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*We reserve the right to change the information in this user manual without prior notice.

DELTA_IA-ASD_ASDA-A3-EP_UM_EN_20241018

Digitized Automation for a Changing World

Delta ASDA-A3-EP Servo Drive User Manual

www.deltaww.com

Preface

Thank you for purchasing this product. This manual provides information about the ASDA-A3-EP servo drive (A3-EP) and the applicable servo motors.

How to use this manual:

Use this manual as a reference when installing, setting up, using, and maintaining the servo drive. Before initiating the tuning or setup process, read Chapters 1 to 5.

Delta technical services:

Consult your Delta equipment distributor or Delta Customer Service Center if you encounter any problems.

The content of this manual may be revised without prior notice. Refer to the latest information from Delta's website.

Safety precautions

A3-EP is a high-resolution open type servo drive. It should be installed in a shielded control cabinet during operation. This product uses precise feedback control and a digital signal processor (DSP) with high-speed calculation capability to control the current output generated by IGBT to operate three-phase permanent magnet synchronous motors (PMSM), achieving precise positioning.

The A3-EP servo drive is used in industrial applications and should be installed in a control cabinet. Servo drives, wires, and motors should all be installed in an environment which complies with the minimum requirement of UL50 Type 1.

Pay special attention to the following safety precautions at all times during inspection, installation, wiring, operation, maintenance, and examination of the servo drive.

The symbols of “DANGER”, “WARNING”, and “STOP” indicate:

DANGER	**Danger. May cause severe or fatal injuries to personnel if the instructions are not followed.**
WARNING	**Warning. May cause moderate injury to personnel, or lead to severe damage or even malfunction of the product if the instructions are not followed.**
STOP	**Absolutely prohibited activities. May cause serious damage or even malfunction of the product if the instructions are not followed.**

Inspection

DANGER	Follow the instructions when using the servo drive and servo motor, or it may cause fire or malfunction.

Installation

DANGER	Do not expose the product to an environment containing water vapor, corrosive gas, inflammable gas, or other foreign matter to reduce the risk of electric shock or fire.

Wiring

DANGER

- Connect the ground terminals to Class 3 ground system. Ground resistance should not exceed 100 Ω. Improper grounding may result in electric shock or fire.
- Do not connect the three-phase power source to the motor output terminals U, V, and W, or it may cause personal injury or fire.
- Tighten the screws of the power and motor output terminals, or it may cause fire.
- When wiring, refer to the description of wire selection in Chapter 3 to prevent any danger.

Operation

WARNING	■ Before operating the machine, change the servo parameter setting according to the application. If the parameters are not adjusted to the correct values, it may lead to malfunction of the machine or the operation might be out of control. ■ Ensure you can activate the emergency stop before operating the machine. ■ When applying power, make sure the motor is not rotating because of inertia of the machine or other causes.

STOP	During motor operation, do not touch any rotating motor parts, or it may cause personal injury.

DANGER	■ To avoid accidents, remove all units during the first test run, so that the motor is operating without any load. ■ If you fail to operate the servo motor properly after it is connected to the machine, it may damage the machine and lead to personal injury. ■ In order to prevent danger, it is strongly recommended that you make sure the servo motor can operate normally without load first. Then, try operating the motor with load. ■ Do not touch the heat sink of the servo drive during operation, or it may cause burns.

Maintenance and examination

STOP	■ Do not touch the internal parts of the servo drive and servo motor, or it may cause electric shock. ■ Do not disassemble the servo drive panel when the power is on, or it may cause electric shock. ■ High voltage may remain in the servo drive after the power is turned off. Do not touch the terminals or perform wiring until the “CHARGE” indicator is off. ■ Do not disassemble the servo motor, or it may cause electric shock or personal injury. ■ Do not change the wiring when the power is on, or it may cause electric shock or personal injury. ■ Only qualified electricians can install, wire, repair, and maintain the servo drive and servo motor.

Main circuit wiring

WARNING

- Do not put the power cable and signal cable in the same channel or bond them together. Separate the power cable and signal cable by at least 30 centimeters (11.8 inches).
- Use stranded wires and multi-core shielded-pair wires for signal cables and encoder cables. The maximum length of the signal cable is 3 meters (9.84 feet) and the maximum length of the encoder cable is 20 meters (65.62 feet).
- Do no touch the wiring terminals until the "CHARGE" indicator is off, since the residual voltage may cause electric shock.

STOP

Do not repeatedly turn the power on and off. If continuous power on and off is needed, wait one minute between intervals.

WARNING

- When wiring, remove the pluggable terminal blocks from the servo drive.
- Use only one wire per terminal socket.
- When inserting the wires, do not short-circuit the adjacent wires.
- Before applying power, inspect and ensure that the wiring is correct.

Leakage current

WARNING

- The leakage current of the servo drive is greater than 3.5 mA.
- According to the IEC 61800-5-1 standards, the wires must comply with either one of the following specifications to ensure proper grounding:
  1. Copper wire with a cross-sectional area of at least 10 mm^2.
  2. Aluminum wire with a cross-sectional area of at least 16 mm^2.
- Failure to comply with the specifications may result in personal injury.
- Before applying power, inspect and ensure that the wiring is correct.

Disposal instructions

WARNING

When disposing of the product, make sure it is disposed of as general industrial waste in accordance with the local laws and regulations.

Inspection and maintenance

Operating conditions:

- Average annual ambient temperature: 30°C (86°F)
- Average load rate: 80% or less
- Average operating time: 20 hours per day

Inspection frequency	Inspection item
Daily inspection	Check if the ambient temperature and humidity are normal.
	Check if the input voltage is normal.
	Check if there is abnormal vibration and noise.
	Check if there is any abnormal smell.
	Check if the servo drive has any visible damage.
	Check if the ventilation holes are kept clear of dust and other foreign objects. *1
	Check if the wirings are damaged or disconnected.
	Check if any cable is loose or damaged.
Annual inspection	Check if any screw is loose or damaged.
	Check if the servo drive, motor, and control cabinet are properly grounded.
	Check if the color and temperature of the power input, power output, and regenerative terminals are normal. *2

Note:

1. Install dust filters on the control cabinet openings (where there are fans or ventilation holes), and clean the filters regularly. Install door seals on cabinet doors and rubber grommets on cable openings for better seal.
2. Check if the servo drive is properly wired. If the color of any terminal turns black or is abnormal, it is suggested that you replace the terminal.

Part replacement

Operating conditions:

- Average annual ambient temperature: 30°C (86°F)
- Average load rate: 80% or less
- Average operating time: 20 hours per day

Product	Part name	Suggested replacement cycle	Note
Servo drive	Electrolytic capacitor	Approx. 5 years	The replacement cycle varies depending on the ambient conditions and usage. Replace the part immediately when any error occurs.
	Cooling fan	2 to 3 years (10,000 to 30,000 hours)	
	Relay	Approx. 100,000 times	
	Soft start resistor	Approx. 20,000 times	
Battery box	Battery	Refer to Section 8.1	
Servo motor	Bearing	20,000 hours	
	Oil seal	5,000 hours	

- When the suggested replacement cycle of a part is reached, consult the distributor or Delta for replacement suggestions.
- Do not attempt to disassemble or repair the product yourself.

EtherCAT

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Table of Contents

Before Operation

1 Product Overview

2 Installation

3 Wiring

4 Panel Operation, Testing and Software Connection

Tuning

5 Tuning

Operation

6 Control Mode

Parameter Setting

7 Parameters

8 Absolute System

9 Third-Party Motor

Troubleshooting

11 Troubleshooting

Appendix

A Specifications

B Accessories

C Using the Safety Functions Module

Product Overview

1

Before using the A3-EP servo drive, pay attention to the items to check after unpacking and the description of the nameplate and model type. You can find a suitable motor model for your A3-EP servo drive in the table in Section 1.3.

1.1 Items to check after unpacking

A complete servo drive set includes:

(1) A servo drive.

(2) A spring clamp terminal block for CN1.

(3) An STO connector for CN10.

(4) Pluggable terminal blocks and one plastic lever.

400 W - 1.5 kW	R, S, T	3-pin pluggable terminal block
	24V, 0V	2-pin pluggable terminal block
	P1, P2, $\ominus$, P3, D, C	6-pin pluggable terminal block
	U, V, W	3-pin pluggable terminal block

(5) Two metal pieces for short-circuiting the terminal block: for 400 W - 1.5 kW models.

One metal piece for short-circuiting the terminal block: for 2 kW - 15 kW models.

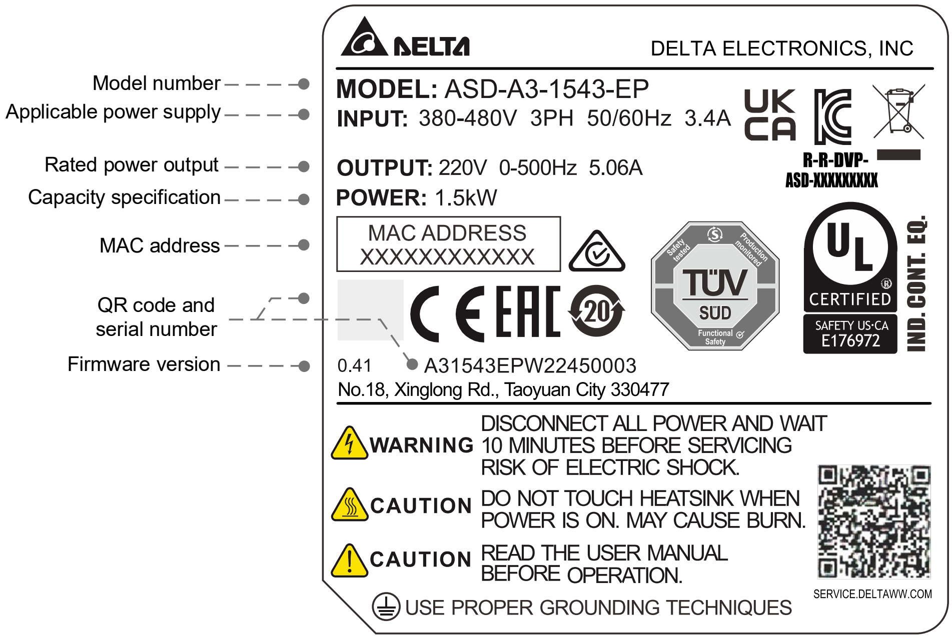
(6) An installation instruction sheet.

1.2 Model overview

1.2.1 Nameplate information

A3-EP servo drive

■ **Nameplate information**



Note: the example only illustrates how the certification marks are displayed; the marks are not printed on the nameplate until the certification progress is complete.

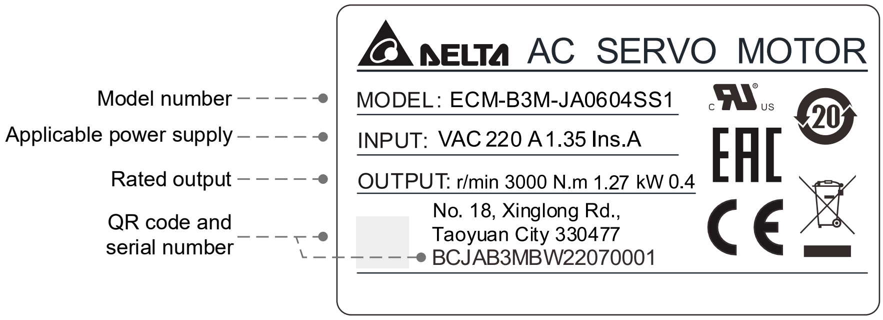
■ **Serial number**

A31543EP	W	22	45	0003
(1)	(2)	(3)	(4)	(5)

(1) Model number
(2) Manufacturing plant (T: Taoyuan; W: Wujiang)
(3) Year of production (22: year 2022)
(4) Week of production (from 1 to 52)
(5) Production sequence in a week (starting from 0001)

ECM-B3 series servo motor

■ Nameplate information



Note:

1. The applicable power supply specified on the nameplate is the certified voltage.
2. The example only illustrates how the certification marks are displayed; the marks are not printed on the nameplate until the certification progress is complete.

■ Serial number

BCJAB3MB	W	22	07	0001
(1)	(2)	(3)	(4)	(5)

(1) Model number
(2) Manufacturing plant (T: Taoyuan; W: Wujiang)
(3) Year of production (22: year 2022)
(4) Week of production (from 1 to 52)
(5) Production sequence in a week (starting from 0001)

1.2.2 Model explanation

A3-EP servo drive

ASD – A3 – 15 43 – EP

(1) (2) (3) (4) (5)

(1) Product name
ASD: AC Servo Drive

(2) Series
A3: A3 Series

(3) Rated power output

Code	Specification	Code	Specification	Code	Specification
04	400 W	20	2 kW	75	7.5 kW
07	750 W	30	3 kW	1B	11 kW
10	1 kW	45	4.5 kW	1F	15 kW
15	1.5 kW	55	5.5 kW	-	-

(4) Input voltage and phase
43: 400V, three-phase

(5) Model type

Code	Full-closed loop control	STO	EtherCAT
EP	-	✓	✓

Note: the model codes listed here are only for demonstration of the naming convention; some combinations of the model codes are not available. Contact the distributors for the models available for purchase.

ECM-B3 series servo motor

ECM	-	B	3	M	-	J	2	06	04	R	S	1
(1)		(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)	(10)	(11)

(1) Product name
ECM: electronically commutated motor

(2) Servo type
B: general type servo motor

(3) Series
3: 3rd series

(4) Inertia
H: high inertia
M: medium inertia
L: low inertia

(5) Rated voltage and speed
C: 220V and 3,000 rpm
J: 400V and 3,000 rpm
K: 400V and 2,000 rpm
L: 400V and 1,500 rpm

(6) Encoder type
A: 24-bit absolute optical encoder
(resolution of single turn: 24-bit; number of revolutions: 16-bit)
2: 24-bit incremental optical encoder (single-turn absolute)
P: 17-bit absolute magnetic encoder
(resolution of single turn: 17-bit; number of revolutions: 16-bit)
M: 17-bit incremental magnetic encoder (single-turn absolute)
Note: number of revolutions means the maximum number of turns the encoder can record.

(7) Motor frame size

Code	Specification	Code	Specification
04	40 mm	13	130 mm
06	60 mm	18	180 mm
08	80 mm	22	220 mm
10	100 mm	-	-

(8) Rated power output

Code	Specification	Code	Specification
01	100 W	18	1.8 kW
02	200 W	20	2 kW
04	400 W	30	3 kW
07	750 W	45	4.5 kW
08	850 W	55	5.5 kW
10	1 kW	75	7.5 kW
13	1.3 kW	1B	11 kW
15	1.5 kW	1F	15 kW

(9) Shaft type and oil seal

	w/o brake, with oil seal	with brake, with oil seal
with keyway with screw hole	R	S

(10) Shaft diameter and connector type

S: standard shaft diameter and standard connectors
7: special shaft diameter (14 mm)*1 and standard connectors
J: standard shaft diameter and CHOGORI (IP67) connectors
K: special shaft diameter (14 mm)*1 and CHOGORI (IP67) connectors
3: standard shaft diameter (42 mm)*2 and standard connectors
B: standard shaft diameter and bulkhead connectors

Note:
1. Special shaft diameter (14 mm) is only available for F80 400 W models.
2. Standard shaft diameter (42 mm) is only available for F180 5.5 kW and 7.5 kW models and F220 11 kW models.

(11) Special code

1: standard products

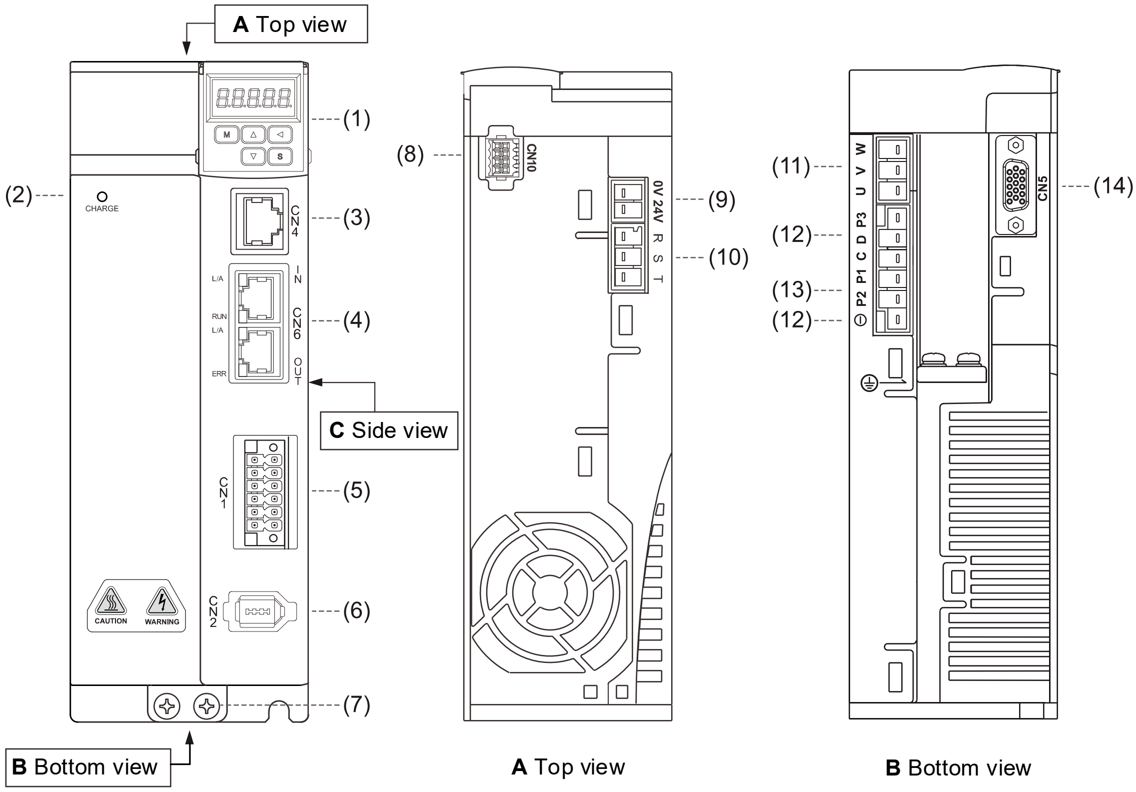
Note: the model codes listed here are only for demonstration of the naming convention; some combinations of the model codes are not available. Contact the distributors for the models available for purchase.

1.3 A3-EP servo drive and motor

Servo motor model							Servo drive model		
Model number	Rated / Max. speed (rpm)	Frame size (mm)	Rated power (W)	Inertia ($x10^{-4}kg \cdot m^2$) with brake / without brake	Rated / Max. current (Arms)	Rated / Max. torque (N·m)	Model number	Rated power (W)	Rated / Max. current (Arms)
ECM-B3L-C□0401	3000 / 6000	40	100	0.0299 / 0.0315	0.857 / 3.44	0.32 / 1.12	ASD-A3-0443-□	400	1.60 / 5.40
ECM-B3M-C□0602		60	200	0.141 / 0.151	1.42 / 6.62	0.64 / 1.97	ASD-A3-0443-□	400	1.60 / 5.40
						0.64 / 2.24	ASD-A3-0743-□	750	3.12 / 9.70
ECM-B3M-J□0604		60	400	0.254 / 0.264	1.35 / 5.20	1.27 / 4.45	ASD-A3-0443-□	400	1.60 / 5.40
ECM-B3M-J□0807		80	750	1.07 / 1.13	2.15 / 7.90	2.4 / 8.4	ASD-A3-0743-□	750	3.12 / 9.70
ECM-B3M-J□1010		100	1k	2.78 / 3.06	3.03 / 9.21	3.18 / 9.54	ASD-A3-1043-□	1k	3.52 / 10.54
ECM-B3M-J□1015		100	1.5k	3.69 / 3.97	3.73 / 11.4	4.77 / 14.31	ASD-A3-1543-□	1.5k	5.06 / 16.35
ECM-B3M-J□1020		100	2k	4.68 / 4.95	5.00 / 15.3	6.37 / 19.11	ASD-A3-2043-□	2k	6.60 / 19.88
ECM-B3M-K□1310	2000 / 3000	130	1k	7.79 / 7.94	3.00 / 9.95	4.77 / 14.3	ASD-A3-1043-□	1k	3.52 / 10.54
ECM-B3M-K□1315		130	1.5k	11.22 / 11.37	4.09 / 13.37	7.16 / 21.48	ASD-A3-1543-□	1.5k	5.06 / 16.35
ECM-B3M-K□1320		130	2k	14.65 / 14.80	5.30 / 17.1	9.55 / 28.65	ASD-A3-2043-□	2k	6.60 / 19.88
ECM-B3H-L□1308	1500 / 4000	130	850	12.44 / 12.62	3.35 / 10.0	5.39 / 16.17	ASD-A3-1043-□	1k	3.52 / 10.54
ECM-B3H-L□1313		130	1.3k	18.00 / 18.14	3.85 / 12.0	8.34 / 25.02	ASD-A3-1543-□	1.5k	5.06 / 16.35
ECM-B3H-L□1318		130	1.8k	22.60 / 22.80	5.75 / 18.1	11.5 / 34.5	ASD-A3-2043-□	2k	6.60 / 19.88
ECM-B3M-K□1820	2000 / 3000	180	2k	29.11 / 30.38	5.7 / 18.1	9.55 / 28.65	ASD-A3-2043-□	2k	6.60 / 19.88
ECM-B3M-L□1830	1500 / 3000	180	3k	53.63 / 54.9	9.1 / 29.45	19.1 / 57.29	ASD-A3-3043-□	3k	9.11 / 29.45
ECM-B3M-L□1845	1500 / 4000	180	4.5k	67.73 / 69.15	13.3 / 35.35	28.65 / 71.6	ASD-A3-4543-□	4.5k	13.30 / 35.35
ECM-B3M-L□1855		180	5.5k	98.88 / 100.1	15.3 / 49.29	35.01 / 105	ASD-A3-5543-□	5.5k	15.34 / 49.29
ECM-B3M-L□1875		180	7.5k	134.95 / 136.24	22.1 / 56.68	47.75 / 119	ASD-A3-7543-□	7.5k	22.40 / 56.68
ECM-B3M-L□221B		220	11k	302.2 / 303.1	21.2 / 56.5	70.03 / 175	ASD-A3-1B43-□	11k	27.30 / 68.25
ECM-B3M-L□221F		220	15k	400 / 400.9	29.2 / 77	95.49 / 238.5	ASD-A3-1F43-□	15k	31.00 / 80.20

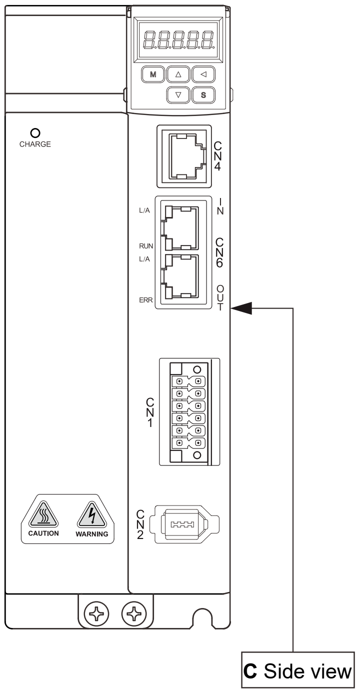
Note: CHOGORI connectors are not supported when 220V motors are used with 400V servo drives.

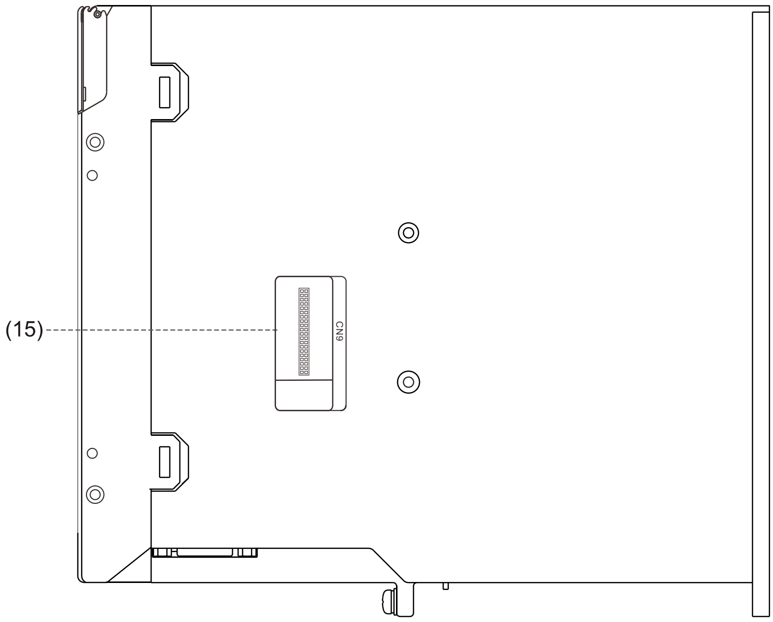
1.4 Description of the drive interface



No.	Name	Description
(1)	-	7-segment display.
(2)	CHARGE	Power indicator.
(3)	CN4	Ethernet communication port. You can choose to use the standard Modbus TCP or ASDA-Soft for communication with the TCP port setting.
(4)	CN6	EtherCAT high-speed communication port.
(5)	CN1	I/O signal interface: connects to PLC or controls I/O.
(6)	CN2	Connector for the 1st set of position feedback signals.
(7)	Grounding screws	Connects to the ground wires of the power supply and servo motor.
(8)	CN10	STO terminal.
(9) *	24V, 0V	Control circuit power input terminal: connects to 24 V_{DC} ± 10% power supply.
(10) *	RST	Main circuit power input terminal: connects to three-phase power supply (380 - 480 V_{AC} ± 10%, 50 / 60 Hz).
(11) *	UVW	Connects to the motor power cable (U, V, W). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(12) *	P3, D, C, ⊖	For using the built-in regenerative resistor, or connecting to the external regenerative resistor or external regenerative unit.
(13) *	P1, P2	Short-circuit P1 and P2.
(14)	CN5	Connector for the 2nd set of position feedback signals.

Note: the type of terminals with * varies with the models, but this does not affect their pin assignments and functions.





C Side view

No.	Name	Description
(15)	CN9	Connects to the safety functions module.

Installation 2

Follow the instructions in this chapter during installation. This chapter includes information about the circuit breaker, magnetic contactor, fuse, and the selection for EMI filter and regenerative resistor.

2

2.1 Ambient storage conditions

Before installation, this product must be kept in the shipping carton. In order to retain the warranty coverage and for maintenance, follow these instructions for storage. While the product is temporarily not in use:

- Store the product in a temperature range of -20°C (-4°F) to +65°C (+149°F).
- Store the product in a relative humidity range of 0% to 90% (non-condensing).
- Avoid storing the product in an environment containing corrosive gas.

2.2 Ambient installation conditions

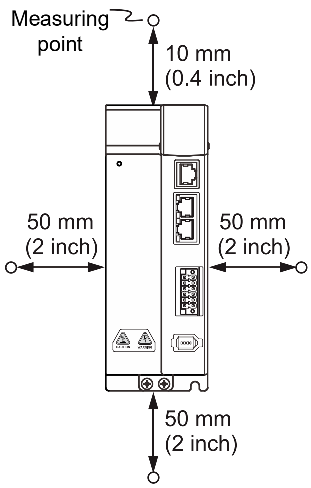
WARNING

A3-EP servo drive: the environment should be free of devices that generate excessive heat; no water, water vapor, dust, and oily dust; no corrosive and inflammable gas or liquids; no airborne dust or metal particles; and the environment should be solid without vibration and free of electromagnetic interference.

Motor: the ambient temperature for the ECM-B3 motors should be between -20°C (-4°F) and +60°C (+140°F) [Note]. The environment should be free of devices that generate excessive heat; no water, water vapor, dust, and oily dust; no corrosive and inflammable gas or liquids; and no airborne dust or metal particles.

Note: if the ambient temperature for the ECM-B3 motors is over 40˚C (104˚F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.

- The ambient operating temperature for the servo drive should be between 0°C (32°F) and 55°C (131°F). If the temperature is over 45°C (113°F), place the product in a well-ventilated environment. During long-term operation, it is advisable to keep the temperature below 45°C (113°F) to ensure the servo drive's performance. When operating the 3 kW models in an ambient temperature between 50°C (122°F) and 55°C (131°F), derate the load to 80%.
- Mount the product vertically in the control cabinet (see the illustration of the correct mounting direction in Section 2.3) and install a fan at the top of the control cabinet for heat dissipation. Ensure that the temperature for the clearance of 5 cm (1.97 inches) beneath and on both sides of the servo drive is kept under 50°C (122°F), and the servo drive must be kept clear of heat sources. Moreover, the airflow velocity at the measuring point, which is 10 mm (0.4 inches) above the servo drive, has to be 1 m/s or higher. Make sure the size of the control cabinet and its ventilation condition can prevent the internal electrical devices from overheating. Besides, check if the vibration of the machine affects the electrical devices in the control cabinet.

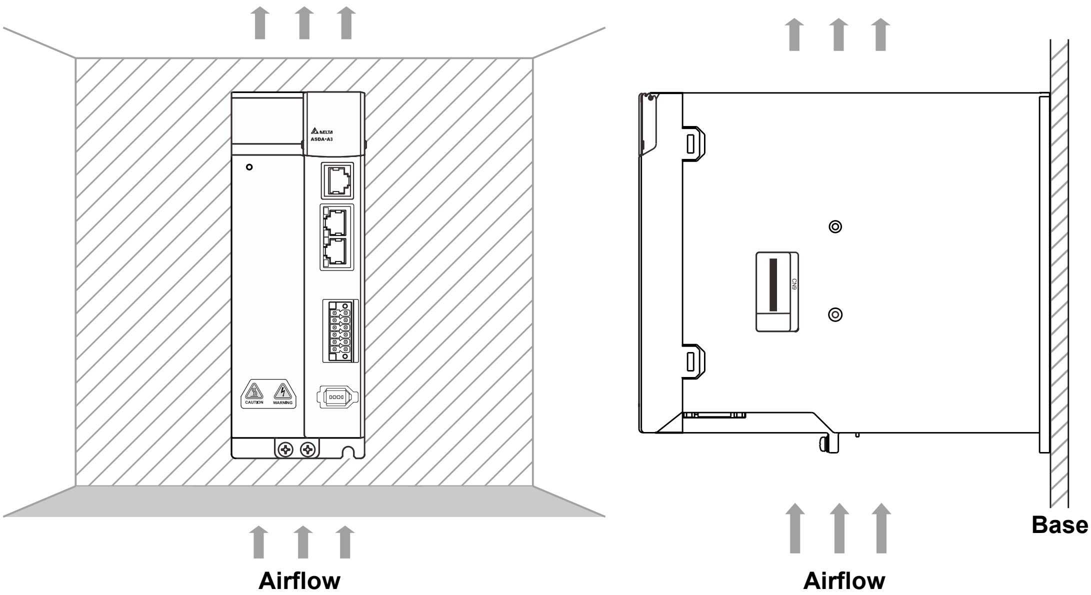


2.3 Mounting direction and space

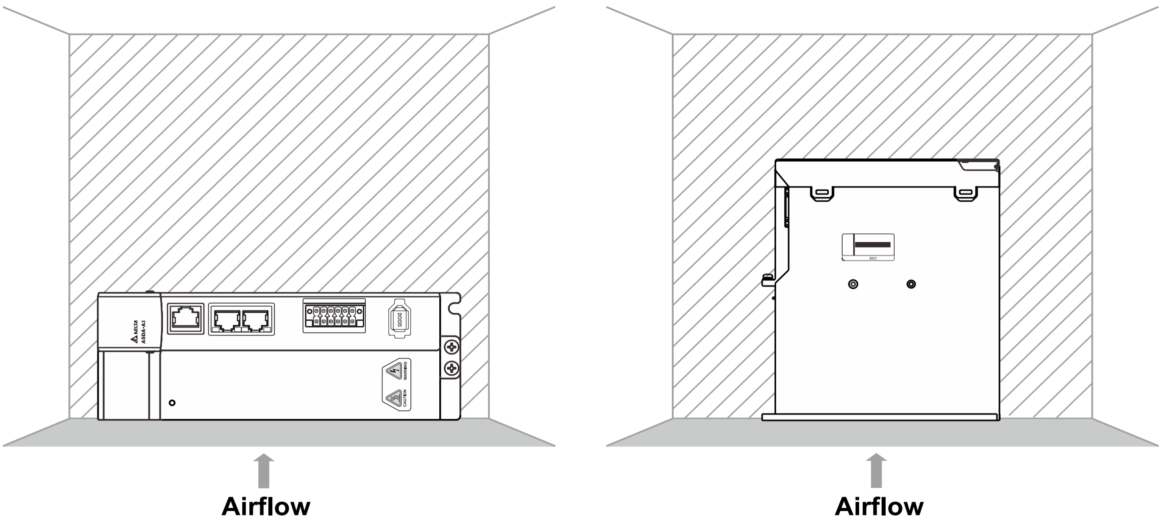
Important:

- Mount the servo drive in the correct direction according to the following illustrations with the base of the heat sink vertically on the wall. Incorrect mounting direction may result in malfunction.
- For better ventilation and cooling, allow sufficient clearance space between the AC servo drive and the adjacent objects and the wall, or overheating may result in malfunction.
- Do not block the ventilation holes of the servo drive, and do not mount the servo drive in the incorrect direction, or it may result in malfunction.

Correct



Incorrect

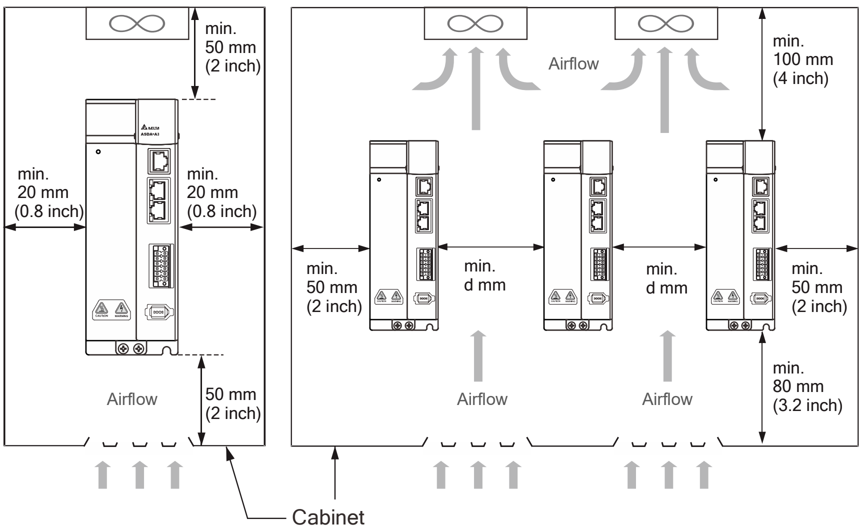


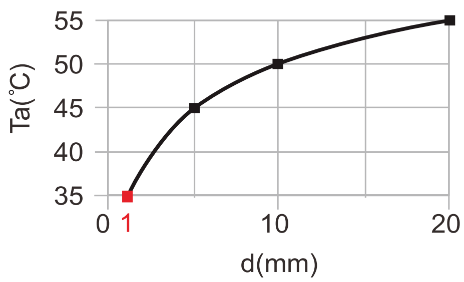
Heat dissipation requirements:

- In order to have adequate air flow for ventilation, follow the suggested clearances when installing one or multiple servo drives.
- Avoid mounting one servo drive above one another, or the drives at the bottom generate heat which rises and causes temperature increase for the drives mounted above.

Note: the following diagrams are not accurately scaled. Refer to the annotations on the diagrams.

One servo drive **Multiple servo drives**



Servo drive model	Cooling method	Ambient temperature (Ta) corresponding to the minimum clearance (d) *Considering the assembly tolerances, the servo drive requires a minimum clearance of 1 mm
ASD-A3-0443-☐ ASD-A3-0743-☐ ASD-A3-1043-☐ ASD-A3-1543-☐ ASD-A3-2043-☐ ASD-A3-3043-☐ ASD-A3-4543-☐ ASD-A3-5543-☐ ASD-A3-7543-☐ ASD-A3-1B43-☐ ASD-A3-1F43-☐	Natural cooling plus forced cooling	

Note: when operating the 400V 3 kW models in an ambient temperature between 50°C (122°F) and 55°C (131°F), derate the load to 80%.

2

2.4 Safety precautions for using motors

The Delta AC servo motor is designed for industrial applications. It is necessary that you fully understand the motor specifications and the content of the user manual. For your safety and correct use, read the safety precautions for the motor carefully before connecting the motor to any equipment.

The safety precautions are as follows:

Handling, mounting, and storage

- When taking out or placing the servo motor, hold the whole motor instead of holding the cable or motor shaft only.
- Do not hit the motor shaft. Impact force will damage the shaft and the encoder that is attached at the rear end of the shaft.
- Keep the axial or radial load on the shaft within the allowable range listed in the specifications.
- The shaft of servo motor is not water- or oil-proof. Do not use, install, or store the servo motor in an environment that contains water, oily liquids, corrosive and inflammable gases, or is with high humidity.
- The material of motor shaft is not rustproof. Although rustproof oil has been applied to the shaft during the manufacturing process, you must check the shaft condition every three months and apply rustproof oil if storing the motor for more than six months.
- Ensure that the environmental conditions for storing the servo motor conform to the specifications in the instruction sheet.
- The encoder attached to the motor is easily damaged; take the necessary measures to avoid electromagnetic interference, vibration, and abnormal temperature changes.
- The magnetic field for placing or installing the motor should be below 10 mT.

Wiring

- If the current exceeds the maximum current in the specifications, the internal parts of the motor may lose their magnetism. Contact the distributor or local Delta sales representative if this problem occurs.
- Check if the motor wiring and the voltage of the motor brake are correct. Also, make sure that the wiring of the encoder power and signal cables is correct. Incorrect wiring will lead to abnormal operation, malfunction, or damage of the motor.
- To avoid capacitive coupling and noise, isolate the motor power cable from the encoder power and signal cables. Do not connect them to the same circuit.
- The AC servo motor must be correctly grounded.
- The encoder connector must not undergo any high voltage test because it will damage the encoder.

- When the motor or brake is undergoing high voltage tests, cut off the power supply for the controller. To maintain the product lifespan, do not perform this kind of test unless necessary.

Operation

- AC servo motor operation is controlled by the servo drive. Do not directly connect a commercial power supply (100/200V, 50/60 Hz) to the servo motor circuit, otherwise the motor cannot operate normally and may be permanently damaged.
- Follow the motor specifications when using the product. The motor temperature during operation must not exceed the specified range.
- The material of the motor shaft is not rustproof. To ensure a longer motor life, apply rustproof oil during operation.
- The built-in brake is for clamping, not for stopping the motor. Note that the built-in brake is not a device for safely stopping the machine. Install another safety device for stopping the machine. When the built-in brake is clamping the motor, rotation backlash can still occur and the maximum rotation is 1° to 2°. Besides, when a motor with a brake is operating, the brake lining sometimes generates a noise (a swishing or clicking sound) caused by the structure of brake module, which is not a malfunction. It will not affect the motor’s function.
- When using a servo motor with a brake, do not use the built-in brake for dynamic braking.
- If any odor, noise, smoke, heat, or abnormal vibration occurs during motor operation, stop the motor and turn off the power immediately.

Others

- Delta AC servo motors have no user-replaceable parts.
- Do not disassemble the motor or change its parts, or it will void the warranty.
- Do not disassemble the motor by yourself, or it may lead to permanent malfunction or damage.
- Do not splash any water or oil on the product.

2.4.1 Troubleshooting for the motor operation and status

When the servo motor makes abnormal noises:

Possible cause	Checking method	Corrective action
There is a source of vibration in the connecting component.	Check if there is any foreign object, damage, or deformation in the movable parts of the connecting component.	Replace the connecting component (such as the coupling) or contact the manufacturer.
The encoder is subject to excessive vibration or shocks.	1. Check if the servo motor has been subject to impact force or vibration which causes damage to the encoder. 2. Remove and shake the motor to see if there are any abnormal noises (disk damage). 3. Visually inspect the encoder's rear cover for dust (encoder damage).	Replace the servo motor.

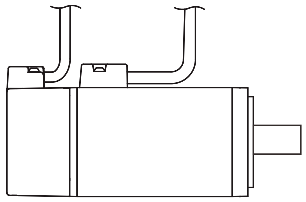
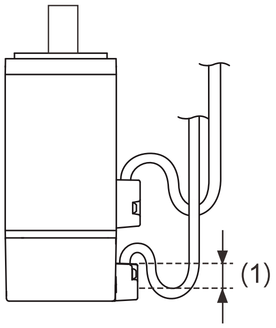
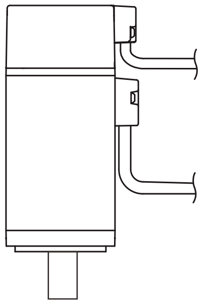
When the servo motor is overheating:

Possible cause	Checking method	Corrective action
Mounting surface of the servo motor has poor thermal conductivity.	Measure the temperatures of the servo motor frame and the mounting surface (metal). The temperature difference should not exceed 20°C (68°F).	Make sure the installation surface is flat. If there is any substance (such as paint or gasket) between the mounting surface and motor surface resulting in poor heat dissipation, remove the substance or use other methods to help heat dissipation (such as forced air cooling for the servo motor).

2

2.4.2 Mounting directions and precautions for the servo motor

You can install the servo motor horizontally or vertically.

Mounting direction	Precautions
Horizontal 	If you are using a servo motor with an oil seal, refer to Section 2.4.5 for oil and water prevention measures for the servo motor.
Vertical - shaft end up 	■ When wiring, you need to install an oil trap (marked as (1) in the figure on the left) to prevent water vapor from entering the motor. ■ When installing the servo motor in a machine (such as in a gearbox), you must adhere to the measures in Section 2.4.5 to prevent oil and gas from entering the servo motor.
Vertical - shaft end down 	If you are using a servo motor with an oil seal, refer to Section 2.4.5 for oil and water prevention measures for the servo motor.

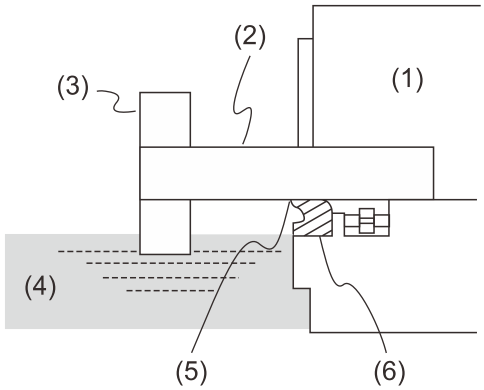
Note: if you desire to install gears on the servo motor, follow the manufacturer's instructions for installation.

2

2.4.3 Precautions for using servo motor with oil seal

This section defines the operating conditions for using the servo motor with an oil seal:

1. In the operating environment, keep the oil level lower than the oil seal lip. If the oil seal lip is lower than the oil level, the oil will enter the servo motor and cause damage to the motor.

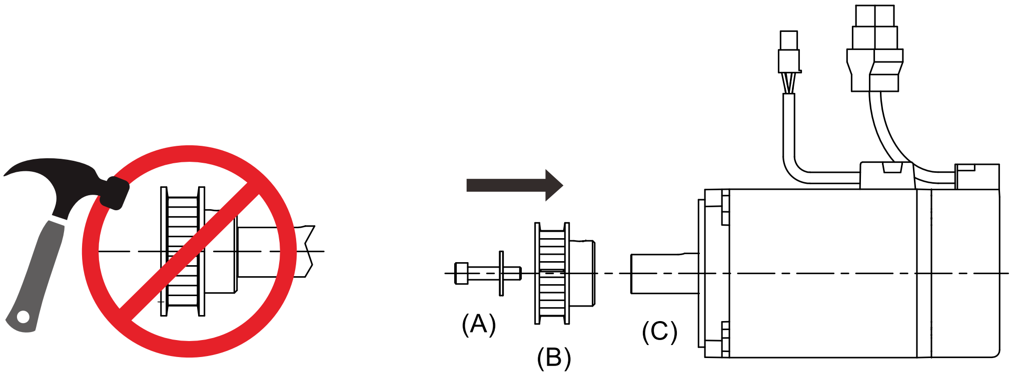


(1) Servo motor; (2) Motor shaft; (3) Gear; (4) Oil; (5) Oil seal lip; (6) Oil seal

2. The oil seal cannot be submerged in the liquid; it can only withstand splashes of oil.
3. The oil seal lip cannot be soaked in oil.

2.4.4 Precautions for installing servo motor accessories

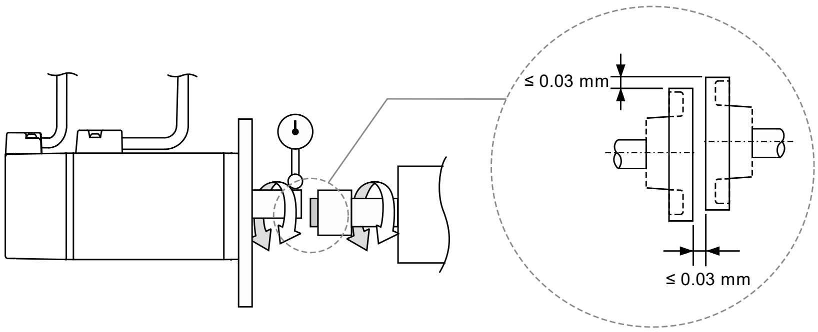
- Wipe off the rustproof coating or oil on the motor shaft.
- If you use a servo motor with a keyway, install the attached key or a key matching the specified dimensions to the motor shaft.
- When installing the key or the motor shaft accessories (such as a belt pulley or gear) to the servo motor, do not apply excessive impact force to the keyway, the accessories installed to the motor shaft (A and B), or the motor shaft (C). Instead, use a screwdriver and a screw.



(A) Screw and washer; (B) Belt pulley; (C) Servo motor shaft

Installation safety precautions for coupling applications

- It is suggested that you use flexible couplings specifically designed for servo motors, especially double spring couplings, which provide some buffer tolerance during eccentric motion and deflection of the motor. Select a coupling of appropriate size for the operating conditions. Improper use or connection may cause damage to the motor.
- Use a dial gauge or other methods to ensure the centering precision is within the specifications. If you are not allowed to use a dial gauge or other methods in the environment, slide the coupling along both shafts and adjust it until it does not get stuck.



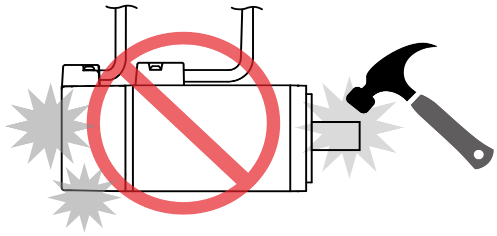
As shown in the previous figure, the distance is measured at four different positions on the circumference for the centering precision. The difference between the maximum and minimum measurements should be 0.03 mm or less. Even within this range, you can make adjustments to increase the centering precision.

Important: when you are doing the measurements, rotate the coupling and the motor shaft together.

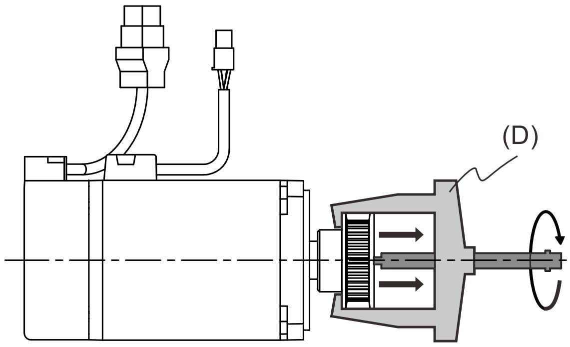
2

Installation safety precautions for motor shaft accessories

- When connecting the shafts, make sure that the required centering precision is reached. If the shafts are not correctly centered, vibration may damage the bearings and encoder.
- When installing the coupling, do not apply excessive force to the shaft or the area around the encoder, as the impact may damage the encoder.



- If the coupling makes any abnormal noise, realign the shafts until the noise disappears.
- Ensure the axial load and radial load are within the specifications. Refer to the specifications for the maximum axial load (N) and maximum radial load (N) for each servo motor.
- Use a bearing puller (D) to remove the motor shaft accessories (such as a coupling, gear, or belt pulley). Do not tug or apply excessive force.

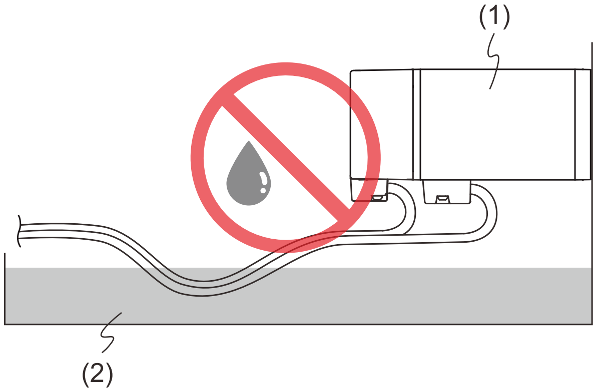


2

2.4.5 Oil and water prevention measures for the servo motor

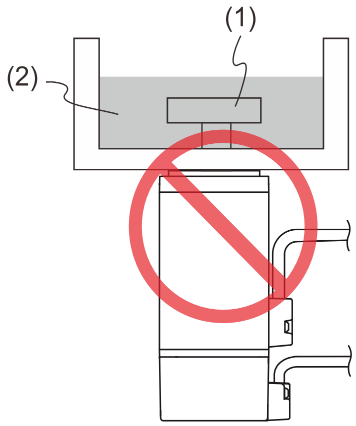
Follow these precautions and do not allow water, oil, or other foreign objects to enter the servo motor.

- Do not submerge the cable in oil or water.



(1) Servo motor; (2) Oil

- If oil or water is unavoidable, use oil-resistant cables. Delta does not provide oil-resistant cables.
- If the servo motor must be mounted with the shaft end up, do not use it in a machine, gearbox, or other environment where the servo motor may have contact with oil or water.



(1) Gear; (2) Oil

- Do not use the servo motor in an environment with cutting fluids. Depending on the cutting fluid types, the sealing materials, coated colloids, cables, and other components may be affected or even deteriorated.
- Do not continuously expose the servo motor to oil mist, water vapor, oil, water, or grease.

If you cannot avoid using the servo motor under the preceding conditions, take prevention measures to avoid dirt and water from entering the machine.

2.4.6 Measures to suppress temperature increase of the servo motor

- When installing the servo motor, pay attention to the cooling conditions (such as size of the heat sink) provided in the specifications of each servo motor type.
- The heat generated during motor operation is dissipated to the heat sink through the motor mounting surface. Therefore, if the surface area of the heat sink is too small, the temperature of the servo motor may increase abnormally.
- If it is difficult to apply large heat sinks in the operating environment or if the ambient air temperature or height exceeds the given specifications, take the following measures:
  (1) Reduce the full-load rating of the servo motor. For more details, refer to the specifications of each servo motor type. When selecting servo motors, consider motors with the power capacity 1 to 2 levels higher.
  (2) Reduce the acceleration and deceleration of the work cycle to lower the motor load.
  (3) Apply external forced air cooling to the servo motor by using cooling fans or other methods.

Important: do not place a gasket or other insulating materials between the servo motor and heat sink, as it may cause motor temperature increase and poor noise immunity, and result in malfunction.

2.5 Specifications for the circuit breaker, magnetic contactor and fuse

Servo drive model	Circuit breaker	Magnetic contactor (MC)	Fuse (Class T)
ASD-A3-0443-☐	10 A	5 A	10 A
ASD-A3-0743-☐	15 A	10 A	15 A
ASD-A3-1043-☐	15 A	10 A	15 A
ASD-A3-1543-☐	20 A	15 A	20 A
ASD-A3-2043-☐	25 A	15 A	25 A
ASD-A3-3043-☐	30 A	25 A	35 A
ASD-A3-4543-☐	50 A	40 A	50 A
ASD-A3-5543-☐	50 A	40 A	60 A
ASD-A3-7543-☐	60 A	50 A	80 A
ASD-A3-1B43-☐	90 A	80 A	100 A
ASD-A3-1F43-☐	90 A	80 A	110 A

Note:
1. In the servo drive model number, ☐ represents the model type.
2. Operation mode: standard.
3. If the servo drive is equipped with a residual-current device (RCD) for electricity leakage protection, select a circuit breaker with sensitivity of at least 200 mA and with minimum 0.1 sec working time to avoid incorrect operation of the RCD.
4. Select the Type B residual-current device (RCD) with time delay, as the system ground wire may contain DC electricity.
5. Use the fuse and circuit breaker that comply with the UL / CSA standard.
6. If authority in the country may designate I△n and maximum fault loop impedance, you shall follow the rule in such a case. Otherwise, follow the maximum fault loop impedance in this table:

Servo drive model	Maximum fault loop impedance	
	TN system	TT system
ASD-A3-0443-☐	1.6 Ω	220 Ω
ASD-A3-0743-☐	1.3 Ω	220 Ω
ASD-A3-1043-☐	1.3 Ω	220 Ω
ASD-A3-1543-☐	1.01 Ω	220 Ω
ASD-A3-2043-☐	0.85 Ω	220 Ω
ASD-A3-3043-☐	0.75 Ω	220 Ω
ASD-A3-4543-☐	0.69 Ω	220 Ω
ASD-A3-5543-☐	0.65 Ω	220 Ω
ASD-A3-7543-☐	0.65 Ω	220 Ω
ASD-A3-1B43-☐	0.62 Ω	220 Ω
ASD-A3-1F43-☐	0.62 Ω	220 Ω

2.6 Ferrite ring

The ferrite ring suppresses high-frequency noise, reducing high-frequency interference in the power cable, signal cable, and connectors. The ferrite ring is usually made of Mn-Zn ferrite. The impedance of the ferrite ring varies with frequency. Normally, its impedance is relatively small to low-frequency signals; however, when the frequency of the signal increases, the impedance increases dramatically, which optimizes signal transmission. The suggested ferrite ring model is as follows.

Ferrite ring model	Applicable servo drive model
ASD-ACFC7K00	ASD-A3-2043-☐, ASD-A3-3043-☐, ASD-A3-4543-☐, ASD-A3-5543-☐, ASD-A3-7543-☐, ASD-A3-1B43-☐, ASD-A3-1F43-☐

Note: in the servo drive model number, ☐ represents the model type.

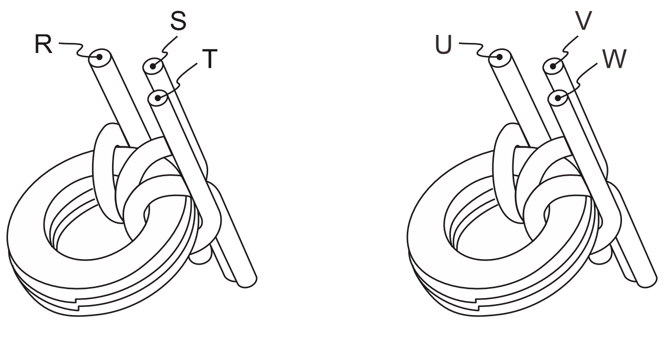
Installation precautions

The ferrite ring is commonly used when peripheral devices (such as the controller) are affected by noise from conduction and radiation when the servo motor is in the Servo On state.
The parasitic capacitance between the cables in the wiring panel and the ground is typically small, but as the frequency of the signal increases (in the Servo On state), the resistance of the parasitic capacitance becomes small enough for the common-mode current to flow through. Normally, common-mode current only leads to common-mode interference due to an unstable circuit caused by a poor connection in the power circuit and between the servo drive and the ground. If the common-mode current flows through the external cables, common-mode interference may also happen due to electrical interference caused by unstable electric potential.

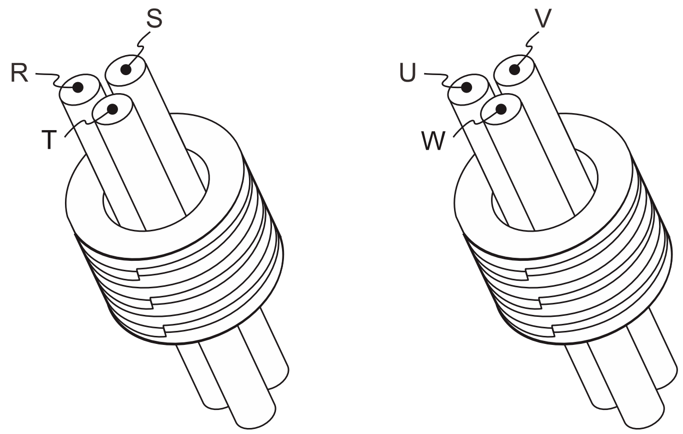
When suppressing common-mode interference, the ferrite ring causes eddy current losses to high-frequency signals and transforms them into heat. The ferrite ring acts as a low-pass filter to effectively suppress high-frequency noise and ensure the stability of the circuit while the impedance to low-frequency signals is relatively small.

Winding several turns of wire onto the ferrite ring can increase inductance and the ability to filter out high-frequency noise. The suggested winding methods are shown as follows:

1. For 2 kW to 7.5 kW models



2. For 11 kW to 15 kW models

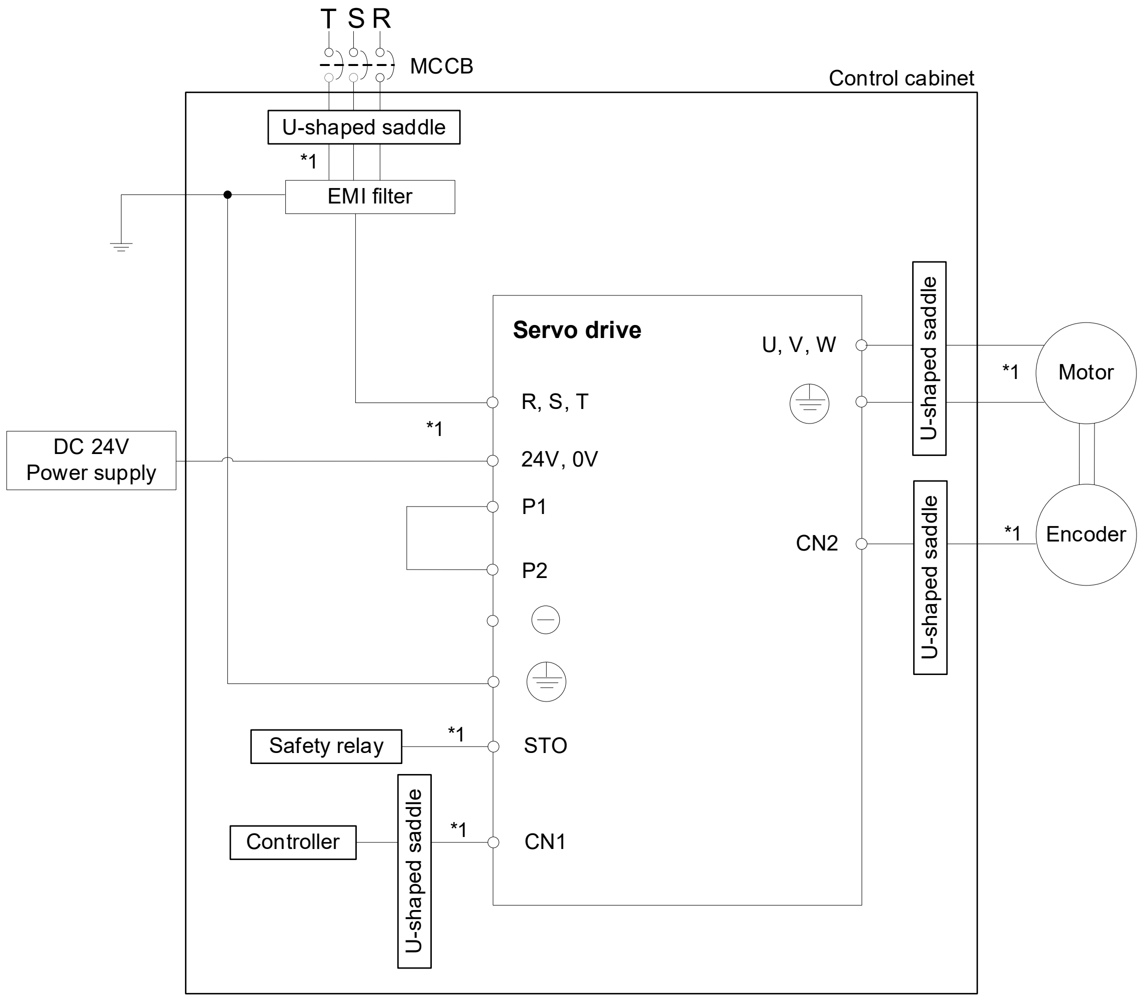


Note:
1. Refer to Section 3.1.6.5 for the selection of the motor power cable.
2. Only the motor power cable or servo drive power cable can run through the ferrite ring. If needed, prepare extra ferrite rings for grounding.
3. An EMI filter for absorbing radiation may be required when a longer motor power cable is used.

2

2.7 Installation requirements for EMC

This section illustrates the installation requirements for passing the EMC test. Note that the EMC rating varies based on the installation structure or wiring. Delta servo products are designed in accordance with the EMC standards. Refer to the following diagram for the standard installation, through which the Delta servo products passed the EMC test.



Note:
*1. Use shielded wires.

2.7.1 EMI filters

All electronic equipment (including servo drives) generates high or low frequency noise during operation, which interferes with peripheral equipment through conduction or radiation. With an EMI filter correctly installed and used, you can eliminate much of the interference. For optimized performance, it is recommended that you use Delta's EMI filter for suppressing the interference.

Power	Servo drive model	Recommended EMI filter
		3PH
400 W	ASD-A3-0443-☐	EMF014A43A
750 W	ASD-A3-0743-☐	EMF014A43A
1 kW	ASD-A3-1043-☐	EMF014A43A
1.5 kW	ASD-A3-1543-☐	EMF014A43A
2 kW	ASD-A3-2043-☐	EMF018A43A
3 kW	ASD-A3-3043-☐	EMF018A43A
4.5 kW	ASD-A3-4543-☐	EMF033A43A
5.5 kW	ASD-A3-5543-☐	EMF033A43A
7.5 kW	ASD-A3-7543-☐	EMF033A43A
11 kW	ASD-A3-1B43-☐	B84143D0075R127
15 kW	ASD-A3-1F43-☐	B84143D0075R127

Note: in the servo drive model number, ☐ represents the model type.

General precautions for installation

To ensure the best performance of the EMI filter, apart from the installation and wiring instructions of the servo drive in the user manual, pay attention to these precautions:

1. The servo drive and EMI filter must be mounted on the same metal plate.
2. The wiring should be as short as possible.
3. The metal plate should be well grounded.
4. It is recommended that you install one servo drive with one EMI filter.

Refer to the following standards for more specifications of EMI filter installation:

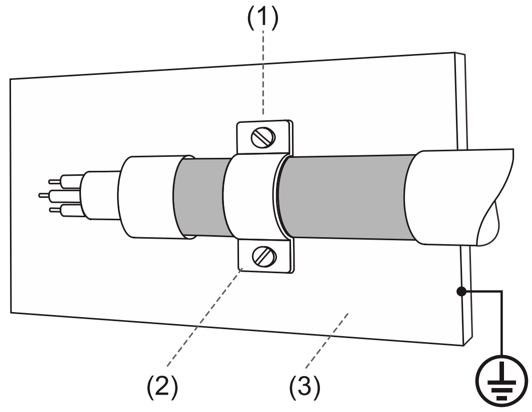
1. EN 61000-6-4 (2001)
2. EN 61800-3 (2004) PDS of category C2
3. EN 55011+A2 (2007) Class A Group 1

2

Motor power cable selection and installation precautions

The selection of motor power cable and installation accuracy determine the performance of the EMI filter. Follow these precautions:

1. Use a cable that has braided shielding (the effect of double shielding is better).
2. The shield on both ends of the motor power cable should be grounded with the shortest distance and the largest contact area.
3. Remove the protective paint on the U-shaped saddle and metal plate to ensure good contact. See the following figure.
4. Correctly connect the braided shielding of the motor power cable and the metal plate: fix the braided shielding on both ends of the motor power cable with the U-shaped saddle and metal plate. See the following figure.



(1) Remove the protective paint on the U-shaped saddle and metal plate to ensure good contact.

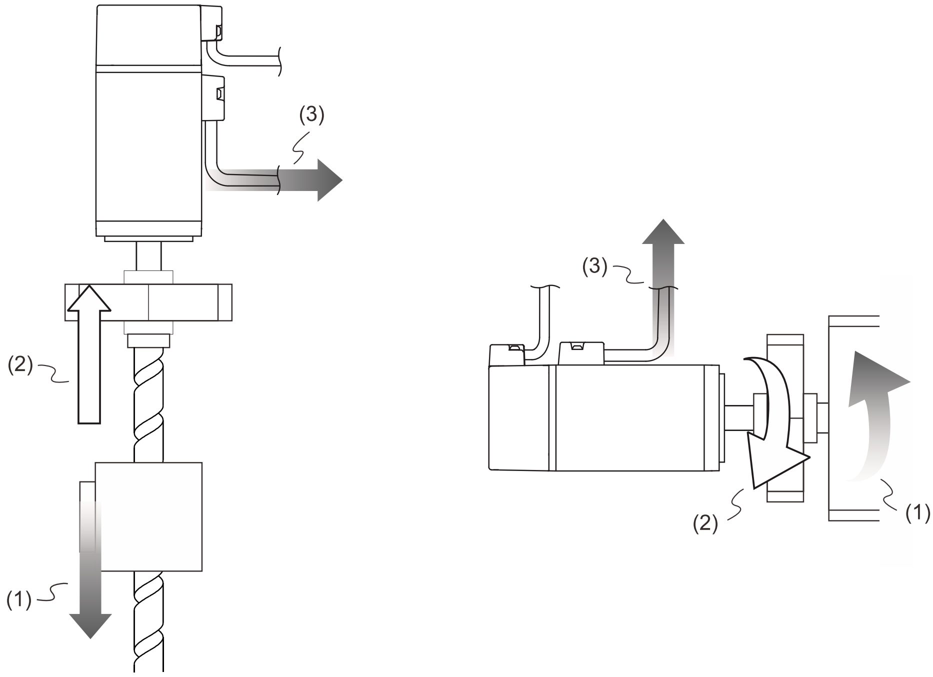
(2) U-shaped saddle

(3) Well-grounded metal plate

2.8 Selecting the regenerative resistor

2

Some of the servo drive models have a built-in regenerative resistor, and you can use an external regenerative resistor if needed. When the direction of torque is opposite to the direction of rotation, the energy generated returns to the servo drive from the load. This energy is turned into electricity in the capacitance of the DC Bus and thus increases the voltage. When the voltage reaches a given value, the excess energy is consumed by a regenerative resistor. Refer to the following table to select the suitable regenerative resistor.



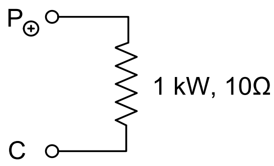
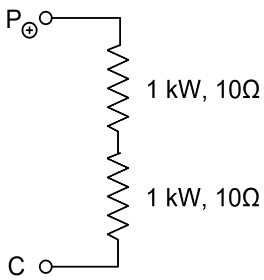
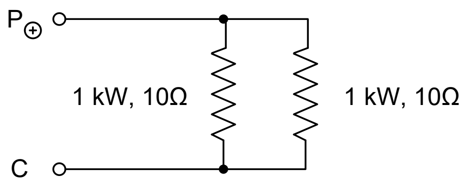
(1) Moving direction of the object; (2) Direction of torque; (3) Regenerative energy

Servo drive (kW)	Specifications of the built-in regenerative resistor		Capacity of the built-in regenerative resistor (Watt)	Minimum allowable resistance value (reference for external resistors) (Ohm)
	Resistance (Ohm)	Capacity (Watt)		
0.4	80	60	30	80
0.75	80	60	30	60
1	80	60	30	60
1.5	80	60	30	40
2	-	-	-	40
3	-	-	-	30
4.5	-	-	-	25
5.5	-	-	-	25
7.5	-	-	-	15
11	-	-	-	15
15	-	-	-	15

When the regenerative energy exceeds the capacity of the built-in regenerative resistor, use an external one. Pay special attention to the following when using a regenerative resistor:

1. Correctly set the resistance value (P1.052) and capacity (P1.053) for the regenerative resistor, otherwise it might affect the performance.
2. When using an external regenerative resistor, ensure the total resistance value is greater than the minimum allowable resistance value of the servo drive.
3. The general application is to connect multiple resistors in series. If the resistance value exceeds the setting range, you can reduce the value by connecting the resistors in parallel. If you want to connect the resistors in parallel to increase the capacity of the regenerative resistors, make sure the resistance value meets the requirements.

   See the following for connecting the regenerative resistors in series and in parallel.

Connect to one external regenerative resistor	
	P1.052 = 10 (Ω) P1.053 = 1000 (W)
Connect to external regenerative resistors (serial connection)	
	P1.052 = 20 (Ω) P1.053 = 2000 (W)
Connect to external regenerative resistors (parallel connection)	
	P1.052 = 5 (Ω) P1.053 = 2000 (W)

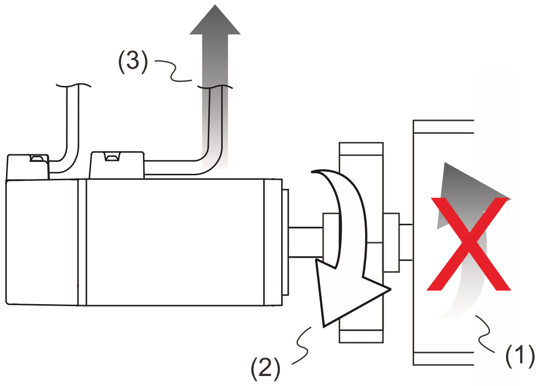
4. Normally, if the average regenerative energy is within the rated capacity of regenerative resistor, the resistor temperature can increase to 120°C (248°F) or even higher when the regenerative energy continues to function. For safety reasons, apply forced cooling to reduce the resistor temperature. Alternatively, use regenerative resistors equipped with thermal switches. Contact the manufacturer for the load characteristics of the regenerative resistor.

When installing an external regenerative resistor, connect the resistor to P3 and C contacts, and leave P3 and D contacts open. Choose the external regenerative resistors of the resistance values specified in the table on the previous page. For easy calculation of the required regenerative resistor capacity, regardless of the energy consumed by IGBT, select the capacity of the external regenerative resistor according to the selected rotary motor.

Rotary motor:

Selecting the regenerative energy

(a) Calculation of the regenerative energy when there is no external torque.



(1) Moving direction of the object; (2) Direction of torque;
(3) Regenerative energy generated when the motor decelerates

If the motor is making a reciprocating motion, the regenerative resistor consumes the excess return energy. Refer to the following table when calculating and selecting the required regenerative resistor.

Inertia	Servo drive (kW)	Motor	Rotor inertia (× 10^{-4} kg·m^2)	Regenerative energy generated when the motor decelerates from rated speed to a stop without load Eo (joule)	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
Medium inertia	0.4	ECM-B3M-J□0604□□□	0.254	1.26	8.42
	0.75	ECM-B3M-J□0807□□□	1.07	5.29	10.30
	1.0	ECM-B3M-J□1010□□□	2.78	13.75	12.17
	1.5	ECM-B3M-J□1015□□□	3.69	18.25	14.66
	2.0	ECM-B3M-J□1020□□□	4.68	23.14	24.34
	1.0	ECM-B3M-K□1310□□□	7.79	17.12	12.17
	1.5	ECM-B3M-K□1315□□□	11.22	24.66	14.66
	2.0	ECM-B3M-K□1320□□□	14.65	32.20	24.34
High inertia	1.0	ECM-B3H-L□1308□□□	12.44	15.38	12.17
	1.5	ECM-B3H-L□1313□□□	18	22.25	14.66
	2.0	ECM-B3H-L□1318□□□	22.6	27.94	24.34
Medium inertia	2.0	ECM-B3M-K□1820□□□	41.9	92.09	24.34
	3.0	ECM-B3M-L□1830□□□	53.63	66.3	29.33
	4.5	ECM-B3M-L□1845□□□	67.73	83.73	42.43
	5.5	ECM-B3M-L□1855□□□	98.88	122.24	51.17
	7.5	ECM-B3M-L□1875□□□	134.95	166.83	63.65
	11	ECM-B3M-L□221B□□□	302	373.35	76.75
	15	ECM-B3M-L□221F□□□	400	494.51	102.34

Assuming that the load inertia is N times the motor inertia, when the motor decelerates from 3,000 rpm to a stop, the regenerative energy is (N + 1) × Eo and the regenerative resistor needs to consume (N + 1) × Eo - Ec joules. Assuming that the reciprocating motion cycle is T sec, then the required capacity of regenerative resistor = 2 × ((N + 1) × Eo - Ec) / T. The calculation is as follows:

Step	Item	Calculation and setting method
1	Set the capacity of the regenerative resistor to the maximum.	Set P1.053 to the maximum value.
2	Set the reciprocating motion cycle (T).	Manual input.
3	Set the rotation speed (wr).	Manual input or read the status with P0.002.
4	Set the ratio (N) of load inertia to motor inertia.	Manual input or read the status with P0.002.
5	Calculate the maximum regenerative energy (Eo).	Eo = J x wr^2 / 182
6	Find the regenerative energy that can be absorbed by the capacitor (Ec).	Refer to the preceding table.
7	Calculate the required capacity of the regenerative resistor.	2 × ((N + 1) × Eo - Ec) / T

Take the 0.75 kW motor (ECM-B3M-JA0807RS1) for example. When the reciprocating motion cycle (T) is 0.4 sec, the rotation speed is 3000 rpm, and the ratio of load inertia to motor inertia is 1. The calculation is as follows:

Servo drive (kW)	Motor	Rotor inertia J ($\times 10^{-4}$ kg·m^2)	Regenerative energy generated when the motor decelerates from rated speed to a stop without load Eo (joule)	Maximum regenerative energy that can be absorbed by the capacitor Ec (joule)
0.75	ECM-B3M-JA0807RS1	1.07	5.29	10.30

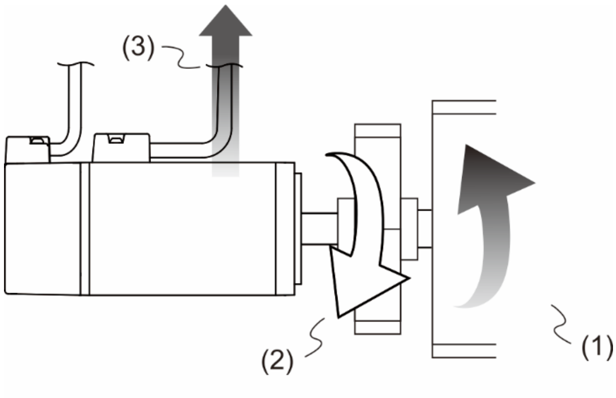
Eo = 5.29 joules

Ec = 10.3 joules

The required regenerative resistor capacity = $\frac{2 \times ((N + 1) \times E_o - E_c)}{T} = \frac{2 \times ((1 + 1) \times 5.29 - 10.3)}{0.4}$ = 1.4 W

From the preceding calculation, the required capacity of the regenerative resistor is 1.4 W, which is smaller than the specified capacity of the built-in regenerative resistor. In this case, the built-in regenerative resistor of 60 W fulfills the need. In general, the built-in regenerative resistor can meet the requirement when the external load is not too great.

(b) Calculation of the regenerative energy when there is external torque and the motor does the negative work.



(1) Moving direction of the object; (2) Direction of torque; (3) Regenerative energy

Usually, when the motor does positive work, the motor's torque direction is identical to the rotation direction. However, in some circumstances, the motor's torque direction is opposite to the rotation direction. This means the motor is doing negative work and the external energy is applied to the servo drive through the motor. For instance, if the external force direction is identical to the rotation direction (such as downward motion of the vertically mounted machine), the servo system outputs more power to counterbalance the excessive external force (the weight of vertically mounted machine) in order to keep up with the specified target speed. In this case, considerable energy returns to the servo drive. When the DC Bus is full and cannot store more energy, this energy is absorbed by the regenerative resistor.

Take the 0.75 kW motor (ECM-B3M-JA0807RS1) for example. When the torque of the external load is +50% of the rated torque (2.4 N·m) with the rotation speed up to 3,000 rpm, the required external regenerative resistor is:

$2 \times (0.5 \times 2.4) \times \left(\frac{3000 \times 2 \times \pi}{60}\right) = 753.6$ W.

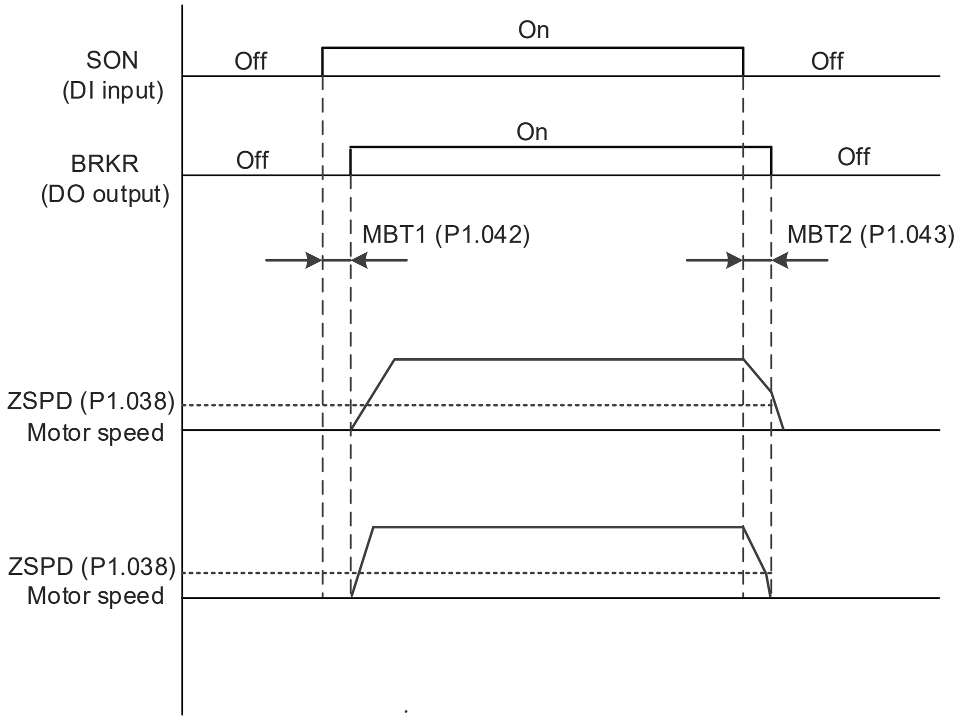
Therefore, a regenerative resistor of 760 W and 60 Ω is needed.

2

2.9 The use of braking

A brake is usually used for motions in the Z-axis direction because gravity causes the machine to fall. A brake can prevent the machine from falling and reduce the motor's excessive resistance. The motor lifespan could be reduced due to the excessive heat generated by continuous resistance. To avoid incorrect operation, the brake can be enabled only when the servo is switched off. The drive controls the brake with DO. If DO.BRKR is set to Off, it means the brake is not operating and the motor is clamped; if DO.BRKR is set to On, it means the brake is operating and the motor can run freely. You can use MBT1 (P1.042) and MBT2 (P1.043) for the delay time settings.

Timing diagram of brake control:

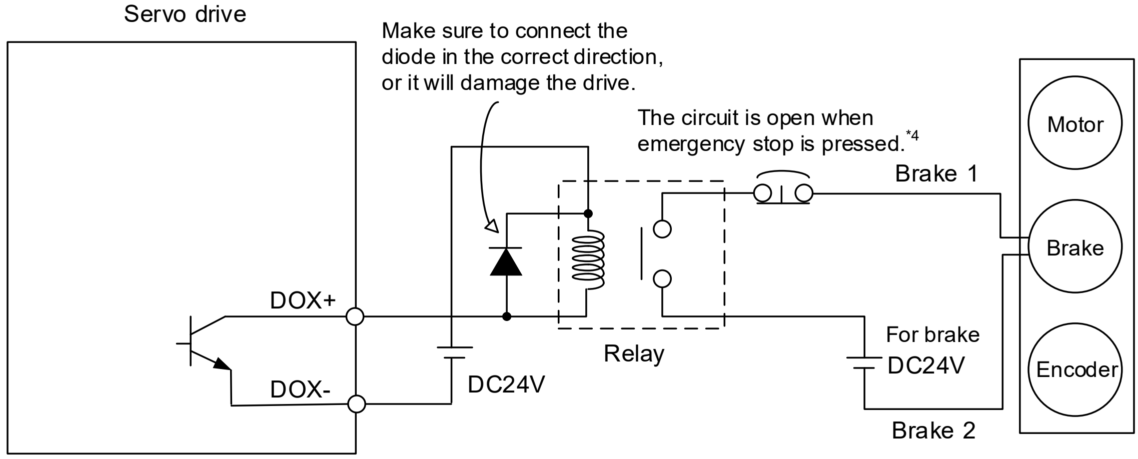


Output timing of the BRKR signal:

1. When the servo drive is off and the time set for P1.043 is exceeded, but the motor speed is still higher than the speed set for P1.038, DO.BRKR is Off (the motor is clamped).
2. When the servo drive is off and the time set for P1.043 is not yet reached, but the motor speed is already lower than the speed set for P1.038, DO.BRKR is Off (the motor is clamped).

When the motor runs normally (Servo On), DO.BRKR [0x08] should be set to On, it means the brake is operating and the motor can run freely. Use the emergency stop button in an emergency to cut off the circuit and set DI.EMGS [0x21] to On. Then AL013 is triggered, and the motor is immediately stopped.

Wiring of the brake:



Note:

1. Refer to Chapter 3 Wiring.
2. The brake signal controls the solenoid valve, providing power to the brake and enabling the brake.
3. There is no polarity for the brake coil.
4. Pressing the emergency stop button during motor operation may cause damage to the motor brake.

Calculate the brake’s rated current (the ECM-B3M-JA0807RS1 motor is used as an example). Brake power consumption (at 20°C (68°F)) = 8 W (refer to Appendix A Specifications), so the brake's rated current = $\frac{8\text{ W}}{24\text{V}}$ = 0.34 A.

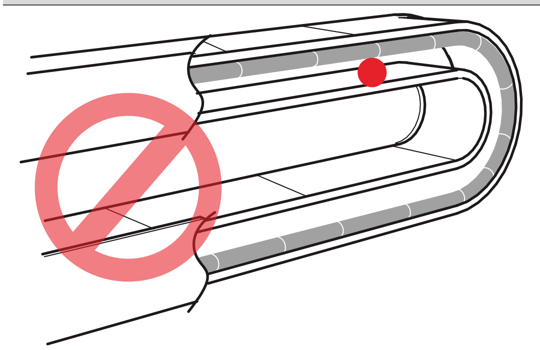
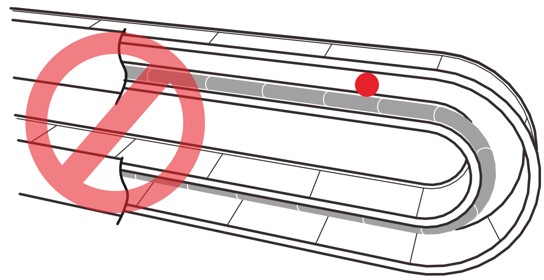
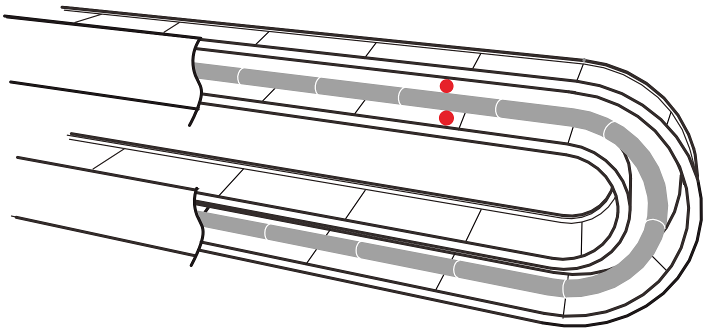
2.10 The use of cable

Precautions for using standard cable:

- Do not use a standard cable when the application requires the cable to move or bend. If required, use a flexible cable instead.

Precautions for using flexible cable:

- Inappropriate installation and wrong usage shorten the cable lifespan.
- Do not twist the cable when installing.
- Do not fix the cable on or near the bending part, otherwise the cable may break.
- After cable fixation, make sure the cable can be moved with ease, so that it does not create excessive tension on the bending or fixation part.
- Prevent the connectors of the cable from being subject to stress.
- Excessive cable length causes unnecessary bending, while insufficient cable length leads to breakage due to the excessive tension on the cable fixation part. Estimate the suitable cable length by dragging the cable carrier to the longest and shortest possible.

Cable is too long	Cable is too short
	
Appropriate cable length, with clearance on both sides of cable	
	

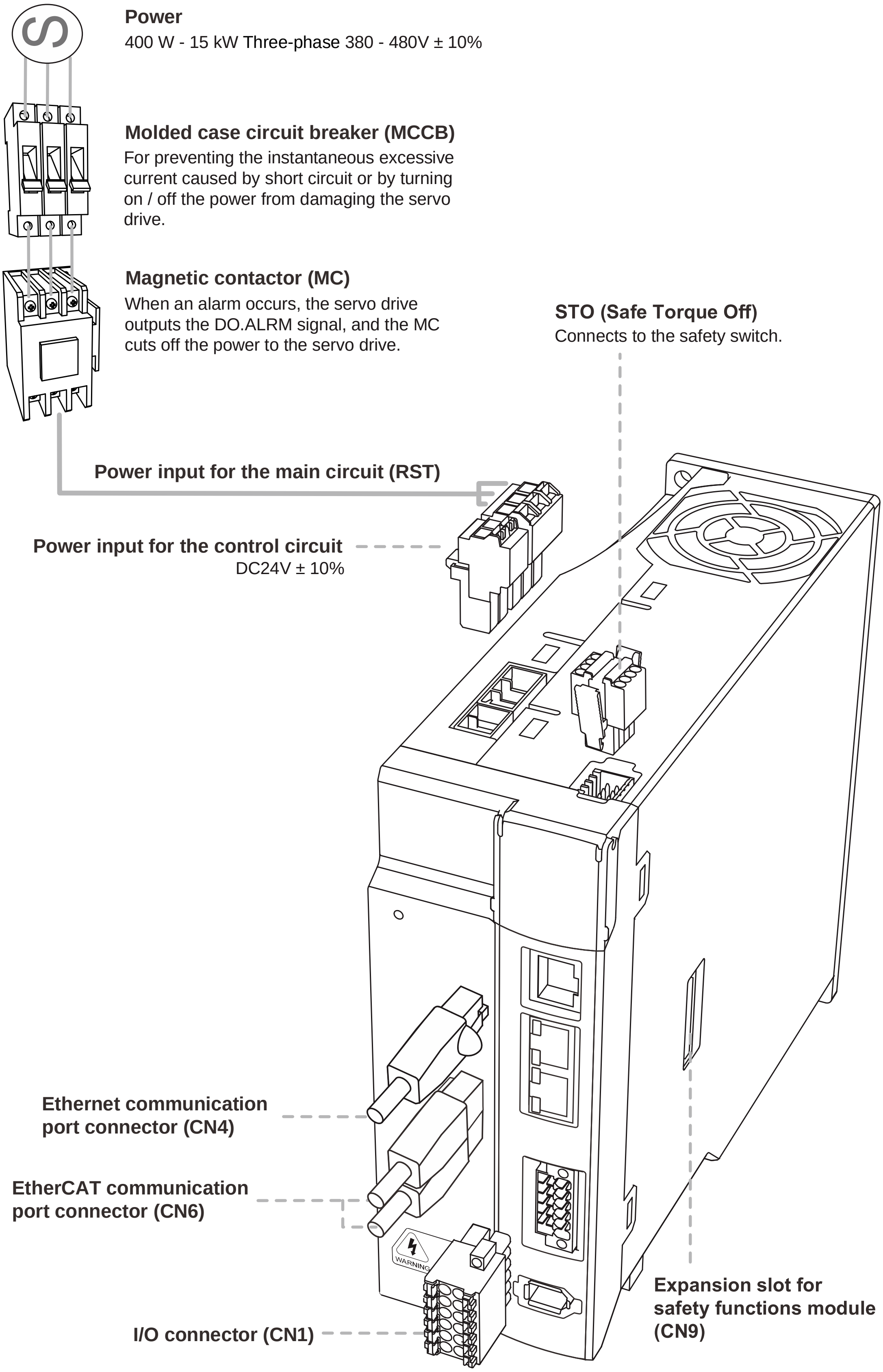
- When installing the cable carrier, avoid contact between the cables. Do not stack the cables one above the other; use dividers to prevent cable entanglement.
- Avoid scraping, crushing, or stepping on the cable. This can damage the inner wires even when the cable seems intact on the outside.
- Do not bend the flexible cable under any normal circumstances. Refer to Section 3.1.6.6 for detailed flexible cable specifications.

Wiring 3

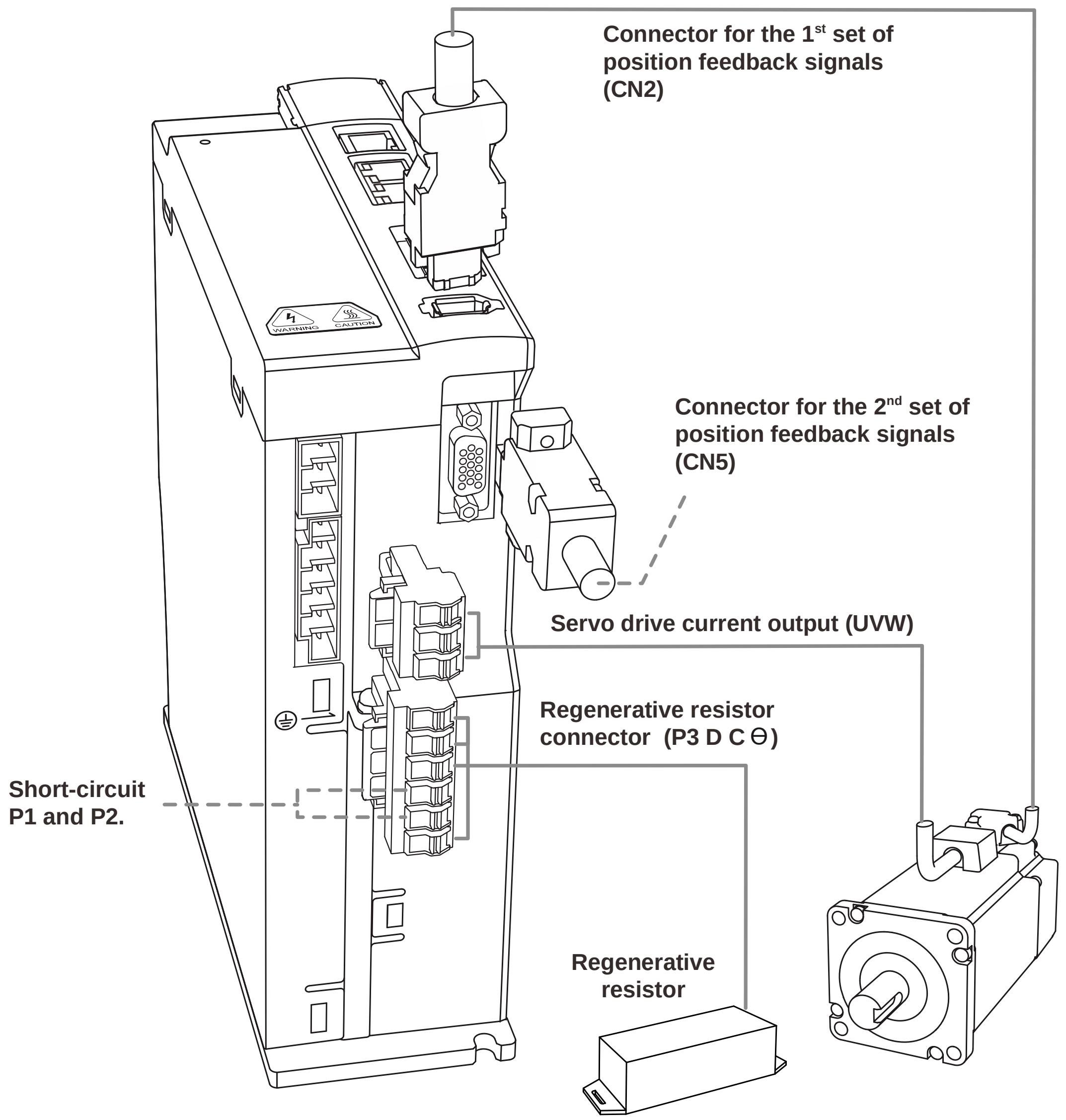
This chapter illustrates the power supply circuit, connectors, and wiring of the A3-EP models.

3.1 System connection

3.1.1 Connecting to peripheral devices (connecting to Delta communication type servo motor)



3


Connector for the 1st set of position feedback signals (CN2)
Connector for the 2nd set of position feedback signals (CN5)
Servo drive current output (UVW)
Regenerative resistor connector (P3 D C ⊖)
Short-circuit P1 and P2.
Regenerative resistor

3.1.2 Connectors and terminals

<table>
<tr><th>Terminal</th><th>Name</th><th colspan="3">Description</th></tr>
<tr><td>DC24V, DC0V</td><td>Power input for the control circuit</td><td colspan="3">Connect to DC 24V power.</td></tr>
<tr><td>P1, P2</td><td>-</td><td colspan="3">Short-circuit P1 and P2.</td></tr>
<tr><td>R, S, T</td><td>Power input for the main circuit</td><td colspan="3">Connect to three-phase AC power.
(Refer to the model specification for the proper input voltage.)</td></tr>
<tr><td rowspan="6">U, V,
W, FG</td><td rowspan="6">Terminals for motor connection</td><td colspan="3">Connect to the servo motor.</td></tr>
<tr><td>Terminal</td><td>Wire color</td><td>Description</td></tr>
<tr><td>U</td><td>Red</td><td rowspan="3">Connection terminals for the power cable.</td></tr>
<tr><td>V</td><td>White</td></tr>
<tr><td>W</td><td>Black</td></tr>
<tr><td>FG</td><td>Yellow / Green</td><td>Connect to the ground terminal ⏚ for the servo drive.</td></tr>
<tr><td rowspan="3">P3, D,
C, ⊖</td><td rowspan="3">Terminals for the regenerative resistor or regenerative unit</td><td colspan="2">Use the built-in resistor</td><td>Short-circuit P3 and D contacts, and P3 and C contacts are left open.</td></tr>
<tr><td colspan="2">Use an external resistor</td><td>Connect P3 and C contacts to the resistor, and P3 and D contacts are left open.</td></tr>
<tr><td colspan="2">Use an external regenerative unit</td><td>Connect the regenerative unit to P3 and ⊖ on the servo drive. P3 & D contacts and P3 & C contacts are left open.</td></tr>
<tr><td>⏚</td><td>Ground terminals</td><td colspan="3">Connect to the ground wires for the power and servo motor.</td></tr>
<tr><td>CN1</td><td>I/O connector</td><td colspan="3">Connect to the controller. Refer to Section 3.3 for more information.</td></tr>
<tr><td>CN2</td><td>Connector for the 1st set of position feedback signals</td><td colspan="3">Connect to the Delta servo motor or BiSS C encoder. Refer to Section 3.4 for more information.</td></tr>
<tr><td>CN4</td><td>Ethernet communication port</td><td colspan="3">Connect to PC or laptop.
Refer to Section 3.5 for more information.</td></tr>
<tr><td>CN5</td><td>Connector for the 2nd set of position feedback signals</td><td colspan="3">Connect to the Delta servo motor, third-party motor, or Hall sensor; support Delta communication type servo motors, BiSS C, TTL, SIN/COS, and HIPERFACE encoders. Refer to Section 3.6 for more information.</td></tr>
<tr><td>CN6</td><td>EtherCAT communication port</td><td colspan="3">For EtherCAT communication. Refer to Section 3.7 for more information.</td></tr>
<tr><td>CN9</td><td>Expansion slot for safety functions module</td><td colspan="3">Connect to the safety functions module. Refer to Section 3.8 for more information.</td></tr>
<tr><td>CN10</td><td>STO terminal</td><td colspan="3">STO function. Refer to Section 3.9 for more information.</td></tr>
</table>

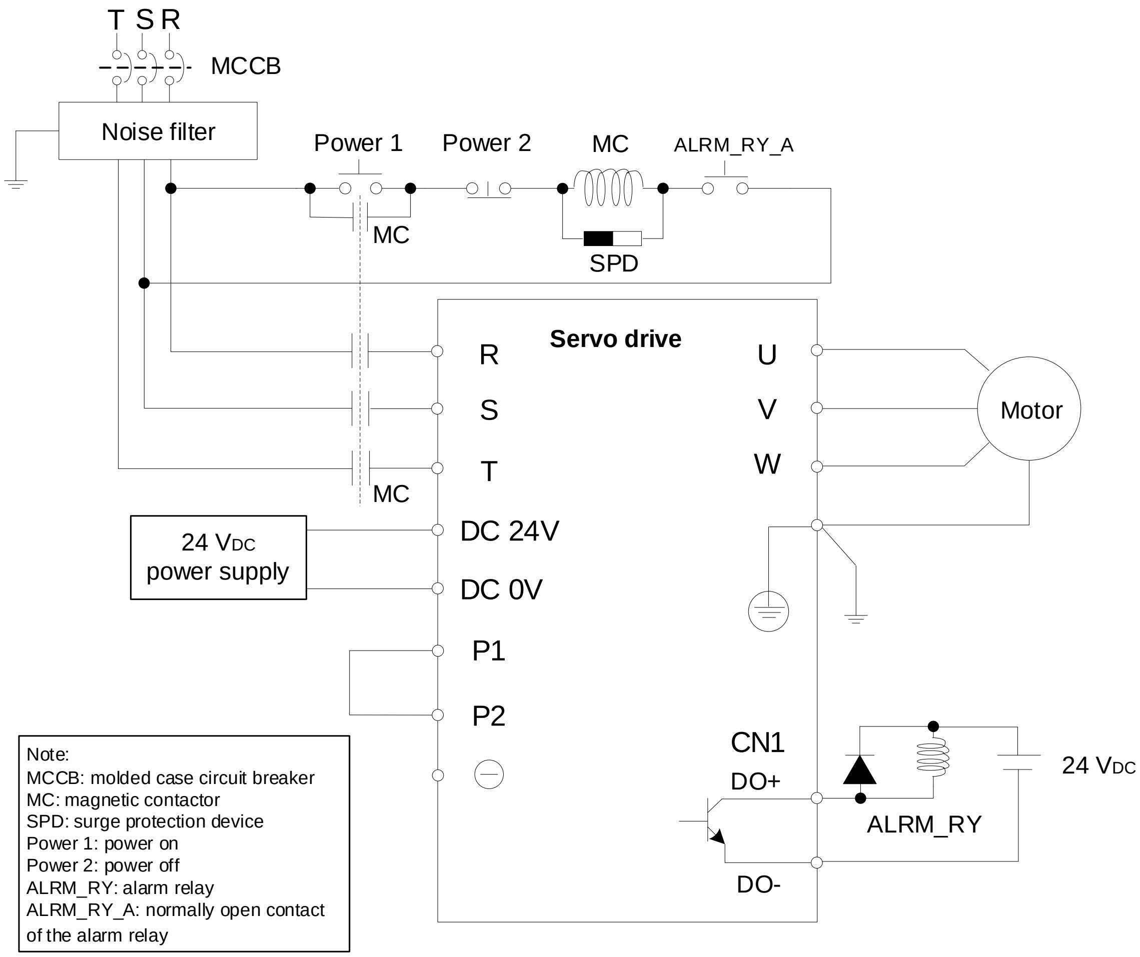
Pay special attention to the following when wiring:

1. Do not touch the RST and UVW cables immediately after the power is off since the capacitance inside the servo drive can still contain a dangerously large amount of electric charge. Wait until the CHARGE indicator is off.
2. The minimum separation distances should be at least 30 cm (11.8 inches) between power cables (for supplying power to servo drive or motor) and signal cables (for transmitting I/O signal or encoder signal) to prevent misoperation.
3. For the connection cable for CN2 and CN5, use a metal braided shielded twisted-pair cable that conforms to UL2464 specifications.
4. When using Ethernet or EtherCAT, use the shielded twisted-pair communication cable to ensure the communication quality.
5. Do not use any external capacitor, or it may damage the servo drive.

3.1.3 Wiring for power supply

The three-phase wiring is applicable to the servo drive. In the following diagram, Power 1 and ALRM_RY_A are normally open contacts, and Power 2 is a normally closed contact. MC (magnetic contactor) is the power relay and the contact for the main power circuit.

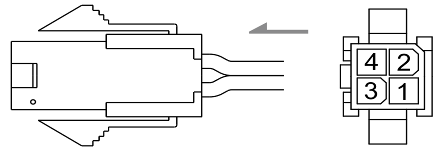
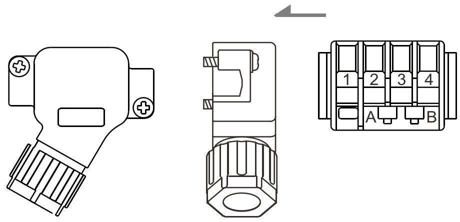
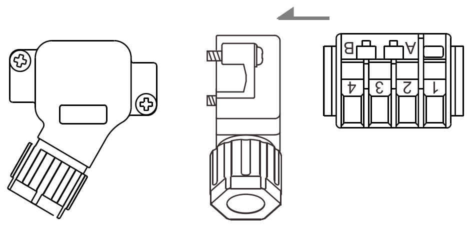
■ Wiring method for three-phase power supply (for all series)



3

3.1.4 UVW power connector specifications

3.1.4.1 F40 - F80 motors – Power connectors

Connector type	Applicable model Model number	UVW power connector - w/o brake
Standard	ECM-B3 ECM-B3□-□□△△□□RS□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards motor shaft	ECM-B3 ECM-B3□-□□△△□□RB□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards encoder	ECM-B3 ECM-B3□-□□△△□□RB□ △△ = 04, 06, 08	

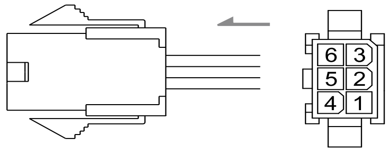
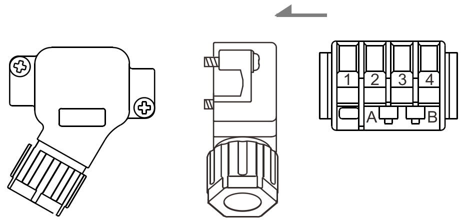
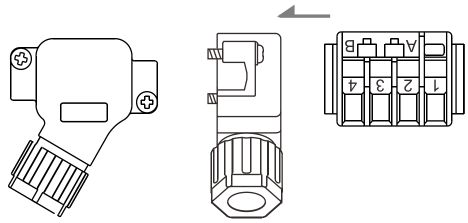
Pin assignment			
U (Red)	V (White)	W (Black)	FG (Yellow / Green)
1	2	3	4

Note: all bulkhead connectors are with brakes. Do not wire Pin A and Pin B when using the motors without brakes.

Recommended connectors:

Connector type	Brand	Model number	IP rating
Standard	Delta	ACS3-CAPW1000	IP20
	Molex	39-01-2041 (case) + 39-00-0040 (terminal)	IP20
Bulkhead - cable exit direction towards motor shaft	Delta	ACS3-AFPWSS00	IP67
	SUNCHU	SC-ACS3-AFPWSS00	IP67
Bulkhead - cable exit direction towards encoder	Delta	ACS3-ABPWSS00	IP67
	SUNCHU	SC-ACS3-ABPWSS00	IP67

Note: refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.

Connector type	**Applicable model** / **Model number**	**UVW power connector - with brake**
Standard	ECM-B3 ECM-B3□-□□△△□□SS□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards motor shaft	ECM-B3 ECM-B3□-□□△△□□SB□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards encoder	ECM-B3 ECM-B3□-□□△△□□SB□ △△ = 04, 06, 08	

Pin assignment						
Connector type	U (Red)	V (White)	W (Black)	FG (Yellow / Green)	BRAKE1 (Brown)	BRAKE2 (Blue)
Standard	1	2	4	5	3	6
Bulkhead	1	2	3	4	A	B

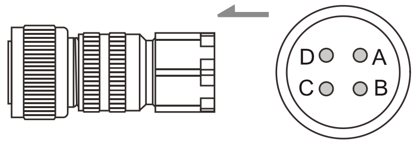
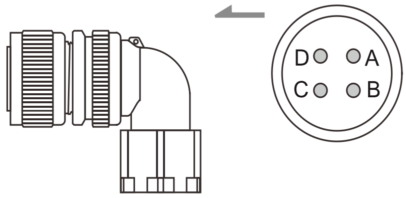
Note: power supply for the brake is 24 V_{DC}; do not share the same power supply with other signals. The brake coil has no polarity; its pin symbols are BRAKE1 and BRAKE2.

Recommended connectors:

Connector type	Brand	Model number	IP rating
Standard	Delta	ACS3-CAPW2000	IP20
	Molex	39-01-2061 (case) + 39-00-0040 (terminal)	IP20
Bulkhead - cable exit direction towards motor shaft	Delta	ACS3-AFPWSS00	IP67
	SUNCHU	SC-ACS3-AFPWSS00	IP67
Bulkhead - cable exit direction towards encoder	Delta	ACS3-ABPWSS00	IP67
	SUNCHU	SC-ACS3-ABPWSS00	IP67

Note: refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.

3.1.4.2 F100 - F130 motors – Power connectors

Connector type	Applicable model Model number	UVW power connector - w/o brake
Military - straight 3106A-18-10S	ECM-B3 ECM-B3□-□□△△□□□S□ △△ = 10, 13	
Military - right angle 3108A-18-10S	ECM-B3 ECM-B3□-□□△△□□□S□ △△ = 10, 13	

Pin assignment			
U (Red)	V (White)	W (Black)	FG (Yellow / Green)
A	B	C	D

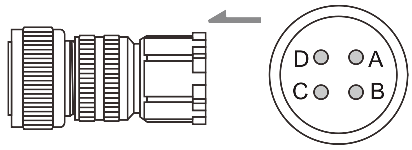
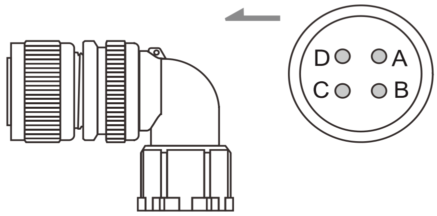
Note: refer to Section 3.1.4.5 for the brake connector.

Recommended connectors:

Connector type	Brand	Model number	IP rating
Military - straight 3106A-18-10S	Delta	ACS3-CAPWA000	IP67
	SUNCHU	CMS3106A18-10SBI (connector & compression ring)	IP67
Military - right angle 3108A-18-10S	Delta	ACS3-CRPWA000	IP67
	SUNCHU	CMS3108A18-10SBI (connector & compression ring)	IP67

Note: refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.

3.1.4.3 F180 4.5 kW (or below) motors – Power connectors

Connector type	Applicable model / Model number	UVW power connector - w/o brake
Military - straight 3106A-22-22S	ECM-B3 ECM-B3□-□□△△▲▲□S□ △△ = 18; ▲▲= 20, 30, 45	
Military - right angle 3108A-22-22S	ECM-B3 ECM-B3□-□□△△▲▲□S□ △△ = 18; ▲▲= 20, 30, 45	

Pin assignment			
U (Red)	V (White)	W (Black)	FG (Yellow / Green)
A	B	C	D

Note: refer to Section 3.1.4.5 for the brake connector.

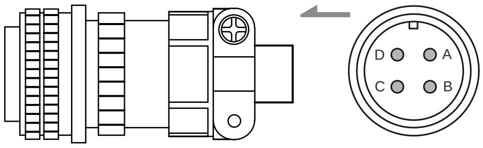
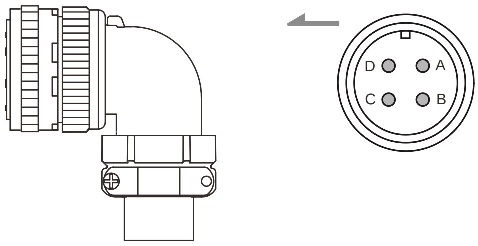
Recommended connectors:

Connector type	Brand	Model number	IP rating
Military - straight 3106A-22-22S	Delta	ACS3-CAPWC000	IP67
	SUNCHU	CMS3106A22-22SBI (connector & compression ring)	IP67
Military - right angle 3108A-22-22S	Delta	ACS3-CRPWC000	IP67
	SUNCHU	CMS3108A22-22SBI (connector & compression ring)	IP67

Note: refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.

3

3.1.4.4 F180 5.5 kW (or above) & F220 motors – Power connectors

Connector type	Applicable model Model number	UVW power connector - w/o brake
Military - straight 3106A-32-17S	ECM-B3 ECM-B3□-□□△△▲▲□3□ △△ = 18, 22; ▲▲ = 55, 75, 1B ECM-B3□-□□△△▲▲□S□ △△ = 22; ▲▲ = 1F	
Military - right angle 3108A-32-17S	ECM-B3 ECM-B3□-□□△△▲▲□3□ △△ = 18, 22; ▲▲ = 55, 75, 1B ECM-B3□-□□△△▲▲□S□ △△ = 22; ▲▲ = 1F	

Pin assignment			
U (Red)	V (White)	W (Black)	FG (Yellow / Green)
A	B	C	D

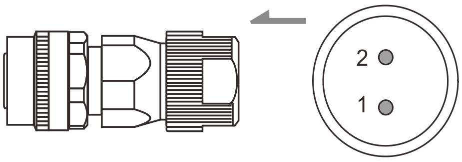
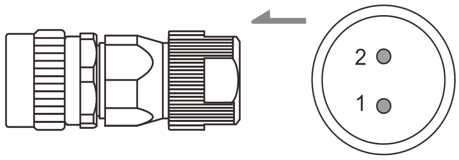
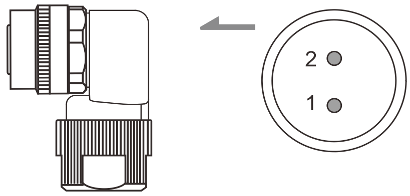
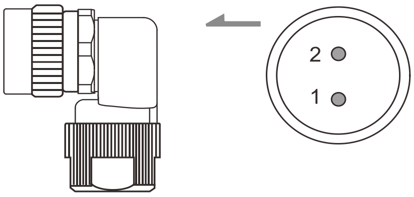
Note: refer to Section 3.1.4.5 for the brake connector.

Recommended connectors:

Connector type	Brand	Model number	IP rating
Military - straight 3106A-32-17S	Delta	ACS3-CAPWE000	IP42
	SUNCHU	CMS3106A32-17S (connector & compression ring)	IP42
	PLT	WPS3106A32-17S-R (connector) AMS3057-20A-R (cable clamp)	IP65
Military - right angle 3108A-32-17S	Delta	ACS3-CRPWE000	IP42
	SUNCHU	CMS3108A32-17S (connector & compression ring)	IP42

Note: refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.

3.1.4.5 F100 - F220 motors – Brake connectors

Connector type	Applicable model Model number	Brake connector
Military - straight CMV1-SP2S [bayonet]	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18, 22	
Military - straight [threaded, M17.5]	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18, 22	
Military - right angle CMV1-AP2S [bayonet]	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18, 22	
Military - right angle [threaded, M17.5]	ECM-B3 ECM-B3□-□□△△□□S□□ △△ = 10, 13, 18, 22	

Pin assignment	
BRAKE1 (Red)	BRAKE2 (Black)
1	2

Note: power supply for the brake is 24 V_{DC}; do not share the same power supply with other signals. The brake coil has no polarity.

Recommended connectors:

Connector type	Brand	Model number	IP rating
Military - straight CMV1-SP2S [bayonet]	Delta	ACS3-CABRA000	IP67
	DDK*2	CM1V1-SP2S-M1	IP67
	Suntone*3	SM10-SP2S-M1-D6-V	IP67
Militaryr - straight [threaded, M17.5]	Delta	ACS3-CABRM000	IP67
Military - right angle CMV1-AP2S [bayonet]	Delta	ACS3-CRBRA000	IP67
	DDK*2	CMV1-AP2S-M1	IP67
	Suntone*3	SM10-AP2S-M1-D6-V	IP67
Military - right angle [threaded, M17.5]	Delta	ACS3-CRBRM000	IP67

Note:

1. Refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.
2. The contacts, solder contacts (CMV1-#22BSC-S2-100) or crimp contacts (CMV1-#22BSC-C3-100), for the listed DDK connectors are sold separately.
3. The contacts, solder contacts (SMS-5012 or SMS-5013) or crimp contacts (SMS-5011), for the listed Suntone connectors are sold separately.
4. Motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.9 for details.

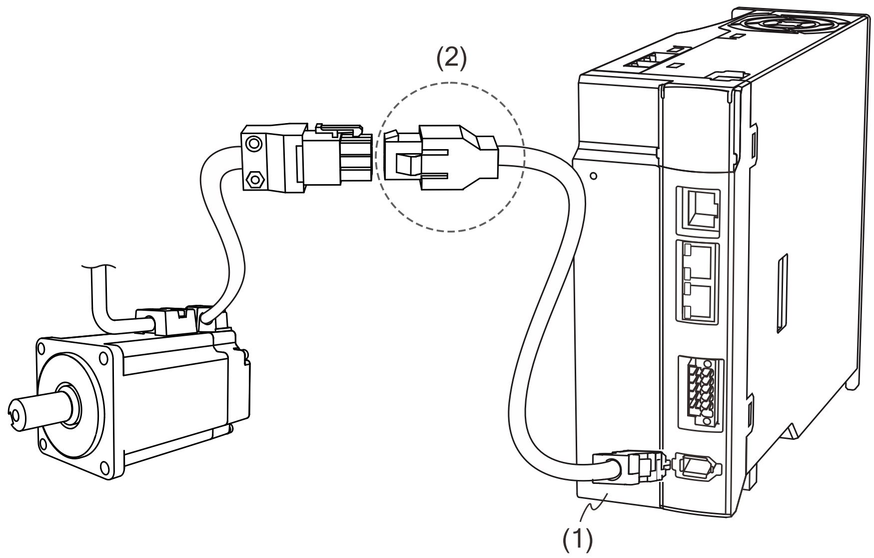
3

3.1.5 Encoder connector specifications

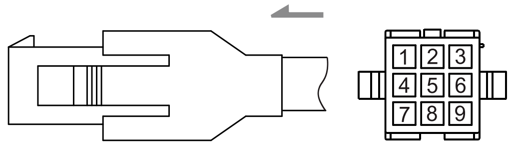
Select the appropriate connector according to the code of **Shaft diameter and connector type** in the motor model number. Refer to Section 1.2.2 for the model explanation of the servo motor.

3.1.5.1 F40 - F80 motors – Encoder connectors

Standard connector



(1) CN2 connector; (2) Standard connector

Connector type	Applicable model Model number	Encoder connector
Standard	ECM-B3 ECM-B3□-□□△△□□□S□ △△ = 04, 06, 08	

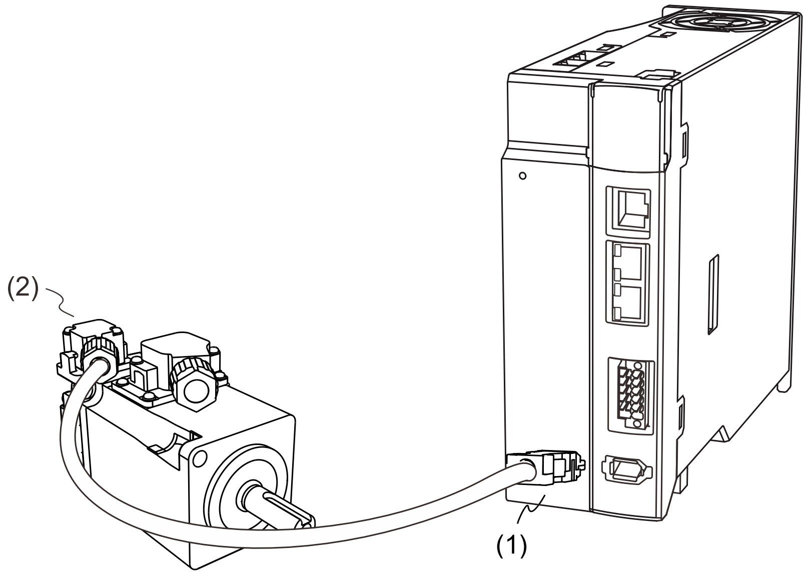
Note: refer to Section 3.4 for the encoder connector pin assignment.

Recommended connectors:

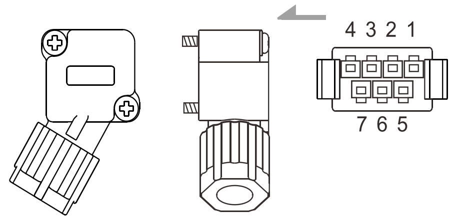
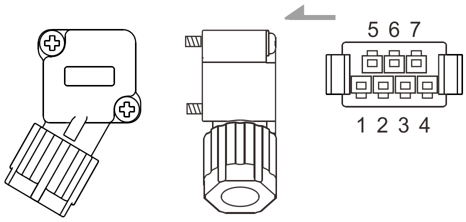
Connector type	Brand	Model number	IP rating
Standard	Delta	ACS3-CAEN0000	IP20
	TE Connectivity	1-172161-9 or 172161-1 (case) 170359-1 (tin-plated terminal) or 170359-3 (gold-plated terminal)	IP20

Note: we recommend using the connector with tin-plated terminals since the connector of the encoder cable from the servo motor side is also tin-plated.

Bulkhead connector



(1) CN2 connector; (2) Bulkhead connector (cable exit direction towards motor shaft)

Connector type	Applicable model / Model number	Encoder connector
Bulkhead - cable exit direction towards motor shaft	ECM-B3 ECM-B3□-□□△△□□□B□ △△ = 04, 06, 08	
Bulkhead - cable exit direction towards encoder	ECM-B3 ECM-B3□-□□△△□□□B□ △△ = 04, 06, 08	

Note: refer to Section 3.4 for the encoder connector pin assignment.

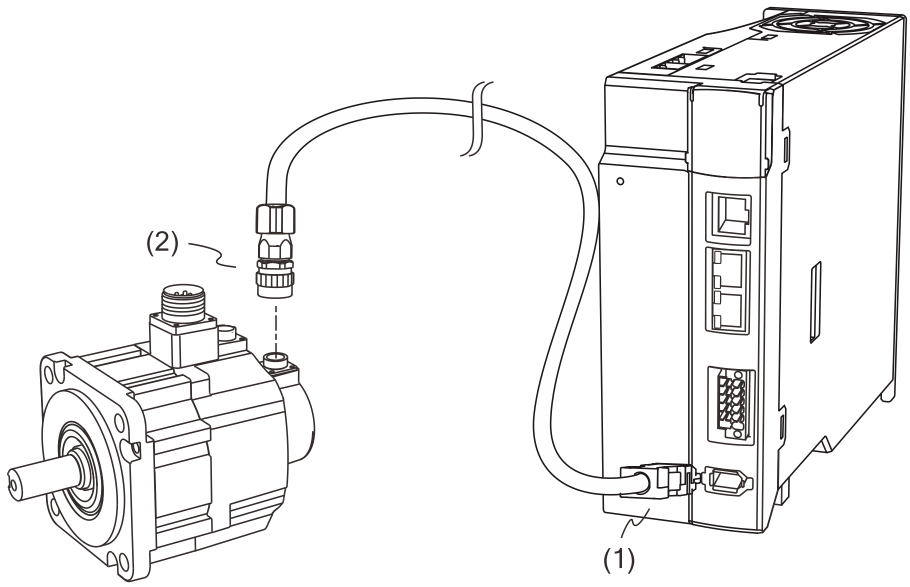
Recommended connectors:

Connector type	Brand	Model number	IP rating
Bulkhead - cable exit direction towards motor shaft / towards encoder	Delta	ACS3-AFEASA00	IP67
	SUNCHU	SC-ACS3-AFEASA00	IP67

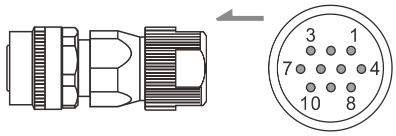
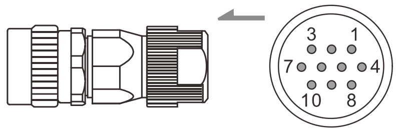
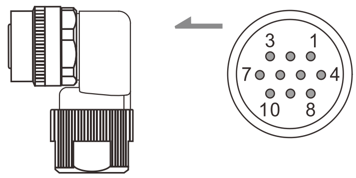
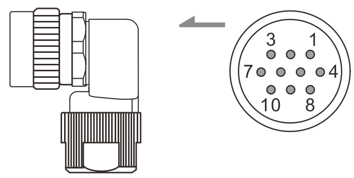
Note: refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.

3

3.1.5.2 F100 - F220 motors – Encoder connectors



(1) CN2 connector; (2) Military connector

Connector type	Applicable model Model number	Encoder connector
Military - straight CMV1-SP10S [bayonet]	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18, 22	
Military - straight [threaded, M17.5]	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18, 22	
Military - right angle CMV1-AP10S [bayonet]	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18, 22	
Military - right angle [threaded, M17.5]	ECM-B3 ECM-B3□-□□△△□□□□□ △△ = 10, 13, 18, 22	

Note: refer to Section 3.4 for the encoder connector pin assignment.

Recommended connectors:

Connector type	Brand	Model number	IP rating
Military - straight CMV1-SP10S [bayonet]	Delta	ACS3-CAENA000	IP67
	DDK*2	CMV1-SP10S-M1	IP67
	Suntone*3	SM10-SP10S-M1-D6-V	IP67
Military - straight [threaded, M17.5]	Delta	ACS3-CAENM000	IP67
Military - right angle CMV1-AP10S [bayonet]	Delta	ACS3-CRENA000	IP67
	DDK*2	CMV1-AP10S-M1	IP67
	Suntone*3	SM10-AP10S-M1-D6-V	IP67
Military - right angle [threaded, M17.5]	Delta	ACS3-CRENM000	IP67

Note:

1. Refer to Section 3.1.7 for Delta waterproof connector wiring instructions. For connector specification of other brands, contact the manufacturers.
2. The contacts, solder contacts (CMV1-#22ASC-S1-100) or crimp contacts (CMV1-#22ASC-C1-100 or CMV1-#22ASC-C2-100), for the listed DDK connectors are sold separately. Purchase the contacts according to the wire diameter.
3. The contacts, solder contacts (SMS-5012 or SMS-5013) or crimp contacts (SMS-5011), for the listed Suntone connectors are sold separately.
4. Motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.9 for details.

3.1.6 Wire selection

3.1.6.1 Wire specification and terminals / ferrules

The following tables are the suggested specification for wiring the terminals and signals for A3-EP.

