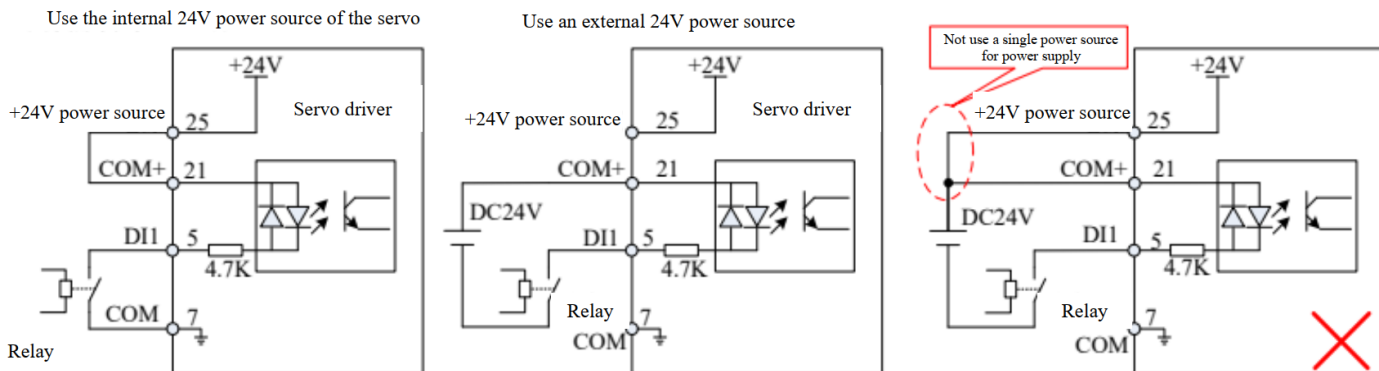
Fig. 3-9 Wiring of the digital input terminal when the higher-level device has relay output

Caution☞	**In this Manual, the following content is provided in default:** ➢ The COM terminal has 7 pins; the user may also use 22/36 pins. ➢ The internal +24V power source of the servo uses 25 pins; the user may also use 40 pins

2) When the higher-level device has NPN open-collector output:
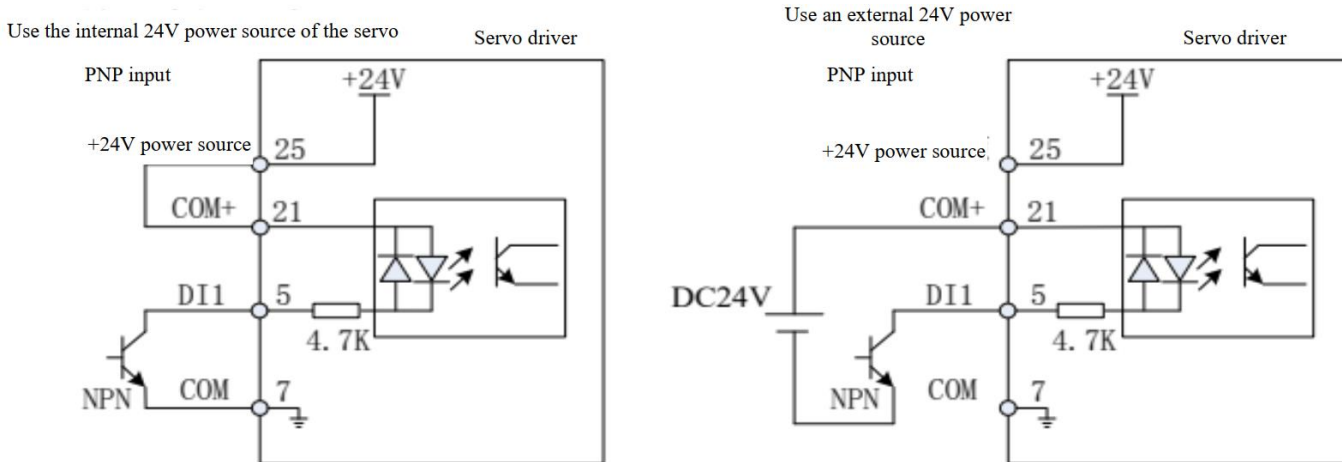
Fig. 3-10 (a) Wiring of the digital input terminal when the higher-level device has NPN open-collector output

3) When the higher-level device has PNP open-collector output:
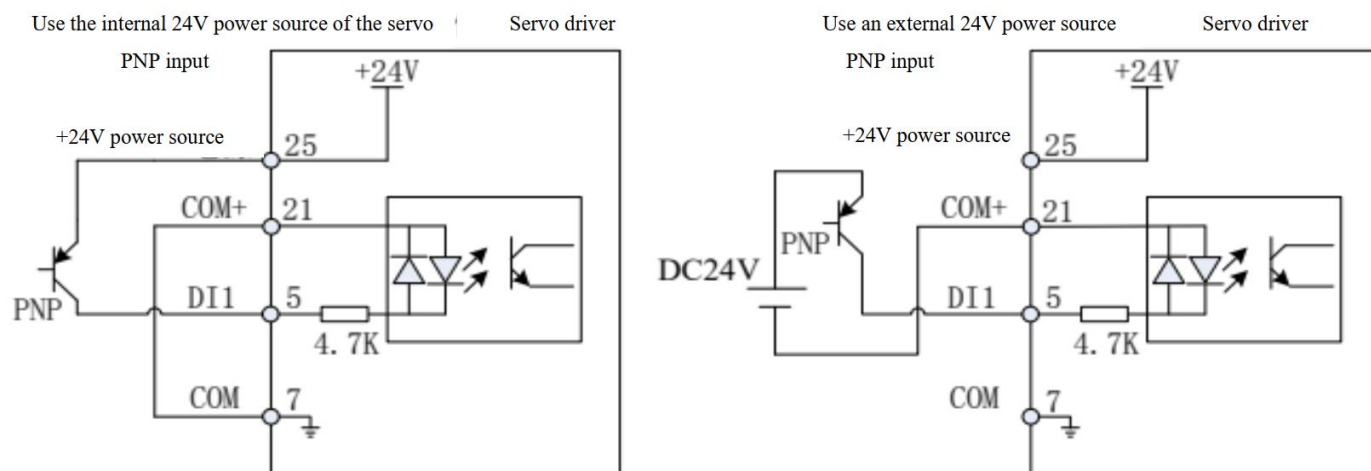
Fig. 3-10 (b) Wiring of the digital input terminal when the higher-level device has PNP open-collector output

Caution☞	**1. When an external power source is used, do make sure the circuit between 24V and COM+ terminals is open** **2. Mixed use of PNP and NPN is not supported**

3.4.5 Wiring of digital output terminal

Take DO1 for example. DO1~DO4 have the same interface circuits.

1) When the higher-level device has relay input
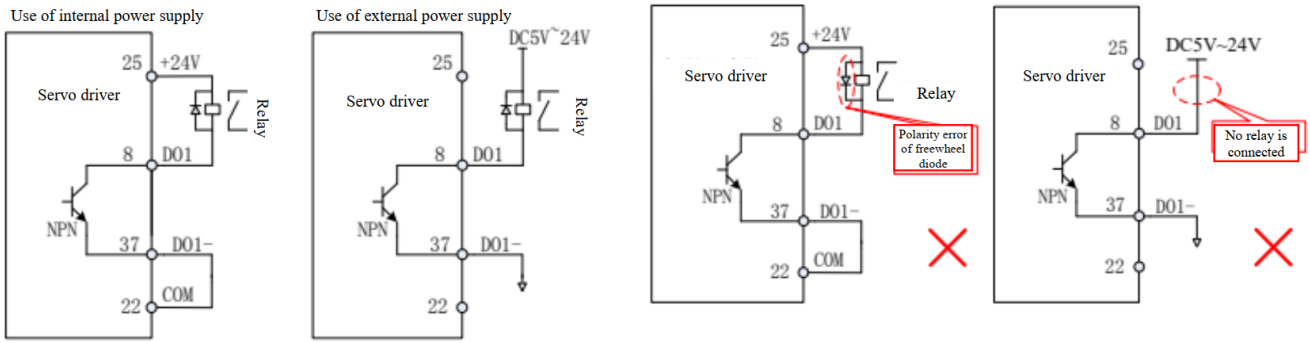
Fig. 3-11(a) Correct wiring of the DO terminal when the higher-level device has relay input

Fig. 3-11(b) Incorrect wiring of the DO terminal when the higher-level device has relay input

Caution☞	When the higher-level device has a relay input, do connect a freewheel diode; otherwise damage may be caused to the DO terminal

2) When the higher-level device has optical coupling input
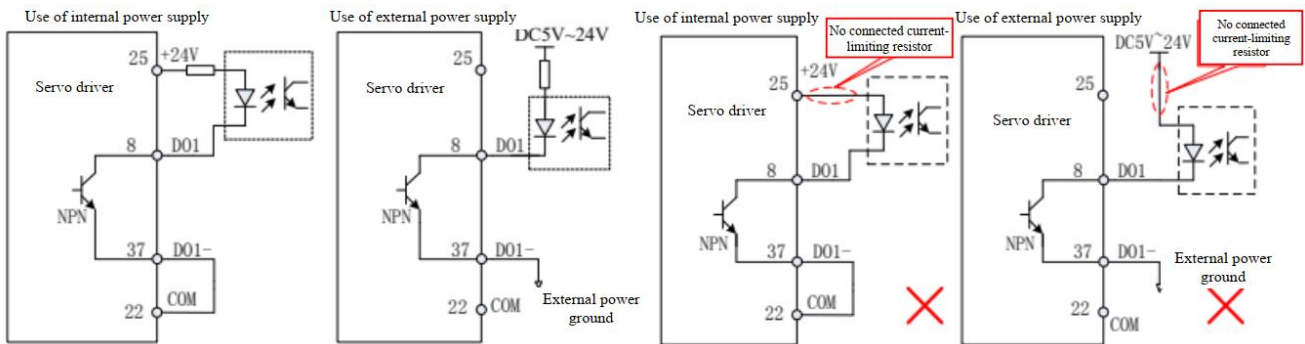
Fig. 3-12(a) Correct wiring of the DO terminal when the higher-level device has optical coupling input

Fig. 3-12(b) Incorrect wiring of the DO terminal when the higher-level device has optical coupling input

Caution☞	The maximum allowable voltage and current capacity of the optical coupling output circuit inside the servo driver: ➢ Voltage: DC30V (maximum) ➢ Current: DC50mA (maximum) ➢ If it drives an induced load (such as a relay or contactor), it is required to additionally install a surge voltage absorption circuit, such as: RC absorption circuit (note that the leak current shall be smaller than the holding current of the control contactor or the relay), voltage-dependent resistor, or freewheel diode (for use in a DC electromagnetic circuit; special attention shall be paid to the polarity upon installation). The components of the absorption circuit should be installed close to both ends of the relay or contactor coil.

3.4.6 Wiring of CN4 analog input terminal

Signal name		Pin number	Function	
Analog quantity	AI1	15	Voltage analog input	Voltage input range: -10V to +10V, 12 bits in resolution Maximum allowable voltage: ±12V Input impedance: 10K
	AI2	30		
	GND	29	Analog input ground	

AI1 and AI2 are generally used for input of speed or torque analog signals.
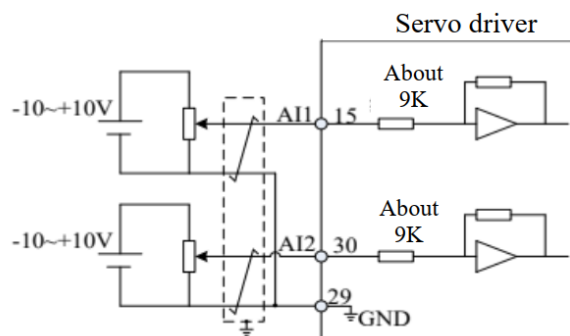
Fig.3-13 AI1/AI2 Terminal Wiring Diagram

3.4.7 CN4 position command input signal

Position command pulse input signal and command symbol input signal terminals in CN4 are described below.

Table 3-6 Description of position pulse input signal

Signal name		Pin number	Function	
Position command	PULSE+	33	Input mode of pulse command: Differential input Input of open collector	Input pulse form: Direction + pulse A, B-phase orthogonal pulse CW/CCW pulse
	PULSE-	34		
	SIGN+	31		
	SIGN-	32		
	PULHIP	1	External power input interface of command pulse	
	PULHIS	16		
	+24V	25/40	24V power positive end	
	COM	36	24V power ground	

Pulse command can be input by using the open-collector or the differential mode. In case of the differential mode, the maximum input pulse frequency is 500Kpps; in case of the open-collector mode, the maximum input pulse frequency is 200Kpps.

For the pulse input terminal, it is required to set a filter time to prevent entry of interference signal into the servo driver resulting in malfunction of the motor. For information on the filter time, refer to description of P1-15 function parameters.

Different command input pulse forms have different timing sequence and time parameters. For details, see Table 3-7 and Table 3-8:

Table 3-7 Timing sequence table of different command pulses

Pulse command form	Logic status	Pulse waveform
Pulse + direction	P1-01=0 positive logic	
	P1-01=1 negative logic	
Two-phase orthogonal pulse (quadruplicated frequency)	P1-01=2 positive logic	
	P1-01=3 negative logic	
CW+CCW pulse	P1-01=4 positive logic	
	P1-01=5 negative logic	

Table 3-8 Pulse input time parameters

Pulse mode	Maximum input frequency	Minimum allowable width				Voltage specification
		T1	T2	T3	T4	
Difference	500Kpps	1μs	1μs	2μs	0.5μs	5V
Open collector	200Kpps	2.5μs	2.5μs	5μs	1.25μs	24V(MAX)

3.4.7.1 Differential input mode of position command pulse
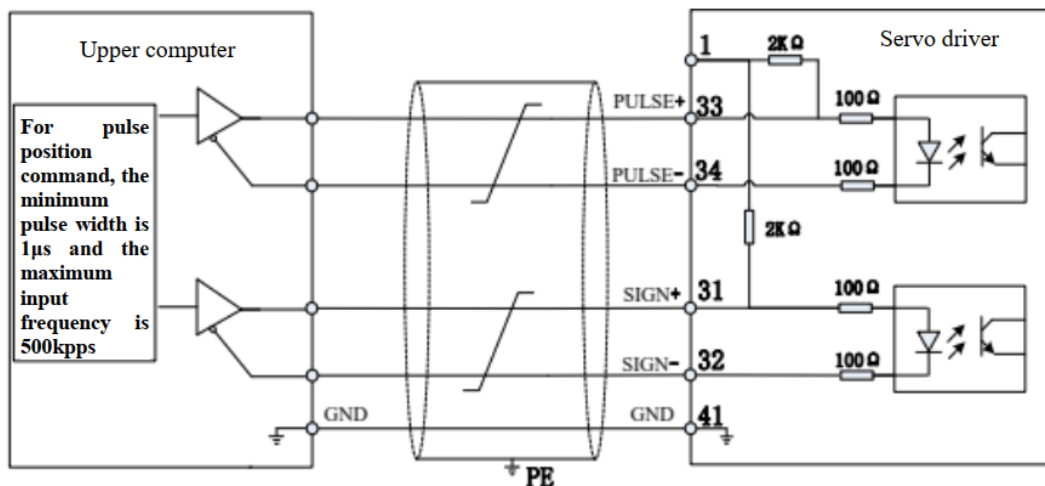
Fig. 3-14 Wiring diagram for differential input of pulse command

Caution☞	**Make sure "2.8V≤ (H level - L level) ≤3.7V"; otherwise the servo driver will have unstable input pulse, resulting in the following circumstances:** ➢ Upon input of command pulses, pulse loss occurs. ➢ Upon input of a command direction, a reverse command direction is taken.

3.4.7.2 Open-collector input mode of position command pulse

•   Wiring for using the internal 24V power source of the servo
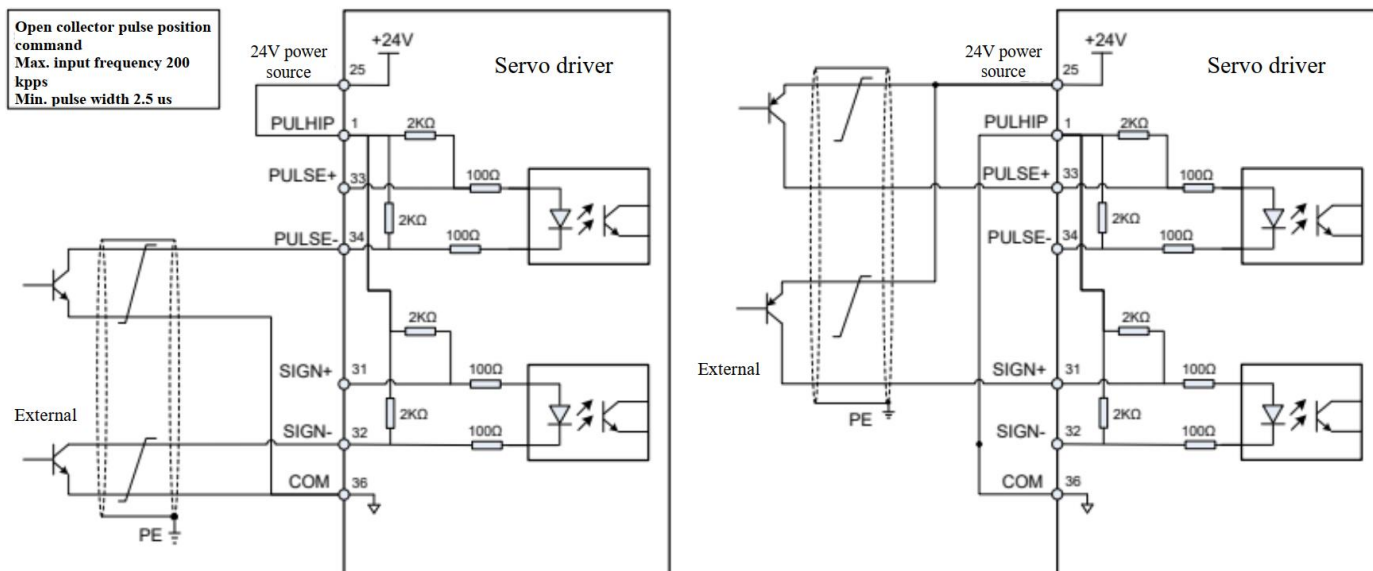
Fig. 3-15 Wiring diagram for open-collector input of pulse command (using the 24V power source of the servo)

- Wiring for using an external 24V power source and internal current-limiting resistor of the driver
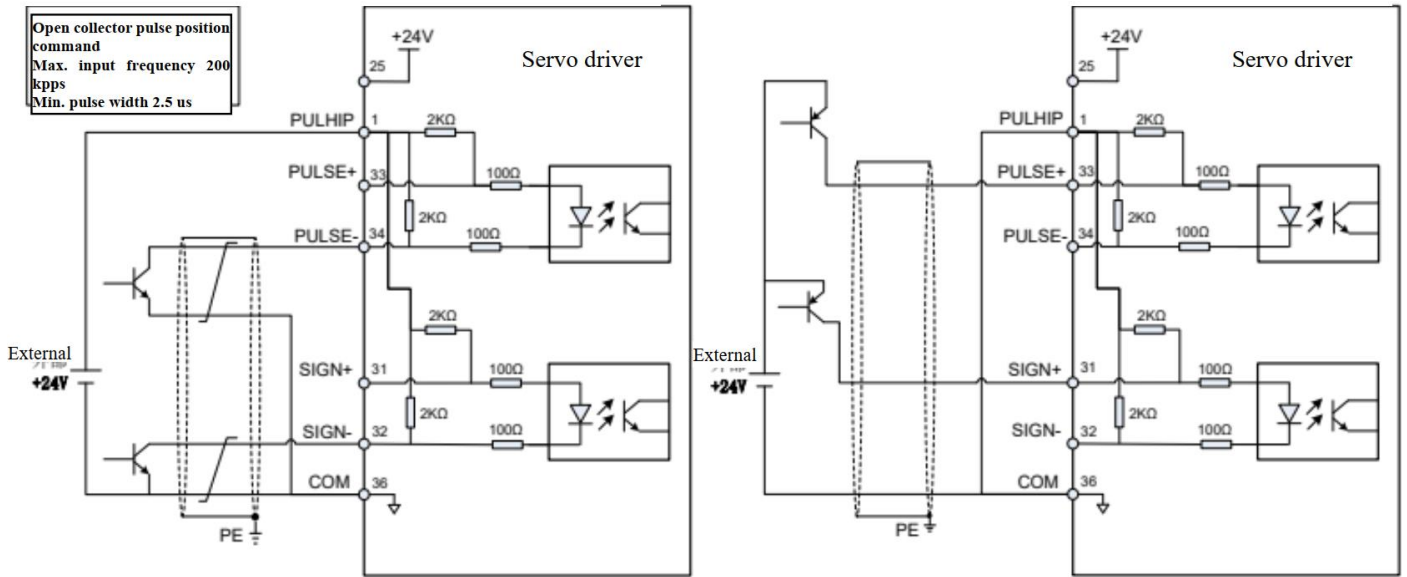
Fig. 3-16 (a) Wiring diagram for open-collector input of pulse command (using an external power source and the internal current-limiting resistor)

- Wiring for using an external 24V power source and external current-limiting resistor
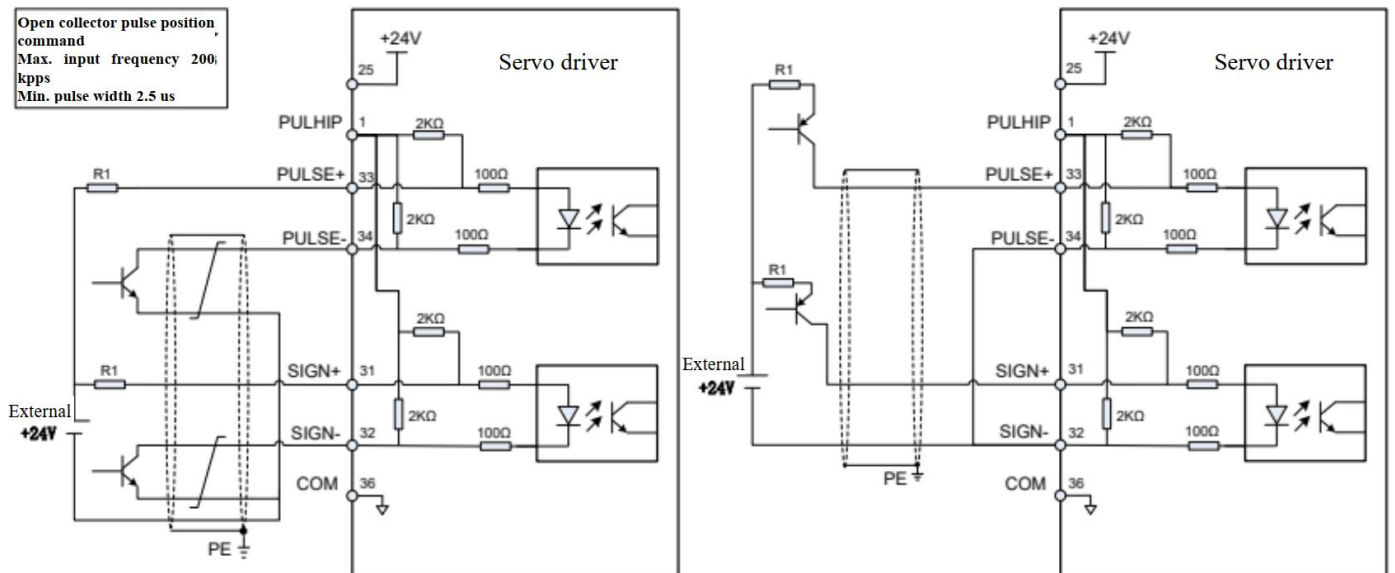
Fig. 3-16 (b) Wiring diagram for open-collector input of pulse command (using an external power source and external current-limiting resistor)

The current-limiting resistor R1 is selected as follows:

$$\frac{V_{CC} - 1.5}{R1 + 200} = 10mA$$

Resistor R1 shall be selected to satisfy the formula:

Recommended resistance for R1:

VCC voltage	R1 resistance	R1 power
24V	2.0K	0.5W
12V	0.8K	0.5W

Caution☞	1. A pair of differential signals shall use a twisted-pair cable. 2. The pulse input signal cable must be run separately from the power cable, with at least 30cm or greater spacing. 3. The pulse input interface is not a shielded input interface. To reduce noise disturbance, it is recommended to connect the output signal ground of the upper computer and the signal ground of the driver.

3.4.8 Frequency division output circuit of CN4 encoder

Table 3-9 Description of frequency division output signal of the encoder

Signal name	Pin number	Function	
PA+	28	Differential frequency division output of phase A	Orthogonal frequency division pulse output of A and B
PA-	13		
PB+	12	Differential frequency division output of phase B	
PB-	27		
PZ+	11	Differential frequency division output of phase C	Pulse output at the origin of the encoder
PZ-	26		
OCA	43	OC-gate frequency division output of phase A　NPN type	Orthogonal frequency division pulse open-collector output of A and B
OCB	42	OC-gate frequency division output of phase B　NPN type	
OCZ	35	OC-gate frequency division output of phase Z　NPN type	Pulse open-collector output at the origin of the encoder
GND	29	Pulse open-collector output signal ground	

The frequency division output circuit of the encoder outputs differential signal through the differential driver and open-collector signal through the transistor. Commonly, when a control system is formed with the higher-level device, feedback signal is provided. In the upper computer, please use a differential or optically coupled circuit or NPN circuit based on the signal type selected to receive the signal. The maximum current of differential output is 20mA; the maximum current of open-collector output is 40mA.
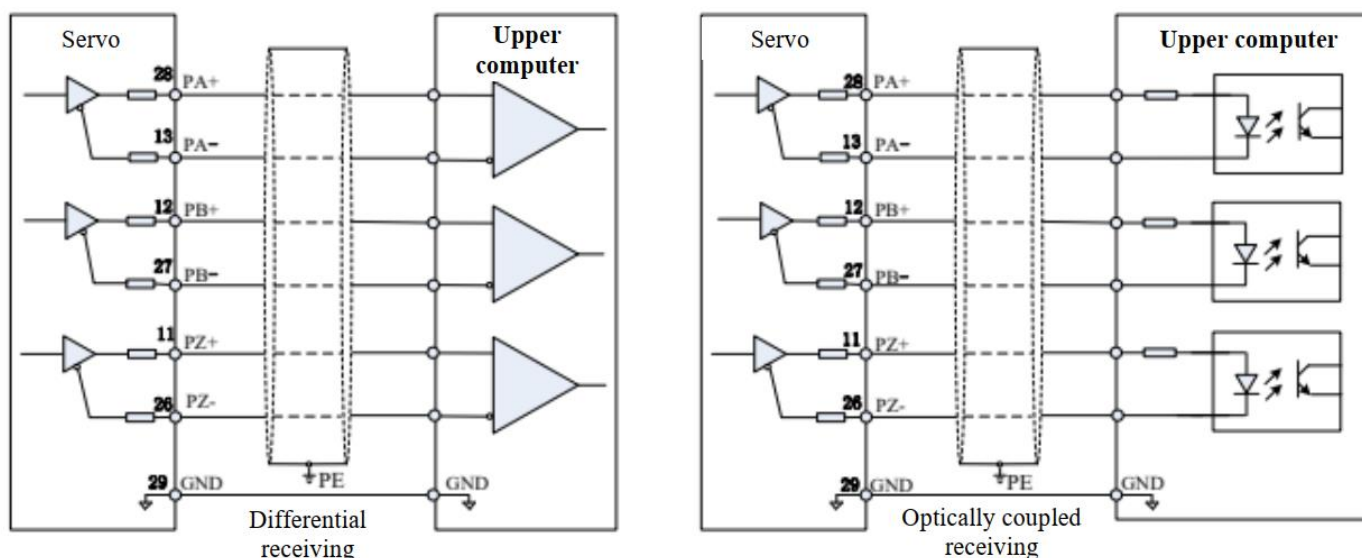
Fig. 3-17 Wiring diagram of differential frequency division output
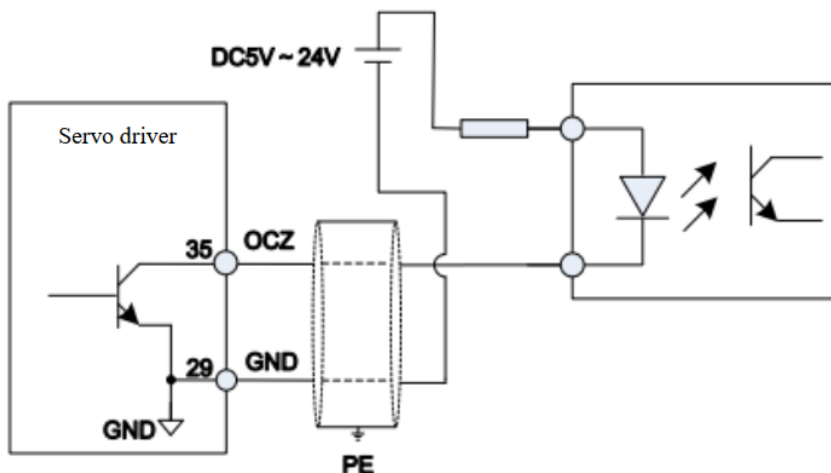
Fig. 3-18 Wiring diagram of the open-collector frequency division output terminal
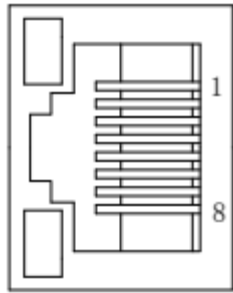
Caution☞　Do connect the signal power ground of the upper computer with the driver GND, and use a twisted shielded pair to reduce noise disturbance.
The maximum voltage tolerance of the triode inside the driver is DC30V, and the maximum allowable input current is 40mA.

3.5 CN2 and CN3 communication terminal wiring

The driver is connected to the upper computer through the two identical communication signal connectors CN2 and CN3 connected in parallel inside of it; the user may operate the driver by MODBUS communication; the communication distance is about 15m.

Table 3-10 Description of the communication connector pins

Signal name	Pin number	Function	Pin distribution of the terminal
RS485+	1	RS485 communication port	
RS485-	2		
GND	3	RS485/RS232 communication reference ground	
RS232-RXD	4	The receiving terminal of RS232 connects to the transmitting terminal of the upper computer	
RS232-TXD	5	The transmitting terminal of RS232 connects to the receiving terminal of the upper computer	
-	6		
-	7		
-	8		
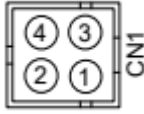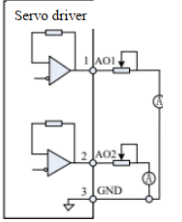
Fig. 3-16 Wiring of communication terminals

3.6 CN1 analog output terminal

Table 3-11 Instructions on analog output signals

Signal name	Pin number	Function		Pin distribution of the terminal	Wiring diagram
AO1	1	Analog output 1, output voltage -10V~10V, Maximum output current 1mA	You can set output info via Set P6 function codes		
AO2	2	Analog output 2, output voltage -10V~10V, Maximum output current 1mA		(Driver upright, viewed from the front of the driver)	
GND	3	Common ground of analog output signal			
Reserved	4	Cannot be connected with any signal line			

Precautions:

1) Upon turning OFF the control power, the analog monitoring output terminal might output a voltage of around 5 V in a period of up to 10 ms. Please take it into account when using it.

2) The max. output current of the analog terminal is 1 mA. Any values beyond that might damage the driver. Please take full account when choosing the load.

3.7 Holding brake

When a motor is used to drive a vertical shaft or in other similar circumstances (such as presence of external force), to prevent motion of any moving part due to gravity or external force in case of power failure, the motor used shall have a holding brake.

Caution☞	1. A holding brake is only used to hold the motor in the stop position, and it may not be used to stop operation of a motor. 2. When the motor with a holding brake operates, the brake may produce clicks but this does not affect the function of the motor.

The holding brake requires provision of an external 24V power source. Wiring diagram of the brake signal and brake power source is shown below:
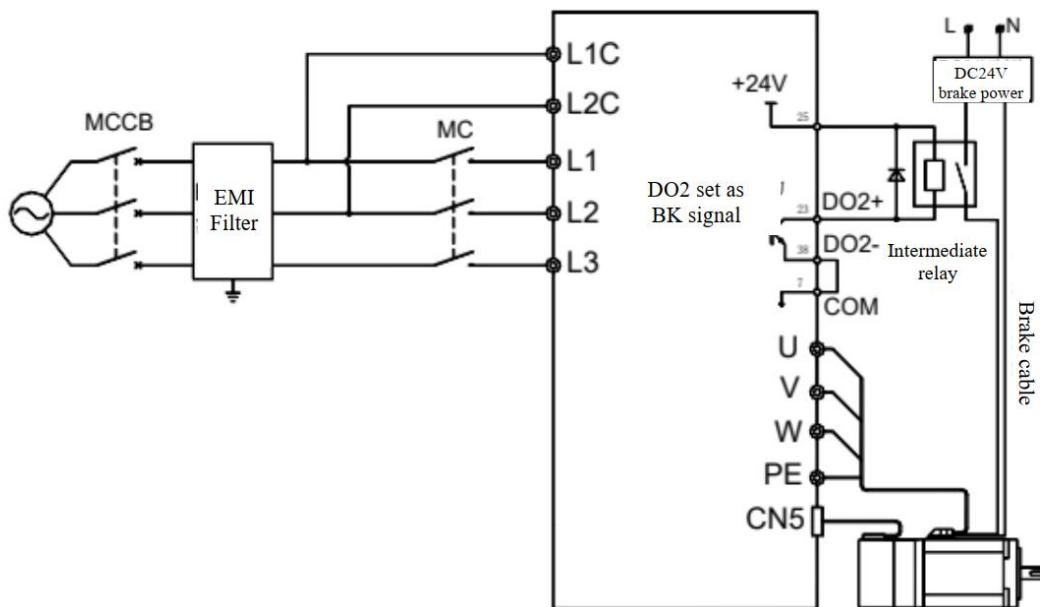
Fig. 3-21 Brake signal and brake power wiring

3.7.1 Precautions for wiring of the holding brake:

1) **The intermediate relay must be controlled through the signal terminal (DO2+ and DO2- in the figure above) of function No. 2 (BK) defined by EA350 servo driver; connection and disconnection of the holding brake to power supply is controlled by the normally open contact of the intermediate relay.**

2) The holding brake coil has no polarity; when powered on, it is released (at this time, the brake disc is separated without braking force).

3) **The holding brake requires use of an external power source.** DC24V power supply to the intermediate relay coil can be sourced from the servo driver; when an external power source is used, it is not recommended to use the same power source with the holding brake.

4) When an external power is used for the intermediate relay coil, note that DO2+ terminal shall connect to the positive terminal of the power source and DO2- shall connect to the negative terminal of the power source.

5) For operation of the holding brake, it is required to ensure an input voltage of 21.5V; for this reason, full consideration shall be given to voltage drop resulted from the power cable resistance of the holding brake, and cable of $0.5mm^2$ or above is recommended for use. For specific power parameters of the holding brake, see Chapter 12.

6) The holding brake should preferably not share a power source with other appliances, so as to prevent operation of the other appliances resulting in voltage or current reduction and finally in malfunction of the holding brake.

3.7.2 Action sequence of the holding brake

3.7.2.1 The holding brake is subject to action delay; for the releasing and closing time of the holding brake, refer to the following figure
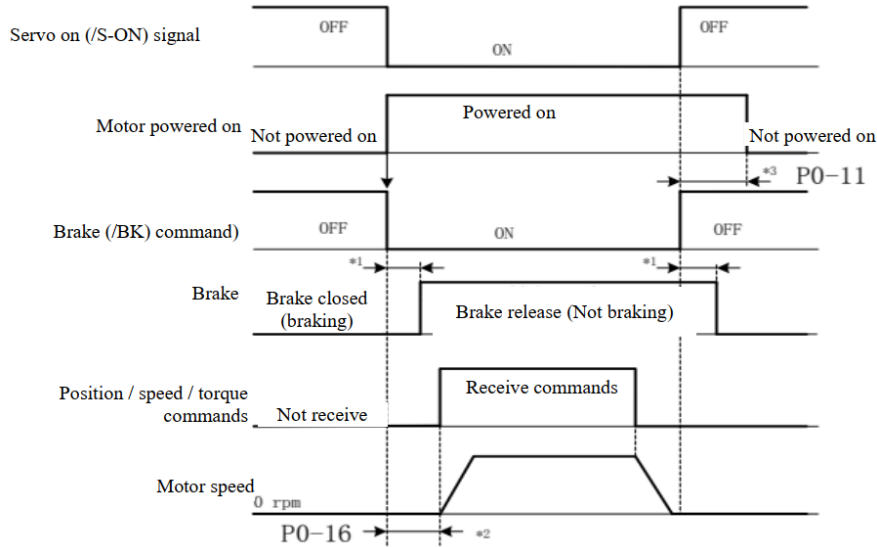
Fig. 3-22 Delay in releasing and closing of the holding brake

*1: The delay in action of the holding brake may differ with different motor models. For details, refer to Chapter 12. The actual conditions shall always prevail.

*2: P0-16 provides the time from when the servo driver receives a Servo On (/S-ON) command to when a position/speed/torque command can be received, and the time must be longer than that required for the holding brake to release. When the upper device outputs a command to the servo driver, the command shall be output upon the lapse of the time following the /S-ON signal.

*3: The holding brake actuation and the servo OFF shall be set through P0-09, P0-10 and P0-11.

3.7.2.2 Brake signal (/BK) output time when the servo motor stops

Upon application to a vertical shaft, gravity of mechanical moving parts or external force may cause slight movement of the machine. Such slight movement can be eliminated by setting the P0-11 to make the motor power off after the brake closes.
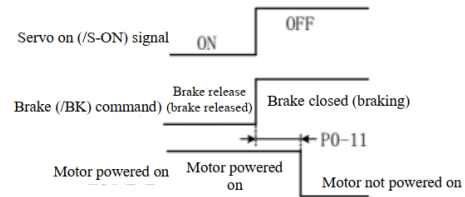
Fig. 3-23 Action sequence of the holding brake when the servo is off

Caution☞	When an alarm occurs in any circumstance, P0-11 is invalid and the servo motor immediately enters the power-off state. At this time, the moving part of the machine can move freely before the brake acts.

3.7.2.3 Brake signal (/BK) output time when the servo motor rotates

When an alarm occurs during rotation of the servo motor, or when the off signal is forced during rotation of the servo motor, the servo motor immediately enters the power-off state. At this time, the brake signal (/BK) output time can be adjusted by setting the brake command output speed value P0-10 and the servo OFF-brake command waiting time P0-09.

Brake actuation condition upon rotation of the servo motor

Brake signal will act when any of the following conditions establish:

- When the motor speed goes below the P0-10 set value after the motor enters the power-off state.

- When the time set by P0-09 elapses after the motor enters the power-off state.
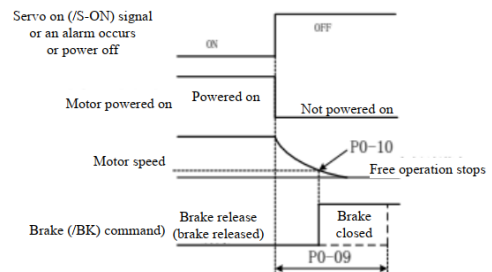
Fig. 3-24 Brake action upon rotation of the servo motor

Caution☞	1. Even if a value exceeding the maximum speed of the servo motor used is set in P0-10, the servo motor is still subject to upper speed limit. 2. Do not assign motor rotation signal (TGON) and brake signal (BK) to the same terminal. If the signals are assigned to the same terminal, falling speed of the vertical shaft may set the TGON signal on, and the brake may fail to act.

3.8 Standard Wiring Diagram of Control Circuit

3.8.1 Standard wiring of the position control mode

Fig. 3-25 Wiring of the standard control circuit in the position mode

3.8.2: Standard wiring diagram for speed control mode

For the default standard wiring, the internal +24V power source of the servo is used

+24V power source — +24V 25

COM+ 21

CN1 terminal

Status input

1. For DI terminal function, see explanation for function codes of P6 group
2. For DI terminal wiring, see Section 3.4.5

Signal			
Servo on	S-ON	DI1	5
Alarm resetting and clearing	ALM-RST	DI2	20
Inhibit forward drive	P_OT	DI3	4
Inhibit reverse drive	N_OT	DI4	19
Internal speed command bit 0	CMD0	DI5	3
Internal speed command bit1	CMD1	DI6	18
Internal speed command bit2	CMD2	DI7	2
Internal speed command bit3	CMD3	DI8	17

COM 7/22 — All COMs have been internally short-circuited

AO1 — GND — Analog 1 output

AO1 — GND — Analog 2 output

For AO output wiring, see 3.6

Status output

	DO		
8	DO1	S-RDY	Servo ready
37	DO1-		
23	DO2	BK	Brake output
38	DO2-		
9	DO3	COIN	Position reached
39	DO3-		
24	DO4	ALM	Fault output
10	DO4-		

1. For DO output function planning, see explanation for the function codes of P6 group
2. For DO terminal wiring, see Section 3.4.6
3. To be provided by the user: DC5V~24V
Maximum allowable voltage: DC30V
Maximum allowable current: DC50mA

Pulse speed setting

For wiring diagram of pulse command, see Section 3.4.8

PULHIP 1 — 2KΩ
PULSE+ 33 — 100Ω
PULS — PULSE- 34 — 100Ω [CW A phase]
SIGN [CCW B phase] — 2KΩ
SIGN+ 31 — 100Ω
SIGN- 32 — 100Ω

Note 1; Analog speed setting signal Input: ±10V
Approximate input impedance: 9kΩ

Frequency-divided pulse output of the encoder - difference

28	PA+
13	PA-
12	PB+
27	PB-
11	PZ+
26	PZ-
29	GND

Upper computer

For output circuit of differential frequency division, see Section 3.4.9

Analog speed setting

For analog input circuit, refer to 3.4.7.

AI1 15
GND 29
GND
AI2 30
GND 29

All GNDs have been internally short-circuited

Open-collector output of encoder

43	OCA
42	OCB
35	OCZ
29	GND

For output circuit of the collector frequency division signal, see Section 3.4.9

+10V 44 +10V
29 GND

Internal +10V power supply, max. allowable current 20 mA (note 3)

Note 2: analog torque limit Signal input: 0~10V
Approximate input impedance: 9kΩ

EA350 servo driver

Note 1: Corresponding to P2-00 set as 1 and P2-12 set as 0
Note 2: Corresponding to P0-05 set to 2
Note 3: +10V is not supported by all models

Fig. 3-26 Wiring of standard control circuit for speed mode

3.8.3 Standard wiring diagram for torque control mode

Fig. 3-27 Wiring of standard control circuit for torque mode

3.9 Precautions for control circuit wiring

■ The control circuit cable must be run separately from the power cable, with at least 30cm spacing.

■ If the control circuit cable needs to be extended, it is required to make sure the shielding layer is reliably connected to secure reliable shielding and grounding;

■ +24V of the servo driver refers to COM; +5V/+10V refers to GND. The load shall not exceed the allowed maximum current; otherwise the driver cannot operate normally.

■ Use the shortest cable for command input and the encoder as far as possible.

■ Ground cable used shall be of above 1.5mm^2.

■ Single-point grounding is required.

Chapter 4 Display and operation

4.1 Appearance of the display and key operation area

Digital tube display — Driver model and serial number

MODE UP DOWN SHIFT Enter
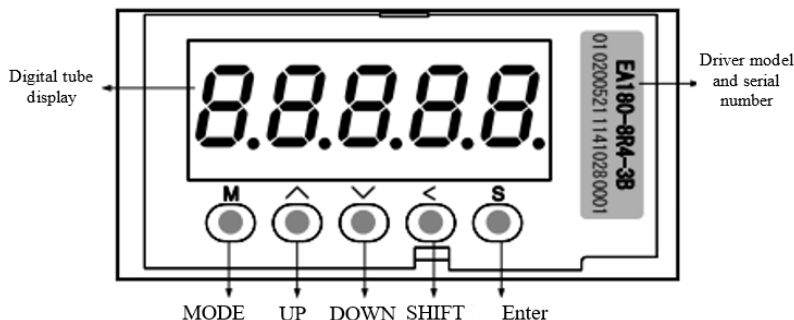
Name of Part	Graphics in the document	Function description
MODE	M	• Switching between different operating modes • Exit from the current parameter/function operation • Exit from the AL mode to the normal operation mode
UP	∧	• The value where the cursor is currently located increases • When it is the second level of AF-02 auxiliary function, jog forward • When it is the second level of dS and CG, directly display the first level of the next parameter • When it is the AL mode and an alarm is currently present, shift down to view the alarm message • In the St mode, AF-07 selected parameter and the driver status is switched for monitoring
DOWN	∨	• The value where the cursor is currently located decreases • When it is the second level of AF-02 auxiliary function, jog reversely • In the AL mode and an alarm is currently present, shift upward to view the alarm message • When it is the second level of dS and CG, directly display the first level of the previous parameter
SHIFT	<	• When it is the first level of the dS, Pr and AF mode, the cursor moves rightward (>); • When it is the second level of the Pr and AF mode, the cursor moves leftward (<); • When it is the second level of dS and CG mode, and the parameter screen 1 is insufficient for display, switch the display;
Enter	S	• Confirm the current operation
Digital tube LED0 LED1 LED2 LED3 LED4	$Ji\ dt$	• The box contains information displayed on the digital tube;
	$i.20.$	• ☼ on the upper side of the box indicates flushing of the whole digital tube at corresponding location; • ☼ on the lower side of the box indicates flushing of the lower right point of the digital tube at corresponding location;
	$-.\ 11$	• When the lower right dot "." on the single LED4 is solidly on, it means the current screen is the second page of the current message; the first and second pages can be switched for display by using the (SHIFT) key;
	$-.\ 11$ $i.3.0\ 11$	• Symbol "-" on LED4 means the current data is negative (the digit number of data on the current page≤ 4); • When the lower right dots ".." on LED4 and LED3 are solidly on, it means the current data is negative (the digit number of data on the current page = 5);
	$i.3.0\ 11$	• When the lower right dot "." on LED4 flashes and the lower right dot "." on LED3 is solidly on, it means the current screen is the second page of the current message; the first and second pages can be switched for display by using the (SHIFT) key, and the current data is negative;
	$i.20.$	• In case of digital display, the lower right dot "." on the LED3, LED2 and LED1 represents the decimal point.
		• When the lower right dot "." on LED0 flashes, it means an alarm or warning is present

4.2 General description of driver operation modes

The EA350 servo driver has 7 operation modes:

Operation mode		Function	Example of menu display at all levels		
Item	Identification		Level 1	Level 2	Level 3
Initialization mode	`I t`	Display driver model	-	`EA 180`	-
Status monitoring mode	`St`	Display the current driver status	-	`-Prdy`	-
Parameter monitoring mode	`d0`	Select a monitoring parameter and monitor its value	`d0-00`	`- 100`	-
Parameter setting mode	`Pr`	Select a parameter to be changed, and change its value	`P0-00`	`1`	`-End-`
Auxiliary function mode	`AF`	Select an auxiliary function, and perform corresponding operation	`AF-05`	`JI dt`	`JI dt`
Modified parameter mode (hidden by default)	`CG`	Inconsistent parameters can be displayed for viewing (through the auxiliary function AF-08=1; when the machine is powered on again, they are still hidden)	`P 1-00`	`0`	-
Warning and alarm mode (displayed on abnormality)	`AL`	Display warning and alarm message	-	`AL.E03`	-

Modes can be switched as follows:
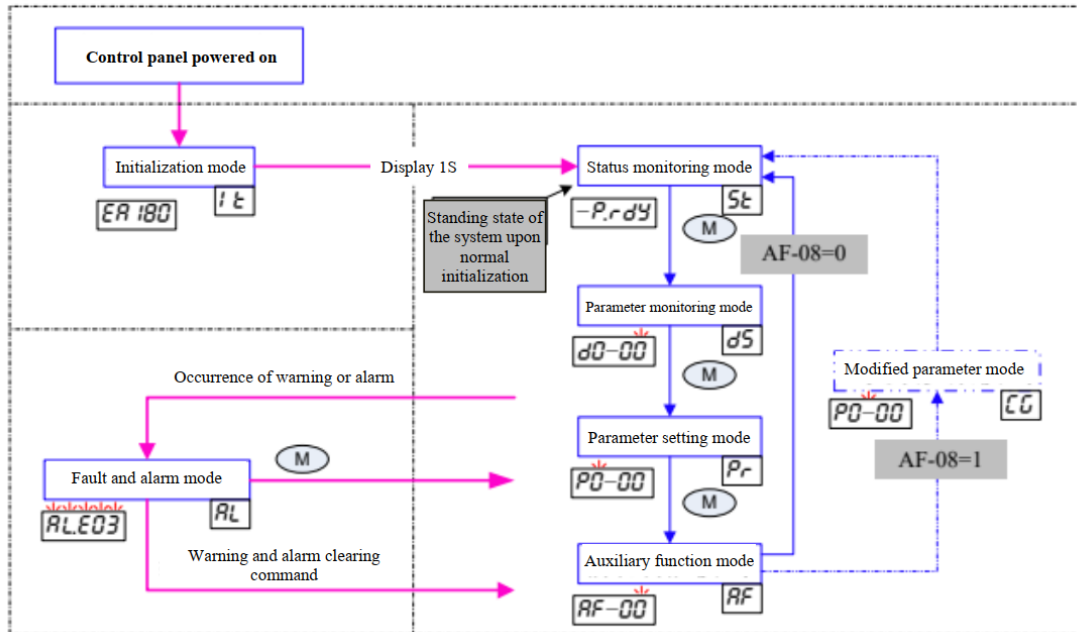
4.3 Initialization mode `I t`

When the driver control panel (L1C and L2C) is initially powered on or reset by using software AF-00, the system will enter the initialization mode and display `EA 180`; 1s later, it will automatically enter the status monitoring mode.

4.4 Status monitoring mode `St`

The system will automatically enter the status monitoring mode 1s after normal initialization:
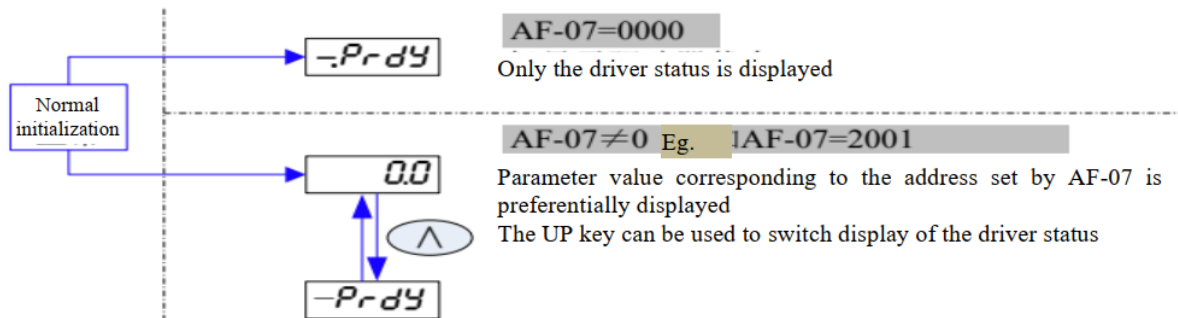
The following figure shows display of the driver LED in the status monitoring mode

LED4 LED3 LED2 LED1 LED0
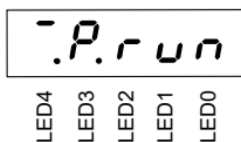
The LED2 to LED0 display drivers have the following five working modes:

ndY	The current driver is not ready (please check the control circuit/drive circuit bus voltage, presence of any warning, and so on)
rdY	The current driver is ready and can be activated
run	The current driver is in the activated state
Poo	The current driver is homing
PAL	The current driver has a warning or alarm

LED3 displays the control mode of the current servo driver, and the decimal point shows whether the brake unit is in the discharge status.

P	The servo is in the position control mode, and the brake unit is not working	P.	The servo is in the position control mode, and the brake unit is discharging
S	The servo is in the speed control mode, and the brake unit is not working	S.	The servo is in the speed control mode, and the brake unit is discharging
t	The servo is in the torque control mode, and the brake unit is not working	t.	The servo is in the torque control mode, and the brake unit is discharging

LED4 displays the current rotating direction of the motor, and the decimal point shows the status of the holding brake terminal (BK)

	The motor rotates reversely, and output of the BK terminal is valid		The motor rotates reversely, and output of the BK terminal is invalid
	The motor has zero speed, and output of the BK terminal is valid		The motor has zero speed, and output of the BK terminal is invalid
	The motor rotates forward, and output of the BK terminal is valid		The motor rotates forward, and output of the BK terminal is invalid

For example: An LED monitor is interpreted as shown in the following figure:

Motor forward rotation

Currently working in the position mode

The servo is in the activated and normal running state

Output of the brake control terminal is valid

The braking unit is discharging
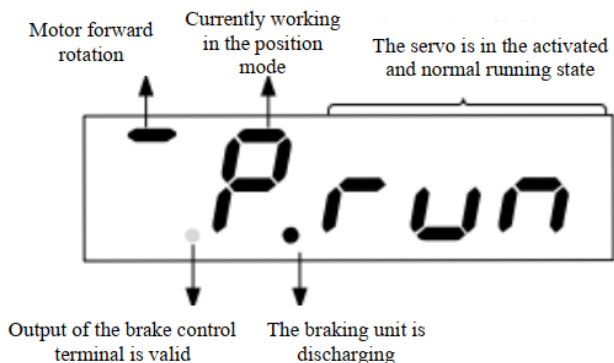
Caution☞
1: AF-07 parameter is hexadecimal. For example, the communication address of d0-01 is 2001H; when input by using the keyboard, it is simply required to enter 2001; when written via communication, it is required to write 2001H.

2: AF-07 cannot be set to an address that does not exist; otherwise unknown content may be displayed.

3: If it is currently not activated, LED3 will display the position control mode; once activated, the actual operation control mode will be displayed.

4: In speed mode, LED3 should display S. However, if the speed is zero and zero position fixation is enabled for zero speed commands, LED3 will toggle to position display mode P.

4.5 Parameter monitoring mode $\boxed{d5}$

After normal initialization, the system will automatically enter the status monitoring mode; press $\boxed{M}$ for once to switch to the parameter monitoring mode.

The following figure shows operation of the keyboard in parameter monitoring mode to view partial information of previous warning (d0-12~d0-14 and d0-16).
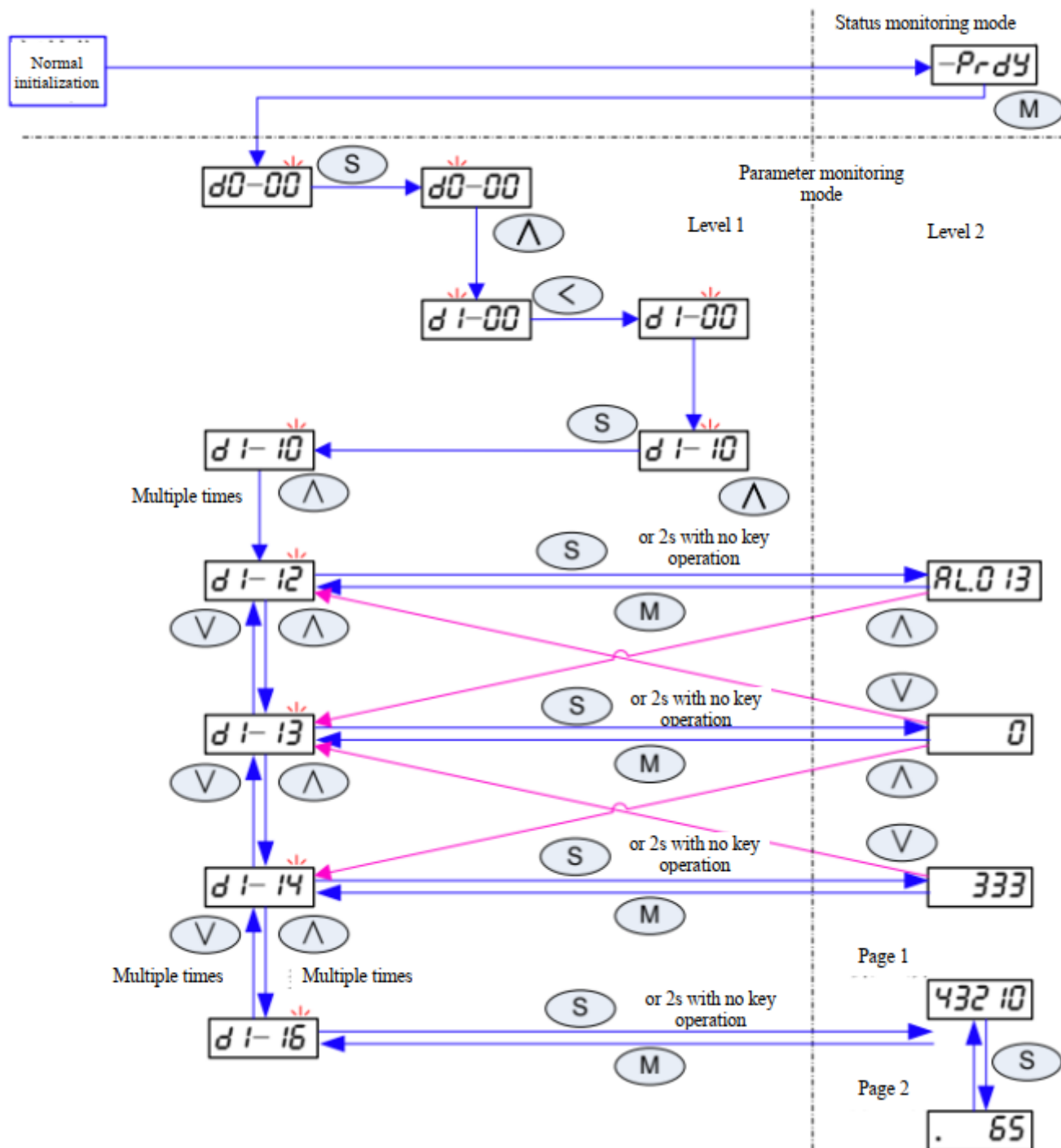
- Upon selection of monitoring parameter dx-yz, please select a group number (x) first, and then select a number in the group (in case of yz, z can be carried over to y).

- The shift key $\boxed{S}$ controls rightward cyclical movement of the cursor on the first level interface in this mode; the position change follows the rule below: LED0 (initial position)→LED3→LED1→LED0…, and it also controls alternative display of data on page 1 and page 2 on the second level interface in this mode.

- The monitored parameter values can be more efficiently viewed; in this mode, if the screen currently shows the second level interface, the $\boxed{\wedge}$ key can be used to directly switch to the first interface of the next parameter (equivalent to pressing $\boxed{M}+\boxed{\wedge}$ +); the $\boxed{\vee}$ key can be used to directly switch to the first interface of the previous parameter (equivalent to pressing $\boxed{M}+\boxed{\vee}$ +);

- In this mode, when the first level interface is displayed, it can be directly switched to the second level interface for display by pressing the $\boxed{S}$ key. Otherwise they system will automatically enter the second level interface if no key operation occurs within 2s or a longer time.

4.6 Parameter setting mode $\boxed{Pr}$

After normal initialization, the system enters the status monitoring mode; press the ⓜ key for twice to switch to the parameter setting mode. For demonstrative purpose, set P1-01=2 and Pb-01=1; then return to parameters of P1 group.
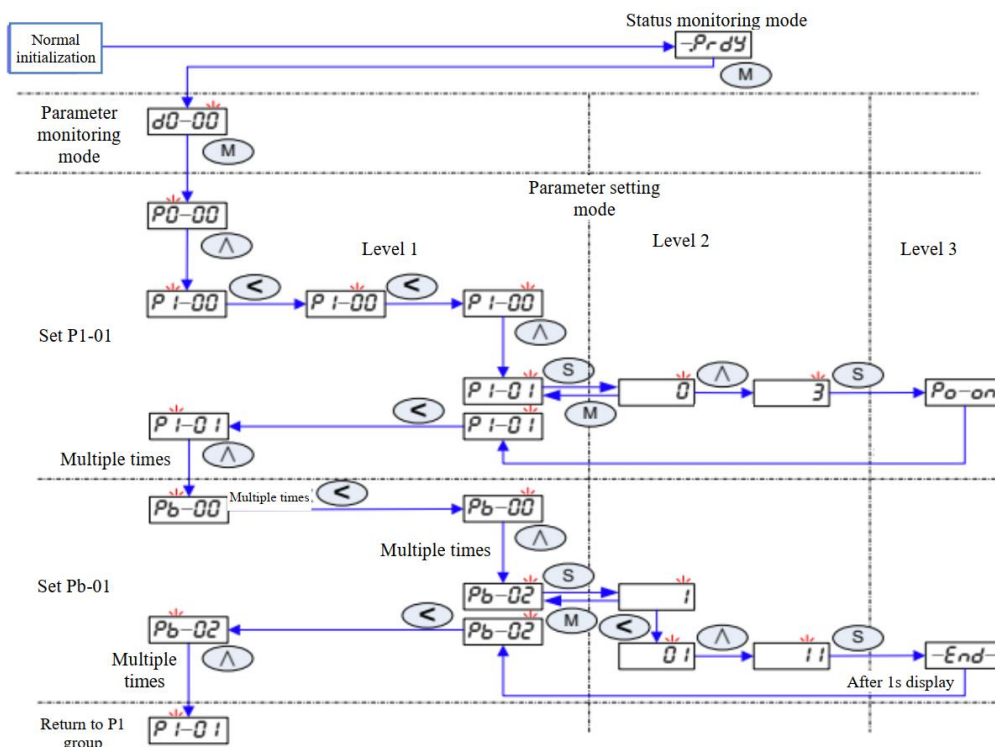
- Upon selection of setting parameter Px-yz, please select a group number (x) first, and then select a number in the group (in case of yz, z can be carried over to y). During selection of a group, the system will automatically call a number in the last group of the previous operation (if it returns to P1 group again, P1-01 will be directly displayed).

- The shift key ⓒ in this mode controls rightward cyclical movement of the cursor on the first level interface; the position change follows the rule below: LED3 (initial position) →LED1→LED0→LED3…; in this mode, the cursor moves cyclically rightwards under control on the second level interface, and the position change follows the rule below: LED0 (initial position) →LED1→LED2→LED3→LED4→ (second page LED0→ second page LED1→second page LED2→second page LED3→second page LED4) →LED0→LED1… The leftmost position of the cursor is determined by the number of bits displayed of the current parameter;

- When the system enters the parameter setting mode from any other mode, the cursor is on LED3 in default;

  On the second level of this mode, press ⓜ or Ⓢ to enter the first level; the cursor is on LED0 in default;

- When the system enters the second level interface of a parameter, it will automatically cache and display the current value; at this time, if the value is changed by other means (such as communication), the display will not be automatically refreshed;

  If after a parameter is modified by using the keyboard the ⓜ key is pressed, the system will return to the first level and the parameter value will remain unchanged;

  If after a parameter is modified by using the keyboard the Ⓢ key is pressed to confirm the current setting, the system will display the third level and 1s later automatically return to the first level, while the parameter is updated to the changed value.

- Set a parameter and press the Ⓢ key; whether the current parameter will immediately take effect and what the third level interface will display are associated with attributes of the parameter

Parameter attribute	Ⓢ Display after the key is pressed	Description of taking effect
○	-End-	Setting can be performed at any time and will take immediate effect
●	Po-on	After change, the value differs from that before the change: Setting can be performed at any time and will take effect when the system is powered on again
	-End-	After change, the value remains the same with that before the change: The initial value is always valid
☆	HALt	After change, the value differs from that before the change: Setting can be performed at any time, and will take effect upon the lapse of 1s after the motor becomes static
	-End-	After change, the value remains the same with that before the change: The initial value is always valid
▲		Read-only parameter that cannot be set

4.7 Modified parameter mode [ƐƓ]

Each time after the control panel is powered on, the modified parameter mode is hidden in default; it is required to set AF-08=1 and switch to this mode by pressing the (M) key.

Two circumstances are described below:

- There is no function code differing from corresponding factory setting: When the system enters the modified parameter mode, the LED displays [nuLL].

- The following function codes (P1-00/P1-02/P9-08/P9-13/P9-14) differ from corresponding factory settings:

A. To reflect difference from normal function display, a flashing LED2 symbol "-" is used in this mode for distinction;

B. Search forward/backward to find the modified function code by pressing the (∧) or (∨) key;

C. To efficiently view modified parameters in this mode, if the screen currently shows the second level interface, the (∧) key can be pressed to directly switch to the first level interface of the next parameter (equivalent to pressing + (M)+(∧)); the (∨) key can be directly pressed to switch to the first level interface of the previous parameter (equivalent to pressing (M)+(∨));

D. The second level interface simply allows viewing the current modified value and does not support parameter modification.
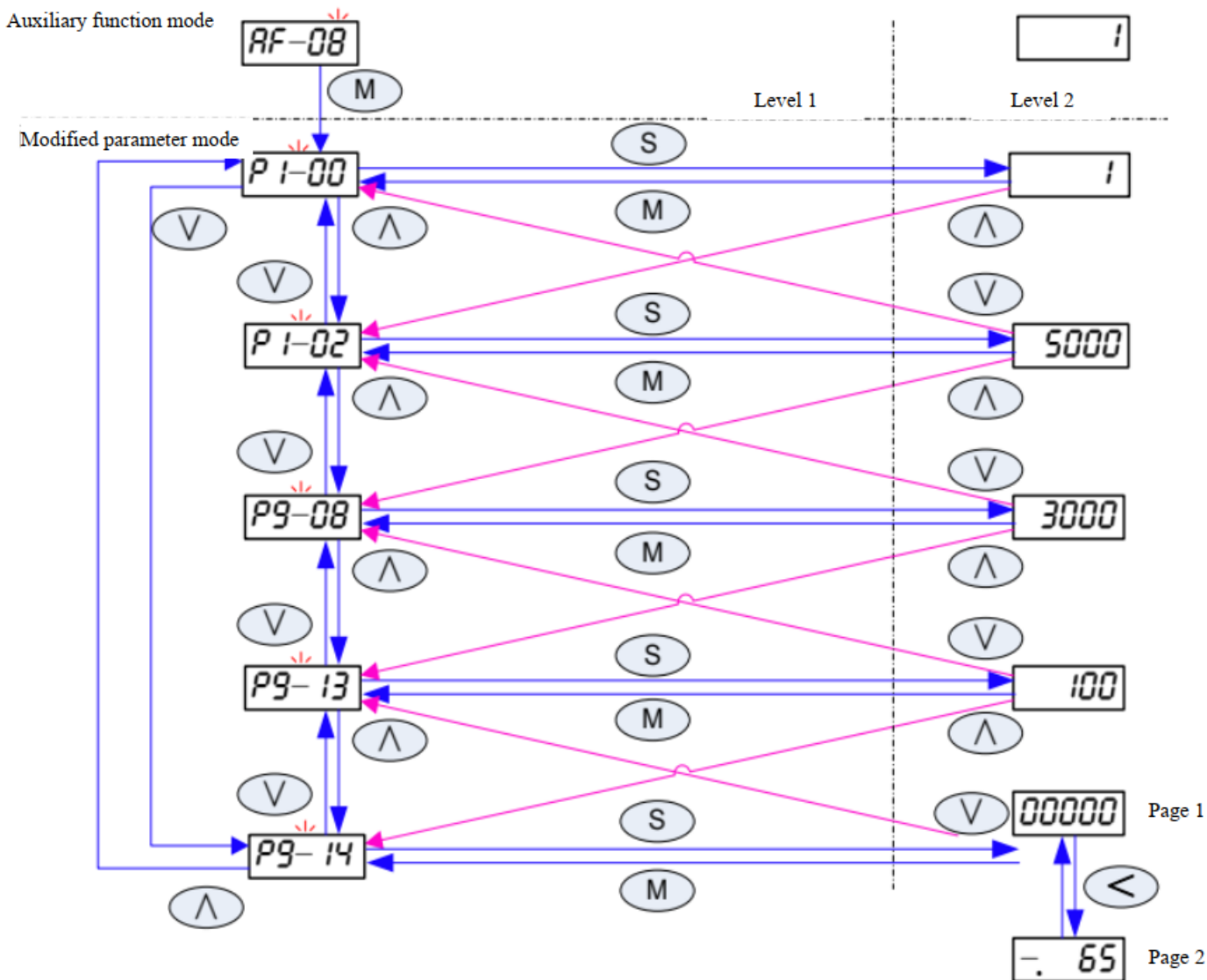
4.8 Warning and alarm mode [Al]

In any mode, the system will directly enter the warning or alarm mode once a warning or alarm occurs. At this time, the user may press the

(M) key to temporarily switch the system to the normal operation mode (the lower right dot of LED0 flashes for distinction); yet the system will still go back to the warning or alarm mode if no key operation occurs within 10s.
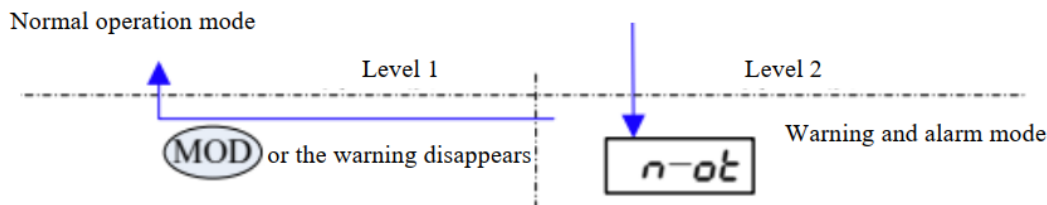
The figure above shows the keyboard operation when a warning is present; in the warning mode, only the warning sign (n⁻ot) is displayed. After elimination of the warning, the system automatically restores the normal operation mode.
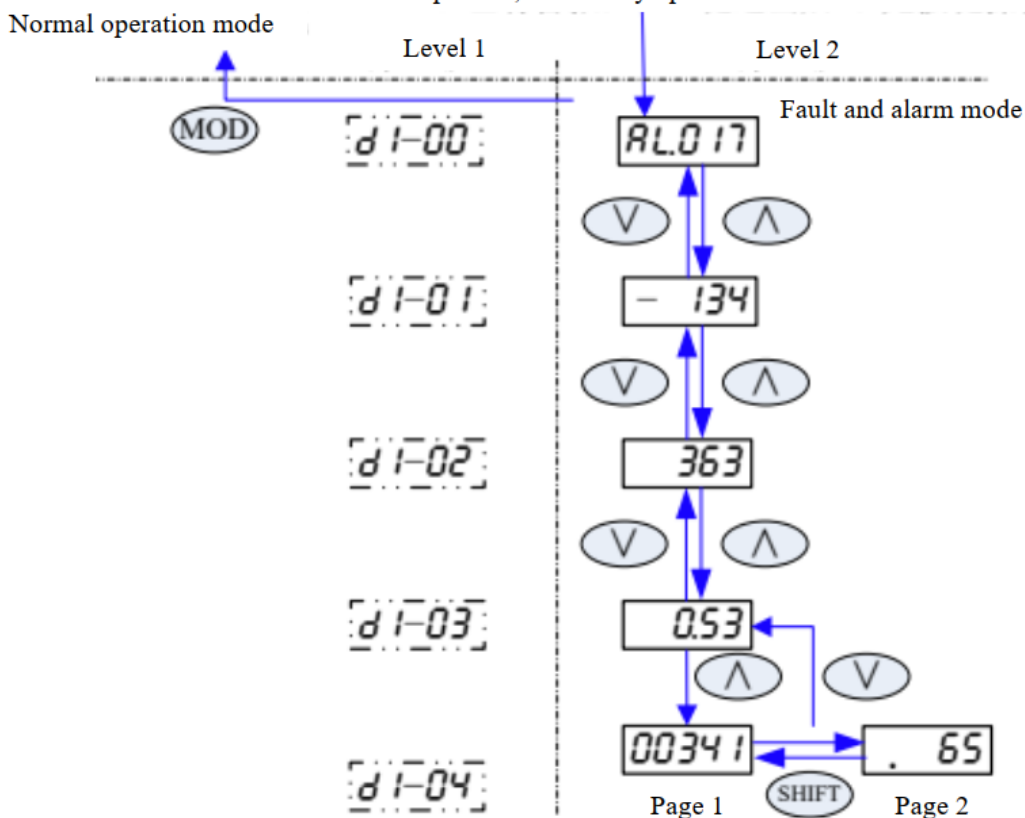
The figure above shows the keyboard operation when an alarm is present; in the warning and alarm modes, the (∧) or (∨) keys can be used to switch the modes for viewing alarm messages (alarm code AL. 017, motor speed upon occurrence of an alarm -134rpm, bus voltage 363V, motor current 0.53A, cumulative running time 6500341min).

Upon occurrence of an alarm, it is required to clear the alarm source first; only when the alarm is reset or the control power is switched on will the system exit from the warning or alarm mode.

Example of display	Content
AL.0nn	When the driver gives an alarm, the panel will display the alarm symbol "AL.0" and the alarm number "nn".
AL.Enn	When the driver gives a warning, the panel will display the warning symbol "AL.E" and the warning code "nn". *: For forward overrun and reverse overrun, characters " -POt⁻" "-nOt⁻" are directly displayed.

Note: For specific warning and alarm information, refer to the warning and alarm handling section

4.9 Auxiliary function mode [AF]

After normal initialization, the system will automatically enter the status monitoring mode; press [M] for three times to switch to the auxiliary function mode.

Operation of the AF-03 (internal S-ON) auxiliary function is described below for demonstrative purpose. Other functions operate in the same way, but only with different display levels and representations.
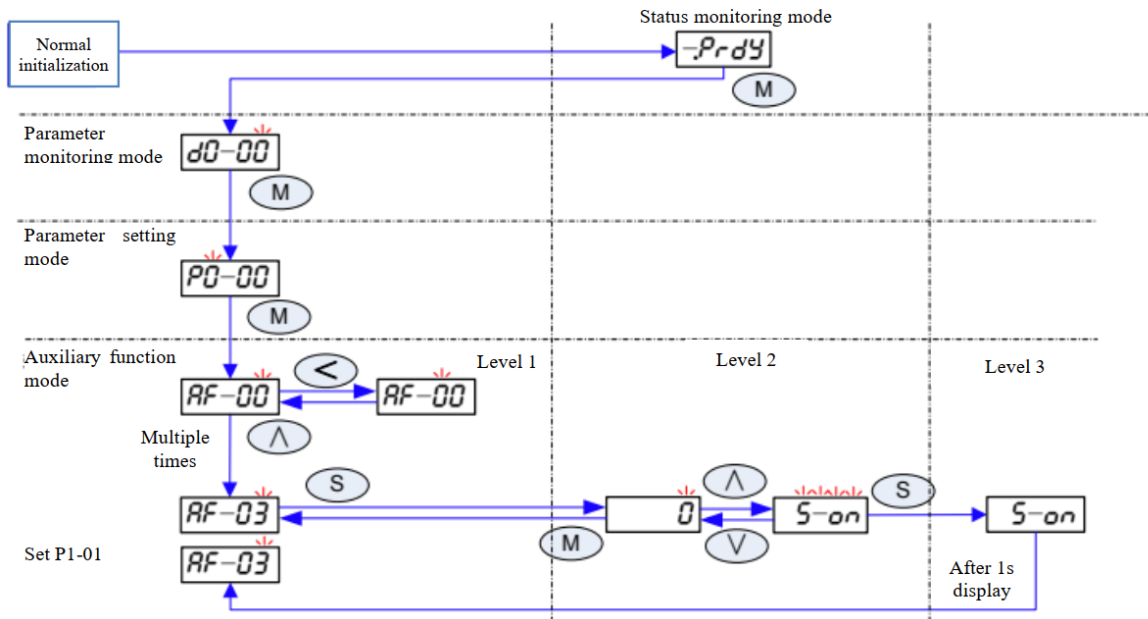
- Upon selection of the auxiliary function AF-yz, the user may, considering the few parameters of the group, directly press [∧] or [∨] for selection when the cursor flashes at place z; and z will automatically carry over to or borrow from y. Alternatively, the [<] key can be used to move the cursor for respective setting;

- The shift key [<] in this mode controls the cursor to cyclically move between places z and y on the first level interface;

- When the system enters the second level interface of a parameter, it will automatically cache and display the current value; at this time, if the value is changed by other means (such as communication), the display will not be automatically refreshed. If after a parameter is modified by using the keyboard, the [M] key is pressed, the system will return to the first level and the parameter value will remain unchanged;

- If after a parameter is modified by using the keyboard the [S] key is pressed to confirm the current operation, the system will display the third level and 1s later automatically return to the first level.

> An auxiliary function is a parameter set for executing specific functional operation; the keyboard does not display values in the internal register.
>
> **Important:** When the keyboard is used, symbols displayed shall be observed. When communication is relied on for operation, it is required to write the register value to corresponding address. If the register value is "-", it suggests that the operation cannot be performed by means of communication.

4.10 Operation of auxiliary function

AF-00	**Reset by software**		Data size	16bit	Communication address	3F00H
			Register value storage	Automatic zeroing upon completion		
	Register value	Keyboard display	Operation			
	0	`0`	Press the [S] key to display `-End-`, without any operation			
	1	`rESEt`	Press the [S] key for resetting by software (equivalent to switching on the control power)			

AF-01	**Alarm reset**		Data size	16bit	Communication address	3F01H
			Register value storage	Automatic zeroing upon completion		
	Register value	Keyboard display	Operation			
	0	`0`	Press the [S] key to display `-End-`, without any operation			
	1	`AL.CLr`	Press the [S] key to execute an alarm resetting operation * It must be a resettable alarm and the cause of the current alarm has been eliminated.			

RF-02 **JOG function**			Data size	16bit	Communication address	3F02H
			Register value storage	-		
	Register value	Keyboard display	Operation			
	-	$-5JoG$	Press the $\wedge$ key, and the motor runs forward, displaying $-5JoG$; press the $\vee$ key, and the motor runs reversely, displaying $-5JoG$. When no key is pressed, the motor stands still, displaying $-5JoG$ * The jog running speed is determined by P8-00, and the acceleration and deceleration time is determined by P8-01. * Jog running occurs in the $-.Prdy$ (inactivated and ready) state; if a warning occurs during jog running, the system will automatically exit from the mode.			