- For the pluggable terminal blocks connected to the 1.5 kW (or below) models, use wire ferrules (end cord insulated terminals).
- For the screw terminal blocks on 2 kW (or above) models, use ring terminals.
- The suggested brand in the following tables is K.S. Terminals Inc. Refer to Sections 3.1.6.2 and 3.1.6.3 for the suitable ferrule / terminal specifications.

<table>
<tr><th rowspan="2">Servo drive model</th><th colspan="2">DC24V, DC0V</th><th colspan="2">R, S, T, P1, P2</th><th colspan="2">U, V, W</th><th colspan="2">P3, D, C, ⊖</th></tr>
<tr><th>Wire spec.</th><th>Wire ferrule</th><th>Wire spec.</th><th>Wire ferrule</th><th>Wire spec.</th><th>Wire ferrule</th><th>Wire spec.</th><th>Wire ferrule</th></tr>
<tr><td>ASD-A3-0443-□</td><td rowspan="4">0.32 mm^2 (22 AWG)</td><td>E0308</td><td>0.32 mm^2 (22 AWG)</td><td>E0308</td><td rowspan="2">0.82 mm^2 (18 AWG)</td><td>E1012</td><td>0.32 mm^2 (22 AWG)</td><td>E0308</td></tr>
<tr><td>ASD-A3-0743-□</td><td>E0308</td><td rowspan="2">0.52 mm^2 (20 AWG)</td><td>E0512</td><td>E1012</td><td rowspan="2">0.52 mm^2 (20 AWG)</td><td>E0512</td></tr>
<tr><td>ASD-A3-1043-□</td><td>E0308</td><td>E0512</td><td rowspan="2">1.3 mm^2 (16 AWG)</td><td>E1512</td><td>E0512</td></tr>
<tr><td>ASD-A3-1543-□</td><td>E0308</td><td>0.82 mm^2 (18 AWG)</td><td>E1012</td><td>E1512</td><td>0.82 mm^2 (18 AWG)</td><td>E1012</td></tr>
</table>

<table>
<tr><th rowspan="2">Servo drive model</th><th colspan="2">DC24V, DC0V</th><th colspan="2">R, S, T, P1, P2</th><th colspan="2">U, V, W</th><th colspan="2">P3, C, ⊖</th></tr>
<tr><th>Wire spec.</th><th>Ring terminal</th><th>Wire spec.</th><th>Ring terminal</th><th>Wire spec.</th><th>Ring terminal</th><th>Wire spec.</th><th>Ring terminal</th></tr>
<tr><td>ASD-A3-2043-□</td><td rowspan="5">0.52 mm^2 (20 AWG)</td><td>RVBL1-4</td><td>1.3 mm^2 (16 AWG)</td><td>RVBL2-4</td><td rowspan="2">2.1 mm^2 (14 AWG)</td><td>RVBL2-4</td><td rowspan="2">1.3 mm^2 (16 AWG)</td><td>RVBL2-4</td></tr>
<tr><td>ASD-A3-3043-□</td><td>RVBL1-4</td><td>2.1 mm^2 (14 AWG)</td><td>RVBL2-4</td><td>RVBL2-4</td><td>RVBL2-4</td></tr>
<tr><td>ASD-A3-4543-□</td><td>RVBL1-4</td><td>3.3 mm^2 (12 AWG)</td><td>RVBS5-4</td><td rowspan="2">3.3 mm^2 (12 AWG)</td><td>RVBS5-4</td><td>2.1 mm^2 (14 AWG)</td><td>RVBL2-4</td></tr>
<tr><td>ASD-A3-5543-□</td><td>RVBL1-4</td><td rowspan="2">5.3 mm^2 (10 AWG)</td><td>RVBS5-4</td><td>RVBS5-4</td><td>3.3 mm^2 (12 AWG)</td><td>RVBS5-4</td></tr>
<tr><td>ASD-A3-7543-□</td><td>RVBL1-4</td><td>RVBS5-4</td><td rowspan="2">5.3 mm^2 (10 AWG)</td><td>RVBS5-4</td><td rowspan="2">5.3 mm^2 (10 AWG)</td><td>RVBS5-4</td></tr>
<tr><td>ASD-A3-1B43-□</td><td rowspan="2">0.82 mm^2 (18 AWG)</td><td>RVB1-5</td><td rowspan="2">8.4 mm^2 (8 AWG)</td><td>RNYBS8-5</td><td>RVB5-6</td><td>RVBS5-4</td></tr>
<tr><td>ASD-A3-1F43-□</td><td>RVB1-5</td><td>RNYBS8-5</td><td>8.4 mm^2 (8 AWG)</td><td>RNYBS8-6</td><td>8.4 mm^2 (8 AWG)</td><td>RNYBS8-5</td></tr>
</table>

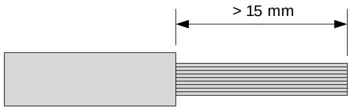
Note:
1. The shield should connect to the ground terminal ⏚.
2. When wiring, use the wires suggested in this section to avoid danger.
3. Choose the suitable terminals that comply with the wiring specifications. Use a crimping tool to properly crimp the terminals / ferrules and wires.
4. Do not use bare wires for wiring, or the loose wires may cause accidents.
5. Refer to Section 3.1.6.2 for the terminal / ferrule crimping description.

3.1.6.2 Crimping the terminals / ferrules

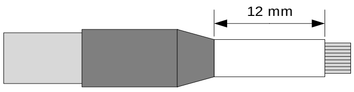
- The descriptions in this section are applied to all the servo drive terminals except CN1 and CN10.
- Do not use bare wires for wiring, or the loose wires may cause accidents.
- Use a crimping tool to properly crimp the terminals / ferrules and wires.

Crimping for wire ferrules

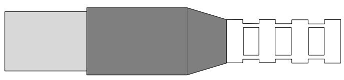
Use a ferrule with the barrel length of **12 mm (0.47 inches)** and the wires of corresponding specifications for the drives. If the barrel length is shorter than 12 mm, the wire may fall off and cause danger.



Step 1: strip the wire insulation to expose the conductor for more than 15 mm (0.59 inches).

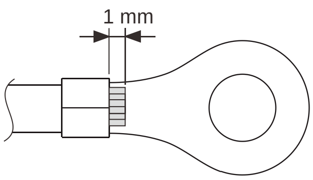


Step 2: insert the wire into the ferrule.



Step 3: use a ferrule crimper to crimp the barrel. Cut off the exposed wire; the remaining length of the exposed part should be shorter than 0.5 mm (0.02 inches).

Crimping for ring terminals



Strip the wire insulation and insert the wire into the terminal. Leave about 1 mm (0.04 inches) of exposed wire, and then crimp the terminal.

Wire specifications for the attached terminals of Delta connectors

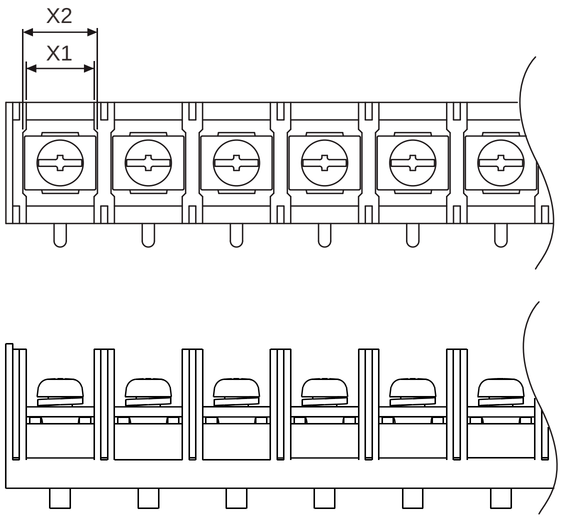
The following table shows the Delta connectors with terminals attached and the applicable wire specifications. Refer to the actual product specification when wiring.

Connector type	Model number	Applicable wire spec.
Standard	ACS3-CAPW1000	24 - 18 AWG (0.21 mm² - 0.82 mm²)
	ACS3-CAPW2000	24 - 18 AWG (0.21 mm² - 0.82 mm²)
Standard	ACS3-CAEN0000	26 - 22 AWG (0.13 mm² - 0.32 mm²)
Bulkhead - cable exit direction towards motor shaft	ACS3-AFPWSS00	UVW: 20 - 18 AWG (0.52 mm² - 0.82 mm²) Brake: 26 - 22 AWG (0.13 mm² - 0.32 mm²)
Bulkhead - cable exit direction towards encoder	ACS3-ABPWSS00	
Bulkhead - cable exit direction towards motor shaft / towards encoder	ACS3-AFEASA00	26 - 22 AWG (0.13 mm² - 0.32 mm²)

3

3.1.6.3 Screw terminal block dimensions / screw and tightening torque specifications

Screw terminal block dimensions



Servo drive model	X1 mm (inch) / X2 mm (inch)			
	DC24V, DC0V	R, S, T, P1, P2	U, V, W	P3, C, ⊖
ASD-A3-2043-□	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)
ASD-A3-3043-□	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)
ASD-A3-4543-□	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)
ASD-A3-5543-□	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)
ASD-A3-7543-□	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)	10 (0.39) / 11 (0.43)
ASD-A3-1B43-□	10.5 (0.41) / 11 (0.43)	10.5 (0.41) / 11 (0.43)	12 (0.47) / 13 (0.51)	10.5 (0.41) / 11 (0.43)
ASD-A3-1F43-□	10.5 (0.41) / 11 (0.43)	10.5 (0.41) / 11 (0.43)	12 (0.47) / 13 (0.51)	10.5 (0.41) / 11 (0.43)

Screw specification and tightening torque

Servo drive model	Screw specification and tightening torque (kgf-cm)									
	DC24V, DC0V		R, S, T, P1, P2		U, V, W		P3, C, ⊖		⏚	
ASD-A3-0443-□	-	-	-	-	-	-	-	-	M4	12 - 14
ASD-A3-0743-□	-	-	-	-	-	-	-	-	M4	12 - 14
ASD-A3-1043-□	-	-	-	-	-	-	-	-	M4	12 - 14
ASD-A3-1543-□	-	-	-	-	-	-	-	-	M4	12 - 14
ASD-A3-2043-□	M4	12	M4	12	M4	12	M4	12	M4	12 - 14
ASD-A3-3043-□	M4	12	M4	12	M4	12	M4	12	M4	12 - 14
ASD-A3-4543-□	M4	12	M4	12	M4	12	M4	12	M4	12 - 14
ASD-A3-5543-□	M4	12	M4	12	M4	12	M4	12	M4	12 - 14
ASD-A3-7543-□	M4	12	M4	12	M4	12	M4	12	M4	12 - 14
ASD-A3-1B43-□	M4	12	M4	12	M6	27	M4	12	M4	12 - 14
ASD-A3-1F43-□	M4	12	M4	12	M6	27	M4	12	M4	12 - 14

Tightening torque (kgf-cm)	
CN1	CN5
0.1	2 - 2.5

3.1.6.4 Encoder cable specifications

Item	Standard cable	Flexible cable
Model number	ACS3-CAEN01XX ACS3-CAEA01XX ACS3-CAENA1XX ACS3-CAEAA1XX ACS3-CRENA1XX ACS3-CREAA1XX ACS3-CAENM1XX ACS3-CRENM1XX ACS3-CAEAM1XX ACS3-CREAM1XX	ACS3-CAEF01XX ACS3-CAEB01XX ACS3-CAEFA1XX ACS3-CAEBA1XX ACS3-CREFA1XX ACS3-CREBA1XX ACS3-CAEFM1XX ACS3-CREFM1XX ACS3-CAEBM1XX ACS3-CREBM1XX
Specification	UL2464 (Temp. rating: 80°C / 176°F)	UL2464 (Temp. rating: 80°C / 176°F)
DC+5V / GND	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.3 mm	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.3 mm
T+ / T-	AWG#24-2P (0.21 mm²) Outer diameter of insulated wire: Φ1.1 mm	AWG#24-2P (0.21 mm²) Outer diameter of insulated wire: Φ1.1 mm
Cable outer diameter	Φ7 mm	
Max. wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

Item	Standard cable	Flexible cable
Model number	ACS3-AFEASIXX ACS3-ABEASIXX ACS3-AFEASAXX ACS3-ABEASAXX	ACS3-AFERSIXX ACS3-ABERSIXX ACS3-AFERSAXX ACS3-ABERSAXX
Specification	UL20276 (Temp. rating: 80°C / 176°F)	UL20276 (Temp. rating: 80°C / 176°F)
DC+5V / GND	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.3 mm	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.3 mm
T+ / T-	AWG#26-2P (0.13 mm²) Outer diameter of insulated wire: Φ1.1 mm	AWG#26-2P (0.13 mm²) Outer diameter of insulated wire: Φ1.1 mm
Cable outer diameter	Φ5.8 - Φ6.2 mm	
Max. wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

Note:
1. Use a shielded twisted-pair cable to reduce the noise interference.
2. The shield should connect to the ground terminal ⏚.
3. When wiring, use the wires suggested in this section to avoid danger.
4. Wire specification of the encoder conversion cables is the same as that of the encoder cables. For the cable length, refer to Section B.6.

3

3.1.6.5 Power cable specifications

F40 - F80 motors

Item	Standard cable	Flexible cable
Model number	ACS3-CAPW21XX ACS3-CAPW31XX	ACS3-CAPF21XX ACS3-CAPF31XX
Specification	UL2586 (Temp. rating: 105°C / 221°F)	UL2586 (Temp. rating: 105°C / 221°F)
UVW wire	AWG#18-4C (0.82 mm²) Outer diameter of insulated wire: Φ2.1 mm Voltage rating: 600 V_{AC}	AWG#18-4C (0.82 mm²) Outer diameter of insulated wire: Φ2.1 mm Voltage rating: 600 V_{AC}
Brake wire	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.6 mm Voltage rating: 600 V_{AC}	AWG#22-2C (0.32 mm²) Outer diameter of insulated wire: Φ1.6 mm Voltage rating: 600 V_{AC}
Cable outer diameter	Power cable w/o brake: Φ7.7 mm; power cable with brake: Φ8.6 mm	
Max. wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

Note:
1. For detailed screw terminal block dimensions / screw and tightening torque specifications, refer to Section 3.1.6.3.
2. Apart from the preceding specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.

Item	Standard cable	Flexible cable
Model number	ACS3-AFPWSAXX ACS3-AFPWSBXX ACS3-ABPWSAXX ACS3-ABPWSBXX	ACS3-AFPRSAXX ACS3-AFPRSBXX ACS3-ABPRSAXX ACS3-ABPRSBXX
Specification	UL2586 (Temp. rating: 105°C / 221°F)	UL2586 (Temp. rating: 105°C / 221°F)
UVW wire	AWG#20-4C (0.52 mm²) Outer diameter of insulated wire: Φ1.7 mm Voltage rating: 600 V_{AC}	AWG#20-4C (0.52 mm²) Outer diameter of insulated wire: Φ1.7 mm Voltage rating: 600 V_{AC}
Brake wire	AWG#24-2C (0.21 mm²) Outer diameter of insulated wire: Φ1.35 mm Voltage rating: 600 V_{AC}	AWG#24-2C (0.21 mm²) Outer diameter of insulated wire: Φ1.35 mm Voltage rating: 600 V_{AC}
Cable outer diameter	Φ6.0 - Φ6.8 mm	
Max. wiring length	20 m	
Standard length provided by Delta	L = 3 m, 5 m, 10 m, 20 m	

Note: wire specification of the power conversion cables is the same as that of the power cables. For the cable length, refer to Section B.3.

F100 - F130 motors

Item		Standard cable	Flexible cable
Power cable	Model number	ACS3-CAPWA2XX ACS3-CRPWA2XX	ACS3-CAPFA2XX ACS3-CRPFA2XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#16-4C (1.3 mm²) Outer diameter of insulated wire: Φ3.2 mm Cable outer diameter: Φ11 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#16-4C (1.3 mm²) Outer diameter of insulated wire: Φ3.2 mm Cable outer diameter: Φ11 mm Voltage rating: 600 V_{AC}
	Model number	ACS3-CAPWA3XX ACS3-CRPWA3XX	ACS3-CAPFA3XX ACS3-CRPFA3XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#14-4C (2.1 mm²) Outer diameter of insulated wire: Φ2.8 mm Cable outer diameter: Φ9.5 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#14-4C (2.1 mm²) Outer diameter of insulated wire: Φ2.8 mm Cable outer diameter: Φ9.5 mm Voltage rating: 600 V_{AC}
Brake cable	Model number	ACS3-CABRA1XX ACS3-CRBRA1XX ACS3-CABRM1XX ACS3-CRBRM1XX	ACS3-CABFA1XX ACS3-CRBFA1XX ACS3-CABFM1XX ACS3-CRBFM1XX
	Specification	UL2517 (Temp. rating: 105°C / 221°F) AWG#20-2C (0.52 mm²) Outer diameter of insulated wire: Φ1.8 mm Cable outer diameter: Φ5.5 mm Voltage rating: 300 V_{AC}	UL2517 (Temp. rating: 105°C / 221°F) AWG#20-2C (0.52 mm²) Outer diameter of insulated wire: Φ1.8 mm Cable outer diameter: Φ5.5 mm Voltage rating: 300 V_{AC}
Max. wiring length		20 m	
Standard length provided by Delta		L = 3 m, 5 m, 10 m, 20 m	

Note:

1. For detailed screw terminal block dimensions / screw and tightening torque specifications, refer to Section 3.1.6.3.
2. Apart from the preceding specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.

F180 4.5 kW (or below) motors

Item		Standard cable	Flexible cable
Power cable	Model number	ACS3-CAPWC3XX ACS3-CRPWC3XX	ACS3-CAPFC3XX ACS3-CRPFC3XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#14-4C (2.1 mm²) Outer diameter of insulated wire: Φ2.8 mm Cable outer diameter: Φ9.5 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#14-4C (2.1 mm²) Outer diameter of insulated wire: Φ2.8 mm Cable outer diameter: Φ9.5 mm Voltage rating: 600 V_{AC}
	Model number	ACS3-CAPWC4XX ACS3-CRPWC4XX	ACS3-CAPFC4XX ACS3-CRPFC4XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#12-4C (3.3 mm²) Outer diameter of insulated wire: Φ4.0 mm Cable outer diameter: Φ14.5 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#12-4C (3.3 mm²) Outer diameter of insulated wire: Φ4.0 mm Cable outer diameter: Φ14.5 mm Voltage rating: 600 V_{AC}
	Model number	ACS3-CAPWC5XX ACS3-CRPWC5XX	ACS3-CAPFC5XX ACS3-CRPFC5XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#10-4C (5.3 mm²) Outer diameter of insulated wire: Φ4.6 mm Cable outer diameter: Φ15 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#10-4C (5.3 mm²) Outer diameter of insulated wire: Φ4.6 mm Cable outer diameter: Φ15 mm Voltage rating: 600 V_{AC}
	Model number	ACS3-CAPWC6XX ACS3-CRPWC6XX	ACS3-CAPFC6XX ACS3-CRPFC6XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#8-4C (8.4 mm²) Outer diameter of insulated wire: Φ7.0 mm Cable outer diameter: Φ22 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#8-4C (8.4 mm²) Outer diameter of insulated wire: Φ7.0 mm Cable outer diameter: Φ22 mm Voltage rating: 600 V_{AC}
Brake cable	Model number	ACS3-CABRA1XX ACS3-CRBRA1XX ACS3-CABRM1XX ACS3-CRBRM1XX	ACS3-CABFA1XX ACS3-CRBFA1XX ACS3-CABFM1XX ACS3-CRBFM1XX
	Specification	UL2517 (Temp. rating: 105°C / 221°F) AWG#20-2C (0.52 mm²) Outer diameter of insulated wire: Φ1.8 mm Cable outer diameter: Φ5.5 mm Voltage rating: 300 V_{AC}	UL2517 (Temp. rating: 105°C / 221°F) AWG#20-2C (0.52 mm²) Outer diameter of insulated wire: Φ1.8 mm Cable outer diameter: Φ5.5 mm Voltage rating: 300 V_{AC}
Max. wiring length		20 m	
Standard length provided by Delta		L = 3 m, 5 m, 10 m, 20 m	

Note:
1. For detailed screw terminal block dimensions / screw and tightening torque specifications, refer to Section 3.1.6.3.
2. Apart from the preceding specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.

F180 5.5 kW (or above) & F220 motors

Item		Standard cable	Flexible cable
Power cable	Model number	ACS3-CAPWE6XX ACS3-CRPWE6XX	ACS3-CAPFE6XX ACS3-CRPFE6XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#8-4C (8.4 mm²) Outer diameter of insulated wire: Φ7.0 mm Cable outer diameter: Φ22 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#8-4C (8.4 mm²) Outer diameter of insulated wire: Φ7.0 mm Cable outer diameter: Φ22 mm Voltage rating: 600 V_{AC}
	Model number	ACS3-CAPWE7XX ACS3-CRPWE7XX	ACS3-CAPFE7XX ACS3-CRPFE7XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#6-4C (13.3 mm²) Outer diameter of insulated wire: Φ8.8 mm Cable outer diameter: Φ28 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#6-4C (13.3 mm²) Outer diameter of insulated wire: Φ8.8 mm Cable outer diameter: Φ28 mm Voltage rating: 600 V_{AC}
	Model number	ACS3-CAPWE8XX ACS3-CRPWE8XX	ACS3-CAPFE8XX ACS3-CRPFE8XX
	Specification	UL2586 (Temp. rating: 105°C / 221°F) AWG#4-4C (21.2 mm²) Outer diameter of insulated wire: Φ10.2 mm Cable outer diameter: Φ32 mm Voltage rating: 600 V_{AC}	UL2586 (Temp. rating: 105°C / 221°F) AWG#4-4C (21.2 mm²) Outer diameter of insulated wire: Φ10.2 mm Cable outer diameter: Φ32 mm Voltage rating: 600 V_{AC}
Brake cable	Model number	ACS3-CABRA1XX ACS3-CRBRA1XX ACS3-CABRM1XX ACS3-CRBRM1XX	ACS3-CABFA1XX ACS3-CRBFA1XX ACS3-CABFM1XX ACS3-CRBFM1XX
	Specification	UL2517 (Temp. rating: 105°C / 221°F) AWG#20-2C (0.52 mm²) Outer diameter of insulated wire: Φ1.8 mm Cable outer diameter: Φ5.5 mm Voltage rating: 300 V_{AC}	UL2517 (Temp. rating: 105°C / 221°F) AWG#20-2C (0.52 mm²) Outer diameter of insulated wire: Φ1.8 mm Cable outer diameter: Φ5.5 mm Voltage rating: 300 V_{AC}
Max. wiring length		20 m	
Standard length provided by Delta		L = 3 m, 5 m, 10 m, 20 m	

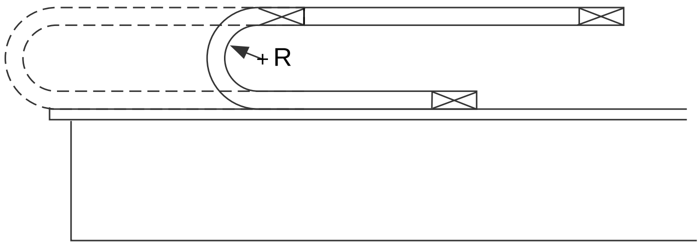
Note:

1. For detailed screw terminal block dimensions / screw and tightening torque specifications, refer to Section 3.1.6.3.
2. Apart from the preceding specifications, refer to Section 2.7.1 for the motor power cable selection and installation precautions.

3

3.1.6.6 Flexible cable specifications

Delta provides two types of power and encoder cables: standard cables and flexible cables. Use flexible cable when connecting to a moving machinery. Refer to the following table for flexible cable specifications.



R = bend radius of the cable

Item	Specification
Bend radius	10 times of the cable outer diameter
Number of bending times	10 million times*1
Bending speed	3 m/s
Acceleration	15 m/s^2

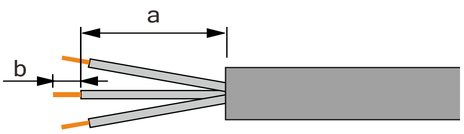
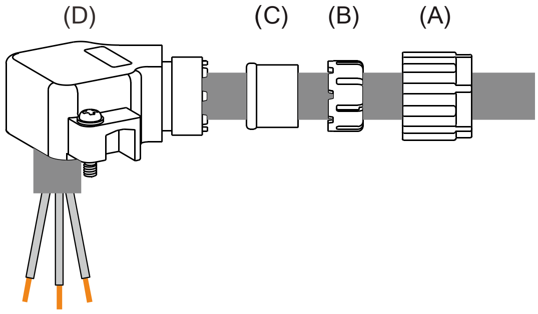
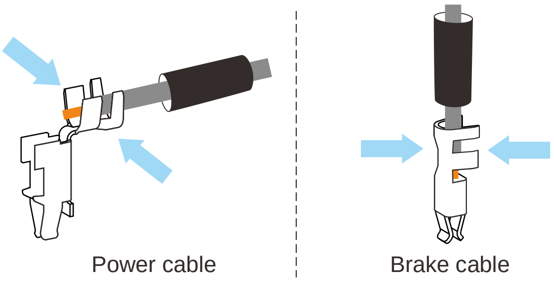
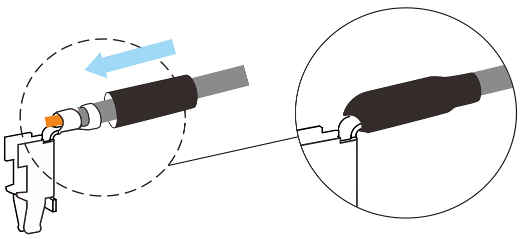
Note:
1. Bending the cable into a curve and then straightening it is considered as one time.
2. For precautions relevant to the use of cables, refer to Section 2.10.

3

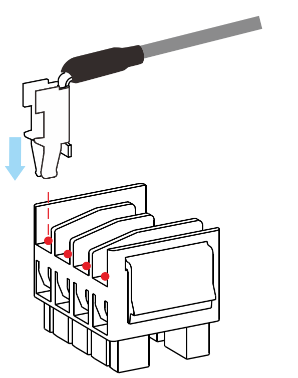
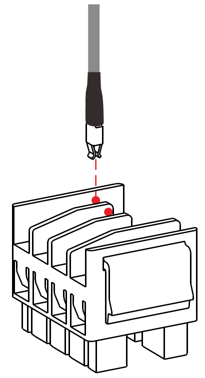
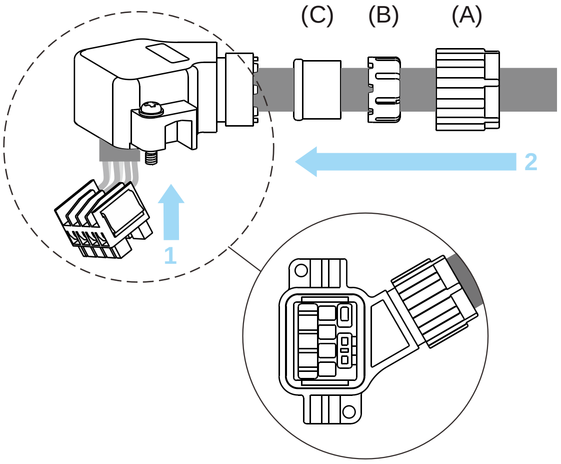
3.1.7 Waterproof connector wiring instructions

3.1.7.1 F40 - F80 motors – Power / Brake / Encoder connectors

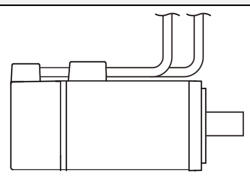
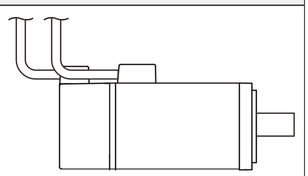
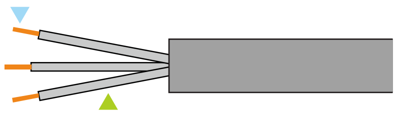
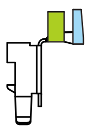
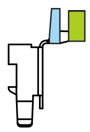
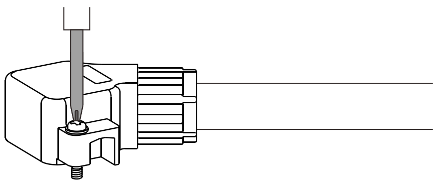
The example here uses the **bulkhead connector - cable exit direction towards motor shaft**:

Bulkhead connector		
Step 1		Strip the cable; the exposed wire length (a) should be 15 mm (0.59 inches) and the conductor length (b) should be as follows: ■ For encoder cables / brake cables: 1.5 - 1.8 mm (0.059 - 0.071 inches) ■ For power cables with bulkhead connectors (cable exit direction towards motor shaft): 2 - 2.2 mm (0.079 - 0.087 inches) ■ For power cables with bulkhead connectors (cable exit direction towards encoder): 1.8 - 2 mm (0.071 - 0.079 inches)
Step 2		Place the (A) seals nut, (B) compression ring, (C) rubber ring (with the bulge side towards the housing), and (D) housing on the cable in sequence. Note: use the rubber ring corresponding to the cable in order to meet the IP67 standard.
Step 3		Slide the heat shrink onto the cable, and then crimp the terminal.
Step 4		Shrink the tubing at a distance of 1 mm (0.039 inches) away from the terminal. Specifications of heat shrink: ■ For power cables: 5 mm (0.2 inches) ■ For brake cables: 10 mm (0.39 inches) ■ For shielded cables: 18 mm (0.71 inches) Note: heat shrink is not required for the encoder cable.

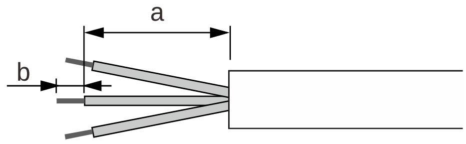
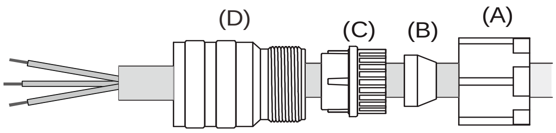
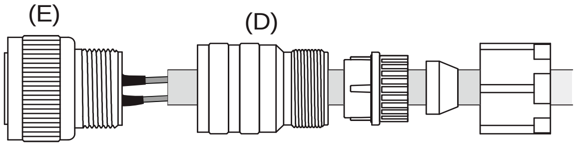
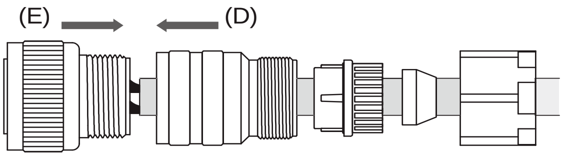
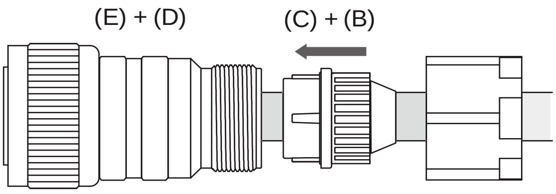
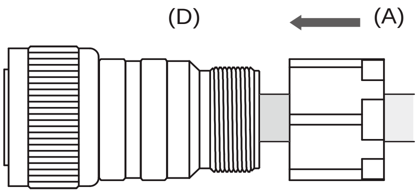
3

Bulkhead connector		
Step 5	 Power cable  Brake cable	Plug the terminal into the connector. ■ Refer to Section 3.1.4.1 for pin assignment of power connectors. ■ Refer to Section 3.4.1 for pin assignment of encoder connectors.
Step 6	 	Put the connector in the housing, and secure the (C) rubber ring, (B) compression ring, and (A) seals nut to the housing in sequence. Use a wrench to lock the seals nut to the housing to complete the wiring.

Note the following:

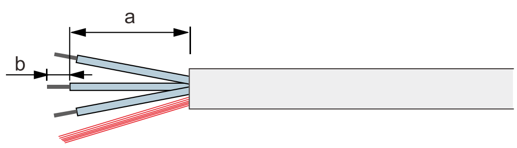
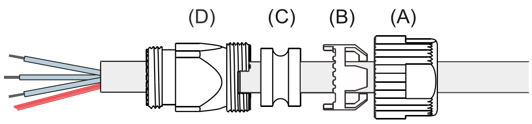
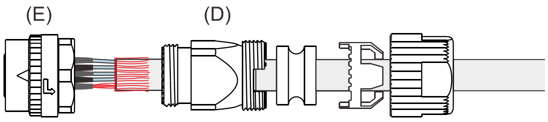
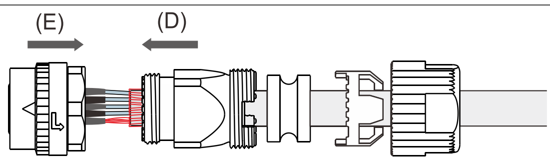
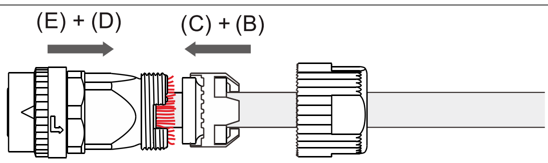
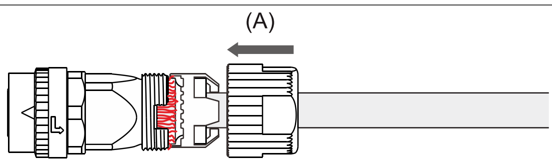
Cable exit direction towards motor shaft	Cable exit direction towards encoder	
		Illustrations for the cable exit direction.
  Power cable with bulkhead connectors (cable exit direction towards motor shaft)  Power cable with bulkhead connectors (cable exit direction towards encoder)  Brake cable Encoder cable		The green highlighted area on the terminal is where you crimp the copper conductor. The blue highlighted area on the terminal is where you crimp the wire insulation. Refer to Section 3.1.6.2 for the wire specifications of terminals.
		It is advisable to tighten the connector to the motor at the torque of 0.15 ± 0.015 N·m. Use the M2 screw for tightening.

3.1.7.2 F100 - F180 4.5 kW (or below) motors – Power connectors

Military connector		
Step 1		Strip the cable and the exposed wire length (a) should be 23 - 27 mm (0.9 - 1.06 inches) for straight connectors and 28 - 32 mm (1.1 - 1.26 inches) for right angle connectors, and the tinned conductor length (b) should be 3 - 5 mm (0.12 - 0.2 inches).
Step 2		Place the (A) seals nut, (B) rubber ring, (C) black compression ring, and (D) straight or right angle connector on the cable in sequence. Note: use the rubber ring corresponding to the cable in order to meet the IP67 standard.
Step 3		Refer to Section 3.1.4.3 for pin assignment of power connectors. Note: it is suggested that you use 20 mm (0.79 inches) heat shrink for straight connectors, and 25 mm (0.98 inches) heat shrink for right angle connectors.
Step 4		Tighten (D) and (E) with adequate torque. For the torque value, refer to Section 3.1.7.4.
Step 5		Place (B) in (C), and then place (C) + (B) in (D).
Step 6		Tighten (A) and (D) at the torque of 10 N·m.

3.1.7.3 F100 - F180 motors – Brake / Encoder connectors

The example here uses the **encoder connector**. For brake connectors, disregard the descriptions about metal shield.

Brake / Encoder connector		
Step 1		Strip the cable and expose the wires covered by the metal shield. The exposed wire length (a) should be 12 mm (0.47 inches) for straight connectors and 17 mm (0.67 inches) for right angle connectors, and the tinned wire length (b) should be 2 mm (0.08 inches).
Step 2		Place the (A) seals nut, (B) compression ring, (C) rubber ring, and (D) straight or right angle connector on the cable in sequence. Note: use the rubber ring corresponding to the cable in order to meet the IP67 standard.
Step 3		■ The pins of brake connectors have no polarity. ■ Refer to Section 3.4.2 for pin assignment of encoder connectors. Separate the metal shield into two parts. Solder one part of the metal shield to the solder cup, and then fold back the other part. Note: it is suggested that you use 8 mm (0.31 inches) heat shrink
Step 4		Tighten (D) and (E) with adequate torque. For the torque value, refer to Section 3.1.7.4.
Step 5		Place (B) in (C), and then place (C) + (B) in (D).
Step 6		Tighten (A) and (D) at the torque of 2.1 N·m to join the folded metal shield and the metal case together. This increases the contact area of the ground terminal and reduces the interference.

3.1.7.4 Waterproof connector installation and wiring specifications

IP67 waterproof connector

When mating, ensure the IP67 waterproof connector is fully locked and the diameter of the wire matches that of the rubber ring. If you choose a wire of smaller diameter and a rubber ring of larger diameter, the combination does not meet the IP67 standard.

Frame size & power	Connector type	Connector model	Rubber ring diameter (mm)	Torque for tightening the connector
F40 - F80	Bulkhead - cable exit direction towards motor shaft	ACS3-AFPWSS00	Φ6.0 - Φ6.8	0.4 - 0.6 N·m
	Bulkhead - cable exit direction towards encoder	ACS3-ABPWSS00	Φ6.0 - Φ6.8	0.4 - 0.6 N·m
	Bulkhead - cable exit direction towards motor shaft / towards encoder	ACS3-AFEASA00	Φ5.8 - Φ6.2	0.4 - 0.6 N·m
F100 - F130	Military - straight	ACS3-CAPWA000	Two sets of rubber rings attached Φ9 - Φ10 and Φ11 - Φ12	8 - 9 N·m (Φ9 - Φ10) 9 - 10 N·m (Φ11 - Φ12)
	Military - right angle	ACS3-CRPWA000		
F180	Military - straight	ACS3-CAPWC000	Two sets of rubber rings attached Φ11 - Φ12 and Φ15 - Φ16	7.5 - 8.5 N·m (Φ11 - Φ12) 7.5 N·m (Φ15 - Φ16)
	Military - right angle	ACS3-CRPWC000		
F100 - F180 4.5 kW (or below)	Military - straight CMV1-SP2S [bayonet]	ACS3-CABRA000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle CMV1-AP2S [bayonet]	ACS3-CRBRA000		
	Military - straight [threaded, M17.5]	ACS3-CABRM000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle [threaded, M17.5]	ACS3-CRBRM000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - straight CMV1-SP10S [bayonet]	ACS3-CAENA000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle CMV1-AP10S [bayonet]	ACS3-CRENA000		
	Military - straight [threaded, M17.5]	ACS3-CAENM000	Φ5.5 - Φ7.5	4 - 5 N·m
	Military - right angle [threaded, M17.5]	ACS3-CRENM000	Φ5.5 - Φ7.5	4 - 5 N·m

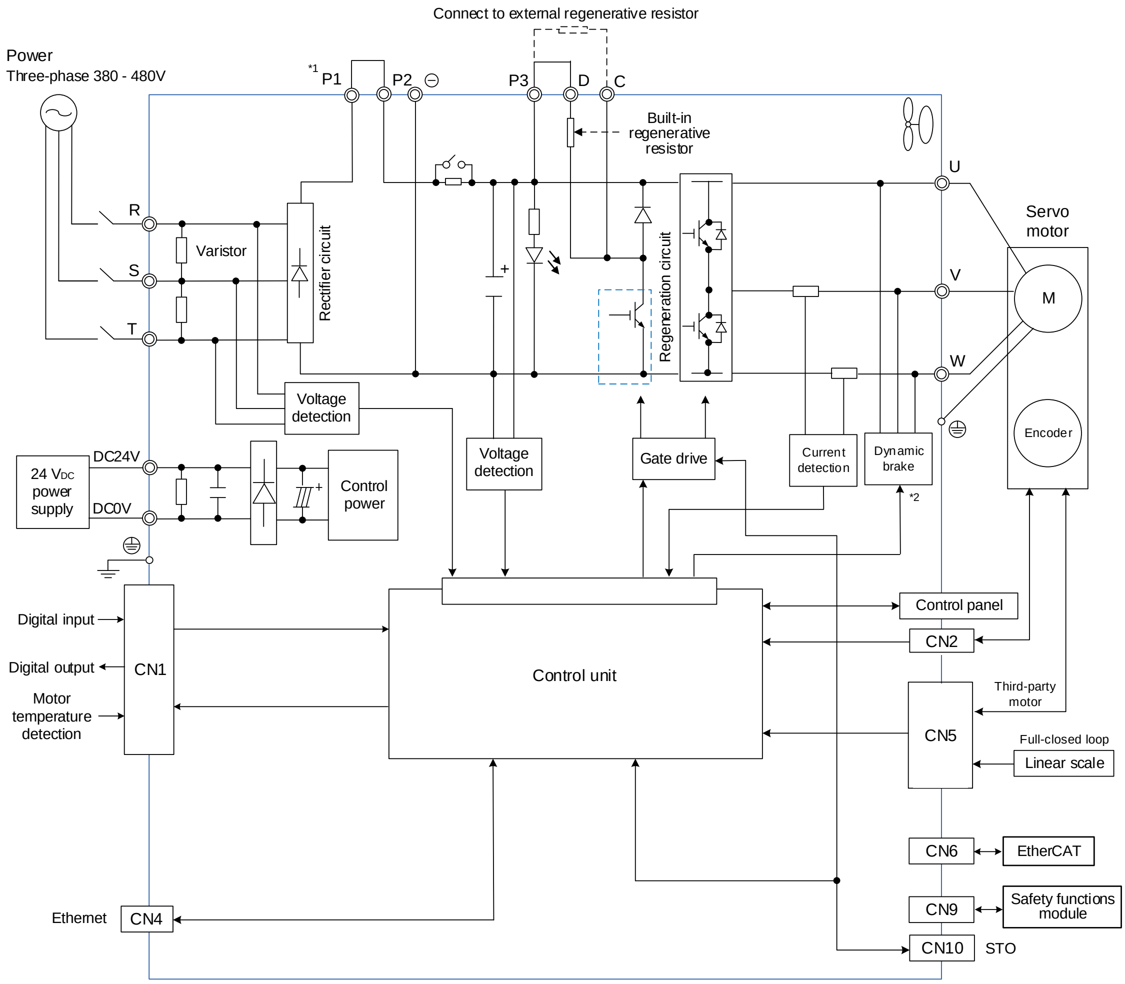
IP42 connector

Frame size & power	Connector type	Connector model	Wire diameter (mm)	Torque for tightening the connector
F180 5.5 kW (or above) & F220	Military - straight	ACS3-CAPWE000	Φ20 Max.	Tighten until snug
	Military - right angle	ACS3-CRPWE000		

3

3.2 Servo system wiring diagram

400 W - 1.5 kW models

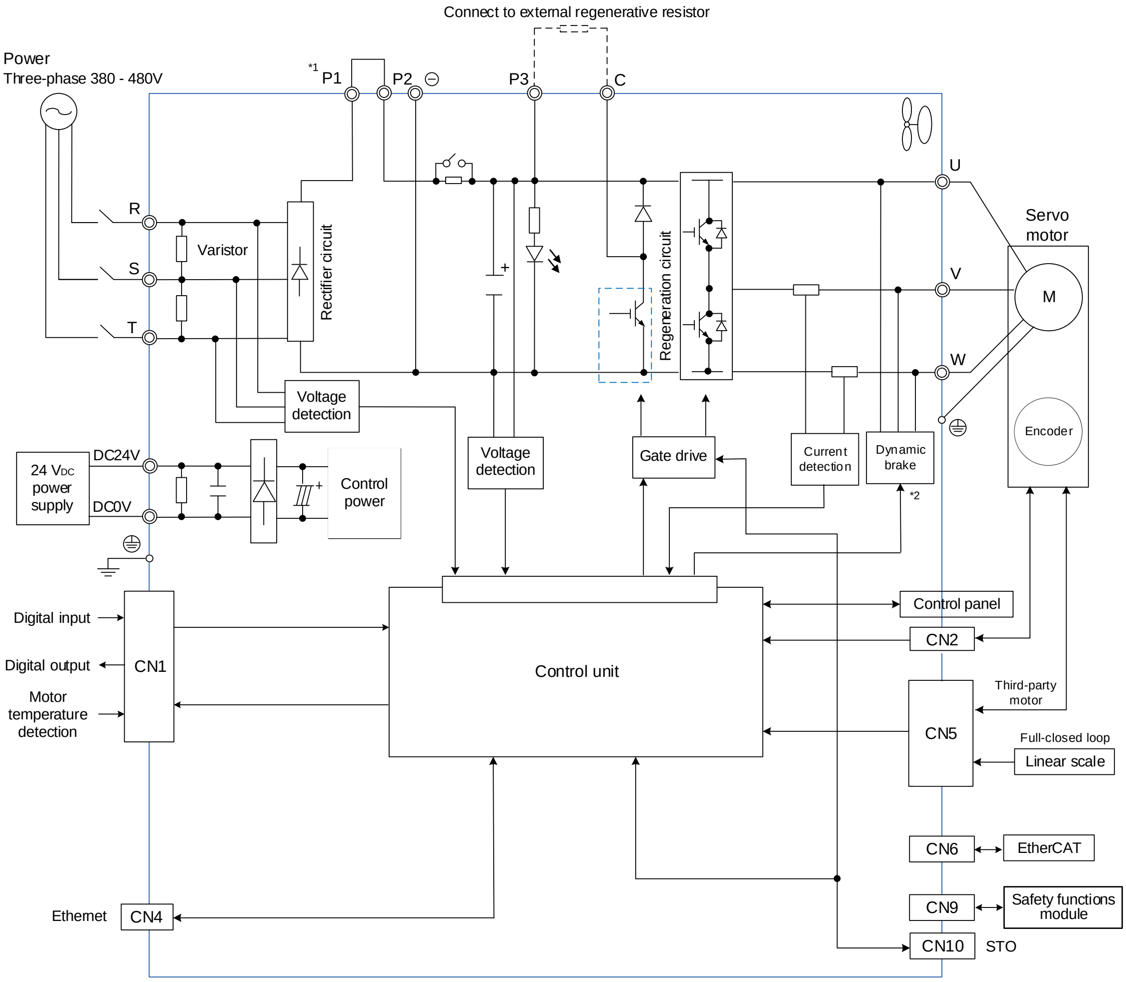


Note:

1. Short-circuit P1 and P2 as shown in the figure.
2. The dynamic brake is activated when power to the servo drive is lost. When the dynamic brake is in operation, the UVW is short-circuited.

3

2 kW - 15 kW models



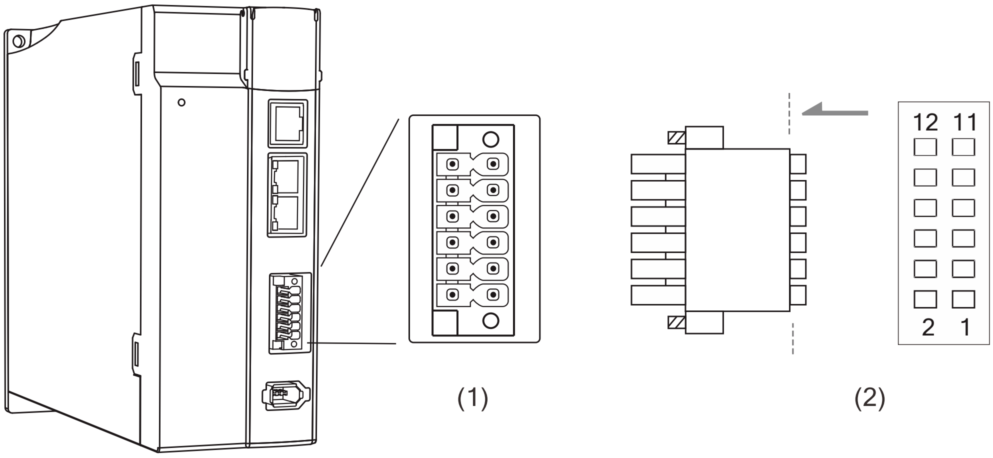
Note:
1. Short-circuit P1 and P2 as shown in the figure.
2. The dynamic brake is activated when power to the servo drive is lost. When the dynamic brake is in operation, the UVW is short-circuited.

3.3 Wiring for CN1 I/O connector

3.3.1 CN1 I/O connector

To increase the communication flexibility between the servo drive and the controller, the CN1 I/O connector includes 4 inputs and 2 outputs for you to define their functions. In addition, the motor temperature detection supports NTC and PTC thermistors.

When wiring, use a flathead screwdriver with a tip width of 2.5 mm (0.1 inches) and tip thickness of 0.4 mm (0.016 inches) to press down the spring on the terminal block. The wire specification is 0.21 - 1.31 mm^2 (24 - 16 AWG) and the exposed wire length is 9 - 10 mm (0.35 - 0.4 inches).



(1) CN1 connector (female); (2) CN1 connector (male)

Pin assignment:

Pin No.	Signal	Description	Pin No.	Signal	Description
1	DO1+	Digital output	7	DI3-	Digital input
2	DO1-	Digital output	8	DI4-	Digital input
3	DO2+	Digital output	9*1	NC*2	-
4	DO2-	Digital output	10*1	COM+	Power input (24V ± 10%)
5	DI1-	Digital input	11	TEMP+	Motor temperature detection
6	DI2-	Digital input	12	TEMP-	Motor temperature detection

Note:
1. **For the servo drives produced in and before week 9 of year 2023, Pin 9 is COM+ and Pin 10 is NC. For the servo drives produced after week 9 of year 2023, Pin 9 is NC and Pin 10 is COM+.**
2. NC represents “No connection”, which is for internal use only. Do not connect to NC, or it may damage the servo drive.

Signal description:

Signal		Pin No.	Description
Power	COM+	10	NPN: COM+ is for DI voltage input (positive end) and requires an external power supply (24V ± 10%). PNP: COM+ is for DI voltage input (negative end) and requires an external power supply (24V ± 10%).
Motor temperature detection	TEMP+ TEMP-	11 12	Supports NTC and PTC thermistors. Set parameters PM.022 and PM.024 according to the actual configuration.

The servo drive provides user-defined DI/DOs for you to set functions according to the application requirements. See Section 7.3 and refer to Table 7.1 Digital input (DI) descriptions and Table 7.2 Digital output (DO) descriptions. The default DI/DO signal configuration includes the most commonly used functions and meets the requirements for general applications. To reset the signals to the default values, set P1.001.U to 1 and cycle the power to the servo drive.

See the following table for the default DI/DO functions. DI/DOs not listed in the following table are set to 0x00 by default.

DI	Control mode	DO	Control mode
	Communication		Communication
	Default		Default
	Signal		Signal
1	0x01	1	0x01
	SON		SRDY
2	0x22	2	0x07
	NL		ALRM
3	0x23	-	-
	PL		-
4	0x21	-	-
	EMGS		-

Note: refer to Chapter 7 for the description of each DI / DO signal.

If the default DI/DO functions cannot meet the application requirement, you can specify the DI/DO functions by setting the DI and DO codes to the corresponding parameters.

Signal		CN1 Pin No.	Corresponding parameter	Signal		CN1 Pin No.	Corresponding parameter
Standard DI	DI1-	5	P2.010	Standard DO	DO1+	1	P2.018
	DI2-	6	P2.011		DO1-	2	
	DI3-	7	P2.012		DO2+	3	P2.019
	DI4-	8	P2.013		DO2-	4	

3

3.3.2 CN1 wiring diagrams

Caution: when the drive connects to an inductive load, you must install the diode.

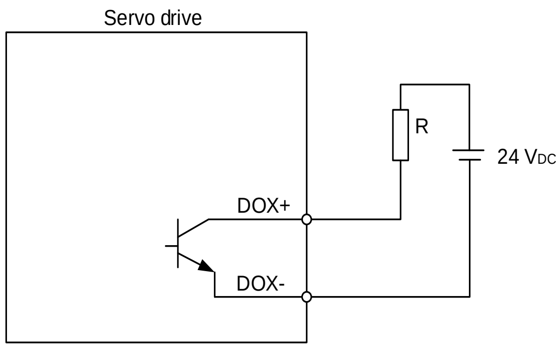
DO specification:

Permissible current: below 40 mA; surge current: below 100 mA; maximum voltage: 30V.

Diode specification:

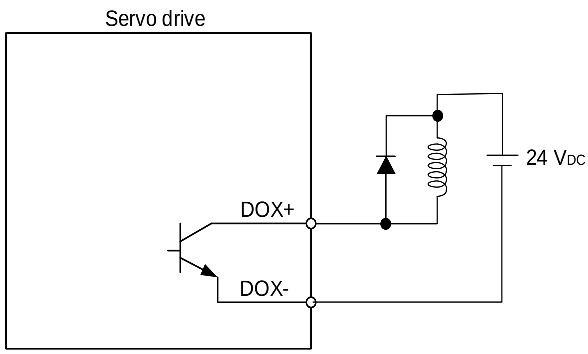
1A or above, 500V or above (e.g., 1N4005).

C5: DO wiring - the servo drive uses an external power supply and the resistor is for general load.



C6: DO wiring - the servo drive uses an external power supply and the resistor is for inductive load.

Important: make sure the polarity of diode is correct, or it may damage the servo drive.



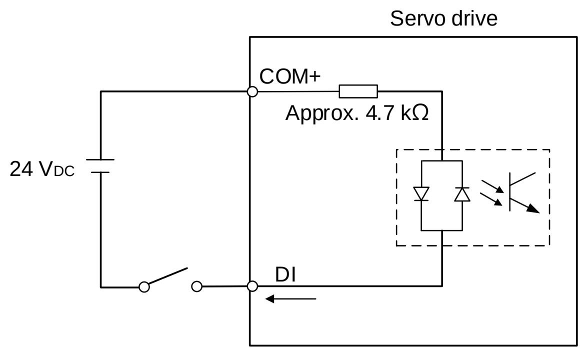
DI wiring - input signals by relay or open collector transistor.

Conditions of DI On / Off:

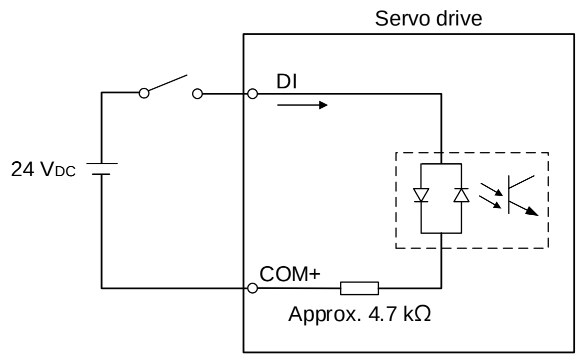
ON: 15V - 24V; condition: input current = 8 mA.

OFF: 5V or below; the input current must not be higher than 0.5 mA.

C7: NPN transistor (SINK mode)



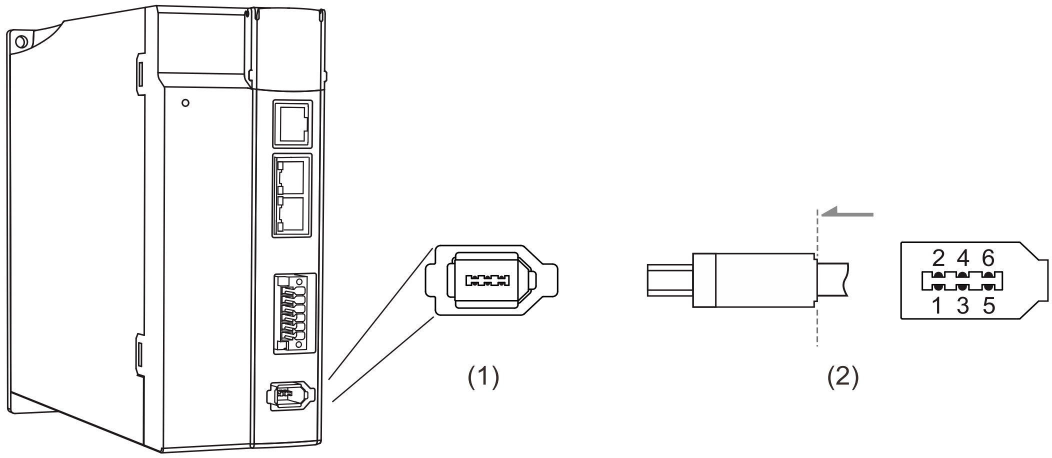
C8: PNP transistor (SOURCE mode)



3

3.4 Wiring for CN2 connector (1st set of position feedback signals)

The wiring of the CN2 connector is shown as follows:

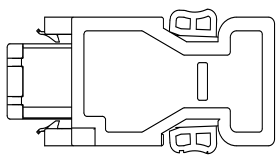


(1) CN2 connector (female); (2) CN2 connector (male)

WARNING

- DO NOT wire Pin 3 and Pin 4 of the servo drive CN2 connector. These pins are for third-party motors and internal use only*. Wiring them will cause damage to the internal circuit.
- When an absolute encoder is used, the battery supplies power directly to the encoder, so wiring the battery wires to the CN2 connector of the servo drive is not required.
- Separate the RST and UVW cables from the encoder cable with a minimum separation distance of 30 cm (11.8 inches).

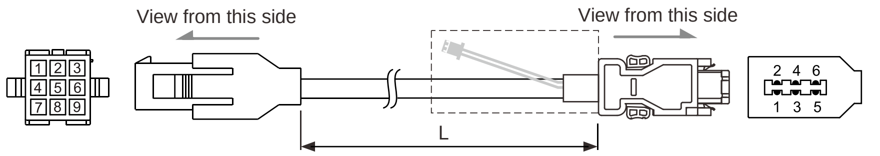
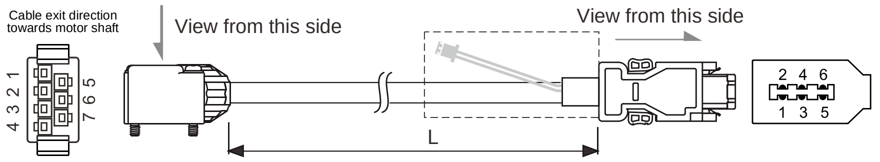
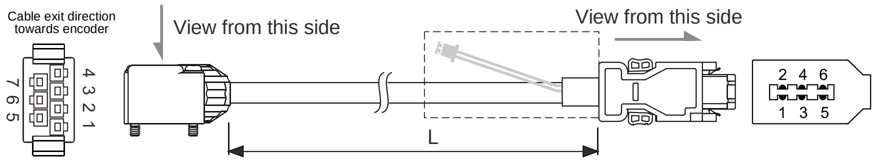
Note: third-party motors are not yet supported.

CN2 connector


Recommended connectors:

Brand	Model number
Delta	ACS3-CNENC200
JAWS	IES06G7AQB1

3.4.1 F40 - F80 motors – Encoder cables

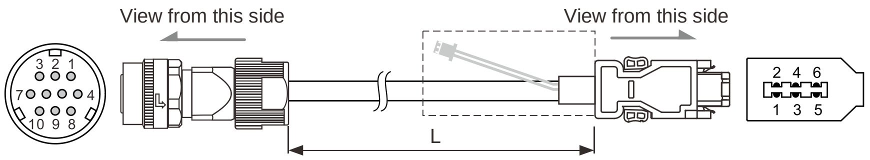
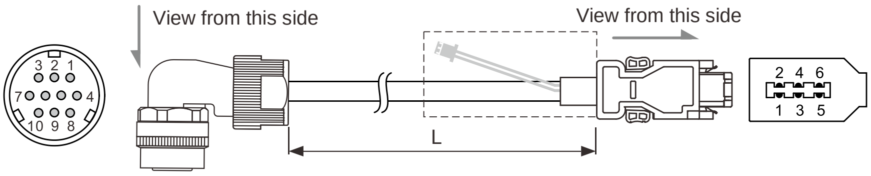
Encoder cable	
Standard connector	
Bulkhead connector - cable exit direction towards motor shaft	
Bulkhead connector - cable exit direction towards encoder	

Note: only the absolute encoder cables have the battery box connection wire.

Pin assignment:

Encoder cable connector					CN2 of servo drive		Description
Motor with cables		Motor with bulkhead connectors		Third-party motors			
Standard	Color	Bulkhead	Color	BiSS C	Pin No.	Signal	
7	Brown	3	Red	+5V_{DC}	1	+5V	+5V power supply
8	Blue	4	Orange	GND	2	GND	Power ground
-	-	-	-	MA+	3	CLOCK+	**DO NOT connect these pins. They are for third-party motors and internal use only.**
-	-	-	-	MA-	4	CLOCK-	
1	White	1	Blue	SL+	5	T+	Serial communication signal (+)
4	White/ Red	2	Purple	SL-	6	T-	Serial communication signal (-)
9	-	7	-	Shielding	Case	Shielding	Shielding
2	Red	5	Brown	-	-	-	+3.6V battery
5	Black	6	Black	-	-	-	Battery ground

3.4.2 F100 - F180 motors – Encoder cables

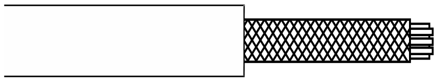
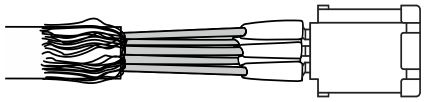
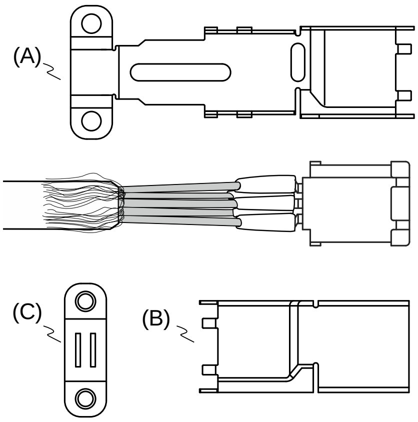
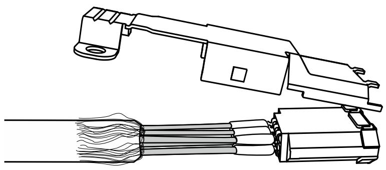
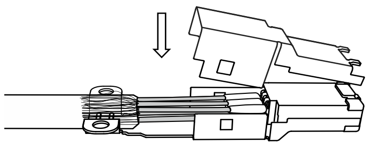
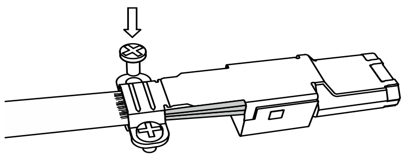
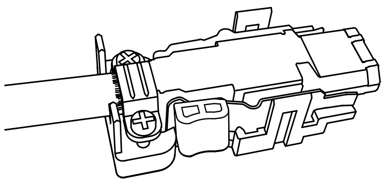
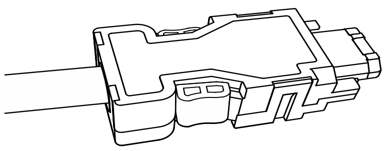
Encoder cable	
Military connector - straight	
Military connector - right angle	

Note: only the absolute encoder cables have the battery box connection wire.

Pin assignment:

Encoder cable connector			CN2 of servo drive		Description
Delta motors		Third-party motors	Pin No.	Signal	
Military	Color	BiSS C			
4	Brown	+5V$_{DC}$	1	+5V	+5V power supply
9	Blue	GND	2	GND	Power ground
-	-	MA+	3	CLOCK+	**DO NOT connect these pins. They are for third-party motors and internal use only.**
-	-	MA-	4	CLOCK-	
1	White	SL+	5	T+	Serial communication signal (+)
2	White/Red	SL-	6	T-	Serial communication signal (-)
10	-	Shielding	Case	Shielding	Shielding
6	Red	-	-	-	+3.6V battery
5	Black	-	-	-	Battery ground

3.4.3 Installing shielded wires for CN2 connector

Step 1		Strip the cable and expose the wires covered by the metal shield. The exposed wire length should be 20 - 30 mm (0.79 - 1.18 inches).
Step 2		Unravel the metal shield and fold it back. Refer to the pin assignment in the preceding tables to connect the wires.
Step 3		You need the following items to assemble the connector: (A) Big metal case (B) Small metal case (C) U-shaped bracket
Step 4		Place the big metal case to cover the exposed metal shield. Make sure the metal shield is completely covered to maintain the integrity of the shielding.
Step 5		Fasten the small metal case on the other side.
Step 6		Place the U-shaped bracket over the big metal case and fasten them with screws.
Step 7		Fit one side of the plastic case over the connector.
Step 8		Place and fasten the other side of the case to complete assembling the connector.

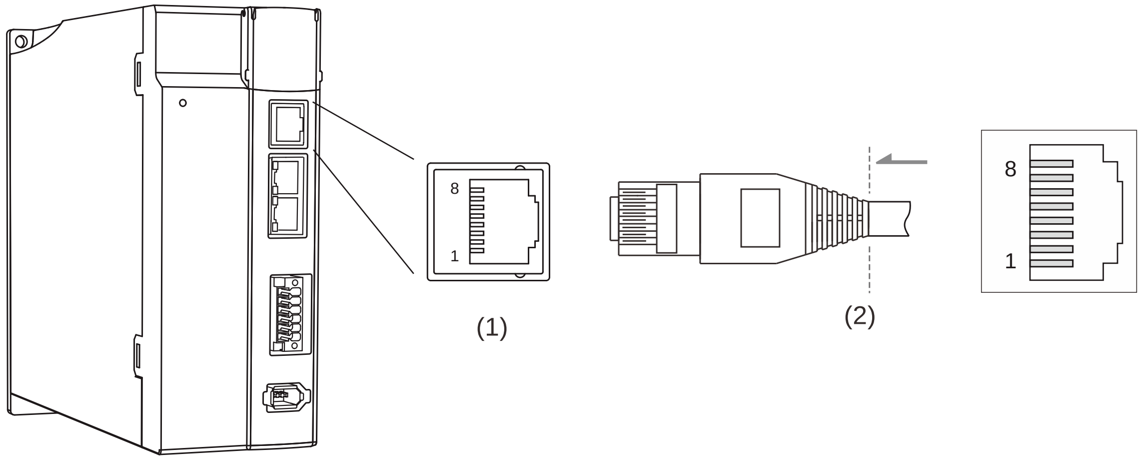
3

3.5 Wiring for CN4 connector (Ethernet communication port)

The CN4 port supports TCP/IP networks. Select the required communication protocol with different TCP port settings.

The default IP address for A3-EP is 192.168.1.4.

TCP port	Function
502	Standard Modbus/TCP communication protocol: for connecting to the controller software.
1502 (default)	For ASDA-Soft communication only: you can perform parameter setting, tuning, and scope settings.

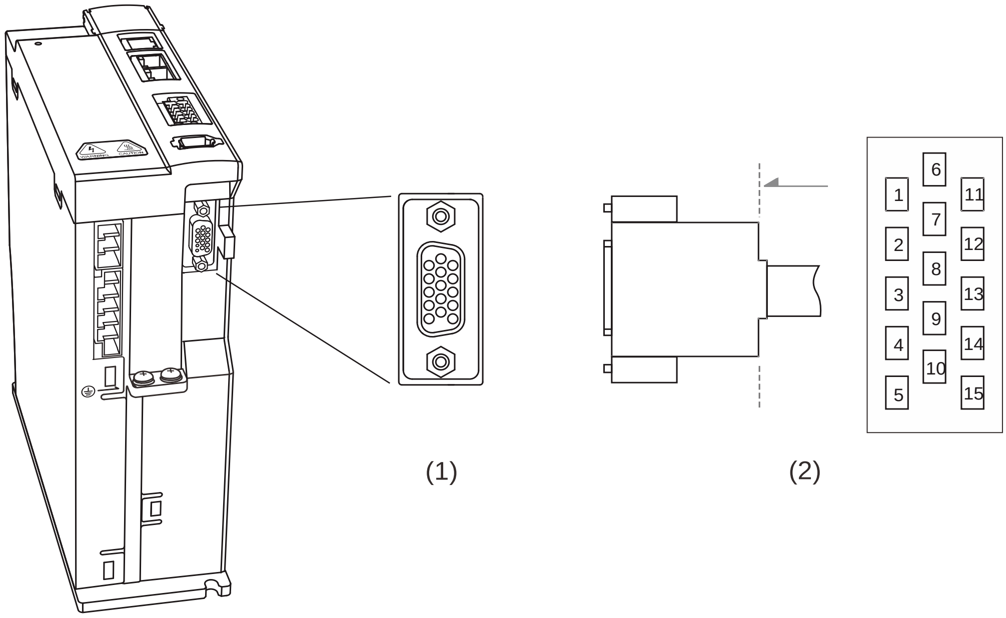


(1) CN4 connector (female); (2) CN4 connector (male)

3.6 Wiring for CN5 connector (2nd set of position feedback signals)

3

The CN5 connector is for connecting to a Delta servo motor, third-party motor, or Hall sensor.



(1) CN5 connector (female); (2) CN5 connector (male)

Pin assignment:

Pin No.	Delta motor	BiSS C	TTL	SIN/COS	Hiperface	Hall sensor
1	GND	GND	GND	GND	GND	GND
2	$+5V_{DC}$	$+5V_{DC}$	$+5V_{DC}$	$+5V_{DC}$	-	$+5V_{DC}$
3	-	-	/Z	-	-	-
4	-	-	/A	/SIN	/SIN	-
5	-	-	A	SIN	SIN	-
6	-	-	-	-	$+9V_{DC}$	-
7	-	-	B	COS	COS	-
8	-	-	/B	/COS	/COS	-
9	T+	SL+	Z	-	DATA+	-
10	T-	SL-	-	-	DATA-	-
11	-	-	-	-	-	Hall_U
12	-	-	-	-	-	Hall_V
13	-	-	-	-	-	Hall_W
14	-	MA+	-	-	-	-
15	-	MA-	-	-	-	-

3

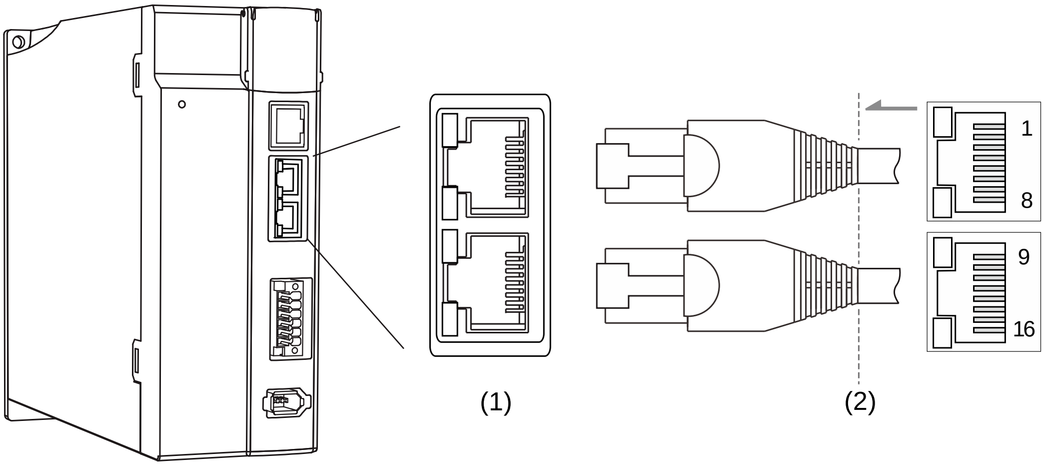
Specifications for the CN5 signals:

Signal type	Hall sensor	A, B, Z phase signal
Operating voltage	5V	5V
Signal format	Single-ended	Differential
Encoder power (5V) output	≤ 300 mA	≤ 300 mA
Pull-up resistor	≤ 20 kΩ	-
Max. pulse frequency	5 kHz	Single-phase pulse frequency: 4 MHz
V_{HALL} voltage	High-level voltage > 3.2V (Min.) Low-level voltage < 2.2V (Max.)	-

3.7 Wiring for CN6 connector

3.7.1 Wiring for the EtherCAT communication connector

The servo drive provides two EtherCAT ports for connecting multiple servo drives, with one way in and the other way out.



(1) CN6 connector (female); (2) CN6 connector (male)

Pin assignment:

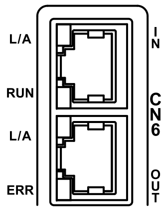
Transmission port	Pin No.	Signal	Description
IN	1	TX+	Transmit +
	2	TX-	Transmit -
	3	RX+	Receive +
	4	-	Reserved
	5	-	Reserved
	6	RX-	Receive -
	7	-	Reserved
	8	-	Reserved
OUT	9	TX+	Transmit +
	10	TX-	Transmit -
	11	RX+	Receive +
	12	-	Reserved
	13	-	Reserved
	14	RX-	Receive -
	15	-	Reserved
	16	-	Reserved

Note:

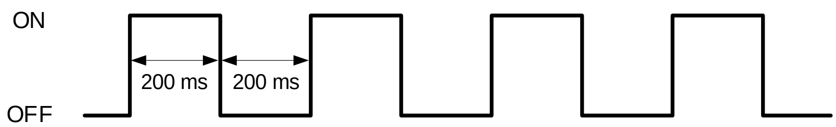
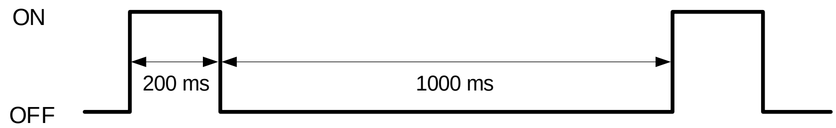
1. When multiple servo drives are connected, the maximum distance between each servo drive is 50 m (164.04 inches).
2. Use CAT5e STP cable.
3. It is suggested that you use a Beckhoff network cable (model number: ZB9020).
4. The IN port is for connecting the controller or the previous servo drive, and the OUT port is for connecting the next servo drive or not connecting to any devices. Incorrect wiring will lead to communication failure.

3

Description of each indicator for the CN6 connector:



■ LED indicator state description

Indicator	Description
On	
Blinking	
Single flash	
Off	

■ Network state indicator (L/A)

Indicator	Status	Description
On	Network is connected	Network connection is established but no data transmission.
Blinking	Network connection is established and data is in transmission	Data in transmission.
Off	No connection	Network connection is not established.

■ EtherCAT connection state indicator (RUN)

Indicator	Status	Description
Off	Init	After power cycling and the initialization of the servo drive is complete, the communication has not yet started, but the controller can access the servo drive's register.
On	Operational	SDO, TxPDO, and RxPDO data packets can be transmitted.
Blinking	Pre-Operational	The controller can exchange data through the mailbox.
Single flash	Safe-Operational	The servo drive can use the SDO and TxPDO data packets to exchange data with the controller.

■ EtherCAT error indicator (ERR)

Indicator	Status	Description
Off	No error	No error has occurred.
On	PDI watchdog timeout	Servo drive malfunction. Contact the distributor for assistance.
Blinking	State change error	Parameter setting error causes the system unable to switch the states. Refer to the following diagram.
Single flash	Synchronization error / SyncManager error	The synchronization between the controller and the servo drive failed or the data was lost during data reception.

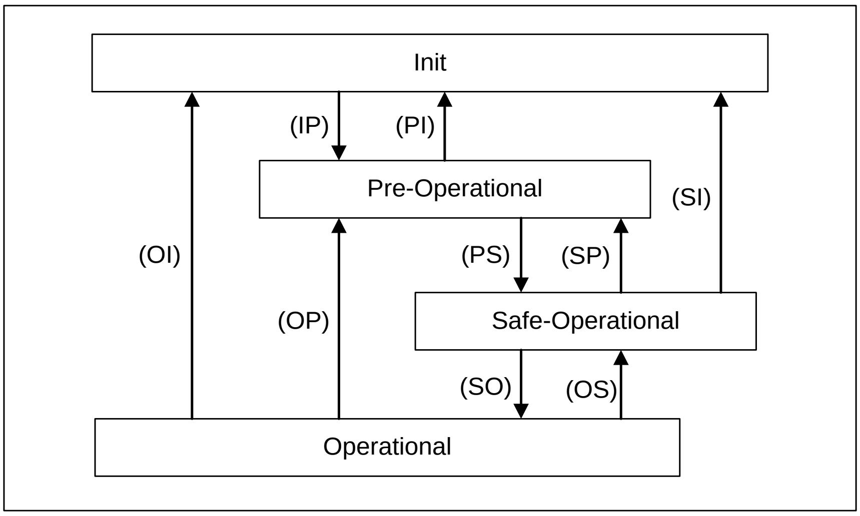
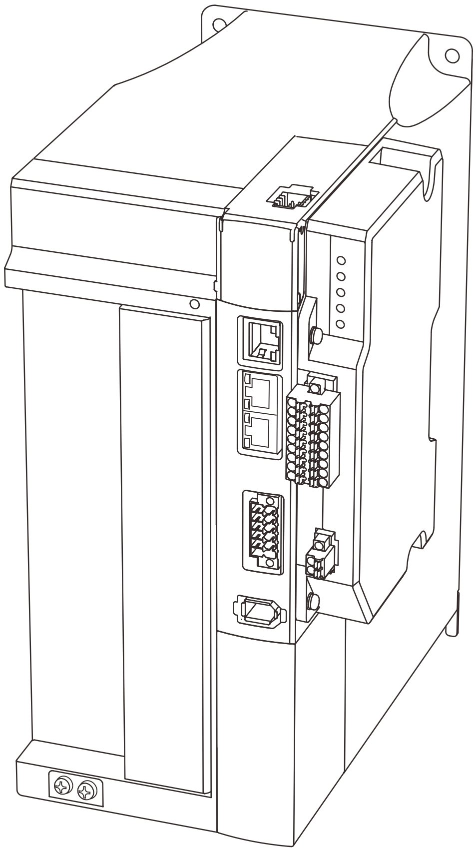


Figure 3.7.1.1 EtherCAT State Machine

3.8 CN9 connector (for safety functions module connection)

3



After the safety functions module is installed, the A3-EP servo drive can use the following safety functions. For details, refer to the Delta ACS3-SF Safety Functions Module User Manual.

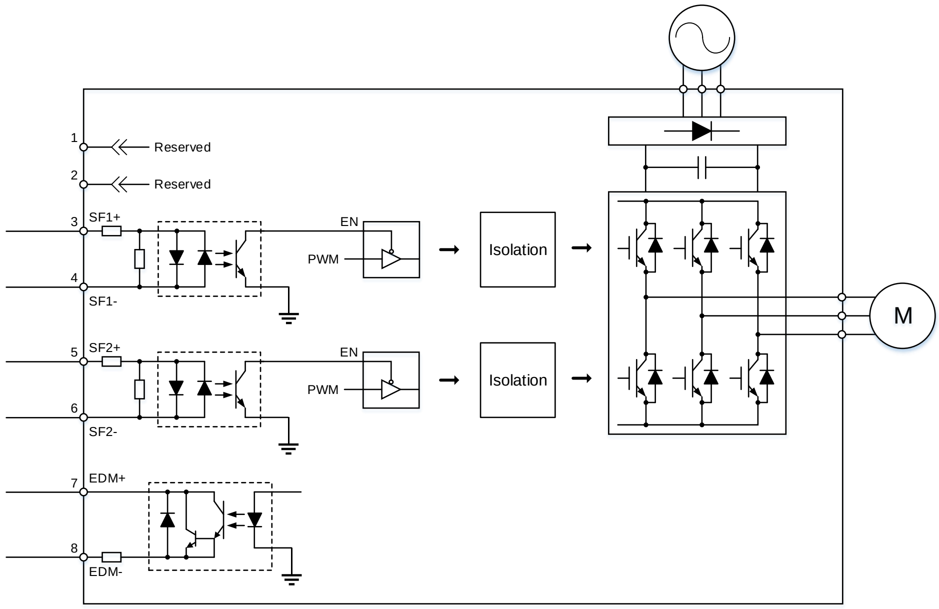
Function type	Abbreviation	Function name
Safe stop functions	STO	Safe Torque Off
	SS1-t	Safe Stop 1 time controlled
	SS1-r	Safe Stop 1 ramp monitored
	SS2-t	Safe Stop 2 time controlled
	SS2-r	Safe Stop 2 ramp monitored
Safe monitoring functions	SOS	Safe Operating Stop
	SLS	Safely-limited Speed
	SMS	Safe Maximum Speed
	SSM	Safe Speed Monitor
	SLI	Safely-limited Increment
	SDI	Safe Direction
	SLP	Safely-limited Position
Safe output function	SBC	Safe Brake Control
Auxiliary function	SBT	Safe Brake Test

3

3.9 CN10 STO (Safe Torque Off) function

3.9.1 Introduction to STO

The STO function stops the current to the motor immediately. The dual-channel input signals (SF1 and SF2 signals) stop the servo drive from supplying power to the motor.



Note:
1. STO certification application is in progress.
2. For this servo drive, the safe state is defined as “the state that power supply to the motor is cut off”. If an error or danger is diagnosed, take the measure to have the servo drive enter the safe state.

3.9.2 Precautions for using STO function

Read the following safety precautions carefully to ensure system safety.

- Only qualified personnel fully understanding the safety standards can design, install, and operate the system after reading this operation manual.
- Use products with safety certifications or machines compliant with safety specifications to build a safe electrical circuit.
- Before installation and wiring, read the operation manuals of all the peripheral devices carefully.
- If the motor is moved by external forces when the STO function is activated, take safety measures such as using the mechanical brake.
- Evaluate the risk of using the machine or the connecting devices.

3

3.9.3 Potential risks of STO

After the STO function is activated, the servo drive can no longer control the motor. Hence, you must evaluate all the potential risks that may result from the activation of the STO function to ensure safety. Delta is not liable for any mechanical damage or personal injury caused by the potential risks.

- Do not touch the servo drive after activating the STO function. The STO function stops the servo drive from supplying power to the motor but does not cut off the power to the servo drive. Thus, there is a potential risk of electric shock.
  When maintaining the servo drive, use the molded-case circuit breaker (MCCB) or magnetic contactor (MC) to cut off the power to the servo drive.
- When the STO function is activated, the servo drive can no longer stop or decelerate the motor.
- The STO function cuts off the power to the motor, but the motor can still be moved by other external forces.
- When installing the machine or changing the servo drive, ensure to check if the STO function works normally.
- The motor may move due to malfunction of the power device, and the maximum moving range is 180 electrical degrees.
- Supply power to the STO input signals with a single power source. If you use a split power supply, the leakage current may result in STO misoperation. In addition, the STO function must be powered by the safety extra-low voltage (SELV) power source with reinforced insulation.
- The EDM output signals are not safety output signals, which are used only for failure monitoring. Incorrect use of the EDM signals may result in personnel injury. When an STO failure is detected with the EDM signals, keep the STO input signals off.
- To avoid malfunction caused by accumulated errors, you must check the safety functions at least once every 3 months.

3.9.4 Safety parameters

To comply with the EN ISO 13849-1 PL e and IEC / EN 61508 SIL3 standards, you have to monitor the EDM signals with the controller. If you do not monitor the EDM signals, the system only meets the IEC / EN 61508 SIL2 standard. Refer to the following tables for the related standards.

Standard	
Functional Safety	IEC / EN 61508: 2010
Machinery Directive	EN IEC 62061: 2021
	EN 61800-5-2: 2017
	EN ISO 13849-1: 2015
Low Voltage Directive	EN 61800-5-1:2007/A11:2021
EMC for Functional Safety	EN 61326-3-1: 2017
	EN 61000-6-7: 2015

Item	Description	Standard	EDM signal monitoring with controller	No EDM signal monitoring
Safety function	Safety function	EN 61800-5-2	STO	STO
HFT	Hardware fault tolerance	IEC / EN 61508	1	1
Subsystem	Subsystem	IEC / EN 61508	Type A	Type A
SIL	Safety integrity level	IEC / EN 61508	SIL3	SIL2
		EN IEC 62061	maximum SIL3	maximum SIL2
PFH	Probability of dangerous failure per hour [h^{-1}]	IEC / EN 61508 EN IEC 62061	1.61×10^{-9} [1/h] (1.61% of SIL3)	1.66×10^{-9} [1/h] (0.166% of SIL2)
Response time	Response time	IEC / EN 61508	≤ 10 ms	≤ 10 ms
Category	Category	EN ISO 13849-1	Category 3	Category 3
PL	Performance level	EN ISO 13849-1	PL e	PL d
$MTTF_d$	Mean time to dangerous failure	EN ISO 13849-1	High	High
DC	Diagnostic coverage	EN ISO 13849-1	Medium	Low
Mission time	Mission time	EN ISO 13849-1	20 years	20 years

3.9.5 How does the STO function work?

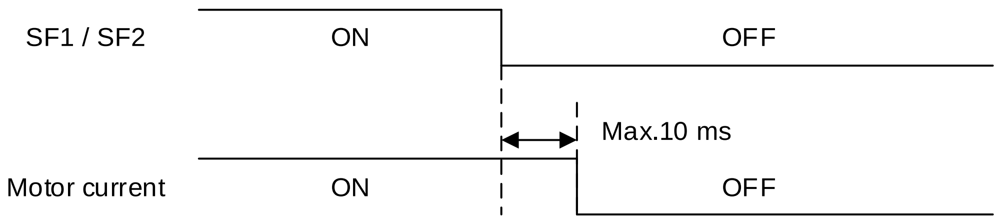
The STO function controls the motor current by two individual circuits. When the STO function is activated, it cuts off the power to the motor, so the motor is free from torque force. The following table details how this function works.

Signal		Status of opto-isolator			
STO	SF1+ SF1-	ON	ON	OFF	OFF
	SF2+ SF2-	ON	OFF	ON	OFF
Servo drive output status		Ready	Torque off (SF2 lost)	Torque off (SF1 lost)	Torque off (STO activated)
Diagnostic output (EDM)		OFF	OFF	OFF	ON
Alarm		N/A	AL502	AL501	AL500

Note:
1. AL500 is triggered only when P1.120 is set to 1 or 3.
2. Definition of STO signal status: ON = 24V; OFF = 0V.
3. Definition of EDM signal status: OFF = open (open circuit); ON = close (closed circuit).
4. The status of the EDM signals changes at once according to the status of the safety signals (SF1 and SF2 signals).

3.9.5.1 Response time

When either SF1 signal or SF2 signal becomes OFF, the circuit cuts off the current to the motor within 10 ms.

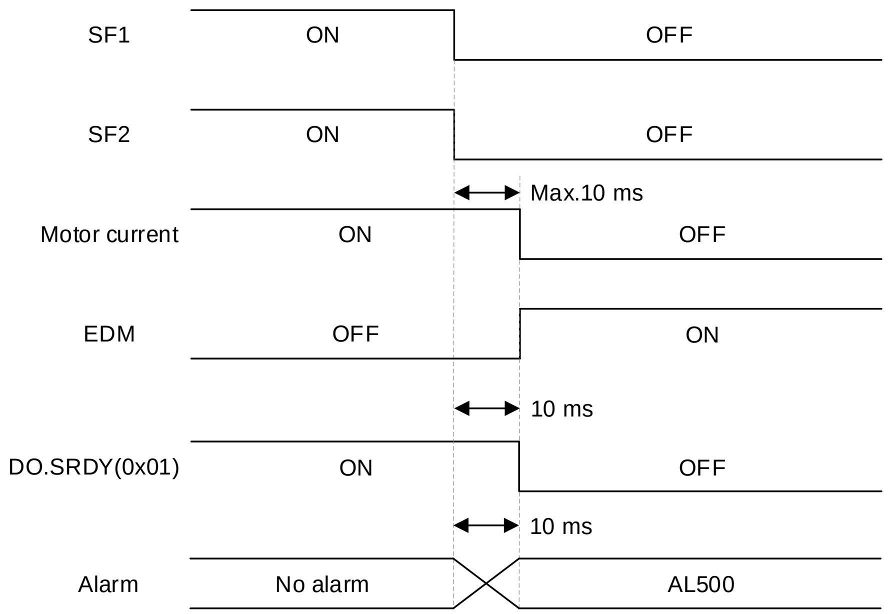


3.9.5.2 Alarm triggering

(1) AL500 (STO function is enabled)

When both SF1 and SF2 signals become OFF, the servo drive keeps displaying AL500; refer to the following diagram.

You can set P1.120 for the panel to display “AL500” or “-STO-”.



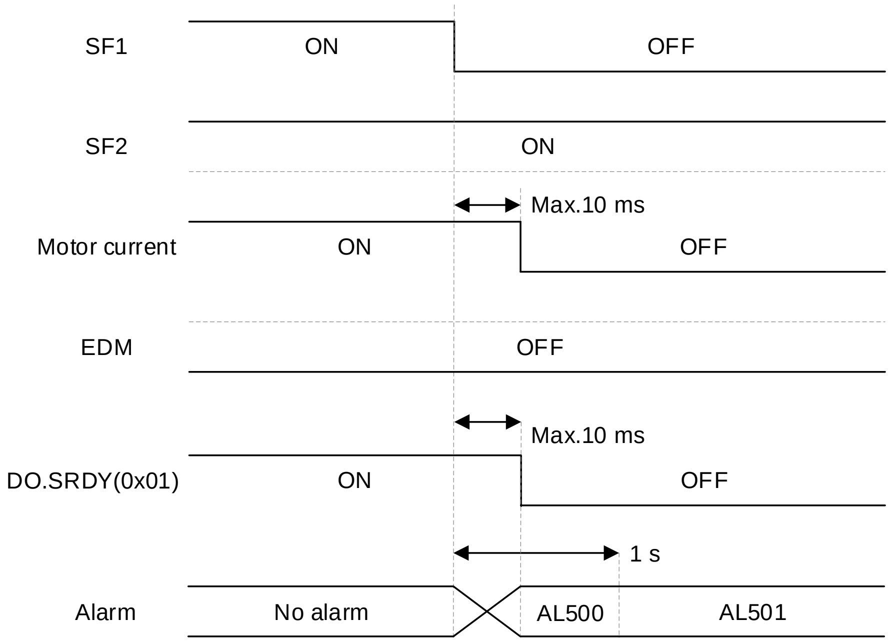
In addition, when either SF1 signal or SF2 signal becomes OFF, AL500 is also triggered. See the descriptions of AL501 and AL502 for details.

3

(2) AL501(SF1 lost) / AL502 (SF2 lost) (signal loss or signal error)

When either SF1 signal or SF2 signal becomes OFF, the STO function is activated, the circuit cuts off the current to the motor within 10 ms, and the servo drive is Off, triggering AL500. After 1 second, AL501 or AL502 is triggered. The following diagram illustrates how AL501 is triggered.

You can set P1.120 for the panel to display “AL500” or “-STO-”.



Note: when SF1 becomes OFF, AL501 occurs. When SF2 becomes OFF, AL502 occurs.

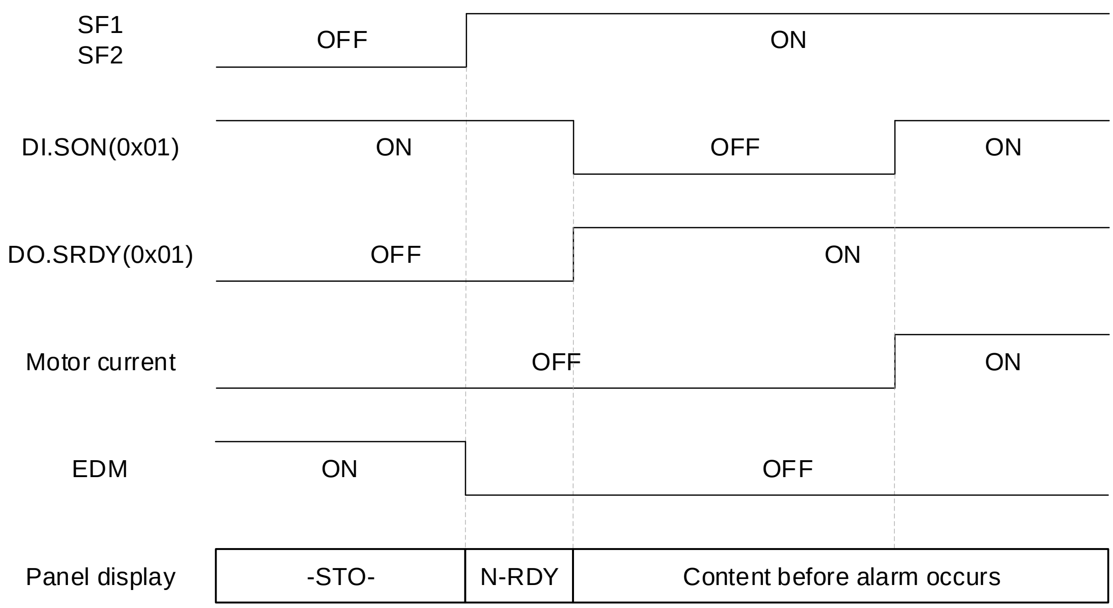
3.9.5.3 STO deactivation settings

Set P1.120 to choose the way to deactivate the STO function.

P1.120	Function
0	Switching on the servo drive is invalid / prohibited after the STO function is activated. To deactivate the STO function and restart the servo drive, send the Servo Off command to cancel the state (Servo On invalid / prohibited), and then send the Servo On command.
1	AL500 is triggered after the STO function is activated. To deactivate the STO function and restart the servo drive, you have to clear the alarm first, send the Servo Off command to cancel the state (Servo On invalid / prohibited), and then send the Servo On command.
2 (Recommended)	Switching on the servo drive is invalid / prohibited when the STO function is activated. The servo drive starts to operate again after the STO function is deactivated.
3 (Default)	AL500 is triggered after the STO function is activated. To deactivate the STO function and restart the servo drive, you have to clear the alarm.

Note: if a safety functions module is used, refer to the STO deactivation settings of the safety functions module.

(1) When P1.120 = 0 and the Servo On / Off command is sent with external DI



Note: DI.SON is invalid in communication modes, and thus you have to switch the drive to Servo On with the controller.

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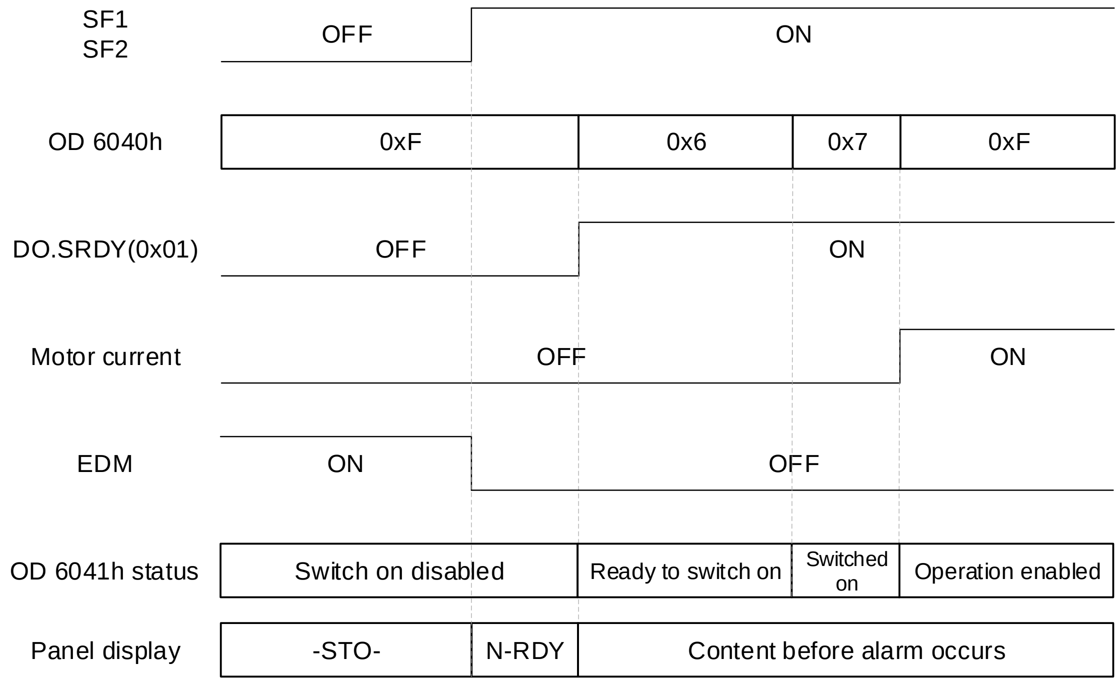
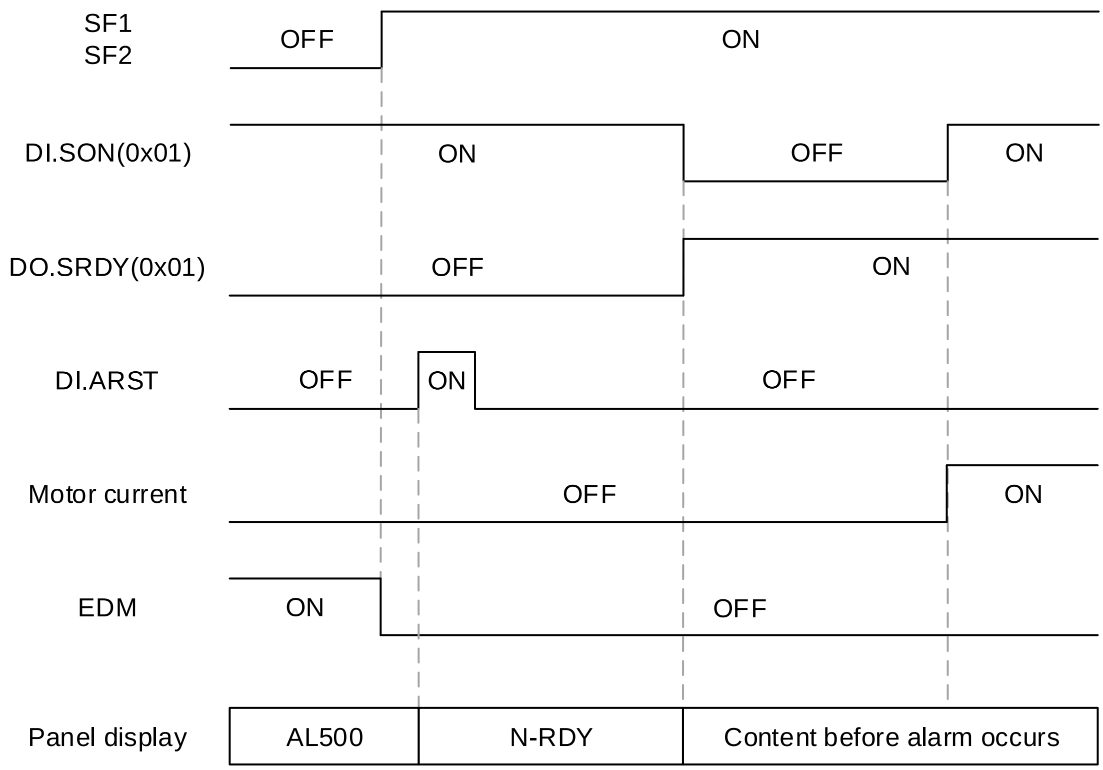
(2) When P1.120 = 0 and the Servo On / Off command is sent through EtherCAT communication



(3) When P1.120 = 1 and the Servo On / Off command is sent with external DI



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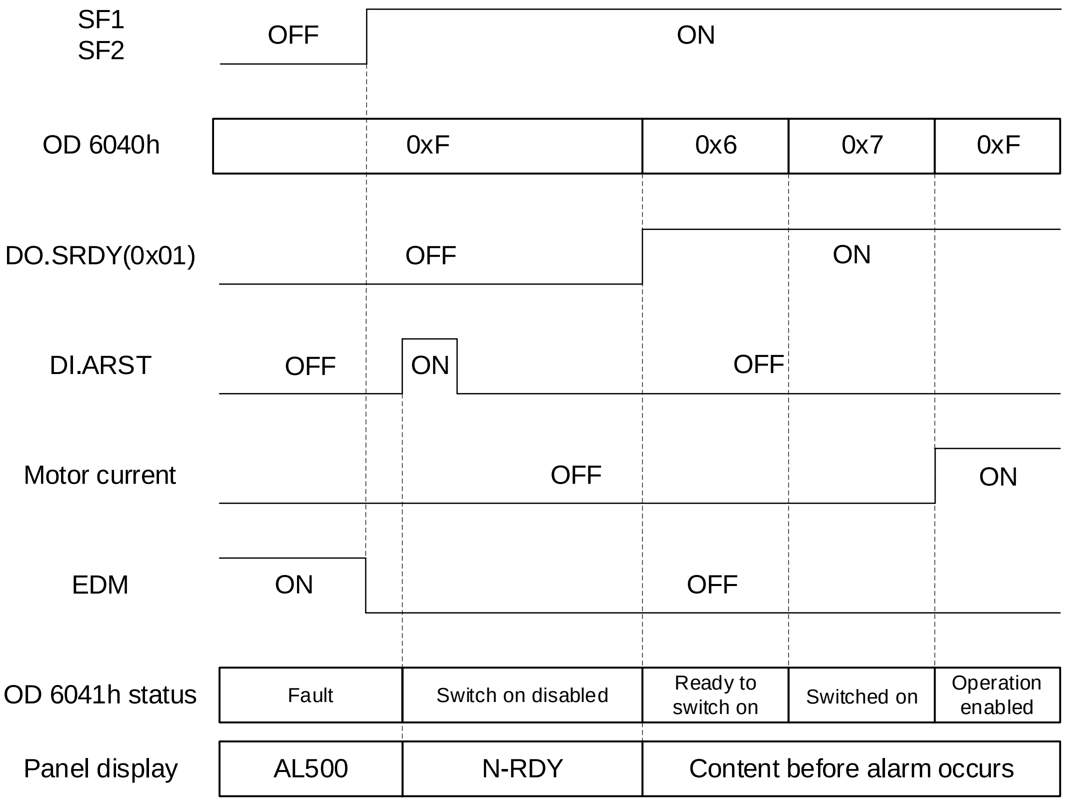
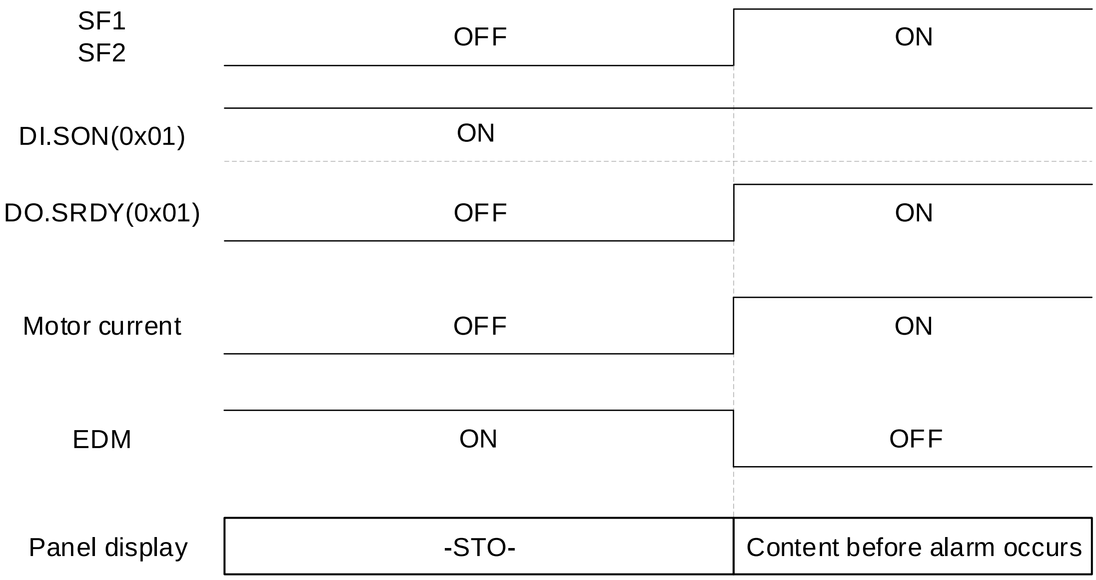
(4) When P1.120 = 1 and the Servo On / Off command is sent through EtherCAT communication



(5) When P1.120 = 2 and the Servo On / Off command is sent with external DI



Note: if you switch the STO signals to ON when the servo drive sends the position or speed command to the motor, it may cause drastic motor rotation. Before switching the STO signals to ON, check if there is any command input and ensure personnel safety.

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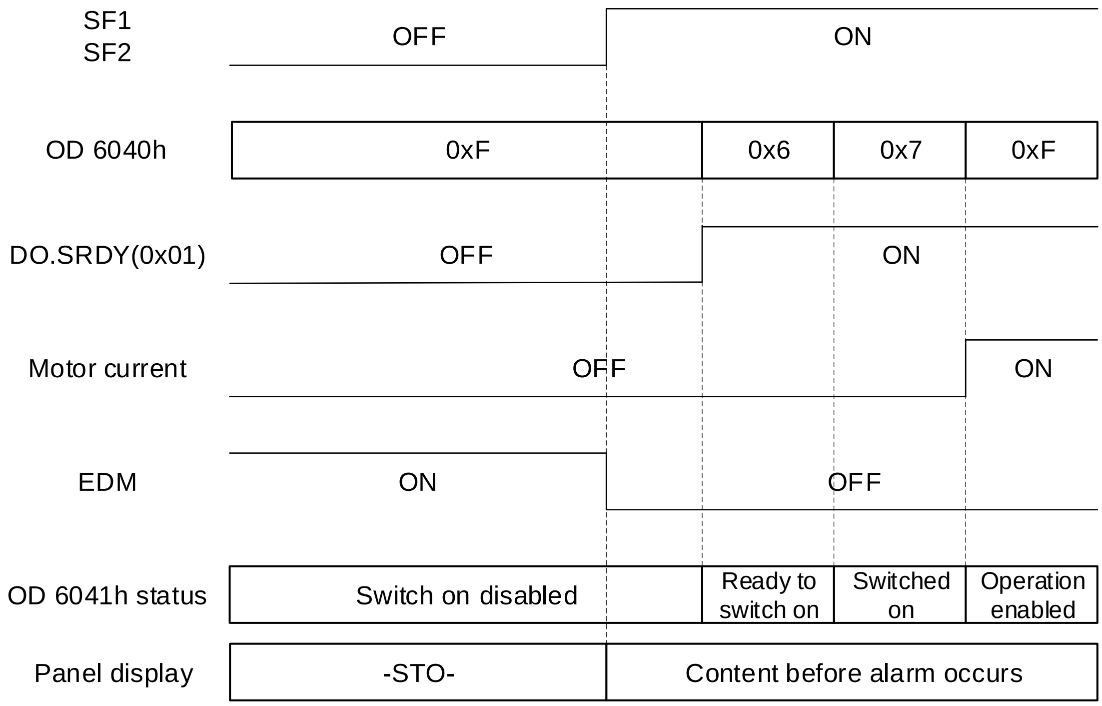
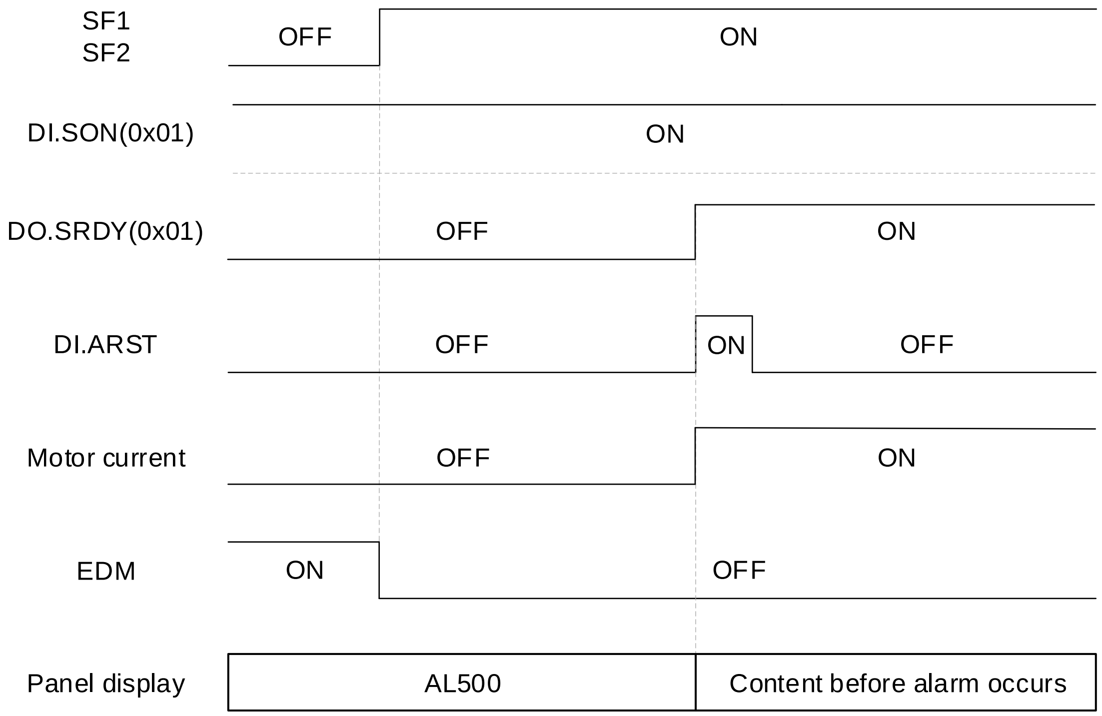
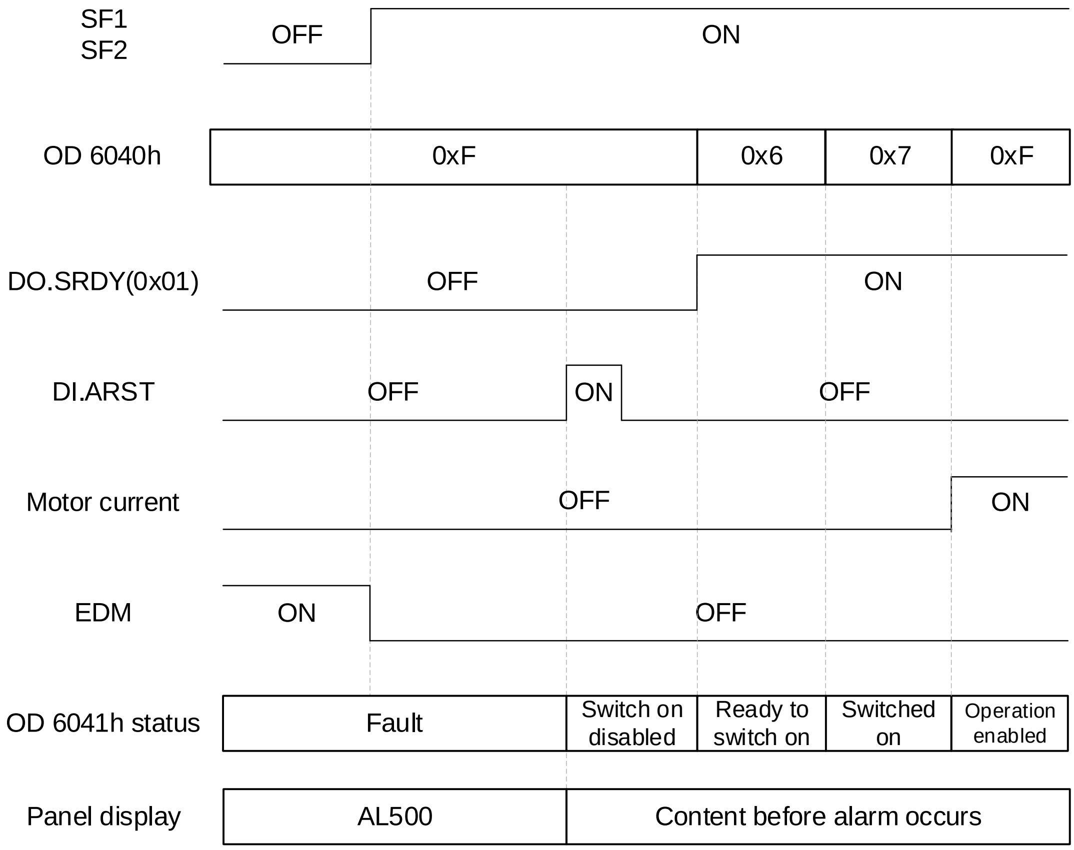
(6) When P1.120 = 2 and the Servo On / Off command is sent through EtherCAT communication



(7) When P1.120 = 3 and the Servo On / Off command is sent with external DI



(8) When P1.120 = 3 and the Servo On / Off command is sent through EtherCAT communication



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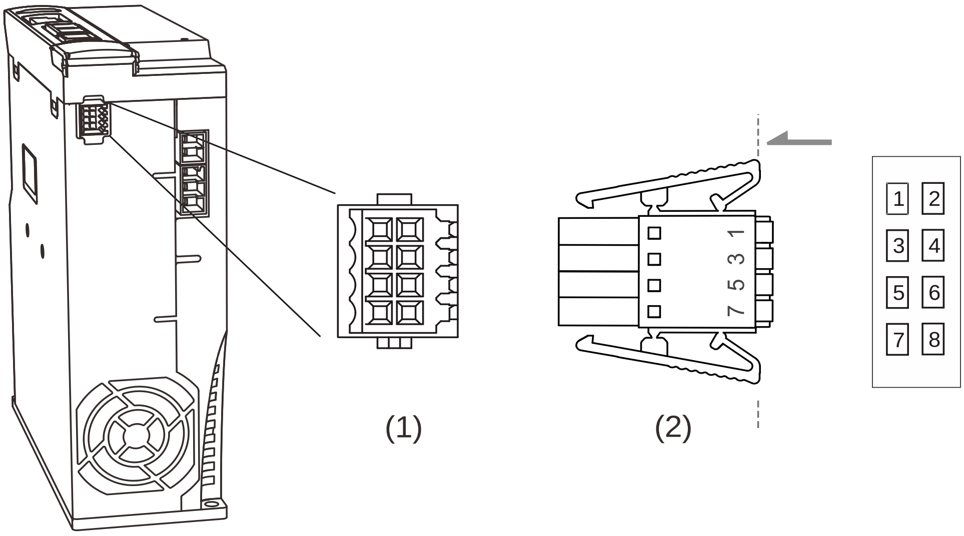
3.9.6 Wiring for STO

For STO wiring, the recommended wire specification is 0.11 - 0.52 mm^2 (30 - 20 AWG).

3.9.6.1 CN10 STO terminal

This terminal provides the STO function.

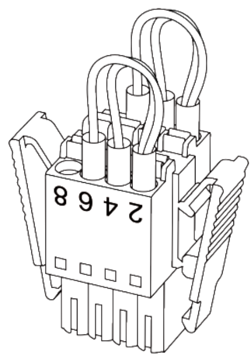


(1) CN10 STO terminal (female); (2) CN10 STO connector (male)

Pin assignment:

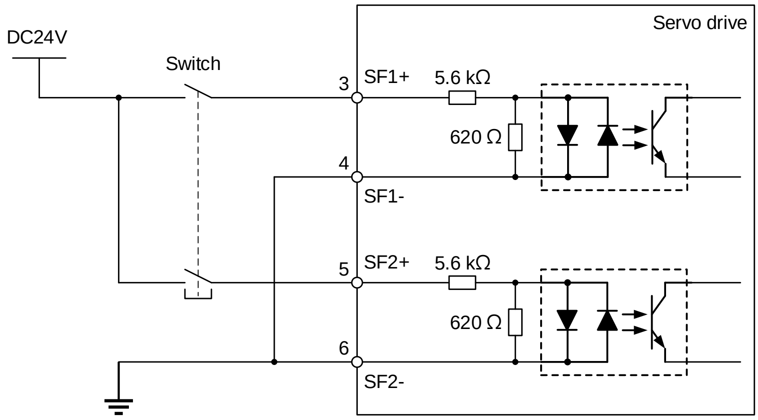
Pin No.	Signal	Description	Function
1	-	Reserved	For deactivating the STO function; refer to Section 3.9.6.3 for the wiring diagram. Do not connect these two pins if using the STO function is required.
2	-	Reserved	
3	SF1+	STO input SF1+	Input signal for the STO function. ON (close): servo drive is in normal operation OFF (open): STO is activated
4	SF1-	STO input SF1-	
5	SF2+	STO input SF2+	Input signal for the STO function. ON (close): servo drive is in normal operation OFF (open): STO is activated
6	SF2-	STO input SF2-	
7	EDM+	Diagnostic output+	Monitoring outputs for STO input status and STO circuit failure.
8	EDM-	Diagnostic output-	

If you do not need the STO function, plug in the STO connector that comes with the servo drive. The short-circuit wiring has been done as shown in the figure on the right. If the wiring is removed, refer to the wiring information in Section 3.9.6.3 Not using the STO function.



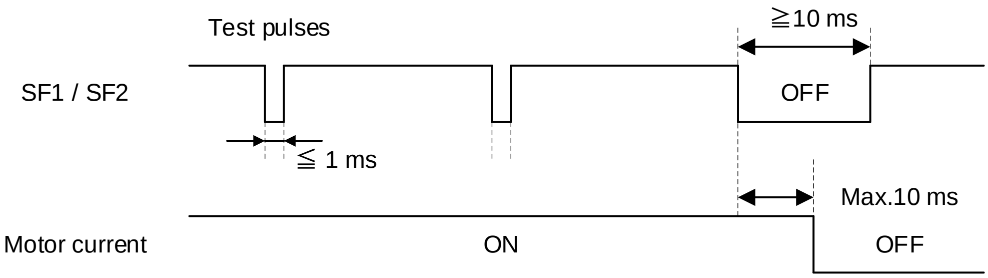
3.9.6.2 Input / output signal specification

(1) Safety input signals (SF1+, SF1-, SF2+, SF2-)

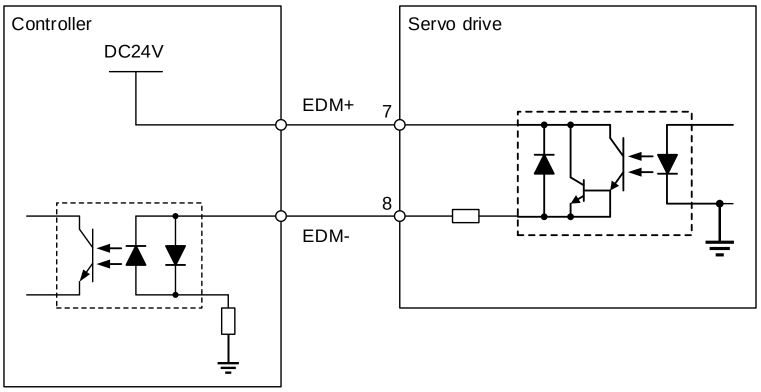


Item	Specification	Note
Internal impedance	5.6 kΩ	-
Operable voltage	DC24V ± 20%	Use the SELV power source.
Maximum delay time	10 ms	The time duration from STO signal Off to STO function activated.

■ The Off time duration of the external test pulse input should be 1 ms or less.



(2) Diagnostic output signal (EDM+, EDM-)



Item	Specification	Note
Maximum allowable voltage	DC24V	Use the SELV power source.
Maximum allowable current	50 mA	-
Maximum voltage drop	1.5V	When the current is 50 mA.

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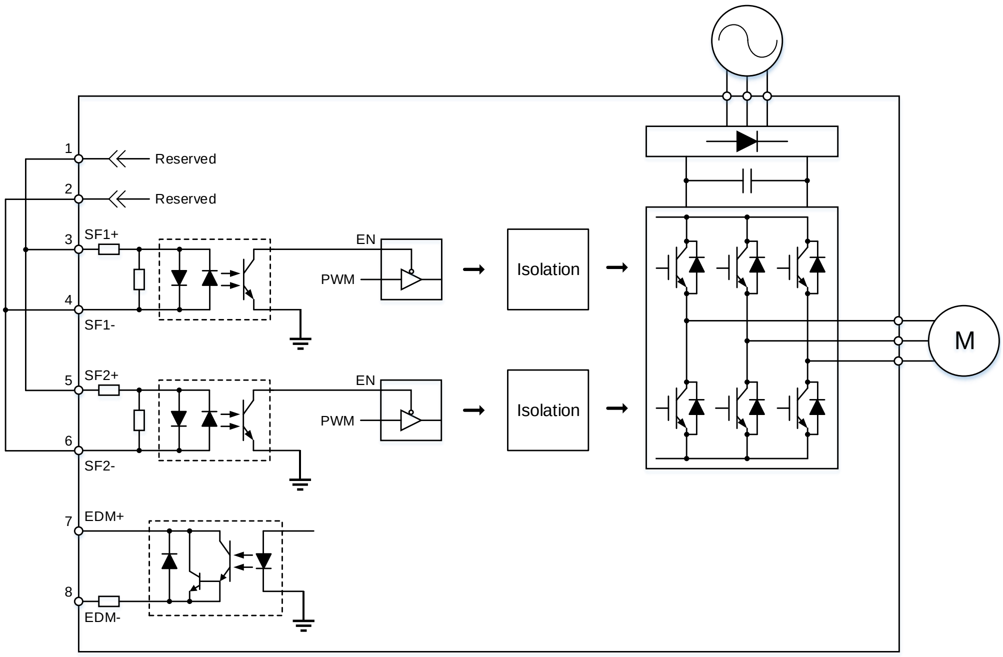
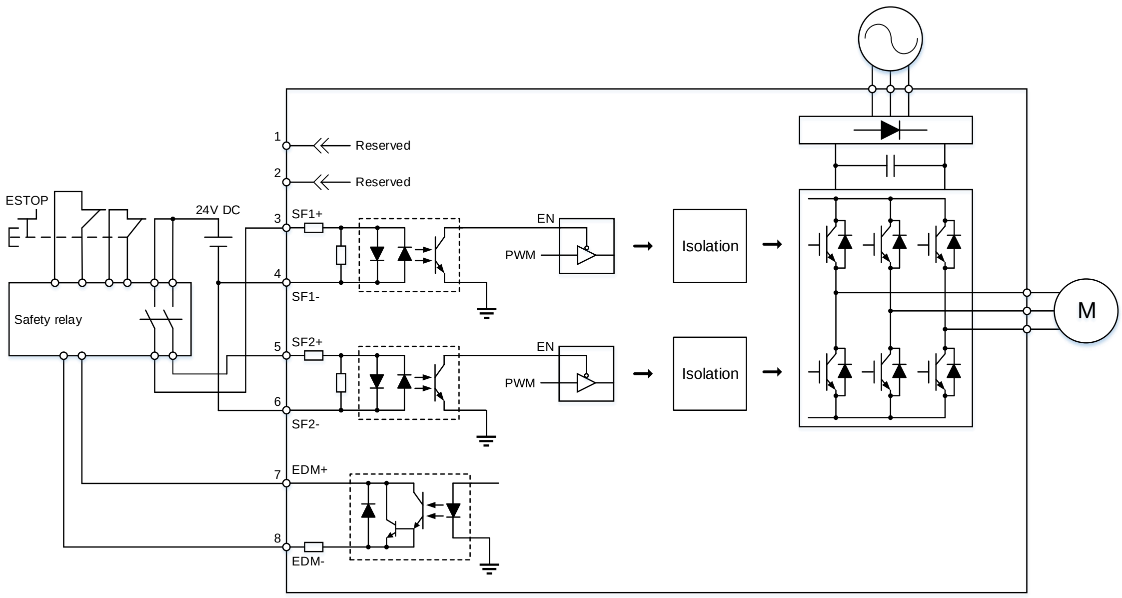
3.9.6.3 Not using the STO function

Follow the diagram for wiring or plug in the short-circuit connector that comes with the servo drive.



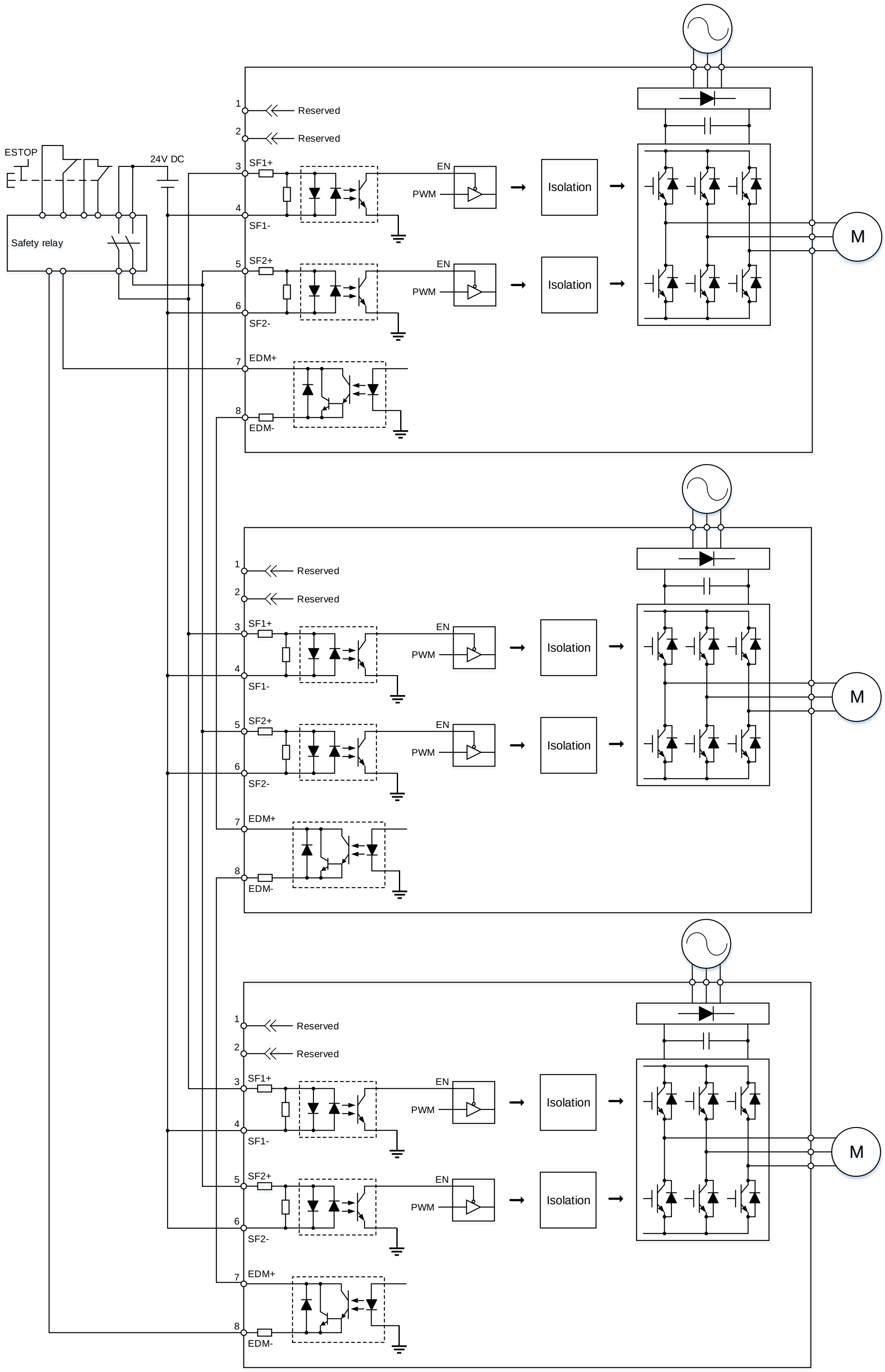
3.9.6.4 Using the STO function for a single drive

To use a safety relay to trigger the STO function, follow the diagram for wiring.



3.9.6.5 Using the STO function for multiple drives

Follow the diagram for wiring if using multiple servo drives. However, ensure the value of multiplying PFH and the number of servo drives is within the intended safety value for the multi-axis servo system.



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3.9.7 Validation test

When installing, maintaining, or changing the servo drive, ensure to perform the following validation tests. (It is suggested that you keep a record of the test results.)

■ **With EDM diagnosis (SIL3 system)**

(1) When either SF1 or SF2 signal is off, the servo motor cannot be operated.

(2) When you switch the SF1 and SF2 signals to ON or OFF, the input / output logic has to be in accordance with the following table.

Signal		Status of opto-isolator			
STO	SF1+ SF1-	ON	ON	OFF	OFF
	SF2+ SF2-	ON	OFF	ON	OFF
Diagnostic output (EDM)		OFF	OFF	OFF	ON

■ **Without EDM diagnosis (SIL2 system)**

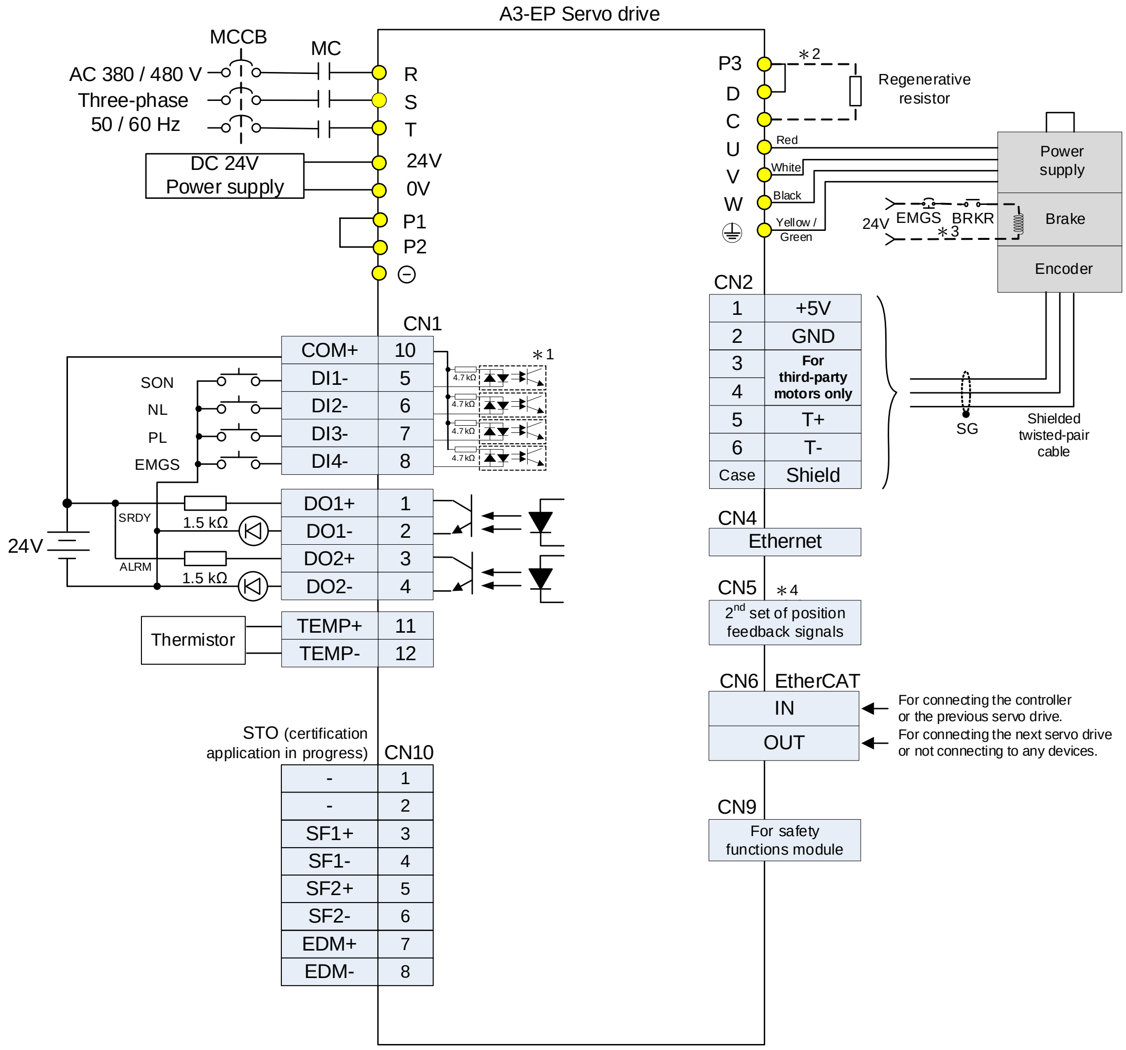
(1) When either SF1 or SF2 signal is off, the servo motor cannot be operated.

(2) When SF1 and SF2 signals are both ON or OFF, neither AL501 nor AL502 is triggered.

Note:

1. Ensure to perform the validation tests once every 3 months even if you do not install, maintain, or change the servo drive.
2. If an error or danger is diagnosed, switch the safety input signals to OFF to have the servo drive enter the safe state.

3.10 Standard wiring example



Note:

1. Refer to Section 3.3 for wiring.
2. Models of 2 kW and above do not have built-in regenerative resistors.
3. The brake coil has no polarity.
4. Refer to Section 3.6 for the pin assignment of CN5 connector (2nd set of position feedback signals).

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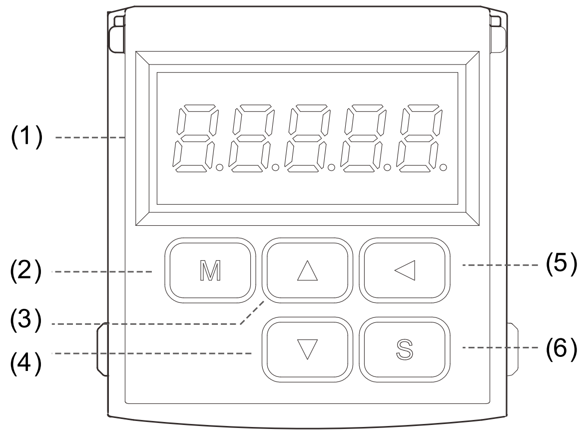
Panel Operation, Testing and Software Connection 4

This chapter describes the panel display, panel operation, and test operation for the A3-EP servo drive. Descriptions for connecting ASDA-Soft to the servo drive are also provided.

4

4.1 Panel description



(1) Display: the 5-digit, 7-segment LED display shows the monitoring values, parameter numbers, and parameter setting values.

(2) MODE key (M): switches the display among Monitoring mode, Parameter mode, CiA 402 state machine, and Alarm mode. In Editing mode, pressing this key switches back to Parameter mode.

(3) UP key (▲): changes the monitoring code, parameter number, and parameter setting value.

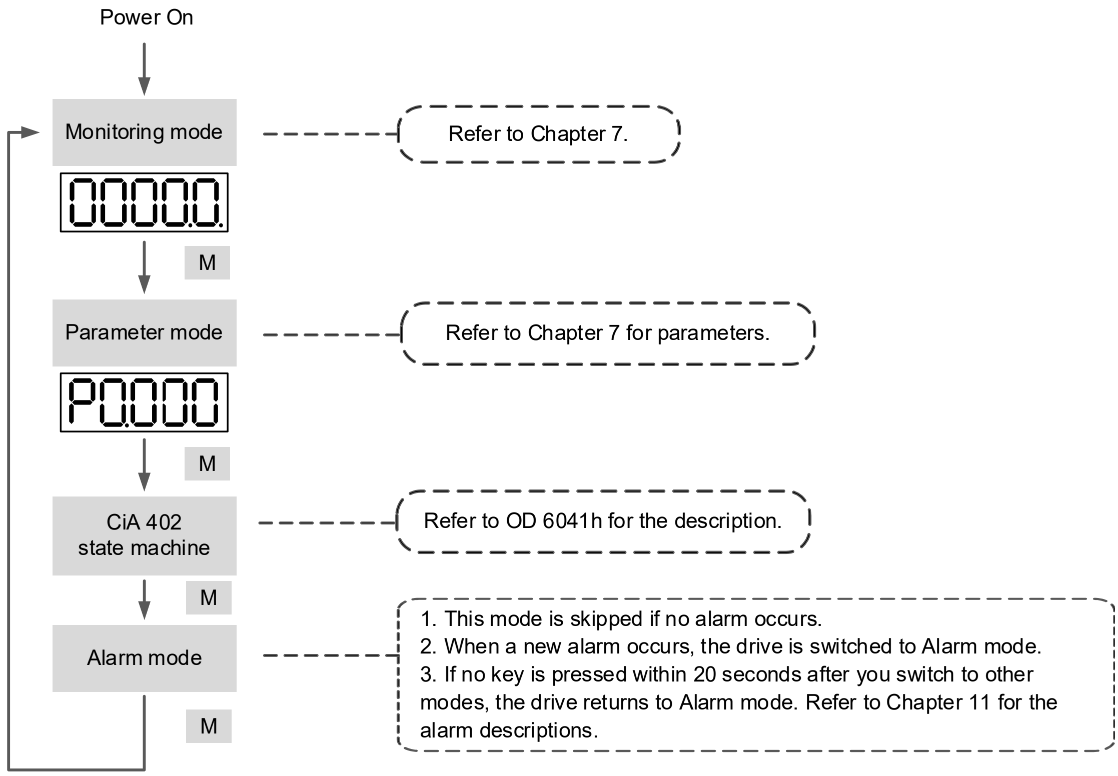
(4) DOWN key (▼): changes the monitoring code, parameter number, and parameter setting value.

(5) SHIFT key (◄): in Monitoring mode, pressing this key switches between high / low word display. In Parameter mode, pressing this key changes the group number. In Editing mode, pressing this key moves the blinking (selected) digit to the left for adjusting the value.

(6) SET key (S): in Monitoring mode, pressing this key switches between decimal and hexadecimal display. In Parameter mode, pressing this key switches to Editing mode. In Editing mode, pressing this key saves the setting.

4.2 Parameter setting procedure

Switching modes:



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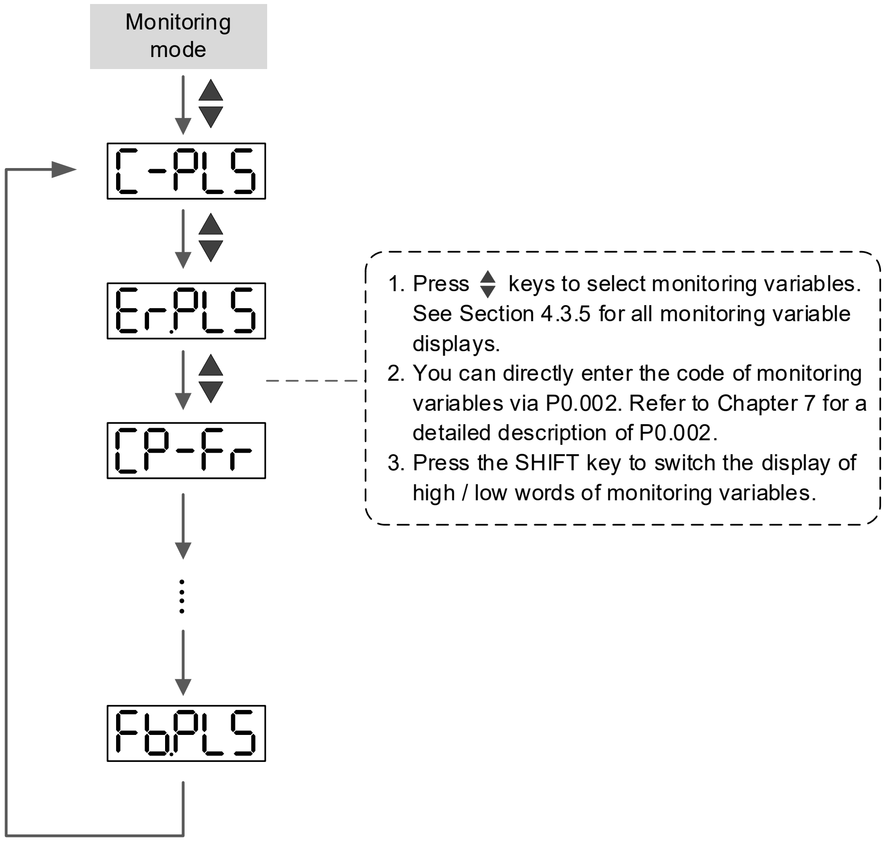
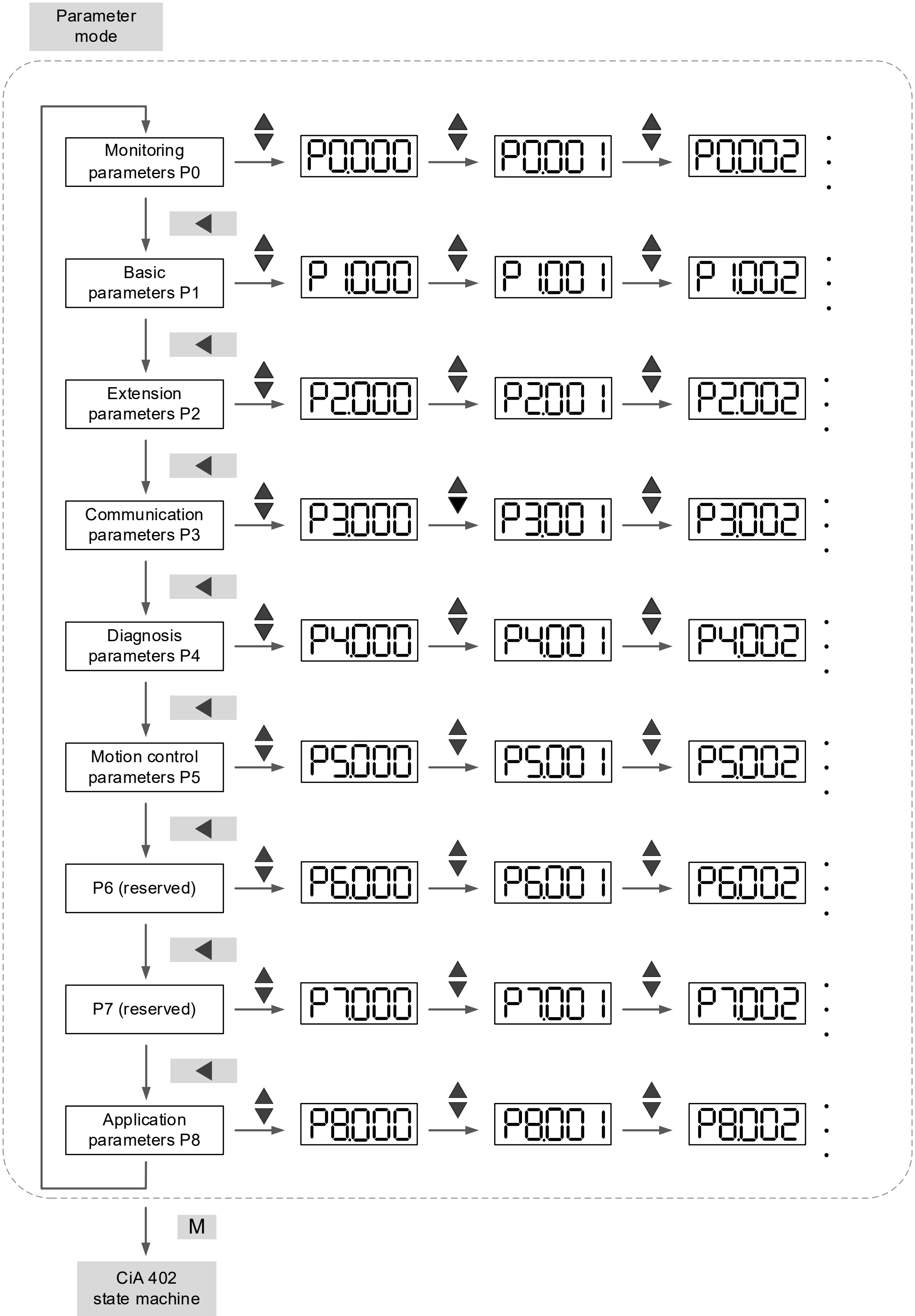
Operating in each mode:

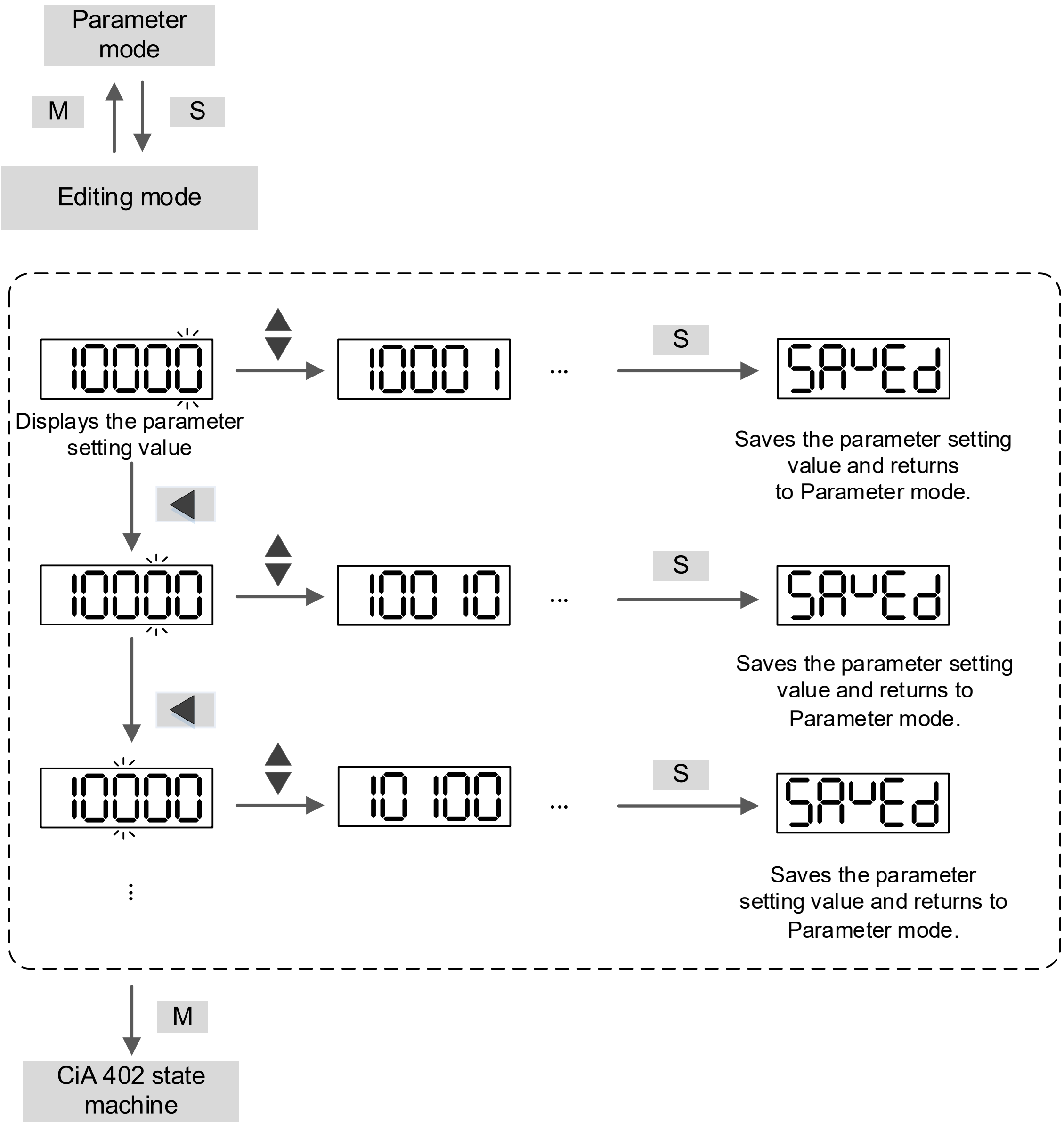
Monitoring mode



Parameter mode



Editing mode



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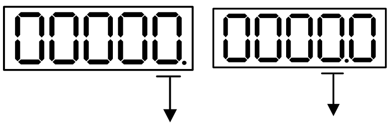
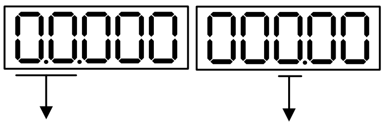
4.3 Status display

4.3.1 Data save status

When you complete editing the parameter and press the SET key to save the setting, the panel displays the status symbol for one second.

Displayed symbol	Description
SAVEd	The setting value is correctly saved (Saved).
r-OLY	The parameter is read-only and write-protected (Read-only).
LocKd	Wrong password or no password is entered (Locked).
Out-r	The setting value is incorrect or a reserved value is set (Out of Range).
SV-on	The parameter cannot be changed when the servo is in the Servo On state (Servo On).
Po-On	The setting takes effect only after you cycle power on the servo drive (Power On).

4.3.2 Decimal points

Displayed symbol	Description
 Low word High word	High word / low word indication: indicates the high word or low word when the 32-bit data is displayed in decimal format.
 Negative sign No function	Negative sign: the two decimal points on the left represent the negative sign when the 16- or 32-bit data is displayed in decimal format. When in hexadecimal format, it only shows positive values.

4.3.3 Alarm messages

Displayed symbol	Description
AL.nnn	When an alarm occurs, the panel displays 'AL' as the alarm symbol and 'nnn' as the alarm code. Refer to Chapter 11 Troubleshooting for alarm details.

4.3.4 Positive and negative sign setting

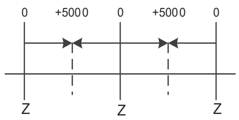
In Editing mode, pressing and holding the SHIFT key for 2 seconds switches between the positive and negative signs. If the value is out of the parameter setting range after switching, then the servo drive automatically resets it to the original value.

Display example	Description
02468	The positive value has no decimal points.
2.4.680	The negative value has two decimal points on the left.

4.3.5 Monitoring display

When power is applied to the drive, the panel displays the monitoring symbol for one second, and then enters Monitoring mode. In this mode, pressing the UP (▲) and DOWN (▼) keys changes the monitoring variables, or you can directly specify the monitoring code in P0.002. The default monitoring code displayed at power-on is the value set in P0.002. For example, if P0.002 = 0, when power is applied, the panel displays “Fb.PUU” first and then the motor feedback pulse number. See the following table for more information. For all monitoring variables, refer to Table 7.3 Monitoring variables descriptions in Chapter 7.

P0.002 setting value	Displayed symbol	Description	Unit
0	Fb.PUU	Motor feedback pulse number (after the scaling of E-Gear ratio)	PUU
1	C-PUU	Number of input pulse commands (after the scaling of E-Gear ratio)	PUU
2	Er.PUU	The difference between control command pulse and feedback pulse number	PUU
3	Fb.PLS	Motor feedback pulse number	pulse
4	C-PLS	Number of input pulse commands (before the scaling of E-Gear ratio)	pulse
5	Er.PLS	Error pulse number (after the scaling of E-Gear ratio)	pulse
6	CP-Fr	Frequency of input pulse commands	Kpps
7	SPEEd	Motor speed	rpm
8	CSPd1	Speed command	Volt
9	CSPd2	Speed command	rpm
10	C-tq1	Torque command	Volt

P0.002 setting value	Displayed symbol	Description	Unit
11	C-tq2	Torque command	%
12	AVG-L	Average torque	%
13	PE-L	Peak torque	%
14	V buS	Main circuit voltage	Volt
15	J-L	Ratio of load inertia to motor inertia Note: if it shows 13.0, it means the load inertia ratio is 13.	1 times
16	IGbt.t	IGBT temperature	°C
17	rSn.Fr	Resonance frequency (low word is the first resonance and high word is the second one).	Hz
18	d IFF.Z  	The absolute pulse number of encoder Z phase equals the homing value, 0. It is -4999 to +5000 pulses when the motor rotates in the forward or reverse direction.	-
19	MAP 1	Mapping parameter #1: shows the content of P0.025 (Specify the mapping target by P0.035)	-
20	MAP2	Mapping parameter #2: shows the content of P0.026 (Specify the mapping target by P0.036)	-
21	MAP3	Mapping parameter #3: shows the content of P0.027 (Specify the mapping target by P0.037)	-
22	MAP4	Mapping parameter #4: shows the content of P0.028 (Specify the mapping target by P0.038)	-
23	VAr-1	Monitoring variable #1: shows the content of P0.009 (Specify the monitoring variable code by P0.017)	-
24	VAr-2	Monitoring variable #2: shows the content of P0.010 (Specify the monitoring variable code by P0.018)	-
25	VAr-3	Monitoring variable #3: shows the content of P0.011 (Specify the monitoring variable code by P0.019)	-
26	VAr-4	Monitoring variable #4: shows the content of P0.012 (Specify the monitoring variable code by P0.020)	-
27	Z-d IF.	Offset value between motor position and Z phase. (Only available for Delta CNC controllers.)	PUU
28	ALM-C	The alarm code (in decimal). The value being converted to the hexadecimal notation is identical to the alarm code displayed in P0.001 and the error code of communication models.	-
29	AFb.UU	Position feedback from the auxiliary encoder.	PUU

P0.002 setting value	Displayed symbol	Description	Unit
30	AEr.UU	Position difference between the position feedback and the command from the auxiliary encoder.	PUU
31	MAE.UU	Feedback position difference between the main encoder and auxiliary encoder.	PUU

The following table shows the panel display of 16-bit and 32-bit values.

Display example	Description	
0 1234 (Dec)	16 bits	If the value is 1234, 01234 is displayed (in decimal format).
1234 (Hex)		If the value is 0x1234, 1234 is displayed (in hexadecimal format; the MSB is not shown).
1234.5 (Dec high) 67890. (Dec low)	32 bits	If the value is 1234567890, the display of the high word is 1234.5 and the low word is 67890 (in decimal format).
h 1234 (Hex high) L5678 (Hex low)		If the value is 0x12345678, the display of the high word is h1234 and the low word is L5678 (in hexadecimal format).

The following table shows the panel display for the negative sign.

Display example	Description
1.2.345	If the value is -12345, 1.2.345 is displayed (only in decimal format; there is no positive or negative sign for hexadecimal format display).

Note:

1. Dec means the value is displayed in decimal format; Hex means the value is displayed in hexadecimal format.
2. The preceding displays are applicable in both Monitoring mode and Editing mode.
3. All monitoring variables are 32-bit data, and the display can be switched between high / low word or Dec / Hex.
   The parameter (Px.xxx) data formats are defined in Chapter 7. Each parameter only supports one display method and cannot be switched.

4.3.6 CiA 402 state display

For detailed description of the state machine, refer to OD 6041h in Chapter 10.

Display symbol	Description
rEAdy	Ready to switch on
_ _on_	Switched on
Son	Operation enabled
FAULt	Fault
qSA	Quick stop active
_d IS_	Switch on disabled
UndFn	Undefined Note: when the symbol is displayed, contact Delta for service.

4.3.7 Safety function state display

State displays of the servo drive and safety functions module are as follows.

Display symbol	Description
-Sto-	STO state. When P1.120 is 0 or 2, if the STO function is activated, the panel displays this symbol instead of "AL500".
S. In It	Initialization of the safety functions module is not complete.
SN-oK.	Initialization of the safety functions module is complete.
PAr.Ud.	Parameter of the safety functions module is being updated.
S.POS.U.	Home position of the safety functions module is not set.
S.POSd.	Home position of the safety functions module is being diagnosed.
-Sbt-	SBT is in execution.

4

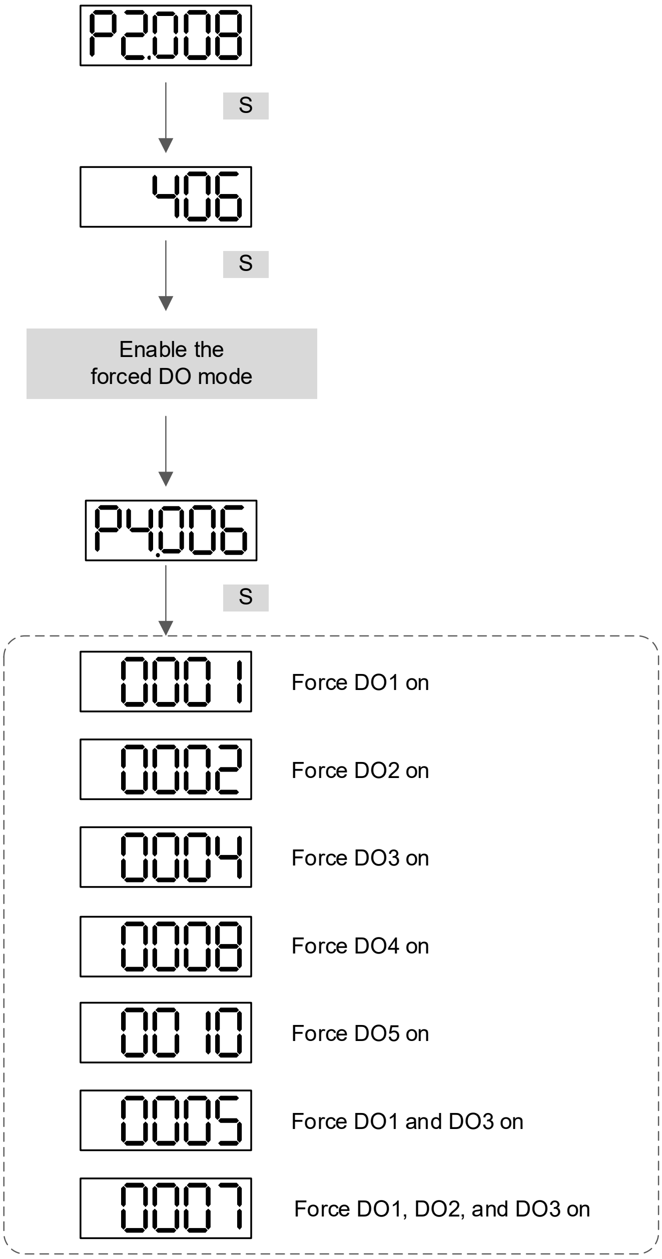
4.4 General functions

4.4.1 Operation of fault record display

In Parameter mode, select P4.000 - P4.004 and press the SET key to show the corresponding fault records.

4.4.2 Force DO on

You can switch to Diagnosis mode by the following steps and then force the DO on. The mode is volatile; the drive returns to the normal DO mode after power cycling. You can also set P2.008 to 400 to switch to the normal DO mode.

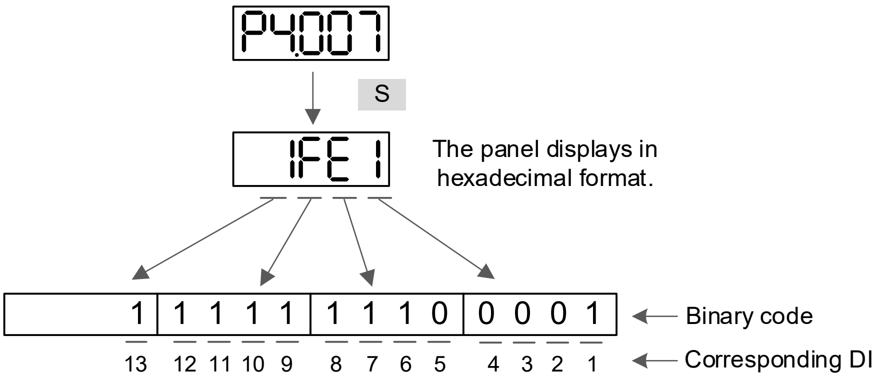


Note: P4.006 is displayed in hexadecimal format. Therefore, the MSB is not shown.

4.4.3 Digital input diagnosis operation

You can switch to Diagnosis mode by the following steps. When the DIs are triggered by external signals, P4.007 displays the DI trigger status in hexadecimal format. When in binary format, each bit indicates the corresponding DI status.

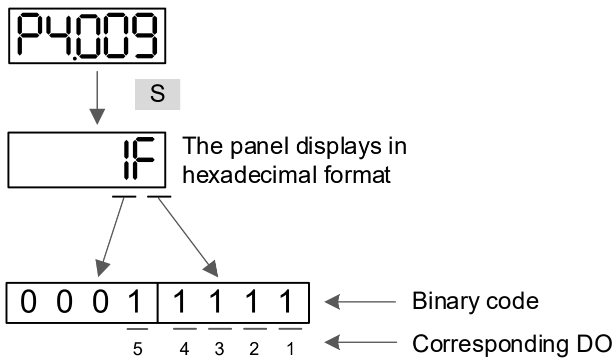
For example, if P4.007 shows 1FE1, the hexadecimal E equals 1110 in binary, indicating that DI6 - DI8 are On.



4.4.4 Digital output diagnosis operation

You can switch to Diagnosis mode by the following steps. P4.009 displays the DO trigger status in hexadecimal format. When in binary format, each bit indicates the corresponding DO status.

For example, if P4.009 shows 1F, the hexadecimal F equals 1111 in binary, indicating that DO1 - DO4 are On.



4.5 Testing

This section introduces the test operations without load. To avoid danger, be sure to operate the servo motor without load first.

4

4.5.1 Initial testing

Remove the load from the servo motor, including coupling on the shaft and other accessories, to avoid any damage to the servo drive or machine. This prevents the parts on the motor shaft from falling off and possibly causing personal injury or equipment damage during operation.

Caution: to prevent danger, it is strongly advisable to check that the motor runs normally without load during normal operation. Then, try operating the motor with load.

Check the following items carefully to avoid damages during motor operation.

Inspection before operation (without power)	■ Check for any obvious visible damage on the servo drive. ■ The wires at the wiring terminal should be isolated. ■ Make sure the wiring is correct to avoid damage or any abnormal operation. ■ Check for and remove any conductive objects, including sheet metals and screws, or inflammable objects inside or near the servo drive. ■ Check that the control switch is in the Off state. ■ Do not place the servo drive or external regenerative resistor on inflammable objects. ■ To ensure the electromagnetic brake works, check that the stop and circuit breaker functions are working normally. ■ Reduce the electromagnetic interference if there is electromagnetic interference with the peripheral devices. ■ Make sure the external voltage level of the servo drive is correct.
Inspection during operation (power is applied)	■ Protect the encoder cable from excessive stress. When the motor is running, make sure the cable is not worn or stretched. ■ Contact Delta if the servo motor vibrates or makes unusual noise during operation. ■ Make sure the settings for the parameters are correct. Different machinery has different characteristics. Adjust the parameters according to the characteristics of each machine. ■ Reset the parameters when the servo drive is in the Servo Off state, or it may cause malfunction. ■ If there is no contact noise or other abnormal noise when the relay is operating, please contact Delta. ■ Check that the power indicator and LED display work properly.

4

4.5.2 Applying power to servo drive

Follow the steps.

1. Make sure the wiring between the motor and servo drive is correct:
   (1) U, V, W, and FG have to connect to the red, white, black, and yellow/green wires respectively. If the wiring is incorrect, the motor cannot work properly. The motor ground wire FG must connect to the drive's ground terminal. Refer to Chapter 3 for wiring.
   (2) The motor encoder is correctly connected to CN2: if you only want to use the JOG function, connecting to CN1 and CN3 is not necessary. Refer to Chapter 3 for the wiring for CN2.

Caution: do not connect power to the servo drive output terminals (U, V, W), or it may damage the servo drive.

2. Connect power to the servo drive. Refer to Section 3.1.3 Wiring for power supply.
3. Turn on the power to the control circuit and main circuit.

Applying power for the first time

When you apply power to the drive for the first time, the functions of emergency stop, negative limit, and positive limit are **On by default**, so AL013, AL014, and AL015 are displayed. To clear these alarms, see the following descriptions. If other alarm occurs, refer to Chapter 11 Troubleshooting. If the panel displays no symbol, check if the control circuit power is undervoltage.

■ **AL013 (Emergency stop):**

Check if any of the digital inputs is set to emergency stop (DI.EMGS) and is On.

Corrective action:

1. If the emergency stop function is needed, make sure this DI is on when it is preset as normally closed (function code: 0x0021), and then set this DI as normally open (function code: 0x0121).
2. If the emergency stop function is not needed, set the Y and X digits to 00 for the DI which is set as DI.EMGS [0x21] to disable the function.
   Important: when the drive is in bus communication mode, if you have modified the setting value, you need to execute alarm reset (DI.ARST) to clear AL013.

■ **AL014 (Negative limit error):**

Check if any of the digital inputs is set to negative limit (DI.NL) and is On.

Corrective action:

1. If the negative limit function is needed, make sure this DI is on when it is preset as normally closed (function code: 0x0022), and then set this DI as normally open (function code: 0x0122).
2. If the negative limit function is not needed, set the Y and X digits to 00 for the DI which is set as DI.NL [0x22] to disable the function.
   Important: when the drive is in bus communication mode, if you have modified the setting value, you need to execute alarm reset (DI.ARST) to clear AL014.

- **AL015 (Positive limit error):**

Check if any of the digital inputs is set to positive limit (DI.PL) and is On.

Corrective action:

1. If the positive limit function is needed, make sure this DI is on when it is preset as normally closed (function code: 0x0023), and then set this DI as normally open (function code: 0x0123).
2. If the negative limit function is not needed, set the Y and X digits to 00 for the DI which is set as DI.PL [0x23] to disable the function.

   Important: when the drive is in bus communication mode, if you have modified the setting value, you need to execute alarm reset (DI.ARST) to clear AL015.

4.6 ASDA-Soft connection to servo drive

4

The CN4 port supports TCP/IP networks. Select the required communication protocol with different TCP port settings.

The default IP address for A3-EP is 192.168.1.4.

TCP port	Function
502	Standard Modbus/TCP communication protocol: for connecting to the controller software.
1502 (default)	For ASDA-Soft communication only: you can perform parameter setting, tuning, and scope settings.

Make sure the firewall on your PC does not block TCP ports 502 and 1502.

When using an external network, cybersecurity measures such as setting up a network firewall are requisite to avoid malicious attacks.

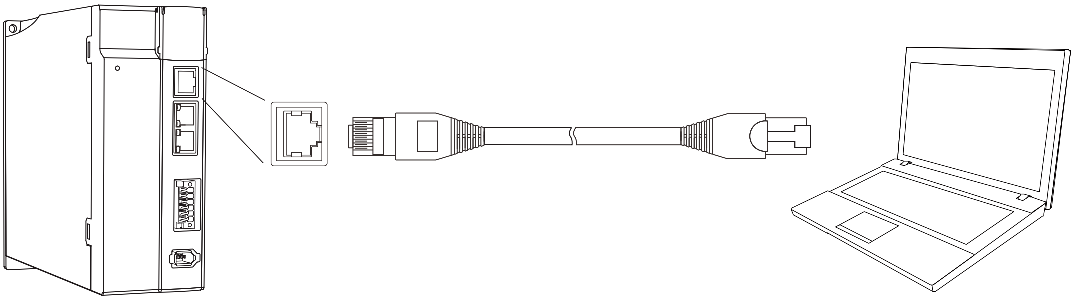
4.6.1 FAQ

Question	Answer
Can I configure the static IP address?	You can configure the static IP address and subnet mask. The setting parameters are as follows. ■ IP address: P3.050 - P3.053 (default: 192.168.1.4). ■ Subnet mask: P3.054 - P3.057 (default: 255.255.255.0). ■ Default gateway: P3.058 - P3.061 (default: 192.168.1.1).
Can I specify the TCP port?	Two dedicated TCP ports are currently available. ■ Port 502: for standard Modbus/TCP communication. ■ Port 1502: for ASDA-Soft communication.
Is DHCP (Dynamic Host Configuration Protocol) supported?	DHCP is currently not supported. Use a static IP instead.
Is IP detection supported?	Not supported.
What if my PC does not have an Ethernet port?	Use an Ethernet adapter with RJ45 port.
What should I do when the connection fails?	Use the servo drive panel to check if you have correctly set the Ethernet parameters (P3.050 - P3.061), computer IP address, and subnet mask. See Section 4.6.2 Instructions for connection for details.
How do I connect multiple servo drives?	Connect the servo drives to a hub. The default IP of every servo drive is 192.168.1.4; therefore, make sure to set P3.053 of each servo to different values (1 - 250) to prevent IP address conflicts.

4.6.2 Instructions for connection

4.6.2.1 Connecting single servo drive

1. Get an Ethernet cable with RJ45 plugs on both ends ready for connecting the PC's Ethernet port and the servo drive's CN4 port. If your PC does not have an RJ45 Ethernet port, use an Ethernet adapter with RJ45 port.



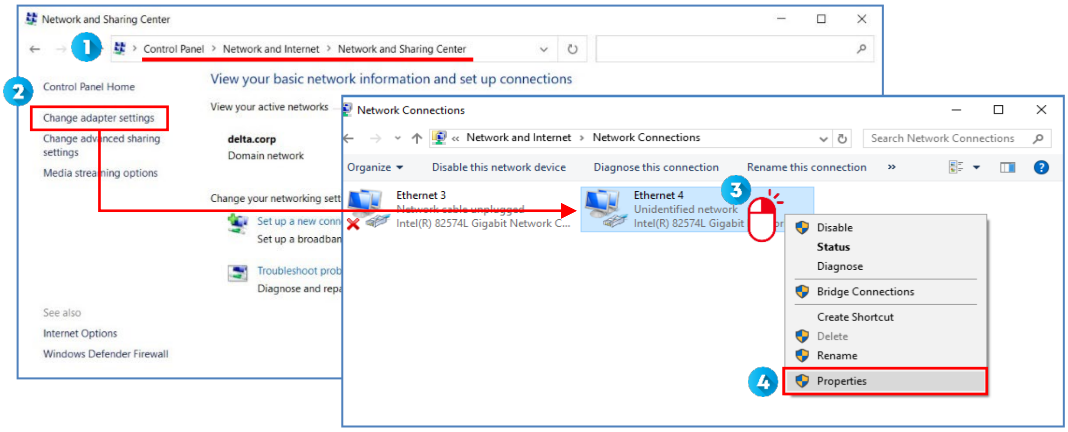
2. Change the computer IP settings:

   Note that the screen display may differ with different Windows versions.

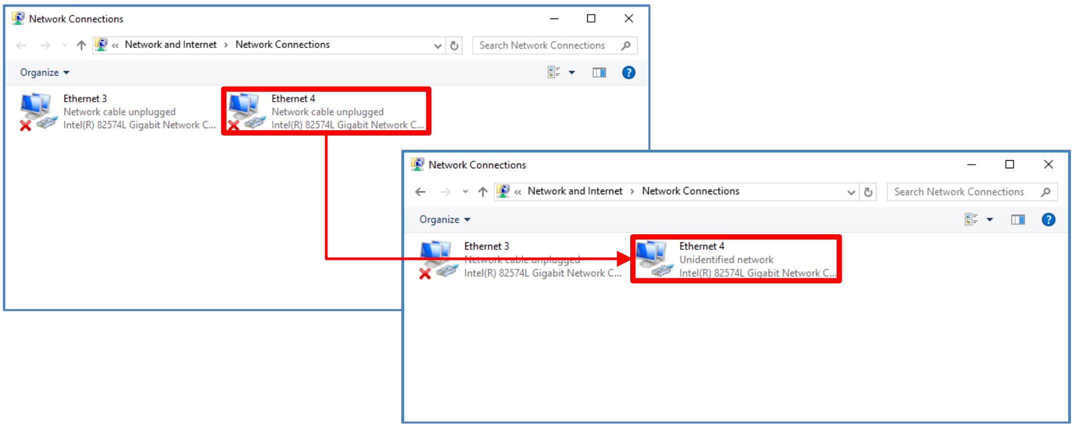
   (1) Go to **Control Panel** → **Network and Internet** → **Network and Sharing Center**.

   (2) Click **Change adapter settings**.

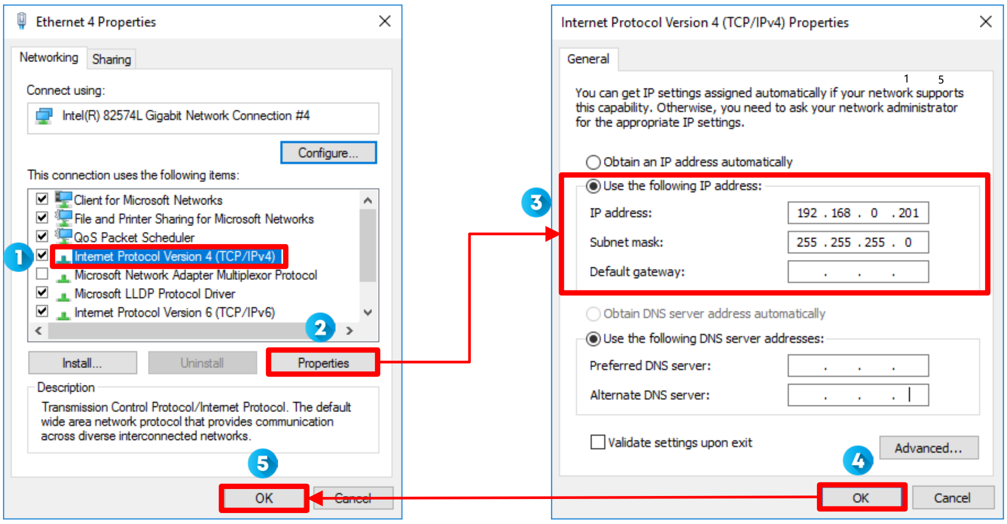
   (3) Right-click **Ethernet** (or **Local Area Connection**) → click **Properties**.



If unsure which Ethernet connection is being used, check by unplugging and plugging the network cable. When the cable is unplugged, the corresponding connection shows "Network cable unplugged". When the cable is plugged back in, the corresponding connection shows "Unidentified network".



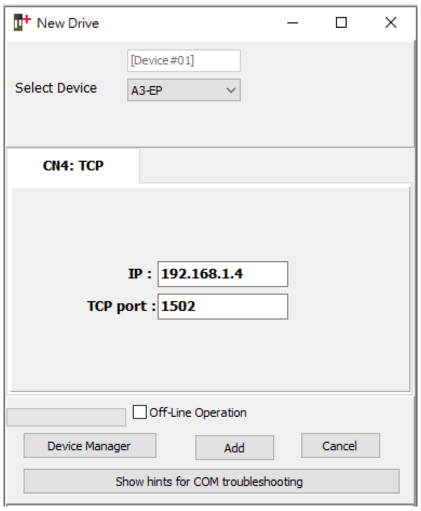
3. In the **Ethernet Properties** window, select the check box for **Internet Protocol Version 4 (TCP/IPv4)** → click **Properties** → set the **IP address** and **Subnet mask** → **OK** → **OK**.



Set the IP address parameters as follows:

Parameter	Setting	Description
IP address	192.168.1.X	The first three quads (192.168.1) indicate the network ID, which must be identical with that of the servo drive IP address. The final quad (X) indicates the host ID. The suggested setting value is 1 - 250 and which should not be the same as that of the servo drive IP address. For example, if the default servo IP address is 192.168.1.4, you can set the computer IP address to 192.168.1.5.
Subnet mask	255.255.255.0	-
Default gateway	-	Optional.

4. Start ASDA-Soft, and select the device to be connected in the **New Drive** window. Input the servo drive default IP address (192.168.1.4) in the **IP** field, and set the **TCP port** to 1502.



Tuning 5

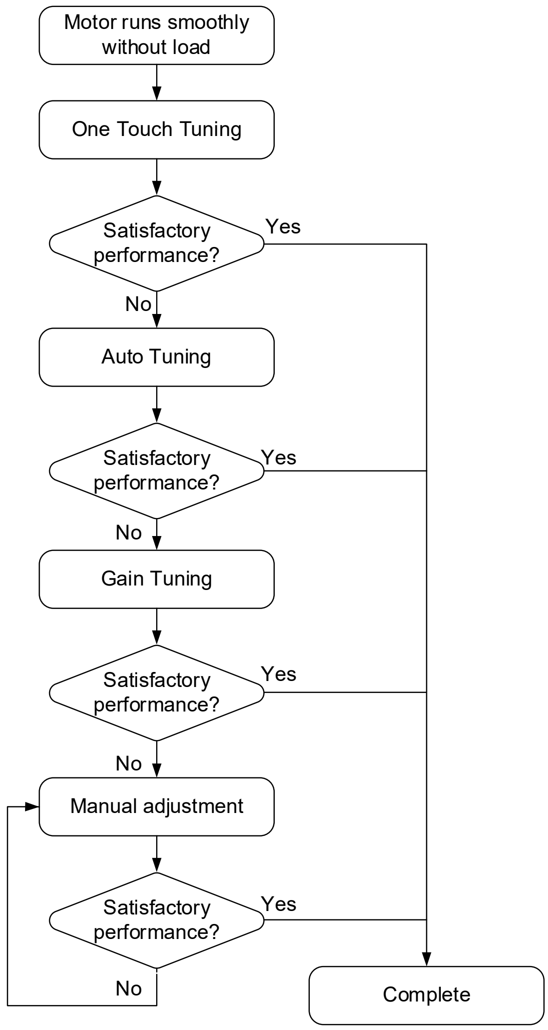
This chapter contains information about One Touch tuning, Auto tuning, and gain adjustment modes. Advanced users can also tune the servo system in Manual mode. In addition, this chapter also describes how to deal with the mechanical resonance and noise and the adjustments for application functions.

5

5.1 Tuning procedure

You can tune the servo drive by following this flowchart. First, start from **One Touch Tuning**.

If you are not satisfied with the tuning results, then use **Auto Tuning**, **Gain Tuning**, and Manual mode in sequence to meet the requirements.



Function	Description
Inertia (Weight) estimation	When you use the functions of **One Touch Tuning**, **Auto Tuning**, or Gain adjustment mode 1 (Level adjustment - Auto) with ASDA-Soft, the servo drive automatically estimates the load inertia during the tuning process. You can also perform the estimation with the **Inertia (Weight) Estimation** function. Whether the load inertia ratio (P1.037) is correctly set affects the speed loop bandwidth of the servo drive.
One Touch Tuning	You must use the **One Touch Tuning** function with ASDA-Soft. During the tuning process, the motor slightly moves and makes high-frequency noise. For the detailed operation procedure, refer to Section 5.3.
Auto tuning	You can use the **Auto Tuning** function with ASDA-Soft or through the panel. The command source can be the servo drive or the controller. During the tuning process, the drive controls the motor to run back-and-forth between two positioning points. For the detailed operation procedure, refer to Section 5.4.
Gain adjustment	The servo provides five gain adjustment modes (not including Manual mode and Gain adjustment mode 4 (Reset to the default gain values)), which are set with P2.032. For the detailed operation procedure and parameter adjustment, refer to Section 5.5.
Manual adjustment	In Manual mode (P2.032 = 0), users can fine-tune all the gain parameters for optimal performance of the machine. For the detailed parameter adjustment, refer to Sections 5.6 and 5.7.

5.2 Inertia (Weight) estimation

Whether the load inertia ratio (P1.037) is correctly set affects the speed loop bandwidth of the servo drive. If set incorrectly, the system's performance cannot be optimized after tuning. When you use the functions of **One Touch Tuning**, **Auto Tuning**, or Gain adjustment mode 1 (Level adjustment - Auto) with ASDA-Soft, the servo drive automatically estimates the load inertia during the tuning process. If not using the preceding functions, you can directly use the **Inertia (Weight) Estimation** function.

The estimation of load inertia can be done without the controller's command. During the estimation process, the motor runs back-and-forth in the forward and reverse directions.

If the estimation cannot be done or the inertia cannot be correctly estimated in the systems described in the following section, perform the estimation by yourself and set P1.037 with the estimated value.

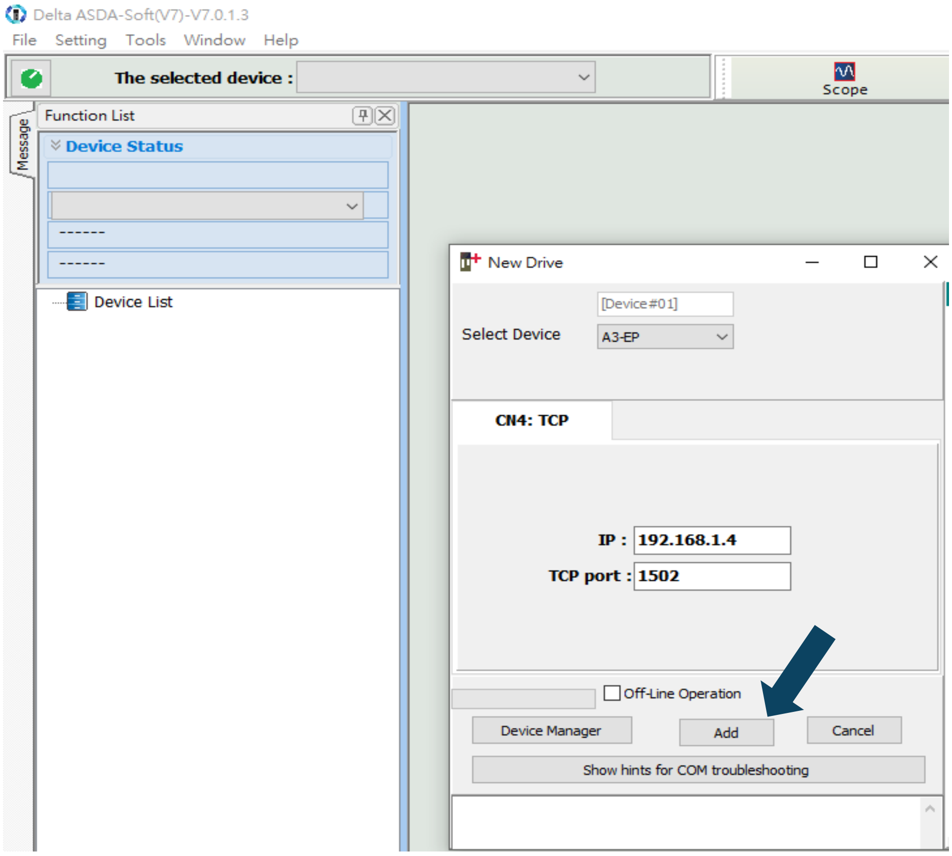
5.2.1 Precautions for inertia (weight) estimation

Item	Rotary motor
	Inertia estimation
Recommended settings	1. Jog speed: 500 rpm or above. 2. Acceleration time from 0 rpm to 3,000 rpm or deceleration time from 3,000 rpm to 0 rpm: within 200 ms. 3. Traveling distance: 1 revolution or above. If the estimated load inertia cannot be reduced to a stable value, increase the jog speed first. If the traveling distance is too long, the estimation time is longer, too.
Estimation cannot be done in the systems where:	1. The mechanical part only moves in a single direction. 2. The movement speed of the mechanical part is lower than 200 rpm.The effective stroke of the mechanical part is shorter than the traveling distance when the motor rotates 0.5 revolution.
Estimation cannot be correctly done in the systems where:	1. The load inertia ratio of the mechanical part changes drastically. 2. The load inertia ratio of the mechanical part is greater than 50 times. 3. The bandwidth of the mechanical part is lower than 10 Hz. 4. The viscous friction of the mechanical part is high.The torque limit of the mechanical part is too low.

5

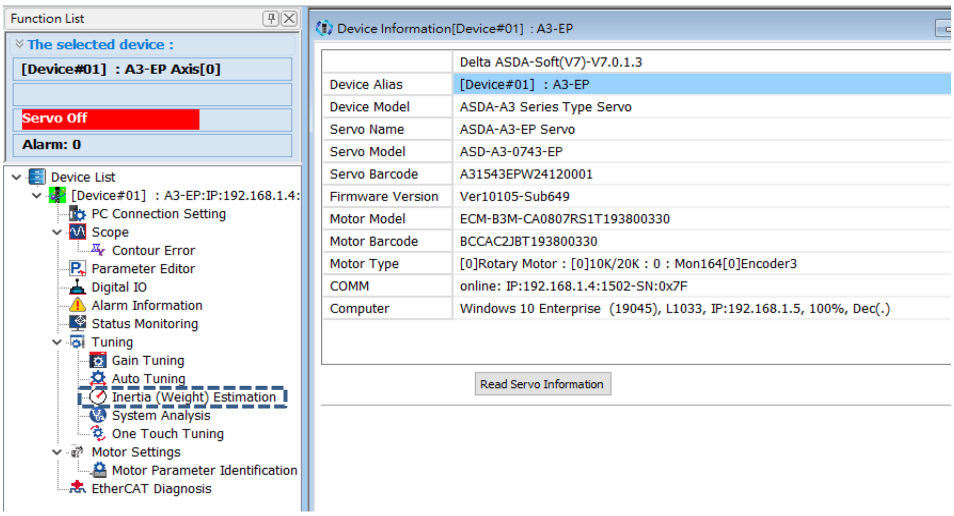
5.2.2 Inertia (Weight) estimation with ASDA-Soft

Go to [Delta's website] to download ASDA-Soft for free to tune the servo drive. After installing ASDA-Soft, start the executable file and the screen is as follows.



Make sure your servo drive, servo motor, and power are all properly connected. Enter the corresponding IP address and TCP port number, and then click **Add** for the ASDA-Soft to be in online mode.

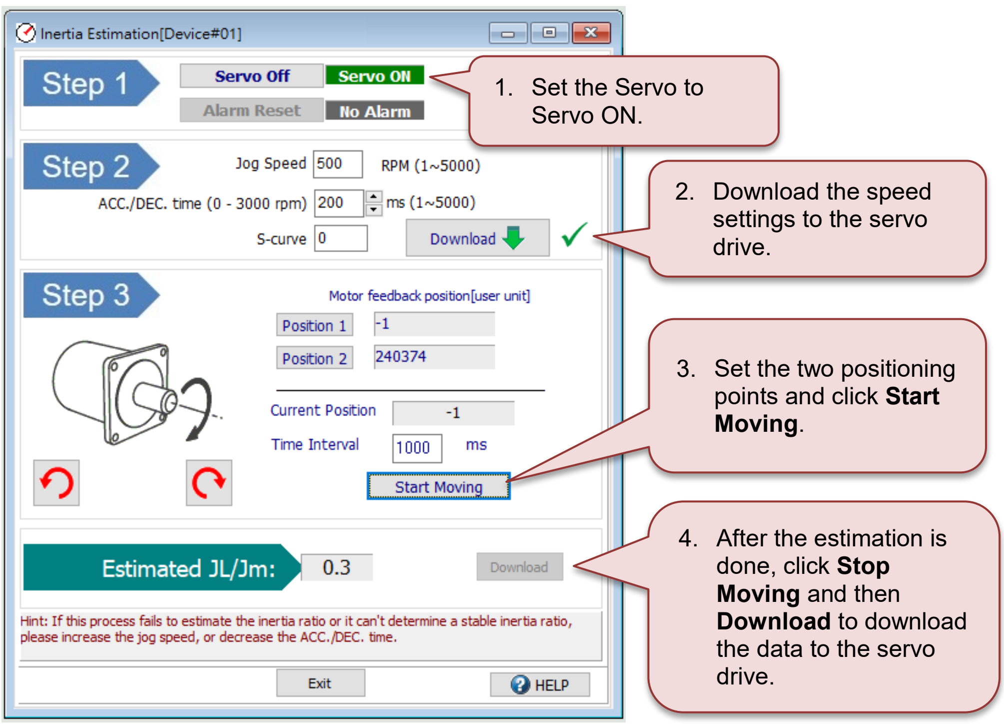
When ASDA-Soft is in online mode, the program window appears as follows. Click **Inertia (Weight) Estimation** in the Function List tree view.



5.2.2.1 Rotary motor

Perform the inertia estimation according to the following descriptions.

1. Set the system to the Servo ON state.
2. The default jog speed is 20 rpm and the default acceleration / deceleration time is 200 ms. For mechanical parts with limited strokes, low speed movement reduces the risk of collision. Executing positioning between two points at low speed is recommended. For mechanical parts with longer strokes or without limits, you can set the movement speed higher. After completing the settings, click the Download button, and then use the Left () or Right () button to rotate the motor to Position 1 and Position 2.
3. Check the acceleration / deceleration time and jog speed again. It is advisable to set the jog speed to no less than 500 rpm. Then click the Download button. After the download is complete, click **Start Moving**, and the motor regards Position 1 and Position 2 as the positive and negative limits and starts rotating in the forward and reverse directions.
4. After the estimation is complete, click **Stop Moving** and then **Download** to download the estimated load inertia ratio to the servo drive.
5. Since the new inertia ratio causes a change in the equivalent bandwidth, resonance may occur in the system. Thus, you need to use the **Gain Tuning** function to set the bandwidth and gain again when writing the new inertia ratio to the system.



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5.3 One Touch Tuning

You must use the One Touch Tuning function with ASDA-Soft. During the tuning process, the motor slightly moves and makes high-frequency noise. The following table lists the parameters which settings change according to the results of one touch tuning. In One Touch Tuning mode, the vibration elimination function is enabled and the low-frequency vibration suppression function is disabled. If the two functions are enabled simultaneously, the response becomes slower.

Gain parameters			
Parameter No.	Function	Parameter No.	Function
P1.037	Load inertia ratio	P2.032	Gain adjustment mode
P2.000	Position control gain	P2.089	Command response gain
P2.004	Speed control gain	P2.090	Two degree of freedom mode - anti-interference gain
P2.006	Speed integral compensation	P2.094	Special bit register 3 (enable the two degree of freedom control function)
P2.031	Bandwidth response level	-	-

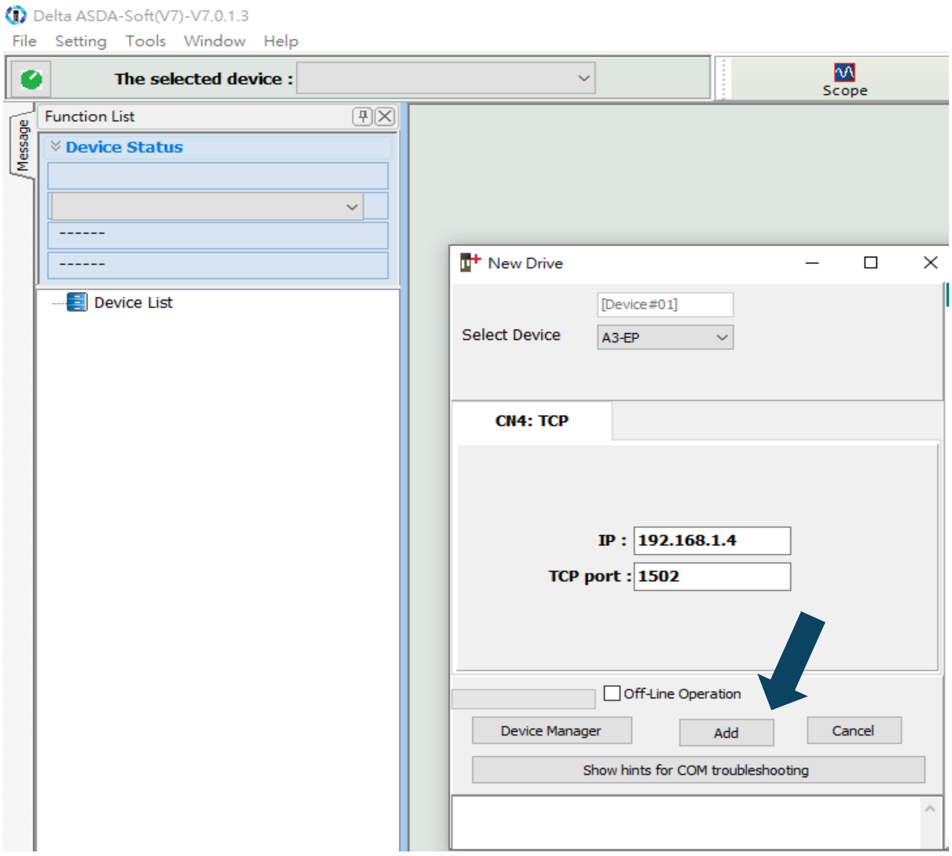
Filter and resonance suppression parameters			
Parameter No.	Function	Parameter No.	Function
P1.025	Low-frequency vibration suppression frequency 1	P2.044	Notch filter 2 - attenuation level
P1.026	Low-frequency vibration suppression gain 1	P2.045	Notch filter 3 - frequency
P1.027	Low-frequency vibration suppression frequency 2	P2.046	Notch filter 3 - attenuation level
P1.028	Low-frequency vibration suppression gain 2	P2.049	Speed detection filter and jitter suppression
P2.023	Notch filter 1 - frequency	P2.098	Notch filter 4 - frequency
P2.024	Notch filter 1 - attenuation level	P2.099	Notch filter 4 - attenuation level
P2.025	Resonance suppression low-pass filter	P2.101	Notch filter 5 - frequency
P2.043	Notch filter 2 - frequency	P2.102	Notch filter 5 - attenuation level

5.3.1 Precautions for one touch tuning

Item	Rotary motor
One touch tuning cannot be done in the systems where:	The mechanical part only moves in a single direction.
One touch tuning cannot be correctly done in the systems where:	1. The load inertia ratio of the mechanical part changes drastically. 2. The load inertia ratio of the mechanical part is greater than 100 times. 3. The viscous friction of the mechanical part is high. 4. The torque limit of the mechanical part is too low. 5. The gear backlash in the mechanical part is too large.

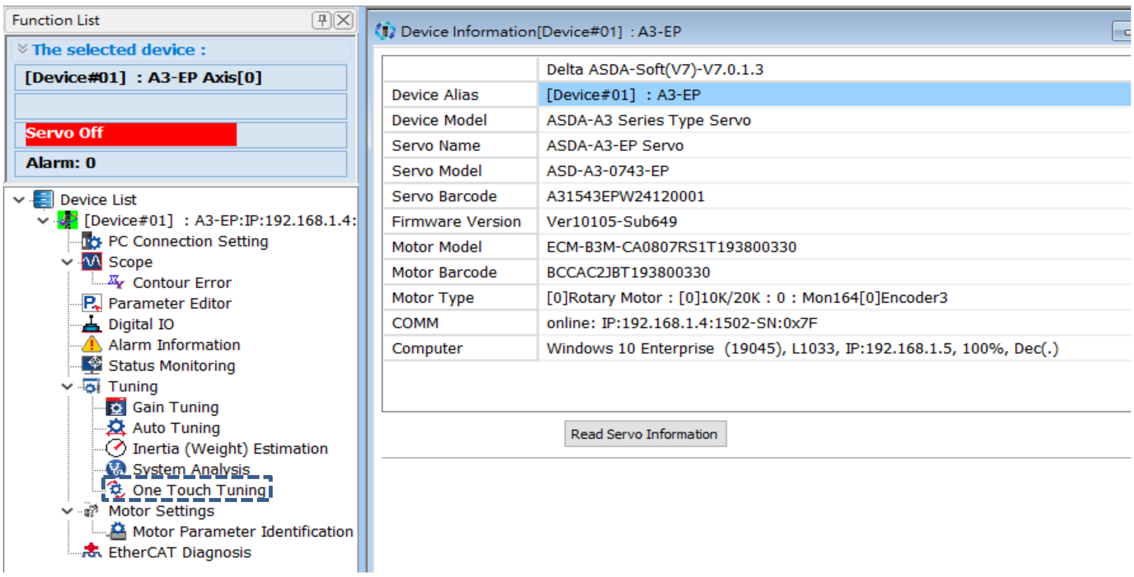
5.3.2 One touch tuning with ASDA-Soft

Go to Delta's website to download ASDA-Soft for free to tune the servo drive. After installing ASDA-Soft, start the executable file and the screen is as follows.



Make sure your servo drive, servo motor, and power are all properly connected. Enter the corresponding IP address and TCP port number, and then click **Add** for the ASDA-Soft to be in online mode.

When ASDA-Soft is in online mode, the program window appears as follows. Click **One Touch Tuning** in the Function List tree view.



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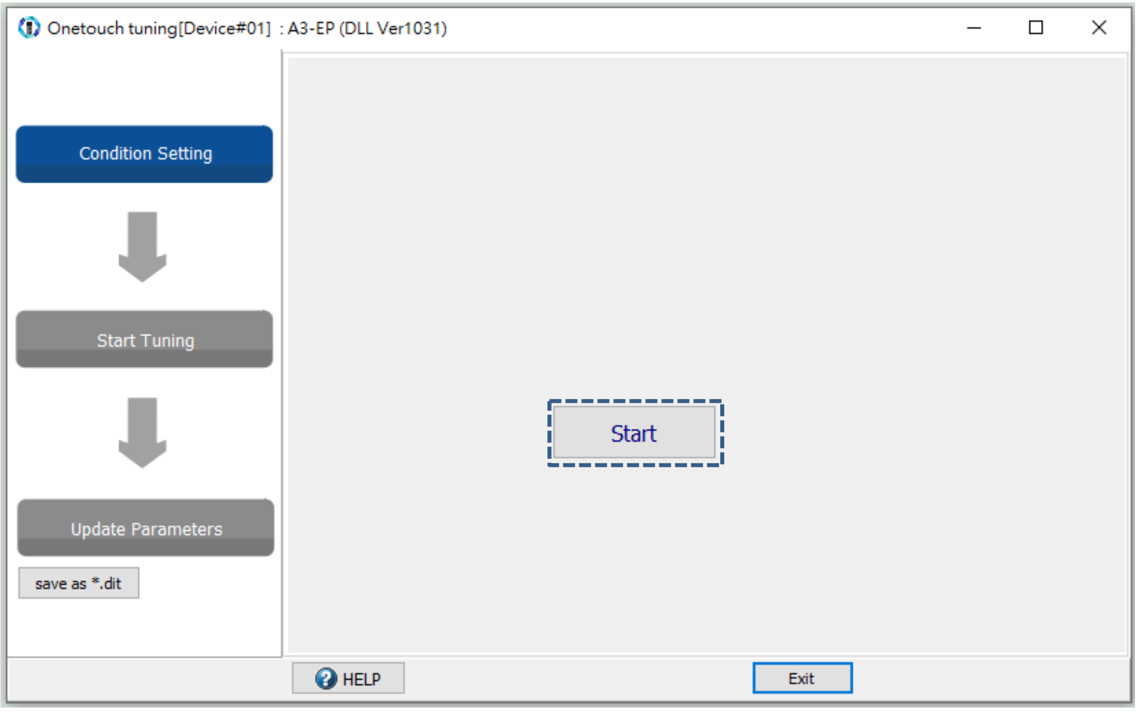
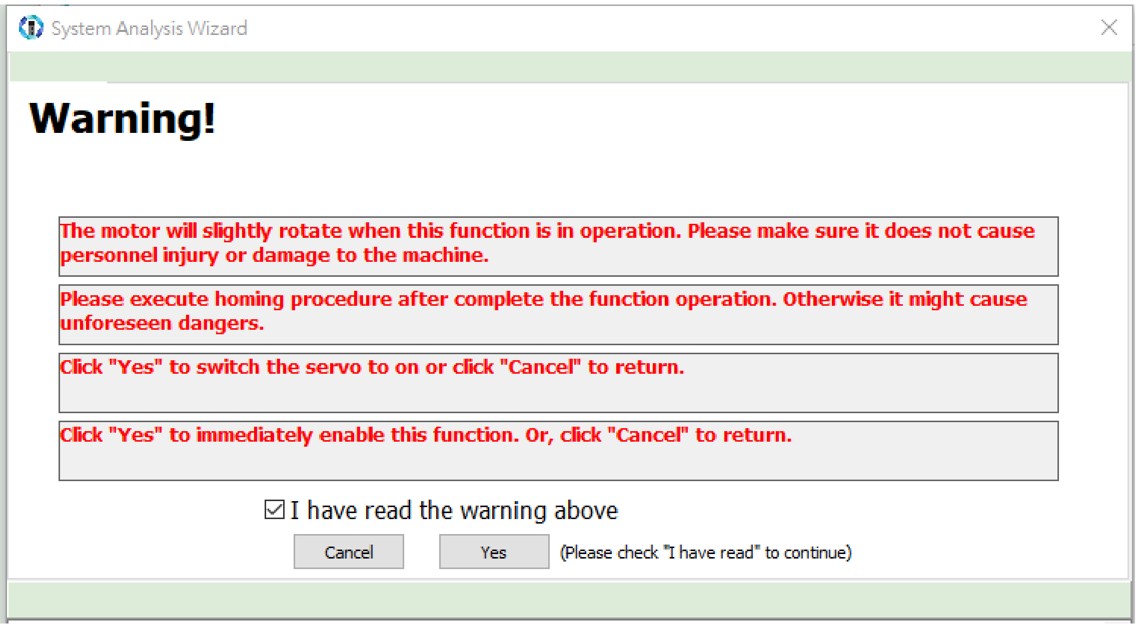
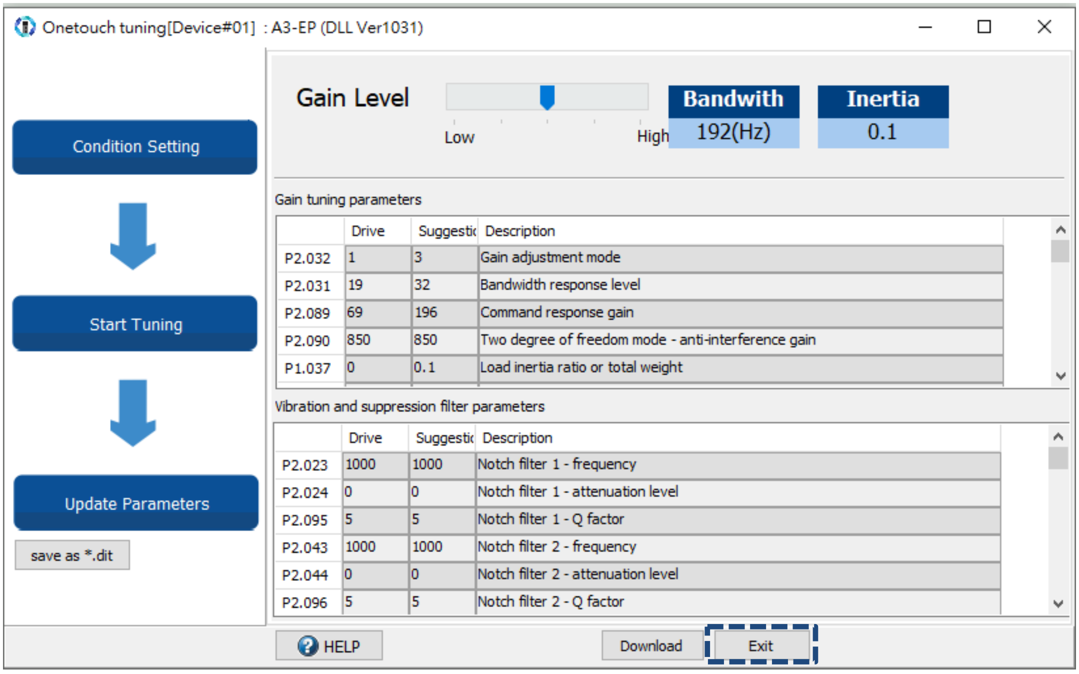
Click **Start**.



Carefully read the content in the warning window and make sure you have checked all the items one by one. Select the check box for **I have read the warning above** and click **Yes**.



The screen shows a table comparing the parameter values before and after tuning. In the screen, you can fine-tune the gain level, and the adjustments affect the settings of other relevant parameters.



Click **Download** to complete one touch tuning.

Note: if you click **Exit** without clicking **Download** first, the suggested values estimated by the one touch tuning function are not loaded to the servo drive.

5

5.4 Auto tuning

The auto tuning function enables the system to perform real-time estimation for machine inertia and uploads the optimized parameters to the servo drive. You can start auto tuning with ASDA-Soft or through the drive panel. The following table lists the parameters that change according to the results of auto tuning.

Gain parameters			
Parameter No.	Function	Parameter No.	Function
P1.037	Load inertia ratio	P2.031	Bandwidth response level
P2.000	Position control gain	P2.032	Gain adjustment mode
P2.002	Position feed forward gain	P2.089	Command response gain
P2.004	Speed control gain	P2.090	Two degree of freedom mode - anti-interference gain
P2.006	Speed integral compensation	P2.094	Special bit register 3 (enable the two degree of freedom control function)
P2.026	Anti-interference gain	-	-

Filter and resonance suppression parameters			
Parameter No.	Function	Parameter No.	Function
P1.025	Low-frequency vibration suppression frequency 1	P2.025	Resonance suppression low-pass filter
P1.026	Low-frequency vibration suppression gain 1	P2.043	Notch filter 2 - frequency
P1.027	Low-frequency vibration suppression frequency 2	P2.044	Notch filter 2 - attenuation level
P1.028	Low-frequency vibration suppression gain 2	P2.045	Notch filter 3 - frequency
P1.029	Auto low-frequency vibration suppression mode	P2.046	Notch filter 3 - attenuation level
P1.061	Viscous friction compensation	P2.049	Speed detection filter and jitter suppression
P1.062	Percentage of friction compensation	P2.095	Notch filter 1 - Q factor
P1.063	Constant of friction compensation	P2.096	Notch filter 2 - Q factor
P1.089	Vibration elimination 1 - anti-resonance frequency	P2.097	Notch filter 3 - Q factor
P1.090	Vibration elimination 1 - resonance frequency	P2.098	Notch filter 4 - frequency
P1.091	Vibration elimination 1 - resonance difference	P2.099	Notch filter 4 - attenuation level
P1.092	Vibration elimination 2 - anti-resonance frequency	P2.100	Notch filter 4 - Q factor
P1.093	Vibration elimination 2 - resonance frequency	P2.101	Notch filter 5 - frequency
P1.094	Vibration elimination 2 - resonance difference	P2.102	Notch filter 5 - attenuation level
P2.023	Notch filter 1 - frequency	P2.103	Notch filter 5 - Q factor
P2.024	Notch filter 1 - attenuation level	-	-

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5.4.1 Precautions for auto tuning

Item	Rotary motor
Recommended settings	1. Jog speed: 500 rpm or above. 2. Acceleration time from 0 rpm to 3,000 rpm or deceleration time from 3,000 rpm to 0 rpm: within 200 ms. 3. Traveling distance: 1 revolution or above. It is advisable to set the minimum distance for the motor to accelerate from zero speed to the constant speed zone as the traveling distance, and the constant speed is equal to the set jog speed. If the traveling distance is too long, the estimation time is longer, too. For mechanical parts with long strokes, it is recommended that you set the traveling distance as the working range for operation.
Auto tuning cannot be done in the systems where:	1. The mechanical part only moves in a single direction. 2. The movement speed of the mechanical part is lower than 200 rpm. 3. The effective stroke of the mechanical part is shorter than the traveling distance when the motor rotates 0.5 revolution.
Auto tuning cannot be correctly done in the systems where:	1. The load inertia ratio of the mechanical part changes drastically. 2. The load inertia ratio of the mechanical part is greater than 50 times. 3. The bandwidth of the mechanical part is lower than 10 Hz. 4. The viscous friction of the mechanical part is high. 5. The torque limit of the mechanical part is too low.

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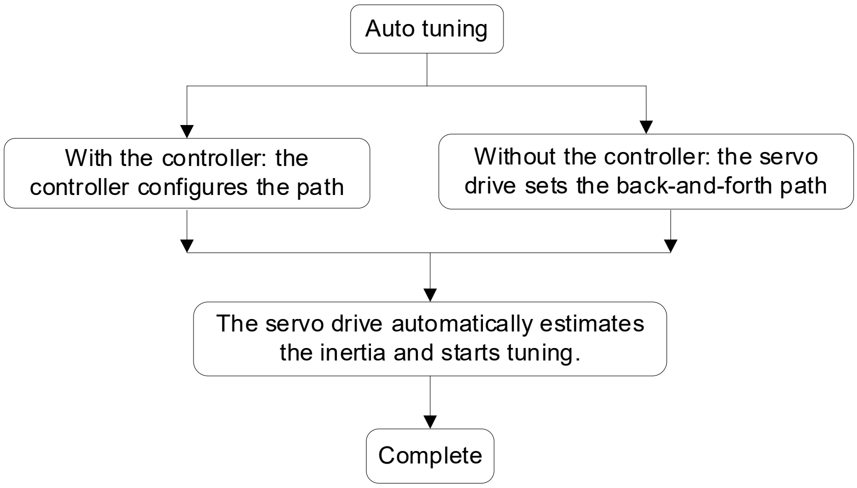
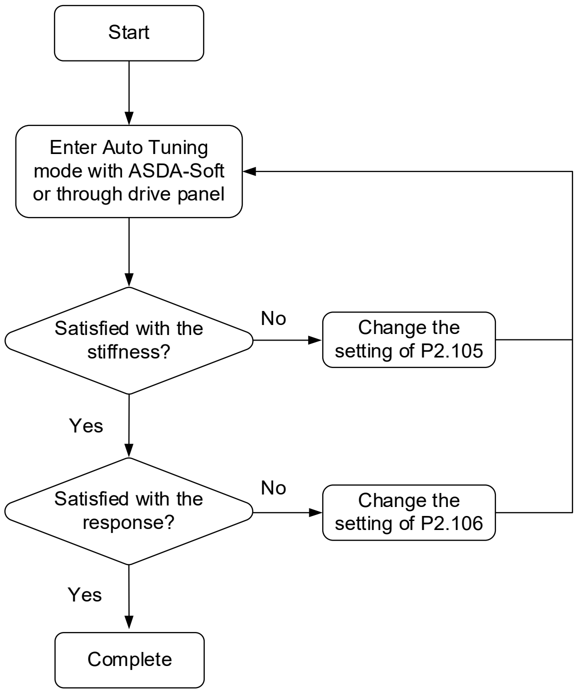
5.4.2 Flowchart of auto tuning

You can complete auto tuning through the drive panel or with ASDA-Soft. The Auto Tuning function helps you to find the most suitable parameters for your system according to the machine characteristics.



Note: when the path is configured by the controller, make sure the dwell time is added to the operation cycle. Otherwise, AL08B occurs and the servo drive cannot complete auto tuning.

You can use P2.105 and P2.106 to adjust the stiffness and response in Auto Tuning mode. See the following flowchart.



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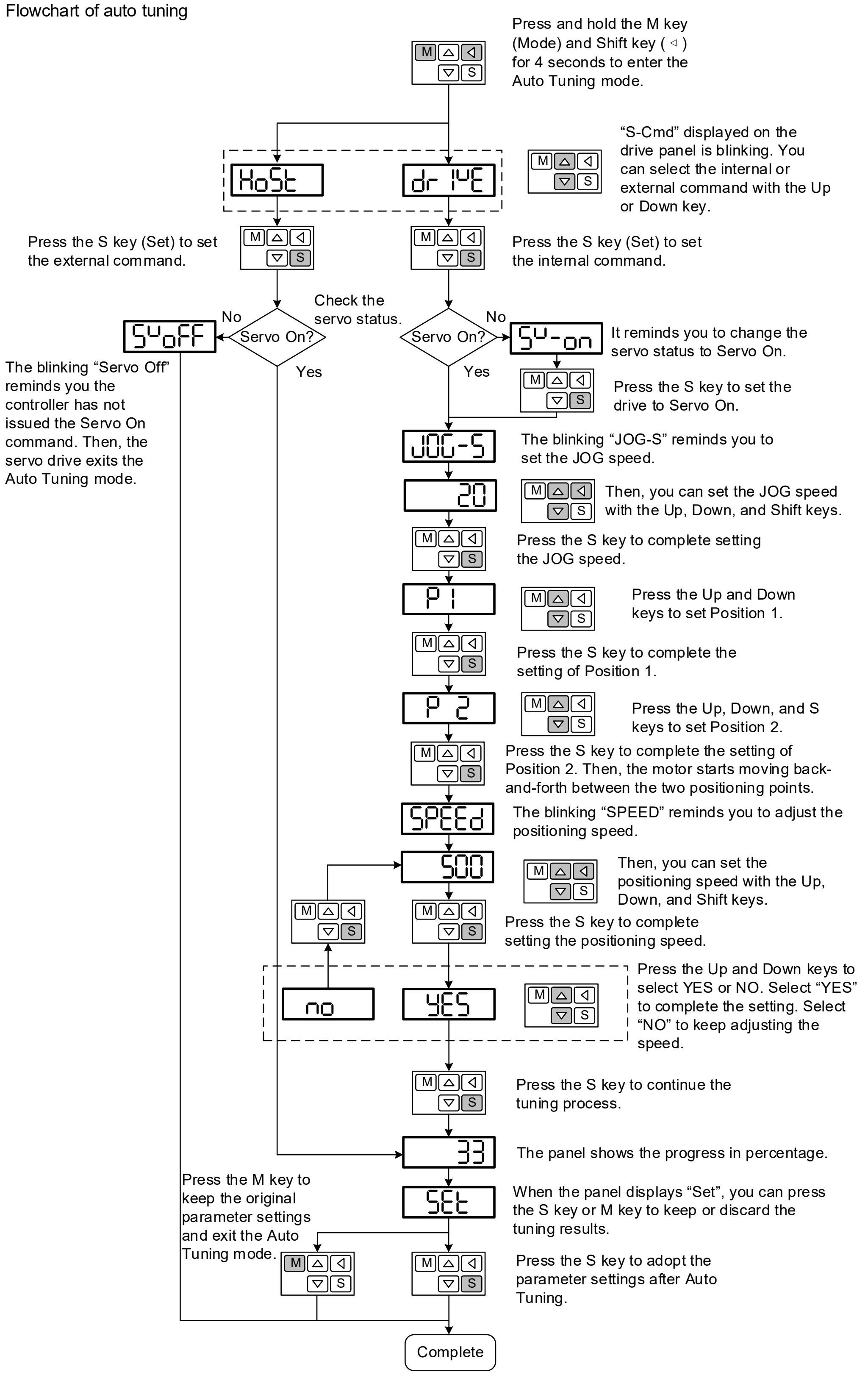
5.4.3 Auto tuning through the drive panel

You can use the drive panel to start auto tuning. Make sure the emergency stop and the positive and negative limit switches work properly before you start to tune the system.

5.4.3.1 Rotary motor

Flowchart of auto tuning



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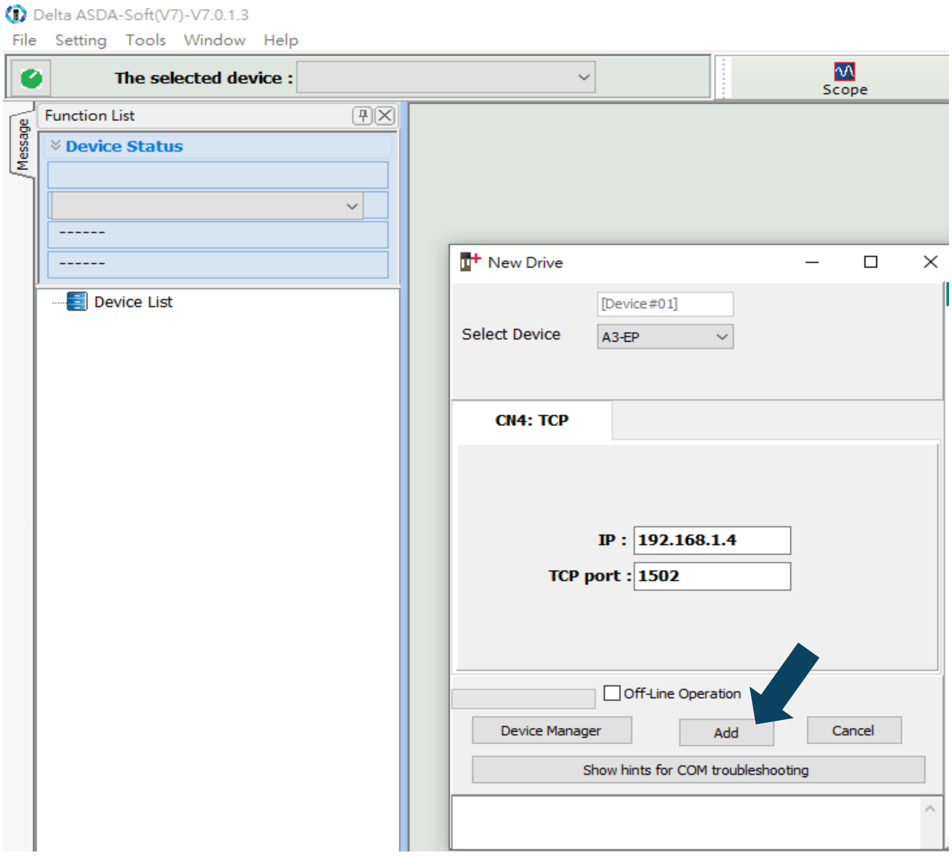
5.4.4 Auto tuning with ASDA-Soft

In addition to executing auto tuning through the drive panel, you can go to Delta's website to download ADSA-Soft for free to tune the servo drive. After installing ASDA-Soft, start the executable file and the screen is as follows.



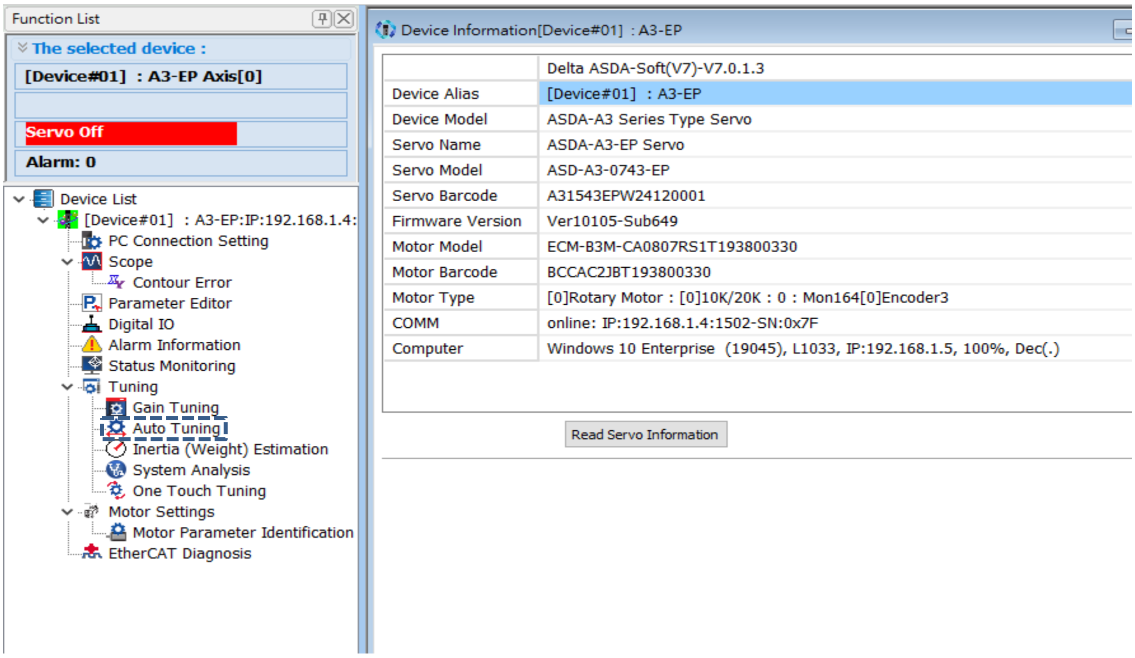
Make sure your servo drive, servo motor, and power are all properly connected. Enter the corresponding IP address and TCP port number, and then click **Add** for the ASDA-Soft to be in online mode.

When ASDA-Soft is in online mode, start auto tuning according to the following steps. The following describes two auto tuning procedures, one using the controller and the other using the servo drive.

■ Auto-tuning with the controller: the controller sends the commands to drive the motor.

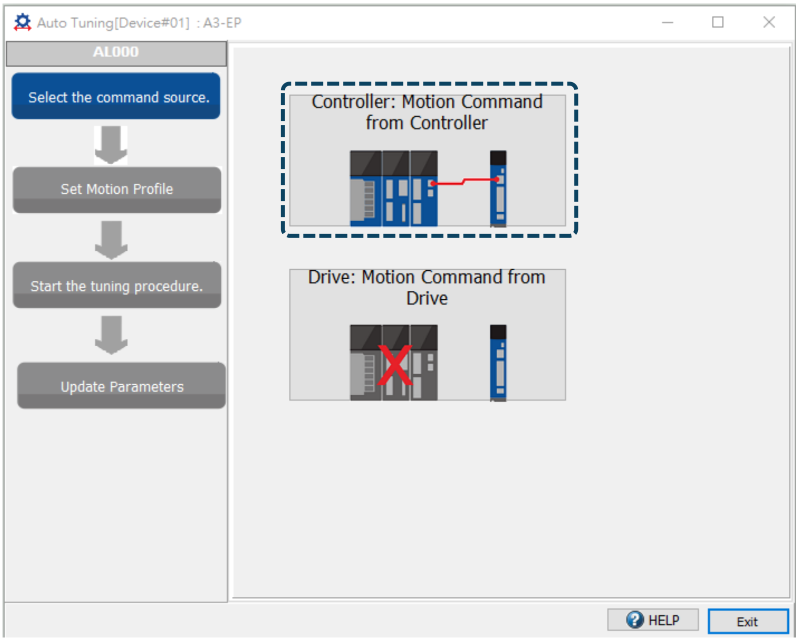
Step 1:

When ASDA-Soft is in online mode, the program window appears as follows. Click **Auto Tuning** in the Function List tree view.



Step 2:

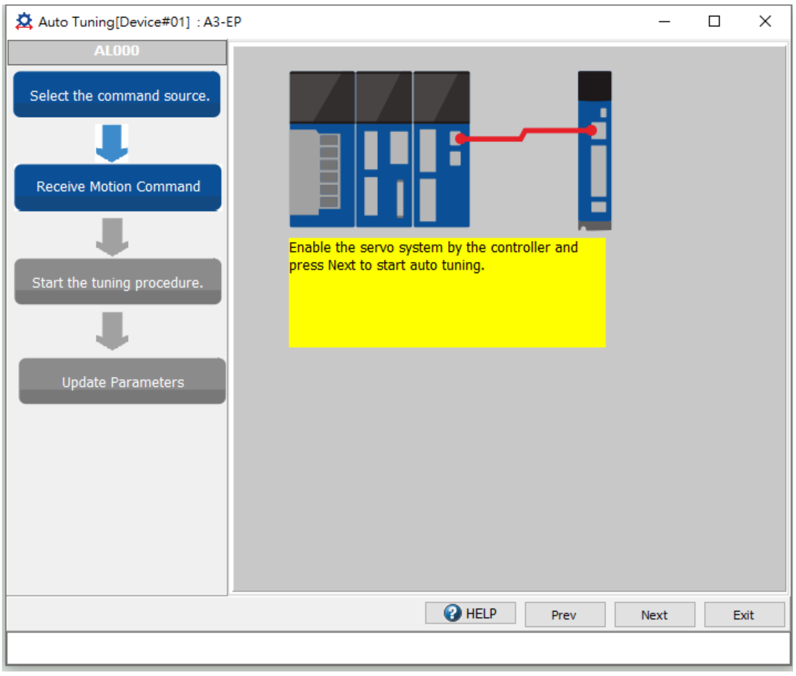
Click **Controller: Motion Command from Controller** and check for the motion / machining path.



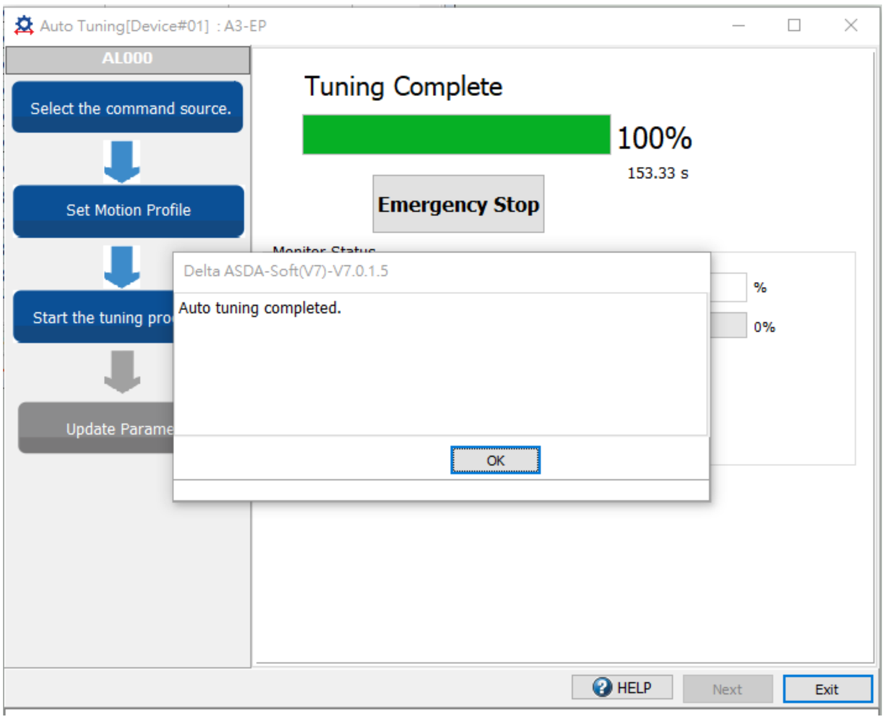
Suggestions: set the motor to operate at least one cycle in both forward and reverse directions. The dwell time for reaching the positioning points in both forward and reverse directions should be no less than 1000 ms with the running speed no less than 500 rpm.

Step 3:

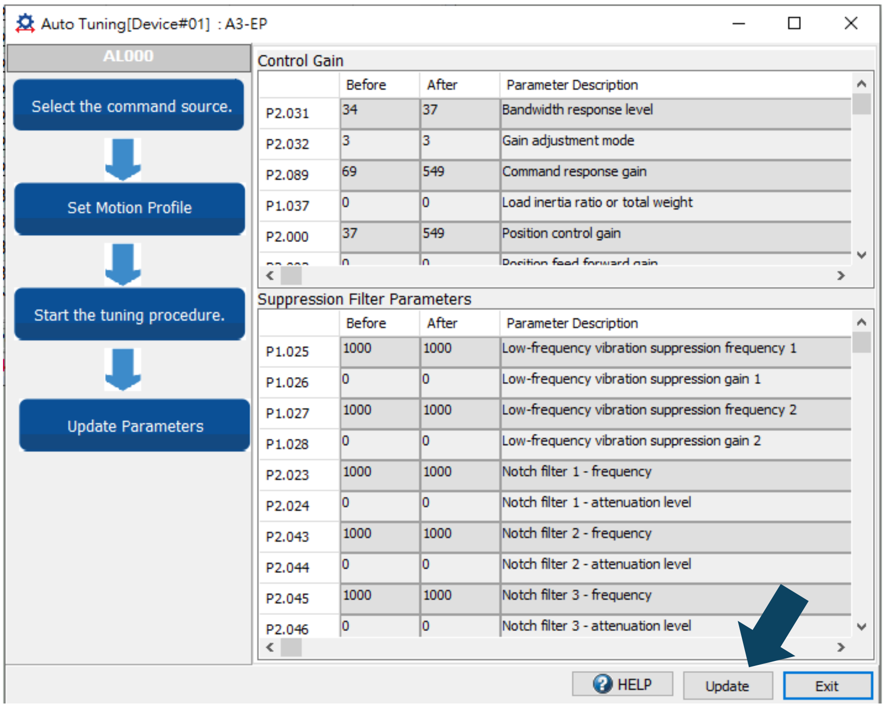
Repeatedly run the motor with the path you just set. Make sure no personnel is standing close to the machinery, and then you can click **Next** to start the auto tuning procedure.



Wait until the tuning progress bar reaches 100%, and a window with “Auto tuning completed.” appears as follows. Then click **OK**.



The screen shows a table comparing the parameter values before and after tuning.



Click **Update** to complete auto tuning.

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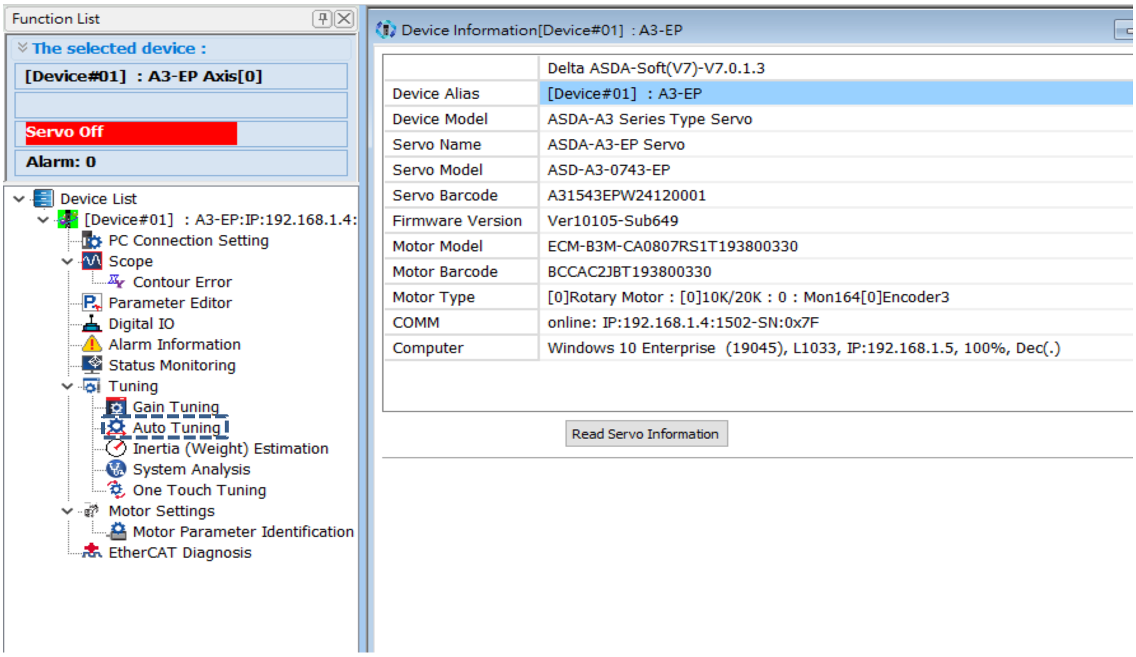
■ Auto-tuning with the servo drive: the servo drive sends the commands to drive the motor.

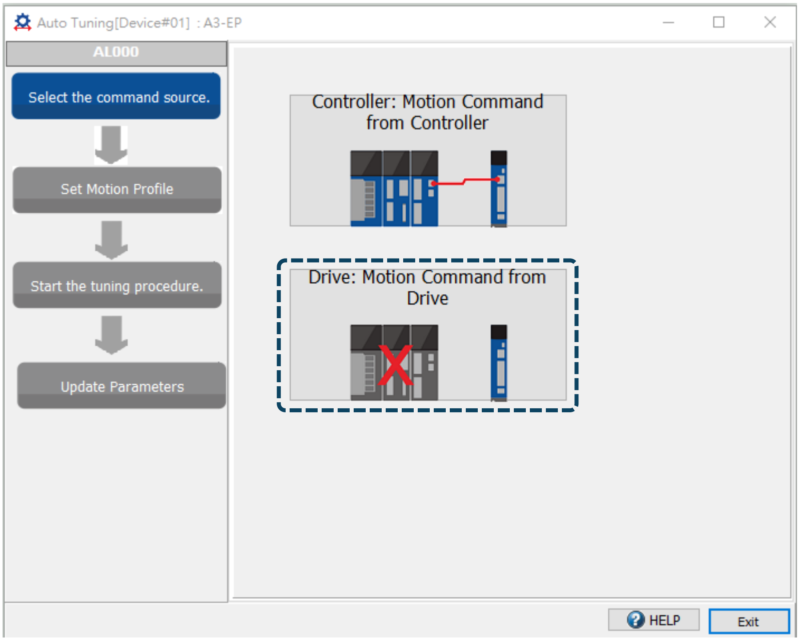
Step 1:

When ASDA-Soft is in online mode, the program window appears as follows. Click **Auto Tuning** in the Function List tree view.



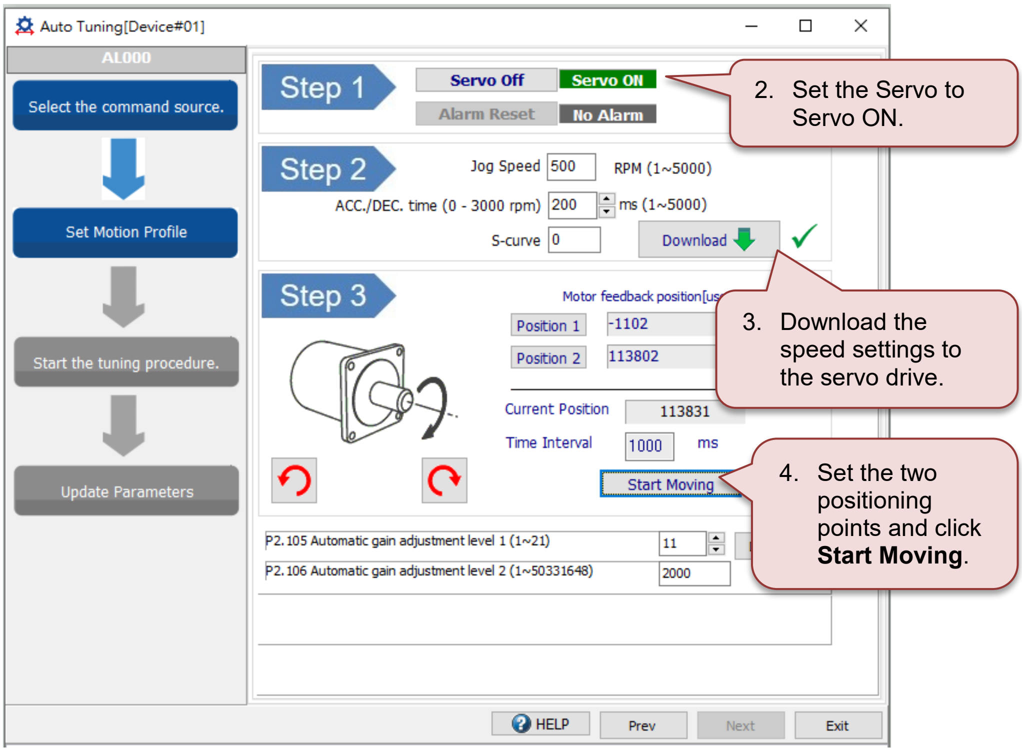
Step 2:

Click **Drive: Motion Command from Drive** to enter the setting screen of motion profile.



Follow these steps to set the motor running path:

1. Set P2.105 and P2.106 based on the application condition. Refer to Section 5.4.5 for details.
   - P2.105: the higher the setting value, the higher the bandwidth after auto tuning, which is applicable to devices with high stiffness or high response. On the other hand, the lower the setting value, the lower the bandwidth after auto tuning, which is applicable to devices with complex structure or low stiffness.
   - P2.106: the lower the setting value, the smaller the overshoot after auto tuning. But if the setting value is too low, the settling time may be too long.
2. Set the system to the Servo ON state.
3. The default jog speed is 20 rpm and the default acceleration / deceleration time is 200 ms. For mechanical parts with limited strokes, low speed movement reduces the risk of collision. Executing positioning with two points at low speed is recommended. For mechanical parts with longer strokes or without limits, you can set the movement speed higher. After completing the settings, click the Download button, and then use the Left ( ) or Right ( ) button to rotate the motor to Position 1 and Position 2.
4. Check the acceleration / deceleration time and jog speed again. It is advisable to set the jog speed to no less than 500 rpm. Then click the Download button. After the download is complete, click **Start Moving**, and the motor regards Position 1 and Position 2 as the positive and negative limits and starts rotating in the forward and reverse directions.
5. After completing the settings, make sure no personnel is standing close to the machinery. Then, click **Next**.
6. If the tuning results do not meet the requirements, modify the setting values of P2.105 and P2.106, or refer to Section 5.6 to manually adjust certain parameters and then perform the auto tuning again.



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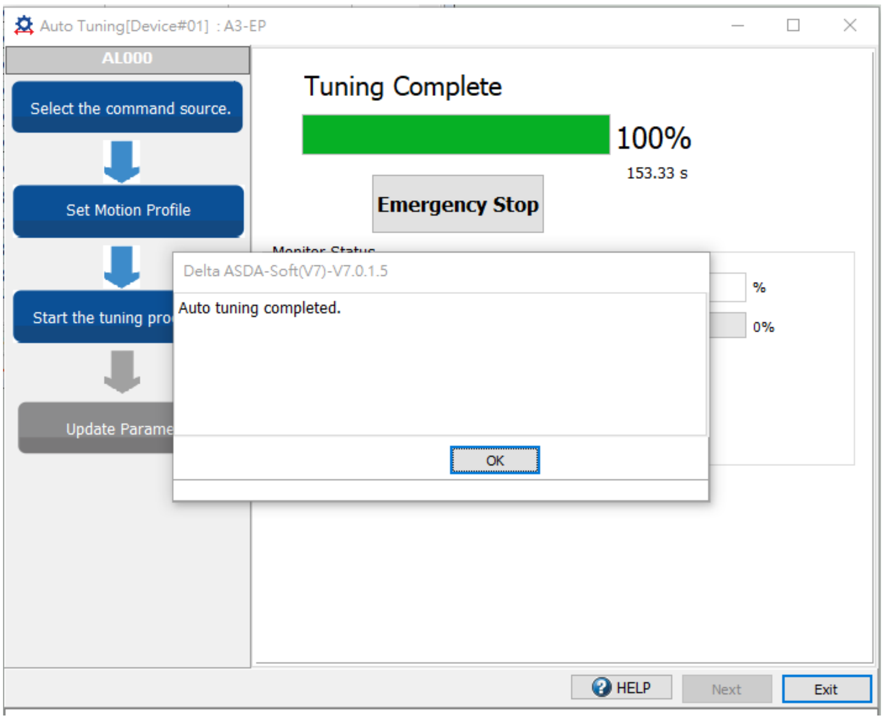
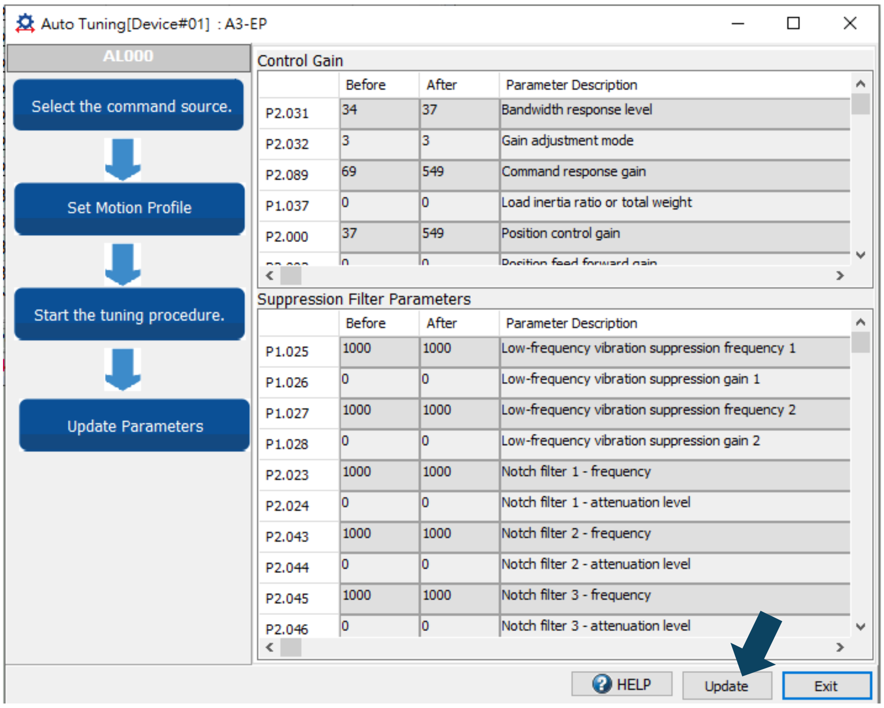
Step 3:

Wait until the tuning progress bar reaches 100%, and a window with “Auto tuning completed.” appears as follows. Then click **OK**.



The screen shows a table comparing the parameter values before and after tuning.



Click **Update** to complete auto tuning.

5.4.5 Parameters related to auto tuning

Before the auto gain adjustment starts, first set the automatic gain adjustment level 1 (P2.105) and automatic gain adjustment level 2 (P2.106), which are only available for **Auto Tuning**.

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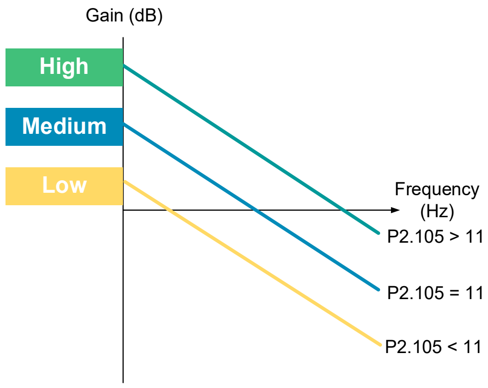
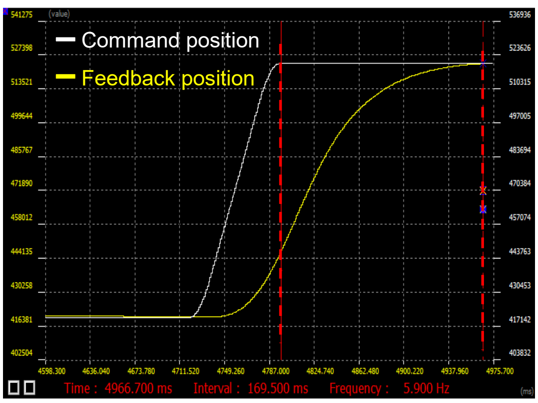
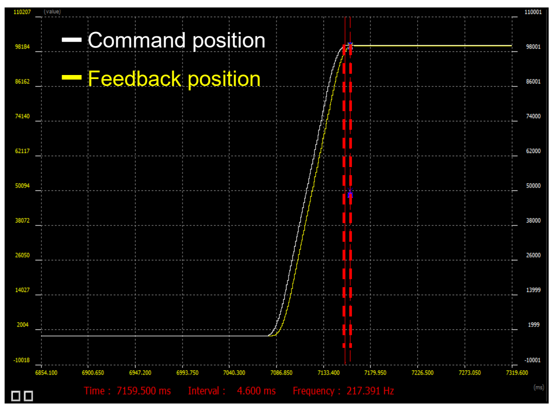
5.4.5.1 Automatic gain adjustment level 1 (P2.105) - stiffness adjustment



P2.105 defines the servo stiffness after auto tuning. The higher the setting value, the greater the bandwidth after auto tuning. On the other hand, the system margin becomes smaller, which means resonance is more likely to occur when the system is degrading. You can first set P2.105 to the default value of 11 and then change the setting according to the following conditions.

1. It is advisable to increase P2.105 if the machine has all the following characteristics.
   - The load inertia changes slightly during machine operation.
   - Connected to transmission components with high stiffness (for example, they are direct-coupled or connected with couplings).
   - The machine requires high responsiveness.
2. It is advisable to decrease P2.105 if the machine has one of the following characteristics.
   - The load inertia changes constantly during machine operation (such as transport equipment and robotic arms).
   - The machine has a transmission component with long strokes (such as a lead screw with the length of 3 m or longer or a belt with the length of 1 m or longer).

P2.105 = 1	P2.105 = 11
	

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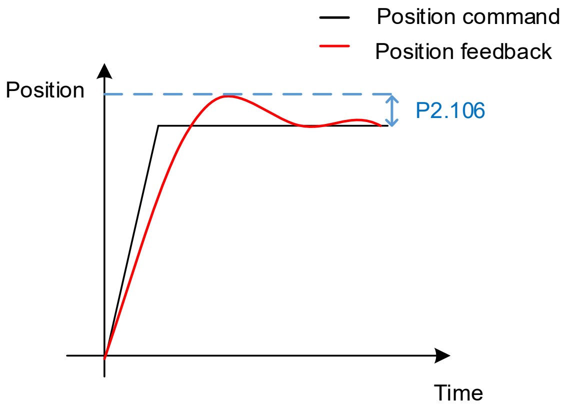
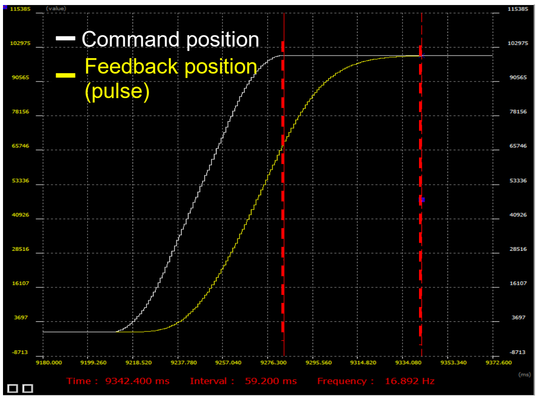
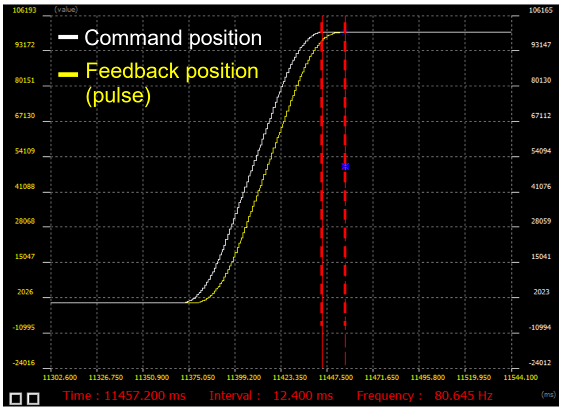
5.4.5.2 Automatic gain adjustment level 2 (P2.106) - response adjustment

P2.106 sets the maximum overshoot. A proper setting of the amount of overshoot increases the system response. The higher the setting value, the greater the allowable amount of overshoot. For mechanical parts with higher stiffness, the setting of P2.106 affects the position loop parameters P2.000 and P2.089 instead of the parameters related to speed loop gain and filters.

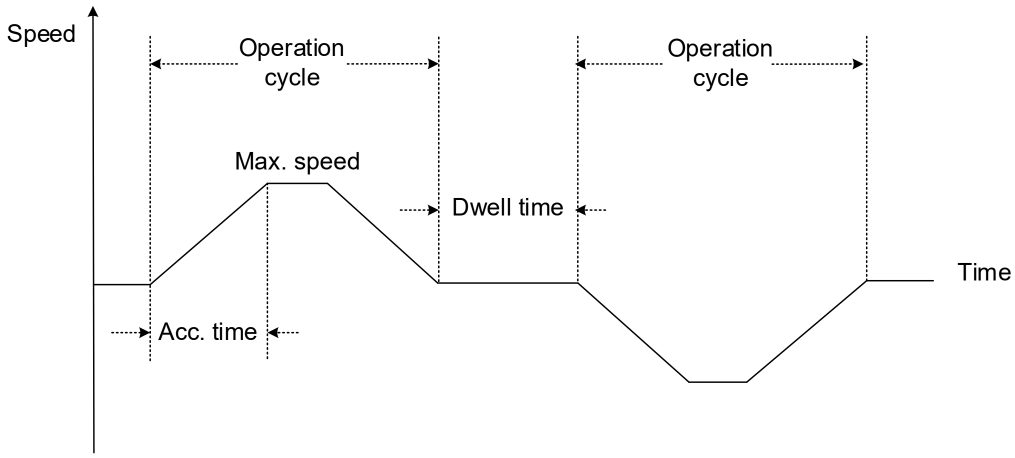


Parameter setting range: 1 to 50331648 (unit: pulse); default: 2000

<table>
<tr><th>P2.106 = 1</th><th>P2.106 = 30000</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Allowable amount of overshoot ≤ 1 pulse
Settling time: 59.2 ms</td><td>Allowable amount of overshoot ≤ 30000 pulses
Settling time: 12.4 ms</td></tr>
</table>

5.4.6 Alarms related to auto tuning

In Auto Tuning mode, it is vital that you program the command path. The path must contain the operation cycle (including acceleration, constant speed, and deceleration) and dwell time. See the following figure. When any of the settings is incorrect, the servo drive stops tuning and displays an alarm. Check the alarm causes and take corrective actions.