RF-03 **Internal S_ON command**			Data size	16bit	Communication address	3F03H
			Register value storage	Save		
	Register value	Keyboard display	Operation			
	0	0	Press S to display $-End-$; if there is no other activation input, the driver will enter the OFF state			
	1	$5-on$	If the activation conditions are satisfied, press S to display $5-on$ and the driver will enter the ON state.			

* This parameter will be saved and immediately activated (ON) when the system is powered on next time. If this is not desired, please set the parameter value to 0 before power-off.

RF-04 **FFT test**			Data size	16bit	Communication address	3F04H
			Register value storage	Automatic zeroing upon completion		
	Register value	Keyboard display	Operation			
	0	0	Press the S key to display $-End-$, without any operation			
	1	$EYdFt$	Press S to display $EYdFt$, and use the software identification system of the upper computer to perform speed and band width tests; after the tests, the system will automatically exit, and upload data to the upper computer for analysis and display. * The motor will jitter slightly with sound produced.			

RF-05 **Offline inertia identification**			Data size	16bit	Communication address	3F05H
			Register value storage	Automatic zeroing upon completion		
	Register value	Keyboard display	Operation			
	0	0	Press the S key to display $-End-$, without any operation			
	1	$Ji\ dt$	Press S to display $Ji\ dt$, and start to identify the current system inertia; following successful identification, the system inertia (a multiple relative to the motor inertia) will be automatically saved to P4-10. * Please refer to Section 6.6 for details of inertia identification.			

RF-06 **AI channel self-correction**			Data size	16bit	Communication address	3F06H
			Register value storage	Automatic zeroing upon completion		
	Register	Keyboard	Operation			

	value	display	
	0	`0`	Press the (S) key to display `-End-`, without any operation
	1	`Ai 1`	If AI1 external voltage source is set as 0V (an impossible value in practice), press (S) to display `Ai 1` and carry out zero drift self-learning, upon which the result will be saved into P6-33 automatically.
	2	`Ai 2`	If AI2 external voltage source is set as 0V (an impossible value in practice), press (S) to display `Ai 2` and carry out zero drift self-learning, upon which the result will be saved into P6-34 automatically.

Caution☞

1: Make sure the setting command of the master per se is 0 V (an impossible value in practice) before performing zero drift self-correction.

2: Zero drift self-correction applies only to scenarios where external setting falls in -10 to 10V.

3: If the actual voltage of the AI terminal exceeds ±2 V during correction, the alarm $AL.034$ will be raised.

AF-07	**Default status display upon power-on**		Data size	16bit	Communication address	3F07H
			Register value storage	Storage		
	Register value	Keyboard display	Operation			
	0000H	`0000`	Press (S) to display `-End-`; at this time, the status monitoring mode only displays the driver status			
	2001H (example)	`2001`	Press (S) to display `-End-`; if AF-07 has a non-zero value, the status monitoring mode displays, in default, the function code value corresponding to its communication address (such as d0-01); the (∧) key can be used to switch between the monitored value and the driver status for display. `0.0` ↕ (∧) `-Prdy` Parameter value corresponding to the address set by AF-07 is preferentially displayed. The UP key can be used to switch display of the driver status			

Caution☞
1: AF-07 is displayed in hexadecimal and represents the communication address; if the set address has no corresponding function code, value unknown is displayed.
2: If it is currently not activated, LED3 will display the position mode (P); once it is activated, the actual operation control mode will be displayed

AF-08	**Display of non-default setting**		Data size	16bit	Communication address	3F08H
			Register value storage	Automatic zeroing upon power-on		
	Register value	Keyboard display	Operation			
	0	`0`	Press (S) to display `-End-`, and it displays normally			
	1	`1`	Press (S) to display `-End-`, and then press (M) to enter the modified parameter mode; the difference from normal function code display is that there is "-" flashing in the middle. Press (∧) or (∨) to view modified parameters in sequence; press (S) to view modified values.			

AF-09	**System parameter initialization**		Data size	16bit	Communication address	3F09H
			Register value storage	Automatic zeroing upon power-on		
	Register value	Keyboard display	Operation			
	0	`1`	If AF-09≠65535, press (S) to display `Po-on`, without any operation			
	65535	`65535`	If AF-09=65535, press (S) to display `Po-on`, and restore the factory setting of the function code.			

Caution☞
1: When this function is used, it is required to turn on the control power.
2: This operation will not restore the motor parameters

AF-10	**Display of motor group parameters**		Data size	16bit	Communication address	3F0AH
			Register value storage	Automatic zeroing upon power-on		
	Register value	Keyboard display	Operation			
	0	`0`	Press (S) to display `-End-`, with parameters of the Pd group hidden			
	1	`1`	Press (S) to display `-End-`, with parameters of the Pd group shown			

AF-16	**Absolute type encoder multiple-turn data and alarm processing**		Data size	16bit	Communication address	3F10H
			Register value	Automatic zeroing upon completion		

		storage	
Register value	Keyboard display		Operation
0	⎡ 0 ⎤	Press the (S) key to display ⎡−End−⎤, without any operation	
1	⎡ 1 ⎤	Clear multiple-turn encoder alarm: Press (S) to display ⎡−End−⎤, and execute corresponding operation	
2	⎡ 2 ⎤	Clear multiple-turn data and alarm of multiple-turn encoder: Press (S) to display ⎡−End−⎤, and execute corresponding operation	
Important: This function can only be operated in the inactivated state			

Chapter 5 Commissioning

According to instructions provided in this Manual, the servo motor may not be connected to a load until it runs normally. Generally a driver shall undergo the following tests before being put into service.

1) Wiring and inspection.

2) Driver power-on, parameter adjustment.

3) Operation with no load.

4) Control function debugging.

| It is highly recommended: | Let the servo motor operate normally with no load first and then allow it to operate with load, so as to avoid any potential danger! |

5.1 Driver power-on

5.1.1 Inspection before power-on

1) Check whether the driver matches the motor specification.

2) Make sure wiring of L1, L2, L3 and U, V, W is absolutely correct and tight.

3) U, V, W of the motor must correspond to U, V, W of the driver.

4) Check whether the input voltage is consistent with the voltage indicated on the driver nameplate or panel.

5) Check whether the encoder terminal is well connected.

6) Check whether the servo motor and driver are well grounded.

5.1.2 Power-on time sequence

1) Ensure correct power-on timing sequence with reference to Section 3.3.2.

5.2 Commissioning

5.2.1 Parameter setting for jogging operation

In the Servo OFF state, set the following parameters

Parameter	Item
P8-00	JOG speed setting (commonly the factory setting can be used)
P8-01	JOG acceleration/deceleration time (commonly the factory setting can be used)

5.2.2 Jog operation

Operate following the figure below
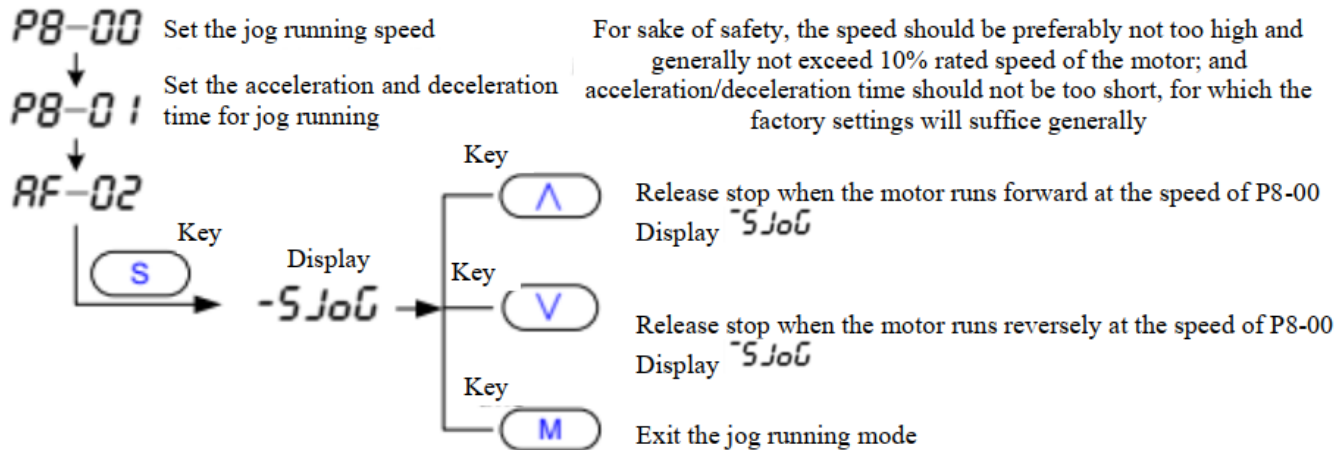
Normal jog running of the motor suggests that wiring and basic functions of the driver and the motor are normal.

If the motor does not rotate or operates abnormally, first check if the system wiring is correct (including UVW phase sequence and contact of the motor control cable) and if the encoder wiring is correct and contact well; then confirm the motor CODE (d2-01) for consistency with the actual motor. If the motor still fails to operate normally after repeating the above procedures, please contact the manufacturer for a solution.

5.3 Servo On method

There are three methods to activate the driver

1) After the driver is powered on, it can be activated by setting the parameter AF-03 to 1 (the keyboard displays 5-on) (if AF-03 setting is not modified, the driver will be immediately activated when it is powered on again).

2) The default input terminal DI1 of the driver is intended for servo activation; setting P6-01=00000001 can reverse the logic of DI1 terminal and activate the servo (if P6-01 setting is not modified, the servo will be immediately activated when it is powered on again).

3) According to the standard wiring method, S_ON command can be given by defining the DI terminal of the S_ON function.

Chapter 6 Adjustment

6.1 Block diagram of position control mode

Pulse string

PULS
SIGN

External pulse input setting
Pulse type — P1-01
High-frequency filtering — P1-15

Command source selection
Command selection — P1-00

Multi-segment position setting
Execution mode — P9-00
Acceleration time — P9-03
Deceleration time — P9-04
Command benchmark — P9-02
Segment setting — P9-06~P9-69

d0-02
Command pulse accumulation (command unit)

Electronic gear
1 revolution
P1-02 1st numerator — P1-04 2nd numerator — P1-08
Denominator — P1-06 3rd numerator — P1-10
4th numerator — P1-12

Gain switching
Switching condition — P4-15
Switching time — P4-16
Switching threshold — P4-18

d0-10
Position deviation (command unit)

Position command speed (rpm)
d0-18

Smooth filtering
Primary delay P — P1-14
FIR — P5-23

Friction compensation
Addition value — P4-32 Viscous friction — P4-31
Forward direction — P4-33 Smooth filtering — P4-30
Reverse direction — P4-34

Speed feedforward
Gain — P4-06
Filter — P4-08

d0-19
Speed command (rpm)

Torque feedforward
Gain — P4-24
Filter — P4-25

Notch filter
Frequency Width Depth
1st P5-02 P5-03 P5-04
2nd P5-05 P5-06 P5-07
3rd P5-08 P5-09 P5-10
4th P5-11 P5-12 P5-13
Self-adaption setting mode P5-00

Position control
1st gain — P4-02
Conversion ratio — P4-19

Speed control
1st gain — P4-03 P4-05
Conversion ratio — P4-20 -
1st inertia ratio — P4-10
Performance expansion — P4-22
2nd inertia ratio — P4-11
PDFF control — P4-12

Torque filtering
Filter — P4-29

Position deviation (encoder unit)
d0-10

Reverse conversion of electronic gear ratio

d0-06
d0-04
Feedback pulse accumulation (command unit)

Speed detection filtering
Filter — P4-08
Observation ending — P4-23
Speed observation — P4-22 bit3

Acceleration feedback
P4-22 bit0

Torque limit
Command source — P0-05
Forward rotation limit — P0-06
Reverse rotation limit — P0-07
External limit — P8-25

Frequency division output
Output per revolution — P0-21
Reverse — P0-22
Z pulse width — P0-23

Pulse output
PA
PB
PZ

Speed detection

d0-00
Motor speed (rpm)

Disturbance observer
Gain — P4-28
Filter — P4-29

d0-01
Motor load rate (%)

Encoder — Motor

Current control
Response setting — Pd-27
Pd-28

Main power

Load

Torque command (%)
d0-20

6.2 Block diagram of speed control mode

6.3 Block diagram of torque control mode

6.4 Gain adjustment introduction

6.4.1 Purpose

For commands given by the upper computer, the driver needs to make the motor work following the commands faithfully without delay. To make the motor act more closely to the command and give a full play to mechanical performance, gain adjustment is necessary.

(For example: screw rod)

	Gain setting: Low		Gain setting: High		Gain setting: High + Feedforward setting	
Position loop gain	20.0 1/s	Position loop gain	60.0 1/s	Position loop gain	60.0 1/s
Speed loop gain	8.0 Hz	Speed loop gain	30.0 Hz	Speed loop gain	30.0 Hz
Speed loop integral time constant	30.0 ms	Speed loop integral time constant	30.0 ms	Speed loop integral time constant	30.0 ms
Speed feedforward gain	0.0 %	Speed feedforward gain	0.0 %	Speed feedforward gain	100.0 %
Inertia ratio	20.0	Inertia ratio	20.0	Inertia ratio	20.0

6.4.1 Gain adjustment type

Adjustment mode	P4-00	Load inertia ratio	Automatically set parameters	Manually set parameters	Generally applicable scenarios
Manual mode	P4-00=0		-	All gain parameters	General
Semi-automatic mode	P4-00=1	Fixed to the P4-10 value	P4-02 P4-03 P4-05 P4-29	P4-01 P4-10	Basically unchanged load inertia
Automatic mode 1	P4-00=2	Automatic determination	P4-10 P4-02 P4-03 P4-05 P4-29	P4-01	Slow load inertia change
Automatic mode 2	P4-00=3				Relatively fast load inertia change
Automatic mode 3	P4-00=4				Fast load inertia change

Caution☞
1 Slow inertia change refers to change of load inertia from the lowest to the highest, which is generally a linear process at the tens of seconds level.
2 Relatively fast inertia change refers to change of load inertia from the lowest to the highest, which is roughly a linear process at the second level.
3 Fast inertia change refers to change of load inertia from the lowest to the highest, which is roughly a linear process at the millions of milliseconds level.
4 For scenarios where load inertia may abruptly change, automatic modes 1, 2 and 3 cannot be used.

6.4.2 Effect of gain adjustments

	Function	Description
Automatic adjustment	Real-time automatic gain adjustment	An appropriate gain is automatically set according to the inertia of mechanical load determined in real time
	Semi-automatic gain adjustment	Inertia of load is measured offline, with an appropriate rigidity value set to automatically generate the gain
	Adaptive filter	In the actual running state, resonance frequency can be deduced through analysis of the motor speed, and the notch filter coefficient can be automatically set; removal of the resonance component from the torque command can reduce vibration at points of resonance
Manual adjustment	Basic steps	Adjustment of the position control mode
		Adjustment of the speed control mode
		Adjustment of the torque control mode
	Gain switching function	Internal data or external signal is used for gain switching, so as to reduce vibration at stop, shorten the setting time and improve the command followability
	Suppression of mechanical resonance	When the mechanical rigidity is low, resonance resulted from shaft twisting and belt extension / contraction may produce vibration or noise, and makes improvement of gain setting impossible; in this case, a notch filter can be used to suppress resonance
	Feedforward function	Upon position control, speed feedforward can improve the responsiveness. Acceleration feedforward can improve the responsiveness of speed control.
	External disturbance suppression function	It functions to suppress change of the motor speed and improve the stability by changing the external disturbance torque and the addition amplitude load change estimation
	Friction torque compensation	This function reduces the impact of mechanical friction, and provides dynamic friction compensation, viscous friction compensation and vertical shaft gravity compensation.

	Inertia ratio switching function	It switches between two inertia ratios corresponding to the 2-stage load change of the actual inertia ratio
	Torque command filter	It can adjust the torque command filtering to reduce vibration.

6.4.3 Steps

```
                          ┌─────────────┐
                          │    Start    │
                          └──────┬──────┘
                                 │
                    ┌────────────────────────┐
                    │ Run against the factory│
                    │        settings        │
                    └────────────┬───────────┘
                                 │
      Yes              ◇ Run OK? ◇
      ┌────────────────                                          Slow change rate
      │                         No
      │                          │
      │              ◇ Load inertia changes ◇ ──Yes──→ ◇ Load inertia change ◇ ──Moderate change rate
      │              ◇ during running?      ◇          ◇    frequency         ◇
      │                          │
   End│                        No                Fast change rate
      │                          │
      │              ┌────────────────────────┐      ┌────────────────────────┐
      │              │ Use of offline inertia │      │  Automatic adjustment  │
      │         ←────│ to identify learning   │←─    │        mode 3          │
      │              │     load inertia       │      │       P4-00=4          │
      │              └────────────┬───────────┘      └────────────────────────┘
      │                           │                  ┌────────────────────────┐
      │                   ◇ Succeeded? ◇ ──No──      │  Automatic adjustment  │
      │                           │                  │        mode 2          │
      │                          Yes                 │       P4-00=3          │
      │              ┌────────────────────────┐      └────────────────────────┘
      │              │    Semi-automatic      │      ┌────────────────────────┐
      │              │   adjustment mode      │      │  Automatic adjustment  │
      │              │       P4-00=1          │      │        mode 1          │
      │              └────────────┬───────────┘      │       P4-00=2          │
      │              ┌────────────────────────┐      └────────────────────────┘
      │              │  Rigidity adjustment   │
      │              │        P4-01           │
      │              └────────────┬───────────┘
      │                           │
   Yes│              ◇ Running normally? ◇
   ┌──                           │               ◇ Adjustment OK? ◇ ──Yes──
   │                            No                         │
   │              ┌────────────────────────┐              No
   │              │  Manual gain adjustment │      ┌────────────────────────┐
   │         ←────│        P4-00=0          │      │  Adjust rigidity P4-01 │
   │              └────────────┬───────────┘      └────────────────────────┘
   │                           │            No                 │        Yes
   │                           │               ◇ Adjustment OK? ◇ ──────
   │              ┌─────────────────────────┐
   └─────────────→│          End            │←──────────────
                  └─────────────────────────┘
```

6.5 Real-time automatic gain adjustment

6.5.1 Overview

The driver detects the real-time mechanical load inertia during operation, and automatically adjusts the basic gain value based on the detection results in combination with the set rigidity. There are 3 options, applicable to load of different characteristics

6.5.2 Scope of application

Real-time automatic gain adjustment applies to the position control mode and the speed control mode.

6.5.3 Operation methods

1) Servo activation OFF

2) P4-00 is set to 2~4; the factory setting is 1

Settings	Real-time automatic adjustment
2	Applicable to scenarios with a slow load inertia change rate (at tens of seconds level)
3	Applicable to scenarios with a moderate load inertia change rate (at seconds level)
4	Applicable to scenarios with a fast load inertia change rate (at millions of milliseconds level)

3) Set P4-01 to a low value

4) Properly set the position deviation counter clearing, command input disable, torque limit and other parameters, allowing the motor to rotate normally without obstacle.

5) The servo activation ON, and drive the machine to operate normally.

6) The driver starts to detect load inertia characteristic.

7) Increase the set value of P4-01 (rigidity) to improve machine responsiveness.

8) Observe the positioning time or vibration status, and change to an appropriate value.

6.5.4 Precautions

Real-time automatic gain adjustment may be unavailable in the following conditions. Please change the load condition, or use the semi-automatic gain adjustment/manual gain adjustment (P4-00=1, 0)

	Conditions affecting real-time automatic gain adjustment
Load inertia	• When the total load inertia is less than twice or more than twenty times that of the motor rotor
Load	• When the mechanical rigidity is extremely low. • When nonlinear characteristics such as back clearance exists.
Motion model	• When used at the speed of less than 100rpm and continuously at a low speed • When in the steady state with the acceleration/deceleration of less than 2,000rpm/s. • When the acceleration / deceleration torque is smaller than the eccentric loading and viscous friction torques. • When the speed is above 100rpm, the acceleration/deceleration is above 2,000rmp/s and the duration is no longer than 50ms.

➢ After power-on and initial servo activation ON or increase of the P4-01 rigidity value, and before stable load characteristic is detected, abnormal noise or oscillation may occur; this is normal if stability can be soon achieved. If abnormal noise still persists after repetition of continued oscillation or action for 3 times, the following measures shall be taken:
   ◆ Reduce the set value of P4-01.
   ◆ Set P4-00 to 1 or 0 to deactivate real-time automatic adjustment
➢ Upon occurrence of abnormal noise or oscillation, the value of P4-10 (inertia ratio) may become extreme; at this time, please set P4-10 to the automatically calculated inertia ratio.
➢ In results of the automatic gain adjustment, P4-10 is written to EEPROM once every 30 minutes. When power is connected again, this data will be used as the initial value for automatic adjustment.
➢ The gain is updated upon stop. When the motor is still running, even if the value of P4-01 is modified the change will not take effect.
➢ The following functions are inactive upon use of real-time automatic gain adjustment:
   ■ Acceleration feedback
   ■ Disturbance observer
   ■ Speed observer
   ■ Torque feedforward
   ■ Gain switching
   ■ Offline inertia identification

6.6 Offline inertia identification

6.6.1 Overview

The load inertia ratio will be directly involved in calculation of speed loop gain, and feedforward functions are preconditioned by a correct load inertia ratio. For this reason, before use of the semi-automatic gain adjustment and manual gain adjustment, if conditions are satisfied, it is strongly recommended to use offline inertia identification to obtain a correct load inertia ratio.

6.6.2 Conditions for valid offline inertia identification

➢ The maximum actual motor speed is 150rpm;
➢ The acceleration upon actual acceleration/deceleration is above 2,000rpm/s;
➢ The load torque ratio is stable without any sharp change;
➢ The load inertia does not exceed 120 times that of the motor rotor;
➢ No extremely low mechanical rigidity or large back clearance of transmission mechanism exists.

6.6.3 Steps of offline inertia identification
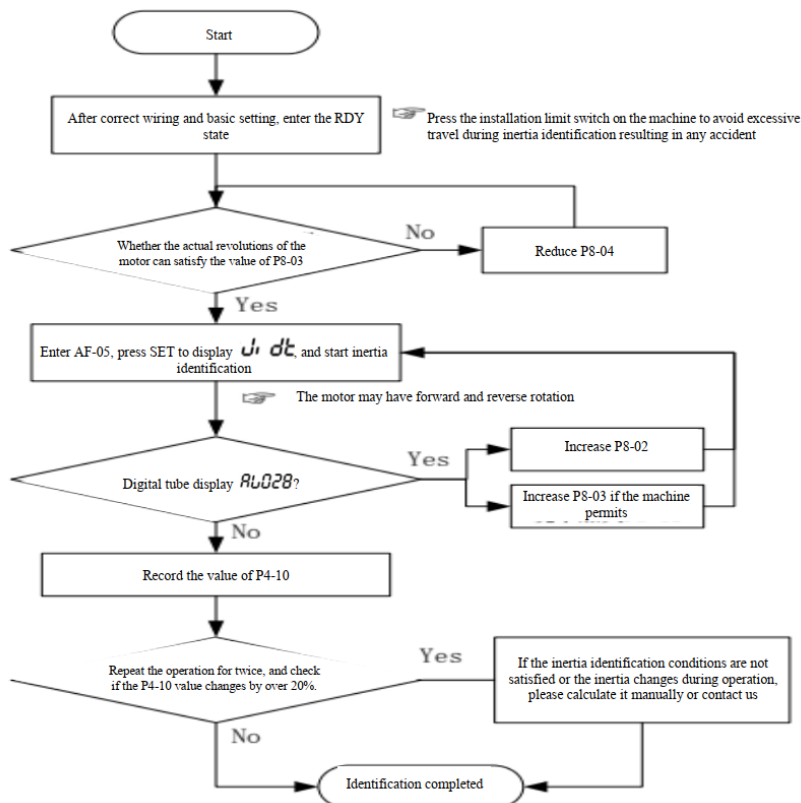
6.7 Semi-automatic gain adjustment

6.7.1 Overview

After the actual load inertia ratio is obtained, select an appropriate rigidity value based on actual conditions of the machine; the driver will automatically set the basic gain value based on the load inertia ratio P4-10 and rigidity P4-01.

6.7.2 Scope of application

Scenarios with basically little or no load inertia change.

6.7.3 Operation methods

1) Servo activation OFF

2) Set P4-00 to 1

3) Servo activation ON (no command input is allowed)

4) Properly set the position deviation counter clearing, command input disable, torque limit and other parameters, allowing the motor to rotate normally without obstacle.

5) Verify consistency of the P4-10 value with the actual conditions of the machine, or perform offline inertia identification first.

6) Set the rigidity value P4-01 based on conditions of the machine (please set it to a relatively low value ranging between 1~4); the following parameters will be automatically set.

P4-02 position loop gain

P4-03 speed loop gain

P4-05 Speed loop integral time constant

P4-29 Torque command low-pass smoothing constant

7) Increase the set value of P4-01 to improve machine responsiveness.

Observe the positioning time or vibration status, and gradually adjust it to an appropriate value.

6.8 Rigidity adjustment coefficient

When real-time automatic gain adjustment or semi-automatic gain adjustment is used for a mechanical system with poor responsiveness (relatively low mechanical rigidity), and setting a high rigidity value (P4-01) for the driver may cause vibration and abnormal noise, it is required to set the P4-01 to a low value. If a rigidity adjustment coefficient is used, when the rigidity is low, the user may apply a forced increase of the speed loop gain to improve the responsiveness of the whole mechanical system, but this may result in greater vibration.

➤ Associated parameter

Function code	Parameter name	Function
P4-13	Rigidity adjustment coefficient	When P4-00≠0, apply a forced adjustment of the speed loop gain. $$Speed\ loop\ gain = \frac{P4\text{-}03}{P4\text{-}13}$$

6.9 Suppression of mechanical resonance

When the mechanical rigidity is low, resonance resulted from shaft twisting and belt extension/contraction may produce vibration or noise; the gain setting may not be raised. In this case, a notch filter can be used to suppress points of resonance, so that a higher gain can be set or vibration can be reduced.

6.9.1 Block diagram of EA350 resonance suppression function
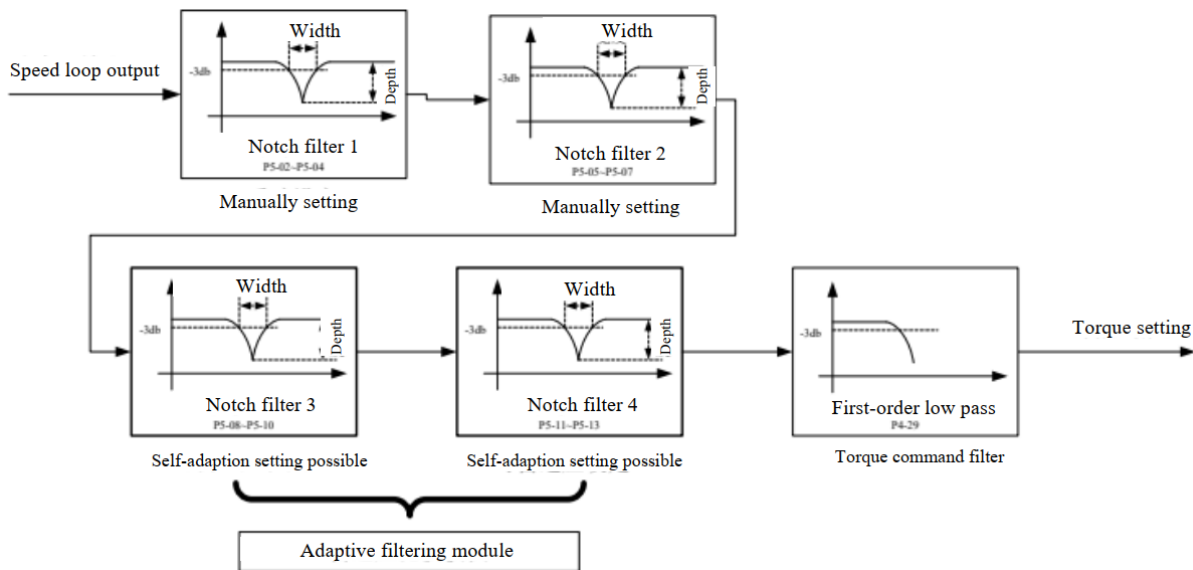
6.9.2 Torque command filter (P4-29)

➢ Set the filter time constant for gain attenuation upon approaching the resonance frequency.

➢ The cut-off frequency of the torque command filter can be calculated by using the formula below:

$$\text{Cutoff frequency (Hz)} = \frac{\text{P4-03}}{2\pi \times \text{setting value of parameter} \times 0.00001}$$

6.9.3 Notch filter

➢ The EA350 servo driver has 4 notch filters, whose frequency, width and depth can be manually adjusted. The automatic mode is provided for the 3rd and 4th notch filter.

➢ Set P5-00 to 1, enter the motion command. When the resonance point affects the motor speed, the center frequency and notch depth parameters of the 3rd and the 4th notch filters can be automatically set.

➢ If no resonance point is detected but vibration is present, the P05-01 value (automatic vibration detection accuracy and sensitivity) can be properly reduced in hope to find vibration points of smaller amplitudes.
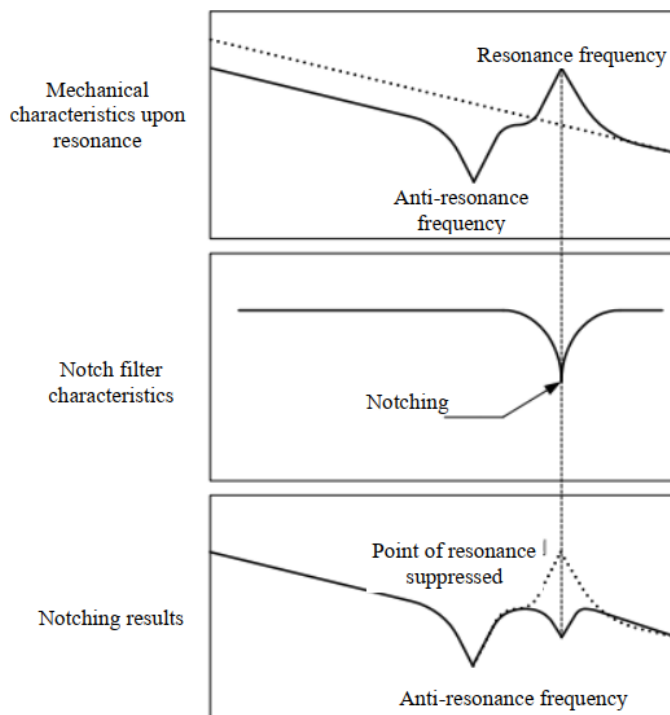
➢ About the notching width and depth

The notching center frequency when the notch filter width/depth is 0 and the ratio of frequency and bandwidth at the attenuation rate of -3dB are shown in the left table below.

The notch filter depth represents input of the center frequency at full cut-off when the set value is 0, or the output/input ratio at full pass when the set value is 100. When represented in dB, numerical values in the right table below can be obtained.

Notching width	Bandwidth/center frequency
0	0.1
1	0.59
2	0.71
3	0.84
4	1.0
5	1.19
6	1.41
7	1.68
8	2.0
9	2.38
10	2.83
11	3.36
12	4.0
13	4.76
14	5.66
15	6.73
16	8.0
17	9.51
18	11.31
19	13.45
20	16.0

Notching depth	Output/input ratio	dB
0	0	$-\infty$
1	0.01	-40
2	0.02	-34
3	0.03	-30.5
4	0.04	-28
5	0.05	-26
6	0.06	-24.4
7	0.07	-23.1
8	0.08	-21.9
9	0.09	-20.9
10	0.1	-20
15	0.15	-16.5
20	0.2	-14
25	0.25	-12
30	0.3	-10.5
35	0.35	-9.1
40	0.4	-8
45	0.45	-6.9
50	0.5	-6
60	0.6	-4.4
70	0.7	-3.1
80	0.8	-1.9
90	0.9	-0.9
100	1	0

For the notch filter width, the factory setting (2) is generally used

➢ Correspondence between notching width and depth

Depth 50, width 4
Depth 0, width 4
Depth 0, width 8
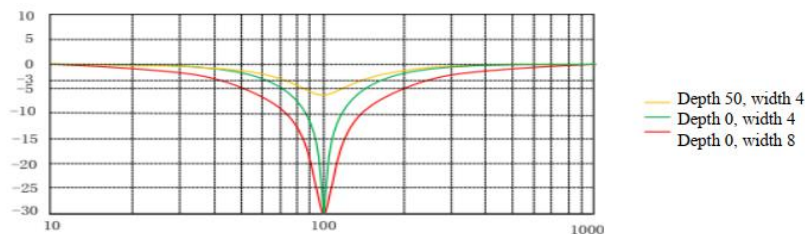
➢ Precautions for use of the notch filter

■ The notch filter cannot be used in the torque control mode.

■ When the notching frequency is set to 5,000, the notch filer is inactive.

■ For setting the first and the second notch filters, the user may first use the automatic mode to obtain the third and the fourth notch filter, and then copy their parameters.

■ Though there are 4 notch filters, it is recommended that no more than 2 notch filters be used simultaneously; otherwise vibration may be aggravated.

■ When adaptive notch filters are used, if vibration cannot be eliminated in a long time, please timely turn off the driver activation function.

➢ Relation between gain adjustment and mechanical rigidity

To improve the mechanical rigidity

■ The machine shall be firmly fixed onto the foundation to avoid shaking.

■ Highly rigid couplers shall be used.

■ Broad synchronous belts shall be used and tension of the synchronous belts shall be set within the allowable axial load range of the motor.

■ Special reduction gears for servo or gears with small clearances shall be used. Low mechanical rigidity represents low inherent vibration (resonance frequency).

■ Low mechanical rigidity will largely affect gain adjustment of the servo; for a machine of low rigidity, the servo responsiveness shall not be set too high (high gain).

Caution☞	**Not all vibration is caused by mechanical resonance. Adjustment of servo gain to its limit may also cause vibration. In this case, improvement can only be made by reducing the gain or shortening the torque command filtering time.**

6.10 Manual gain adjustment (basic)

The EA350 series servo has an automatic gain adjustment function; yet due to restriction by load condition, automatic gain adjustment may be unable to meet requirements; to achieve the highest responsiveness and stability through coordination between the servo system and the machine, it is recommended to use manual gain adjustment.

6.10.1 Adjustment of the position control mode

For the position control mode of EA350 series, refer to the block diagram of position control mode in Section 6.1.

Adjustment of the position control mode shall follow the order below.

1) Activate the driver.

2) Set P4-00 to 0

3) For all gain parameters, default values are used

4) Enter the P4-10 load inertia ratio. It can be identified by the driver through the AF-05 function (with restrictions), or manually calculated

5) Values in the table below are used as reference for adjustment.

Order	Parameter	Parameter name	Reference value	Adjustment method
1	P4-03	Speed loop gain	18.0	Increase within a range where no abnormal noise or vibration occurs. Decrease when abnormal noise is produced.
2	P4-31	Torque command filter	1.26	To suppress vibration after stop, increase P4-03 and reduce P4-31. If excessive vibration occurs at the instant of stop, try to reduce P4-31
3	P4-02	Position loop gain	32.0	Observe the positioning time; increase the set value, and positioning is expedited. A significant change may cause vibration.
4	P4-05	Speed loop integral time constant	31.0	No adjustment is needed if the operation is normal. When the value is reduced, the positioning time is shortened; if it is shortened too much, vibration will occur. If the value is too high, the position deviation may diverge. Increase within a range where no abnormal action or noise occurs
5	P4-06	Speed feedforward gain	30.0	When the feedforward amount is set too high, occurrence of overshooting and jitter of the positioning completion signal may make reduction of the setting time impossible. When the command pulse input is non-uniform, improvement can be made by increase the set value of P4-07.

6.10.2 Adjustment of the speed control mode

For the speed control mode of EA350 series, refer to the block diagram of speed control mode in Section 6.2.

Adjustment of the speed control mode is similar to adjustment of the position control mode. The only difference is that no adjustment of the position loop gain P4-02 and the speed feedforward gain P4-06 is required.

6.10.3 Adjustment of the torque control mode

For the torque control mode of EA350 series, refer to the block diagram of torque control mode in Section 6.3.

The essence of torque control is to control the torque based on speed control. For this reason, it is mainly required to set the torque limit and the speed limit.

➤ Upon torque control, the reverse direction refers to the rotating direction of the motor and the opposite direction of the torque command. This circumstance may occur when traction is applied in the reverse direction by an external device. In this circumstance, the motor is in the continuous power generation state and the drive will give an $AL.017$ alarm. It is required to provide a proper external braking resistor, and correctly set the P8-10, P8-11 and P8-13 according to parameters of the braking resistor.

➤ The speed limit is only valid in the torque command direction; when the motor is reversely dragged by an external device, the driver only controls the output torque of the control motor, while the motor speed is determined by the external device.

➤ When the motor speed reaches the limit in the torque command direction, the driver will switch from the torque command-based torque control to speed control with speed limit as the command.

➤ To ensure stable operation at the speed limit, it is required to set the speed loop parameter according to adjustment of the speed control mode.

➤ When the speed limit is too low, the speed loop gain is too low or the speed loop integral time constant is 3000.0 (integral invalid), if the input of torque limit reduces, torque output following a command may fail sometimes.

➤ Upon torque control, the following functions are invalid:
- Acceleration feedback
- Disturbance observer
- Speed observer
- Torque feedforward
- Online inertia identification
- Gain switching
- Adaptive filter
- Friction compensation
- Notch filter

6.10.4 Gain switching

Upon gain switching according to internal data or external data, the following results can be realized:
- Reducing the gain upon stop (servo locking) to suppress vibration.

- Increasing the gain upon stop (upon setting) to shorten the setting time.
- Increasing the gain upon action to improve the command followability.
- Switching according to external DI signal for mechanical status.
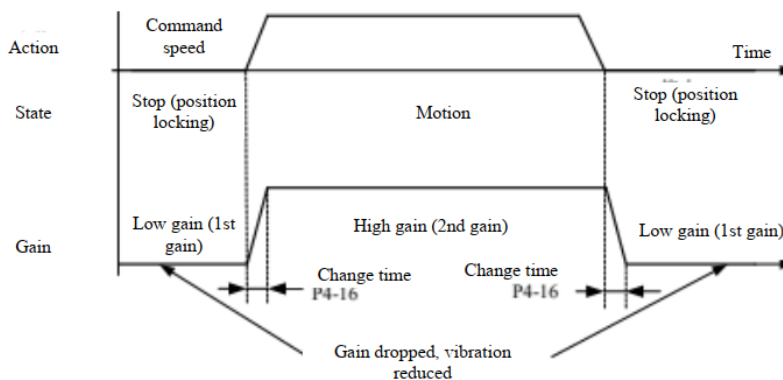
> ➢ Gain switching condition

P4-15		Switching condition	Gain switching mode
bit1	bit0		
0	0	Fix the 1st gain	Always use the 1st gain
	1	DI terminal input	When the gain switching terminal (GAIN_SEL) is active, it is the 2nd gain When the gain switching terminal (GAIN_SEL) is inactive, it is the 1st gain *If no terminal is defined as GAIN_SEL, it is fixed as the 1st gain
	2	Position deviation high	When it is currently at the 1st gain and the absolute value of the position deviation exceeds P4_18+lagging, shift to the 2nd gain. When it is currently at the 2nd gain and the absolute value of the position deviation exceeds P4_18-lagging, go back to the 1st gain. * The lagging value of position deviation is 100 pulse command units
	3	Speed command high	When it is currently at the 1st gain and the absolute value of the speed command exceeds P4_18+lagging, shift to the 2nd gain. When it is currently at the 2nd gain and the absolute value of the speed command exceeds P4_18-lagging, go back to the 1st gain. * The lagging value of speed command is 10rpm
	4	Actual speed high	When it is currently at the 1st gain and the absolute value of the motor speed exceeds P4_18+lagging, shift to the 2nd gain. When it is currently at the 2nd gain and the absolute value of the motor speed exceeds P4_18-lagging, go back to the 1st gain. * The lagging value of motor speed is 10rpm
1	0	Integral action valid	The speed loop integral time constant is always invalid
	1	DI terminal input	When the gain switching terminal (GAIN_SEL) is active, cancel the speed loop integral action When the gain switching terminal (GAIN_SEL) is inactive, restore the integral action of the speed loop *If no terminal is defined as GAIN_SEL, the integral action will be constantly effective
	2	Position deviation high	When it is currently at the first gain and the absolute value of the position deviation exceeds P4_18+lagging, the speed loop integral action is cancelled. When it is currently at the second gain and the absolute value of the position deviation is smaller than P4_18-lagging, the speed loop integral action is restored. * The lagging value of position deviation is 100 pulse command units
	3	Speed command high	When it is currently at the first gain and the absolute value of the speed command exceeds P4_18+lagging, the speed loop integral action is cancelled. When it is currently at the second gain and the absolute value of the speed command is smaller than P4_18-lagging, the speed loop integral action is restored. * The lagging value of speed command is 10rpm
	4	Actual speed high	When it is currently at the first gain and the absolute value of the motor speed exceeds P4_18+lagging, the speed loop integral action is cancelled. When it is currently at the second gain and the absolute value of the motor speed is smaller than P4_18-lagging, the speed loop integral action is restored. * The lagging value of motor speed is 10rpm

- ■ Cancelling the speed loop integral action may reduce the possibility of speed overshooting, but the servo response may also become slow.
- ■ bit0=5, 6, 7, 8 indicates reverse actions; please refer to description of the function code P4-15

> ➢ Associated parameter

Function code	Parameter name	Function
P4-16	Gain switching time	When the gain switching condition is satisfied, the gain value will switch from the current stage linearly to the target gain within the time.
P4-18	Gain switching threshold	Reference value for determining whether the gain switching condition is satisfied. * The unit of the parameter setting depends on P4-15
P4-19	Change coefficient of the 2nd position loop gain	The second position loop gain = P4_02*P4_19
P4-20	Change coefficient of the 2nd speed loop gain	The second speed loop gain = P4_03*P4_20

6.11 Manual gain adjustment (applied)

6.11.1 Feedforward function

Upon position control, it calculates the speed control command required for action based on the internal position command, and adds the speed command obtained by comparison with the position feedback to derive the speed feedforward; compared with feedback control, it can better reduce the position deviation and improve the responsiveness.

Calculation of the torque command based on the speed control command and addition of the torque command obtained by comparison with the speed feedback to derive the torque feedforward can improve the responsiveness of the speed control system.

➢ Associated parameter

Function code	Parameter name	Function
P4-06	Speed feedforward gain	The speed control command calculated based on the internal position command is multiplied by the set ratio of this parameter and then added to the speed command after position control processing.
P4-07	Speed feedforward filtering time constant	Set the time constant of the primary inertia filter required for speed feedforward input to reduce harmonic component in the command.
P4-24	Torque feedforward gain	Position control mode: The torque command calculated based on second-order differential of the external position command is multiplied by the set ratio of this parameter and then added to the torque command after speed control processing.
		Speed control mode: The torque command calculated based on the internal speed command is multiplied by the set ratio of this parameter and then added to the torque command after speed control processing.
P4-25	Torque feedforward filtering time constant	Set the time constant of the primary inertia filter required for speed feedforward input to reduce harmonic component in the command.

➢ Application instance of speed feedforward

When using the factory setting (5ms), the speed feedforward smoothing filter gives a play to the speed feedforward by gradually raising the speed feedforward gain. At a given speed, the position deviation for an action may be adjusted by using the formula below

$$\text{Position deviation (command unit)} = \frac{\text{Speed corresponding to position command}}{\text{Position loop gain}} \times \frac{(100\text{-speed feedforward gain})}{100}$$

If the speed feedforward gain is set to 100%, then the position deviation in calculation is the gain; yet this will cause significant overshooting upon acceleration and deceleration.

Besides, when the position command input has relatively low or non-uniform pulse frequency, speed feedforward gain may lead to great impact or noise during operation. In this case, a position command filter (inertia filter P1-14, position FIR filter P5-23) shall be used.

➢ Application instance of torque feedforward

When torque feedforward is used, it is required to correctly set the load inertia ratio P4-10. It can be obtained by using offline inertia identification or based on the actual mechanical conditions.

When the torque feedforward smoothing filter time constant is the factory setting (5ms), the torque feedforward gain can be gradually raised to make the torque feedforward valid.

Provision of torque feedforward gain can make the position deviation at a fixed acceleration or deceleration approach to 0. For this consideration, in the ideal condition of no external disturbing torque, position deviation in all action areas driven according to a trapezoidal speed curve can be made close to 0.

In fact, external disturbing torque does exist, and therefore the position deviation cannot be 0.

6.11.2 Friction torque compensation

Friction is inevitable for machines. For different machines, there are mainly three types of friction. EA350 can provide compensation against the three types of friction.

➢ Associated parameter

Function code	Parameter name	Function
P4-30	Friction compensation smoothing time constant	Primary inertia filtering of the three types of torque compensation can prevent vibration resulted from abrupt change of the torque command; yet a too high setting may lead to slow compensation.
P4-31	Viscous friction compensation gain	The product of the command speed multiplied by the setting is used as the torque compensation value added to the torque command. *It is used for compensation when friction increases linearly with speed.
P4-32	Added torque	Addition to the torque command in a fixed direction. When this value is positive, it suggests that the direction of the added value is the forward rotating direction of the motor, or otherwise it is the reverse rotating direction of the motor. * Only if the activation is ON, torque addition will be performed even if there is no command.
P4-33	Torque compensation in the forward direction	It is added to the torque command when the motor rotates in the forward direction to compensate the forward dynamic friction. *The physical direction of motor forward or backward rotation is determined by P0-01.
P4-34	Negative torque compensation	It is added to the torque command when the motor rotates in the reverse direction to compensate the reverse dynamic friction

*The reference value for friction torque compensation is the rated torque of the motor
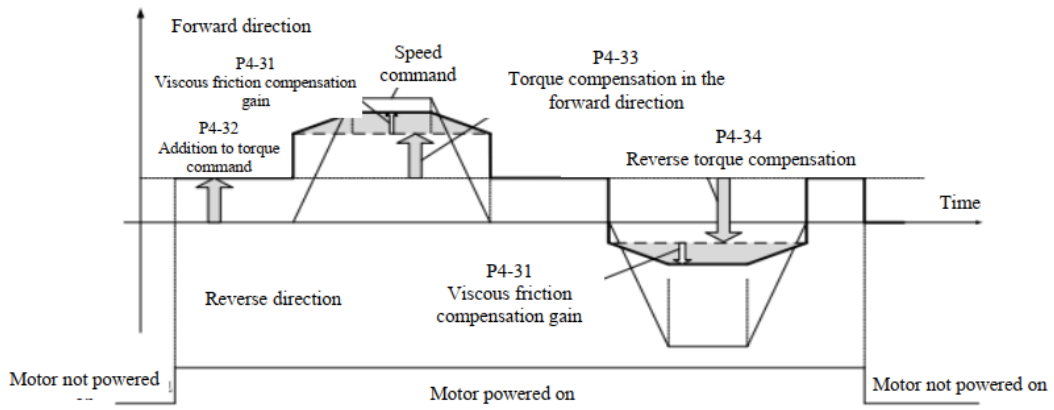
If the torque command is T, then the compensated torque command Tb is:

Forward direction: Tb=T+P4_32+P4_31*motor speed/1000+P4_33

Reverse direction: Tb=T+P4_32+P4_31*motor speed/1000-P4_34

Caution☞   **Friction torque compensation is invalid in the torque control mode.**

6.11.1 PDFF control

When the speed command drives the motor to rotate, as the servo motor has a mechanical load dragging on the shaft end, the performance characteristic of the motor shaft is still determined by the response characteristic of the mechanical system. Considering needs of various mechanical systems, EA350 servo is also designed with a PDFF controller in its speed loop, which can be used in the non-torque mode.

The PDFF controller is a controller between PI and IP controllers, having features of both the PI and IP controllers.

IP controller structure:
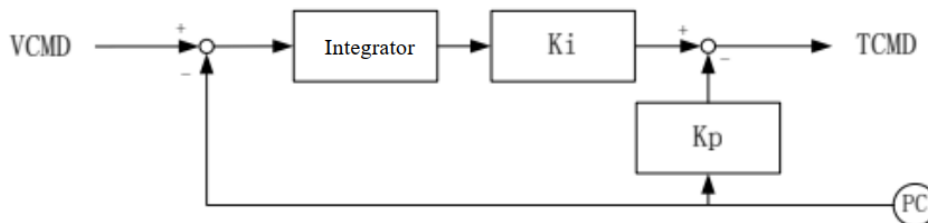
PI controller structure
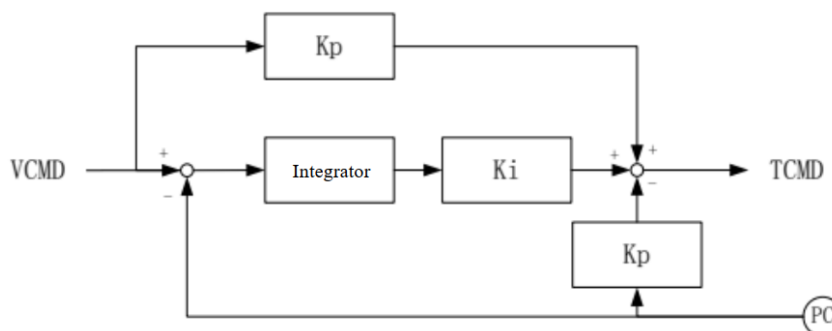
Comparison of the IP and PI control effect in case of the same proportional gain and integral time parameter
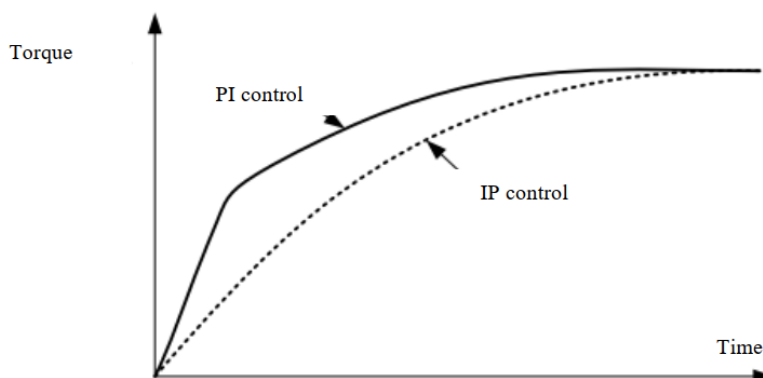
IP controllers are commonly designed for small machines with quick response (high mechanical rigidity). For step command of position, softening torque rise characteristic upon startup can reduce vibration.

PI controllers are commonly designed for large machines with slow response (low mechanical rigidity). As a large torque can be attained within a relatively short time after receipt of a speed command, use in machines with high rigidity (such as small machines driven by using screw rods) can improve the torque rise characteristic upon startup.

PDFF controllers have characteristics of both IP and PI controllers. They can be used for biased IP or PI control depending on the value of the PDFF coefficient, with both response and reduction of vibration upon frequent start/stop considered.

➢ Associated parameter

Function code	Parameter name	Function
P4-12	PDFF control coefficient	When the set value approaches to 0, the control is biased towards IP control; when it is 0, the control is totally IP control. When the set value approaches to 100, the control is biased towards PI control; when the set value is 100, the control is totally PI control. When overshooting occurs to speed feedback, P4-12 shall be gradually reduced from 100 until the desired effect is achieved.

Chapter 7 Table of functional parameters

7.1 Definition of function parameters

For a function parameter, the first two bits of the initial code (such as P0) is the group number, and the two following parameters (such as 00) is the number in the group.

Group dx-xx: monitoring and inquiry parameters, only for display and read.

Group St-xx: status display parameters, only for display and read

Group Px-xx: parameters for setting

Group AF-xx: function switch parameters.

Setting attribute of function parameters:

○: Setting can be performed at any time and will take immediate effect

●: Setting can be performed at any time and will take effect when the system is powered on again

☆: Shutdown setting, takes immediate effect

▲: Read-only parameter that cannot be set

Description of data type:

U16: The data length is 16 bits, without symbol; the communication address length is 1

I16: The data length is 16 bits, with symbol; the communication address length is 1

U32: The data length is 32 bits, without symbol; the communication address length is 2

I32: The data length is 32 bits, with symbol; the communication address length is 2

Explanation of letters after the digits:

H: Corresponding digits are operated, displayed and set in hexadecimal

B: Corresponding digits are operated, displayed and set in binary

Description of control mode:

P: Position control mode

S: Speed control mode

T: Torque control mode

Unit explanation

rpm	revolutions per minute	kHz	Kilohertz	rad/s	radian per second
Pulse	Command pulse	mV	Millivolt	%	Percent
rev	Revolution	V	Volt	ms/s	Millisecond per second
PUL	Encoder pulse	A	Amp	min	min
ppr	Can be set to command or encoder pulse	°C	°C	°	Angle

7.2 Table of functional parameters

7.2.1 Group d0 - General monitoring parameters

Parameter	Function	Data type	Initial value (example)	Unit	Communication address
d0-00	Motor speed	I16	0	rpm	2000H
d0-01	Motor load rate	I16	0.0	%	2001H
d0-02	Total count of external pulses acquired	I32	0	Pulse	2002H
d0-04	Total count of feedback pulses (command pulse unit)	I32	0	Pulse	2004H
d0-06	Total count of feedback pulses (encoder unit)	I32	0	PUL	2006H
d0-08	Frequency of external pulses received	I32	0.00	kHz	2008H
d0-10	Position deviation	I32	0	ppr	200AH
d0-12	DI terminal status 0: invalid; 1: valid	U16	00000000B	-	200CH
d0-13	DO terminal status 0: invalid; 1: valid	U16	00000B	-	200DH
d0-14	AI1 command voltage (after system processing)	I16	0	mV	200EH
d0-15	AI2 command voltage (after system processing)	I16	0	mV	200FH
d0-16	Bus voltage	U16	0	V	2010H
d0-17	Valid motor current	U16	0.00	A	2011H
d0-18	Rotating speed corresponding to pulse command	I16	0	rpm	2012H
d0-19	Speed command value	I16	0	rpm	2013H
d0-20	Torque command value	I16	0.0	%	2014H
d0-21	Maximum instantaneous motor load rate	I16	0.0	%	2015H
d0-22	IGBT module temperature	U16	0	°C	2016H
d0-23	Bus voltage of switching power	U16	0	V	2017H
d0-24	Total operating time of system:	U32	0	min	2018H

Parameter	Function	Data type	Initial value (example)	Unit	Communication address
d0-26	Brake load rate	U16	0.0	%	201AH
d0-27	Electrical angle of current motor	U16	0.0	°	201BH
d0-28	-				
d0-29	Revolutions of absolute type encoder	I16	0	rev	201DH
d0-30	Current revolution position value of serial encoder	U32	0	PUL	201EH
d0-32	Total count of external pulses acquired	I32	0	Pulse	2020H
d0-34	Current position of servo motor (command pulse unit)	I32	0	Pulse	2022H
d0-36	Current position of servo motor (encoder unit)	I32	0	PUL	2024H
d0-38	Positioning status 0: Positioning; 1: Positioning completed	U16	0	-	2026H
d0-39	Current segment of multi-segment speed	U16	0	-	2027H
d0-40	Current segment of multi-segment position	U16	0	-	2028H
d0-41	AI1 physical voltage (actual value)	I16	0	mV	2029H
d0-42	AI2 physical voltage (actual value)	I16	0	mV	202AH
d0-46	Average load rate of motor	U16	0.0	%	202EH
d0-47	Heat accumulation of driver	U16	0.000	-	202FH
d0-48	Heat accumulation of motor (instantaneous)	U16	0.000	-	2030H
d0-49	Heat accumulation of motor (steady state)	U16	0.000	-	2031H
d0-62	GBK detected position pulse value/length	I32	0	-	203EH
d0-64	Over-temperature point of motor encoder	U16	90	°C	2040H
d0-65	Encoder temperature upon power-on	U16	40	°C	2041H
d0-67	Zero drift value of output current	U16	Uncertain	-	2043H
d0-68	Total count of feedback pulses of external encoder (command pulse unit)	I32	0	Pulse	2044H
d0-70	Total count of feedback pulses of external encoder (external encoder unit)	I32	0	PUL	2046H
d0-72	Fully closed-loop position deviation counter	I32	0	PUL	2048H

7.2.2 Group d1 - Alarm query parameters

Parameter	Function	Data type	Initial value (example)	Unit	Communication address
d1-00	Current alarm code	U16	Al000	-	2100H
d1-01	Rotating speed upon the current alarm	I16	0	rpm	2101H
d1-02	Bus voltage upon the current alarm	U16	0	V	2102H
d1-03	Active current upon the current alarm	U16	0.00	A	2103H
d1-04	Running time upon the current alarm	U32	0	min	2104H
d1-06	Previous alarm code	U16	Al000	-	2106H
d1-07	Rotating speed of the previous alarm	I16	0	rpm	2107H
d1-08	Bus voltage upon the previous alarm	U16	0	V	2108H
d1-09	Active current upon the previous alarm	U16	0.00	A	2109H
d1-10	Running time upon the previous alarm	U32	0	min	210AH
d1-12	Previous 2 alarm codes	U16	Al000	-	210CH
d1-13	Rotating speed upon the previous 2 alarms	I16	0	rpm	210DH
d1-14	Bus voltage upon the previous 2 alarms	U16	0	V	210EH
d1-15	Active current upon the previous 2 alarms	U16	0.00	A	210FH
d1-16	Running time upon the previous 2 alarms	U32	0	min	2110H
d1-18	Previous 3 alarm codes	U16	Al000	-	2112H
d1-19	Rotating speed upon the previous 3 alarms	I16	0	rpm	2113H
d1-20	Bus voltage upon the previous 3 alarms	U16	0	V	2114H
d1-21	Active current upon the previous 3 alarms	U16	0.00	A	2115H
d1-22	Running time upon the previous 3 alarms	U32	0	min	2116H
d1-24	Current alarm status	U16	0	-	2118H
d1-25	Current warning status	U16	0	-	2119H

7.2.3 Group d2 - Product information query parameters

Parameter	Function	Data type	Initial value (example)	Unit	Communication address
d2-00	Ones place: Encoder type 0: - 1: 17/23-bit serial communication encoder Tens place: Command type 1: Analog quantity and pulse type (EA350)	U16	10	-	2200H
d2-01	Current motor code	U16	101	-	2201H

Parameter	Function	Data type	Initial value (example)	Unit	Communication address
d2-02	CPUA software version number	U16	100	-	2202H
d2-03	Performance software serial number	U16	0.101	-	2203H
d2-04	CPUB software version number	U16	100	-	2204H
d2-05	CPUB software serial number	U16	0.101	-	2205H

7.2.4 Group d3 - Real-time monitoring parameters

Parameter	Function	Data type	Initial value (example)	Unit	Communication address
d3-05	Motor speed	I16	0	rpm	2305H
d3-06	Position deviation	I32	0	ppr	2306H
d3-08	Motor load rate	I16	0.0	%	2308H
d3-09	Revolutions of absolute type encoder	I16	0	Rev	2309H
d3-10	Current revolution position of serial encoder	U32	0	Pulse	230AH
d3-12	Total count of command pulses acquired	I32	0	Pulse	230CH
d3-14	Current position of motor (based on command pulse)	I32	0	Pulse	230EH
d3-18	Low zero position of machine 32 bits (based on encoder pulse)	I32	0	Pulse	2312H
d3-20	High zero position of machine 32 bits (based on encoder pulse)	I32	0	Pulse	2314H
d3-22	Low current position of motor 32 bits (based on encoder pulse)	I32	0	Pulse	2316H
d3-24	High current position of motor 32 bits (based on encoder pulse)	I32	0	Pulse	2318H

7.2.5 Operation of auxiliary function

An auxiliary function is a parameter set for executing specific functional operation; the keyboard does not display values in the internal register.

Important: When the keyboard is used, symbols displayed shall be observed. When communication is relied on for operation, it is required to write the register value to corresponding address. If the register value is "-", it suggests that the operation cannot be performed by means of communication.

AF-00	**Reset by software**		Data size	16bit	Communication address	3F00H
			Register value storage	Automatic zeroing upon completion		
	Register value	Keyboard display	Operation			
	0	`0`	Press the (S) key to display `-End-`, without any operation			
	1	`rESEt`	Press the (S) key for resetting by software (equivalent to switching on the control power)			

AF-01	**Alarm reset**		Data size	16bit	Communication address	3F01H
			Register value storage	Automatic zeroing upon completion		
	Register value	Keyboard display	Operation			
	0	`0`	Press the (S) key to display `-End-`, without any operation			
	1	`AL.CLr`	Press the (S) key to execute an alarm resetting operation. * It must be a resettable alarm and the cause of the current alarm has been eliminated.			

AF-02	**JOG function**		Data size	16bit	Communication address	3F02H
			Register value storage	-		
	Register value	Keyboard display	Operation			
	-	`-SJoG`	Press the (∧) key, and the motor runs forward, displaying `-SJoG`; press the (∨) key, and the motor runs reversely, displaying `-SJoG`. When no key is pressed, the motor stands still, displaying `-SJoG`			

| | | | * The jog running speed is determined by P8-00, and the acceleration and deceleration time is determined by P8-01.

* Jog running occurs in the ⌐.Prdy (inactivated and ready) state; if a warning occurs during jog running, the system will automatically exit from the mode. |

			Data size	16bit	Communication address	3F03H
AF-03	**Internal S_ON command**		Register value storage	Save		
	Register value	Keyboard display	Operation			
	0	0	Press S to display −End−; if there is no other activation input, the driver will enter the OFF state			
	1	S-on	If the activation conditions are satisfied, press S to display S-on and the driver will enter the ON state.			

* This parameter will be saved and immediately activated (ON) when the system is powered on next time. If this is not desired, please set the parameter value to 0 before power-off.

	FFT test		Data size	16bit	Communication address	3F04H
AF-04			Register value storage		Automatic zeroing upon completion	
	Register value	Keyboard display	Operation			
	0	`0`	Press the (S) key to display `-End-`, without any operation			
	1	`EYdFt`	Press (S) to display `EYdFt`, and use the software identification system of the upper computer to perform speed and band width tests; after the tests, the system will automatically exit, and upload data to the upper computer for analysis and display. * The motor will jitter slightly with sound produced.			

	Offline inertia identification		Data size	16bit	Communication address	3F05H
AF-05			Register value storage		Automatic zeroing upon completion	
	Register value	Keyboard display	Operation			
	0	`0`	Press the (S) key to display `-End-`, without any operation			
	1	`JI dt`	Press (S) to display `JI dt`, and start to identify the current system inertia; following successful identification, the system inertia (a multiple relative to the motor inertia) will be automatically saved to P4-10. * Please refer to Section 6.6 for details of inertia identification.			

	AI channel self-correction		Data size	16bit	Communication address	3F06H
AF-06			Register value storage		Automatic zeroing upon completion	
	Register value	Keyboard display	Operation			
	0	`0`	Press the (S) key to display `-End-`, without any operation			
	1	`AI 1`	If AI1 external voltage source is set as 0V (an impossible value in practice), press (S) to display `AI 1` and carry out zero drift self-learning, upon which the result will be saved into P6-33 automatically.			
	2	`AI 2`	If AI2 external voltage source is set as 0V (an impossible value in practice), press (S) to display `AI 2` and carry out zero drift self-learning, upon which the result will be saved into P6-34 automatically.			

Caution☞	**1: Make sure the setting command of the master per se is 0 V (an impossible value in practice) before performing zero drift self-correction.** **2: Zero drift self-correction applies only to scenarios where external setting falls in -10 to 10V.** **3: If the actual voltage of the AI terminal exceeds ±2 V during correction, the alarm AL034 will be raised.**

	Default status display upon power-on		Data size	16bit	Communication address	3F07H
AF-07			Register value storage		Storage	
	Register value	Keyboard display	Operation			
	0000H	`0000`	Press (S) to display `-End-`; at this time, the status monitoring mode only displays the driver status			
	2001H (example)	`2001`	Press (S) to display `-End-`; if AF-07 has a non-zero value, the status monitoring mode displays, in default, the function code value corresponding to its communication address (such as d0-01); the (∧) key can be used to switch between the monitored value and the driver status for display.			

			Parameter value corresponding to the address set by AF-07 is preferentially displayed The UP key can be used to switch display of the driver status

Caution☞	**1: AF-07 is displayed in hexadecimal and represents the communication address; if the set address has no corresponding function code, value unknown is displayed.** **2: If it is currently not activated, LED3 will display the position mode (P); once it is activated, the actual operation control mode will be displayed**

	Display of non-default setting		Data size	16bit	Communication address	3F08H
			Register value storage	Automatic zeroing upon power-on		
RF-08	Register value	Keyboard display	Operation			
	0	`0`	Press (S) to display `-End-`, and it displays normally			
	1	`1`	Press (S) to display `-End-`, and then press (M) to enter the modified parameter mode; the difference from normal function code display is that there is "-" flashing in the middle. Press (∧) or (∨) to view modified parameters in sequence; press (S) to view modified values.			

	System parameter initialization		Data size	16bit	Communication address	3F09H
			Register value storage	Automatic zeroing upon power-on		
RF-09	Register value	Keyboard display	Operation			
	0	`1`	If AF-09≠65535, press (S) to display `Po-on`, without any operation			
	65535	`65535`	If AF-09=65535, press (S) to display `Po-on`, and restore the factory setting of the function code.			

Caution☞ 1: When this function is used, it is required to turn on the control power.
2: This operation will not restore the motor parameters

	Display of motor group parameters		Data size	16bit	Communication address	3F0AH
			Register value storage	Automatic zeroing upon power-on		
RF-10	Register value	Keyboard display	Operation			
	0	`0`	Press (S) to display `-End-`, with parameters of the Pd group hidden			
	1	`1`	Press (S) to display `-End-`, with parameters of the Pd group shown			

	Parameter reading of motor with serial encoder		Data size	16bit	Communication address	3F0FH
			Register value storage	Automatic zeroing upon power-on		
RF-15	Register value	Keyboard display	Operation			
	0	`0`	Press (S) to display `-End-`, with parameters of the Pd group hidden			
	1	`1`	Press (S) to display `-End-`; read and use motor parameter data stored in the serial encoder. If no data is read, the originally set motor parameters of group Pd will be used.			