Display	Alarm name
AL08A	Auto-tuning function - command error
AL08B	Auto-tuning function - dwell time is too short
AL08C	Auto-tuning function - inertia estimation error

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5.5 Gain adjustment modes

In addition to the Auto Tuning function, the servo drive also provides the following gain adjustment modes. You can easily complete tuning by increasing or decreasing the bandwidth response level (P2.031) or the bandwidth for speed loop response (P2.126). It is advisable to follow the tuning procedure in Section 5.1.

5.5.1 Differences between gain adjustment modes

Level adjustment: set the response level with P2.031 to adjust the servo bandwidth. With the load inertia ratio increased or decreased, the bandwidth corresponding to the response level set by P2.031 changes as well.
Bandwidth adjustment: set P2.126 to directly determine the servo bandwidth, which fine-tunes the bandwidth.

P2.032	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
0	Manual	Manual mode	Fixed set value of P1.037	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102	N/A
1	Gain adjustment mode 1	**Level adjustment** - Auto	Real-time estimation	P2.031	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
2	Gain adjustment mode 2	**Level adjustment** - Semi-auto	Fixed set value of P1.037	P1.037 P2.031	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
3	Gain adjustment mode 3 (Available when two degree of freedom control function is enabled)	**Level adjustment** - Two degree of freedom	Fixed set value of P1.037	P1.037 P2.031 P2.089	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.098, P2.099, P2.101, P2.102
4	Gain adjustment mode 4	-	Reset to the default gain values	-	-

P2.032	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
5	Gain adjustment mode 5 (Same as setting P2-32 = 1 for the A2 series)	**Bandwidth adjustment** - Auto	Real-time estimation	P2.126	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102
6	Gain adjustment mode 6 (Same as setting P2-32 = 2 for the A2 series)	**Bandwidth adjustment** - Semi-auto	Fixed set value of P1.037	P1.037 P2.126	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102

Note: when the two degree of freedom control function is disabled (P2.094 [Bit 12] = 0), the effect of Gain adjustment mode 3 is the same as that of Gain adjustment mode 2, so setting P2.089 is invalid in that scenario.

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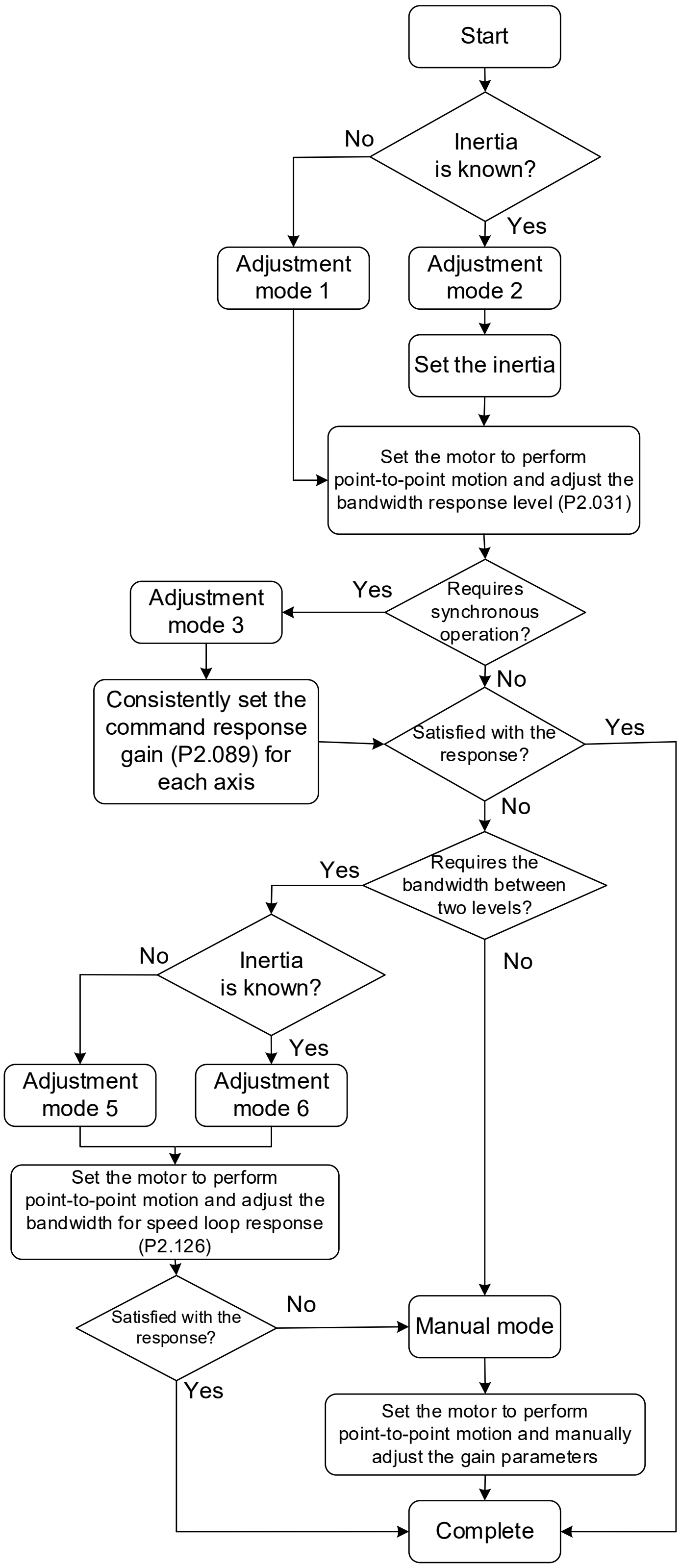
5.5.2 Flowchart of gain adjustment mode



Note: Gain adjustment modes 5 and 6 are similar to Gain adjustment modes 1 and 2 respectively. The main difference is that you can set the bandwidth for modes 5 and 6.

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5.5.3 Gain adjustment mode 1

You can use this mode when the load inertia is unknown or the inertia changes during machine operation.

The servo drive continually estimates the machine inertia and updates the value of P1.037. To reach the expected response, simply adjust the bandwidth response level (P2.031).

P2.032	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
1	Gain adjustment mode 1	Level adjustment - Auto	Real-time estimation	P2.031	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102

5.5.4 Gain adjustment mode 2

When the inertia cannot be successfully estimated in Gain adjustment mode 1, it is probably because the machine inertia ratio is greater than 100 times or the speed and acceleration / deceleration of the actual motor operation are too low. In this case, you can use Gain adjustment mode 2 to tune the servo system.

In Gain adjustment mode 2, you need to correctly set the machine inertia ratio in P1.037 first and then adjust the bandwidth response level (P2.031) to reach the expected response.

Note: inertia estimation is available for most machines. However, when the machine does not comply with the requirements for inertia estimation, you have to set the correct inertia ratio in P1.037.

P2.032	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
2	Gain adjustment mode 2	Level adjustment - Semi-auto	Fixed set value of P1.037	P1.037 P2.031	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102

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5.5.5 Gain adjustment mode 3

When Gain adjustment modes 1 and 2 cannot meet the requirements, try Gain adjustment mode 3 to tune the servo system. P2.089 (Command response gain) is available for manual adjustment in this mode. You can increase the gain value to shorten the response and settling time for the position command. However, if you set the gain value too high, it might cause position overshoot and machinery vibration. This parameter is effective only when the commands are changing, such as in the acceleration / deceleration application, and adjusting this parameter can improve the response. However, when the two degree of freedom control function is disabled (P2.094 [Bit 12] is set to 0), the effect of Gain adjustment mode 3 is the same as that of Gain adjustment mode 2, so setting P2.089 is invalid in that scenario.

P2.032	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
3	Gain adjustment mode 3 (Available when two degree of freedom control function is enabled)	Level adjustment - Two degree of freedom	Fixed set value of P1.037	P1.037 P2.031 P2.089	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.098, P2.099, P2.101, P2.102

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5.5.6 Gain adjustment mode 4

When P2.032 is set to 4, the setting value of P2.032 is restored to the value set before initialization other than the default value after parameter reset (P2.008 = 10). For example, if P2.032 is 1, P2.032 is still 1 after gain initialization (P2.032 = 4).

Original setting value of P2.032	0	1	2	3
Setting value of P2.032 after parameter reset (P2.008 = 10)	1	1	1	1
Setting value of P2.032 after gain initialization (P2.032 = 4)	0	1	2	3

When P2.032 is set to 4, if the notch filters are set to Manual for manual resonance suppression, the related notch filter parameters are not reset. If the notch filters are automatically set, the related notch filter parameters and the parameters in the following tables are reset to the default.

The default values of other related parameters are as follows.

Gain parameters		
Parameter No.	Default	Function
P1.037	6.0	Load inertia ratio
P2.000	36	Position control gain
P2.004	144	Speed control gain
P2.006	23	Speed integral compensation
P2.031	19	Bandwidth response level
P2.089	23	Command response gain
P2.105	11	Automatic gain adjustment level 1
P2.106	2000	Automatic gain adjustment level 2

Filter and resonance suppression parameters		
Parameter No.	Default	Function
P1.025	100.0	Low-frequency vibration suppression frequency 1
P1.026	0	Low-frequency vibration suppression gain 1
P1.027	100.0	Low-frequency vibration suppression frequency 2
P1.028	0	Low-frequency vibration suppression gain 2
P2.023	1000	Notch filter 1 - frequency
P2.024	0	Notch filter 1 - attenuation level
P2.025*	5.0	Resonance suppression low-pass filter
P2.043	1000	Notch filter 2 - frequency
P2.044	0	Notch filter 2 - attenuation level
P2.045	0	Notch filter 3 - frequency
P2.046	0	Notch filter 3 - attenuation level
P2.047	1	Auto resonance suppression mode
P2.049*	5.0	Speed detection filter and jitter suppression
P2.098	1000	Notch filter 4 - frequency
P2.099	5	Notch filter 4 - attenuation level
P2.101	100	Notch filter 5 - frequency
P2.102	0	Notch filter 5 - attenuation level

Note: when P2.032 is set to 0 and then 4, the default settings of P2.025 and P2.049 are both 0.8.

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5.5.7 Gain adjustment mode 5

You can use this mode when the load inertia is unknown or the inertia changes during machine operation.

The servo drive continually estimates the machine inertia and updates the value of P1.037. To reach the expected response, simply set the bandwidth for speed loop response (P2.126) to adjust the servo stiffness or reduce the noise.

P2.032	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
5	Gain adjustment mode 5 (Same as setting P2-32 = 1 for the A2 series)	Bandwidth adjustment - Auto	Real-time estimation	P2.126	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102

5.5.8 Gain adjustment mode 6

When the inertia cannot be successfully estimated in Gain adjustment mode 5, it is probably because the machine inertia ratio is greater than 100 times or the speed and acceleration / deceleration of the actual motor operation are too low. In this case, you can use Gain adjustment mode 6 to tune the servo system.

In Gain adjustment mode 6, you need to correctly set the machine inertia ratio in P1.037 first and then adjust the bandwidth for speed loop response (P2.126). Setting P2.126 higher can increase the servo stiffness and setting P2.126 lower can reduce the noise.

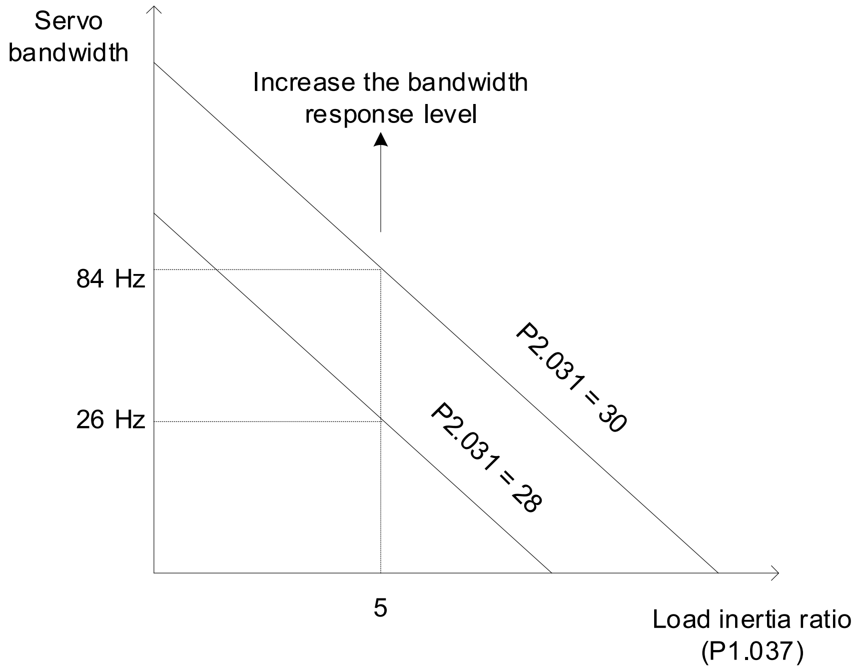
P2.032	Adjustment mode	Mode name	Inertia estimation	Parameter	
				Manual	Auto
6	Gain adjustment mode 6 (Same as setting P2-32 = 2 for the A2 series)	Bandwidth adjustment - Semi-auto	Fixed set value of P1.037	P1.037 P2.126	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102

5.5.9 Parameters related to gain adjustment modes

5.5.9.1 Bandwidth response level (P2.031) - stiffness adjustment

This parameter enables you to tune the servo drive in a simple and instinctive way. When the inertia is fixed and you increase the bandwidth response level (P2.031), the servo's bandwidth increases as well. If resonance occurs, decrease the setting value of P2.031 by one or two bandwidth response levels (you should adjust the bandwidth response level according to the actual situation). For instance, if the value of P2.031 is 30, you can lower the setting to 28. When you adjust the value of this parameter, the servo drive automatically adjusts the corresponding gain parameters, such as P2.000 and P2.004.

Note: enabling the bandwidth response level reversion function (P2.125 [Bit 3]) is recommended when you are adjusting the bandwidth response level (P2.031).



Bandwidth response level reversion (P2.125 [Bit 3])

When the bandwidth response level reversion function is enabled (P2.125 [Bit 3] = 1), the servo automatically sets the upper limit for the setting value of P2.031 to reduce hazards caused by resonance.

When the bandwidth response level reversion function is enabled, resonance caused by increasing P2.031 can be suppressed with the Notch filter. When any of the 5 sets of Notch filter is not set, the servo automatically sets that Notch filter for resonance suppression. If the resonance cannot be suppressed when P2.031 is increased, the servo automatically decreases P2.031 to the level where the resonance does not occur, and then the servo sets the last set value of P2.031 before it is decreased as the upper limit of P2.031. If requiring to further increase P2.031, disable the bandwidth response level reversion function and the upper limit is lifted.

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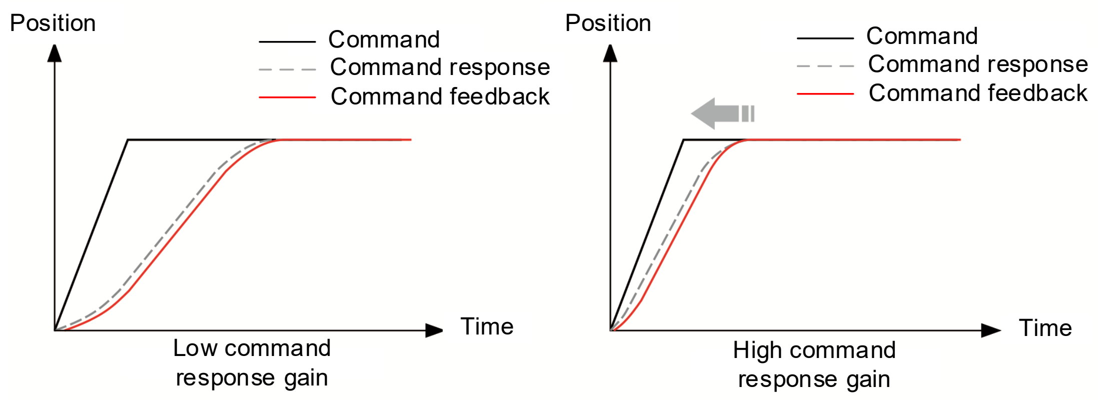
5.5.9.2 Command response gain (P2.089) - response adjustment

Use P2.089 to adjust the command response gain to improve the response to the servo command. Increasing the gain can reduce the transient error (in acceleration or deceleration zone) between the position command and command response. That is, the setting is effective only when the commands are changing. This parameter is available only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1) in Position mode. (The two degree of freedom control function is enabled by default).



5.5.9.3 Bandwidth for speed loop response (P2.126) - bandwidth adjustment

P2.126 sets the bandwidth for the speed loop, and the corresponding position loop bandwidth and the speed loop bandwidth are at a fixed ratio. To fine-tune the ratio between the position bandwidth and speed bandwidth (P2.000 and P2.004) or the ratio between the proportional gain (P2.004) and integral gain (P2.006) of the speed loop, switch the system to Manual mode for operation.

Assuming that the bandwidth setting of P2.126 = BW, the recommended settings for the gain parameters are as follows.

- P2.000 = P2.004 / 4
- P2.004 = BW * 2 * π
- P2.006 = BW
- P2.026 = BW

5.6 Manual tuning of gain parameters

The position or speed response bandwidth is determined by the mechanical stiffness and the application. Generally, for applications or machines that require high-speed positioning and high precision, higher response bandwidth is required. However, increasing the response bandwidth is likely to cause mechanical resonance. Thus, machinery with higher stiffness is used to solve this problem. When the allowable response bandwidth of the machine is unknown, you can gradually increase the gain parameter values to increase the response bandwidth. Then, decrease the gain parameter values until you hear the sound of the resonance. The following are the descriptions of the gain adjustment parameters.

- P2.000 Position control gain (KPP)

  This parameter determines the response of the position control circuit. The bigger the KPP value, the higher the bandwidth of the position loop. This lowers the following error and position error, and shortens the settling time. However, if you set the value too high, it can cause machine jitter or cause overshoot when positioning. The calculation of position loop bandwidth is as follows:

$$\text{Position loop bandwidth (Hz)} = \frac{\text{KPP}}{2\pi}$$

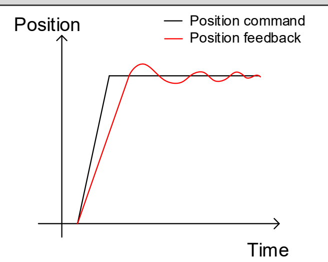
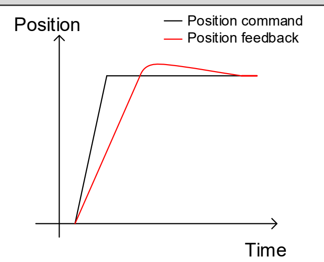
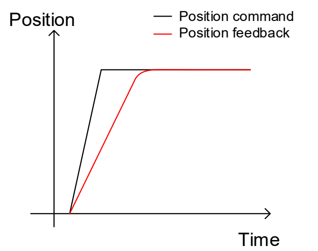
- P2.004 Speed control gain (KVP)

  This parameter determines the response of the speed control circuit. The bigger the KVP value, the higher the bandwidth of the speed loop and the lower the following error. However, if you set the value too high, it is likely to cause mechanical resonance. The speed loop bandwidth must be 4 times (or more) the position loop bandwidth; otherwise, it can cause machine jitter or cause overshoot when positioning. The calculation of speed loop bandwidth is as follows:

$$\text{Speed loop bandwidth (Hz)} = \left(\frac{\text{KVP}}{2\pi}\right) \times \left[\frac{(1 + \text{P1.037} / 10)}{(1 + \text{JL} / \text{JM})}\right]$$

  JM: motor inertia; JL: load inertia

  The following table illustrates the changes in position feedback when the speed loop bandwidth is 1 time, 2 times, and 4 times the position loop bandwidth.

Speed loop bandwidth: 100 Hz Position loop bandwidth: 100 Hz	Speed loop bandwidth: 100 Hz Position loop bandwidth: 50 Hz	Speed loop bandwidth: 100 Hz Position loop bandwidth: 25 Hz
		

When P1.037 (auto estimation or manually set value) is equal to the actual load inertia ratio (JL / JM), the actual speed loop bandwidth is:

$$\text{Speed loop bandwidth (Hz)} = \left(\frac{\text{KVP}}{2\pi}\right)$$

- P2.006 Speed integral compensation (KVI)

The higher the KVI value, the better the elimination of the deviation. However, if you set the value too high, it can cause machine jitter. It is advisable to set the value as follows:

$$\text{KVI} \leq 1.5 \times \text{Speed loop bandwidth (Hz)}$$

- P2.025 Resonance suppression low-pass filter (NLP)

A high load inertia ratio reduces the speed loop bandwidth. Therefore, you must increase the KVP value to maintain the speed loop bandwidth. Increasing the KVP value might cause mechanical resonance. Use this parameter to eliminate the noise. The higher the value, the better the capability of reducing high-frequency noise. However, if you set the value too high, it can cause instability in the speed control circuit and overshoot. It is advisable to set the value as follows:

$$\text{NLP} \leq \frac{10000}{6 \times \text{Speed loop bandwidth (Hz)}}$$

- P2.026 Anti-interference gain (DST)

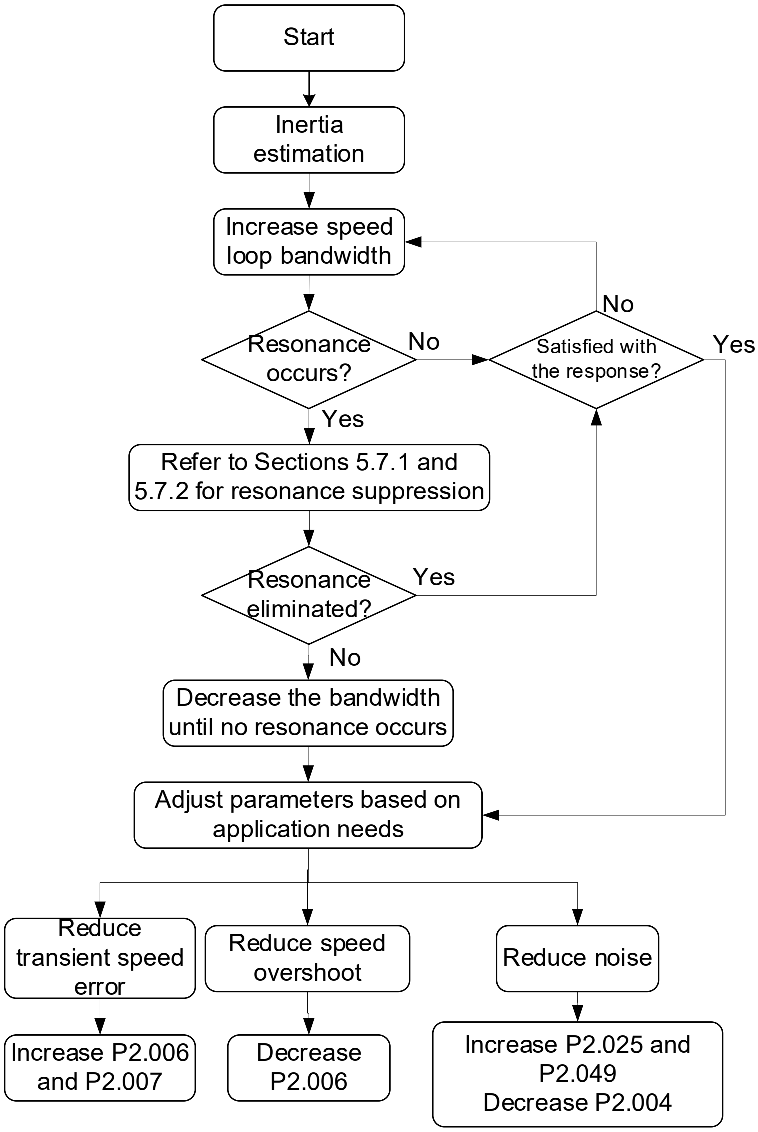
Use this parameter to increase the ability to resist external force and reduce overshoot during acceleration / deceleration. The default value is 0. Adjusting this value in Manual mode is not suggested unless it is for fine-tuning the results of auto tuning.

Note: P2.026 is invalid when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1).

- P2.002 Position feed forward gain (PFG)

This parameter can reduce the position error and shorten the settling time. However, if you set the value too high, it might cause overshoot when positioning. When the resolution of the pulse command is low, adjusting this parameter might cause noise. In this case, try using P2.003, P1.008, and P1.068 to eliminate the noise.

5.6.1 Flowchart of manual tuning in Speed mode



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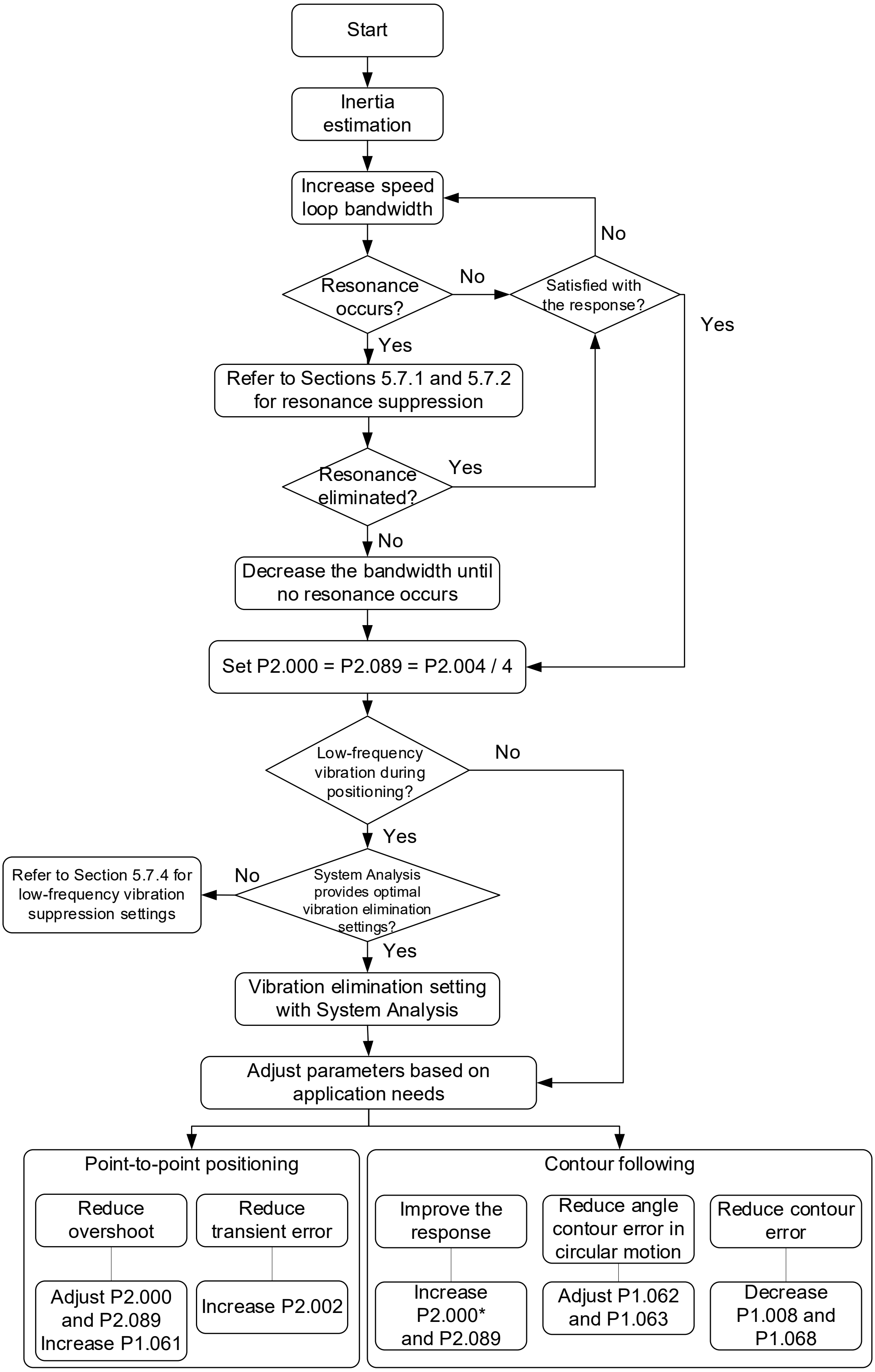
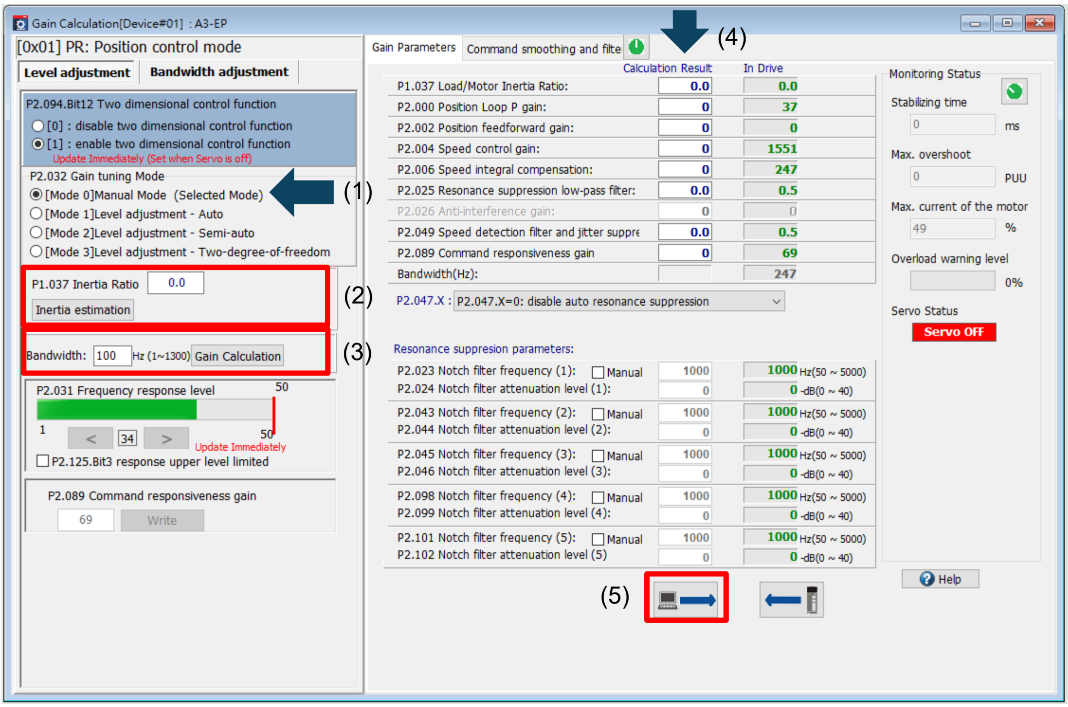
5.6.2 Flowchart of manual tuning in Position mode



Note: it is advisable to set P2.004 four times (or more) the setting value of P2.000; otherwise a jitter occurs in the corner contour.

5.6.3 Manual tuning with ASDA-Soft

1. Select **[Mode 0] Manual Mode**.
2. Click **Inertia estimation**.
3. Set the bandwidth, click **Gain Calculation**, and the Calculation Result fields on the right show the corresponding parameter settings according to the set speed loop bandwidth.
4. Fine-tune the values in the Calculation Result fields. It is advisable to set P2.004 four times (or more) the setting value of P2.000.
5. After fine-tuning the parameters, click the  button to write the parameters to the servo drive.



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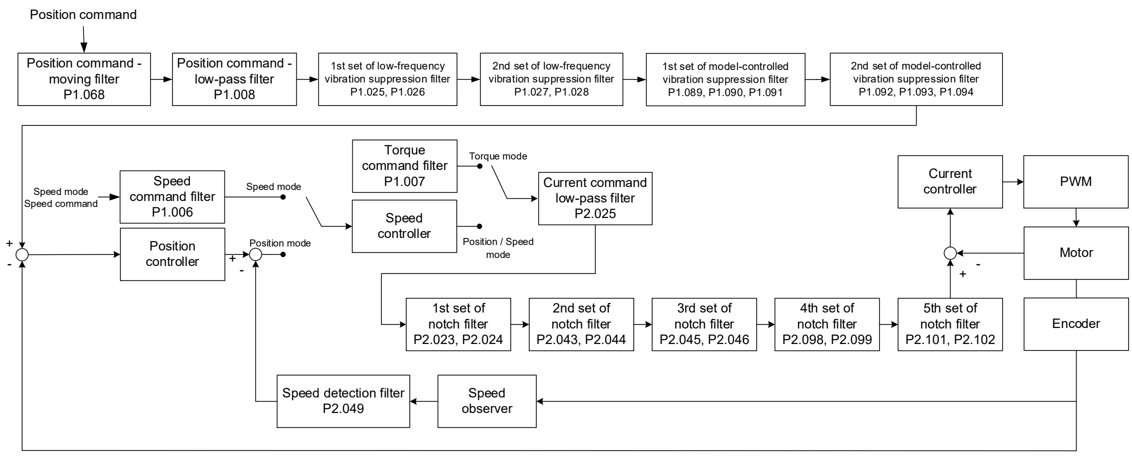
5.7 Mechanical resonance suppression and noise elimination

When mechanical resonance occurs, it is probably because the stiffness of the servo drive control system is too high or the response bandwidth is too great. Eliminating these two factors can improve the situation. During the tuning process, when you gradually increase the servo response bandwidth, the frequency at the resonance point is likely to be reached, causing noise and vibration. In this case, use the following filters to effectively eliminate the noise and vibration and therefore increase the response bandwidth.

Block diagram of filter setting



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5.7.1 Notch filter

5.7.1.1 Function restriction

1. The Notch filter frequency settings (P2.023, P2.043, P2.045, P2.098, and P2.101) must be 2 times (or more) the speed loop bandwidth (P2.004 / 2π), or it might lead to system divergence.
2. It is recommended that the notch depth (magnitude) of the resonance point should remain at -15 to -10 dB after resonance suppression.

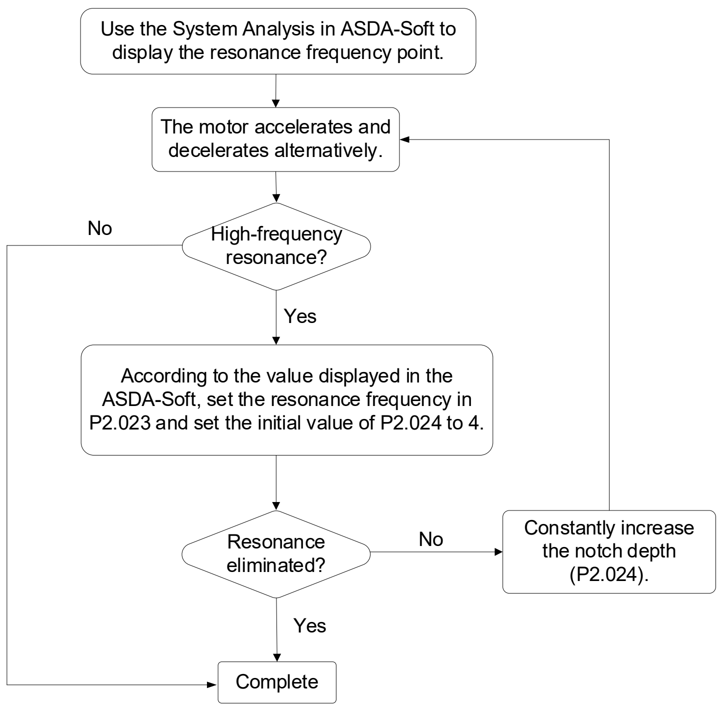
Note: it is recommended that you set the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft; the zero-crossing frequency is the speed loop bandwidth.

5.7.1.2 Function description

The servo provides 5 sets of notch filters with the frequency setting range of 50 to 5000 Hz. Each set of notch filter supports the function of auto resonance suppression (P2.047 and P2.048). In addition, you can suppress the resonance manually. The precautions and operation procedure for manual resonance suppression are as follows.

- Use the **System Analysis** function in ASDA-Soft V6 to find the resonance frequency.
- The sudden loss of load inertia is likely to cause resonance. It is advisable to tune the servo drive at maximum load.
- If the resonance frequency is incorrectly set, the noise and vibration might be worse.
- The higher the attenuation level and Q factor, the better the effect of resonance suppression. However, if the values are set too high, it results in phase lag and causes resonance at other frequencies.

Flowchart of manual resonance suppression:



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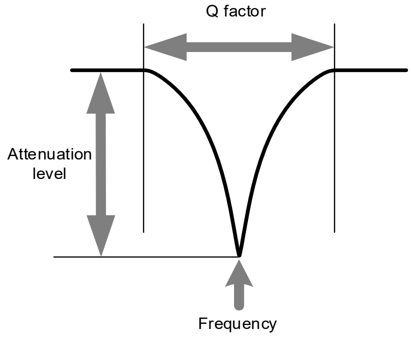
5.7.1.3 Parameter descriptions

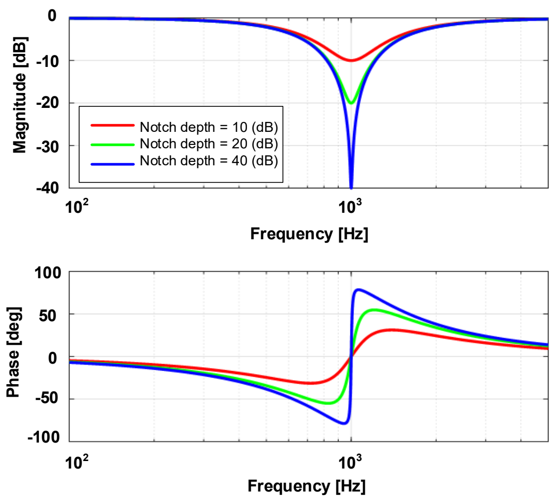
A notch filter is used to remove frequencies within a specific range. You can set the three parameters, including frequency, attenuation level, and Q factor, for each set of notch filter. The following describes the parameters of attenuation level (notch depth) and Q factor.



Attenuation level of notch filter

The attenuation level of the notch filter determines the notch depth (magnitude) of the frequency to be filtered. Properly set the attenuation level to effectively suppress the vibration. The higher the setting value, the better the effect of resonance suppression, but the phase margin of the system becomes smaller. When you set the value too high, the phase margin may become insufficient, causing resonance at other frequencies.

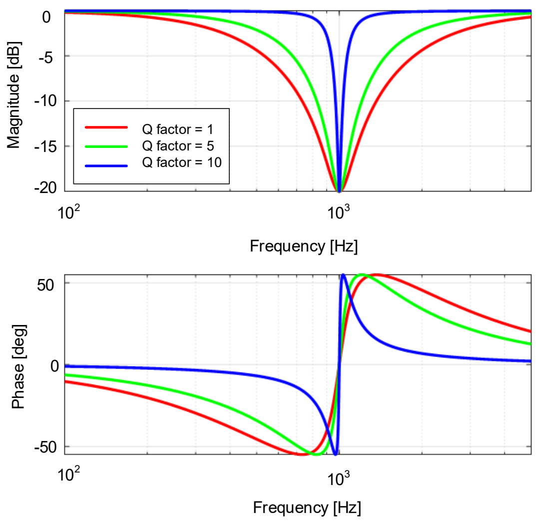
When the attenuation level of the notch filter is set to 0, it means the filter function is disabled.



Q factor of notch filter

The Q factor of the notch filter determines the frequency range (amount of signal) around the specific frequency to be filtered. **The higher the Q factor, the narrower the filtered frequency band**, and thus the phase margin of the system is **less** affected. In general, for systems with higher inertia or lower stiffness, the Q factor at the resonance point is relatively high.

If the Q factor is set too high, the resonance cannot be completely suppressed, and it is likely to cause resonance at the cut-off frequencies around the resonance point. In this case, set the Q factor lower to improve the condition.



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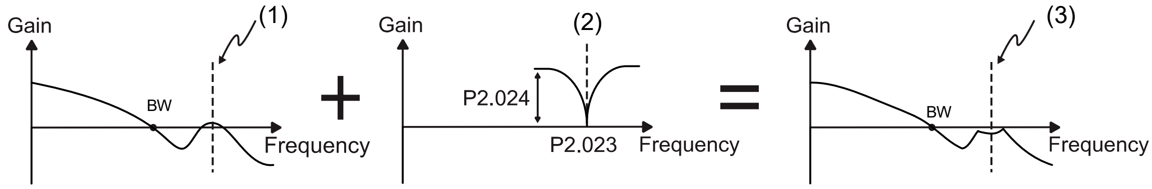
5.7.1.4 Application example

It is advisable to perform domain-frequency analysis and time-domain analysis alternately for comparing and monitoring the results.

Frequency-domain analysis

Draw Bode plots by setting the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft. The following figure shows the speed open-loop gain with resonance and (1) indicates the resonance point. Set the frequency at the resonance point as the frequency of the notch filter and gradually increase the attenuation level (magnitude) of the notch filter in the corresponding parameter. When increasing the notch depth, you can set the Analysis Type to **Speed Open-loop** in the System Analysis* to check if the resonance point is neutralized. If the notch depth is too shallow, resonance might occur in the system again. If the notch depth is too deep, the phase margin of the system will be sacrificed, making it difficult to increase the bandwidth afterwards. It is recommended that the notch depth (magnitude) of the resonance point should remain at -15 to -10 dB after resonance suppression.

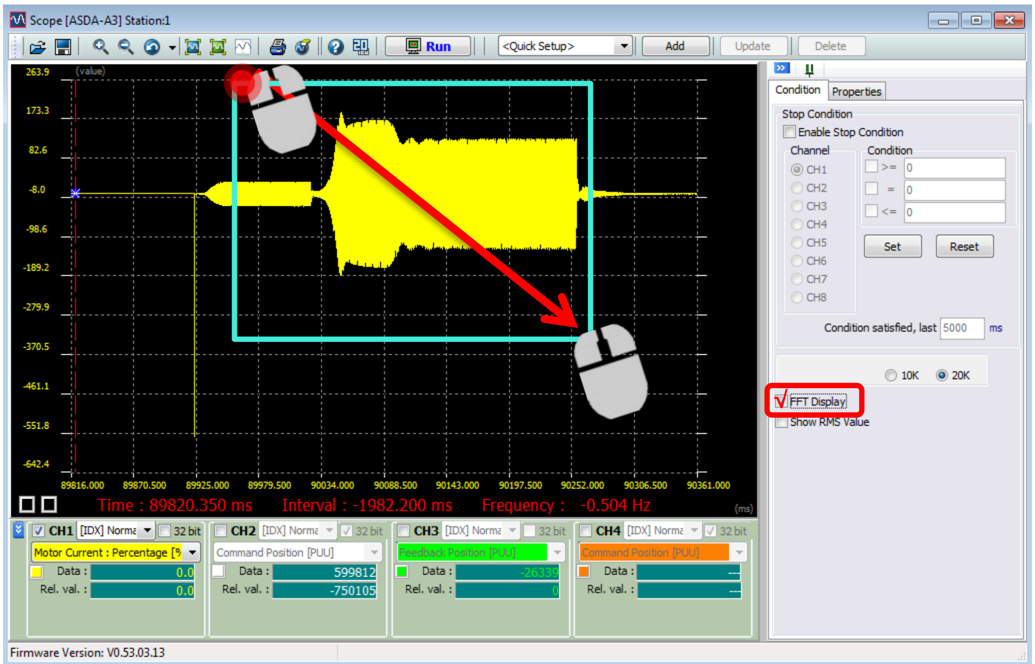
Note: when the frequency setting is lower than 100 Hz, it is advisable to select the check box for **Enable Low Frequency Analysis** in the System Analysis of ASDA-Soft. If the check box is not selected, the zero-crossing frequency might not be correctly detected or the low-frequency resonance point might be ignored or regarded as noise.



(1) Resonance point; (2) Notch filter; (3) Resonance point after resonance suppression

Time-domain analysis

1. Execute the Scope function in ASDA-Soft and select **Motor Current: Percentage [%]** for the channel.
2. Click **Run**, and the scope collects the current data when the motor is operating.
3. Click **Stop**, and the operation status of the motor is displayed in the software interface.
4. Select the check box for **FFT Display**, then left-click and drag the mouse to select the area with data displayed, and the spectrum display window appears on the screen.



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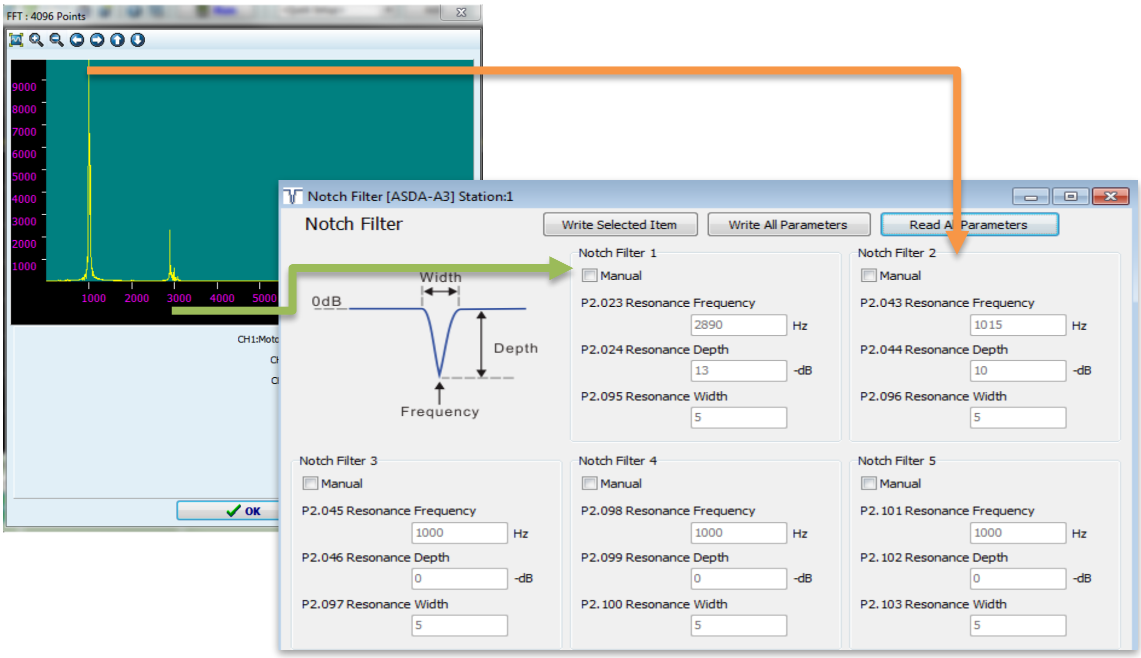
According to the spectrum, we can find two resonance points at the frequencies of 1015 Hz and 2890 Hz. In the following figure, P2.047.X is set to 1 or 2 for the servo to automatically fill in the resonance suppression parameters. To set the resonance points for manual resonance suppression, select the check box for **Manual** under the specific set of notch filter, and then the corresponding bit of P2.047.Y or P2.047.Z is automatically set to 1. In this case, you can manually set the resonance suppression parameters.



Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameters.

Parameter	Function
P2.023	Notch filter 1 - frequency
P2.024	Notch filter 1 - attenuation level
P2.043	Notch filter 2 - frequency
P2.044	Notch filter 2 - attenuation level
P2.045	Notch filter 3 - frequency
P2.046	Notch filter 3 - attenuation level
P2.047	Auto resonance suppression mode
P2.048	Auto resonance detection level
P2.095	Notch filter 1 - Q factor
P2.096	Notch filter 2 - Q factor
P2.097	Notch filter 3 - Q factor
P2.098	Notch filter 4 - frequency
P2.099	Notch filter 4 - attenuation level
P2.100	Notch filter 4 - Q factor
P2.101	Notch filter 5 - frequency
P2.102	Notch filter 5 - attenuation level
P2.103	Notch filter 5 - Q factor

5

5.7.2 Resonance suppression low-pass filter

5.7.2.1 Function restriction

It is recommended that the filter bandwidth (1000 / P2.025) should be 8 times (or more) the speed loop bandwidth (P2.004 / 2π).

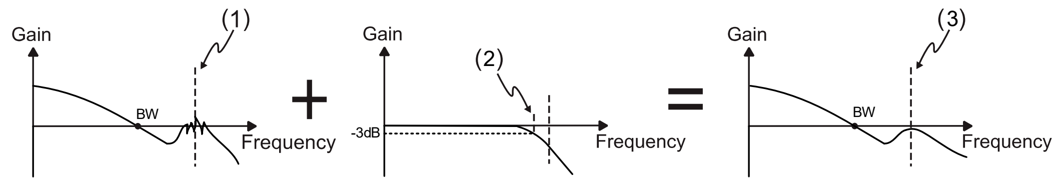
Note: it is recommended that you set the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft; the zero-crossing frequency is the speed loop bandwidth.

5.7.2.2 Function description

The current command generated in the speed loop is filtered by the resonance suppression low-pass filter, which reduces the interference of high-frequency resonance or noise to current control. Since the filter causes a delay in the current command, when increasing the servo response bandwidth, you must set the time constant for the low-pass filter (P2.025) smaller. However, it causes greater noise during motor operation.

5.7.2.3 Application example

Draw Bode plots by setting the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft. When there is more than one resonance point and the distance between each is small, it is advisable to use the resonance suppression low-pass filter to suppress the resonance occurring at the resonance points within a specified range.
If the resonance frequency is known, the Notch filter works better than the resonance suppression low-pass filter for resonance suppression. If the spectrum displays multiple resonance points which are intensively distributed, or the resonance frequency drifts significantly with time or due to other causes, use the resonance suppression low-pass filter instead.
When P2.025 is gradually increased, the filter bandwidth becomes smaller. Although resonance does not occur in this condition, the servo response is slower and the phase margin is reduced. If the ratio between the filter bandwidth (1000 / P2.025) and speed loop bandwidth (P2.004 / 2π) is too small, the system becomes unstable.



(1) Resonance point;

(2) Resonance suppression low-pass filter (Cut-off frequency of low-pass filter = 1000 / P2.025 Hz);

(3) Resonance point after resonance suppression

Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameter.

Parameter	Function
P2.025	Resonance suppression low-pass filter

5

5.7.3 Speed detection filter

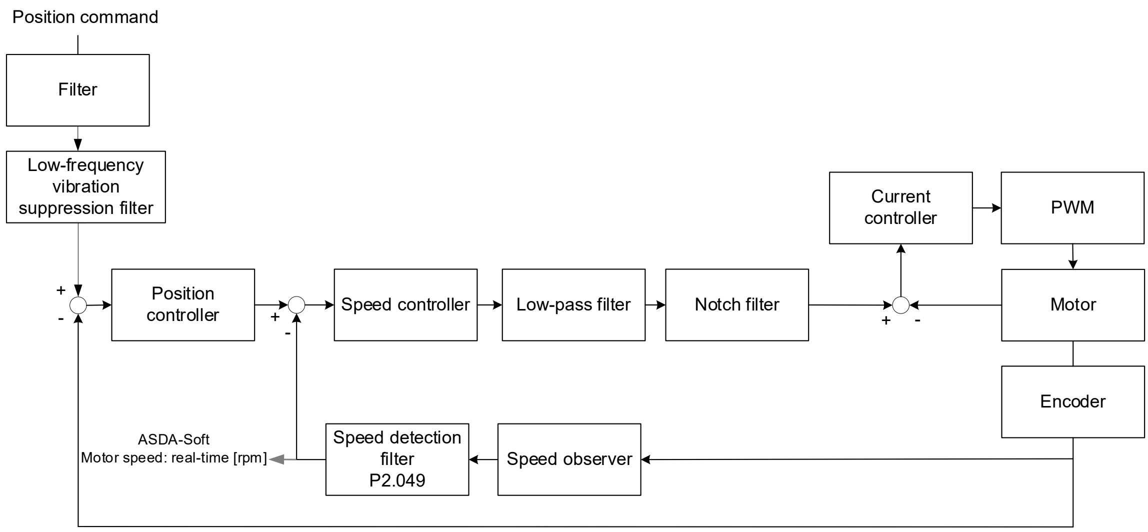
5.7.3.1 Function restriction

It is recommended that the filter bandwidth (1000 / P2.049) should be 8 times (or more) the speed loop bandwidth (P2.004 / 2π).

Note: it is recommended that you set the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft; the zero-crossing frequency is the speed loop bandwidth.

5.7.3.2 Function description

When the motor speed is unstable, use this function to reduce the jitter in the motor speed. You can obtain the speed information after the position feedback signal from the encoder is processed by the speed observer. You can use the Scope function of ASDA-Soft to monitor the speed signal processed by the speed detection filter by setting the channel to **Motor speed: real-time [rpm]**.

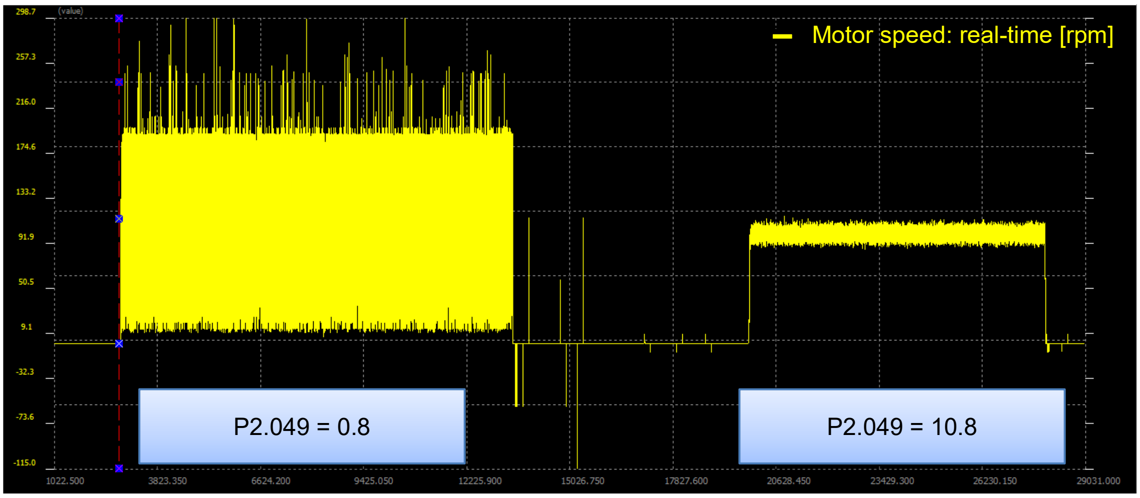


You can set P2.084.U to select the speed observer.

P2.084.U	Speed observer	Filter bandwidth	Applicable range
0	Speed observer 1	1000 / P2.049	Available for high resolution encoders.
1	Speed observer 2	The bandwidth cannot be adjusted.	Available for encoders with low resolution, such as rotary encoders with the single-turn resolution smaller than 40000 pulse/rev used in low speed (< 100 rpm) applications.
2	Speed observer 3	1000 / P2.049	

5.7.3.3 Application example

The following figure illustrates the difference between setting P2.049 to 0.8 and 10.8 when the speed observer 1 is used (P2.084.U = 0). You need to select a suitable speed observer for different installation methods for mechanical parts or different motors and then verify if the results meet the requirements.



Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameters.

Parameter	Function
P2.049	Speed detection filter and jitter suppression
P2.084	Special function for low resolution motor

5

5.7.4 Low-frequency vibration suppression filter

5.7.4.1 Function restriction

1. Set the EtherCAT operation mode to Profile Position mode (PP) or Cyclic Synchronous Position mode (CSP).
2. Frequency range: 1.0 Hz to 100.0 Hz.
3. If the low-frequency vibration suppression function and the vibration elimination function are enabled simultaneously, the system response becomes slower.

5.7.4.2 Function description

The low-frequency vibration suppression filter is also called position command notch filter, which filters the frequencies causing mechanical vibration but delays the system response time.
If the machine stiffness is insufficient, mechanical vibration persists even when the motor stops after the positioning command is complete. The low-frequency vibration suppression function can reduce this vibration; the suppression range is between 1.0 Hz and 100.0 Hz.
The servo provides both auto and manual settings for this function. During the auto tuning process, the auto low-frequency vibration suppression function is enabled and properly set.

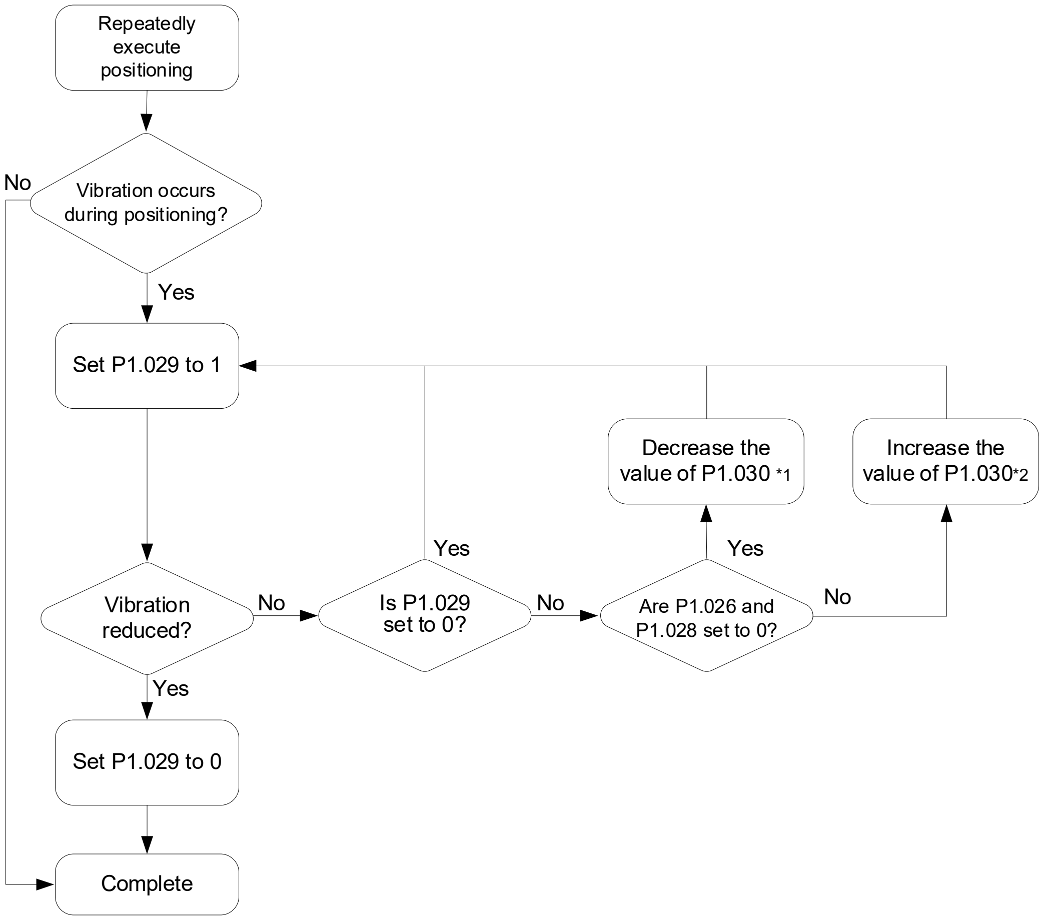
Auto setting:

If you have difficulty finding the frequency, enable the auto low-frequency vibration suppression function to automatically search for the vibration frequency.
If you set P1.029 to 1, the system automatically disables the auto low-frequency vibration suppression function (P1.026 and P1.028 are set to 0) and starts to search for the frequency which causes low-frequency vibration. When the detected frequency remains at the same level, the system automatically changes the settings in the following order.

1. Automatically resets P1.029 to 0.
2. Sets P1.025 as the first set of frequency and P1.026 to 1.
3. Sets P1.027 as the second set of frequency and P1.028 to 1.

When P1.029 automatically resets to 0 and the low-frequency vibration still persists, check if either P1.026 or P1.028 is automatically set to 1; if so, increase the setting of P1.030 (Low-frequency vibration detection). If the values of P1.026 and P1.028 are both 0, it means no frequency is detected. Lower the value of P1.030 and set P1.029 to 1 to search for the vibration frequency again.
P1.030 sets the detection range for the peak-to-peak amplitude of low-frequency vibration. When the frequency is not detected, it is probably because the setting value of P1.030 is higher than the vibration of the machine. If so, it is suggested that you decrease the value of P1.030. Note that if the value is set too small, the system might mistakenly regard noises as low-frequency vibrations. In this case, you can use the Scope function of ASDA-Soft and set the channel to **Position error (pulse)** to observe the peak-to-peak amplitude of the signal during positioning for setting P1.030.

Flowchart of auto low-frequency vibration suppression:



Note:

1. When the values of P1.026 and P1.028 are both 0, it means no frequency is detected. It is probably because P1.030 is set too high so that the low-frequency vibration is not detected.
2. When the value of P1.026 or P1.028 is greater than 0, but the vibration persists, it is probably because P1.030 is set too low, causing the system to mistakenly regard minor frequency or noise as the low-frequency vibration.

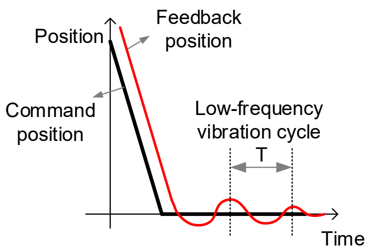
Manual setting:

When the auto suppression procedure is complete, but the vibration persists, you can manually set P1.025 or P1.027 to suppress the vibration if you have identified the vibration frequency. The low-frequency vibration suppression function provides two sets of low-frequency vibration suppression filters: one is parameters P1.025 - P1.026 and the other is parameters P1.027 - P1.028. You can use these two sets of parameters to reduce two different low-frequency vibrations. Use P1.025 and P1.027 to set the frequencies for low-frequency vibration suppression. The filter function works only when the parameter setting is close to the actual vibration frequency. Use P1.026 and P1.028 to set the response after frequency filtering. The bigger the values of P1.026 and P1.028, the better the response. However, if you set the values too high, the motor might not operate smoothly. The default values of P1.026 and P1.028 are 0, which means the two filters are disabled by default.

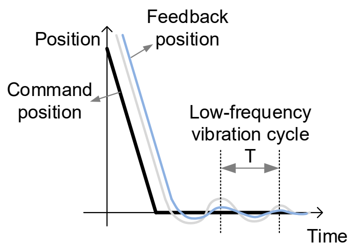
5.7.4.3 Application example

During position settling, if a vibration with the frequency lower than 100 Hz (not the high-frequency noise when the motor is moving) occurs and it is difficult to identify the frequency with the **System Analysis** function of ASDA-Soft, use the low-frequency vibration suppression function to suppress the vibration caused by the specific frequency. Setting the low-frequency vibration suppression filter makes the system more stable but lowers the response. When the frequency setting is the same for the two sets of low-frequency vibration suppression filter, the effect of vibration suppression is doubled.

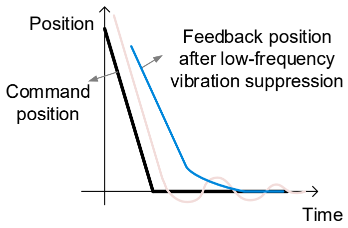
If the frequency of the low-frequency vibration in the system varies during operation, such as in a long-distance belt drive system, the vibration frequency may be different at two positioning points. In this case, set the two sets of low-frequency vibration suppression filters individually.



1. Set the first set of low-frequency vibration suppression filter.
   P1.025 = 1/T
   P1.026 = 1



2. If the vibration is smaller but not completely eliminated, you can set another set of low-frequency vibration suppression filter with the same frequency. The effect of vibration suppression is doubled.
   P1.027 = 1/T
   P1.028 = 1



3. If the vibration is completely eliminated but the response is too slow, gradually increase P1.026.
   P1.026 = 2

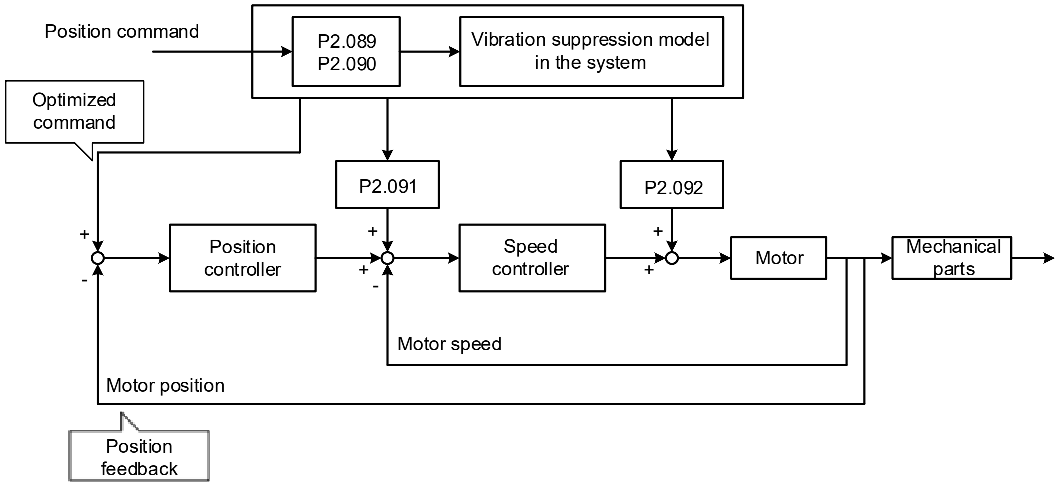
Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameters.

Parameter	Function
P1.025	Low-frequency vibration suppression frequency 1
P1.026	Low-frequency vibration suppression gain 1
P1.027	Low-frequency vibration suppression frequency 2
P1.028	Low-frequency vibration suppression gain 2
P1.029	Auto low-frequency vibration suppression mode
P1.030	Low-frequency vibration detection

5.7.5 Model-controlled vibration suppression filter

The idea of model-following control is to build a virtual model of the real physical system in the servo drive in digital format. The virtual model processes the position command planned by the user and generates an optimized position command. At the same time, the model designs optimized position feed forward and speed feed forward, so the feedback system follows the optimized position command, achieving the expected response. If the response designed by the system does not meet your requirements, fine-tune the parameters P2.091 and P2.092.



5.7.5.1 Restrictions of the two degree of freedom control function

Setting P2.094 [Bit 12] to 1 enables the two degree of freedom control mode, but you need to note for the following restrictions.

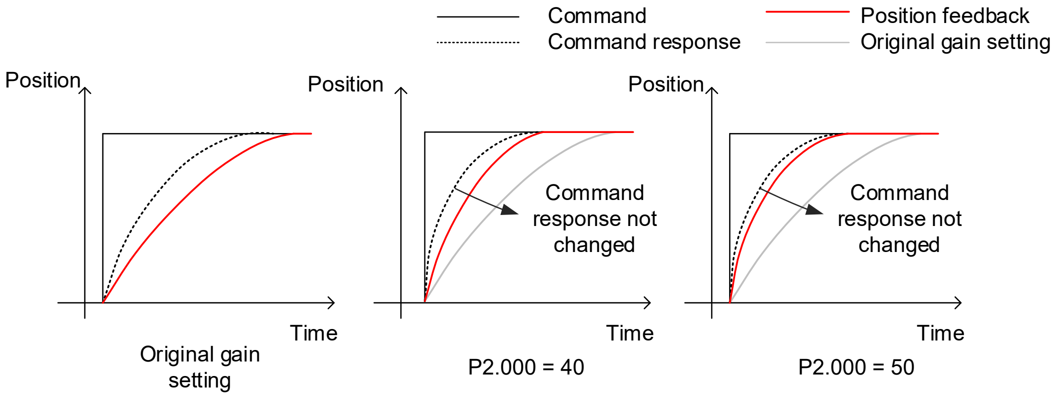
1. Set the EtherCAT operation mode to Profile Position mode (PP) or Cyclic Synchronous Position mode (CSP).
2. Set the load inertia ratio(P1.037) correctly when using this function.
3. The setting of anti-interference gain (P2.026) is invalid when this function is used.

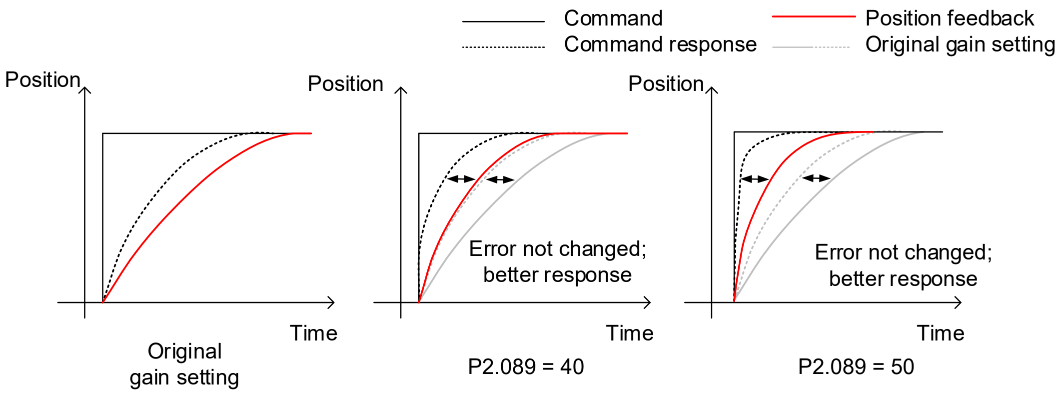
5

5.7.5.2 Function description of two degree of freedom control function

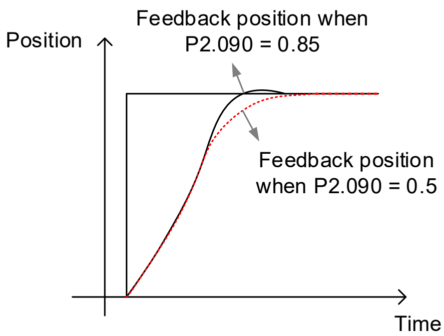
When the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1), set P2.000 and P2.089 for better position response.

Set P2.089 to adjust how well the command response follows the command. Setting P2.089 higher can reduce the transient error between the position command and command response, but the error between the command response and feedback does not change. Thus, P2.089 is valid only when the position command changes. To reduce the difference between the command response and feedback, or to reduce the position jitter when the motor stops, adjust P2.000 or other control gain parameters.



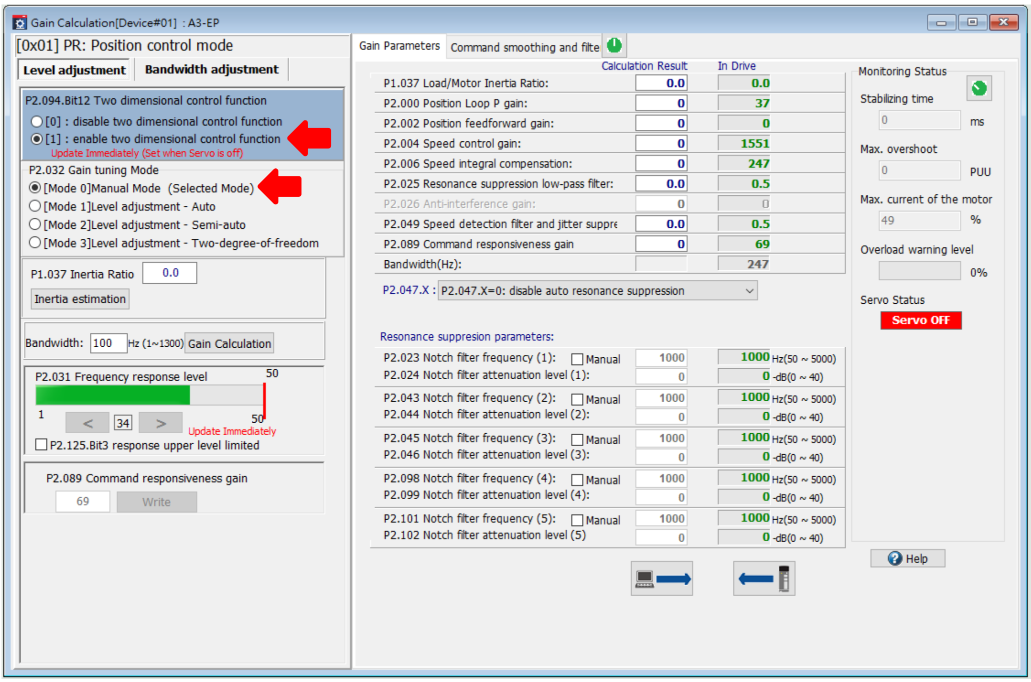


Setting P2.090 (Two degree of freedom mode - anti interference gain) can adjust the position settling waveform but does not change the command response time. Setting P2.090 to a smaller value lowers the response after the command is complete but reduces the position feedback overshoot.



5.7.5.3 Application example of two degree of freedom control function

This section describes the parameter settings when the two degree of freedom control function is used in Manual Mode (P2.032 = 0). Refer to the following steps.



Switch the servo status to Servo ON and then start tuning. Change the parameter settings and at the same time use the Scope function to verify if the settings meet the requirements. It is advisable to increase the bandwidth gradually. To adjust the bandwidth significantly, enable the auto resonance suppression function (P2.047.X ≠ 0), set P2.047.Y and P2.047.Z to auto mode, and do not set the corresponding resonance parameters.

1. Increase the setting values of P2.000 and P2.089 while maintaining the ratio of P2.000 to P2.089 at approximately 1:1.
2. When the mechanical parts start to vibrate or generate high-frequency sounds, stop increasing P2.000 and decrease P2.000 until the mechanical parts are stable.
3. To increase the servo response, setting P2.089 higher to reduce the transient error of command response, but the position overshoot becomes greater. It is recommended that the setting value of P2.089 should be no more than two times the setting value of P2.000.
4. To fine-tune the positioning behavior, you can adjust P2.090.

Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameters.

Parameter	Function
P2.000	Position control gain
P2.089	Command response gain
P2.090	Two degree of freedom mode - anti-interference gain
P2.091	Two degree of freedom mode - position feed forward gain
P2.092	Two degree of freedom mode - speed feed forward gain
P2.094	Special bit register 3 (enable the two degree of freedom control function)

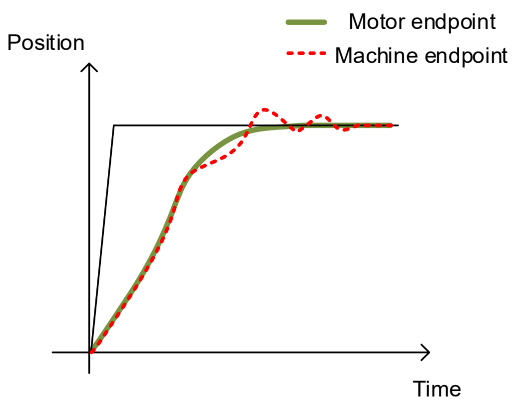
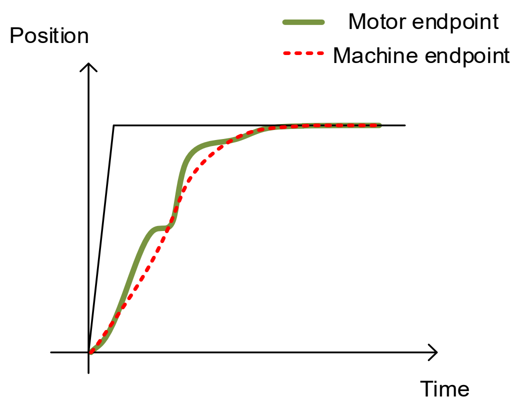
5.7.5.4 Restrictions of vibration elimination

1. The two degree of freedom control function must be enabled (P2.094 [Bit 12] = 1).
2. Frequency range: 1.0 Hz to 400.0 Hz.

5.7.5.5 Function description of vibration elimination

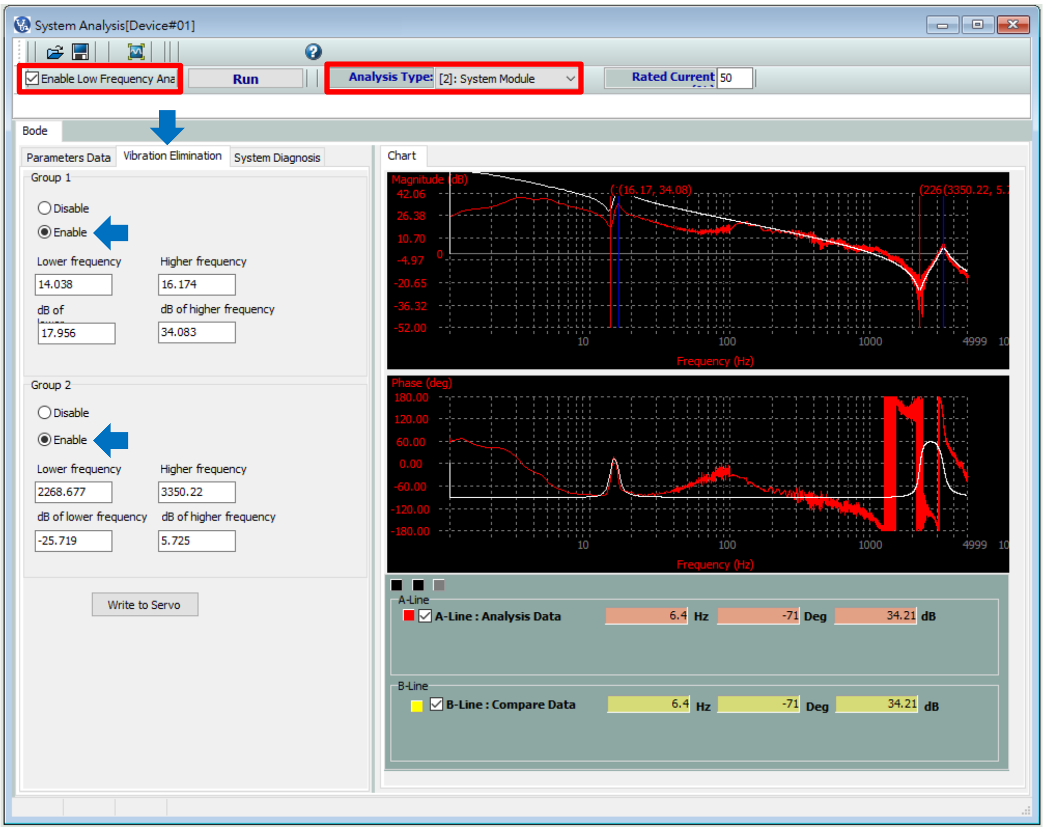
The vibration elimination function uses a special algorithm, which can eliminate the vibration in the machine endpoint without slowing down the system response. This function is automatically set during the One Touch Tuning process, or you can set this function in the **System Analysis** function window of ASDA-Soft.

The vibration elimination function builds the flexible mechanical vibration model in the servo drive under the two degree of freedom control mode, so you need to enable the two degree of freedom control function before using the vibration elimination function. When the connection between mechanical parts is not rigid enough, the response between the motor endpoint and the machine endpoint is not consistent, resulting the condition where the motor has stopped but the machine endpoint still vibrates. As for this condition, you can use the **System Analysis** function in ASDA-Soft to provide optimal settings for the vibration elimination parameters, and set P2.094 [Bit 8] and [Bit 9] to enable one or two sets of the vibration elimination function. After the vibration elimination function is enabled, the servo adjusts the motor command according to the internal model. When you monitor the motor position feedback in the scope, there might be a jitter, but the machine endpoint is stable when settling.

Vibration elimination not enabled	Vibration elimination enabled
	

5.7.5.6 Application example of vibration elimination

1. Start ASDA-Soft and enter the **System Analysis** function window.
2. Select the check box for **Enable Low Frequency Analysis** and select **[2]: System Module** for the Analysis Type, and then click **Run** to start analyzing.
3. After the analysis is complete, go to the Vibration Elimination tab and click the radio button of **Enable** to enable the vibration elimination function. Then, click **Write to Servo** to complete the procedure.



Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameter.

Parameter	Function
P2.094	Special bit register 3 (enable the two degree of freedom control function)

5

5.7.6 Position command filter

5.7.6.1 Function restriction

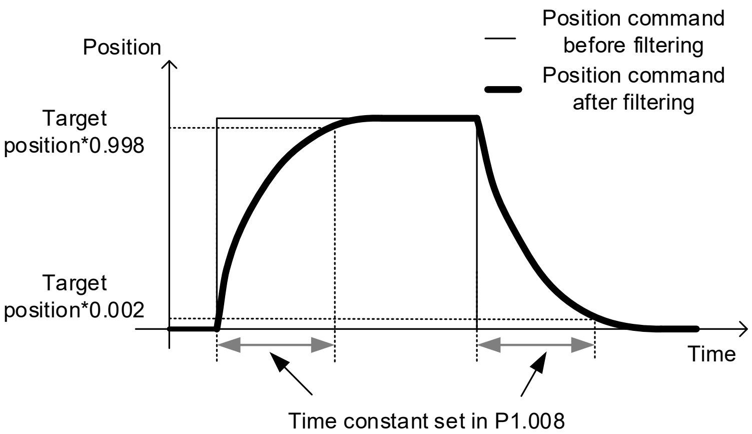
Set the EtherCAT operation mode to Profile Position mode (PP) or Cyclic Synchronous Position mode (CSP).

5.7.6.2 Function description

If the position command changes too drastically, the speed command or current command may become saturated, causing the machine unable to operate according to the expected response. If the resolution of a pulse command is low, it may cause unexpected machine vibration. Adjusting the position command filter can improve the previous two conditions. It is advisable to use the position command filter with P1.008 and P1.068.

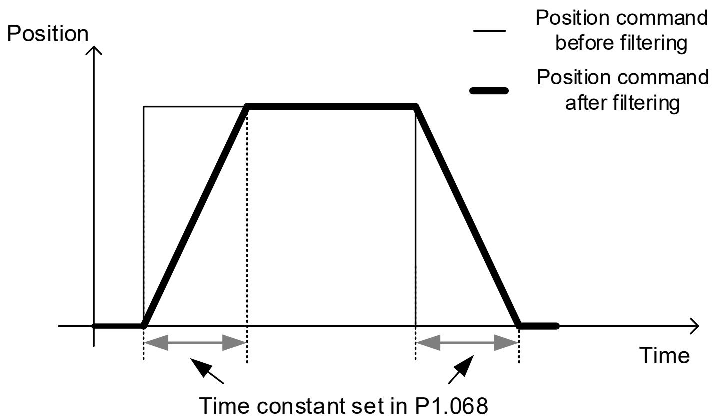
Position command - smoothing constant (low-pass filter) (P1.008)

After the position command is processed with the first-order low-pass filter, the unwanted high-frequency response or noise is attenuated, and the command becomes smoother.



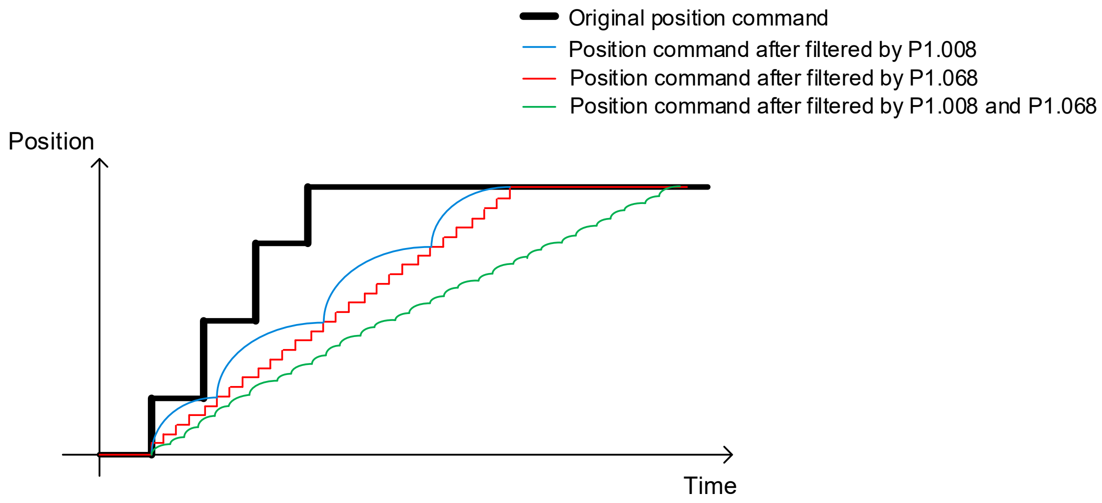
Position command - moving filter (P1.068)

This function distributes the position commands evenly within the set time. When the resolution of the position command is low, using the filter function of P1.068 is recommended. If you use P1.008, it will cause drastic speed changes.



5.7.6.3 Application example

When the resolution of the position command is low (for example, the command resolution is lower than 10000 pulse/rev), using the position command filter reduces the jitter in the command feedback caused by low resolution.



Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameters.

Parameter	Function
P1.008	Position command - smoothing constant (low-pass filter)
P1.068	Position command - moving filter

5

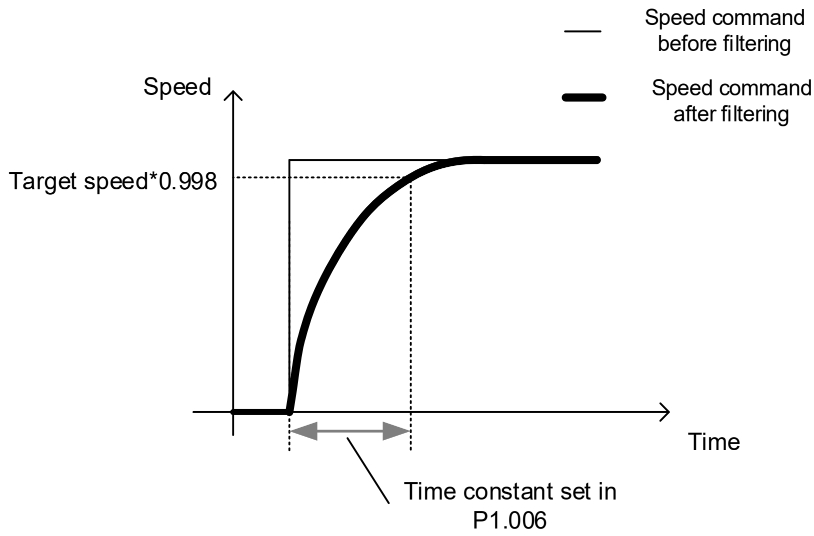
5.7.7 Speed command filter

5.7.7.1 Function restriction

Set the EtherCAT operation mode to Profile Velocity mode (PV) or Cyclic Synchronous Velocity mode (CSV).

5.7.7.2 Function description

After the speed command is processed with the first-order low-pass filter, the unwanted high-frequency response or noise is attenuated, and the command becomes smoother.



5.7.7.3 Application example

To reduce the noise in the command, increase the setting value of P1.006. However, if the filter time is set too long, the position control response of the controller becomes slower. If desiring to keep the position control response stable, set the filter bandwidth 8 times (or more) the position bandwidth of the controller.

Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.006	Speed command - smoothing constant (low-pass filter)

5

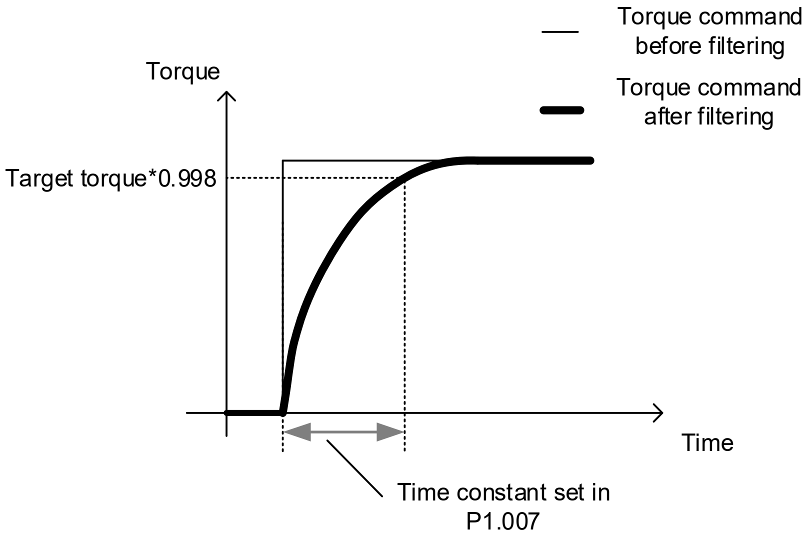
5.7.8 Torque command filter

5.7.8.1 Function restriction

Set the EtherCAT operation mode to Profile Torque mode (PT) or Cyclic Synchronous Torque mode (CST).

5.7.8.2 Function description

After the torque command is processed with the first-order low-pass filter, the unwanted high-frequency response or noise is attenuated, and the command becomes smoother.



5.7.8.3 Application example

When the servo is performing force control (such as tension or pressure control), the command value is usually a constant which changes slowly. Since the bandwidth of the servo current loop is much higher than that of the position loop and speed loop, it is highly responsive but is subject to noise interference. Properly adjust P1.007 to reduce the high-frequency noise and increase the control accuracy.

Relevant parameter

Refer to Chapter 7 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.007	Torque command - smoothing constant (low-pass filter)

5

5.8 Application function adjustment

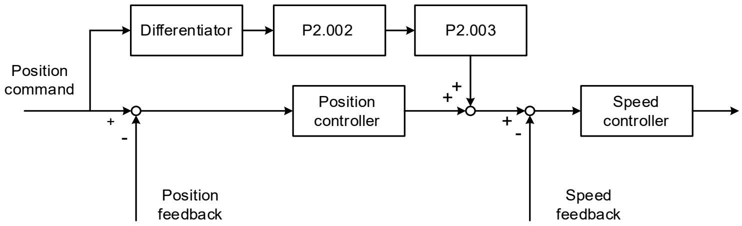
5.8.1 Adjusting position error in constant speed zone

5.8.1.1 Function restriction

1. When using P2.002 and P2.003, set the EtherCAT operation mode to Profile Position mode (PP) or Cyclic Synchronous Position mode (CSP).
2. When using P2.007, you must set the EtherCAT operation mode to Profile Position mode (PP), Profile Velocity mode (PV), Cyclic Synchronous Position mode (CSP), or Cyclic Synchronous Velocity mode (CSV).

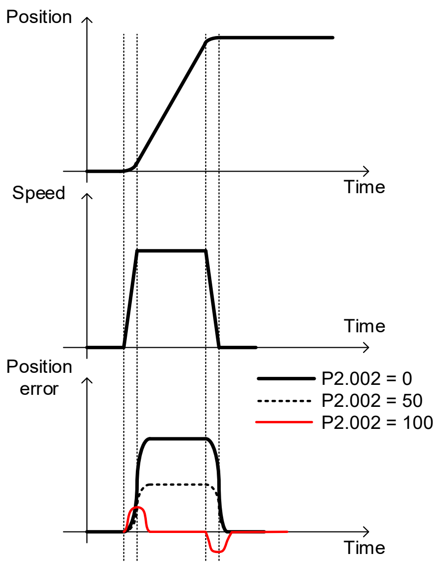
5.8.1.2 Function description

In Position mode, this function uses the Position command to calculate an ideal speed value and applies this value to the Speed command. This function reduces the position error in the constant speed zone during position control. Therefore, you can use this function to shorten the settling time or reduce the following error.



Position feed forward gain (P2.002)

This parameter converts the difference of the position command changes into an ideal speed value and applies this value to the Speed command. The higher the value of P2.002, the smaller the error in the constant speed zone, thus reducing the error when the system performs dynamic following. When this parameter is set to 100, it completely eliminates the position error at the constant speed zone but causes a greater position overshoot. When this parameter is set to 0, the position feed forward gain function is disabled.



Position feed forward gain smoothing constant (P2.003)

The ideal speed is calculated by the position command with a differentiator, so the discontinued noise of the position command is also magnified. The lower the position command resolution, the more severe the noise. In this case, you can set a higher constant value to reduce the interference from the noise. Note that the overshoot is greater during the position settling process if you set a higher value for the filter.

Speed feed forward gain (P2.007)

In Speed mode, this parameter calculates the ideal current using the speed command and applies this result to the electric current command. Using this function can reduce the speed error that occurs during uniform acceleration and deceleration. In Position mode, using this function is not recommended because it causes a rather poor settling performance.

5.8.1.3 Application example

In the application of contour control, to reduce the geometric error caused by the servo following error (i.e., the actual feedback radius is shorter than the command radius when circular path is executed), you can increase the setting of P2.002. In the point-to-point positioning application, you can also set a higher value for P2.002 to reduce the transient position error during acceleration. However, using the position feed forward gain function is more likely to cause position overshoot and a longer settling time.

Important: do not use P2.002 (Position feed forward gain) for applications that do not allow overshoot, use P1.061 (Viscous friction compensation) instead.

Relevant parameter

Refer to Chapter 7 for detailed descriptions.

Parameter	Function
P1.061	Viscous friction compensation
P1.062	Percentage of friction compensation
P1.063	Constant of friction compensation
P2.002	Position feed forward gain
P2.003	Position feed forward gain smoothing constant
P2.007	Speed feed forward gain

5

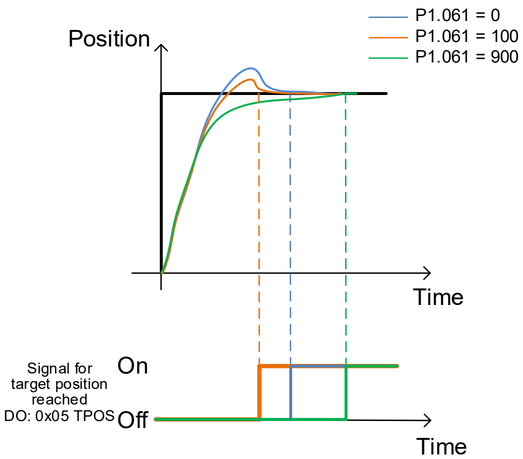
5.8.2 Position overshoot adjustment

5.8.2.1 Function restriction

When using this function, you must set the EtherCAT operation mode to Profile Position mode (PP), Profile Velocity mode (PV), Cyclic Synchronous Position mode (CSP), or Cyclic Synchronous Velocity mode (CSV).

5.8.2.2 Function description

The position overshoot occurred during positioning may be caused by the high value of P2.002 or a great change in the system friction. Lowering the setting of P2.002 or properly setting the viscous friction compensation can reduce the position overshoot.
When using the viscous friction compensation (P1.061), set the percentage of friction compensation (P1.062) to a non-zero value. Viscous friction compensation (P1.061) is the torque compensation amount in units of 0.1%/1000 rpm, which is based on the change of motor speed. It is recommended that you first set this parameter to 100, then 200, and then gradually increase the setting value. Setting the value too high may cause an increased overshoot or a longer settling time with an unchanged overshoot.



5.8.2.3 Application example

For the applications that do not allow overshoot, using this function can reduce the position overshoot; however, a high value of P1.061 can cause a longer positioning time.

Relevant parameter

Refer to Chapter 7 for detailed descriptions.

Parameter	Function
P1.061	Viscous friction compensation
P1.062	Percentage of friction compensation
P2.002	Position feed forward gain

5.8.3 Multi-axis contour control

5.8.3.1 Function restriction

1. In the communication mode, settings for P1.034 - P1.036, P2.068, and P1.017 for each axis have to be consistent.
2. The two degree of freedom control function settings (P2.094 [Bit 12]) for each axis have to be consistent.
   - When the Two degree of freedom control function is enabled (P2.094 [Bit 12] = 1), settings of P2.002, P2.089, P1.008, and P1.068 for each axis must be consistent.
   - When the Two degree of freedom control function is disabled (P2.094 [Bit 12] = 0), settings of P2.000, P2.002, P1.008, and P1.068 for each axis must be consistent.
3. Setting the same speed loop bandwidth (P2.004 / 2π) for each axis is recommended.

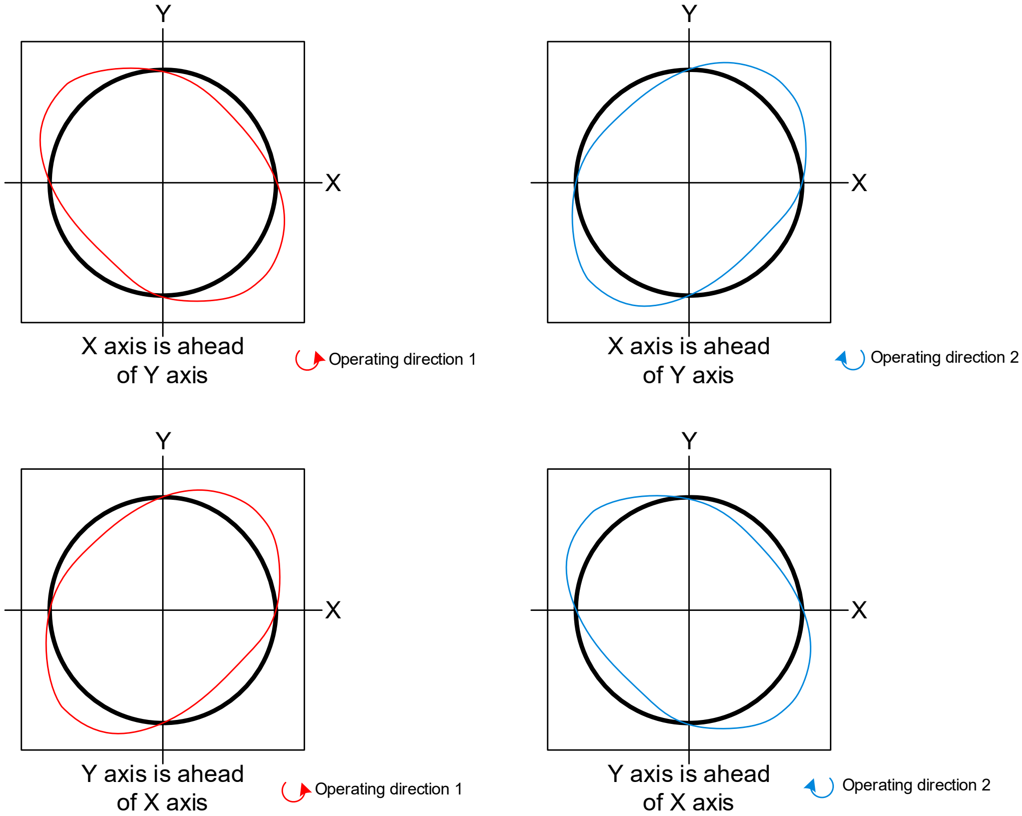
5.8.3.2 Function description

For the application of multi-axis contour control, make sure the servo parameters among all axes are consistent. If the response settings among each axis do not match, the contour distorts.

1. When the filter parameter settings (P1.008, P1.068) of each axis are inconsistent, the response of the axis with a lower filter parameter setting goes ahead of the other axes.
2. When the position gain parameter settings (P2.000, P2.002, P2.089) of each axis are inconsistent, the response of the axis set with a higher position gain goes ahead of the other axes.
3. After all axes are tuned, if their speed loop bandwidth settings (P2.004 / 2π) are not consistent but the contours remain undistorted, you can apply the position gain parameters of the axis with the lowest bandwidth to the other axes.

Note: it is recommended that you set the Analysis Type to **Speed Open-loop** in the System Analysis of ASDA-Soft; the zero-crossing frequency is the speed loop bandwidth.

The contours in black indicate that the response settings of each axis are consistent. The distorted contours in red and blue are generated due to the inconsistent response settings.



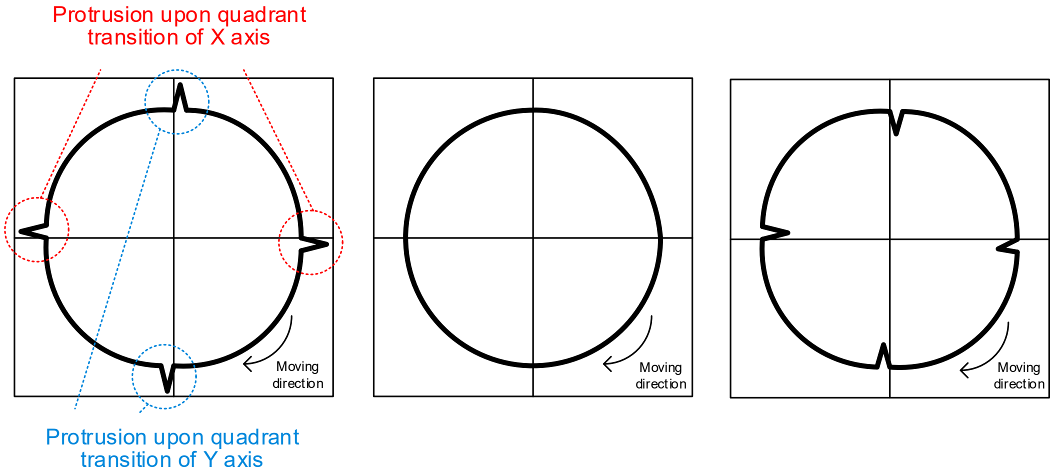
5.8.3.3 Application example

Adjusting the contour errors:

If the contour becomes unsmooth when transiting from one quadrant to another, it is caused by undercompensation of friction for the servo. Descriptions for manually and automatically adjusting the friction compensation are as follows.

Manual adjustment:

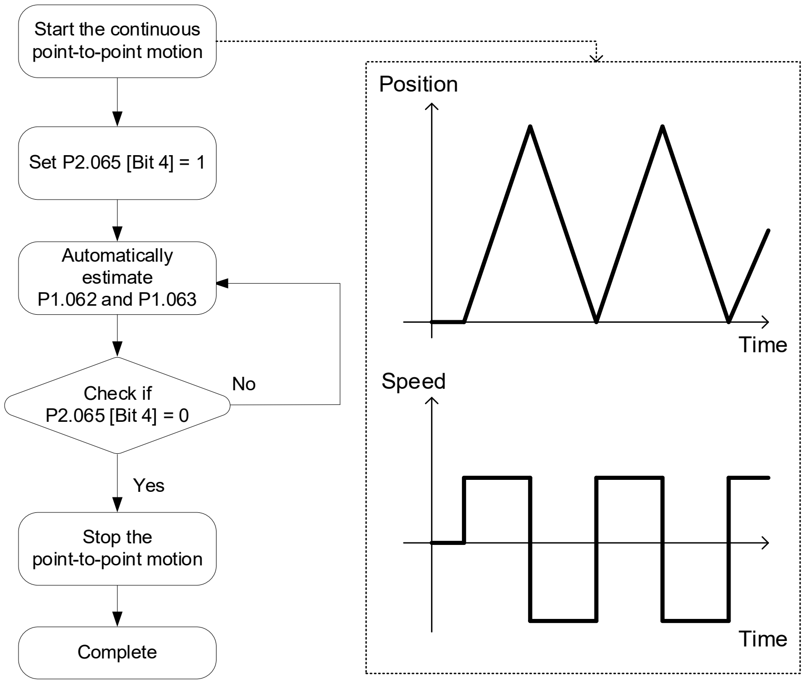
Take the circular motion for example; you can gradually increase the value of P1.062 until the quadrant protrusion disappears and the quadrant becomes concave, and then start adjusting P1.063. On the basis of the default 100% of P1.063, the lower the value of P1.063, the sooner the system reaches the setting of P1.062; the higher the value of P1.063, the slower the system reaches the setting of P1.062. When the contour (error) upon quadrant transition slightly becomes concave, you can increase the setting of P1.063 to speed up the compensation. If the contour slightly becomes convex, reduce the setting of P1.063 to slow down the compensation.



Undercompensation of friction Proper compensation of friction Overcompensation of friction

Auto adjustment:

The parameter for automatic friction estimation switch is P2.065 [Bit 4]. Set P2.065 [Bit 4] to 1 to enable the automatic friction estimation. Set a continuous point-to-point motion (do not set the delay time) with the controller to keep the estimation performance. Once the estimation is complete, the servo automatically sets P2.065 [Bit 4] to 0.



Relevant parameter

Refer to Chapter 7 for detailed descriptions.

Parameter	Function
P1.062	Percentage of friction compensation
P1.063	Constant of friction compensation
P2.065 [Bit 4]	Special bit register 1 (Automatic friction estimation)

Control Mode 6

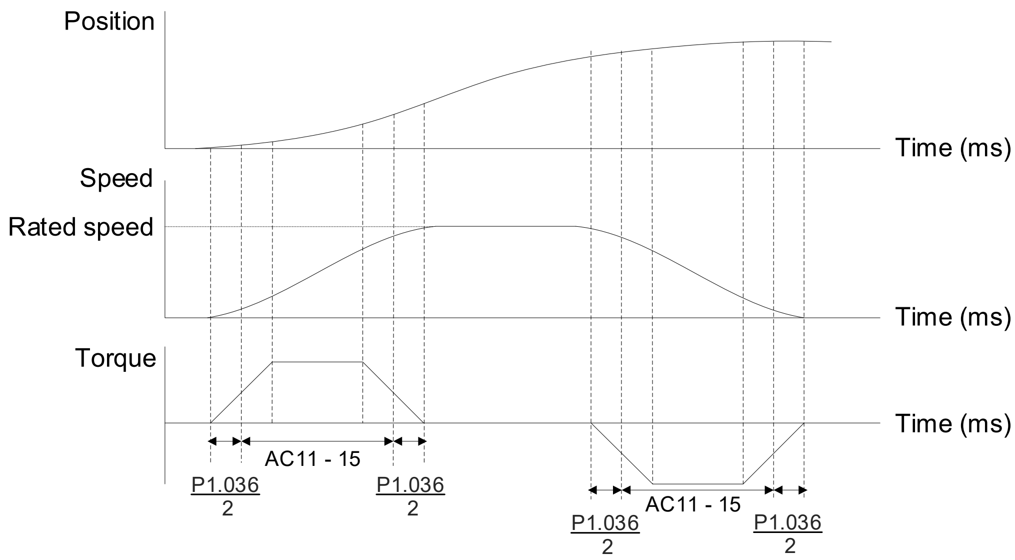
This chapter introduces the use of gain adjustment and filters.

6

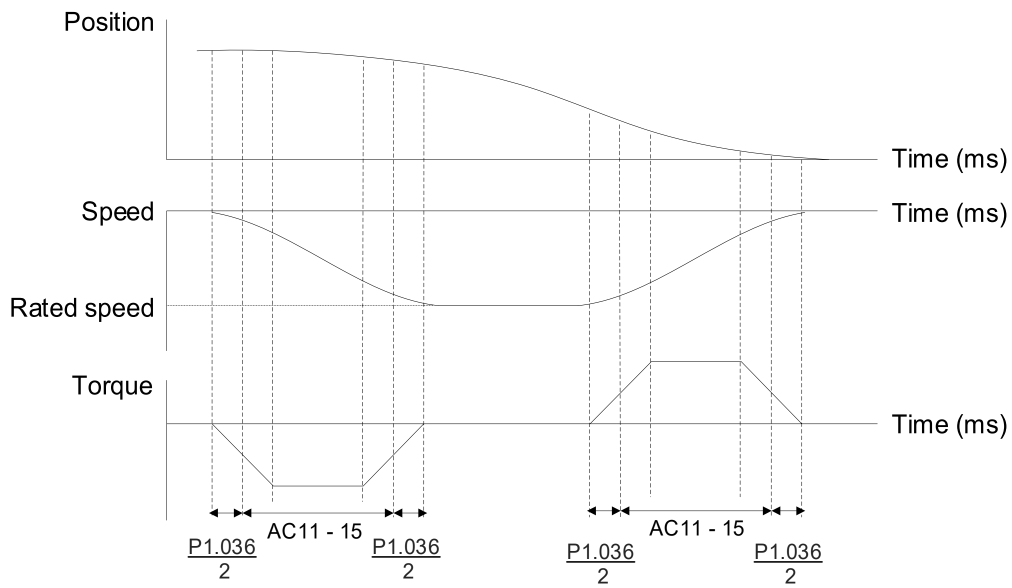
6.1 Introduction to the control mode

6.1.1 S-curve filter for Position commands

The S-curve filter smoothes the motion command. The filter makes the speed and acceleration continuous and reduces jerks, resulting in a smoother mechanical operation. If the load inertia increases, the motor operation is affected by the friction and inertia generated when the motor starts or stops rotating. Setting a larger acceleration / deceleration smoothing constant for the S-curve (P1.036) and the deceleration time in P5.031 - P5.035 can increase the smoothness of operation. When the Position command source is pulse input, the speed and angular acceleration are continuous, so the S-curve filter is not necessary.



S-curve speed profile of Position command and time setting (incremental position command)



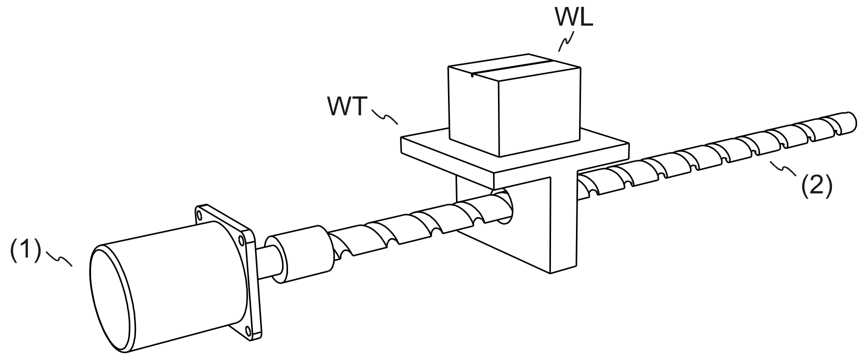
S-curve speed profile of Position command and time setting (decremental position command)

6.1.2 Electronic gear ratio (E-Gear ratio)

The E-Gear ratio (P1.044 and P1.045) provides easy settings for the resolution. The resolution of the servo drive is 24-bit, which means 16,777,216 pulses are generated per motor revolution. Regardless of the encoder resolution (17-bit, 20-bit, or 22-bit), the E-Gear ratio is set according to the servo drive resolution (24-bit).

When the E-Gear ratio is 1, it means 16,777,216 pulses are generated per motor revolution; when the E-Gear ratio is 0.5, then every two pulses from the command (controller) corresponds to one pulse for the motor. A high E-Gear ratio might create a sharp corner in the profile and lead to a high jerk. To solve this problem, apply an S-curve filter or a low-pass filter.

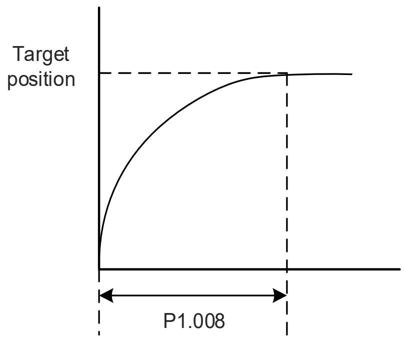
For example, if a workpiece is moved at the speed of 1 μm/pulse after you set a proper E-Gear ratio, then it means the workpiece moves 1 μm per pulse.



(1) Motor; (2) Ball screw pitch: 3 mm (equals 3000 μm); WL: workpiece; WT: platform

	Gear ratio	Moving distance per 1 PUU command
E-Gear is not applied	$= \frac{1}{1}$	$= \dfrac{3000\,\frac{\mu m}{rev}}{16777216\,\frac{pulse}{rev}} \times \frac{1}{1} = \frac{3000}{16777216}$ (Unit: μm/pulse)
E-Gear is applied	$= \frac{16777216}{3000}$	$= \dfrac{3000\,\frac{\mu m}{rev}}{16777216\,\frac{pulse}{rev}} \times \frac{16777216}{3000} = 1$ (Unit: μm/pulse)

6.1.3 Smoothing the Position command



Refer to Chapter 7 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.008	Position command - smoothing constant (low-pass filter)

6

6.1.4 Gain adjustment of the position loop

There are two ways of gain adjustment for the position loop: auto and manual.

Auto adjustment

The servo drive can complete the gain adjustment with the Auto Tuning function. Refer to the Auto tuning section in Chapter 5 for details.

Manual adjustment

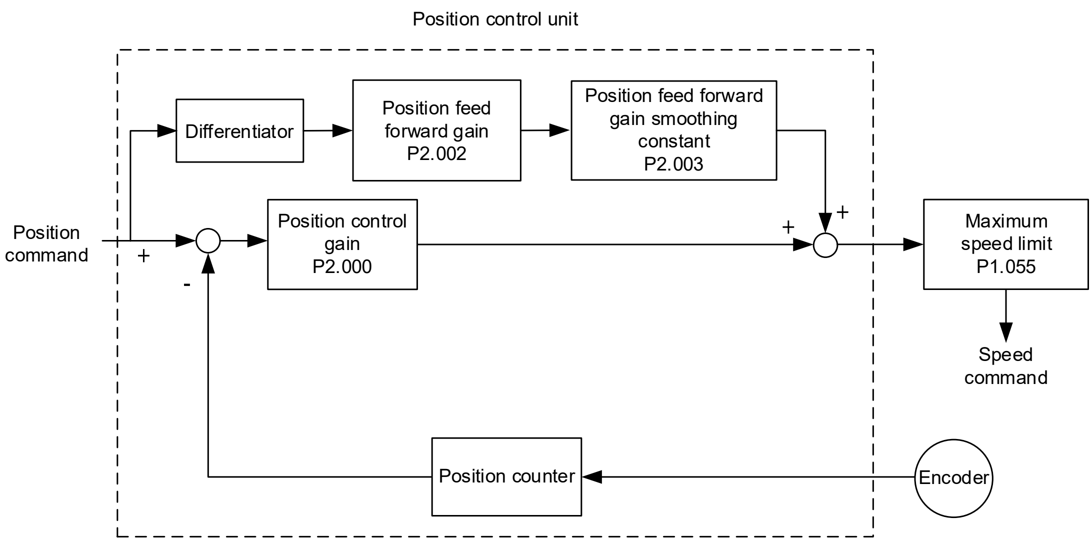
Before setting the position control unit, you have to manually set the speed control unit with P2.004 and P2.006 since a speed loop is included in the position loop. Then, set the position control gain (P2.000) and position feed forward gain (P2.002). The parameter descriptions are as follows.

- P2.000 Position control gain (KPP): increasing this gain achieves a larger response bandwidth of position loop.
- P2.002 Position feed forward gain (PFG): increasing this gain reduces the deviation of phase delay.

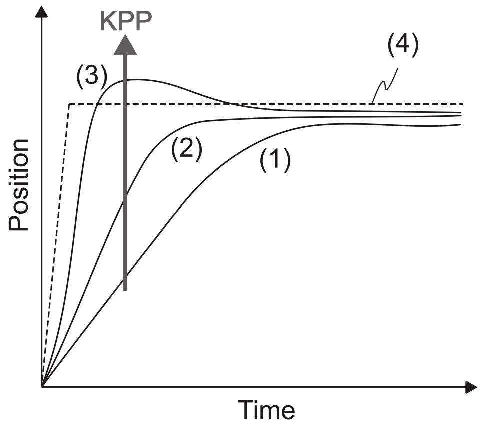
The position loop bandwidth (fp) should not be larger than the speed loop bandwidth (fv): fp ≤ $\frac{fv}{4}$

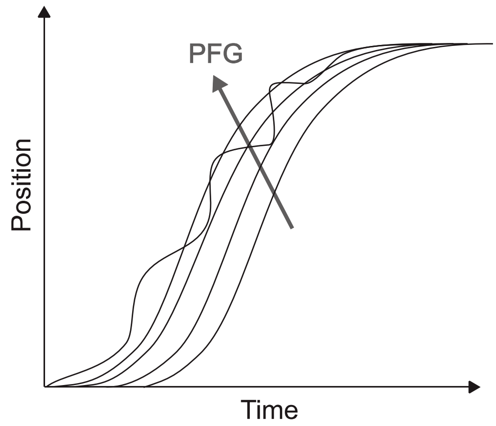
Calculation: KPP = 2 × π × fp

Example: if the desired position loop bandwidth is 20 Hz, set KPP to 125. (2 × π × 20 Hz = 125)



When you set the value of KPP (P2.000) too high, the bandwidth for the position loop is increased and the phase margin is reduced. This causes the rotor to rotate and vibrate in the forward and reverse directions; you have to decrease the KPP value until the rotor stops vibrating. However, when there is an external torque (e.g. workpiece is added to the platform), a low value of KPP might not be able to reduce the position following error. In this case, increasing the value of PFG (P2.002) can effectively reduce the position following error.





The actual position profile changes from (1) to (3) with the increase in the KPP value.
(4) stands for the Position command.

6.1.5 Low-frequency vibration suppression

If the machine is too flexible, vibration persists even when the motor stops after the positioning command is complete. The low-frequency vibration suppression function can reduce the machine vibration. The suppression range is between 1.0 Hz and 100.0 Hz. You can use this function with either auto or manual setting. Refer to Section 5.7.4 for details.

6

6.1.6 Smoothing the Speed command

S-curve filter

During the process of acceleration or deceleration, the three-phase motion profile of the S-curve filter provides a smoother motion. Using the S-curve filter avoids jerks (rapid changes of acceleration), resonance, and noise caused by abrupt changes in the speed input. You can use the following parameters for adjustment.

- P1.034 S-curve acceleration constant: adjusts the slope of the change in acceleration.
- P1.035 S-curve deceleration constant: adjusts the slope of the change in deceleration.
- P1.036 S-curve acceleration / deceleration smoothing constant: improves the stability of the motor when it starts and stops.

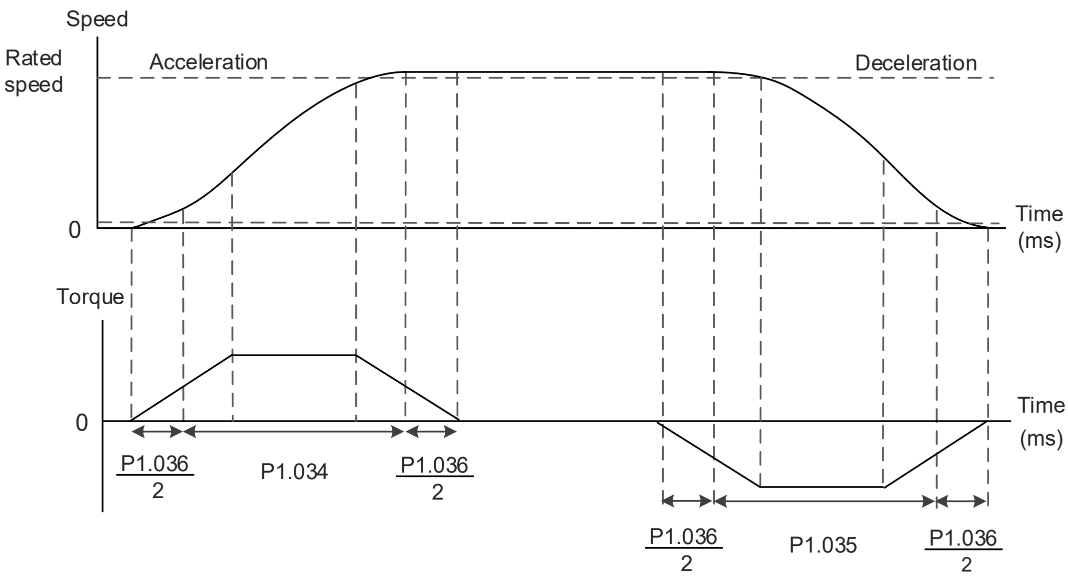
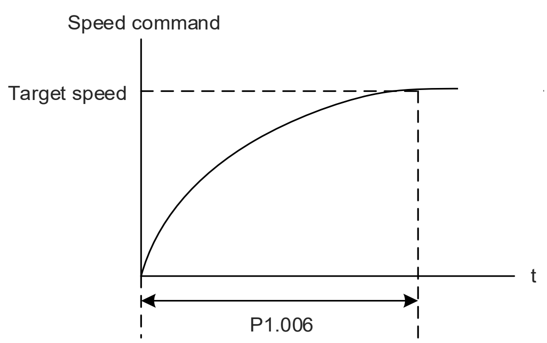


Figure 6.1.6.1 S-curve speed profile of Speed command and time setting

Low-pass filter for Speed commands

The low-pass filter for Speed commands is usually used to remove unwanted high-frequency response or noise so that the speed change is smoother.

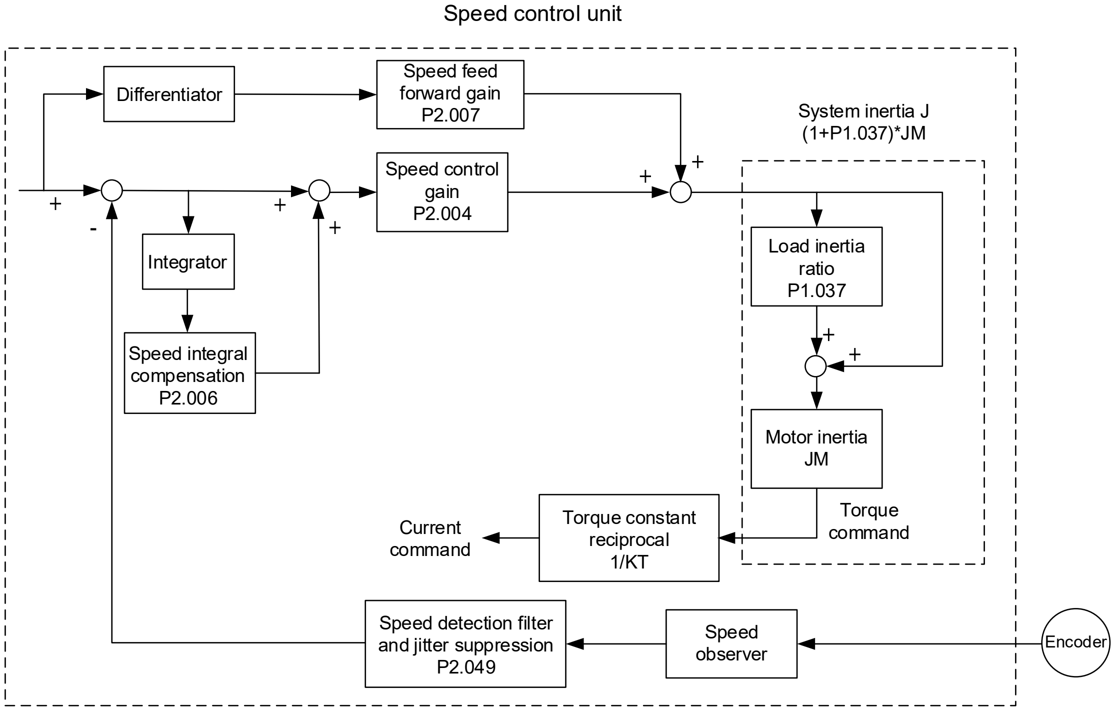


Refer to Chapter 7 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.006	Speed command - smoothing constant (low-pass filter)

6.1.7 Gain adjustment of the speed loop

The structure of the speed control unit is shown in the following diagram.