	Absolute type encoder multiple-turn data and alarm processing		Data size	16bit	Communication address	3F10H
			Register value storage	Automatic zeroing upon completion		
RF-16	Register value	Keyboard display	Operation			
	0	`0`	Press the (S) key to display `-End-`, without any operation			
	1	`1`	Clear multiple-turn encoder alarm: Press (S) to display `-End-`, and execute corresponding operation			
	2	`2`	Clear multiple-turn data and alarm of multiple-turn encoder: Press (S) to display `-End-`, and execute corresponding operation			
Important: This function can only be operated in the inactivated state						

7.2.6 Group P0 - Basic setting parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P0-00	Control mode selection	0: Speed control mode 1: Position control mode 2: Torque control mode 3: Speed-position switching mode (zero speed) 4: Reserved 5: Position-torque switching mode (zero speed) 6: Speed-position switching mode (immediately) 7: Torque-speed switching mode (immediately) 8: Position-torque switching mode (immediately)	U16	1	-	P S T	●	0000H
P0-01	Motor rotating direction	0: In case of a forward direction command, the motor rotates anticlockwise (CCW) 1: In case of a reverse direction command, the motor rotates clockwise (CW)	U16	0	-	P S T	☆	0001H
P0-02	Maximum rotating speed setting	0~10000	U16	3000	rpm	P S T	●	0002H
P0-03	Zero-speed signal output value	10~1000	U16	10	rpm	P S T	○	0003H
P0-04	Rotation signal output value	10~1000	U16	20	rpm	P S T	○	0004H
P0-05	Torque limit source selection of the 1st revolution	0: Digital limit of forward and reverse torque 1: Forward and reverse torque is limited also by AI1 2: Forward and reverse torque is limited also by AI2 3: Forward torque limited by AI1; and reverse torque subject to digital limit 4: Forward torque limited by AI2; and reverse torque subject to digital limit 5: Forward torque subject to digital limit; and reverse torque limited by AI1 6: Forward torque subject to digital limit; and reverse torque limited by AI2 7: Forward torque limited by AI1; and reverse torque by AI2 8: Reverse torque limited by AI1; and forward torque by AI2	U16	0	-	P S T	○	0005H
P0-06	Torque limit of the 1st revolution - forward maximum	0.0~500.0	U16	300.0	%	P S T	○	0006H
P0-07	Torque limit of the 1st revolution - reverse maximum	0.0~500.0	U16	300.0	%	P S T	○	0007H
P0-08	Braking mode selection	000H~311H Bit 0: Braking mode upon servo activation OFF 0: Free braking; the motor remains in the free state 0: Zero-speed braking; the motor remains in the free state after braking Bit 1: Breaking mode upon secondary alarm 0: Free braking; the motor remains in the free state 0: Zero-speed braking; the motor remains in the free state after braking Bit 2: Processing mode upon overrun 0: Free braking; the motor remains in the free state 1: Deceleration to zero; the motor	U16	200H	-	P S T	○	0008H

		remains in the free state afterwards 2: Deceleration to zero; the motor remains in the position locked state afterwards 3: not processed						
P0-09	Activation OFF - delay time of brake release command	1~65535	U16	500	ms	P S T	○	0009H
P0-10	Speed threshold of brake release command	1~1000	U16	20	rpm	P S T	○	000AH
P0-11	Brake release command- delay time of motor power-off	0~500	U16	200	ms	P S T	○	000BH
P0-12	Selection of re-activation condition for each braking mode	0: Activation based on condition P0-13 only upon free braking 1: Activation based on condition P0-13 upon free braking and zero-speed braking	U16	0	-	P S T	○	000CH
P0-13	Servo activation condition	0: Activation ON when P0-14 is satisfied 1: Activation ON when P0-15 is satisfied 2: Activation ON when P0-14 and P0-15 are satisfied 3: Immediate activation ON	U16	3	-	P S T	○	000DH
P0-14	Delay time of activation ON after activation OFF	1~30000	U16	500	ms	P S T	○	000EH
P0-15	Speed limit threshold of activation ON	0~10000	U16	20	rpm	P S T	○	000FH
P0-16	Activation ON - delay time of receiving command	0~500	U16	200	ms	P S T	○	0010H
P0-17	Deceleration time for zero-speed braking	1~65535	U16	200	ms	P S T	○	0011H
P0-18	Deceleration time of overrun protection	1~65535	U16	200	ms	P S T	○	0012H
P0-19	Emergency braking time	1~65535	U16	50	ms	P S T	○	0013H
P0-20	Definition of pulse output setting value	0: before frequency quadruplication 1: after frequency quadruplication (only supported by 17-bit and 23-bit encoder)	U16	0	-	P S T	●	0014H

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P0-21	Count of output pulses per revolution of the motor	30~2,500 (2,500-wire incremental type) 30~8,192 (17-bit or 23-bit encoder, and P0-20=0) 120~16,383 (17-bit or 23-bit encoder, and P0-20=1)	U16	2500	Pulse	P S T	●	0015H
P0-22	AB pulse output logic selection and Z pulse output polarity setting	Bit 0: AB pulse output logic 0: A is ahead of B when the motor rotates forward 1: B is ahead of A when the motor rotates forward Bit 1: Z-pulse output polarity 0: Low level pulse 1: High level pulse	U16	00	-	P S T	●	0016H
P0-23	Z-pulse output width	0~3	U16	0	ms	P S T	●	0017H
P0-24	Pulse output source	0: Motor encoder feedback 1: Command pulse (P0-20, 21, 22 invalid) 2: Speed command 3: External encoder feedback	U16	0	-	P S T	●	0018H

7.2.7 Group P1 - Position control parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P1-00	Position command source selection	0: External pulse command (pt) 1: Multi-segment position command (Pr)	U16	0	-	P	○	0100H
P1-01	Input form of external pulse command	0: Pulse + direction, positive logic 1: Pulse + direction, negative logic 2: Two-phase orthogonal pulse (quadruplicated frequency), positive logic 3: Two-phase orthogonal pulse (quadruplicated frequency), negative logic 4: CW/CCW pulse, positive logic 5: CW/CCW pulse, negative logic	U16	0	-	P	●	0101H
P1-02	Count of pulses per revolution of the motor	0~8388608	U32	10000	Pulse	P	○	0102H
P1-04	Electronic gear numerator 1	0~1073741824	U32	0	-	P	○	0104H
P1-06	Electronic gear denominator	1~1073741824	U32	10000	-	P	○	0106H
P1-08	Electronic gear numerator 2	0~1073741824	U32	0	-	P	○	0108H
P1-10	Electronic gear numerator 3	0~1073741824	U32	0	-	P	○	010AH
P1-12	Electronic gear numerator 4	0~1073741824	U32	0	-	P	○	010CH
P1-14	Low-pass smoothing and filtering time of external pulse	0.00~300.00	U16	0.00	ms	P	●	010EH
P1-15	High-frequency filtering factor of external pulse input	0~4095	U16	90	10ns	P S	●	010FH
P1-16	Selection of external DI signal action for position deviation clearing	0: Clear through P-CLR rising edge 1: Clear through P-CLR low level 2: Clear through P-CLR high level 3: Clear through P-CLR falling edge	U16	0	-	P	○	0110H
P1-17	Reserved							
P1-18	Position error following warning value	0~1073741824	U32	80000	ppr	P	○	0112H

P1-20	Position error following alarm value	0~1073741824	U32	100000	ppr	P		0114H
P1-22	Positioning completion output setting	0~6	U16	1	-	P	○	0116H
P1-23	Positioning approach width	1~65535	U16	20	ppr	P	○	0117H
P1-24	Positioning completion width	0~65535	U16	10	ppr	P	○	0118H
P1-25	INP holding time	0~3000	U16	10	ms	P	○	0119H
P1-26	Forward limit position	-2147483647~2147483647	I32	2147483647	ppr	P S T	○	011AH
P1-28	Reverse limit position	-2147483647~2147483647	I32	-2147483647	ppr	P S T	○	011CH
P1-30	Pulse deviation	0~65535	U16	100	Pulse	P	○	011EH
P1-31	Execution time of pulse deviation	1~65535	U16	100	ms	P	○	011FH
P1-33	Analog adjustment options of electronic gear ratio	0: Disable analog adjustment of electronic gear ratio 1: Adjust electronic gear ratio via AI1 2: Adjust electronic gear ratio via AI2	U16	0	-	P	○	0121H
P1-34	Analog adjustment multiplier of electronic gear ratio	0.01~10.00	U16	1.00	-	P	○	0122H

7.2.8 Group P2 - Speed control parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P2-00	Speed command source 1 option	0: Digital speed setting 1 (P2-01 setting) 1: AI1 setting 2: AI2 setting 3: Multi-segment speed setting 4: Pulse input	U16	0	-	S	○	0200H
P2-01	Digital speed setting 1	-30000~30000	I16	100	rpm	S	○	0201H
P2-02	Reserved							
P2-03	Reserved							
P2-04	Speed S-type acceleration time T$_{SACC}$	1~65535	U16	200	ms	S	○	0204H
P2-05	Speed S-type deceleration time T$_{SDEC}$	1~65535	U16	200	ms	S	○	0205H
P2-06	Speed S-type acceleration/deceleration smoothing time T$_{SL}$	0~10000	U16	50	ms	S	○	0206H
P2-07	Zero position fixation threshold for speed command	0~3000	U16	10	rpm	S	○	0207H
P2-08	Reached speed	1~10000	U16	1000	rpm	PST	○	0208H
P2-09	Speed consistency threshold	1~10000	U16	10	rpm	S	○	0209H
P2-10	Speed command source 2	0: Digital command 1: AI1 2: AI2 3: process PID 4: Pulse input	U16	0	-	S	○	020AH
P2.11	Digital speed command 2	-6000~6000	U16	100	-	S	○	020BH
P2.12	Speed command	0: Speed command source 1 1: Speed command source 2 2: Speed command source 1 + speed command source 2 3: Switching between speed command sources 1 and 2 (CMD_SEL)	U16)	0	-	S	○	020CH
P2.13	Given limit for speed in the forward direction	-6000~6000	U16	3000	rpm	S	○	020DH
P2-14	Given limit for speed in the reverse direction	-6000~6000	U16	3000	rpm	S	○	020EH
P2-15	Pulse input reference	Pulse input frequency corresponding to 2.0~200.0 speed command 1,000rpm	U16	20.0	kHz	S	○	020FH
P2-16	Pulse output reference	Pulse output frequency corresponding to 2.0~200.0 speed command 1,000rpm	U16	20.0	kHz	S	○	0210H

7.2.9 Group P3 - Torque control parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P3-00	Selection of torque setting command source	0: Torque P3-01 setting, symmetrical between the forward and reverse directions 1: Torque P3-01 setting, with the reverse direction limited by P3-02 2: Torque P3-01 setting, with the reverse direction limited by AI1 3: Torque P3-01 setting, with the reverse direction limited by AI2 4: Torque AI1 setting, symmetrical between the forward and reverse directions 5: Torque AI1 setting, with the reverse direction limited by P3-02 6: Torque AI1 setting, with the reverse direction limited by AI2 7: Torque AI2 setting, symmetrical between the forward and reverse directions	U16	0	-	T	○	0300H

		8: Torque AI2 setting, with the reverse direction limited by P3-02 9: Torque AI2 setting, with the reverse direction limited by AI1						
P3-01	Digital torque setting	-500.0~500.0	I16	100.0	%	T	○	0301H
P3-02	Reverse torque limit	0.0~500.0	U16	300.0	%	T	○	0302H
P3-03	Reserved							
P3-04	Selection of speed limit command source for torque command direction	0: Digital speed setting (P3-05 setting) 1: AI1-limited speed 2: AI2-limited speed	U16	0	-	T	○	0304H
P3-05	Speed limit in the torque command direction upon torque control	0~10000	U16	100	rpm	T	○	0305H
P3-06	Torque consistency threshold	3.0~100.0	U16	5.0	%	T	○	0306H
P3-07	Reached torque	3.0~500.0	U16	100.0	%	P S T	○	0307H
P3-08	Torque command increase slope	0.0~500.0	U16	500.0	%/ms	T	○	0308H
P3-09	Torque command decrease slope	0.0~500.0	U16	500.0	%/ms	T	○	0309H

7.2.10 Group P4 - Gain tuning parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P4-00	Selection of gain adjustment mode	0: Manual 1: Semi-automatic adjustment mode (rigidity table) 2: Automatic adjustment mode 1 (slow inertia change) 3: Automatic adjustment mode 2 (relatively fast inertia change) 4: Automatic adjustment mode 3 (fast inertia change)	U16	1	-	P S T	○	0400H
P4-01	Rigidity	1~31	U16	13	-	P S T	○	0401H
P4-02	Position loop proportional gain APR_P	1.0~2000.0	U16	48.0	1/s	P	○	0402H
P4-03	Speed loop proportional gain ASR_P	0.1~5000.0	U16	27.0	Hz	P S	○	0403H
P4-04	Speed ring differential time constant ASR_T_d	0.0~3000.0	U16	0.0	ms	P S	○	0404H
P4-05	Speed loop integral time constant ASR_T_i	0.1~3000.0	U16	21.0	ms	P S	○	0405H
P4-06	Speed feedforward gain APR_Kp	0.0~300.0	U16	30.0	%	P	○	0406H
P4-07	Speed feedforward filtering time constant	0.00~10.00	U16	5.00	ms	P	○	0407H
P4-08	Speed feedback filtering time constant	0.00~20.00	U16	0.00	ms	P S	○	0408H
P4-09	Factory parameters	0~10000	U16	0	-	P S T	○	0409H
P4-10	The 1st load inertia ratio (total inertia/motor rotor inertia)	1.00~120.00	U16	2.50	-	P S T	○	040AH
P4-11	The 2nd load inertia ratio (total inertia/motor rotor inertia)	1.00~120.00	U16	1.00	-	P S T	○	040BH
P4-12	PDFF control coefficient	0~100	U16	100	%	P S T	○	040CH
P4-13	Rigidity adjustment coefficient	0.5~1.0	U16	0.5	-	P S T	○	040DH
P4-14	Control loop coefficient	10~100	U16	75	-	P S T	○	040EH
P4-15	Gain switching condition	00H~18H	U16	00H	-	P S T	○	040FH
P4-16	Gain switching time	0~3000	U16	5	ms	P S T	○	0410H
P4-17	Reserved							
P4-18	Gain switching threshold	0~32767	U16	100	rpm	P S T	○	0412H
P4-19	Change coefficient of the 2nd position loop gain	10~500	U16	50	%	P S T	○	0413H
P4-20	Change coefficient of the 2nd speed loop gain	10~500	U16	50	%	P S T	○	0414H
P4-21	Reserved							
P4-22	Suppression performance expansion	Bit 0: Acceleration feedback function bit1: Reserved bit2: Reserved bit3: Reserved Bit 4: Speed observer function Bit 5: Low noise mode	U16	00000B	-	P S T	○	0416H
P4-23	Speed observer cutoff frequency grade	0~13	U16	13	-	P S T	○	0417H
P4-24	Torque feedforward gain	0.0~200.0	U16	0.0	%	P S T	○	0418H

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P4-25	Torque feedforward filtering time constant	0.00~10.00	U16	5.00	ms	P S T	○	0419H
P4-26	Speed loop differential output limit	0.0~10.0	U16	0.0	%	P S	○	041AH
P4-27	Reserved							
P4-28	External disturbance resistance gain	0.0~100.0	U16	0.0	%	P S T	○	041CH
P4-29	Torque command low-pass smoothing constant	0.00~100.00	U16	0.84	ms	P S T	○	041DH
P4-30	Friction compensation smoothing time constant	10~1000	U16	50	ms	P S	○	041EH
P4-31	Viscous friction compensation gain	0~1000	U16	0.0	0.1% / 1000rpm	P S	○	041FH
P4-32	Addition to torque command	-100.0~100.0	I16	0.0	%	P S	○	0420H
P4-33	Torque compensation in the forward direction	-100.0~100.0	I16	0.0	%	P S	○	0421H
P4-34	Reverse torque compensation	-100.0~100.0	I16	0.0	%	P S	○	0422H
P4-35	Static friction torque compensation value	0.0~100.0	U16	0.0	%	S T	○	0423H
P4-36	Cutoff rotating speed for static friction torque compensation	0~200	U16	0	rpm	S T	○	0424H

7.2.11 Group P5 - vibration suppression parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P5-00	Adaptive filter mode setting	0: Manually set 4 notch filters 1: Manually set width of notch filters 3 and 4, and automatically set other notch filters 2: Clear notch filters 3 and 4	U16	0	-	P	●	0500H
P5-01	Automatic vibration detection accuracy and sensitivity	10~30000	U16	100	-	P	○	0501H
P5-02	1st notching frequency	50~5000	U16	5000	Hz	P	●	0502H
P5-03	1st notching width selection	0~20	U16	2	-	P	●	0503H
P5-04	1st notching depth selection	0~99	U16	0	dB	P	●	0504H
P5-05	2nd notching frequency	50~5000	U16	5000	Hz	P	●	0505H
P5-06	2nd notching width selection	0~20	U16	2	-	P	●	0506H
P5-07	2nd notching depth selection	0~99	U16	0	dB	P	●	0507H
P5-08	3rd notching frequency	50~5000	U16	5000	Hz	P	●	0508H
P5-09	3rd notching width selection	0~20	U16	2	-	P	●	0509H
P5-10	3rd notching depth selection	0~99	U16	0	dB	P	●	050AH
P5-11	4th notching frequency	50~5000	U16	5000	Hz	P	●	050BH
P5-12	4th notching width selection	0~20	U16	2	-	P	●	050CH
P5-13	4th notching depth selection	0~99	U16	0	dB	P	●	050DH
P5-14	Reserved							
P5-15	Reserved							
P5-16	Reserved							
P5-17	Reserved							
P5-18	Reserved							
P5-19	Reserved							
P5-20	Reserved							
P5-21	Reserved							
P5-22	Reserved							
P5-23	Position FIR filter	0.0~128.0	U16	0.0	ms	P	○	0517H

7.2.12 Group P6 - Input and output parameters

Parameter	Function	Parameter scope			Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P6-00	DI filtering time	0～20			U16	2	ms	P S T	○	0600H
P6-01	DI level logic	00000000B～11111111B 0: Positive logic; 1: Negative logic			U16	00000000B	-	P S T	○	0601H
P6-02	DI1 function number	Value	Item	Function name	U16	1	-	P S T	●	0602H
		0	Disabled	Terminal inactive						
		1	S-ON	Servo on						
P6-03	DI2 function number	2	ALM-RST	Warning and warning reset	U16	2	-	P S T	●	0603H
		3	P-CLR	Position deviation counter clearing						
P6-04	DI3 function number	4	DIR-SEL	Direction selection for speed command	U16	13	-	P S T	●	0604H
P6-05	DI4 function number	5	CMD0	Internal command bit0	U16	14	-	P S T	●	0605H
		6	CMD1	Internal command bit1						
		7	CMD2	Internal command bit2						
P6-06	DI5 function number	8	CMD3	Internal command bit3	U16	3	-	P S T	●	0606H
		9	CTRG	Internal command trigger						
		10	MSEL	Control mode switching						
P6-07	DI6 function number	11	ZCLAMP	Zero position fixation on for speed command	U16	12	-	P S T	●	0607H
		12	INHIBIT	Pulse inhibited						
P6-08	DI7 function number	13	P-OT	Inhibit forward drive	U16	20	-	P S T	●	0608H
		14	N-OT	Inhibit reverse drive						
		15	GAIN SEL	Gain switching						
		16	J_SEL	Inertia switching						
P6-09	DI8 function number	17	JOG_P	Forward jog	U16	21	-	P S T	●	0609H
		18	JOG_N	Reverse jog						
		19	TDIR-SEL	Direction selection for torque command						
		20	GNUM0	Numerator selection 0 for electronic gear ratio						
		21	GNUM1	Numerator selection 1 for electronic gear ratio						
		22	ORGP	External detector input						
		23	SHOM	Homing						
		24	TL2	External torque limit						
		25	EMGS	Emergency stop						
		28	CMD_SEL	Speed source switching						
		33	PDIR_SEL	Direction selection for position command						
		34	GBK	Position probe						
		35	PUL_UP	Forward pulse deviation						
		36	PUL_DN	Reverse pulse deviation						
		47	FCL	External encoder switching						
P6-10	DI forced valid	00000000B~11111111B 0: Depending on the terminal status; 1: forced valid			U16	00000000B	-	P S T	○	060AH
P6-11	DO level logic	00000B～11111B 0: Positive logic; 1: Negative logic			U16	00000B	-	P S T	○	060BH
P6-12	DO1 function number	Value	Item	Function name	U16	1	-	P S T	●	060CH
		0	Disable	Terminal inactive						
		1	S-RDY	Servo ready						
P6-13	DO2 function number	2	BK	Brake control	U16	2	-	P S T	●	060DH
		3	TGON	Motor rotation						
		4	ZER0	Zero speed of motor						
P6-14	DO3 function number	5	V-CLS	Speed reached	U16	8	-	P S T	●	060EH
		6	V-CMP	Speed consistency						
		7	PNEAR	Positioning approach						
P6-15	DO4 function number	8	COIN	Positioning completion	U16	12	-	P S T	▲	060FH
		9	C-LT	Torque limit						
		10	V-LT	Rotating speed limit						

		11	WARN	Warning output						
		12	ALM	Alarm output						
		13	Tcmp	Torque consistency						
		14	Home	Homing completed						

Parameter	Function		Parameter scope		Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
		15	S-RUN	Servo on						
		27	T_CLS	The torque is reached						
		29	SPD_P	Speed programming comparison output						
		30	TRQ_P	Torque programming comparison output						
		31	SPD_TRQ	Speed and torque programming comparison output						
P6-16	DO1 valid delay	0~65535			U16	0	ms	P S T	○	0610H
P6-17	DO1 invalid delay	0~65535			U16	0	ms	P S T	○	0611H
P6-18	DO2 valid delay	0~65535			U16	0	ms	P S T	○	0612H
P6-19	DO2 invalid delay	0~65535			U16	0	ms	P S T	○	0613H
P6-20	DO3 valid delay	0~65535			U16	0	ms	P S T	○	0614H
P6-21	DO3 invalid delay	0~65535			U16	0	ms	P S T	○	0615H
P6-22	DO4 valid delay	0~65535			U16	0	ms	P S T	○	0616H
P6-23	DO4 invalid delay	0~65535			U16	0	ms	P S T	○	0617H
P6-24	DO forced valid output	0000B~1111B 0: Depending on the terminal function status; 1: Forced valid			U16	0000B	-	P S T	○	0618H
P6-25	AI1 filtering time	0~10000			U16	10	ms	P S T	○	0619H
P6-26	AI2 filtering time	0~10000			U16	10	ms	P S T	○	061AH
P6-27	AI1 hysteresis	0~300			U16	2	-	P S T	○	061BH
P6-28	AI2 hysteresis	0~300			U16	2	-	P S T	○	061CH
P6-29	AI1 offset adjustment	-3000~3000			I16	0	mV	P S T	○	061DH
P6-30	AI2 offset adjustment	-3000~3000			I16	0	mV	P S T	○	061EH
P6-31	AI1 dead zone	0~3000			U16	10	mV	P S T	○	061FH
P6-32	AI2 dead zone	0~3000			U16	10	mV	P S T	○	0620H
P6-33	AI1 zero drift	-2000~2000			I16	0	mV	P S T	○	0621H
P6-34	AI2 zero drift	-2000~2000			I16	0	mV	P S T	○	0622H
P6-35	AO1 function selection	0~20			U16	0	-	P S T	●	0623H
P6-36	AO2 function selection	0~20			U16	1	-	P S T	●	0624H
P6-37	AO1 gain adjustment	-10.00~10.00			I16	1.00	-	P S T	○	0625H

P6-38	AO2 gain adjustment	-10.00~10.00	I16	1.00	-	P S T	○	0626H
P6-39	AO1 offset adjustment	-10000~10000	I16	0	mV	P S T	○	0627H
P6-40	AO2 offset adjustment	-10000~10000	I16	0	mV	P S T	○	0628H
P6-41	AO direct output 1	-10000~10000	I16	0	-	P S T	○	0629H
P6-42	AO direct output 2	-10000~10000	I16	0	-	P S T	○	062AH
P6-43	Reserved							
P6-44	Reserved							
P6-45	Reserved							
P6-46	VDI status selection	00000000B~11111111B 0: depending on P6-55; 1: depending on VDOx	U16	00000000B	-	P S T	○	062EH
P6-47	VDI1 function number	Same with P6-02~P6-09	U16	0	-	P S T	●	062FH
P6-48	VDI2 function number		U16	0	-	P S T	●	0630H
P6-49	VDI3 function number		U16	0	-	P S T	●	0631H
P6-50	VDI4 function number		U16	0	-	P S T	●	0632H
P6-51	VDI5 function number		U16	0	-	P S T	●	0633H
P6-52	VDI6 function number		U16	0	-	P S T	●	0634H
P6-53	VDI7 function number		U16	0	-	P S T	●	0635H
P6-54	VDI8 function number		U16	0	-	P S T	●	0636H
P6-55	VDI input control	00000000B~11111111B	U16	00000000B	-	P S T	○	0637H
P6-56	VDI input status	00000000B~11111111B	U16	00000000B	-	P S T	▲	0638H
P6-57	VDO1 function number	Same with P6-12~P6-15	U16	0	-	P S T	●	0639H
P6-58	VDO2 function number		U16	0	-	P S T	●	063AH
P6-59	VDO3 function number		U16	0	-	P S T	●	063BH
P6-60	VDO4 function number		U16	0	-	P S T	●	063CH
P6-61	VDO5 function number		U16	0	-	P S T	●	063DH
P6-62	VDO6 function number		U16	0	-	P S T	●	063EH
P6-63	VDO7 function number		U16	0	-	P S T	●	063FH

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P6-64	VDO8 function number		U16	0	-	P S T	●	0640H
P6-65	VDO1 valid delay	0~65535	U16	0	ms	P S T	○	0641H
P6-66	VDO1 invalid delay	0~65535	U16	0	ms	P S T	○	0642H
P6-67	VDO2 valid delay	0~65535	U16	0	ms	P S T	○	0643H
P6-68	VDO2 invalid delay	0~65535	U16	0	ms	P S T	○	0644H
P6-69	VDO3 valid delay	0~65535	U16	0	ms	P S T	○	0645H
P6-70	VDO3 invalid delay	0~65535	U16	0	ms	P S T	○	0646H
P6-71	VDO4 valid delay	0~65535	U16	0	ms	P S T	○	0647H
P6-72	VDO4 invalid delay	0~65535	U16	0	ms	P S T	○	0648H
P6-73	VDO forced valid output	00000000B~11111111B	U16	00000000B	-	P S T	○	0649H
P6-74	VDO output status	00000000B~11111111B	U16	00000000B	-	P S T	▲	064AH
P6-75	VDI1 valid delay	0~65535	U16	0	ms	P S T	○	064BH
P6-76	VDI1 invalid delay	0~65535	U16	0	ms	P S T	○	064CH
P6-77	VDI2 valid delay	0~65535	U16	0	ms	P S T	○	064DH
P6-78	VDI2 invalid delay	0~65535	U16	0	ms	P S T	○	064EH
P6-79	VDI3 valid delay	0~65535	U16	0	ms	P S T	○	064FH
P6-80	VDI3 invalid delay	0~65535	U16	0	ms	P S T	○	0650H
P6-81	VDI4 valid delay	0~65535	U16	0	ms	P S T	○	0651H
P6-82	VDI4 invalid delay	0~65535	U16	0	ms	P S T	○	0652H
P6-83	VDI level logic	00000000B~11111111B 0: Positive logic; 1: Negative logic	U16	00000000B	-	P S T	○	0653H
P6-84	VDO	00000000B~11111111B	U16	00000000B	-	P S T	○	0654H

		level logic	0: Positive logic; 1: Negative logic						
P6-85	VDO output selection	00000000B~11111111B 0: depending on the function number; 1: depending on DIx	U16	00000000B	-	P S T	○	0655H
P6-86	DI3 valid delay	0~65535	U16	0	ms	P S T	○	0656H
P6-87	DI3 invalid delay	0~65535	U16	0	ms	P S T	○	0657H
P6-88	DI4 valid delay	0~65535	U16	0	ms	P S T	○	0658H
P6-89	DI4 invalid delay	0~65535	U16	0	ms	P S T	○	0659H
P6-90	DI5 valid delay	0~65535	U16	0	ms	P S T	○	065AH
P6-91	DI5 invalid delay	0~65535	U16	0	ms	P S T	○	065BH
P6-92	DI6 valid delay	0~65535	U16	0	ms	P S T	○	065CH
P6-93	DI6 invalid delay	0~65535	U16	0	ms	P S T	○	065DH
P6-94	DI7 valid delay	0~65535	U16	0	ms	P S T	○	064EH
P6-95	DI7 invalid delay	0~65535	U16	0	ms	P S T	○	065FH
P6-96	DI8 valid delay	0~65535	U16	0	ms	P S T	○	0660H
P6-97	DI8 invalid delay	0~65535	U16	0	ms	P S T	○	0661H

7.2.13 Group P7 - Communication setting parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P7-00	Modbus communication address setting	1~254	U16	1	-	P S T	○	-
P7-01	Baud rate of Modbus communication	0: 4800bps 1: 9600bps 2: 19200bps 3: 38400bps 4: 57600bps 5: 115200bps	U16	1	-	P S T	○	-
P7-02	Modbus communication data format	0: No check 1+8+N+1 1: Odd parity check 1+8+O+1 2: Even parity check 1+8+E+1 3: No check 1+8+N+2 4: Odd parity check 1+8+O+2 5: Even parity check 1+8+E+2	U16	0	-	P S T	○	-
P7-03	Modbus communication response delay	1~20	U16	2	ms	P S T	○	-
P7-04	Parameter storage selection upon Modbus communication	Bit 0: Parameter storage selection 0: Storage determined according to P7-05 selection 1: Parameters changed by communication are not saved Bit 1: Return selection upon receipt of a write command via communication 0: Received data is returned upon receipt of a write command 1: Received data is not returned upon receipt of a write command	U16	00	-	P S T	○	-
P7-05	Address selection upon Modbus communication	0: Address + 8000H stored 1: Address + 8000H not stored	U16	1	-	P S T	○	-
P7-06	Reserved							
P7-07	Reserved							
P7-08	Reserved							
P7-09	Status sequence setting for high 32-bit function code upon Modbus communication	0: For both read and write, the low 16 bits are before the high 16 bits 1: For both read and write, the high 16 bits are before the low 16 bits 2: For read, the low 16 bits are before the high 16 bits; for write, the high 16 bits are before the low 16 bits 3: For read, the high 16 bits are before the low 16 bits; for write, the low 16 bits are before the high 16 bits	U16	0	-	PST	○	0709H
P7-10~P7-29 are reserved								
P7-30	Source address 1 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	071EH
P7-31	Target address 1 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	071FH
P7-32	Source address 2 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0720H
P7-33	Target address 2 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0721H
P7-34	Source address 3 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0722H
P7-35	Target address 3 of Modbus	0000H~FFFFH	U16	FFFFH	-	PST	○	0723H

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
	communication mapping							
P7-36	Source address 4 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0724H
P7-37	Target address 4 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0725H
P7-38	Source address 5 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0726H
P7-39	Target address 5 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0727H
P7-40	Source address 6 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0728H
P7-41	Target address 6 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0729H
P7-42	Source address 7 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	072AH
P7-43	Target address 7 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	072BH
P7-44	Source address 8 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	072CH
P7-45	Target address 8 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	072DH
P7-46	Source address 9 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	072EH
P7-47	Target address 9 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	072FH
P7-48	Source address 10 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0730H
P7-49	Target address 10 of Modbus communication mapping	0000H~FFFFH	U16	FFFFH	-	PST	○	0731H

7.2.14 Group P8 - Expanded function parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P8-00	JOG speed	0~10000	U16	100	rpm	P S T	○	0800H
P8-01	JOG acceleration and deceleration time	1~65535	U16	200	ms	P S T	○	0801H
P8-02	Self-learning torque for offline inertia identification	10~200	U16	50	%	P S T	○	0802H
P8-03	Maximum number of revolutions and travel coefficient for offline inertia identification	0001~2020	U16	2010	rev	P S T	○	0803H

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P8-04	Reserved							
P8-05	Upper limit for revolutions of absolute type encoder	1~32767	U16	32767	rev	P S T	○	0805H
P8-06	Selection of the usage for absolute type encoder	0: Use as an incremental encoder 1: Use as an absolute type encoder	U16	0	-	P S T	●	0806H
P8-07	Fan control	0: Fan operates upon servo activation and alarm/warning 1: Fan operates after power-on 2: Fan operation is controlled based on the driver temperature	U16	0	-	P S T	○	0807H
P8-08	Driver overload warning threshold	20~100	U16	80	%	P S T	○	0808H
P8-09	Motor overload warning threshold	20~100	U16	80	%	P S T	○	0809H
P8-10	Braking resistance setting	20~30000	U16	50	Ω	P S T	○	080AH
P8-11	Braking resistor power setting	10~30000	U16	100	W	P S T	○	080BH
P8-12	Brake duty cycle	0~100	U16	100	%	P S T	○	080CH
P8-13	Braking resistor derating percentage	1~100	U16	40	%	P S T	●	080DH
P8-14	Minimum load for judgment of motor locked-rotor	10.0~250.0	U16	150.0	%	P S T	○	080EH
P8-15	Rotating speed for judgment of motor locked-rotor	0-500 (0: Locked-rotor judgment off)	U16	0	rpm	P S T	○	080FH
P8-16	Locked-rotor judgment time for motor	10~3000	U16	100	ms	P S T	○	0810H
P8-17	Locked-rotor torque limit for motor	0.0~150.0	U16	100.0	%	P S T	○	0811H
P8-18	Function switch 1	Bit 0: Under-voltage torque limit function Bit 1: Instantaneous power outage (PLRT) holding function Bit 2: Power failure detection function (associated with bit 1) Bit 3: Position judgment based on switching between command unit and encoder unit Bit 4: Reverse direction of speed command (speed mode) bit5: reserved by vendor	U16	00100B	-	P S T	○	0812H
P8-19	Function switch 2	Bit 0: Zero servo switch upon activation OFF Bit 1: Runaway detection switch Bit 2: Automatic restoration switch for under-voltage of encoder battery	U16	10B	-	P S T	○	0813H
P8-20	Reserved							
P8-21	Reserved							
P8-22	Torque limit upon voltage drop of the main circuit	1.0~100.0	U16	50.0	%	P S T	○	0816H
P8-23	Lifting time of torque limit upon voltage drop of the main circuit	10~1000	U16	100	ms	P S T	○	0817H
P8-24	Instantaneous outage holding time	10~1000	U16	100	ms	P S T	○	0818H
P8-25	External torque limit	0.0~500.0	U16	100.0	%	P S T	○	0819H
P8-26	External torque limit switching rate 1	0.1~500.0	U16	300.0	%/ms	P S T	○	081AH
P8-27	External torque limit switching rate 2	0.1~500.0	U16	300.0	%/ms	P S T	○	081BH
P8-28	When the external torque limit is valid, the position deviation warning detection is shielded	0: Normal detection 1: Shielding detection	U16	0	-	P S T	○	081CH
P8-29	When the external torque limit becomes invalid, alarm shielding	1~10000	U16	10000	ms	P S T	○	081DH

	inactivation is delayed							
P8-30	Reserved							
P8-31	Reserved							
P8-33	Reserved							
P8-36	Speed DO judgment selection	0: Setting 1 > speed > setting 2 1: Speed > setting 1, or speed < setting 2 2: Speed > setting 1 3: Speed < setting 2	U16	0	-	P S T	○	0824H
P8-37	Speed DO judgment setting 1	-10000~10000	I16	100	rpm	P S T	○	0825H
P8-38	Speed DO judgment setting 2	-10000~10000	I16	-100	rpm	P S T	○	0826H
P8-39	Torque DO judgment selection	0: Setting 1 > torque > setting 2 1: Torque > setting 1, or torque < setting 2 2: Torque > setting 1 3: Torque < setting 2	U16	0	-	P S T	○	0827H
P8-40	Torque DO judgment setting 1	-500.0~500.0	I16	100.0	%	P S T	○	0828H
P8-41	Torque DO judgment setting 2	-500.0~500.0	I16	-100.0	%	P S T	○	0829H
P8-42	Special gear ratio for GBK measurement	0.000~65.535	U16	0	mm	P S T	○	082AH
P8-43	Motor parameters to be read after power-on	0: Off 0: On	U16	0	-	P S T	○	082BH

7.2.15 Group P9 - Multi-segment position setting parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P9-00	Multi-segment position execution mode	0: Pr1~Pr16, activate cyclic operation to run the selected segment 1: Pr1~Pr16, activate execution of the selected segment 2: Pr1~Pr16, trigger execution of the selected segment 3: Trigger execution of the segment selected by the external DI s 4: Pr1~Pr16, trigger execution of segment 1 for cyclic operation 5: Pr1~Pr16, trigger execution of segment 1 6: Trigger execution of the segment selected by P9-01 7: Immediately execute the segment selected by P9-01 8: pr1~pr16, activate the cyclic sequence to run the selected segment 9: pr1~pr16, trigger the sequence to execute the selected segment 10: Immediately execute for the segment selected by the external DI	U16	0	-	P	●	0900H
P9-01	Segment selection for multi-segment position execution	0: Waiting command status 1~16: Segment corresponding to execution (automatic zeroing upon completion of execution)	U16	0	-	P	○	0901H
P9-02	Multi-segment position command reference setting	bit0: Multi-segment position command running mode 0: Incremental position running 1: Absolute type position running bit1: memory options 0: Memory upon S-OFF 1: No memory	U16	0	-	P	○	0902H
P9-03	Multi-segment acceleration time TPACC	1~10000	U16	100	ms	P	○	0903H
P9-04	Multi-segment deceleration time TPDEC	1~10000	U16	100	ms	P	○	0904H
P9-05	Reserved							
P9-06	Pulses of multi-segment position command Pr1	-2147483647~2147483647	I32	100000	Pulse	P	○	0906H
P9-08	Moving speed of multi-segment position command Pr1	1~10000	U16	100	rpm	P	○	0908H
P9-09	Pr1 stop time	0~65535	U16	0	ms	P	○	0909H
P9-10	Pulses of multi-segment position command Pr2	-2147483647~2147483647	I32	-100000	Pulse	P	○	090AH
P9-12	Moving speed of multi-segment position command Pr2	1~10000	U16	100	rpm	P	○	090CH
P9-13	Pr2 stop time	0~65535	U16	0	ms	P	○	090DH
P9-14	Pulses of multi-segment position command Pr3	-2147483647~2147483647	I32	0	Pulse	P	○	090EH
P9-16	Moving speed of multi-segment position command Pr3	1~10000	U16	100	rpm	P	○	0910H
P9-17	Pr3 stop time	0~65535	U16	0	ms	P	○	0911H
P9-18	Pulses of multi-segment position command Pr4	-2147483647~2147483647	I32	0	Pulse	P	○	0912H
P9-20	Moving speed of multi-segment position command Pr4	1~10000	U16	100	rpm	P	○	0914H
P9-21	Pr4 stop time	0~65535	U16	0	ms	P	○	0915H
P9-22	Pulses of multi-segment position command Pr5	-2147483647~2147483647	I32	0	Pulse	P	○	0916H
P9-24	Moving speed of multi-	1~10000	U16	100	rpm	P	○	0918H

	segment position command Pr5							
P9-25	Pr5 stop time	0~65535	U16	0	ms	P	○	0919H
P9-26	Pulses of multi-segment position command 6	-2147483647~2147483647	I32	0	Pulse	P	○	091AH
P9-28	Moving speed of multi-segment position command 6	1~10000	U16	100	rpm	P	○	091CH
P9-29	Pr6 stop time	0~65535	U16	0	ms	P	○	091DH
P9-30	Pulses of multi-segment position command Pr7	-2147483647~2147483647	I32	0	Pulse	P	○	091EH
P9-32	Moving speed of multi-segment position command Pr7	1~10000	U16	100	rpm	P	○	0920H
P9-33	Pr7 stop time	0~65535	U16	0	ms	P	○	0921H
P9-34	Pulses of multi-segment position command Pr8	-2147483647~2147483647	I32	0	Pulse	P	○	0922H
P9-36	Moving speed of multi-segment position command Pr8	1~10000	U16	100	rpm	P	○	0924H
P9-37	Pr8 stop time	0~65535	U16	0	ms	P	○	0925H
P9-38	Pulses of multi-segment position command Pr9	-2147483647~2147483647	I32	0	Pulse	P	○	0926H
P9-40	Moving speed of multi-segment position command Pr9	1~10000	U16	100	rpm	P	○	0928H
P9-41	Pr9 stop time	0~65535	U16	0	ms	P	○	0929H
P9-42	Pulses of multi-segment position command Pr10	-2147483647~2147483647	I32	0	Pulse	P	○	092AH
P9-44	Moving speed of multi-segment position command Pr10	1~10000	U16	100	rpm	P	○	092CH
P9-45	Pr10 stop time	0~65535	U16	0	ms	P	○	092DH
P9-46	Pulses of multi-segment position command Pr11	-2147483647~2147483647	I32	0	Pulse	P	○	092EH
P9-48	Moving speed of multi-segment position command Pr11	1~10000	U16	100	rpm	P	○	0930H
P9-49	Pr11 stop time	0~65535	U16	0	ms	P	○	0931H
P9-50	Pulses of multi-segment position command Pr12	-2147483647~2147483647	I32	0	Pulse	P	○	0932H
P9-52	Moving speed of multi-segment position command Pr12	1~10000	U16	100	rpm	P	○	0934H
P9-53	Pr12 stop time	0~65535	U16	0	ms	P	○	0935H

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
P9-54	Pulses of multi-segment position command Pr13	-2147483647~2147483647	I32	0	Pulse	P	○	0936H
P9-56	Moving speed of multi-segment position command Pr13	1~10000	U16	100	rpm	P	○	0938H
P9-57	Pr13 stop time	0~65535	U16	0	ms	P	○	0939H
P9-58	Pulses of multi-segment position command Pr14	-2147483647~2147483647	I32	0	Pulse	P	○	093AH
P9-60	Moving speed of multi-segment position command Pr14	1~10000	U16	100	rpm	P	○	093CH
P9-61	Pr14 stop time	0~65535	U16	0	ms	P	○	093DH
P9-62	Pulses of multi-segment position command Pr15	-2147483647~2147483647	I32	0	Pulse	P	○	093EH
P9-64	Moving speed of multi-segment position command Pr15	1~10000	U16	100	rpm	P	○	0940H
P9-65	Pr15 stop time	0~65535	U16	0	ms	P	○	0941H
P9-66	Pulses of multi-segment position command Pr16	-2147483647~2147483647	I32	0	Pulse	P	○	0942H
P9-68	Moving speed of multi-segment position command Pr16	1~10000	U16	100	rpm	P	○	0944H
P9-69	Pr16 stop time	0~65535	U16	0	ms	P	○	0945H
P9-70	Starting segment of cyclic operation	1~16 (only options 2 and 9 are valid for the initial run)	U16	1	-	P	○	0946H
P9-71	Ending segment of cyclic operation	1~16	U16	16	-	P	○	0947H
P9-72	Whether interruption of the current segment is allowed (when P9-00=10)	0: not allowed; 1: allowed	U16	0	-	P	○	0948H

7.2.16 Group PA - Multi-segment speed setting parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
PA-00	Multi-segment speed execution mode	0: Spd1~Spd16, activate cyclic operation 1: Spd1~Spd16, activate a run 2: Spd1~Spd16, trigger a run 3: Select a segment speed based on the external DI for running 4: Select a segment speed based on PA-01 for running	U16	0	-	S	●	0A00H
PA-01	Segment selection for execution of a multi-segment speed command	0: Waiting command status 1~16: Position of segment corresponding execution	U16	0	-	S	○	0A01H
PA-02	Multi-segment speed command Spd1	-10000~10000	I16	100	rpm	S	○	0A02H
PA-03	Running time of multi-segment speed command Spd1	0.0~6553.5	U16	1.0	s	S	○	0A03H
PA-04	Multi-segment speed command Spd2	-10000~10000	I16	-100	rpm	S	○	0A04H
PA-05	Running time of multi-segment speed command Spd2	0.0~6553.5	U16	1.0	s	S	○	0A05H
PA-06	Multi-segment speed command Spd3	-10000~10000	I16	0	rpm	S	○	0A06H
PA-07	Running time of multi-segment speed command Spd3	0.0~6553.5	U16	0.0	s	S	○	0A07H
PA-08	Multi-segment speed command Spd4	-10000~10000	I16	0	rpm	S	○	0A08H
PA-09	Running time of multi-segment speed command Spd4	0.0~6553.5	U16	0.0	s	S	○	0A09H
PA-10	Multi-segment speed	-10000~10000	I16	0	rpm	S	○	0A0AH

	command Spd5							
PA-11	Running time of multi-segment speed command Spd5	0.0~6553.5	U16	0.0	s	S	○	0A0BH
PA-12	Multi-segment speed command Spd6	-10000~10000	I16	0	rpm	S	○	0A0CH
PA-13	Running time of multi-segment speed command Spd6	0.0~6553.5	U16	0.0	s	S	○	0A0DH
PA-14	Multi-segment speed command Spd7	-10000~10000	I16	0	rpm	S	○	0A0EH
PA-15	Running time of multi-segment setting command Spd7	0.0~6553.5	U16	0.0	s	S	○	0A0FH
PA-16	Multi-segment speed command Spd8	-10000~10000	I16	0	rpm	S	○	0A10H
PA-17	Running time of multi-segment setting command Spd8	0.0~6553.5	U16	0.0	s	S	○	0A11H
PA-18	Multi-segment speed command Spd9	-10000~10000	I16	0	rpm	S	○	0A12H
PA-19	Running time of multi-segment setting command Spd9	0.0~6553.5	U16	0.0	s	S	○	0A13H
PA-20	Multi-segment speed command Spd10	-10000~10000	I16	0	rpm	S	○	0A14H
PA-21	Running time of multi-segment speed command Spd10	0.0~6553.5	U16	0.0	s	S	○	0A15H
PA-22	Multi-segment speed command Spd11	-10000~10000	I16	0	rpm	S	○	0A16H
PA-23	Running time of multi-segment speed command Spd11	0.0~6553.5	U16	0.0	s	S	○	0A17H
PA-24	Multi-segment speed command Spd12	-10000~10000	I16	0	rpm	S	○	0A18H
PA-25	Running time of multi-segment speed command Spd12	0.0~6553.5	U16	0.0	s	S	○	0A19H
PA-26	Multi-segment speed command Spd13	-10000~10000	I16	0	rpm	S	○	0A1AH
PA-27	Running time of multi-segment speed command Spd13	0.0~6553.5	U16	0.0	s	S	○	0A1BH
PA-28	Multi-segment speed command Spd14	-10000~10000	I16	0	rpm	S	○	0A1CH
PA-29	Running time of multi-segment speed command Spd14	0.0~6553.5	U16	0.0	s	S	○	0A1DH
PA-30	Multi-segment speed command Spd15	-10000~10000	I16	0	rpm	S	○	0A1EH
PA-31	Running time of multi-segment speed command Spd15	0.0~6553.5	U16	0.0	s	S	○	0A1FH
PA-32	Multi-segment speed command Spd16	-10000~10000	I16	0	rpm	S	○	0A20H
PA-33	Running time of multi-segment speed command Spd16	0.0~6553.5	U16	0.0	s	S	○	0A21H

7.2.17 Group Pb - Homing parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
Pb-00	Homing failure alarm time	0~65535	U16	0	ms	P	○	0B00H
Pb-01	Homing start mode	0: Turn off the homing function 1: Automatically execute homing when activated 2: Homing is triggered by the SHOW terminal (function No. 23)	U16	0	-	P	○	0B01H
Pb-02	Homing mode	1~35	U16	1	-	P	○	0B02H
Pb-03	High speed setting for the first segment of homing	0~10000	U16	500	rpm	P	○	0B03H
Pb-04	Low speed setting for the second segment of homing	0~10000	U16	50	rpm	P	○	0B04H
Pb-05	Acceleration and deceleration time for homing	1~65535	U16	100	ms	P	○	0B05H
Pb-06	Reserved							
Pb-07	Reserved							
Pb-08	Pulses of homing deviation	-2147483647~2147483647	I32	0	Pulse	P	○	0B08H
Pb-10	Position upon homing completion	-2147483647~2147483647	I32	0	PUL	P	○	0B0AH
Pb-12	Offset of the absolute position from the electrical origin	-2147483647~2147483647	I32	0	PUL	P	●	0B0CH
Pb-14	Locked-rotor torque limit for homing	0.0~150.0	U16	50.0	%	P	○	0B0EH

7.2.18 PC set - fully closed-loop parameters

Parameter	Function	Parameter scope	Data type	Initial value	Unit	Applicable mode	Attribute	Communication address
PC-00	Encoder feedback selection	0: Use motor encoder 1: Use external encoder	U16	0	-	P	☆	0C00H
PC-01	Selection of external encoder direction	0: In direction of standard motion 1: In direction of reverse motion	I16	0	-	P	☆	0C01H
PC-02	Pulse count of external encoder feedback per motor revolution	0~1073741824	U32	10000	Pulse	P	☆	0C02H
PC-04	Alarm threshold for excessive motor-load position deviation	0~1073741824	U32	10000	Pulse	P	○	0C04H
PC-06	Clear excessive motor-load position deviation	0~100	U16	0	-	P	○	0C06H
PC-07	Filtering time for hybrid vibration suppression	0.0~6553.5	I16	0.0	ms	P	○	0C07H
PC-08	External encoder disconnection detection	0: Do not detect external encoder disconnection 1: Detect external encoder disconnection	U16	0	-	P	●	0C08H

7.2.19 Pd set-motor parameters

Code	Function	Initial value		Unit	Attribute	Communication address
Pd-00	Reserved					
Pd-01	Motor code	Corresponding motor code		-	●	0D01H
Pd-02	Rated power of electric motor	Determined by motor code		kW	●	0D02H
Pd-03	Rated current of motor	Determined by motor code		A	●	0D03H
Pd-04	Rated torque of motor	Determined by motor code		Nm	●	0D04H
Pd-05	Rated voltage of motor	Determined by motor code		V	●	0D05H

Pd-06	Rated speed	Determined by motor code	rpm	●	0D06H
Pd-07	Max. motor speed	Determined by motor code	rpm	●	0D07H
Pd-08	Number of motor pole pairs	Determined by motor code	-	●	0D08H
Pd-09	Q-axis inductance	Determined by motor code	mH	●	0D09H
Pd-10	D-axis inductance	Determined by motor code	mH	●	0D0AH
Pd-11	Resistance between wires	Determined by motor code	Ω	●	0D0BH
Pd-12	Torque constant	Determined by motor code	N/A	●	0D0CH
Pd-13	Counter electromotive force	Determined by motor code	V	●	0D0DH
Pd-14	Motor rotor inertia	Determined by motor code	kg.cm^2	●	0D0EH

Code	Function	Initial value	Unit	Attribute	Communication address
Pd-15	Encoder type 0: - 1: - 2: - 3: - 4: Positive logic of serial encoder 5: Negative logic of serial encoder	Determined by motor code	-	●	0D0FH
Pd-16	Encoder line count	Determined by motor code	Pulse	●	0D10H
Pd-18	Electrical angle at the origin of the encoder	Determined by motor code	°	●	0D12H
Pd-19	-				
Pd-20	Reserved				
Pd-21	Encoder supports absolute value (multi-revolution) applications	Determined by motor code	-	●	0D15H
Pd-22	-				
Pd-23	Current regulator - Q-axis proportional gain	Determined by motor code	-	●	0D17H
Pd-24	Current regulator - D-axis proportional gain	Determined by motor code	-	●	0D18H
Pd-25	Current regulator - Q-axis integral gain	Determined by motor code	-	●	0D19H
Pd-26	Current regulator - D-axis integral gain	Determined by motor code	-	●	0D1AH
Pd-27	Current loop proportion turning	100	%	●	0D1BH
Pd-28	Current loop gain turning	100	%	●	0D1CH
Pd-29	Motor flange size	Determined by motor code	mm	●	0D1DH

Chapter 8 Details of functional parameters

8.1 d0-xx general monitoring parameters   **Monitoring parameters are used to view the status of a servo driver and cannot be modified**

d0-00	Motor speed			Initial value	0	Communication address	2000H
				Unit	rpm	Category	Display
	Scope	-6000~6000	Format	Decimal	Data size	16bit	Control mode	P S T

Current actual rotating speed of the servo motor, accurate to 1rpm. A negative number suggests reverse rotation of the motor (defined by P0-01)

d0-01	Motor load rate			Initial value	0.0	Communication address	2001H
				Unit	%	Category	Display
	Scope	-500.0~500.0	Format	Decimal	Data size	16bit	Control mode	P S T

The ratio of the current motor's load torque and rated torque is displayed. A negative number suggests reverse rotation of the motor.

$$Motor\ load\ rate = \frac{Actual\ load\ torque\ of\ motor}{Rated\ torque\ of\ motor} \times 100\%$$

d0-02	Total count of external pulses acquired			Initial value	0	Communication address	2002H
				Unit	Pulse	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

In the position mode, the total count of pulses sent by the upper computer to the servo is only useful in the position control mode.

1: This value is the count of external pulses that are actually received without frequency division/multiplication of the electronic gear ratio.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: This value refers to the count of continuous command pulses in the forward direction, and increases in the forward direction; when the command direction changes to the opposite, the value will continue to reduce to zero and then increase in the negative direction.

4: If the count of pulses received exceeds the above range, the value will restart from the maximum value in the opposite direction.

5: When the servo activation is OFF, this parameter will be automatically set to zero.

d0-04	Total count of feedback pulses (command pulse unit)			Initial value	0	Communication address	2004H
				Unit	Pulse	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

The total count of pulses for command pulse-based revolutions of the servo motor is displayed, which is only useful in the position control mode.

1: This value is the count of position command pulses obtained after electronic gear ratio reversing of encoder feedback pulses.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: This value increases in the forward direction when the motor continuously rotate forward; when the motor changes the rotating direction, the value will continue to reduce to zero and then increase in the reverse direction.

4: If the count of feedback pulses exceeds the above range, the value will restart from the maximum value in the opposite direction.

5: When the servo activation is OFF, this parameter will be automatically set to zero.

d0-06	Total count of feedback pulses (encoder unit)			Initial value	0	Communication address	2006H
				Unit	PUL	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

The total count of pulses for encoder resolution-based revolutions of the servo motor is displayed, which is only useful in the position control mode.

1: This value refers to the actual count of encoder feedback pulses, and shall be used with special attention paid to the resolution of the motor encoder.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: The counting method and out-of-limit handling according to d0-04 shall apply.

4: When the servo activation is OFF, this parameter will be automatically set to zero.

d0-08	Frequency of external pulses received			Initial value	0.00	Communication address	2008H
				Unit	kHz	Category	Display
	Scope	-10000.00~10000.00	Format	Decimal	Data size	32bit	Control mode	P

The external pulse frequency currently collected is displayed, which is only useful in the position control mode.

d0-10	Position deviation			Initial value	0	Communication address	200AH

					Unit	ppr	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

The current position offset, i.e. the difference between the received command pulses and feedback pulses, based on the command pulse unit in default (P8-18 bit3=0) is displayed.

Caution☞	**This parameter may have the encoder unit modified by setting P8-18 bit3 to 1. See detailed description of P8-18**

d0-12	DI terminal status					Initial value	00000000B	Communication address	200CH
						Unit	-	Category	Display
	Scope	00000000B~11111111B		Format	Binary	Data size	16bit	Control mode	P S T

The DI terminal status is displayed. Totally 8-bit data are displayed, respectively representing DI1~DI8.

For example, panel display:	通过 < 键切换 DI5 DI4 DI3 DI2 DI1 / 保留 保留 DI8 DI7 DI6	suggesting that DI1, DI3, DI6 and DI8 are active (Whether a DI terminal is active at the high level or the low level depends on setting of parameter P6-01)

d0-13	DO terminal status					Initial value	00000B	Communication address	200DH
						Unit	-	Category	Display
	Scope	00000B~11111B		Format	Binary	Data size	16bit	Control mode	P S T

The DO terminal status is displayed. Totally 5-bit data are displayed, respectively representing DO1~DO5.

For example, panel display:	00101 DO4 DO3 DO2 DO1	suggesting that DO1 and DO3 are in the active output status. (Whether a DO terminal is active for output in the connected or open status depends on setting of parameter P6-11)

d0-14	AI1 command voltage (after system processing)					Initial value	0	Communication address	200EH
						Unit	mV	Category	Display
	Scope	-10000~10000		Format	Decimal	Data size	16bit	Control mode	P S T

The voltage collected through the analog input channel AI1 and processed by filtering, offset, hysteresis, dead zone and zero-drift is displayed

d0-15	AI2 command voltage (after system processing)					Initial value	0	Communication address	200FH
						Unit	mV	Category	Display
	Scope	-10000~10000		Format	Decimal	Data size	16bit	Control mode	P S T

The voltage collected through the analog input channel AI2 and processed by filtering, offset, hysteresis, dead zone and zero-drift is displayed

d0-16	Bus voltage					Initial value	0	Communication address	2010H
						Unit	V	Category	Display
	Scope	0~1000		Format	Decimal	Data size	16bit	Control mode	P S T

The actual value of internal DC bus voltage of the driver (L1/L2/L3) is displayed

d0-17	Valid motor current					Initial value	0.00	Communication address	2011H
						Unit	A	Category	Display
	Scope	0.00~655.35		Format	Decimal	Data size	16bit	Control mode	P S T

The current valid value of motor current is displayed

Valid motor current $I = \sqrt{\frac{2}{3}(I_U^2 + I_V^2 + I_W^2)}$

d0-18	Rotating speed corresponding to pulse command					Initial value	0	Communication address	2012H
						Unit	rpm	Category	Display
	Scope	-6000~6000		Format	Decimal	Data size	16bit	Control mode	P

The speed command value corresponding to the current command pulse is displayed

d0-19	Speed command value					Initial value	0	Communication address	2013H
						Unit	rpm	Category	Display
	Scope	-6000~6000		Format	Decimal	Data size	16bit	Control mode	P S T

The current speed command value is displayed.

d0-20	Torque command value					Initial value	0	Communication address	2014H
						Unit	%	Category	Display
	Scope	-500.0~500.0		Format	Decimal	Data size	16bit	Control mode	P S T

The current torque command value is displayed, with the motor rated torque taken as reference

d0-21	Maximum instantaneous motor load rate		Initial value	0	Communication address	2015H

					Unit	%	Category	Display
	Scope	-500.0~500.0	Format	Decimal	Data size	16bit	Control mode	P S T

The ratio of the motor's actual maximum output torque and rated torque during the whole process from activation ON to activation OFF is displayed.

d0-22	**IGBT module temperature**			Initial value	0	Communication address	2016H
				Unit	°C	Category	Display
Scope	0~150	Format	Decimal	Data size	16bit	Control mode	P S T

Internal temperature of IGBT module

The driver is provided with a completed over-temperature protection mechanism. For reason of temperature detection at different locations, the temperature displayed may reach up to 100°C or higher. This is normal.

d0-23	**Bus voltage of switching power**			Initial value	0	Communication address	2017H
				Unit	V	Category	Display
Scope	0~1000	Format	Decimal	Data size	16bit	Control mode	P S T

Displays the actual value of switch power bus voltage for the internal control circuit in the driver (L1C/L2C)

d0-24	**Total operating time of system:**			Initial value	0	Communication address	2018H
				Unit	min	Category	Display
Scope	0~2147483647	Format	Decimal	Data size	32bit	Control mode	P S T

The cumulative operating (activation ON) time of the servo driver after it is delivered out of the factory is displayed. (To prevent EEPROM damage, this parameter is saved once every 10 minutes)

d0-26	**Brake load rate**			Initial value	0.0	Communication address	201AH
				Unit	%	Category	Display
Scope	0.0~400.0	Format	Decimal	Data size	16bit	Control mode	P S T

When the motor is in the brake mode, the load rate of the current braking resistor is displayed.

$$\text{Brake load rate} = \frac{\text{Power actually applied on the braking resistor}}{\text{Rated power of braking resistor}} \times 100\%$$

d0-27	**Electrical angle of current motor**			Initial value	Depending on the motor	Communication address	201BH
				Unit	°	Category	Display
Scope	0.0~359.9	Format	Decimal	Data size	16bit	Control mode	P S T

The current electrical angle of the motor rotor is displayed

Electrical angle = mechanical angle of the motor * number of motor pole pairs

d0-29	**Revolutions of absolute type encoder**			Initial value	0	Communication address	201DH
				Unit	Rev	Category	Display
Scope	-32768~+32767	Format	Decimal	Data size	16bit	Control mode	P S T

In case of an absolute type encoder, the multi-turn value fed back is displayed. The negative sign suggests the reverse direction (the actual rotating direction of the motor is defined by P0-01)

d0-30	**Current revolution position value of serial encoder**			Initial value	0	Communication address	201EH
				Unit	PUL	Category	Display
Scope	0~8388608	Format	Decimal	Data size	32bit	Control mode	P S T

The current single revolution position value of the serial encoder is displayed

d0-32	**Total count of external pulses acquired**			Initial value	0	Communication address	2020H
				Unit	Pulse	Category	Display
Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

In the position mode, the total count of pulses sent by the upper computer to the servo is only useful in the position control mode.

1: This value is the count of external pulses that are actually received without frequency division/multiplication of the electronic gear ratio.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: This value refers to the count of continuous command pulses in the forward direction, and increases in the forward direction; when the command direction changes to the opposite, the value will continue to reduce to zero and then increase in the negative direction.

4: If the count of pulses received exceeds the above range, the value will restart from the maximum value in the opposite direction.

5: This parameter value starts calculation when the servo driver is powered on, and will be automatically set to zero when the driver is powered off.

d0-34	**Current position of servo motor (command pulse unit)**			Initial value	0	Communication address	2022H
				Unit	Pulse	Category	Display
Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P S T

The total count of pulses for command pulse-based revolutions of the servo motor is displayed, which is valid in any mode.

1: This value is the count of corresponding command pulses obtained after electronic gear ratio reversing of encoder feedback pulses.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: This value increases in the forward direction when the motor continuously rotate forward; when the motor changes the rotating direction, the value will continue to reduce to zero and then increase in the reverse direction.

4: If the count of feedback pulses exceeds the above range, the value will restart from the maximum value in the opposite direction.

5: This parameter value starts calculation when the servo is powered on (in case of an incremental system, it starts from 0; in case of an absolute value system, it starts from the encoder position currently obtained; after homing, it starts from Pb-07). It's zeroed automatically upon driver power-down.

d0-36	Current position of servo motor (encoder unit)			Initial value	0	Communication address	2024H
				Unit	PUL	Category	Display
Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P S T

The total count of pulses for encoder resolution-based revolutions of the servo motor is displayed, which is valid in any mode.

1: This value refers to the actual count of encoder feedback pulses, and shall be used with special attention paid to the resolution of the motor encoder.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: The way of value change and out-of-limit handling described above shall apply.

4: This parameter value starts calculation when the servo is powered on (in case of an incremental system, it starts from 0; in case of an absolute value system, it starts from the encoder currently obtained; after homing, it starts from Pb-10). It's zeroed automatically upon driver power-down.

d0-38	Positioning status			Initial value	0	Communication address	2026H
				Unit	-	Category	Display
Scope	0~1	Format	Decimal	Data size	16bit	Control mode	P

The positioning status is displayed

0: Positioning in process

1: Positioning completed

d0-39	Current segment of multi-segment speed			Initial value	0	Communication address	2027H
				Unit	-	Category	Display
Scope	0~16	Format	Decimal	Data size	16bit	Control mode	P S T

When the multi-segment speed mode is used, the current segment being executed is displayed. If no segment is currently being executed, the previous segment executed is displayed.

d0-40	Current segment of multi-segment position			Initial value	0	Communication address	2028H
				Unit	-	Category	Display
Scope	0~16	Format	Decimal	Data size	16bit	Control mode	P S T

When the multi-segment position mode is used, the current segment being executed is displayed. 0 means the previous segment has been executed, and there is no segment requiring execution or being executed.

d0-41	AI1 physical voltage (actual value)			Initial value	0	Communication address	2029H
				Unit	mV	Category	Display
Scope	-10000~10000	Format	Decimal	Data size	16bit	Control mode	P S T

The actual voltage collected through the analog input channel AI1 is displayed

d0-42	AI2 physical voltage (actual value)			Initial value	0	Communication address	202AH
				Unit	mV	Category	Display
Scope	-10000~10000	Format	Decimal	Data size	16bit	Control mode	P S T

The actual voltage collected through the analog input channel AI2 is displayed

d0-46	Average load rate of motor			Initial value	0.0	Communication address	202EH
				Unit	%	Category	Display
Scope	0~500.0	Format	Decimal	Data size	16bit	Control mode	P S T

The average load rate of motor from the first activation of the driver is displayed.

d0-47	Heat accumulation of driver			Initial value	0.000	Communication address	202FH
				Unit	-	Category	Display
Scope	0.000~1.000	Format	Decimal	Data size	16bit	Control mode	P S T

The current heat accumulation of the driver is displayed. An `AL.00E` alarm will occur when the value reaches 1.000. (If this value slowly increases during normal operation, please check if the selected model/control plan is proper)

d0-48	Heat accumulation of motor (instantaneous)			Initial value	0.000	Communication address	2030H
				Unit	-	Category	Display
Scope	0.000~1.000	Format	Decimal	Data size	16bit	Control mode	P S T

d0-49	Heat accumulation of motor (steady state)			Initial value	0.000	Communication address	2031H
				Unit	-	Category	Display
Scope	0.000~1.000	Format	Decimal	Data size	16bit	Control mode	P S T

The current heat accumulation of the motor is displayed. An $\mathit{AL.00d}$ alarm will occur when the value reaches 1.000. (If this value slowly increases during normal operation, please check if the selected model/control plan is proper)

d0-62	GBK detected position pulse value/length				Initial value	0	Communication address	203EH
					Unit	-	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P S T

When the DI terminal set to function No. 34 (GBK function) is triggered, the actual rotation pulses/length of the motor is displayed.

When P8-42=0, pulses of the encoder unit is displayed.

When P8-42≠0, length in mm is displayed.

d0-64	Over-temperature point of motor encoder			Initial value	0	Communication address	2040H
				Unit	°C	Category	Display
	Scope	0~65535	Format	Decimal	Data size	16bit	Control mode	P S T

The set over-temperature point of the motor encoder is displayed, which is only applicable to the 17/23-bit serial encoders.

d0-65	Encoder temperature upon power-on			Initial value	0	Communication address	2041H
				Unit	°C	Category	Display
	Scope	-128~128	Format	Decimal	Data size	16bit	Control mode	P S T

The temperature of the serial encoder upon power-on, or the current temperature obtained through AF-15=2 operation in the OFF state is displayed.

d0-67	Zero drift value of output current			Initial value	Uncertain	Communication address	2043H
				Unit	-	Category	Display
	Scope	0000~9999	Format	Decimal	Data size	16bit	Control mode	P S T

The units place and ten's place represent the zero drift of phase U current. Their combination falls in the scope of 0 - 99. If it's greater than 50, the final zero drift is positive and should be deducted by 50;

otherwise the negative zero drift is obtained by direct negation.

The hundred's place and the thousand's place represent phase V zero drift (combination of which also falls in 0 - 99) and share the same meaning as phase U.

d0-68	Total count of feedback pulses of external encoder (command pulse unit)			Initial value	0	Communication address	2045H
				Unit	Pulse	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

When PC-00=1, total pulses of external encoder feedback based on command pulse are displayed.

1: This value is the count of corresponding command pulses obtained after electronic gear ratio reversing of external encoder feedback pulses.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: This value increases in the forward direction when the external encoder continuously moves forward; when the movement direction changes, the value will continue to reduce to zero and then increase in the reverse direction.

4: If the count of feedback pulses exceeds the above range, the value will restart from the maximum value in the opposite direction.

5: This parameter value starts calculation when the servo driver is powered on, and will be automatically set to zero when the driver is powered off.

d0-70	Total count of feedback pulses of external encoder (encoder pulse unit)			Initial value	0	Communication address	2047H
				Unit	PUL	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

When PC-00=1, total pulses of external encoder feedback based on encoder pulse are displayed.

1: This value refers to the actual count of pulses fed by the external encoder.

2: This value may have more than five bits, and the shift key can be used to view the bit values.

3: This value increases in the forward direction when the external encoder continuously moves forward; when the movement direction changes, the value will continue to reduce to zero and then increase in the reverse direction.

4: If the count of feedback pulses exceeds the above range, the value will restart from the maximum value in the opposite direction.

5: This parameter value starts calculation when the servo driver is powered on, and will be automatically set to zero when the driver is powered off.

d0-72	Fully closed-loop position deviation			Initial value	0	Communication address	2049H
				Unit	PUL	Category	Display
	Scope	-2147483647~2147483647	Format	Decimal	Data size	32bit	Control mode	P

When PC-00=1, fully closed-loop position deviation is displayed based on the external encoder pulse unit.

Fully closed-loop position deviation = pulse count of external encoder feedback - pulse count of motor encoder feedback converted to external encoder (by PC-02).

8.2 d1-xx Alarm query parameter

Alarm query allows query the current and previous three alarm records. Here only the current alarm is described, as other alarms are the same.

d1-00	Current alarm code			Initial value	0	Communication address	2100H
				Unit	-	Category	Display
Scope	00~FF	Format	Hexadecimal	Data size	16bit	Control mode	P S T

Code of the current alarm is displayed. For meaning of the alarm code and corresponding countermeasure, refer to Chapter 11

d1-01	Rotating speed upon the current alarm			Initial value	0	Communication address	2101H
				Unit	rpm	Category	Display
Scope	-6000~6000	Format	Decimal	Data size	16bit	Control mode	P S T

The rotating speed of the motor upon occurrence of the current alarm is displayed. Minus means the motor rotates in the reverse direction (defined by P0-01)

d1-02	Bus voltage upon the current alarm			Initial value	0	Communication address	2102H
				Unit	V	Category	Display
Scope	0~1000	Format	Decimal	Data size	16bit	Control mode	P S T

Bus voltage of the servo driver upon occurrence of the current alarm is displayed

d1-03	Active current upon the current alarm			Initial value	0.00	Communication address	2103H
				Unit	A	Category	Display
Scope	0.00~655.35	Format	Decimal	Data size	16bit	Control mode	P S T

Active current of the motor upon occurrence of the current alarm is displayed

d1-04	Running time upon the current alarm			Initial value	0	Communication address	2104H
				Unit	min	Category	Display
Scope	0~2147483647	Format	Decimal	Data size	32bit	Control mode	P S T

Cumulative running time of the driver upon occurrence of the current alarm is displayed (as of departure of the driver from the factory)

d1-24	Current alarm status			Initial value	0	Communication address	2118H
				Unit	-	Category	Display
Scope	00~FF	Format	Hexadecimal	Data size	16bit	Control mode	P S T

When 0 is displayed, it means no alarm is currently present;

When any value other than 0 is displayed, it means there is an alarm present; the value is the alarm code (ALO not displayed). For meaning of the alarm code and corresponding countermeasure, refer to Chapter 11

d1-25	Current warning status			Initial value	0	Communication address	2119H
				Unit	-	Category	Display
Scope	00~FF	Format	Hexadecimal	Data size	16bit	Control mode	P S T

When 0 is displayed, it means no alarm is currently present;

When any value other than 0 is displayed, it means there is a warning present; the value is the warning code (ALE not displayed). For meaning of the warning code and corresponding countermeasure, refer to Chapter 11

8.3 d2-xx Product information query parameters

d2-00	Servo driver type				Initial value	10	Communication address	2200H
					Unit	-	Category	Display
	Scope	0~131		Format	Decimal	Data size	16bit	Control mode	P S T

The servo driver type is displayed.

d2-00 tens place	d2-00 ones place	Command type	Encoder type
0	0	Reserved	-
	1		-
1	0	Analog quantity and pulse type EA350	2500ppr incremental encoder
	1		17/23-bit serial communication encoder

d2-00 hundreds place represents the factory parameter, which shall be provided upon requesting technical support.

d2-01	Current motor CODE				Initial value	0	Communication address	2201H
					Unit	-	Category	Display
	Scope	0~999		Format	Decimal	Data size	16bit	Control mode	P S T
d2-02	Performance software serial number 1				Initial value	100.00	Communication address	2202H
					Unit	-	Category	Display
	Scope	0.00~655.35		Format	Decimal	Data size	16bit	Control mode	P S T

Other parameters in this group will not be further elaborated.

8.4 d3-xx Real-time monitoring parameters

Parameter	Function	Data type	Initial value (example)	Unit	Communication address
d3-05	Motor speed	I16	0	rpm	2305H
d3-06	Position deviation	I32	0	ppr	2306H
d3-08	Motor load rate	I16	0.0	%	2308H
d3-09	Revolutions of absolute type encoder	I16	0	Rev	2309H
d3-10	Current revolution position of serial encoder	U32	0	Pulse	230AH
d3-12	Total count of command pulses acquired (maintained on power-on)	I32	0	Pulse	230CH
d3-14	Current position of motor (based on command pulse, maintained on power-on)	I32	0	Pulse	230EH
d3-18	Low zero position of machine 32 bits (based on encoder pulse)	I32	0	Pulse	2312H
d3-20	High zero position of machine 32 bits (based on encoder pulse)	I32	0	Pulse	2314H
d3-22	Low current position of motor 32 bits (based on encoder pulse)	I32	0	Pulse	2316H
d3-24	High current position of motor 32 bits (based on encoder pulse)	I32	0	Pulse	2318H

Parameters d3-05~d3-14 have the same meaning with corresponding function parameters in group d0, but they are refreshed once every 1ms and thus cannot be accurately identified by naked eyes. When real-time data needs to be acquired by the upper computer, the data can be read by communication.

64-bit motor position data comprising d3-18 and d2-20 displays the position of the absolute value encoder (encoder unit) corresponding to the mechanical zero point, which is only valid in the absolute position mode and can be used when needed.

Caution☞
1. Mechanical zero point is the encoder position obtained by the stop position of the motor after homing minus the set value of Pb-10.
2. Note that Pb-10 is a command pulse unit and needs to be converted into an encoder unit through the electronic gear ratio.
3. This mode works only when the absolute type encoder is used and P8-06=1, that is, the absolute position mode is enabled.

64-bit motor position data comprising d3-22 and d2-24 displays the offset of the current motor position relative to the mechanical zero point and the encoder unit, which can be used when needed.

8.5 P0-xx Basic control parameters

P0-00	**Control mode selection**		Initial value	1	Communication address	0000H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~8	Data size	16bit	Control mode	P S T

Parameter functions: Select the control mode of the servo system

P0-00=0: Speed control mode

The servo driver works in the speed control mode, and can determine the rotating speed of the motor through communication, parameter setting, analog, and multi-segment speed.

Default functions of DI and DO terminals will change automatically. See description of group P6.

P0-00=1: Position control mode

The servo driver works in the position control mode. The rotating position of the motor can be determined through external position pulse and internal multi-segment position setting. The rotating speed of the motor can be regulated through pulse frequency.

Default functions of DI and DO terminals will change automatically. See description of group P6.

P0-00=2: Torque control mode

The servo driver works in the torque control mode, and can determine the output torque of the motor by communication, parameter setting, and analog.

Default functions of DI and DO terminals will change automatically. See description of group P6.

P0-00=3: Speed-position switching mode (zero speed)

The driver works in the speed-position switching mode and switching occurs only at zero speed.

Mode switching can be realized through the DI terminal defined as MSEL function.

When the motor is at zero speed, the driver can switch between the speed and position modes by changing the status of the MSEL terminal.

☞ When it switches from the position control mode to the speed control mode, stranded pulses will be cleared.

☞ Zero speed is the set value of P0-03.

☞ When the zero-speed condition is dissatisfied, even if the mode switching MSEL signal switches between ON/OFF to subsequently meet the zero-speed condition, the driver still cannot switch between the control modes.

☞ When the MSEL terminal is invalid, the driver works in the speed control mode.
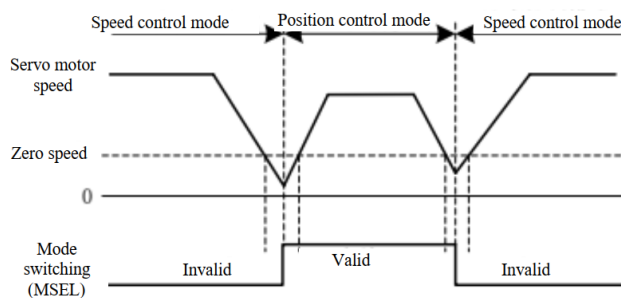
P0-00=5: Position-torque switching mode (zero speed)

The driver works in the position-torque switching mode and switching occurs only at zero speed.

Mode switching can be realized through the DI terminal defined as MSEL function.

When the motor is at zero speed, the driver can switch between the position and torque modes by changing the status of the MSEL terminal.

☞ When it switches from the position control mode to the torque control mode, stranded pulses will be cleared.

☞ Zero speed is the set value of P0-03.

☞ When the zero-speed condition is dissatisfied, even if the mode switching MSEL signal switches between ON/OFF to subsequently meet the zero-speed condition, the driver still cannot switch between the control modes.

☞ When the MSEL terminal is invalid, the driver works in the position control mode.
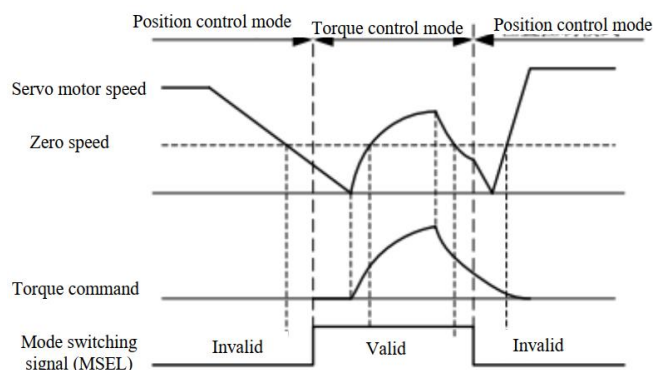
P0-00=6: Speed-position switching mode (immediately)

The driver works in the speed-position switching mode and the mode can be switched at any time.

Mode switching can be realized through the DI terminal defined as MSEL function.

No matter whether the motor rotates, by changing the status of the MSEL terminal, the driver can immediately switch between the speed and position control modes.

☞   When it switches from the position control mode to the speed control mode, stranded pulses will be cleared.

☞   When the MSEL terminal is invalid, the driver works in the speed control mode.
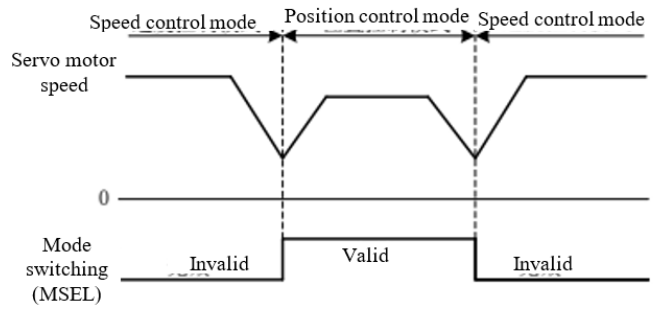
Caution☞	In this mode, mechanical shock or driver alarm may occur during the switching process.

P0-00=7: Torque-speed switching mode (immediately)

The driver works in the torque-speed switching mode and the mode can be switched at any time.

Mode switching can be realized through the DI terminal defined as MSEL function.

No matter whether the motor rotates, by changing the status of the MSEL terminal, the driver can immediately switch between the torque and speed control modes.

☞ When the MSEL terminal is invalid, the driver works in the torque control mode.
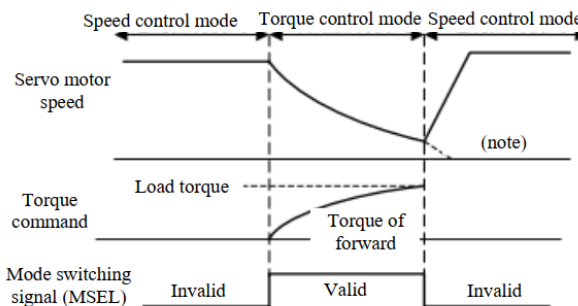
Caution☞	If upon switching to the speed control mode, the speed command value is 0, the servo motor will decelerate over the time defined by P2-05 to stop.

P0-00=8: Position-torque switching mode (immediately)

The driver is working in the position-torque switching mode and can be switched at any time.

Mode switching can be realized through the DI terminal defined as MSEL function.

No matter whether the motor rotates, by changing the status of the MSEL terminal, the driver can immediately switch between the position and torque control modes.

☞ When it switches from the position control mode to the torque control mode, stranded pulses will be cleared.

☞ When the MSEL terminal is invalid, the driver works in the position control mode.
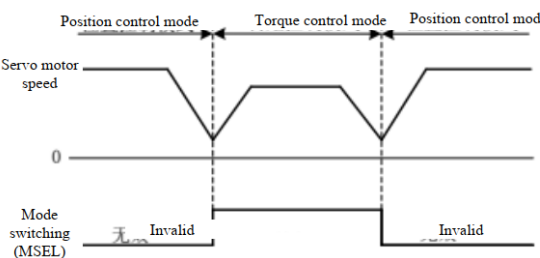
Caution☞	In this mode, mechanical shock or driver alarm may occur during the switching process.

P0-01	Rotation direction		Initial value	0	Communication address	0001H
			Unit	-	Time of taking effect	Motor static state activated
	Setting range	0~1	Data size	16bit	Control mode	P S T

Parameter functions: Set the motor rotation direction.

P0-01=0: In case of a forward direction command, the motor rotates anticlockwise (CCW)

P0-01=1: In case of a forward direction command, the motor rotates anticlockwise (CCW)
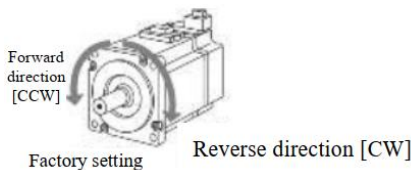
P0-02	Maximum rotating speed setting		Initial value	3000	Communication address	0002H
			Unit	rpm	Time of taking effect	Taking effect upon power-on again
	Setting range	0~10000*	Data size	16bit	Control mode	P S T

Parameter functions: Set the allowed maximum servo motor speed. The value given by the system may not be higher than this value. If the running speed of the motor goes beyond 1.1 times the set value, an overspeed alarm will occur.

Caution☞	Even if a greater value is set, an overspeed alarm will still occur when the rotating speed exceeds the maximum speed permitted by the motor. Setting of the actual rotating speed is subject to limit of the actual motor parameters. This will not be further elaborated in (subsequent) description of function codes.

P0-03	Zero-speed signal output value		Initial value	10	Communication address	0003H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting	10~1000	Data size	16bit	Control mode	P S T

	range					

Parameter functions: Set the standard for zero-speed detection and timing of ZERO (motor zero-speed) signal output.

P0-03 setting is valid regardless of the direction and is valid in both forward and reverse directions. There is 10rpm lagging.
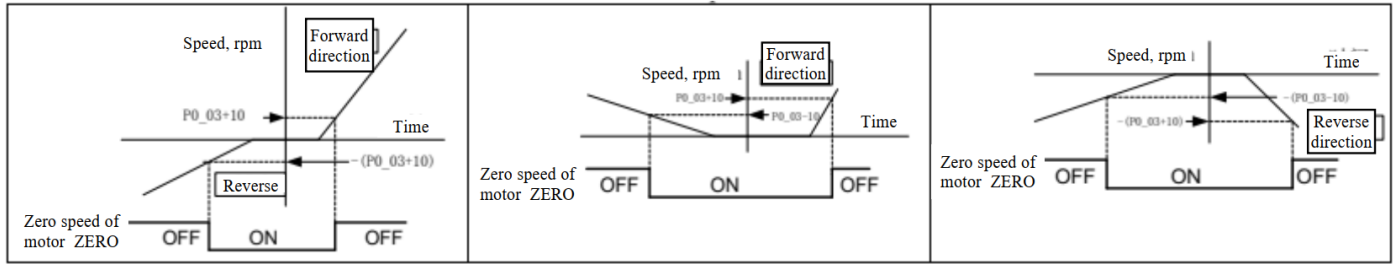
P0-04	**Rotation signal output value**		Initial value	20	Communication address	0004H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	10~1000	Data size	16bit	Control mode	P S T

Parameter functions: Set the standard for rotating status detection of motor and timing of TGON (motor rotation) signal output.

P0-04 setting is valid regardless of the direction and is valid in both forward and reverse directions. There is 10rpm lagging.
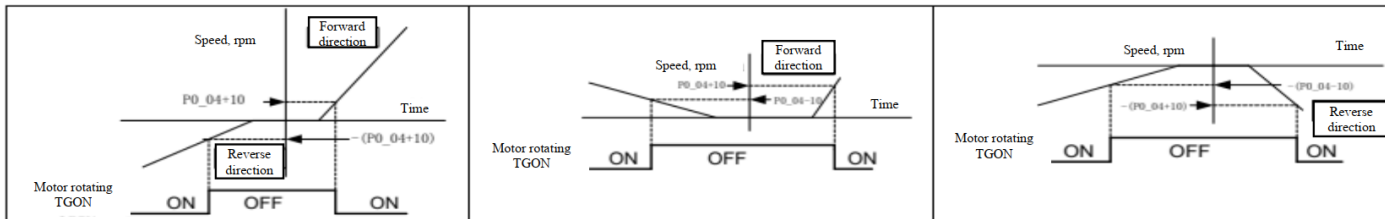
P0-05	**Torque limit source selection of the 1st revolution**		Initial value	0	Communication address	0005H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~8	Data size	16bit	Control mode	P S T

Parameter functions: Select a source for limiting the motor output torque

P0-05=0: P0-06 limits the forward torque; P0-07 limits the negative torque;

P0-05=1: AI1 limits the forward and negative torque;

P0-05=2: AI2 limits the forward and negative torque;

P0-05=3: AI1 limits the forward torque; P0-07 limits the negative torque;

P0-05=4: AI2 limits the forward torque; P0-07 limits the negative torque;

P0-05=5: P0-06 limits the forward torque; AI1 limits the negative torque;

P0-05=6: P0-06 limits the forward torque; AI2 limits the negative torque;

P0-05=7: AI1 limits the forward torque; AI2 limits the negative torque;

P0-05=8: AI1 limits the negative torque; AI2 limits the forward torque;

Taking P0-05=1 as an example, refer to the figure on the right for definitions of torque limits

$$\text{Forward torque limit value} = \left|\frac{AI1}{10V}\right| * P0\text{-}06 \qquad \text{Backward torque limit value} = \left|\frac{AI1}{10V}\right| * P0\text{-}07$$
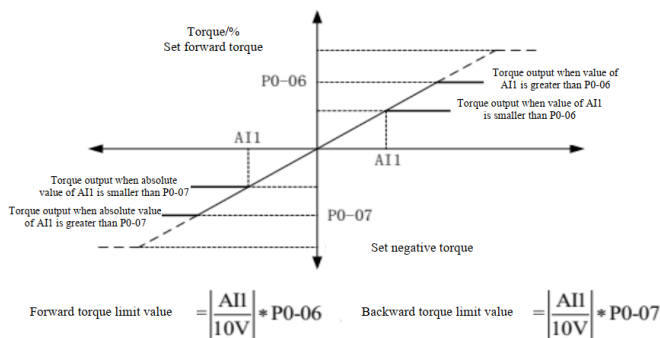
Caution☞	The TL2 terminal can be defined for switching the torque limit to the external torque limit at any time. See description of P8-25~29 for details.

P0-06	**Torque limit of the 1st revolution - forward maximum**		Initial value	300.0	Communication address	0006H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~500.0*	Data size	16bit	Control mode	P S T
P0-07	**Torque limit of the 1st revolution - reverse maximum**		Initial value	300.0	Communication address	0007H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~500.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the torque limit in corresponding direction, with the rated torque of the motor as reference.

☞ The smallest value will always be used when the torque is limited by analog or other parameters.

Caution☞	If values of these two parameters are changed to be greater than respective factory settings, over-current alarm or other alarms may be liable to occur. For this reason, it is commonly recommended to reduce the values. The actual maximum torque limit depends on specific models. (Subsequent) parameter description will not be repeated.

P0-08	**Braking mode selection**	Initial value	200H	Communication address	0008H

			Unit		-	Time of taking effect	With immediate effect
	Setting range	000H~311H		Data size	16bit	Control mode	P S T

Parameter functions: Set the braking mode. The letter H at the end of the number means the parameter value is expressed in hexadecimal, and shall be noted during communication.

P0-08 bit0=0: When the servo activation is OFF, the motor can brake freely and after braking it remains in the free state.

P0-08 bit0=1: When the servo activation is OFF, the motor will decelerate over the time set by P0-17 to stop, and after braking it remains in the free state.

Caution☞	**1. When activation is OFF, if the P0-17 value is smaller than P0-09, then after deceleration over P0-17 to stop, the servo will enter the zero-servo state (even if in the speed or torque mode). Only when the time set by P0-09 is reached will the motor power be cut off to render the motor in the free state.** **2. If you don't want zero servo state (i.e. motor shaft locked state) to be activated when P0.09 - P0.17 are available, the user can set P0.17 to be equal or greater than P0.09, or set P8-19 bit0 as 1.**

P0-08 bit1=0: When a second level alarm occurs, the motor can brake freely and after braking it remains in the free state.