In the speed control unit, you can adjust different gain parameters manually or by using the multiple gain adjustment modes.

Gain adjustment mode

Refer to the Auto tuning section in Chapter 5.

Manual mode

Manually set the parameters; all auto or auxiliary functions are disabled in this mode.

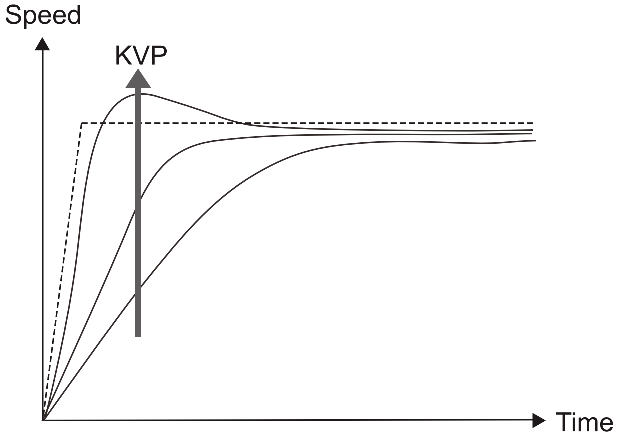
In Manual mode (P2.032 = 0), you can set the speed control gain (P2.004), speed integral compensation (P2.006), and speed feed forward gain (P2.007). The parameter descriptions are as follows.

- P2.004 Speed control gain (KVP): increasing this gain achieves a larger response bandwidth of speed loop.
- P2.006 Speed integral compensation (KVI): increasing this gain achieves a higher low frequency rigidity of speed loop and reduces the steady-state error. However, the phase margin becomes smaller. If you set this gain too high, it reduces the system stability.
- P2.007 Speed feed forward gain (KVF): increasing this gain reduces the deviation of phase delay.

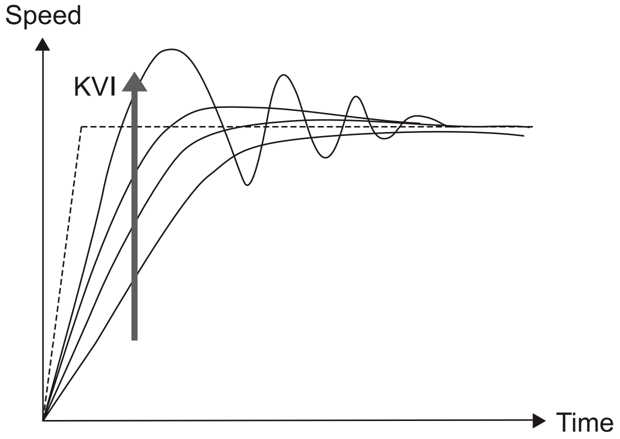
6

Here, the step response is used to illustrate the basic principles for speed control gain (KVP), speed integral compensation (KVI), and speed feed forward gain (KVF). Refer to the following examples.

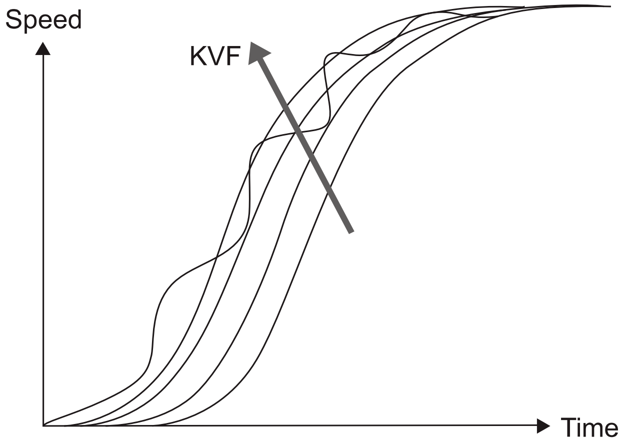
Time domain



The higher the KVP value, the larger the bandwidth. The time of the speed increase will also be shorter. However, if the KVP value is set too high, the phase margin becomes too small. The effect of KVP is not as good as that of KVI for the steady-state error but is better in reducing the following error.



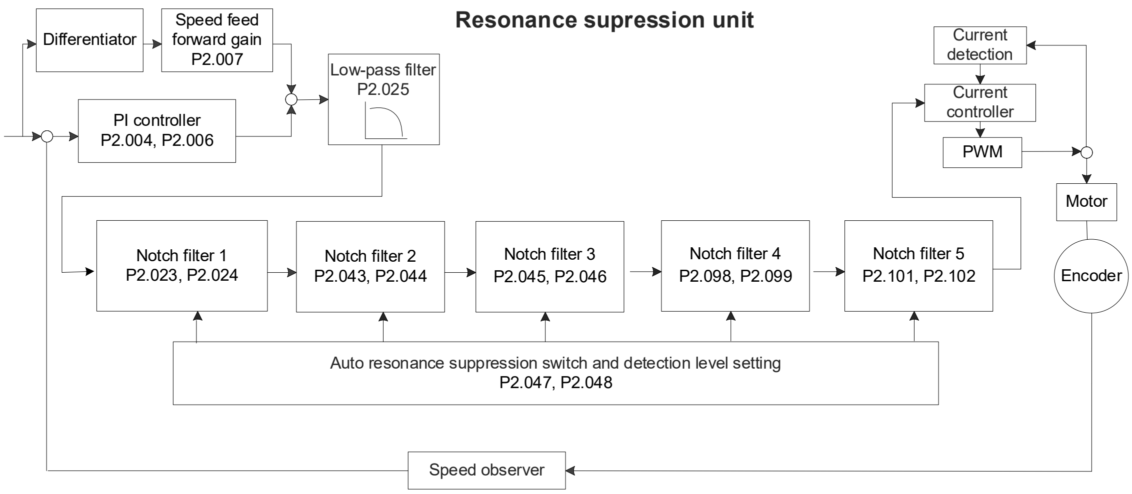
The higher the KVI value, the larger the low-frequency gain. It shortens the time for the steady-state error to reduce to zero but reduces the phase margin. However, it does not significantly reduce the following error.



The closer the KVF value is to 1, the more complete the forward compensation. The following error becomes very small. However, setting the KVF value too high causes vibration.

6.1.8 Resonance suppression unit

When resonance occurs, it is probably because the stiffness of the control system is too high or the response bandwidth is too great. Eliminating these two factors can improve the situation.
In addition, use the low-pass filter (P2.025) and Notch filters (P2.023, P2.024, P2.043 - P2.046, and P2.095 - P2.103) to suppress the resonance if you want the control parameters to remain unchanged.



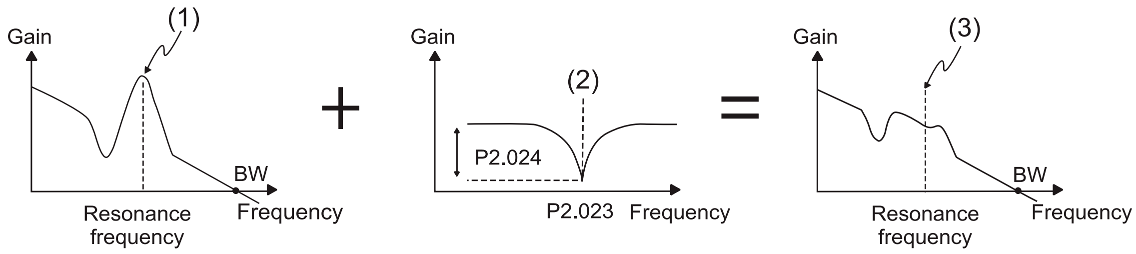
Refer to Chapter 7 for detailed descriptions of the relevant parameters.

Parameter	Function
P2.023	Notch filter 1 - frequency
P2.024	Notch filter 1 - attenuation level
P2.025	Resonance suppression low-pass filter
P2.043	Notch filter 2 - frequency
P2.044	Notch filter 2 - attenuation level
P2.045	Notch filter 3 - frequency
P2.046	Notch filter 3 - attenuation level
P2.095	Notch filter 1 - Q factor
P2.096	Notch filter 2 - Q factor
P2.097	Notch filter 3 - Q factor
P2.098	Notch filter 4 - frequency
P2.099	Notch filter 4 - attenuation level
P2.100	Notch filter 4 - Q factor
P2.101	Notch filter 5 - frequency
P2.102	Notch filter 5 - attenuation level
P2.103	Notch filter 5 - Q factor

The servo drive provides two filters, the Notch filter and the low-pass filter, for suppressing the resonance. See the following diagrams for the effects of these filters.

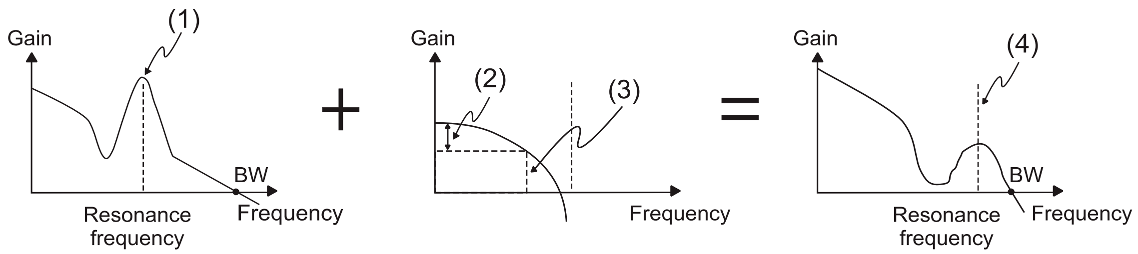
System open-loop gain with resonance:

- Notch filter



(1) Resonance point; (2) Notch filter; (3) Resonance point suppressed by the Notch filter

- Low-pass filter



(1) Resonance point; (2) Attenuation level (-3 dB);

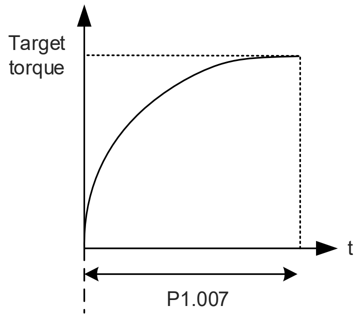
(3) Low-pass filter (Cutoff frequency of low-pass filter = 1000 / P2.025 Hz);

(4) Resonance point suppressed by the low-pass filter

If you increase the value of P2.025 from 0, the bandwidth (BW) becomes smaller. Although it eliminates the resonance frequency, it also reduces the response bandwidth and phase margin, making the system unstable.

If knowing the resonance frequency, you can suppress the resonance frequency by using the Notch filter, which is better than using the low-pass filter in this condition. The setting range of the Notch filter frequency is 50 - 5000 Hz and the attenuation level is 0 - 40 dB.
If the resonance frequency is out of the previous range, or drifts significantly with time or due to other causes, it is suggested that you use the low-pass filter to reduce the resonance.

6.1.9 Smoothing the Torque command



Refer to Chapter 7 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.007	Torque command - smoothing constant (low-pass filter)

(This page is intentionally left blank.)

Parameters 7

This chapter introduces the parameter settings of the servo drive and provides the descriptions for digital input (DI) and digital output (DO). You can control the drive functions with these parameters and DI/O.

7

7.1 Parameter definitions

The servo drive parameters are divided into the following groups. The first character after the start code P is the group character and the following three characters are the parameter indicator. The communication address is the combination of the group number and the three-digit number, expressed in hexadecimal. The parameter groups are:

Group 0: Monitoring parameters	(Example: P0.xxx)
Group 1: Basic parameters	(Example: P1.xxx)
Group 2: Extension parameters	(Example: P2.xxx)
Group 3: Communication parameters	(Example: P3.xxx)
Group 4: Diagnosis parameters	(Example: P4.xxx)
Group 5: Motion control parameters	(Example: P5.xxx)
Group 8: Application parameters	(Example: P8.xxx)
Group M: Motor parameters	(Example: PM.xxx)

Control mode description:

EtherCAT: communication control; see the descriptions of each mode in the chapter of EtherCAT Mode.

Special symbol description:

Icon of parameter property	Description
★	Read-only parameter. You can only read the value of the parameter.
▲	Parameter cannot be changed when servo is in Servo On state.
●	Parameter changes become valid after power cycling.
■	Parameter resets to its default value after power cycling.

7

7.2 Parameter descriptions

P0.xxx Monitoring parameters

P0.000★	Firmware version		Address: 0000H 0001H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	16-bit

Settings:

Displays the firmware version of the servo drive.

P0.001■	Current drive alarm code (seven-segment display)		Address: 0002H 0003H
Default:	-	Control mode:	All
Unit:	-	Setting range:	0x0000: alarm clear (same as DI.ARST). 0x0001 - 0xFFFF: displays the alarm code (not writable).
Format:	HEX	Data size:	16-bit

Settings:

For the list of alarms, refer to Section 11.1 Alarm list.

P0.002	Drive status		Address: 0004H 0005H
Default:	1	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Input the monitoring code to P0.002 to view changes to the variable on the panel. For the list of monitoring variables, refer to Table 7.3 Monitoring variables descriptions.

P0.003 - P0.007	Reserved

P0.008★	**Total servo drive operation time**		**Address: 0010H 0011H**
Default:	0x00000000	Control mode:	All
Unit:	hour	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Displays the total power-on time and Servo On time of the servo drive from the date of shipment. The time is in hours and durations of less than 1 hour are not recorded. The recorded hours are non-volatile when the power is off.

DCBA	Total Servo On time	UZYX	Total power-on time

P0.009★■	**Status monitoring register 1**		**Address: 0012H 0013H**
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

Set the value to be read from P0.009 in P0.017 through the drive panel or communication (refer to P0.002). To get the status, read the communication addresses through the communication port or monitor the value from the panel (set P0.002 to 23, and the panel displays “VAR-1” and then the value of P0.009).

For example, when you set P0.017 to 3, reading P0.009 can access the feedback position (pulse). To access the data through Modbus communication, have the servo drive read the two 16-bit values (0012H and 0013H) as a single 32-bit value. (0013H : 0012H) = (High word : Low word). To monitor the data from the panel, set P0.002 to 23, and the panel displays “VAR-1” and then the value of P0.009.

P0.010★■	**Status monitoring register 2**		**Address: 0014H 0015H**
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

Set the value to be read from P0.010 in P0.018 through the drive panel or communication (refer to P0.002). To get the status, read the communication addresses through the communication port or monitor the value from the panel (set P0.002 to 24, and the panel displays “VAR-2” and then the value of P0.010).

P0.011★■	Status monitoring register 3		Address: 0016H 0017H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

Set the value to be read from P0.011 in P0.019 through the drive panel or communication (refer to P0.002). To get the status, read the communication addresses through the communication port or monitor the value from the panel (set P0.002 to 25, and the panel displays “VAR-3” and then the value of P0.011).

P0.012★■	Status monitoring register 4		Address: 0018H 0019H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

Set the value to be read from P0.012 in P0.020 through the drive panel or communication (refer to P0.002). To get the status, read the communication addresses through the communication port or monitor the value from the panel (set P0.002 to 26, and the panel displays “VAR-4” and then the value of P0.012).

P0.013★■	Status monitoring register 5		Address: 001AH 001BH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

Set the value to be read from P0.013 in P0.021 through the drive panel or communication (refer to P0.002). To get the status, read the communication addresses through the communication port.

P0.014 - P0.016	Reserved

7

P0.017	Select content displayed by status monitoring register 1		Address: 0022H 0023H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 7.3 for the available values.

For example, when you set P0.017 to 7, then reading P0.009 displays the speed feedback.

P0.018	Select content displayed by status monitoring register 2		Address: 0024H 0025H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 7.3 for the available values.

P0.019	Select content displayed by status monitoring register 3		Address: 0026H 0027H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 7.3 for the available values.

P0.020	Select content displayed by status monitoring register 4		Address: 0028H 0029H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 7.3 for the available values.

P0.021	Select content displayed by status monitoring register 5		Address: 002AH 002BH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 7.3 for the available values.

P0.022 - P0.024	Reserved

7

P0.025■	Mapping parameter 1		Address: 0032H 0033H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

You can continuously read and write two different parameters faster with mapping parameters. Use P0.035 to specify the parameter number(s) to be read or written with this mapping parameter through the panel or communication. P0.025 shows the parameter value(s) specified by P0.035. Refer to P0.035 for its settings.

P0.026■	Mapping parameter 2		Address: 0034H 0035H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.036.

P0.027■	Mapping parameter 3		Address: 0036H 0037H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.037.

P0.028■	Mapping parameter 4		Address: 0038H 0039H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.038.

7

P0.029■	Mapping parameter 5		Address: 003AH 003BH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.039.

P0.030■	Mapping parameter 6		Address: 003CH 003DH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.040.

P0.031■	Mapping parameter 7		Address: 003EH 003FH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.041.

P0.032■	Mapping parameter 8		Address: 0040H 0041H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.042.

P0.033 - P0.034	Reserved

P0.035	Target setting for mapping parameter P0.025		Address: 0046H 0047H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The formats of parameter High Word (PH) and parameter Low Word (PL) are:

BA	Hexadecimal code for the parameter index	YX	Hexadecimal code for the parameter index
C	Hexadecimal code for the parameter group	Z	Hexadecimal code for the parameter group
D	N/A	U	N/A

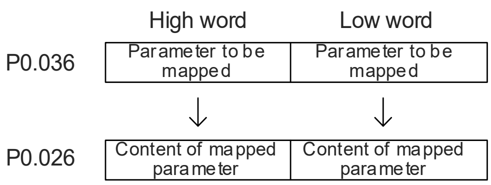
Select the corresponding parameter(s) for the data block access register 1 (P0.035). The mapping content is a 32-bit value, which can be two 16-bit parameters or one 32-bit parameter.

P0.035: (Parameter(s) to be mapped: P0.035; Content of mapped parameter(s): P0.025)

1. When PH ≠ PL, it indicates that the content of P0.025 includes two 16-bit parameters.
2. When PH = PL, it indicates that the content of P0.025 includes one 32-bit parameter.

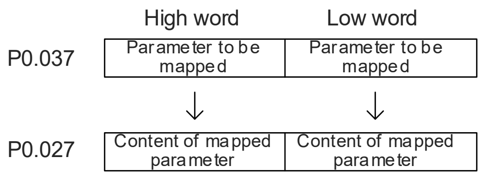
P0.036	Target setting for mapping parameter P0.026		Address: 0048H 0049H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



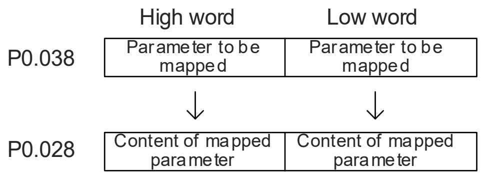
P0.037	Target setting for mapping parameter P0.027		Address: 004AH 004BH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



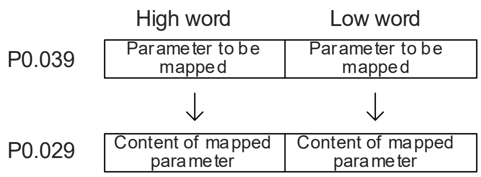
P0.038	Target setting for mapping parameter P0.028		Address: 004CH 004DH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



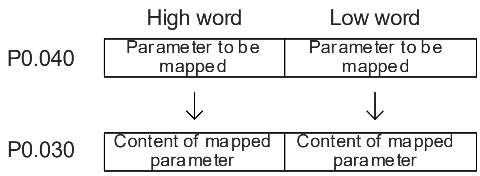
P0.039	Target setting for mapping parameter P0.029		Address: 004EH 004FH
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



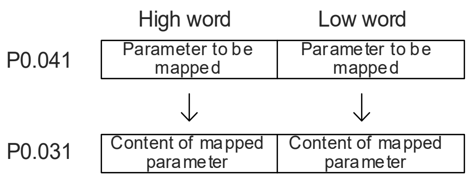
P0.040	Target setting for mapping parameter P0.030		Address: 0050H 0051H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



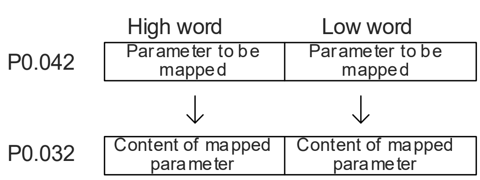
P0.041	Target setting for mapping parameter P0.031		Address: 0052H 0053H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



P0.042	Target setting for mapping parameter P0.032		Address: 0054H 0055H
Default:	-	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:



P0.043	Reserved

7

P0.044★■	Status monitoring register (for PC software)		Address: 0058H 0059H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

This setting is the same as P0.009.

P0.045■	Status monitoring register content selection (for PC software)		Address: 005AH 005BH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

This setting is the same as P0.017.

P0.046★■	Servo drive digital output (DO) status		Address: 005CH 005DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x00FF
Format:	HEX	Data size:	16-bit

Settings:

Bit	Function	Bit	Function
0	SRDY (servo ready)	8	HOME (homing complete)
1	SON (Servo On)	9	OLW (early warning for motor overload)
2	ZSPD (zero speed detection)	10	WARN (servo warning)
3	TSPD (target speed reached)	11	Reserved
4	TPOS (target position reached)	12	Reserved
5	TQL (torque limit activated)	13	Reserved
6	ALRM (servo alarm)	14	Reserved
7	BRKR (electromagnetic brake control output)	15	Reserved

P0.047 - P0.048	Reserved

P0.049■	**Update encoder absolute position**		**Address: 0062H 0063H**
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0003
Format:	HEX	Data size:	16-bit

Settings:

0002

U Z Y X

X	Command processing	Z	Reserved
Y	Reserved	U	Reserved

■ X: command processing

0: N/A

1: update the encoder data to P0.051 - P0.052.

2: update P0.051 - P0.052 and clear the position error. When this command takes effect, the motor's current position is set to the terminal point of the Position command.

3: keep updating the encoder data to P0.051 - P0.052.

P0.050★■	**Absolute position system status**		**Address: 0064H 0065H**
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x001F
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0	Absolute position status	0: normal. 1: lost.
Bit 1	Battery voltage status	0: normal. 1: undervoltage.
Bit 2	Status of absolute number of revolutions	0: normal. 1: overflows.
Bit 3	PUU status	0: normal. 1: overflows.
Bit 4	Absolute position status	0: established. 1: not yet established.
Bit 5 - Bit 15	Reserved	-

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P0.051★■	Encoder absolute position - number of revolutions		Address: 0066H 0067H
Default:	0	Control mode:	All
Unit:	rev	Setting range:	-32768 to +32767
Format:	DEC	Data size:	16-bit

Settings:

When you set P2.070 [Bit 1] to 1 for reading the pulse number, this parameter displays the encoder's absolute position in the form of number of revolutions.

When you set P2.070 [Bit 1] to 0 for reading the PUU number, this parameter becomes invalid and the panel displays 0.

P0.052★■	Encoder absolute position - pulse number within single turn or PUU		Address: 0068H 0069H
Default:	0	Control mode:	All
Unit:	pulse or PUU	Setting range:	0 to 16777216-1 (pulse) -2147483648 to +2147483647 (PUU)
Format:	DEC	Data size:	32-bit

Settings:

When you set P2.070 [Bit 1] to 1 for reading the pulse number, this parameter displays the encoder's absolute position in the form of pulse number within a single turn.

When you set P2.070 [Bit 1] to 0 for reading the PUU number, this parameter displays the motor's absolute position in PUU.

P0.053 - P0.062	Reserved

P0.063★	Total duration of DC Bus voltage exceeding 800V		Address: 007EH 007FH
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0 - 2147483647
Format:	DEC	Data size:	32-bit

Settings:

400V models: records the total time during which the voltage of the DC Bus exceeded 800V.

P0.064 - P0.078	Reserved

P0.079★	IGBT highest temperature		Address: 009EH 009FH
Default:	0	Control mode:	All
Unit:	°C	Setting range:	0 - 2147483647
Format:	DEC	Data size:	32-bit

Settings:

Records the highest IGBT temperature.

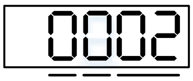
P0.080 - P0.100	Reserved

P1.xxx Basic parameters

P1.000	Reserved

P1.001●	Input for control mode and control command		Address: 0102H 0103H
Default:	0x000C	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x112F
Format:	HEX	Data size:	16-bit

Settings:



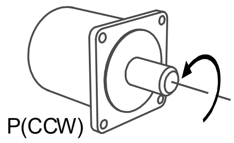
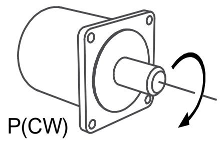
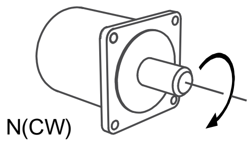
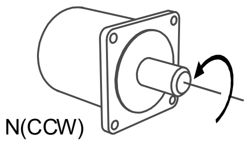
U Z YX

YX	Control mode setting	Z	Direction control
-	-	U	DIO value control

- YX: control mode setting

  0C: EtherCAT mode (Communication mode: the command source is from the external fieldbus controller, which sends the command to the servo drive through direct communication.)

- Z: direction control

	Z = 0	Z = 1
Positive direction		
Negative direction		

- U: DIO value control (volatile)

  0: when modes are switched, DIO settings remain the same.

  1: when modes are switched, DIO settings are reset to the default for each mode.

  Note: refer to Chapter 3 for the default DIO settings.

P1.002 - P1.005	Reserved

P1.006	**Speed command - smoothing constant (low-pass filter)**		**Address: 010CH 010DH**
Default:	0	Control mode:	PV / CSV
Unit:	ms	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

0: disable this function.

P1.007	**Torque command - smoothing constant (low-pass filter)**		**Address: 010EH 010FH**
Default:	0	Control mode:	PT / CST
Unit:	ms	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

0: disable this function.

P1.008	**Position command - smoothing constant (low-pass filter)**		**Address: 0110H 0111H**
Default:	0	Control mode:	PP / CSP
Unit:	10 ms	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit
Example:	11 = 110 ms		

Settings:

0: disable this function.

P1.009 - P1.016	**Reserved**

P1.017	**Additional compensation time for the following error**		**Address: 0122H 0123H**
Default:	0	Control mode:	PP / CSP
Unit:	ms (minimum scale is μs)	Setting range:	-25.000 to +25.000 (includes 3 decimal places)
Format:	DEC	Data size:	16-bit

Settings:

When the following error compensation function is enabled (P1.036 = 1), the servo calculates the compensation amount according to the command and adjusts the position error (PUU) close to 0. If setting the position feed forward gain (P2.002) and position integral compensation (P2.053) cannot reduce the position error, set the additional compensation time to compensate the error.

Additional compensation amount = P1.017 x Motor speed

Note: enable the following error compensation function (P1.036 = 1) to use the additional compensation function.

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P1.018 - P1.024	Reserved

P1.025	Low-frequency vibration suppression frequency 1		Address: 0132H 0133H
Default:	1000	Control mode:	PP / CSP
Unit:	0.1 Hz	Setting range:	10 to 1000
Format:	DEC	Data size:	16-bit
Example:	150 = 15 Hz		

Settings:

The frequency of the first low-frequency vibration suppression filter. When you set P1.026 to 0, the first low-frequency vibration suppression filter is disabled.

P1.026	Low-frequency vibration suppression gain 1		Address: 0134H 0135H
Default:	0	Control mode:	PP / CSP
Unit:	-	Setting range:	0 to 9
Format:	DEC	Data size:	16-bit

Settings:

The gain of the first low-frequency vibration suppression filter. Increasing the value improves the position response. If you set the value too high, the motor may not operate smoothly. The suggested value is 1. Setting P1.026 to 0 disables the first low-frequency vibration suppression filter.

P1.027	Low-frequency vibration suppression frequency 2		Address: 0136H 0137H
Default:	1000	Control mode:	PP / CSP
Unit:	0.1 Hz	Setting range:	10 to 1000
Format:	DEC	Data size:	16-bit
Example:	150 = 15 Hz		

Settings:

The frequency of the second low-frequency vibration suppression filter. When you set P1.028 to 0, the second low-frequency vibration suppression filter is disabled.

P1.028	Low-frequency vibration suppression gain 2		Address: 0138H 0139H
Default:	0	Control mode:	PP / CSP
Unit:	-	Setting range:	0 to 9
Format:	DEC	Data size:	16-bit

Settings:

The gain of the second low-frequency vibration suppression filter. Increasing the value improves the position response. If you set the value too high, the motor may not operate smoothly. The suggested value is 1. Setting P1.028 to 0 disables the second low-frequency vibration suppression filter.

P1.029	Auto low-frequency vibration suppression mode		Address: 013AH 013BH
Default:	0	Control mode:	PP / CSP
Unit:	-	Setting range:	0 to 1
Format:	DEC	Data size:	16-bit

Settings:

Setting value	Setting description
0	Disable the automatic low-frequency vibration detection function.
1	Vibration suppression is in automatic mode. When the vibration frequency cannot be detected or the vibration frequency is stable, the system resets the parameter to 0 and automatically saves the vibration suppression frequency to P1.025.

P1.030	Low-frequency vibration detection		Address: 013CH 013DH
Default:	8000	Control mode:	PP / CSP
Unit:	pulse	Setting range:	1 to 128000
Format:	DEC	Data size:	32-bit

Settings:

Sets the detection level when automatic vibration suppression is enabled (P1.029 = 1). Setting P1.030 lower improves the detection sensibility, but the system may also misjudge noise or treat other low-frequency vibrations as frequencies to be suppressed. Setting P1.030 higher reduces the possibility of misjudgment, but if the vibration of the machine is small, the system may not properly detect low-frequency vibrations.

P1.031	Reserved

P1.032	Motor stop mode		Address: 0140H 0141H
Default:	0x0060	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x0060
Format:	HEX	Data size:	16-bit

Settings:

0000
U Z Y X

X	Reserved	Z	Reserved
Y	Motor stop mode	U	Reserved

■ Y: motor stop mode

Bit	7	6	5	4	3	2	1	0
	Y							
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 5, Bit 4	Motor stopping method upon alarm occurrence	See the following table.
Bit 6	Trigger stop command when RST power error (AL022) occurs[Note]	0: disable this function. 1: when P1.043 is a negative value and RST power error (AL022) occurs, the servo drive commands the motor to decelerate to 0 in the Servo On state. Note: this function is available only under position and speed modes (PP, CSP, PV, and CSV), and is valid only when the setting value of P1.043 (Delay time for disabling the electromagnetic brake) is a negative value.
Bit 7	Reserved	-

When the motor reaches PL (CCWL) or NL (CWL), refer to P5.003 for setting the deceleration time. If you set the deceleration time to 1 ms, the motor stops instantly.

Motor stopping methods and stopped states for different alarms:

Grouping	Alarm code	Description	Bit 5[Note*2]	Bit 4	Motor stopping method	Motor stopped state
1	AL002, AL005, AL007, AL010, AL024, AL030, AL031, AL050, AL051, AL052, AL055, AL056, AL057, AL058, AL05C, AL05D, AL088, AL555, ALC31	Servo Off; motor stops according to the setting of P1.032	0	0	Dynamic braking	Dynamic braking
			0	1	Free run	Free run
			1	0	Dynamic braking	Free run
2	AL011, AL025, AL027, AL029, AL033, AL034, AL041, AL072, AL073, AL074, AL077, AL079, AL07A, AL07B, ALD08, ALD10	Motor performs open-loop brake control according to the settings of P2.108 and P2.109	0	0	Torque[Note 1]	Dynamic braking
			0	1	Torque[Note 1]	Free run
			1	0	Torque[Note 1]	Free run
3	Other alarms (ALM), excluding warnings (WARN)	Motor decelerates according to the setting of P5.003.C	0	0	Deceleration	Dynamic braking
			0	1	Deceleration	Free run
			1	0	Deceleration	Free run
4	AL001, AL083, AL500, AL501, AL502, AL503	Servo Off; motor directly stops	-		Free run	Free run

Note:
1. When the motor stopping method is torque, if braking is not done within the time set by P2.109, the dynamic braking is activated afterwards.
2. When Bit 5 = 1, the motor is in a stopped state if the motor speed is lower than P1.038.

P1.033	Reserved

P1.034	S-curve acceleration constant		Address: 0144H 0145H
Default:	200	Control mode:	PV / CSV
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

Sets the time for the rotary motor to accelerate from zero speed to 3000 rpm. You can set P1.034, P1.035, and P1.036 individually.

P1.035	S-curve deceleration constant		Address: 0146H 0147H
Default:	200	Control mode:	PV / CSV
Unit:	ms	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

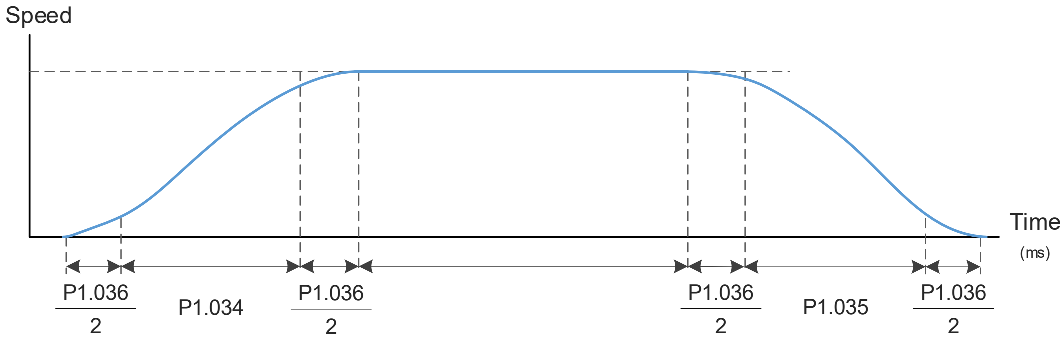
Settings:

Sets the time for the rotary motor to decelerate from 3000 rpm to zero speed. You can set P1.034, P1.035, and P1.036 individually.

P1.036	S-curve acceleration / deceleration constant		Address: 0148H 0149H
Default:	0	Control mode:	PP / CSP / PV / CSV
Unit:	ms	Setting range:	0 to 65500
Format:	DEC	Data size:	16-bit

Settings:

0: disable this function.



P1.034: sets the acceleration time for the trapezoid-curve.

P1.035: sets the deceleration time for the trapezoid-curve.

P1.036: sets the smoothing time for the S-curve acceleration and deceleration.

You can set P1.034, P1.035, and P1.036 individually. Even if you set P1.036 to 0, the acceleration and deceleration still follow a trapezoid-curve.

	P1.036 = 0	P1.036 = 1	P1.036 > 1
Smoothing function for S-curve	Disabled	Disabled	Enabled
Following error compensation function	Disabled	Enabled	Determined by P2.068.X

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P1.037	Load inertia ratio			Address: 014AH 014BH
Operation interface:	Panel / software	Communication	Control mode:	PP / CSP / PV / CSV
Default:	6.0	60	Data size:	32-bit
Unit:	1 times (rotary)*	0.1 times (rotary)*	-	-
Setting range:	0.0 to 200.0 (rotary)*	0 to 2000 (rotary)*		
Format:	One decimal	DEC	-	-

Settings:

Rotary motor load inertia ratio (J_load / J_motor).

J_motor: rotational inertia of the servo motor

J_load: total equivalent inertia of external mechanical load

Note: rotary means a permanent-magnet synchronous rotary motor.

P1.038	Zero speed detection level			Address: 014CH 014DH
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	10.0	100	Data size:	16-bit
Unit:	1 rpm (rotary)*	0.1 rpm (rotary)*	-	-
Setting range:	0.0 to 200.0	0 to 2000	-	-
Format:	One decimal	DEC	-	-

Settings:

When the absolute value of the motor speed is lower than this value, the condition for triggering the zero-speed signal is met and DO.ZSPD is on.

Note: rotary means a permanent-magnet synchronous rotary motor.

P1.039	Target speed detection level		Address: 014EH 014FH
Default:	3000	Control mode:	All
Unit:	1 rpm (rotary)*	Setting range:	0 to 30000 (rotary)*
Format:	DEC	Data size:	16-bit

Settings:

Sets the motor target speed. When the absolute value of the motor speed is higher than this value, the condition for triggering the target speed reached signal is met and DO.TSPD is on.

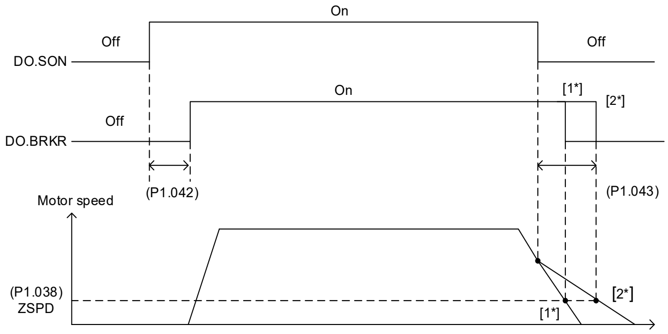
Note: rotary means a permanent-magnet synchronous rotary motor.

P1.040 - P1.041	Reserved

P1.042	Delay time for enabling the electromagnetic brake		Address: 0154H 0155H
Default:	100	Control mode:	All
Unit:	ms	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the delay time from Servo On state to the activation of electromagnetic brake signal (DO: 0x08, BRKR).



Note:
1. If the delay time specified in P1.042 has not passed yet and the motor speed is slower than the value of P1.038, the electromagnetic brake signal (DO.BRKR) is disabled.
2. If the delay time specified in P1.042 has passed and the motor speed is faster than the value of P1.038, the electromagnetic brake signal (DO.BRKR) is disabled.

P1.043	Delay time for disabling the electromagnetic brake		Address: 0156H 0157H
Default:	-100	Control mode:	All
Unit:	ms	Setting range:	-1000 to +1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the delay time from Servo Off state to the deactivation of electromagnetic brake signal (DO: 0x08, BRKR). Refer to P1.042 for the detailed diagram.

Note: if P1.043 is a negative value and the servo is Off due to an alarm (except for AL022) or emergency stop, the setting of P1.043 is invalid. This is equivalent to setting the delay time to 0.

P1.044▲	E-Gear ratio - numerator N1		Address: 0158H 0159H
Default:	1	Control mode:	PP / CSP
Unit:	pulse	Setting range:	1 to $(2^{29}-1)$
Format:	DEC	Data size:	32-bit

Settings:

For the E-Gear ratio setting, refer to P1.045.

Note: do not change this setting in the Servo On state.

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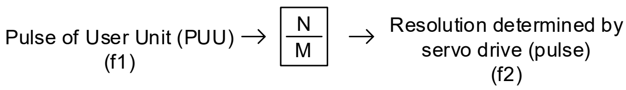
P1.045▲	E-Gear ratio - denominator M		Address: 015AH 015BH
Default:	1	Control mode:	PP / CSP
Unit:	pulse	Setting range:	1 to (2^{31}-1)
Format:	DEC	Data size:	32-bit

Settings:

If the setting is incorrect, the servo motor is prone to sudden unintended acceleration. Follow these instructions.

E-Gear ratio setting: $f2 = f1 \times \frac{N}{M}$



Range of E-Gear ratio: 1 ≤ Nx / M ≤ 262144.

Note: do not change this setting in the Servo On state.

P1.046	Reserved

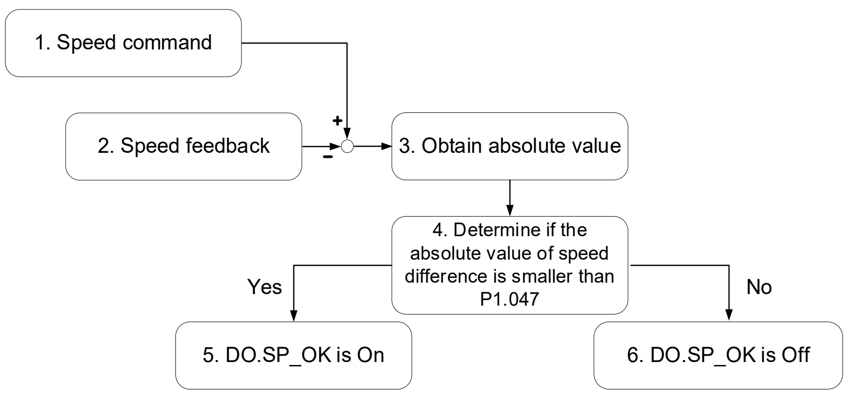
P1.047	Speed reached (DO.SP_OK) range		Address: 015EH 015FH
Default:	10	Control mode:	PV
Unit:	1 rpm (rotary)*	Setting range:	0 to 300
Format:	DEC	Data size:	16-bit

Settings:

In PV mode, when the absolute value of the difference between the Speed command and the motor speed feedback is less than this parameter and this status is kept for the time duration set in P1.049, DO.SP_OK (DO: 0x19) is On.

Note: when the difference between the Speed command and the motor speed feedback exceeds the range set in P1.047, the system recalculates the duration.

Diagram:



1. Speed command: the command that you input without acceleration or deceleration, rather than the command from the front end speed circuit.
2. Speed feedback: the actual speed of the motor which has been filtered.

3. Obtain the absolute value.
4. Determine whether the absolute value of the speed difference is smaller than the parameter value. If you set the parameter to 0, DO.SP_OK is always Off. If the absolute value is smaller than the parameter, the digital output is On, otherwise it is Off.

Note: rotary means a permanent-magnet synchronous rotary motor.

P1.048	Reserved

P1.049	Accumulated time to reach desired speed		Address: 0162H 0163H
Default:	0	Control mode:	PV
Unit:	ms	Setting range:	0 to 65535
Format:	DEC	Data size:	16-bit

Settings:

In PV mode, when the absolute value of the difference between the Speed command and the motor speed feedback is less than the range set in P1.047 and this status is kept for the time duration set in P1.049, DO.SP_OK (DO: 0x19) is On. If the difference exceeds the range set in P1.047, no matter how long it lasts, the system recalculates the duration.

P1.050 - P1.051	Reserved

P1.052	Regenerative resistor value		Address: 0168H 0169H
Default:	Determined by the model. Refer to the following table.	Control mode:	All
Unit:	Ohm	Setting range:	Refer to the following table.
Format:	DEC	Data size:	16-bit

Settings:

Model		Default (Ω)	Setting range (Ω)
400V	400 W	80	80 - 750
	750 W - 1 kW	80	60 - 750
	1.5 kW - 2 kW	80	40 - 750
	3 kW	80	30 - 750
	4.5 kW - 5.5 kW	80	25 - 750
	7.5 kW - 15 kW	80	15 - 750

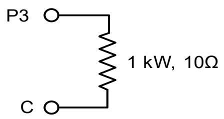
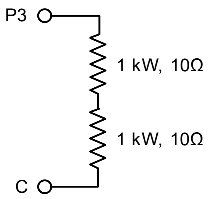
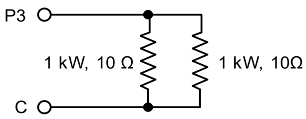
Refer to the description of P1.053 for the parameter values when connecting the regenerative resistor with different methods.

P1.053	Regenerative resistor capacity		Address: 016AH 016BH
Default:	Determined by the model. Refer to the following table.	Control mode:	All
Unit:	Watt	Setting range:	0 to 15000
Format:	DEC	Data size:	16-bit

Settings:

Model		Default (Watt)
400V	1.5 kW or below	60
	2 kW - 15 kW	0

Setting the parameter values when connecting the regenerative resistor with different methods:

<table>
<tr><th>External regenerative resistor</th><th>Setting</th></tr>
<tr><td>Single

</td><td>Setting:
P1.052 = 10 (Ω)
P1.053 = 1000 (W)</td></tr>
<tr><td>In series

</td><td>Setting:
P1.052 = 20 (Ω)
P1.053 = 2000 (W)</td></tr>
<tr><td>In parallel

</td><td>Setting:
P1.052 = 5 (Ω)
P1.053 = 2000 (W)</td></tr>
</table>

P1.054	Pulse range for position reached		Address: 016CH 016DH
Default:	167772	Control mode:	PP / CSP
Unit:	pulse	Setting range:	0 to 16777216
Format:	DEC	Data size:	32-bit

Settings:

When the difference between the target position and the actual motor position is less than this parameter, the condition for triggering the target position reached signal is met and DO.TPOS is On.

Example:

For a rotary motor, if P1.054 = 167772 and the error is less than 167772 pulses, which equals 0.01 turns (167772 / 16777216 = 0.01), then DO.TPOS is On.

P1.055	Maximum speed limit		Address: 016EH 016FH
Default:	Rated speed of each model (rotary)*	Control mode:	All
Unit:	1 rpm (rotary)*	Setting range:	0 to maximum speed
Format:	DEC	Data size:	16-bit

Settings:

Sets the maximum speed of the servo motor.

Note: rotary means a permanent-magnet synchronous rotary motor.

P1.056	Motor output overload warning level		Address: 0170H 0171H
Default:	120	Control mode:	All
Unit:	%	Setting range:	0 to 120
Format:	DEC	Data size:	16-bit

Settings:

When the value is 0 - 100 and the servo motor continuously outputs load that is higher than the setting of P1.056, the pre-warning signal for overload (DO: 0x10, OLW) is On. If the value is over 100, the pre-warning function is disabled.

P1.057	Motor hard stop 1 - torque percentage		Address: 0172H 0173H
Default:	0	Control mode:	All
Unit:	%	Setting range:	0 to 300
Format:	DEC	Data size:	16-bit

Settings:

Sets the protection level which is the rated torque in percentage. Set the value to 0 to disable the function and set the value to 1 or above to enable the function.

When there is no external force, the setting value = (motor current in percentage when the motor runs at constant speed in the forward direction + motor current in percentage when the motor runs at constant speed in the reverse direction) / 2 + protection torque value. When there is external force, set P1.060 additionally.

P1.058	Motor hard stop - protection time		Address: 0174H 0175H
Default:	1	Control mode:	All
Unit:	ms	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the protection time. When the motor torque reaches the protection level and the protection time is exceeded, AL030 occurs.

P1.059	Reserved

P1.060	Motor hard stop 1 - level offset		Address: 0178H 0179H
Default:	0	Control mode:	All
Unit:	%	Setting range:	-300 to +300
Format:	DEC	Data size:	16-bit

Settings:

When using P1.057 (Motor hard stop 1 - torque percentage) and the average torque level deviates due to an external force, such as Z-axis gravity, you can use this parameter to set the corresponding compensation.

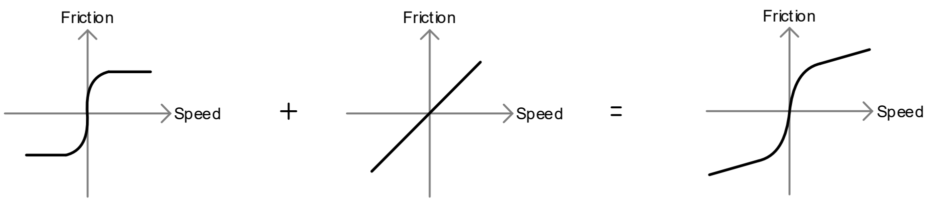
Suggested setting value = (Average torque at constant speed in positive direction + Average torque at constant speed in negative direction) / 2

Note: refer to P0.002 = 54 (Torque feedback) for the average torque at constant speed.

P1.061	Viscous friction compensation		Address: 017AH 017BH
Default:	0	Control mode:	PP / CSP / PV / CSV
Unit:	0.1%/1000 rpm (rotary)*	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Because viscous friction corresponds with the speed, you can use this parameter to compensate the motor torque according to the speed, improving the position error during acceleration and deceleration. When P1.062 = 0, this parameter is invalid.



P1.062 Percentage of friction compensation
P1.063 Constant of friction compensation

P1.061 Viscous friction compensation

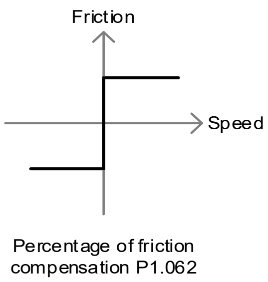
P1.062 Percentage of friction compensation
P1.063 Constant of friction compensation
P1.061 Viscous friction compensation

Note: rotary means a permanent-magnet synchronous rotary motor.

P1.062	Percentage of friction compensation		Address: 017CH 017DH
Default:	0	Control mode:	PP / CSP / PV / CSV
Unit:	%	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

Sets the level of friction compensation, which is the rated torque in percentage. Set the value to 0 to disable the friction compensation function. Set the value to 1 or above to enable the function to reduce the position error at the moment the motion starts.



P1.063	Constant of friction compensation		Address: 017EH 017FH
Default:	100	Control mode:	PP / CSP / PV / CSV
Unit:	%	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Use this parameter to set the speed for the friction compensation value to reach the setting value of P1.062. Based on the default setting of 100%, decreasing the value of P1.063 shortens the time for reaching the setting value of P1.062; increasing the value of P1.063 lengthens the time for reaching the setting value of P1.062.

P1.064 - P1.067	Reserved

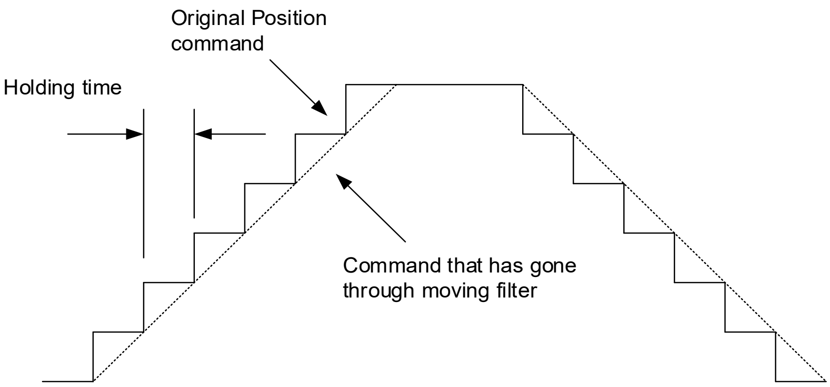
7

P1.068	Position command - moving filter		Address: 0188H 0189H
Default:	0	Control mode:	PP / CSP
Unit:	ms	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

0: disable this function.

The moving filter smooths the beginning and end of the step command, but it also delays the command.

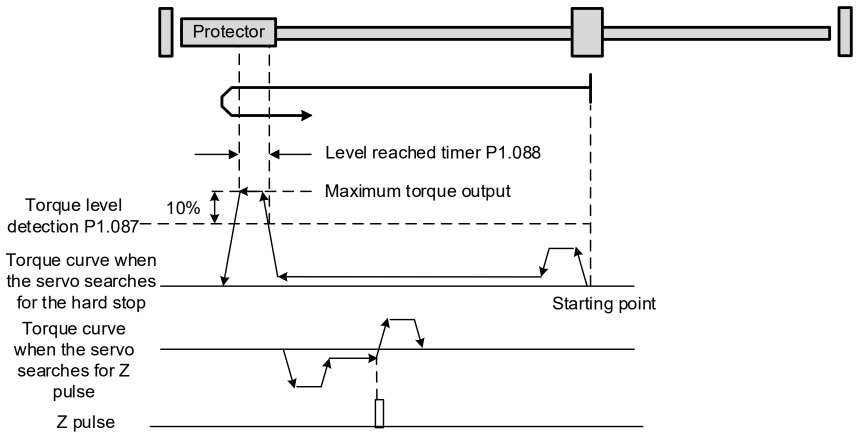


P1.069 - P1.086	Reserved

P1.087	Torque homing - torque level detection		Address: 01AEH 01AFH
Default:	1	Control mode:	HM
Unit:	%	Setting range:	1 to 300
Format:	DEC	Data size:	16-bit

Settings:

This setting is only for the torque homing mode. As shown in the following figure, after homing is triggered, the motor runs in one direction and the mechanical part reaches the protector. The servo drive then outputs a larger motor current in order to counter the external force. The servo drive uses P1.087 and P1.088 as the conditions for homing. Since the hard stops are not always the same, it is recommended that you have the servo reverse to find the Z pulse as the origin.



Note: the actual maximum torque output of the motor is 10% greater than the detected torque level (P1.087). For example: set P1.087 to 50%, and then the maximum torque output of the motor is 60%.

P1.088	Torque homing - level reached timer		Address: 01B0H 01B1H
Default:	2000	Control mode:	HM
Unit:	ms	Setting range:	2 to 2000
Format:	DEC	Data size:	16-bit

Settings:

The setting of the **torque level reached timer** for the torque homing mode. If the motor torque output continues to exceed the level set by P1.087 and the duration exceeds this setting, the homing is complete. Refer to P1.087 for the timing diagram of torque homing mode.

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P1.089	Vibration elimination 1 - anti-resonance frequency		Address: 01B2H 01B3H
Default:	4000	Control mode:	PP / CSP
Unit:	0.1 Hz	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Anti-resonance frequency for the first set of low frequency vibration elimination.

Use this function in flexible machines with low rigidity. The definition of a flexible machine is one for which when the target position is reached, due to lack of rigidity, the machine vibrates and needs more time to become stable.

The servo drive provides two sets of vibration elimination. The first set is P1.089 - P1.091 and the second set is P1.092 - P1.094. The vibration elimination settings must be obtained through the **System Module** function in **System Analysis** of the ASDA-Soft with the check box for **Low Frequency Analysis** selected.

Vibration elimination takes effect only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1). After enabling the two degree of freedom control function, turn on the first set of vibration elimination with P2.094 [Bit 8] and the second set with P2.094 [Bit 9].

Example:

1. Set P2.094 = 0x11☐☐ to enable the first set.
2. Set P2.094 = 0x12☐☐ to enable the second set.
3. Set P2.094 = 0x13☐☐ to enable the first and second sets simultaneously.

P1.090	Vibration elimination 1 - resonance frequency		Address: 01B4H 01B5H
Default:	4000	Control mode:	PP / CSP
Unit:	0.1 Hz	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Resonance frequency for the first set of low frequency vibration elimination.

P1.091	Vibration elimination 1 - resonance difference		Address: 01B6H 01B7H
Default:	10	Control mode:	PP / CSP
Unit:	0.1 dB	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the first set of low frequency vibration elimination.

P1.092	Vibration elimination 2 - anti-resonance frequency		Address: 01B8H 01B9H
Default:	4000	Control mode:	PP / CSP
Unit:	0.1 Hz	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Anti-resonance frequency for the second set of low frequency vibration elimination. The setting method is the same as the first set of vibration elimination (P1.089).

P1.093	Vibration elimination 2 - resonance frequency		Address: 01BAH 01BBH
Default:	4000	Control mode:	PP / CSP
Unit:	0.1 Hz	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Resonance frequency for the second set of low frequency vibration elimination.

P1.094	Vibration elimination 2 - resonance difference		Address: 01BCH 01BDH
Default:	10	Control mode:	PP / CSP
Unit:	0.1 dB	Setting range:	10 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the second set of low frequency vibration elimination.

P1.095 - P1.097	Reserved

P1.098	Disconnection detection protection (UVW) response time		Address: 01C4H 01C5H
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0, 100 to 800
Format:	DEC	Data size:	16-bit

Settings:

When the switch for motor power cable disconnection detection (ALC31) is enabled (P2.065 [Bit 9] = 1), select the detection response time with this parameter.

Set P1.098 to 0 to use the servo's default response time.

When P1.098 is not set to 0, the setting value should be between 100 and 800 for the detection response time.

Note:
1. If it is necessary to shorten the response time, it is recommended that you use this parameter.
2. When the servo is On and has not started running, it is recommended that you set this parameter if you need to detect disconnection.

P1.099	Reserved

P1.100	Safety functions module setting		Address: 01C8H 01C9H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0002
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	The use of the safety functions module	Z	Reserved
Y	Reserved	U	Reserved

- X: the use of the safety functions module

  0: no safety functions module installed*

  1: use the safety functions module in I/O mode

  2: use the safety functions module in EtherCAT communication (FSoE) mode

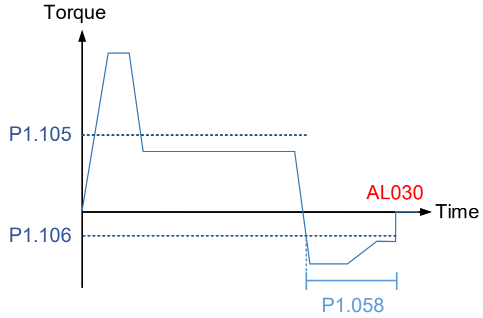
  Note: when the safety functions module is installed to the drive, do not set P1.100.X to 0; otherwise, the panel keeps displaying “-STO-“ and cannot be cleared. If P1.120 is set to 1 or 3, the panel keeps displaying “AL500”.

P1.101 - P1.104	Reserved

P1.105	Motor hard stop 2 - torque upper limit		Address: 01D2H 01D3H
Default:	0	Control mode:	All
Unit:	%	Setting range:	-300 to +300
Format:	DEC	Data size:	16-bit

Settings:

When Motor hard stop 2 is enabled (P2.112 [Bit 8] = 1), the settings of torque percentage (P1.057) and level offset (P1.060) for Motor hard stop 1 are invalid. During motor operation, if the motor torque is higher than the setting of P1.105 and the duration of this condition exceeds the time set in P1.058, AL030 will be triggered.



P1.106	Motor hard stop 2 - torque lower limit		Address: 01D4H 01D5H
Default:	0	Control mode:	All
Unit:	%	Setting range:	-300 to +300
Format:	DEC	Data size:	16-bit

Settings:

When Motor hard stop 2 is enabled (P2.112 [Bit 8] = 1), the settings of torque percentage (P1.057) and level offset (P1.060) for Motor hard stop 1 are invalid. During motor operation, if the motor torque is lower than the setting of P1.106 and the duration of this condition exceeds the time set in P1.058, AL030 will be triggered.

P1.107 - P1.110	Reserved

P1.111	Overspeed protection level		Address: 01DEH 01DFH
Default:	Maximum motor speed x 1.1	Control mode:	All
Unit:	1 rpm (rotary)*	Setting range:	0 to 66000
Format:	DEC	Data size:	32-bit

Settings:

This function is to protect the motor from overspeeding, which can be applied to all control modes. When the filtered motor speed exceeds this set speed, AL056 occurs.

Note: rotary means a permanent-magnet synchronous rotary motor.

P1.112■	Single-direction torque limit		Address: 01E0H 01E1H
Default:	500	Control mode:	All
Unit:	%	Setting range:	-500 to +500
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of P4.044 for more details.

P1.113 - P1.119	Reserved

P1.120	STO deactivation settings		Address: 01F0H 01F1H
Default:	3	Control mode:	All
Unit:	-	Setting range:	0 to 3
Format:	DEC	Data size:	16-bit

Settings:

The servo state when STO is activated and the way to deactivate STO for restarting the servo vary with the setting of P1.120. Descriptions for each setting value are as follows. For more details, refer to the signal timing diagrams in Section 3.9.5.3.

0: to deactivate STO and restart the servo, send the Servo Off command first and then the Servo On command.

1: to deactivate STO and restart the servo, clear the alarm first, and send the Servo Off command and then the Servo On command.

2: the servo restarts after STO is deactivated.

3: to deactivate STO and restart the servo, clear the alarm first.

Setting value		0	1	2 (recommended)	3 (default)
Servo state when STO is activated	Panel display	-STO-	AL500	-STO-	AL500
	Drive state	STO state	Fault	STO state	Fault
	OD 6041h [Bit 3] (Fault)	0	1	0	1
	OD 6041h [Bit 7] (Warning)	1	0	1	0
	Emergency object data	N/A	0x05009000	N/A	0x05009000
	OD 603Fh (Error code)	0x0000	0x9000	0x0000	0x9000
To deactivate STO and restart the servo	OD 6040h [Bit 7] (Fault Reset)	No need to set to 1	Must set to 1	No need to set to 1	Must set to 1
	OD 6040h: 0x6 → 0x7 → 0xF Servo Off → Servo On	Obligatory	Obligatory	Obligatory	Obligatory

Note: if a safety functions module is installed, follow the STO deactivation methods of the module.

P2.xxx Extension parameters

P2.000	**Position control gain**		**Address: 0200H 0201H**
Default:	35	Control mode:	PP / CSP
Unit:	rad/s	Setting range:	0 to 2047
Format:	DEC	Data size:	16-bit

Settings:

Increasing the position control gain enhances the position response and reduces the position errors. If you set the value too high, it may cause vibration and noise.

P2.001	**Reserved**

P2.002	**Position feed forward gain**		**Address: 0204H 0205H**
Default:	50	Control mode:	PP / CSP
Unit:	%	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

If the position control command changes smoothly, increasing the gain value reduces the position following errors. If the position control command does not change smoothly, decreasing the gain value reduces mechanical vibration.

P2.003	**Position feed forward gain smoothing constant**		**Address: 0206H 0207H**
Default:	5	Control mode:	PP / CSP
Unit:	ms	Setting range:	2 to 100
Format:	DEC	Data size:	16-bit

Settings:

If the position control command changes smoothly, decreasing the smoothing constant value reduces the position following errors. If the position control command does not change smoothly, increasing the smoothing constant value reduces mechanical vibration.

P2.004	**Speed control gain**		**Address: 0208H 0209H**
Default:	500	Control mode:	PP / CSP / PV / CSV
Unit:	rad/s	Setting range:	0 to 8191
Format:	DEC	Data size:	16-bit

Settings:

Increasing the speed control gain enhances the speed response. If you set the value too high, it may cause vibration and noise.

7

P2.005	Reserved

P2.006	Speed integral compensation		Address: 020CH 020DH
Default:	100	Control mode:	PP / CSP / PV / CSV
Unit:	rad/s	Setting range:	0 to 1023
Format:	DEC	Data size:	16-bit

Settings:

Increasing the value of the integral speed control enhances the speed response and reduces the speed control errors. If you set the value too high, it may cause vibration and noise.

P2.007	Speed feed forward gain		Address: 020EH 020FH
Default:	0	Control mode:	PP / CSP / PV / CSV
Unit:	%	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

If the speed control command changes smoothly, increasing the gain value reduces the speed following errors. If the speed control command does not change smoothly, decreasing the gain value reduces mechanical vibration.

P2.008■	Special parameter write-in function		Address: 0210H 0211H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to 501
Format:	DEC	Data size:	16-bit

Settings:

Special parameter write-in function:

Setting value	Function
10	Reset parameter groups P0 - P8 (cycle the power after reset).
18	Reset parameter group PM (cycle the power after reset).
20	P4.010 is writable.
22	P4.015 - P4.021 are writable.
271	Set P2.008 to 271 and P2.069.X to 1, and then set P2.071 to 0x0001 to establish the absolute origin position.
406	Enable forced DO mode.
400	When forced DO mode is enabled, switch to the normal DO mode.

7

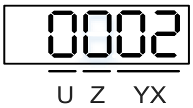
P2.009	**DI response filter time**		**Address: 0212H 0213H**
Default:	2	Control mode:	All
Unit:	ms	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

When environmental interference is high, increasing this value enhances the control stability. If you set the value too high, it affects the response time.

P2.010	**DI1 functional planning**		**Address: 0214H 0215H**
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:



YX	Input function selection	Z	Input contact: A or B contact
-	-	U	Reserved

- YX: input function selection

  Refer to Table 7.1.

- Z: input contact: A or B contact

  0: set this input contact to be normally closed (B contact)

  1: set this input contact to be normally open (A contact)

When these parameters are modified, cycle power on the servo drive to ensure they function normally. Use P3.006 to change the source for the digital input signal, which can be either an external terminal block or the parameter P4.007.

P2.011	**DI2 functional planning**		**Address: 0216H 0217H**
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

7

P2.012	DI3 functional planning		Address: 0218H 0219H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.013	DI4 functional planning		Address: 021AH 021BH
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.014	DI5 functional planning		Address: 021CH 021DH
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. There is no physical pin for DI5. This parameter is a virtual digital input to be used when the number of physical DI points is insufficient or to trigger through communication. You can set the DI to be used as soon as power is on (e.g. DI.SON) to be a virtual DI and normally closed.

P2.015	DI6 functional planning		Address: 021EH 021FH
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. There is no physical pin for DI6. This parameter is a virtual digital input to be used when the number of physical DI points is insufficient or to trigger through communication. You can set the DI to be used as soon as power is on (e.g. DI.SON) to be a virtual DI and normally closed.

P2.016	DI7 functional planning		Address: 0220H 0221H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. There is no physical pin for DI7. This parameter is a virtual digital input to be used when the number of physical DI points is insufficient or to trigger through communication. You can set the DI to be used as soon as power is on (e.g. DI.SON) to be a virtual DI and normally closed.

P2.017	DI8 functional planning		Address: 0222H 0223H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

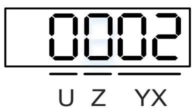
Settings:

Refer to the description of P2.010.

There is no physical pin for DI8. This parameter is a virtual digital input to be used when the number of physical DI points is insufficient or to trigger through communication. You can set the DI to be used as soon as power is on (e.g. DI.SON) to be a virtual DI and normally closed.

P2.018	DO1 functional planning		Address: 0224H 0225H
Default:	0x0101	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:



YX	Output function selection	Z	Output contact: A or B contact
-	-	U	Reserved

- YX: output function selection

  Refer to Table 7.2.

- Z: output contact: A or B contact

  0: set this output contact to be normally closed (B contact)

  1: set this output contact to be normally open (A contact)

When these parameters are modified, cycle power on the servo drive to ensure they function normally.

7

P2.019	DO2 functional planning		Address: 0226H 0227H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.020	DO3 functional planning		Address: 0228H 0229H
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.021	DO4 functional planning		Address: 022AH 022BH
Default:	0x0007	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.022	DO5 functional planning		Address: 022CH 022DH
Default:	0x0100	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x014F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.023	Notch filter 1 - frequency		Address: 022EH 022FH
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the first Notch filter. This function is disabled if P2.024 is 0.

P2.023, P2.024, and P2.095 are the first set of Notch filter parameters.

P2.024	Notch filter 1 - attenuation level		Address: 0230H 0231H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the first Notch filter. A value of 5 indicates -5 dB. Setting this parameter to 0 disables the first Notch filter.

P2.025	Resonance suppression low-pass filter			Address: 0232H 0233H
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	1.0	10	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Setting range:	0.0 to 100.0	0 to 1000	-	-
Format:	One decimal	DEC	-	-

Settings:

Sets the time constant for the low-pass filter for resonance suppression. Setting this parameter to 0 disables the low-pass filter.

P2.026	Anti-interference gain		Address: 0234H 0235H
Default:	0	Control mode:	PP / CSP / PV / CSV
Unit:	rad/s	Setting range:	0 to 1023
Format:	DEC	Data size:	16-bit

Settings:

Increasing the value of this parameter increases the damping of the speed loop and reduces the speed loop response. Setting the value of P2.026 to the same value as P2.006 is recommended. See the following for setting P2.026:

1. In Speed modes (PV, CSV), increasing the value of this parameter reduces the speed overshoot.
2. In Position modes (PP, CSP), decreasing the value of this parameter reduces the position overshoot.

Note: this gain parameter is invalid when the two degree of freedom control function is on (P2.094 [Bit 12] = 1).

P2.027 - P2.029	Reserved

7

P2.030■	Auxiliary function		Address: 023CH 023DH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-8 to +8
Format:	DEC	Data size:	16-bit

Settings:

Value	Function
0	Disable all functions described as follows.
1	Switch the servo to the Servo On state.
5	This setting makes all parameter settings volatile. When there is no need to permanently save the data continually written through the panel or communication, this setting can avoid shortening the lifespan of the EEPROM from continuous writing. You must use this function when using communication control.
6	This setting enables command simulation mode. In this mode, use the **Digital IO** function in ASDA-Soft to switch the servo to the Servo On state as the external Servo On signal cannot work, the error code of the servo drive (monitoring variable 0x6F) is read as 0, and P0.001 only shows part of the error codes (such as positive / negative limit, emergency stop). When DO.SRDY is on, commands are accepted in each mode. You can use the **Scope** function in ASDA-Soft to observe these commands to examine their accuracy, but the motor does not operate.
8	Back up all current parameter values to EEPROM, so that the values are retained after power cycling. The panel displays ‘to.rom’ during execution. This feature can also be executed when the servo is in the Servo On state.
-1, -5, -6	Respectively disable the functions of setting values 1, 5, and 6.
-2 to -4, -7, -8, 2 to 4, 7	Reserved

Note: set this parameter to 0 during normal operation. The value returns to 0 automatically after power cycling of the servo drive.

P2.031	Bandwidth response level		Address: 023EH 023FH
Default:	19	Control mode:	All
Unit:	-	Setting range:	1 to 50
Format:	DEC	Data size:	16-bit

Settings:

In gain adjustment mode (P2.032), adjust the servo bandwidth with the bandwidth response level parameter (P2.031). When you increase the bandwidth response level (P2.031), the servo bandwidth increases as well. Refer to Chapter 5 for adjustment details.

P2.032	Gain adjustment mode		Address: 0240H 0241H
Default:	0x0001	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0006
Format:	HEX	Data size:	16-bit

7

Settings:

The servo drive provides the following gain adjustment modes for fine tuning. You can then easily complete tuning by increasing or decreasing the bandwidth response level (P2.031). Recommendations for tuning the machine are in Section 5.1.

Value	Adjustment mode	Inertia estimation	Parameter	
			Manual	Auto
0	Manual	Fixed set value of P1.037	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102	N/A
1	Gain adjustment mode 1	Real-time estimation	P2.031	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
2	Gain adjustment mode 2	Fixed set value of P1.037	P1.037 P2.031	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
3	Gain adjustment mode 3 (only when the two degree of freedom control function is enabled)	Fixed set value of P1.037	P1.037 P2.031 P2.089	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.098, P2.099, P2.101, P2.102
4	Gain adjustment mode 4	Reset to gain default value	-	-
5	Gain adjustment mode 5 (same as setting P2-32 to 1 for A2 series)	Real-time estimation; the result is updated to P1.037 every 30 minutes	P2.126	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102
6	Gain adjustment mode 6 (same as setting P2-32 to 2 for A2 series)	Fixed set value of P1.037	P1.037 P2.126	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.094, P2.098, P2.099, P2.101, P2.102

Note: when the two degree of freedom control function is disabled (P2.094 [Bit 12] = 0), the effect of gain adjustment mode 3 is equivalent to that of gain adjustment mode 2, so setting P2.089 is invalid in that scenario.

P2.033	Reserved

7

P2.034	Excessive deviation warning condition of Speed command		Address: 0244H 0245H
Default:	5000	Control mode:	PV / CSV
Unit:	1 rpm (rotary)	Setting range:	1 to 30000 (rotary)
Format:	DEC	Data size:	16-bit

Settings:

In Speed modes, this parameter sets the allowable difference between the command speed and the speed feedback. If the difference is greater than this value, AL007 occurs. For the actual speed control error, refer to the corresponding monitoring variable by setting P0.002 = -24.

If requiring to adjust the delay time of triggering AL007, refer to parameters P2.110 and P2.111.

Note: when P2.094 [Bit 6] = 1, this parameter is available in Position modes (PP, CSP) and Speed modes (PV, CSV).

P2.035	Excessive deviation warning condition of Position command		Address: 0246H 0247H
Default:	50331648	Control mode:	PP / CSP
Unit:	pulse	Setting range:	1 to 1677721600
Format:	DEC	Data size:	32-bit

Settings:

In Position modes, this parameter sets the allowable difference between the command position and the position feedback. If the difference is greater than this value, AL009 occurs.

P2.036 - P2.042	Reserved

P2.043	Notch filter 2 - frequency		Address: 0256H 0257H
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the second Notch filter. This function is disabled if P2.044 is 0.

P2.043, P2.044, and P2.096 are the second set of Notch filter parameters.

P2.044	Notch filter 2 - attenuation level		Address: 0258H 0259H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the second Notch filter. A value of 5 indicates -5 dB. Setting this parameter to 0 disables the second Notch filter.

P2.045	Notch filter 3 - frequency		Address: 025AH 025BH
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the third Notch filter. This function is disabled if P2.046 is 0.

P2.045, P2.046, and P2.097 are the third set of Notch filter parameters.

P2.046	Notch filter 3 - attenuation level		Address: 025CH 025DH
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the third Notch filter. A value of 5 indicates -5 dB. Setting this parameter to 0 disables the third Notch filter.

P2.047	Auto resonance suppression mode		Address: 025EH 025FH
Default:	0x0001	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x01F2
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Auto resonance suppression function	Z	Fixed resonance suppression parameter
Y	Fixed resonance suppression parameter	U	Reserved

- X: auto resonance suppression function

  0: disable the auto resonance suppression. After the function is disabled, the existing resonance suppression parameter values do not change.

  1: auto resonance suppression mode 1; when the servo determines it is stable*2, the servo stores the known resonance suppression points to EEPROM (non-volatile memory for parameters) and disables the auto resonance suppression function (X = 0).

  Before the servo is stable,

  (1) If you cycle power on the servo drive, the found resonance suppression points are lost and will not be saved. The servo searches for the resonance suppression points again.

  (2) If you switch the setting of X from 1 to 0, the known resonance suppression points will be stored to EEPROM.

(3) If you keep the setting of X as 1, the known resonance suppression points will not be cleared, but they are not written to EEPROM yet. They are written to EEPROM when the servo determines it is stable.

2: auto resonance suppression mode 2; when the servo determines it is stable*2, the servo stores the known resonance suppression points to EEPROM (non-volatile memory for parameters). In this mode, the searching cycle continues until the 5 sets of resonance suppression parameters are set, and then the auto resonance suppression function is disabled (X = 0).

Before the servo is stable,

(1) If you cycle power on the servo drive, the resonance suppression points that are not yet stored in EEPROM are lost and will not be saved. The resonance suppression points that have been stored in EEPROM will not be affected.

(2) If you switch the setting of X from 2 to 0, the known resonance suppression points will be stored to EEPROM.

(3) If you keep the setting of X as 2, the known resonance suppression points will not be cleared, but they are not written to EEPROM yet. They are written to EEPROM when the servo determines it is stable.

Note:
1. If you switch the setting of X from 0 to 1 or 2, the unfixed Notch filter is automatically cleared, the frequency is set to 1,000 Hz, and the suppression level is set to 0 dB.
2. The servo determines it is stable when the following conditions are met: resonances have been suppressed, no other interference that affects the operation is found, and the motor speed is maintained at above 10 rpm for 3 minutes.

- Y: fixed resonance suppression parameter

In auto resonance suppression mode, you can set the resonance suppression parameters manually by setting P2.047.Y.

Bit	Function	Description
4	Notch 1 auto / manual setting	0: auto resonance suppression 1: manually set the first set of resonance suppression parameters
5	Notch 2 auto / manual setting	0: auto resonance suppression 1: manually set the second set of resonance suppression parameters
6	Notch 3 auto / manual setting	0: auto resonance suppression 1: manually set the third set of resonance suppression parameters
7	Notch 4 auto / manual setting	0: auto resonance suppression 1: manually set the fourth set of resonance suppression parameters

- Z: fixed resonance suppression parameter

In auto resonance suppression mode, you can set the resonance suppression parameters manually by setting P2.047.Z.

Bit	Function	Description
8	Notch 5 auto / manual setting	0: auto resonance suppression 1: manually set the fifth set of resonance suppression parameters
9 to 11	Reserved	-

Example: if P2.047 = 0x0021, the auto resonance suppression function is enabled, and the servo searches for the point of resonance and suppresses it. When you set Y to 2, you manually set the second set of resonance suppression parameters. Then, if the servo finds 2 resonance points, it writes the data of the 1st point to the 1st set of resonance suppression parameters and the data of the 2nd point to the 3rd set of resonance suppression parameters. That is, it skips the 2nd set of parameters.

P2.048	Auto resonance detection level		Address: 0260H 0261H
Default:	100	Control mode:	All
Unit:	-	Setting range:	0 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Setting P2.048 higher reduces the resonance sensitivity; on the other hand, setting P2.048 lower improves the resonance sensitivity.

P2.049	Speed detection filter and jitter suppression			Address: 0262H 0263H
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	1.0	10	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Setting range:	0.0 to 100.0	0 to 1000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

Sets the filter for speed estimation. Adjusting this parameter improves the extent of the speed jitter, but when the value is too high, the phase margin affecting the speed loop decreases, and thus makes the system unstable.

P2.050 - P2.051	Reserved

P2.052▲	Rotary axis position scale		Address: 0268H 0269H
Default:	1073741824	Control mode:	All
Unit:	PUU	Setting range:	32 to 1073741824
Format:	DEC	Data size:	32-bit

Settings:

Sets the scale of the rotary system. If the value is too small, it may cause errors in the rotary system. The input range of P2.052 is:

$$\text{P2.052} > 1.05 \times \text{Maximum motor speed (rpm)} \times \frac{16777216}{60000} \times \frac{\text{P1.045}}{\text{P1.044}}$$

7

P2.053	Position integral compensation		Address: 026AH 026BH
Default:	0	Control mode:	PP / CSP
Unit:	rad/s	Setting range:	0 to 1023
Format:	DEC	Data size:	16-bit

Settings:

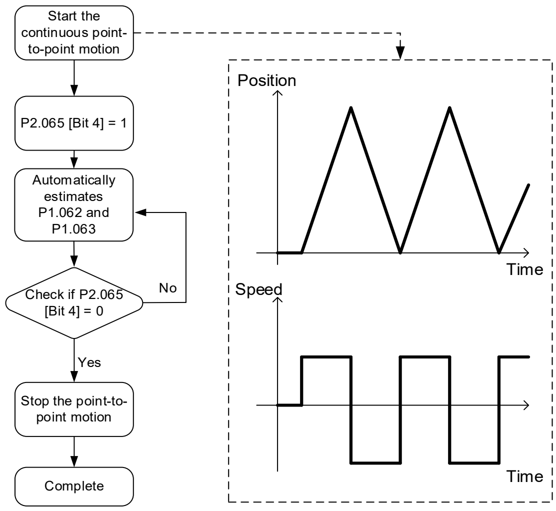
Increasing the position control integral compensation reduces the position steady-state errors. If the value is too high, it may cause position overshoot and noise.

P2.054 - P2.064	Reserved

P2.065	Special bit register 1		Address: 0282H 0283H
Default:	0x0320	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0xFFFF
Format:	HEX	Data size:	-

Settings:

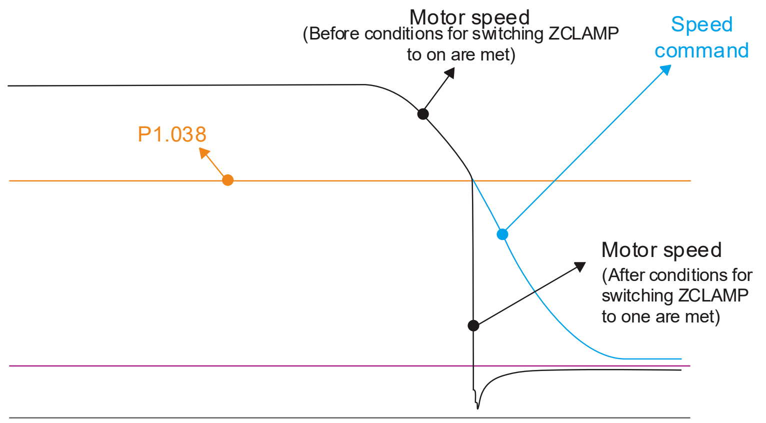
Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0 - Bit 3	Reserved	-
Bit 4	Automatic friction estimation	After enabling this function, you must conduct the continuous point-to-point motion to automatically write the estimated values to P1.062 and P1.063. 0: disable the function. 1: enable the function. 
Bit 5	Switch for AL003 (Undervoltage) and AL022 (RST power error) in Servo Off state	0: when the servo is Off, disable the detection for AL003 (Undervoltage) and AL022 (RST power error). 1: when the servo is Off, enable the detection for AL003 (Undervoltage) and AL022 (RST power error).
Bit 6 - Bit 7	Reserved	-
Bit 8	Switch for motor power cable wiring error detection (AL031)	0: disable the detection. 1: enable the detection.

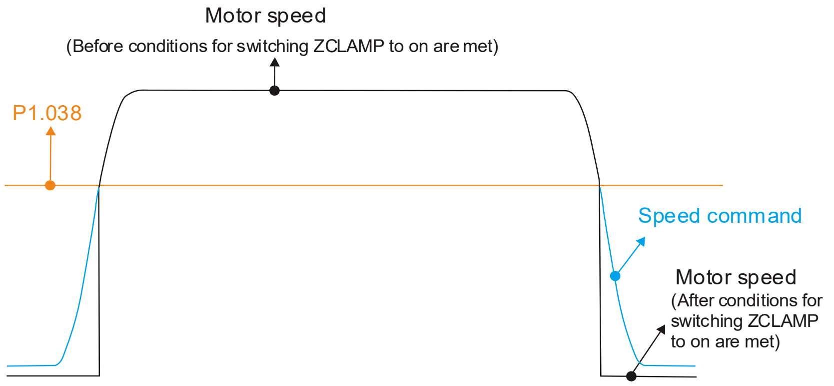
Bit	Function	Description
Bit 9	Switch for motor power cable disconnection detection (ALC31)	0: disable the detection. 1: enable the detection.
Bit 10	ZCLAMP function selection	The ZCLAMP function is enabled when all the following conditions are met. ■ In Speed modes ■ DI.ZCLAMP is On ■ Motor speed is slower than the value of P1.038

Bit 10 description

When Bit 10 = 0, the system uses the filtered Speed command to determine if the ZCLAMP function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.



When Bit 10 = 1, the system uses the filtered Speed command to determine if the ZCLAMP function should be enabled. When ZCLAMP conditions are met, the motor speed is set to 0 rpm.



Bit	Function	Description
Bit 11	Reserved	-
Bit 12	RST power error (AL022) detection function	0: enable the RST power error (AL022) detection function. 1: disable the RST power error (AL022) detection function.
Bit 13 - Bit 15	Reserved	-

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P2.066	Special bit register 2		Address: 0284H 0285H
Default:	0x0030	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x187F
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0, Bit 1	Reserved	-
Bit 2	Disable the AL003 (Undervoltage) latch	0: latch enabled; the undervoltage error is not cleared automatically. 1: latch disabled; the undervoltage error is cleared automatically.
Bit 3	Reserved	-
Bit 4	Disable the detection for AL044 (Servo function overload warning)	0: enable the detection. 1: disable the detection.
Bit 5	Enable the detection for AL041 (CN5 is disconnected)	This function is only applicable to pulse motors, and not to communication motors. 0: disable the detection. 1: enable the detection.
Bit 6	RST power error (AL022) latch	0: disable the latch; RST power error (AL022) is cleared automatically. 1: enable the latch; RST power error (AL022) is not cleared automatically.
Bit 7, Bit 8	Reserved	-
Bit 9	Set AL003 (Undervoltage) as ALM or WARN	0: WARN 1: ALM
Bit 10, Bit 11	Reserved	-
Bit 12	Set AL022 (RST power error) as ALM or WARN	0: WARN 1: ALM
Bit 13 - Bit 15	Reserved	-

P2.067	Reserved

P2.068	Following error compensation switch		Address: 0288H 0289H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x2101
Format:	HEX	Data size:	16-bit

Settings:

0000
U Z Y X

X	Following error compensation switch	Z	Reserved
Y	Reserved	U	EtherCAT PV mode unit selection

- X: following error compensation switch (only functions under the condition of P1.036 > 1)

  0: disable the following error compensation

  1: enable the following error compensation

- U: EtherCAT PV mode unit selection

  0: 0.1 rpm

  1: 0.01 rpm

  Note: when you change the setting of P2.068.U, the units of OD 606Bh, OD 606Ch, OD 60FFh, and P5.003 (Deceleration time for auto-protection) in bus communication mode will change as well (when P2.068.U = 1, the units of P5.031 - P5.035 are defined as 10 ms). Make sure the setting values are correct.

P2.069●	Absolute encoder		Address: 028AH 028BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x1211
Format:	HEX	Data size:	16-bit

Settings:

0000
U Z Y X

X	Operation mode setting	Z	Function of preventing rotary axis position offset when overflow occurs
Y	Pulse command setting when absolute position is lost	U	Single-turn absolute function

- X: operation mode setting

  0: incremental mode. An absolute type motor can be operated as an incremental type motor.

  1: absolute mode. This setting is only applicable to an absolute type motor. If it is used for an incremental type motor, AL069 occurs.

- Y: pulse command setting when absolute position is lost

  0: when AL060 or AL06A occurs, the system cannot accept a pulse command.

  1: when AL060 or AL06A occurs, the system can accept a pulse command.

- Z: function of preventing rotary axis position offset when overflow occurs

  0: when the number of revolutions of the encoder overflows, the absolute position and rotary axis position are offset after power is off.

  1: during power-on initialization and the establishment of origin position, the position feedback remains unchanged as the servo drive position feedback. The rotary axis position is not affected by overflow, but the absolute position is offset (AL062, AL066, and AL289 do not function).

  2: during power-on initialization and the establishment of origin position, the position feedback is set as the current rotary axis position. The rotary axis position is not affected by overflow, but the absolute position is offset (AL062, AL066, and AL289 do not function). This setting is applicable when the Delta AX series or DVP50MC series controller is used; optional when other controllers are used.

- U: single-turn absolute function

  0: disable the single-turn absolute function.

  1: enable the single-turn absolute function and automatically set both P2.069.X and P2.069.Z to 1.

  Important: when you are using the single-turn absolute function, the motor must not rotate more than 1/4 revolution when power is off.

Note: changes to this setting are effective only after power is cycled on the servo drive.

P2.070	Read data selection		Address: 028CH 028DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0007
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0	DI/DO data unit setting	0: PUU 1: pulse
Bit 1	Unit setting for P0.051 and P0.052	0: P0.051 is invalid; P0.052 is in units of PUU. 1: P0.051 is in units of number of revolutions; P0.052 is in units of pulse.
Bit 2	Overflow warning setting	0: the servo drive issues the overflow warnings AL289 (PUU), AL066 (pulse), and AL062 (pulse). 1: no overflow warning.
Bit 3 - Bit 15	Reserved	-

P2.071■	Absolute position reset		Address: 028EH 028FH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0001
Format:	HEX	Data size:	16-bit

Settings:

Setting P2.071 to 0x0001 resets the current absolute position of the encoder. The clear function is enabled by setting P2.008 to 271 and P2.069.X to 1.

P2.072 - P2.080	Reserved

P2.081	Pulse leakage detection function		Address: 02A2H 02A3H
Default:	1	Control mode:	All
Unit:	-	Setting range:	0 to 1
Format:	DEC	Data size:	16-bit

Settings:

Pulse leakage detection function switch. Set 0 to disable this function; set 1 to enable this function. This parameter is only applicable to pulse motors.

P2.082	Pulse leakage warning level		Address: 02A4H 02A5H
Default:	400	Control mode:	All
Unit:	pulse	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

When P2.081 is set to 1 and the number of pulse leakage exceeds this set value, AL057 is triggered. This parameter is only applicable to pulse motors.

P2.083	Reserved

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P2.084	Special function for low resolution motor		Address: 02A8H 02A9H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x311F
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8
	U							

Bit	Function	Description
Bit 0 - Bit 7	Reserved	-
Bit 8	Speed smoothing function	When the resolution of the motor is low, enable this function to smooth the uneven speed. This function is only applicable to pulse motors. 0: disable 1: enable
Bit 9 - Bit 11	Reserved	-
U	Speed observer	When the resolution of the motor is low, enable this function to smooth the speed with a **filtering effect**. Before this function is enabled, it is suggested that you gradually lower the set value for P2.025 to avoid sacrificing the phase due to excessive filtering and thus resulting in resonance of the machine. 0: speed observer 1; the filter bandwidth is 1000 / P2.049. 1: speed observer 2; the filter bandwidth cannot be adjusted. 2: speed observer 3; the filter bandwidth is 1000 / P2.049. Note: 1. Speed observer 1 is applicable to high resolution encoders. 2. Speed observers 2 and 3 are applicable to encoders with low resolution. For example, the single-turn resolution of the rotary encoder is smaller than 40000 pulse/rev and the application requires low speed (lower than 100 rpm).

P2.085 - P2.088	Reserved

P2.089	Command response gain		Address: 02B2H 02B3H
Default:	25	Control mode:	PP / CSP
Unit:	rad/s	Setting range:	1 to 2000
Format:	DEC	Data size:	16-bit

Settings:

Increasing this gain speeds up the responsiveness of the Position command and shortens the settling time, but when the gain is too large, it causes position overshoot which leads to machine jitter.

Note: enable the two degree of freedom control function (P2.094 [Bit 12] = 1) before adjusting this parameter.

P2.090	Two degree of freedom mode - anti-interference gain		Address: 02B4H 02B5H
Default:	850	Control mode:	PP / CSP
Unit:	0.001	Setting range:	500 to 1999
Format:	DEC	Data size:	16-bit

Settings:

This parameter improves the command response and fine tunes the overshoot when the command is settling. Setting this parameter to a smaller value reduces the occurrence of command overshoot. This parameter is valid only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1) and its function is similar to that of P2.026.

P2.091	Two degree of freedom mode - position feed forward gain		Address: 02B6H 02B7H
Default:	1000	Control mode:	PP / CSP
Unit:	0.1%	Setting range:	0 to 3000
Format:	DEC	Data size:	16-bit

Settings:

This parameter reduces the following error of the motor. If the value is set too high, it may cause overshoot during positioning. It is suggested that you set this parameter to the default value or only make small adjustments. This parameter is valid only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1) and its function is similar to that of P2.002.

P2.092	Two degree of freedom mode - speed feed forward gain		Address: 02B8H 02B9H
Default:	1000	Control mode:	PP / CSP
Unit:	0.1%	Setting range:	0 to 3000
Format:	DEC	Data size:	16-bit

Settings:

This parameter reduces the following error when the motor starts and stops. Use this parameter to roughly adjust the overshoot during positioning. Setting this parameter to a larger value reduces overshoot. This parameter is valid only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1) and its function is similar to that of P2.007.

P2.093	Reserved

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P2.094▲	Special bit register 3		Address: 02BCH 02BDH
Default:	0x1090	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0xF3F6
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0 - Bit 3	Reserved	-
Bit 4	Dynamic brake options	0: disable the new dynamic brake. 1: enable the new dynamic brake.
Bit 5	Switch for AL016 (IGBT overheat)	0: enable AL016 (IGBT overheat). 1: disable AL016 (IGBT overheat).
Bit 6	Switch for AL007 detection in Position modes	Switch for AL007 detection in Position modes (PP and CSP) 0: disable the AL007 detection. 1: enable the AL007 detection.
Bit 7	Switch for AL086	Switch for the brake resistor temperature protection when the input voltage is too high 0: disable 1: enable
Bit 8	First set of vibration elimination	This function is only available in Position modes (PP and CSP). 0: disable the first set of vibration elimination. 1: enable the first set of vibration elimination (P1.089 - P1.091). Vibration elimination takes effect only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1).
Bit 9	Second set of vibration elimination	This function is only available in Position modes (PP and CSP). 0: disable the second set of vibration elimination. 1: enable the second set of vibration elimination (P1.092 - P1.094). Vibration elimination takes effect only when the two degree of freedom control function is enabled (P2.094 [Bit 12] = 1).
Bit 10, Bit 11	Reserved	-
Bit 12	Two degree of freedom control function	This function is only available in Position modes (PP and CSP). 0: disable the two degree of freedom control function (A2 and B2 models do not have this function.). 1: enable the two degree of freedom control function.
Bit 13 - Bit 15	Reserved	-

P2.095	Notch filter 1 - Q factor		Address: 02BEH 02BFH
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the first Notch filter. This function is disabled if P2.024 is 0.

P2.023, P2.024, and P2.095 are the first set of Notch filter parameters.

P2.096	Notch filter 2 - Q factor		Address: 02C0H 02C1H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the second Notch filter. This function is disabled if P2.044 is 0.

P2.043, P2.044, and P2.096 are the second set of Notch filter parameters.

P2.097	Notch filter 3 - Q factor		Address: 02C2H 02C3H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the third Notch filter. This function is disabled if P2.046 is 0.

P2.045, P2.046, and P2.097 are the third set of Notch filter parameters.

P2.098	Notch filter 4 - frequency		Address: 02C4H 02C5H
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the fourth Notch filter. This function is disabled if P2.099 is 0.

P2.098, P2.099, and P2.100 are the fourth set of Notch filter parameters.

P2.099	Notch filter 4 - attenuation level		Address: 02C6H 02C7H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the fourth Notch filter. A value of 5 indicates -5 dB. Setting this parameter to 0 disables the fourth Notch filter.

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P2.100	Notch filter 4 - Q factor		Address: 02C8H 02C9H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the fourth Notch filter. This function is disabled if P2.099 is 0.

P2.098, P2.099, and P2.100 are the fourth set of Notch filter parameters.

P2.101	Notch filter 5 - frequency		Address: 02CAH 02CBH
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 to 5000
Format:	DEC	Data size:	16-bit

Settings:

The resonance frequency of the fifth Notch filter. This function is disabled if P2.102 is 0.

P2.101, P2.102, and P2.103 are the fifth set of Notch filter parameters.

P2.102	Notch filter 5 - attenuation level		Address: 02CCH 02CDH
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 to 40
Format:	DEC	Data size:	16-bit

Settings:

The attenuation level of the fifth Notch filter. A value of 5 indicates -5 dB. Setting this parameter to 0 disables the fifth Notch filter.

P2.103	Notch filter 5 - Q factor		Address: 02CEH 02CFH
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 to 10
Format:	DEC	Data size:	16-bit

Settings:

The resonance Q factor of the fifth Notch filter. This function is disabled if P2.102 is 0.

P2.101, P2.102, and P2.103 are the fifth set of Notch filter parameters.

P2.104	Torque command condition for P/PI switching		Address: 02D0H 02D1H
Default:	800	Control mode:	PP / CSP / PV / CSV
Unit:	%	Setting range:	1 to 800
Format:	DEC	Data size:	16-bit

Settings:

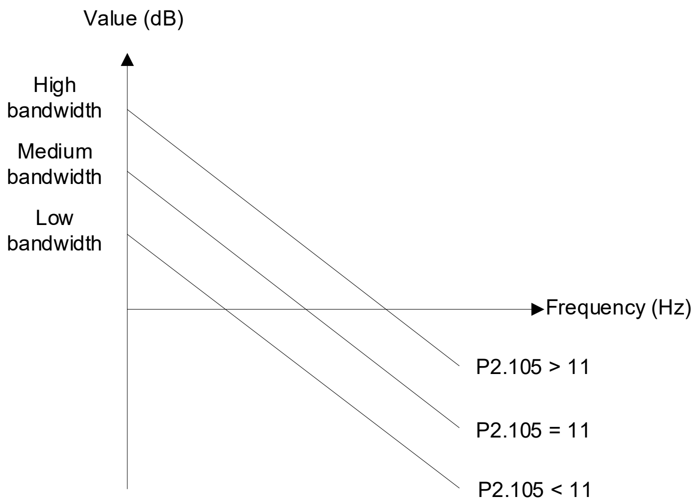
When the Torque command exceeds P2.104, the speed controller gain is switched from PI to P in order to reduce response overshoot.

P2.105	Automatic gain adjustment level 1		Address: 02D2H 02D3H
Default:	11	Control mode:	All
Unit:	-	Setting range:	1 to 21
Format:	DEC	Data size:	16-bit

Settings:

Use this parameter to adjust the bandwidth when auto-tuning. Setting P2.105 higher increases the bandwidth after auto-tuning but may reduce the system margin, causing machine jitter. Setting P2.105 lower decreases the bandwidth after auto-tuning but slows down the response.

Automatic gain adjustment level 1	Stiffness and response	Applicable mechanical parts
1 - 7	Low stiffness and low response	Belt, gear rack, reducer, cam
8 -14	Medium stiffness and medium response	Screw
15 - 21	High stiffness and high response	Direct-coupled mechanical parts



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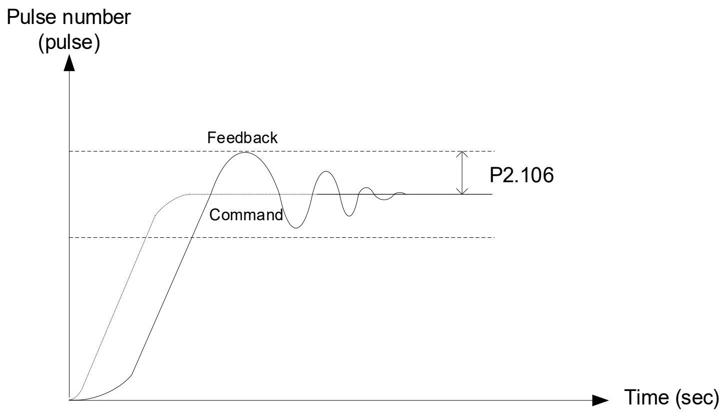
P2.106	Automatic gain adjustment level 2		Address: 02D4H 02D5H
Default:	2000	Control mode:	All
Unit:	pulse	Setting range:	1 to 50331648
Format:	DEC	Data size:	32-bit

Settings:

Use this parameter to adjust the maximum allowable overshoot when auto-tuning. The overshoot range is set according to either the user's requirement or the machine characteristics. Setting P2.106 higher increases the maximum overshoot allowed by auto-tuning and speeds up the response. Setting P2.106 lower reduces the maximum overshoot allowed by auto-tuning but slows down the response.



P2.107	Rate of change for resonance suppression low-pass filter		Address: 02D6H 02D7H
Default:	100	Control mode:	All
Unit:	%	Setting range:	0 to 100
Format:	DEC	Data size:	16-bit

Settings:

Adjusts the rate of change for **the resonance suppression low-pass filter** (P2.025) according to the gain switching condition.

(This parameter is inversely proportional to the value of P2.025. Setting P2.107 lower improves the filtering effect.)

P2.108	Open-loop brake control - output current		Address: 02D8H 02D9H
Default:	200	Control mode:	All
Unit:	%	Setting range:	0 - 300
Format:	DEC	Data size:	16-bit

Settings:

The output motor current (in percentage) when the drive triggers the open-loop brake control.

7

P2.109	**Open-loop brake control - triggering time**		**Address: 02DAH 02DBH**
Default:	1000	Control mode:	All
Unit:	ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

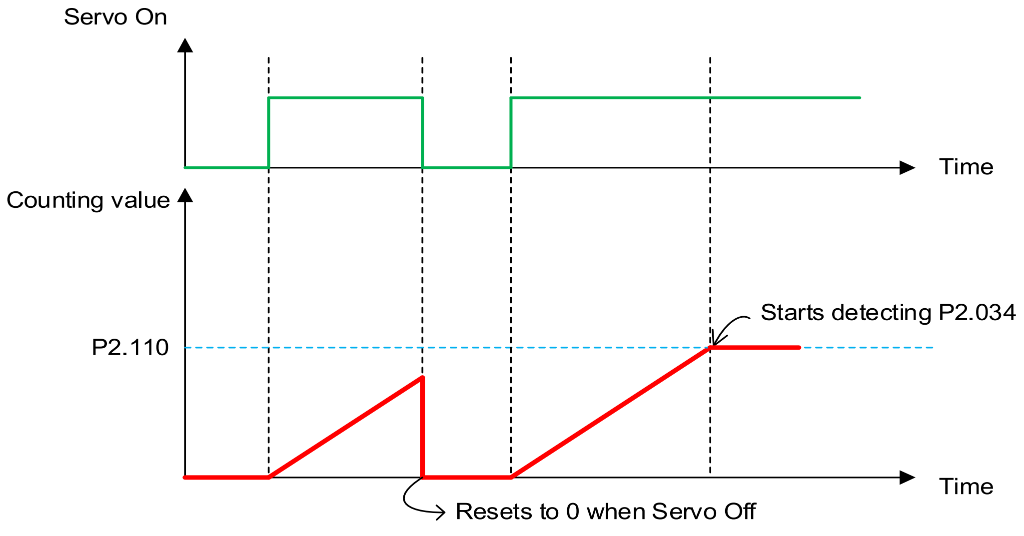
Settings:

The time duration when the drive triggers the open-loop brake control.

P2.110	**Delay time before P2.034 detection**		**Address: 02DCH 02DDH**
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

When the servo is On, setting this parameter delays the detection of P2.034 (Excessive deviation warning condition of Speed command); when the servo is Off, P2.110 resets to 0.



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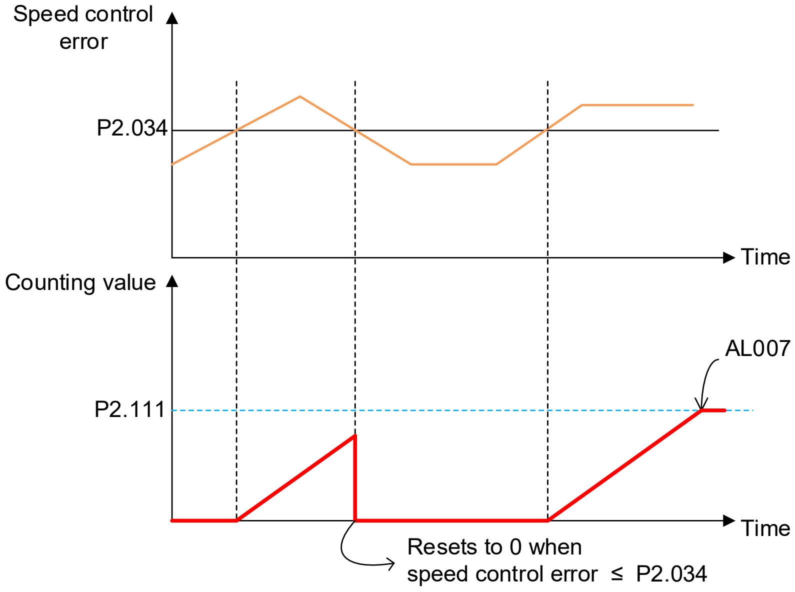
P2.111	Delay time before AL007 triggering		Address: 02DEH 02DFH
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

This parameter sets the allowable time duration of P2.034 (Excessive deviation warning condition of Speed command). When the speed control error (monitoring variable of P0.002 = -24) exceeds the setting value of P2.034, P2.111 starts counting the time duration. When the counting value exceeds the setting value of P2.111, the drive displays AL007. When the speed control error ≤ P2.034, P2.111 resets to 0.



7

P2.112▲	Special bit register 4		Address: 02E0H 02E1H
Default:	0x2018	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0x753F
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0	Reserved	-
Bit 1	Enable AL089	0: disable AL089 1: enable AL089
Bit 2 - Bit 7	Reserved	-
Bit 8	Motor hard stop function selection	Not applicable to Torque mode. Motor hard stop 2 currently supports motors with Hall sensors (PM.003.Y = 1) or absolute motors. 0: Motor hard stop 1 (Refer to the settings of P1.057, P1.058, and P1.060.) 1: Motor hard stop 2 (Refer to the settings of P1.058, P1.105, and P1.106.)
Bit 9 - Bit 12	Reserved	-
Bit 13	Regenerative braking method	Use method 2 to release the capacitor voltage faster which reduces the load voltage of the capacitor. 0: method 1 1: method 2
Bit 14 - Bit 15	Reserved	-

P2.113	Bandwidth of disturbance attenuation		Address: 02E2H 02E3H
Default:	50	Control mode:	PT / CST
Unit:	Hz	Setting range:	0 - 3000
Format:	DEC	Data size:	16-bit

Settings:

The disturbance attenuation function is disabled when P2.114 is 0. It is recommended that you set P2.113 to the default of 50. Setting P2.113 higher increases the possibility of high-frequency resonance; on the other hand, setting P2.113 lower reduces the effect of the low-frequency vibration.

7

P2.114	Level of disturbance attenuation		Address: 02E4H 02E5H
Default:	0	Control mode:	PT / CST
Unit:	-	Setting range:	0 - 500
Format:	DEC	Data size:	16-bit

Settings:

Setting P2.114 to 0 disables the disturbance attenuation function. Increasing this parameter better attenuates the disturbance. However, setting the value too high may cause slower response and system divergence.

P2.115 - P2.120	Reserved

P2.121	Special bit register 6		Address: 02F2H 02F3H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	0x00000000 to 0x000001FF
Format:	HEX	Data size:	32-bit

Settings:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16

Bit	Function	Description
Bit 0	Reserved	-
Bit 1	Behavior after homing in communication mode	0: after homing, execute absolute positioning to the position with the offset distance set in OD 607Ch 1: decelerate to a stop after homing
Bit 2	Reserved	-
Bit 3	Unit of Homing speeds (OD 6099h) in communication mode	0: 0.1 rpm 1: 1 rpm
Bit 4	Reserved	-
Bit 5	Unit selection for Homing speeds (OD 6099h), Homing acceleration (OD 609Ah), Profile acceleration (OD 6083h), and Profile deceleration (OD 6084h) in communication mode	0: unit of OD 6099h is determined by the setting of P2.121 [Bit 3]; unit of OD 609Ah, OD 6083h, and OD 6084h is ms (0 - 3000 rpm). When P2.121 [Bit 3] = 0, the unit of OD 6099h is 0.1 rpm. When P2.121 [Bit 3] = 1, the unit of OD 6099h is 1 rpm. 1: unit of OD 6099h is PUU/sec; unit of OD 609Ah, OD 6083h, and OD 6084h is PUU/sec^2.
Bit 6 - Bit 7	Reserved	-
Bit 8	Auto clearing of AL180 and AL185 after the state machine re-enters the Operational state in EtherCAT mode	0: no; manually clear the alarms 1: yes
Bit 9 - Bit 11	Reserved	-
Bit 12	AL500 (STO function is enabled) as ALM or WARN	This function only changes the display of OD 6041h; the STO function is not affected. 0: ALM (OD 6041h [Bit 3] = On, [Bit 7] = Off) 1: WARN (OD 6041h [Bit 3] = Off, [Bit 7] = On)
Bit 13 - Bit 31	Reserved	-

P2.122 - P2.124	Reserved

P2.125	Special bit register 7		Address: 02FAH 02FBH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 to 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0	Frequency setting of the filter processing the speed feedback (monitoring variable of P0.002 = 7)	0: 15 Hz 1: 1 Hz
Bit 1, Bit 2	Reserved	-
Bit 3	Bandwidth response level reversion	Before using this function, set the gain adjustment mode to mode 1, mode 2, or mode 3. When the system limit is reached and the resonance cannot be suppressed, the servo automatically reverts to the response level where the resonance does not occur. 0: on 1: off
Bit 4 - Bit 6	Reserved	-
Bit 7	Smoothing function for Velocity offset (OD 60B1h) and Torque offset (OD 60B2h) in EtherCAT mode	0: on 1: off
Bit 8 - Bit 15	Reserved	-

P2.126	Bandwidth for speed loop response		Address: 02FCH 02FDH
Default:	40	Control mode:	All
Unit:	Hz	Setting range:	1 to 1000
Format:	DEC	Data size:	16-bit

Settings:

The setting of P2.126 is effective only when you set P2.032 to 5 or 6.

Bandwidth	Stiffness and response	Applicable mechanical parts
1 - 100 Hz	Low stiffness and low response	Belt, gear rack, reducer, cam
101 - 250 Hz	Medium stiffness and medium response	Screw
251 Hz or above	High stiffness and high response	Direct-coupled mechanical parts

Note: the servo drive automatically sets the response of the position loop according to the setting of P2.126. The function of P2.126 is the same as that of P2-31 for the A2 series models.

P3.xxx Communication parameters

P3.000●	Address		Address: 0300H 0301H
Default:	0x007F	Control mode:	All
Unit:	-	Setting range:	0x0001 - 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

0020

U Z YX

YX	Communication address setting	UZ	Reserved

■ EtherCAT

When P3.018.A = 1, the address refers to the setting of P3.000; when P3.018.A = 0, the address must be set by the controller.

P3.001 - P3.005	Reserved

P3.006■	Digital input (DI) control switch		Address: 030CH 030DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x1FFF
Format:	HEX	Data size:	16-bit

Settings:

Control switch for the source of DI. Each bit of this parameter determines the input source of one DI signal: Bit 0 - Bit 7 correspond to DI1 - DI8. The setting for each bit is as follows:

0: DI status is controlled by the external terminal block.

1: DI status is controlled by P4.007.

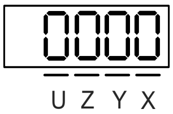
For more information on DI functional planning, refer to:

DI1 - DI8: P2.010 - P2.017

P3.007 - P3.010	Reserved

P3.011	EtherCAT options		Address: 0316H 0317H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	Shown as follows
Format:	HEX	Data size:	16-bit

Settings:



X	Store parameters in EEPROM or not	Z	Reserved
Y	Reserved	U	Reserved

- X: store parameters in EEPROM or not

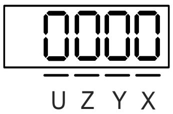
  0: not to store parameters in EEPROM.

  1: when writing through EtherCAT packets (PDOs), store parameters in EEPROM.

  Note: if you set X to 1 and continuously write parameters through EtherCAT PDOs, it shortens the lifespan of the EEPROM.

P3.012	Communication support setting		Address: 0318H 0319H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x1111
Format:	HEX	Data size:	16-bit

Settings:



X	Reserved	Z	Reserved
Y	Reserved	U	Error clearing when the limit alarm occurs

Methods to write parameters to EEPROM (non-volatile):

SDO: parameters are stored in EEPROM when written.

PDO: refer to the setting of P3.011.X. (X = 1: when written through PDOs, parameters are stored in EEPROM; X = 0: when written through PDOs, parameters are not stored in EEPROM.)

Note: rotary means a permanent-magnet synchronous rotary motor.

- U: error clearing when the limit alarm occurs

  0: when the limit alarm (AL014 or AL015) occurs, it needs to be cleared before the servo reverses to move away from the limit.

  1: when the limit alarm (AL014 or AL015) occurs, it does not need to be cleared before the servo reverses to move away from the limit.

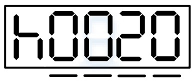
  Note: determine whether the servo has reached the limit with the bit status of OD 6041h (Statusword) and OD 60FDh (Digital inputs).
  Positive limit: OD 6041h [Bit 14] is On & OD 60FDh [Bit 1] is On
  Negative limit: OD 6041h [Bit 15] is On & OD 60FDh [Bit 0] is On
  The status of other bits of OD 6041h (Fault / Warning / Quick stop) remains unchanged when the servo reaches the limit.

P3.013 - P3.017	**Reserved**

P3.018	**EtherCAT special function switch**		**Address: 0324H 0325H**
Default:	0x00002000	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0x01112211
Format:	HEX	Data size:	32-bit

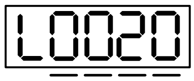
Settings:

High word



D C B A

Low word



U Z Y X

A	Source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on	X	Unit selection for OD 60FFh (Target velocity) and OD 606Ch (Velocity actual value) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode
B	Calculation method of OD 60F4h (Following error actual value)	Y	Reserved
C	Unit selection for the maximum speed of OD 607Fh and OD 6080h	Z	AL185 communication disconnection detection setting
D	Reserved	U	Reserved

- X: unit selection for OD 60FFh (Target velocity) and OD 606Ch (Velocity actual value) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode.

  0: 0.1 rpm

  1: pulse/sec

- Z: AL185 communication disconnection detection setting

  0: disconnection detection starts after EtherCAT communication enters OP state.

  1: disconnection detection starts after EtherCAT communication enters Init state.

  2: disable the disconnection detection.

  Note: when using the ring topology connection, set P3.018.Z to 2 to disable the disconnection detection.

- A: source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on

  0: determined by the setting value in the EEPROM address field (ADR 0x0004) of EtherCAT; this field must be set through the controller interface.

  1: determined by the setting value of servo parameter P3.000.

- B: calculation method of OD 60F4h (Following error actual value)

  0: directly calculates the difference between OD 6062h (Position demand value) and OD 6064h (Position actual value) in units of PUU.

  1: calculates the difference in units of pulse and then converts it to PUU through E-Gear ratio.

- C: unit selection for the maximum speed of OD 607Fh and OD 6080h

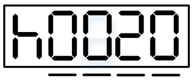
  0: 0.1 rpm for OD 607Fh and rpm for OD 6080h.

  1: pulse/sec for OD 607Fh and OD 6080h.

P3.019	Statusword display content		Address: 0326H 0327H
Default:	0x00000021	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0x0002FFFF
Format:	HEX	Data size:	32-bit

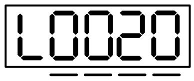
Settings:

High word



D C B A

Low word



U Z Y X

A	OD 6041h additional display and servo status when the limit is reached	X	Reserved
B	Reserved	Y	Reserved
C	Reserved	Z	Display content of OD 6041h [Bit 14]
D	Reserved	U	Reserved

- Z: display content of OD 6041h [Bit 14]

  0: display the positive limit status.

  1: display the current synchronization status between the servo drive and controller. When the status displays On, it indicates that the synchronization is complete (SYNC_OK).

- A: OD 6041h additional display and servo status when the limit is reached

  0: bit status of Quick stop is Off (OD 6041h [Bit 5] = Off, this bit is a B contact); Servo On.

  1: bit status of Fault is On (OD 6041 [Bit 3] = On); Servo Off.

  2: bit status of Fault is On (OD 6041 [Bit 3] = On); Servo On.

  Note: when the servo reaches the limit, the bit statuses are as follows.
  Positive limit: OD 6041h [Bit 7] = On & OD 6041h [Bit 14] = On & OD 60FDh [Bit 1] = On.
  Negative limit: OD 6041h [Bit 7] = On & OD 6041h [Bit 15] = On & OD 60FDh [Bit 0] = On

P3.020 - P3.021	Reserved

P3.022	EtherCAT PDO timeout setting		Address: 032CH 032DH
Default:	0xFF04	Control mode:	All
Unit:	-	Setting range:	0x0002 - 0xFF14
Format:	HEX	Data size:	16-bit

Settings:

When using the PDO to transmit data periodically, use this parameter to set the allowable timeout. The following two sets of digits specify the trigger conditions for AL180 and AL3E3 respectively to ensure that the servo drive receives the PDO. When one of the alarms occurs, it means the packet loss period has exceeded the allowable range.

Digit	UZ	YX
Function	AL180 trigger condition	AL3E3 trigger condition
Range	0x00 (disabled) - 0xFF (default)	0x02 to 0x14

- YX: AL3E3 trigger condition (allowable cycle for elapsed time); applicable to CSP / CSV / CST mode. AL3E3 occurs when the servo drive does not receive the PDO within the set cycle.

  When the communication cycle is 4 ms and you set this parameter to 0x02 (allow two cycles), it means if the servo drive does not receive any PDO within 8 ms, AL3E3 occurs.

- UZ: AL180 trigger condition (allowable duration for elapsed time); applicable to all operation modes. AL180 occurs when the servo drive does not receive the PDO within the set duration (unit: ms). For example, when you set P3.022.UZ to 0x01, the duration is 1 ms; when you set P3.022.UZ to 0x02, the duration is 2 ms; and when you set P3.022.UZ to 0xFF, the duration is 255 ms.

P3.023 - P3.025	Reserved

P3.026	Touch Probe function setting		Address: 0334H 0335H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0001
Format:	HEX	Data size:	16-bit

Settings:

- X: pulse source for Touch Probe 1 and Touch Probe 2

  0: main encoder

  1: auxiliary encoder

P3.027 - P3.028	Reserved

P3.029●	FSoE address		Address: 033AH 033BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

Sets the drive's FSoE address, which cannot be identical to the FSoE addresses of other slave axes.

P3.030 - P3.049	Reserved

P3.050	IP address 1		Address: 0364H 0365H
Default:	192	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's IP address (first quad) for Ethernet communication.

For example: when P3.050 = 192, the drive's IP address is 192.XXX.XXX.XXX

P3.051	IP address 2		Address: 0366H 0367H
Default:	168	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's IP address (second quad) for Ethernet communication.

For example: when P3.051 = 168, the drive's IP address is XXX.168.XXX.XXX

P3.052	IP address 3		Address: 0368H 0369H
Default:	1	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's IP address (third quad) for Ethernet communication.

For example: when P3.052 = 1, the drive's IP address is XXX.XXX.1.XXX

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P3.053	IP address 4		Address: 036AH 036BH
Default:	4	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's IP address (fourth quad) for Ethernet communication.

For example: when P3.053 = 4, the drive's IP address is XXX.XXX.XXX.4

P3.054	Subnet mask 1		Address: 036CH 036DH
Default:	255	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's subnet mask (first quad) for Ethernet communication.

For example: when P3.054 = 255, the drive's subnet mask is 255.XXX.XXX.XXX

P3.055	Subnet mask 2		Address: 036EH 036FH
Default:	255	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's subnet mask (second quad) for Ethernet communication.

For example: when P3.055 = 255, the drive's subnet mask is XXX.255.XXX.XXX

P3.056	Subnet mask 3		Address: 0370H 0371H
Default:	255	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's subnet mask (third quad) for Ethernet communication.

For example: when P3.056 = 255, the drive's subnet mask is XXX.XXX.255.XXX

P3.057	Subnet mask 4		Address: 0372H 0373H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive’s subnet mask (fourth quad) for Ethernet communication.

For example: when P3.057 = 0, the drive’s subnet mask is XXX.XXX.XXX.0

P3.058	Default gateway 1		Address: 0374H 0375H
Default:	192	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive’s default gateway (first quad) for Ethernet communication.

For example: when P3.058 = 192, the drive’s default gateway is 192.XXX.XXX.XXX

P3.059	Default gateway 2		Address: 0376H 0377H
Default:	168	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive’s default gateway (second quad) for Ethernet communication.

For example: when P3.059 = 168, the drive’s default gateway is XXX.168.XXX.XXX

P3.060	Default gateway 3		Address: 0378H 0379H
Default:	1	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive’s default gateway (third quad) for Ethernet communication.

For example: when P3.060 = 1, the drive’s default gateway is XXX.XXX.1.XXX

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P3.061	Default gateway 4		Address: 037AH 037BH
Default:	1	Control mode:	All
Unit:	-	Setting range:	0 - 255
Format:	DEC	Data size:	16-bit

Settings:

The drive's default gateway (fourth quad) for Ethernet communication.

For example: when P3.061 = 1, the drive's default gateway is XXX.XXX.XXX.1

P4.xxx Diagnosis parameters

P4.000	Fault record (last)		Address: 0400H 0401H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The last fault record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to EtherCAT.

P4.001★	Fault record (second to last)		Address: 0402H 0403H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The second to last fault record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to EtherCAT.

P4.002★	Fault record (third to last)		Address: 0404H 0405H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The third to last fault record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to EtherCAT.

P4.003★	Fault record (fourth to last)		Address: 0406H 0407H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The fourth to last fault record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to EtherCAT.

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P4.004★	Fault record (fifth to last)		Address: 0408H 0409H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The fifth to last fault record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to EtherCAT.

P4.005	Reserved

P4.006■	Software digital output register (readable and writable)		Address: 040CH 040DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

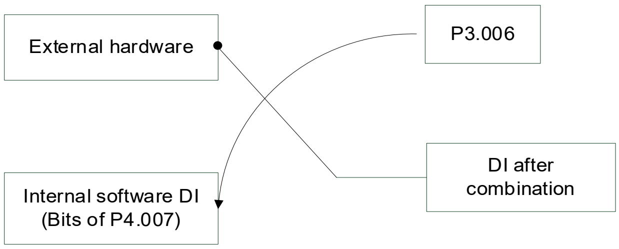
bit 00: corresponds to DO code = 0x30	bit 08: corresponds to DO code = 0x38
bit 01: corresponds to DO code = 0x31	bit 09: corresponds to DO code = 0x39
bit 02: corresponds to DO code = 0x32	bit 10: corresponds to DO code = 0x3A
bit 03: corresponds to DO code = 0x33	bit 11: corresponds to DO code = 0x3B
bit 04: corresponds to DO code = 0x34	bit 12: corresponds to DO code = 0x3C
bit 05: corresponds to DO code = 0x35	bit 13: corresponds to DO code = 0x3D
bit 06: corresponds to DO code = 0x36	bit 14: corresponds to DO code = 0x3E
bit 07: corresponds to DO code = 0x37	bit 15: corresponds to DO code = 0x3F

If you set P2.018 to 0x0130, then the output of DO1 is the bit 00 status of P4.006, and so forth. Set the DO codes (0x30 - 0x3F) through communication DO, and then write to P4.006.

P4.007■	Multi-function for digital input		Address: 040EH 040FH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x3FFF
Format:	HEX	Data size:	16-bit

Settings:

The source of the DI input signal can be the external hardware terminal or the internal software DI (P4.007), which is determined by P3.006. If the corresponding bit of P3.006 is 1, it means the source is the software DI (P4.007); if the corresponding bit is 0, then the source is the hardware DI. See the following figure:



Reading this parameter displays the DI status after combining external DI and software DI.

Writing this parameter means to write the software DI status. The result is the same either you use the panel or communication to set the parameter.

For example: if the read value of P4.007 is 0x0011, it means DI1 and DI5 are On after combination; if the value written to P4.007 is 0x0011, it means the software DI1 and DI5 are On. Refer to P2.010 - P2.014 for more information on DI1 - DI5 functional planning.

P4.008★	Input status of servo drive panel (read-only)		Address: 0410H 0411H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Read-only
Format:	HEX	Data size:	16-bit

Settings:

Read this parameter through communication and check if the five keys (MODE, UP, DOWN, SHIFT, and SET) can function normally.

P4.009★	Digital output status (read-only)		Address: 0412H 0413H
Default:	-	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x001F
Format:	HEX	Data size:	16-bit

Settings:

There is no difference either reading by panel or through communication.

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P4.010▲■	Hardware calibration options		Address: 0414H 0415H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to 14
Format:	DEC	Data size:	16-bit

Settings:

0: reserved	4: calibrate the offset of the current detector (W phase)
1: reserved	5: calibrate the offset of options 3 - 4
2: reserved	6 - 14: reserved
3: calibrate the offset of the current detector (V phase)	-

Note: the calibration function must be enabled by setting P2.008. When calibration, remove all external wirings for torque input and make sure the servo is in the Servo Off state.

P4.011 - P4.014	Reserved

P4.015	Current detector (V1 phase) - hardware offset calibration		Address: 041EH 041FH
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Manually calibrate the hardware offset. The function must be enabled by setting P2.008. Do not change the auxiliary calibration as this parameter cannot be reset.

P4.016	Current detector (V2 phase) - hardware offset calibration		Address: 0420H 0421H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Manually calibrate the hardware offset. The function must be enabled by setting P2.008. Do not change the auxiliary calibration as this parameter cannot be reset.

P4.017	Current detector (W1 phase) - hardware offset calibration		Address: 0422H 0423H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Manually calibrate the hardware offset. The function must be enabled by setting P2.008. Do not change the auxiliary calibration as this parameter cannot be reset.

P4.018	Current detector (W2 phase) - hardware offset calibration		Address: 0424H 0425H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	13926 to 18842
Format:	DEC	Data size:	16-bit

Settings:

Manually calibrate the hardware offset. The function must be enabled by setting P2.008. Do not change the auxiliary calibration as this parameter cannot be reset.

P4.019	IGBT NTC calibration level (cannot reset)		Address: 0426H 0427H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	1 to 4
Format:	DEC	Data size:	16-bit

Settings:

Cool down the drive to 25°C (77°F) before calibration. The function must be enabled by setting P2.008.

P4.020 - P4.023	Reserved

P4.024	Level of undervoltage error		Address: 0430H 0431H
Default:	270	Control mode:	All
Unit:	V (rms)	Setting range:	270 to 380
Format:	DEC	Data size:	16-bit

Settings:

When the voltage of the DC Bus is lower than P4.024 x $\sqrt{2}$, AL003 (Undervoltage) occurs.

P4.025 - P4.077	Reserved

P4.078★	Invalid Frame Counter		Address: 049CH 049DH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	8-bit

Settings:

Refer to the ETG documentation: EtherCAT Diagnosis for Users.

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P4.079★	RX Error Counter		Address: 049EH 049FH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	8-bit

Settings:

Refer to the ETG documentation: EtherCAT Diagnosis for Users.

P4.080★	Forwarded RX Error Counter		Address: 04A0H 04A1H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	8-bit

Settings:

Refer to the ETG's website.

P4.081★	ECAT Processing Unit Error Counter		Address: 04A2H 04A3H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	8-bit

Settings:

Refer to the ETG's website.

P4.082★	PDI Error Counter		Address: 04A4H 04A5H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	8-bit

Settings:

Refer to the ETG's website.

P4.083★	Lost Link Counter		Address: 04A6H 04A7H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	8-bit

Settings:

Refer to the ETG documentation: EtherCAT Diagnosis for Users.

P4.084★	Safety functions module initialization state		Address: 04A8H 04A9H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 1
Format:	DEC	Data size:	16-bit

Settings:

0: initialization of the safety functions module is not complete

1: initialization of the safety functions module is complete

P4.085★	Safety functions module homing state		Address: 04AAH 04ABH
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 1
Format:	DEC	Data size:	16-bit

Settings:

0: home position of the safety functions module is not set (before using the SLP function, execute homing for the safety functions module)

1: home position of the safety functions module is set

Note: for detailed descriptions, refer to the Delta ACS3-SF Safety Functions Module User Manual.

P4.086★	Safety functions module home position diagnosing		Address: 04ACH 04ADH
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 1
Format:	DEC	Data size:	16-bit

Settings:

0: home position of the safety functions module does not need diagnosing

1: home position of the safety functions module requires diagnosing

Note: for detailed descriptions, refer to the Delta ACS3-SF Safety Functions Module User Manual.

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P5.xxx Motion control parameters

P5.000★■	Firmware subversion		Address: 0500H 0501H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	-
Format:	DEC	Data size:	32-bit

Settings:

The low word is the subversion of the firmware.

P5.001 - P5.002	Reserved

P5.003	Deceleration time for auto-protection		Address: 0506H 0507H
Default:	0xEEEFEEFF	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

The parameter setting is divided into D, C, B, A, U, Z, Y, and X (hexadecimal), and the corresponding functions are as follows:

Digit	D	C	B	A	U	Z	Y	X
Function	Reserved	PFQS ILK	Reserved	OVF	SNL	SPL	NL	PL
Range	-	B - F	-	B - F	B - F	B - F	B - F	B - F

1. OVL (DO: 0x12, position command / feedback overflows), SPL, SNL, PL, and NL are auto-protection functions.
2. Use B - F to index the deceleration time settings of P5.031 - P5.035. For example: if you set the digit X to B, then the deceleration time of PL is determined by P5.031.

P5.004 - P5.007	Reserved

P5.008	Positive software limit		Address: 0510H 0511H
Default:	2147483647	Control mode:	All
Unit:	PUU	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

When the motor moves in the positive direction and its position feedback exceeds the value of P5.008, AL283 occurs.

P5.009	Negative software limit		Address: 0512H 0513H
Default:	-2147483648	Control mode:	All
Unit:	PUU	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

When the motor moves in the negative direction and its position feedback exceeds the value of P5.009, AL285 occurs.

P5.010 - P5.015	Reserved

P5.016■	Axis position - main encoder		Address: 0520H 0521H
Default:	0	Control mode:	All
Unit:	PUU	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Read: feedback position of the main encoder, which is the monitoring variable 000 (00h) + offset value (value written in P5.016).

Write: writing any value to the parameter neither changes the monitoring variable 000 (00h) nor affects the position system. It is only for adjusting the offset value when observation.

P5.017 - P5.030	Reserved

P5.031	Deceleration time #11		Address: 053EH 053FH
Default:	3000	Control mode:	All
Unit:	ms (P2.068.U = 0) 10 ms (P2.068.U = 1)	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The deceleration time setting for the functions to decelerate the motor to a stop.

Rotary motor: the duration to decelerate from 3,000 rpm to 0.

P5.032	Deceleration time #12		Address: 0540H 0541H
Default:	5000	Control mode:	All
Unit:	ms (P2.068.U = 0) 10 ms (P2.068.U = 1)	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The deceleration time setting for the functions to decelerate the motor to a stop.

Rotary motor: the duration to decelerate from 3,000 rpm to 0.

P5.033	Deceleration time #13		Address: 0542H 0543H
Default:	8000	Control mode:	All
Unit:	ms (P2.068.U = 0) 10 ms (P2.068.U = 1)	Setting range:	1 to 65500
Format:	DEC	Data size:	16-bit

Settings:

The deceleration time setting for the functions to decelerate the motor to a stop.

Rotary motor: the duration to decelerate from 3,000 rpm to 0.

P5.034	Deceleration time #14		Address: 0544H 0545H
Default:	50	Control mode:	All
Unit:	ms (P2.068.U = 0) 10 ms (P2.068.U = 1)	Setting range:	1 to 1500
Format:	DEC	Data size:	16-bit

Settings:

The deceleration time setting for auto-protection. The default value is small for faster deceleration.

P5.035	Deceleration time #15		Address: 0546H 0547H
Default:	30	Control mode:	All
Unit:	ms (P2.068.U = 0) 10 ms (P2.068.U = 1)	Setting range:	1 to 1200
Format:	DEC	Data size:	16-bit

Settings:

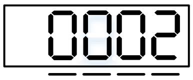
The deceleration time setting for auto-protection. The default value is small for faster deceleration.

P8.xxx Application parameters

P8.001 - P8.013	Reserved

P8.014	Backlash compensation setting		Address: 081CH 081DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0141
Format:	HEX	Data size:	16-bit

Settings:



U Z Y X

X	Backlash compensation switch	Z	Backlash compensation direction
Y	Backlash compensation type	U	Reserved

- X: backlash compensation switch

  0: off

  1: on

- Y: backlash compensation type

  0: direct execution

  1: proportional (based on distance)

  2: reserved

  3: proportional (based on time)

- Z: backlash compensation direction

  0: compensate the positive position command

  1: compensate the negative position command

P8.015	Backlash compensation value		Address: 081EH 081FH
Default:	1	Control mode:	All
Unit:	PUU	Setting range:	1 - 1280000
Format:	DEC	Data size:	32-bit

Settings:

Backlash compensation value in units of PUU.

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P8.016	Backlash compensation distance / time (proportional)		Address: 0820H 0821H
Default:	1	Control mode:	All
Unit:	PUU or 125 μs	Setting range:	1 - 1280000
Format:	DEC	Data size:	32-bit

Settings:

- When P8.014.Y = 1, backlash is compensated in units of PUU.
  Calculate the distance between the command start point and the position set in P8.016 in proportion and multiply it by P8.015, which makes the compensation output.
- When P8.014.Y =3, backlash is compensated in units of 125 μs.
  Calculate the time required from the command start point to the timepoint set in P8.016 in proportion and multiply it by P8.015, which makes the compensation output.

P8.017	Low-pass filter for backlash compensation		Address: 0822H 0823H
Default:	0	Control mode:	PT / CST
Unit:	ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

0: disable the filter.

P8.018 - P8.019	Reserved

PM.xxx Motor parameters

PM.000▲●	Motor type		Address: FD00H FD01H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to 3
Format:	DEC	Data size:	16-bit

Settings:

Value	Motor type
0	Permanent-magnet synchronous rotary motor (SPM)
1	Reserved
2	Reserved
3	Reserved

PM.001▲■	Motor parameter automatic identification function		Address: FD02H FD03H
Default:	0	Applicable motor:	All
Unit:	-	Setting range:	0 to 1
Format:	DEC	Data size:	16-bit

Settings:

0: disable

1: enable

Note: this parameter is invalid if you are using a Delta communication type rotary motor.

PM.002▲●	Motor parameter identification status		Address: FD04H FD05H
Default:	0	Applicable motor:	All
Unit:	-	Setting range:	0 to 1
Format:	DEC	Data size:	16-bit

Settings:

After executing the motor parameter identification, the servo drive automatically detects whether the identification is complete. You can use this parameter to obtain the motor parameter identification status.

0: motor parameter identification is not yet complete.

1: motor parameter identification is complete.

- If the motor parameter identification is not yet complete, switching the servo to the Servo On state triggers AL053. This parameter is automatically set to 1 when the identification is complete.

Note: this parameter value is always 1 and unchangeable if you are using a Delta rotary motor.

PM.003▲●	Encoder type		Address: FD06H FD07H
Default:	0x0010	Applicable motor:	All
Unit:	-	Setting range:	0x0000 - 0x1312
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Reserved	Z	Reserved
Y	Hall sensor	U	Main encoder signal source

- Y: Hall sensor

  0: no Hall sensor

  1: with Hall sensor

  Important: if you set PM.003.Y to 0, the motor moves slightly to detect the magnetic pole when the servo is On for the first time. It is suggested that you execute the Z-axis magnetic field detection after installing the Hall sensor.

  Note: the setting of Y is invalid when you use a Delta communication type rotary motor.

- U: main encoder signal source

  0: CN2

  1: CN5

PM.004▲●	Main encoder resolution		Address: FD08H FD09H
Default:	-	Applicable motor:	All
Unit:	Rotary motor: Pulse signal: pulse/rev Sine wave signal: period/rev Communication type*: pulse/rev or bits	Setting range:	Rotary motor: Pulse signal: 128 to 2^{28} Sine wave signal: 64 to $2^{30\text{-PM.005}}$ Communication type*: 7 to 30
Format:	DEC	Data size:	32-bit

Settings:

Set the resolution according to the encoder specifications.

When PM.003.U = 0, input the resolution of the encoder connected to CN2; when PM.003.U = 1, input the resolution of the encoder connected to CN5.

- Rotary motor:

1. Pulse encoder: input the number of single-phase pulses per revolution; the resolution of the motor is (PM.004 x 4) pulse/rev.
2. Sine wave encoder: input the number of single-phase sine waves per revolution; the resolution of the motor is (PM.004 x $2^{\text{PM.005}}$) pulse/rev.
3. Communication type encoder: input the resolution according to the Motor Parameter Identification Wizard process.

Note: communication type indicates the third-party encoder communication formats supported by A3-EP, which are BiSS C and Hiperface.

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PM.005	Sine wave signal interpolation magnification		Address: FD0AH FD0BH
Default:	11	Applicable motor:	Third-party rotary motor
Unit:	-	Setting range:	2 - 11
Format:	DEC	Data size:	16-bit

Settings:

This parameter improves the motor resolution with interpolation magnification. It is applicable to sine wave encoders but not to pulse encoders.

The resolution of the sine wave encoder after interpolation is PM.004 x $2^{PM.005}$.

PM.006▲●	Motor UVW and Hall sensor phase sequences		Address: FD0CH FD0DH
Default:	0x0000	Applicable motor:	Third-party rotary motor
Unit:	-	Setting range:	0x0000 - 0x0011
Format:	HEX	Data size:	16-bit

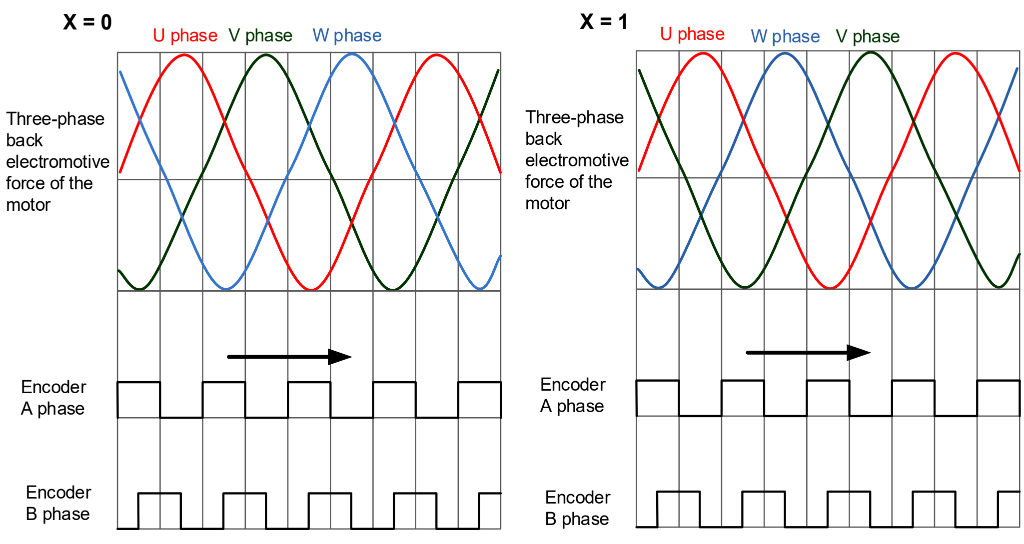
Settings:

During the motor parameter identification process, the servo drive automatically detects the phase sequences of the motor UVW and Hall sensor. You can use this parameter to obtain this information.

■ X: motor UVW phase sequence and encoder incremental direction

0: when the encoder A phase is ahead of B phase, the motor phase sequence is U, V, and W.

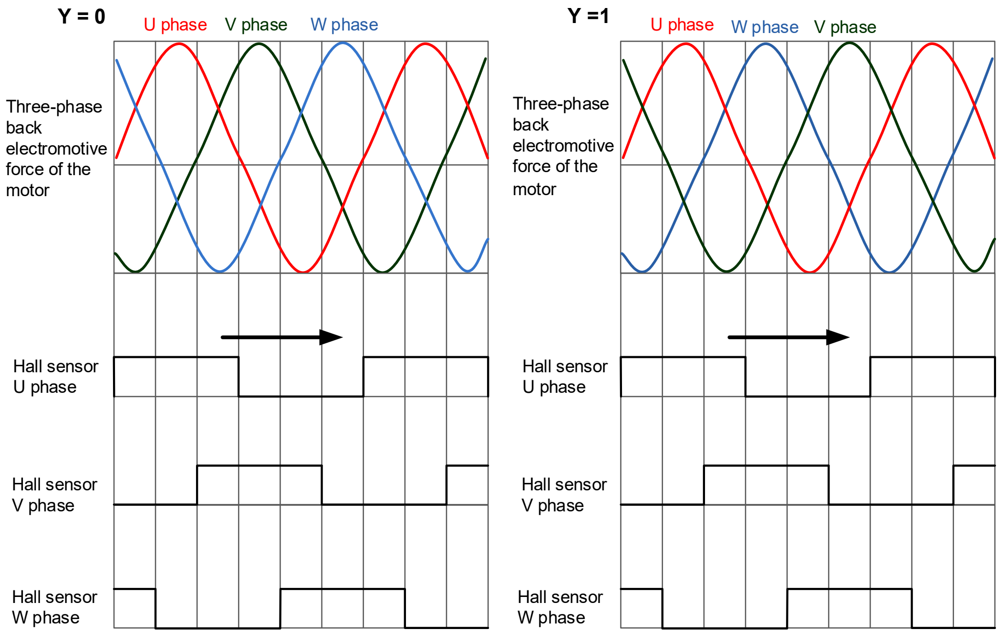
1: when the encoder A phase is ahead of B phase, the motor phase sequence is U, W, and V.



- Y: motor UVW phase sequence and Hall sensor UVW direction

  0: when the Hall sensor phase sequence is U, V, and W, the motor phase sequence is U, V, and W.

  1: when the Hall sensor phase sequence is U, V, and W, the motor phase sequence is U, W, and V.

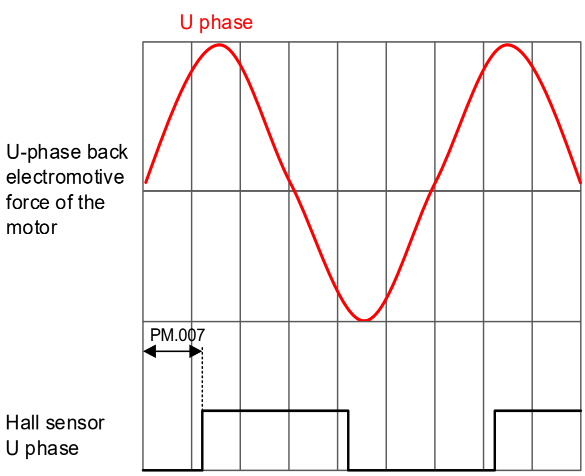


PM.007▲●	Hall sensor offset angle		Address: FD0EH FD0FH
Default:	0.0	Applicable motor:	All
Unit:	Degree	Setting range:	0.0 to 360.0
Format:	DEC	Data size:	16-bit

Settings:

During the motor parameter identification process, the servo drive automatically detects the offset angle of the Hall sensor. You can use this parameter to obtain this information.

When the Hall sensor causes hysteresis due to different moving directions of the motor, the U-phase zero point of the Hall sensor is based on the central angle of the hysteresis. For the description of hysteresis, refer to the diagram of PM.008.



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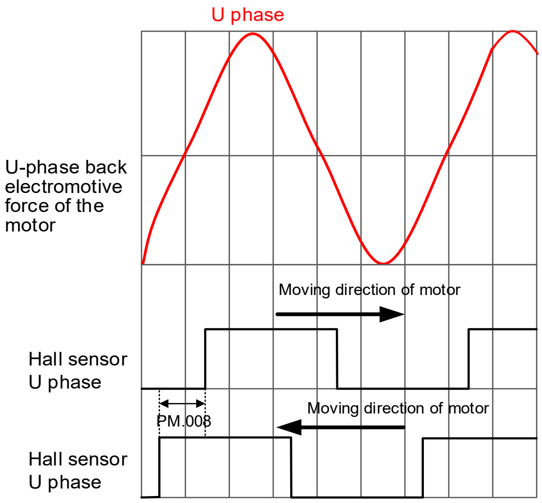
PM.008 ▲●	Hall sensor hysteresis width		Address: FD10H FD11H
Default:	0.0	Applicable motor:	All
Unit:	Degree	Setting range:	0.0 to 360.0
Format:	DEC	Data size:	16-bit

Settings:

During the motor parameter identification process, the servo drive automatically detects the hysteresis width of the Hall sensor. You can use this parameter to obtain this information.



PM.009 ▲	Electrical angle settings		Address: FD12H FD13H
Default:	0x0000	Applicable motor:	Third-party rotary motor
Unit:	-	Setting range:	0x0000 - 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 0	Reserved	-
Bit 1	Magnetic field detection after powering on	Magnetic field detection after the absolute encoder is powered on (cycle the power for this setting to take effect) 0: after the absolute encoder is powered on, the initial magnetic field angle is determined by PM.010. 1: after the absolute encoder is powered on, the initial magnetic field angle is determined by PM.012 (Initial magnetic field detection function).
Bit 2	Detecting the number of magnetic poles	Set whether to automatically detect the number of magnetic poles when executing the motor parameter identification for the third-party rotary motor. 0: automatically detecting the number of magnetic poles 1: not detecting the number of magnetic poles. Manually input the number of magnetic poles to PM.028 Permanent-magnet rotary motor pole number.
Bit 3	Reserved	-

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Bit	Function	Description
Bit 4	Using the Hall sensor to determine whether the motor magnetic field is deviated	Use the Hall sensor to determine whether the motor magnetic field is deviated 0: disable 1: enable If the deviation between the magnetic field detected by the Hall sensor and the actual magnetic field of the motor is too large, AL055 (Motor magnetic field error) occurs.
Bit 5 - Bit 15	Reserved	-

PM.010▲●	Offset between absolute encoder zero point and motor magnetic field zero point		Address: FD14H FD15H
Default:	180.0	Applicable motor:	Absolute motor
Unit:	Degree	Setting range:	0.0 to 360.0
Format:	DEC	Data size:	16-bit

Settings:

The accumulated angle starting from the motor magnetic field zero point to the absolute encoder zero point with the motor rotating in the positive (CCW) direction (positive phase sequence).

This parameter value will be automatically detected and input during the motor parameter identification process.

PM.011▲	Current setting for initial magnetic field detection		Address: FD16H FD17H
Default:	100	Applicable motor:	Third-party rotary motor
Unit:	%	Setting range:	0 to 250
Format:	DEC	Data size:	16-bit

Settings:

If the motor is not installed with a Hall sensor, the servo drive will automatically detect the motor magnetic field when the servo is switched to On for the first time. Use this parameter to set the current value during the motor magnetic field detection. If you are using a Hall sensor (PM.003.Y = 1), you do not need to set this parameter.

The current affects the motion range of the motor during magnetic field detection, and the servo obtains the magnetic field data through the motion.

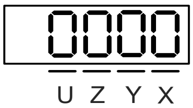
Note the following when setting this parameter:

1. When the friction between the motor and the mechanical parts is too large, magnetic field detection error may occur which triggers AL052. Setting PM.011 higher reduces the occurrence of AL052.
2. When the motor moves too much during the magnetic field detection, setting PM.011 lower reduces the motion range during detection.

Note:
1. It is suggested that you do not use the initial magnetic field detection for the Z axis. Install a Hall sensor to the Z axis for magnetic field detection.
2. The gantry application requires a Hall sensor for magnetic field detection. Thus, using this function is not suggested.

PM.012▲	**Initial magnetic field detection**		**Address: FD18H FD19H**
Default:	0x0044	Applicable motor:	Third-party rotary motor
Unit:	-	Setting range:	0x0011- 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:



X	Initial magnetic field detection condition 1	Z	Initial magnetic field detection delay time
Y	Initial magnetic field detection condition 2	U	Special function

■ X: initial magnetic field detection condition 1

Value	1	2	3	4	5	6	7	8
Electrical angle	0.25	0.5	0.75	1	1.25	1.5	1.75	2
Value	9	A	B	C	D	E	F	-
Electrical angle	2.25	2.5	2.75	3	3.25	3.5	3.75	-

■ Y: initial magnetic field detection condition 2

Value	1	2	3	4	5	6	7	8
Electrical angle	10	20	30	40	50	60	70	80
Value	9	A	B	C	D	E	F	-
Electrical angle	90	100	110	120	130	140	150	-

■ Z: initial magnetic field detection delay time

When the servo is switched to Servo On for the first time, the initial magnetic field detection starts after this set delay time.

Value	0	1	2	3	4	5	6	7
Time (ms)	0	50	100	150	200	250	300	350
Value	8	9	A	B	C	D	E	F
Time (ms)	400	450	550	650	750	850	950	1050

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■ U: special function

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8
	U							

Bit	Function	Description
Bit 12, Bit 13	Initial magnetic field detection for Z axis	■ Before using this function, first set Bit 14 and Bit 15 to 0 (quick mode). ■ When executing parameter identification for the Z axis, place the translation stage under the mechanical part at a balanced position. Check for the mechanical limits, set this parameter, and then execute initial magnetic field detection, which leads to successful detection. Bit 13 = 0, Bit 12 = 0: disable this function. Bit 13 = 0, Bit 12 = 1: when the PUU value of the motor position feedback increases towards a positive value, the motor reaches the mechanical limit. Bit 13 = 1, Bit 12 = 0: when the PUU value of the motor position feedback decreases towards a negative value, the motor reaches the mechanical limit.
Bit 14, Bit 15	Initial magnetic field detection when power is on	■ The initial magnetic field detection is not available for motors with brakes. ■ The smooth mode does not support the initial magnetic field detection for Z axis. Bit 15 = 0, Bit 14 = 0: quick mode; the motor moves significantly. Bit 15 = 0, Bit 14 = 1: smooth mode; the motor moves slightly.

The usage of PM.012.U [Bit 14] is described as follows.

	PM.012.U [Bit 14] = 0	PM.012.U [Bit 14] = 1
Mode	Quick mode	Smooth mode
Motion of motor magnetic field	Great	Small
Detection time	Short	Long
Condition for alarm triggering	When the initial magnetic field detection conditions 1 and 2 (PM.012.X and PM.012.Y) cannot be met at the same time, the servo starts the detection again. If the detection fails for 4 consecutive times, the servo displays AL052.	The mode only refers to the result of the initial magnetic field detection condition 1 (PM.012.X). If the detection fails for 10 consecutive times, the servo displays AL052.
Condition for successful detection	When the motion of the motor magnetic field is greater than PM.012.X and the command controlling the magnetic field is greater than PM.012.Y.	When the motion of the motor magnetic field is smaller than PM.012.X.
Condition setting	The default setting is recommended.	The default setting is recommended.
Important	If you are using a motor with a brake for the Z-axis mechanical part, do not use the initial magnetic field detection function. Use a Hall sensor or an absolute motor instead.	

PM.013▲●	Motor flag		Address: FD1AH FD1BH
Default:	0	Applicable motor:	All
Unit:	-	Setting range:	0 to 1
Format:	DEC	Data size:	16-bit

Settings:

When a third-party motor is used, the servo drive automatically detects and writes the parameter identification status to this parameter after executing the motor parameter identification process. If you have not executed the motor parameter identification process, set this parameter to 1.

1. PM.013 is automatically set to 0 when a Delta communication type motor is used.
2. When you are not using a Delta communication type motor, set PM.013 to 1.
   PM.013 is automatically set to 1 when you execute the Motor Parameter Identification Wizard.

PM.014	Reserved

PM.015	Current loop proportional gain (kp)			Address: FD1EH FD1FH
Operation interface:	Panel / software	Communication	Applicable motor:	All
Default:	0.000	0	Data size:	32-bit
Unit:	1 rad/s	0.001 rad/s	-	-
Setting range:	0.000 to 1023.000 (rotary)*	0 to 1023000 (rotary)*		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 rad/s	1500 = 1.5 rad/s		

Settings:

You do not need to set this parameter when using a Delta communication type motor.

Increasing the current control gain enhances the current response and reduces the current control errors. However, setting the value too high may cause vibration and noise. It is suggested that general users do not adjust this parameter.

Note: rotary means a permanent-magnet synchronous rotary motor.

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PM.016	Current loop integral gain (ki)		Address: FD20H FD21H
Default:	0	Applicable motor:	All
Unit:	%	Setting range:	0 to 32767
Format:	DEC	Data size:	16-bit

Settings:

You do not need to set this parameter when using a Delta communication type motor.

Increasing the current control integral enhances the current response and reduces the current control errors. However, setting the value too high may cause vibration and noise. It is suggested that general users do not adjust this parameter.

PM.017 - PM.018	Reserved

PM.019▲	Load increase gain		Address: FD26H FD27H
Default:	100	Applicable motor:	All
Unit:	%	Setting range:	0 to 600
Format:	DEC	Data size:	16-bit

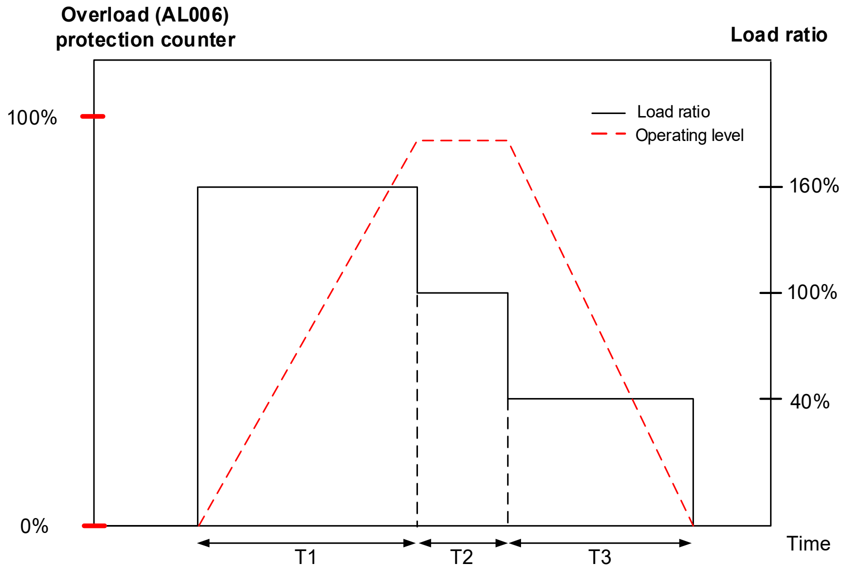
Settings:

Use this parameter to adjust the motor overload protection time. For the setting details, refer to the following table and figures.

Load ratio	Operating time	Load ratio	Operating time
0	12 sec × PM.020	260%	3.9 sec × PM.019
20%	12.3 sec × PM.020	280%	3.3 sec × PM.019
40%	13.6 sec × PM.020	300%	2.8 sec × PM.019
60%	16.3 sec × PM.020	320%	2.5 sec × PM.019
80%	22.6 sec × PM.020	340%	2.2 sec × PM.019
100%	N/A	360%	2.0 sec × PM.019
120%	263.8 sec × PM.019	380%	1.8 sec × PM.019
140%	35.2 sec × PM.019	400%	1.6 sec × PM.019
160%	17.6 sec × PM.019	420%	1.4 sec × PM.019
180%	11.2 sec × PM.019	440%	1.3 sec × PM.019
200%	8 sec × PM.019	460%	1.2 sec × PM.019
220%	6.1 sec × PM.019	480%	1.1 sec × PM.019
240%	4.8 sec × PM.019	500%	1 sec × PM.019

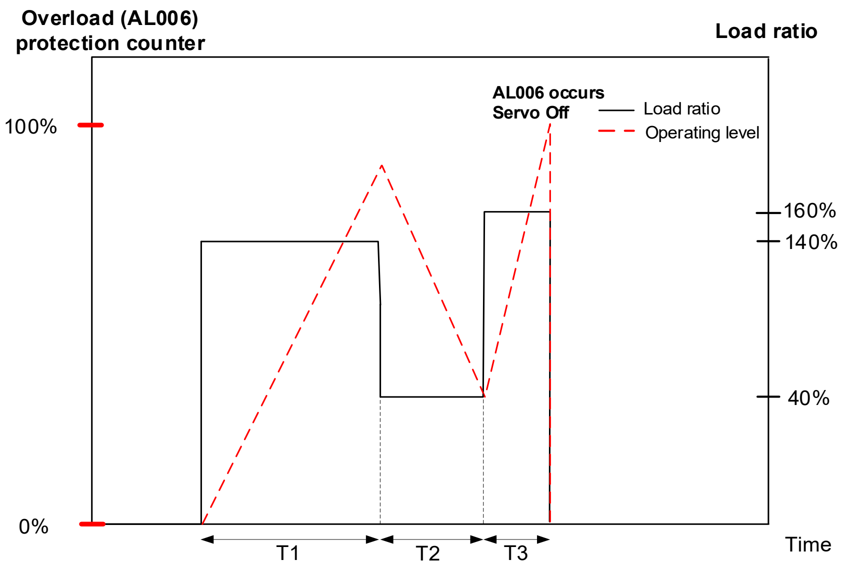
The “Operating time” in the preceding table means the time required for the motor protection level to reach the overload level from the normal level. When the protection level reaches the overload level, AL006 is triggered. The measurement basis of the load ratio is 100%. When the ratio is above 100%, the operating time refers to PM.019 (Load increase gain); when the ratio is less than 100%, the operating time refers to PM.020 (Load decrease gain).

Example 1:



1. When the load ratio is 160%, the overload (AL006) protection counter continues to increase.
2. When the load ratio is 100%, the operating level is leveled off.
3. When the load ratio is 40%, the overload (AL006) protection counter continues to decrease.

Example 2:



As shown in the preceding figure, the load ratio affects whether the load is accumulated. When the load accumulates over 100%, the operating time must be taken into consideration, or else AL006 occurs.

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PM.020▲	Load decrease gain		Address: FD28H FD29H
Default:	100	Applicable motor:	All
Unit:	%	Setting range:	15 to 600
Format:	DEC	Data size:	16-bit

Settings:

This parameter setting affects the operating time of the load decrease and the overall motion planning. Refer to the description of PM.019.

PM.021	Reserved

PM.022▲●	Motor temperature sensor		Address: FD2CH FD2DH
Default:	0	Applicable motor:	Third-party rotary motor
Unit:	-	Setting range:	0 to 3
Format:	DEC	Data size:	16-bit

Settings:

Sets the type of motor temperature sensor connected to the servo drive CN1 Pin 11 and Pin 12 (see Section 3.3.1).

0: a motor temperature sensor is not connected

1: reserved

2: NTC thermistor (level protection)

3: PTC thermistor (level protection)

PM.023	Reserved

PM.024▲	Motor temperature sensor resistance		Address: FD30H FD31H
Default:	50000	Applicable motor:	Third-party rotary motor
Unit:	ohm	Setting range:	0 to 50000
Format:	DEC	Data size:	32-bit

Settings:

This parameter is valid only when PM.022 is set to 2 or 3. Refer to the Resistance/Temperature table for the NTC or PTC thermistor, and then set PM.024 to the resistance value corresponded to the desired temperature upper limit.

PM.025 - PM.027	Reserved

PM.028▲●	Permanent-magnet rotary motor pole number		Address: FD38H FD39H
Default:	10	Applicable motor:	Permanent-magnet rotary motor
Unit:	pole	Setting range:	2 to 100
Format:	DEC	Data size:	16-bit

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

Note: pole number = pole pair x 2

PM.029▲●	Permanent-magnet rotary motor rated current			Address: FD3AH FD3BH
Operation interface:	Panel / software	Communication	Applicable motor:	Permanent-magnet rotary motor
Default:	-	-	Data size:	16-bit
Unit:	Arms	0.01 Arms		
Setting range:	0.00 to servo drive rated current	0 to servo drive rated current x 100		
Format:	Two decimals	DEC		
Example:	1.5 = 1.5 Arms	150 = 1.5 Arms		

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

Unit conversion between Ampere peak (Apk) and Ampere RMS (Arms):

$$\text{Apk} = \text{Arms} \times \sqrt{2}$$

PM.030▲●	Permanent-magnet rotary motor maximum current			Address: FD3CH FD3DH
Operation interface:	Panel / software	Communication	Applicable motor:	Permanent-magnet rotary motor
Default:	-	-	Data size:	16-bit
Unit:	Arms	0.01 Arms		
Setting range:	0.00 to servo drive maximum current	0 to servo drive maximum current x 100		
Format:	Two decimals	DEC		
Example:	1.5 = 1.5 Arms	150 = 1.5 Arms		

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

Unit conversion between Ampere peak (Apk) and Ampere RMS (Arms):

$$\text{Apk} = \text{Arms} \times \sqrt{2}$$

PM.031▲	Permanent-magnet rotary motor rated speed		Address: FD3EH FD3FH
Default:	-	Applicable motor:	Permanent-magnet rotary motor
Unit:	rpm	Setting range:	0 to 4000
Format:	DEC	Data size:	16-bit

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

PM.032▲	Permanent-magnet rotary motor maximum speed		Address: FD40H FD41H
Default:	-	Applicable motor:	Permanent-magnet rotary motor
Unit:	rpm	Setting range:	0 to 7500
Format:	DEC	Data size:	16-bit

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

PM.033▲	Permanent-magnet rotary motor torque constant			Address: FD42H FD43H
Operation interface:	Panel / software	Communication	Applicable motor:	Permanent-magnet rotary motor
Default:	-	-	Data size:	32-bit
Unit:	Nm/Arms	0.001 Nm/Arms		
Setting range:	0.000 to 65.535	0 to 65535		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 Nm/Arms	1500 = 1.5 Nm/Arms		

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

PM.034▲	Permanent-magnet rotary motor rotor inertia			Address: FD44H FD45H
Operation interface:	Panel / software	Communication	Applicable motor:	Permanent-magnet rotary motor
Default:	-	-	Data size:	32-bit
Unit:	10^{-4} kg·m^2	0.001 x 10^{-4} kg·m^2		
Setting range:	0.000 to 2147483.647	0 to 2147483647		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 x 10^{-4} kg·m^2	1500 = 1.5 x 10^{-4} kg·m^2		

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

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PM.035▲	Permanent-magnet rotary motor phase resistance			Address: FD46H FD47H
Operation interface:	Panel / software	Communication	Applicable motor:	Permanent-magnet rotary motor
Default:	-	-	Data size:	32-bit
Unit:	ohm	0.001 ohm		
Setting range:	0.000 to 2000.000	0 to 2000000		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 ohm	1500 = 1.5 ohm		

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

PM.036▲	Permanent-magnet rotary motor phase inductance			Address: FD48H FD49H
Operation interface:	Panel / software	Communication	Applicable motor:	Permanent-magnet rotary motor
Default:	-	-	Data size:	32-bit
Unit:	mH	0.01 mH		
Setting range:	0.00 to 1000.00	0 to 100000		
Format:	Two decimals	DEC		
Example:	1.5 = 1.5 mH	150 = 1.5 mH		

Settings:

Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

PM.037	Reserved

PM.038▲	Permanent-magnet rotary motor back electromotive force constant			Address: FD4CH FD4DH
Operation interface:	Panel / software	Communication	Applicable motor:	Permanent-magnet rotary motor
Default:	-	-	Data size:	32-bit
Unit:	Vrms/rpm	0.0001 Vrms/rpm		
Setting range:	0.0000 to 2.2876	0 to 22876		
Format:	Four decimals	DEC		
Example:	1.5 = 1.5 Vrms/rpm	15000 = 1.5 Vrms/rpm		

Settings:

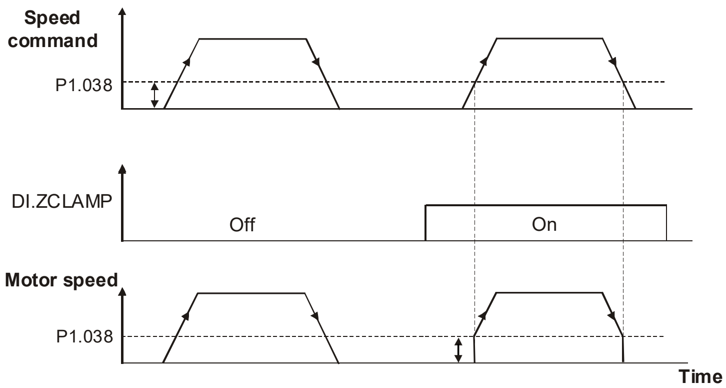
Input the correct value according to the specifications of the third-party permanent-magnet rotary motor.

PM.039 - PM.063	Reserved

Table 7.1 Digital input (DI) descriptions

Value: 0x01			
DI name	Description	Triggering method	Control mode
SON	When this DI is on, the servo is activated (Servo On).	Level triggered	All

Value: 0x02			
DI name	Description	Triggering method	Control mode
ARST	After you troubleshoot an alarm, this DI is on and the alarm message display on the drive panel is cleared.	Rising-edge triggered	All

Value: 0x05			
DI name	Description	Triggering method	Control mode
ZCLAMP	When the motor speed is slower than the setting of P1.038 (Zero speed range), the motor stops operating when this DI is on.  	Level triggered	CSV, PV

Value: 0x21			
DI name	Description	Triggering method	Control mode
EMGS	When this DI is on, the motor stops immediately.	Level triggered	All

Value: 0x22			
DI name	Description	Triggering method	Control mode
NL (CWL)	Negative inhibit limit (normally closed contact).	Level triggered	All

Value: 0x23			
DI name	Description	Triggering method	Control mode
PL (CCWL)	Positive inhibit limit (normally closed contact).	Level triggered	All

Value: 0x24			
DI name	Description	Triggering method	Control mode
ORGP	During homing, when this DI is on, the servo regards this position as the homing origin.	Rising- and falling-edge triggered	HM

Value: 0x47			
DI name	Description	Triggering method	Control mode
PFQS	The deceleration time for this emergency stop can be set by P5.003. When this DI is on, AL35F occurs and the motor starts decelerating. When the speed reaches 0, AL3CF occurs and the servo is switched to Servo Off.	Rising-edge triggered	All

Value: 0x4D			
DI name	Description	Triggering method	Control mode
ILK	When this DI is triggered, the motor decelerates to a stop and the servo is Off, and the deceleration time is set by P5.003. When this DI is On, the EtherCAT state machine cannot be switched, and the servo drive displays AL310.	Level triggered	All

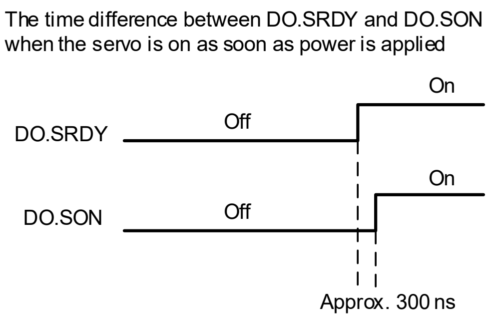
Note: the digital input function is disabled when P2.010 - P2.017 are set to 0x0100.

Table 7.2 Digital output (DO) descriptions

Value: 0x01

DO name	Description	Triggering method	Control mode
SRDY	When the control circuit power and main circuit power are applied to the drive, this DO is on if no alarm occurs.	Level triggered	All

Value: 0x02

DO name	Description	Triggering method	Control mode
SON	When the servo is activated (Servo On), this DO is on if no alarm occurs. 	Level triggered	All

Value: 0x03

DO name	Description	Triggering method	Control mode
ZSPD	When the motor speed is slower than the setting of P1.038 (Zero speed range), this DO is on.	Level triggered	All

Value: 0x04

DO name	Description	Triggering method	Control mode
TSPD	When the motor speed is faster than the setting of P1.039 (Target speed detection level), this DO is on.	Level triggered	All

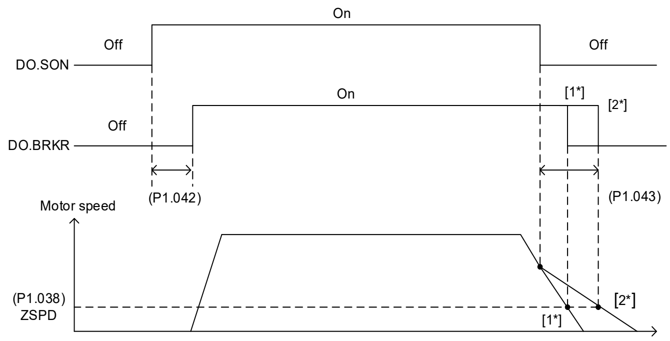
Value: 0x05

DO name	Description	Triggering method	Control mode
TPOS	When the pulse error is smaller than the setting of P1.054 (Pulse range for position reached), this DO is on.	Level triggered	PP, CSP

Value: 0x06

DO name	Description	Triggering method	Control mode
TQL	When the torque limit is activated, this DO is on.	Level triggered	All (except for PT and CST)

Value: 0x07			
DO name	Description	Triggering method	Control mode
ALRM	When a servo alarm occurs, this DO is on.	Level triggered	All

Value: 0x08			
DO name	Description	Triggering method	Control mode
BRKR	Output signal of the electromagnetic brake control. Setting P1.042 and P1.043 adjusts the delay time before and after the electromagnetic brake control function is activated and deactivated.  Refer to the note in P1.042.	Level triggered	All

Value: 0x09			
DO name	Description	Triggering method	Control mode
HOME	When homing is complete, it means the position system and position counter are defined and this DO is on. ■ When power is applied for the first time, this DO is off. ■ When homing is complete, this DO is on. ■ During operation, this DO is on until the position counter overflows (including commands or feedback). Then, this DO turns off. ■ When the homing command is triggered, this DO is off.	Level triggered	HM

Value: 0x0D			
DO name	Description	Triggering method	Control mode
ABSW	When an absolute encoder alarm occurs, this DO is on.	-	All

Value: 0x0E			
DO name	Description	Triggering method	Control mode
IDXD	When this DO is on, it means the rotary axis position is defined. The rotary axis position is defined once the homing is complete.	-	All

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Value: 0x10			
DO name	Description	Triggering method	Control mode
OLW	This DO is on when the overload accumulative time exceeds $\mathbf{t_{OL}}$. However, if the overload accumulative time exceeds the overload allowable time of the servo, the servo sends the overload alarms AL006 and AL023. $\mathbf{t_{OL}}$ = Overload allowable time of the servo x setting value of P1.056 (Motor output overload warning level) For example: P1.056 = 60 (unit: %). When the output average load of the servo drive is 200% and the output time exceeds 8 seconds, the overload alarms (AL023 and AL006) occur. $\mathbf{t_{OL}}$ = 8 sec x 60% = 4.8 sec That is, when the output average load of the servo drive is 200% for over $\mathbf{t_{OL}}$ = 4.8 seconds, DO.OLW (DO: 0x10) is on. If the duration exceeds 8 seconds, the servo drive sends AL006 (overload) and AL023 (early overload warning).	Level triggered	All

Value: 0x11			
DO name	Description	Triggering method	Control mode
WARN	Output signal of warnings.	Level triggered	All

Value: 0x12			
DO name	Description	Triggering method	Control mode
OVF	Position command / feedback overflows.	Level triggered	PP

Value: 0x13			
DO name	Description	Triggering method	Control mode
SNL (SCWL)	Software limit (negative limit). PP / CSP: the motor stops; this DI is On and AL285 is displayed. PT / PV / CST / CSV: the motor does not stop; this DI is On and AL285 is displayed.	Level triggered	PP, CSP, PT, PV, CST, CSV

Value: 0x14			
DO name	Description	Triggering method	Control mode
SPL (SCCWL)	Software limit (positive limit). PP / CSP: the motor stops; this DI is On and AL283 is displayed. PT / PV / CST / CSV: the motor does not stop; this DI is On and AL283 is displayed.	Level triggered	PP, CSP, PT, PV, CST, CSV

Value: 0x19			
DO name	Description	Triggering method	Control mode
SP_OK	Motor speed reaches the target speed: in Speed modes, when the error between the speed feedback and the command is smaller than the value of P1.047, this DO is on.	Level triggered	PV, CSV

Value: 0x30			
DO name	Description	Triggering method	Control mode
SPO_0	Output bit 00 of P4.006.	Level triggered	All

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Value: 0x31			
DO name	Description	Triggering method	Control mode
SPO_1	Output bit 01 of P4.006.	Level triggered	All

Value: 0x32			
DO name	Description	Triggering method	Control mode
SPO_2	Output bit 02 of P4.006.	Level triggered	All

Value: 0x33			
DO name	Description	Triggering method	Control mode
SPO_3	Output bit 03 of P4.006.	Level triggered	All

Value: 0x34			
DO name	Description	Triggering method	Control mode
SPO_4	Output bit 04 of P4.006.	Level triggered	All

Value: 0x35			
DO name	Description	Triggering method	Control mode
SPO_5	Output bit 05 of P4.006.	Level triggered	All

Value: 0x36			
DO name	Description	Triggering method	Control mode
SPO_6	Output bit 06 of P4.006.	Level triggered	All

Value: 0x37			
DO name	Description	Triggering method	Control mode
SPO_7	Output bit 07 of P4.006.	Level triggered	All

Value: 0x38			
DO name	Description	Triggering method	Control mode
SPO_8	Output bit 08 of P4.006.	Level triggered	All

Value: 0x39			
DO name	Description	Triggering method	Control mode
SPO_9	Output bit 09 of P4.006.	Level triggered	All

Value: 0x3A			
DO name	Description	Triggering method	Control mode
SPO_A	Output bit 10 of P4.006.	Level triggered	All

Value: 0x3B			
DO name	Description	Triggering method	Control mode
SPO_B	Output bit 11 of P4.006.	Level triggered	All

Value: 0x3C			
DO name	Description	Triggering method	Control mode
SPO_C	Output bit 12 of P4.006.	Level triggered	All

Value: 0x3D			
DO name	Description	Triggering method	Control mode
SPO_D	Output bit 13 of P4.006.	Level triggered	All

Value: 0x3E			
DO name	Description	Triggering method	Control mode
SPO_E	Output bit 14 of P4.006.	Level triggered	All

Value: 0x3F			
DO name	Description	Triggering method	Control mode
SPO_F	Output bit 15 of P4.006.	Level triggered	All

Value: 0x41			
DO name	Description	Triggering method	Control mode
MAG_OK	Initial magnetic field detection is complete.	Level triggered	All

Note: the digital output function is disabled when P2.018 - P2.022 are set to 0x0100.

Table 7.3 Monitoring variables descriptions

Description of monitoring variables:

Item	Description
Monitoring code	Each monitoring variable has a code, and you can set the code to P0.002 and monitor the variable.
Format	Each monitoring variable is stored in the 32-bit format (long integer) in the servo drive.
Category	Basic variables / extension variables: 1. Basic variables: the variables displayed on the panel within the loop of pressing the UP / DOWN keys in Monitoring mode. 2. Extension variables: the variables other than basic variables.
Monitoring method	Panel display / mapping: 1. Panel display: monitor with the panel 2. Mapping: monitor the variables or parameters by mapping parameters
Panel display	1. Use the MODE key to switch to the Monitoring mode and press the UP / DOWN keys to select the variable to monitor. 2. Input the code of the variable to be monitored into P0.002 and start monitoring. Press the SHIFT key on the panel to switch between high and low word display; press the SET key on the panel to switch between decimal and hexadecimal display.
Mapping	1. Parameters that support monitoring variable mapping: P0.009 - P0.013. Refer to Section 7.2 Parameter descriptions. 2. Read the monitoring variables through communication using mapping parameters. 3. The values of the mapping parameters (P0.009 - P0.013) are the content of the basic variables (17h, 18h, 19h, and 1Ah). To monitor the value through P0.009, set P0.017 to the value to read (refer to P0.002). When reading the data through communication, you can directly read the data specified by P0.017; when monitoring the data through the panel (P0.002 = 23), you can find that the panel displays “VAR-1” and then the value of P0.009.

The property code of each monitoring variable is described in the following table:

Property	Description
B	BASE: basic variables. Select the variables with the UP / DOWN keys on the panel.
D1 D2	Decimal place displayed on the panel: D1 indicates 1 decimal place and D2 indicates 2 decimal places.
Dec	Only decimal display is available on the panel, and you cannot switch to hexadecimal display by pressing the SET key.
Hex	Only hexadecimal display is available on the panel, and you cannot switch to decimal display by pressing the SET key.

Monitoring variables are described in the following table by the code sequence:

Code	Variable name / property	Description
000 (00h)	Feedback position (PUU) B	Current position feedback of the motor encoder. Unit: Pulse of User Unit (PUU)
001 (01h)	Position command (PUU) B	Current position of the Position command. Unit: Pulse of User Unit (PUU)
002 (02h)	Following error (PUU) B	Difference between the Position command before filtered and the position feedback. Unit: Pulse of User Unit (PUU)
003 (03h)	Feedback position (pulse) B	Current position feedback of the motor encoder. Unit: encoder unit (pulse)
004 (04h)	Position command (pulse) B	Current position of the Position command. Unit: encoder unit (pulse)
005 (05h)	Following error (pulse) B	Difference between the Position command before filtered and the position feedback. Unit: encoder unit (pulse)
006 (06h)	Position command frequency B	Frequency of the pulse command received by the drive. Unit: Kpps. Applicable to CSP mode.
007 (07h)	Speed feedback B D1 Dec	Current motor speed. Unit: 0.1 rpm This is the speed processed by the low-pass filter, which makes it more stable.
009 (09h)	Speed command B	Integrated Speed command. Unit: 0.1 rpm
011 (0Bh)	Torque command B	Integrated Torque command. Unit: percentage (%)
012 (0Ch)	Average load rate B	Average load rate (moving average every 20 ms) from the servo drive. Unit: percentage (%)
013 (0Dh)	Peak load rate B	Maximum load rate from the drive. Unit: percentage (%)
014 (0Eh)	DC Bus voltage B	Rectified capacitor voltage. Unit: Volt
015 (0Fh)	Load inertia ratio B D1 Dec	Ratio of the load inertia to the motor inertia. Unit: 0.1 times
016 (10h)	IGBT temperature B	Temperature of IGBT. Unit: °C
017 (11h)	Resonance frequency B Dec	Resonance frequency of the system, consisting of two sets of frequencies: F1 and F2 When monitoring from the panel, press the SHIFT key to switch between F1 and F2: F2 displays zero decimal places; F1 displays 1 decimal place. When reading by communication (mapping parameter): Low word returns frequency F2. High word returns frequency F1.

Code	Variable name / property	Description
018 (12h)	Z phase offset B Dec	Offset value between motor position and Z phase; range: -4999 to +5000. When the motor position overlaps with Z phase, the value is 0; the greater the absolute value of this variable, the greater the offset.
019 (13h)	Mapping parameter content #1 B	Returns the value of P0.025 which is mapped by P0.035.
020 (14h)	Mapping parameter content #2 B	Returns the value of P0.026 which is mapped by P0.036.
021 (15h)	Mapping parameter content #3 B	Returns the value of P0.027 which is mapped by P0.037.
022 (16h)	Mapping parameter content #4 B	Returns the value of P0.028 which is mapped by P0.038.
023 (17h)	Mapping monitoring variable #1 B	Returns the value of P0.009 which is mapped by P0.017.
024 (18h)	Mapping monitoring variable #2 B	Returns the value of P0.010 which is mapped by P0.018.
025 (19h)	Mapping monitoring variable #3 B	Returns the value of P0.011 which is mapped by P0.019.
026 (1Ah)	Mapping monitoring variable #4 B	Returns the value of P0.012 which is mapped by P0.020.
027 (1Bh)	Z phase offset B	Offset value between motor position and Z phase. (Only available for Delta CNC controllers.)
028 (1Ch)	Alarm code Dec B	The alarm code (in decimal). The value being converted to the hexadecimal notation is identical to the alarm code displayed in P0.001 and the error code of communication models.
032 (20h)	Position error (PUU)	Difference between the Position command after filtered and the position feedback. Unit: Pulse of User Unit (PUU)
033 (21h)	Position error (pulse)	Difference between the Position command after filtered and the position feedback. Unit: encoder unit (pulse)
038 (26h)	Voltage level of the battery	Voltage level of the battery in an absolute encoder. To display the voltage level, enable the absolute encoder setting (P2.069).
039 (27h)	DI status (integrated) Hex	Integrated DI status of the drive. Each bit corresponds to one DI channel. Source includes hardware channel or P4.007, which is determined by P3.006.
040 (28h)	DO status (hardware) Hex	Actual status from the DO hardware. Each bit corresponds to one DO channel.
041 (29h)	Status of the drive	Returns the value of P0.046. Refer to the description of P0.046.
051 (33h)	Speed feedback (immediate) D1 Dec	Actual motor speed at present. Unit: 0.1 rpm

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Code	Variable name / property	Description
053 (35h)	Torque command (integrated) D1 Dec	Integrated Torque command. Unit: 0.1%
054 (36h)	Torque feedback D1 Dec	Actual motor torque at present. Unit: 0.1%
055 (37h)	Current feedback D2 Dec	Actual motor current at present. Unit: 0.01 ampere (Amp)
056 (38h)	DC Bus voltage D1 Dec	Rectified capacitor voltage. Unit: 0.1 Volt
091 (5Bh)	Rotary axis position feedback	Immediate feedback of the rotary axis position. Unit: Pulse of User Unit (PUU)
096 (60h)	Drive firmware version Dec	Includes 2 versions: DSP and CPLD. When monitoring from the panel, press the SHIFT key to switch between DSP and CPLD: DSP displays zero decimal places; CPLD displays 1 decimal place. When reading by communication (mapping parameter): Low word returns the DSP version number. High word returns the CPLD version number.
111 (6Fh)	Error code of the servo drive	Error code from the servo drive: control loop of the servo only, not including the motion controller.
119 (77h)	EtherCAT state machine	1: Init 2: Pre-Operational (Pre-OP) 4: Safe-Operational (Safe-OP) 8: Operational (OP)
120 (78h)	Communication error rate	When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase.
123 (7Bh)	Value returned when monitoring by panel	Monitoring value displayed when returned to the panel.
-24	Speed control error	Difference between the Speed command and the speed feedback. Unit: rpm
-80	Encoder communication error rate	When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase.
-91	Overload (AL006) protection counter	Displays the motor load during operation. When the value reaches 100%, AL006 occurs.
-111	Regeneration error (AL005) protection counter	When the value of the regeneration counter reaches 100%, AL005 occurs.
-124	Encoder temperature	Monitor the encoder temperature.
-169	Regenerative resistor overload (AL086) protection counter	The average power consumption (unit: %) of the regenerative resistor when the energy of the servo drive capacitor is released to the regenerative resistor. When the value reaches 100%, AL086 occurs.
-177	Main encoder’s Hall sensor phase sequence and Z pulse data	Use the bit to determine the UVW phase sequence of the main encoder’s Hall sensor and Z pulse. Bit 0: Z pulse, Bit 1: U phase, Bit 2: V phase, Bit 3: W phase. Note: use the **Scope** function of ASDA-Soft to monitor this value at the sampling rate of 16k / 20k. This monitoring variable is only available on third-party incremental encoders.
-201	Number of pulse leakage	The accumulated number of pulse leakage monitored when the pulse leakage detection function is enabled (P2.081 = 1).
-202	Motor electrical angle	The current electrical angle multiplied by 4.

Code	Variable name / property	Description
-207	Regenerative resistor power consumption	The power consumption (unit: %) of the regenerative resistor at the time when the energy of the servo drive capacitor is released to the regenerative resistor.
-233	Maximum speed control error	Maximum difference between the Speed command and the speed feedback. Unit: rpm

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Absolute System 8

This chapter introduces the absolute servo system, including the installation of the battery box, and the steps and procedures for initializing and operating the system for the first time.

Important

A complete absolute servo system includes an A3-EP servo drive, an absolute servo motor, and a battery box. The battery box supplies power to the system so that the encoder continues operating when the main power to the servo drive is off. In addition, the absolute encoder can continuously record the motor's actual position at any time, even when the motor shaft is rotated after power off. The absolute servo system must be used with an absolute motor; if it is used with an incremental motor and the absolute function is enabled (P2.069.X =1), AL069 occurs.

When using an absolute motor, make sure the motor speed is lower than 250 rpm at the moment when power is on. When the encoder is operating with the battery, make sure the maximum speed of the motor does not exceed 200 rpm.

To determine whether an absolute motor is used, check the model number as follows:

ECM-B3 series servo motor

ECM－B3□－□□□□□□□□□

A / P: absolute motor

Correctly connect the battery box to the encoder. One servo drive uses one single battery box; two servo drives can share one dual battery box. Use the specified Delta's encoder cable to connect to the battery box.

8.1 Battery specifications

Precautions

Carefully read the following precautions. Only use batteries in accordance with the specifications as follows to avoid damage or dangerous conditions.

8

WARNING

- Make sure the installation location is free of water vapor, corrosive gas, and inflammable gas.
- Properly store the batteries to avoid short-circuiting.
- Do not short-circuit the positive and negative electrodes of the battery, or install the batteries in reverse direction.
- Do not use new and used batteries together to avoid losing power or shortening the life of the new batteries. Replacing all batteries with new ones is recommended.
- The battery box J1 port connects to the battery, and J2 port connects to the servo drive.
- The current consumption is nearly 0 when the absolute origin position is not established. Once the absolute origin position is established, the battery power consumption starts. To avoid battery power consumption when the machine is in transport, it is recommended that you disconnect the battery or do not establish the absolute origin position.
- When installing and wiring the battery box, follow the instructions in this manual to avoid danger.

STOP

- Do not place the battery in fire or an environment over 100°C (212°F), or this may cause a fire or an explosion.
- The batteries are non-rechargeable. Do not charge the batteries as this may cause an explosion.
- Do not directly weld on the surface of the battery.

Battery specifications

Item	Li/SOCl2 Cylindrical Battery
Model number	ER14505
Delta model number	ASD-CLBT0100
International standard size	AA
Nominal voltage	3.6V
Nominal capacity	2700 mAh
Max. continuous discharge current	100 mA
Max. pulse current	200 mA
Dimensions (D x H)	14.5 x 50.5 mm
Weight	Approx. 19 g
Operating temperature	-40°C to +85°C (-40°F to +185°F)
Supplier	EVE Energy Co., Ltd
Part number for the battery with wires	0991023281

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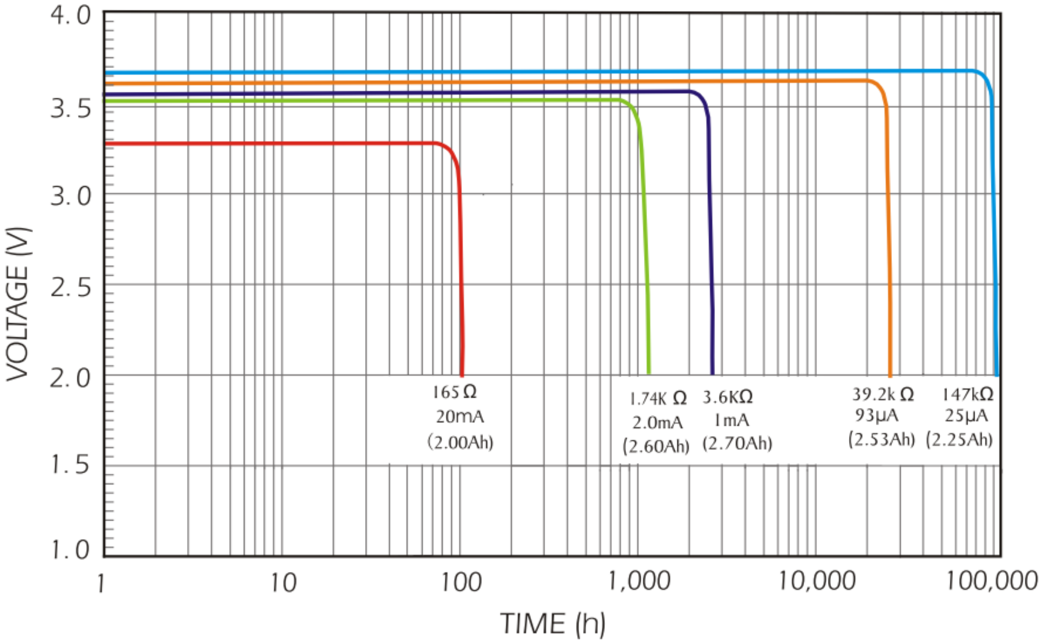
Battery life



Source: EVE Energy Co. ER14505 Discharge Characteristics

(1) The preceding figure illustrates the discharge current curves measured in the constant current test. According to the five curves shown in the preceding figure, if the voltage of the battery keeps at 3V or higher, the battery life expectancy is as shown in the following table. Therefore, the lowest battery voltage level for an absolute encoder is defined as 3.1V.

Motor	Current consumption (μA) when the encoder operates with the battery	Battery life expectancy (month)
ECM-B3□-□A□□□□□□□ ECM-B3□-□P□□□□□□□	30	87.5

(2) When the battery is stored in a cool dry place, the battery voltage can be kept at 3.6V or above for up to 5 years.

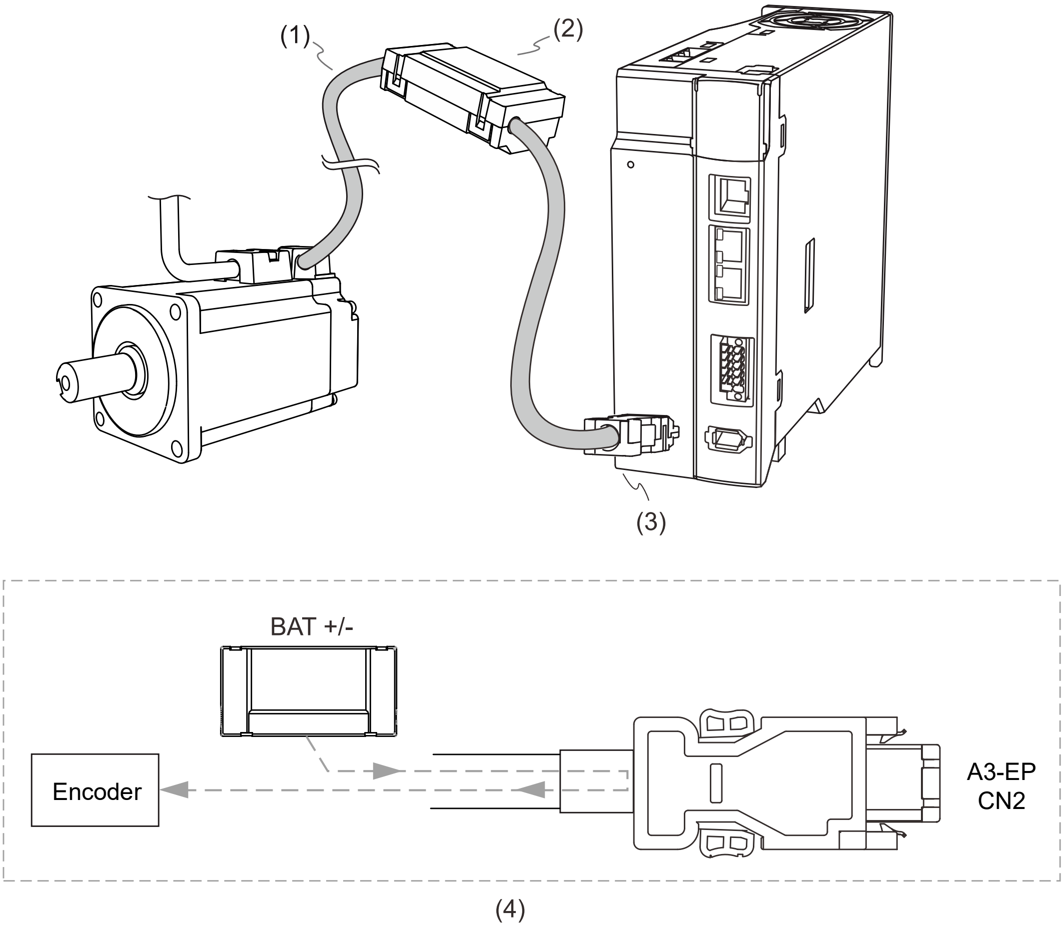
Note: the battery life expectancy is measured with a test using a servo drive, a motor, and a single battery.

8.2 Installation

- For the pin assignments of the absolute encoder cables, refer to Section 3.4.
- When selecting the battery box and the absolute encoder cables, refer to Appendix B.

8.2.1 Installing the battery box in the servo system

When an absolute encoder is used, the battery supplies power directly to the encoder, so wiring the battery wires to the CN2 connector of the servo drive is not required.
Do not wire Pin 3 and Pin 4 of the servo drive CN2 connector, or it will cause damage to the internal circuit.



(1) Encoder cable; (2) Single battery box; (3) CN2 connector; (4) Battery box wiring

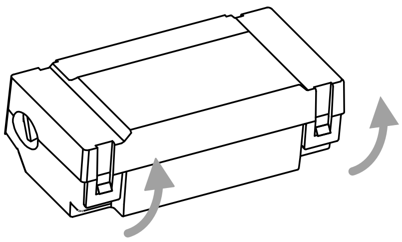
8.2.2 Installing and replacing batteries

When the servo drive displays the alarm AL061, it means the voltage of the absolute encoder is too low. In this case, you can set P0.002 to 38 to read the voltage level of the battery. If the displayed value is lower than 31 (indicating that the voltage is under 3.1V), replace the battery immediately to avoid data loss.

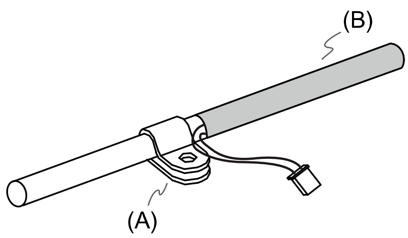
When the battery voltage is under 2.9V, the motor's position record may be lost. If the servo drive displays the alarm AL060, it will then display AL06A after the battery is replaced. In this case, you need to re-establish the absolute origin position.

Caution: replace the battery only when the main power to the servo drive is on to avoid absolute position data loss.

Single battery box

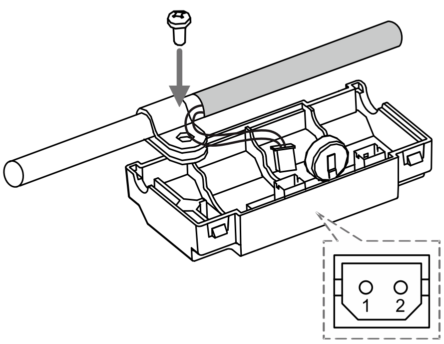


Step 1:
Release the snap-fit tabs on both sides and remove the battery box cover.

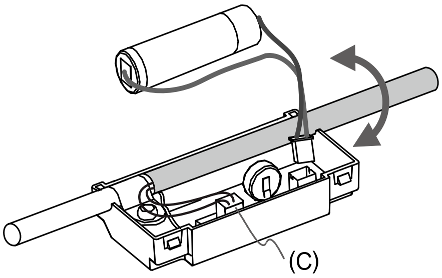


Step 2:
Attach the cable clamp to the encoder cable. Note that the cable clamp should be placed as close as possible to the heat shrink.

(A) Cable clamp; (B) Heat shrink

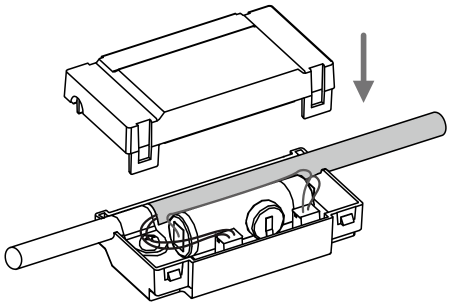


Step 3:
Tighten a cable clamp screw to secure the clamp to the battery box, and then connect the battery box connection wire to the J2 port on the battery box.



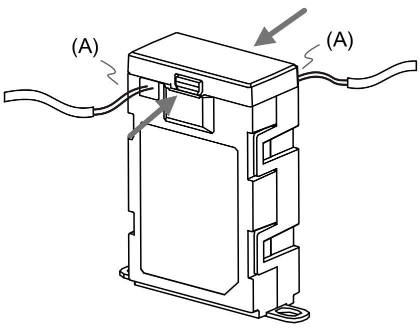
Step 4:
Install a new battery, and then connect the battery wire to the J1 port on the battery box. Replace the battery only when the main power to the servo drive is on. Do not remove the battery box connection wire which connects to the servo drive, or else the system data may be lost.

(C) Battery box connection wire



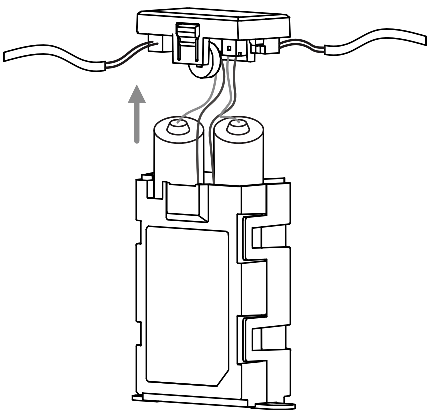
Step 5:
Place the wires into the box and fit the cover, and then the battery replacement and battery box installation is complete.

Dual battery box

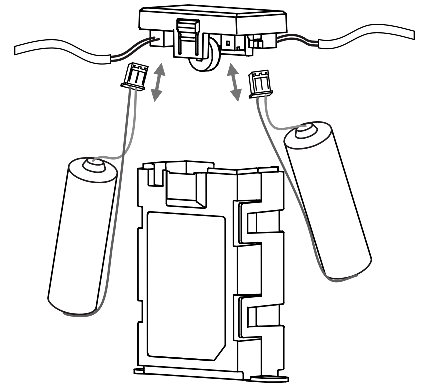


Step 1:
Release the snap-fit tabs on both sides and remove the battery box lid.
Replace the batteries only when the main power to the servo drive is on. Do not remove the battery box connection wires which connect to the servo drive, or else the system data may be lost.

(A) Battery box connection wires

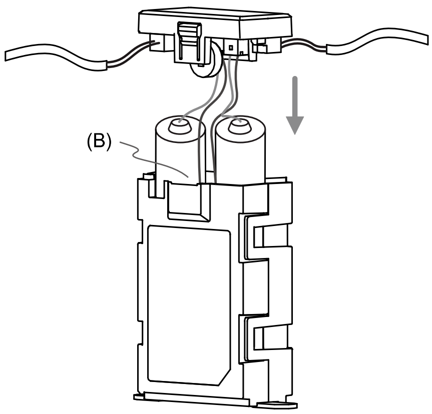


Step 2:
Lift the lid and pull out the batteries.



Step 3:

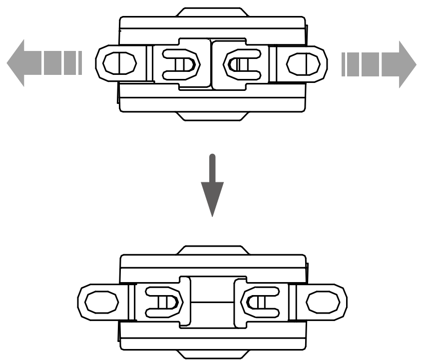
Unplug the connectors to remove the used batteries, and then plug in the wires of the new batteries. Complete the replacement within ten minutes to avoid data loss.



Step 4:

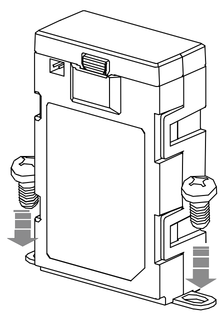
Fit the lid.

(B) Push the battery wires inward so that the batteries both fit inside the box.



Step 5:

Pull the clips at the bottom of the battery box outward.



Step 6:

Tighten the screws to secure the battery box.

8.3 System initialization and operating procedures

8.3.1 System initialization

- AL06A occurs when you initialize the absolute system for the first time because the position system has not been established. Clear the alarm by setting up the position system.
- When the main power is not supplied to the servo drive, and insufficient battery power or interruption of battery power causes loss of the position system, AL060 occurs when the servo drive is powered on.
- In the absolute system, the position data is within a specific range.
  When the number of motor revolutions exceeds the range of -32,768 to +32,767, AL062 occurs.
  When the PUU number exceeds the range of -2,147,483,648 to +2,147,483,647, AL289 occurs.
- In addition to the preceding alarms (which are enabled by default), you can use P2.070 [Bit 2] to set whether to show AL062, AL066, and AL289 when the absolute position system overflows (the number of revolutions or the PUU number exceeds the preceding ranges). This function is for systems which use incremental commands to operate in a single direction.

Steps for system initialization:

1. Establish the absolute origin position. When the position is established, AL06A (or AL060) is automatically cleared. The controller can establish the absolute origin position in pulses or PUU. You can establish the absolute origin position with parameter settings or the EtherCAT Homing Mode.
2. When the system is power cycled, the controller can access the motor's absolute position through communication. Based on the setting of P2.070 [Bit 1], the controller can read the position value in PUU (refer to Section 8.3.3) or the number of revolutions plus the pulse number within a single revolution (refer to Section 8.3.2).

8.3.2 Pulse number

If you want P0.051 to show the number of revolutions, and P0.052 to show the pulse number within a single turn, first set P2.070 [Bit 1] to 1, and then set P0.049.X to 1 or 3. Otherwise, P0.051 and P0.052 cannot show the actual values. Refer to Section 8.3.5 for detailed descriptions and usage.

When the motor rotates clockwise, the number of revolutions is defined as a negative value. When the motor rotates counterclockwise, the number of revolutions is defined as a positive value. The countable number of revolutions is between -32,768 and +32,767. AL062 occurs once the number of revolutions overflows (i.e. the number exceeds the range). To clear the alarm, you must re-establish the absolute origin position. If P2.070 has been set to not show AL062, then the system ignores the overflow.

If the motor rotates counterclockwise and the number of revolutions reaches +32,767, the value jumps to -32,768 in the next turn and keeps increasing from -32,768 to +32,767. If the motor rotates clockwise and the number of revolutions reaches -32,768, the value jumps to +32,767 in the next turn and keeps decreasing from +32,767 to -32,768.

In addition, there are 16,777,216 pulses (0 to 16,777,215) in one motor revolution. Pay attention to the motor's rotation direction. You can read the number of revolutions and the pulse number within a single turn through communication.

Total pulse number = m (number of revolutions) x 1,677,7216 + pulse number within a single turn (0 to 16,777,215).

The conversions between pulse number and PUU are as follows:

When P1.001.Z = 0: the PUU number when power on = pulse number x $\frac{\text{P1.045}}{\text{P1.044}}$ + P6.001.

When P1.001.Z = 1: the PUU number when power on = (-1) x pulse number x $\frac{\text{P1.045}}{\text{P1.044}}$ + P6.001.

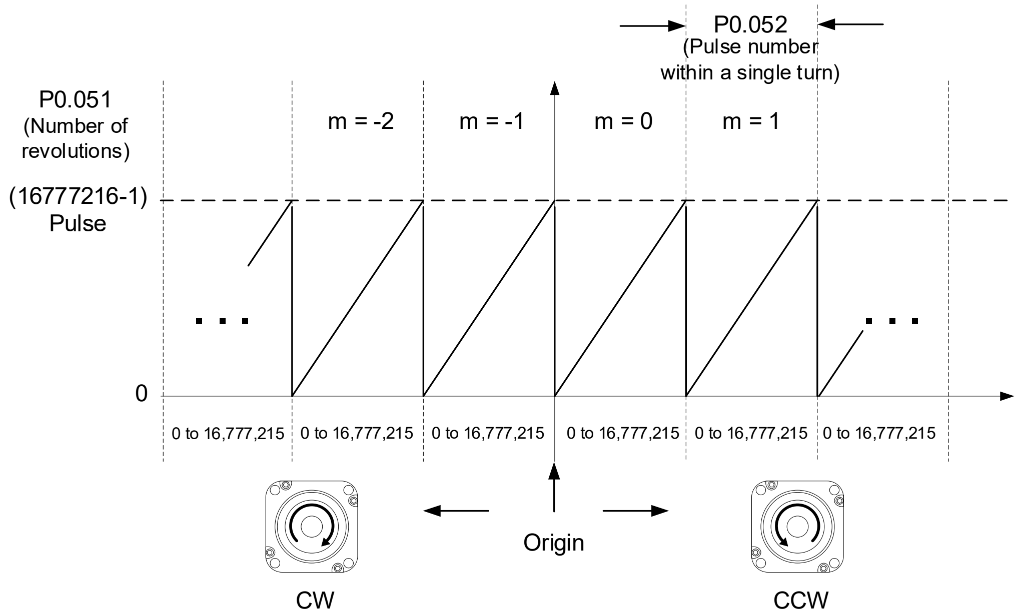


Figure 8.3.2.1 Absolute position in pulses

8.3.3 PUU number

The PUU number is a 32-bit absolute position data with a positive or negative sign. The relation between the pulse number within a single turn and motor shaft rotation angle is defined by the E-Gear ratio P1.044 (OD 6093h sub1) and P1.045 (OD 6093h sub2). When the motor is operating in the positive direction, the PUU number increases; when the motor is operating in the negative direction, the PUU number decreases. The motor operation direction (positive / negative) is defined by P1.001.Z; operation in the clockwise direction does not necessarily mean the motor is operating in the positive direction. The feedback position (PUU) can be read by setting the monitoring variable of P0.002 to 0 or through OD 6064h under the EtherCAT mode.

If the motor keeps operating in the same direction and the number of revolutions exceeds the range of -32,768 to +32,767, the servo drive generates AL062 or AL066. If the motor's PUU number exceeds the range of -2,147,483,648 to +2,147,483,647, the servo drive generates AL289. When an overflow issue occurs to the absolute encoder, re-establish the absolute origin position to clear the alarm. You can set P2.070 to determine whether the servo drive generates AL062, AL066, and AL289 when an overflow occurs. If the motor rotates in the positive direction and the absolute position data reaches +2,147,483,647 PUU, the value jumps to -2,147,483,648 in the next turn and keeps increasing from -2,147,483,648 to +2,147,483,647. If the motor rotates in the negative direction and the absolute position data reaches -2,147,483,648 PUU, the value jumps to +2,147,483,647 in the next turn and keeps decreasing from +2,147,483,647 to -2,147,483,648.

See the following examples:

Example 1: when P1.044 = 16,777,216 and P1.045 = 100,000, the motor needs 100,000 PUU to run one revolution. 2,147,483,647 ÷ 100,000 ≒ 21,474.8, so once the motor runs over 21,474.8 (< 32,767) revolutions in the positive direction, AL289 occurs.

Example 2: when P1.044 = 16,777,216 and P1.045 = 10,000, the motor needs 10,000 PUU to run one revolution. 2,147,483,647 ÷ 10,000 ≒ 214,748.3, so once the motor runs over 32,767 (< 214,748.3) revolutions in the positive direction, AL062 occurs.

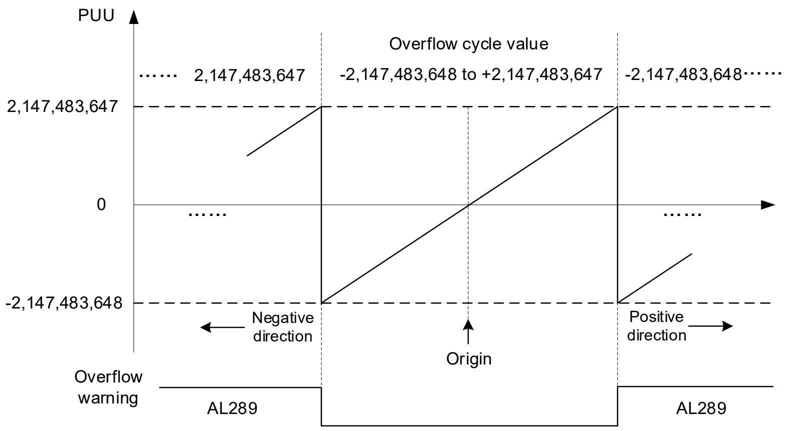


Figure 8.3.3.1 Absolute position in PUU

Note: after the absolute origin position is established, any modification of P1.001.Z or the E-Gear ratio P1.044 (OD 6093h sub1) and P1.045 (OD 6093h sub2) changes the original setting of the absolute origin position. If one of these parameters is changed, re-establish the absolute origin position.

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8.3.4 Establishing the absolute origin position

When the absolute position is lost, the servo drive provides several methods to establish the absolute origin position. The following details each method.

8.3.4.1 Establishing the absolute origin position with parameters

Set P2.071 to 0x0001 to establish the absolute origin position through the panel or through communication. Since P2.071 is write-protected by P2.008, you must set P2.008 to 271 first, and then set P2.071 to 0x0001. Then, the absolute position system immediately resets.

8.3.4.2 Establishing the absolute origin position with EtherCAT Homing Mode

You can establish the absolute origin position by using the Homing Modes defined by CiA 402 protocol under the EtherCAT mode.

8.3.5 Reading the absolute position

You can access the data of the absolute encoder through two communication methods: instant access or register access.

Instant access

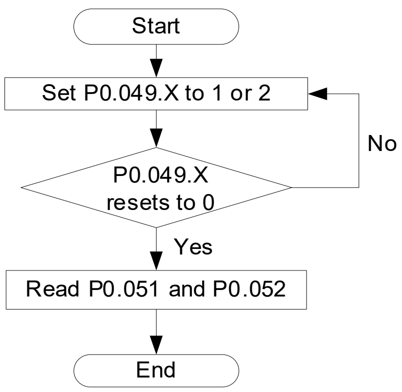
There are two ways to directly read the motor's position feedback once the servo is powered on.

1. Set P0.017 (Select content displayed by status monitoring register 1) to 0, and then read P0.009 (Status monitoring register 1) to access the motor's feedback position (PUU).
2. Set the monitoring variable of P0.002 to 0, and then read the feedback position (PUU) through the panel.

Register access

The motor's position is stored in the drive's register and the read value does not change with the motor's movement. Once you set P0.049.X through communication, the encoder absolute position is stored in P0.051 and P0.052, which data unit can be set with P2.070 [Bit 1].

- When P0.049.X = 1, the drive does not clear the position error while reading the position value. After finishing reading P0.051 and P0.052, set P0.049.X to 1 again to read the value.
- When P0.049.X = 2, the drive clears the position error while reading the position value. After the motor is enabled, it moves slightly forward and backward to correct its position even when stopped. To avoid the difference between the actual and read positions, set P0.049.X to 2 to update the motor's actual position to the drive, which clears the position error.
  For example, the motor's current position is 20000, but the actual position is between 19999 and 20001 under normal circumstances. If you issue a command to read the position when the motor is at 20001, the read value is 20001 and updated to the drive as the motor position, which clears the position error. If the read position is not updated, a command error occurs.
- When P0.049.X = 3, the drive does not clear the position error while reading the position value. After finishing reading P0.051 and P0.052, you can continuously read the position value without setting P0.049.X again.
- When the position data is updated to P0.051 and P0.052, P0.049.X automatically resets to 0, meaning the controller can access the values of P0.051 and P0.052.
- P0.050 shows the status of the absolute encoder. When "absolute position lost" or "absolute number of revolutions overflows" is shown, the read absolute position is invalid. In this case, you must re-establish the absolute origin position.



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Third-Party Motor 9

This chapter provides the usage and setting details for the third-party motors.

9

9.1 Third-party motors

A3-EP supports motors of the following communication formats. Refer to Chapter 3 for detailed wiring instructions.

Communication format	CN2	CN5	Motor parameter identification	Note
Delta communication type	✓	✓	Not required	-
BiSS C	✓	✓	Required	Brands: Renishaw, Beckhoff
Hiperface	-	✓	Required	Brand: Rockwell
Sine wave type (SIN/COS)	-	✓	Required	-
Pulse type (TTL)	-	✓	Required	-

9.1.1 Third-party communication type motors

A3-EP supports the third-party encoder communication formats: BiSS C and Hiperface.

The maximum resolution of the encoders supported by the servo drive is as follows. Encoders with the resolution higher than the following specification are not supported.
Rotary encoder: 30-bit

When the servo drive is connected to a third-party communication type motor, make sure that the setting value of PM.003.U matches the actual configuration; if you change the PM.003.U setting, you need to cycle power on the servo drive. After power cycling, if AL011 (CN2 communication failed) or AL041 (CN5 is disconnected) is not displayed, execute the Motor Parameter Identification Wizard and then cycle power on the servo drive after the identification is complete.

In addition, follow these instructions.

1. **Changing the machine:** even if there are multiple machines with the same mechanical design, you need to import the parameter file for each machine **individually** and then cycle power on the servo drive. Next, execute the Motor Parameter Identification Wizard for each machine and cycle power on the servo drive after the identification is complete.
2. **Changing the motor:** after connecting the servo drive to a third-party motor and completing the configuration, if you need to change to a third-party motor of different communication formats, re-configure the Motor Parameter Identification Wizard.
3. When using the absolute function, establish the absolute position of the origin; otherwise sudden unintended acceleration of motor may occur.

9.2 Setting the third-party motor with ASDA-Soft

The motor parameter identification of Z-axis motors may fail due to gravity. It is suggested that you place the motor on a flat surface before starting the identification.

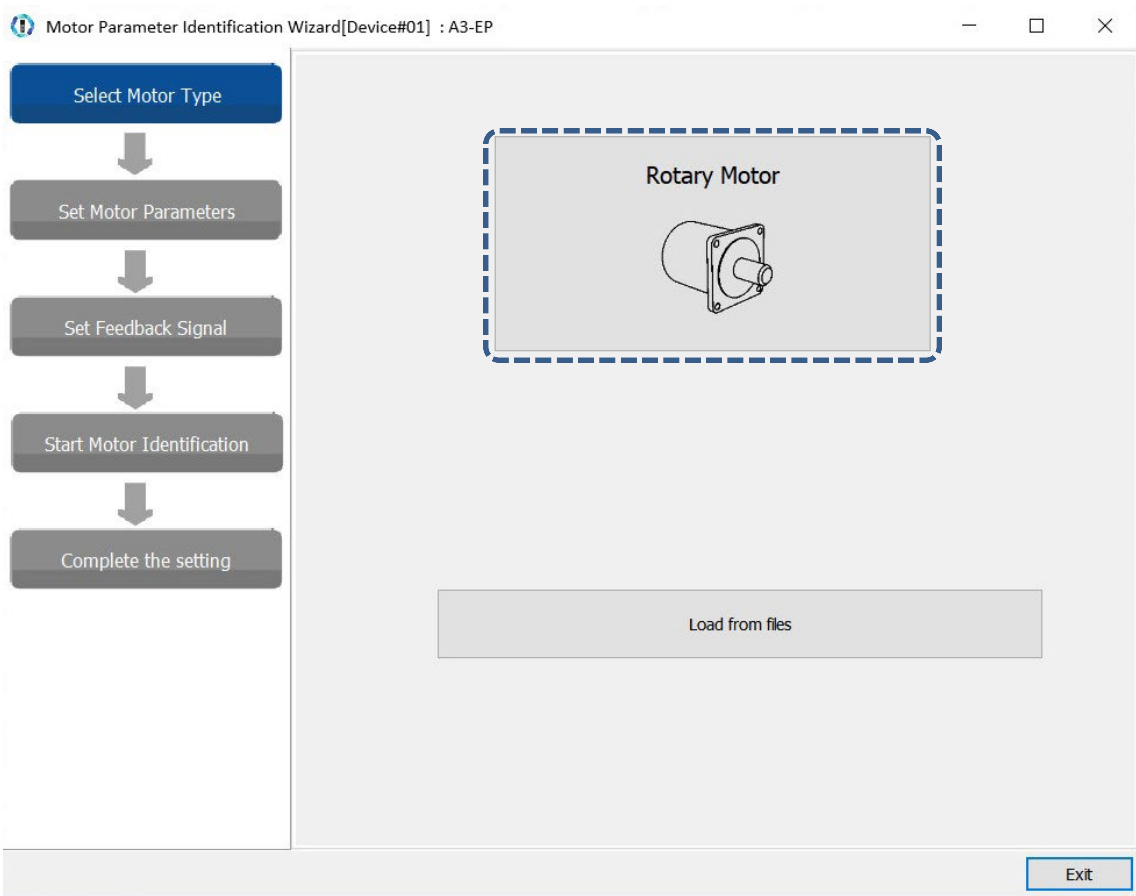
After starting ASDA-Soft, check that the setting value of PM.003.U is correct, and then execute the Motor Parameter Identification Wizard.
If you do not execute the motor parameter identification, alarms may be triggered due to parameter setting errors, or the motor may be burnt due to motor current setting errors. When you replace the motor with a different motor model, execute the motor parameter identification again.

During the identification, the motor moves by 1 pole pair distance. It is suggested that you execute the motor parameter identification before installing the mechanical parts; otherwise there is a risk of collision when the mechanical parts are moving.

9.2.1 Motor parameter identification for rotary motors

There are four steps in the motor parameter identification procedure for the rotary motors, “Select Motor Type”, “Set Motor Parameters”, “Set Feedback Signal”, and “Start Motor Identification”. Complete the setting by following the four steps. The details are as follows.

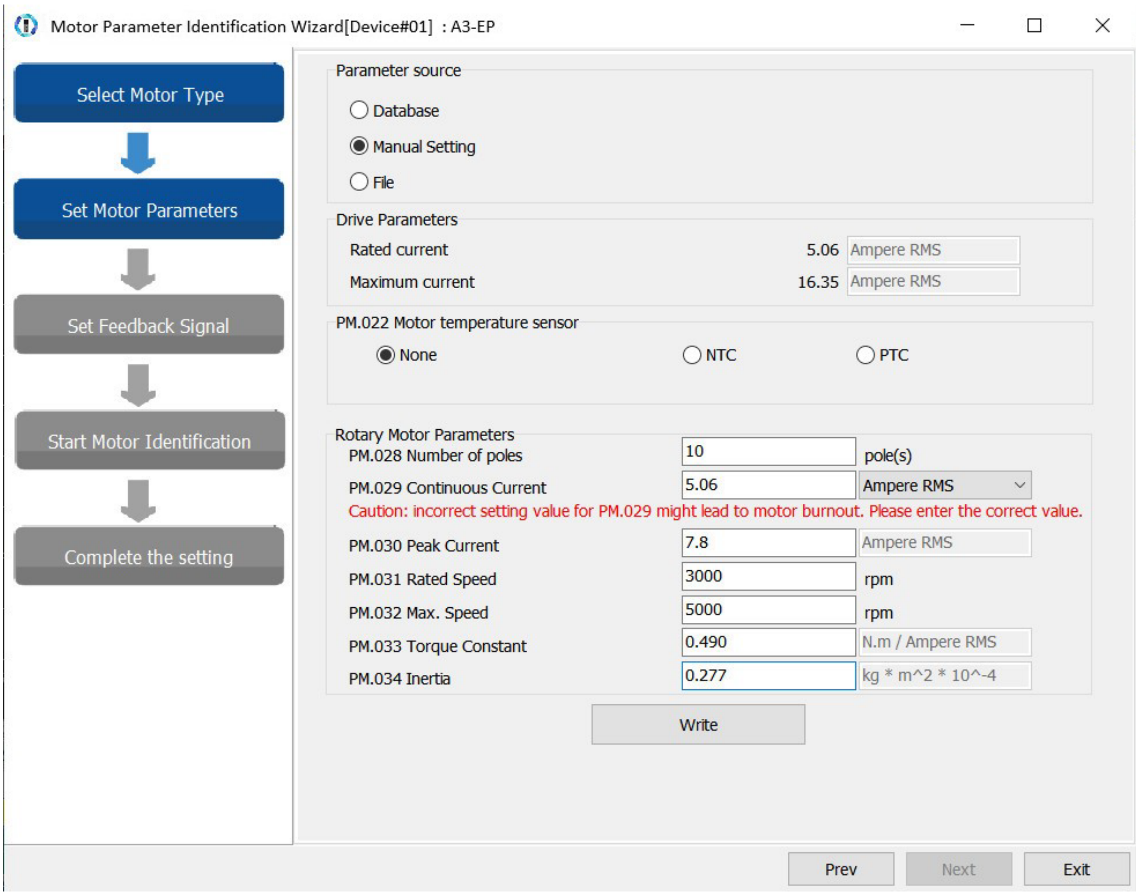
Step 1: Select Motor Type



Start the Motor Parameter Identification Wizard and select “Rotary Motor”.

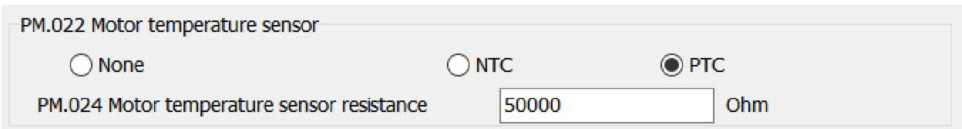
9

Step 2: Set Motor Parameters



Parameter source: the third-party communication type, sine wave type, and pulse type motors only support “Manual Setting”.

PM.022 Motor temperature sensor: if the third-party motor is equipped with a temperature sensor, select the type of the temperature sensor and then set PM.024 (Motor temperature sensor resistance).



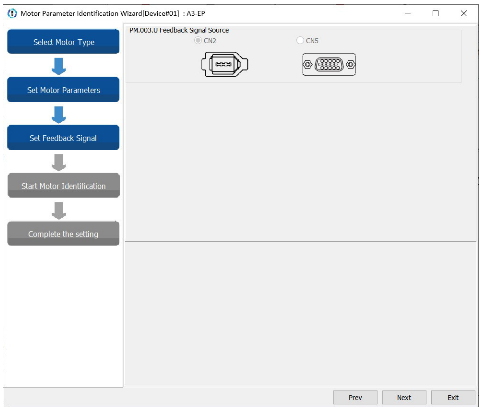
Rotary Motor Parameters: input all motor specifications manually. Correctly set the motor current parameters (PM.029 and PM.030), or the motor may be burnt. Be sure to double check the parameter settings and whether the unit is Ampere RMS or Ampere Peak.

When the settings are complete, click **Write** and then click **Next**.

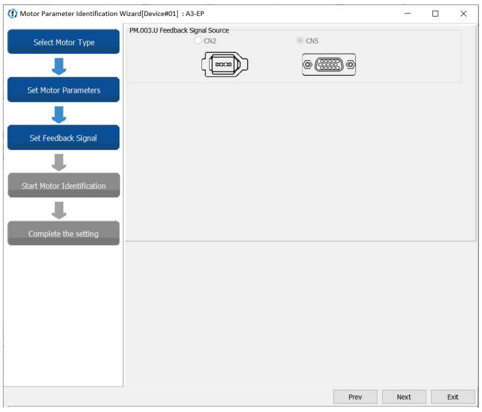
Note: the grayed-out fields are read-only and cannot be edited.

Step 3: Set Feedback Signal

CN2 communication type



CN5 communication type

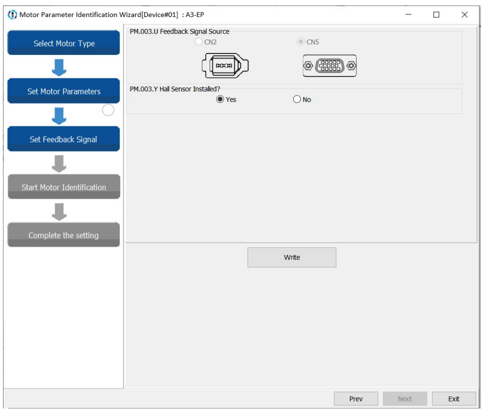


PM.003.U Feedback Signal Source: check that the signal source is correct. If incorrect, exit the Motor Parameter Identification Wizard, go to the Parameter Editor to correct the setting value of PM.003.U, cycle power on the servo drive, and then restart the Motor Parameter Identification Wizard.

Note: A3-EP supports pulse type, sine wave type, and some of the third-party communication type encoders; for details, refer to the table in Section 9.1. If the hardware connection does not match the parameter setting, AL011 (CN2 communication failed) or AL041 (CN5 is disconnected) is triggered.

When the checking is complete, click **Next**.

CN5 pulse type / CN5 sine wave type



PM.003.U Feedback Signal Source: check that the signal source is correct. If incorrect, exit the Motor Parameter Identification Wizard, go to the Parameter Editor to correct the setting value of PM.003.U, cycle power on the servo drive, and then restart the Motor Parameter Identification Wizard.

Note: A3-EP supports pulse type, sine wave type, and some of the third-party communication type encoders; for details, refer to the table in Section 9.1. If the hardware connection does not match the parameter setting, AL011 (CN2 communication failed) or AL041 (CN5 is disconnected) is triggered.

PM.003.Y Hall Sensor Installed: when the signal source is CN5 sine wave type or pulse type, check if the Hall sensor is installed.

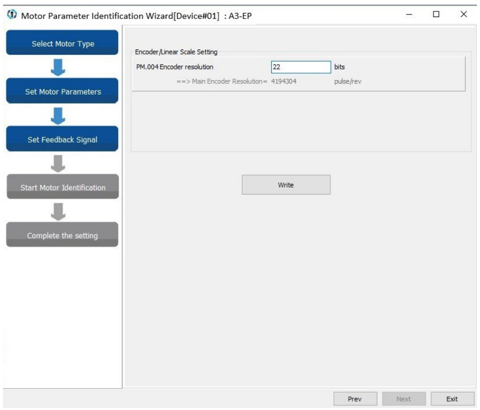
When the settings are complete, click **Write** and then click **Next**.

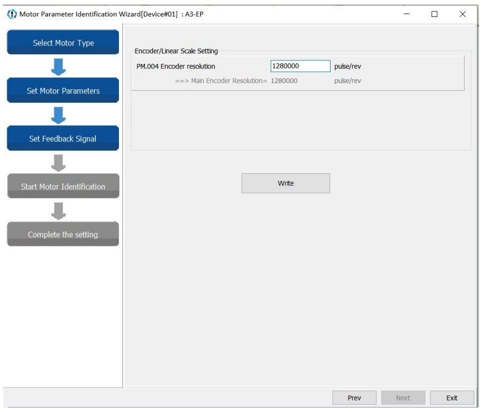
Note: the grayed-out field is read-only and cannot be edited.

9

The Encoder Setting includes communication type, sine wave type, and pulse type. Refer to the following descriptions.

CN2 communication type

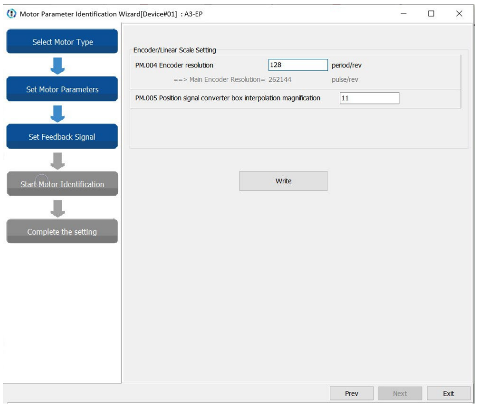




PM.004 Main encoder resolution: input the resolution of the communication type motor (unit: bits or pulse/rev).

When the settings are complete, click **Write** and then click **Next**.

CN5 sine wave type

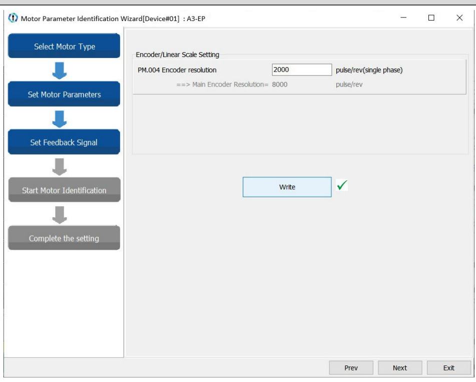


PM.004 Main encoder resolution: input the single-phase sine wave pulse number of one revolution (unit: period/rev).

PM.005 Sine wave signal interpolation magnification: it is suggested that you set it to the default value of 11. After the interpolation, the resolution is PM.004 x 2^N pulse/rev, where N = PM.005.

When the settings are complete, click **Write** and then click **Next**.

CN5 pulse type

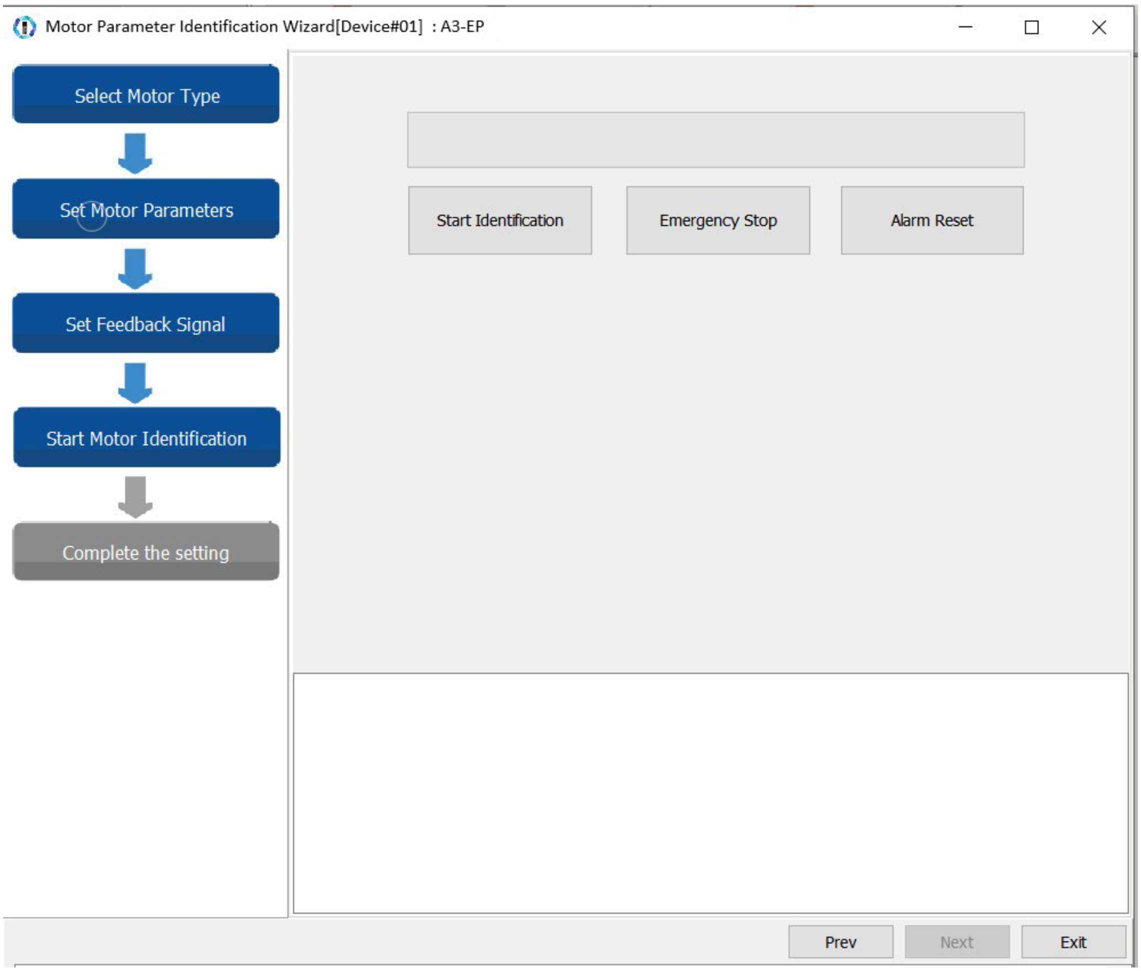


PM.004 Main encoder resolution: input the single-phase pulse number of one revolution (unit: pulse/rev).

When the settings are complete, click **Write** and then click **Next**.

Note: the grayed-out field is read-only and cannot be edited.

Step 4: Start Motor Identification



If an alarm occurs during the identification process, refer to Chapter 11 Troubleshooting to clear the alarm. The software continues with the identification process only when the alarm is cleared. Cycle power on the servo drive after the identification process is complete. Without power cycling, you cannot switch the servo to the Servo On state.

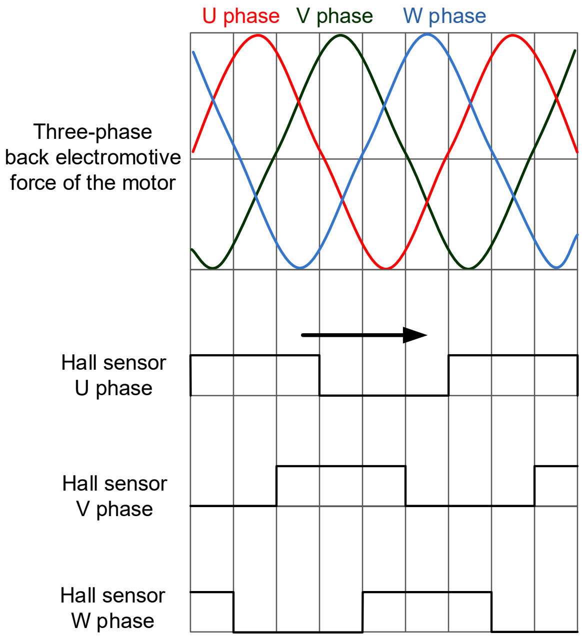
9

9.3 Hall sensor

The magnetic pole sensor, also known as the Hall sensor, can be used to detect the motor pole. The servo drive must know the position of the motor magnetic field to efficiently actuate the motor and move the motor in the right direction. As shown in the following figure, the Hall sensor generally sends three-phase signals, by which the motor magnetic field from 0° to 360° is divided into six blocks (1, 0, 1), (1, 0, 0), (1, 1, 0), (0, 1, 0), (0,1,1), and (0,0,1), so that the servo drive can know the current position of the motor magnetic field.

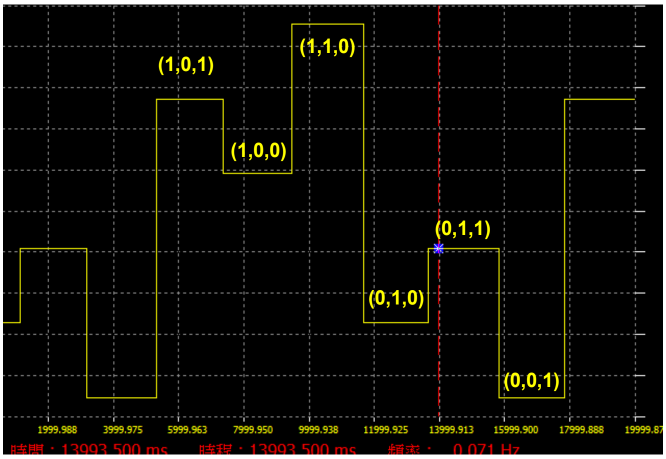
Before using the motor, check if it is equipped with a Hall sensor (or determine whether to use a Hall sensor according to the Motor Parameter Identification Wizard). If a Hall sensor is installed, set PM.003.Y to 1. If you are not using the installed Hall sensor or the motor is not equipped with a Hall sensor, set PM.003.Y to 0. When you are not using a Hall sensor, install a spring or balancing unit on the Z-axis mechanical part. If a magnetic pole is detected without a Hall sensor, the motor slightly vibrates during the detection after the servo is switched to the Servo On state for the first time after powered on.

Currently, A3-EP only supports Hall sensor of single-ended signals. Refer to Chapter 3 for the wiring of CN5 connector.



9.3.1 Checking the Hall sensor phase sequence

Set P0.017 to -177, and then observe the phase sequence of the Hall sensor with P0.009. The bits of the monitoring variable -177 are (Bit 3, Bit 2, Bit 1) = (W phase, V phase, U phase). The following figure shows the waveform monitored by the scope when the motor is moving. You can see the phase sequence in the cycle of (1, 0, 1), (1, 0, 0), (1, 1, 0), (0, 1, 0), (0, 1, 1), and (0, 0, 1). When the motor reverses, the phase sequence is also reversed. Incorrect phase sequence may cause the motor to go in the wrong direction or even be out of control.



9

9.4 Parameter setting

9.4.1 Overload gain

The overload gain setting is for protecting the motor from overheating. Under normal circumstances, set PM.019 (Load increase gain) and PM.020 (Load decrease gain) to the default of 100% or adjust the values according to the following table. These parameters do not affect the motor performance. You can monitor the motor load with the monitoring variable -91 (Overload protection counter), which value ranges from 0 to 100. When the value reaches 100, it means the motor is overloaded and AL006 is triggered.

The "Operating time" in the following table means the time required for the motor protection level to reach the overload level from the normal level. The measurement basis of the load ratio is 100%. When the ratio is above 100%, the operating time refers to PM.019; when the ratio is less than 100%, the operating time refers to PM.020. The load ratio determines whether the overload protection count is increased or decreased. If the load ratio is over 100%, the operating time must be taken into consideration, or AL006 will be triggered. If the load ratio is below 100%, you do not need to consider the operating time.

Load ratio	Operating time	Load ratio	Operating time
0	12 sec × PM.020	260%	3.9 sec × PM.019
20%	12.3 sec × PM.020	280%	3.3 sec × PM.019
40%	13.6 sec × PM.020	300%	2.8 sec × PM.019
60%	16.3 sec × PM.020	320%	2.5 sec × PM.019
80%	22.6 sec × PM.020	340%	2.2 sec × PM.019
100%	N/A	360%	2.0 sec × PM.019
120%	263.8 sec × PM.019	380%	1.8 sec × PM.019
140%	35.2 sec × PM.019	400%	1.6 sec × PM.019
160%	17.6 sec × PM.019	420%	1.4 sec × PM.019
180%	11.2 sec × PM.019	440%	1.3 sec × PM.019
200%	8 sec × PM.019	460%	1.2 sec × PM.019
220%	6.1 sec × PM.019	480%	1.1 sec × PM.019
240%	4.8 sec × PM.019	500%	1 sec × PM.019

Note: for detailed parameter descriptions, refer to Chapter 7 Parameters.

EtherCAT Mode 10

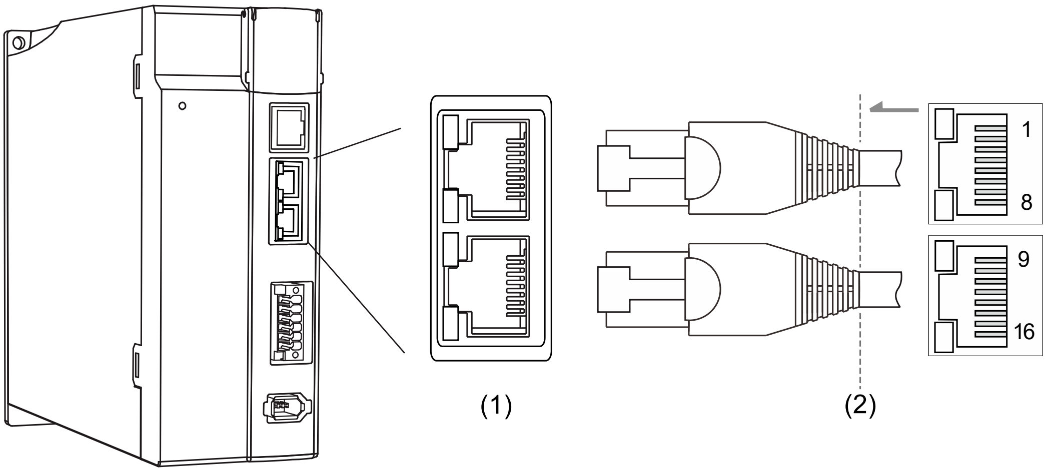
This chapter provides details for the required parameter settings when the servo communicates with the controller through the EtherCAT communication function.

10

10.1 Basic configuration

10.1.1 Hardware configuration

The pin assignments of the two EtherCAT ports are the same. Note that the IN port is for connecting the controller or the previous servo drive, and the OUT port is for connecting the next servo drive or not connecting to any devices. Incorrect wiring will lead to communication failure.



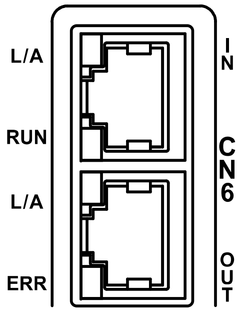
(1) CN6 connector (female); (2) CN6 connector (male)

Pin assignment:

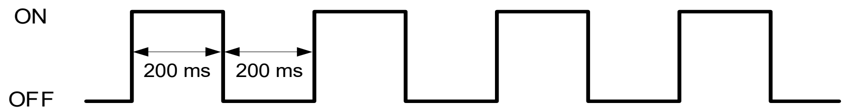
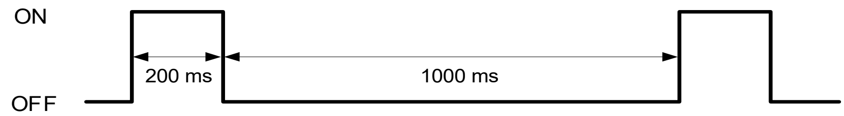
Transmission port	Pin No.	Signal	Description
IN	1	TX+	Transmit +
	2	TX-	Transmit -
	3	RX+	Receive +
	4	-	Reserved
	5	-	Reserved
	6	RX-	Receive -
	7	-	Reserved
	8	-	Reserved
OUT	9	TX+	Transmit +
	10	TX-	Transmit -
	11	RX+	Receive +
	12	-	Reserved
	13	-	Reserved
	14	RX-	Receive -
	15	-	Reserved
	16	-	Reserved

Note:
1. When multiple servo drives are connected, the maximum distance between each servo drive is 50 m (164.04 inches).
2. Use CAT5e STP cables with metal connectors.
3. It is suggested that you use a Beckhoff network cable (model number: ZB9020).

Description of each indicator for the CN6 connector:



■ LED indicator state description

Indicator	Description
On	
Blinking	
Single flash	
Off	

■ Network state indicator (L/A)

Indicator	Status	Description
On	Network is connected	Network connection is established but no data transmission.
Blinking	Network connection is established and data is in transmission	Data is in transmission.
Off	No connection	Network connection is not established.

■ EtherCAT connection state indicator (RUN)

Indicator	Status	Description
Off	Init	After power cycling and the initialization of the servo drive is complete, the communication has not yet started, but the controller can access the servo drive's register.
On	Operational	SDO, TxPDO, and RxPDO data packets can be transmitted.
Blinking	Pre-Operational	The controller can exchange data through the mailbox.
Single flash	Safe-Operational	The servo drive can use the SDO and TxPDO data packets to exchange data with the controller.

■ EtherCAT error indicator (ERR)

Indicator	Status	Description
Off	No error	No error has occurred.
On	PDI watchdog timeout	Servo drive malfunction. Contact the distributor for assistance.
Blinking	State change error	Parameter setting error causes the system unable to switch the states. Refer to the following diagram.
Single flash	Synchronization error / SyncManager error	The synchronization between the controller and the servo drive failed or the data was lost during data reception.

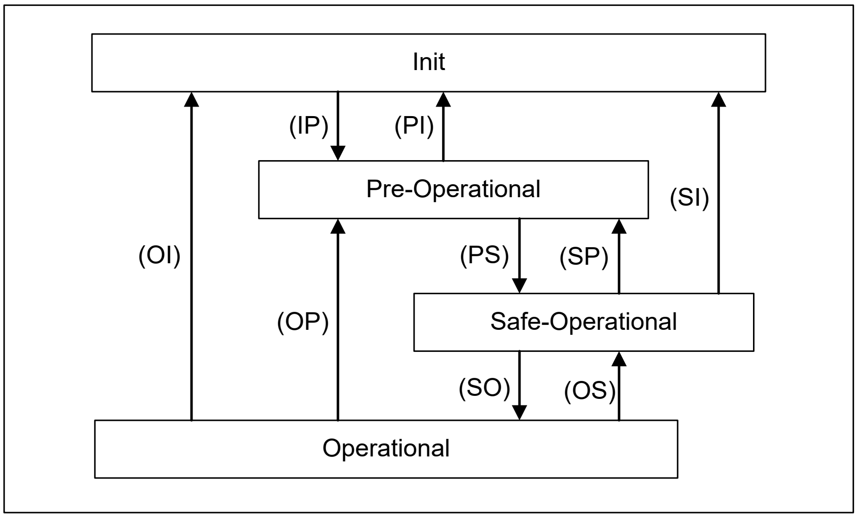


Figure 10.1.1.1 EtherCAT State Machine

10.1.2 ESI file import

The EtherCAT motion control fieldbus is an open standard that requires using the ESI (EtherCAT Slave Information) file to configure the functions and related object properties for each slave device. Generally, the ESI file is a standard XML file.

Integration with Delta controller

No need to import ESI files.

Integration with Non-Delta controller

Import the ESI file of the slave device to the controller software, so the controller can recognize and control each slave device according to the configuration in the ESI file. An ESI file can contain data of multiple devices.

Download the ESI file from the Download Center of Delta's website.

After being imported into the controller software, the ESI file is stored in the following path:

Beckhoff TwinCAT

TwinCAT 2: C:\TwinCAT\IO\EtherCAT

TwinCAT 3: C:\TwinCAT\3.1\Config\Io\EtherCAT

Omron Sysmac Studio

C:\Program Files (x86)\OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles

Note: refer to the controller manufacturer's instruction manuals for the actual storage path.

10.1.3 Parameter settings of EtherCAT mode

Set the slave address (P3.000 = 0x001 - 0x007F) to connect the EtherCAT controller and the servo drive.

P3.018	**EtherCAT special function switch**		**Address: 0324H 0325H**
Default:	0x00002000	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0x01112211
Format:	HEX	Data size:	32-bit

Settings:

High word

D C B A

Low word

U Z Y X

A	Source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on	X	Unit selection for OD 60FFh (Target velocity) and OD 606Ch (Velocity actual value) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode
B	Calculation method of OD 60F4h (Following error actual value)	Y	Reserved
C	Unit selection for the maximum speed of OD 607Fh and OD 6080h	Z	AL185 communication disconnection detection setting
D	Reserved	U	Reserved

- X: unit selection for OD 60FFh (Target velocity) and OD 606Ch (Velocity actual value) when in the PV (Profile Velocity) mode or CSV (Cyclic Synchronous Velocity) mode

  0: 0.1 rpm

  1: pulse/sec

- Z: AL185 communication disconnection detection setting

  0: disconnection detection starts after EtherCAT communication enters OP state.

  1: disconnection detection starts after EtherCAT communication enters Init state.

  2: disable the disconnection detection.

  Note: when using the ring topology connection, set P3.018.Z to 2 to disable the disconnection detection.

- A: source setting for the content loaded to the EtherCAT Station Alias Register 0x0012 after the servo drive is powered on

  0: determined by the setting value in the EEPROM address field (ADR 0x0004) of EtherCAT; this field must be set through the controller interface.

  1: determined by the setting value of servo parameter P3.000.

- B: calculation method of OD 60F4h (Following error actual value)

  0: directly calculates the difference between OD 6062h (Position demand value) and OD 6064h (Position actual value) in units of PUU.

  1: calculates the difference in units of pulse and then converts it to PUU through E-Gear ratio.

- C: unit selection for the maximum speed of OD 607Fh and OD 6080h

  0: 0.1 rpm for OD 607Fh and rpm for OD 6080h.

  1: pulse/sec for OD 607Fh and OD 6080h.

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P3.022	EtherCAT PDO timeout setting		Address: 032CH 032DH
Default:	0xFF04	Control mode:	All
Unit:	-	Setting range:	0x0002 - 0xFF14
Format:	HEX	Data size:	16-bit

Settings:

When using the PDO to transmit data periodically, use this parameter to set the allowable timeout. The following two sets of digits specify the trigger conditions for AL180 and AL3E3 respectively to ensure that the servo drive receives the PDO. When one of the alarms occurs, it means the packet loss period has exceeded the allowable range.

0020

U Z Y X

Digit	UZ	YX
Function	AL180 trigger condition	AL3E3 trigger condition
Range	0x00 (disabled) - 0xFF (default)	0x02 - 0x14

- YX: AL3E3 trigger condition (allowable cycle for elapsed time); applicable to CSP / CSV / CST mode. AL3E3 occurs when the servo drive does not receive the PDO within the set cycle.
  When the communication cycle is 4 ms and you set this parameter to 0x02 (allow two cycles), it means if the servo drive does not receive any PDO within 8 ms, AL3E3 occurs.
- UZ: AL180 trigger condition (allowable duration for elapsed time); applicable to all operation modes. AL180 occurs when the servo drive does not receive the PDO within the set duration (unit: ms). For example, when you set P3.022.UZ to 0x01, the duration is 1 ms; when you set P3.022.UZ to 0x02, the duration is 2 ms; and when you set P3.022.UZ to 0xFF, the duration is 255 ms.

P0.002	Drive status		Address: 0004H 0005H
Default:	1	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

Input the monitoring code to P0.002 to view changes to the variable on the panel. For the list of monitoring variables, refer to Table 7.3 Monitoring variables descriptions.