P0-08 bit1=1: When a second level alarm occurs, the motor will decelerate over the time set by P0-17 to stop and after braking it remains in the free state.

P0-08 bit2=0: When overrun occurs, the motor can brake freely and after braking it remains in the free state (when the servo activation is ON, the holding brake will not act).

P0-08 bit2=1: When overrun occurs, the motor will decelerate over the time set by P0-18 to stop and after braking it remains in the free state (when the servo activation signal is valid, the holding brake will not act).

P0-08 bit2=2: When overrun occurs, the motor will decelerate over the time set by P0-18 to stop and after braking it remains in the position holding state. (The servo must be in the activated state)

P0-08 bit2=3: No overrun judgment will be performed and processed.

Important: In case of vertical shaft application, P0-08 bit2 must be set to 2; otherwise fall will occur when overrun happens.

			Initial value	500	Communication address	0009H
P0-09	**Activation OFF - delay time of brake release command**		Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P S T

Parameter functions: When the motor rotates, if the servo activation is OFF or an alarm occurs, then the brake control terminal BK will be turned off upon lapse of the time. See section 3.7.2 for details.

			Initial value	20	Communication address	000AH
P0-10	Speed value of brake release command		Unit	rpm	Time of taking effect	With immediate effect
	Setting range	1~1000	Data size	16bit	Control mode	P S T

Parameter functions: When the motor rotates, if the servo activation is OFF or an alarm occurs, then the holding brake control terminal BK will be turned off upon falling of the motor speed to and below this set value.

Refer to section 3.7.2 for details.

			Initial value	200	Communication address	000BH
P0-11	**Brake release command- delay time of motor power-off**		Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~500	Data size	16bit	Control mode	P S T

Parameter functions: When the motor is in the static status, if the servo activation is OFF, then immediately turn off the control terminal BK of the holding brake, and continue supply of power to the motor (only for zero-speed braking); cut off the power supply to the motor upon lapse of the time set by this parameter. Refer to section 3.7.2 for details.

			Initial value	0	Communication address	000CH
P0-12	**Selection of re-activation condition for each braking mode**		Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P S T

Parameter functions: Processing mode when activation ON command is received again in case two different braking modes are selected.

P0-12=0: In case of free braking, set activation ON according to P0-13 setting; in case of zero-speed braking, immediately set activation ON.

P0-12=1: Regardless of free braking or zero-speed braking, set activation ON according to P0-13 setting.

			Initial value	3	Communication address	000DH
P0-13	**Condition for servo activation ON**		Unit	-	Time of taking effect	With immediate effect
	Setting range	0~3	Data size	16bit	Control mode	P S T

Parameter functions: Set the condition for turning on activation when an activation ON command is received.

P0-13=0: Activation ON when P0-14 is satisfied.

P0-13=1: Activation ON when P0-15 is satisfied.

P0-13=2: Activation ON when both P0-14 and P0-15 are satisfied.

P0-13=3: Immediate activation ON.

			Initial value	500	Communication address	000EH
P0-14	**Interval required to set activation ON again after activation OFF**		Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~30000	Data size	16bit	Control mode	P S T

Parameter functions: Set the time required to set activation ON again after activation OFF when P0-13=0 or 2.

P0-15	**Speed upper limit setting for activation ON**	Initial value	20	Communication	000FH

				address	
		Unit	rpm	Time of taking effect	With immediate effect
Setting range	0~10000	Data size	16bit	Control mode	P S T

Parameter functions: Set the speed upper limit setting for activation ON when P0-13=1 or 3. If the motor speed is higher than the set value of this parameter, the servo activation cannot be turned ON.

To set the condition for setting servo activation ON again after activation OFF, it is required to first set the braking mode P0-08, then select whether zero-speed braking requires setting activation ON condition P0-12 (free braking must be followed), and finally set the specific condition for activation ON.
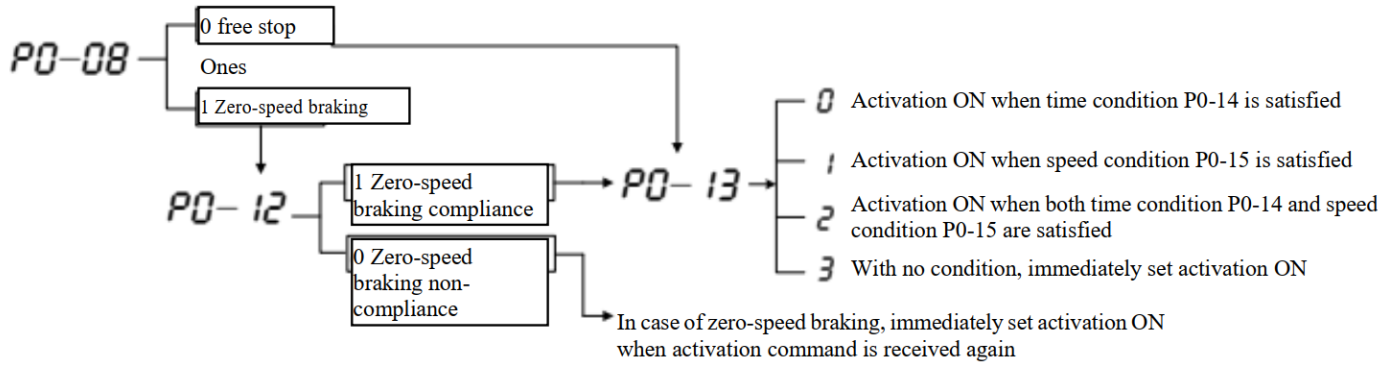
As shown below, different settings may have different activation ON sections. For different P0-13 settings:
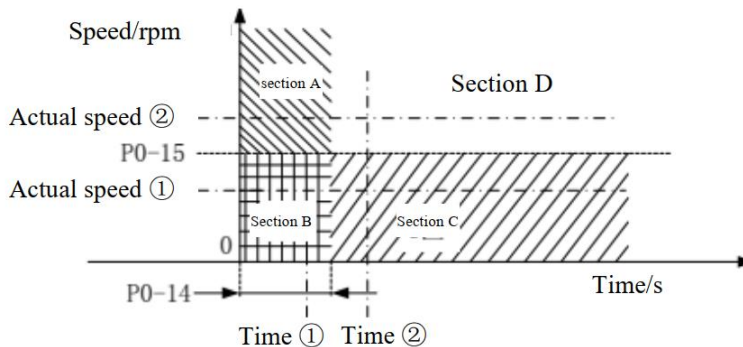
P0-13=0	Activation ON is only possible in sections C and D. Namely the time interval is greater than P0-14, such as time ②. At time ① in the figure, activation ON is impossible.
P0-13=1	Activation ON is only possible in sections B and C. Namely the motor speed is within P0-15, such as the actual rotating speed ①. Activation ON is impossible if the actual motor speed in the figure is at ②.
P0-13=2	Activation ON is only possible when section C has S-ON. Namely the time interval is greater than P0-14, and the actual speed is less than P0-15.

P0-16	**Activation ON - delay time of receiving command**	Initial value	200	Communication address	0010H
		Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~500	Data size	16bit	Control mode	P S T

Parameter functions: Servo activation ON. Only after lapse of the time can position, speed and torque commands be received.

Caution☞	For vertical shaft or other application scenarios with similar external force, as the motor has a holding brake, after the servo is activated, it is required to first power on the motor, and then turn on the brake control terminal to release the holding brake. As the relay, intermediate relay and holding brake require some time to act, it is required to properly set the time to prevent the motor starting operation following commands without assured release of the holding brake, thereby resulting in abnormalities.

P0-17	**Deceleration time for zero-speed braking**	Initial value	200	Communication address	0011H
		Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P S T

Parameter functions: When the braking mode is set to zero-speed braking (by P0-08), this parameter defines the deceleration time after the activation OFF command is received or a second level alarm occurs.

P0-18	**Deceleration time of overrun protection**	Initial value	200	Communication address	0012H
		Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P S T

Parameter functions: The time required for the motor decelerating to stop when an overrun warning (P-OT, N-OT) occurs and P0-08 is set to zero-speed braking for overrun.

P0-19	**Deceleration time for emergency stop**	Initial value	50	Communication address	0013H
		Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P S T

Parameter functions: The time required for the motor decelerating to stop when the emergency stop terminal (EMGS) is active.

Caution☞	If the deceleration time above is set too short, an alarm is likely to occur, resulting in entry of the motor into the free state. For this consideration, the parameter shall be properly set with care based on the actual conditions.

P0-20	**Definition of pulse output setting value**	Initial value	0	Communication address	0014H
		Unit	-	Time of taking effect	Taking effect upon power-on again

	Setting range	0~1	Data size	16bit	Control mode	P S T

Parameter functions: Set the meaning of parameter P0-21.

P0-20=0: Count of A or B-phase pulses before P0-21 is set to quadruplicated frequency (for a 2,500ppr encoder, only this option is available)

P0-20=1: Total count of pulses of phases A and B after P0-21 is set to quadruplicated frequency.

			Initial value	2500	Communication address	0015H
P0-21	**Count of output pulses per revolution of the motor**		Unit	Pulse	Time of taking effect	Taking effect upon power-on again
	Setting range	2,500ppr encoder: 30~2500 17~23-bit encoder: 30~8192 (P0-20=0) 17~23-bit encoder: 120~16383 (P0-20=1)	Data size	16bit	Control mode	P S T

Parameter functions: Set the count of output pulses per revolution of the motor.

For example, as shown in the right figure, 7 pulses are output respectively for phase A and phase B during one revolution of the motor. If P0-20=0, P0-21 shall be set to 7; and if P0-20=1, P0-21 shall be set to 28.	Phase A Phase B

P0-22	AB pulse output logic selection and Z pulse output polarity setting	Initial value	00	Communication address	0016H
		Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	00B~11B	Data size	16bit	Control mode	P S T

Parameter functions: Set the phase relation of output pulses between phase A and phase B and polarity of Z pulses when the rotating direction of the motor remains unchanged.

bit0=0: A is ahead of B when the motor rotates forward

bit0=1: B is ahead of A when the motor rotates forward

P0-22	Forward	Reverse
P0-22=x0	Phase A is ahead of phase B by 90°	Phase B is ahead of phase A by 90°
P0-22=x1	Phase B is ahead of phase A by 90°	Phase A is ahead of phase B by 90°
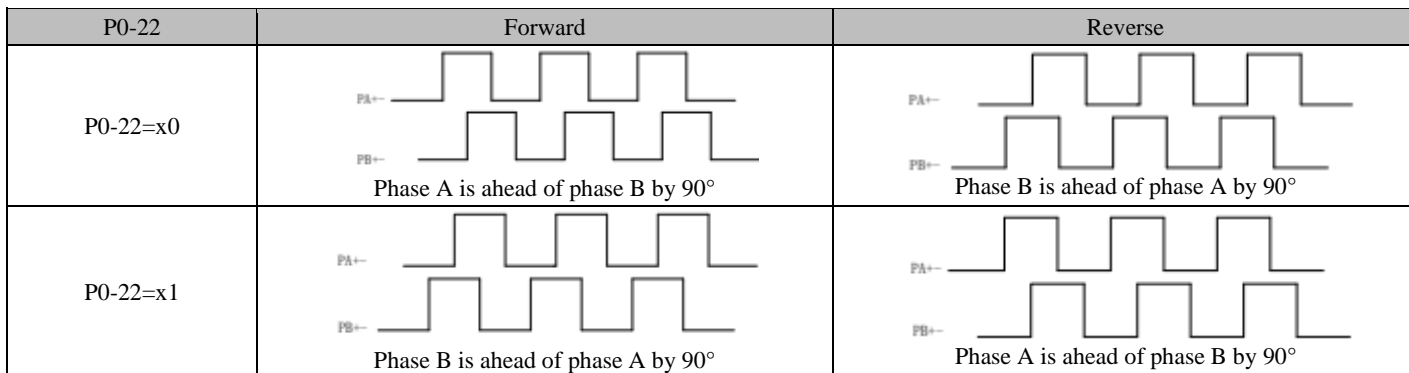
bit1=0: Z pulses are of high level, i.e. when output at the Z pulse port turns from low level to high level, it means the encoder reaches the origin of a single turn.

bit1=1: Z pulses are of low level, i.e. when output at the Z pulse port turns from high level to low level, it means the encoder reaches the origin of a single turn.

P0-23	Z pulse width	Initial value	0	Communication address	0017H
		Unit	ms	Time of taking effect	Taking effect upon power-on again
	Setting range	0~3	Data size	16bit	Control mode	P S T

Parameter functions: Expand the width of Z pulses. When the upper computer cannot capture relatively narrow Z pulses, the width of the Z pulses may be expanded.

As the width of Z pulses will reduce as the motor speed increases, the width of Z pulses may be adjusted based on the actual conditions for better accommodation to different upper computers. When it is set to 0, it means the output of Z pulses is the original width of the encoder's Z signal.
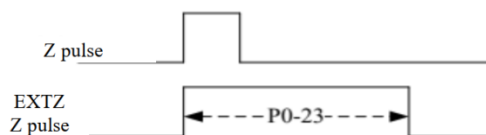
P0-24	Pulse output source	Initial value	0	Communication address	0018H
		Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~3	Data size	16bit	Control mode	P S T

Parameter functions: Select a source for frequency division output.

P0-24=0: The source of pulse output is the encoder feedback.

P0-24=1: The source of pulse output is command pulses received by the driver (without electronic gear calculation). At this time, parameters, P0-20, P0-21 and P0-22 are invalid. **Signals acquired from the PULSE channel are output through PB+ and PB-; signals acquired from the SIGN channel are output through PA+ and PA-.**

P0-24=2: The source of pulse output is speed commands; the pulse frequency is determined based on the P2-16 setting.

P0-24=3: The source of pulse output is the external encoder feedback.

8.6 P1-xx Position control parameters

P1-00	**Position command source selection**		Initial value	0	Communication address	0100H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P

Parameter functions: Select a position command source

P1-00=0: External pulse command (pt)

Position pulses are sourced from external input; the frequency of external pulses determines the motor speed.

P1-00=1: Multi-segment position command (Pr)

Position commands are sourced from the multi-segment position command set by group P9.

See detailed description of group P9.

P1-01	**Input form of external pulse command**		Initial value	0	Communication address	0101H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~5	Data size	16bit	Control mode	P

Parameter functions: Select a mode of external pulse commands.

Note that forward rotation refers to clockwise or anticlockwise rotation of the motor shaft, which is determined by P0-01. The view is from the shaft end by default, and the forward rotation is counterclockwise.

Parameter	Pulse form	Logic status	Rotation direction	
			Forward	**Reverse**
P1-01=0	Pulse + direction	Positive logic	PULS / SIGN	PULS / SIGN
P1-01=1	Pulse + direction	Negative logic	PULS / SIGN	PULS / SIGN
P1-01=2	Two-phase orthogonal pulse (quadruplicated frequency)	Positive logic	PULS / SIGN (90°)	PULS / SIGN (90°)
P1-01=3	Two-phase orthogonal pulse (quadruplicated frequency)	Negative logic	PULS / SIGN (90°)	PULS / SIGN (90°)
P1-01=4	CW+CCW pulse	Positive logic	PULSE CW / SIGN CCW	
P1-01=5	CW+CCW pulse	Negative logic	PULSE CW / SIGN CCW	

P1-02	**Count of pulses per revolution of the motor**		Initial value	10000	Communication address	0102H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~8388608	Data size	32bit	Control mode	P

Parameter functions: Set the count of command pulses required for one revolution of the motor (360°).

The command pulses may come from an external pulse command or from a multi-segment position command.

When this parameter is set to 0, it means this parameter is inactive; in this case, the relation between the count of command pulses and revolutions of the motor is set by using the electronic gear ratio.

P1-04	**Electronic gear ratio numerator 1**		Initial value	0	Communication address	0104H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1073741824	Data size	32bit	Control mode	P
P1-06	**Electronic gear ratio denominator**		Initial value	10000	Communication	0106H

						address	
			Unit		-	Time of taking effect	With immediate effect
	Setting range	1~1073741824	Data size		32bit	Control mode	P
P1-08		**Electronic gear ratio numerator 2**	Initial value		1	Communication address	0108H
			Unit		-	Time of taking effect	With immediate effect
	Setting range	0~1073741824	Data size		32bit	Control mode	P
P1-10		**Electronic gear ratio numerator 3**	Initial value		1	Communication address	010AH
			Unit		-	Time of taking effect	With immediate effect
	Setting range	0~1073741824	Data size		32bit	Control mode	P

P1-12	**Electronic gear ratio numerator 4**		Initial value	1	Communication address	010CH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1073741824	Data size	32bit	Control mode	P

Parameter functions: P1-04~P1-12 is used to set the electronic gear ratio, which is valid when P1-02=0.

Parameters P1-08, P1-10 and P1-12 are only useful when switching of the electronic gear ratio is required.

Relation between P1-02, P1-04 and P1-06 (P1-08, P1-10 and P1-12 have the similar function with P1-04)

P1-02	P1-04	P1-06	Command input and motor output
1~8388608	- No effect	- No effect	Command pulse input × Encoder resolution / P1-02 setting → Position command
0	0	1~1073741824	Command pulse input × Encoder resolution / P1-06 setting → Position command
	1~1073741824	1~1073741824	Command pulse input × P1-04 setting / P1-06 setting → Position command

Note: The position commands in the table refer to the encoder unit. For example, if P1_02 is set as 10,000 and the motor encoder is of 23 bits, i.e. 1 round equals 8,388,608 pulses, the number of commands converted to encoder pulses will be 100× 8,388,608/10,000= 83,886.08 when the number of command pulses is 100, and the motor will rotate for 83,886.08/8,388,608=0.1=36°.

When multiple different electronic gear ratios need to be used,

- Communication may be relied upon for online modification of P1-04 and P1-06 (RAM address shall be used; or otherwise damage can be easily caused to storage elements of the driver);
- The user may set two DI terminals to function No. 20 (GNUM0) and No. 21 (GNUM1), so as to realize switching through external DI input; in this case, the DI terminal status corresponds to the electronic gear ratio numerator as follows (0 means the terminal is inactive; 1 means the terminal is active):

GNUM0	GNUM1	Valid electronic gear ratio numerator
0	0	P1-04
0	1	P1-08
1	0	P1-10
1	1	P1-12

- When an external terminal is used to switch the electronic gear ratio, the electronic gear denominator is a fixed value; so in this case, please carefully select a proper value for P1-06.

Caution☞	1. P1-02 and the electronic gear ratio are valid for both external pulse command and internal multi-segment position command. 2. Setting range of the electronic gear ratio: 1/1000~64000/1. If the range is exceeded, the driver will give an $AL032$ alarm. 3. You can multiply the calculation result of electronic gear ratio by the multiplier determined by the magnitude of analog using analog input via the P1-33 and 34 settings. But this is limited to the numerator/denominator method only. When P1-02=0, the multiplier can't be adjusted by analog.

P1-14	**External pulse smoothing and filtering time**		Initial value	0.00	Communication address	010EH
			Unit	ms	Time of taking effect	Taking effect upon power-on again
	Setting range	0.00~300.00	Data size	16bit	Control mode	P

Parameter functions: Time constant for smoothing and filtering external pulse command signals. It is inactive when set to 0.

This parameter is intended to smooth input pulse commands, but may cause command delay. It is generally used:

- when the upper computer does not have the acceleration/deceleration function;
- when the electronic gear ratio is high;
- when the command frequency is low;
- when stepping or instability occurs during motor operation.
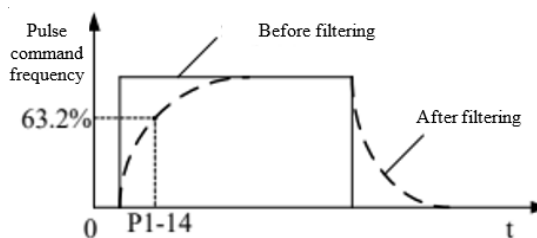
Caution☞	To reduce vibration and other problems resulted from abrupt change to the command pulse frequency, the position FIR filtering (P5-23) function can be used.

P1-15	**High-frequency filtering factor of external pulse input**		Initial value	90	Communication address	010FH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~4095	Data size	16bit	Control mode	P S

Parameter functions: Set the time constant for high-frequency filtering of external pulse command input

When the pulse setting position command is used, error may occur to the count of pulses received by the servo driver due to high-frequency disturbance resulted from various factors. Properly setting this parameter can avoid high-frequency disturbance.

If the time constant for pulse input filtering is T_f, and the minimum width of input signal is T_{min}, then the input signal and the signal after filtering are shown in the following figure. Compared with the input signal, the signal after filtering is delayed for T_f.
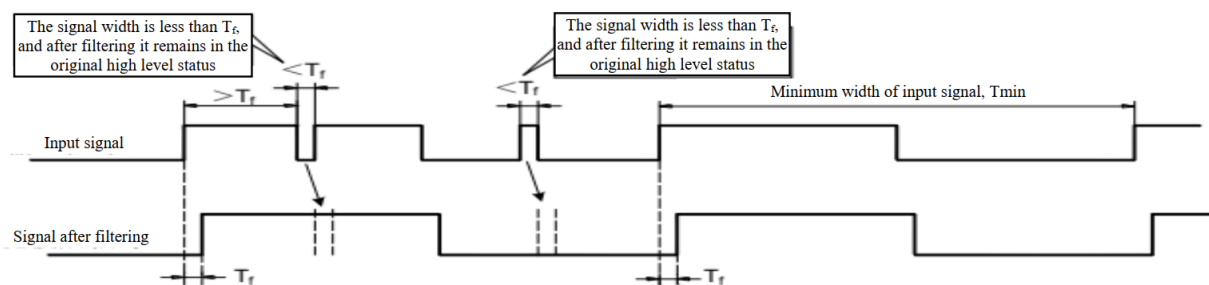
The time constant for pulse input filtering T_f shall meet: $T_f \leq (20\% \sim 25\%) \ T_{min}$

If the maximum frequency of the input pulse signal (or minimum pulse width) is known, the recommended filtering time parameter is shown in the following table:

Maximum input pulse frequency	Pulse width	Recommended P1-15 parameter	Actual filtering time
<100K	>10µs	250	2.5µs
100K~167K	6 µs ~10µs	160	1.6µs
167K~250K	4 µs ~6µs	120	1.2µs
250K~500K	2 µs ~4µs	90	0.9µs

P1-16	Selection of external DI signal action for position deviation clearing		Initial value	0	Communication address	0110H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~3	Data size	16bit	Control mode	P

Parameter functions: Select which external DI signal is used to clear deviation.

P1-16=0: Clear through P-CLR rising edge

P1-16=1: Clear through P-CLR low level

P1-16=2: Clear through P-CLR high level

P1-16=3: Clear through P-CLR falling edge

Caution☞ **When the servo activation is OFF or an alarm occurs, the position deviation will be automatically cleared.**

P1-18	**Warning threshold for the position following deviation**		Initial value	80000	Communication address	0112H
			Unit	ppr	Time of taking effect	With immediate effect
	Setting range	0~1073741824	Data size	32bit	Control mode	P

Parameter functions: Set the warning threshold for the position following deviation.

When the position deviation reaches or goes beyond the set value, warning signal for too high position following deviation will be output.

The motor continues running, the LED monitor displays $AL.EOS$, and output of the DO terminal defined as WARN is valid. Once the position deviation falls below the set value, the warning will be automatically cancelled.

P1-20	**Alarm threshold for the position following deviation**		Initial value	100000	Communication address	0114H
			Unit	ppr	Time of taking effect	With immediate effect
	Setting range	0~1073741824	Data size	32bit	Control mode	P

Parameter functions: Set the alarm threshold for the position following deviation.

When the position deviation reaches or goes beyond corresponding set value, alarm signal for too high position following deviation will be output.

The motor stops running, the LED monitor displays $AL.0\ 13$, and it is defined as valid output of the ALM DO terminal.

Caution☞ **1. When P1-18=0, position following deviation warnings will be shielded; when P1-20=0, alarms for too high position deviation will be shielded.**
2. The default setting unit is a command unit, but the encoder unit can be changed via P8-18 bit 3. When the encoder unit is used, it is required to set a proper value based on the encoder resolution, so as to avoid frequent alarms as a result of a too small set value.

P1-22	**Positioning completion output setting**		Initial value	1	Communication address	0116H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~6	Data size	16bit	Control mode	P

Parameter functions: Select the condition for valid output of positioning completion signal (defined as the DO terminal of COIN).

P1-22=0: The absolute value of position deviation is smaller than P1-24.

P1-22=1: The absolute value of position deviation is smaller than P1-24, and the position command is 0.

P1-22=2: The absolute value of position deviation is smaller than P1-24, the position command is 0, and the motor has zero speed.

P1-22=3: The absolute value of position deviation is smaller than P1-24, and the position command is 0. Both conditions are satisfied, and the lasting time reaches the INP holding time P1-25.

If any of the 3 conditions above is dissatisfied, COIN output is immediately invalidated. Revalidation requires re-judgment.

P1-22=4: The absolute value of position deviation is smaller than P1-24, the position command is 0, and the motor has zero speed. All the three conditions are satisfied, and the lasting time reaches the INP holding time P1-25.

If any of the 4 conditions above is dissatisfied, COIN output is immediately invalidated. Revalidation requires re-judgment.

P1-22=5: When the prerequisite of the position command being 0 is satisfied: A. If the holding time P1-25≠0 and the absolute value of position deviation is smaller than P1-24, COIN output is valid. After the lapse of P1-25, whether COIN output is valid or invalid will depend on the relation between the position deviation and P1-24 then. B. If the holding time P1-25=0 and the absolute value of position deviation is smaller than P1-24, COIN output is valid and will constantly remain valid. Once the position command is not zero, the COIN output will be immediately invalidated.

After invalidation of COIN output, revalidation requires re-judgment.

P1-22=6: When the prerequisite of the position command being 0 is satisfied: A. If the holding time P1-25≠0, the absolute value of position deviation is smaller than P1-24 and the motor has zero speed, then COIN output is valid. After the lapse of P1-25, whether COIN output is valid or invalid will depend on the relation between the position deviation and P1-24 then and zero speed of the motor. B. If the holding time P1-25=0, the absolute value of position deviation is smaller than P1-24 and the motor has zero speed, COIN output is valid and will constantly remain valid. Once the position command is not zero, the COIN output will be immediately invalidated.

After invalidation of COIN output, revalidation requires re-judgment.

Caution☞	**This parameter applies only to DO set to positioning completion (COIN). It is invalid to DO of positioning approach (PNEAR).**

			Initial value	20	Communication address	0117H
P1-23		**Positioning approach width**	Unit	ppr	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P
			Initial value	10	Communication address	0118H
P1-24		**Positioning completion width**	Unit	ppr	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P

Parameter functions: Set the standards for positioning approach and completion.

When the position deviation count is smaller than the set value of P1-23, output of the DO terminal set to positioning approach (PNEAR) will be valid.

When the position deviation count is smaller than the set value of P1-24, and the condition selected by P1-22 is satisfied, output of the DO terminal set to positioning completion (COIN) will be valid.

Caution☞	**1. The default setting unit is a command unit, but the encoder unit can be changed via P8-18 bit 3.** **2. When the encoder unit is selected and used, it is required to set a proper value based on the encoder resolution; or otherwise positioning completion may require a longer time.**

			Initial value	10	Communication address	0119H
P1-25		INP holding time	Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~3000	Data size	16bit	Control mode	P

Parameter functions: Set the lasting time when P1-22=3, 4, 5 or 6.

			Initial value	2147483647	Communication address	011AH
P1-26		**Forward limit position**	Unit	ppr	Time of taking effect	With immediate effect
	Setting range	-2147483647~2147483647	Data size	32bit	Control mode	P S T
			Initial value	-2147483647	Communication address	011CH
P1-28		**Reverse limit position**	Unit	ppr	Time of taking effect	With immediate effect
	Setting range	-2147483647~2147483647	Data size	32bit	Control mode	P S T

Parameter functions: Respectively set the forward and reverse soft limit positions.

When these two parameters have the maximum set values, i.e. the set value is +2147483647 or -2147482647, corresponding position detection is invalid.

If pulses are counted as of power-on of the driver, the result is the value of d0-34 (command unit)/d0-36 (encoder unit). When the value is equal to or greater than the set value of P1-26 or equal to or smaller than the set value of P1-28, it is deemed that the motor has run out of the limits, and a servo overrun warning will occur. Output of the DO terminal defined as WARN is valid, the LED displays $P\text{-}ot$ or $n\text{-}ot$, and the motor stops according to setting of P0-08.

Caution☞	**The default setting unit is a command unit, and the encoder unit can be changed via P8-18 bit 3 (in this case, a proper value shall be set based on the resolution).**

			Initial value	100	Communication address	011EH
P1-30		**Pulse deviation**	Unit	Pulse	Time of taking effect	With immediate effect
	Setting	0~65535	Data size	16bit	Control mode	P S T

			Initial value	100	Communication address	011FH
P1-31	**Execution time of pulse deviation**		Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P S T

Parameter functions: In the position mode, additional increase/decrease of pulses being executed can be triggered by terminals set to the PUL-UP (35) or PUL-UP (36) function.

P1-30: Set start of pulse increase/decrease in command pulses from the rising edge of PUL-UP/PUL-DN.

The increased/decreased command pulses will be evenly executed during the time set by P1-31. The valid edge of the PUL-UP terminal indicates increase, and the valid edge of the PUL-DN terminal indicates decrease.

P1-31: Command pulses set by P1-30 will be evenly and fully executed within the time set by this parameter.

Caution☞	**1: The value set by P1-30 is the count of command pulses.** **2: If after the rising edge of terminal PUL-UP/PUL-DN is triggered for execution and the time set by P1-31 has not be reached, or the time set by P1-31 is reached but increased/decreased pulses cannot be executed by any other reason, then the new rising edge of terminal PUL-UP/PUL-DN will not be responded.** **3: Please set a proper count of deviation pulses and execution time; an excessively large count of pulses in combination with too short execution time may result in mechanical collision.**

P1-33	**Analog adjustment options of electronic gear ratio**		Initial value	0	Communication address	0121H
			Unit	-	Time of taking effect	With immediate effect
Setting range	0~2		Data size	16bit	Control mode	P

Parameter functions: In position mode, enables/disables adjustment of electronic gear ratio multiplier via analog setting.

P1-33=0: Disable electronic gear ratio adjustment via analog.

P1-33=1: Adjust via analog input terminal AI1

P1-33=2: Adjust via analog input terminal AI2

P1-34	**Analog adjustment multiplier of electronic gear ratio**		Initial value	1.00	Communication address	0122H
			Unit	-	Time of taking effect	With immediate effect
Setting range	0.01~10.00		Data size	16bit	Control mode	P

Parameter functions: Sets the multiplier for adjustment of electronic gear ratio via analog.

When P1-33 is set as 1 or 2 and P1-02 = 0 (when setting electronic gear ratio in the numerator/denominator method), this parameter is used to set the multiplier corresponding to the analog. If it's set as 1.00, it means the multiplier corresponding to every 100 mV analog is 1.00.

$$\text{Electronic gear ratio} = \frac{\text{Analog voltage (mV)}}{100} \times P1\_34 \times \frac{P1\_04}{P1\_06}$$

Caution☞	**1. The P1-04 in the formula can be switched to P1-08, 10 or 12 based on the status of DI terminal.** **2. Please note that the analog involves hysteresis, dead zone, offset and etc. subject to settings of P6 functions.**

8.7 P2-xx Speed control parameter

Sketch of speed command:
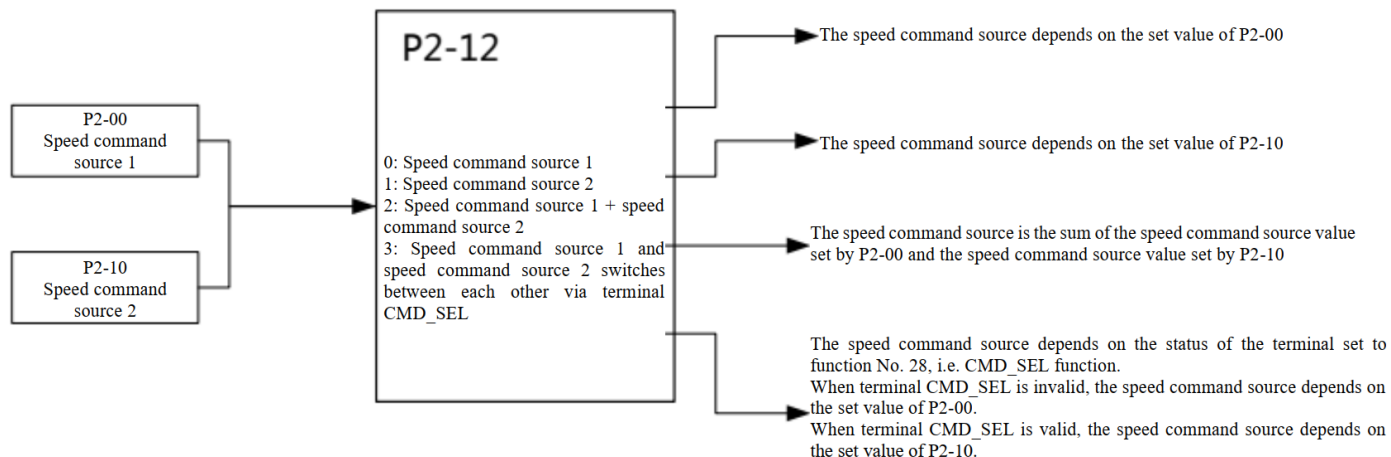
	Speed command source 1 option	Initial value	0	Communication address	0200H
P2-00		Unit	-	Time of taking effect	With immediate effect
	Setting range	0~4	Data size	16bit	Control mode	S

Parameter functions: Select speed command source 1:

P2-00=0: Digital speed setting (set by P2-01)

P2-00=1: AI1 setting;

P2-00=2: AI2 setting;

Important: When P2-00=1: Speed command 1 $= \frac{AI1}{10V} * P2.01$ When P2-00=2: Speed command 1 $= \frac{AI2}{10V} * P2.01$

P2-00=3: Multi-segment speed switching (see description of group P9);

P2-00=4: Pulse input, speed command 1 = input pulse frequency (kHz)*1000/P2-15.

Caution☞	1. Both the analogs AI1 and AI2 are of ±10V input. P2-01 setting can be positive or negative. The sign of speed command 1 is determined by the product of these two (Two negatives make a positive). 2. When pulse input is used, the pulse frequency is the square wave frequency input from the PULS port. a) When P1.01 is set to 0 or 1, direction of the speed command 1 depends on speed pulse input via the PULS port and the level input via the SIGN port. b) When P1.01 is set to 2 or 3, value of the speed command 1 depends on pulse frequency input via the PULS port, and direction of the speed command 1 depends on phases of PULS and SIGN. 3. When P1.01 is set to 0 or 1, if speed pulses are wrongly connected to the SIGN port, the motor may be unable to run or may jitter, while the driver may be unable to operate. 4. For the pulse input frequency, the lowest value 0.1kHz and the highest value is 200kHz.

	Digital speed setting 1	Initial value	100	Communication address	0201H
P2-01		Unit	rpm	Time of taking effect	With immediate effect
	Setting range	-30000~30000	Data size	16bit	Control mode	S

Parameter functions: In the speed control mode, set the target motor speed and direction; the positive indicates the forward direction.

When the analog input is used as the speed command source, this parameter can be interpreted as the analog gain, i.e. the speed command value when the analog equals 10V.

For example, if P2-00=1 and P2-01=1,000, the speed command 1 will be 500rpm forward when AI1 is 5V, and 1,000 rpm negative when AI1 is -10V.

Caution☞	The final speed command is set by P2-12, the final speed is limited by the maximum rotating speed (P0-02), and the rotating direction is determined by P0-01.

P2-04	**Speed S-type acceleration time TSACC**		Initial value	200	Communication address	0204H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	S
P2-05	**Speed S-type deceleration time TSDEC**		Initial value	200	Communication address	0205H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	S
P2-06	**Speed S-type acceleration/deceleration smoothing time TSL**		Initial value	50	Communication address	0206H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~10000	Data size	16bit	Control mode	S

Parameter functions: When the servo driver runs in the speed mode, these three parameters are used to set the motor acceleration/deceleration time.

P2-04: Set the time required for the motor to accelerate from speed 0 to the rated speed.

P2-05: Set the time required for the motor to decelerate from rated speed to speed 0.

P2-06: Set the S curve smoothing time during the acceleration/deceleration process.

If S curve is used (i.e. P2-06≠0), the driver uses three-segment acceleration curve planning for motion command smoothing in the acceleration or deceleration process. In this case, the acceleration generated is continuous, so as to avoid abrupt change of input commands resulting in excessive jerking (acceleration differentiation) and further causing vibration of the mechanical structure and production of noise. The user may use P2-04 to adjust the speed change slope in the acceleration process, use P2-05 to adjust the speed change slope in the deceleration process, and use P2-06 to smooth the start and stop processes of the motor.
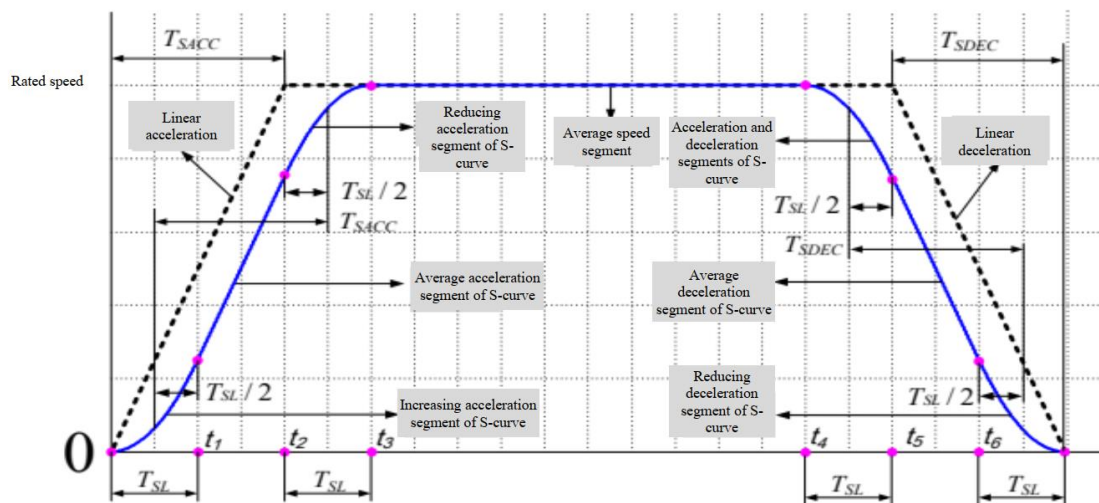
Caution☞ 1. P2-04 and P2-05 refer to the acceleration and deceleration time required for the motor speed to change from or to the rated motor speed. If the change to the target speed does not equal to the value of the rated motor speed, then the time required will change according to the ratio of the change and the rated motor speed.
For example, if the target motor speed is 1,500rpm, the rated motor speed is 3,000rpm, P2-04=200ms and P2-05=300ms, then the motor requires 100ms to accelerate from speed 0 to speed 1,500rpm and 150ms to decelerate speed 1,500rpm to speed 0.
2. The S-shaped acceleration/deceleration time T_{SL} is only valid in the speed mode, and invalid in the JOG, emergency braking, overrun braking, alarm and activation OFF braking conditions.
3. When an alarm, activation OFF, overrun braking or emergency braking occurs, the deceleration time depends on P0-17, P0-18 and P0-19; and P2-05 is invalid.

P2-07	**Zero position fixation threshold for speed command**		Initial value	10	Communication address	0207H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~3000	Data size	16bit	Control mode	S

Parameter functions: Sets zero position fixation value for analog speed command, i.e. zero clamping.

When the servo is set into the speed mode and the speed command is set by external analog, the motor might not be able to stay static even if the analog voltage 0 as a result of external electromagnetic interference or zero drift. This function can be applied if it's required that the motor has to be static when the input voltage of external analog is around 0V.

There are two pre-requisites as given below for this function to be enabled:

➢   The absolute value of the speed command corresponding to the input analog voltage, upon processing of the dead zone and hysteresis, is less than P2-07;

➢   The DI terminal where the driver is defined as the zero position fixation signal ZCLAMP is valid.

With the pre-requisites above fulfilled, the servo will toggle to position mode from speed mode automatically so that the motor will be locked in the scope specified by P1-24 at that position and will return to the locking position even if there is an external force.

Once the speed command is greater than P2-07, it will return to speed mode and follow the commands for running immediately despite of the status of the ZCLAMP termina.

Caution☞	**1. This function is always valid in speed mode.** **2. During position locking, if the motor shaft is rotated by an external force that reaches or exceeds the rated torque of the motor and persists, the driver might be subject to motor overload, overcurrent and other alarms.**

P2-08	**Reached speed**		Initial value	1000	Communication address	0208H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	1~6000	Data size	16bit	Control mode	P S T

Parameter functions: Set the threshold for output of speed reached signal. When the motor speed reaches and exceeds this set value, output of the DO terminal defined as V_CLS is valid.
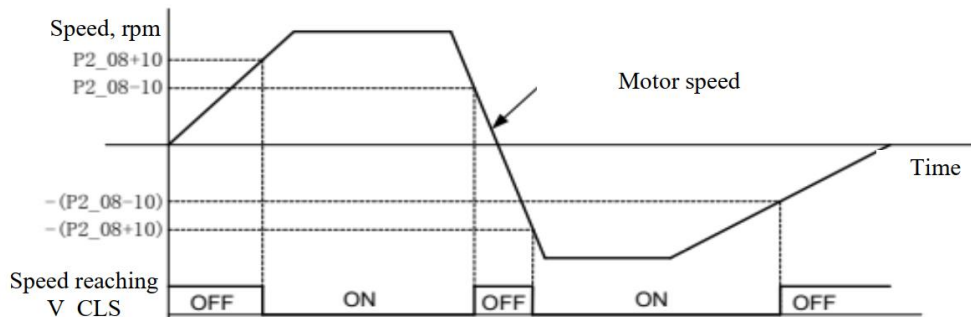
Caution☞   **As there is 10rpm lagging, the output actual value of speed reached signal is:**

     Speed reached output OFF→ON: P2_08+10rpm   ON→OFF: P2_08－10rpm

P2-09	**Speed consistency threshold**		Initial value	10	Communication address	0209H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	1~100	Data size	16bit	Control mode	S

Parameter functions: When |the set speed - the current speed|≤P2-09, output of the DO terminal defined as V-CMP is valid.
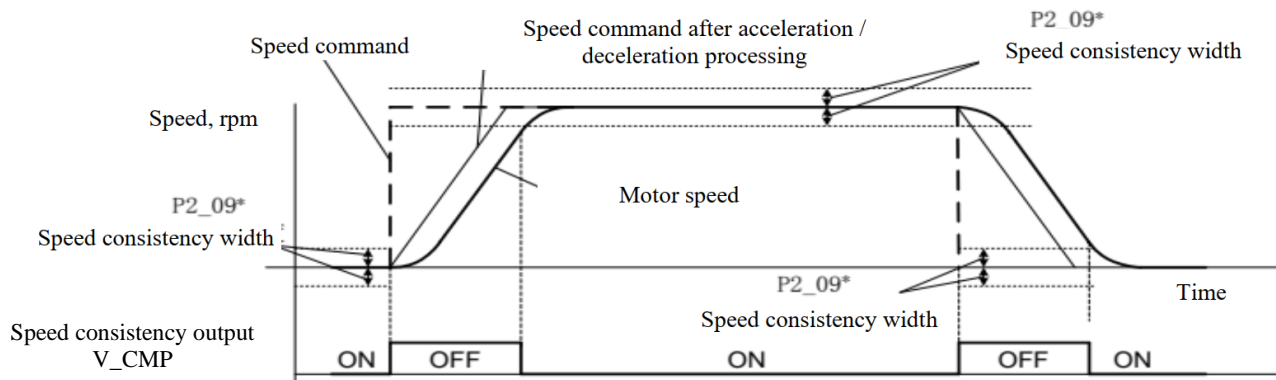
Caution☞   **As there is 10rpm lagging, the actual detection width of speed consistency is:**

     Speed consistency output OFF→ON: P2_09-10rpm   ON→OFF: P2_09+10rpm

P2-10	**Speed command source 2 option**		Initial value	0	Communication address	020AH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~4	Data size	16bit	Control mode	S

Parameter functions: Select speed command source 2:

P2-10=0: Digital speed setting (set by P2-11);

P2-10=1: AI1 setting;

P2-10=2: AI2 setting;

Important: When P2-10=1: Speed command 2 = $\frac{AI1}{10V} * P2.11$ When P2-10=2: Speed command 2 = $\frac{AI2}{10V} * P2.11$

P2-10=3: Process PID (see description of group P9);

P2-10=4: Pulse input, speed command = input pulse frequency (kHz)/P2-15*1000

Caution☞   **1. Both the analogs AI1 and AI2 are of ±10V input. P2-11 setting can be positive or negative. The sign of speed command 2 is determined by the product of these two (Two negatives make a positive).**

2. When pulse input is used, the pulse frequency is the square wave frequency input from the PULS port.

a) When P1.01 is set to 0 or 1, direction of the speed command 1 depends on speed pulse input via the PULS port and the level input via the SIGN port.

b) When P1.01 is set to 2 or 3, value of the speed command 2 depends on pulse frequency input via the PULS port, and direction of the speed command 2 depends on phases of PULS and SIGN.

3. When P1.01 is set to 0 or 1, if speed pulses are wrongly connected to the SIGN port, the motor may be unable to run or may jitter, while the driver may be unable to operate.

4. For the pulse input frequency, the lowest value 0.1kHz and the highest value is 200kHz.

P2-11		**Digital speed setting 2**	Initial value	100	Communication address	020BH
			Unit	Rpm	Time of taking effect	With immediate effect
	Setting range	-30000~30000	Data size	16bit	Control mode	S

Parameter functions: In the speed control mode, set the target rotating speed and direction of the motor. The positive indicates forward rotation.

When the analog input is used as the speed command source, this parameter can be interpreted as the analog gain, i.e. the speed command value when the analog equals 10V.

For example, if P2-10=1 and P2-11=1,000, the speed command 2 will be 500rpm forward when AI1 is 5V, and 1,000 rpm negative when AI1 is -10V.

Caution☞	•	**The final speed command is set by P2-12, the final speed is limited by the maximum rotating speed (P0-02), and the actual rotating direction is controlled by P0-01.**

P2-12		**Speed command**	Initial value	1	Communication address	020CH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~3	Data size	16bit	Control mode	S

Parameter functions: When in the speed control mode, set the speed command source

P2-12=0: Speed command is the speed command source 1;

P2-12=1: Speed command is the speed command source 2;

P2-12=2: Speed command is the sum of speed command source 1 and speed command source 2;

P2-12=3: The speed command switches between speed command sources 1 and 2 according to the status of terminal CMD_SEL set to function No. 28. When terminal CMD_SEL is invalid, the speed command is sourced from speed command source 1; when terminal CMD_SEL is valid, the speed command is sourced from speed command source 2;

Caution☞	**1. The rotating direction of the motor can be changed, if needed, by multiple means:** • **By changing the status of the DI terminal defined as DIR-SEL** • **By changing P0-01** • **By changing P8-18 bit 4.** **2. The actual rotating direction of the motor is controlled by P0-01; the final speed is limited by the maximum speed (P0-02).**

P2-13		**Given limit for speed in the forward direction**	Initial value	3000	Communication address	020DH
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~6000	Data size	16bit	Control mode	S

Parameter functions: When in the speed control mode, set to the maximum value of the forward speed command.

P2-14		**Given limit for speed in the reverse direction**	Initial value	3000	Communication address	020EH
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~6000	Data size	16bit	Control mode	S

Parameter functions: When in the speed control mode, set to the maximum value of the forward speed command. (This parameter is an absolute value)

Caution☞	**1. If the speed command obtained from P2-12 exceeds P2-13 in case of a positive value, it will be limited to the value of P2-13 in the forward direction; in case of a negative value, it will be limited to the value of P2-14 in the reverse direction.** **2. The final speed is limited by the maximum speed (P0-02) and the maximum rotating speed permitted by the driven motor.**

P2-15		**Pulse input reference**	Initial value	10.0	Communication address	020FH
			Unit	kHz	Time of taking effect	With immediate effect
	Setting range	2.0~200.0	Data size	16bit	Control mode	S

Parameter functions: When in the speed control mode, if speed command is selected for pulse input, set the reference for speed calculation.

This parameter refers to the input pulse frequency corresponding to the speed command of 1,000 rpm.

See the introduction when P2.00 and P2.10 are set to 4.

P2-16	**Pulse output reference**	Initial value	10.0	Communication	0210H

				address	
		Unit	kHz	Time of taking effect	With immediate effect
Setting range	2.0~200.0	Data size	16bit	Control mode	S

Parameter functions: In the speed mode, if P0-24 is set to 2, then this parameter sets the pulse output frequency (corresponding to the speed command of 1,000rpm).

Pulse output frequency (kHz) = speed command * P2 - 16/1,000

The speed command is the target speed obtained by the machine based on analog, digital quantity or pulse input, other than the actual rotating speed of the motor.

Upon simultaneous output of phases A and B, the pulse frequency is the frequency of single phase A or B.

Caution☞	**1. Pulses are output via phases A and B of the frequency division output port. The frequency of single phase A determines the value of the speed command; the sequence of phases A and B determines the direction.** **2. Upon output to the next servo driver, the user shall properly set the P2-15 value of the next driver for an appropriate speed proportion; besides, it is required to set P1.01 to 2 or 3, so as to follow the positive/negative change of the command.**

8.8 P3-xx Torque control parameters

Important:

In the torque control mode, reverse direction is defined as: the rotating direction of the motor in opposite to the torque command direction.

This circumstance may occur when there is an external drag in the reverse direction

P3-00	**Selection of torque setting command source**		Initial value	0	Communication address	0300H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~9	Data size	16bit	Control mode	T

Parameter functions: Select the torque setting command source:

P3-00=0: Torque P3-01 setting, symmetrical between the forward and reverse directions;

P3-00=1: Torque P3-01 setting, with the reverse direction limited by P3-02;

P3-00=2: Torque P3-01 setting, with the reverse direction limited by AI1;

P3-00=3: Torque P3-01 setting, with the reverse direction limited by AI2;

P3-00=4: Torque AI1 setting, symmetrical between the forward and reverse directions;

P3-00=5: Torque AI1 setting, with the reverse direction limited by P3-02;

P3-00=6: Torque AI1 setting, with the reverse direction limited by AI2;

P3-00=7: Torque AI2 setting, symmetrical between the forward and reverse directions;

P3-00=8: Torque AI2 setting, with the reverse direction limited by P3-02;

P3-00=9: Torque AI2 setting, with the reverse direction limited by AI1;

Important:

When the torque command is set by AI1\AI2, torque command $= \dfrac{AI1 \backslash AI2}{10V} * P3\text{-}01$

When the reverse torque is limited by AI1\AI2, limit $= \dfrac{AI1 \backslash AI2}{10V} * P3\text{-}02$

Caution☞	Both the analogs AI1 and AI2 are of ±10V input. P3-01 setting can be positive or negative, and hence the direction of torque command is determined by the product of these two (Two negatives make a positive). If analog input is +10V only and you wish to change the output direction of motor torque, a number of options are available: • **By changing the status of the DI terminal defined as TDIR-SEL** • **By changing the sign of P3-01** • **By changing P0-01**

P3-01	**Digital torque setting**		Initial value	100.0	Communication address	0301H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	-500.0~500.0	Data size	16bit	Control mode	T

Parameter functions: In the torque control mode, set the target torque value and direction of the motor, with the rated torque as reference.

When the analog input is used as the torque setting command source, this parameter can be interpreted as the analog gain.

For example, if P3-00=4 and P3-01=200.0, the torque command is 100% rated torque of forward rotation when AI1 is 5V, and 200% rated torque of reverse rotation when AI1 is -10V.

P3-02	**Reverse torque limit**		Initial value	300.0	Communication address	0302H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~500.0	Data size	16bit	Control mode	T

Parameter functions: In the torque control mode, set the torque limit of the motor in the reverse direction.

When the analog input is used as the command source of reverse torque limit, this parameter can be interpreted as the analog gain.

Caution☞ Reverse direction refers to the rotating direction of the motor in opposite to the torque command direction.

P3-04	**Selection of speed limit command source for torque command direction**		Initial value	0	Communication address	0304H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~2	Data size	16bit	Control mode	T

Parameter functions: Selects command source that limits motor rotation speed in torque control mode.

P3-04=0: limited by P3-05;

P3-04=1: speed is limited by AI1;

P3-04=2: speed is limited by AI2.

Caution☞	**When the speed limit command is set by AI1\AI2**, speed limit command = $\dfrac{AI1 \setminus AI2}{10V} * P3\text{-}05$ (limited to 0 in case of negative voltage)

P3-05	Speed limit in the torque command direction upon torque control		Initial value	100	Communication address	0305H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~6000	Data size	16bit	Control mode	T

Parameter functions: In the torque control mode, set the speed limit in the torque command direction. When P3-04=1 or 2, this parameter can be deemed as the analog gain.

Caution☞	In torque mode, this analog will limit both the rotation speed and the torque if P0-05 (option for the 1st torque limit source) is set as limiting torque by AI1\AI2, P3-04 (option for command source of torque and speed limits) is set as limiting motor running speed by AI1\AI2, and the same analog source is shared (e.g. both are AI1).

P3-06	Torque consistency threshold		Initial value	5.0	Communication address	0306H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	3.0~100.0	Data size	16bit	Control mode	T

Parameter functions: When |the set torque - the actual torque|≤P3-06, output of the DO terminal defined as torque consistency (T-CMP) is valid.
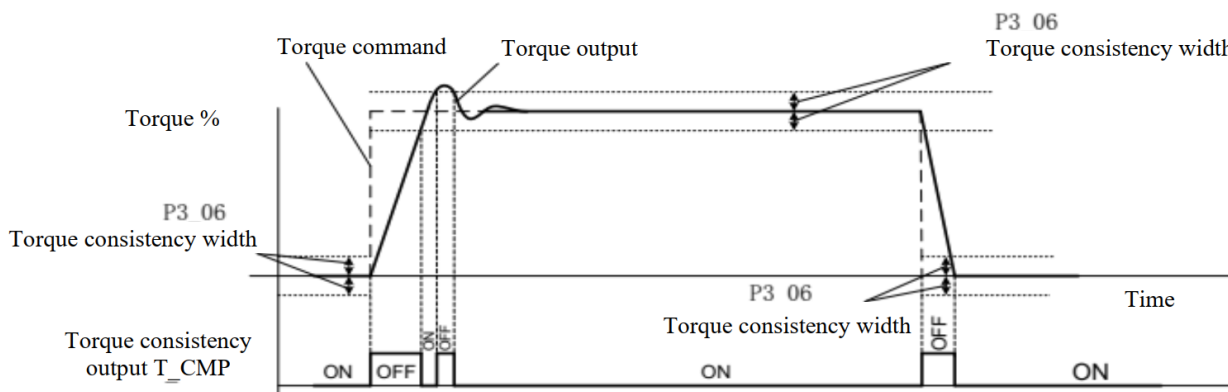
Caution☞	As there is 3% lagging, the actual detection width of torque consistency is:

Consistency output OFF→ON: P3_06-3%   ON→OFF: P3_06+3%

P3-07	Reached torque		Initial value	100.0	Communication address	0307H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	3.0~500.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the threshold for output of torque reached signal. When the motor current reaches and exceeds this set value, output of the DO terminal defined as T_CLS is valid.
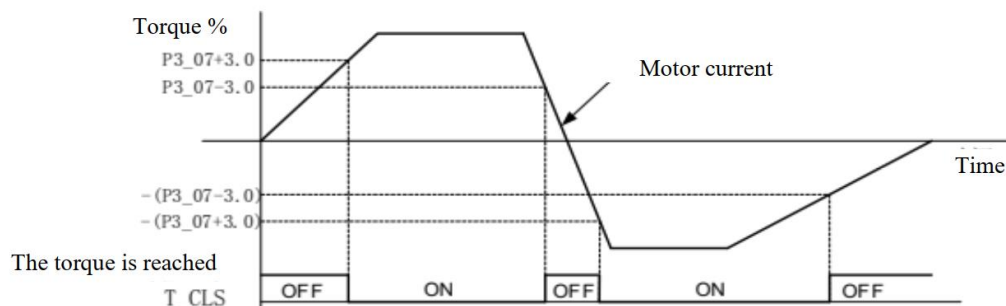
Caution☞	As there is 3% lagging, the actual detection width of torque reached is:

Torque reached output OFF→ON: P3_07+3%   ON→OFF: P3_07-3%

P3-08	Torque command increase slope		Initial value	500.0	Communication address	0308H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.1~500.0	Data size	16bit	Control mode	T

P3-09	**Torque command decrease slope**		Initial value	500.0	Communication address	0309H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.1~500.0	Data size	16bit	Control mode	T

Parameter functions: Set the change slope of the torque command, i.e. the change amplitude of the torque command per ms, with the rated motor torque as reference.

P3-08: For a torque command subject to digital or analog setting, when the absolute value of the torque command increases, the torque actually output will increase by the slope set with this parameter;

P3-09: For a torque command subject to digital or analog setting, when the absolute value of the torque command decreases, the torque actually output will decrease by the slope set with this parameter;

Caution☞	**When the upper computer gives a step torque command, these two parameters can be used for smoothing, so as to reduce jittering; yet in this case, the response speed of the system will also be reduced.**

8.9 P4-xx Gain parameters

P4-00	**Selection of gain adjustment mode**		Initial value	1	Communication address	0400H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~4	Data size	16bit	Control mode	P S T

Parameter functions: Select the gain adjustment mode. The letter H at the end of the number means the parameter value is expressed in hexadecimal, and shall be noted during communication.

P4-00=0: Manual mode

• Parameters relating to position loop and speed loop gains and the load inertia ratio are set by the user.

• In this mode, the control loop coefficient P4-14 is invalid.

• When the automatic mode is switched to the manual mode, the gain parameter will maintain the value calculated in the original automatic mode.

• Gain switching is only valid in this mode.

P4-00=1: Semi-automatic adjustment mode (rigidity table)

• Applicable in scenarios of basically constant load-inertia ratio When this mode is used, the user shall first perform offline inertia identification by AF-05; when identification is successfully completed, the identification result will be written to the parameter P4-10 and saved (if inertia identification is impossible, the user shall assign a value to P4-10 generally based on the mechanical conditions).

• The user needs to select an appropriate rigidity (P4-01) based on the mechanical conditions; the system will, based on the rigidity so selected and the value of P4-10, automatically calculate relevant gain parameters, including P4-02, P4-03, P4-05 and P4-29; meanwhile, these parameters will become read-only.

P4-00=2: Automatic adjustment mode 1

• Applicable to scenarios with frequent change of the load inertia ratio (the inertia ratio changes from the smallest to the largest in tens of seconds or longer). When this mode is used, the servo will monitor the change of the load inertia in real time, and write the identification result to parameter P4-10 every 30 minutes.

• The user needs to select an appropriate rigidity (P4-01) based on the mechanical conditions; the system will, based on inertia value obtained through online identification each time, automatically calculate relevant gain parameters, including P4-02, P4-03, P4-05 and P4-29; meanwhile, these parameters will become read-only.

P4-00=3: Automatic adjustment mode 2

• Similar to automatic adjustment mode 1, but it is more applicable to scenarios with second-level variation of the load inertia ratio.

P4-00=4: Automatic adjustment mode 3

• Similar to automatic adjustment mode 1, but it is more applicable to scenarios with second-level variation of the load inertia ratio.

In the following circumstances, the manual mode shall be used:

➢ When use of the automatic mode cannot render desirable effect.

➢ When mechanical parts are not firmly connected due to presence of reverse clearance or otherwise, and when the mechanical rigidity is extremely low.

➢ When the load inertia ratio is too high (exceeding 20 times) or too low (less than 3 times), or when the load inertia fluctuates.

➢ When operation continues at a low speed (less than 100rpm), or when the speed of no less than 100rpm and the acceleration of no less than 2,000rpm/s fail to last for at least 50ms.

➢ When the acceleration/deceleration is smaller than 2,000rpm/s, and the acceleration/deceleration torque is smaller than the friction torque.

P4-01	**Rigidity**		Initial value	13*	Communication address	0401H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	1~31	Data size	16bit	Control mode	P S T

Parameter functions: Select the rigidity grade.

The following table shows the relation between rigidity setting and gain parameters. The greater the rigidity value is, the quicker the servo response is; yet excessive rigidity may cause vibration and other abnormalities.

P4-01	P4-02	P4-03	P4-05	P4-29
	Position loop proportional gain 1/s	Speed loop proportional gain, Hz	Speed loop integral time constant, ms	Torque command low-pass smoothing constant, ms
1	2.5	2.0	280.0	11.00
2	3.0	2.5	220.0	9.00
3	4.0	3.0	190.0	8.00
4	4.5	3.5	160.0	6.00
5	5.5	4.5	120.0	5.00
6	7.5	6.0	90.0	4.00
7	9.5	7.5	70.0	3.00
8	11.5	9.0	60.0	3.00
9	14.0	11.0	50.0	2.00
10	17.5	14.0	40.0	2.00

11	32.0	18.0	31.0	1.26
12	39.0	22.0	25.0	1.03
13	48.0	27.0	21.0	0.84
14	63.0	35.0	16.0	0.65
15	72.0	40.0	14.0	0.57
16	90.0	50.0	12.0	0.45
17	108.0	60.0	11.0	0.38
18	135.0	75.0	9.0	0.30

P4-01	P4-02 Position loop proportional gain 1/s	P4-03 Speed loop proportional gain, Hz	P4-05 Speed loop integral time constant, ms	P4-29 Torque command low-pass smoothing constant, ms
19	162.0	90.0	8.0	0.25
20	206.0	115.0	7.0	0.20
21	251.0	140.0	6.0	0.16
22	305.0	170.0	5.0	0.13
23	377.0	210.0	4.0	0.11
24	449.0	250.0	4.0	0.09
25	500.0	280.0	3.5	0.08
26	560.0	310.0	3.0	0.07
27	610.0	340.0	3.0	0.07
28	660.0	370.0	2.5	0.06
29	720.0	400.0	2.5	0.06
30	810.0	450.0	2.0	0.05
31	900.0	500.0	2.0	0.05

*: For models of EA350-6R2-□B and below, the factory setting is 13, and for those above, the factory setting is 11.

P4-02	**Position loop gain APR_P**		Initial value	48.0	Communication address	0402H
			Unit	1/s	Time of taking effect	With immediate effect
	Setting range	1.0~2000.0	Data size	16bit	Control mode	P

Parameter functions: Set the position regulator gain APR_P to determine responsiveness of the position control system.

The greater the set value of APR_P is, the higher the response frequency is, the better the position command followability is, the smaller the position error is, and the shorter the position adjustment time is. However, it shall be noted that if the value is set too great, vibration may be caused.

P4-03	**Speed loop gain ASR-P**		Initial value	27.0	Communication address	0403H
			Unit	Hz	Time of taking effect	With immediate effect
	Setting range	0.1~5000.0	Data size	16bit	Control mode	P S

Parameter functions: Set the speed regulator gain **ASR_P** to determine responsiveness of the speed control loop.

The greater the set value of ASR_P is, the higher the speed loop response frequency is and the better the position command followability is. To increase the position loop gain for improvement of the servo system responsiveness, it is required to increase the set value of the speed loop gain. However, it shall be noted that if the value is set too great, vibration may be caused.

The speed loop response frequency must be 4~6 times higher than that of the position loop; otherwise vibration may be caused.

Position loop response frequency $fp = APR\_P / 2\pi$ Speed loop response frequency $fv = ASR\_P \times P4\_10$

P4-04	**Speed ring differential time constant ASR_Td**		Initial value	0.0	Communication address	0404H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0.1~3000.0	Data size	16bit	Control mode	P S

Parameter functions: Set the speed loop differentiation time constant; when the set value is 0.0, there will be no differentiation action.

Differentiation shall be carefully used. Use of differentiation may be considered when commands fluctuate but stable output is desired. Besides it shall be used in combination with P4-26 differentiation output limit to avoid severe differentiation resulting in system oscillation.

P4-05	**Speed loop integral time constant ASR_Ti**		Initial value	21.0	Communication address	0405H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0.1~3000.0	Data size	16bit	Control mode	P S

Parameter functions: Set the speed loop integral time constant; when the set value is 3000.0, there will be no integral action.

The smaller the set value is, the closer to 0 the deviation is upon stop; however, if the value is set too small, vibration may be caused.

Generally, greater load inertia and mechanical resonance shall correspond to a larger setting of the speed loop integral time constant.

If setting of the load inertia ratio P4-10 is consistent with the actual conditions, the following formula can be used to derive the speed loop integral time constant ASR_T_i:

$$ASR\_Ti \geq 5000 / 2\pi fv$$

P4-06	**Speed feedforward gain APR_Kp**		Initial value	30.0	Communication address	0406H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~300.0	Data size	16bit	Control mode	P

Parameter functions: Set the speed feedforward gain.

The product of the speed command obtained through calculation of the position command, multiplied by the ratio of this parameter, is added to the speed command output by the position loop.

When the position control command changes smoothly, increasing this gain value can reduce the position following deviation and improve the position followability.

When the position control command changes not in a smooth manner, mechanical vibration may occur; reducing this gain value can mitigate vibration.

P4-07	**Speed feedforward filtering time constant**		Initial value	5.00	Communication address	0407H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0.00~10.00	Data size	16bit	Control mode	P

Parameter functions: Set the first-order inertia filtering time constant for speed feedforward gain.

When the position control command changes smoothly, shortening this filtering time can reduce the position following deviation and improve the position followability.

When the position control command changes not in a smooth manner, prolonging this filtering time can reduce running vibration of the machine, but the position following deviation will also increase.

P4-08	**Speed feedback low-pass filtering time constant**		Initial value	0.00	Communication address	0408H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0.00~20.00	Data size	16bit	Control mode	P S

Parameter functions: Set the first-order filtering time constant for speed feedback.

The rotating speed of a motor is obtained through differentiation of the position fed back by the encoder. The rotating speed contains resonance and high-frequency disturbance signal. This parameter can be used to eliminate noise, but it can also cause delay and result in slow response of the loop.

P4-10	**1st load inertia ratio**		Initial value	2.50	Communication address	040AH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	1.00~120.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the ratio of the 1st total inertia and the rotor inertia of the motor.

$P4\text{-}10 = J_T / J_M$ J_T: Total inertia, i.e. load inertia + electronic rotor inertia, J_M: Motor rotor inertia

When the inertia self-identification function can be used, this parameter can be obtained through inertia self-identification. Upon setting, the user shall make sure the set value is basically consistent with the actual conditions.

When manual gain setting is used, the user needs to adjust the speed loop gain based on operating conditions of the machine; if relatively accurate data cannot be obtained, the factory setting can be used without this parameter ignored.

Caution☞	**If the user cannot obtain relatively accurate load inertia ratio, then vibration, abnormal noise or alarm may occur when the following functions are enabled.** **Acceleration feedback (P4-22 bit0)** **Speed observer (P4-22 bit3)** **Torque feedforward (P4-24, P4-25)** **External disturbance resistance (P4-28)**

P4-11	**2nd load inertia ratio**		Initial value	1.00	Communication address	040BH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	1.00~120.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the ratio of the 2nd total inertia and the rotor inertia of the motor.

The system can be switched immediately via the functional terminal J_SEL to use of the second load inertia ratio P4-11.

J_SEL valid	2nd load inertia ratio P4-11 is used
J_SEL invalid	1st load inertia ratio P4-10 is used

When the gain is set to the automatic adjustment mode, i.e. P4-00=2, 3 or 4, this function is invalid.

When switching to the second load inertia ratio:

If P4-00=0, the driver will continue using such gain parameters as P4-02, P4-03 and P4-05 (note that the speed loop response frequency is the product of the speed loop gain multiplied by the inertia ratio);

If P4-00=1, the driver will automatically calculate the gain parameter based on the second inertia ratio and rigidity.

Caution☞	**1. It is required to perform inertia switching upon stop of the servo motor; switching upon motor operation may cause vibration or oscillation;** **2. When the first inertia ratio differs largely from the second inertia ratio, even if the motor is stopped, oscillation may occur. It is required to confirm there is no vibration based on the actual conditions before use of this function.**

P4-12	**PDFF control coefficient**		Initial value	100	Communication address	040CH
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0~100	Data size	16bit	Control mode	P

Parameter functions: When this parameter is set to 0, it means an IP controller is used; when it is set to 100, it means a PI controller is used; when it ranges between 1~99, it means a PDFF controller is used.

When an IP controller is used, the motor speed will have no or little overshooting, but the response is slow.

When a PI controller is used, the motor speed will overshoot, but the response is quick.

The PDFF controller has combined features of the IP and PI controllers to reduce overshooting and improve system response. When the parameter approaches closer to 0, it means the IP action is growing stronger, vice versa.

P4-13	Rigidity adjustment coefficient			Initial value	0.5	Communication address	040DH
				Unit	-	Time of taking effect	With immediate effect
	Setting range	0.5~1.0		Data size	16bit	Control mode	P S

Parameter functions: This parameter is only valid when P4-00≠0, i.e. the gain is in the automatic adjustment mode 1, 2, 3 or 4. It is used when P4-01 cannot be set higher to improve the speed loop gain.

Specifically:

$$Speed\ loop\ gain = \frac{P4\text{-}03}{P4\text{-}13}$$

In the automatic adjustment mode, decreasing the set value can improve the response of the servo in low rigidity scenarios. However, if the value is set too small, vibration may be caused

P4-14	**Control loop coefficient**		Initial value	75	Communication address	040EH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	10~100	Data size	16bit	Control mode	P S T

Parameter functions: This parameter is only valid when P4-00 = 1 or 2, i.e. the gain is in the automatic adjustment mode 1 or 2. It is used to determine the relation between the speed bandwidth and the position bandwidth.

This parameter is based on the automatic control theory, i.e. the speed bandwidth shall be at least 4 times the position bandwidth. Generally it shall not be regulated, and specifically may not be down-regulated.

P4-15	**Gain switching condition**		Initial value	00H	Communication address	040FH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00H~18H	Data size	16bit	Control mode	P S T

Parameter functions: When P4-00=0, namely in the manual gain adjustment mode, select the condition for gain switching.

When P4-00≠0, namely in the automatic gain adjustment mode, this function is invalid.

The letter H at the end of the number means the parameter value is expressed in hexadecimal, and shall be noted during communication.

P4-15 =0*H: Simply switch the position loop gain and the speed loop gain;

P4-15 =00H: Turn off the gain switching function;

P4-15 =01H: When the DI terminal defined as gain switching (15: GAIN_SEL) is turned from OFF→ON;

P4-15 =02H: In the position control mode, when the position deviation is greater than the set value of parameter P4-18 (with 100ppr command unit lagging);

P4-15 =03H: In the position control mode, when the speed command is greater than the set value of parameter P4-18 (with 10ppr lagging);

P4-15 =04H: When the rotating speed of the servo motor is greater than the set value of parameter P4-18 (with 10rpm lagging);

P4-15 =05H: When the DI terminal defined as gain switching (15: GAIN_SEL) is turned from ON→OFF;

P4-15 =06H: In the position control mode, when the position deviation is smaller than the set value of parameter P4-18 (with 100ppr command unit lagging);

P4-15 =07H: In the position control mode, when the speed command is smaller than the set value of parameter P4-18 (with 10ppr lagging);

P4-15 =08H: When the rotating speed of the servo motor is smaller than the set value of parameter P4-18 (with 10rpm lagging);

P4-15 =1*H: Simply switch the speed loop integral, PI--->P, i.e. cancel the speed loop integral action

P4-15 =10H: Turn off the integral switching function, and the speed loop integral remains valid;

P4-15 =11H: When the DI terminal defined as gain switching (15: GAIN_SEL) is turned from OFF→ON;

P4-15 =12H: In the position control mode, when the position deviation is greater than the set value of parameter P4-18 (with 100ppr command unit lagging);

P4-15 =13H: In the position control mode, when the speed command is greater than the set value of parameter P4-18 (with 10ppr lagging);

P4-15 =14H: When the rotating speed of the servo motor is greater than the set value of parameter P4-18 (with 10rpm lagging);

P4-15 =15H: When the DI terminal defined as gain switching (15: GAIN_SEL) is turned from ON→OFF.

P4-15 =16H: In the position control mode, when the position deviation is smaller than the set value of parameter P4-18 (with 100ppr command unit lagging);

P4-15 =17H: In the position control mode, when the speed command is smaller than the set value of parameter P4-18 (with 10ppr lagging)

P4-15 =18H: When the rotating speed of the servo motor is smaller than the set value of parameter P4-18 (with 10rpm lagging).

Caution☞
1. See section 6.9.4
2. Due to presence of lagging, the actual value when conditions are satisfied or dissatisfied is: When conditions are satisfied: P4_18 + lagging value; when conditions are dissatisfied: P4_18-lagging value

P4-16	**Gain switching time**		Initial value	5	Communication address	0410H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~3000	Data size	16bit	Control mode	P S

Parameter functions: When the gain switching condition is satisfied, the gain value will change smoothly in a linear manner to the target gain within the time (0: This function is turned off). Please refer to Fig. 7-15.

P4-18	**Gain switching threshold**		Initial value	100	Communication address	0412H
			Unit	Pulse\Kpps\rpm	Time of taking effect	With immediate effect
	Setting range	0~32767	Data size	16bit	Control mode	P S

Parameter functions: Set the threshold for gain switching, with the unit set based on P4-15

➢ When the motor stops, switch to a lower gain to suppress vibration and sharp noise

➢ When the motor stops, switch to a higher gain to enhance the servo rigidity

➢ When the motor runs, switch to a higher gain to obtain better command followability and shorter positioning time

➢   Switch between different gains based on the operating conditions of loaded equipment to realize the best control
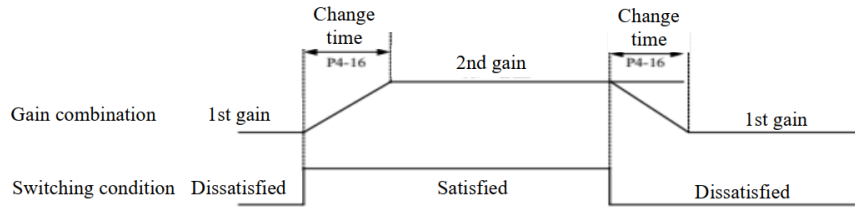
When the switching condition is satisfied, the gain switches to the second gain. If the switching condition is dissatisfied during running at the second gain, then the gain switches to the first gain.

Upon switching, the current gain combination gradually changes in a linear and smooth manner to the target gain combination over the time set by parameter P4-16; during the process, parameters in the combination change accordingly to avoid abrupt change resulting in any mechanical collision. Once switching starts, even if the switching condition changes, the switching will be completed and re-identification of the switching condition will be performed upon completion of the switching.

P4-19	**Change coefficient of the 2nd position loop gain**		Initial value	50	Communication address	0413H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	10~500	Data size	16bit	Control mode	P

Parameter functions: When the gain switching condition is satisfied, it is the proportional gain change rate of the target position regulator.

Proportional gain of the target position regulator APR_P₁=APR_P× (P4-19)×100%

$$Proportional\ gain\ of\ the\ target\ position\ regulator\ APR\_P_1 = APR\_P \times (P4\text{-}19) \times 100\%$$

P4-20	**Change coefficient of the 2nd speed loop gain**		Initial value	50	Communication address	0414H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	10~500	Data size	16bit	Control mode	P S

Parameter functions: When the gain switching condition is satisfied, it is the proportional gain change rate of the target speed regulator.

$$Proportional\ gain\ of\ the\ target\ speed\ regulator\ ASR\_P_1 = ASR\_P \times (P4\text{-}20) \times 100\%$$

P4-22	**Suppression performance expansion 1**		Initial value	000000B	Communication address	0416H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	000000B~111111B	Data size	16bit	Control mode	P S

Parameter functions: Switch of the advanced suppression function.

$$00000$$ bitX=0: Function OFF
bit4 bit3 bit2 bit1 bit0   bitX=1: Function ON
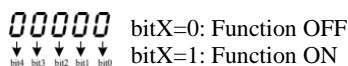
Bit 0: Acceleration feedback function

The acceleration feedback function is to use the acceleration obtained by using software to differentiate speed feedback signal of a motor, multiplied by the acceleration feedback gain, to compensate the torque command. It is used to suppress oscillation of the speed ring.

This function can stabilize the servo system when 50~150Hz vibration occurs if the flexible connection between the motor and the mechanical system is unstable, the load inertia is far greater than the motor inertia, or in other unstable conditions.

When in the automatic gain adjustment mode (i.e. P4-00≠0) or the torque control mode, this function is invalid.

Bit 1, 2, 3: Reserved

Bit 4: Speed observer function

The speed observer estimates the status change of the object under control through software. When the mechanical system resonates at a frequency of above 100Hz, it can be used to remove the high-frequency vibration component, so as to stabilize the speed loop.

When in the automatic gain adjustment mode (i.e. P4-00≠0) or the torque control mode, this function is invalid.

Bit 5: Low noise mode

When this function is enabled, the current loop gain will reduce to some extent, so that noise can be reduced

P4-23	**Speed observer cutoff frequency grade**		Initial value	13	Communication address	0417H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~13	Data size	16bit	Control mode	P S

Parameter functions: Set the cutoff frequency grade of the built-in speed observer.

The greater the set value is, the higher the cutoff frequency of the speed observer will be, and the wider range of vibration is to be suppressed, but the lower suppression effect will be rendered.

P4-24	**Torque feedforward gain**		Initial value	0.0	Communication address	0418H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~200.0	Data size	16bit	Control mode	P S

Parameter functions: Set the value of the acceleration feedforward gain.

The acceleration torque obtained through differentiation of the speed command, multiplied by this parameter, is then added to the torque command output by the speed regulator, which can improve the motor response. The rated torque is taken as reference.

When in the automatic gain adjustment mode (i.e. P4-00≠0) or the torque control mode, this function is invalid.

P4-25	**Torque feedforward filtering time constant**	Initial value	5.00	Communication address	0419H

		Unit	ms	Time of taking effect	With immediate effect
Setting range	0.00~10.00	Data size	16bit	Control mode	P S

Parameter functions: Time constant for first-order low-pass filtering of acceleration torque

The acceleration torque obtained through differentiation of the speed command contains a large quantity of high-order harmonic, and thus when it is added to the torque command, high-frequency vibration of the motor torque may be caused. Low-pass filtering of the acceleration torque before it is added to the torque command can remove high-frequency harmonic and reduce vibration.

		Initial value	0.0	Communication address	041AH
P4-26	**Speed loop differential output limit**	Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~10.0	Data size	16bit	Control mode	P S

Parameter functions: When P4-04 speed loop differentiation is enabled, this parameter can limit the output value of the speed loop differentiation.

P4-28	**External disturbance resistance gain**		Initial value	0.0	Communication address	041CH
			Unit	%	Time of taking effect	With immediate effect
	Setting range	-100.0~100.0	Data size	16bit	Control mode	P S

Parameter functions: This parameter refers to the external disturbance compensation after disturbance observation. It can be used to reduce the speed variation upon load disturbance. Specifically:

Torque after compensation = torque before compensation + observed disturbance *P4-28

When observed disturbance disappears, the torque compensation will be immediately withdrawn. When disturbance torque observed through the disturbance observer is added to the torque command percentage for use as compensation in the automatic gain mode (i.e. P4-00≠0) or the torque control mode, this function is invalid.

P4-29	**Torque command low-pass smoothing constant**		Initial value	1.26	Communication address	041DH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0.00~100.00	Data size	16bit	Control mode	P S T

Parameter functions: Set the time constant for first-order low-pass filtering of torque command output by the speed regulator.

Torque command output by the speed regulator may contain high-order harmonic component that is resulted from speed feedback fluctuation or other factors and may cause vibration of the motor. Low-pass filtering of the torque command can remove the high-order harmonic, but it may also cause phase delay and result in slow response of the motor.

P4-30	**Friction compensation smoothing time constant**		Initial value	50	Communication address	041EH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	10~1000	Data size	16bit	Control mode	P S

Parameter functions: This parameter is intended for first-order filtering of friction compensation value, so as to avoid mechanical vibration resulted from abrupt change of the compensation value.

Friction compensation values include values set by parameters P4-31, P4-32, P4-33 and P4-34.

P4-31	**Viscous friction compensation gain**		Initial value	0	Communication address	041FH
			Unit	0.1%/1000rpm	Time of taking effect	With immediate effect
	Setting range	0~1000	Data size	16bit	Control mode	P S

Parameter functions: Set the torque compensation value for viscous friction load.

The larger the rotating speed is, the greater the viscous friction will be. Advance addition of the viscous friction load may improve the response.

The set value refers to the increment required in the torque command value per 1,000rpm increment in the motor speed.

See P4-34

P4-32	**Addition to torque command**		Initial value	0.0	Communication address	0420H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	-100.0~100.0	Data size	16bit	Control mode	P S

Parameter functions: For vertical shaft scenarios with presence of gravity, this value can be converted into a set torque and added to the torque command setting.

See P4-34

P4-33	**Torque compensation in the forward direction**		Initial value	0.0	Communication address	0421H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	-100.0~100.0	Data size	16bit	Control mode	P S

Parameter functions: Sliding friction compensation upon forward rotation of the motor

See P4-34

P4-34	**Reverse torque compensation**		Initial value	0.0	Communication address	0422H
			Unit	%	Time of taking	With immediate

					effect	effect
Setting range	-100.0~100.0	Data size	16bit		Control mode	P S

Parameter functions: Sliding friction compensation upon reverse rotation of the motor
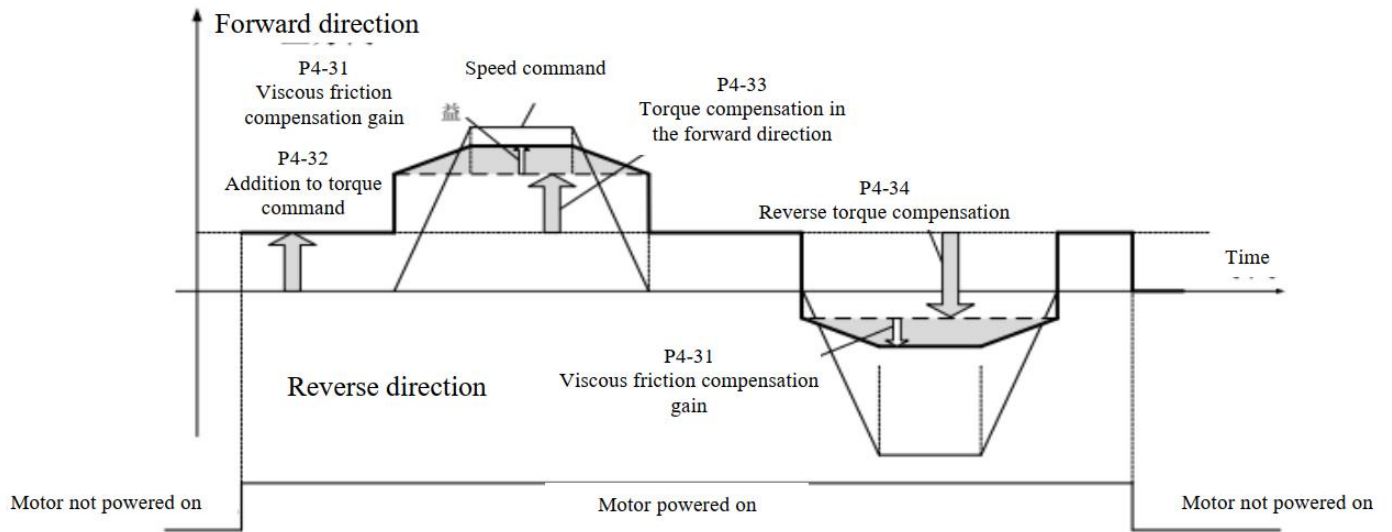
P4-35	**Static friction torque compensation value**		Initial value	0.0	Communication address	0423H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~100.0	Data size	16bit	Control mode	S T
P4-36	**Cutoff rotating speed for static friction torque compensation**		Initial value	0.0	Communication address	0424H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~200	Data size	16bit	Control mode	S T

Parameter functions: Set the torque for static friction compensation and cutoff speed

When mechanical equipment starts in the static state, great static friction is commonly present as the lubrication system has not come into full operation.

When a motor starts running from zero speed, application of a static friction compensation torque in the same direction of motor running can overcome the static friction of the mechanical transmission system during the startup process.

This compensation torque takes the rated torque of the motor as reference, and is applied in the rotating direction of the motor.

When the motor speed reaching the set value of P4-36 is detected, the added static friction compensation torque will be withdrawn linearly within the range of the set value plus 40rpm.

8.10 P5-xx Vibration suppression parameters

P5-00	**Adaptive filter mode setting**		Initial value	0	Communication address	0500H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~2	Data size	16bit	Control mode	P S T

Parameter functions: Select the adaptive filter mode.

P5-00=0: Manually set 4 notch filters

P5-00=1: Automatically adjust the depth of notch filters 3 and 4, and manually set the width

P5-00=2: Clear notch filters 3 and 4

If resonance occurs during operation of a mechanical system, it may have been caused by too high rigidity of the servo system or too quick response. In this case, improvement can be made by reducing the gain, but it may also result in slower response of the system. To suppress mechanical resonance without changing the gain, EA350 servo drivers provide two solutions, i.e. low-pass filtering of command pulses (set by P1-15) and use of notch filters.

Vibration suppression is realized by using notch filters to suppress the resonance peaks of mechanical response, as shown in the following diagram:
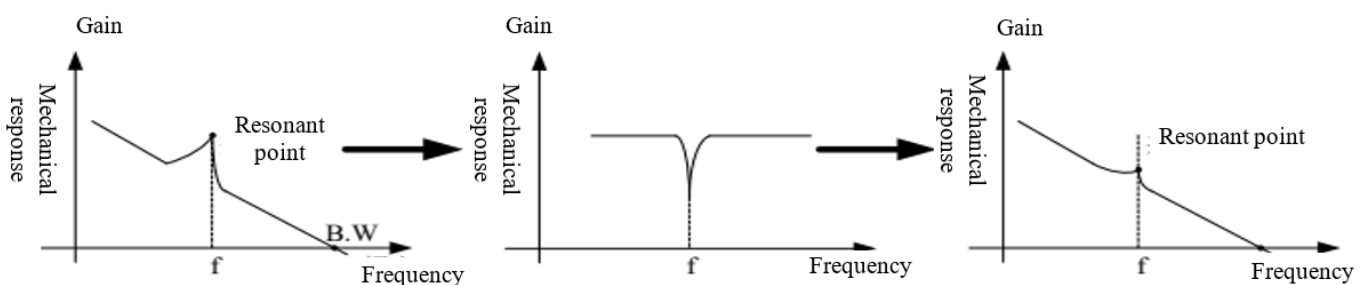
P5-01	**Detection accuracy and sensitivity of automatic vibration suppression**		Initial value	100	Communication address	0501H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	10~30000	Data size	16bit	Control mode	P S T

Parameter functions: Set the range of speed errors. When resonance occurs, speed oscillation will occur; near resonant points, distribution of oscillation frequency is close to normal distribution; if the oscillation width is greater than the set value of this parameter, a resonant point shall be deemed constituted.

P5-02	**1st notching frequency**		Initial value	5000	Communication address	0502H
			Unit	Hz	Time of taking effect	Taking effect upon power-on again
	Setting	50~5000	Data size	16bit	Control mode	P S T

	range					

Parameter functions: Set the central frequency of the first notch filter. When it is set to 5000, the notch filter is inactive.

	1st notching width		Initial value	2	Communication address	0503H
P5-03			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~20	Data size	16bit	Control mode	P S T

Parameter functions: Set the breadth of the 1st notch filter. A greater value indicates greater suppression near the central frequency.

	1st notching depth		Initial value	0	Communication address	0504H
P5-04			Unit	dB	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

Parameter functions: Notching depth of the first notch filter. A smaller value indicates greater suppression

	2nd notching frequency		Initial value	5000	Communication address	0505H
P5-05			Unit	Hz	Time of taking effect	Taking effect upon power-on again
	Setting range	50~5000	Data size	16bit	Control mode	P S T

P5-06		**2nd notching width**	Initial value	2	Communication address	0506H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~20	Data size	16bit	Control mode	P S T
P5-07		**2nd notching depth**	Initial value	0	Communication address	0507H
			Unit	dB	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

Parameter functions: Set the 2nd notch filter

P5-08		**3rd notching frequency**	Initial value	5000	Communication address	0508H
			Unit	Hz	Time of taking effect	Taking effect upon power-on again
	Setting range	50~5000	Data size	16bit	Control mode	P S T
P5-09		**3rd notching width**	Initial value	2	Communication address	0509H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~20	Data size	16bit	Control mode	P S T
P5-10		**3rd notching depth**	Initial value	0	Communication address	050AH
			Unit	dB	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

Parameter functions: Set the 3rd notch filter

P5-11		**4th notching frequency**	Initial value	5000	Communication address	050BH
			Unit	Hz	Time of taking effect	Taking effect upon power-on again
	Setting range	50~5000	Data size	16bit	Control mode	P S T
P5-12		**4th notching width**	Initial value	2	Communication address	050CH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~20	Data size	16bit	Control mode	P S T
P5-13		**4th notching depth**	Initial value	0	Communication address	050DH
			Unit	dB	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

Parameter functions: Set the 4th notch filter

P5-23		**Position FIR filter**	Initial value	0.0	Communication address	0517H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0.0~128.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the time constant for position FIR filter.

Corresponding to a square wave position command with the target speed of Vc, the set value of the position FIR filter can be interpreted as the time to reach Vc.
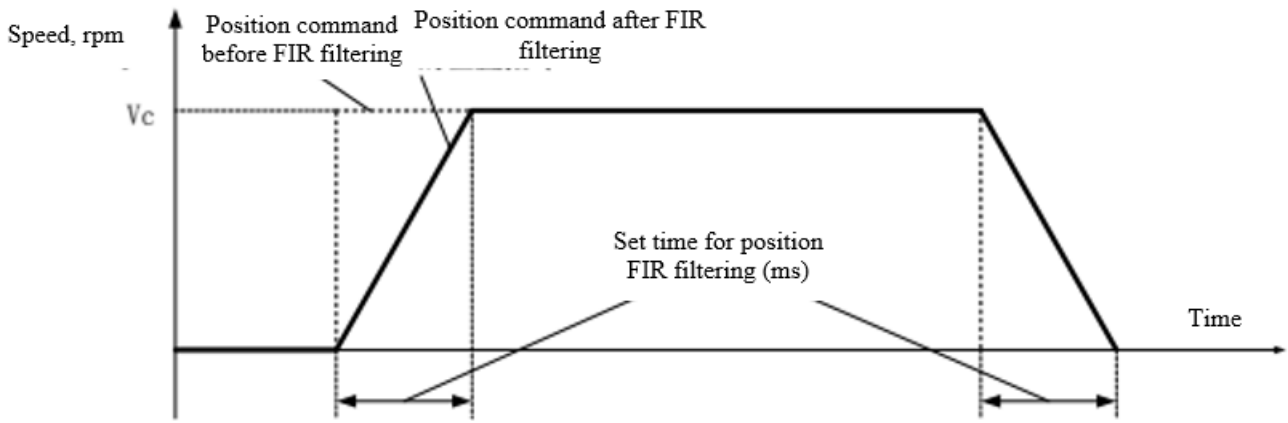
During the whole operation process of the device, particularly when abrupt vibration occurs upon deceleration to stop, a position FIR filter can be used to suppress vibration.

The following figure shows the effect of using aFIR filter
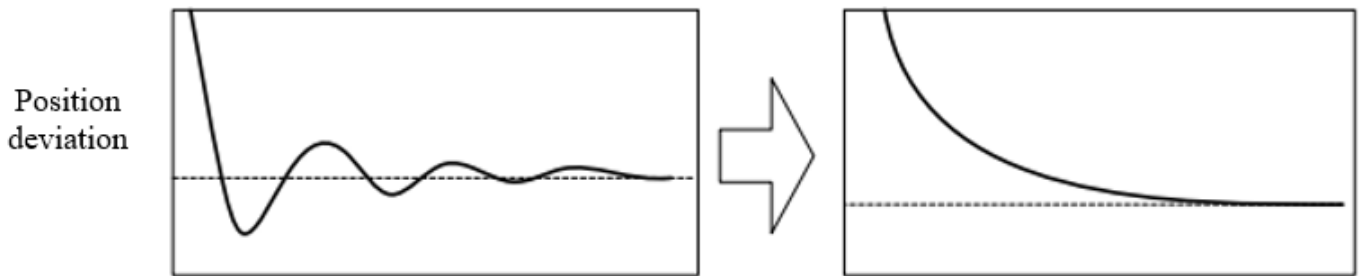
Usage:

Determine the vibration waveform, calculate the vibration cycle and convert it into ms for input into P5-23.

8.11 P6-xx Input and output parameters

P6-00			Initial value	2	Communication address	0600H
	DI filtering time		Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~20	Data size	16bit	Control mode	P S T

Parameter functions: Set the filtering time of DI terminal.

When there is strong external disturbance, to prevent such external disturbance, a filtering time can be set for the DI terminal. It means signal of DI terminal must be held for the time set by P6-00 before the driver can recognize status change of the DI terminal (OFF→ON or ON→OFF).

For example, if P6-00 is set to 2, then the signal of DI terminal must be held for 2ms before the driver can recognize status change. In case of edge trigger, if pulse signal is used, then the width of pulse signal must be greater than 2ms (in case of ideal square waves, a greater width will be actually required). See the attached figure of P6-01

P6-01			Initial value	00000000B	Communication address	0601H
	DI level logic		Unit	-	Time of taking effect	With immediate effect
	Setting range	00000000B~11111111B*	Data size	16bit	Control mode	P S T

Parameter functions: Set the level logic of each DI terminal and set stop. These settings will become valid upon power-on again.

$$0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0$$
DI8 DI7 DI6 DI5 DI4 DI3 DI2 DI1

8 channels of DI can be respectively set; if for some bit, bit X = 0, then external input of low level is valid; otherwise if bit X = 1, then external input of high level is valid.
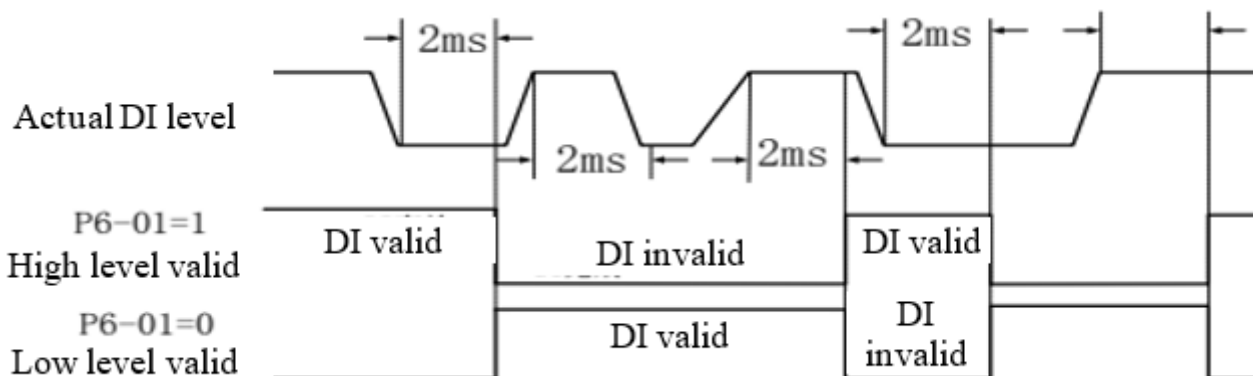
*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon rewriting by communication.

Caution☞	To enable corresponding terminal by means of RS485 communication, please use P6-10 parameter. (Use of this parameter may cause damage to the driver storage)

Important:	For servo enable input (S-ON), disable forward driving (P-OT), and disable reverse driving (N-OT) signals, if the level logic of factory settings is changed, motor power will not be able to be turned OFF and over-travel prevention function will not act in case of signal line disconnection or other anomalies. If you are left with this choice only, please perform act confirmation to rule out safety issues.

P6-02			Initial value	1*	Communication address	0602H
	DI1 function selection		Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-03			Initial value	2*	Communication address	0603H
	DI2 function selection		Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-04	**DI3 function selection**		Initial value	13*	Communication address	0604H

			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-05		**DI4 function selection**	Initial value	14*	Communication address	0605H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-06		**DI5 function selection**	Initial value	3*	Communication address	0606H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-07		**DI6 function selection**	Initial value	12*	Communication address	0607H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-08		**DI7 function selection**	Initial value	20*	Communication address	0608H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-09		**DI8 function selection**	Initial value	21*	Communication address	0609H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

Parameter functions: Set functions of terminals DI1~DI8, see Table 8-1.

The 8 channels of DIs can be set within the range of 0~99; but currently some channels are reserved.

- Different DIs can be set to the same function number and the corresponding logic can be OR, i.e. when D1 or D2 is valid, corresponding function event will occur. If P6-02=1 and P6-03=1, then the servo will be ON when either DI1 or DI2 is valid, and the servo will be OFF when both are invalid.
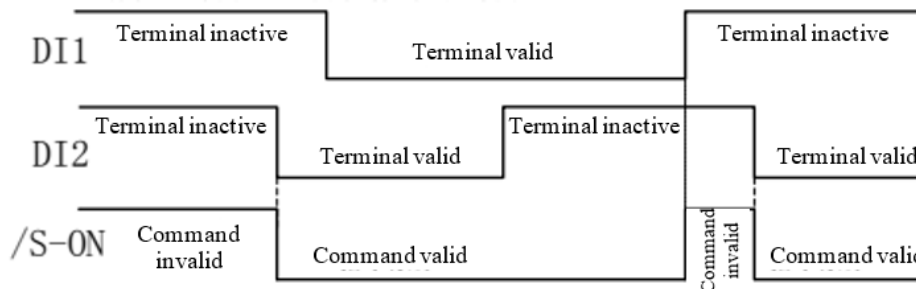
*: When the servo driver is initially set to a different working mode, i.e. when the set value of parameter P0-00 changes, the initial value of the function selection parameter for the DI terminal will change.

The following table shows the default terminal functions when P0-00 is set to different values:

Function Parameter	P0-00=0 (Speed control mode)	P0-00=1 (Position control mode)	P0-00=2 (Torque control mode)
P6-02 (DI1)	1	1	1
P6-03 (DI2)	2	2	2
P6-04 (DI3)	13	13	13
P6-05 (DI4)	14	14	14
P6-06 (DI5)	5	3	0
P6-07 (DI6)	6	12	19
P6-08 (DI7)	7	20	0
P6-09 (DI8)	8	21	0

Caution☞	When the servo driver is initially set to a hybrid working mode, i.e. when the set value of parameter P0-00 is 3, 5, 6, 7 or 8, even if it is the initial setting, the set function of the DI terminal will not be changed.

Table 8-1 DI function definition

Settings	Item	Function name	Terminal inactive	Trigger mode	Level trigger	Running mode	P	S	T
0	Disable	Description	The terminal is invalid, status change of the terminal set to this function has no effect on the driver.						
1	S_ON	Function name	Servo on	Trigger mode	Level trigger	Running mode	P	S	T
		Description	ON: The servo enters the activated state and the servo motor is powered on OFF: The servo exits the activated state and the servo motor is powered off						
2	ALM-RST	Function name	Warning and warning reset	Trigger mode	Edge trigger	Running mode	P	S	T
		Description	OFF→ON: Reset warnings and alarms that can be reset. ON→OFF: No action						
3	P-CLR	Function name	Position deviation counter clearing	Trigger mode	Edge/level trigger	Running mode		P	
		Description	For the trigger mode, see the definition of function parameter P1-16						
4	DIR_SEL	Function name	Direction selection for speed command	Trigger mode	Level trigger	Running mode		S	
		Description	ON: Reverse direction of speed command OFF: Set the direction of a speed command						
5	CMD0	Function name	Internal command bit0	Trigger mode	Level trigger	Running mode		P S	
		Description	In the multi-segment position control mode, the signal corresponds to the multi-segment position switching function In the multi-segment speed control mode, the signal corresponds to the multi-segment speed switching function						
6	CMD1	Function name	Internal command bit1	Trigger mode	Level trigger	Running mode		P S	
		Description	In the multi-segment position control mode, the signal corresponds to the multi-segment position switching function In the multi-segment speed control mode, the signal corresponds to the multi-segment speed switching function						
7	CMD2	Function name	Internal command bit2	Trigger mode	Level trigger	Running mode		P S	

		Description	In the multi-segment position control mode, the signal corresponds to the multi-segment position switching function In the multi-segment speed control mode, the signal corresponds to the multi-segment speed switching function				
8	CMD3	Function name	Internal command bit3	Trigger mode	Level trigger	Running mode	P S
		Description	In the multi-segment position control mode, the signal corresponds to the multi-segment position switching function In the multi-segment speed control mode, the signal corresponds to the multi-segment speed switching function				

9	CTRG	Function name	Internal command trigger	Trigger mode	Edge trigger	Running mode	P
		Description	In the multi-segment position control mode, execution of the position command is triggered. See the description of function parameters in group P9				
10	MSEL	Function name	Control mode switching	Trigger mode	Level trigger	Running mode	P S T
		Description	For switching between the position, speed and torque modes, see the description of function parameter P0-00				
11	ZCLAMP	Function name	Zero position fixation on for speed command	Trigger mode	Level trigger	Running mode	S
		Description	ON: Zero position fixation on for speed command OFF: Zero position fixation function off				
12	INHIBT	Function name	Pulse inhibited	Trigger mode	Level trigger	Running mode	P
		Description	ON: Inhibit command pulse input OFF: Allow pulse input				
13	P_OT	Function name	Inhibit forward drive	Trigger mode	Level trigger	Running mode	P S T
		Description	ON: Inhibit forward drive OFF: Allow forward drive				
14	N_OT	Function name	Inhibit reverse drive	Trigger mode	Level trigger	Running mode	P S T
		Description	ON: Inhibit reverse drive OFF: Allow reverse drive				
15	GAIN_SEL	Function name	Gain switching	Trigger mode	Level trigger	Running mode	P S T
		Description	ON: Use the second gain OFF: Use the first gain				
16	J_SEL	Function name	Inertia switching	Trigger mode	Level trigger	Running mode	P S T
		Description	ON: Use the second inertia ratio P4-11 OFF: Use the first inertia ratio P4-10				
17	JOG_P	Function name	Forward jog	Trigger mode	Level trigger	Running mode	S
		Description	ON: Activate forward jog OFF: No function				
18	JOG_N	Function name	Reverse jog	Trigger mode	Level trigger	Running mode	S
		Description	ON: Activate reverse jog OFF: No function				
19	TDIR_SEL	Function name	Direction selection for torque command	Trigger mode	Level trigger	Running mode	T
		Description	ON: Reverse direction of torque command OFF: The torque command direction is based on the current parameter setting and the analog command direction				
20	GNUM0	Function name	Numerator selection 0 for electronic gear ratio	Trigger mode	Level trigger	Running mode	PT
21	GNUM1	Function name	Numerator selection 1 for electronic gear ratio	Trigger mode	Level trigger	Running mode	P
		Description	See the description of GNUM0				
22	ORGP	Function name	External detector input	Trigger mode	Level trigger	Running mode	P S T
		Description	Rising edge: External detector active Falling edge: External detector inactive It is used for origin switching. When the origin switch detects the origin block, a rising edge is produced; when the origin block departs, a falling edge is produced.				
23	SHOM	Function name	Homing	Trigger mode	Level trigger	Running mode	P S T
		Description	OFF→ON: Start the homing function				

The Description cell for GNUM0 (row 20) contains:

GNUM1	GNUM0	Electronic gear ratio numerator
0	0	P1-04 setting
0	1	P1-08 setting
1	0	P1-10 setting
1	1	P1-12 setting

24	TL2	Function name	2nd torque limit enabled	Trigger mode	Level trigger	Running mode	P S T
		Description	ON - External torque limit enabled OFF - External torque limit disabled See the description of function parameters P8-25, 26, 27, 28, 29				
25	EMGS	Function name	Emergency stop	Trigger mode	Level trigger	Running mode	P S T
		Description	ON: Emergency braking. The servo decelerates to stop according to the time set by parameter P0-19; after stop, the motor remains in the free state. OFF: No function				

28	CMD_SEL	Function name	Speed command source switching	Trigger mode	Level trigger	Running mode	S
		Description	ON: Switch to speed command source 2 (set by P2-10) OFF: Switch to speed command source 1 (set by P2-00) It is required to set P2-12 to 3 to enable this function.				
31	PID_PAUSE	Function name	PID pause	Trigger mode	Level trigger	Running mode	S
		Description	ON: Pause PID adjustment OFF: Resume PID adjustment When process PID function is selected, current PID output will remain unchanged if the terminal is ON until it is turned OFF. If the terminal is OFF, PID adjustment will be resumed based on current PID output.				
33	PDIR_SEL	Function name	Reverse position command	Trigger mode	Level trigger	Running mode	P
		Description	ON: Reverse position command OFF: No function				
34	GBK	Function name	Position probe	Trigger mode	Level trigger	Running mode	P
		Description	Rising edge: Enable the position probe function Falling edge: No action See the description of P8-42				
35	PUL_UP	Function name	Forward pulse deviation	Trigger mode	Level trigger	Running mode	P
		Description	Rising edge: Execute a forward pulse deviation Falling edge: No action See the description of function parameters P1-30 and 31				
36	PUL_DN	Function name	Reverse pulse deviation	Trigger mode	Level trigger	Running mode	P
		Description	Rising edge: Execute reverse pulse deviation once Falling edge: No action See the description of function parameters P1-30 and 31				
47	FCL	Function name	External encoder switching	Trigger mode	Level trigger	Running mode	P
		Description	ON: Use external encoder OFF: Use motor encoder See Chapter 9 on full closed-loop function.				

P6-10	**DI forced valid**		Initial value	00000000B	Communication address	060AH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00000000B~11111111B	Data size	16bit	Control mode	P S T

Parameter functions: Forced activation of DI terminal

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=1, it means the DI terminal corresponding to this bit is valid, and the function corresponding to this DI terminal is activated.

Caution☞	**1. When the driver is controlled by means of communication, if it is desired to simulate the switch-on/off of the DI terminal by communication, such simulation shall be done by adapting this parameter.** **2. When the servo is restarted after power off, this parameter will be automatically set to zero.**

P6-11	**DO connection/disconnection logic**		Initial value	00000B	Communication address	060BH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00000B~11111B	Data size	16bit	Control mode	P S T

Parameter functions: Set the logic of 4 DOs and set stop. These settings will become valid upon power-on again.

$$0 \quad 0 \quad 0 \quad 0$$
DO4 DO3 DO2 DO1

bitX=0: Connection of the DO terminal corresponding to this bit is valid; it is connected when the event is valid and cut off when the event is invalid

bitX=1: Cutoff of the DO terminal corresponding to this bit is valid; it is cut off when the event is valid and connected when the event is invalid

P6-12		**DO1 function selection**	Initial value	1	Communication address	060CH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-13		**DO2 function selection**	Initial value	2	Communication address	060DH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

P6-14	**DO3 function selection**		Initial value	8	Communication address	060EH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-15	**DO4 function selection**		Initial value	12	Communication address	060FH
			Unit	-	Time of taking effect	Cannot be modified
	Setting range	0~99	Data size	16bit	Control mode	P S T

Parameter functions: Set the event corresponding to each DO; see Table 8-2.

When corresponding event occurs, output of the DO terminal set to corresponding event is valid.

For example, when P6-12=1, if the servo is ready, the output of DO1 terminal is valid (when P6-11 bit0=0, DO1 terminal is connected; when P6-11 bit0=1, DO1 is cut off).

Table 8-2 DO function definition

Settings	Item	Function name	Description	Running mode
0	Disable	Terminal inactive		
1	S-RDY	Servo ready	Active - The servo is ready and can receive S-ON commands Inactive - The servo is not ready and cannot receive S-ON commands	P S T
2	BK	Brake control	Active - Release the holding brake (brake powered on) Inactive - Close the holding brake (brake powered off)	P S T
3	TGON	Motor rotation	Active - The motor is rotating (the rotating speed is higher than the P0-04 set value) Inactive - The motor stops rotating (the rotating speed is lower than the P0-04 set value)	P S T
4	ZER0	Zero speed of motor	Active - The motor speed is zero (the speed is lower than the P0-03 set value) Inactive - The motor speed is not zero (the speed is higher than the P0-03 set value)	P S T
5	V-CLS	Speed reached	Valid: The actual motor speed reaches or exceeds the P2-08 set value (regardless of direction).	P S T
6	V-CMP	Speed consistency	Valid: Upon speed control, the absolute value of the difference between the actual motor speed and the speed command value is smaller than the P2-09 set value	S
7	PNEAR	Positioning approach	Valid: In the position control mode, the count of position deviation pulses is smaller than the P1-23 set value of the positioning approach width	P
8	COIN	Positioning completion	Valid: In the position control mode, the count of position deviation pulses is smaller than the P1-24 set value of the positioning completion width, and satisfies the condition of P1-22	P
9	C-LT	Torque limit	Valid - Motor torque limited Invalid - Motor torque not limited	P S T
10	V-LT	Rotating speed limit	Valid - Motor speed limited Invalid - Motor speed not limited	T
11	WARN	Warning output	Valid: A warning event occurs Invalid: No warning event	P S T
12	ALM	Alarm output	Valid: An alarm event occurs Invalid: No alarm event	P S T
13	Tcmp	Torque consistency	Valid: The motor output torque reaches the set value Invalid: The motor output torque does not reach the set value	T
14	Home	Homing completed	Valid: Homing completed Invalid: Homing not completed yet	P
15	S-RUN	Servo on	Valid - The servo is on Invalid - The servo is off	P S T
27	T_CLS	The torque is reached	Valid: The motor current percentage reaches or exceeds the P3-07 set value (regardless of the direction)	P S T
29	SPD_P	Speed programming comparison output	P8-36 selects the judgment logic; when the condition is satisfied, the output is valid; otherwise when the condition is dissatisfied, the output is invalid; when 10rpm hysteresis is present, the output remains unchanged during the hysteresis.	P S T
30	TRQ_P	Torque programming comparison output	P8-39 selects the judgment logic; when the condition is satisfied, the output is valid; otherwise when the condition is dissatisfied, the output is invalid; when 3.0% hysteresis is present, the output remains unchanged during the hysteresis.	P S T
31	SPD_TRQ	Speed and torque programming	Valid: Both SPD_P and TRQ_P are valid simultaneously Invalid: SPD_P or TRQ_P is invalid	P S T

		comparison output				

Caution☞	1. Generally 10rpm speed hysteresis is present; during the hysteresis, the output remains unchanged. 2. Generally 3.0% hysteresis is present; during the hysteresis, the output remains unchanged.

			Initial value	0	Communication address	0610H
P6-16		**DO1 valid delay**	Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
			Initial value	0	Communication address	0611H
P6-17		**DO1 invalid delay**	Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T

P6-18		**DO2 valid delay**	Initial value	0	Communication address	0612H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-19		**DO2 invalid delay**	Initial value	0	Communication address	0613H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-20		**DO3 valid delay**	Initial value	0	Communication address	0614H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-21		**DO3 invalid delay**	Initial value	0	Communication address	0615H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-22		**DO4 valid delay**	Initial value	0	Communication address	0616H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-23		**DO4 invalid delay**	Initial value	0	Communication address	0617H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T

Parameter functions: Set the delay time for activation and inactivation of each DO
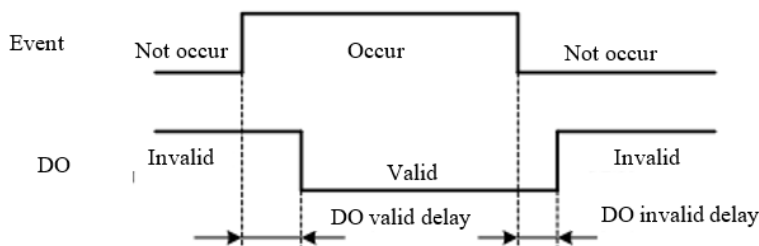
P6-24		Forced output of DO	Initial value	0000B	Communication address	0618H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0000B~1111B*	Data size	16bit	Control mode	P S T

Parameter functions: For forced activation of the DO terminal.

<center>0   0   0   0</center>
<center>DO4 DO3 DO2 DO1</center>

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=1, it means output of the DO terminal corresponding to this bit is valid.

Caution☞	**1. This function can be used to test whether connection between the DO terminal of the driver and an external unit is sound when the servo is not activated.** **2. When the servo is restarted after power off, this parameter will be automatically set to zero.** **3. During forced output, the DO delay time set via P6_16~P 6_23 is invalid.**

P6-25		**AI1 filtering time**	Initial value	10	Communication address	0619H

			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~10000	Data size	16bit	Control mode	P S T
P6-26		**AI2 filtering time**	Initial value	10	Communication address	061AH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~10000	Data size	16bit	Control mode	P S T

Parameter functions: Sets first-order low-pass filtering time constant of AI1 and AI2 analog input respectively.

Performs first-order low-pass filtering on the analog input from AI1 and AI2 to reduce analog fluctuation arising from external electromagnetic interference and delay vibration caused by analog mutation. However, a value too big will slow system response.
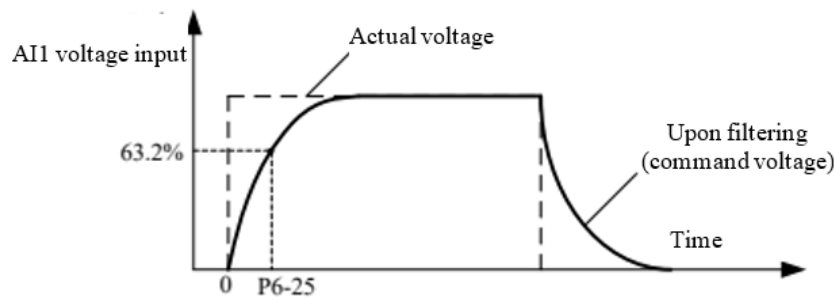
P6-27		**AI1 hysteresis**	Initial value	2	Communication address	061BH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~300	Data size	16bit	Control mode	P S T
P6-28		**AI2 hysteresis**	Initial value	2	Communication address	061CH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~300	Data size	16bit	Control mode	P S T

Parameter functions: Sets hysteresis level of AI1 and AI2 analog input respectively.

When adjusting speed or torque using analog, the analog actually detected by the driver might be subject to fluctuations due to electromagnetic interference and internal sampling circuit despite that the analog setting remains unchanged, leading to unstable speed or torque setting. This can be improved by adjusting this parameter.

Usage:

When a constant analog signal (non-zero, recommended to be greater than 1V) is set externally, monitor the values of d0-14 (AI1 channel) and d0-15 (AI2 channel). If an unaccetable fluctuation is identified, increase P6-27 (AI1 channel) and P6-28 (AI2 channel) appropriately so that the values monitored becomes stable.

Caution☞	**The greater the hysteresis, the greater the steps of speed or torque commands, i.e. the less possible to adjust the speed or torque to a certain value via analog.** For example, if the hysteresis coefficient is 4, it's might be the case that the speed command can be adjusted to 100 rpm or 102 rpm, but 101 rpm is unable to reach.

P6-29		**AI1 offset**	Initial value	0	Communication address	061DH
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	-3000~3000	Data size	16bit	Control mode	P S T
P6-30		**AI2 offset**	Initial value	0	Communication address	061EH
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	-3000~3000	Data size	16bit	Control mode	P S T

Parameter functions: Sets the offset voltage of AI1 and AI2 analog input respectively.

External analog might be subject to some DC offset voltage due to the circuit. For example, if the external setting is 5V, the collected voltage displayed by the driver might be 5.2 V. This can be corrected through this parameter.

Usage:

Measure the voltage actually set by AI1 and AI2, and check the values displayed by d0-14 and d0-15. If the difference between them is XmV, set P6-29 and P6-30 as X, and the deviation is eliminated.
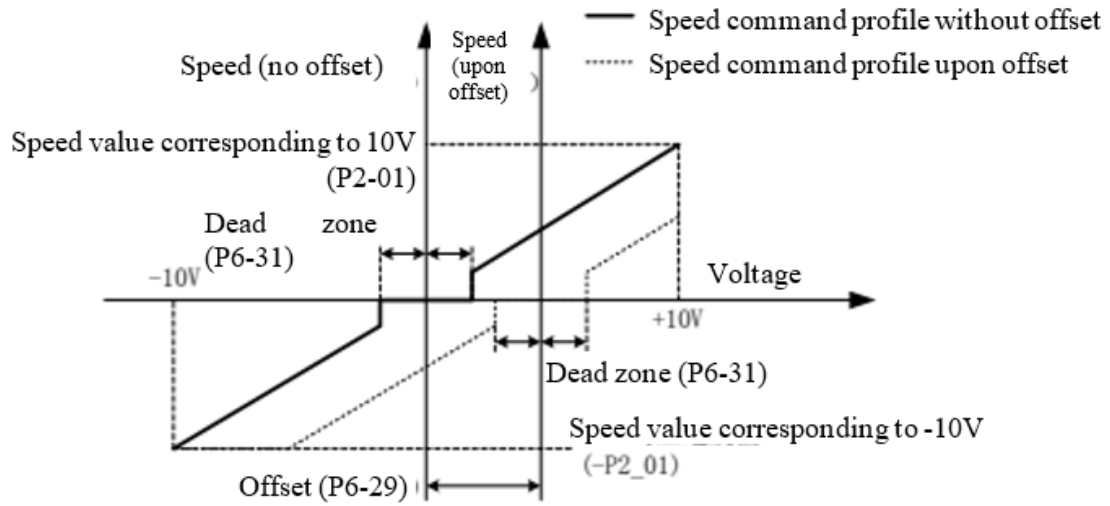
Caution☞ Offset pans the entire analog profile. If the offset exists only at 0V, you should adjust it with dead zone instead of offset.

P6-31		**AI1 dead zone**	Initial value	10	Communication address	061FH
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	0~3000	Data size	16bit	Control mode	P S T
P6-32		**AI2 dead zone**	Initial value	10	Communication address	0620H
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	0~3000	Data size	16bit	Control mode	P S T

Parameter functions: Sets the range of dead zone of AI1 and AI2 analog input respectively.

The analog might be subject to zero drift due to the circuit and the environment. This parameter is used to set loop width. When the actual value of the external analog setting falls in the range, it will be taken as 0V.

For example, if P6-31 is set as 50, and the actual voltage of the analog input through AI1 falls in the range of -50mV ~ +50mV, it will be taken as 0V.

P6-33		**AI1 zero drift**	Initial value	0	Communication address	0621H
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	-2000~2000	Data size	16bit	Control mode	P S T
P6-34		**AI2 zero drift**	Initial value	0	Communication address	0622H
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	-2000~2000	Data size	16bit	Control mode	P S T

Parameter functions: No setting required. This is set by the driver automatically when performing automatic correction via AF-06.

P6-35		**AO1 function selection**	Initial value	0	Communication address	0623H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~20	Data size	16bit	Control mode	P S T
P6-36		**AO2 function selection**	Initial value	1	Communication address	0624H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~20	Data size	16bit	Control mode	P S T

Parameter functions: Sets the definition of AO terminal output

When the output of AO terminal is 10 V, it means that the value it represents has reached the maximum.

Table 8-3 Definitions of AO output

Settings	Definitions of AO output	Settings	Definitions of AO output
0	Actual motor speed: 1 V corresponds to 1,000 rpm	9	Direct output of write P6-42: -10000~10000mV
1	Speed command: 1 V corresponds to 1,000 rpm	10	AI1 input: -10V~10V corresponds to -10V~10V
2	Torque command: 1 V corresponds to 100.0% rated torque	11	AI2 input: -10V~10V corresponds to -10V~10V
3	Position deviation: 1 mV corresponds to 1 command unit deviation	12	Speed feedforward value: 1 V corresponds to 1,000 rpm
4	Position deviation: 1 mV corresponds to 1 encoder unit deviation	13	Torque feedforward value: 1 V corresponds to 100.0% rated torque
5	Speed corresponding to pulse command: 1 V corresponds to 1,000 rpm	14	Effective gain: 0 V - 1st gain; 5 V - 2nd gain
6	Actual torque output: 1 V corresponds to 100.0% rated torque	15	Completion of position command transmission: 5 V - Completed; 0 V - Not completed
7	Positioning completion: 5 V - Completed; 0 V - Not completed	16	Bus voltage: 1 V corresponds to 100 V
8	Direct output of write P6-41: -10000~10000mV		

P6-37		**AO1 gain adjustment**	Initial value	1.00	Communication address	0625H
			Unit	-	Time of taking	With immediate

					effect	effect
	Setting range	-10.00~10.00	Data size	16bit	Control mode	P S T
P6-38		**AO2 gain adjustment**	Initial value	1.00	Communication address	0626H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	-10.00~10.00	Data size	16bit	Control mode	P S T
P6-39		**AO1 offset adjustment**	Initial value	0	Communication address	0627H
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	-10000~10000	Data size	16bit	Control mode	P S T
P6-40		**AO2 offset adjustment**	Initial value	0	Communication address	0628H
			Unit	mV	Time of taking effect	With immediate effect
	Setting range	-10000~10000	Data size	16bit	Control mode	P S T

Parameter functions: Adjusts the gain and offset of analog output terminals AO1 and AO2.

Analog output voltage = selected output * analog gain + analog offset. Note that these are signed, and hence operation relations should be taken into account. For example, P6-35 = 0, and AO1 represents motor speed:

Set P6-37 gain as 1.00 and P6-39 offset as 0, and the analog output 3 V corresponds to forward 3,000 rpm and -3 V to reverse 3,000 rpm.

Set P6-37 gain as 2.00 and P6-39 offset as -5,000, and the analog output 0 V corresponds to forward 2,500 rpm, -5 V to 0 speed, and -10 V to reverse 2,500 rpm.

Set P6-37 gain as 3.33 and P6-39 offset as 5,000, and the analog output 0 V corresponds to reverse 1,500 rpm, 5 V to 0 speed, and 10 V to forward 1,500 rpm.

P6-41		**AO direct output 1**		Initial value	0	Communication address	0629H
				Unit	mV	Time of taking effect	With immediate effect
	Setting range	-10000~10000		Data size	16bit	Control mode	P S T
P6-42		**AO direct output 2**		Initial value	0	Communication address	062AH
				Unit	mV	Time of taking effect	With immediate effect
	Setting range	-10000~10000		Data size	16bit	Control mode	P S T

Parameter functions: The voltage desired to be output from AO port.

When P6-35 and P6-36 is set as 8 or 9, and P6-41 (corresponding to 8) and P6-42 (corresponding to 9) are written via communication (or keyboard input), corresponding AO port will output corresponding voltage for testing of driver output, lines, and integrity of the master.

For example: set P6-35 as 8 and P6-41 via the keyboard or communication as 5,000, and AO1 terminal should output 5 V.

Caution☞	**When the servo is restarted after power off, these two parameters will be automatically set to zero.**

Important:
Parameters of P6-46~P6-85 are used to set virtual terminals.
The virtual terminal is defined as a DI/DO terminal whose parameters can only be modified by means of communication. It is generally used in combination with a touch screen or other devices. Virtual keys can be established on the touch screen and mapped to the VDI/VDO terminal of the driver to achieve effects of physical keys.

P6-46		**VDI status selection**		Initial value	0000000B	Communication address	062EH
				Unit	-	Time of taking effect	With immediate effect
	Setting range	0000000B~11111111B		Data size	16bit	Control mode	P S T

Parameter functions: Select the VDI (virtual input terminal) usage

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=0, it means whether the VDI terminal corresponding to this bit is valid depends on the value of P6-55. For example, if P6-46=11111110 and P6-47 is set to 2, then when P6-55 bit0=1, VDI1 is valid and corresponding function is ALM-RST.

When bitX=1, it means the function of the VDI terminal corresponding to this bit depends on the status of corresponding VDOx.

For example, if P6-46=00000010 and P6-48 is set to 2, then when VDO2 is valid, VDI2 is valid and corresponding function is ALM-RST.

For example, if P6-46=00000100 and P6-49 is set to 2, then when VDO3 is valid, VDI3 is valid and corresponding function is ALM-RST.

P6-47		**VDI1 function selection**		Initial value	0	Communication address	062FH
				Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99		Data size	16bit	Control mode	P S T
P6-48		**VDI2 function selection**		Initial value	0	Communication address	0630H
				Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99		Data size	16bit	Control mode	P S T
P6-49		**VDI3 function selection**		Initial value	0	Communication address	0631H
				Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99		Data size	16bit	Control mode	P S T
P6-50		**VDI4 function selection**		Initial value	0	Communication address	0632H
				Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting	0~99		Data size	16bit	Control mode	P S T

	range					
P6-51		**VDI5 function selection**	Initial value	0	Communication address	0633H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-52		**VDI6 function selection**	Initial value	0	Communication address	0634H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-53		**VDI7 function selection**	Initial value	0	Communication address	0635H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-54		**VDI8 function selection**	Initial value	0	Communication address	0636H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

Parameter functions: Set functions of terminals VDI1~VDI8; see Table 7-5.

Set corresponding functions of 8 VDIs; other logic relations are the same with DI terminals.

P6-55	**VDI input control**		Initial value	00000000B	Communication address	0637H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00000000B~11111111B	Data size	16bit	Control mode	P S T

Parameter functions: Activate a VDI terminal

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=1, it means the VDI terminal corresponding to this bit is valid, and the function corresponding to this VDI terminal is activated.

Caution☞ 1. When the servo is restarted after power off, this parameter will be automatically set to zero.

P6-56	**VDI input status**		Initial value	00000000B	Communication address	0638H
			Unit	-	Time of taking effect	Read-only parameter
	Setting range	00000000B~11111111B	Data size	16bit	Control mode	P S T

Parameter functions: Check the VDI terminal status

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=1, it means the VDI terminal corresponding to this bit is valid.

P6-57	**VDO1 function selection**		Initial value	0	Communication address	0639H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-58	**VDO2 function selection**		Initial value	0	Communication address	063AH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-59	**VDO3 function selection**		Initial value	0	Communication address	063BH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-60	**VDO4 function selection**		Initial value	0	Communication address	063CH
			Unit	-	Time of taking effect	Cannot be modified
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-61	**VDO5 function selection**		Initial value	1	Communication address	063DH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-62	**VDO6 function selection**		Initial value	0	Communication address	063EH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T
P6-63	**VDO7 function selection**		Initial value	8	Communication address	063FH
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~99	Data size	16bit	Control mode	P S T

P6-64		VDO8 function selection		Initial value	0	Communication address	0640H
				Unit	-	Time of taking effect	Cannot be modified
	Setting range	0~99		Data size	16bit	Control mode	P S T

Parameter functions: Set the event corresponding to each VDO; see Table 7-6.

When corresponding event occurs, output of the VDO terminal set to corresponding event is valid.

P6-65		VDO1 valid delay		Initial value	0	Communication address	0641H
				Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535		Data size	16bit	Control mode	P S T
P6-66		VDO1 invalid delay		Initial value	0	Communication address	0642H
				Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535		Data size	16bit	Control mode	P S T
P6-67		VDO2 valid delay		Initial value	0	Communication address	0643H
				Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535		Data size	16bit	Control mode	P S T
P6-68		VDO2 invalid delay		Initial value	0	Communication address	0644H
				Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535		Data size	16bit	Control mode	P S T
P6-69		VDO3 valid delay		Initial value	0	Communication address	0645H
				Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535		Data size	16bit	Control mode	P S T
P6-70		VDO3 invalid delay		Initial value	0	Communication address	0646H
				Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535		Data size	16bit	Control mode	P S T

P6-71		**VDO4 valid delay**	Initial value	0	Communication address	0647H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-72		**VDO4 invalid delay**	Initial value	0	Communication address	0648H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T

Parameter functions: Set the delay time for activation and inactivation of each VDO.

See the description of P6-12~P6-23.

P6-73		**Forced output of VDO**	Initial value	00000000B	Communication address	0649H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00000000B~11111111B*	Data size	16bit	Control mode	P S T

Parameter functions: For forced activation of the VDO terminal.

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=1, it means output of the VDO terminal corresponding to this bit is valid.

Caution☞ 1. When the servo is restarted after power off, this parameter will be automatically set to zero.

P6-74		**VDO output status**	Initial value	00000000B	Communication address	064AH
			Unit	-	Time of taking effect	Read-only parameter
	Setting range	00000000B~11111111B	Data size	16bit	Control mode	P S T

Parameter functions: Check the VDI terminal status

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=1, it means the VDI terminal corresponding to this bit is valid.

P6-75		**VDI1 valid delay**	Initial value	0	Communication address	064BH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-76		**VDI1 invalid delay**	Initial value	0	Communication address	064CH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-77		**VDI2 valid delay**	Initial value	0	Communication address	064DH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-78		**VDI2 invalid delay**	Initial value	0	Communication address	064EH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-79		**VDI3 valid delay**	Initial value	0	Communication address	064FH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T

P6-80		**VDI3 invalid delay**	Initial value	0	Communication address	0650H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-81		**VDI4 valid delay**	Initial value	0	Communication address	0651H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-82		**VDI4 invalid delay**	Initial value	0	Communication address	0652H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T

Parameter functions: Set the delay time for activation and inactivation of each VDI.

These functions are intended for VDI input. Please refer to P6-86~P6-97.

Caution☞	**1: P6-75~P6-82 are intended for virtual terminal VDI instead of actual DI intput terminal.** **2: Please use this function with caution, especially for invalid delay of DI, otherwise unexpected results might occur due to command delay.**

P6-83		**VDI level logic**	Initial value	00000000B	Communication address	0653H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00000000B~11111111B*	Data size	16bit	Control mode	P S T

P6-84		**VDO level logic**	Initial value	00000000B	Communication address	0654H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00000000B~11111111B*	Data size	16bit	Control mode	P S T

Parameter functions: Set the level logic of each VDI and VDO terminal.

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon rewriting by communication.

When bitX=1, it means the VDI corresponding to this bit is valid when 0 is written into P6-55 and invalid when 1 is written.

When bitX=1, it means the VDO corresponding to this bit has the P6-74 bit = 0 upon occurrence of an event.

P6-85		**VDO output selection**	Initial value	0000000B	Communication address	0655H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0000000B~11111111B	Data size	16bit	Control mode	P S T

Parameter functions: Select the VDO (virtual output terminal) usage

*: The letter B at the end of the number means the parameter value is expressed in binary, and shall be noted upon communication.

When bitX=0, it means the status of the VDO terminal corresponding to this bit depends on the function number. For example, if P6-85=11111110 and P6-57 is set to 1, then VDO1 corresponds to function S-RDY; when an S-RDY event occurs, the VDO1 is valid.

When bitX=1, it means the status of the VDO terminal corresponding to this bit depends on the DIx status.

For example, if P6-85=00000010, when DI2 is valid, VDO2 is valid.

For example, if P6-85=00000100, when DI3 is valid, VDO3 is valid.

P6-86		**DI3 valid delay**	Initial value	0	Communication address	0656H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-87		**DI3 invalid delay**	Initial value	0	Communication address	0657H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-88		**DI4 valid delay**	Initial value	0	Communication address	0658H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-89		**DI4 invalid delay**	Initial value	0	Communication address	0659H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-90		**DI5 valid delay**	Initial value	0	Communication address	065AH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-91		**DI5 invalid delay**	Initial value	0	Communication address	065BH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-92		**DI6 valid delay**	Initial value	0	Communication address	065CH
			Unit	ms	Time of taking effect	With immediate effect
	Setting	0~65535	Data size	16bit	Control mode	P S T

	range					
P6-93		**DI6 invalid delay**	Initial value	0	Communication address	065DH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-94		**DI7 valid delay**	Initial value	0	Communication address	065EH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-95		**DI7 invalid delay**	Initial value	0	Communication address	065FH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-96		**DI8 valid delay**	Initial value	0	Communication address	0660H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T
P6-97		**DI8 invalid delay**	Initial value	0	Communication address	0661H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P S T

Parameter functions: Set the delay time for activation and inactivation of each DI.
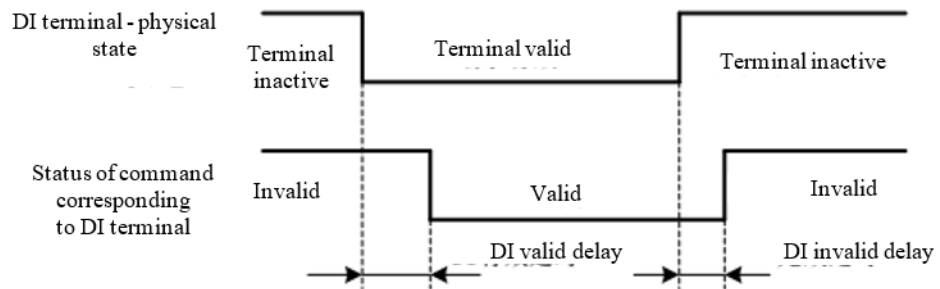
Caution☞	1: P6-86~P6-97 are intended for actual DI input terminal instead of virtual VDI terminal.
	2: Please use this function with caution, especially for invalid delay of DI, otherwise unexpected results might occur due to command delay.

8.12 P7-xx communication parameters

P7-00	**Modbus communication address setting**		Initial value	1	Communication address	-
			Unit	-	Time of taking effect	With immediate effect
	Setting range	1~254	Data size	16bit	Control mode	P S T

Parameter functions: This device is used as the address of the communication slave station.

P7-01	**Baud rate of Modbus communication**		Initial value	1	Communication address	-
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~5	Data size	16bit	Control mode	P S T

Parameter functions: Set the baud rate for communication of the device

P7-01=0: 4800 bps

P7-01=1: 9600 bps

P7-02=2: 19200 bps

P7-03=3: 38400 bps

P7-04=4: 57600 bps

P7-04=5: 115200 bps

P7-02	**Modbus communication data format**		Initial value	0	Communication address	-
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~5	Data size	16bit	Control mode	P S T

Parameter functions: Set the communication data format for the device

P7-02=0: No check 1+8+N+1 (1 start bit + 8 data bits + no check bit + 1 stop bit)

P7-02=1: Odd parity check 1+8+O+1 (1 start bit + 8 data bits + odd parity bit + 1 stop bit)

P7-02=2: Odd parity check 1+8+E+1 (1 start bit + 8 data bits + even parity bit + 1 stop bit)

P7-02=3: No check 1+8+N+2 (1 start bit + 8 data bits + no check bit + 2 stop bits)

P7-02=4: Odd parity check 1+8+O+2 (1 start bit + 8 data bits + odd parity bit + 2 stop bits)

P7-02=5: Odd parity check 1+8+E+2 (1 start bit + 8 data bits + even parity bit + 2 stop bits)

P7-03	**Modbus communication response delay**		Initial value	2	Communication address	-
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~20	Data size	16bit	Control mode	P S T

Parameter functions: Set the delay time of communication response

When the device receives a communication command from the upper computer, response will be delayed for the length of the time.

P7-04	**Parameter storage and return control upon Modbus communication**		Initial value	00	Communication address	-
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00B~01B	Data size	16bit	Control mode	P S T

Parameter functions:

Bit0=0: Whether data sent to the driver via MODBUS communication will be saved depends on the setting of P7-05.

Bit0=1: Data sent to the driver via MODBUS communication will never be saved.

Bit1=0: Received data is returned upon receipt of a write command via MODBUS communication, and write is executed.

Bit1=1: Received data is not returned upon receipt of a write command via MODBUS communication, and write is executed.

P7-05	**Address definition selection upon Modbus communication**		Initial value	1	Communication address	-
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P S T

Parameter functions:

P7-05=0: If for communication, an address provided in the parameter list of this Manual is used, then the parameter will be written to the RAM register of the driver, and whether it will take immediate effect will depend on the parameter attribute; the parameter will not be saved upon power-off. If for communication, an address provided in the parameter list of this Manual + 8000H is used, then the parameter will be written to EEPROM of the driver and immediately saved; whether it will take immediate effect will depend on the parameter attribute.

P7-05=1: If for communication, an address provided in the parameter list of this Manual + 8000H is used, then the parameter will be written to the RAM register of the driver, and whether it will take immediate effect will depend on the parameter attribute; the parameter will not be saved upon power-off. If for communication, an address provided in the parameter list of this Manual is used, then the parameter will be written to EEPROM of the driver and immediately saved; whether it will take immediate effect will depend on the parameter attribute.

Effect of P7-04 bit0 and P7-05 settings on the communication address and storage

Function Parameter		MODBUS communication address	
P7-04 bit0	P7-05	0000H~3FxxH	(0000H~3FxxH)+8000H
0 (default value)	**1 (default value)**	**Write to EEPROM, and save**	**Write to RAM, without saving**
0	0	Write to RAM, without saving	Write to EEPROM, and save
1	1	Write to RAM, without saving	Write to RAM, without saving
1	0	Write to RAM, without saving	Write to RAM, without saving

P7-09	Status sequence setting for high 32-bit function code upon Modbus communication		Initial value	0	Communication address	0709H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~3	Data size	16bit	Control mode	P S T

Parameter functions: Set the data high/low-position when the upper computer reads/writes a 32-bit function code. In actual applications, if a 16-bit function code reads/writes normally but a 32-bit function code reads/writes abnormally, this parameter needs to be changed.

P7-09=0: For read/write, the low 16 bits are before the high 16 bits

P7-09=1: For read/write, the high 16 bits are before the low 16 bits

P7-09=2: For read, the low 16 bits are before the high 16 bits; for write, the high 16 bits are before the low 16 bits

P7-09=3: For read, the high 16 bits are before the low 16 bits; for write, the low 16 bits are before the high 16 bits

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Important: The sequence of high and low bits shall be set with reference to definition by the upper computer. The following shows a demonstration by reading a 32-bit function code P1-02=1234567 (in hexadecimal 0012 D687H).

- **P7-09=0 (default value): The low 16 bits (D687H) are before the high 16 bits (0012H).**
  Write P1-02 Upper computer sending command: 01 10 01 02 00 02 04 **D6 87 00 12** CRCL CRCH
     Driver returning command: 01 10 01 02 00 02 CRCL CRCH
  Read P1-02 Upper computer sending command: 01 03 01 02 00 02 CRCL CRCH
     Driver returning command: 01 03 04 **D6 87 00 12** CRCL CRCH
- **P7-09=1: The high 16 bits (0012H) are before the low 16 bits (D687H).**
  Write P1-02 Upper computer sending command: 01 10 01 02 00 02 04 **00 12 D6 87** CRCL CRCH
     Driver returning command: 01 10 01 02 00 02 CRCL CRCH
  Read P1-02 Upper computer sending command: 01 03 01 02 00 02 CRCL CRCH
     Driver returning command: 01 03 04 **00 12 D6 87** CRCL CRCH

P7-30	Source address 1 of Modbus communication mapping		Initial value	FFFFH	Communication address	071EH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0000H~FFFFH	Data size	16bit	Control mode	P S T
P7-31	Target address 1 of Modbus communication mapping		Initial value	FFFFH	Communication address	071FH
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0000H~FFFFH	Data size	16bit	Control mode	P S T

Parameter functions: It is used for address mapping upon Modbus communication, and totally 10 groups of 16-bit parameters can be mapped (5 groups of 32-bit parameters). Two examples are given below for demonstration.

Example 1: P7-30 = 7654H, P7-31 = 2000H (d0-00 communication address).

When the address received by the driver is the original address (7654H), it will be processed by the program as a target address (2000H), i.e. actually the operation is made to the d0-00 function code.

Example 2: P7-32 = 7655H, P7-33 = 8906H (P9-06 communication address 1 + 8000H); P7-34 = 7656H, P7-34 = 8907H (P9-06 communication address 2 + 8000H). When the upper computer operates two consecutive addresses with 7655H as the starting address, it is equivalent to an operation to P9-06; in case of a write operation, data will not be saved to EEPROM in default.

Example 3: Based on settings in examples 1 and 2, the upper computer can realize read/write operations to non-consecutive addresses by using 1 command (mapping of the initial address is required). Namely, when the upper computer reads 3 addresses starting from 7654H, the driver will return values of parameters d0-00 (16-bit) and P9-06 (32-bit).

Caution☞	1. The target address requires corresponding actual parameter; otherwise an error may occur upon communication; 2. Address mapping of a 32-bit parameter requires space of two consecutive groups; 3. When 0x03/0x10 reads/writes n consecutive addresses, if the starting address has been mapped, then the remaining (n-1) addresses also require mapping, and target addresses of mapping can be non-consecutive.

8.13 P8-xx Expanded function parameters

P8-00	**JOG speed**		Initial value	100	Communication address	0800H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~6000	Data size	16bit	Control mode	P S T
P8-01	**JOG acceleration and deceleration time**		Initial value	200	Communication address	0801H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P S T

Parameter functions: Set the motor speed and acceleration/deceleration time upon jog; the reference acceleration/deceleration time is the time required for the motor to accelerate from speed 0 to the rated speed or to decelerate from the rated speed to speed 0.

Jog of the driver can be realized through the function parameter AF-02 or through the DI terminal set to JOG-P or JOG-N.

Jog operation through the function parameter AF-02 is available only when the servo is OFF, while jog operation through the DI terminal is available whether the servo is OFF or ON.

Execution of the jog command:

Original status	JOG terminal turning from OFF→ON and then maintaining the state	JOG terminal turning from ON→OFF
Motor static	Run according to P8-01 to the speed set by P8-00, and then continue running	Decelerate according to P8-01 to speed 0, and restore the original control mode
Position mode of pulse command	Clear stranded pulses; start with the current speed and run according to P8-01 to the speed set by P8-00, and continue running.	Restore running in the position mode from the moment when the JOG command becomes invalid, and start receiving command pulses.
Multi-segment position mode	Clear stranded pulses; start with the current speed and run according to P8-01 to the speed set by P8-00, and continue running.	Restore the multi-segment position mode, and run remaining pulse commands of the current segment (stranded pulses that have been cleared will no longer be executed)
Speed mode	Run according to P8-01 to the speed set by P8-00, and then continue running	Accelerate according to P2-04 or decelerate according to P2-05 to the speed specified by the current speed command.
Torque mode	Run according to P8-01 from the current speed to the speed set by P8-00, and continue running	Restore the torque mode, and run according to the current torque command

P8-2	**Self-learning torque for offline inertia identification**		Initial value	50	Communication address	0802H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	10~200	Data size	16bit	Control mode	P S T

Parameter functions: The percentage of the motor output torque to the motor rated torque upon offline learning of the load inertia ratio.

A larger set value may cause greater mechanical shock, but lead to shorter identification time and fewer revolutions required of the motor. The value shall be properly set based on conditions of the machine.

P8-03	**Maximum number of revolutions and travel coefficient for offline inertia identification**		Initial value	2010	Communication address	0803H
			Unit	rev	Time of taking effect	With immediate effect
	Setting range	0001~2020	Data size	16bit	Control mode	P S T

Parameter functions: Set the maximum number of revolutions and travel coefficient permitted for offline inertia identification

Tens and ones places: Set the maximum number of revolutions permitted for offline inertia identification. If the system inertia has not been successfully identified when the motor has rotated by the number of revolutions, or the motor cannot rotate to the number of revolutions during inertia identification, an $RL.028$ alarm will occur.

Thousands and hundreds places: Set the travel coefficient permitted for offline inertia identification. A larger set value means a greater number of motor revolutions during identification, but the number of revolutions will not exceed the maximum number of revolutions set by the tens and ones places.

The travel coefficient defines the rotating speed range for inertia identification. It shall be set based on the rigidity of the load transmission system. In case of a device with low rigidity (for example upon belt transmission), a smaller travel coefficient may cause larger deviation of the identification result. In case of a device with low rigidity (for example upon coupler transmission), the value of the travel coefficient has little effect on the identification result.

Caution☞ When the system inertia cannot be successfully identified but more revolutions of the motor are permitted according to the mechanical conditions, it is required to set a greater value of the combination of the tens and ones places.

When the system inertia cannot be successfully identified and more revolutions of the motor are not permitted according to the mechanical conditions, the set value of P8-02 shall be added.

If the system inertia still cannot be successfully identified by the two methods above, it is required to reduce the set value of the

combination of the thousands and hundreds places.
See section 6.6 for details.

P8-05	**Upper limit for revolutions of absolute type encoder**		Initial value	32767	Communication address	0805H
			Unit	rev	Time of taking effect	With immediate effect
	Setting range	1~32767	Data size	16bit	Control mode	P S T

Parameter functions: Set the upper limit for revolutions of the absolute type encoder

If the number of revolutions of the absolute type encoder is a positive number exceeding the set value, and the current command is in the forward direction, it shall be processed as a forward overrun. If the LED shows $P\text{-}ot$, WARN terminal output is valid; if the number of revolutions is a negative value exceeding the setting, and the current command is in the reverse direction, it shall be processed as a reverse overrun. If the LED shows $n\text{-}ot$, the WARN terminal output is valid.

P8-06	**Selection of the usage for absolute type encoder**		Initial value	0	Communication address	0806H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~1	Data size	16bit	Control mode	P S T

Parameter functions: Select the usage of the absolute type encoder

P8-06=0: Used as an incremental encoder

P8-06=1: Used as an absolute type encoder

P8-07	**Fan control**		Initial value	0	Communication address	0807H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~2	Data size	16bit	Control mode	P S T

Parameter functions: Control running of the driver cooling fan

P8-07=0: The cooling fan of the driver runs when the servo activation is ON and a warning/alarm occurs

P8-07=1: The cooling fan of the driver starts to run immediately after power on

P8-07=2: After power-on of the driver, the cooling fan will start to run when the detected radiator temperature of the driver exceeds 50°C, and stop running when the temperature falls below 40°C.

P8-08	**Driver overload warning threshold**		Initial value	80	Communication address	0808H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	20~100	Data size	16bit	Control mode	P S T

Parameter functions: Set the threshold for driver overload warning based on the rated output current of the driver.

The driver has an overload protection function, which will start to generate overload curves according to 100% rated current of the driver; however, in this case, it will not directly enter the alarm state. This parameter can be used to set the threshold for overload warning of the driver; once the detected driver overload exceeds this set value, a driver overload warning $AL.E04$ will be given, but the driver will not stop running.

P8-09	**Motor overload warning threshold**		Initial value	80	Communication address	0809H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	20~100	Data size	16bit	Control mode	P S T

Parameter functions: Set the threshold for servo motor overload warning based on the rated current of the servo driver.

The driver has a function to protect the motor against overloading; the function will start to generate overload curves according to 100% rated current of the servo motor; in this case, the driver will directly enter the alarm state. This parameter can be used to set the threshold for motor overload warning. Once the detected motor overload exceeds this set value, a motor overload warning $AL.E03$ will be given, but the motor will not stop running.

P8-10	**Braking resistance setting**		Initial value	50	Communication address	080AH
			Unit	Ω	Time of taking effect	With immediate effect
	Setting range	20~30000	Data size	16bit	Control mode	P S T

Parameter functions: Set resistance of a braking resistor. It cannot be changed when a built-in braking resistor is used.

When an external braking resistor is used, setting shall be performed based on the actual resistance; besides, the resistance of the braking resistor shall not be less than that provided in section 2.7.1.

P8-11	**Braking resistor power setting**		Initial value	100	Communication address	080BH
			Unit	W	Time of taking effect	With immediate effect
	Setting range	10~30000	Data size	16bit	Control mode	P S T

Parameter functions: Set power of a braking resistor. It cannot be changed when a built-in braking resistor is used.

Setting shall be made based on the actual power of the external braking resistor. Incorrect setting may cause damage to the resistor due to overheat or result in frequent $AL.017$ alarm of the driver.

P8-12	**Brake duty cycle**		Initial value	30	Communication address	080CH
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0~100	Data size	16bit	Control mode	P S T

Parameter functions: Duty cycle of the brake pipe upon braking

When P8-12 is set to 100, the brake duty cycle is 100%; namely, the brake pipe is fully open during braking;

When P8-12 is set to 0, the brake duty cycle is 0%; namely, the brake pipe is fully closed during braking (no braking resistor is used).

Generally this parameter requires no adjustment. If during running, the $AL.006$ alarm is prone to occur, the user may set an appropriately larger value.

P8-13	**Braking resistor derating percentage**		Initial value	40	Communication address	080DH
			Unit	%	Time of taking effect	Taking effect upon power-on again
	Setting range	1~100	Data size	16bit	Control mode	P S T

Parameter functions: Set the derating of a braking resistor. It cannot be changed when a built-in braking resistor is used.

This parameter is intended to prevent damage of the braking resistor due to overheating. When an external braking resistor is used, if the resistor can withstand the power set by P8-11 for a long time, then the parameter can be set to 100; otherwise the setting shall be derated based on the actual conditions of the braking resistor.

P8-14	**Minimum load for judgment of motor locked-rotor**		Initial value	150.0	Communication address	080EH
			Unit	%	Time of taking effect	With immediate effect
	Setting range	10.0~250.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the minimum output torque for motor locked rotor judgment.

When rotor locking occurs during running of the motor due to mechanical reasons, the motor will continue output according to settings of P0-06 and P0-07 as the motor speed fails to reach the command value. As the motor does not rotate, this will cause heating of the driver and the motor, and further result in damage.

The driver is provided with a motor locked rotor protection function to solve this problem.

Logic for locked-rotor judgment:
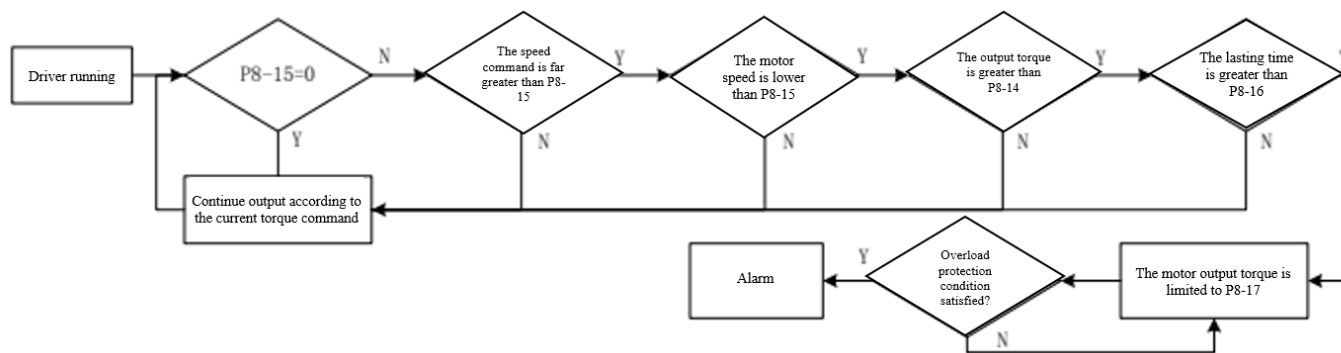
| P8-15	**Rotating speed for judgment of motor locked-rotor**		Initial value	0	Communication address	080FH
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~500	Data size	16bit	Control mode	P S T

Parameter functions: Set the maximum motor speed for judging whether the motor has a locked motor when locked-rotor protection of the motor is activated.

When P8-15=0, the locked-rotor judgment function is off.

P8-16	**Locked-rotor judgment time for motor**		Initial value	100	Communication address	0810H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	10~3000	Data size	16bit	Control mode	P S T

Parameter functions: Set the lasting period for judging whether the motor has a locked motor when locked-rotor protection of the motor is activated.

P8-17	**Locked-rotor torque limit for motor**		Initial value	100.0	Communication address	0811H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~150.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the maximum torque of the motor in the locked rotor state when locked-rotor protection of the motor is activated.

P8-18	**Function switch 1**		Initial value	000100B	Communication address	0812H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	000000B~111111B	Data size	16bit	Control mode	P S T

Parameter functions:

 bitX=0: Function OFF
bitX=1: Function ON
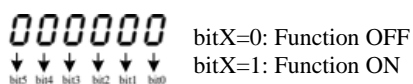
P8-18 bit0: Torque limit function upon voltage drop of the main circuit

bit0=0: Turn off the torque limit function upon voltage drop of the main circuit, when P8-22 and P8-23 are invalid

bit0=1: Turn on the torque limit function upon voltage drop of the main circuit; when the bus voltage is detected to be lower than 80% of the rated value, the output torque of the motor will be limited to the value set by P8-22. This function can be used in combination with the instantaneous outage holding function to keep the motor running when voltage drop of the power source occurs, so as to prevent shutdown due to alarm.
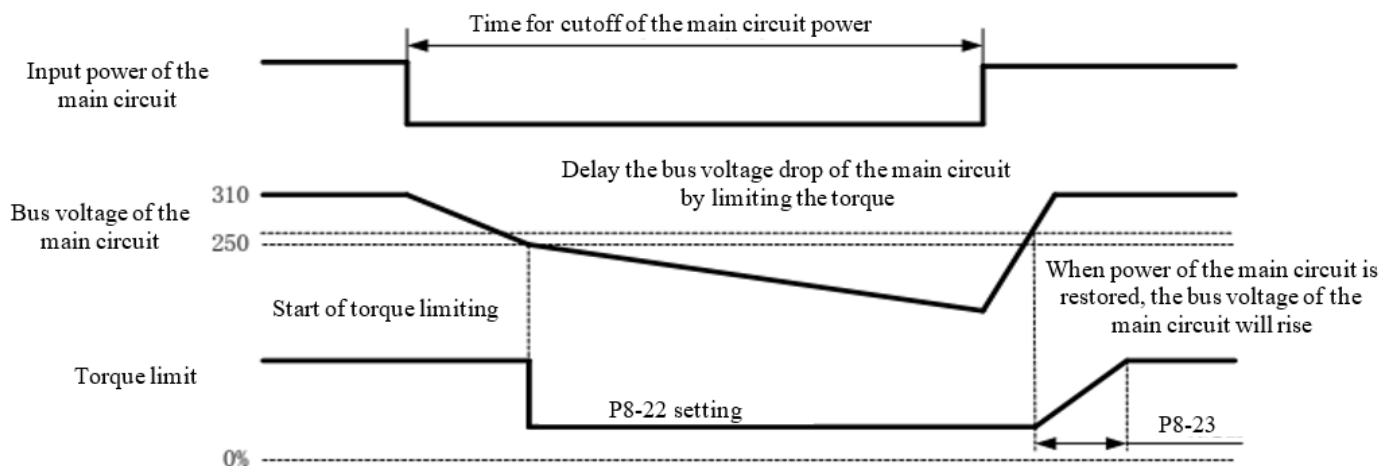
P8-18 bit1: Instantaneous power outage holding function

bit1=0: Turn off the instantaneous power outage holding function

bit1=1: Turn on the instantaneous outage holding function; it will turn on the outage detection function in default, and shield the $AL.0\ Id$ alarm within the time set by P8-24.

When this function is enabled, even if the main circuit of the driver is out of power, the motor can remain powered on (servo ON) within the time set by P8-24.

When the duration of instantaneous outage is shorter than the value set by P8-24, the motor will remain powered on; otherwise when the duration is greater than the set value, the motor will be powered off, and the driver will be subject to $AL.0\ Id$ or $AL.00A$ alarms.
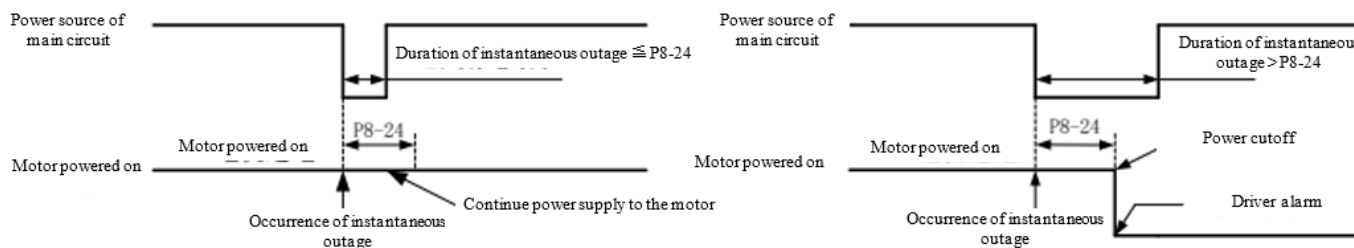
When the value set by P8-24 ≥ the duration of instantaneous outage

When the value set by P8-24 < the duration of instantaneous outage

Caution☞	1: For vertical shaft applications, it is not recommended to use this function, as it may result in a fall. (If this function is enabled when a DO terminal is set to BK, reconnection of the control power will cause an *RL005* alarm) 2: When this function is enabled, it is also recommended to enable the torque limit function upon voltage drop of the main circuit and set a proper value for P8-22. 3: The servo control power holds for about 80ms. If the control circuit power cannot continue power supply upon instantaneous outage, it will be handled as a general power cutoff, and the P8-24 setting is invalid.