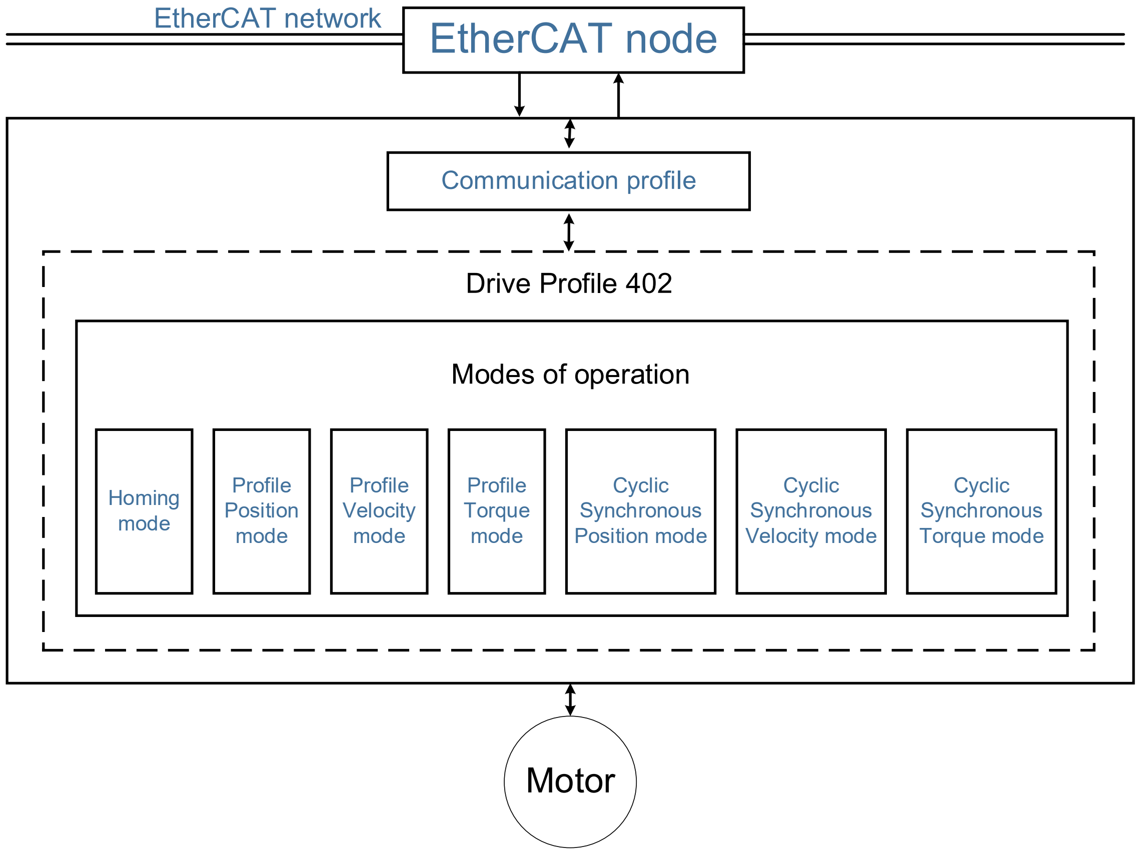
10.2 Communication function

10.2.1 Specifications

EtherCAT communication functions	Physical layer	100BASE-TX
	Communication interface	RJ45 × 2
	Network connection	Serial connection
	Baud rate	2 x 100 Mbps (full duplex)
	Data frame length	Maximum 1,484 bytes
	SyncManager	SM0: mailbox output SM1: mailbox input SM2: process data output SM3: process data input
	Fieldbus Memory Management Units (FMMU)	FMMU0: process data output area FMMU1: process data input area FMMU2: mailbox status area
	Application layer protocol	CoE: CANopen over EtherCAT
	Synchronization mode	DC-Synchronous mode (SYNC0) Asynchronous mode (Free Run)
	Communication object	SDO: Service data object PDO: Process data object SYNC: Synchronization object EMCY: Emergency object
	LED indicator (on RJ45 connector)	EtherCAT ERR × 1 EtherCAT L/A (Link / Activity) × 2 EtherCAT RUN × 1
	Application layer specifications	IEC 61800-7 CiA DS402 Drive Profile
Supported CiA DS402 operation modes		■ Profile Position (PP) mode ■ Profile Velocity (PV) mode ■ Profile Torque (PT) mode ■ Homing (HM) mode ■ Cyclic Synchronous Position (CSP) mode ■ Cyclic Synchronous Velocity (CSV) mode ■ Cyclic Synchronous Torque (CST) mode

The EtherCAT architecture of the servo drive is as follows:

- Communication profile: this protocol includes the communication objects (PDO, SDO, SYNC, and EMCY) and related communication object dictionary.
- DS402 is the device profile for drives and motion control. It defines the behavior of each operation mode and the required object parameter settings for execution.



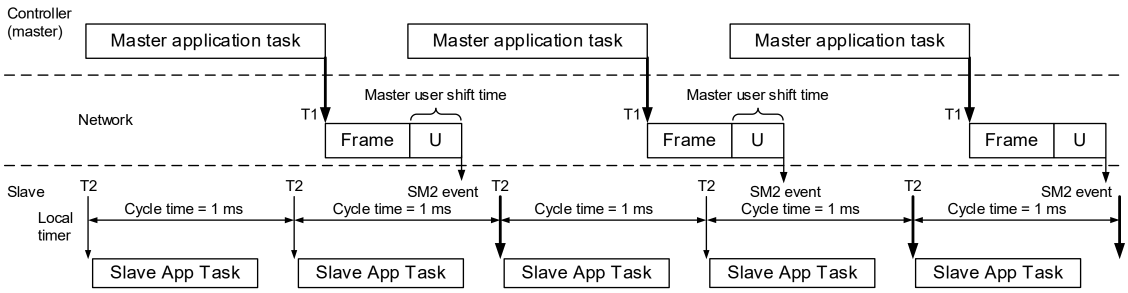
10.2.2 Synchronization mode

10.2.2.1 Synchronization modes of the servo drive

The servo drive supports two synchronization modes: Free Run mode and DC-Synchronous mode. Note that the Free Run mode is defined as a synchronization mode in the EtherCAT specification established by the EtherCAT Technology Group (ETG).

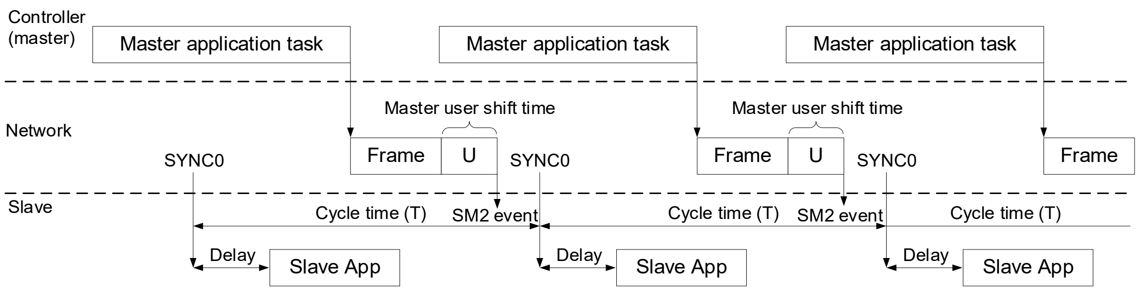
Free Run mode (Asynchronous)

Actually, the master and slave(s) run asynchronously in the Free Run mode. The slave clock runs independently of the master clock. That is, the clocks are not synchronized. The command and feedback between the master and slave(s) are transmitted sequentially rather than synchronously. For example, the master sends a PDO at the time T1, and the slave(s) receives the PDO at the time T2 after the SM2 event.



DC-Synchronous mode (DC mode - synchronous with SYNC0 event)

There is precise time synchronization between the master and slave(s) in the DC-Synchronous mode. The master executes the control program and sends PDO packets at a fixed time cyclically according to the distributed clocks (DC), transmitting the command to and receives the feedback from the slave(s). The slave(s) receives and updates the PDO data at a fixed time according to the distributed clocks.



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10.2.2.2 Select Synchronization mode

Follow these steps to select DC-Synchronous or Free Run mode.

1. Select **Drive 3 (ASDA-A3-EP CoE Drive)** in the left column of the TwinCAT System Manager window.
2. Under the **DC** tab in the right column, select **DC-Synchronous** or **Free Run** as the Operation Mode.

10.2.2.3 Distributed clocks setting

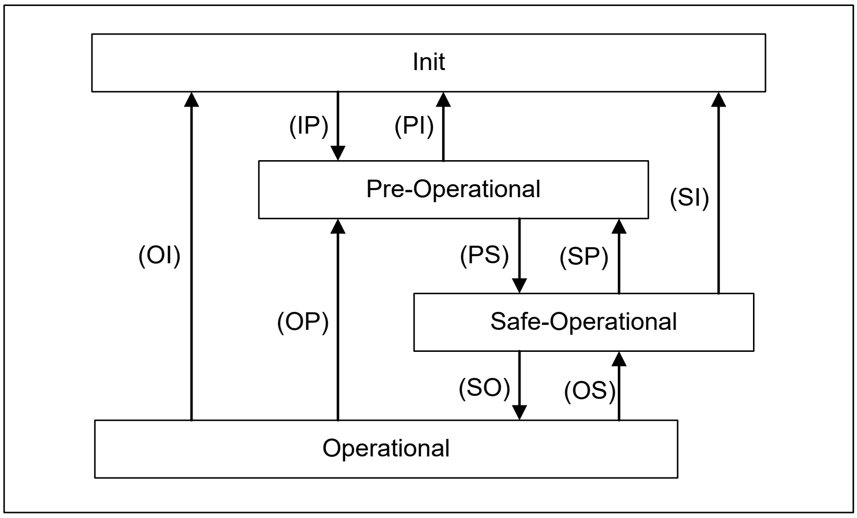
Follow these steps to set the data exchange cycle.

1. Select **NC-Task 1 SAF** in the left column of the TwinCAT System Manager window.
2. Set the data exchange cycle in the **Cycle ticks** field under the **Task** tab in the right column.

The SYNC0 cycle is used to define the PDO cycle time. The minimum unit of the SYNC0 cycle is 125 μs. The SYNC0 cycles within 1 ms are 125 μs, 250 μs, and 500 μs in sequence. The SYNC0 cycles above 1 ms are accumulated at intervals of 1 ms, such as 1 ms, 2 ms, 3 ms… 10 ms. If the system configuration includes an A2-E servo drive, the unit is the minimum unit of A2-E (1 ms).

10.2.3 EtherCAT State Machine

In EtherCAT communication, the servo drive's state machine can be in the following states. The controller (master) controls the servo (slave) based on the actual state. The controller needs to configure the servo drive according to the designated flow in the following figure. After the controller completes the initialization of the communication, the servo is in the Operational state and waits for the user's command to perform motion control. Use the monitoring variable of P0.002 = 119 to monitor the current state of the EtherCAT State Machine.



Panel display when P0.002 = 119	State	Description
1	Init	The servo drive successfully completes the initialization without any error occurring after being powered on. The packets cannot yet be transmitted in this state.
2	Pre-Operational (Pre-OP)	Data can be exchanged with SDOs. If an alarm occurs in the servo drive, an emergency message is sent to notify the controller.
4	Safe-Operational (Safe-OP)	The servo drive can use SDO and TxPDO data packets to exchange data with the controller.
8	Operational (OP)	All data exchanges including SDOs and PDOs (TxPDO and RxPDO) are allowed.

10

The controller (master) issues corresponding commands to the servo (slave) according to the state transition.

State transition	Description
IP	■ The master confirms the VendorID, ProductCode, and RevisionNumber of the slave. ■ The master calibrates the distributed clocks of the slave (DC-Synchronous mode). ■ The master defines the slave address and the SyncManager 0 and 1 (SM0 and SM1) register, and establishes the mailbox communication. ■ The master issues the command and confirms that the slave switches to the Pre-Operational state.
PS	■ The master uses the SDOs to set the PDO mapping and DC related parameters. ■ The master defines the FMMU and the SyncManager 2 and 3 (SM2 and SM3) registers, and the slave continues to transmit PDO (TxPDO) packets to the master. ■ The master issues the command and confirms that the slave switches to the Safe-Operational state.
SO	■ The master starts transmitting PDOs (RxPDOs). ■ The DC synchronization process between the master and slave is started.
PI, SI, OI	■ The slave disables all communication functions, including the SDOs and PDOs. ■ The slave switches to the Init state.
SP, OP	■ The slave disables the PDO function. ■ The slave switches to the Pre-Operational state.
OS	■ The master stops transmitting PDOs (RxPDOs). ■ The slave switches to the Safe-Operational state.

10.2.4 PDO mapping configuration

The PDO mapping objects are allocated in the object dictionary: OD 1600h - OD 1603h for RxPDOs and OD 1A00h - OD 1A03h for TxPDOs. The RxPDOs and TxPDOs in each group support updating up to 8 sets of 32-bit PDO data.

10.2.4.1 Default PDO mapping configuration

The following tables show the default PDO mapping configuration of the EtherCAT servo drive for data exchange. This is also defined in the ESI file of the EtherCAT slave. You can modify the PDO mapping configuration according to the requirements. The fourth group is the suggested configuration for Omron controllers.

The first to fourth groups of PDO configuration in the ESI file are shown as follows:

First group of PDO mapping

RxPDO (OD 1600h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Touch probe function (OD 60B8h)

TxPDO (OD 1A00h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Touch probe status (OD 60B9h)
	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)		

Second group of PDO mapping (default)

RxPDO (OD 1601h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Touch probe function (OD 60B8h)			

TxPDO (OD 1A01h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Torque actual value (OD 6077h)
	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)	

Third group of PDO mapping

RxPDO (OD 1602h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Modes of operation (OD 6060h)	Touch probe function (OD 60B8h)		

TxPDO (OD 1A02h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Velocity actual value (OD 606Ch)	Torque actual value (OD 6077h)
	Modes of operation display (OD 6061h)	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Digital inputs (OD 60FDh)

Fourth group of PDO mapping (for Omron controllers)

RxPDO (OD 1603h)	Controlword (OD 6040h)	Target position (OD 607Ah)	Target velocity (OD 60FFh)	Target torque (OD 6071h)
	Modes of operation (OD 6060h)	Positive torque limit (OD 60E0h)	Negative torque limit (OD 60E1h)	Touch probe function (OD 60B8h)

TxPDO (OD 1A03h)	Statusword (OD 6041h)	Position actual value (OD 6064h)	Torque actual value (OD 6077h)	Modes of operation display (OD 6061h)
	Touch probe status (OD 60B9h)	Touch probe pos1 pos value (OD 60BAh)	Error code (OD 603Fh)	Digital inputs (OD 60FDh)

10.2.4.2 Set PDO mapping

Take the default (the second group) PDO mapping configuration OD 1601h and OD 1A01h as an example, and the settings are as follows:

1. Disable the PDO configuration: set OD 1C12h sub0 to 0 (RxPDO) and OD 1C13h sub0 to 0 (TxPDO).
2. Disable the PDO mapping setting: set OD 1600h sub0 to 0 (RxPDO) and OD 1A01h sub0 to 0 (TxPDO).
3. Set OD 1601h sub1 - sub5 for the RxPDO mapping content, and set OD 1601h sub0 to 5 for the RxPDO mapping number.

Mapping parameter setting for RxPDO	Data			Description
OD 1601h sub1	6040h	00h	10h	Controlword (6040h); data length is 16-bit.
OD 1601h sub2	607Ah	00h	20h	Target position (607Ah); data length is 32-bit.
OD 1601h sub3	60FFh	00h	20h	Target velocity (60FFh); data length is 32-bit.
OD 1601h sub4	6071h	00h	10h	Target torque (6071h); data length is 16-bit.
OD 1601h sub5	60B8h	00h	10h	Touch probe function (60B8h); data length is 16-bit.
OD 1601h sub0	5			Set 5 for the RxPDO mapping number.

4. Set OD 1A01h sub1 - sub7 for the TxPDO mapping content, and set OD 1A01h sub0 to 7 for the TxPDO mapping number.

Mapping parameter setting for TxPDO	Data			Description
OD 1A01h sub1	6041h	00h	10h	Statusword (6041h); data length is 16-bit.
OD 1A01h sub2	6064h	00h	20h	Position actual value (6064h); data length is 32-bit.
OD 1A01h sub3	606Ch	00h	20h	Velocity actual value (606Ch); data length is 32-bit.
OD 1A01h sub4	6077h	00h	10h	Torque actual value (6077h); data length is 16-bit.
OD 1A01h sub5	60B9h	00h	10h	Touch probe status (60B9h); data length is 16-bit.
OD 1A01h sub6	60BAh	00h	20h	Touch probe pos1 pos value (60BAh); data length is 32-bit.
OD 1A01h sub7	60FDh	00h	20h	Digital inputs (60FDh); data length is 32-bit.
OD 1A01h sub0	7			Set 7 for the TxPDO mapping number.

5. Specify to use the second group of PDO mapping configuration: set OD 1C12h sub1 to 0x1601 (RxPDO) and OD 1C13h sub1 to 0x1A01 (TxPDO).
6. Enable the PDO configuration: set OD 1C12h sub0 to 1 (RxPDO) and OD 1C13h sub0 to 1 (TxPDO).

10.2.4.3 PDO mapping object

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Real-time data transmission can be achieved with Process data objects (PDOs). There are two types of PDOs: transmit PDOs (TxPDOs) and receive PDOs (RxPDOs). This definition is from the perspective of the servo drive; for example, TxPDO refers to the object that the servo drive sends to the controller. Set the mapping parameters as shown in the following table to use the PDOs.

Communication object	Mapping object index
RxPDO1	1600h
RxPDO2	1601h
RxPDO3	1602h
RxPDO4	1603h

Communication object	Mapping object index
TxPDO1	1A00h
TxPDO2	1A01h
TxPDO3	1A02h
TxPDO4	1A03h

The format of PDO mapping parameter is:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

10.2.4.4 SDO abort codes

The abort codes are as follows:

Abort code	Description
05040001h	Client / server command is invalid or does not exist.
06010002h	Attempt to write a read-only object.
06020000h	Object does not exist in the object dictionary.
06040041h	Unable to map the object to the PDO.
06040042h	The number and length of mapped objects exceed the PDO length.
06060000h	Access failed due to a hardware error (storage or restoring error).
06070010h	Data type does not match; parameter length does not match.
06090011h	Sub-index does not exist.
06090030h	The written parameter value is out of range.
08000000h	General error.
080000a1h	Object error when reading from EEPROM.
080000a2h	Object error when writing to EEPROM.
080000a3h	Invalid range when accessing EEPROM.
080000a4h	EEPROM data content error when accessing EEPROM.
080000a5h	The entered password is incorrect when data is written to the encryption area.
08000020h	Unable to transfer data or store data to the application.
08000021h	Unable to transfer data or store data to the application due to restrictions (storage or restoring in the wrong state).
08000022h	Object is in use.

10.3 EtherCAT operation modes

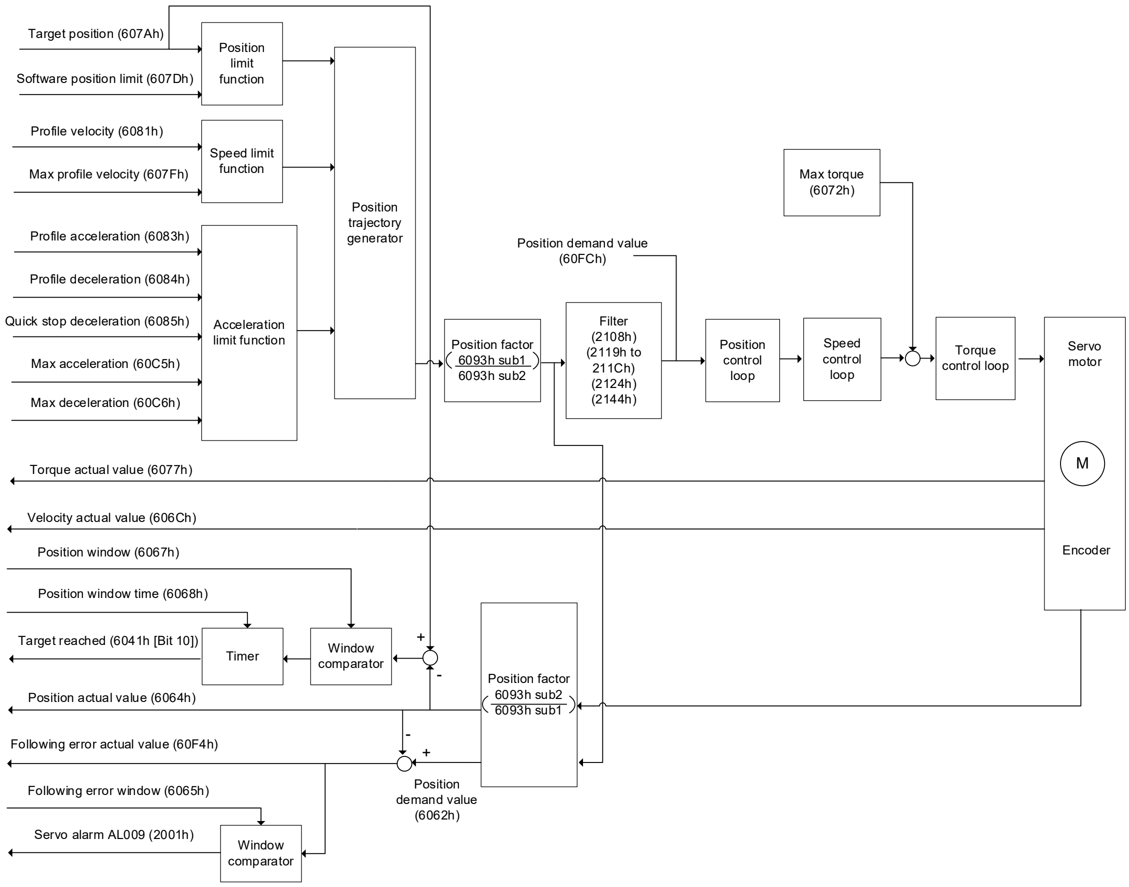
This section describes the modes of operation specified by CiA DS402 when the servo is in the EtherCAT mode. The content includes basic operation settings and related object descriptions.

10.3.1 Profile Position mode

After receiving the position command transmitted from the controller, the servo drive controls the servo motor to reach the target position.

In Profile Position (PP) mode, the controller only informs the servo drive of the target position, speed command, and acceleration / deceleration settings at the beginning. The motion planning from command triggering to target reaching is performed by the trajectory generator in the servo drive.

The following figure shows the Profile Position mode architecture of the servo drive:



Operation steps:

1. Set the mode to Profile Position mode: OD 6060h = 01h.
2. Set the target position (OD 607Ah) (unit: PUU).
3. Set the profile velocity (OD 6081h) (unit: PUU/sec).
4. Set the profile acceleration (OD 6083h) (unit: ms).
5. Set the profile deceleration (OD 6084h) (unit: ms).
6. Set the Controlword (OD 6040h) by following these steps. Steps 6.1 and 6.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 10.4.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
6.1	0	0	1	1	0	Shutdown.
6.2	0	0	1	1	1	Switch on (ready for Servo On).
6.3	0	1	1	1	1	Enable operation (Servo On).
6.4	1	1	1	1	1	Command triggering (rising-edge triggered)

7. After the servo completes the first motion command, you need to set the target position, speed, and other conditions for the servo to execute the next motion command.
8. Set the Controlword (OD 6040h). Since the command is rising-edge triggered, switch Bit 4 to Off first and then to On.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
8.1	0	1	1	1	1	Enable operation (Servo On).
8.2	1	1	1	1	1	Command triggering (rising-edge triggered)

Read the servo drive information:

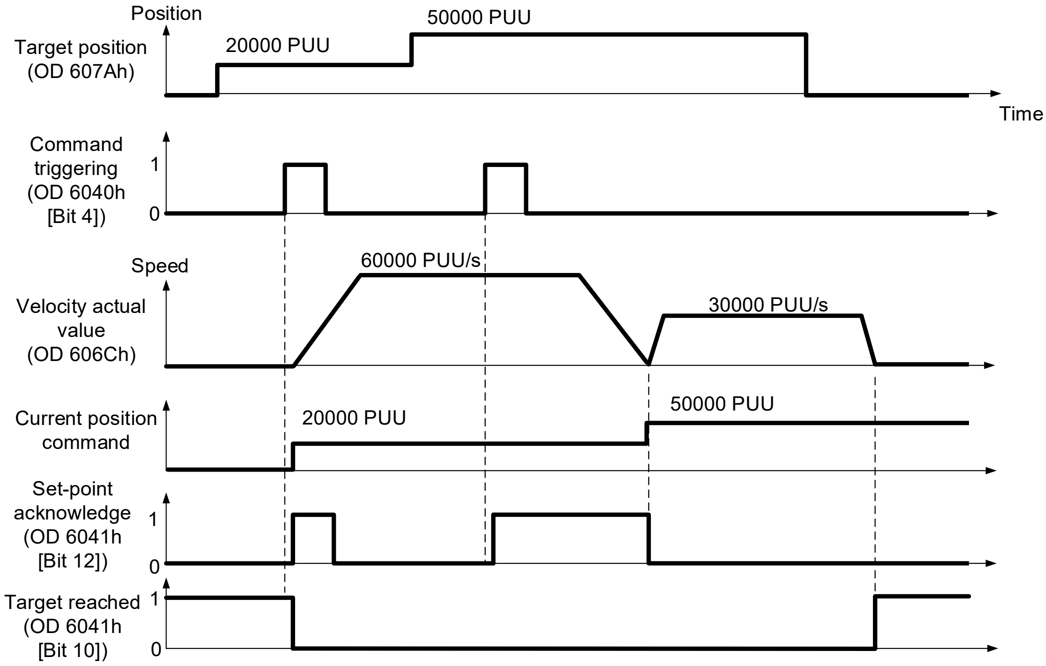
1. Read OD 6064h to obtain the actual value of the motor position at present.
2. Read OD 6041h to obtain the servo drive status, including following error, set-point acknowledge (servo received the command signal), and target reached.

Command taking immediate effect

In Profile Position mode, set the command to take immediate effect or not with OD 6040h [Bit 5].

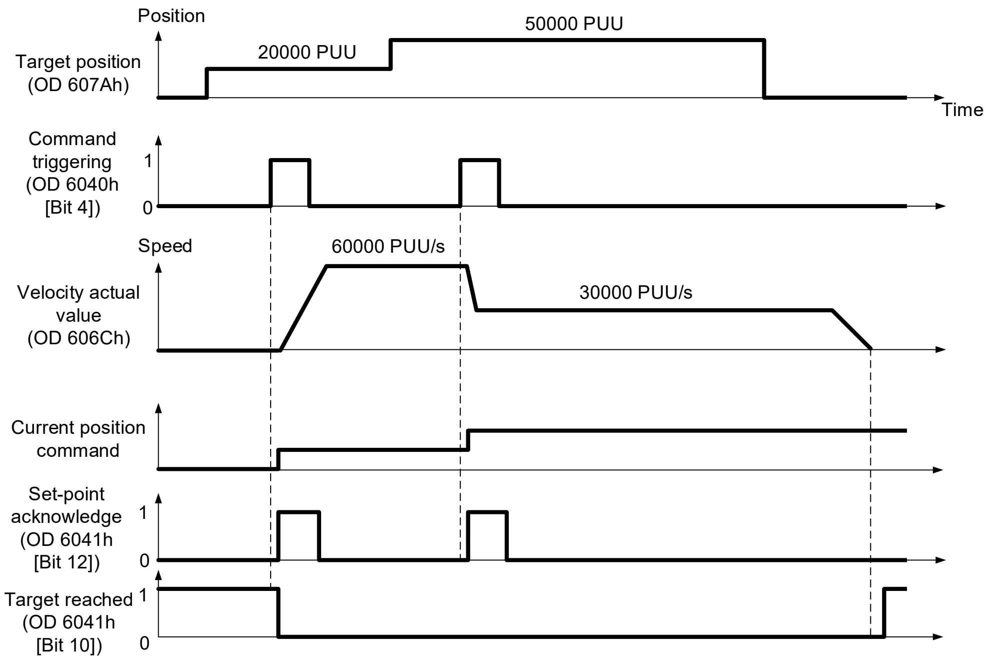
■ Set OD 6040h [Bit 5] to 0 to disable the command from taking immediate effect

If the command is not enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo continues to execute the current motion command even if a new command is triggered. The new command is acknowledged and executed only after the current command is complete.



■ Set OD 6040h [Bit 5] to 1 to enable the command to take immediate effect

If the command is enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo immediately interrupts the current command and executes the new command once receiving the new command.



Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6062h	Position demand value (PUU)	INTEGER32	RO
6063h	Position actual internal value (pulse)	INTEGER32	RO
6064h	Position actual value (PUU)	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
6067h	Position window	UNSIGNED32	RW
6068h	Position window time	UNSIGNED16	RW
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Ah	Target position	INTEGER32	RW
607Dh	Software position limit	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6081h	Profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 10.4.3 Details of objects.

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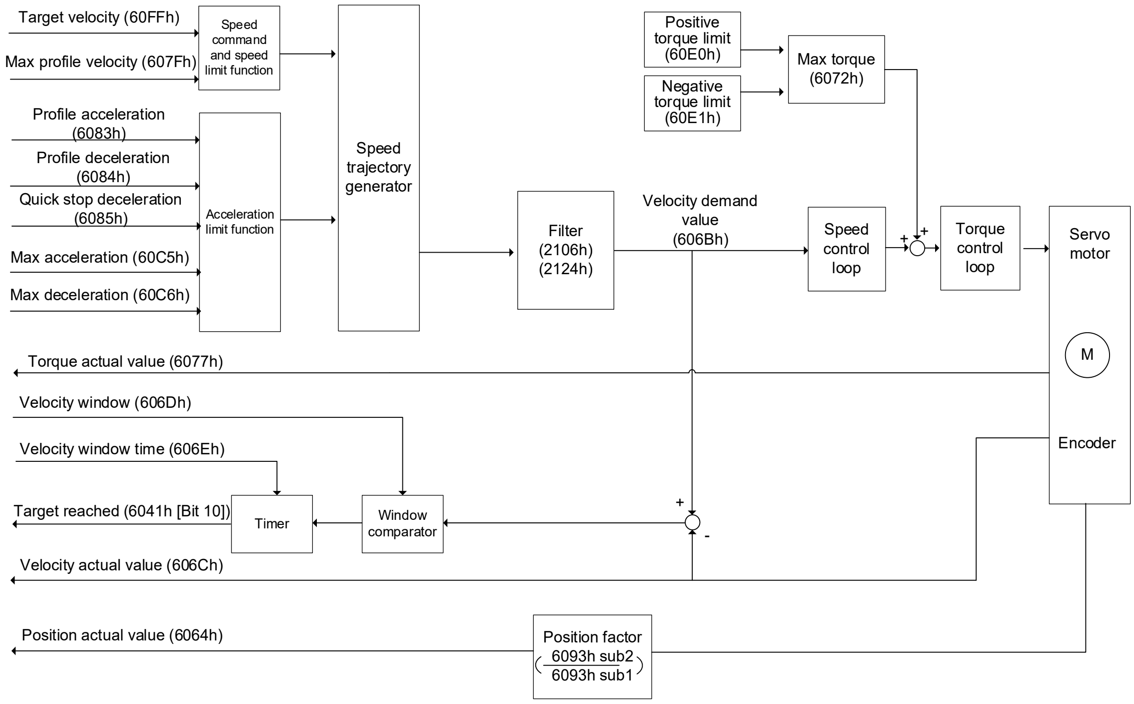
10.3.2 Profile Velocity mode

In Profile Velocity (PV) mode, the controller specifies the speed command and acceleration / deceleration conditions, and then the trajectory generator of the servo drive plans the motion path according to these conditions.



Operation steps:

1. Set the mode to Profile Velocity mode: OD 6060h = 03h.
2. Set the profile acceleration (OD 6083h).
3. Set the profile deceleration (OD 6084h).
4. Set the target velocity (OD 60FFh) to 0. In Profile Velocity mode, the servo motor starts operating once the servo drive is switched to Servo On (Step 5). Therefore, set OD 60FFh = 0 to ensure that the motor maintains at 0 rpm at the moment of Servo On.
5. Set the Controlword (OD 6040h) by following these steps. Steps 5.1 and 5.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 10.4.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
5.1	0	0	1	1	0	Shutdown.
5.2	0	0	1	1	1	Switch on (ready for Servo On).
5.3	0	1	1	1	1	Enable operation (Servo On).

6. Set the target velocity (OD 60FFh).

Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 606Ch to obtain the current velocity actual value.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value (PUU)	INTEGER32	RO
606Bh	Velocity demand value	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
606Dh	Velocity window	UNSIGNED16	RW
606Eh	Velocity window time	UNSIGNED16	RW
606Fh	Velocity threshold	UNSIGNED16	RW
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Fh	Max profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 10.4.3 Details of objects.

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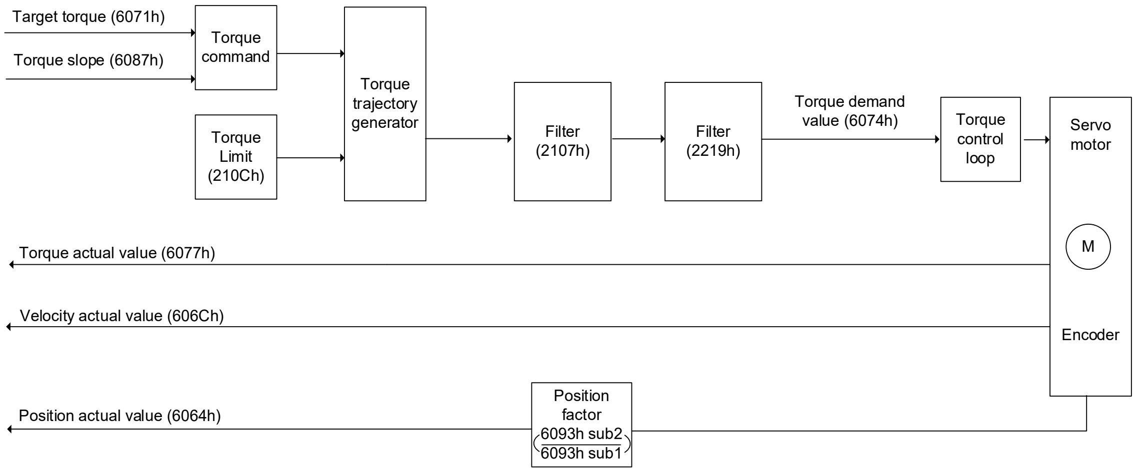
10.3.3 Profile Torque mode

In Profile Torque (PT) mode, the controller specifies the torque command and filtering conditions, and then the trajectory generator of the servo drive plans the torque slope according to these conditions.



Operation steps:

1. Set the mode to Profile Torque mode: OD 6060h = 04h.
2. Set the torque slope (OD 6087h).
3. Set the target torque (OD 6071h) to 0. In Profile Torque mode, the servo target torque takes effect once the servo drive is switched to Servo On (Step 4). Therefore, set OD 6071h = 0 for safety reasons.
4. Set the Controlword (OD 6040h) by following these steps. Steps 4.1 and 4.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 10.4.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
4.1	0	0	1	1	0	Shutdown.
4.2	0	0	1	1	1	Switch on (ready for Servo On).
4.3	0	1	1	1	1	Enable operation (Servo On).

5. Set the target torque (OD 6071h).

Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6077h to obtain the current torque actual value.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value (PUU)	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6071h	Target torque	INTEGER16	RW
6074h	Torque demand value	INTEGER16	RO
6075h	Motor rated current	UNSIGNED32	RO
6077h	Torque actual value	INTEGER16	RO
6078h	Current actual value	INTEGER16	RO
6087h	Torque slope	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW

Note: for more details, refer to Section 10.4.3 Details of objects.

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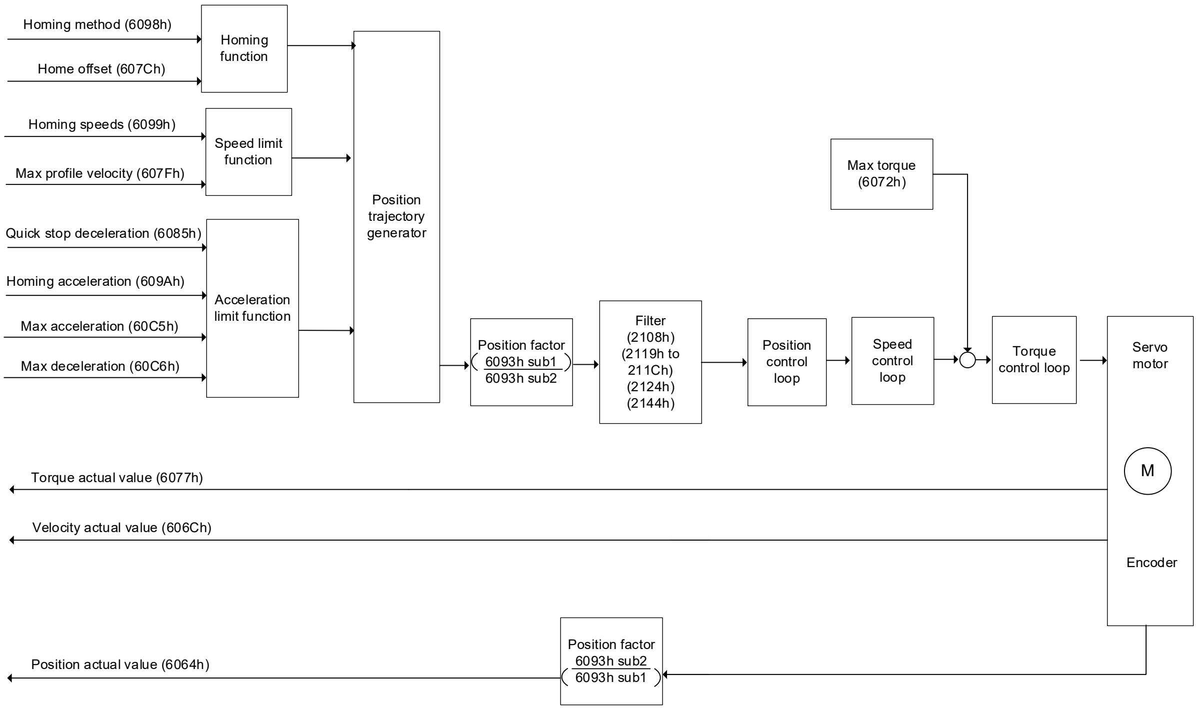
10.3.4 Homing mode

After homing is complete, the position system of the servo drive is established and the drive can start executing the position command issued by the controller. The Delta A3-EP servo drive offers multiple homing methods, including homing on the home switch, positive or negative limit, motor Z pulse, and hard stop.



Operation steps:

1. Set the mode to Homing mode: OD 6060h = 06h.
2. Set the home offset (OD 607Ch).
3. Set the homing method (OD 6098h).
4. Set the speed during search for switch (OD 6099h sub1).
5. Set the speed during search for zero (OD 6099h sub2).
6. Set the homing acceleration (OD 609Ah).
7. Set the Controlword (OD 6040h) by following these steps. Steps 7.1 and 7.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 10.4.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
7.1	0	0	1	1	0	Shutdown.
7.2	0	0	1	1	1	Switch on (ready for Servo On).
7.3	0	1	1	1	1	Enable operation (Servo On).
7.4	1	1	1	1	1	Homing (rising-edge triggered).

Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6064h to obtain the actual value of the motor position at present.

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value (PUU)	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
607Ch	Home offset	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
6098h	Homing method	INTEGER8	RW
6099h	Homing speeds	UNSIGNED32	RW
609Ah	Homing acceleration	UNSIGNED32	RW
60C5h	Max acceleration	UNSIGNED32	RW
60C6h	Max deceleration	UNSIGNED32	RW

Note: for more details, refer to Section 10.4.3 Details of objects.

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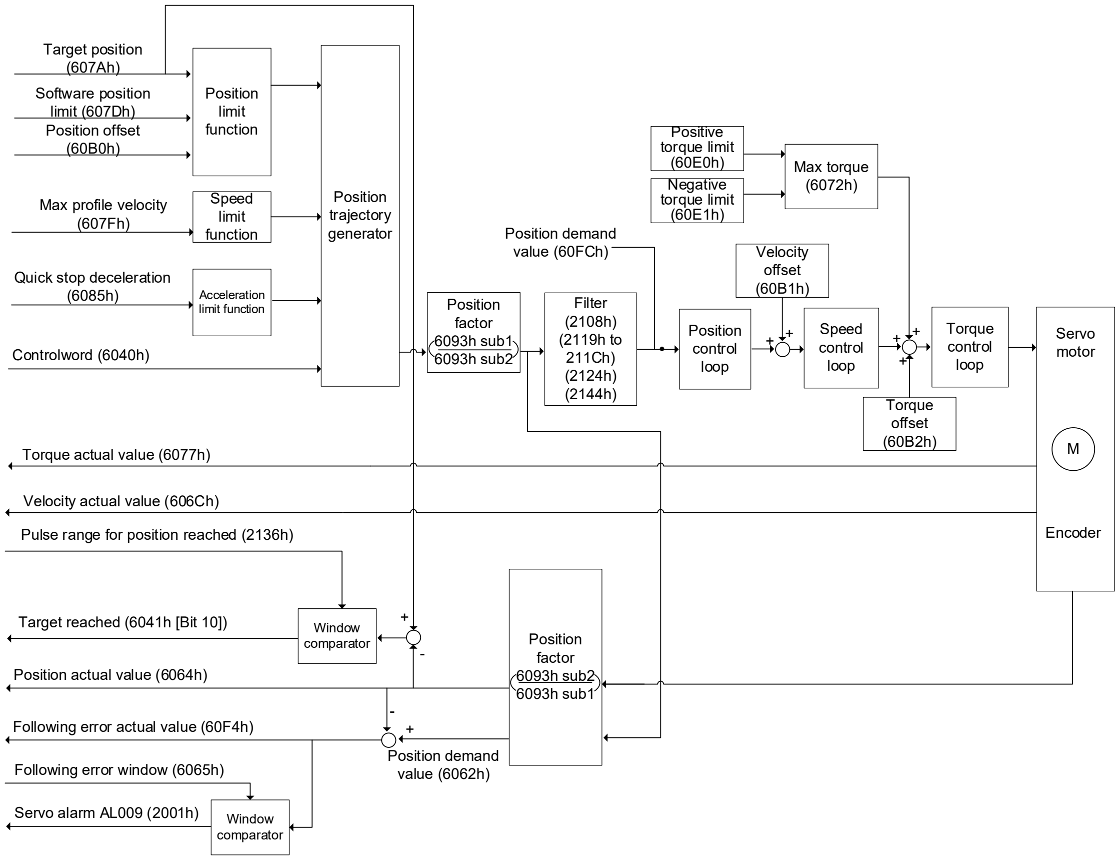
10.3.5 Cyclic Synchronous Position mode

In Cyclic Synchronous Position (CSP) mode, the controller plans the path and transmits PDOs to the servo drive periodically. When the controller transmits each PDO in CSP mode, it simultaneously transmits the target position and controlword data to the servo drive. The velocity offset and torque offset can be used as the velocity and torque feed forward control setting.



Operation steps:

1. Set the mode to Cyclic Synchronous Position mode: OD 6060h = 08h.
2. Set the target position (OD 607Ah) (unit: PUU).
3. Set the Controlword (OD 6040h) by following these steps. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 10.4.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6062h	Position demand value (PUU)	INTEGER32	RO
6064h	Position actual value (PUU)	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Ah	Target position	INTEGER32	RW
607Dh	Software position limit	INTEGER32	RW
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60B0h	Position offset	INTEGER32	RW
60B1h	Velocity offset	INTEGER32	RW
60B2h	Torque offset	INTEGER16	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 10.4.3 Details of objects.

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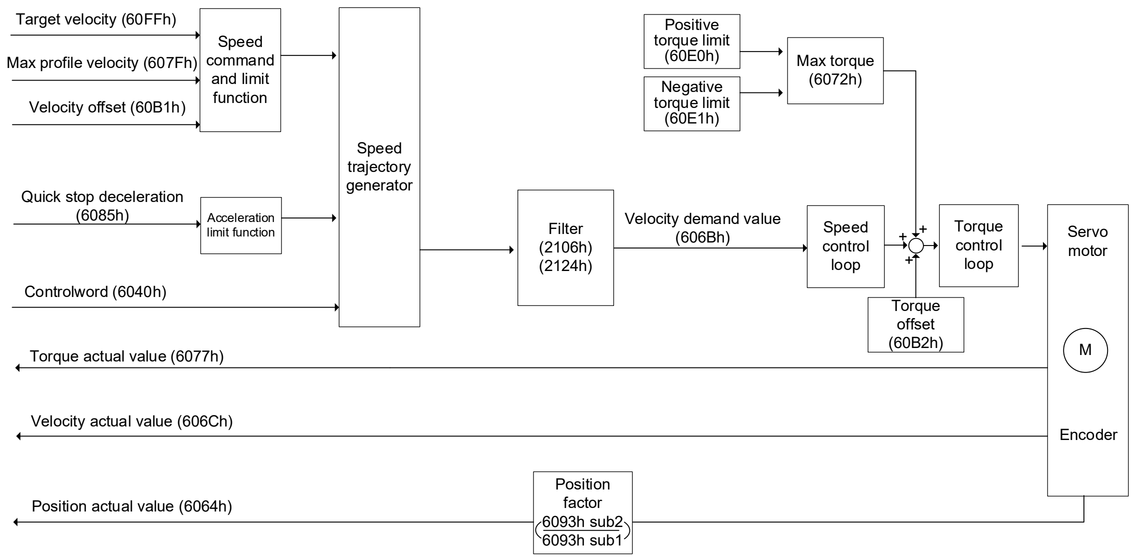
10.3.6 Cyclic Synchronous Velocity mode

In Cyclic Synchronous Velocity (CSV) mode, the controller plans the speed and transmits PDOs to the servo drive periodically. When the controller transmits each PDO in CSV mode, it simultaneously transmits the target velocity and controlword data to the servo drive. The velocity offset and torque offset can be used as the velocity and torque feed forward control setting.



Operation steps:

1. Set the mode to Cyclic Synchronous Velocity mode: OD 6060h = 09h.
2. Set the target velocity (OD 60FFh) to 0. In Cyclic Synchronous Velocity mode, the servo motor starts operating once the servo drive is switched to Servo On (Step 3). Therefore, set OD 60FFh = 0 to ensure that the motor maintains at 0 rpm at the moment of Servo On.
3. Set the Controlword (OD 6040h) by following these steps. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For the description of the state machine, refer to the OD 6040h description in Section 10.4.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

4. Set the target velocity (OD 60FFh).

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value (PUU)	INTEGER32	RO
606Bh	Velocity demand value	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6072h	Max torque	UNSIGNED16	RW
6077h	Torque actual value	INTEGER16	RO
607Fh	Max profile velocity	UNSIGNED32	RW
6085h	Quick stop deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60B1h	Velocity offset	INTEGER32	RW
60B2h	Torque offset	INTEGER16	RW
60E0h	Positive torque limit	UNSIGNED16	RW
60E1h	Negative torque limit	UNSIGNED16	RW
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 10.4.3 Details of objects.

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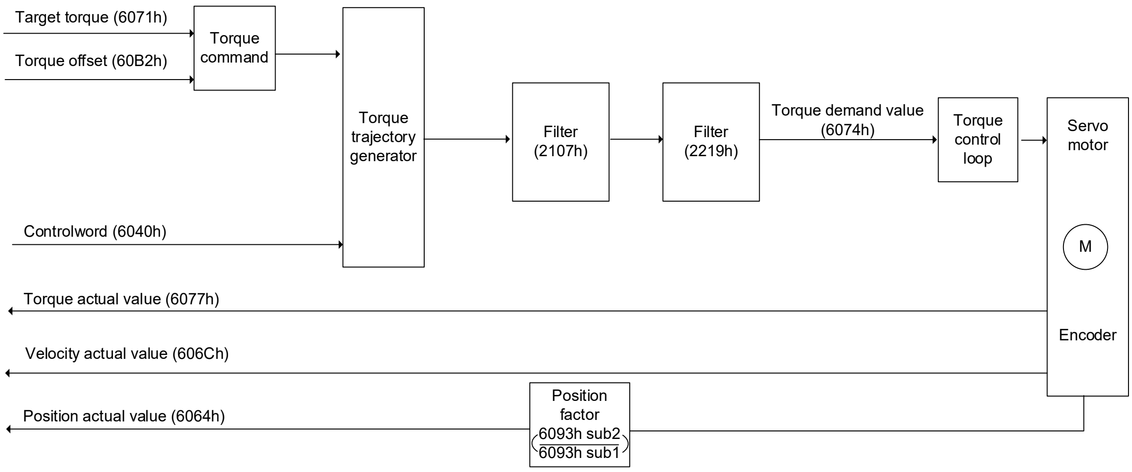
10.3.7 Cyclic Synchronous Torque mode

In Cyclic Synchronous Torque (CST) mode, the controller plans the torque and transmits PDOs to the servo drive periodically. When the controller transmits each PDO in CST mode, it simultaneously transmits the target torque and controlword data to the servo drive. The torque offset can be used as the torque feed forward control setting.



Operation steps:

1. Set the mode to Cyclic Synchronous Torque mode: OD 6060h = 0Ah.
2. Set the target torque (OD 6071h) to 0. In Cyclic Synchronous Torque mode, the servo target torque takes effect once the servo drive is switched to Servo On (Step 3). Therefore, set OD 6071h = 0 for safety reasons.
3. Set the Controlword (OD 6040h) by following these steps. Steps 3.1 and 3.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to the OD 6040h description in Section 10.4.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
3.1	0	0	1	1	0	Shutdown.
3.2	0	0	1	1	1	Switch on (ready for Servo On).
3.3	0	1	1	1	1	Enable operation (Servo On).

4. Set the target torque (OD 6071h).

Relevant object list

Index	Name	Data type	Access
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6064h	Position actual value (PUU)	INTEGER32	RO
606Ch	Velocity actual value	INTEGER32	RO
6071h	Target torque	INTEGER16	RW
6074h	Torque demand value	INTEGER16	RO
6077h	Torque actual value	INTEGER16	RO
6093h	Position factor	UNSIGNED32	RW
60B2h	Torque offset	INTEGER16	RW

Note: for more details, refer to Section 10.4.3 Details of objects.

10.3.8 Touch Probe function and Touch Probe status

The Touch Probe function can be triggered by high-speed digital inputs (only DI1 and DI2, with the hardware response time of 5 μs) or by the motor Z pulse. This function is used for high-speed measurement or packaging applications.

If the capture source is the motor Z pulse or DI of CN1, note the following:

1. When the capture source is set to the motor Z pulse, you can only use Touch Probe 1. Regardless of the settings of OD 60B8h [Bit 4] and [Bit 5], the command is rising-edge triggered and the data is stored in OD 60BAh.
2. When the capture source is set to the DI of CN1, the function code previously set for the DI is changed to 0x0100 so one DI does not have two functions.

Set the Touch Probe function with OD 60B8h. The definition of each bit is as follows.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 switch	0: disable Touch Probe 1. 1: enable Touch Probe 1.
Bit 1	Touch Probe 1 number of capturing times	0: capture data one time. If the Touch Probe 1 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture data multiple times.
Bit 2	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 3	Reserved	-
Bit 4	Touch Probe 1 rising-edge triggering	0: N/A 1: start capturing data when the Touch Probe 1 signal is rising-edge triggered and store the data in OD 60BAh.
Bit 5	Touch Probe 1 falling-edge triggering	0: N/A 1: start capturing data when the Touch Probe 1 signal is falling-edge triggered and store the data in OD 60BBh.
Bit 6 - Bit 7	Reserved	-
Bit 8	Touch Probe 2 switch	0: disable Touch Probe 2. 1: enable Touch Probe 2.
Bit 9	Touch Probe 2 number of capturing times	0: capture data one time. If the Touch Probe 2 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture data multiple times.
Bit 10	Touch Probe 2 capture source	0: DI2 of CN1
Bit 11	Reserved	-
Bit 12	Touch Probe 2 rising-edge triggering	0: N/A 1: start capturing data when the Touch Probe 2 signal is rising-edge triggered and store the data in OD 60BCh.

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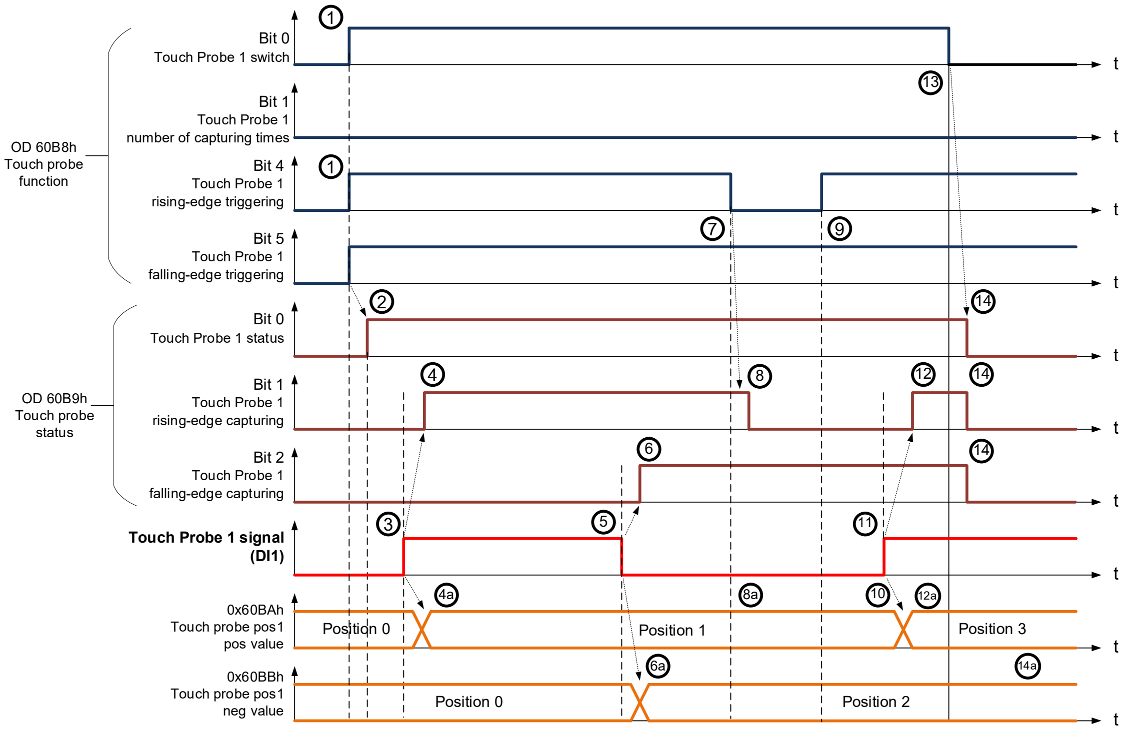
Bit	Function	Description
Bit 13	Touch Probe 2 falling-edge triggering	0: N/A 1: start capturing data when the Touch Probe 2 signal is falling-edge triggered and store the data in OD 60BDh.
Bit 14 - Bit 15	Reserved	-

You can access the Touch Probe status with OD 60B9h. The definition of each bit is as follows.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 status	0: Touch Probe 1 disabled. 1: Touch Probe 1 enabled.
Bit 1	Touch Probe 1 rising-edge capturing	0: capturing is not triggered. 1: the Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
Bit 2	Touch Probe 1 falling-edge capturing	0: capturing is not triggered. 1: the Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
Bit 3 - Bit 5	Reserved	-
Bit 6	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 7	Touch Probe 1 signal for capturing multiple times (available when OD 60B8h [Bit 1] Number of capturing times is enabled)	The status is reversed once the capturing succeeds. Refer to the timing diagram in Example 3.
Bit 8	Touch Probe 2 status	0: Touch Probe 2 disabled. 1: Touch Probe 2 enabled.
Bit 9	Touch Probe 2 rising-edge capturing	0: capturing is not triggered 1: the Touch Probe 2 signal is rising-edge triggered and the data is successfully captured.
Bit 10	Touch Probe 2 falling-edge capturing	0: capturing is not triggered 1: the Touch Probe 2 signal is falling-edge triggered and the data is successfully captured.
Bit 11 - Bit 13	Reserved	-
Bit 14	Touch Probe 2 capture source	0: DI2 of CN1
Bit 15	Touch Probe 2 signal for capturing multiple times (available when OD 60B8h [Bit 9] Number of capturing times is enabled)	The status is reversed once the capturing succeeds.

Example 1: the following is the timing diagram for the Touch Probe 1 function, with the capture source as the external DI. When OD 60B8h [Bit 1] = 0 and OD 60B8h [Bit 4] & [Bit 5] = 1, the data is captured once when the DI signal is rising-edge and falling-edge triggered.



Status	Function	Description
(1)	OD 60B8h [Bit 0] = 1	Enable Touch Probe 1.
	OD 60B8h [Bit 1] = 0	Capture data one time.
	OD 60B8h [Bit 4] = 1	Start capturing data when the Touch Probe 1 signal is rising-edge triggered.
	OD 60B8h [Bit 5] = 1	Start capturing data when the Touch Probe 1 signal is falling-edge triggered.
(2)	OD 60B9h [Bit 0] = 1	Touch Probe status: Touch Probe 1 enabled.
(3)	-	Touch Probe 1 signal is rising-edge triggered by external signal.
(4)	OD 60B9h [Bit 1] = 1	Touch Probe status: Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
(4a)	OD 60BAh	Store the captured data in OD 60BAh when the Touch Probe 1 signal is rising-edge triggered.
(5)	-	Touch Probe 1 signal is falling-edge triggered by external signal.
(6)	OD 60B9h [Bit 2] = 1	Touch Probe status: Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
(6a)	OD 60BBh	Store the captured data in OD 60BBh when the Touch Probe 1 signal is falling-edge triggered.
(7)	OD 60B8h [Bit 4] = 0	Disable the rising-edge triggering of Touch Probe 1.
(8)	OD 60B9h [Bit 1] = 0	Touch Probe status: reset the rising-edge capture status to non-triggered.
(8a)	OD 60BAh	Data captured at the rising-edge remains the same.
(9)	OD 60B8h [Bit 4] = 1	Start capturing data when the Touch Probe 1 signal is rising-edge triggered.
(10)	OD 60BAh	Data captured at the rising-edge remains the same.
(11)	-	Touch Probe 1 signal is rising-edge triggered by external signal.
(12)	OD 60B9h [Bit 1] = 1	Touch Probe status: Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.

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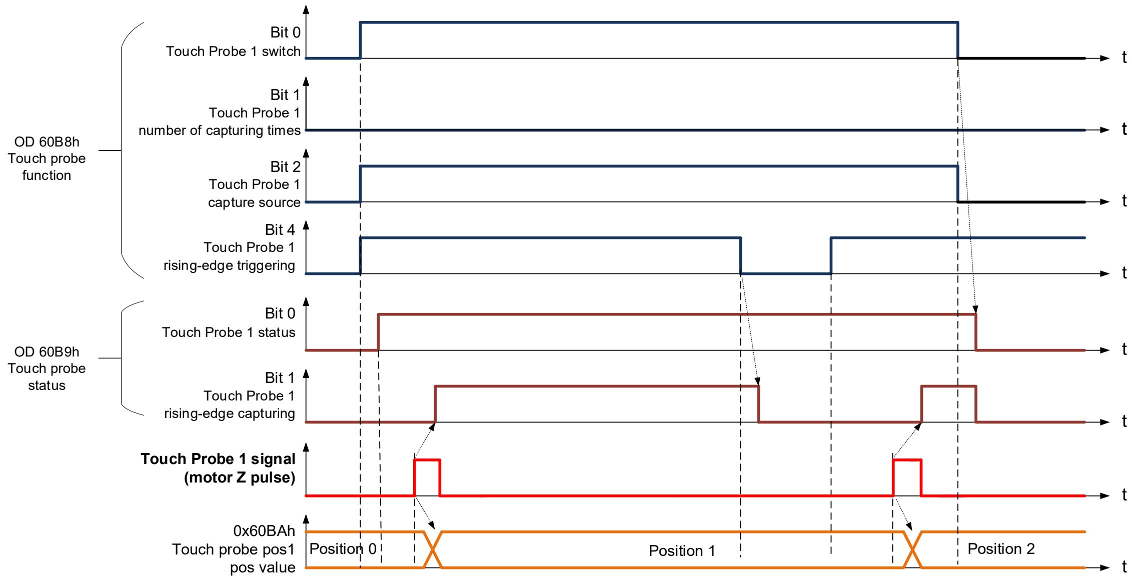
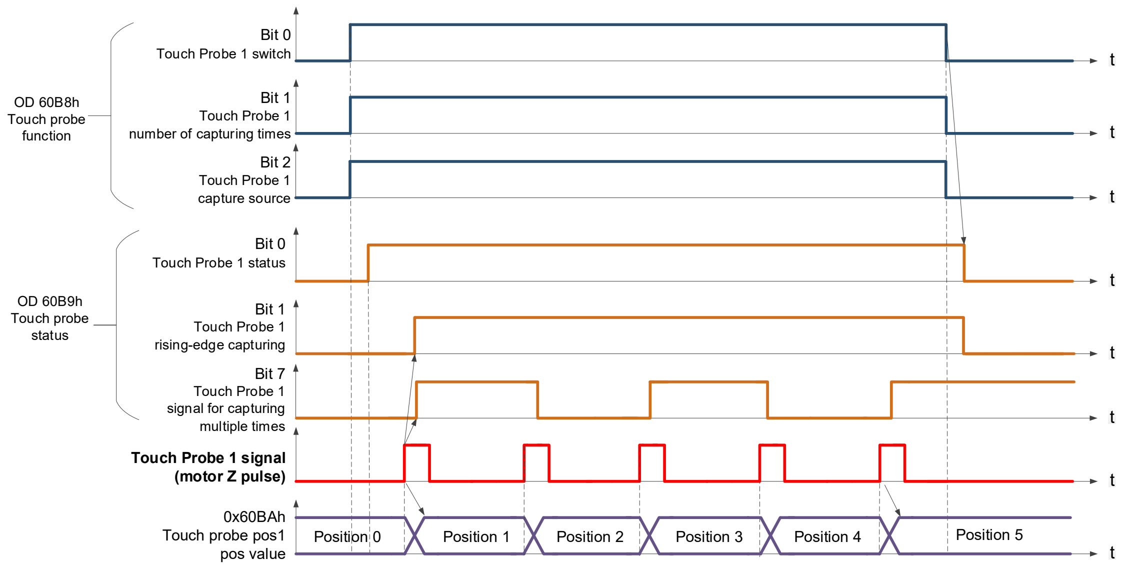
Status	Function	Description
(12a)	OD 60BAh	Store the captured data in OD 60BAh when the Touch Probe 1 signal is rising-edge triggered.
(13)	OD 60B8h [Bit 0] = 0	Disable Touch Probe 1.
(14)	OD 60B9h [Bit 0] = 0 OD 60B9h [Bit 1] = 0 OD 60B9h [Bit 2] = 0	Reset Touch Probe 1 status.
(14a)	OD 60BAh	The previously captured data remains the same.

Example 2: the following is the timing diagram for the Touch Probe 1 function, with the capture source as the motor Z pulse. The data is captured once only when the Touch Probe 1 signal is rising-edge triggered.



Example 3: the following is the timing diagram for the Touch Probe 1 function, with the capture source as the motor Z pulse. The data is captured **multiple times** when the Touch Probe 1 signal is rising-edge triggered.



Relevant object list

Index	Name	Data type	Access
60B8h	Touch probe function	UNSIGNED16	RW
60B9h	Touch probe status	UNSIGNED16	RO
60BAh	Touch probe pos1 pos value	INTEGER32	RO
60BBh	Touch probe pos1 neg value	INTEGER32	RO
60BCh	Touch probe pos2 pos value	INTEGER32	RO
60BDh	Touch probe pos2 neg value	INTEGER32	RO

Note: for more details, refer to Section 10.4.3 Details of objects.

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10.4 Object dictionary

This section details the EtherCAT objects supported by the servo. The contents include object index, name, data type, data length, and read / write permissions (access).

10.4.1 Specifications for objects

Object code

Object code	Description
VAR	A single value, such as an UNSIGNED8, Boolean, float, and INTEGER16.
ARRAY	An object of multiple data fields consisting of multiple variables of the same data type, such as an UNSIGNED16 array. The sub-index 0 data type is UNSIGNED8, so it is not an ARRAY data.
RECORD	An object of multiple data fields consisting of multiple variables of different data types. The sub-index 0 data type is UNSIGNED8, so it is not a RECORD data.

Data type

Refer to CANopen DS301.

10.4.2 List of objects

OD 1XXXh communication object group

Index	Object code	Name	Data type	Access
1000h	VAR	Device type	UNSIGNED32	RO
1001h	VAR	Error register	UNSIGNED8	RO
1003h	ARRAY	Pre-defined error field	UNSIGNED32	RW
1600h - 1603h	RECORD	Receive PDO mapping parameter	UNSIGNED32	RW
1A00h - 1A03h	RECORD	Transmit PDO mapping parameter	UNSIGNED32	RW
1C12h	ARRAY	RxPDO assign	UNSIGNED16	RW
1C13h	ARRAY	TxPDO assign	UNSIGNED16	RW

Note: only 1001h can be mapped to PDO.

OD 2XXXh servo parameter group

Index	Object code	Name	Data type	Access	Mappable
2XXXh	VAR	Parameter mapping	INTEGER16/32	RW	Y

OD 6XXXh communication object group

Index	Object code	Name	Data type	Access	Mappable
603Fh	VAR	Error code	UNSIGNED16	RO	Y
6040h	VAR	Controlword	UNSIGNED16	RW	Y
6041h	VAR	Statusword	UNSIGNED16	RO	Y
605Bh	VAR	Shutdown option code	INTEGER16	RW	Y
6060h	VAR	Modes of operation	INTEGER8	RW	Y
6061h	VAR	Modes of operation display	INTEGER8	RO	Y
6062h	VAR	Position demand value (PUU)	INTEGER32	RO	Y
6063h	VAR	Position actual internal value (pulse)	INTEGER32	RO	Y
6064h	VAR	Position actual value (PUU)	INTEGER32	RO	Y
6065h	VAR	Following error window	UNSIGNED32	RW	Y
6067h	VAR	Position window	UNSIGNED32	RW	Y
6068h	VAR	Position window time	UNSIGNED16	RW	Y
606Bh	VAR	Velocity demand value	INTEGER32	RO	Y
606Ch	VAR	Velocity actual value	INTEGER32	RO	Y
606Dh	VAR	Velocity window	UNSIGNED16	RW	Y
606Eh	VAR	Velocity window time	UNSIGNED16	RW	Y
606Fh	VAR	Velocity threshold	UNSIGNED16	RW	Y
6071h	VAR	Target torque	INTEGER16	RW	Y
6072h	VAR	Max torque	UNSIGNED16	RW	Y
6074h	VAR	Torque demand value	INTEGER16	RO	Y
6075h	VAR	Motor rated current	UNSIGNED32	RO	Y
6076h	VAR	Motor rated torque	UNSIGNED32	RO	Y
6077h	VAR	Torque actual value	INTEGER16	RO	Y
6078h	VAR	Current actual value	INTEGER16	RO	Y
607Ah	VAR	Target position	INTEGER32	RW	Y
607Ch	VAR	Home offset	INTEGER32	RW	Y
607Dh	ARRAY	Software position limit	INTEGER32	RW	Y

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Index	Object code	Name	Data type	Access	Mappable
607Fh	VAR	Max profile velocity	UNSIGNED32	RW	Y
6080h	VAR	Max motor speed	UNSIGNED32	RW	Y
6081h	VAR	Profile velocity	UNSIGNED32	RW	Y
6083h	VAR	Profile acceleration	UNSIGNED32	RW	Y
6084h	VAR	Profile deceleration	UNSIGNED32	RW	Y
6085h	VAR	Quick stop deceleration	UNSIGNED32	RW	Y
6086h	VAR	Motion profile type	INTEGER16	RO	Y
6087h	VAR	Torque slope	UNSIGNED32	RW	Y
6093h	ARRAY	Position factor	UNSIGNED32	RW	Y
6098h	VAR	Homing method	INTEGER8	RW	Y
6099h	ARRAY	Homing speeds	UNSIGNED32	RW	Y
609Ah	VAR	Homing acceleration	UNSIGNED32	RW	Y
60B0h	VAR	Position offset	INTEGER32	RW	Y
60B1h	VAR	Velocity offset	INTEGER32	RW	Y
60B2h	VAR	Torque offset	INTEGER16	RW	Y
60B8h	VAR	Touch probe function	UNSIGNED16	RW	Y
60B9h	VAR	Touch probe status	UNSIGNED16	RO	Y
60BAh	VAR	Touch probe pos1 pos value	INTEGER32	RO	Y
60BBh	VAR	Touch probe pos1 neg value	INTEGER32	RO	Y
60BCh	VAR	Touch probe pos2 pos value	INTEGER32	RO	Y
60BDh	VAR	Touch probe pos2 neg value	INTEGER32	RO	Y
60C5h	VAR	Max acceleration	UNSIGNED32	RW	Y
60C6h	VAR	Max deceleration	UNSIGNED32	RW	Y
60E0h	VAR	Positive torque limit	UNSIGNED16	RW	Y
60E1h	VAR	Negative torque limit	UNSIGNED16	RW	Y
60F4h	VAR	Following error actual value	INTEGER32	RO	Y
60FCh	VAR	Position demand value	INTEGER32	RO	Y
60FDh	VAR	Digital inputs	UNSIGNED32	RO	Y
60FEh	ARRAY	Digital outputs	UNSIGNED32	RW	Y
60FFh	VAR	Target velocity	INTEGER32	RW	Y
6502h	VAR	Supported drive modes	UNSIGNED32	RO	Y

10.4.3 Details of objects

10.4.3.1 OD 1XXXh communication object group

Object 1000h: Device type

Index	1000h
Name	Device type
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Model type	X	Bit 0 - Bit 15 Device profile number
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: device profile number (servo drive: 0192)
- DCBA: model type

DCBA	Model type
0702	A3

Object 1001h: Error register

Index	1001h
Name	Error register
Object code	VAR
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED8
Default	0

Object function:

The bits and corresponding functions are as follows:

Bit	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Generic error
Bit 1	Current
Bit 2	Voltage
Bit 3	Temperature
Bit 4	Communication error
Bit 5 - Bit 7	Reserved

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Object 1003h: Pre-defined error field

Index	1003h
Name	Pre-defined error field
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of errors
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 5
Default	0

Sub-index	1h - 5h
Description	Standard error field
Data type	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

A	Bit 16 - Bit 31 Delta servo alarm	X	Bit 0 - Bit 15 Error code
B		Y	
C		Z	
D		U	

Definitions are as follows:

- UZYX: error code. Refer to the error code definition in DS402.
- DCBA: Delta servo alarm. Refer to Chapter 11 Troubleshooting.

Example:

When you operate the servo, if the encoder cable is not correctly connected, the servo drive panel displays AL011 and its error code is stored in the 1003h array. The display is as follows:

Byte:	High word	Low word
	Delta servo alarm (UINT16)	Error code (UINT16)
	0x0011	0x7305

AL011 is defined as “CN2 communication failed” according to the Delta servo alarm.

Error code: 0x7305 is defined as “Incremental sensor 1 fault” according to DS402.

Objects 1600h - 1603h: Receive PDO mapping parameter

Index	1600h, 1601h, 1602h, 1603h
Name	Receive PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0h
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1h - 8h
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

The format of this object is as follows:

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0 - Bit 7	Object data length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

Example:

To set the three PDOs, OD 6040h, OD 607Ah, and OD 6060h, in the first group of RxPDO, the setting is as follows.

Mapping parameter setting for RxPDO	Data			Description
OD 1600h sub1	6040h	00h	10h	Mapping the Controlword (6040h); data length is 16-bit
OD 1600h sub2	607Ah	00h	20h	Mapping the target position (607Ah); data length is 32-bit
OD 1600h sub3	6060h	00h	08h	Mapping the operation mode (6060h); data length is 8-bit
OD 1600h sub0	3			Set 3 for the RxPDO mapping number.
Note	The total length is 38h (56-bit) which meets the specification of less than 64-bit.			

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Objects 1A00h - 1A03h: Transmit PDO mapping parameter

Index	1A00h, 1A01h, 1A02h, 1A03h
Name	Transmit PDO mapping parameter
Object code	RECORD
Data type	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0h
Description	Number of PDO mappings
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0: disable 1 - 8: set the number of PDO mapping and enable the function
Default	0

Sub-index	1h - 8h
Description	Specify the 1st (to 8th) object and its content to be mapped
Data type	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA; (Low word L) UZYX

<table>
<tr><td rowspan="2">DCBA</td><td rowspan="2">Bit 16 - Bit 31
Object index</td><td>YX</td><td>Bit 0 - Bit 7
Object data length</td></tr>
<tr><td>UZ</td><td>Bit 8 - Bit 15
Object sub-index</td></tr>
</table>

Object 1C12h: RxPDO assign

Index	1C12h
Name	RxPDO assign
Object code	ARRAY
Data type	UNSIGNED16
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 1
Default	1

Sub-index	1h
Description	Specify the RxPDO index to be used
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0x1600, 0x1601, 0x1602, 0x1603
Default	0x1601

Object 1C13h: TxPDO assign

Index	1C13h
Name	TxPDO assign
Object code	ARRAY
Data type	UNSIGNED16
Access	RW
PDO mapping	No

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 1
Default	1

Sub-index	1h
Description	Specify the TxPDO index to be used
Data type	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0x1A00, 0x1A01, 0x1A02, 0x1A03
Default	0x1A01

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10.4.3.2 OD 2XXXh servo parameter group

Object 2XXXh: Parameter mapping

Index	2XXXh
Name	Parameter mapping
Object code	VAR
Data type	INTEGER16 / INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER16 / INTEGER32
Default	N/A

Object function:

Access the corresponding servo parameters with the OD 2XXXh group. The conversion between the parameter number and object index is as follows:

Object index	Servo parameter	Description
2aBCh	Pa.bcd	“BC” is the hexadecimal format of “bcd”.

You can read the object index first to get the information of the parameter length, and then use SDO or PDO to change the data.

Example 1:

Object 2300h: Node-ID [P3.000]

Index	2300h
Name	Node-ID
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	7F

Example 2:

Object 212Ch: Electronic Gear [P1.044]

Index	212Ch
Name	Electronic Gear
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	1

10.4.3.3 OD 6XXXh communication object group

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Object 603Fh: Error code (CANopen defined)

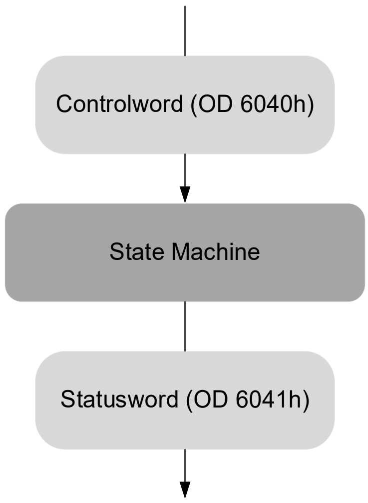
Index	603Fh
Name	Error code
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object 6040h: Controlword

Index	6040h
Name	Controlword
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0x0004

Object function:

The Controlword contains many functions, such as Servo On, command triggering, fault reset, and quick stop. The state machine architecture is as follows:



Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

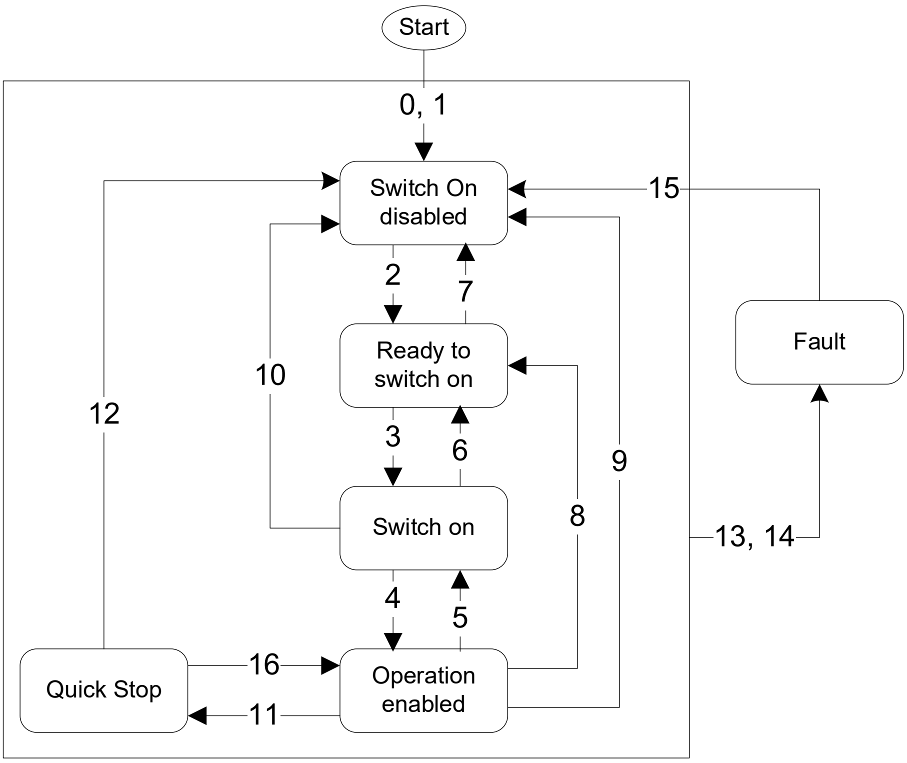
Bit	Function	Description
Bit 0	Switch on	Ready for Servo On.
Bit 1	Enable voltage	-
Bit 2	Quick stop (B contact (NC))	-
Bit 3	Enable operation	Servo On.
Bit 4 - Bit 6	Operation mode specific	Individually defined based on the operation mode, as shown in the following table.
Bit 7	Fault reset	-
Bit 8	Halt	-
Bit 9 - Bit 15	Reserved	-

Bits 4 - 6 are individually defined based on the operation mode, as shown in the following table:

Bit	PP	HM	PV / PT / CSP / CSV / CST
Bit 4	Command triggering (rising-edge triggered)	Homing (rising-edge triggered)	-
Bit 5	Command taking immediate effect	-	-
Bit 6	0: absolute position command 1: relative position command	-	-

Note: - indicates the bit is invalid.

Finite state machine (as shown in the following diagram) defines the behavior of a servo drive system. Each state represents an internal or external behavior. For example, the servo drive can execute point-to-point motion only in the Operation enabled state.



The state transitions are defined as follows:

Transition	Event	Action
0, 1	Automatic transition after power-on	Device boot and initialization
2	Shutdown command	N/A
3	Switch on command	Servo is ready for Servo On
4	Enable operation command	Servo switches to Servo On and enters the mode in which the controller is allowed to issue a motion command
5	Disable operation command	Servo switches to Servo Off
6	Shutdown command	N/A
7	Disable voltage or quick stop command	N/A
8	Shutdown command	Servo switches to Servo Off
9	Disable voltage command	Servo switches to Servo Off
10	Disable voltage or quick stop command	N/A
11	Quick stop command The following two errors belong to this quick stop type: 1. Positive / negative limit switch triggered 2. Quick stop triggered by the Controlword (OD 6040h [Bit 2] = 0)	Quick stop function is enabled. The time setting for deceleration to a stop is different for the two errors. 1. OD 2503h (P5.003) 2. OD 6085h
12	Disable voltage command (OD 6040h = 0000 0110 or OD 6040h [Bit 1] = 0)	Servo switches to Servo Off
13, 14	Alarm occurs	Servo switches to Servo Off
15	Fault reset	N/A
16	Enable operation command; no alarm	Motion operation restart. The restart action is mode-dependent.

State transition can be achieved with the Controlword (OD 6040h). The commands are as follows:

Command	OD 6040h					Transition
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	
Shutdown	0	X	1	1	0	2, 6, 8
Switch on	0	0	1	1	1	3
Switch on + Enable operation	0	1	1	1	1	3 + 4
Disable voltage	0	X	X	0	X	7, 9, 10, 12
Quick stop	0	X	0	1	X	7, 10, 11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16
Fault reset	↑	X	X	X	X	15

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Object 6041h: Statusword

Index	6041h
Name	Statusword
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

The Statusword contains many statuses, such as Servo On, command statuses, fault / warning signal, and target reached. The state machine architecture is as follows:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Status		Description
Bit 0	Ready to switch on	Ready to be activated	Current status of the servo drive (see the following table for details).
Bit 1	Switched on	Servo ready	
Bit 2	Operation enabled	Servo On	
Bit 3	Fault	Fault signal	
Bit 4	Voltage enabled	Servo is powered on	
Bit 5	Quick stop	-	
Bit 6	Switch on disabled	Servo disabled	
Bit 7	Warning	Warning signal	When outputting the warning signal, the servo keeps outputting the Servo On signal.
Bit 8	Reserved	-	-
Bit 9	Remote	Remote control	-
Bit 10	Target reached	-	-
Bit 11	Reserved	-	-
Bit 12 - Bit 13	Operation mode specific	-	Individually defined based on the operation mode, as shown in the following table.
Bit 14	Positive limit	-	-
Bit 15	Negative limit	-	-

Bit 0 - Bit 6: current status of the servo drive.

Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	-	-	0	0	0	0	Not ready to switch on.
1	-	-	0	0	0	0	Switch on disabled.
0	1	-	0	0	0	1	Ready to switch on.
0	1	-	0	0	1	1	Switched on.
0	1	-	0	1	1	1	Operation enabled (Servo On).
0	0	-	0	1	1	1	Quick stop active.
0	-	-	1	1	1	1	Fault reaction active.
0	-	-	1	0	0	0	Servo fault (servo switches to Servo Off).

Note: 0 indicates the bit is Off, 1 indicates the bit is On, and - indicates the bit is invalid.

Bit 12 - Bit 13: individually defined based on the operation mode, as shown in the following table.

Bit	PP	PV	PT	HM	CSP	CSV	CST
Bit 12	Set-point acknowledge (servo received the command signal)	Zero speed	-	Homing is complete	Mode is in effect	Mode is in effect	Mode is in effect
Bit 13	Following error	-	-	Homing error	Following error	-	-

Note: - indicates the bit is invalid.

Object 605Bh: Shutdown option code

Index	605Bh
Name	Shutdown option code
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	0

Object function:

0: when Servo Off, the dynamic brake has no effect, so the motor runs freely and the machine stops only by friction.

-1: when Servo Off, the servo stops with the activation of the dynamic brake.

Object 6060h: Modes of operation

Index	6060h
Name	Modes of operation
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object sets the mode for operation.

Setting value	Mode
0	Reserved
1	Profile Position mode
2	Reserved
3	Profile Velocity mode
4	Profile Torque mode
5	Reserved
6	Homing mode
7	Reserved
8	Cyclic Synchronous Position mode
9	Cyclic Synchronous Velocity mode
10	Cyclic Synchronous Torque mode

Object 6061h: Modes of operation display

Index	6061h
Name	Modes of operation display
Object code	VAR
Data type	INTEGER8
Access	RO
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object displays the current operation mode. Refer to the table in OD 6060h.

Object 6062h: Position demand value (PUU)

Index	6062h
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This position demand value is the interpolation command calculated by the servo internal interpolator. This command is processed by the servo internal filter. Refer to the servo architecture diagram of each mode.

Object 6063h: Position actual internal value (pulse)

Index	6063h
Name	Position actual internal value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	pulse (unit for encoder pulse resolution)

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Object 6064h: Position actual value (PUU)

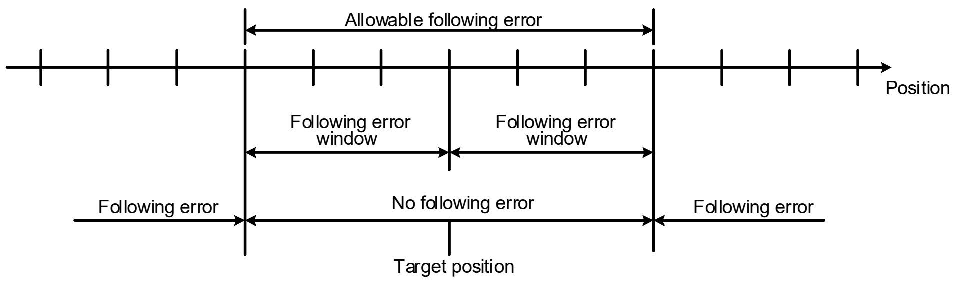
Index	6064h
Name	Position actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object 6065h: Following error window

Index	6065h
Name	Following error window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	50331648
Unit	PUU

Object function:

When the following error actual value (OD 60F4h) exceeds the following error window, AL009 (Excessive deviation of Position command) is triggered.



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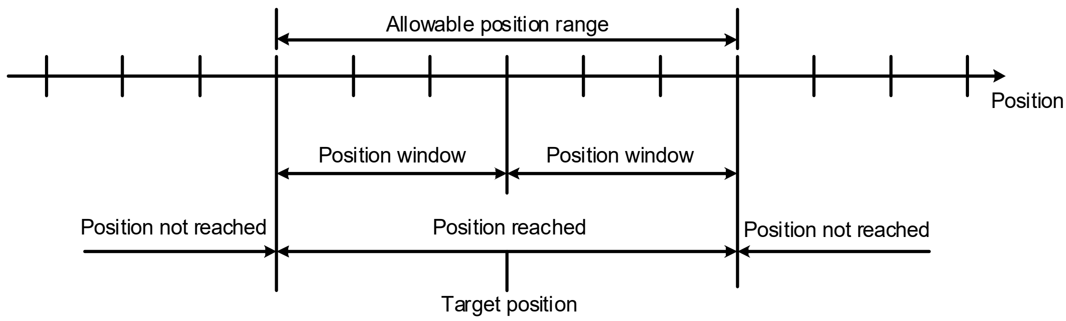
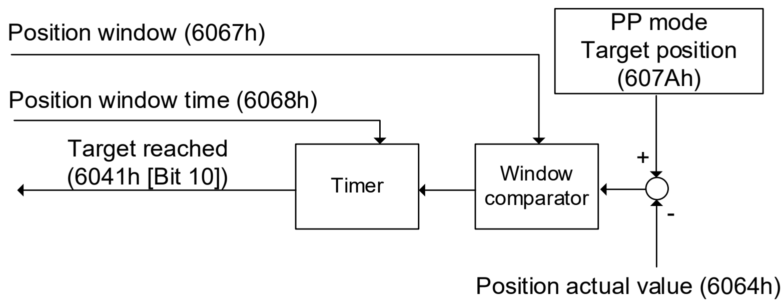
Object 6067h: Position window

Index	6067h
Name	Position window
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	PUU

Object function:

When the difference (absolute value) between the target position (PP mode: OD 607Ah) and the position actual value (OD 6064h) is within the Position window (OD 6067h), and the duration of this condition is longer than the Position window time (OD 6068h), the target reached signal (OD 6041h [Bit 10]) is output.



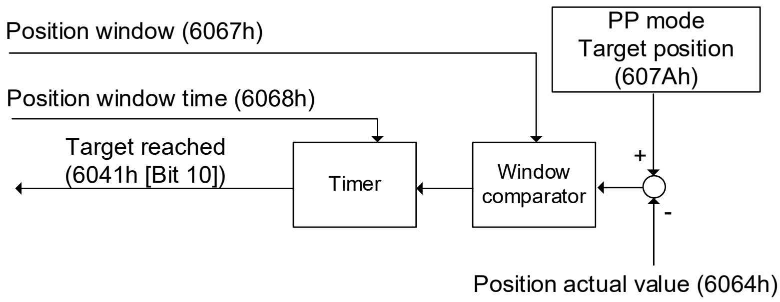


Object 6068h: Position window time

Index	6068h
Name	Position window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

When the difference (absolute value) between the target position (PP mode: OD 607Ah) and the position actual value (OD 6064h) is within the Position window (OD 6067h), and the duration of this condition is longer than the Position window time (OD 6068h), the target reached signal (OD 6041h [Bit 10]) is output.



Object 606Bh: Velocity demand value

Index	606Bh
Name	Velocity demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Unit	0.1 rpm

Object function:

The velocity demand value is a command generated by the speed trajectory generator and filtered by the command filter of the drive. This object is available in Profile Velocity mode and Cyclic Synchronous Velocity mode. For more details, refer to Sections 10.3.2 and 10.3.6.

Object 606Ch: Velocity actual value

Index	606Ch
Name	Velocity actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Unit	0.1 rpm

Object function:

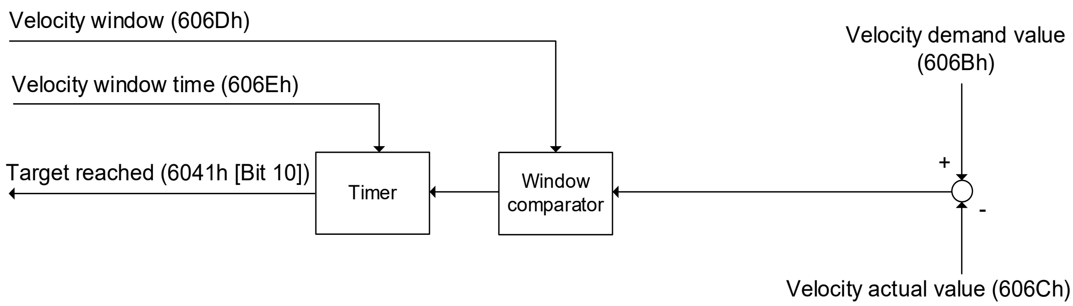
Returns the motor speed at present for monitoring.

Object 606Dh: Velocity window

Index	606Dh
Name	Velocity window
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	100
Unit	0.1 rpm

Object function:

The window comparator compares the speed difference with the velocity window (OD 606Dh). When the difference (absolute value) is within the Velocity window (OD 606Dh), and the duration of this condition is longer than the Velocity window time (OD 606Eh), the target reached signal (OD 6041h [Bit 10]) is output. This object is available in Profile Velocity mode. For more details, refer to Section 10.3.2.



Object 606Eh: Velocity window time

Index	606Eh
Name	Velocity window time
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

For the function of this object, refer to OD 606Dh.

Object 606Fh: Velocity threshold

Index	606Fh
Name	Velocity threshold
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 2000
Default	100
Unit	0.1 rpm

Object function:

This object sets the range for the zero-speed signal output. When the forward or reverse speed (absolute value) of the motor is lower than this set value, the zero-speed signal (OD 6041h [Bit 12]) outputs 1.

Object 6071h: Target torque

Index	6071h
Name	Target torque
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3500 to +3500
Default	0
Unit	0.1%

Object function:

This object sets the target torque in Profile Torque mode and Cyclic Synchronous Torque mode. If OD 6071h = 1000 (100.0%), it corresponds to the motor rated torque.

Object 6072h: Max torque

Index	6072h
Name	Max torque
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3500
Default	3500
Unit	0.1%

Object function:

This object sets the maximum torque in Profile Torque mode and Cyclic Synchronous Torque mode.

Object 6074h: Torque demand value

Index	6074h
Name	Torque demand value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

The torque demand value is a command generated by the speed trajectory generator and filtered by the command filter of the drive. This object is available in Profile Torque mode and Cyclic Synchronous Torque mode. For more details, refer to Sections 10.3.3 and 10.3.7.

Object 6075h: Motor rated current

Index	6075h
Name	Motor rated current
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	mA

Object function:

This object displays the rated current specified on the motor nameplate.

Object 6076h: Motor rated torque

Index	6076h
Name	Motor rated torque
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	0.001 N·m

Object function:

This object displays the rated torque specified on the motor nameplate.

Object 6077h: Torque actual value

Index	6077h
Name	Torque actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor torque feedback in percentage at present.

Object 6078h: Current actual value

Index	6078h
Name	Current actual value
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the motor current feedback in percentage at present.

Object 607Ah: Target position

Index	607Ah
Name	Target position
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object sets the target position and is available in Profile Position mode and Cyclic Synchronous Position mode. For more details, refer to Sections 10.3.1 and 10.3.5.

Object 607Ch: Home offset

Index	607Ch
Name	Home offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The origin reference point (such as the origin sensor and Z pulse) which the system looks for during the homing procedure is Home position. When the origin reference point is found, the position offset from this point is the user-defined origin (Zero position), and the offset value is Home offset.

Object 607Dh: Software position limit

Index	607Dh
Name	Software position limit
Object code	ARRAY
Data type	INTEGER32
Access	RW

Sub-index	0h
Description	Number of entries
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1h
Description	Min position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	-2147483648
Unit	PUU

Sub-index	2h
Description	Max position limit
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	-2147483648 to +2147483647
Default	+2147483647
Unit	PUU

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Object 607Fh: Max profile velocity

Index	607Fh
Name	Max profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055 (rpm) * 10
Unit	0.1 rpm

Object function:

The unit of this object is 0.1 rpm, so dividing this object by 10 is equivalent to P1.055 (Maximum speed limit in units of 1 rpm).

Object 6080h: Max motor speed

Index	6080h
Name	Max motor speed
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	Varies depending on the motor model
Corresponding servo parameter	P1.055
Unit	rpm

Object function:

This object is equivalent to P1.055, which is the maximum speed limit of the motor.

Object 6081h: Profile velocity

Index	6081h
Name	Profile velocity
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	10000
Unit	PUU/s

Object function:

This object sets the profile velocity and is available in Profile Position mode. For more details, refer to Section 10.3.1.

Object 6083h: Profile acceleration

Index	6083h
Name	Profile acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm. This object is available in Profile Position mode and Profile Velocity mode. For more details, refer to Sections 10.3.1 and 10.3.2.

Object 6084h: Profile deceleration

Index	6084h
Name	Profile deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm. This object is available in Profile Position mode and Profile Velocity mode. For more details, refer to Sections 10.3.1 and 10.3.2.

Object 6085h: Quick stop deceleration

Index	6085h
Name	Quick stop deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm using the quick stop function.

Object 6086h: Motion profile type

Index	6086h
Name	Motion profile type
Object code	VAR
Data type	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	0
Default	0

Object function:

This object sets the type of motion profile for operation. Currently, only linear ramp (trapezoidal profile) is available.

Setting value	Mode
0	Linear ramp (trapezoidal profile)

Object 6087h: Torque slope

Index	6087h
Name	Torque slope
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0 - 65500
Default	200
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to change from 0% to 100% of the rated torque.

Object 6093h: Position factor

Index	6093h
Name	Position factor
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Corresponding servo parameter	P1.044 and P1.045

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1h
Description	E-Gear ratio numerator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.044
Note	For the E-Gear ratio setting, refer to Section 6.1.2.

Sub-index	2h
Description	E-Gear ratio denominator
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.045
Note	For the E-Gear ratio setting, refer to Section 6.1.2.

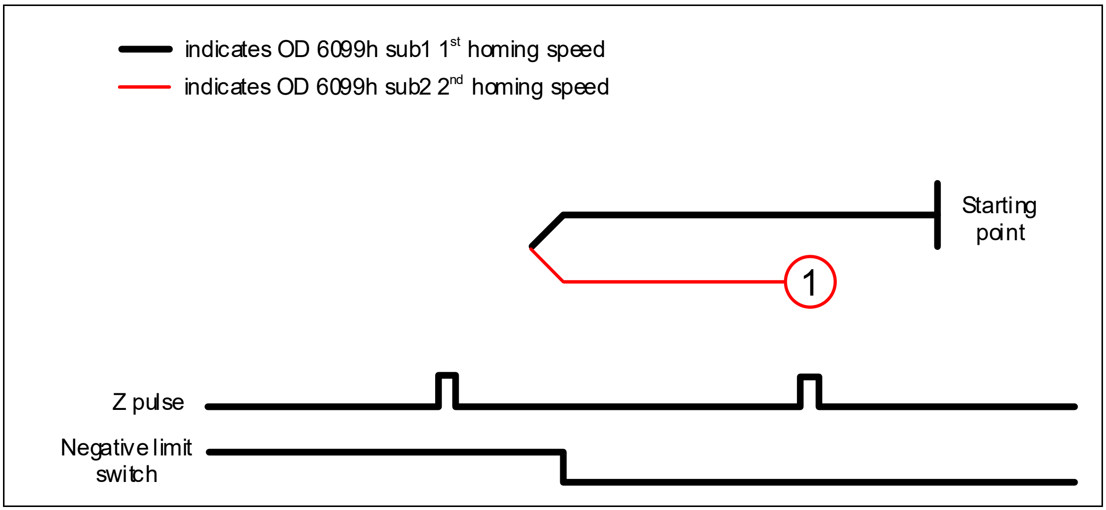
Object 6098h: Homing method

Index	6098h
Name	Homing method
Object code	VAR
Data type	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	-4 to +35
Default	0

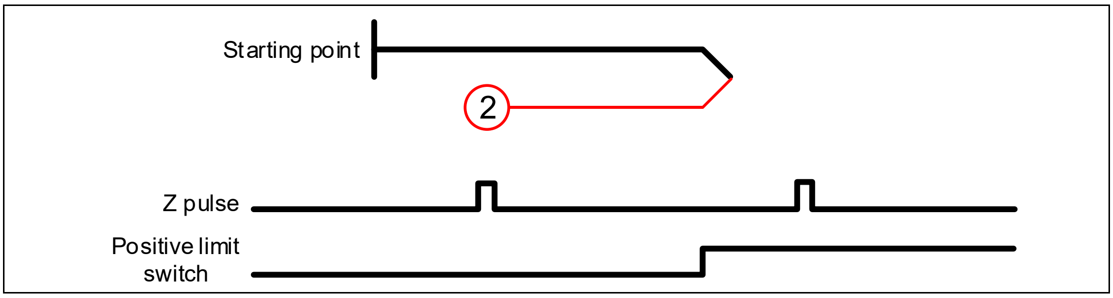
Object function:

The homing methods include looking for the Z pulse (Methods 1 - 14, 33, 34, 36, 37), not looking for the Z pulse (Methods 17 - 30), defining the current position as the origin (Method 35), and looking for the hard stop (Methods 36 - 39). Methods 15, 16, 31, and 32 are reserved. To use Methods 1 to 35, set OD 6098h to 1 to 35. To use Methods 36 to 39, set OD 6098h to -1 to -4.

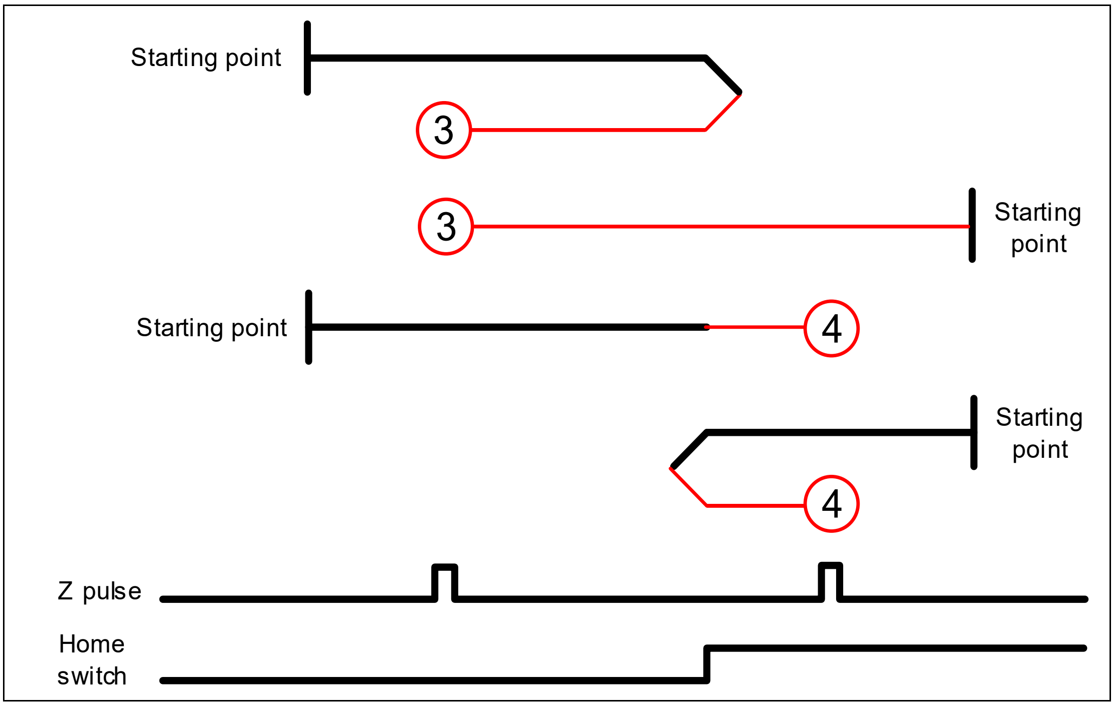
Method 1: homing on the negative limit switch and Z pulse



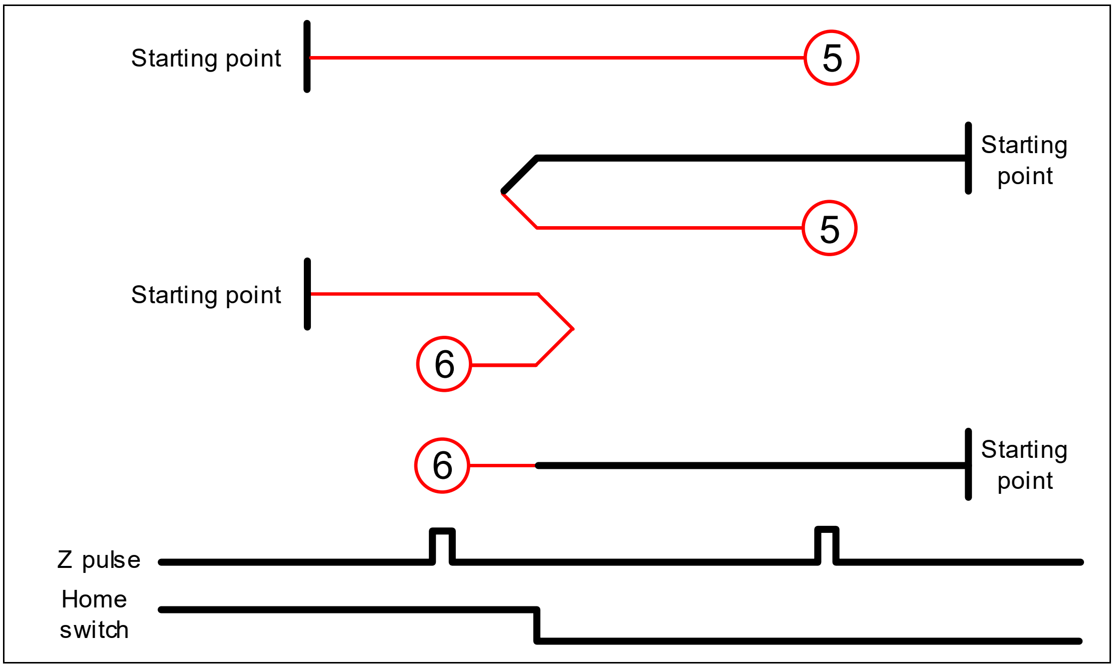
Method 2: homing on the positive limit switch and Z pulse



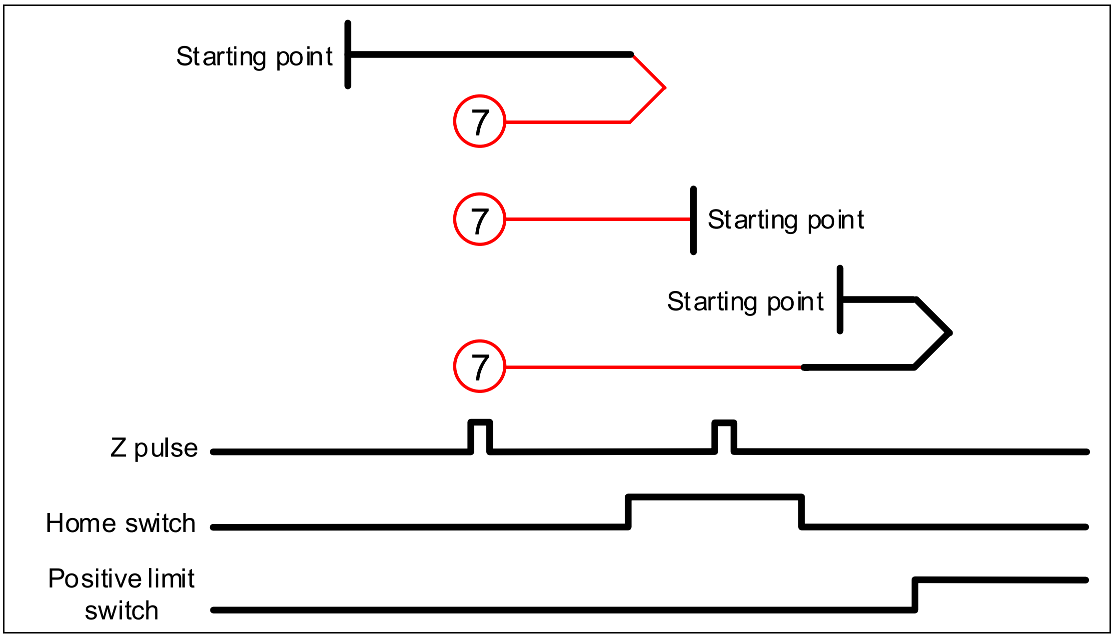
Methods 3 and 4: homing on the home switch and Z pulse



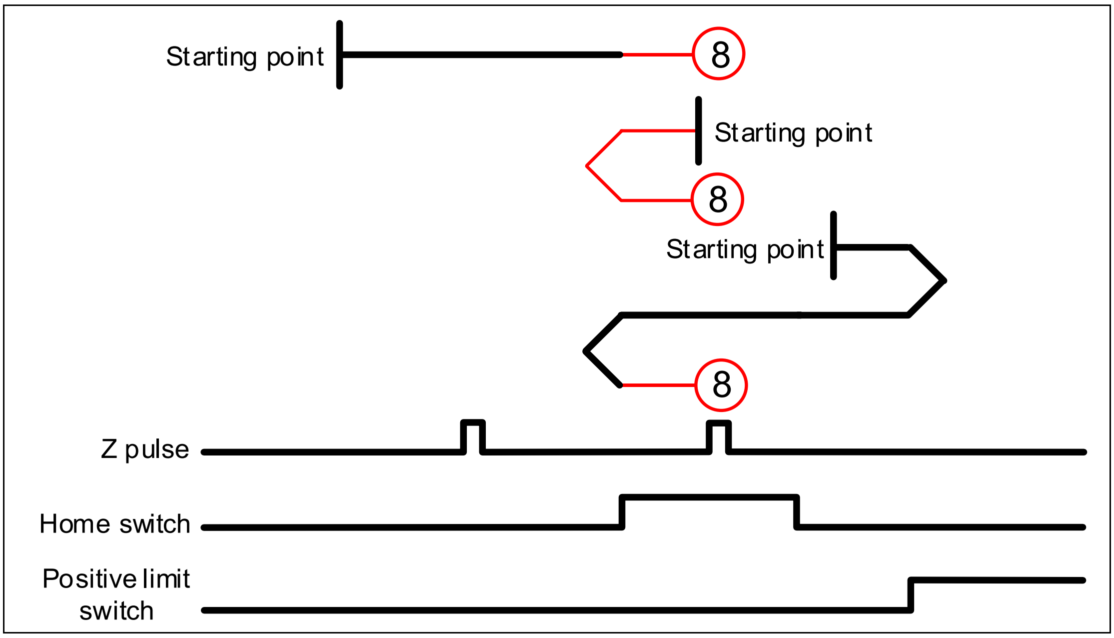
Methods 5 and 6: homing on the home switch and Z pulse



Method 7: homing on the positive limit switch, home switch, and Z pulse



Method 8: homing on the positive limit switch, home switch, and Z pulse



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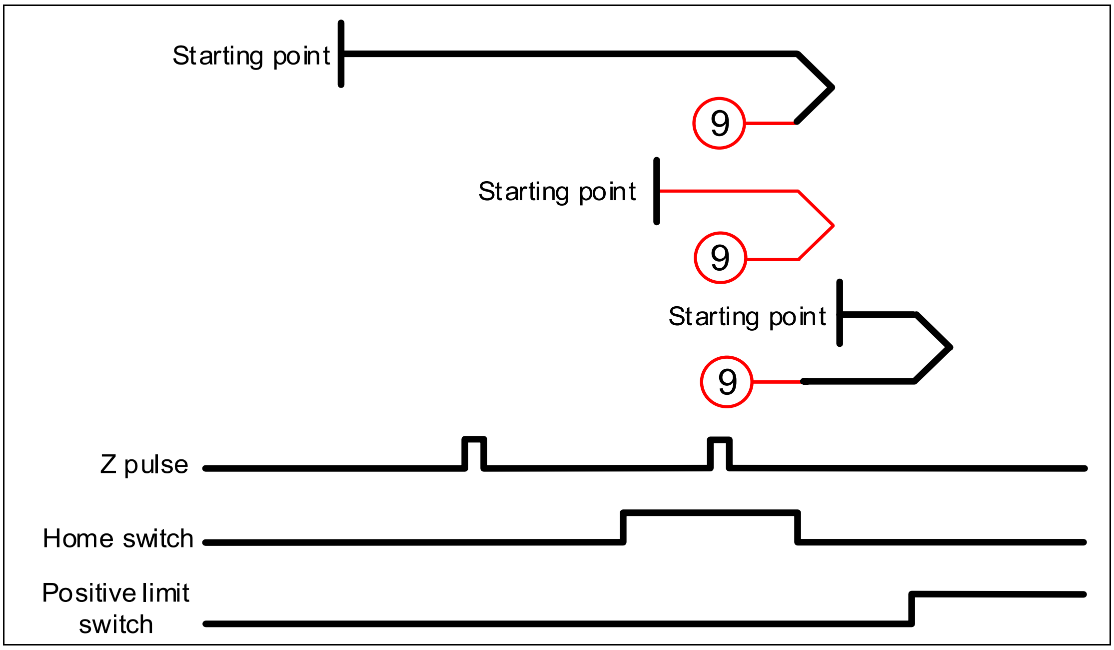
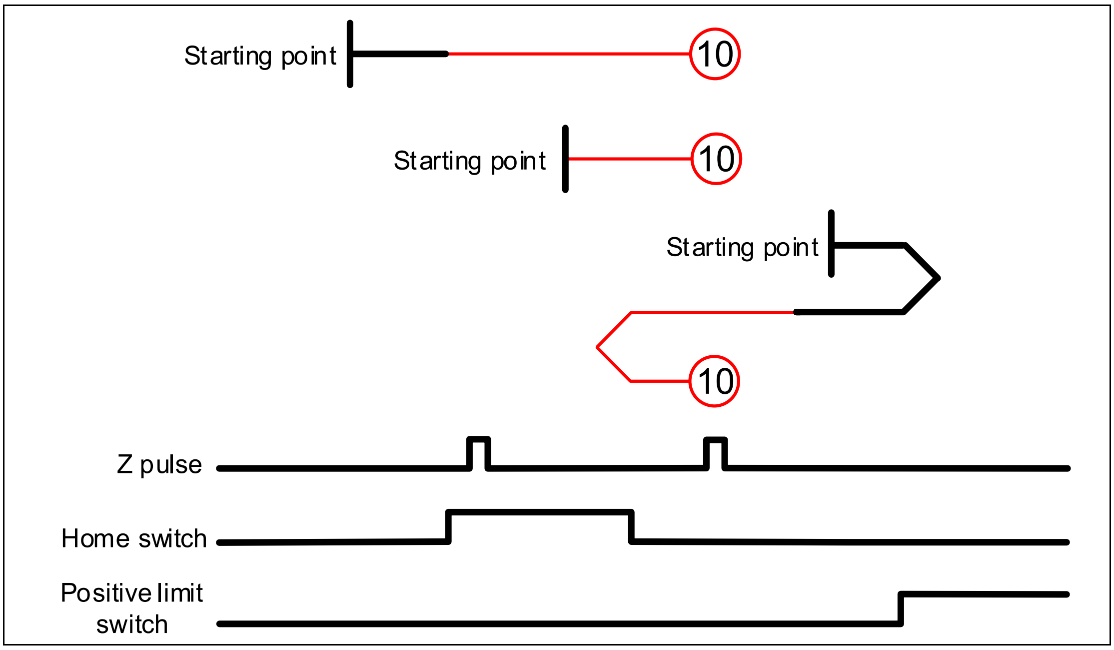
Method 9: homing on the positive limit switch, home switch, and Z pulse



Method 10: homing on the positive limit switch, home switch, and Z pulse



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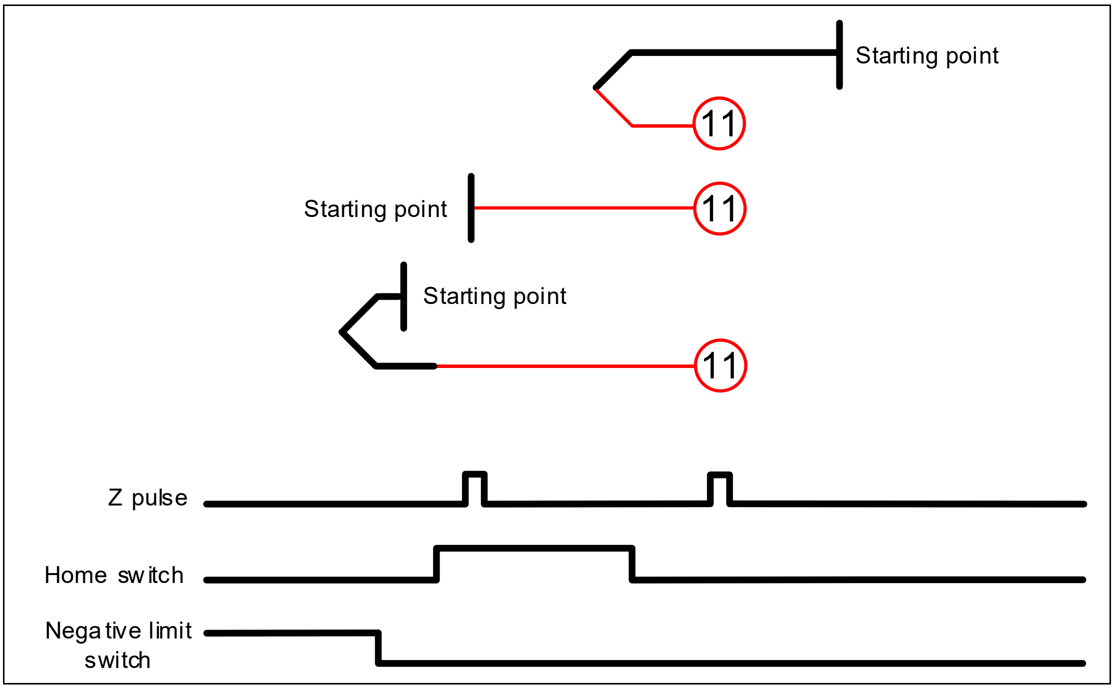
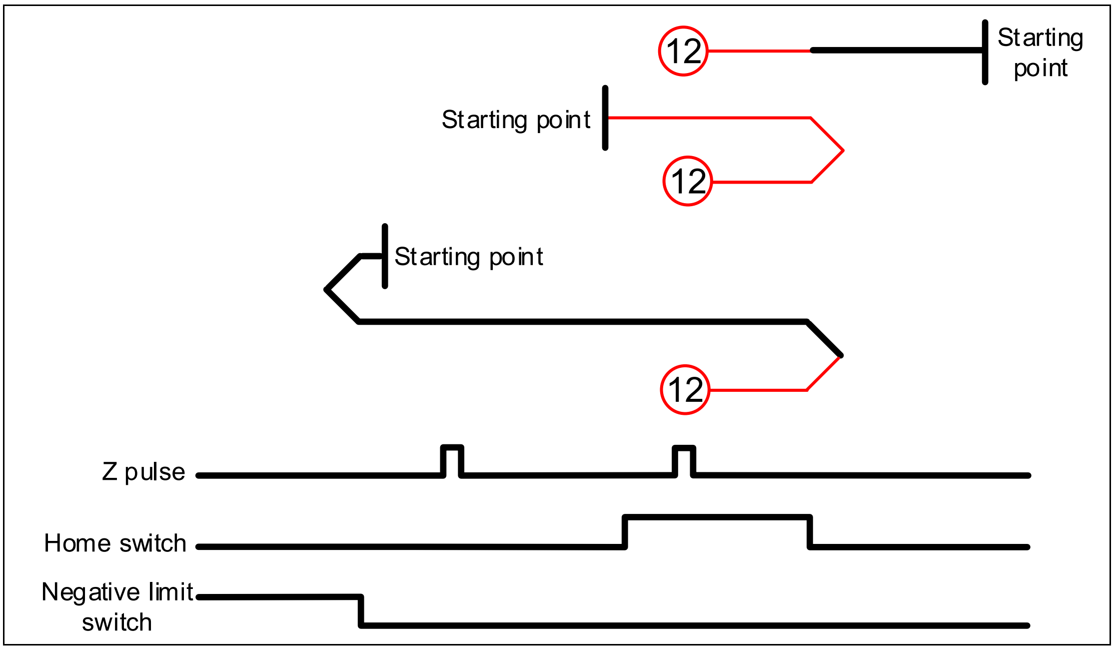
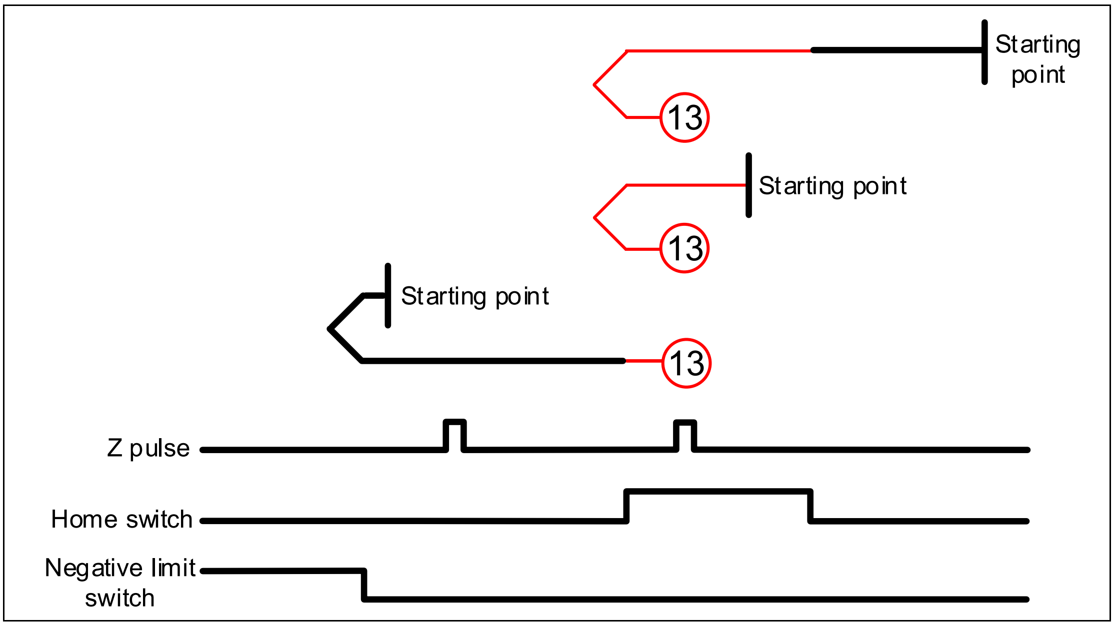
Method 11: homing on the negative limit switch, home switch, and Z pulse



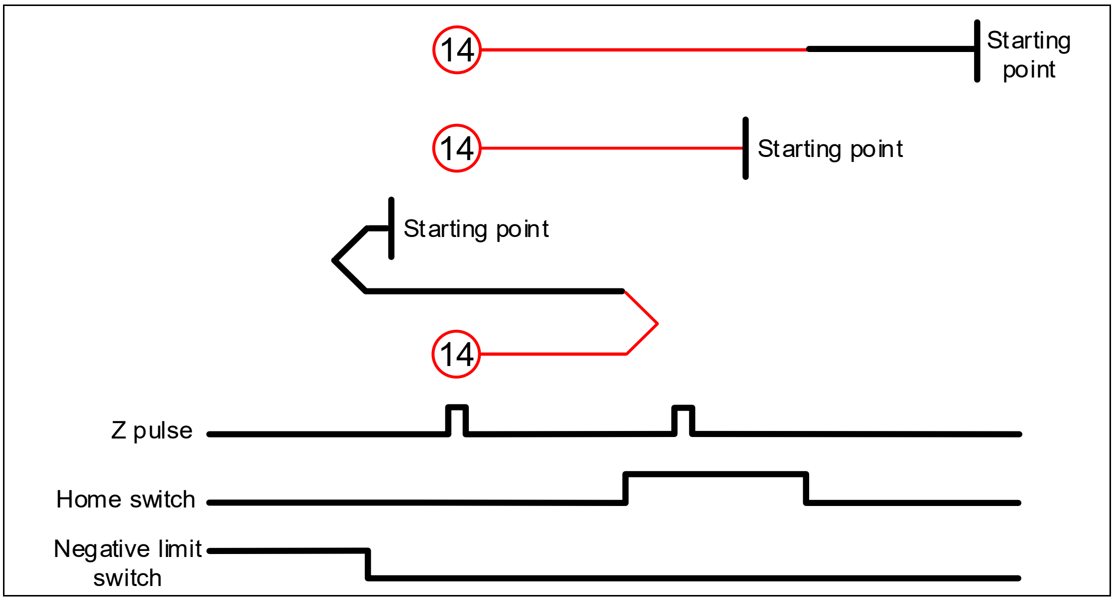
Method 12: homing on the negative limit switch, home switch, and Z pulse



Method 13: homing on the negative limit switch, home switch, and Z pulse

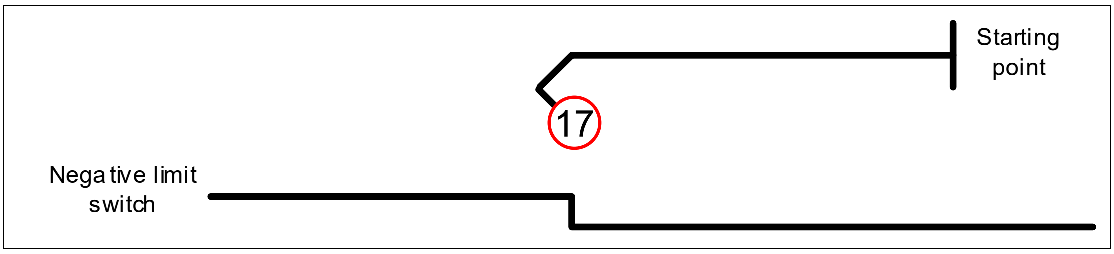


Method 14: homing on the negative limit switch, home switch, and Z pulse

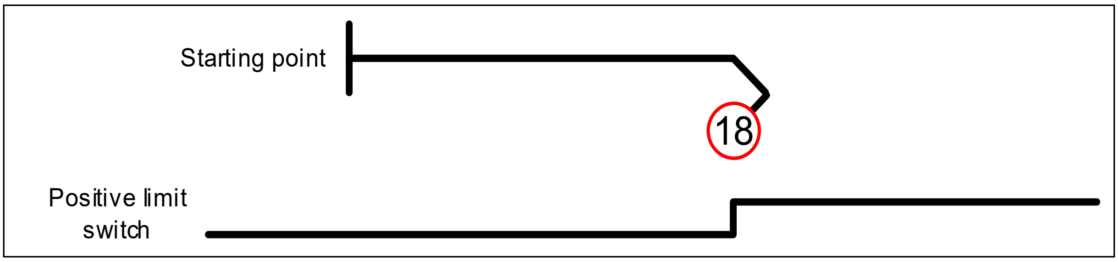


Methods 15 and 16: reserved

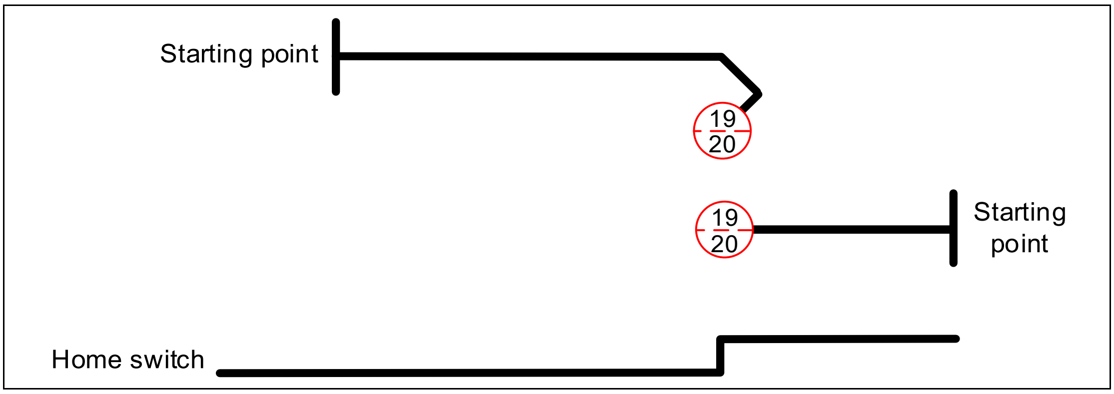
Method 17: homing on the negative limit switch



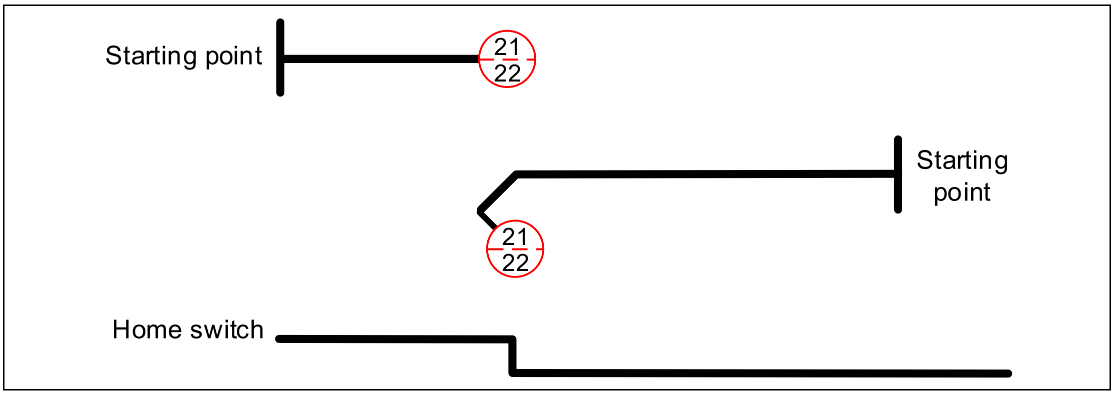
Method 18: homing on the positive limit switch



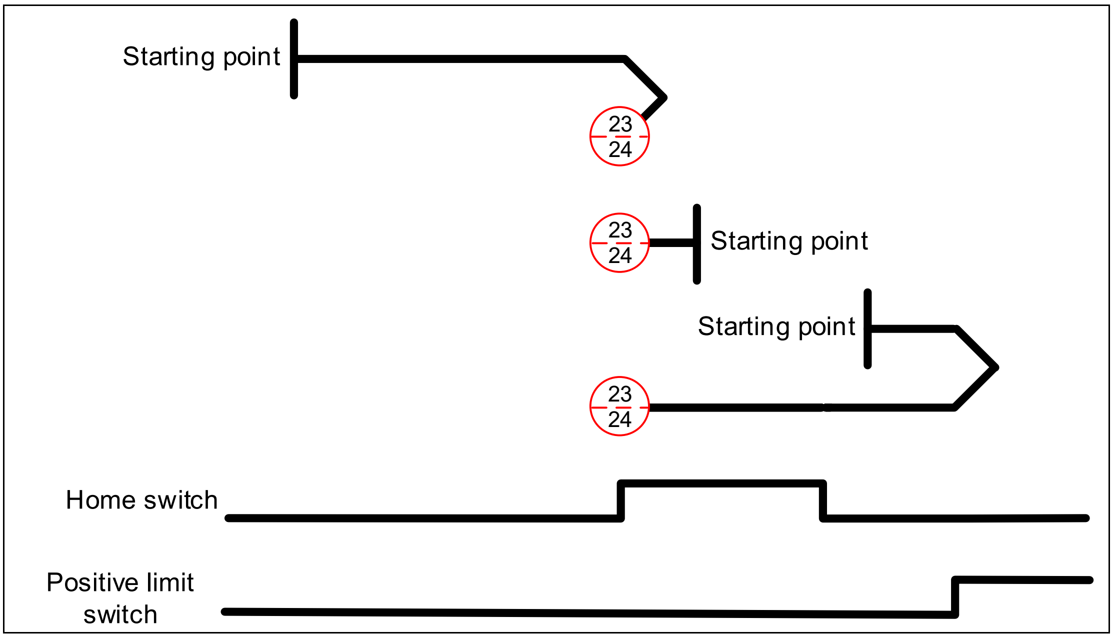
Methods 19 and 20: homing on the home switch



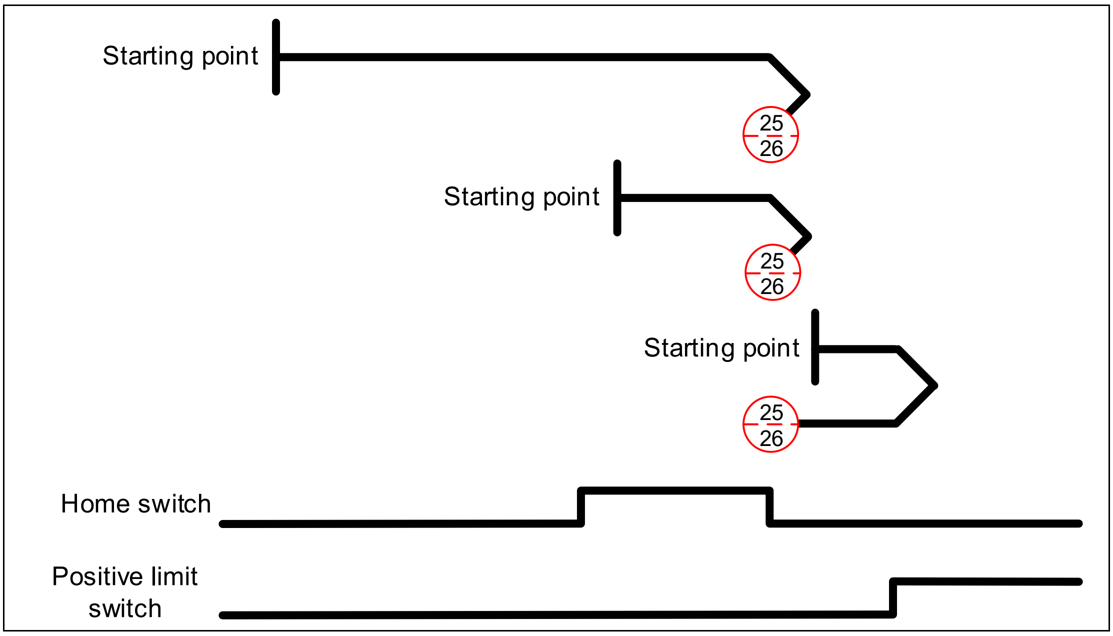
Methods 21 and 22: homing on the home switch



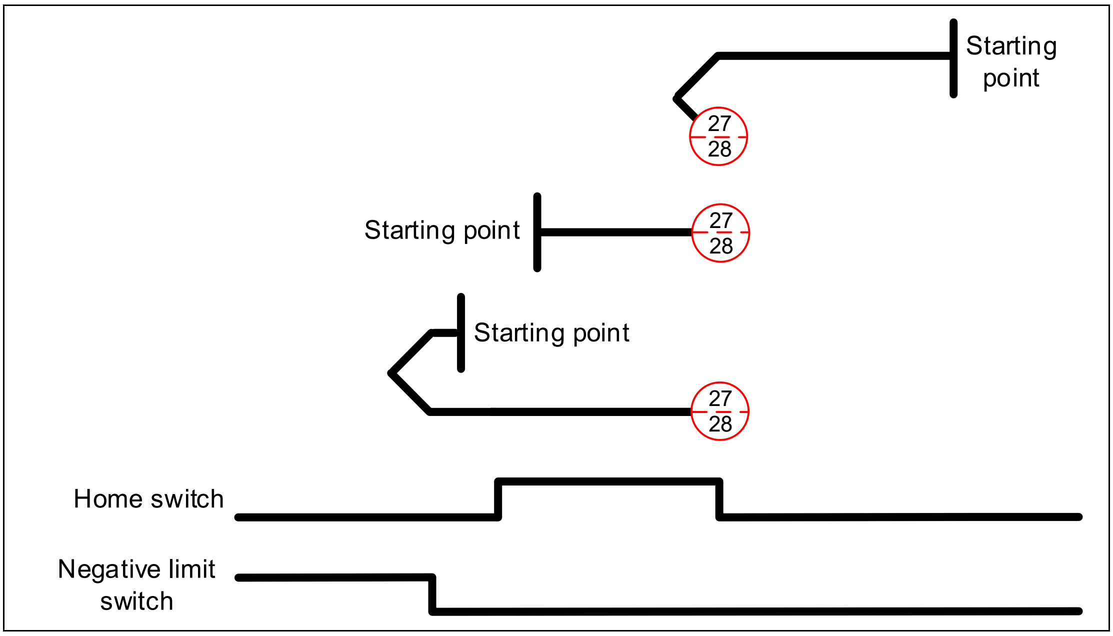
Methods 23 and 24: homing on the positive limit switch and home switch



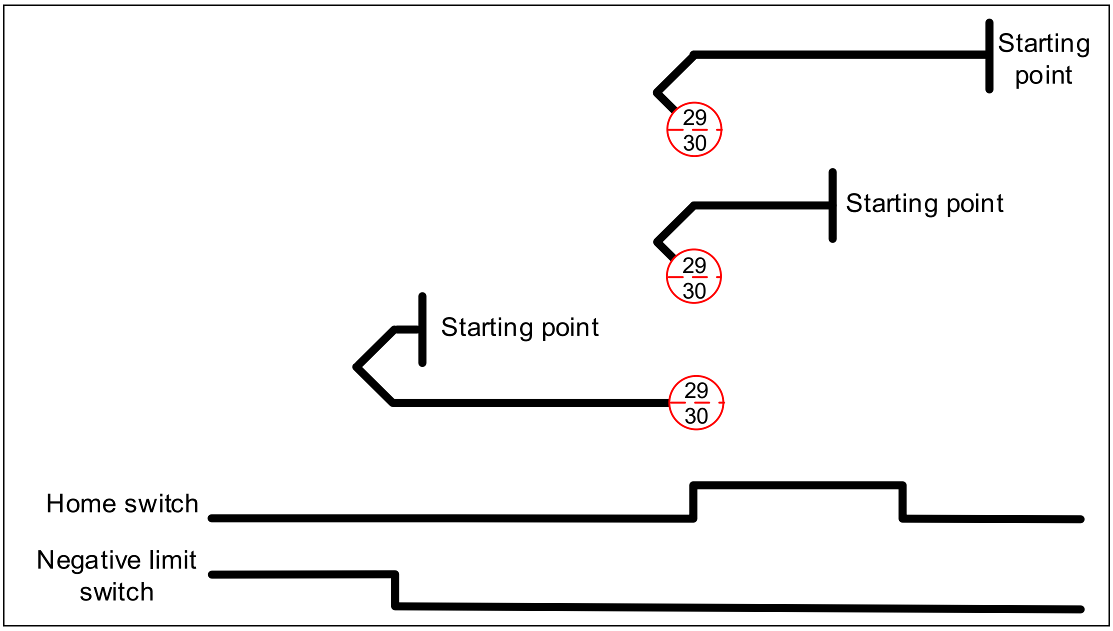
Methods 25 and 26: homing on the positive limit switch and home switch



Methods 27 and 28: homing on the negative limit switch and home switch

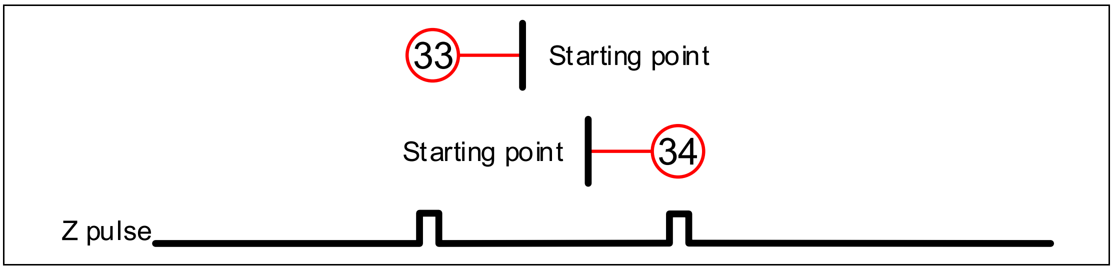


Methods 29 and 30: homing on the negative limit switch and home switch



Methods 31 and 32: reserved

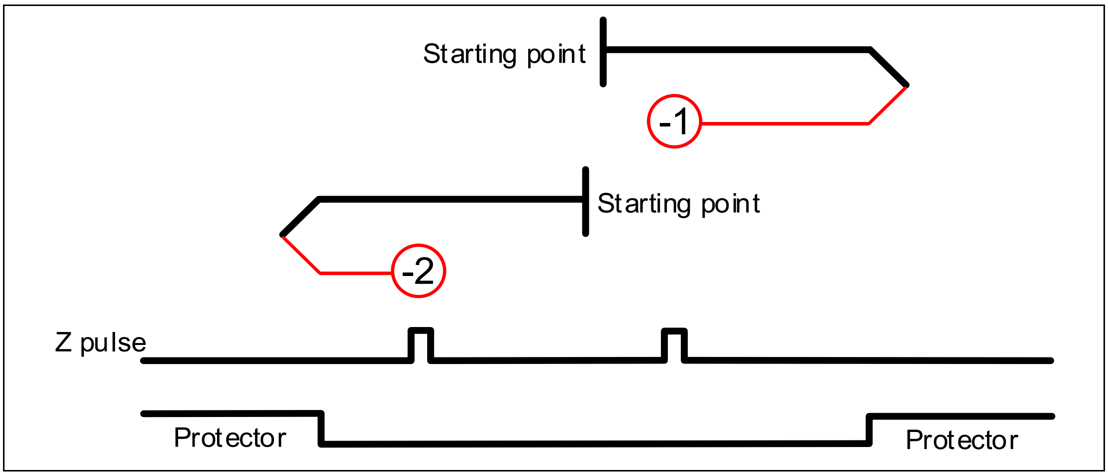
Methods 33 and 34: homing on the Z pulse



Method 35: defines the current feedback position as the origin

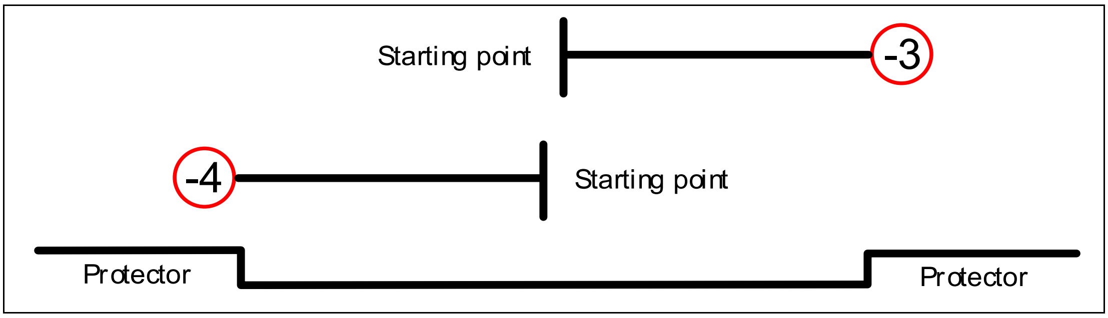
Methods 36 and 37:

When OD 6098h is set to -1 or -2: homing on the hard stop and Z pulse



Methods 38 and 39:

When OD 6098h is set to -3 or -4: homing on the hard stop



Object 6099h: Homing speeds

Index	6099h
Name	Homing speeds
Object code	ARRAY
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1h
Description	Speed during search for switch
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 20000
Default	100
Unit	0.1 rpm (rotary motor)

Sub-index	2h
Description	Speed during search for zero
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 5000
Default	20
Unit	0.1 rpm (rotary motor)

Object 609Ah: Homing acceleration

Index	609Ah
Name	Homing acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm and decelerate from 3,000 rpm to 0 rpm. This object is available in Homing mode. For more details, refer to Section 10.3.4.