The holding time of instantaneous outage may differ with the output of a servo unit. If the servo motor is highly loaded or has an *RL00R* alarm during instantaneous outage, this function is invalid.

P8-18 bit2: Power failure detection function (associated with bit 1)

bit2=0 and bit1=0: Turn off the power failure detection function, and power failure of the main circuit will no longer be detected.

In case of a vertical shaft application, it is required to turn on the power failure detection function; otherwise the holding brake cannot be immediately closed upon power failure of the main circuit

bit2=1: Turn on the power failure detection function.

If the instantaneous outage holding function is not enabled at the same time, then an *RL0 id* alarm will occur immediately upon power failure of the main circuit.

P8-18 bit3: Position judgment reference switching

Bit 3 = 0: Command unit-based position judgment

The command unit is the unit of 1 pulse input from the upper device (including group P9 multi-segment position).

bit3=1: Encoder unit based position judgment

The encoder unit is the unit of 1 pulse fed back from the motor encoder. **Encoder unit = command unit × electronic gear ratio**

For example, the default state upon use of a motor with a 17-bit encoder:

As the electronic gear ratio =131072/10000, the encoder unit = command unit × 131072/10000

Caution☞	Settings of these four parameters are subject to this function: P1-18 position deviation following warning, P1-20 position deviation following alarm, P1-23 positioning approach width, P1-24 positioning completion width, and d0-10 position deviation.

P8-18 bit4: Reverse direction of speed command (speed mode)

bit4=0: In case of a positive speed command, the motor rotates forward (forward direction is defined by P0-01).

bit4=1: In case of a negative speed command, the motor rotates forward (forward direction is defined by P0-01).

P8-18 bit5: reserved by vendor

		Initial value	000B	Communication address	0813H
P8-19	**Function switch 2**	Unit	-	Time of taking effect	With immediate effect
	Setting range	000B~111B	Data size	16bit	Control mode	P S T

Parameter functions:

P8-19 bit0: Zero servo switch upon activation OFF

bit0=0: When activation is set OFF, if P0-09 > P0-17, the motor will enter the zero servo state within the time set by P0.09-P0.17 (see description of P0-08 bit0=1);

bit0=1: When the activation is set OFF, even if P0-09 > P0-17, the servo will not enter the zero servo state; when it decelerate to speed zero, the motor enters the free state.

P8-19 bit1: Runaway detection function switch

bit1=0: Turn on the runaway detection function;

bit1=1: Turn off the runaway detection function.

Caution☞	Runaway detection is used to prevent runaway resulted from possible speed feedforward/feedback upon incorrect UVW connection. It cannot be used when a vertical shaft and the motor may be dragged reversely.

P8-19 bit2: Automatic restoration upon under-voltage of the encoder battery

bit2=0: When an absolute encoder is used, if an $Au.0\ 1A$ alarm occurs due to under-voltage of the encoder battery, the $Au.0\ 1A$ alarm will be automatically reset when the encoder is powered on again after replacement of the battery;

bit2=1: $Au.0\ 1A$ alarm can only be reset by setting AF-16 to 1 or 2 (clear encoder fault information).

P8-22	**Torque limit upon voltage drop of the main circuit**		Initial value	50.0	Communication address	0816H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	1.0~100.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the output torque limit of the motor when the DC bus voltage of the driver is lower than 80%.

See P8-18 bit0 for details.

P8-23	**Lifting time of torque limit upon voltage drop of the main circuit**		Initial value	100	Communication address	0817H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	10~1000	Data size	16bit	Control mode	P S T

Parameter functions: When the independent circuit voltage restores to 90% of the rated voltage, the torque limit starts to restore the original value within this time.

See P8-18 bit0 for details.

P8-24	**Instantaneous outage holding time**		Initial value	100	Communication address	0818H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	10~1000	Data size	16bit	Control mode	P S T

Parameter functions: Time for the motor to remain powered on after instantaneous outage of the main circuit.

See P8-18 bit1 for details.

P8-25	**External torque limit**		Initial value	100.0	Communication address	0819H
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~500.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the external torque limit, with the rated torque of the motor as reference.

When the DI terminal set to TL2 function is valid, the output torque limit of the motor set according to P8-26 will transition smoothly to the set value of this parameter and remain at the value until the TL2 terminal goes invalid.

When the TL2 terminal goes invalid, the output torque value of the motor is set according to P8-27. It will transition smoothly to the torque limit source value set by P0-05.
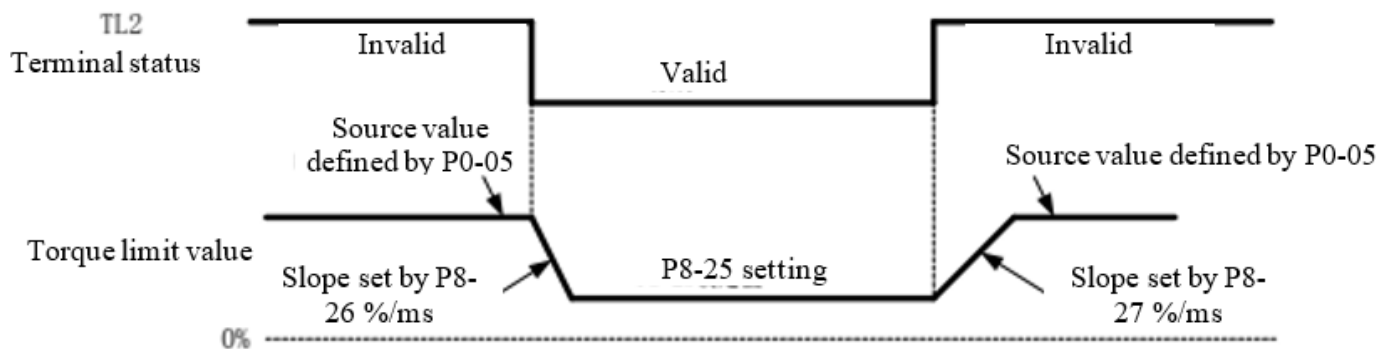
Caution☞	1: The external torque limit is valid in both forward and reverse directions 2: Generally, the set value of P8-25 shall be smaller than P0-06 and P0-07, but it can also be greater.

P8-26	**External torque limit switching rate 1**		Initial value	300.0	Communication address	081AH
			Unit	%/ms	Time of taking effect	With immediate effect
	Setting range	0.1~500.0	Data size	16bit	Control mode	P S T

Parameter functions: When the TL2 terminal is valid, the output torque value of the motor will change by this slope to the set value of P8-25.

The change of torque limit per millisecond corresponds to the rated torque percentage of the motor.

P8-27	**External torque limit switching rate 2**	Initial value	300.0	Communication address	081BH

		Unit	%/ms	Time of taking effect	With immediate effect
Setting range	0.1~500.0	Data size	16bit	Control mode	P S T

Parameter functions: When the TL2 terminal is invalid, the output torque value of the motor will change by this slope to the set source value of P0-05.

The change of torque limit per millisecond corresponds to the rated torque percentage of the motor.

P8-28	**When the external torque limit is valid, the position deviation warning detection option is shielded**	Initial value	0	Communication address	081CH
		Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P S T

Parameter functions: Select whether to pause excessive position deviation detection when the TL2 terminal is valid and the motor output torque is limited to the set value of P8-25.

P8-28=0: Continue excessive position deviation detection when the TL2 terminal is valid;

P8-28=1: Pause excessive position deviation detection when the TL2 terminal is valid.

P8-29	**When the external torque limit becomes invalid, alarm shielding inactivation is delayed**		Initial value	10000	Communication address	081DH
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~10000	Data size	16bit	Control mode	P S T

Parameter functions: When P8-28=1, set the delay for restoration of excessive position deviation detection when the TL2 terminal turns from valid to invalid.

If P1-20 is set to a small value, the TL2 terminal is valid, the motor is in the locked rotor state, and the driver continuously receives command pulses, then when the TL2 terminal goes invalid, the device may immediately detects an excessive position deviation alarm. A delay can be set by this parameter to allow the motor to run, so as to reduce the position deviation and avoid immediate occurrence of an excessive position deviation alarm.

P8-36	**Speed DO judgment selection**		Initial value	0	Communication address	0824H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~3	Data size	16bit	Control mode	P S T

Parameter functions: Set the condition for SPD_P judgment of the DO terminal.

P8-36=0: Setting 1 > speed > setting 2

When the motor speed enters the (setting 2, setting 1) interval, the SPD_P function of the DO terminal is valid;

When the motor speed ≥ (setting 1 + 10), or motor speed ≤ (setting 2 - 10), SPD_P is invalid.
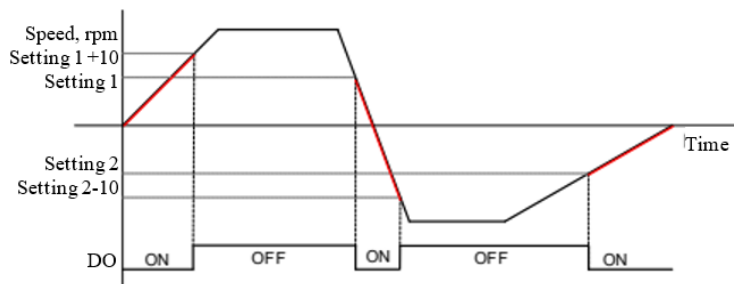
Caution☞	**Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 10rpm hysteresis. During hysteresis, output continues.**

P8-36=1: Speed > setting 1, or speed < setting 2

When the motor speed ≥ setting 1 or ≤ setting 2, the SPD_P function of the DO terminal is valid;

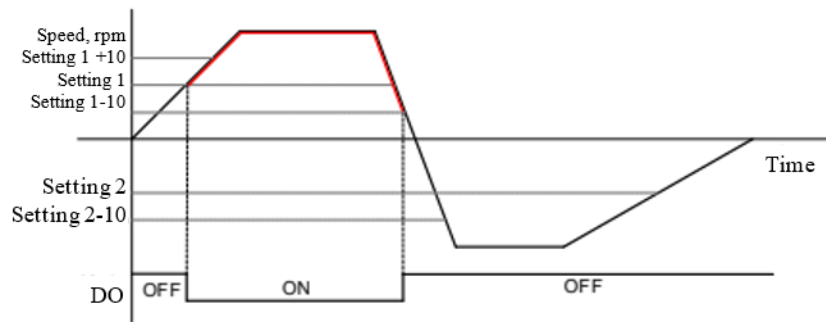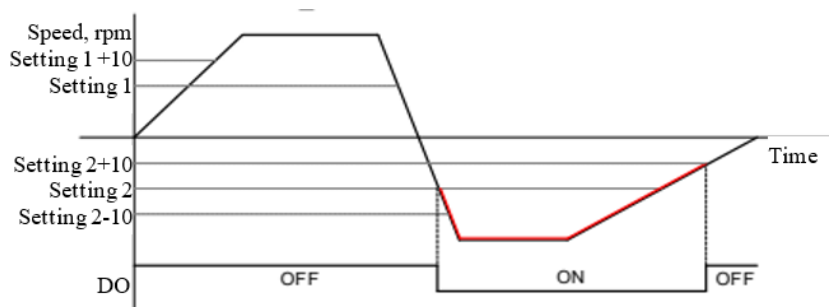When the motor speed enters the (setting 2 + 10, setting 1 - 10) interval, the SPD_P function is invalid.
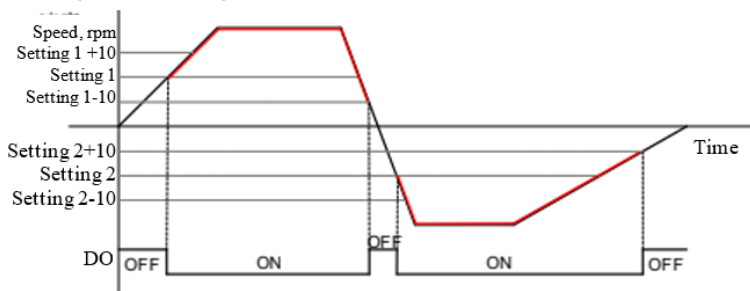
Caution☞	**1. Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 10rpm hysteresis. During hysteresis, output continues.** **2. When setting parameters, make sure "setting 2 +10 < setting 1 - 10".**

P8-36=2: Speed > setting 1

When the motor speed ≥ setting 1, the SPD_P function of the DO terminal is valid;

When the motor speed ≤ (setting 1 - 10), SPD_P is invalid.

Caution☞	Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 10rpm hysteresis. During hysteresis, output continues.

P8-36=3: speed < setting 2

When the motor speed ≤ setting 2, the SPD_P function of the DO terminal is valid;

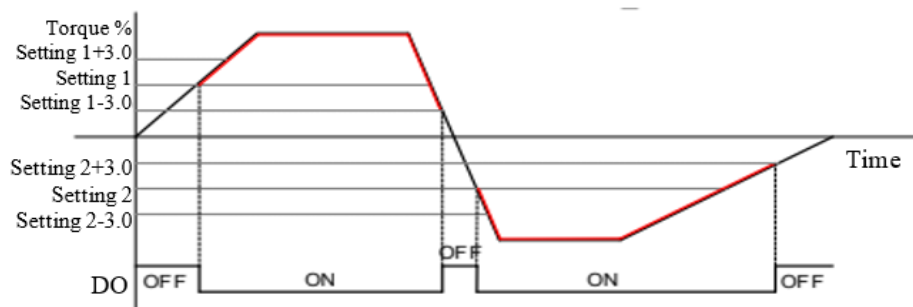When the motor speed ≥ (setting 2 + 10), SPD_P is invalid.

Caution☞	**Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 10rpm hysteresis. During hysteresis, output continues.**

			Initial value	100	Communication address	0825H
P8-37		**Speed DO judgment setting 1**	Unit	rpm	Time of taking effect	With immediate effect
	Setting range	-10000~10000	Data size	16bit	Control mode	P S T
P8-38		**Speed DO judgment setting 2**	Initial value	-100	Communication address	0826H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	-10000~10000	Data size	16bit	Control mode	P S T

Parameter functions: Set the value for speed DO judgment. See P8-36 for details.

Caution☞	**1. Note that there may be 10rpm hysteresis if judgment is performed on a boundary point.** **2. When setting 1 and setting 2 are both used in judgment, make sure "setting 1 > setting 2"!**

			Initial value	0	Communication address	0827H
P8-39		**Torque DO judgment selection**	Unit	-	Time of taking effect	With immediate effect
	Setting range	0~3	Data size	16bit	Control mode	P S T

Parameter functions: Set the condition for TRQ_P judgment of the DO terminal. Here "torque" actually refers to the "torque percentage", i.e. "load rate".

P8-39=0: Setting 1 > torque > setting 2

When the motor torque enters the (setting 2, setting 1) interval, the TRQ_P function of the DO terminal is valid;

When the motor torque ≥ (setting 1 + 3.0), or motor torque ≤ (setting 2 - 3.0), TRQ_P is invalid.
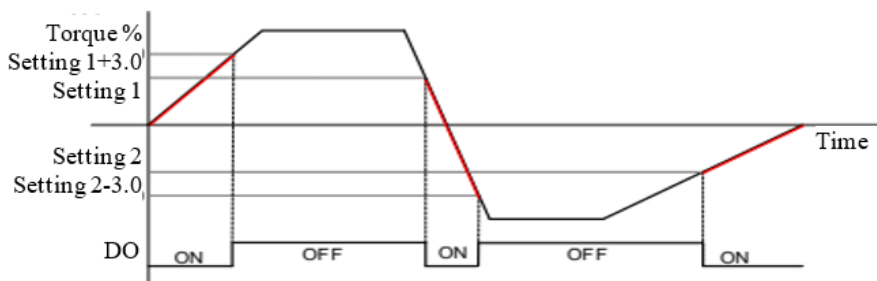
Caution☞	**Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 3.0% hysteresis. During hysteresis, output continues.**

P8-39=1: Torque > setting 1, or torque < setting 2

When the motor torque ≥ setting 1, or the motor torque ≤ setting 2, the TRQ_P function of the DO terminal is valid;

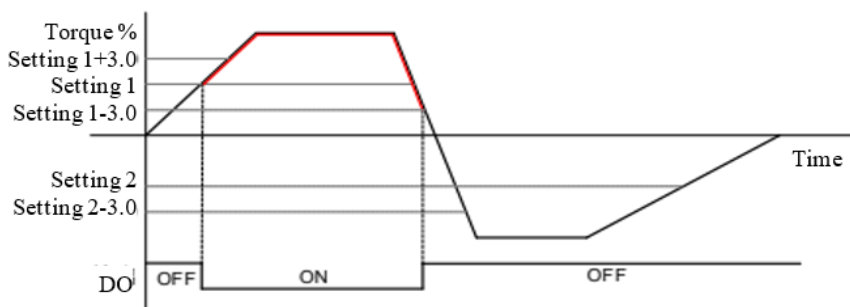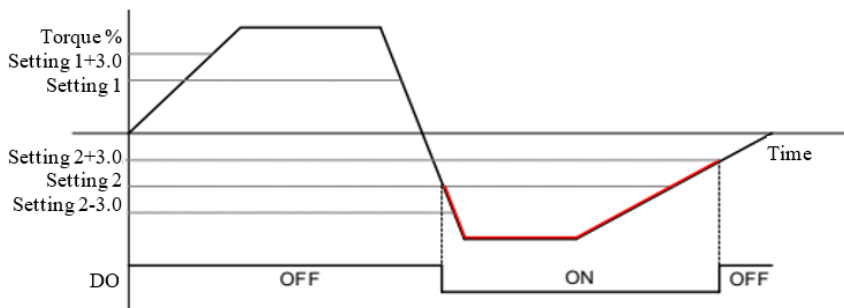When the motor torque falls within the (setting 2 + 3.0, setting 1 - 3.0) interval, TRQ_P is invalid.

Caution☞	1. Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 3.0% hysteresis. During hysteresis, output continues. 2. When setting parameters, make sure "setting 2 +3.0 < setting 1 - 3.0".

P8-39=2: Torque > setting 1

When the motor torque ≥ setting 1, the TRQ_P function of the DO terminal is valid;

When the motor torque ≤ (setting 1 - 3.0), TRQ_P is invalid.

Caution☞	Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 3.0% hysteresis. During hysteresis, output continues.

P8-39=3: torque < setting 2

When the motor torque ≤ setting 2, the TRQ_P function of the DO terminal is valid;

When the motor torque ≥ (setting 2 + 3.0), TRQ_P is invalid.

Caution☞	Upon going from invalid to valid, there is no hysteresis judgment; upon going from valid to invalid, there is 3.0% hysteresis. During hysteresis, output continues.

			Initial value	100.0	Communication address	0828H
P8-40		**Torque DO judgment setting 1**	Unit	%	Time of taking effect	With immediate effect
	Setting range	-500.0~500.0	Data size	16bit	Control mode	P S T
			Initial value	-100.0	Communication address	0829H
P8-41		**Torque DO judgment setting 2**	Unit	%	Time of taking effect	With immediate effect
	Setting range	-500.0~500.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the value for torque DO judgment. See P8-39 for details.

Caution☞	1. Note that there may be 3.0% hysteresis if judgment is performed on a boundary point. 2. When setting 1 and setting 2 are both used in judgment, make sure "setting 1 > setting 2"!

			Initial value	0.000	Communication address	082AH
P8-42		**Mechanical transmission ratio upon GBK detection**	Unit	mm	Time of taking effect	With immediate effect
	Setting range	0.000~65.535	Data size	16bit	Control mode	P S T

Parameter functions: Set the displacement distance corresponding to one revolution of the motor when the DI terminal triggers function No. 34 (GBK function).

If this parameter is 0.000, then the displayed value of parameter d0-62 is the count of detected encoder pulses.

If this parameter is not 0.000, then the displayed value of parameter d0-62 is the displacement distance obtained through transmission ratio calculation.

Usage of the GBK function:

Device as shown in the right figure.

First, determine the mechanical origin. The mechanical origin can be determined by homing, or the motor position upon power-on of the servo system can be taken as the mechanical origin.

After the GBK terminal is triggered, the motor runs forward; when motor locked rotor is detected, the count of encoder pulses generated by running of the motor (or displacement distance) will be written to d0-62; then the motor will automatically return to the mechanical origin and wait for the next GBK command.

The GBK is triggered by the rising edge. Before the motor returns to the mechanical origin after the function is triggered for execution, this terminal will not respond to any additional trigger.
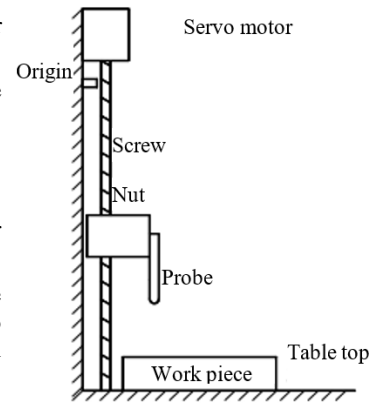
For use of this function, it is required to set P0-00 to 6, with a DI terminal set to 10, and the terminal shall be set to be valid upon power on by P6-01.

P0-6 and P0-07 shall be properly set to prevent equipment and motor damage. Setting values of these two parameters shall not exceed 100.00. P2-01 and P9-08 shall be set property to prevent overspeed resulting in mechanical problems.

		Initial value	0	Communication address	0900H
P8-43	**Motor parameters to be read after power-on**	Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P

Parameter functions: Set whether to enable the function of reading motor parameters stored in the serial encoder upon power-on.

P8-43=0: Set whether to enable the function of reading motor parameters stored in the serial encoder upon power-on. (For an incremental encoder, this parameter can only be 0)

P8-43=1: When the servo driver is powered on, if a properly connected encoder is detected and the encoder is a serial encoder (only for Tamagawa Encoder Protocol), motor parameters stored in the encoder will be immediately read and used. If parameters fail to be read or parameters read are abnormal, motor parameters defined by Pd-01 are used in default.

8.14 P9-xx Multi-segment position parameters

If the servo driver is currently in the position mode (P0-00=1), and the position command source is a multi-segment position command (P1-00=1), this group of functions can be enabled.

P9-xx comprises 54 function codes, including 16 groups (starting from P9-06) defined as a multi-segment position that corresponds to multi-segment position commands Pr1 to Pr16; a stop time is set for every 3 function codes relative to the target positions, the average speed permitted for running to the target positions and the stop time upon completion of positioning.

|		Initial value	0	Communication address	0900H
P9-00	**Multi-segment position execution mode**	Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~10	Data size	16bit	Control mode	P

Parameter functions: When P0-00 and P1-00 are set to 1, i.e. when multi-segment position control is used, this parameter can be used to select the multi-segment position execution mode.

Internal multi-segment position modes can be classified into two types, i.e. general execution mode (non-sequential execution mode) and sequential execution mode, which can be differentiated as follows:

- **General mode.** After a segment is completed and the motor stops, the next segment will be started. The stop time is set by a function code.
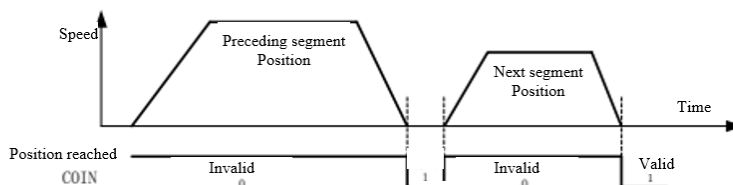
- **Sequential mode.** Upon completion of a segment, the following segment will be started without stop of the motor, while the speed at the first segment will accelerate or decelerate to the speed for the following segment.
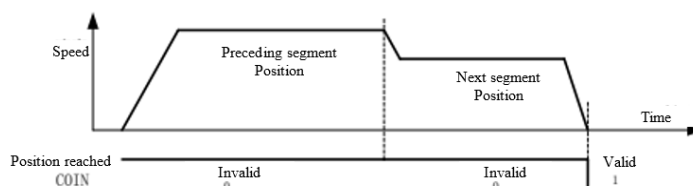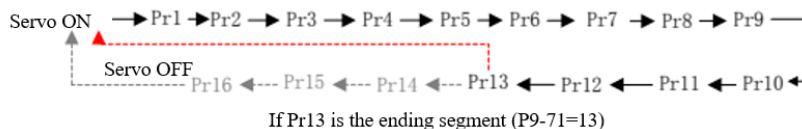

P9-00=0: After the servo activation is set ON, the servo will start execution from the 1st segment and continue to the end of the segment set by P9-71; afterwards, it will run cyclically between the starting segment set by P9-70 and the ending segment set by P9-71 until the servo is deactivated. Execution is performed in the general mode.
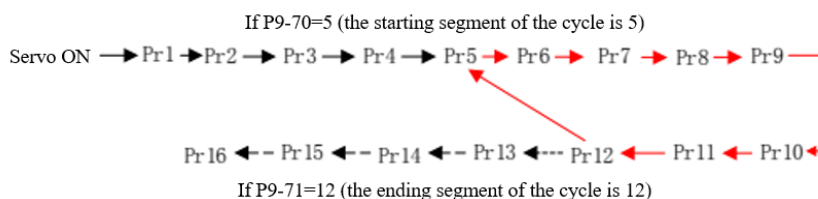
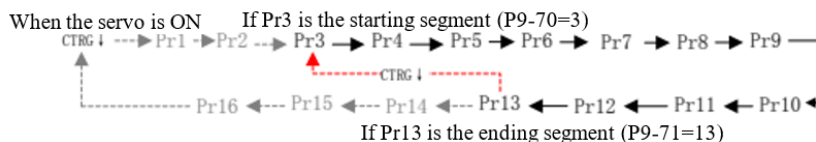| Caution☞	1. When activation is set ON again after it is set OFF, the servo will start execution from Pr1.
	2. When each segment of position is completed, the motor shaft will stop first and wait for lapse of the stop time before the next segment is executed.

P9-00=1: After activation is set ON, the servo will start running from Pr1 and continue to the end of the segment set by P9-71(after completion the servo will enter the zero servo state). Execution is performed in the general mode.

Servo ON → Pr1 → Pr2 → Pr3 → Pr4 → Pr5 → Pr6 → Pr7 → Pr8 → Pr9

Servo OFF — Pr16 ◄--- Pr15 ◄--- Pr14 ◄--- Pr13 ◄— Pr12 ◄— Pr11 ◄— Pr10

If Pr13 is the ending segment (P9-71=13)

Caution☞	**1. When activation is set ON again after it is set OFF, the servo will start execution from Pr1.** **2. When each segment of position is completed, the motor shaft will stop first and wait for lapse of the stop time before the next segment is executed.**

P9-00=2: After servo activation is set ON, the servo will start running when the falling edge of the DI terminal defined as CTRG is received, from the starting segment selected by P9-70 to the end of the segment set by P9-71. For another run, it is required to give an additional CTRG falling edge signal. Execution is performed in the general mode.

When the servo is ON   If Pr3 is the starting segment (P9-70=3)

CTRG ↓ ---► Pr1 -►Pr2 --► Pr3 → Pr4 → Pr5 → Pr6 → Pr7 → Pr8 → Pr9

---------- CTRG↓ ----------

---------- Pr16 ◄--- Pr15 ◄--- Pr14 ◄--- Pr13 ◄— Pr12 ◄— Pr11 ◄— Pr10

If Pr13 is the ending segment (P9-71=13)

Caution☞	**1. Each run needs to be triggered by CTRG, and starts from the starting segment set by P9-70.** **2. When each segment of position is completed, the motor shaft will stop first and wait for lapse of the stop time before the next segment is executed.**

P9-00=3: A segment desired to be executed is selected by external DI according to Table 8-4, and the execution is triggered by the falling edge of the CTRG terminal; when the execution is completed, the motor become static.
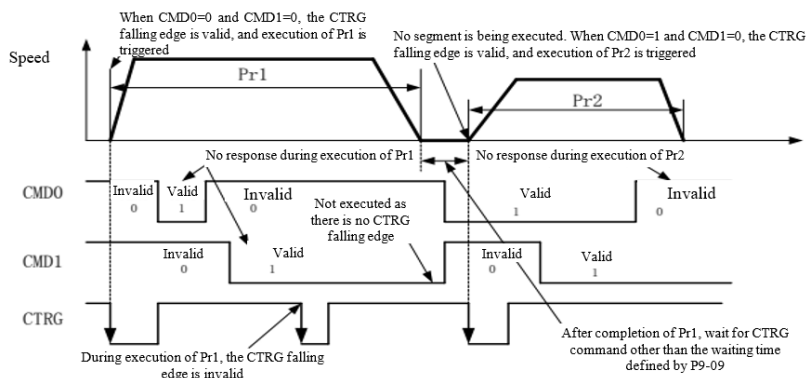

Table 8-4 Correspondence between DI terminal status and multi-segment position command

Pr command	CMD3	CMD2	CMD1	CMD0	CTRG	Count of traveling pulses	Permitted speed	Stop time
Pr1	0	0	0	0	↓	P9-06	P9-08	P9-09
Pr2	0	0	0	1	↓	P9-10	P9-12	P9-13
Pr3	0	0	1	0	↓	P9-14	P9-16	P9-17
Pr4	0	0	1	1	↓	P9-18	P9-20	P9-21
Pr5	0	1	0	0	↓	P9-22	P9-24	P9-25
Pr6	0	1	0	1	↓	P9-26	P9-28	P9-29
Pr7	0	1	1	0	↓	P9-30	P9-32	P9-33
Pr8	0	1	1	1	↓	P9-34	P9-36	P9-37
Pr9	1	0	0	0	↓	P9-38	P9-40	P9-41
Pr10	1	0	0	1	↓	P9-42	P9-44	P9-45
Pr11	1	0	1	0	↓	P9-46	P9-48	P9-49
Pr12	1	0	1	1	↓	P9-50	P9-52	P9-53
Pr13	1	1	0	0	↓	P9-54	P9-56	P9-57
Pr14	1	1	0	1	↓	P9-58	P9-60	P9-61
Pr15	1	1	1	0	↓	P9-62	P9-64	P9-65
Pr16	1	1	1	1	↓	P9-66	P9-68	P9-69

Note: 0/1 in the table means the DI terminal is invalid/valid, other than the actual level.

Caution☞	**1. It is required to set a DI terminal as function CTRG, while a DI terminal of CMDx function can be set as needed.** **2. When a segment of position command is executed, execution of current segment of position will not be interrupted by any change to the status of the CMDx or CTRG terminal.** **3. In this mode, the stop time parameter of each segment is invalid. The motor will remain in the static state after execution of the first segment of a position command is completed, until receipt of a CTRG falling edge when it will start to execute corresponding segment of the position command according to the DI terminal status then.**

P9-00=4: Trigger cyclic operation in the step-by-step mode.

After the servo activation is set ON, the servo triggered by the falling edge of the defined CTRG terminal will start running from Pr1 step by step to the end of the segment set by P9-71. Afterwards, it will run in a step-by-step mode between the starting segment set by P9-70 and the ending segment set by P9-71.
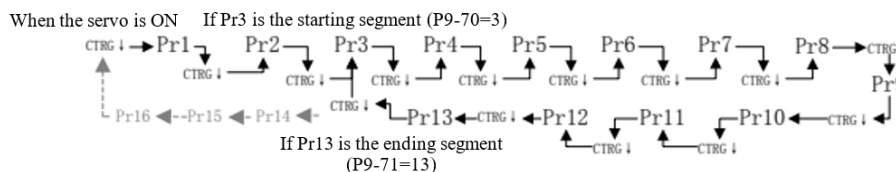
P9-00=5: Same with the case when P9-00=4, except that the servo will not respond when receiving a CTRG falling edge again after completion of the ending segment. You need to turn the servo to S-OFF and then S-ON again before using he CTRG terminal for triggering.

Caution☞	**1: During execution of the current segment of the position command, CTRG is not detected. It is required to wait until the previous segment is completed and the motor become static before presence of CTRG falling edge is detected.** **2: In these two modes, the stop time parameter of each segment is invalid.** **3: At any time, if a homing command is received, the servo will first execute homing before receipt of a CTRG falling edge can trigger execution of Pr1.**

P9-00=6: Execute the segment set by P9-01, and the execution will be triggered by the falling edge of the defined CTRG terminal.

When the servo activation is set ON, a CTRG falling edge will trigger execution of the segment set by P9-01; upon completion of the execution, the motor will become static and P9-01 will automatically set to zero and wait for the next command.

P9-00=7: Immediately execute the segment set by P9-01.

When the servo activation is set ON, the servo will execute the segment set by P9-01; upon completion of the execution, the motor will become static and P9-01 will automatically set to zero and wait for the next command.

Caution☞	**1: During execution of the current segment of the position command, no response will be made to any modification to P9-01.** **2: In these two modes, the stop time parameter of each segment is invalid.** **3: In these two modes, P9-01 applications shall be written appropriately through RS485 communication.**

P9-00=8: Activate the cyclic sequence to execute a selected segment. Execution is performed in the sequence mode.

After the servo activation is set ON, the servo will start execution from the 1st segment and continue to the end of the segment set by P9-71; afterwards, it will run cyclically between the starting segment set by P9-70 and the ending segment set by P9-71 until the servo is deactivated.
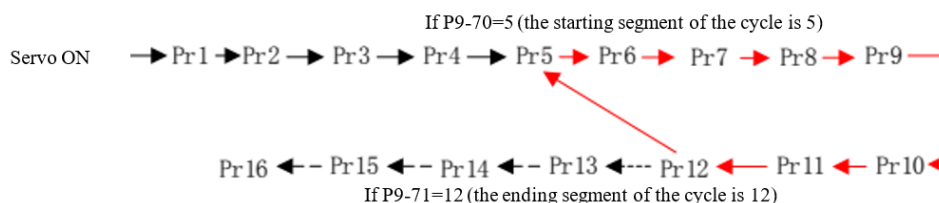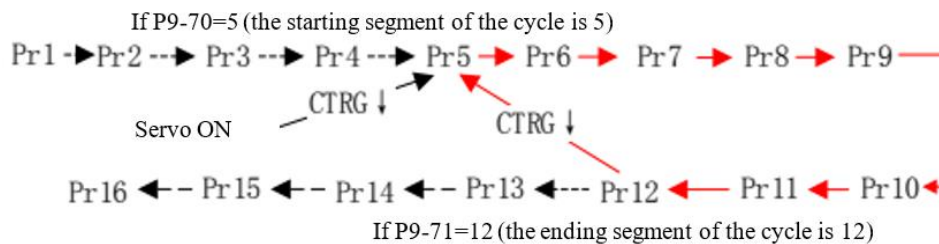

Caution☞	**1: In this mode, the stop time between segments is invalid.** **2: This mode has no significant ending segment, so the position reached output is always invalid.**

P9-00=9: Trigger sequential execution selection segment. Execution is performed in the sequence mode.

After the servo activation is set ON, the servo triggered by the falling edge of the defined CTRG terminal will start running from the segment set by P9-70 to the end of the segment set by P9-71. Afterwards, it will wait for the next CTRG trigger signal.

Caution☞	**1: The stop time between segments is invalid in this mode.** **2: During running in this mode, including switch upon completion of one segment to the next segment for running, output of position reached signal is invalid, until execution of the last segment is completed.**

P9-00=10: A segment desired to be executed (only Pr1~Pr4) is selected by external DI according to the following table for immediate execution; and when execution is completed, the motor will become static.

Pr command	CMD1	CMD0	Count of traveling pulses	Permitted speed	Stop time
Pr1	0	0	P9-06	P9-08	Invalid
Pr2	0	1	P9-10	P9-12	Invalid
Pr3	1	0	P9-14	P9-16	Invalid
Pr4	1	1	P9-18	P9-20	Invalid

Note: 0/1 in the table means the DI terminal is invalid/valid, other than the actual level.

Caution☞

1. In this mode, the stop time parameter of each segment is invalid. The motor will remain in the static state after execution of the first segment of a position command is completed, until a change is detected in the state of CMDI terminal, upon which the position command of corresponding segment will be executed.

2. When a segment of position command is executed, you can set via P9-72 whether it's allowed to terminate the position command of current segment immediately and execute that of the newly selected segment instead. 3. In this mode, CTRG triggering is not required. Execution will be carried out immediately upon detection of state change in CMDI terminal by the driver.

Caution☞

1: Modification to any parameter of the currently running segment will take effect upon the next execution of the segment.

2: If activation is set OFF or power failure or homing occurs during operation, the segment that has been executed will be cleared.

3: When the CTRG terminal is used to trigger execution, it is required to set the DI terminal defined as CTRG to be valid at the low level.

P9-01	**Segment selection for multi-segment position execution**		Initial value	0	Communication address	0901H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~16	Data size	16bit	Control mode	P

Parameter functions: When P9-00 is set to 6 or 7, this parameter is used to select a segment to be executed.

When it is set to a non-zero value, and no multi-segment position is currently being executed, the designated segment will be executed according to condition P9-00. When execution is completed, this parameter will be automatically reset to zero, and the device will wait for the next command.

If this parameter is set to 8 when the motor is static, the servo will immediately execute segment Pr8 defined by parameters P9-33 and P9-34 (without executing P9-35); when execution is completed, this parameter will be automatically reset to 0 and the motor becomes static.

P9-02	**Multi-segment position command reference setting**		Initial value	00	Communication address	0902H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	00~11	Data size	16bit	Control mode	P

Parameter functions: Sets whether a command is executed by the relative position or the absolute position when the servo runs in multi-segment position.

P9-02 bit0=0: Execution is performed by incremental position with the current position as reference.

The count of pulses defined by each segment command of a multi-segment position starts from the current static position of the motor.

For example:

When P9-06 is set to 12000 and P9-10 is set to -10000, Pr2 will be executed when execution of Pr1 is completed.

When segment Pr1 is executed, the motor rotates forward from the current static position by 12000 command pulses; then segment Pr2 is executed, and the motor rotates reversely by 10,000 command pulses. Finally the motor stops at the position of 2,000 command pulses forward from the original position.

P9-02 bit0=1: Execution is performed by absolute position with the current position as reference.

The count of pulses defined by each segment command of a multi-segment position corresponds to an absolute position and starts from the current position (d0-34) of the motor.

For example:

When P9-06 is set to 12000 and P9-10 is set to -10000, Pr2 will be executed when execution of Pr1 is completed. Before execution of Pr1, the motor is static, and the value of d0-34 is 65300.

When segment Pr1 is executed, the motor rotates reversely from the current static position by (65300-12000=43300) command pulses to arrive at the position d0-34=12000. And then, when segment Pr2 is executed, the motor rotates reversely by (12000- (-10000) =22000) command pulses. Finally the motor stops at the position d0-34=-10000.

P9-02 bit1=0: When P9.01=7 or 10, if during execution of the current segment, execution is interrupted due to activation OFF, power failure or otherwise, the driver will memorize the pulses that have been executed of the current segment, and continue to execute pulses that have not be finished when S-ON is activated again.

P9-02 bit1=1: If execution is interrupted due to activation OFF, power failure or homing during execution of the current segment, the segment that has been executed will be cleared.

P9-03	**Multi-segment acceleration time TPACC**		Initial value	100	Communication address	0903H
			Unit	ms	Time of taking effect	Effective from the next segment
	Setting range	1~10000	Data size	16bit	Control mode	P
P9-04	**Multi-segment deceleration time TPDEC**		Initial value	100	Communication address	0904H
			Unit	ms	Time of taking effect	Effective from the next segment
	Setting range	1~10000	Data size	16bit	Control mode	P

Parameter functions: It is used to set the acceleration/deceleration time of the motor when it is accelerated/decelerated by using a position command in the multi-segment position control mode. When a position command set by external pulses is used, these two parameters are invalid.

P9-03: Set the acceleration time of the motor when it is accelerated in the multi-segment position mode.

P9-04: Set the deceleration time of the motor when it is decelerated in the multi-segment position mode.
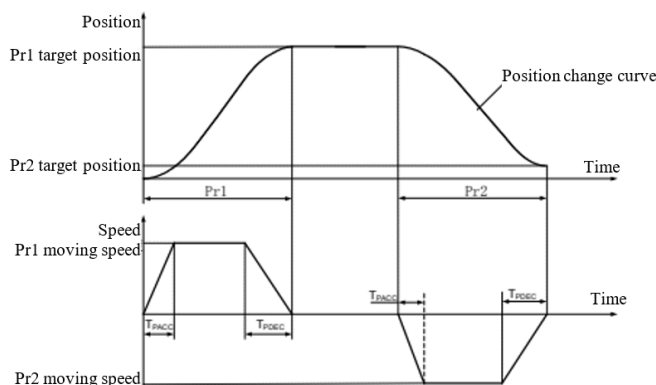
Caution☞	1. This can smooth the movement command and avoid abrupt change of a position command triggering vibration and abnormal noise of the mechanical structure. 2. P9-03 and P9-04 refer to the acceleration and deceleration time required for the motor speed to change from or to the rated motor speed. If the change to the target speed does not equal to the value of the rated motor speed, then the time required will change according to the ratio of the change and the rated motor speed. For example, if the target motor speed is 1,500rpm, the rated motor speed is 3,000rpm, P9-03=200ms and P9-04=300ms, then the motor requires 100ms to accelerate from speed 0 to speed 1,500rpm and 150ms to decelerate speed 1,500rpm to speed 0.

A detailed description of parameters P9-06~P9-08 involved in the 1st segment of Pr1 is given below; the same applies to the other 15 segments, and will not be repeatedly elaborated.

P9-06	Pulses of multi-segment position command Pr1		Initial value	100000	Communication address	0906H
			Unit	Pulse	Time of taking effect	With immediate effect
	Setting range	-2147483647~2147483647	Data size	32bit	Control mode	P

Parameter functions: Set the target count of pulses for the 1 segment of position movement.

The value of this parameter is preceded by a plus or minus symbol. The plus symbol indicates forward rotation of the motor according to P0-01, and the minus symbol indicates the reverse direction.

Caution☞	The set count of pulses corresponds to a command pulse unit.

P9-08	Moving speed of multi-segment position command Pr1		Initial value	100	Communication address	0908H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	1~6000	Data size	16bit	Control mode	P

Parameter functions: Set the constant rotating speed for the 1 segment of position movement.

Caution☞	The motor may be unable to reach this speed during actual operation if there are less frequent pulses. Therefore, this parameter shall be interpreted as the upper limit of the motor speed during execution of the Pr1 segment.

P9-09	Pr1 stop time		Initial value	0	Communication address	0909H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P

Parameter functions: If cyclic operation (P9-00=0, 1 or 2) is selected, when execution of pulses for the current segment is completed, the servo will wait for the time set by this parameter before it starts to execute the next segment of position command.

Caution☞	Only when P9-00=0, 1 or 2, this parameter is valid.

P9-70	Starting segment of cyclic operation		Initial value	1	Communication address	0946H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	1~16	Data size	16bit	Control mode	P
P9-71	Ending segment of cyclic operation		Initial value	16	Communication address	0947H
			Unit	-	Time of taking	With immediate

					effect	effect
	Setting range	1~16	Data size	16bit	Control mode	P

Parameter functions: Set the starting and ending segments in case of operation in the multi-segment position mode

P9-00	S_ON starting segment	Starting segment of the cycle	Ending segment
0: pr1~pr16, activate cyclic operation to run the selected segment	Pr1	P9-70	P9-71
1: pr1~pr16, activate execution of the selected segment	Pr1	Not involved	P9-71
2: pr1~pr16, trigger execution of the selected segment	P9-70	P9-70	P9-71

3: Trigger execution of the segment selected by the external DI s	Not involved		
4: pr1~pr16, trigger execution of segment 1 for cyclic operation	Pr1	P9-70	P9-71
5: pr1~pr16, trigger execution of segment 1	Pr1	Not involved	P9-71
6: Trigger execution of the segment selected by P9-01	Not involved		
7: Immediately execute the segment selected by P9-01	Not involved		
8: pr1~pr16, activate the cyclic sequence to run the selected segment	Pr1	P9-70	P9-71
9: pr1~pr16, trigger the sequence to execute the selected segment	P9-70	P9-70	P9-71

Caution☞	1. Whether this parameter is valid depends on the selected mode.
	2. For normal work, the starting segment shall never be set greater than the ending segment.

P9-72	Whether interruption of the current segment is allowed (when P9-00=10)		Initial value	0	Communication address	0947H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P

Parameter functions: Only when P9-00=10, set whether it is allowed to interrupt the position command of the segment being currently executed and switch to execute the position command of a newly selected segment.

P9-72=0: No interruption is allowed during execution of the segment being currently executed. Selection of a new segment will be executed immediately after execution of the current segment is completed.

P9-72=1: If a new segment selection command is received during execution of the current segment, the servo will immediately terminate execution of the current segment and switch to execute the newly selected segment.

Caution☞	1. This parameter is only valid when P9-00 = 10.
	2. When this function is used, make sure P9-02=1; namely execution is performed in the absolute position mode. Otherwise unexpected results may occur.

**8.15 PA-xx Multi-segment speed parameter**

If the servo driver is currently in the speed mode (P0-00=0), and the speed command source is a multi-segment speed command (P2-00=1), this group of functions can be enabled.

PA-xx comprises 34 function codes, including 16 groups (starting from PA-02) that correspond to multi-segment position commands Pr1 to Pr16; a running speed and time is set for every 2 function codes.

| PA-00	Multi-segment speed command execution mode		Initial value	0	Communication address	0A00H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~4	Data size	16bit	Control mode	S

Parameter functions: When P0-00=1 and P2-00=1, the multi-segment speed running mode is selected.

PA-00=0: Start continuous cyclic operation from spd1 based on a 16-segment speed command and the operation starts automatically when the servo activation is set on.
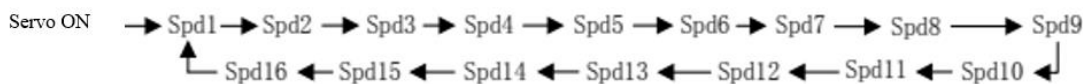
Caution☞ When activation is set ON again after it is set OFF, the servo will start execution from Pr1.

PA-00=1: Start a single cycle of operation from spd1 based on a 16-segment speed command; the operation will start automatically when the servo activation is set on and will stop when spd16 is completed. For another run, reactivation is required.
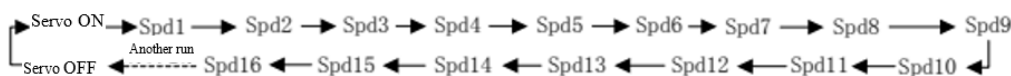
PA-00=2: Start a single cycle of operation from spd1 based on a 16-segment speed command; the operation will start when the servo activation is set on and the CTRG receives a falling edge; when spd16 is completed, the operation will stop. For another run, it is required to receive an additional CTRG falling edge signal.

PA-00=3: A segment desired to be executed is selected by the external DI according to Table 8-5; the servo will continue running, until the command changes.
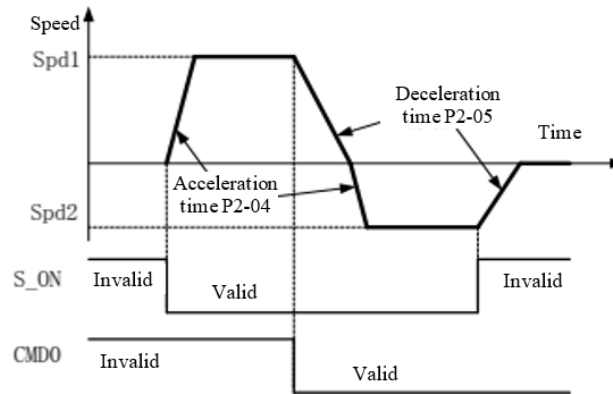
Table 8-5 Correspondence between DI status and multi-segment speed command

Multi-segment speed command	CMD3	CMD2	CMD1	CMD0	Running speed	Run time
Spd1	0	0	0	0	PA-02	PA-03
Spd2	0	0	0	1	PA-04	PA-05
Spd3	0	0	1	0	PA-06	PA-07
Spd4	0	0	1	1	PA-08	PA-09
Spd5	0	1	0	0	PA-10	PA-11
Spd6	0	1	0	1	PA-12	PA-13
Spd7	0	1	1	0	PA-14	PA-15
Spd8	0	1	1	1	PA-16	PA-17
Spd9	1	0	0	0	PA-18	PA-19
Spd10	1	0	0	1	PA-20	PA-21
Spd11	1	0	1	0	PA-22	PA-23
Spd12	1	0	1	1	PA-24	PA-25
Spd13	1	1	0	0	PA-26	PA-27
Spd14	1	1	0	1	PA-28	PA-29
Spd15	1	1	1	0	PA-30	PA-31
Spd16	1	1	1	1	PA-32	PA-33

Note: 0/1 in the table means the DI terminal is invalid/valid, other than the actual level.

Caution☞
1. Set a DI terminal to the CMD0, CMD1, CMD2 or CMD3 function as needed.
2. When the terminal status changes, the segment being executed will immediately change by accelerating or decelerating to the set speed of the target segment according to settings of P2-04 or P2-05.

PA-00=4: Continue execution by the segment speed set by PA-01, and stop when PA-01=0.

Caution☞
1. Modification to any parameter of the segment that is currently running following the command sequence at an internal multi-segment speed (i.e. PA-00=0, 1 or 2) will not be executed during the current run, nor become valid until the next execution of the segment.
2. When a DI terminal is used for multi-segment speed switching, i.e. PA-00=3, the run time parameter is invalid, and the servo motor runs at the speed of corresponding segment according to the status of the external terminal. Besides, any modification to the speed of the current segment will be immediately executed.
3. If activation is set OFF or power failure occurs during operation, executed segment will be cleared.
4. When the CTRG terminal is used to trigger execution, it is required to set the DI terminal defined as CTRG to be valid at the low level.

PA-01	Segment selection in case of multi-segment speed for execution		Initial value	0	Communication address	0A00H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	0~16	Data size	16bit	Control mode	S

Parameter functions: When PA-00=4, this parameter is used to select a segment to be executed.

When this parameter is set to a non-zero value, the designated segment speed will be immediately executed. For example, if this parameter is changed to 8, the servo will immediately run at the speed set by PA-17 for segment spd8. When this parameter is set to 0, the servo will stop and wait for the next command.

Two parameters involved in spd 1 are taken below for demonstration. The same applies for other groups.

PA-02	Running speed for spd 1 of the multi-segment speed command		Initial value	100	Communication address	0A02H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	-6000~6000	Data size	16bit	Control mode	S

Parameter functions: First-segment rotating speed of the multi-segment speed.

PA-03	Running time of multi-segment speed command Spd1		Initial value	1.0	Communication address	0A03H
			Unit	s	Time of taking effect	With immediate effect
	Setting range	0~6553.5	Data size	16bit	Control mode	S

Parameter functions: It refers to the run time of the first-segment speed when cyclic operation is selected (PA-00=0, 1, 2).

Caution☞ When PA-00=3, 4, this parameter is invalid.

8.16 Pb-xx Homing parameters

Encoder position: At absolute position, the absolute position after multiple rounds is considered; and at incremental position, the position where the motor passes upon power-on.

Mechanical origin: Position of stop upon homing (position of mechanical origin switch or Z pulse of motor encoder).

Mechanical zero: The reference value of mechanical position (recorded by D3-24:D3-22) upon homing. For absolute position mode, the mechanical zero is the position of encoder position at mechanical zero minus P6-10 setting, and is stored in (D3-20:D3-18). When running with the absolute position mode on a later stage, the mechanical zero will be the reference point.

Electrical zero: You can set electrical zero arbitrarily via the function code PB12 (offset between electrical zero and mechanical zero). You can return the motor to electrical zero via Pb-02=36.

Mechanical position: Upon homing, the absolute position of motor running is no longer the encoder position. Instead, it becomes the one based mechanical zero, which is recorded in (D3-24:D3-22).

		Initial value	0	Communication address	0B00H
Pb-00	**Homing failure alarm time**	Unit	ms	Time of taking effect	With immediate effect
	Setting range	0~65535	Data size	16bit	Control mode	P

Parameter functions: If after receiving a homing command, the servo fails to be positioned to the origin within the time set by this parameter, the driver will show an $RL.O\ iC$ alarm and the ALM terminal will act.

When this parameter is set to 0, the homing monitor is turned off; in this case, no alarm will be given even if homing fails.

Caution☞	Set a proper time for Pb-00 based on the actual conditions to avoid occurrence of an error alarm in case the execution lasts long

		Initial value	0	Communication address	0B01H
Pb-01	**Homing start mode**	Unit	-	Time of taking effect	With immediate effect
	Setting range	0~2	Data size	16bit	Control mode	P

**Parameter functions:** Select a start mode for the homing function

Pb-01=0: Turn off the homing function.

Pb-01=1: Immediately execute homing when the servo driver is never activated and set to S-ON.

Pb-01=2: Immediately start execution of homing when the DI terminal defined as SHOM (homing activation) (function No. 23) is valid. During homing, invalidation of the SHOM terminal cannot stop homing.

Sequence diagram for the homing trigger and start mode

1: Automatically execute homing when the servo is activated (Pb-01=1)
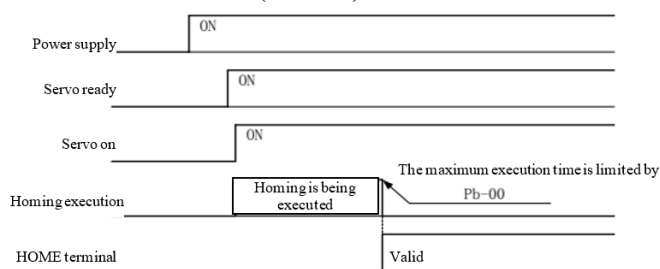
2: Homing is triggered by the SHOW terminal (function No. 23) (Pb-01=2)
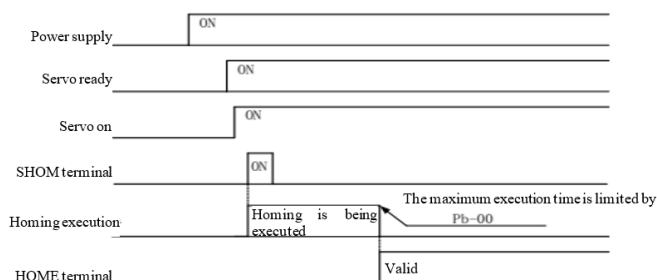
Upon completion of homing, the output terminal defined as HOME (function No. 14) immediately outputs valid signals. If servo activation is cancelled or an alarm occurs during homing, the homing function will terminate, and the HOME terminal does not output valid signals.

Caution☞	The SHOM terminal is triggered by level. If this terminal remains valid after completion of homing, homing will be executed again.

| Pb-02	**Homing mode**		Initial value	1	Communication address	0B02H
			Unit	-	Time of taking effect	With immediate effect
	Setting range	1~35	Data size	16bit	Control mode	P

Parameter functions: Set the short-distance movement mode upon approaching the origin:

Pb-02=1:

Target zero position: The first Z signal of the motor following the falling edge of the reverse limit switch N-OT.

Deceleration point: Reverse limit switch (N-OT)

- If the N-OT signal is invalid upon start of homing, the servo will run reversely at the speed of Pb-03, and start to decelerate to stop when it receives an N-OT rising edge; then it will run forward at the speed of Pb-04 until it finds and stops at the target zero position.
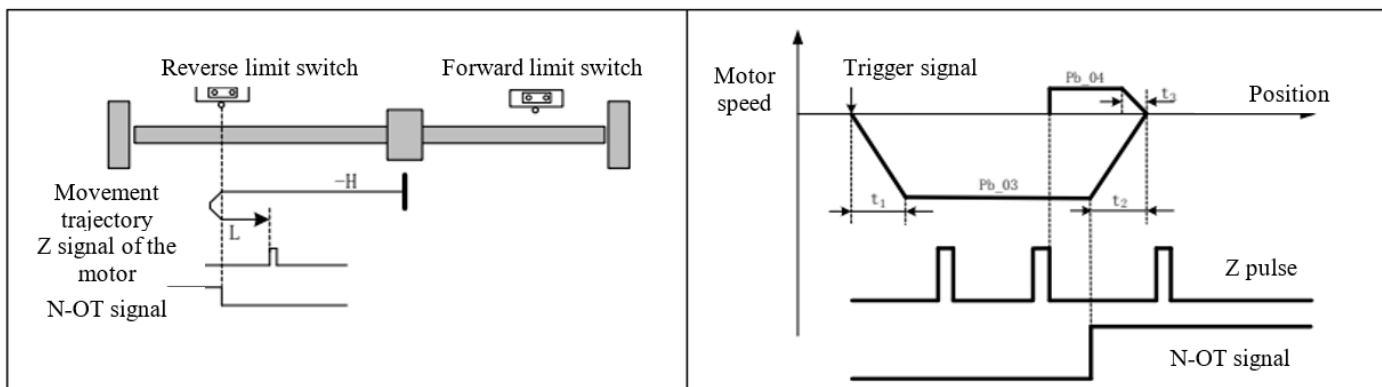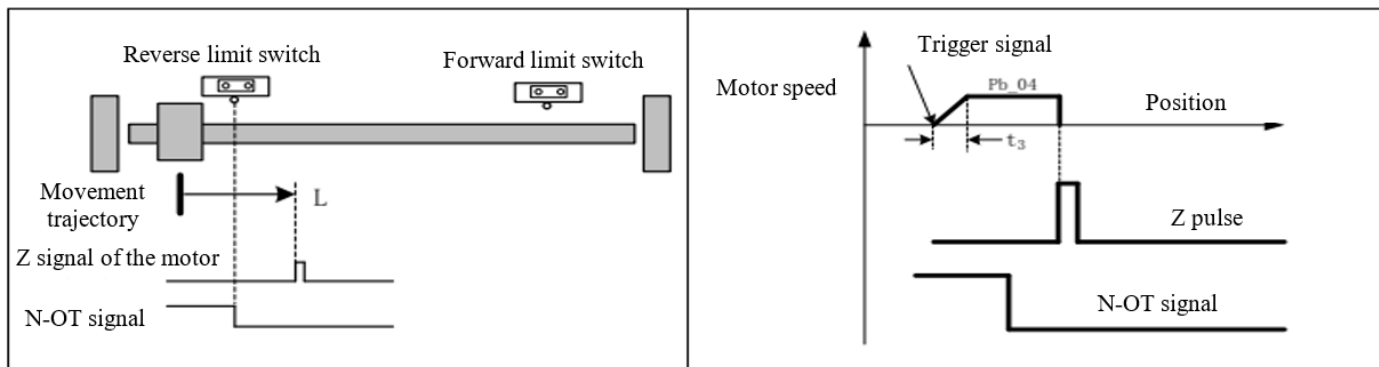

Caution☞ | **H: Forward speed Pb-03** | **-H: Reverse speed Pb-03**

L: Forward speed Pb-04 | **-L: Reverse speed Pb-04.**

$$t_1 = \frac{Pb\text{-}03}{\text{Rated speed}} \times Pb\text{-}05 \quad t_2 = \frac{Pb\text{-}03}{\text{Rated speed}} \times Pb\text{-}06 \quad t_3 = \frac{Pb\text{-}04}{\text{Rated speed}} \times Pb\text{-}05$$

Same below

- If the N-OT signal is valid upon start of homing, the servo will run forward at the speed of Pb-05 to search and stop at the target zero position.


Pb-02=2:

Target zero position: The first Z signal of the motor encoder following the falling edge of the forward limit switch P-OT.
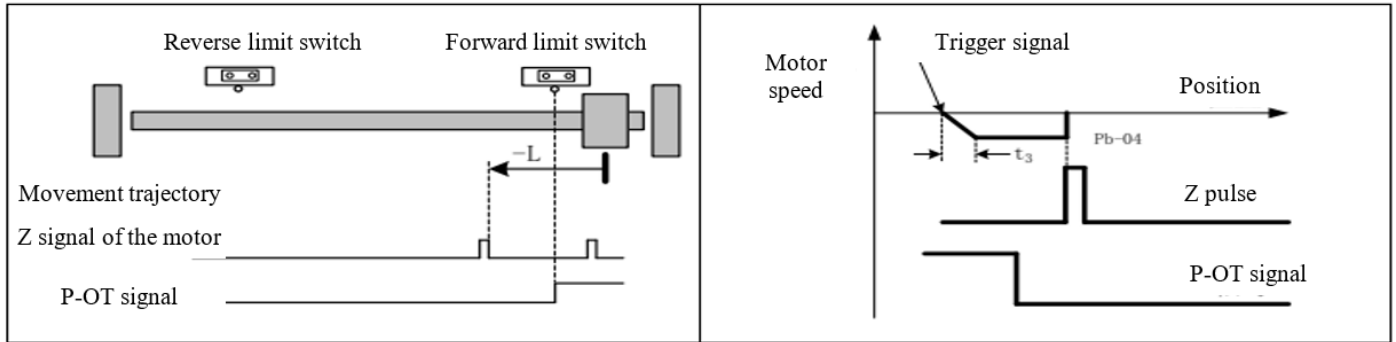
Deceleration point: Forward limit switch (P-OT)

- If the P-OT signal is invalid upon start of homing, the servo will run forward at the speed of Pb-03, and start to decelerate to stop when it receives a P-OT rising edge; then it will run forward at the speed of Pb-04 until it finds and stops at the target zero position.
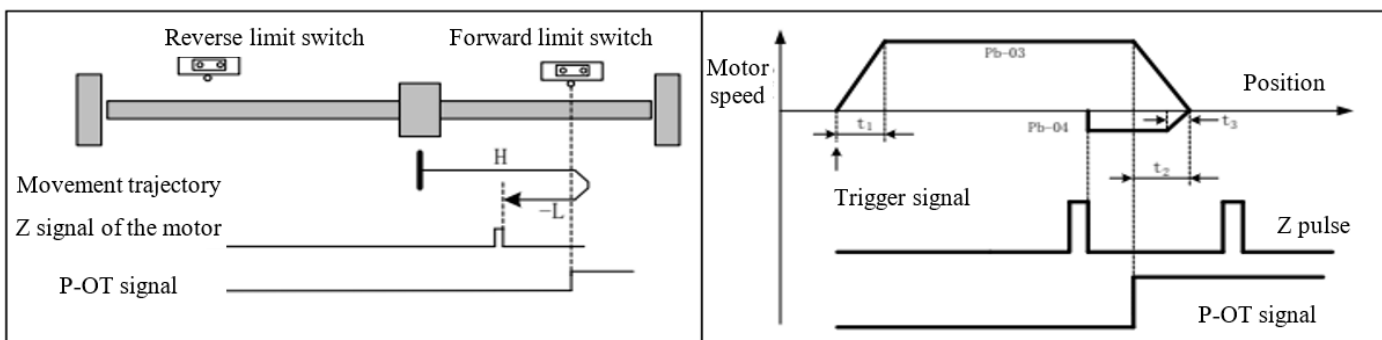
- If the P-OT signal is valid upon start of homing, the servo will run reversely at the speed of Pb-04 to search and stop at the target zero position.
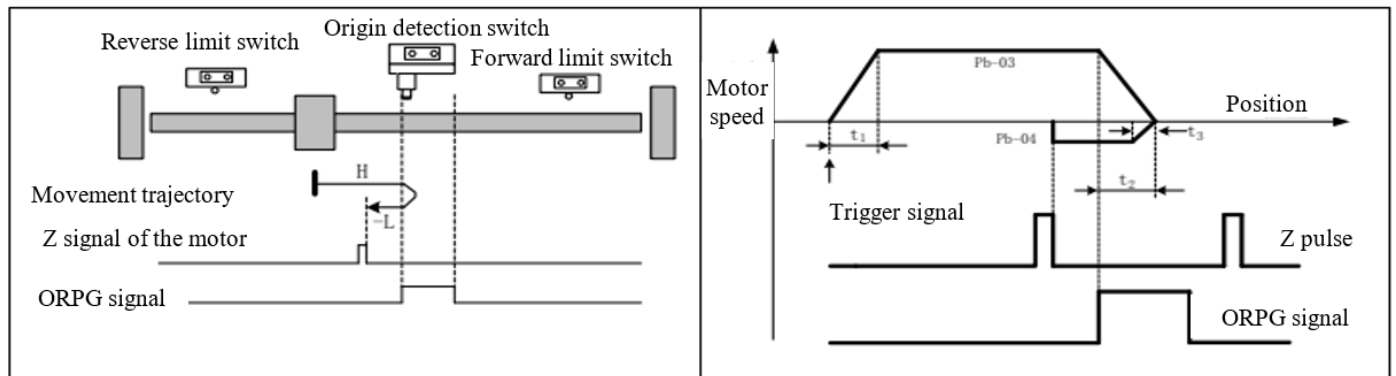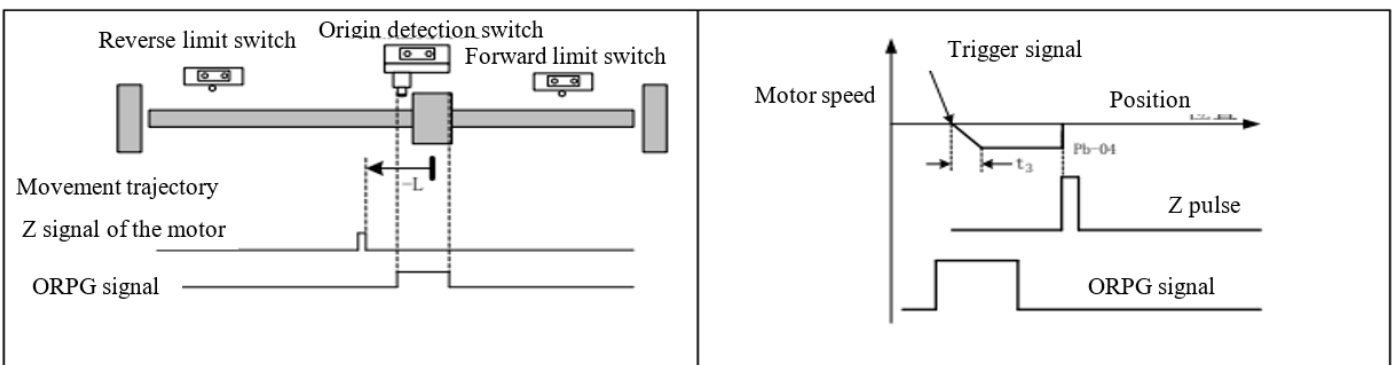

Pb-02=3:

Target zero position: First Z signal of the motor following the ORPG falling edge

Deceleration point: Origin switch (ORPG)

- If the ORPG signal is invalid upon start of homing, the servo will run forward at the speed of Pb-03, and start to decelerate to stop when it receives an ORPG rising edge; then it will run reversely at the speed of Pb-04 until it finds and stops at the target zero position.

- If the ORPG signal is valid upon start of homing, the servo will run reversely at the speed of Pb-05 to search the target zero position.

Pb-02=4:

Target zero position: First Z pulse following the ORPG rising edge

Deceleration point: Origin switch (ORPG)

- If the ORPG signal is invalid upon start of homing, the servo will run forward at the speed of Pb-04 to search the target zero position.

- If the ORPG signal is valid upon start of homing, the servo will run reversely at the speed of Pb-03, and start to decelerate to stop when it receives an ORPG falling edge; then it will run forward at the speed of Pb-04 to search the target zero position.

Pb-02=5:

Target zero position: First Z signal following the ORPG falling edge

Deceleration point: Origin switch (ORPG)

- If the ORPG signal is invalid upon start of homing, the servo will run reversely at the speed of Pb-03, and start to decelerate to stop when it receives an ORPG rising edge; then it will run forward at the speed of Pb-04 to search the target zero position.

- If the ORPG signal is valid upon start of homing, the servo will run forward at the speed of Pb-04 to search the target zero position.
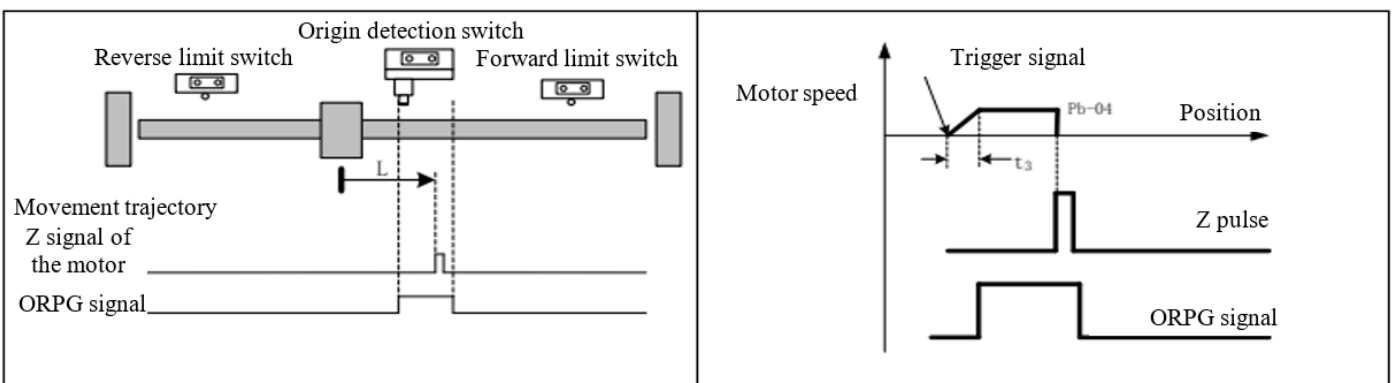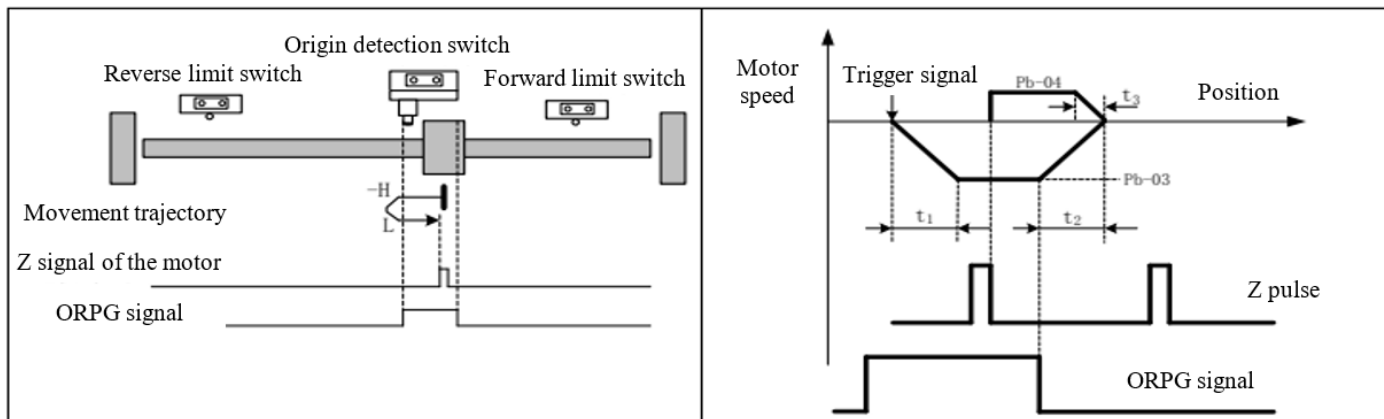

Pb-02=6:

Target zero position: First Z pulse following the ORPG rising edge

Deceleration point: Origin switch (ORPG)

- If the ORPG signal is valid upon start of homing, the servo will run forward at the speed of Pb-03, and start to decelerate to stop when it receives an ORPG falling edge; then it will run reversely at the speed of Pb-04 to search the target zero position.

• If the ORPG signal is invalid upon start of homing, the servo will run reversely at the speed of Pb-04 to search the target zero position.
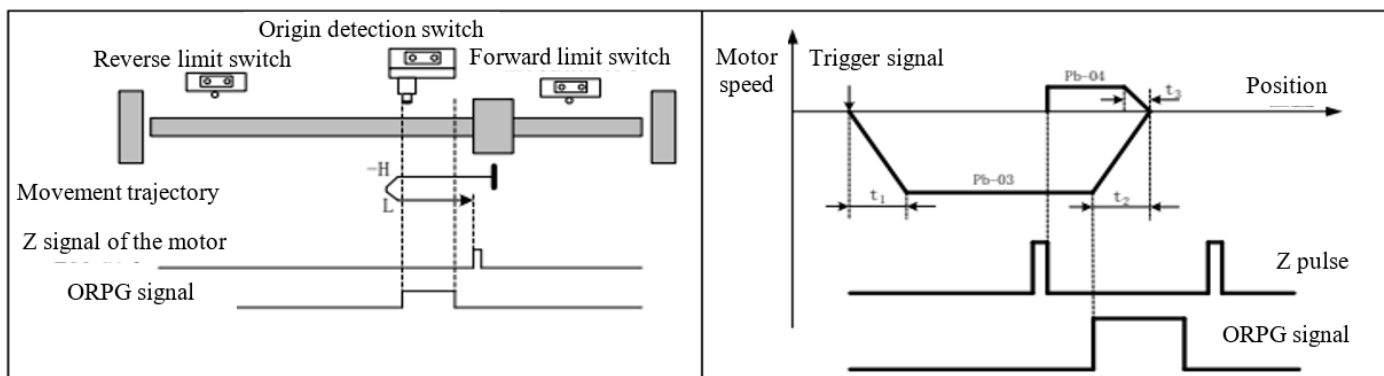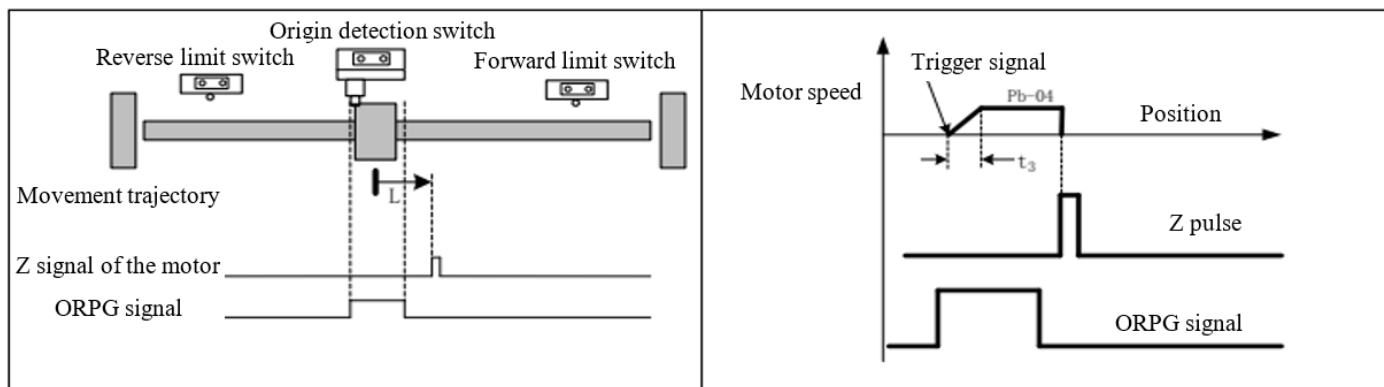

Pb-02=7:

Target zero position: First Z signal following the ORPG falling edge

Deceleration point: Origin switch (ORPG)

• If the ORPG signal is invalid upon start of homing, the servo will run forward at the speed of Pb-03:

■ If no signal of the forward limit switch P-OT is received, the servo will decelerate to stop when it receives an ORPG rising edge signal; then it will run reversely at the speed of Pb-04 to search the target zero position.

• If a signal of the forward limit switch P-OT is received, the servo will automatically run in the reverse direction at the speed of Pb-03; when it receives an ORPG rising edge signal, it will start to decelerate to the speed of Pb-04, and then keep running to and stop at the target zero position.

• If the ORPG signal is valid upon start of homing, the servo will run reversely at the speed of Pb-04 to search the target zero position.
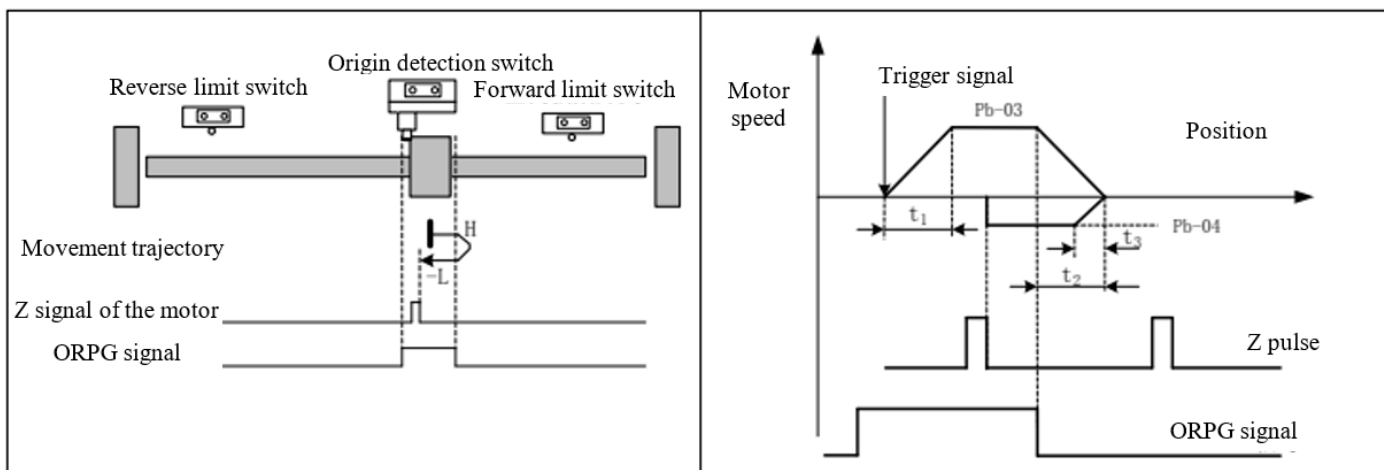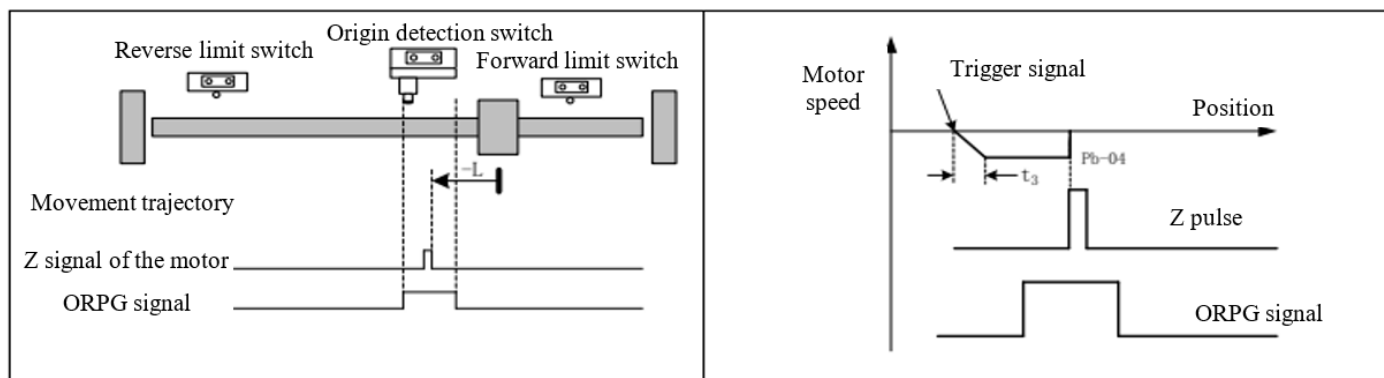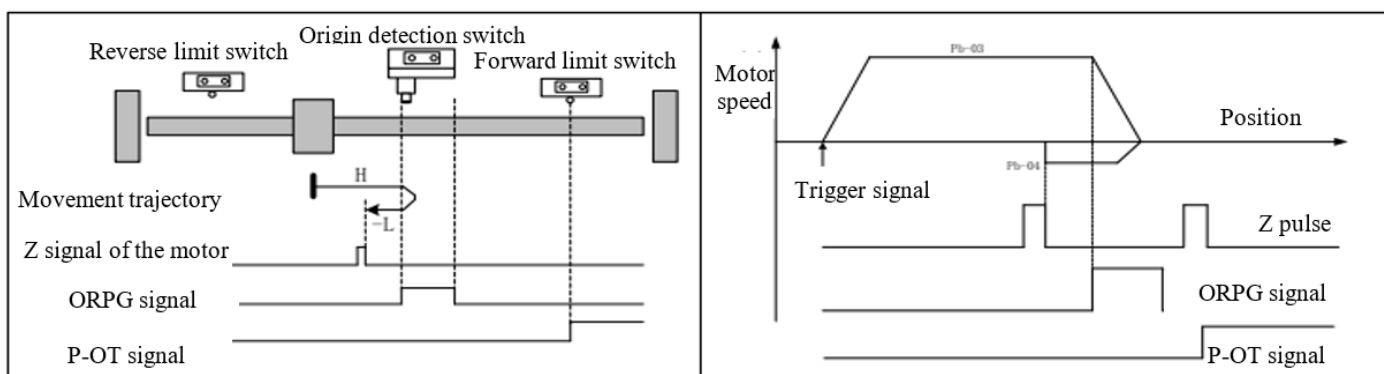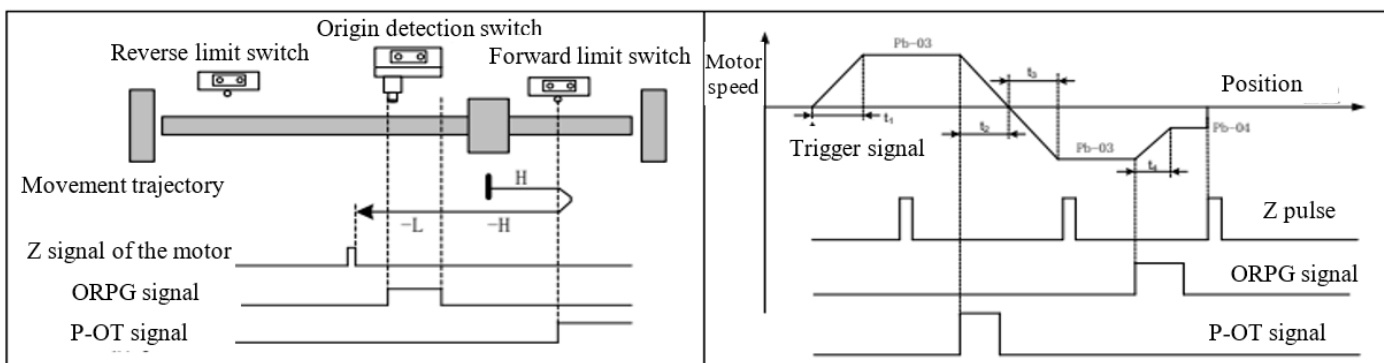

Pb-02=8:

Target zero position: First Z pulse following the ORPG rising edge

Deceleration point: Origin switch (ORPG)

• If the ORPG signal is invalid upon start of homing, the servo will run forward at the speed of Pb-03:

   ▪ If no signal of the forward limit switch P-OT is received, the servo will decelerate to stop when it receives an ORPG rising edge signal; then it will run reversely at the speed of Pb-04 until it receives an ORPG falling edge and then starts to run forward to search the target zero position.
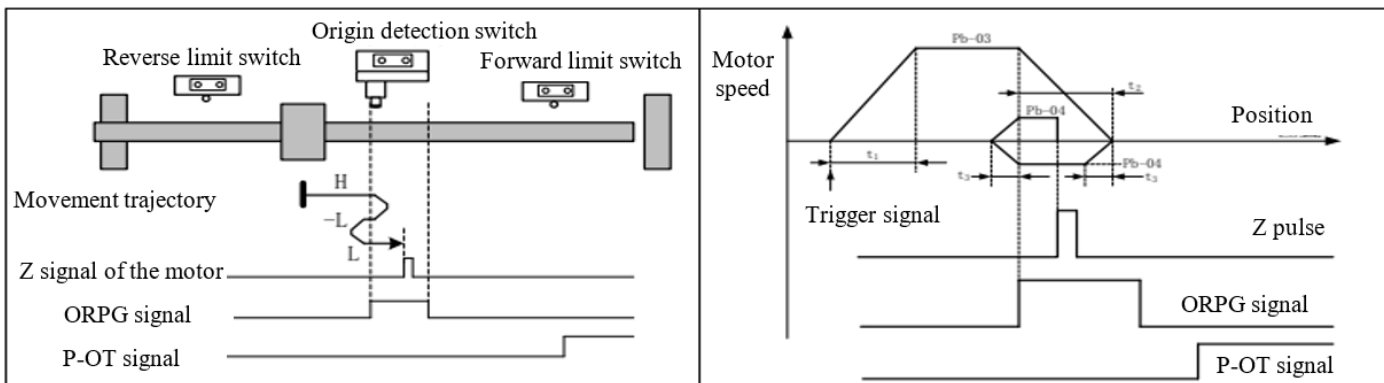
• If a signal of the forward limit switch P-OT is received, the servo will automatically run in the reverse direction at the speed of Pb-03; when it receives an ORPG rising edge signal, it will start to decelerate; after it decelerates to the speed of Pb-04, it will continue running at this speed until it receives an ORPG falling edge and then starts to run reversely at the speed of Pb-04; when it comes to the target zero position, it will stop running
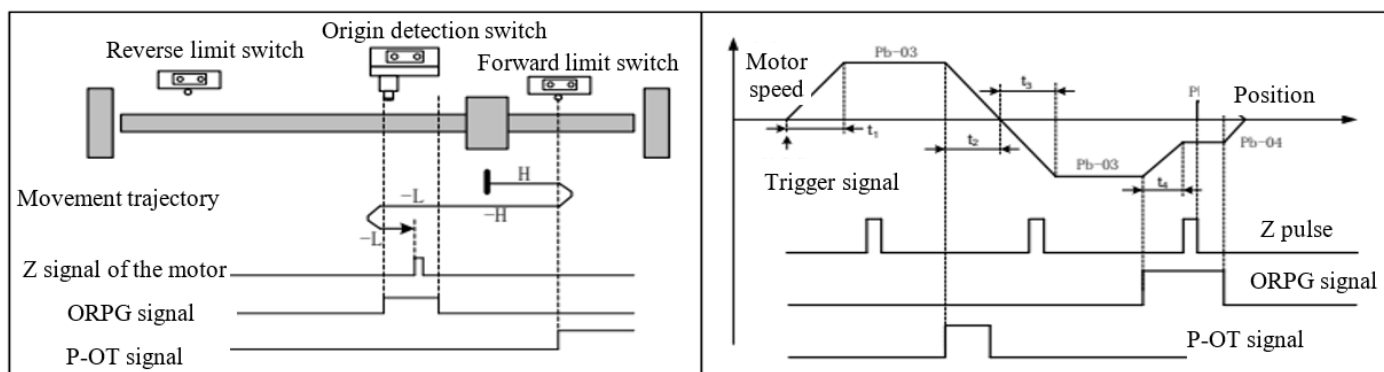
• If the ORPG signal is valid upon start of homing, the servo will run reversely at the speed of Pb-04; when it receives an ORPG falling edge, it will start to decelerate to stop; then it will run forward at the speed of Pb-04 to search the target zero position.
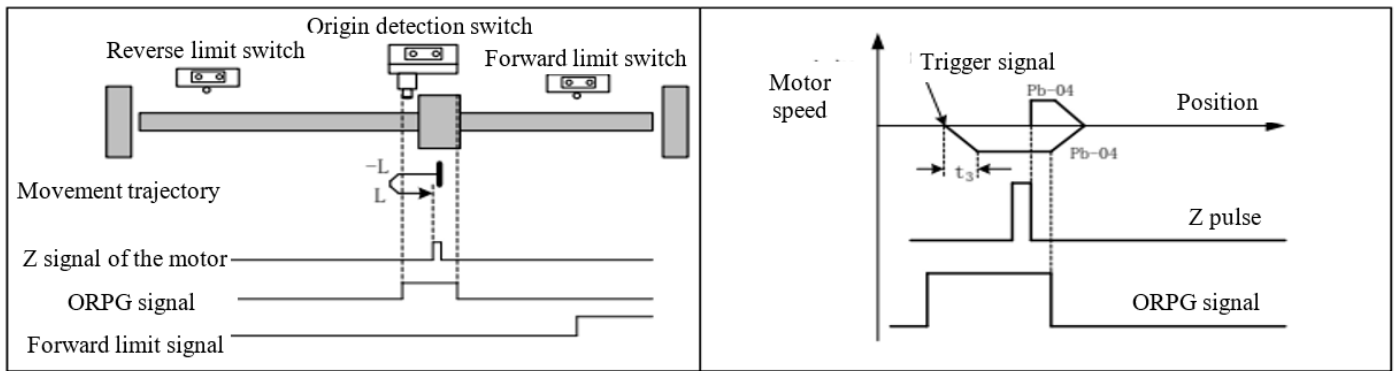
Pb-02=**9**:

Target zero position: First Z pulse following the ORPG rising edge
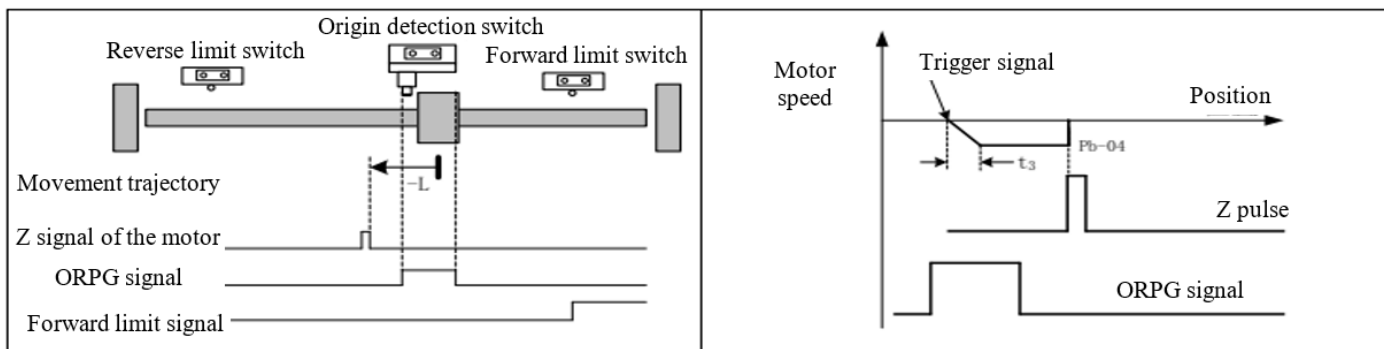
Deceleration point: Origin switch (ORPG)

- If the ORPG signal is invalid upon start of homing, the servo will run forward at the speed of Pb-03:
  - If no signal of the forward limit switch P-OT is received, the servo will decelerate when it receives an ORPG rising edge signal; after it decelerates to the speed of Pb-04, it will continue running forward at this speed until it receives an ORPG falling edge; then it will decelerate to stop; afterwards, it will run reversely at the speed of Pb-04 to search the target zero position.
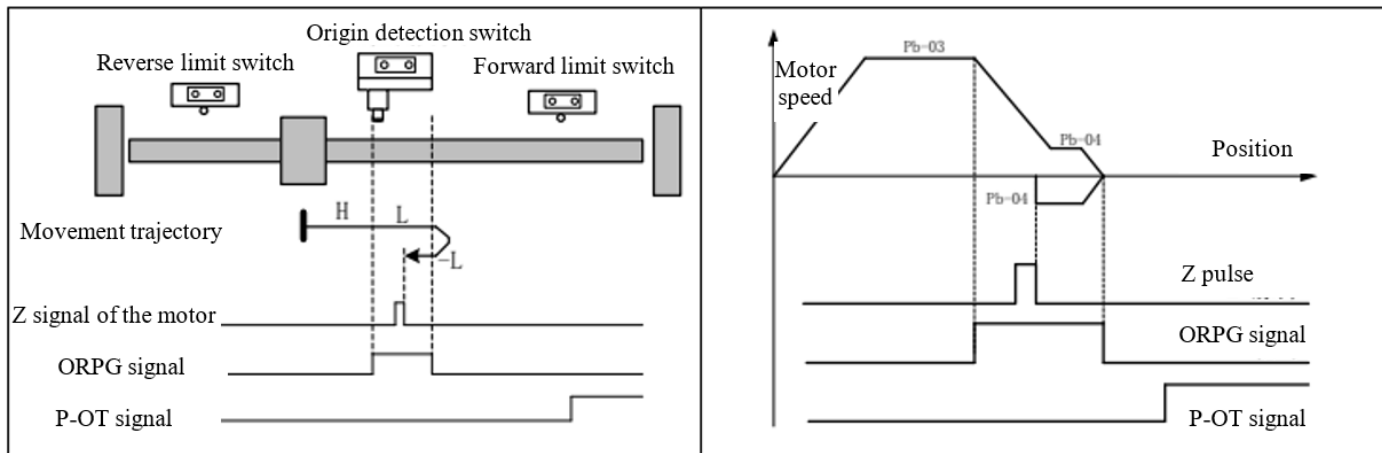
  - If a signal of the forward limit switch P-OT is received, the servo will automatically run in the reverse direction at the speed of Pb-03; when it receives an ORPG rising edge signal, it will start to decelerate to stop; then it will run forward at the speed of Pb-04; when it receives an ORPG falling edge, the servo will decelerate to stop, and then run reversely at the speed of Pb-04 to search the target zero position; when it comes to the target zero position, it will stop running
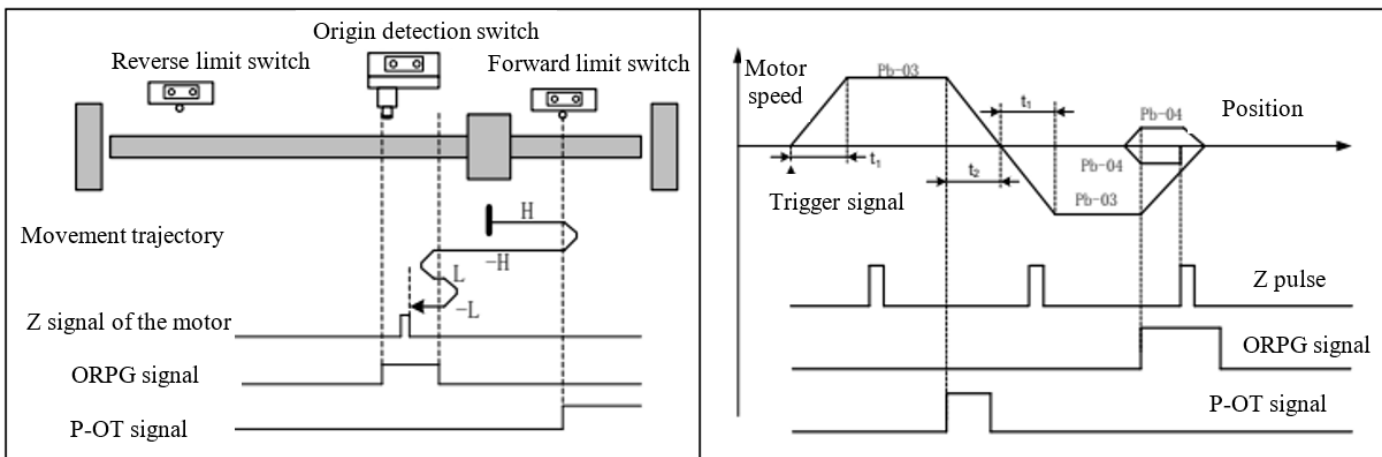
- If the ORPG signal is valid upon start of homing, the servo will run forward for homing at the speed of Pb-04; when it receives an ORPG falling edge, it will start to decelerate to stop; then it will run reversely at the speed of Pb-04 to search the target zero position.
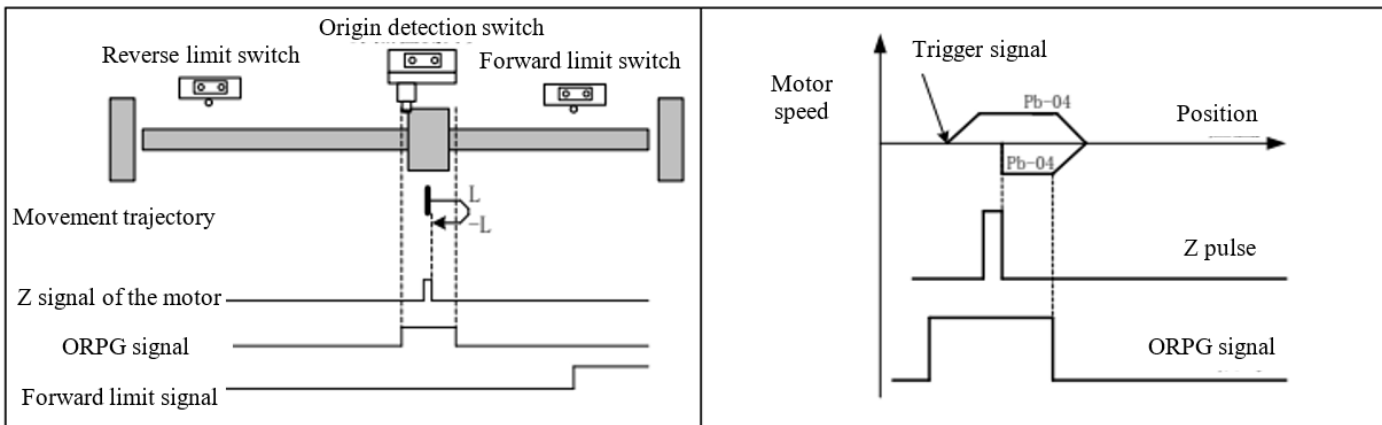
Pb-02=10:

Target zero position: First Z signal following the ORPG falling edge

Deceleration point: Origin switch (ORPG)

- If the ORPG signal is invalid upon start of homing, the servo will run forward at the speed of Pb-03:
  - If no signal of the forward limit switch P-OT is received, the servo will decelerate when it receives an ORPG rising edge signal; after it decelerates to the speed of Pb-04, it will continue running forward to search the target zero position.
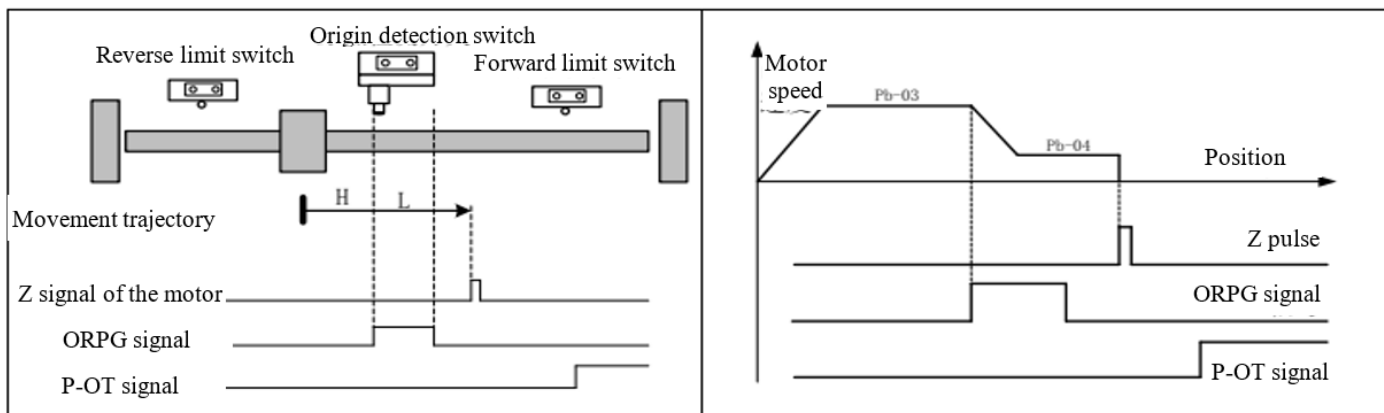
  - If a signal of the forward limit switch P-OT is received, the servo will automatically run in the reverse direction at the speed of Pb-03; when it receives an ORPG rising edge signal, it will start to decelerate to stop; then it will run forward at the speed of Pb-04 to search the target zero position; when it comes to the target zero position, it will stop running

- If the ORPG signal is valid upon start of homing, the servo will run forward at the speed of Pb-04 to search the target zero position.
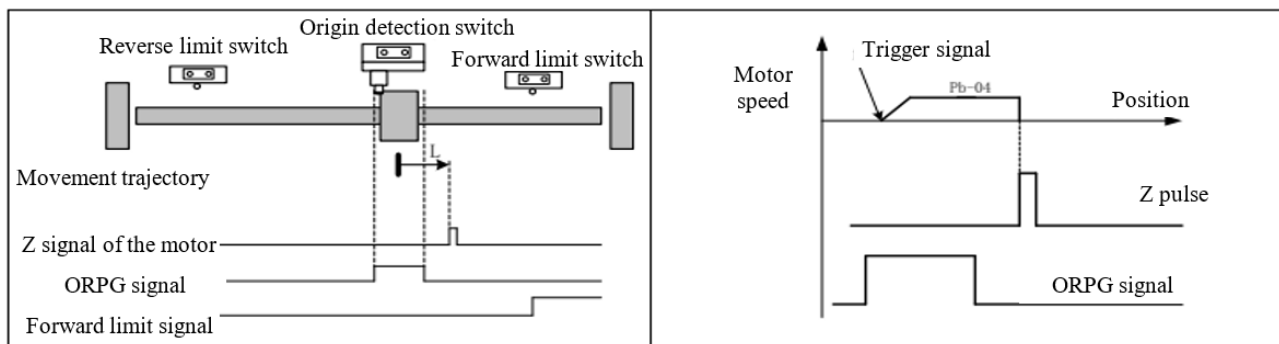

Pb-02=11, **12**, **13**, **14**:

Similar to the case of Pb-02=7~10, only the initial running direction is reverse and the reverse limit switch is N-OT.

Pb-02=17 to 30: With the same movement curve as Pb-02=1~14, only the last step of searching Z signal is omitted. Immediately stop when the following origin signal is received.

Pb-02=	Origin signal		Pb-02=	Origin signal
17	N-OT falling edge		24	ORPG rising edge
18	P-OT falling edge		25	ORPG rising edge
19	ORPG falling edge		26	ORPG falling edge
20	ORPG rising edge		27	ORPG falling edge
21	ORPG falling edge		28	ORPG rising edge
22	ORPG rising edge		29	ORPG rising edge
23	ORPG falling edge		30	ORPG falling edge

Pb-02=31:

Target zero position: Move forward at the second segment of low speed set by Pb-04; the motor torque is limited to the setting of Pb-14; when any obstacle is encountered and entry of the motor into the locked rotor state is detected, movement will immediately stop, and the position is taken as the origin.

Deceleration point: None. The running speed is always the second segment of low speed set by Pb-04.

Movement trajectory

Locked rotor signal
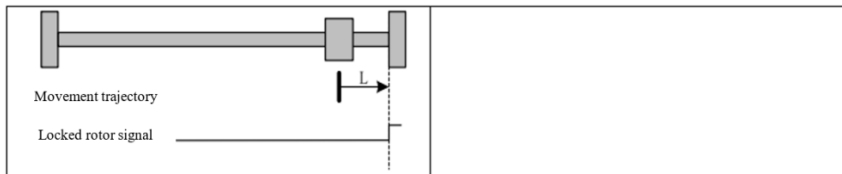
Caution☞	1. In this mode, the limit switch is invalid. 2. In this mode, it is required to set a relatively low Pb-04 speed and relatively low Pb-14 torque, so as to prevent fast shock or excessive impact resulting in mechanical problems. 3. The origin determined in this mode has limited accuracy; therefore, it is only applicable to specific scenarios with less strict requirement for positioning accuracy. 4. It is required to enable the locked rotor protection function, and use P8-14, P8-15 and P8-16 in combination; P8-14 must be smaller than Pb-14; an improper setting may cause an $RL.005$ alarm. 5. Too low setting of the Pb-14 may cause mechanical movement failure or slow mechanical movement; at this time, if Pb-00≠0, an $RL.0 IC$ may occur. If Pb-00=0, the servo may never be able to exit from the homing state. 6. Pb-08 shall be used for proper deviation of the origin from any collision point, so as to avoid continuous rotor locking or occurrence of collision upon each movement.

Pb-02=32:

The process is the same as Pb-02=31, but with a reverse initial movement direction.

Pb-02=33, 34:

Origin signal: Z pulse

Deceleration point: None

- Homing mode 33: Run reversely at the speed of Pb-04, and stop when the first Z pulse is received.

- Homing mode 34: Run forward at the speed of Pb-04, and stop when the first Z pulse is received.

Movement trajectory

Z signal of the motor
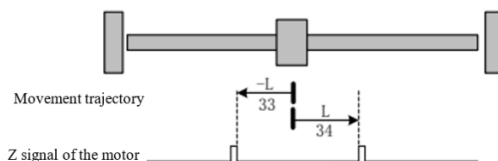
Caution☞	In this mode, the limit switch is invalid; make sure there is no mechanical interference

Pb-02=35:

Take the current position as the mechanical origin. After homing is triggered, take the current position as the origin and give a homing completed signal.

Pb-02=36:

Trigger homing to the electrical zero point at the speed of Pb-03 and return to the electrical zero point defined by Pb-12; upon arrival, give a homing completed signal.

Caution☞	This mode is only applicable to an absolute type encoder and is used when the absolute position mode is enabled; otherwise an accident may occur.

Pb-03	**High speed setting for the first segment of homing**		Initial value	500	Communication address	0B03H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~6000	Data size	16bit	Control mode	P

Parameter functions: Set the running speed of the motor before reaching the reference point upon execution of the homing function.

Pb-04	**Low speed setting for the second segment of homing**		Initial value	50	Communication address	0B04H
			Unit	rpm	Time of taking effect	With immediate effect
	Setting range	0~6000	Data size	16bit	Control mode	P

Parameter functions: Set the running speed of the motor upon execution of homing after it arrives at the reference point for final positioning to the origin.

This speed shall not be set too high; otherwise overshooting may occur in case of large load inertia.

Pb-05	**Acceleration and deceleration time for homing**		Initial value	100	Communication address	0B05H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	1~65535	Data size	16bit	Control mode	P

Parameter functions: Set the acceleration and deceleration time for homing.

Acceleration time refers to the time required to accelerate from speed 0 to the rated motor speed.

Deceleration time refers to the time required to decelerate from the rated motor speed to the speed 0.

Pb-08	**Pulses of homing deviation**		Initial value	0	Communication address	0B08H
			Unit	Pulse	Time of taking effect	With immediate effect
	Setting range	-2147483647~2147483647	Data size	32bit	Control mode	P

Parameter functions: Upon execution of homing, if the user desires some deviation of the motor stop position from the reference point, this parameter can be used to set pulses of the deviation.

Caution☞ The count of pulses set by Pb-08 corresponds to a command pulse unit.

Pb-10	**Position upon homing completion**		Initial value	0	Communication address	0B0AH
			Unit	Pulse	Time of taking effect	With immediate effect
	Setting range	-2147483647~2147483647	Data size	32bit	Control mode	P

Parameter functions: This parameter is used to set the current position of the motor when homing is completed.

When homing is completed, the set value of Pb-10 becomes the value of parameter d0-34. The value of d0-36 is obtained through electronic gear conversion of d0-34.

Caution☞ The count of pulses set by Pb-10 corresponds to a command pulse unit.

Pb-12	**Offset of the absolute position from the electrical origin**		Initial value	0	Communication address	0B0CH
			Unit	PUL	Time of taking effect	Taking effect upon power-on again
	Setting range	-2147483647~2147483647	Data size	32bit	Control mode	P

Parameter functions: This parameter can be used to set the deviation of the electrical zero point from the mechanical origin when the motor stop position is the mechanical origin upon completion of homing.

For the absolute value system, after the electrical zero point is set, all position commands subsequently received will take the electrical zero point as the reference starting position. It shall be specially noted that data referenced upon setting the electrical zero point shall be the motor encoder position comprising d0-29 and d0-30, other than data of d0-36.

The electrical zero point is based on absolute position data of the encoder. Therefore, the electrical zero point is fixed unless the following operations are performed.

■ Set another value for Pb-12

■ Re-execute homing

■ Execute the "Clear multiple-turn data of encoder" operation (AF-16=2)

For an incremental system, the electrical zero point can also be taken as the reference starting position. However, when the system is powered off and then powered on again, the electrical zero point will deviate from the motor position upon power-on by Pb-12.

Caution☞ The count of pulses set by Pb-12 corresponds to an encoder pulse unit.

Pb-14	**Locked-rotor torque limit for homing**		Initial value	50.0	Communication address	0B0EH
			Unit	%	Time of taking effect	With immediate effect
	Setting range	0.0~150.0	Data size	16bit	Control mode	P S T

Parameter functions: Set the maximum output torque upon homing in the mode 31 or 32.

Caution☞ 1. This parameter is dedicated for homing in mode 31 or 32. It is required to use P8-14, P8-15 and P8-16 in combination.
2. If the motor locked rotor protection function (P8-15=0) is not enabled or though the function is enabled (P8-15≠0), parameter P8-15 is set improperly (P8-15≥Pb-04 or P8-14≥Pb-14), the driver will give a *Ru. 0 IC* or *Ru. 005* alarm.

8.17 PC-xx fully closed-loop parameters

Important: This section discusses setting of parameters related to fully closed loop. Please refer to the guides in Chapter IX so that you can use the fully closed-loop function properly.

		Initial value	0	Communication address	0C00H
PC-00	**Encoder feedback selection**	Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P

Parameter functions: Selects the source of encoder feedback.

PC-00=0: use motor encoder;

PC-00=1: use external encoder, in case of which the fully closed-loop function is enabled.

Caution☞	**1. You'll have to purchase and install the E18-PG-1 expansion card component and correctly connect it to the external encoder before you can use the fully closed-loop function.**

		Initial value	0	Communication address	0C01H
PC-01	**Selection of external encoder direction**	Unit	-	Time of taking effect	With immediate effect
	Setting range	0~1	Data size	16bit	Control mode	P

Parameter functions: Sets counting direction of the external encoder upon enabling the fully enclosed-loop function.

PC-01=0: standard direction. The pulse counting direction of the external encoder is the same as that of the motor encoder.

When the motor runs, the pulse count of the external encoder increases with the pulse count of the motor encoder.

PC-00=1: reverse. The pulse counting direction of the external encoder is opposite to that of the motor encoder.

When the motor runs, the pulse count of the external encoder decreases if the pulse count of the motor encoder increases.

		Initial value	10000	Communication address	0C02H
PC-02	**Pulse count of external encoder feedback per motor revolution**	Unit	PUL	Time of taking effect	Taking effect upon power-on again
	Setting range	0~1073741824	Data size	32bit	Control mode	P

Parameter functions: Sets the number of pulses fed by the external encoder for every turn completed by the servo motor.

This parameter is used to establish equivalence between the external encoder and the number of pulses fed by the motor encoder.

Caution☞	**1. You must ensure that the core parameters of fully closed-loop applications are properly set, otherwise positioning might be subject to deviation.**

		Initial value	10000	Communication address	0C04H
PC-04	**Alarm thresholds for excessive deviation of fully closed-loop position**	Unit	PUL	Time of taking effect	With immediate effect
	Setting range	0~1073741824	Data size	32bit	Control mode	P

Parameter functions: Sets the threshold for the absolute value of position deviation in case of the alarm for excessive deviation in fully closed-loop position.

During running, if | number of pulses fed by motor encoder (external encoder unit) - pulses fed by external encoder | is greater than this parameter setting, the $AL045$ alarm will be raised, and the driver will stop as per the method set by P0-08.

Used to prevent lose of control arising from external encoder damage or detect "slippage" in the belt drive mechanism.

Count of feedback pulses of motor encoder converted to external encoder unit = $\dfrac{\text{Number of pulses fed by motor encoder}}{\text{Resolution of motor encoder}} \times PC.\,02$

In case of a remainder, the numbers after the decimal point will be rounded off.

Caution☞	**1. If this parameter is 0, the servo drive will not perform fault detection of excessive deviation in fully closed-loop position. Instead, it will keep eliminating the deviation in fully closed-loop position.** **2. The setting value of this parameter is the pulse unit of the external encoder.**

		Initial value	0	Communication address	0C06H
PC-06	**Elimination setting of fully closed-loop position deviation**	Unit	Rev	Time of taking effect	With immediate effect
	Setting range	0~100	Data size	16bit	Control mode	P

Parameter functions: Sets after how many turns of the motor will the fully closed-loop position deviation be cleared once during running of the driver.

Turns of the motor are reflected by the number of pulses fed by the motor encoder.

If it's set as 0, the fully closed-loop position deviation will always be cleared.

If it's set as n:

- Within the n turns of the servo motor, if the fully closed-loop position deviation is always smaller than the setting value of PC-04, the driver will clear the deviation on the nth turn and start from zero again to count fully closed-loop position deviation and turns of the motor.

- Within the n turns of the servo motor, once the fully closed-loop position deviation becomes equal to or greater than the setting value of PC-04, the driver will clear the deviation immediately and raise the alarm of excessive deviation $Au045$, and the driver will stop in the way set by P0-08.

Caution☞	1. If this parameter is 0, the fully closed-loop position deviation will always be cleared, which means that no external encoder anomaly or transmission mechanism "slippage" will be detected.

PC-07	**Filtering time constant for fully closed-loop hybrid vibration suppression**		Initial value	0	Communication address	0C07H
			Unit	ms	Time of taking effect	With immediate effect
	Setting range	0.0~6553.5	Data size	16bit	Control mode	P

Parameter functions: Sets the time constant of hybrid vibration suppression for fully closed-loop control.

In case of fully closed-loop control, please increase the setting value gradually and check changes in the response.

If the rigidity of the transmission mechanism between the full closed loop and the inner loop is insufficient, you can specify an appropriate time constant to improve system stability, i.e. being able to secure inner loop effect in transient state and fully closed loop in steady state. This can be ignored in case of sufficient rigidity.

Caution☞	**1. This parameter will affect system response. A greater value gives rise to slower system performance. Use it in case of oscillation arising from insufficient rigidity of the transmission shaft between the external encoder and the servo motor.**

PC-08	**External encoder disconnection detection switch**		Initial value	0	Communication address	0C08H
			Unit	-	Time of taking effect	Taking effect upon power-on again
	Setting range	0~1	Data size	16bit	Control mode	P

Parameter functions: Sets the time constant of hybrid vibration suppression for fully closed-loop control.

PC-08=0: Do not detect external encoder disconnection.

PC-08=1: Detect external encoder disconnection.

Caution☞	**Detection of external encoder disconnection can't be guaranteed.**

Chapter 9 Applications of fully closed loop

9.1 Preparations

1. Please purchase the EA350 series servo driver that comes with the fully closed-loop feature (which is not included in standard products).

2. Please also purchse our fully closed-loop module E18-PG-1 separately to form a system as shown below.
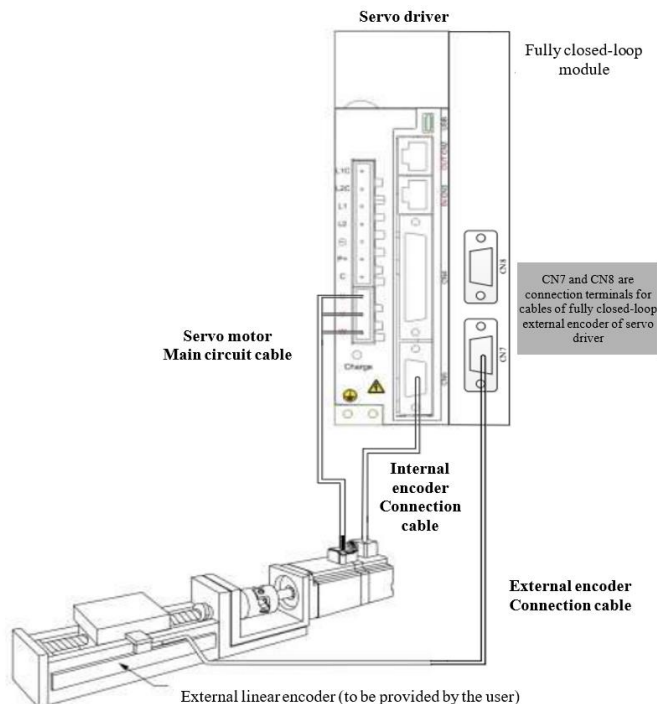
Caution☞	•	**The figure above is a connection diagram for the external encoder. For connection details on power supply and peripherals, please refer to Chapter 3.**
	•	**Mechanical wobble or twisted connection will result in unstable positioning precision or vibration of the fully closed-loop system.**

3. Set the basic parameters properly for the servo driver, and toggle it to position control mode.

4. Servo gain adjustment: With the fully closed-loop function not enabled, check if the basic settings for the master and the servo are correct, and if the connections of mechanical components are proper, and perform identification of load-inertia ratio.

9.2 Box diagram of fully closed-loop control
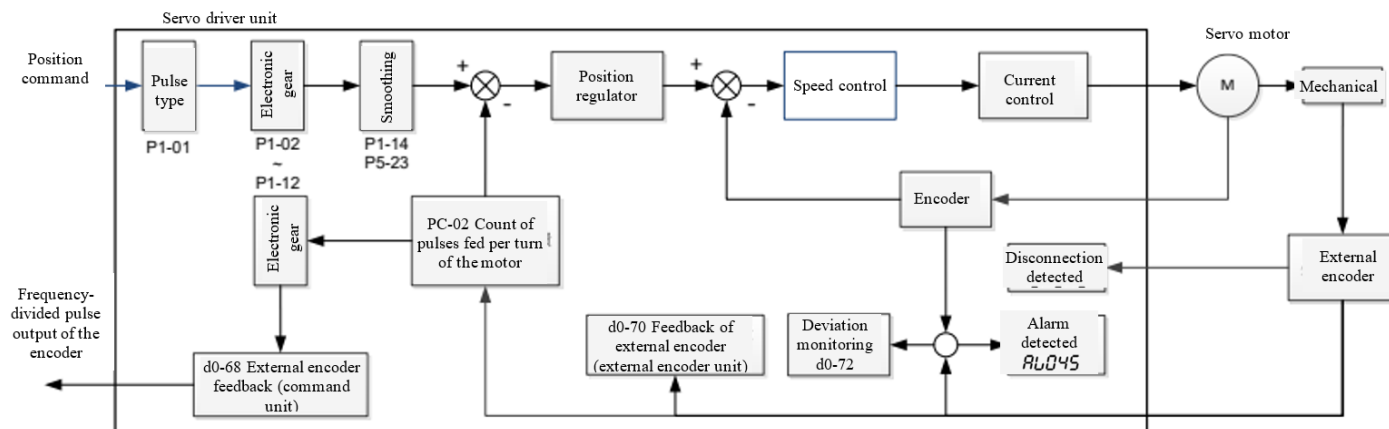
9.3 Settings of fully closed loop

With fully closed-loop not enabled, set the gain parameter of the servo driver first to make sure the servo runs properly without any overshooting or over-tuning and stops without any abnormal noise. Upon meeting these conditions, set the parameters of fully closed loop in the steps described below:

1. Determine running direction of the external encoder

Function Code	Name of function code	Parameter description of function code	Unit	Default setting	Ways of taking effect
PC-01	Selection of external encoder direction	0: standard direction 1: reverse	-	0	With immediate effect

The counting direction of the external encoder and the servo motor encoder must conform to the setting of PC-01. An error will lead to positive feedback and cause galloping.

Enter the JOG mode for the driver, and perform jogging upon setting a low speed for P8-00. Observe the display of pulse feedback of the motor encoder and the external encoder. If they share the same variation trend (increasing or decreasing concurrently), set the use method as 0 for the external encoder; otherwise set it as 1.

2. Determine the resolution of the external encoder (pulse count of the external encoder corresponding to each turn of the motor)

Function Code	Name of function code	Parameter description of function code	Unit	Default setting	Ways of taking effect
PC-02	Pulse count of external encoder feedback per motor revolution	0~1073741824	PUL	10000	Power-on again

This parameter indicates the count of pulses (upon quadruplicated frequency) returned by the external encoder for each turn completed by the motor, in PUL (Pulses/turn).

Assume there is a screw drive, the transmission ratio of the reducer is 1: 1, the screw lead is 10 mm, and the resolution of the external encoder is 0.005 mm/pulse. When the servo motor completes a turn, the nut will travel for 10 mm in linear distance, and the external encoder will return (10÷0.005) = 2,000 pulses, that is, the external encoder returns 2,000 pulses for every turn completed by the motor. Therefore, this parameter should be set to 2,000.

3. Alarm detection setting

Settings of alarm detection (threshold of excessive deviation in fully closed-loop, and elimination setting of fully closed-loop position deviation).

a) Setting of threshold for excessive motor-load position deviation (detection value for excessive motor-load deviation)

Function Code	Name of function code	Parameter description of function code	Unit	Default setting	Ways of taking effect
PC-04	Alarm threshold for excessive motor-load position deviation	0~1073741824	PUL	10000	With immediate effect

This sets the allowable difference in the counts of feedback pulses between the motor encoder and and the external encoder, expressed in external encoder unit.

For example:

If you set the alarm threshold as 1,000 for excessive motor-load position deviation, the alarm $AL045$ excessive motor-load position deviation will be raised when the absolute difference in feedback pulse count between the motor encoder and the external encoder exceeds 1,000.

If this setting is 0, the servo drive will not perform alarm detection for excessive motor-load position deviation. Instead, it will keep eliminating the motor-load position deviation.

b) Setting of clearing excessive motor-load position deviation

Function Code	Name of function code	Parameter description of function code	Unit	Default setting	Ways of taking effect
PC-06	Setting of clearing excessive motor-load position deviation	0~100	Rev	0	With immediate effect

Sets after how many turns of the motor will the motor-load position deviation be cleared once during running of the driver.

9.4 Enable fully closed-loop feature

With the abovementioned fully closed-loop parameters correctly set and confirmed, enable the fully closed-loop feature.

To do this, set PC-00 as 1 and select the external encoder as the encoder feedback source. The setting can be performed only in S-OFF state.

Function Code	Name of function code	Parameter description of function code	Unit	Default setting	Ways of taking effect
PC-00	Encoder feedback selection	0: Use motor encoder 1: Use external encoder	-	0	With immediate effect

You can switch the source of encoder feedback through the DI terminal defined as FCL function.

If the DI terminal defined as the FCL function is valid, the external encoder will be used, and the fully closed-loop feature will be enabled.

If the DI terminal defined as the FCL function is invalid, the motor encoder will be used, and the fully closed-loop feature will be disabled.

Switching states of the FCL terminal is valid only in S-OFF state. That is, the servo can only detect the state of the FCL terminal before enabling. After enabling, swiching of FCL terminal will not take effect.

Caution☞ **Please refer to the explanations on fully closed-loop parameter in 8.17.**

Chapter 10 Communication protocol

10.1 Scope of application

1. Applicable series: EA350 series servo driver.

2. Applicable network: "Single-master multi-slave" communication network with MODBUS-RTU protocol and RS485 bus.

A typical RTU message frame format as shown below:

Start Bit	Equipment address	Function code	Data	CRC check	End mark
T1-T2-T3-T4	8Bit	8Bit	n*8Bit	16Bit	T1-T2-T3-T4

10.2 Physical interface

RS485 asynchronous half-duplex communication mode.

Default data format of RS485 terminal: 1-8-N-1, baud rate: 9600bps.

Data formats 1-8-N-1/2, 1-8-O-1/2 and 1-8-E-1/2, and baud rates 4800bps, 9600bps, 19200bps, 38400bps, 57600bps and 115200bps are available for selection through function codes P7-01 and P7-02.

10.3 Protocol format
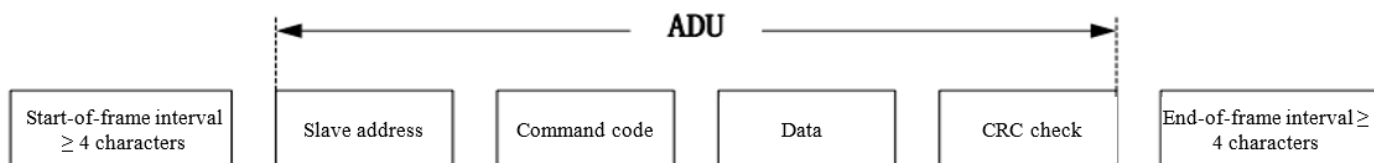
Check in ADU(Application Data Unit) is derived from high-low byte swap of the CRC16 checksum of the first three parts in ADU. In the protocol format, the low byte of CRC check is in front of the high byte.

10.4 Command explanation

Command code 0x03: Read a function code of the servo driver

Details of the ADU part	Number of bytes	Scope
Request sent by the host:		
Slave address	1	0x00-0xFEH
Command code	1	0x03
Starting address of register	2	0x0000-0xFFFF
Number of registers	2	0x0001-0x0022
CRC check (low byte in front)	2	
Slave acknowledgement:		
Slave address	1	Address of the unit
Command code	1	0x03
Number of bytes read	1	2 * number of registers
Register content	2 * number of registers	
CRC check	2	

Command code 0x06: Write a single function code of the servo driver

Details of the ADU part	Number of bytes	Scope
Request sent by the host:		
Slave address	1	0x00-0xFEH
Command code	1	0x06
Address of register	2	0x0000-0xFFFF
Register content	2	0x0000-0xFFFF
CRC check	2	
Slave acknowledgement:		
Slave address	1	Address of the unit
Command code	1	0x06
Address of register	2	0x0000-0xFFFF
Register content	2	0x0000-0xFFFF
CRC check	2	

Command code 0x10: Rewrite multiple continuous function codes of the servo driver

Details of the ADU part	Number of bytes	Scope
Request sent by the host:		
Slave address	1	0x00-0xFEH
Command code	1	0x10
Starting address of register	2	0x0000-0xFFFF
Number of registers	2	0x0000-0x0020
Bytes of register content	1	2 * number of registers
Register content	2 * number of registers	
CRC check	2	
Slave acknowledgement:		
Slave address	1	Address of the unit
Command code	1	0x10
Starting address of register	2	0x0000-0xFFFF
Number of registers	2	0x0000-0x0020
CRC check	2	

Command code 0x08: Line diagnosis

Details of the ADU part	Number of bytes	Scope
Request sent by the host:		
Slave address	1	0x00-0xFEH
Command code	1	0x08
Sub-function code	2	0x0000
Data	2	0x0000-0xFFFF
CRC check	2	
Slave acknowledgement:		
Slave address	1	Address of the unit
Command code	1	0x08
Sub-function code	2	0x0000
Data	2	0x0000-0xFFFF
CRC check	2	

Note: Command code 0x08 is only used to check whether the line is connected.

10.5 Description of the protocol format

10.5.1 Address code

Servo driver slave address. Setting range 1-247.

10.5.2 Function code

Function code	Function
03H	Read a function code of the servo driver
06H	Write a single function code of the servo driver (this operation is not intended for a 32-bit function code)
10H	Write multiple continuous function codes of the servo driver (For a 32-bit function code, use 10H for operation, with one function code occupying 2 consecutive addresses)
08H	Line diagnosis

10.5.3 Register address distribution

Item	Address Space	Description
Function parameter address	0000H-3FxxH	When P7-04=0 and P7-05=1, this address segment corresponds to the EEPROM address of the driver; parameters written to these addresses will be saved. For example: The EEPROM address corresponding to P2-01 is 0201H (when P7-04=0 and P7-05=1)
	8000H-BFxxH	If it is required to frequently modify the parameters, content of the RAM register shall be modified; when P7-04=0 and P7-05=1, the function parameter address shall be defined as +8000H For example: The RAM register address corresponding to P2-01 is 8201H (when P7-04=0 and P7-05=1)

Note: Frequent writing of parameters required to be frequently written to EEPROM may cause damage to EEPROM due to the limited read/write life span of the EEPROM (about 1 million times).

Function Parameter		MODBUS communication address	
P7-04	P7-05	0000H~3FxxH	(0000H~3FxxH)+8000H
0	1	Write to EEPROM, and save	Write to RAM, without saving
0	0	Write to RAM, without saving	Write to EEPROM, and save
1	1	Write to RAM, without saving	Write to RAM, without saving
1	0	Write to RAM, without saving	Write to RAM, without saving

10.5.4 CRC check

The transmitter first calculates the CRC value, which is included in the sent message. Upon receiving the message, the receiver will recalculate the CRC value and compare the calculated value with the received CRC value. If the two values are not equal, it means that there is an error in the sending process.

Calculation process of CRC check:

1) Define a CRC register and assign an initial value, FFFFH.

2) Perform the XOR calculation with the first byte of the transmitted message and the value of the CRC register, and store the result in the CRC register. Starting from the address code, the start bit and stop bit are not involved in calculation.

3) Extract and check the LSB (the least significant bit of the CRC register).

4) All bits of the CRC register are shifted to the right by one bit, and the most significant bit is filled by 0.

5) If the LSB is 1, perform the XOR calculation of the CRC register value and A001H, and store the result in the CRC register.

6) Repeat the steps 3, 4, and 5 until 8 shifts are completed.

7) Repeat the steps 2, 3, 4, 5 and 6 to process next byte of the transmitted message, until all bytes of the transmitted message are processed. Repeat the above procedures until all bytes of information are processed and transmitted.

8) After the calculation, the content of the CRC register is the value of CRC check.

9) Upon transmission, low bytes of the CRC check value will be sent before high bytes.

10.5.5 Line diagnosis and 0x08 setting description

Sub-function code	Request data	Ack data	Sub-function meaning
0000H	#data16	Same with the request data	Line diagnosis

10.5.6 Exception response

When the host sends incorrect data or the servo receives incorrect data due to external interference, an exception response message will be sent back. Data structure of exception response:

Details of the ADU part	Number of bytes	Description
Address code	1	Slave address
Function code	1	Equal to the sent function code + 0x80
Exception code	1	See the exception code table
CRC check (L)	2	CRC16
CRC check (H)		CRC16

Exception code table:

Data	Meaning
1	Function code incorrect
2	Address incorrect
3	Data length or CRC check incorrect
5	Write a parameter in excess of the range
6	The current parameter cannot be written

Note: If the function code is incorrect, the exception code is 0x01

10.6 Examples

Write No. 01 servo driver as position control, i.e. P1-00=1, and save it. (P7-04 and P7-05 are default settings)

Transmission order	0	1	2	3	4	5	6	7	8	9
Transmission content		01H	06H	01H	00H	00H	01H	49H	F6H	

Receiving order	0	1	2	3	4	5	6	7	8	9
Receiving content		01H	06H	01H	00H	00H	01H	49H	F6H	

Chapter 11 Warning, alarm and handling

11.1 Alarm diagnosis and handling measures

When the servo driver becomes subject to an alarm, the digital manipulator will display $AL.$ for the alarm; and the motor will automatically brake or brake at zero speed (according to setting of P0-08; but zero-speed braking only applies to a second-level alarm). The driver will record information on the latest four alarms, which can be viewed via group d1. Alarm display and its handling measures are provided below:

$AL.001$: Output short circuit

$AL.002$: Hardware over-current 1

$AL.003$: Hardware over-current 2

$AL.00C$: Software over-current

Reason for alarm	Inspection	Handling method
Motor wiring error	Check the wiring phase between the motor and the driver	Reconnect the wire according to the instructions
Control parameter setting abnormal	Check whether the setting is far greater than the default value	Restore the default value and make corrections step by step
Command changes too sharp	Check if the control input command changes too wildly	Correct the input command change rate or enable the filtering function
Driver output short circuit	1: Check the wiring status between the motor and the driver or check the conductor against short circuit 2: Check if the motor is damaged	1: Rule out short circuit, and prevent exposure of the metal conductor 2: Replace the damaged motor
The external braking resistor has too small resistance or is short-circuited	Check if the external braking resistor conforms to the specification	Use a braking resistor conforming to the instructions, and properly set parameters P8-10, P8-11 and P8-13
Driver hardware failure	Alarm still remains after all problems above are eliminated	Send it to the distributor or manufacturer for repair

$AL.004$: Storage abnormality alarm

Reason for alarm	Inspection	Handling method
Abnormal write of parameter data	Cut off the power and restart; check whether the alarm still occurs	Replace the driver
Highly frequent storage	Check the upper computer program to see whether frequent write operations are performed to the EEPROM of the driver	Correct the upper computer program, and use the RAM address for parameters requiring frequent write operations. The address direction can be adjusted through group P7.

$AL.005$: System parameter abnormal

Reason for alarm	Inspection	Handling method
Parameters set have conflicts	Check parameters set before the alarm 1: When a DO terminal is set to BK function, instantaneous outage holding function is enabled (by setting P8-18 bit1 as 1). 2: When homing method is selected as 31 or 32, the locked-rotor protection function (P8-15≠0) is not enabled for the motor. Or, though it's enabled, the parameters related to locked-rotor protection (P8-15≥Pb-04 or P8-14≥Pb-14) are set improperly.	Correct wrong parameters

$AL.006$: Zero drift anomaly

Reason for alarm	Inspection	Handling method
An abnormal value is detected by the output current detection circuit during power-on self-inspection.	1: Cut off the power and restart; check whether the alarm still occurs 2: In non-enabled state, set AF04 as 2 and perform zero drift self-learning.	Upon zero drift self-learning, check if the d0-67 combination of the units place and the tens place, or the hundred's place and the thousand's place, is greater than 50. If yes, return the product to the distributor or the manufacturer for repairing.

$AL.007$: Encoder abnormality 1

Reason for alarm	Inspection	Handling method
Encoder released	Check the CN5 and encoder connector of the driver	Reinstallation
Encoder wiring error	Check is the encoder is wired following the recommended route in the instructions	Correct wiring
Poor encoder wiring	Check whether the CN5 and encoder of the driver are properly connected and if the shielding layer is sound	Reconnect the wire
The encoder is damaged.	After the wiring problem is eliminated, this alarm still occurs	Replace the motor

$AL.008$: Encoder abnormality 2

Reason for alarm	Inspection	Handling method

Abnormal AB signal of an incremental encoder	Same as *RL.007*	Same as *RL.007*
CRC check error of an absolute type encoder		

RL.009: Encoder abnormality 3

Reason for alarm	Inspection	Handling method
Abnormal Z signal of an incremental encoder	Same as *RL.007*	Same as *RL.007*
Communication error of an absolute type encoder		

AL.00A: Undervoltage

Reason for alarm	Inspection	Handling method
Input voltage of the main circuit is lower than the permitted value	Check whether the input voltage and wiring of the main circuit are normal	Recheck the power wiring
No input voltage of the main circuit	Check whether the main circuit voltage is normal	Recheck the power switch
Power error	Check whether the power is consistent with the specification	Use a proper power source

AL.00b: Overvoltage

Reason for alarm	Inspection	Handling method
Input voltage of the main circuit exceeds the permitted value	Check whether the main circuit voltage falls within the permitted range	Use a proper power source
Power input error	Check whether the power is consistent with the specification	Use a proper power source
Too fast deceleration of the motor	Check if the system inertia is too high and if the deceleration is too fast	Prolong the deceleration time, or use an appropriate external braking resistor
The load inertia is high and no braking resistor is connected	Check whether overvoltage occurs upon stop	Install a braking resistor with proper capacity and resistance, and correctly set the braking resistor parameter
Driver hardware alarm	The main circuit voltage is within the permitted range according to measurement, but this alarm still occurs when the motor is not running	Send it to the distributor or manufacturer for repair

AL.00C : Software over-current

See **AL.002** for details

AL.00d / AL.00E: Motor overload/driver overload

Reason for alarm	Inspection	Handling method
Continuing use when the rated load is exceeded	1: Monitor whether d0-01 is constantly above 100% 2: Monitor whether d0-46 is constantly above the rated value 3: Monitor whether d0-47~49 constantly increase	1: Increase the motor capacity or reduce the load 2: Increase the driver capacity or reduce the load
The motor encoder is improperly wired	Check U, V, W and encoder wiring	Correct wiring
The motor power cable is cut off or has poor contact	1: Check whether the motor power line and the driver are reliably connected 2: Check whether the motor connector are reliably connected; particularly check the specification of plastic connectors if used	1: Tighten screws and eliminate poor contact, poor cable connection and other problems. 2: Fix connectors to prevent them shaking or getting stressed under external load. 3: Check reeds in connectors against deformation and make corrections.
Improper setting of control parameters	1: Check whether the machine oscillates and whether the motor produces abnormal noise 2: Acceleration/deceleration is set too fast	1: Adjust the position/speed gain 2: Slow down acceleration and deceleration
Driver or motor alarm	Eliminate the above problems	Send it to the distributor or manufacturer for repair

AL.0 10: Driver overheating

Reason for alarm	Inspection	Handling method
Excess environment temperature.	Check whether the ambient temperature falls within the permitted range	Improve the installation environment
The driver cooling fan is damaged	Check if the cooling fan runs during operation	Replace the non-operating fan
Heat dissipation of the servo driver is affected	1: Check whether the driver is installed in conformity to specified requirements 2: Check whether the radiator of the driver is blocked	1: Install the driver properly according to requirements provided in Chapter II 2: Clear blockage

AL.0 11: The auxiliary supply voltage is too low

Reason for alarm	Inspection	Handling method
The auxiliary power supply has continuous voltage drop over above 40ms and the drop reaches above 50%	1: Check whether the auxiliary power supply is properly wired 2: Check if there is sound power supply	Improve the power quality. Eliminate poor contact or other wiring abnormalities

AL.0 12: Over-speed

Reason for alarm	Inspection	Handling method
UVW phase sequence error	Check if the UVW phase sequence is correct	Wire the terminals according to the correct phase sequence

Improper setting of overspeed judgment parameter	Check whether the overspeed parameter is set too small	Set a proper overspeed reference value
The speed input command changes too sharp	Check whether the analog voltage signal is abnormal	Adjust the change rate of the input signal or adjust filtering
The encoder is disturbed	Check whether lines are properly laid and whether the system is grounded	Adjust the line layout and ground the system reliably

$RL.0$ 13 : The position deviation is too high

Reason for alarm	Inspection	Handling method
The value of alarm for a position following error is too small	Check whether parameter P1-20 is set properly	Increase the set value of P1-20
The pulse command frequency is higher than the requirement of the specification	Check the pulse command frequency	Adjust the pulse frequency to make it no higher than the requirement of the specification
The gain setting is too small	Check if the setting is appropriate	Properly set the gain value
The torque limit is too low	Check the torque limit value	Properly adjust the torque limit value
The load inertia is too high	Calculate the ratio of the load to the rotor inertia of the motor	Reduce the load inertia or reevaluate the motor capacity

$RL.0$ 14 : Input phase loss

Reason for alarm	Inspection	Handling method
Main circuit power abnormal	Check whether power lines L1, L2 and L3 are loose or there is only single-phase input	Make sure a normal three-phase power source is connected; if the abnormality persists, send the product to the distributor or manufacturer for repair
Drive parameter setting error	Set the single-phase power supply to three-phase power supply for the driver	Set the parameter correctly

`AL.0 15`: Motor phase sequence error

Reason for alarm	Inspection	Handling method
The motor rotates in a direction inconsistent with the set direction	Check whether U, V and W are properly wired	Ensure proper wiring; if the abnormality persists, send the product to the distributor or manufacturer for repair

`AL.0 16`: Parameter setting abnormal

Reason for alarm	Inspection	Handling method
Some parameters of the driver are abnormal	1: The driver Code set doesn't match corresponding model; 2: The driver Code set doesn't exist (beyond range)	Check d2-09~d2-10 and the driver nameplate and make records; contact the distributor or manufacturer

`AL.0 17`: Braking resistor overload

Reason for alarm	Inspection	Handling method
No braking resistor is connected or the braking resistor connected has a too small capacity	1: Check connection of the braking resistor 2: Calculate resistance of the braking resistor	1: Reconnect the external braking resistor 2: Use a suitable braking resistor
IGBT for braking fails	Check whether the IGBT for braking is damaged	Send it to the distributor or manufacturer for repair
The parameter is set incorrectly when an external braking resistor is connected	Check the settings of the braking resistor (P8-10) and the braking resistor power (P8-11)	Set the parameter correctly

`AL.0 18`: Encoder overheating

Reason for alarm	Inspection	Handling method
The absolute type encoder is overheated	Check whether the ambient temperature for motor operation is too high	Lower the ambient temperature or cool down the motor by forced air cooling

`AL.0 19`: Battery low alarm for the absolute type encoder

Reason for alarm	Inspection	Handling method
The battery voltage of the absolute type encoder is lower than 3.1V	Measure the battery voltage	Replace the battery (make sure the encoder and driver CN5 terminals are well connected and the battery is replaced when the driver is powered on. If the battery is replaced when the encoder is powered off, an `AL.0 1A` alarm will occur upon power-on again)

`AL.0 1A`: The battery voltage of the absolute type encoder is too low

Reason for alarm	Inspection	Handling method
The battery voltage of the absolute type encoder is lower than 2.5V. Multi-turn position information is lost	Measure the battery voltage	Replace the battery, manually clear the multi-turn alarm information through AF-16 after power-on, power the encoder on again
Fail to clear alarms after replacement of the battery		Clear the multi-turn alarm information through AF-16.

`AL.0 1b`: Driver and motor matching error

Reason for alarm	Inspection	Handling method
The motor CODE set doesn't exist. The driver and the motor do not match	1: Check whether the motor code in the driver is consistent with that on the motor nameplate 2: The rated current of the motor is greater than that of the driver. 3: Whether the type of the encoder match that of the driver. 4: Whether the motor CODE set is complete.	1: Correctly match the driver and the motor 2: Enter a correct motor code

`AL.0 1C`: Homing failure

Reason for alarm	Inspection	Handling method
Parameter Pb-00 is set too small	Check whether a proper value is set for Pb-00	Increase the value of Pb-00
The external detector or limit switch fails	Check the external detector, limit switch and wire	Troubleshooting

`AL.0 1d`: Main power failure

Reason for alarm	Inspection	Handling method
The main circuit power is cut off	Check whether the power supply logic is correct	Adjust the power supply logic, or maintain the current status when the main circuit power needs to be cut off

`AL.0 1F`: The system needs to be restarted

Reason for alarm	Inspection	Handling method
Some operations require restart of the driver to become valid	None	Cut off the driver power and power it on again

AL.027: UVW short-to-ground alarm

Reason for alarm	Inspection	Handling method
The motor U, V or W wire is shorted to the ground	Check the motor wire and connectors.	Make good of insulation
Internal wire insulation of the motor is damaged	Check insulation of the motor windings	Send it to the distributor or manufacturer for repair

`AL.028`: Load inertia identification fails

Reason for alarm	Inspection	Handling method
The load inertia is too high	Check whether the load inertia is too high	Manage to reduce the load inertia or replace with a motor with higher inertia
The mechanical connection between the load and the motor is abnormal	Check whether the load and the motor is properly connected	Eliminate mechanical problems
The number of revolutions for the motor is too small	Check whether revolutions of the motor is greater than the set value of P8-03	Properly increase the set value of the tens and hundreds places of P8-03
The set value of the tens and ones places of P8-03 is too small	Check whether the motor can rotate for more revolutions	Properly increase the set value of P8-02 Properly decrease the set value of the thousands and hundreds places of P8-03

`AL.032`: The electronic gear ratio range is set improperly

Reason for alarm	Inspection	Handling method
The electronic gear ratio is set improperly	Check whether relevant parameter of the electronic gear ratio is properly set	Adjust the parameter

`AL.033`: The input pulse frequency is too high

Reason for alarm	Inspection	Handling method
The input pulse frequency exceeds 1MHz	Whether the input pulse frequency is too high. Whether serious interference is present	Adjust the output of the master. Use conforming shielded twisted pairs to transmit pulse signals

`AL.034`: Analog zero-drift correction error

Reason for alarm	Inspection	Handling method
Upon self-learning of zero drift, above 2V external voltage is sampled	Check whether the master command is set to 0 during execution of zero drift self-learning. Check if the output voltage exceeds 2V when the master command is set to 0.	Set the master command to 0, and repeat zero drift self-learning. Correct the output of the master.

`AL.038`: The relay fails to fully close

Reason for alarm	Inspection	Handling method
The soft start relay of the servo main circuit fails to fully close	Check whether the alarm is cleared after power-on again	Send it to the distributor or manufacturer for repair

`AL.039`: The number of serial encoder lines is improperly set

Reason for alarm	Inspection	Handling method
An incorrect number of encoder lines is set by the customer	Check relevant parameters	Set it correctly. The number of lines is one fourth of the set number of encoder lines

`AL.040`: An error occurs upon writing to the encoder EEPROM

Reason for alarm	Inspection	Handling method
An error occurs when a parameter is written to the motor encoder	1: Check whether the communication protocol of the encoder conforms to the requirement. 2: Check whether the encoder cables are correct and properly connected.	Repeat the write operation

`AL.042`: A check error occurs upon reading the encoder EEPROM

Reason for alarm	Inspection	Handling method
The parameter check read from the motor encoder is incorrect, or such parameter has not been written to the encoder	1: Check whether the encoder cables are correct and properly connected.	Repeat the read operation; if it fails, use the motor CODE

`AL.045`: Excessive fully closed-loop position deviation

Reason for alarm	Inspection	Handling method
The absolute value of fully closed-loop position deviation is greater than PC-04 setting	1: Whether the threshold setting is too small for excessive fully closed-loop position deviation 2: If the connector is disengaged, or if other mechanisms are subject to connection issues 3: Whether the parameter of PC-01 is correct.	1: Increase the threshold of excessive fully closed-loop position deviation 2: Check if the connector is disengaged from the mechanisms 3: Select the correct movement direction

`AL.046`: Disconnection of fully closed-loop external encoder

Reason for alarm	Inspection	Handling method
Connector of external encoder is disengaged	Check the terminals of interface cards and connectors of the external encoder	Reinstallation
External encoder wiring error	Check if the external encoder is wired following the recommended route in the instructions	Correct wiring

Poor wiring of external encoder	Check if the wiring is proper for the terminals of interface cards and connectors of the external encoder, including integrity of the shielding layer.	Reconnect the wire
External encoder damage	After the wiring problem is eliminated, this alarm still occurs	Replace the external encoder

AL.02C: The temperature sensor of the servo driver is abnormal

Reason for alarm	Inspection	Handling method
Open-circuit or short-circuit occurs to the built-in temperature sensor of the servo driver	Check whether the alarm is cleared after power-on again	Send it to the distributor or manufacturer for repair

11.2 Warning diagnosis and handling measures

When the servo driver becomes subject to a warning, the digital manipulator will display "*ALE*" for warning. If a warning indicating that a system anomaly is detected occurs, but the motor will not stop operating, please identify the cause immediately and perform troubleshooting. Warning display and its handling measures are provided below:

ALE02: Driver overheat warning

Warning reason	Inspection	Handling method
Excess environment temperature.	Check whether the ambient temperature falls within the permitted range	Improve the cooling condition of the servo driver and lower the ambient temperature
The driver cooling fan is damaged	Check if the cooling fan of the driver runs during operation	Replace the non-operating fan
Installation direction of the servo driver or the air inlet/outlet of the cooling fan is blocked	1: Check whether the driver is installed in conformity to specified requirements 2: Check whether the radiator of the driver is blocked	1: Install the driver according to requirements provided in Chapter II 2: Clear blockage
The servo driver has some fault	Cut off the power and wait for some time before restart the device	If the alarm still remains, replace the servo driver

ALE03: Motor overload warning

Warning reason	Inspection	Handling method
Motor load has reached the threshold of motor overload warning set in P8-09.	1: Refer to *AL.00d* and *AL.00E* 2: Parameter P8-09 is set too small	1: Refer to *AL.00d* and *AL.00E* 2: Parameter P8-09 is set too small

ALE04: Driver overload warning

Warning reason	Inspection	Handling method
The driver load reaches the overload warning threshold set by P8-08	1: Refer to *AL.00d* and *AL.00E* 2: Parameter P8-08 is set too small	1: Refer to *AL.00d* and *AL.00E* 2: Properly increase the set value of P8-08

ALE05: Position deviation too high warning

Warning reason	Inspection	Handling method
The warning threshold for a position following error is too small	Check whether parameter P1-18 is set properly	Increase the set value of P1-18
The pulse command frequency is higher than the requirement of the specification	Check the pulse command frequency	Adjust the pulse frequency to make it no higher than the requirement of the specification
The gain setting is too small	Check if the setting is appropriate	Properly set the gain value
The torque limit is too low	Check the torque limit value	Properly adjust the torque limit value
The load inertia is too high	Calculate the ratio of the load to the rotor inertia of the motor	Reduce the load inertia or reevaluate the motor capacity

ALE06: Braking overload warning

Warning reason	Inspection	Handling method
No braking resistor is connected or the braking resistor connected has a too small capacity	1: Check connection of the braking resistor 2: Calculate resistance of the braking resistor	1: Reconnect the external braking resistor 2: Use a braking resistor with proper resistance
The load inertia is too high	Check whether the total load/rotor inertia ratio is proper	Reduce the load inertia or replace with a motor with higher inertia
Improper parameter setting	Check the settings of the braking resistor (P8-10) and the braking resistor power (P8-11)	Set the P8-10 and P8-11 parameters correctly
	Check whether the braking resistor derating percentage (P8-13) is proper	When an external braking resistor is used, if the power is high enough, increase the set value of P8-13
	Check whether the deceleration time is too short	Increase the deceleration time.

-Pot-: Forward overrun warning

Warning reason	Inspection	Handling method
The P-OT terminal is active, and the command is forward	Check the position of the forward limit switch	1: Release the forward limit switch 2: Give a reverse command
Run beyond the forward limit position	Check the current position of motor and value of P1-26	Correct the command and the P1-26 set value Set P1-26 to the maximum value, and turn off its function
The absolute value system runs forward to exceed the allowed number of revolutions and the command is in the forward	Check whether a proper value is set for P8-05	Adjust the value set for P8-05. Give a reverse command.

direction		
The servo system has insufficient stability	Check the set control parameter and the load inertia	Re-correct the control parameter or reevaluate the motor capacity

─not─: Reverse overrun warning

Warning reason	Inspection	Handling method
The N-OT terminal is active, and the command is in the reverse direction	Check the status of the reverse limit switch	Reverse limit switch 2: Give a forward command
Run beyond the reverse limit position	Check the current position of motor and value of P1-28	1: Correct the command and the P1-28 set value 2: Set P1-28 to the maximum value, and turn off its function
The absolute value system runs reversely to exceed the allowed number of revolutions and the command is in the reverse direction	Check whether a proper value is set for P8-05	1: Adjust the value set for P8-05 2: Give a forward command
The servo system has insufficient stability	Check the set control parameter and the load inertia	Re-correct the control parameter or reevaluate the motor capacity

AL.E09: Warning for excessive times of writing a parameter to EEPROM via communication (the parameter can be normally written after occurrence of the arming)

Warning reason	Inspection	Handling method
After power-on, the upper computer/PLC/touch screen parameter has been modified for too many times	Check whether the parameter requiring real-time modification uses corresponding RAM address	For real-time change of the parameter address to corresponding RAM address (without presence of EEPROM), see 10.5.3 for details.

AL.E0A: Request for power-on again

Warning reason	Inspection	Handling method
The parameter of power-on again is changed	-	When the parameter setting is completed, power on the device again

AL.E0b: No braking resistor is connected (supported by SIZE B and C models)

Warning reason	Inspection	Handling method
No braking resistor is connected	1: Check whether the short-circuit piece of the built-in braking resistor is connected (P+ and D) 2: When an external braking resistor is used, check whether lines are well connected 3: Test the braking resistor in the power failure status	Upon wiring, power on the device again. Replace the braking resistor

Chapter 12 Rated values and specifications

12.1 Rated value of AC220V driver

Model EA350-		0R9-1B	1R6-1B	2R5-1B	4R8-2B	6R2-2B	011-2B
Adaptive motor encoder		17/23-bit serial encoder, conforming to the RA-CODER format					
Adaptive motor power (kW)		0.05	0.1/0.2	0.4	0.75	1.0	1.5
Maximum allowable motor power (kW)*		0.05	0.2	0.4	0.8	1.2	2.0
Rated output current (Arms)		0.9	1.6	2.5	4.8	6.2	11.0
Maximum instantaneous output current (Arms)		3.2	4.8	7.5	14.4	18.6	27.5
Power supply	Main power	Single-phase AC220V, -15% ~ +10%, 50/60Hz					-
		-			Three-phase AC220V, -15% ~ +10%, 50/60Hz		
	Control power	Single-phase AC220V, -15% ~ +10%, 50/60Hz					
Braking resistor	Built-in braking resistor	-	-	-	50Ω/100W	50Ω/100W	50Ω/100W
	Minimum allowable external resistance	50Ω	50Ω	50Ω	40Ω	40Ω	35Ω

*: The maximum allowable power of the AC permanent magnet synchronous servo motor. In the meanwhile, the rated current of the motor should not exceed the rated output current of the driver.

12.2 Rated value of AC380V driver

Model EA350-		5R6-3B	8R5-3B	013-3B	017-3B	022-3B	028-3B	038-3B	052-3B	062-3B
Adaptive motor encoder		17/23-bit serial encoder, conforming to the RA-CODER format								
Adaptive motor power (kW)		1.5	2.0	3.0	4.4	5.5	7.5	18.0	22.0	30.0
Maximum allowable motor power (kW)*		1.8	2.4	3.9	5.2	7.5	13.5	20.0	24.0	32.0
Rated output current (Arms)		5.6	8.5	13.0	17.0	22.0	28.0	38.0	52.0	62.0
Maximum instantaneous output current (Arms)		16.8	25.5	32.0	45.9	55.0	70.0	95.0	130.0	145
Power supply	Main power	Three-phase AC380V, -15%~+10%, 50/60Hz								
	Control power	Single-phase AC380V, -15%~+10%, 50/60Hz								
Braking resistor	Built-in braking resistor	50Ω/100W	50Ω/100W	50Ω/100W	-	-	-	-	-	-
	Minimum allowable external resistance	50Ω	40Ω	40Ω	30Ω	30Ω	25Ω	10Ω	10Ω	10Ω

*: The maximum allowable power of the AC permanent magnet synchronous servo motor. In the meanwhile, the rated current of the motor should not exceed the rated output current of the driver.

Caution☞ A driver with AC380V input can, when the following conditions are satisfied, drive a 220V AC permanent-magnet servo motor
1: The motor power cannot exceed the maximum allowable motor power.
2: The rated current of the motor cannot exceed the rated output current of the driver.
3: The voltage resistance of the motor windings reaches AC1500V or above.
4: Correctly set the rated voltage of the motor on the driver to 220V.

12.3 EA350 servo driver specification

Operating conditions	Temperature	Working temperature 0~40°, storage temperature -20°~85°		
	Humidity	Working/storage: ≤ 90%RH (without dew condensation)		
	Altitude	≤ 1,000m		
	Vibration	≤4.9m/s^2, 10~60Hz (no operation at the point of resonance is permitted)		
Cooling method		Fan cooling		
Control method		SVPWM, vector control		
Six control modes		Speed control, position control, torque control, speed/position control, torque/speed control, position/torque control		
Front panel		5 keys, 5-digit LED		
Regenerative brake		Built-in brake unit (a built-in brake resistor is provided in partial specifications), which can have an external resistor connected		
Feedback mode		RS485 serial communication encoder, RA-CODER or FA-FORMAT protocol (non-standard version of FA-FORMAT is supported)		
Digital input/output	Input	Servo start, alarm resetting, position pulse deviation counter clearing, speed command direction selection, position/speed multi-segment switching, internal command trigger, control mode switching, pulse disable, forward drive disable, reverse drive disable, forward jog, backward jog		
	Output	Servo ready, brake output, motor rotation output, zero-speed signal, speed approach, speed reached, position approach, torque limit, rotating speed limit, warning output, alarm output.		
Protective Function	Hardware	Over-voltage, under-voltage, over-speed, overheat, overload, over-speed, encoder alarm, and so on.		
	Software	Excessively large position error, EEPROM fault, and so on.		
Alarm data tracking function		Record 4 groups of historical alarms and relevant data		
Communication function		Modbus RTU		
Encoder signal output	Signal type	A, B, Z differential outputs, Z signal open-collector output; Z signal width can be set		
	Resolution	Any frequency division can be programmed and output before or after frequency quadruplication		
Position control mode	Maximum input pulse frequency	Differential input mode: 500Kpps Open-collector input mode: 200Kpps		
	Pulse command mode	Pulse + symbol, A and B-phase orthogonal pulse, CW/CCW		
	Command control mode	External pulse command, multi-segment position command		
	Command smoothing mode	Low-pass filtering, FIR filter, trapezoid-shaped smoothing of multi-segment position command		
	Electronic gear ratio	Electronic gear ratio: N/M multiples (0.001<N/M<64000= N: 1~2^{30}, M: 1~2^{30}		
	Position accuracy	±1 pulse command		
Speed control mode	Command control mode	External analog quantity command, digital speed command, multistage speed command, inching command		
	Command smoothing mode	Low-pass filtering, smooth S curve		
	Analog command input	Voltage range	-10V~ 10V	
		Input impedance	10KΩ	
		Time constant	200μs	
	Torque limit	Digital setting or external analog quantity limit		
	Speed regulation ratio	1:5000 (23-bit encoder)		Minimal speed/rated rotating speed of continuous stable operation under the rated load
	Bandwidth	1,300Hz (23-bit encoder) -3dB		
	Speed fluctuation ratio	Load fluctuation (0 ~100%)	Maximum 0.1%	For a 23-bit encoder, when the speed command is the rated rotating speed, (rotating speed without load - rotating speed with full load)/rated rotating speed.
		Supply voltage change ±10%	Maximum 0.1%	
		Ambient temperature (0~ 50℃)	Maximum 0.1%	
Torque	Command	External analog command, digital torque command		

control mode	control mode		
	Command smoothing mode	Low-pass filtering	
	Analog command input	Voltage range	-10V~ 10V
		Input impedance	10KΩ
		Time constant	200μs
	Speed limit	Digital setting or external analog quantity limit	
	Accuracy	±1% (current repetition accuracy)	

12.4 EA350 servo driver size

SIZE A: Overall dimensions of EA350-0R9-1B EA350-1R6-1B EA350-2R5-1B

Installation hole making diagram
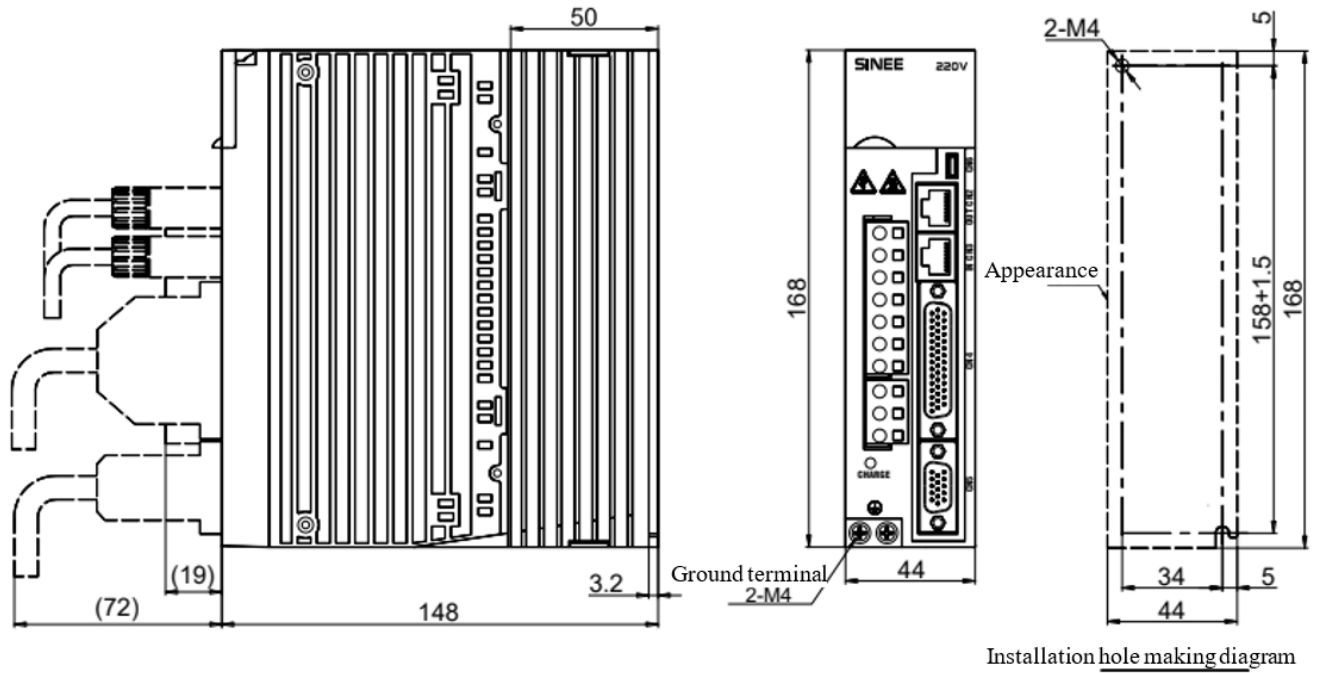
SIZE B: Overall dimensions of EA350-4R8-2B EA350-6R2-2B

Installation hole making diagram
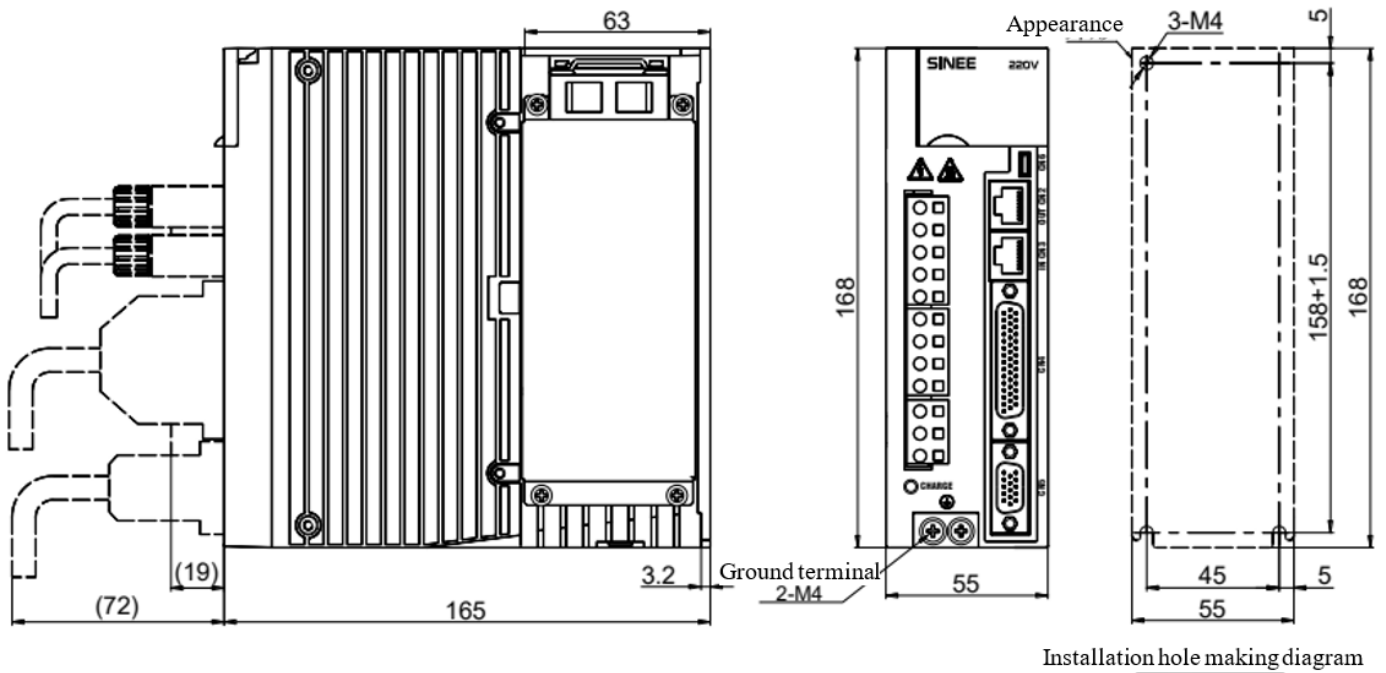
SIZE C: Overall dimensions of EA350-5R6-3B EA350-8R5-3B EA350-013-3B EA350-011-2B
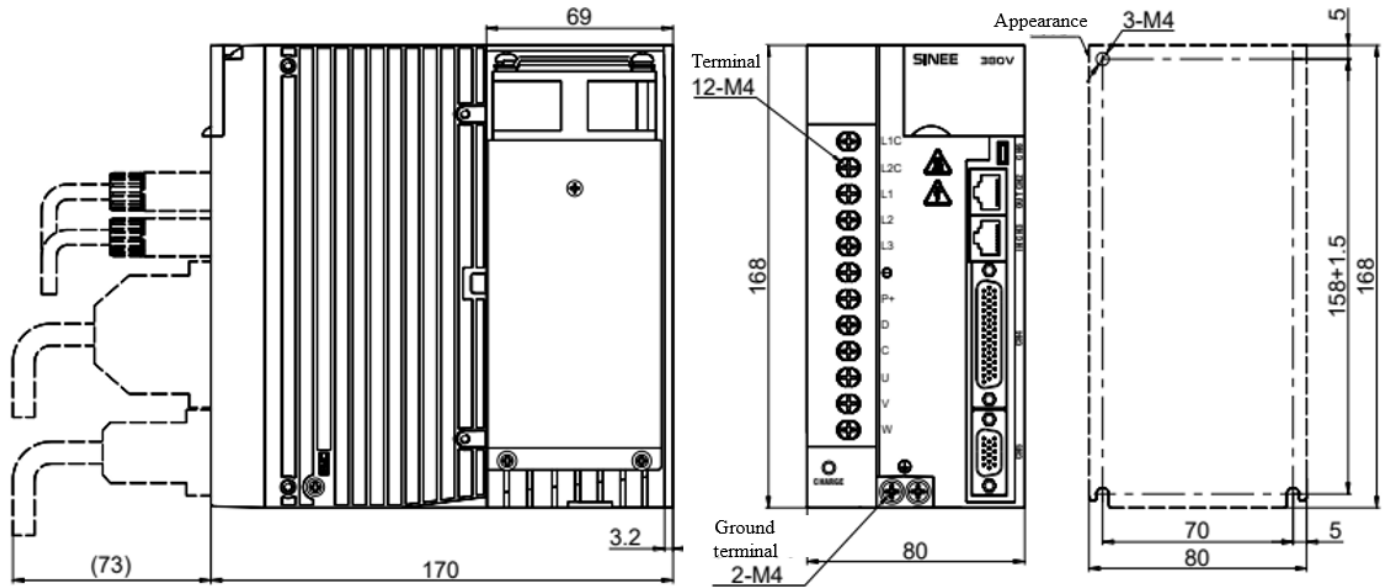
Installation hole making diagram

SIZE D: Overall dimensions of EA350-017-3B EA350-022-3B EA350-028-3B
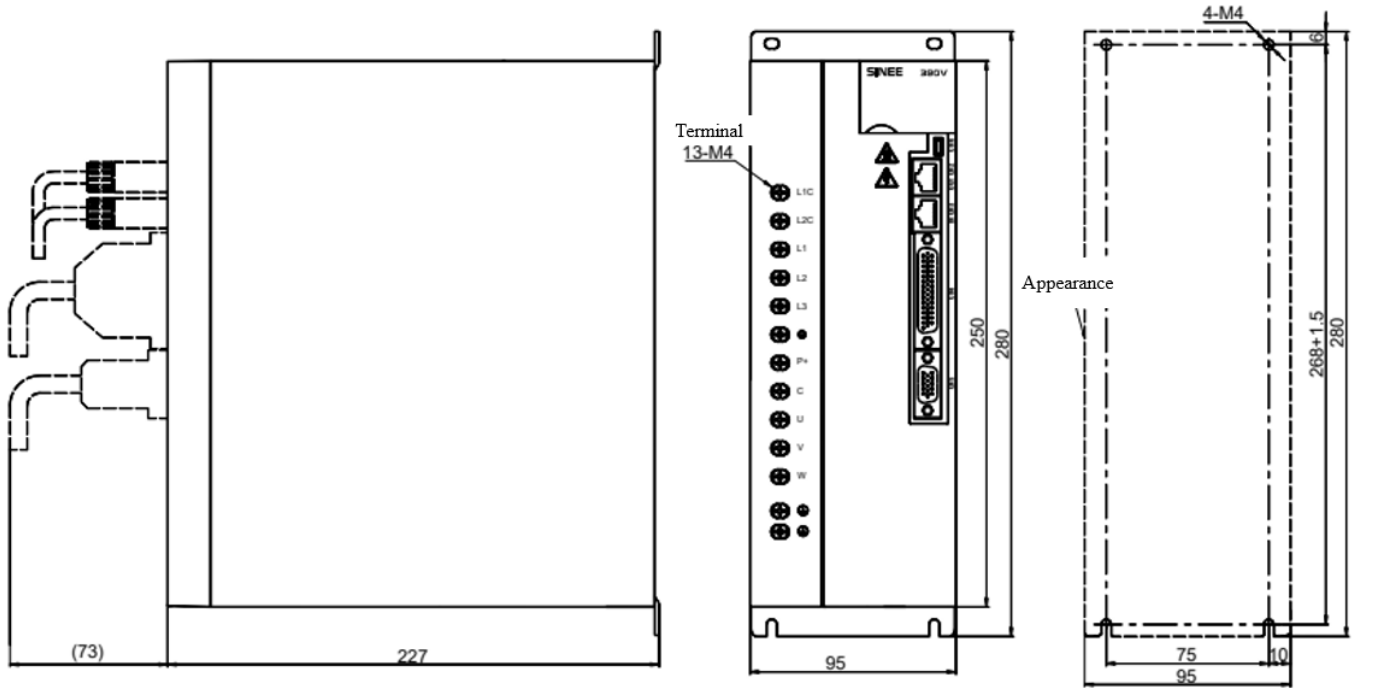
Installation hole making diagram

SIZE E: Overall dimensions of EA350-038-3B EA350-052-3B EA350-062-3B

Installation hole making diagram   Hole-making diagram for through-wall mounting

Note: Accessories should be purchased separately for through-wall installation. The customer can also fabricate such accessories by themselves.

12.5 Servo motor specification

SER 08 - 0R7 - 30 - 2 F A Y 1 -XX
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

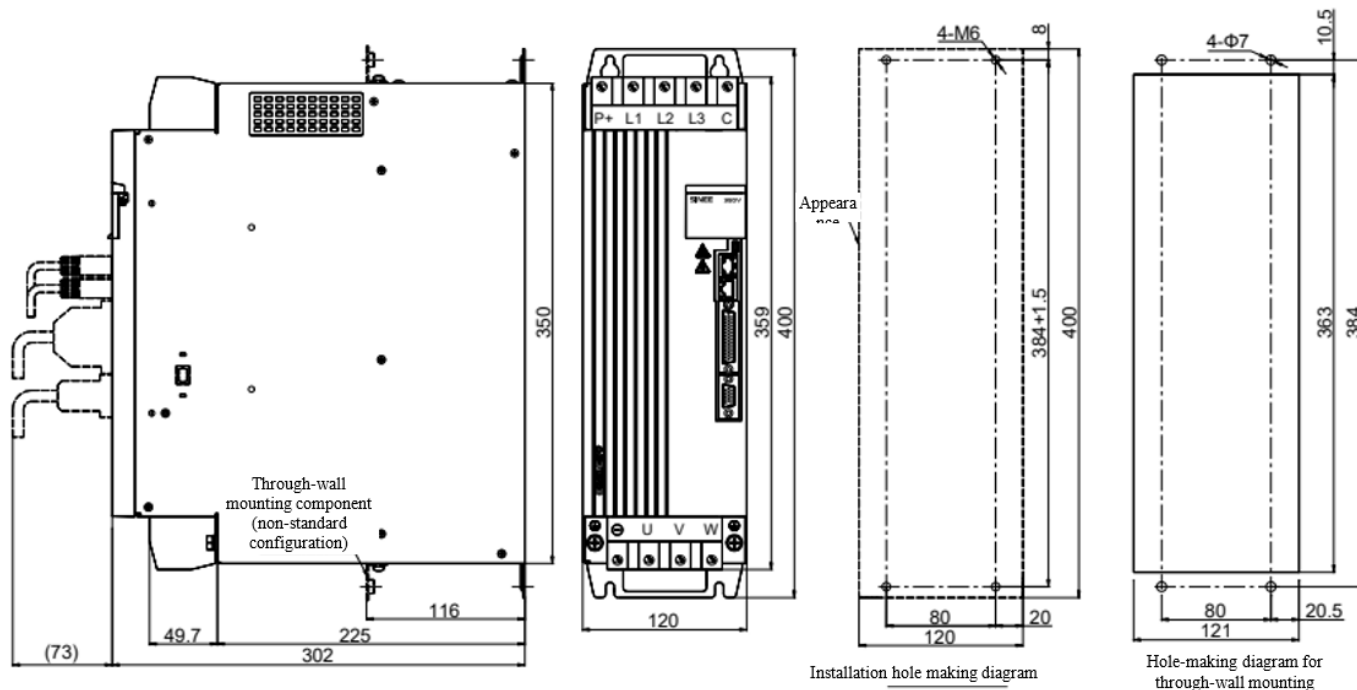| 1st place	Series	2nd place	Motor flange size	3rd place	Rated output power of motor
SER: Standard servo motor SES: High-performance servo motor SEC: Large-power servo motor		04: 40mm 06: 60mm 08: 80mm 09: 86mm 11: 110mm 13: 130mm 18: 180mm 20: 200mm 23: 230mm		005: 50W 0R1: 100W 0R2: 200W 4R4: 4400W 5R5: 5500W 7R5: 7500W 011: 11kW 029: 29kW	
4th place	Rated speed				
10: 1000rpm 15: 1500rpm 20: 2000rpm 25: 2500rpm 30: 3000rpm		7th place	Inertia type	9th place	Optional
		A: Low inertia B: Medium inertia C: High inertia		Null: No optional accessory 1: With holding brake (DC24V) 2: With oil seal 3: With holding brake and oil seal 4: With fans 5: With holding brake and fans	
5th place	Voltage class				
2: 220V 3: 380V		8th place	Shaft end		
6th place	Encoder type	X: Optical axis, without key slot *[1] Y: With U-shaped key slot and screw hole *[2] Z: With double-circular key slot and screw hole			
B: 17-bit incremental encoder F: 23-bit absolute type encoder				10th place	Special specifications

*1: It is not recommended to choose any non-standard variety.

*2: For a 130 flange motor, Y is a 8mm-wide open key, Z is a 6mm-wide double round or open key.

Elements of the 10 servo motor models are not subject to causal combination. For details, refer to the selection guide or consult us.

12.5.1 Common features of servo motors:

Motor insulation level	F Class
Withstand voltage of insulation	1500V 60s
Insulation resistance	DC500V, above 10MΩ
Thermal resistance level of the motor	B
Protection level	Fully-closed self cooling type, IP65 (except for the shaft running-through part)
Service environment	Ambient temperature 0-40°, RH 20%~80% (without dew condensation)
Installation method	Flange installation
Rotation direction	Rotate counterclockwise (CCW) under a forward command if viewed from the load side

12.5.2 Holding brake specification:

Motor flange size	Rated torque of motor	Rated voltage	Static friction torque	Rated power	Closing voltage	Release voltage	Set the closing action time	Set the release action time
mm	Nm	VDC	Nm	W	VDC	VDC	ms	ms
40	0.32≤		0.35	3.5			63	55
60	0.64~1.27		2	6.3				
80	1.3~3.5		4	10.4			87	72
86	3.2~3.5		4	10.4				
110	2~6	24	10	11.6	22	1.5		
130	3.2~15		20	19.5			110	95
180	17~35		44	25			140	120
180	≥36		74	45			152	130
200	35~95.5		120	95			165	140
230	70~184		200	120			230	180

1: The holding brake is used to keep the motor locked after stop, and cannot be used for braking.
2: A 24V power source shall be provided by the user for the holding brake, and it is prohibited to connect the holding brake to the 24V power in the servo driver. The 24V power source shall have a capacity that is at least 1.5 times the rated power of the holding brake (excluding capacity of any 24V power source for other devices).
3: The action time of the holding brake may differ for different circuits. The time provided above is only for reference, and the actual time depends on the physical product.
4: Static friction torque refers to the static friction torque provided by the brake when the motor is static; if there is external impact, keeping the motor static cannot be assured.

12.5.4 Parameter table of SES series servo motor:

Servo motor model	Voltage class (V)	Rated power (W)	Rated rotating speed, rpm	Maximum rotating speed, rpm	Rated current A	Maximum instantaneous current, A	Rated torque Nm	Maximum instantaneous torque, Nm	Torque constant Nm/A	Rotating inertia, Kg.cm^2*10^{-4}	Adaptable driver EA350-
SES04-005-30-2□AY□		50	3000	6000	0.6	1.8	0.16	0.48	0.26	0.02(0.02)	0R9-1□
SES04-0R1-30-2□AY□		100	3000	6000	1.1	3.3	0.32	0.96	0.29	0.04(0.04)	1R6-1□
SES06-0R2-30-2□BY□		200	3000	6000	1.6	4.8	0.64	1.92	0.44	0.29(0.34)	1R6-1□
SES06-0R4-30-2□BY□	AC 220	400	3000	6000	2.3	6.9	1.27	3.81	0.59	0.56(0.61)	2R5-1□
SES08-0R7-30-2□BY□		750	3000	5000	4.0	12	2.4	7.2	0.653	1.56(1.66)	4R8-2□
SES08-1R0-30-2□BY□		1000	3000	5000	6.0	18	3.2	9.6	0.538	2.03(2.13)	6R2-2□
SES13-0R8-15-2FBY□		850	1500	3000	6.9	17	5.39	13.8	1.72	13.95(16.1)	011-2B
SES13-0R8-15-3FBY□		850	1500	3000	3.5	8.5	5.39	13.8	1.72	13.95(16.1)	5R6-3B
SES13-1R3-15-3FBY□		1300			5.4	14	8.34	23.3	1.78	19.95(22.1)	5R6-3B
SES13-1R8-15-3FBY□		1800			8.4	20	11.5	28.7	1.5	26.1(28.1)	8R5-3B
SES18-2R9-15-3FBY□	AC 380	2900	1500	3000	11.9	28	18.6	45.1	1.7	46.0 (53.9)	013-3B
SES18-4R4-15-3FBY□		4400			16.5	40.5	28.4	71.1	1.93	67.5 (75.4)	017-3B
SES18-5R5-15-3FBY□		5500			20.8	52	35	87.6	1.8	89.0(96.9)	022-3B
SES18-7R5-15-3FBY□		7500			25.7	65	48	119	1.92	125.0(133)	028-3B
SES18-3R6-20-3FBY□		3600	2000	2500	9.5	28.5	16.7	50.16	2.1	46.0(53.9)	013-3B

Note: 1: Value in () is the value in case a brake is provided;

2: When an oil seal is provided, it shall be derated by 10% for use

3: Rated torque refers to the continuous permitted torque upon installation on an aluminum heat sink of the following dimension and at the ambient temperature 40°C.

Motors with flanges 40, 60 and 80: 250*250*6mm   Motors with flanges 90 and 110: 300*300*10mm

Motor with flange 130: 400*400*15mm   Motor with flange 180: 550*550*20mm

12.5.5 Parameter table of SER series servo motor:

Servo motor model	Voltage class (V)	Rated power (W)	Rated rotating speed, rpm	Maximum rotating speed, rpm	Rated current A	Maximum instantaneous current, A	Rated torque Nm	Maximum instantaneous torque, Nm	Torque constant Nm/A	Rotating inertia, Kg.cm^2*10^{-4}	Adaptable driver EA350-
SER06-0R2-30-2□AY□	AC 220	200	3000	5500	1.2	3.6	0.64	1.92	0.53	0.18(0.18)	1R6-1□
SER06-0R4-30-2□AY□		400	3000	4500	2.3	6.9	1.27	3.81	0.55	0.3(0.3)	2R5-1□
SER08-0R7-30-2□AY□		750	3000	4500	4.3	12.9	2.4	7.20	0.56	1.01(1.02)	4R8-2□
SER08-0R7-20-2□AY□			2000	3000	3.0	9.0	3.5	10.50	1.17	1.59(1.6)	
SER08-1R0-30-2□AY□		1000	3000	4000	4.0	12.0	3.2	10.50	0.88	1.59(1.6)	
SER09-0R7-30-2□BZ□		750	3000	4000	3.4	10.2	2.4	7.20	0.71	2.42(2.43)	
SER11-0R6-30-2□BY□		600	3000	4000	2.5	7.5	2.0	6.00	0.8	3.03(3.05)	2R5-1□
SER11-1R0-20-2□BY□		1000	2000	2500	5.0	15.0	5.0	15.00	1.0	7.22(7.24)	6R2-2□
SER11-1R2-30-2□BY□		1200	3000	3500	4.9	14.7	4.0	12.00	0.82	5.54(5.56)	
SER11-1R8-30-2□BY□		1800	3000	3500	6.6	19.8	6.0	18.00	0.91	8.55(8.57)	011-2□
SER13-0R7-20-2□BY□		750	2000	2500	3.88	11.6	3.65	10.95	0.94	6.17(6.19)	4R8-2□
SER13-1R0-10-2□BY□		1000	1000	1500	4.72	14.2	9.55	28.65	2.02	17.14(17.16)	6R2-2□
SER13-1R0-20-2□BY□			2000	2500	4.72	14.2	4.77	14.31	1.01	8.71(8.73)	
SER13-1R0-30-2□BY□			3000	3500	4.96	14.9	3.27	9.81	0.66	6.17(6.19)	
SER13-1R5-10-3□BY□	AC 380	1500	1000	1500	5.4	13.5	14.32	35.80	2.65	25.58(25.6)	5R6-3□
SER13-1R5-20-3□BY□			2000	2500	4.1	10.3	7.16	17.90	1.75	12.08(12.1)	
SER13-1R5-30-3□BY□			3000	3500	4.2	10.5	4.78	11.95	1.14	8.71(8.73)	
SER13-2R0-20-3□BY□		2000	2000	2500	6.5	16.3	9.55	23.88	1.47	17.14(17.16)	8R5-3□
SER13-2R0-30-3□BY□			3000	3500	5.8	14.5	6.5	16.25	1.12	12.08(12.1)	
SER13-3R0-20-3□BY□		3000	2000	2500	9.6	24.0	14.32	35.80	1.49	25.58(25.6)	013-3□
SER13-3R0-30-3□BY□			3000	3500	8.3	20.8	9.55	23.88	1.15	17.14(17.16)	

Note 1: Value in () is the value in case a brake is provided;

2: When an oil seal is provided, it shall be derated by 10% for use

3: Rated torque refers to the continuous permitted torque on an aluminum heat sink of the following dimension and at the ambient temperature 40°C.

Motors with flanges 40, 60 and 80: 250*250*6mm   Motors with flanges 90 and 110: 300*300*10mm   Motor with flange 130: 400*400*15mm

12.5.6 Parameter table of SEC series servo motor:

| Servo motor model	Voltage class (V)	Rated power kW	Rated rotating speed, rpm	Maximum rotating speed, rpm	Rated current A	Maximum instantaneous current, A	Rated torque Nm	Maximum instantaneous torque, Nm	Torque constant Nm/A	Rotating inertia, Kg.cm^2*10^{-4}	Adaptable driver EA350-
SEC20-011-20-3FBY□		11.1	2000	2300	22	44	53	106	2.4	72(74)	028-3B
SEC20-015-20-3FBY□		14.7			28	56	70	140	2.5	97.7(99.8)	028-3B
SEC20-011-15-3FBY□		11.0	1500	1800	21	42	70	140	3.3	97.7(99.8)	028-3B
SEC20-013-15-3FBY□		13.2			23	46	84	168	3.6	114(116)	028-3B
SEC20-015-15-3FBY□	AC 380	15.0			27	54	95.5	191	3.52	130.8(133)	028-3B
SEC23-011-15-3FBY□		11.0			22	55	70	175	3.2	260(262.2)	028-3B
SEC23-015-15-3FBY□		15.0			36	90	95.5	239	2.7	380(382.2)	038-3B
SEC23-018-15-3FBY□		18.5			43	99	118	271	2.7	380(382.2)	052-3B
SEC23-022-15-3FBY□		22.0			52	120	140	322	2.7	500(502.5)	052-3B
SEC23-029-15-3FBY□		29.0			61	134	185	407	3.0	620(622.5)	062-3B

Note 1: Value in () is the value in case a brake is provided;

2: When an oil seal is provided, it shall be derated by 10% for use;

3: These motors come with a cooling fan that is powered by AC380V three phase. Always make sure the draft of the fan heads to the output shaft end during installation. If not, please exchange the R and S phases of fan power.

12.6 Servo motor size

12.6.1 Dimensions of SES series servo motors with flanges 40, 60 and 80
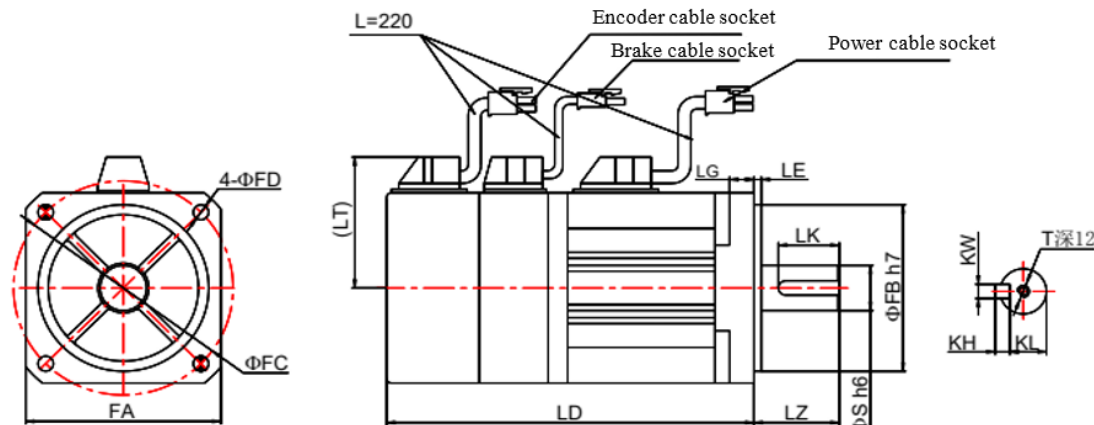
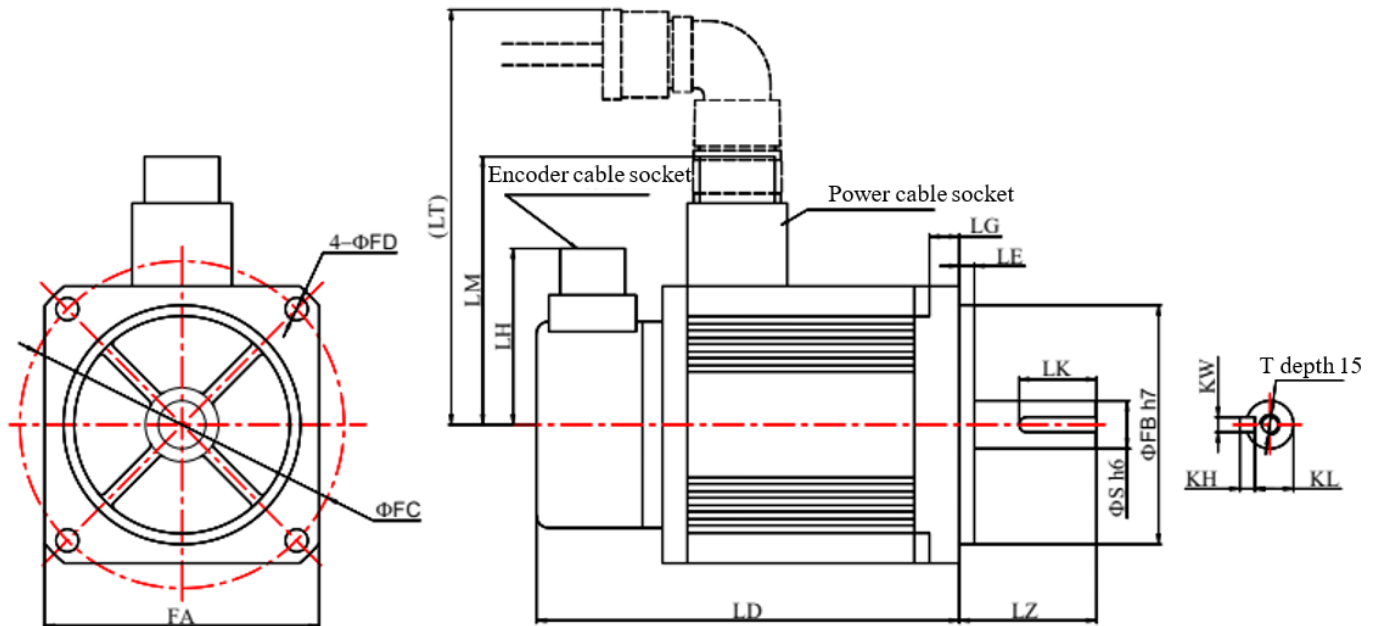| Motor specification/ model	LD (mm)	FA (mm)	FB (mm)	FC (mm)	FD (mm)	LZ (mm)	LK (mm)	LE (mm)	LG (mm)	LT (mm)	S (mm)	KL (mm)	KH (mm)	KW (mm)	T (mm)	Quality (kg)
SES04-005-30- 2□AY□	86.5 (119.5)	40	30	46	4.5	25.5	14	3	8	37	8	6.3	3	3	M3	0.4 (0.6)
SES04-0R1-30- 2□AY□	100.5 (133.5)	40	30	46	4.5	25.5	14	3	8	37	8	6.3	3	3	M3	0.47 (0.67)
SES06-0R2-30- 2□BY□	93.7 (120.2)	60	50	70	4.5	30	20	3	8	48	14	11	5	5	M5	1.01 (1.40)
SES06-0R4-30- 2□BY□	110.7 (137.2)	60	50	70	4.5	30	25	3	8	48	14	11	5	5	M5	1.37 (1.78)
SES08-0R7-30- 2□BY□	122.4 (150.6)	80	70	90	6.3	35	25	3	10	58	19	15.5	6	6	M5	2.4 (2.8)
SES08-1R0-30- 2□BY□	136.4 (164.6)	80	70	90	6.3	35	25	3	10	58	19	15.5	6	6	M5	3.0 (3.4)

Note: An SES04 motor has two installation holes at the two shadowed locations as shown in the figure.

12.6.2 Dimensions of SER series servo motors with flanges 60, 80 and 86
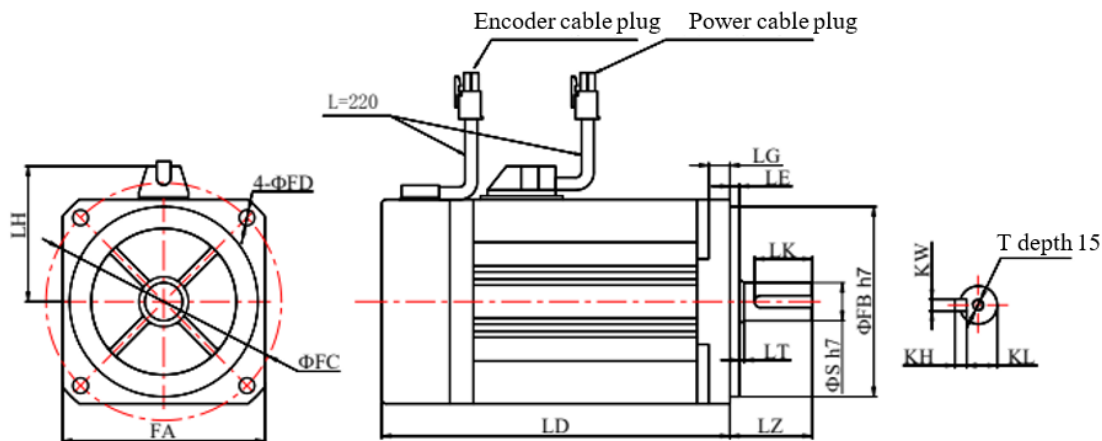
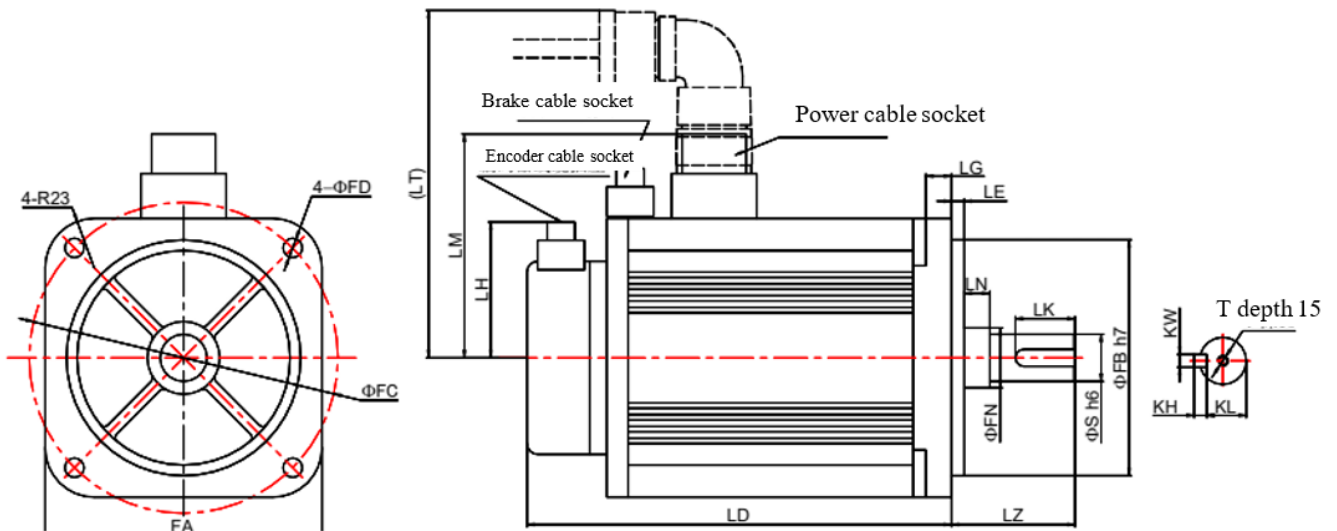| Motor specification/model	LD (mm)	FA (mm)	FB (mm)	FC (mm)	FD (mm)	LZ (mm)	LK (mm)	LE (mm)	LG (mm)	LH (mm)	S (mm)	KL (mm)	KH (mm)	KW (mm)	T (mm)	Quality (kg)
SER06-0R2-30-2□AY□	113.5 (147)	60	50	70	5.5	30	22.5	3	8	44	14	11	5	5	M5	1.01 (1.40)
SER06-0R4-30-2□AY□	134 (168)	60	50	70	5.5	30	22.5	3	8	44	14	11	5	5	M5	1.37 (1.78)
SER08-0R7-30-2□AY□	141.5 (173)	80	70	90	6.5	35	25	3	8	55	19	15.5	6	6	M5	2.47 (3.33)
SER08-0R7-20-2□AY□□	171.5 (203)	80	70	90	6.5	35	25	3	8	55	19	15.5	6	6	M5	3.40 (4.10)
SER08-1R0-30-2□AY□	171.5 (203)	80	70	90	6.5	35	25	3	8	55	19	15.5	6	6	M5	3.40 (4.10)
SER09-0R7-30-2□BY□	148 (183)	86	80	100	6.5	35	25	3	9	58	16	13	5	5	M5	3.24 (3.94)

12.6.3 Dimensions of SER series servo motors with flanges 110 and 130

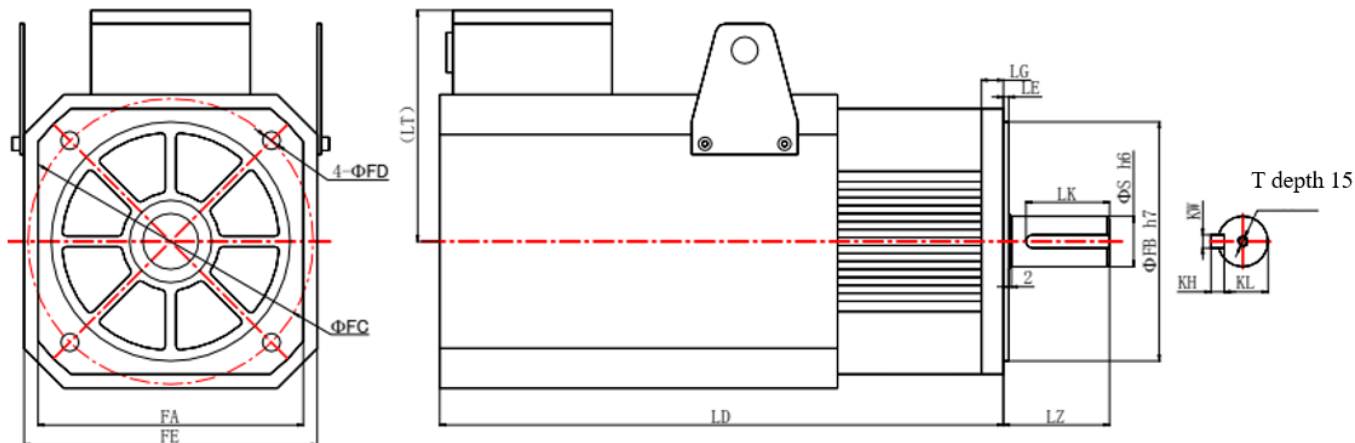| Motor specification/model	LD (mm)	FA (mm)	FB (mm)	FC (mm)	FD (mm)	LZ (mm)	LK (mm)	LE (mm)	LG (mm)	LH (mm)	LM (mm)	LT (mm)	S	KL	KH	KW	T	Quality (kg)
SER11-0R6-30-2□BY□	155.5 (210.5)	110	95	130	9	55	31	6	9	-	107	176	19	15.5	6	6	M6	3.93 (5.39)
SER11-1R0-20-2□BY□	205.5 (260.5)	110	95	130	9	55	31	6	9	-	107	176	19	15.5	6	6	M6	6.42 (7.88)
SER11-1R2-30-2□BY□	185.5 (240.5)	110	95	130	9	55	31	6	9	-	107	176	19	15.5	6	6	M6	5.46 (6.92)
SER11-1R8-30-2□BY□	218.5 (273.5)	110	95	130	9	55	31	6	9	-	107	176	19	15.5	6	6	M6	7.26 (8.72)
SER13-0R7-20-2□CY□	150 (205)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	5.20 (6.90)
SER13-1R0-10-2□BY□	215 (270)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	10.12 (11.67)
SER13-1R0-20-2□BY□	165 (220)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	6.41 (7.94)
SER13-1R0-30-2□BY□	150 (205)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	5.31 (6.89)
SER13-1R5-10-□□BYO	265 (320)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	13.82 (15.40)
SER13-1R5-20-□□BYO	185 (240)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	7.89 (9.43)
SER13-1R5-30-□□BYO	165 (220)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	6.40 (7.96)
SER13-2R0-20-3□BY□	215 (270)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	10.12 (11.67)
SER13-2R0-30-3□BY□	185 (240)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	7.85 (9.47)
SER13-3R0-20-3□BY□	265 (320)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	13.81 (15.34)
SER13-3R0-30-3□BY□	215 (270)	130	110	145	9	58	45	6	12	-	117	186	22	18	7	8	M6	10.12 (11.67)

12.6.4 Dimensions of SES series servo motors with flanges 130 and 180

Motor specification/ model	LD (mm)	FA (mm)	FB (mm)	FC (mm)	FD (mm)	LZ (mm)	LK (mm)	LE (mm)	LG (mm)	LH (mm)	LM (mm)	LT (mm)	LN (mm)	FN (mm)	S (mm)	KL (mm)	KH (mm)	KW (mm)	T (mm)	Quality (kg)
SES13-0R8-15-3FBY□	150.9 (183.4)	130	110	145	9	58	27.5	6	12	63.3	105	230	12	28	19	16	5	5	M5	5.83 (17.8)
SES13-1R3-15-3FBY□	166.9 (199.4)	130	110	145	9	58	28	6	12	63.3	105	230	12	28	22	18.5	6	6	M5	7.25 (9.3)
SES13-1R8-15-3FBY□	184.9 (217.4)	130	110	145	9	58	29	6	12	63.3	105	230	12	28	24	20	8	8	M5	8.8 (10.8)
SES18-2R9-15-3FBY□	173.3 (231)	180	114.3	200	13.5	79	65	3.2	18	63.3	135.5	230	0	35	35	30	8	10	M12	13 (19.5)
SES18-3R6-20-3FBY□	173.3 (231)	180	114.3	200	13.5	79	65	3.2	18	63.3	135.5	230	0	35	35	30	8	10	M12	17.5 (24)
SES18-4R4-15-3FBY□	197.3 (255)	180	114.3	200	13.5	79	65	3.2	18	63.3	135.5	230	0	35	35	30	8	10	M12	17.5 (24)
SES18-5R5-15-3FBY□	236.3 (278)	180	114.3	200	13.5	113	96	3.2	18	114.3	145.5	230	0	42	42	37	10	12	M16	22 (27.8)
SES18-7R5-15-3FBY□	282.3 (324)	180	114.3	200	13.5	113	96	3.2	18	114.3	145.5	230	0	42	42	37	10	12	M16	29.5 (35)

12.6.5 Dimensions of SEC series servo motors with flanges 200 and 230

Motor specification/model	LD (mm)	FA (mm)	FB (mm)	FC (mm)	FD (mm)	FE (mm)	LZ (mm)	LK (mm)	LE (mm)	LG (mm)	LT (mm)	S (mm)	KL (mm)	KH (mm)	KW (mm)	T (mm)	Quality (kg)
SEC20-011-20-3FBY□	387.5 (487.5)	200	180	215	13.5	221	80	63	4	16.5	180	38	33	10	10	M8	45 (60.5)
SEC20-011-15-3FBY□	425 (525)	200	180	215	13.5	221	80	63	4	16.5	180	38	33	10	10	M8	51 (66.5)
SEC20-013-15-3FBY□	451 (551)	200	180	215	13.5	221	80	63	4	16.5	180	38	33	10	10	M8	58 (73.5)
SEC20-015-15-3FBY□	462.5 (562.5)	200	180	215	13.5	221	80	63	4	16.5	180	38	33	10	10	M8	65 (84)
SEC23-011-15-3FBY□	400 (500)	230	200	250	14.5	260.5	110	90	5	21	218.5	42	37	8	12	M12	45 (66.5)
SEC23-015-15-3FBY□	458 (558)	230	200	250	14.5	260.5	110	90	5	21	218.5	45	39.5	9	14	M12	77.5 (99)
SEC23-018-15-3FBY□	458 (558)	230	200	250	14.5	260.5	110	90	5	21	218.5	45	39.5	9	14	M12	77.5 (99)
SEC23-022-15-3FBY□	508 (608)	230	200	250	14.5	260.5	110	90	5	21	218.5	45	39.5	9	14	M12	92.5 (114)
SEC23-029-15-3FBY□	558 (658)	230	200	250	14.5	260.5	110	90	5	21	218.5	48	43	9	14	M16	107 (128.5))

12.7 Servo motor overload characteristics

**12.7.1 Overload protection definition**

Servo motor overload protection is to protect the motor against overheat

12.7.2 Cause of servo motor overload

1) The motor rotates in excess of the rated torque continuously for too long.

2) The load and motor rotor inertia ratio is too high, and highly frequent acceleration/deceleration occurs.

3) The motor power cable or encoder cable is connected improperly.

4) An improper gain is set for the servo motor, resulting in motor oscillation.

5) In case of a motor with a holding brake, the motor rotates without the holding brake open.

12.7.3 Relation between the servo motor load and run time

Servo motors with flanges 40, 60, 80 and 86
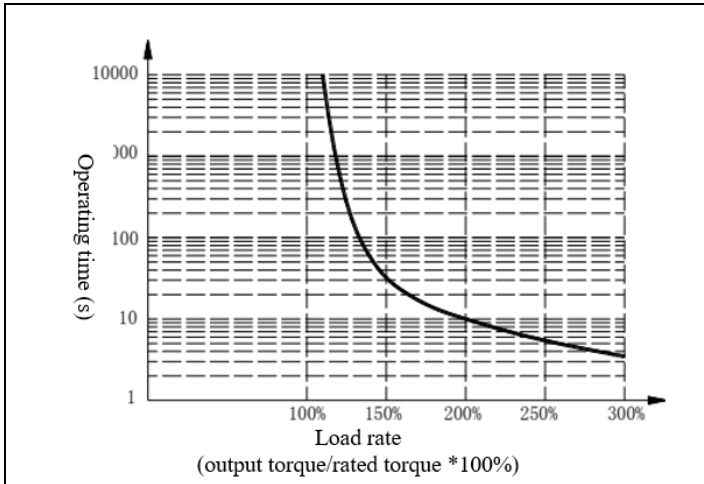
Load rate (%)	Operating time (s)	
	40 Motor with flanges	60, 80, 86 Motor with flanges
120	235.5	327.3
140	31.4	44.0
160	15.7	22.0
180	10.0	14.0
200	7.1	10.0
220	5.4	7.6
240	4.3	6.0
260	3.5	4.9
280	2.9	4.1
300	2.5	3.5

Servo motors with flanges 110, 130 and 180
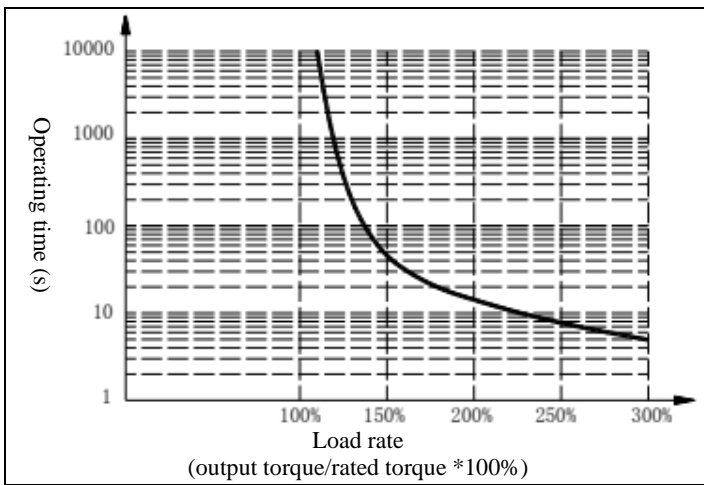
Load rate (%)	Operating time (s)	
	110, 130 Motor with flanges	180 Motor with flanges
120	471.1	608.8
140	62.9	81.2
160	31.4	40.6
180	20.0	25.8
200	14.3	18.5
220	10.9	14.1
240	8.6	11.1
260	7.0	9.0
280	5.9	7.8
300	5.0	6.4

Motors with flanges 200 and 230
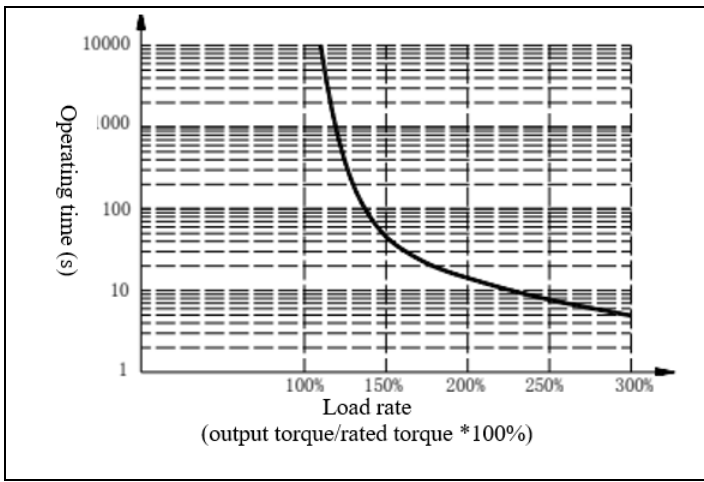
Load rate (%)	Operating time (s)
	200, 230 Motor with flanges
120	525
140	110
160	60
180	38
200	18
220	11
240	8

Chapter 13 Guidance for ordering goods

13.1 Selection of capacity

Determination of the driver unit capacity requires general consideration of load inertia, load torque, required positioning accuracy and required maximum speed, following the recommended steps below:

13.1.1 Calculation of load inertia and torque

13.1.1.1 Torque calculation

Load torque is generated by friction of the drive system and load torsion.

	$2\pi M = FL$	
M	Motor shaft torque	
F	A force required to make a mechanical part move along a straight line	
L	The mechanical displacement distance when the motor rotates by one revolution (2π rad)	

$2\pi M$ is the work performed by the motor when it rotates by one revolution at the torque M; FL is the mechanical work performed when the motor moves by a mechanical displacement distance L at force F. In a real machine tool, due to presence of transmission efficiency and friction coefficient, the torque required by a ball screw to conquer external load P and move at a constant speed is shown in the following figure:
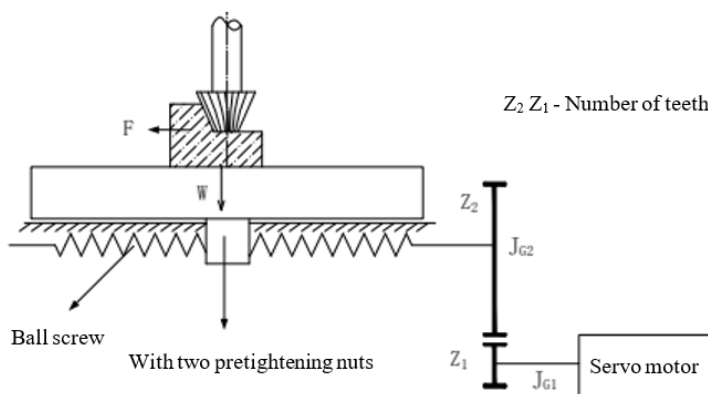
Example of a servo feed drive system

It shall be calculated by using the formula below:

$$M_1 = \left(K \frac{F_{a0} h_{sp}}{2\pi} + \frac{P h_{sp}}{2\pi \eta_1} + M_B \right) \frac{Z_1}{Z_2}$$

M_1	Driving torque in case of movement at a constant speed (N•mm)
$K \frac{F_{a0} h_{sp}}{2\pi}$	Pretightening torque of a double-nut ball screw (N•mm)
F_{a0}	For pretightening force (N), usually 1/3 of the maximum axial workload F_{maz} is taken, i.e. $F_{a0} = 1/3 F_{maz}$; when it is difficult to calculate F_{maz}, $F_{a0} = (0.1\sim0.12) C_a$ (N) can be used.
C_a	The rated load of the ball screw pair can be found in the product sample
h_{sp}	Screw lead (mm)
K	For the pretightening torque coefficient of a ball screw, take 0.1 - 0.2
P	External load (N) applied axially to a screw, $P=F+\mu W$
F	Cutting force (N) applied axially to screw
W	Normal load (N), $W=W_1+P_1$
W_1	Gravity of moving part (N), including the maximum gravity bearing capacity
P_1	Clamping force of clamping plates (such as the headstock)
μ	Guide rail friction coefficient, $\mu=0.09$ for sliding guide pair of plate attached with teflon, $\mu=0.03-0.05$ when there is lubrication, and $\mu=0.003-0.004$ for linear rolling guide.
η_1	For ball screw efficiency, take 0.90-0.95
M_B	Friction torque of a supporting bearing, also known as starting torque (N•m), which can be found in the special bearing sample for ball screws
Z_1	Teeth of gear 1
Z_2	Teeth of gear 2

Finally, the torque of the servo motor is preliminarily determined based on the condition of $M_1 \leq$ the servo motor's rated torque M_S.

13.1.1.2 Inertia matching calculation

Commonly, the following matching relationship is recommended between the motor's rotor inertia J_M and the load inertia J_L (converted to the motor shaft) or the total inertia Jr:

$$0.25 \leqslant \frac{J_L}{J_M} \leqslant 1 \qquad \text{or} \qquad 0.5 \leqslant \frac{J_M}{J_r} \leqslant 0.8 \qquad \text{or} \qquad 0.2 \leqslant \frac{J_L}{J_r} \leqslant 0.5$$

The motor's rotor inertia J_M can be found in the product sample or instructions.

Calculation method of the load inertia is described below:

1) Inertia of axially rotating solid cylindrical rotary bodies

Axially rotating cylindrical rotary bodies include ball screws, couplings, gears and sprockets, among others.
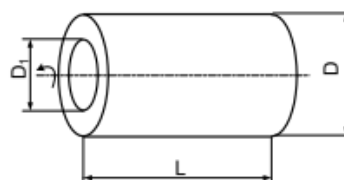

$$J = \frac{\pi \rho}{32} D^4 L \quad (\text{kg} \cdot \text{m}^2)$$
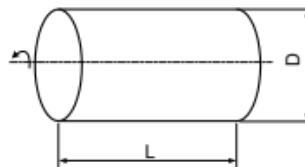
ρ	Density of rotary body material (kg/m^3)	L	Length of cylindrical rotary body (m)
D	Diameter of cylindrical rotary body (m)		

2) Inertia of axially rotating hollow cylindrical rotary bodies

$$J = \frac{\pi \rho}{32} L \left(D^4 - D_1^4 \right) (\text{kg} \cdot \text{m}^2)$$

| ρ	Density of rotary body material (kg/m^3)	L	Length of cylindrical rotary body (m)
D	Outer diameter of cylindrical rotary body (m)	D_1	Inner diameter of cylindrical rotary body (m)

3) Inertia of an object switching from linear movement to movement in the rotating direction of the motor

$$J = m \left(\frac{A}{2\pi} \right)^2 (\text{kg} \cdot \text{m}^2)$$

m	Mass of linearly moving object (kg)
A	Distance moved by the object in one revolution of the motor (in m); if the motor is directly connected with the screw, then A = screw lead h_{sp}

4) When the gear and the synchronous belt transmission decelerate, it is converted into the inertia of the motor shaft.

Teeth at the Z_1 motor shaft end
Teeth at the Z_2 load end

$$J_0 = J \left(\frac{Z_1}{Z_2} \right)^2$$
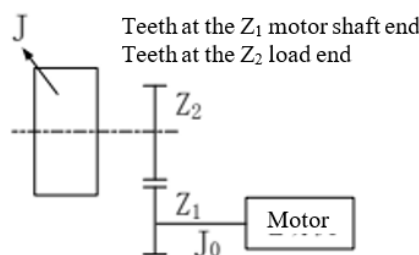
Where, J_0 is the motor shaft inertia converted from the load inertia.

As inherent inertia is present with gears and ball screws, the final load inertia J_L of the motor shaft after conversion is:

$$J_L = J_{G1} + \left(\frac{Z_1}{Z_2} \right)^2 \left[\left(J_{G2} + J_S \right) + m \left(\frac{A}{2\pi} \right)^2 \right] \quad (\text{kg} \cdot \text{m}^2)$$

J_{G1}	Inertia of gear 1 (kg•m^2)
J_{G2}	Inertia of gear 2 (kg•m^2)
J_S	Inertia of ball screw (kg•m^2)
m	Mass of linearly moving object (kg)
A	Distance moved by the object in one revolution of the motor (in m); if the motor is directly connected with the screw, then A = screw lead h_{sp}

13.1.1.3 Calculation of the maximum torque M upon positioning and acceleration

$$M = \frac{2\pi n_m}{60 t_a}\left(J_M + J_L\right) + M_L$$

n_m	Motor speed change during positioning and acceleration (r /min)
t_a	Acceleration/deceleration time (s), if $t_a \approx 3$ /KS, take 0.15-0.2s
K_S	Commonly $8s^{-1}$- $25s^{-1}$ is taken for open-loop gain of the system, and around $20s^{-1}$ is generally taken for a machining center
M_L	Load torque (N•m)
J_M	Motor's rotor inertia (kg•m^2)
J_L	Motor shaft inertia converted from load inertia (kg•m^2)

13.1.2 Preliminary determination of mechanical gear ratio

Calculate the maximum mechanical reduction ratio based on the required maximum speed and maximum rotating speed of the motor. Use the reduction ratio and the minimum revolution unit of the motor to check if the minimal position unit requirement is satisfied; if high position accuracy is required, increase the mechanical reduction ratio (actual maximum speed reduced) or select to use a motor with a higher rotating speed.

13.1.3 Inertia and torque check

Convert the load inertia and load torque into the motor shaft by using the mechanical reduction ratio. The converted inertia shall generally be no greater than 5 times the motor's rotor inertia (with response speed requirements). The converted load torque and effective torque shall be no greater than the motor's rated torque. If the above requirements cannot be satisfied, the user may increase the mechanical reduction ratio (actual maximum speed reduced) or select to use a motor of a larger capacity.

13.2 Stop features

When pulse trains are used to control the servo motor in the position control mode, there is a difference between the command pulse and the feedback pulse, which is known as hysteretic pulse. Hysteretic pulses are accumulatively calculated in the position deviation counter, and have the following relationship with the pulse frequency, the electronic gear ratio and the position proportional gain

$$\varepsilon = \frac{f^* \times G}{K_p}$$

ε	Hysteretic pulse (Puls)	APR-P	Position loop gain
f	Command pulse frequency (Hz)	G	Electronic gear ratio (P1-06÷P1-08)

[Note] The relationship above is obtained under the condition that the [position feedforward gain] is 0%; if the [position feedforward gain] >0%, the count of hysteretic pulses will be smaller than the result obtained by using the formula above.

13.3 Servo system and calculation method for selection of the position controller model

13.3.1 Command displacement and actual displacement:

$$S = \frac{I}{\delta} \cdot \frac{C_R}{C_D} \cdot \frac{D_R}{D_D} \cdot \frac{1}{S_T} \cdot \frac{Z_1}{Z_2} \cdot L$$

S	Actual displacement, mm	D_R	Servo frequency multiplication coefficient
I	Command displacement, mm	D_D	Servo frequency division coefficient
δ	Minimal unit of CNC, in mm	S_T	Number of scale division units per each revolution of the servo motor
C_R	Command frequency multiplication coefficient	Z_1	Motor-side gear teeth
C_D	Command frequency division coefficient	Z_2	Screw-side gear teeth
L	Screw lead, mm		

Commanly S = I, and the command value is equal to the actual value.

13.3.2 CNC maximum command speed:

$$\frac{F}{60 \times \delta} \cdot \frac{C_R}{C_D} \leq f_{max}$$

F	Command speed, mm/min	f_{max}	CNC maximum output frequency, Hz

13.3.3 Maximum speed of the servo system:

$$V_{max} = n_{max} \times \frac{D_R}{D_D} \times L$$

V_{max}	Maximum allowed speed with load of the servo system, mm/min	n_{max}	Maximum allowed rotating speed of the servo motor, rpm

The actual maximum speed of the machine tool is restricted by the maximum speeds of the CNC and the servo system.

13.3.4 Minimum amount of machine tool movement:

$$\alpha = INT\left[INT\left(N \cdot \frac{C_R}{C_D} \right) \cdot \frac{D_R}{D_D} \right]_{min} \cdot \frac{1}{S_T} \cdot \frac{Z_1}{Z_2} \cdot \frac{L}{\delta}$$

| α	Minimum distance of machine tool movement, mm	N	Natural number
INT( )	Represent rounding	INT[ ]$_{min}$	Represent the smallest integer

Chapter 14 Application case

14.1 Typical pulse sequence positioning control (PLC series)

14.1.1 Engineering description

This case mainly describes application of EA350 to positioning control through PLCs of such brands as Mitsubishi FX3U Series, Siemens S7-200 CPU 226 Series, Omron CP1H Series and Delta DVP-10PM, so as to realize regular forward and reverse positioning and homing operations of the servo.

1) Mitsubishi FX3U PLC and EA350
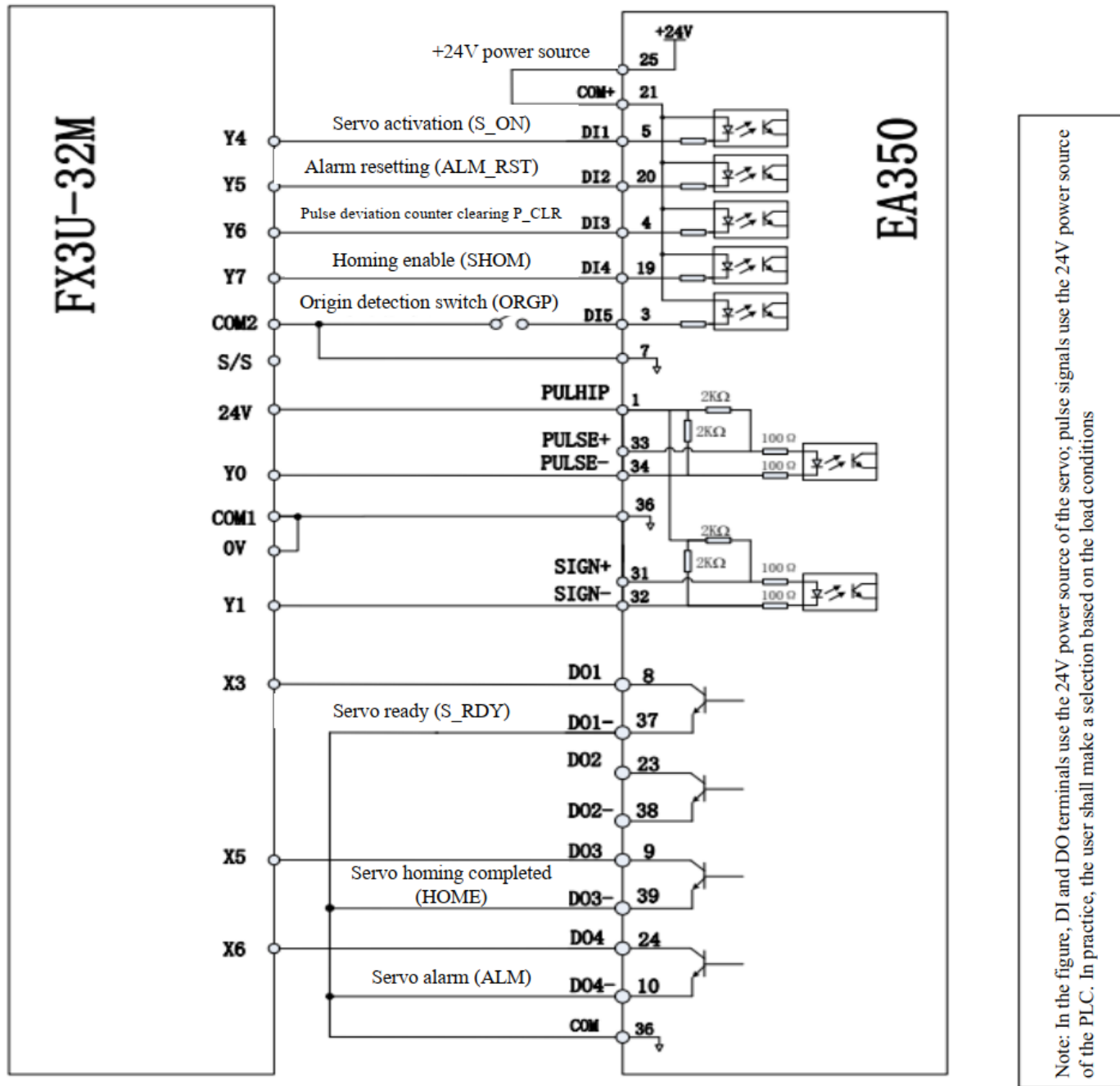
Fig. 13-1 Wiring diagram of Mitsubishi PLC and EA350

Parameter setting of EA350 servo:

Parameter	Set value	Description	Remarks
P0-00	1	Position mode control	
P1-00	0	Input form of external pulses	Set based on actual needs
P6-02	1	DI1 represents servo on	DI terminals are valid at low level P6-01=00000000B
P6-03	2	DI2 represents alarm and warning resetting	
P6-04	3	DI3 represents the position control pulse deviation counter clearning	
P6-05	23	DI4 represents homing enable	
P6-06	22	DI5 represents origin detection signal	
P6-12	1	DO1 represents servo ready	DOs are valid when connected

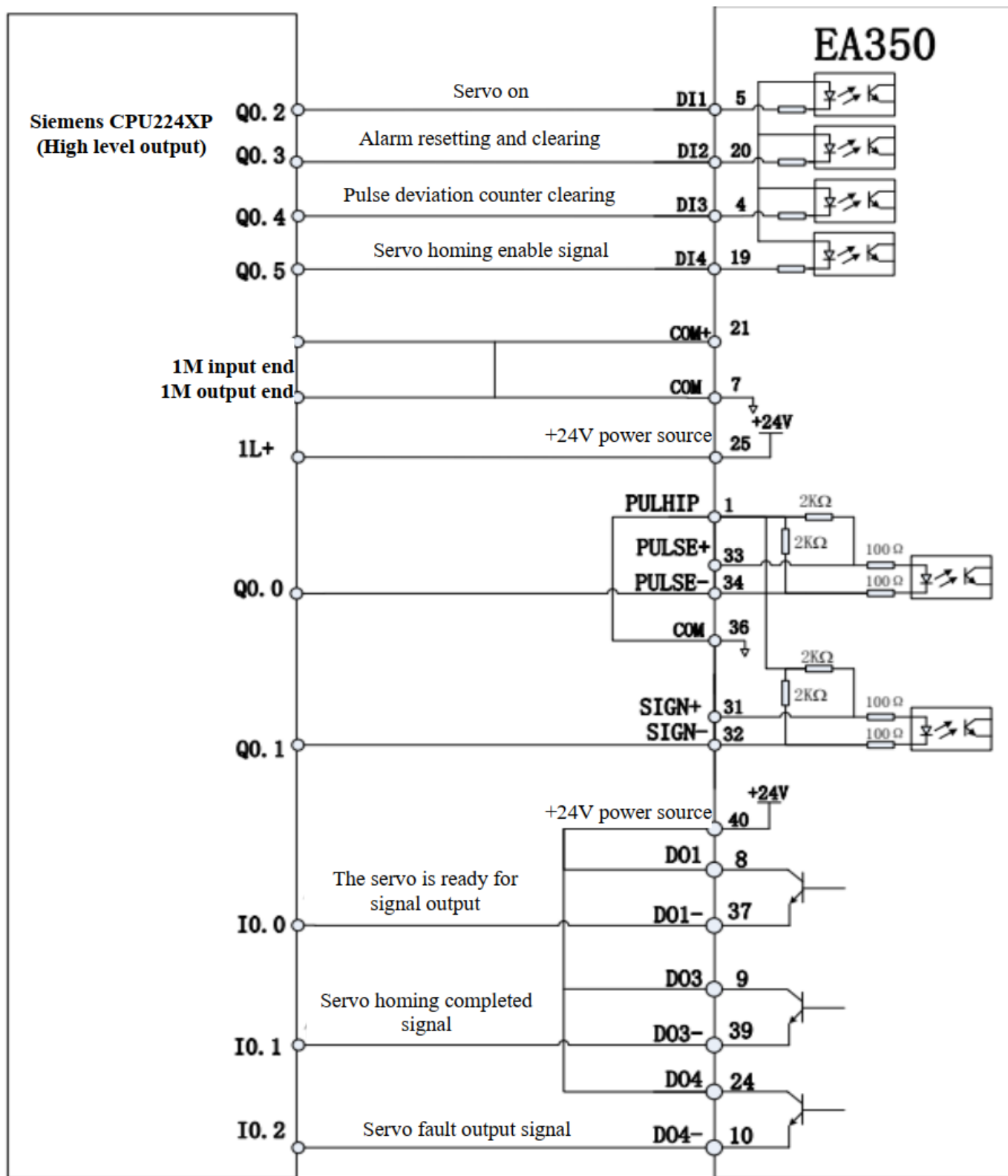| P6-14	14	DO3 represents origin homing completed	P6-11=00000B
P6-15	12	DO4 represents alarm output	
P1-02	10000	Count of pulses per revolution of the motor	Set based on actual needs
P4-01	11	Rigidity	To be set based on the actual conditions

2) Siemens PLC and EA350

Fig. 13-2 Wiring diagram of Siemens PLC and EA350

Parameter setting of EA350 servo:

Parameter	Set value	Description	Remarks
P0-00	1	Position mode control	
P1-00	0	Input form of external pulses	Set based on actual needs
P6-02	1	DI1 represents servo on	
P6-03	2	DI2 represents alarm and warning resetting	
P6-04	3	DI3 represents the position control pulse deviation counter clearning	P6-01=00001111B
P6-05	23	DI4 represents homing enable	

P6-06	22	DI5 represents origin detection signal	
P6-12	1	DO1 represents servo ready	DOs are valid when connected P6-11=00000B
P6-14	14	DO3 represents origin homing completed	
P6-15	12	DO4 represents alarm output	
P1-02	10000	Count of pulses per revolution of the motor	Set based on actual needs
P4-01	11	Rigidity	To be set based on the actual conditions

14.2 Typical pulse sequence positioning control (CNC controller)

This case describes use of the new-generation CNC for semi-closed loop control of EA350 series servos to realize routine forward and reverse positioning of the servos.
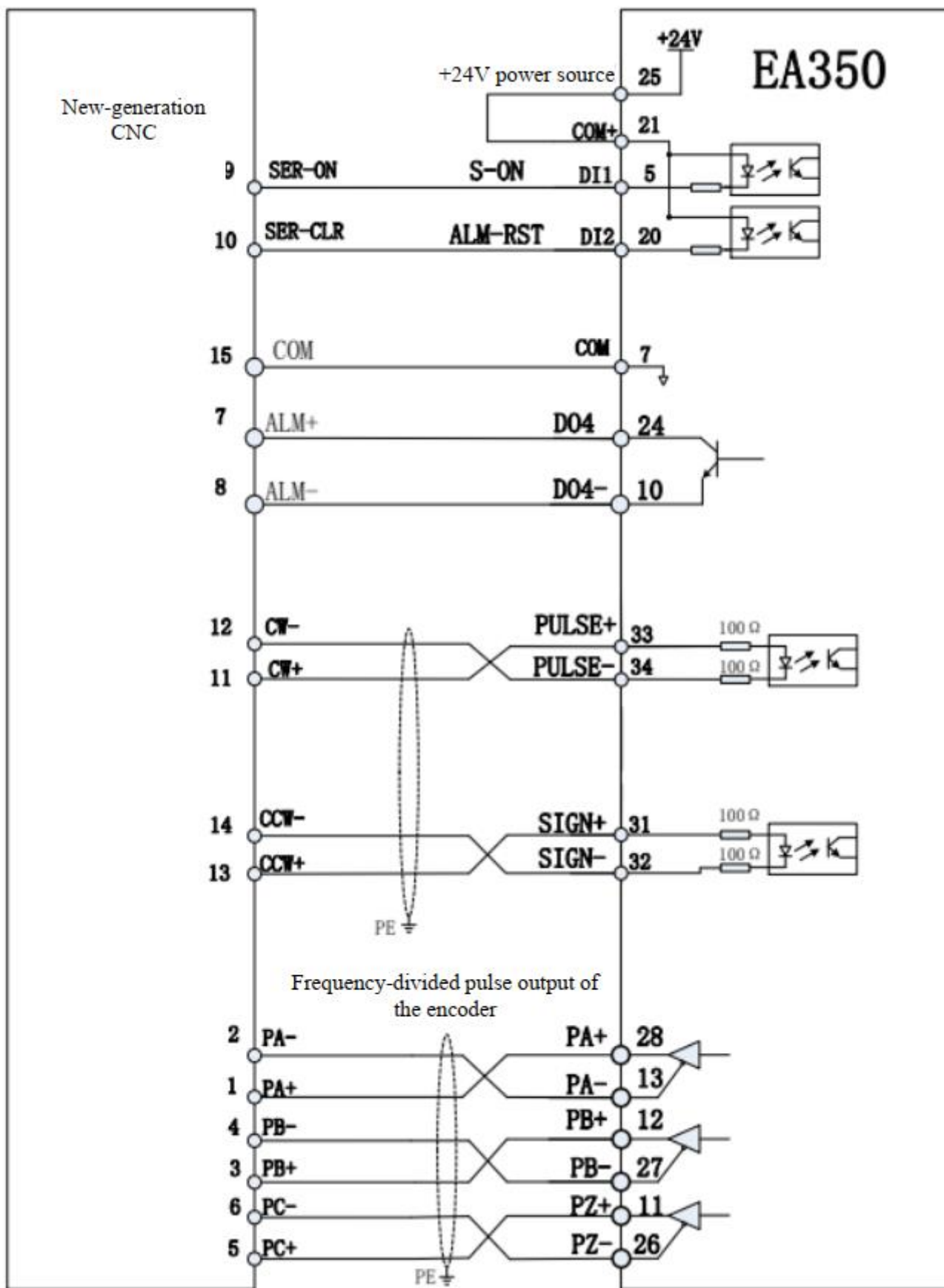

Fig. 13-3 Wiring diagram of new-generation CNC and EA350

Parameter setting of EA350 servo:

Parameter	Set value	Description	Remarks

P0-00	1	Position mode control	
P1-00	0	Position command source selection	External pulse command
P1-02	2	Input form of external pulses	Set based on actual needs
P6-02	1	DI1 represents servo on	P6-01=00000000B
P6-03	2	DI2 represents alarm and warning resetting	
P6-15	12	DO4 represents alarm output	P6-11=00000B
P1-02	10000	Count of pulses per revolution of the motor	Set based on actual needs
P4-01	11	Rigidity	Set based on actual needs