Object 60B0h: Position offset

Index	60B0h
Name	Position offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object sets the position offset and is available in Cyclic Synchronous Position mode. For more details, refer to Section 10.3.5.

Object 60B1h: Velocity offset

Index	60B1h
Name	Velocity offset
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the velocity offset and is available in Cyclic Synchronous Velocity mode. For more details, refer to Section 10.3.6.

Object 60B2h: Torque offset

Index	60B2h
Name	Torque offset
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3500 to +3500
Default	0
Unit	0.1%

Object function:

This object sets the torque offset and is available in Cyclic Synchronous Torque mode. For more details, refer to Section 10.3.7.

Object 60B8h: Touch probe function

Index	60B8h
Name	Touch probe function
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

This object sets the functions related to Touch Probe. For the operation details, refer to Section 10.3.8.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 switch	0: disable Touch Probe 1. 1: enable Touch Probe 1.
Bit 1	Touch Probe 1 number of capturing times	0: capture data one time. If the Touch Probe 1 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture data multiple times.
Bit 2	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 3	Reserved	-
Bit 4	Touch Probe 1 rising-edge triggering	0: N/A 1: start capturing data when the Touch Probe 1 signal is rising-edge triggered and store the data in OD 60BAh.
Bit 5	Touch Probe 1 falling-edge triggering	0: N/A 1: start capturing data when the Touch Probe 1 signal is falling-edge triggered and store the data in OD 60BBh.
Bit 6 - Bit 7	Reserved	-
Bit 8	Touch Probe 2 switch	0: disable Touch Probe 2. 1: enable Touch Probe 2.
Bit 9	Touch Probe 2 number of capturing times	0: capture data one time. If the Touch Probe 2 signal is set to be both rising-edge and falling-edge triggered, the data is captured once for each triggering. 1: capture data multiple times.
Bit 10	Touch Probe 2 capture source	0: DI2 of CN1
Bit 11	Reserved	-
Bit 12	Touch Probe 2 rising-edge triggering	0: N/A 1: start capturing data when the Touch Probe 2 signal is rising-edge triggered and store the data in OD 60BCh.
Bit 13	Touch Probe 2 rising-edge triggering	0: N/A 1: start capturing data when the Touch Probe 2 signal is falling-edge triggered and store the data in OD 60BDh.
Bit 14 - Bit 15	Reserved	-

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Object 60B9h: Touch probe status

Index	60B9h
Name	Touch probe status
Object code	VAR
Data type	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0

Object function:

You can access the Touch Probe status with this object. For the operation details, refer to Section 10.3.8.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Touch Probe 1 status	0: Touch Probe 1 disabled. 1: Touch Probe 1 enabled.
Bit 1	Touch Probe 1 rising-edge capturing	0: capturing is not triggered. 1: the Touch Probe 1 signal is rising-edge triggered and the data is successfully captured.
Bit 2	Touch Probe 1 falling-edge capturing	0: capturing is not triggered. 1: the Touch Probe 1 signal is falling-edge triggered and the data is successfully captured.
Bit 3 - Bit 5	Reserved	-
Bit 6	Touch Probe 1 capture source	0: DI1 of CN1 1: motor Z pulse
Bit 7	Touch Probe 1 signal for capturing multiple times (available when OD 60B8h [Bit 1] Number of capturing times is enabled)	The status is reversed once the capturing succeeds. Refer to Section 10.3.8 for the timing diagram in Example 3.
Bit 8	Touch Probe 2 status	0: Touch Probe 2 disabled. 1: Touch Probe 2 enabled.
Bit 9	Touch Probe 2 rising-edge capturing	0: capturing is not triggered. 1: the Touch Probe 2 signal is rising-edge triggered and the data is successfully captured.
Bit 10	Touch Probe 2 falling-edge capturing	0: capturing is not triggered. 1: the Touch Probe 2 signal is falling-edge triggered and the data is successfully captured.
Bit 11 - Bit 13	Reserved	-
Bit 14	Touch Probe 2 capture source	0: DI2 of CN1
Bit 15	Touch Probe 2 signal for capturing multiple times (available when OD 60B8h [Bit 9] Number of capturing times is enabled)	The status is reversed once the capturing succeeds.

Object 60BAh: Touch probe pos1 pos value

Index	60BAh
Name	Touch probe pos1 pos value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 10.3.8.

Object 60BBh: Touch probe pos1 neg value

Index	60BBh
Name	Touch probe pos1 neg value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 10.3.8.

Object 60BCh: Touch probe pos2 pos value

Index	60BCh
Name	Touch probe pos2 pos value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 10.3.8.

Object 60BDh: Touch probe pos2 neg value

Index	60BDh
Name	Touch probe pos2 neg value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0

Object function:

For the function of this object, refer to Section 10.3.8.

Object 60C5h: Max acceleration

Index	60C5h
Name	Max acceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to accelerate from 0 rpm to 3,000 rpm.

Object 60C6h: Max deceleration

Index	60C6h
Name	Max deceleration
Object code	VAR
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 65500
Default	1
Unit	ms

Object function:

The time slope set by this object is the time required for the motor to decelerate from 3,000 rpm to 0 rpm.

Object 60E0h: Positive torque limit

Index	60E0h
Name	Positive torque limit
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	3000
Unit	0.1%

Object function:

This object sets the positive torque limit.

Object 60E1h: Negative torque limit

Index	60E1h
Name	Negative torque limit
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 3000
Default	3000
Unit	0.1%

Object function:

This object sets the negative torque limit.

Object 60F4h: Following error actual value

Index	60F4h
Name	Following error actual value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The following error actual value is the difference between the position demand value (OD 6062h) and position actual value (OD 6064h). For more details, refer to the architecture diagrams in Section 10.3. When OD 60F4h exceeds OD 6065h, AL009 (Excessive deviation of Position command) is triggered.

Object 60FCh: Position demand value

Index	60FCh
Name	Position demand value
Object code	VAR
Data type	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	pulse (unit for encoder pulse resolution)

Object function:

This command is generated after being processed by the servo drive filter. For more details, refer to the architecture diagrams in Section 10.3.

Object 60FDh: Digital inputs

Index	60FDh
Name	Digital inputs
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	-

Object function:

31 16	15 3	2	1	0
Manufacturer-specific	Reserved	Home switch	Positive limit switch	Negative limit switch

MSB LSB

Bit	Function
Bit 0	Negative limit signal
Bit 1	Positive limit signal
Bit 2	Homing signal
Bit 3 - Bit 15	Reserved
Bit 16	DI1
Bit 17	DI2
Bit 18	DI3
Bit 19	DI4
Bit 20	DI5
Bit 21	DI6
Bit 22	DI7
Bit 23 - Bit 31	Reserved

Object 60FEh: Digital outputs

Index	60FEh
Name	Digital outputs
Object code	ARRAY
Data type	UNSIGNED32
Access	RW

Sub-index	0h
Description	Number of sub-index
Data type	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1h
Description	Physical outputs
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Sub-index	2h
Description	Bit mask
Data type	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	0x00000000 to 0xFFFFFFFF
Default	0

Object function:

OD 60FEh sub1 (Physical outputs)

Bit	DO	Description
Bit 0 - Bit 15	-	Reserved
Bit 16	DO1	0: Off; 1: On
Bit 17	DO2	0: Off; 1: On
Bit 18	DO3	0: Off; 1: On
Bit 19	DO4	0: Off; 1: On
Bit 20 - Bit 31	-	Reserved

OD 60FEh sub2 (Bit mask)

Bit	DO	Description
Bit 0 - Bit 15	-	Reserved
Bit 16	DO1	0: disable physical outputs; 1: enable physical outputs
Bit 17	DO2	0: disable physical outputs; 1: enable physical outputs
Bit 18	DO3	0: disable physical outputs; 1: enable physical outputs
Bit 19	DO4	0: disable physical outputs; 1: enable physical outputs
Bit 20 - Bit 31	-	Reserved

■ To use the software to control the DO output, you must first set the corresponding DO function code.
When P2.018 = 0x0130, the output of DO1 is controlled by the software.
When P2.019 = 0x0131, the output of DO2 is controlled by the software.
When P2.020 = 0x0132, the output of DO3 is controlled by the software.
When P2.021 = 0x0133, the output of DO4 is controlled by the software.

■ DO output settings
When the corresponding OD 60FEh sub2 bit of the DO is set to 1, the output status of this DO is determined by the corresponding bit of OD 60FEh sub1.
When the corresponding OD 60FEh sub2 bit of the DO is set to 0, the output status of this DO is determined by P4.006.

■ Example
1. Setting P2.018 to 0x0130 means the output of DO1 is controlled by the software.
2. When OD 60FEh sub2 [Bit 16] is 1, the output of DO1 is determined by OD 60FEh sub1 [Bit 16]. When OD 60FEh sub2 [Bit 16] is 0, the output of DO1 is determined by P4.006 [Bit 0].

Object 60FFh: Target velocity

Index	60FFh
Name	Target velocity
Object code	VAR
Data type	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the target velocity and is available in Profile Velocity mode and Cyclic Synchronous Velocity mode. For details, refer to Sections 10.3.2 and 10.3.6.

Object 6502h: Supported drive modes

Index	6502h
Name	Supported drive modes
Object code	VAR
Data type	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	03ADh

Object function:

This object provides the operation modes supported by Delta servo drives in EtherCAT mode.

Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function
Bit 0	Profile Position mode
Bit 1	Reserved
Bit 2	Profile Velocity mode
Bit 3	Profile Torque mode
Bit 4	Reserved
Bit 5	Homing mode
Bit 6	Reserved
Bit 7	Cyclic Synchronous Position mode
Bit 8	Cyclic Synchronous Velocity mode
Bit 9	Cyclic Synchronous Torque mode
Bit 10 - Bit 31	Reserved

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10.5 Diagnostics and troubleshooting

Eliminate interference

Packets are particularly sensitive to interference in high-speed network communication applications. To achieve fast and high-precision control, the selection of the wire is extremely important. Use shielded cables for the communication wiring, and make sure that the cable shield is firmly connected to the servo drive communication port. Also, ensure the ground wire is properly connected and grounded.

10.5.1 EtherCAT Diagnosis

To use the EtherCAT automatic error diagnostic function, activate **EtherCAT Diagnosis** in ASDA-Soft and click **Diagnosis** to get the following EtherCAT connection information for error detection.

1. Check if the servo parameter P1.001.YX is set to 0C for communication mode.
2. Port hardware detection (check if Port0 or Port1 is connected).
3. Time synchronization status (Cycle time and DC time).
4. Physical station number (Config ID) and logical station number (P3.000) information.
5. Check the content of PDO mapping to determine if the configuration is correct.
6. SM0 - SM3: the channels used by the SDO & PDO and the channel length information.
7. FMMU0 - FMMU3 configuration information.
8. EtherCAT State Machine display (Init ➔ Pre-Op ➔ Safe-Op ➔ Op).
9. Status display for the EtherCAT communication initialization application layer (Application Layer Error Code).
10. EtherCAT communication error rate display.
11. Controlword (OD 6040h) and Statusword (OD 6041h) display.
12. EtherCAT operation mode status display (OD 6060h, 6061h, 6071h, 6072h, 6080h, 60FFh, 60E0h, 60E1h, and 607Ah)

Note: refer to the latest version of ASDA-Soft for the updated functions of **EtherCAT Diagnosis**.

10.5.2 Alarm list

Display	Alarm name	16-bit error code
AL001	Overcurrent	2310h
AL002	Overvoltage	3110h
AL003	Undervoltage	3120h
AL004	Motor combination error	7122h
AL005	Regeneration error	3210h
AL006	Overload	3230h
AL007	Excessive deviation of Speed command	8400h
AL009	Excessive deviation of Position command	8611h
AL010	Voltage error during regeneration	3210h
AL011	CN2 communication failed	7305h
AL013	Emergency stop	5441h
AL014	Negative limit error	5443h
AL015	Positive limit error	5442h
AL016	Abnormal IGBT temperature	4210h
AL017	EEPROM error	5330h
AL022	RST power error	3130h
AL023	Early overload warning	3231h
AL024	Encoder initial magnetic field error	7305h
AL025	Encoder internal error	7305h
AL026	Encoder unreliable internal data	7305h
AL027	Encoder internal reset error	7305h
AL028	Battery voltage error or encoder internal error	7305h
AL029	Gray code error	7305h
AL02A	Number of revolutions of the encoder is in error	7305h
AL02B	Motor data error	7305h
AL02C	Servo drive overload	3230h
AL02F	Blocked rotor protection	0000h
AL030	Motor collision error	7121h
AL031	Motor power cable wiring error	3300h
AL032	Abnormal encoder vibration	7305h
AL033	Motor is abnormal	7305h
AL034	Encoder internal communication error	7305h
AL035	Temperature of the encoder or external sensor exceeds the protective range	7305h
AL036	Encoder alarm status error	7305h
AL041	CN5 is disconnected	7305h
AL044	Servo function operational warning	6100h
AL045	E-Gear ratio value error	6320h
AL050	Motor parameter identification is complete	0000h
AL051	Motor parameter automatic identification error	0000h
AL052	Initial magnetic field detection error	0000h
AL053	Motor parameter error	0000h
AL054	Parameter is out of range due to switching of motor types	0000h
AL055	Motor magnetic field error	0000h
AL056	Excessive motor speed	0000h
AL057	Feedback pulse is lost	0000h

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Display	Alarm name	16-bit error code
AL058	Excessive position deviation after initial magnetic field detection is complete	0000h
AL05B	Motor type setting does not match	0000h
AL05C	Motor position feedback error	0000h
AL05D	Detection error for offset between absolute encoder zero point and motor magnetic field zero point (PM.010)	0000h
AL060	Absolute position is lost	7305h
AL061	Encoder undervoltage	7305h
AL062	Number of revolutions of the absolute encoder overflows (issued by encoder)	7305h
AL063	Linear scale signal error	7305h
AL064	Encoder vibration warning	7305h
AL066	Number of revolutions of the absolute encoder overflows (issued by servo drive)	7305h
AL067	Encoder temperature warning	7305h
AL069	Wrong motor type	0000h
AL06A	Absolute position is lost	7305h
AL06B	The error between the servo drive internal position and the encoder position is too large	7305h
AL06E	Encoder type is unidentifiable	7305h
AL06F	The absolute position is not established	7305h
AL070	Encoder did not complete the read / write procedure	7305h
AL071	Number of revolutions of the encoder is in error	7305h
AL072	Encoder overspeed	7305h
AL073	Encoder memory error	7305h
AL074	Encoder single-turn absolute position is in error	7305h
AL075	Encoder absolute number of revolutions is in error	7305h
AL077	Encoder internal error	7305h
AL079	Encoder parameter setting incomplete	7305h
AL07A	Encoder Z phase position is lost	7305h
AL07B	Encoder memory is busy	7305h
AL07F	Encoder version error	7305h
AL083	Servo drive outputs excessive current	2310h
AL085	Regeneration setting error	3210h
AL086	Regenerative resistor overload	3110h
AL087	Hardware device error	2310h
AL088	Servo function operational alarm	0000h
AL089	Current detection interference	6100h
AL08A	Auto-tuning function - command error	7305h
AL08B	Auto-tuning function - dwell time is too short	7305h
AL08C	Auto-tuning function - inertia estimation error	7305h
AL095	Regenerative resistor is disconnected	-
AL098	Parameter changes become valid only after power cycling	0098h
AL099	DSP firmware error	5500h
AL09C	Parameter reset failed	5500h
AL0A6	Absolute positions of the servo drive and motor do not match	7305h
AL180	Bus communication timeout	8130h
AL185	Bus hardware error	8120h
AL203	System alarm	0203h

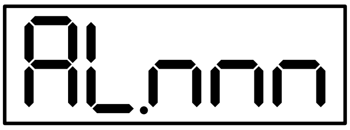
Display	Alarm name	16-bit error code
AL235	Position counter overflow warning	0235h
AL239	System alarm	0239h
AL23F	System alarm	023Fh
AL283	Software positive limit	5444h
AL285	Software negative limit	5445h
AL289	Position counter overflows	7305h
AL310	DI.ILK (0x4D) is triggered	6200h
AL35F	Emergency stop during deceleration	6200h
AL3CF	Emergency stop	6200h
AL3E3	Communication synchronization signal timeout	6200h
AL3F1	Absolute position command of the communication type servo drive is in error	6200h
AL422	Write-in failed caused by control power cut-off	0000h
AL500	STO function is enabled	9000h
AL501	SF1 lost (signal loss or signal error)	9000h
AL502	SF2 lost (signal loss or signal error)	9000h
AL503	STO self-diagnostic error	9000h
AL510	Internal parameter update program of the servo drive is abnormal	0000h
AL520	Calculation program timeout	0000h
AL521	Vibration elimination parameter error	6100h
AL555	System failure	-
AL560	Safety functions module error	9000h
AL561	Safety functions module error	9000h
AL562	Safety functions module error	9000h
AL563	Safety functions module error	9000h
AL565	Safety functions module error	9000h
AL566	Safety functions module error	9000h
AL567	Safety functions module error	9000h
AL568	Safety functions module error	9000h
AL569	Safety functions module error	9000h
AL56A	Safety functions module error	9000h
AL56B	Safety functions module error	9000h
AL56C	Safety functions module error	9000h
AL570	Safety functions module error	9000h
AL571	Safety functions module error	9000h
AL572	Safety functions module error	9000h
AL573	Safety functions module error	9000h
AL574	Safety functions module error	9000h
AL575	Safety functions module error	9000h
AL576	Safety functions module error	9000h
AL580	Safety functions module error	9000h
AL581	Safety functions module error	9000h
AL582	Safety functions module error	9000h
AL583	Safety functions module error	9000h
AL584	Safety functions module error	9000h
AL585	Safety functions module error	9000h
AL586	Safety functions module error	9000h

Display	Alarm name	16-bit error code
AL587	Safety functions module error	9000h
AL588	Safety functions module error	9000h
AL589	Safety functions module error	9000h
AL58A	Safety functions module error	9000h
AL5A0	Safety functions module error	9000h
AL5A1	Safety functions module error	9000h
AL5A2	Safety functions module error	9000h
AL5A3	Safety functions module error	9000h
AL5BF	Safety functions module error	9000h
AL5C0	Safety functions module error	9000h
AL5C1	Safety functions module error	9000h
AL5C2	Safety functions module error	9000h
AL5C6	Safety functions module error	9000h
AL5C7	Safety functions module error	9000h
AL5C8	Safety functions module error	9000h
AL5C9	Safety functions module error	9000h
AL5CA	Safety functions module error	9000h
AL5CB	Safety functions module error	9000h
AL5CC	Safety functions module error	9000h
AL5CD	Safety functions module error	9000h
AL5CE	Safety functions module error	9000h
AL5CF	Safety functions module error	9000h
AL611	Hiperface encoder - motor position error	0000h
AL809	System alarm	0000h
ALC31	Motor power cable disconnection	3300h
ALD08	BiSS C encoder - sensor installation error	7305h
ALD09	BiSS C encoder - sensor installation warning	7305h
ALD10	Hiperface encoder - communication error	7305h

Troubleshooting 11

This chapter provides alarm descriptions and the corrective actions you can take for troubleshooting.

AL.nnn is the alarm format on the 7-segment display, as shown in the following figure.



If the recommended alarm clearing method is DI.ARST, set DI.ARST (alarm reset) to On or P0.001 to 0x0000 for clearing the alarm.

11.1 Alarm list

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL001	Overcurrent	○			○
AL002	Overvoltage	○			○
AL003	Undervoltage		○		○
AL004	Motor combination error	○			○
AL005	Regeneration error	○			○
AL006	Overload	○			○
AL007	Excessive deviation of Speed command	○			○
AL009	Excessive deviation of Position command	○			○
AL010	Voltage error during regeneration	○			○
AL011	CN2 communication failed	○			○
AL013	Emergency stop		○		○
AL014	Negative limit error		○	○	
AL015	Positive limit error		○	○	
AL016	Abnormal IGBT temperature	○			○
AL017	EEPROM error	○			○
AL022	RST power error		○		○
AL023	Early overload warning		○	○	
AL024	Encoder initial magnetic field error	○			○
AL025	Encoder internal error	○			○
AL026	Encoder unreliable internal data	○			○
AL027	Encoder internal reset error	○			○
AL028	Battery voltage error or encoder internal error	○			○
AL029	Gray code error	○			○
AL02A	Number of revolutions of the encoder is in error	○			○
AL02B	Motor data error	○			○
AL02C	Servo drive overload	○			○
AL02F	Blocked rotor protection	○			○
AL030	Motor collision error	○			○
AL031	Motor power cable wiring error	○			○
AL032	Abnormal encoder vibration	○			○
AL033	Motor is abnormal	○			○
AL034	Encoder internal communication error	○			○
AL035	Temperature of the encoder or external sensor exceeds the protective range	○			○
AL036	Encoder alarm status error	○			○
AL041	CN5 is disconnected	○			○
AL044	Servo function operational warning		○	○	
AL045	E-Gear ratio value error	○			○
AL050	Motor parameter identification is complete	○			○
AL051	Motor parameter automatic identification error	○			○
AL052	Initial magnetic field detection error	○			○
AL053	Motor parameter error	○			○
AL054	Parameter is out of range due to switching of motor types	○			○
AL055	Motor magnetic field error	○			○

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL056	Excessive motor speed	○			○
AL057	Feedback pulse is lost	○			○
AL058	Excessive position deviation after initial magnetic field detection is complete	○			○
AL05B	Motor type setting does not match	○			○
AL05C	Motor position feedback error	○			○
AL05D	Detection error for offset between absolute encoder zero point and motor magnetic field zero point (PM.010)	○			○
AL060	Absolute position is lost		○	○	
AL061	Encoder undervoltage		○	○	
AL062	Number of revolutions of the absolute encoder overflows (issued by encoder)		○	○	
AL063	Linear scale signal error		○	○	
AL064	Encoder vibration warning		○	○	
AL066	Number of revolutions of the absolute encoder overflows (issued by servo drive)		○	○	
AL067	Encoder temperature warning		○	○	
AL069	Wrong motor type	○			○
AL06A	Absolute position is lost		○	○	
AL06B	The error between the servo drive internal position and the encoder position is too large		○	○	
AL06E	Encoder type is unidentifiable	○			○
AL06F	The absolute position is not established		○	○	
AL070	Encoder did not complete the read / write procedure		○	○	
AL071	Number of revolutions of the encoder is in error	○			○
AL072	Encoder overspeed	○			○
AL073	Encoder memory error	○			○
AL074	Encoder single-turn absolute position is in error	○			○
AL075	Encoder absolute number of revolutions is in error	○			○
AL077	Encoder internal error	○			○
AL079	Encoder parameter setting incomplete	○			○
AL07A	Encoder Z phase position is lost	○			○
AL07B	Encoder memory is busy	○			○
AL07F	Encoder version error	○			○
AL083	Servo drive outputs excessive current	○			○
AL085	Regeneration setting error	○			○
AL086	Regenerative resistor overload	○			○
AL087	Hardware device error	○			○
AL088	Servo function operational alarm	○			○
AL089	Current detection interference		○	○	
AL08A	Auto-tuning function - command error		○	○	
AL08B	Auto-tuning function - dwell time is too short		○	○	
AL08C	Auto-tuning function - inertia estimation error		○	○	
AL095	Regenerative resistor is disconnected		○	○	

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL098	Parameter changes become valid only after power cycling		○	○	
AL099	DSP firmware error	○			○
AL09C	Parameter reset failed	○			○
AL0A6	Absolute positions of the servo drive and motor do not match		○	○	
AL180	Bus communication timeout	○			○
AL185	Bus hardware error	○			○
AL203	System alarm		○	○	
AL235	Position counter overflow warning		○	○	
AL239	System alarm		○	○	
AL23F	System alarm		○	○	
AL283	Software positive limit		○	○	
AL285	Software negative limit		○	○	
AL289	Position counter overflows		○	○	
AL310	DI.ILK (0x4D) is triggered		○		○
AL35F	Emergency stop during deceleration		○	○	
AL3CF	Emergency stop		○		○
AL3E3	Communication synchronization signal timeout		○	○	
AL3F1	Absolute position command of the communication type servo drive is in error	○			○
AL422	Write-in failed caused by control power cut-off	○			○
AL500	STO function is enabled	○			○
AL501	SF1 lost (signal loss or signal error)	○			○
AL502	SF2 lost (signal loss or signal error)	○			○
AL503	STO self-diagnostic error	○			○
AL510	Internal parameter update program of the servo drive is abnormal		○	○	
AL520	Calculation program timeout	○			○
AL521	Vibration elimination parameter error	○			○
AL555	System failure	○			○
AL560	Safety functions module error	○			○
AL561	Safety functions module error	○			○
AL562	Safety functions module error	○			○
AL563	Safety functions module error	○			○
AL565	Safety functions module error	○			○
AL566	Safety functions module error	○			○
AL567	Safety functions module error	○			○
AL568	Safety functions module error	○			○
AL569	Safety functions module error	○			○
AL56A	Safety functions module error	○			○
AL56B	Safety functions module error	○			○
AL56C	Safety functions module error	○			○
AL570	Safety functions module error	○			○
AL571	Safety functions module error	○			○
AL572	Safety functions module error	○			○
AL573	Safety functions module error	○			○
AL574	Safety functions module error	○			○

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Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL575	Safety functions module error	○			○
AL576	Safety functions module error	○			○
AL580	Safety functions module error	○			○
AL581	Safety functions module error	○			○
AL582	Safety functions module error	○			○
AL583	Safety functions module error	○			○
AL584	Safety functions module error	○			○
AL585	Safety functions module error	○			○
AL586	Safety functions module error	○			○
AL587	Safety functions module error	○			○
AL588	Safety functions module error	○			○
AL589	Safety functions module error	○			○
AL58A	Safety functions module error	○			○
AL5A0	Safety functions module error	○			○
AL5A1	Safety functions module error	○			○
AL5A2	Safety functions module error	○			○
AL5A3	Safety functions module error	○			○
AL5BF	Safety functions module error	○			○
AL5C0	Safety functions module error	○			○
AL5C1	Safety functions module error	○			○
AL5C2	Safety functions module error	○			○
AL5C6	Safety functions module error	○			○
AL5C7	Safety functions module error	○			○
AL5C8	Safety functions module error	○			○
AL5C9	Safety functions module error	○			○
AL5CA	Safety functions module error	○			○
AL5CB	Safety functions module error	○			○
AL5CC	Safety functions module error	○			○
AL5CD	Safety functions module error	○			○
AL5CE	Safety functions module error	○			○
AL5CF	Safety functions module error	○			○
AL611	Hiperface encoder - motor position error	○			○
AL809	System alarm	○			○
ALC31	Motor power cable disconnection	○			○
ALD08	BiSS C encoder - sensor installation error	○			○
ALD09	BiSS C encoder - sensor installation warning		○	○	
ALD10	Hiperface encoder - communication error	○			○

Note: if the servo drive shows an alarm that is not in this table, contact the local distributor or technician.

11.2 Causes and corrective actions

AL001 Overcurrent	
Trigger condition and cause	Condition: main circuit current is greater than 1.5 times the maximum instantaneous current of the servo drive. Cause: 1. The servo drive output is short-circuited. 2. Motor wiring is in error. 3. IGBT error.
Checking method and corrective action	1. Check the connection between the motor and servo drive and make sure that the wire is not short-circuited. Do not expose the metal part of the wiring. Check if you have followed the wiring sequence for connecting the motor to the servo drive as described in this manual. 2. If the temperature of the heat sink is abnormal, send your servo drive back to the distributor or contact Delta. Check if the set value of the parameter is much greater than the default. It is recommended that you reset the parameter to the factory default setting and then modify the setting gradually.
How to clear the alarm?	Cycle power on the servo drive.

AL002 Overvoltage	
Trigger condition and cause	Condition: main circuit voltage exceeds the rated value. Cause: 1. The input voltage of the main circuit is higher than the allowable rated value. 2. Incorrect power input (incorrect power system). 3. Malfunction of the servo drive hardware. 4. Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor.
Checking method and corrective action	1. Use a voltmeter to check if the input voltage of the main circuit is within the allowable rated value (refer to Appendix A Specifications) and check if the power system complies with the specifications. Use the right power supply or connect the transformer and regulator in series to have the voltage be within the specified range. 2. If the alarm occurs when the input voltage of the main circuit measured by the voltmeter is within the allowable rated value, send your servo drive back to the distributor or contact Delta. 3. Check the connection for the regenerative resistor, re-calculate the resistance value of the regenerative resistor, and correctly set the values of P1.052 and P1.053.
How to clear the alarm?	DI.ARST

AL003 Undervoltage	
Trigger condition and cause	Condition: 1. Main circuit voltage is below the rated value. The error type of AL003 is a warning by default. To set AL003 as an alarm, you can set P2.066 [Bit 9] to 1. 2. DC Bus voltage is below P4.024$\times \sqrt{2}$. Cause: 1. The input voltage of the main circuit is lower than the allowable rated value. 2. No voltage input to the main circuit. 3. Incorrect power input (incorrect power system).
Checking method and corrective action	1. Check if the wiring of the power supply is correct and the input voltage of the main circuit is normal. 2. Check the switch of the power supply and use a voltmeter to check the main circuit voltage. 3. Use a voltmeter to check if the power system complies with the specifications. If not, use the right power supply or connect the transformer in series.
How to clear the alarm?	Set P2.066 [Bit 2] to clear AL003: 1. If P2.066 [Bit 2] is set to 0, use DI.ARST to clear the alarm after the voltage is back in the normal range. 2. If P2.066 [Bit 2] is set to 1, the alarm is automatically cleared after the voltage is back in the normal range.

AL004 Motor combination error	
Trigger condition and cause	Condition: an incorrect motor is used with the servo drive. Cause: 1. Motor combination error (the wrong motor is connected to the servo drive). 2. The encoder connector is loose. 3. The encoder is damaged.
Checking method and corrective action	1. Use the right motor. 2. Check and re-install the encoder connector. 3. If the encoder (motor) is not operating properly, replace the motor.
How to clear the alarm?	Cycle power on the servo drive.

AL005 Regeneration error	
Trigger condition and cause	Condition: an error occurs during regeneration. Cause: 1. Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor. 2. P1.053 (Regenerative resistor capacity) is not set to 0 when the regenerative resistor is not connected. 3. Incorrect parameter settings for P1.052 and P1.053.
Checking method and corrective action	1. Check the connection for the regenerative resistor, re-calculate the resistance value of the regenerative resistor, and correctly set the values of P1.052 and P1.053. If the issue persists, send your servo drive back to Delta. 2. Set P1.053 to 0 if not using a regenerative resistor. 3. Correctly set the regenerative resistor value (P1.052) and the regenerative resistor capacity (P1.053).
How to clear the alarm?	DI.ARST

AL006 Overload	
Trigger condition and cause	Condition: overload of motor and servo drive. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. Improper settings for the parameters of the control system. 3. Incorrect motor wiring. 4. Encoder is in error.
Checking method and corrective action	1. Set P0.002 to 12 for monitoring if the average load rate [%] is continuously over 100%. If so, increase the motor capacity or reduce the load. Refer to Appendix A for Graph of load and operating time. 2. Check if there is any mechanical vibration or the setting for acceleration or deceleration is too drastic. 3. Check if the wiring of the motor power cable and encoder cable is correct. 4. Send the motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL007 Excessive deviation of Speed command	
Trigger condition and cause	Condition: difference between the Speed command and the speed feedback exceeds the allowable range set by P2.034. Cause: 1. A drastic change in the Speed command input. 2. Improper setting of P2.034 (Excessive deviation warning condition of Speed command). 3. Incorrect wiring of the UVW and encoder cables.
Checking method and corrective action	1. Check if the Speed command input from the controller is too drastic. If so, adjust the rate of change for input signals or enable the filter function. 2. Check if the value of P2.034 is set properly. 3. Check if the wiring of the motor power cable and encoder cable is correct.
How to clear the alarm?	DI.ARST

AL009 Excessive deviation of Position command	
Trigger condition and cause	Condition: difference between the Position command and the position feedback exceeds the allowable range set by P2.035. Cause: 1. The maximum allowable position deviation is set too low. 2. Gain value is set too low. 3. Excessive external load. 4. Improper setting for the E-Gear ratio. 5. The power cable is loose. 6. The maximum speed limit is set too low.
Checking method and corrective action	1. Check the set value of P2.035 (Excessive deviation of Position command warning). If the value is too low, set a higher value. 2. Check if the gain value is appropriate for the application. 3. Check the external load. Reduce the external load or re-evaluate the motor capacity if necessary. 4. Check if the settings for P1.044 and P1.045 are appropriate for the application. If not, set them to proper values. 5. Check if the power cable is loose. 6. Check if the set value of P1.055 (Maximum speed limit) is too low.
How to clear the alarm?	DI.ARST

AL010 Voltage error during regeneration	
Trigger condition and cause	Condition: an error occurs during regeneration. Cause: 1. The regenerative voltage remains at 800V for a period of time during regeneration. This may be caused by using an incorrect regenerative resistor or not connecting an external regenerative resistor to the servo drive. 2. P1.053 (Regenerative resistor capacity) is not set to 0 when the regenerative resistor is not connected.
Checking method and corrective action	1. Check the connection for the regenerative resistor, re-calculate the resistance value of the regenerative resistor, and correctly set the values of P1.052 and P1.053. If the issue persists, send your servo drive back to Delta. 2. Set P1.053 to 0 if not using a regenerative resistor.
How to clear the alarm?	DI.ARST

AL011 CN2 communication failed	
Trigger condition and cause	Condition: connection to the encoder is in error. Cause: 1. CN2 wiring is incorrect. 2. CN2 connector is loose. 3. CN2 wiring is poor. 4. Connection to the encoder is cut off due to interference. 5. Encoder is damaged. 6. A motor not supported by the A3-EP servo drive is used.
Checking method and corrective action	1. Check if the wiring follows the instructions in the user manual. If not, connect the wire correctly. 2. Check the connection between the CN2 port of the servo drive and the CN2 connector. Reconnect them if the connection is loose. 3. Check for the encoder cable and connector which connect the motor and CN2 port of the servo drive to see if there is any poor wiring or damaged wires. If so, replace the connector and cable. 4. Check the communication error rate by setting P0.002 to -80. If this value increases continuously, it means there is interference. 5. If you took all corrective actions but the issue persists, replace the motor. 6. Contact the distributor for the supported motor models or encoder specifications.
How to clear the alarm?	Cycle power on the servo drive.

AL013 Emergency stop	
Trigger condition and cause	The emergency stop button is pressed.
Checking method and corrective action	Make sure the emergency stop button is off.
How to clear the alarm?	Set DI.EMGS to off.

AL014 Negative limit error	
Trigger condition and cause	Condition: negative limit switch is triggered. Cause: 1. Negative limit switch is triggered. 2. Servo system is unstable.
Checking method and corrective action	1. Make sure the negative limit switch is off. 2. Check the parameter setting or re-estimate the motor capacity.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL015 Positive limit error	
Trigger condition and cause	Condition: positive limit switch is triggered. Cause: 1. Positive limit switch is triggered. 2. Servo system is unstable.
Checking method and corrective action	1. Make sure the positive limit switch is off. 2. Check the parameter setting or re-estimate the motor capacity.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL016 Abnormal IGBT temperature	
Trigger condition and cause	Condition: temperature of IGBT is abnormal. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. The servo drive output is short-circuited.
Checking method and corrective action	1. Check for servo drive overload or motor overcurrent. If so, try increasing the motor capacity or reducing the load. 2. Check if the wiring of servo drive output is correct.
How to clear the alarm?	DI.ARST

AL017 EEPROM error	
Trigger condition and cause	Condition: error occurs when DSP accesses EEPROM. Cause: 1. Parameter writing error or the value exceeds the allowable range. 2. When power is supplied to the servo drive, the data in ROM is damaged or there is no data in ROM.
Checking method and corrective action	Press the SHIFT key to have the panel display EXGAB. X = 1, 2, 3 G = Group number of the parameter AB = Parameter number in hexadecimal format If the panel displays “E320A”, it indicates parameter P2.010. Check the value for the corresponding parameter. 1. The panel displays the parameter code. If this alarm occurs when power is supplied to the drive, it means the parameter value has exceeded the range. Modify the value and then cycle power on the servo drive. If the alarm occurs during normal operation, it means an error occurred when the parameter is written. Use DI.ARST to clear this alarm. 2. The panel displays “E100X” or “E0001”. If this alarm occurs when power is supplied to the drive, it is usually because the data in ROM is damaged or there is no data in ROM. Send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	If this alarm occurs once the drive is on, reset the parameters and then cycle the power. If the alarm occurs during operation, set DI.ARST to on.

AL022 RST power error	
Trigger condition and cause	Condition: RST power cable is loose or there is no power. The error type of AL022 is a warning by default. To set AL022 as an alarm, you can set P2.066 [Bit 12] to 1. Cause: RST power error.
Checking method and corrective action	Check if the RST power cable is loose or there is no power. This alarm occurs when one single phase is not connected to the power supply. Correctly connect the power to the servo drive. If the issue persists, send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL023 Early overload warning	
Trigger condition and cause	Early overload warning.
Checking method and corrective action	1. Check if the motor is overloaded and refer to the corrective actions for AL006 for troubleshooting. 2. Check if the value of P1.056 (Motor output overload warning level) is set too low. If so, set the value higher, or set the value greater than 100 to disable the warning function.
How to clear the alarm?	DI.ARST

AL024 Encoder initial magnetic field error	
Trigger condition and cause	Condition: the magnetic field of the encoder U, V, W signal is in error. Cause: the initial magnetic field of the encoder is in error (magnetic field of the encoder U, V, W signal is in error.)
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the Hall sensor wiring of the motor, and monitor the Hall sensor phase sequence by setting P0.017 to -177 and then reading the content of P0.009. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL025 Encoder internal error	
Trigger condition and cause	Condition: internal memory and counter of the encoder are in error. Cause: 1. Encoder internal error (internal memory and counter are in error). 2. When power is applied, the motor rotates because of the inertia of the mechanical parts or other causes.
Checking method and corrective action	1. If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. (b) Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. (c) Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 2. Make sure the motor shaft does not move when power is turned on.
How to clear the alarm?	Cycle power on the servo drive.

AL026 Encoder unreliable internal data	
Trigger condition and cause	Condition: internal data error occurs three consecutive times. Cause: 1. External interference. 2. Malfunction of the encoder hardware.
Checking method and corrective action	If there is interference, check the following items: 1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the communication error rate by setting P0.002 to -80. If the value is greater than 0 and increases continuously, check the previous three items again. If the value is 0, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

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AL027 Encoder internal reset error	
Trigger condition and cause	Condition: encoder reset error. Cause: encoder reset.
Checking method and corrective action	1. Check if there is poor connection for the encoder signal cable. 2. Check if the power supply for the encoder is stable and make sure to use shielded cable. 3. Check if the operating temperature is over 95°C (203°F). Identify the cause for the high temperature and do not restart the operation before the temperature falls within the allowable range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL028 Battery voltage error or encoder internal error	
Trigger condition and cause	Condition: battery voltage is higher than the specification (> 3.8V) or the encoder signal is in error. Cause: 1. Voltage level of the battery is too high. 2. Encoder internal error.
Checking method and corrective action	1. Check if there is a charging circuit. Avoid incorrect wiring. If Pin 1 (5V) of CN2 is connected to BAT+ of the encoder connector, it means the power (5V) of the servo drive is being charged to the battery. 2. Check if the battery is correctly installed (voltage > 3.8V). 3. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 4. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 5. Use shielded cable for the encoder. Pull out the wire mesh and have it correctly grounded. If the issue persists, send your servo drive and motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL029 Gray code error	
Trigger condition and cause	Absolute position within a single revolution is in error.
Checking method and corrective action	Cycle power on the servo drive to operate the motor. Then, check if the alarm occurs again. If the issue persists, replace the encoder.
How to clear the alarm?	Cycle power on the servo drive.

AL02A Number of revolutions of the encoder is in error	
Trigger condition and cause	Condition: the number of revolutions of the encoder is in error. Cause: the internal signal of the encoder is abnormal, causing error in the number of revolutions.
Checking method and corrective action	Send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	N/A

AL02B Motor data error	
Trigger condition and cause	Accessing the internal data of the motor is in error.
Checking method and corrective action	Send your servo motor back to Delta.
How to clear the alarm?	N/A

AL02C Servo drive overload	
Trigger condition and cause	Condition: servo drive is overloaded. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. Improper setting for the gain parameters or the motion profile of the control system. 3. Motor wiring error. 4. The encoder is damaged or malfunctioning.
Checking method and corrective action	1. Set P0.002 = 55 to monitor the current feedback. Check if the motor current exceeds the rated output current of the servo drive for a long period of time. 2. (a) Check if there is any mechanical vibration. If so, properly adjust the gain parameters. (b) Set a higher acceleration / deceleration time constant or a lower target speed. 3. Check if the wiring of the motor power cable and encoder cable is correct. 4. Replace the encoder.
How to clear the alarm?	DI.ARST

AL02F Blocked rotor protection	
Trigger condition and cause	Condition: the servo drive is overloaded, and the motor speed keeps at 10 rpm (or below) or the rotor is blocked. Cause: 1. The motor or the connected mechanical part is jammed, preventing the motor from rotating. 2. The motor is running at an extremely low speed or the rotor is blocked for a long time.
Checking method and corrective action	1. Set the motor speed higher to shorten the duration of the occurrence of blocked rotor. 2. Check if the mechanical part connected to the motor is working normally. 3. Check if the wiring of the motor power cable and encoder cable is correct. 4. Send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL030 Motor collision error	
Trigger condition and cause	Condition: the motor hits the device, reaching the torque value set by P1.057 for the duration of the time set by P1.058. Cause: 1. Check if the protection function of motor hard stop (P1.057) is enabled. If so, set P1.057 to 0. 2. Check if the value set by P1.057 is too low and the time set by P1.058 is too short. Set P1.057 according to the actual torque. If P1.057 is set too low, it may lead to malfunction; if P1.057 is set too high, it may lose the protection function.
Checking method and corrective action	Cycle power on the servo drive to operate the motor. Then, check if the alarm occurs again. If the issue persists, replace the encoder.
How to clear the alarm?	DI.ARST

AL031 Motor power cable wiring error	
Trigger condition and cause	Condition: incorrect wiring of the motor power cable (U, V, W) and ground wire (GND). Cause: incorrect wiring of the power cable (U, V, W) and ground wire (GND). The switch for wiring error detection is set by P2.065 [Bit 8], which is enabled by default.
Checking method and corrective action	Check if the wiring of the motor power cable (U, V, W) and ground wire (GND) is correct. Follow the instructions in this user manual for correct wiring and proper grounding.
How to clear the alarm?	Cycle power on the servo drive.

AL032 Abnormal encoder vibration	
Trigger condition and cause	Condition: abnormal vibration occurred in the encoder. Cause: the internal signal or mechanical part of the encoder is abnormal, so the encoder returns an error signal.
Checking method and corrective action	Check if the motor vibration range exceeds the specification of 2.5 G. If the vibration is within the range but the alarm still occurs, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

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AL033 Motor is abnormal	
Trigger condition and cause	The motor is abnormal.
Checking method and corrective action	1. Check if the encoder 5V power is lower than 4.3V. 2. Check if the cable complies with the specifications. Do not use cables exceeding the specified length or without wire mesh. 3. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference.
How to clear the alarm?	If the issue persists, send your servo motor back to the distributor or contact Delta.

AL034 Encoder internal communication error	
Trigger condition and cause	Condition: 1. Internal communication error for the absolute encoder. 2. Internal error for other types of encoder. Cause: encoder internal communication error.
Checking method and corrective action	1. Check if the battery wiring is correct or loose. If it is loose, wire it again and cycle power on the system. 2. Check if the battery voltage is within the normal range. 3. Internal communication error for the absolute encoder occurs. Replace the motor.
How to clear the alarm?	Cycle power on the servo drive.

AL035 Temperature of the encoder or external sensor exceeds the protective range	
Trigger condition and cause	Condition: the temperature of the encoder connected through CN2 is over the upper limit of 100°C (212°F) or the temperature detected by the sensor connected through CN1 exceeds the protective range set by PM.022 and PM.024. Cause: a temperature rise is detected in the encoder connected to CN2 or in the temperature sensor connected to CN1.
Checking method and corrective action	1. Check the encoder temperature (CN2): Set P0.002 to -124 to read the temperature and check if it is below 100°C. If the encoder temperature is higher than 100°C, improve the heat dissipation to lower the temperature. If the temperature difference between the encoder and motor is over 30°C (54°F), send the servo motor back to Delta. 2. Check the temperature sensor (CN1): (a) If not using the temperature sensor, set PM.022 to 0. (b) When PM.022 = 2 or 3, check if the setting of PM.024 is correct and the temperature sensor works normally. If so, improve the heat dissipation to lower the temperature.
How to clear the alarm?	After the temperature becomes lower than 100°C, cycle power on the servo drive.

AL036 Encoder alarm status error	
Trigger condition and cause	Condition: abnormal state occurred in the encoder. Cause: the encoder sends out an alarm signal, but the alarm status of the encoder read by the servo drive shows no error.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL041 CN5 is disconnected	
Trigger condition and cause	The communication of CN5 is disconnected.
Checking method and corrective action	1. Check the communication circuit of CN5. 2. When CN5 is not in use, check if PM.003.U is set to 0.
How to clear the alarm?	Cycle power on the servo drive.

AL044 Servo function operational warning	
Trigger condition and cause	Condition: too many motor control functions on the servo drive are enabled. Cause: servo function operational alarm.
Checking method and corrective action	1. If using a filter, see if using the filter is necessary. 2. Set P2.066 [Bit 4] to 1 to disable this alarm.
How to clear the alarm?	1. Disable the unnecessary filter, such as the low-pass filter (P1.006 - P1.008), moving filter (P1.068), low-frequency vibration suppression (P1.025 - P1.028), vibration elimination (P1.089 - P1.094), Notch filter (1^{st} to 5^{th} sets), percentage of friction compensation (P1.062), and motor hard stop (torque percentage) (P1.057). 2. Set P2.066 [Bit 4] to 1 and cycle power on the servo drive.

AL045 E-Gear ratio value error	
Trigger condition and cause	Condition: when the value of the E-Gear ratio exceeds the range (1 - 262144), this alarm occurs once power is cycled to the servo drive. Cause: E-Gear ratio value is found to be in error after the servo drive is powered on.
Checking method and corrective action	Check if the value of the E-Gear ratio is within the allowable range (1 - 262144). If not, correct the value and then cycle power on the servo drive.
How to clear the alarm?	Cycle power on the servo drive after the value is corrected.

AL050 Motor parameter identification is complete	
Trigger condition and cause	Used the Motor Parameter Identification Wizard and the identification is complete.
Checking method and corrective action	Cycle power on the servo drive.
How to clear the alarm?	Cycle power on the servo drive.

AL051 Motor parameter automatic identification error	
Trigger condition and cause	Condition: an error occurs when the Motor Parameter Identification Wizard function is used. Cause: during the execution of the Motor Parameter Identification Wizard function, this alarm is triggered when the motor is unable to operate due to excessive friction, or when the resolution, magnetic pole, or magnetic pole pitch is in error.
Checking method and corrective action	1. Check if PM.003, PM.004, and PM.045 are set correctly according to the specifications. 2. Make sure the motor can operate properly. 3. Check if the friction between the motor and mechanical part is too large. 4. Check if the feedback signal is abnormal. Use the Scope function of ASDA-Soft and select “Feedback Position [PUU]” as the input signal for the channel to monitor whether the feedback value is correct. 5. Check for interference causing pulse leakage. 6. If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. (b) Use shielded cable for the feedback signal cable. Make sure the signal cable is separated from the power supply or any high-current cables to avoid interference.
How to clear the alarm?	DI.ARST

AL052 Initial magnetic field detection error	
Trigger condition and cause	Condition: 1. The initial magnetic field detection is not complete because the motor moves by more than 1/3 pole pair distance or pole pitch during the detection. 2. When the servo is on, it automatically detects the magnetic field. If the detection is not complete in 4 seconds, this alarm is triggered. 3. The motor has not released the brakes or is running unevenly, or the set screws are not removed from the mechanical parts, preventing the machine from operating. Cause: when you choose not to install the Hall sensor (set PM.003.Y to 0 for not using the Hall sensor), the servo automatically detects the magnetic field when Servo On. This alarm is displayed when the servo cannot detect the magnetic field.
Checking method and corrective action	1. To make sure that the source of the feedback signal is correct, check the PM.003.U setting in the Motor Parameter Identification Wizard. 2. Check if the feedback signal is abnormal. Use the Scope function of ASDA-Soft and select “Feedback Position [PUU]” as the input signal for the channel to monitor whether the feedback value is correct. 3. Make sure the motor and mechanical part can operate properly. 4. Check if the friction between the motor and mechanical part is too large. If so, increase the set value of PM.011 by 50% at a time for testing. 5. Check if the moving distance is too large during the initial magnetic field detection when the motor is powered on. Use the Scope function of ASDA-Soft and select “Feedback Position [PUU]” as the input signal for the channel to monitor whether the feedback value is correct. Try reducing the set value of PM.011 (Current setting for initial magnetic field detection). 6. If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. (b) Use shielded cable for the feedback signal cable. Make sure the signal cable is separated from the power supply or any high-current cables to avoid interference.
How to clear the alarm?	DI.ARST

AL053 Motor parameter error	
Trigger condition and cause	1. Motor parameter is in error. 2. If the Motor Parameter Identification Wizard function has not been executed or the identification has failed, once the servo is on, this alarm is triggered.
Checking method and corrective action	1. Check the motor barcode in the Device Information screen of ASDA-Soft or replace the motor. 2. Execute or re-execute the Motor Parameter Identification Wizard function.
How to clear the alarm?	Cycle power on the servo drive.

AL054 Parameter is out of range due to switching of motor types	
Trigger condition and cause	Condition: set value of PM.004 exceeds the allowable range. Cause: set value of PM.004 exceeds the allowable range.
Checking method and corrective action	1. Check if the set values of PM.000, PM.003, PM.004, and PM.013 match the specifications of the connected motor. 2. If the issue persists, set P2.008 to 18 to reset the PM parameters.
How to clear the alarm?	Cycle power on the servo drive.

AL055 Motor magnetic field error	
Trigger condition and cause	Condition: 1. The difference between the monitored magnetic field returned by the Hall sensor and the magnetic field calculated by the servo is too big. 2. The detection occurs only when the rotary motor speed is lower than 100 rpm. Cause: when PM.009 [Bit 4] is set to 1, the servo detects the current magnetic field position of the motor and compares it with the magnetic field position of the Hall sensor. When the difference between the two is too large, this alarm is triggered.
Checking method and corrective action	1. Check if the Hall sensor is abnormal or there is interference. 2. Check if the feedback signal is abnormal. Use the Scope function of ASDA-Soft and select “Feedback Position [PUU]” as the input signal for the channel to monitor whether the feedback value is correct. 3. Check if the feedback signal has interference causing pulse leakage. 4. If the encoder feedback type is a square-wave digital signal, check if the motor speed is too fast and exceeds the maximum limit of 16 MHz that the hardware can receive (the limit is 4 times the frequency).
How to clear the alarm?	Cycle power on the servo drive.

AL056 Excessive motor speed	
Trigger condition and cause	Condition: when the filtered motor speed exceeds the setting of P1.111, the servo drive immediately switches to the Servo Off state and displays this alarm. Cause: this alarm is to remind you that the motor speed has reached the upper limit of the current setting (P1.111).
Checking method and corrective action	1. Check the reason for high motor speed, such as the set value of P1.111 is too small or the bandwidth is not set properly. 2. Evaluate the motor speed and the condition of the mechanical parts. If allowable, increase the speed and the set value of P1.111.
How to clear the alarm?	DI.ARST

AL057 Feedback pulse is lost	
Trigger condition and cause	Condition: when P2.081 is set to 1, the servo drive will detect if there is pulse leakage. When the pulse leakage exceeds the set value of P2.082, this alarm is triggered. Cause: 1. Pulse leakage occurs during motor operation. 2. The pulse signal is interfered by noise.
Checking method and corrective action	1. Check if pulse leakage has occurred to the motor encoder feedback due to noise interference. 2. If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. (b) Use shielded cable for the feedback signal cable. Make sure the signal cable is separated from the power supply or any high-current cables to avoid interference. 3. If the encoder feedback type is a square-wave digital signal, check if the motor speed is too fast and exceeds the maximum limit of 16 MHz that the hardware can receive (the limit is 4 times the frequency). 4. In addition to eliminating the noise interference, if the encoder type is a square-wave digital signal, you can also filter the noise by setting the applicable filter functions. When the main encoder signal source is CN2 (PM.003.U = 0), set PM.003.Z. 5. Set the maximum speed limit of the motor with P1.055.
How to clear the alarm?	Cycle power on the servo drive.

AL058 Excessive position deviation after initial magnetic field detection is complete	
Trigger condition and cause	Condition: 1. After the initial magnetic field detection is complete, the servo system then attempts but fails to reduce the existing position error. 2. If the controller issues commands when the servo system is not fully settled, the position error might thus be greater and cannot be reduced. Cause: the controller issues commands during initial magnetic field detection.
Checking method and corrective action	Check if the controller has issued a command once it is powered on. Use the Scope function of ASDA-Soft and select “Command Position [PUU]” as the input signal for the channel to monitor whether there is a command issued. If so, increase the delay time for the controller to issue the command after it is powered on.
How to clear the alarm?	DI.ARST

AL05B Motor type setting does not match	
Trigger condition and cause	Condition: incorrect setting of PM.000. Cause: a Delta motor is used, but PM.000 is not set to 0.
Checking method and corrective action	1. Check the setting of PM.000. 2. Make sure the type of motor used complies with the setting of PM.000.
How to clear the alarm?	Cycle power on the servo drive.

AL05C Motor position feedback error	
Trigger condition and cause	Condition: sudden jumps occur to the motor position feedback. Cause: 1. Encoder feedback is abnormal or the encoder is damaged. 2. Encoder feedback is interfered.
Checking method and corrective action	1. Check if the feedback signal is abnormal. Use the Scope function of ASDA-Soft and select “Feedback Position [PUU]” as the input signal for the channel and sample at 16 kHz, and then operate the motor manually to monitor whether the feedback value has discontinuous sudden jumps. 2. Check if the feedback signal is interfered, causing sudden jumps to the motor position feedback. 3. Check if the communication error rate increases due to interference. For example, check the communication error rate by setting P0.017 to -80 and monitor whether the value of P0.009 is not 0 and continuously increases.
How to clear the alarm?	Cycle power on the servo drive.

AL05D Detection error for offset between absolute encoder zero point and motor magnetic field zero point (PM.010)	
Trigger condition and cause	Condition: when the Motor Parameter Identification Wizard is executed for the third-party absolute motor, an error occurred when the Wizard detected the offset between the absolute encoder zero point and motor magnetic field zero point (PM.010). Cause: the difference between the actual magnetic field angle of the motor and the set value is too big.
Checking method and corrective action	1. Check if PM.003, PM.004, and PM.028 are set correctly according to the specifications. 2. Make sure you can manually operate the motor. 3. Check if the friction between the motor and mechanical part is too large. 4. Check if the feedback signal is abnormal. Use the Scope function of ASDA-Soft and select “Feedback Position [PUU]” as the input signal for the channel to monitor whether the feedback value is correct. 5. If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. (b) Use shielded cable for the feedback signal cable. Make sure the signal cable is separated from the power supply or any high-current cables to avoid interference.
How to clear the alarm?	DI.ARST

AL060 Absolute position is lost	
Trigger condition and cause	Condition: losing the recorded number of revolutions because of low battery voltage or loss of power. Cause: 1. Voltage level of the battery is too low. 2. The battery is replaced when the control power of the servo drive is off. 3. The battery is not installed when the absolute function is enabled. 4. Poor connection or disconnection of the battery power circuit.
Checking method and corrective action	1. Check if the battery voltage is below 2.9V. Re-establish the absolute origin position after replacing the battery. 2. Do not replace or remove the battery when the servo drive's control power is off. 3. Follow these instructions: (a) Install the battery. (b) Check the wiring between the battery box and the servo drive. (c) Check the encoder wiring. 4. Ensure the wiring is correct so that the battery power is supplied to the encoder and then re-establish the absolute origin position.
How to clear the alarm?	Connect or reconnect the wiring so that the battery power is supplied to the encoder and then re-establish the absolute origin position. Refer to Chapter 8 for more information on the absolute servo system.

AL061 Encoder undervoltage	
Trigger condition and cause	Condition: voltage level of the absolute encoder battery is lower than 3.1V. Cause: voltage level of the battery is too low.
Checking method and corrective action	1. Monitor the battery voltage by setting P0.002 = 38 to see if it is below 3.1V. 2. Measure the battery voltage to see if it is below 3.1V. If the voltage is too low, replace the battery when the servo drive's control power is On.
How to clear the alarm?	The alarm is cleared automatically when the voltage level is higher than 3.1V.

AL062 Number of revolutions of the absolute encoder overflows (issued by encoder)	
Trigger condition and cause	Condition: the number of revolutions of the absolute motor exceeds the range of -32768 to +32767. Cause: motor’s rotation cycle exceeds the allowable range.
Checking method and corrective action	1. Check if the number of revolutions of the motor during operation is within the range of -32768 to +32767. If not, re-establish the absolute origin position. 2. Make sure you have enabled the function of preventing rotary axis position offset when overflow occurs. If the function is disabled, set P2.069.Z to 1 to enable it.
How to clear the alarm?	Cycle power on the servo drive.

AL063 Linear scale signal error	
Trigger condition and cause	An error occurred to the linear scale original signal.
Checking method and corrective action	Check if the linear scale and read head are installed correctly, and then set DI.ARST to On or cycle power on the servo drive. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL064 Encoder vibration warning	
Trigger condition and cause	Condition: abnormal vibration occurred in the encoder. Cause: the internal signal or mechanical part of the encoder is abnormal, so the encoder returns a warning signal.
Checking method and corrective action	Check if the motor vibration range is within the warning range (2.0 to 2.5 G). If the vibration is below the warning range but the alarm still occurs, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL066 Number of revolutions of the absolute encoder overflows (issued by servo drive)	
Trigger condition and cause	Condition: the number of revolutions of the absolute motor (P0.051) exceeds half the number of revolutions of the encoder. 1. The number of revolutions of a Delta motor is -32768 to +32767. 2. For third-party motors, calculate the number of revolutions based on the motor specifications. Cause: motor's rotation cycle exceeds the allowable range.
Checking method and corrective action	1. Check if the motor's number of revolutions during operation is within the specified range. If not, re-establish the absolute origin position. 2. Make sure you have enabled the function for preventing rotary axis position offset when an overflow occurs. If the function is disabled, set P2.069.Z to 1 to enable it.
How to clear the alarm?	Re-establish the absolute origin position.

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AL067 Encoder temperature warning	
Trigger condition and cause	Condition: the encoder temperature is over the warning level of 85°C (185°F), but still under 100°C (212°F), which is within the protective range. Cause: encoder temperature warning (85°C to 100°C).
Checking method and corrective action	Set P0.002 to -124 to monitor if the encoder temperature matches the motor temperature. If the temperature is too high, improve the heat dissipation or decrease the operating temperature. If the temperature difference between the encoder and motor is over 30°C (54°F), send the servo motor back to Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL069 Wrong motor type	
Trigger condition and cause	Incremental motor does not support the absolute function.
Checking method and corrective action	1. Check whether your servo motor has an incremental or absolute encoder. 2. Check the setting of P2.069 and correctly set the value. Set P2.069.X to 0 if desiring to operate the absolute motor as an incremental motor.
How to clear the alarm?	Set P2.069.X to 0 and then cycle power on the servo drive.

AL06A Absolute position is lost	
Trigger condition and cause	There are two conditions that may cause the loss of absolute position. In the first condition, the absolute position is not established, and thus the origin is lost. In the second condition, an error occurred. After the absolute origin position is established, AL06A still occurs after power cycling of the servo drive. ■ The absolute position is not established. Condition: 1. The servo drive is used for the first time. 2. The battery is drained and the control power of the servo drive is cut off. 3. When the bus communication type servo is used with an absolute motor, the user issues an absolute position command after the first use or modification of the E-Gear ratio. Cause: 1. The servo drive is used for the first time, so the absolute origin position is not established. 2. Retaining the absolute position requires power supply, so when the battery is drained and the power supply of the servo drive is cut off, the absolute position of the servo is lost. 3. After the E-Gear ratio is modified, the communication type position system needs to be re-established. ■ An error occurred. Condition: 1. The encoder cable is damaged, including the exterior and internal wiring. 2. There is a momentary power failure in the battery power supply. 3. The absolute motor is in error. 4. The battery box is used, and J1 and J2 are connected reversely. 5. The voltage level of the battery is lower than 2.9V. Cause: 1. Power supply is unstable due to damage of the encoder cable. 2. The reason for the momentary power failure may be that the battery box connector is loose or excessive machine vibration. 3. The absolute encoder of this motor is in error. 4. If J1 and J2 are connected reversely, the battery cannot charge the capacitor. The capacitor functions as a buffer to supply power when the power supply of the servo drive power is switched to the battery due to a main power failure.
Checking method and corrective action	1. Check if the absolute origin position is established (refer to Section 8.3.1 for more information). 2. Replace the battery only when the servo drive is powered on, so the absolute encoder has continuous power supply. 3. Re-establish the absolute origin position. 4. Replace the encoder cable. Use X-ray to check if the internal wiring is damaged. 5. Check if the wiring is loose. If not, replace the battery box for cross-testing. 6. Replace the servo motor. 7. Ensure J1 is connected to the battery and J2 is connected to the servo drive.
How to clear the alarm?	The alarm is automatically cleared after you establish the absolute origin position.

AL06B The error between the servo drive internal position and the encoder position is too large	
Trigger condition and cause	Condition: when the absolute motor is powered by the battery, the number of motor rotations exceeds half the number of revolutions of the encoder. Cause: the error between the servo drive internal position and the encoder position is too large.
Checking method and corrective action	The mechanical parts are not properly fastened when the machine is being transported, causing rotation of the motor.
How to clear the alarm?	Re-establish the absolute origin position.

AL06E Encoder type is unidentifiable	
Trigger condition and cause	The servo drive cannot identify the encoder type.
Checking method and corrective action	N/A
How to clear the alarm?	Replace the motor immediately.

AL06F The absolute position is not established	
Trigger condition and cause	Condition: the establishment of the absolute position has timed out. Cause: the process for establishing the absolute position of the servo drive is in error.
Checking method and corrective action	If the issue persists after you cycle power on the servo drive and re-establish the absolute origin position, contact your local distributor or technician.
How to clear the alarm?	Cycle power on the servo drive and re-establish the absolute origin position.

AL070 Encoder did not complete the read / write procedure	
Trigger condition and cause	Reading and writing commands are not complete.
Checking method and corrective action	Check if the wiring is correct and firmly connected. If not, correctly connect the wire again. Contact Delta if this error persists.
How to clear the alarm?	Cycle power on the servo drive.

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AL071 Number of revolutions of the encoder is in error	
Trigger condition and cause	Condition: the number of revolutions of the encoder is in error. Cause: the internal signal of the encoder is abnormal, causing error in the number of revolutions of the encoder.
Checking method and corrective action	If you executed DI.ARST but the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL072 Encoder overspeed	
Trigger condition and cause	1. When the encoder is powered by the servo drive: over 8,800 rpm. 2. When the encoder is powered by the battery: over 10,000 rpm. 3. Voltage level of the battery is too low.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. 5. Measure the battery voltage to see if it is below 3.1V. 6. Check if the battery wiring has poor contact. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL073 Encoder memory error	
Trigger condition and cause	An error occurs when the encoder is reading data from or writing data to EEPROM.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL074 Encoder single-turn absolute position is in error	
Trigger condition and cause	The single-turn position in the encoder is in error.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL075 Encoder absolute number of revolutions is in error	
Trigger condition and cause	The absolute number of revolutions in the encoder is in error.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL077 Encoder internal error	
Trigger condition and cause	Encoder internal error (internal computing error).
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL079 Encoder parameter setting incomplete	
Trigger condition and cause	The servo drive is not power cycled after the encoder parameter is written to the encoder, and therefore the parameter setting does not take effect.
Checking method and corrective action	Check if the encoder parameter is written. If so, cycle power to have the parameter setting take effect.
How to clear the alarm?	Cycle power on the servo drive.

AL07A Encoder Z phase position is lost	
Trigger condition and cause	Encoder Z phase position is in error.
Checking method and corrective action	Send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	N/A

AL07B Encoder memory is busy	
Trigger condition and cause	The encoder memory is busy.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. 2. Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3. Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 4. Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL07F Encoder version error	
Trigger condition and cause	The encoder version read by the servo drive is in error.
Checking method and corrective action	N/A
How to clear the alarm?	Replace the motor immediately.

AL083 Servo drive outputs excessive current	
Trigger condition and cause	Condition: during general operation, this alarm occurs when the servo drive outputs current that is over the allowable level specified by the firmware. This alarm protects IGBT from overheating or burning because of the high current. Cause: 1. UVW is short-circuited. 2. Motor wiring is in error.
Checking method and corrective action	1. Check the motor power cable and its connector. If metal wire is exposed or the wire is torn, the UVW can short-circuit. In this case, replace the power cable to avoid a short circuit. 2. Refer to Chapter 3 Wiring and check the following items: (a) If you do not use the Delta standard power cable, make sure the UVW wiring sequence is correct. (b) Make sure the UVW wiring between the servo drive and motor is correctly connected.
How to clear the alarm?	DI.ARST

AL085 Regeneration setting error	
Trigger condition and cause	Condition: regeneration control error. Cause: regenerative resistor is not operating, but the regenerative voltage remains at 800V for a period of time.
Checking method and corrective action	Check the connection for the regenerative resistor, re-calculate the resistance value of the regenerative resistor, and correctly set the values of P1.052 and P1.053. If the issue persists, send your servo drive back to Delta.
How to clear the alarm?	DI.ARST

AL086 Regenerative resistor overload	
Trigger condition and cause	Condition: excessive energy in the capacitor of the servo drive is released to the regenerative resistor, causing overload of the resistor. Cause: 1. Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor. 2. Incorrect parameter settings for P1.052 and P1.053. 3. Other energy (such as interference) is input to the servo drive or the input voltage is higher than the allowable rated voltage. 4. Malfunction of the servo drive hardware.
Checking method and corrective action	1. Check the connection for the regenerative resistor and correctly set the values of P1.052 and P1.053. 2. Reassess whether the regenerative energy exceeds the value of P1.053. If so, use another regenerative resistor of higher capacity. 3. Use a voltmeter to measure if the input voltage from the power supply is within the allowable rated voltage (refer to Appendix A Specifications). If the input voltage exceeds the rated range, remove the interference source. 4. Measure the voltage between P3 and ⊖ terminals. If it does not match the DC Bus voltage monitored by setting P0.002 to 14, the servo drive may be malfunctioning. Send your servo drive back to the distributor or contact Delta. 5. If you took the preceding actions and the issue persists, use a scope with a differential probe to measure whether the input voltage has high-frequency signal interference. If there is interference, remove the interference source, and use the right power supply or connect the regulator in series.
How to clear the alarm?	DI.ARST

AL087 Hardware device error	
Trigger condition and cause	Hardware device is in error.
Checking method and corrective action	Send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	N/A

AL088 Servo function operational alarm	
Trigger condition and cause	Condition: too many motor control functions on the servo drive are enabled. Cause: servo function operational alarm.
Checking method and corrective action	If using a filter, see if using the filter is necessary.
How to clear the alarm?	Disable the filter if it is not required, such as the low-pass filter (P1.006 - P1.008), moving filter (P1.068), low-frequency vibration suppression (P1.025 - P1.028), vibration elimination (P1.089 - P1.094), Notch filter (1st to 5th sets), percentage of friction compensation (P1.062), and motor hard stop - torque percentage (P1.057).

AL089 Current detection interference	
Trigger condition and cause	Condition: current detection interference. Cause: current detection in the servo drive is affected by an external interference source.
Checking method and corrective action	Check the environment around the servo drive to see if there is any interference source.
How to clear the alarm?	1. Remove the interference source or move the servo drive away from the interference source. 2. Set P2.112 [Bit 1] to 0 to disable AL089. 3. If the issue persists, send your servo drive back to the distributor or contact Delta.

AL08A Auto-tuning function - command error	
Trigger condition and cause	Condition: no command is issued within 15 seconds after the servo drive starts the auto-tuning procedure. Cause: 1. When the command source is the controller, the controller did not issue the command. 2. When the command source is the servo drive, Position 1 and Position 2 specify the same position. 3. The signal cable is not connected or incorrectly connected so that the servo drive cannot receive the command.
Checking method and corrective action	1. Make sure a command is being issued. 2. Set Position 1 and Position 2 again. 3. Make sure the wiring between the controller and servo drive is correct.
How to clear the alarm?	DI.ARST

AL08B Auto-tuning function - dwell time is too short	
Trigger condition and cause	Condition: the dwell time is too short when the command source is the controller in the auto-tuning procedure. The auto-tuning algorithm requires a certain amount of time to perform the calculation. The tuning result is affected if the dwell time is too short. Cause: dwell time in the cycle is too short.
Checking method and corrective action	1. For a reciprocating motion between two points, a dwell is required on the return, which has to be longer than 1 second. Furthermore, the duration of a single command cannot exceed 20 seconds. 2. For rotation in a single direction, dwell time is required when the motor rotates a certain number of cycles (> 2 cycles).
How to clear the alarm?	DI.ARST

AL08C Auto-tuning function - inertia estimation error	
Trigger condition and cause	Condition: inertia estimation error occurs when the servo drive starts the auto-tuning procedure. Cause: 1. Rotation speed is too slow. 2. Acceleration or deceleration time is too long. 3. Load inertia of the machine is too large. 4. Inertia variation of the machine is too drastic.
Checking method and corrective action	1. The lowest speed should be no less than 200 rpm. It is suggested that you set the speed to 500 rpm or higher. 2. The time for the motor to accelerate from 0 rpm to 3,000 rpm or decelerate from 3,000 rpm to 0 rpm must be within 1.5 seconds. 3. The load inertia should be less than 50 times the motor inertia. 4. Avoid applications that require drastic variation in the inertia.
How to clear the alarm?	DI.ARST

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AL095 Regenerative resistor is disconnected	
Trigger condition and cause	1. The value of P1.053 (Regenerative resistor capacity) is greater than 0, but no regenerative resistor is connected. 2. The regeneration circuit is in error.
Checking method and corrective action	1. Be sure to connect the regenerative resistor, and make sure that the value of P1.053 is correct. 2. If the servo drive does not have a built-in regenerative resistor and no regenerative resistors are used, set P1.053 to 0. 3. Check if the wiring of the regenerative resistor is disconnected. If the issue persists, send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL098 Parameter changes become valid only after power cycling	
Trigger condition and cause	Changed the setting of a parameter which becomes valid only after power cycling, but did not cycle power on the servo drive.
Checking method and corrective action	N/A
How to clear the alarm?	Cycle power on the servo drive.

AL099 DSP firmware error	
Trigger condition and cause	EEPROM is not reset after DSP firmware is updated.
Checking method and corrective action	Check if the firmware is updated. If so, set P2.008 to 30 first and then set it to 28. Next, cycle power on the servo drive. Contact Delta if this error persists.
How to clear the alarm?	Set P2.008 to 30 and then 28. Cycle power on the servo drive.

AL09C Parameter reset failed	
Trigger condition and cause	Condition: the parameter reset process is not complete. Cause: an error occurred during the parameter reset process, so the reset procedure could not be completed.
Checking method and corrective action	Check if the power is cut off during the reset process. Check the power wiring and switch.
How to clear the alarm?	Set P2.008 to 30 and then 28. Cycle power on the servo drive.

AL0A6 Absolute positions of the servo drive and motor do not match	
Trigger condition and cause	Condition: suppose there are servo drive A, servo motor A, servo drive B, and servo motor B. Servo drive A and servo drive B have established the absolute origin positions with servo motor A and servo motor B respectively. In this case, if you operate servo drive A with servo motor B, AL0A6 will be triggered. Cause: the servo drive or servo motor is changed.
Checking method and corrective action	Re-establish the absolute origin positions.
How to clear the alarm?	Re-establish the absolute origin positions.

AL180 Bus communication timeout	
Trigger condition and cause	The servo drive does not receive any PDO data within the set communication cycle time.
Checking method and corrective action	1. Check if the communication is normal. 2. Check if the wiring is correctly connected.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL185 Bus hardware error	
Trigger condition and cause	Condition: bus communication is cut off. Cause: abnormal communication hardware.
Checking method and corrective action	1. Check if the communication cable is intact and firmly connected. 2. Check the communication quality. It is suggested that you use common grounding and shielded cable. 3. For communication type models, check if the value of monitoring variable 120 increases continuously.
How to clear the alarm?	NMT: reset node, OD 6040h [Bit 7] (Fault reset), or DI.ARST.

AL203 System alarm	
Trigger condition and cause	An internal error occurs in the servo drive.
Checking method and corrective action	Keep a detailed record of the operation steps that lead to this alarm, and then provide the record to Delta for analysis.
How to clear the alarm?	N/A

AL235 Position counter overflow warning	
Trigger condition and cause	Condition: a positioning command is executed after the overflow of the position command counter. Cause: overflow of the position command counter.
Checking method and corrective action	Incremental system: When the motor keeps operating in one direction, this leads to overflow of the position feedback register (FB_PUU), and the position system cannot display the correct position. Issuing an absolute position command after overflow results in this error. Use the Scope function of ASDA-Soft to check if the position feedback has overflowed and then execute the homing procedure. Absolute system: This error occurs when the absolute positioning command is issued in the following conditions: 1. Position feedback register (FB_PUU) overflows. 2. Absolute origin position is not established after the setting of P1.001.Z is changed. 3. Absolute origin position is not established after the E-Gear ratio (P1.044 and P1.045) is changed. 4. The absolute origin position is established but the homing procedure is incomplete. 5. When AL060 and AL062 occur, use the Scope function of ASDA-Soft to check if the position feedback has overflowed. Check whether the preceding conditions have occurred, and then establish the absolute origin position.
How to clear the alarm?	Incremental system: perform homing procedure after using DI.ARST. Absolute system: establish the absolute origin position.

AL239 System alarm	
Trigger condition and cause	An internal error occurs in the servo drive.
Checking method and corrective action	Keep a detailed record of the operation steps that lead to this alarm, and then provide the record to Delta for analysis.
How to clear the alarm?	N/A

AL23F System alarm	
Trigger condition and cause	An internal error occurs in the servo drive.
Checking method and corrective action	Keep a detailed record of the operation steps that lead to this alarm, and then provide the record to Delta for analysis.
How to clear the alarm?	N/A

AL283 Software positive limit	
Trigger condition and cause	Condition: the position feedback exceeds the software positive limit. Cause: the software positive limit is triggered.
Checking method and corrective action	Software positive limit triggering is determined by the position feedback. Set an appropriate deceleration time to achieve the desired effect. For more information, refer to the description of P5.003.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL285 Software negative limit	
Trigger condition and cause	Condition: the position feedback exceeds the software negative limit. Cause: the software negative limit is triggered.
Checking method and corrective action	Software negative limit triggering is determined by the position feedback. Set an appropriate deceleration time to achieve the desired effect. For more information, refer to the description of P5.003.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL289 Position counter overflows	
Trigger condition and cause	Position counter overflows.
Checking method and corrective action	1. Set the gear ratio according to the actual application requirements and the total traveling distance of the absolute motor to avoid overflow of the feedback counter. 2. If P2.069.Z is set to 1 (enabling the function of preventing rotary axis position offset when overflow occurs), set P2.070 [Bit 2] to 1 (no overflow warning).
How to clear the alarm?	DI.ARST

AL310 DI.ILK (0x4D) is triggered	
Trigger condition and cause	DI.ILK (0x4D) is On.
Checking method and corrective action	Check the condition of triggering DI.ILK (0x4D) and perform troubleshooting.
How to clear the alarm?	N/A

AL35F Emergency stop during deceleration	
Trigger condition and cause	The rising edge of DI.PFQS (0x47) is triggered, and then the motor decelerates to 0 and triggers AL3CF.
Checking method and corrective action	Check if the DI is set to 0x47 with any of the parameters P2.010 - P2.017 and is triggered.
How to clear the alarm?	Cycle power on the servo drive.

AL3CF Emergency stop	
Trigger condition and cause	After AL35F is triggered and the motor has decelerated to 0, this alarm occurs.
Checking method and corrective action	Check if the DI is set to 0x47 with any of the parameters P2.010 - P2.017 and is triggered.
How to clear the alarm?	DI.ARST

AL3E3 Communication synchronization signal timeout	
Trigger condition and cause	The target command is not received within a continuous communication cycle in the CSP / CSV / CST mode.
Checking method and corrective action	1. Make sure the communication between the servo drive and controller is good. 2. Modify the setting of IP command timeout (P3.022.YX). 3. Ensure the correct time sequence of sending packets from the controller. A drift or delay in packet sending time causes synchronization failure.
How to clear the alarm?	NMT: reset node or OD 6040h [Bit 7] (Fault reset).

AL3F1 Absolute position command of the communication type servo drive is in error	
Trigger condition and cause	Condition: when the bus communication type servo drive is used with an incremental motor and the position overflow occurs with the absolute origin position unestablished, the absolute positioning command is issued. Cause: 1. The absolute origin position is not established. 2. Overflow occurs since the motor keeps rotating in the same direction.
Checking method and corrective action	Establish the absolute origin position.
How to clear the alarm?	Establish the absolute origin position.

AL422 Write-in failed caused by control power cut-off	
Trigger condition and cause	Condition: when P2.069.Z is set to 1 (enabling the function of preventing rotary axis position offset when overflow occurs) and the control power is cut off, the motor fails to store the current position. Cause: 1. The load is over the rated range and the servo drive is in a continuous overload condition. 2. After firmware update, the internal variables vary with the firmware versions. 3. The servo drive hardware EEPROM is abnormal. 4. The hardware of the servo drive is short-circuited. 5. AL520 occurred and causes malfunction of the servo drive.
Checking method and corrective action	1. Set P0.002 to 12 for monitoring if the average load rate [%] is continuously over 100%. If so, increase the motor capacity or reduce the load. Refer to Appendix A for Graph of load and operating time. 2. If the issue persists, send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL500 STO function is enabled	
Trigger condition and cause	Safe torque off function (STO) is enabled.
Checking method and corrective action	Safe torque off function (STO) is enabled. Check why it is enabled.
How to clear the alarm?	1. Reset by using DI.ARST (Alarm reset), OD 6040h [Bit 7] (Fault reset), or setting P0.001 to 0x0000. 2. If not using the STO function, plug the short circuit connector into CN10 or wire to short-circuit the CN10 STO terminal. Follow the instructions in Chapter 3 for the STO wiring.

AL501 SF1 lost (signal loss or signal error)	
Trigger condition and cause	Loss of SF1 signal, or SF1 and SF2 signals are not synchronized for more than 1 second.
Checking method and corrective action	Make sure the wiring of SF1 is correct.
How to clear the alarm?	Cycle power on the servo drive. If the issue persists, contact the distributor.

AL502 SF2 lost (signal loss or signal error)	
Trigger condition and cause	Loss of SF2 signal, or SF1 and SF2 signals are not synchronized for more than 1 second.
Checking method and corrective action	Make sure the wiring of SF2 is correct.
How to clear the alarm?	Cycle power on the servo drive. If the issue persists, contact the distributor.

AL503 STO self-diagnostic error	
Trigger condition and cause	An error occurs during STO self-diagnosis, which may be caused by an abnormality in the STO circuit.
Checking method and corrective action	N/A
How to clear the alarm?	Contact the distributor.

AL510 Internal parameter update program of the servo drive is abnormal	
Trigger condition and cause	Internal parameter update program of the servo drive is abnormal.
Checking method and corrective action	If this alarm occurs when the motor parameter identification function is executing, cycle power on the servo drive and re-execute the motor parameter identification function.
How to clear the alarm?	N/A

AL520 Calculation program timeout	
Trigger condition and cause	Servo drive calculation program timeout.
Checking method and corrective action	1. Cycle power on the servo drive. 2. If the issue persists, disable the vibration elimination function by setting [Bit 8] and [Bit 9] of P2.094 to 0.
How to clear the alarm?	N/A

AL521 Vibration elimination parameter error	
Trigger condition and cause	Condition: the input value for the vibration elimination parameter is not appropriate. Cause: 1. Your input value for the vibration elimination parameter is not appropriate. 2. The Bode plot is in error due to other factors when the **System Analysis** tool of ASDA-Soft is in operation.
Checking method and corrective action	Perform system analysis again and correctly set the value for the vibration elimination parameter.
How to clear the alarm?	1. Perform system analysis again and correctly set the value for the vibration elimination parameter. 2. If the issue persists, disable the vibration elimination function by setting [Bit 8] and [Bit 9] of P2.094 to 0.

AL555 System failure	
Trigger condition and cause	Servo drive DSP is in error.
Checking method and corrective action	If this alarm occurs, send your servo drive directly back to Delta without making any modification.
How to clear the alarm?	N/A

AL560 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL561 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL562 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL563 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL565 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL566 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL567 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL568 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL569 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL56A Safety functions module error	
Trigger condition and cause	Encoder communication is in error.
Checking method and corrective action	1. Check if the compatible motor is used. For the compatible motors, refer to the Delta ACS3-SF Safety Functions Module User Manual. 2. Check the connection between the CN2 port of the servo drive and the CN2 connector. Reconnect them if the connection is loose. 3. Check if the parameter PM.003.U is set to 0. 4. If the issue persists, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
How to clear the alarm?	-

AL56B Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL56C Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL570 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL571 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL572 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL573 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL574 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL575 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL576 Safety functions module error	
Trigger condition and cause	The setting of P1.100 does not match the actual configuration.
Checking method and corrective action	1. When using the safety functions module, set the servo drive parameter P1.100 to 1 or 2. When not using the safety functions module, set P1.100 to 0. 2. If the issue persists, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
How to clear the alarm?	-

AL580 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL581 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

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AL582 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL583 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL584 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL585 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL586 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL587 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL588 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL589 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL58A Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5A0 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5A1 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5A2 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5A3 Safety functions module error	
Trigger condition and cause	Encoder communication is in error.
Checking method and corrective action	1. Check if the compatible motor is used. For the compatible motors, refer to the Delta ACS3-SF Safety Functions Module User Manual. 2. Check the connection between the CN2 port of the servo drive and the CN2 connector. Reconnect them if the connection is loose. 3. Check if the parameter PM.003.U is set to 0. 4. If the issue persists, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
How to clear the alarm?	-

AL5BF Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5C0 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5C1 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5C2 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5C6 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5C7 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5C8 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

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AL5C9 Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5CA Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5CB Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5CC Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5CD Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5CE Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL5CF Safety functions module error	
Trigger condition and cause	This is a safety functions module alarm. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual.
Checking method and corrective action	-
How to clear the alarm?	-

AL611 Hiperface encoder - motor position error	
Trigger condition and cause	1. The installation or wiring of the encoder is incorrect. 2. The installation and operating environment do not meet the specifications, causing encoder error. 3. The encoder is damaged.
Checking method and corrective action	1. Make sure the encoder or read head is correctly installed and wired according to the manufacturer's instruction manual. 2. If the issue persists, contact the distributor of the encoder.
How to clear the alarm?	DI.ARST

AL809 System alarm	
Trigger condition and cause	An internal error occurred in the servo drive.
Checking method and corrective action	Keep a detailed record of the operation steps that lead to this alarm, and then provide the record to Delta for analysis.
How to clear the alarm?	N/A

ALC31 Motor power cable disconnection	
Trigger condition and cause	Condition: disconnection of the motor power cable (U, V, W) and ground wire (GND). Cause: disconnection of the motor power cable (U, V, W) and ground wire (GND). The switch for disconnection detection is set by P2.065 [Bit 9], which is enabled by default.
Checking method and corrective action	Check if the motor power cable (U, V, W) and ground wire (GND) are firmly connected. Follow the instructions in this user manual to properly connect the motor power cable and ground wire.
How to clear the alarm?	Cycle power on the servo drive.

ALD08 BiSS C encoder - sensor installation error	
Trigger condition and cause	Condition: an error occurred to the BiSS C encoder. Cause: 1. The installation or wiring of the encoder is incorrect. 2. The installation and operating environment do not meet the specifications, causing encoder error. 3. The encoder is damaged.
Checking method and corrective action	1. Make sure the encoder or read head is correctly installed and wired according to the manufacturer’s instruction manual. 2. If the issue persists, contact the distributor of the encoder.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

ALD09 BiSS C encoder - sensor installation warning	
Trigger condition and cause	Condition: an error occurred to the BiSS C encoder. Cause: 1. The installation or wiring of the encoder is incorrect. 2. The installation and operating environment do not meet the specifications, causing encoder error. 3. The encoder is damaged.
Checking method and corrective action	1. Make sure the encoder or read head is correctly installed and wired according to the manufacturer’s instruction manual. 2. If the issue persists, contact the distributor of the encoder.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

ALD10 Hiperface encoder - communication error	
Trigger condition and cause	Condition: an error occurred to the encoder communication. Cause: 1. The installation or wiring of the encoder is incorrect. 2. The installation and operating environment do not meet the specifications, causing encoder error. 3. The encoder is damaged.
Checking method and corrective action	1. Make sure the encoder or read head is correctly installed and wired according to the manufacturer's instruction manual. 2. If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the ground end (yellow / green) of the power cable is grounded to the servo drive heat sink. (b) Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. (c) Use shielded cable for the encoder cable. Pull out the wire mesh and have it correctly grounded. 3. If the issue persists, contact the distributor of the encoder.
How to clear the alarm?	Cycle power on the servo drive.

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Specifications Appendix A

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A.1 A3-EP servo drive

A.1.1 Specifications of the servo drive

A3-EP model			400 W	750 W	1 kW	1.5 kW	2 kW	3 kW
			0.4	0.75	1	1.5	2	3
Main circuit	Phase / Voltage		Three-phase 400 V_{AC}					
	Permissible voltage		Three-phase 380 to 480 V_{AC}, -10% to +10%					
	Input current (3PH) (Arms) *1		0.9	1.8	2.4	3.4	4.5	6.3
	Inrush current (Arms)		5.6	5.6	5.6	5.6	12.5	12.5
Control circuit	Voltage*2		24 V_{DC}					
	Permissible voltage		24 V_{DC}, -10% to +10%					
	Input current (Arms)		0.7	0.7	0.7	0.7	1.1	1.1
	Inrush current (Arms)		5	5	5	5	4.8	4.8
Continuous output current (Arms)			1.60	3.12	3.52	5.06	6.60	9.11
Max. instantaneous output current (Arms)			5.40	9.70	10.54	16.35	19.88	29.45
Power dissipation (Watt)			49	72	86	105	125	195
Regenerative resistor	Built-in	Resistance (Ohm)	80	80	80	80	-	-
		Capacity (Watt)	60	60	60	60	-	-
	External	Min. allowable resistance (Ohm)	80	60	60	40	40	30
Cooling method			Fan cooling					

A3-EP model			4.5 kW	5.5 kW	7.5 kW	11 kW	15 kW
			4.5	5.5	7.5	11	15
Main circuit	Phase / voltage		Three-phase 400 V_{AC}				
	Permissible voltage		Three-phase 380 to 480 V_{AC}, -10% to +10%				
	Input current (3PH) (Arms) *1		8.7	10.7	14.1	21.8	29.6
	Inrush current (Arms)		12.5	12.5	12.5	12.5	12.5
Control circuit	Voltage*2		24 V_{DC}				
	Permissible voltage		24 V_{DC}, -10% to +10%				
	Input current (Arms)		1.1	1.1	1.3	1.3	1.3
	Inrush current (Arms)		5.5	5.5	5.5	6	6
Continuous output current (Arms)			13.30	15.34	22.40	27.30	31.00
Max. instantaneous output current (Arms)			35.35	49.29	56.68	68.25	80.20
Power dissipation (Watt)			220	310	400	465	530
Regenerative resistor	Built-in	Resistance (Ohm)	-	-	-	-	-
		Capacity (Watt)	-	-	-	-	-
	External	Min. allowable resistance (Ohm)	25	25	15	15	15
Cooling method			Fan cooling				

Note:
1. The main circuit input current is the actual value measured when the servo drive is under the rated output condition with a power supply of 480 V_{AC}.
2. Use a SELV system to power the control circuit at 24V.

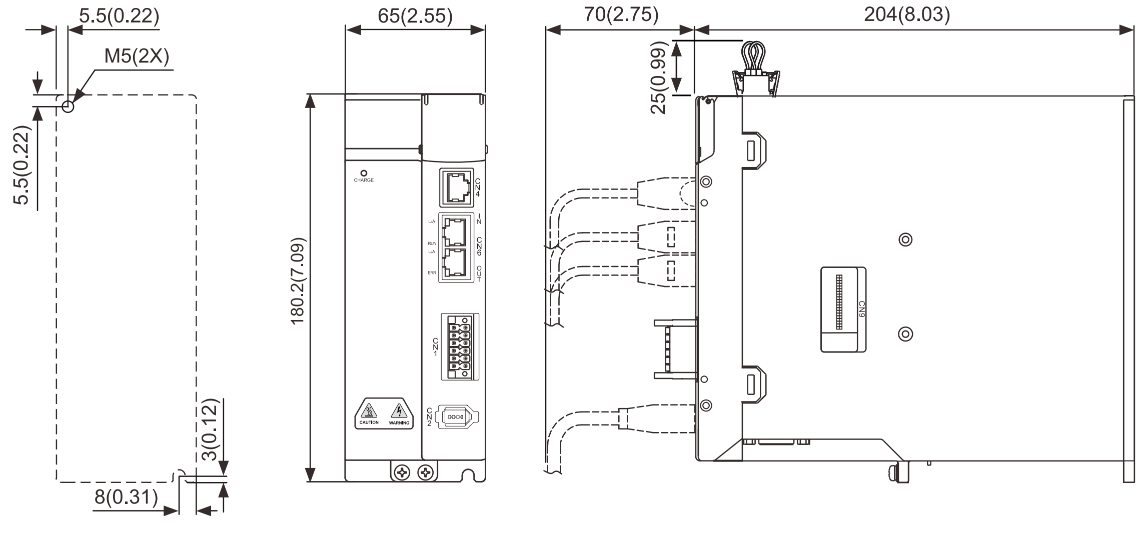
Specification table

Item		Specification
Servo drive resolution		24-bit (16777216 p/rev)
Main circuit control		SVPWM control
Tuning mode		Manual / Auto
Digital input		4 DI points; refer to Chapter 7 for the function settings.
Digital output		2 DO points; refer to Chapter 7 for the function settings.
Protection function		Overcurrent, Overvoltage, Undervoltage, Overheat, Regeneration error, Overload, Excessive speed deviation, Excessive position deviation, CN2 communication failure, Emergency stop, Positive / negative limit error, RST power error, Short-circuit protection for terminals U, V, W
Communication interface		Ethernet / EtherCAT
Environment	Installation site	Indoors (avoid direct sunlight), no corrosive vapor (avoid fumes, flammable gases, and dust)
	Altitude	Less than 2,000 m above sea level
	Atmospheric pressure	86 kPa - 106 kPa
	Ambient temperature	0˚C to 55˚C (32˚F to 131˚F) If the temperature is above 45˚C (113˚F), place the product in a well-ventilated environment; when operating 3 kW models at 50˚C to 55˚C (122˚F to 131˚F), derate the load to 80%.
	Storage temperature	-20˚C to +65˚C (-4˚F to +149˚F)
	Humidity	Under 0 - 90% RH (non-condensing)
	Vibration	10 Hz - 57 Hz: 0.075 mm amplitude; 58 Hz - 150 Hz: 1G
	Pollution degree	Degree 2
	IP rating	IP20*3
	Power system	TN system / TT system
	Approvals*4	IEC/EN/UL 61800-5-1

Note:
1. Within the rated load, the speed ratio is: the minimum speed (smooth operation) / rated speed.
2. Within the rated speed, the speed calibration ratio is: (rotational speed with no load - rotational speed with full load) / rated speed.
3. The terminal blocks are not IP20 rated.
4. Please visit Delta's website to download the certificates.
5. TUV Functional Safety application in progress.
6. This equipment does not have functions of thermal memory for shutdown, thermal memory for loss of power, and speed sensitivity in accordance with EN 61800-5-1:2007/A1:2017.
7. To meet the functional safety requirement, install the servo drive in the control cabinet with a rating of IP54 or higher.

A.1.2 Dimensions of the servo drive

400 W / 750 W / 1 kW / 1.5 kW



(FRONT VIEW)

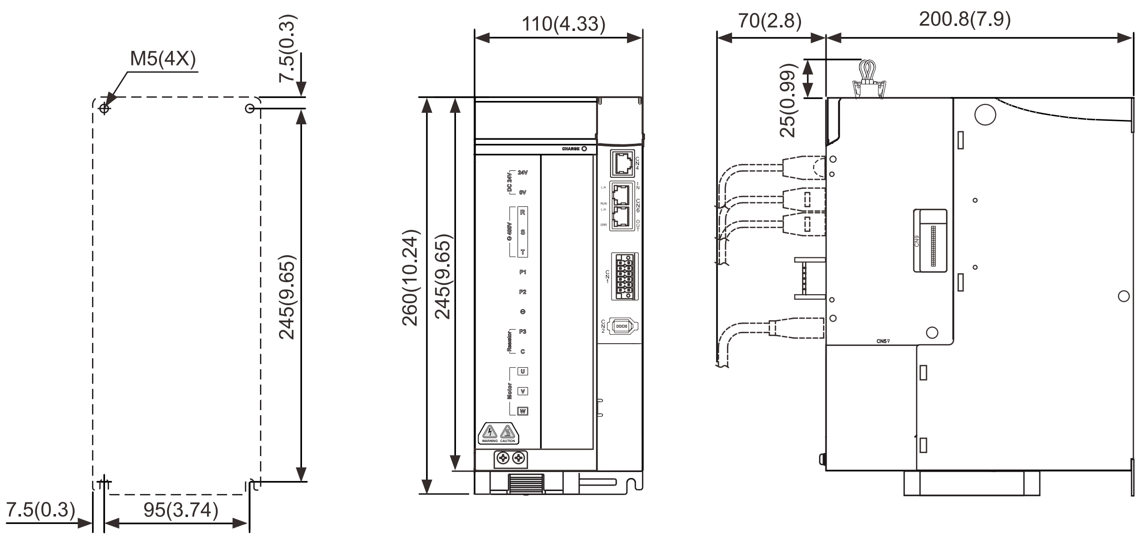
SCREW: M5*2 PCS
TIGHTENING TORQUE: 22-24 (kgf-cm)

SCREW: M4x0.7
TIGHTENING TORQUE: 12-14 (kgf-cm)

Unit: mm (inch)

Weight	1.8 kg (3.97 lb)

2 kW / 3 kW / 4.5 kW / 5.5 kW



(FRONT VIEW)

SCREW: M5*4 PCS
TIGHTENING TORQUE: 22-24 (kgf-cm)

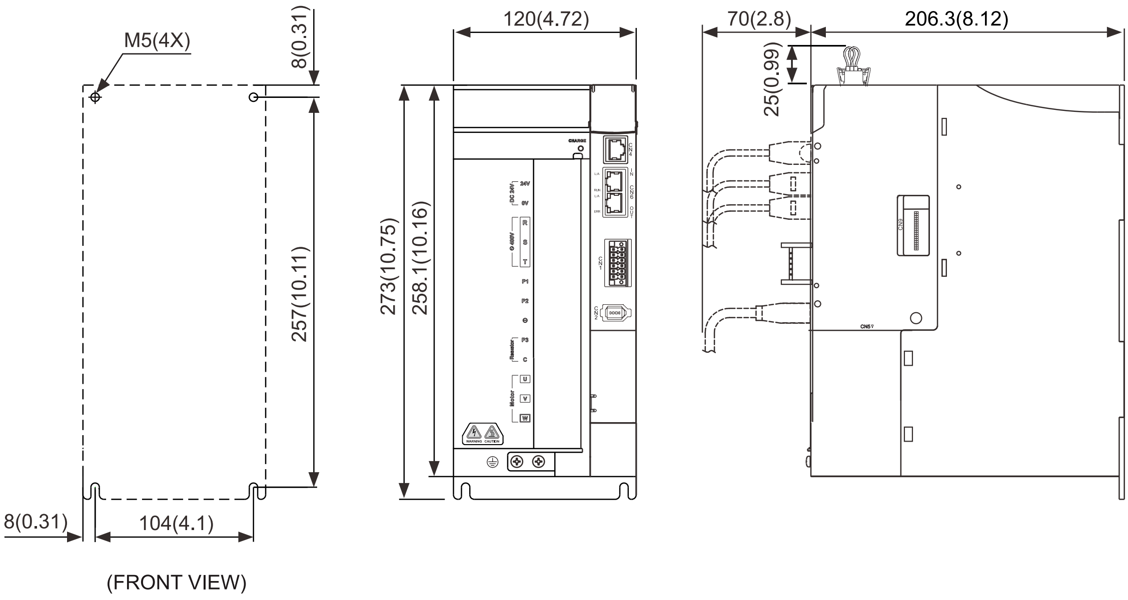
SCREW: M4x0.7
TIGHTENING TORQUE: 12-14 (kgf-cm)

Unit: mm (inch)

Weight	2 kW / 3 kW	3.45 kg (7.61 lb)
	4.5 kW / 5.5 kW	4 kg (8.82 lb)

A

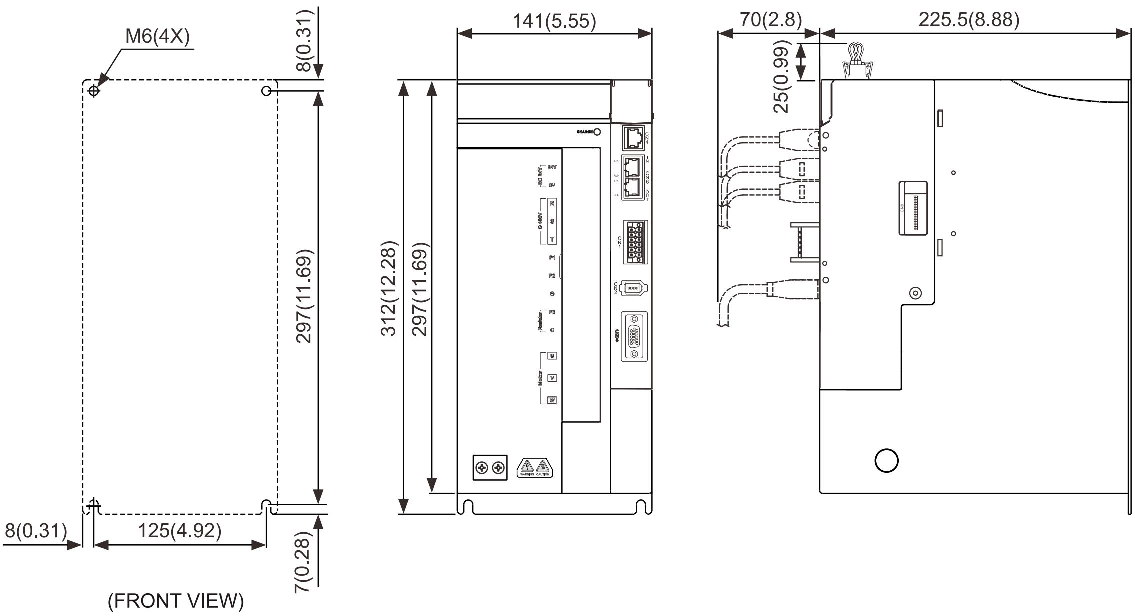
7.5 kW



SCREW: M5*4 PCS TIGHTENING TORQUE: 22-24 (kgf-cm)	SCREW: M4x0.7 TIGHTENING TORQUE: 12-14 (kgf-cm)	Unit: mm (inch)

Weight	5.5 kg (12.13 lb)

11 kW / 15 kW



SCREW: M6*4 PCS TIGHTENING TORQUE: 27-30 (kgf-cm)	SCREW: M4x0.7 TIGHTENING TORQUE: 12-14 (kgf-cm)	Unit: mm (inch)

Weight	7.5 kg (16.53 lb)

Note: dimensions and weights of the servo drive may be updated without prior notice.

A.2 ECM-B3 series servo motor

A.2.1 Specifications of ECM-B3 series servo motor

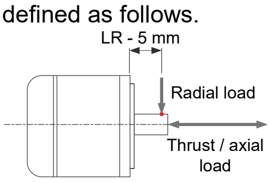
A.2.1.1 220V models

F80 and below motors (low & medium inertia)

ECM-		B3L-C□0401	B3M-C□0602
Rated power (kW)		0.1	0.2
Rated torque (N·m)[*1]		0.32	0.64
Max. torque (N·m)		1.12	2.24
Rated speed (rpm)		3000	
Max. speed (rpm)		6000	
Rated current (Arms)		0.857	1.42
Max. instantaneous current (Arms)		3.44	6.62
Change of rated power (kW/s)	w/o brake	34.25	29.05
	with brake	32.51	27.13
Rotor inertia (× 10^{-4}kg·m^2)	w/o brake	0.0299	0.141
	with brake	0.0315	0.151
Mechanical time constant (ms)	w/o brake	0.50	0.91
	with brake	0.53	0.97
Torque constant-KT (N·m/Arms)		0.374	0.45
Voltage constant-KE (mVrms/rpm)		13.8	16.96
Armature resistance (Ohm)		8.22	4.71
Armature inductance (mH)		19.1	12.18
Electrical time constant (ms)		2.32	2.59
Weight (kg)	w/o brake	0.5	0.9
	with brake	0.7	1.3
Max. radial load (N)[*4]		78	245
Max. axial load (N)[*4]		54	74
Brake operating voltage		24 V_{DC} ± 10%	
Brake power consumption (W) (at 20˚C (68°F))		6.1	7.6
Brake holding torque [N·m (Min)][*2]		0.3	1.3
Brake release time [ms (Max)]		20	20
Brake pull-in time [ms (Max)]		35	50
Derating rate with oil seal (%)		10	10
Insulation class		Class A (UL), Class B (CE)	
Insulation resistance		100 MΩ min. (at 500 V_{DC})	
Insulation strength		1.8 kV_{AC}, 1 sec	
Vibration grade		V15	
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]	
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)	
Ambient and storage humidity		20 - 90% RH (non-condensing)	
Vibration capacity		2.5 G	
IP rating		IP67 (for models using waterproof connectors and shaft seals or oil seals)	
Approvals		CE, cULus	

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C and 40˚C (32˚F and 104˚F). F40 and F60: 250 mm x 250 mm x 6 mm; material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



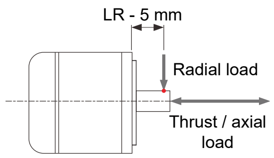
A.2.1.2 400V models

F80 and below motors (medium inertia)

ECM-		B3M-J□0604	B3M-J□0807
Rated power (kW)		0.4	0.75
Rated torque (N·m)[*1]		1.27	2.4
Max. torque (N·m)		4.45	8.4
Rated speed (rpm)		3000	
Max. speed (rpm)		6000	
Rated current (Arms)		1.35	2.15
Max. instantaneous current (Arms)		5.20	7.90
Change of rated power (kW/s)	w/o brake	63.50	53.83
	with brake	61.09	50.97
Rotor inertia (× 10^{-4}kg·m^2)	w/o brake	0.254	1.07
	with brake	0.264	1.13
Mechanical time constant (ms)	w/o brake	0.53	0.55
	with brake	0.55	0.58
Torque constant-KT (N·m/Arms)		0.94	1.12
Voltage constant-KE (mVrms/rpm)		34.66	40.34
Armature resistance (Ohm)		6.47	2.20
Armature inductance (mH)		20.6	11.2
Electrical time constant (ms)		3.18	5.09
Weight (kg)	w/o brake	1.2	2.34
	with brake	1.6	3.15
Max. radial load (N)[*4]		245	392
Max. axial load (N)[*4]		74	147
Brake operating voltage		24 V_{DC} ± 10%	
Brake power consumption (W) (at 20˚C (68°F))		7.6	8
Brake holding torque [N·m (Min)][*2]		1.3	2.5
Brake release time [ms (Max)]		20	20
Brake pull-in time [ms (Max)]		50	60
Derating rate with oil seal (%)		5	5
Insulation class		Class A (UL), Class B (CE)	
Insulation resistance		100 MΩ min. (at 500 V_{DC})	
Insulation strength		2.3 kV_{AC}, 1 sec	
Vibration grade		V15	
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]	
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)	
Ambient and storage humidity		20 - 90% RH (non-condensing)	
Vibration capacity		2.5 G	
IP rating		IP67 (for models using waterproof connectors and shaft seals or oil seals)	
Approvals		CE cULus	

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C and 40˚C (32˚F and 104˚F).
   F60 and F80: 250 mm x 250 mm x 6 mm; material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



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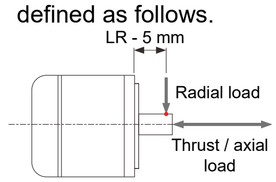
F100 motors (medium inertia)

ECM-		B3M-J□1010	B3M-J□1015	B3M-J□1020
Rated power (kW)		1	1.5	2
Rated torque (N·m)*1		3.18	4.77	6.37
Max. torque (N·m)		9.54	14.31	19.11
Rated speed (rpm)		3000		
Max. speed (rpm)		6000		
Rated current (Arms)		3.03	3.73	5.00
Max. instantaneous current (Arms)		9.21	11.4	15.3
Change of rated power (kW/s)	w/o brake	36.4	61.7	86.7
	with brake	33.0	57.3	82.0
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	2.78	3.69	4.68
	with brake	3.06	3.97	4.95
Mechanical time constant (ms)	w/o brake	0.737	0.546	0.528
	with brake	0.811	0.587	0.559
Torque constant-KT (N·m/Arms)		1.05	1.28	1.27
Voltage constant-KE (mVrms/rpm)		39.5	47.8	47.2
Armature resistance (Ohm)		1.05	0.864	0.646
Armature inductance (mH)		7.50	6.63	4.89
Electrical time constant (ms)		7.14	7.67	7.57
Weight (kg)	w/o brake	3.56	4.37	5.09
	with brake	4.88	5.68	6.505
Max. radial load (N) *4		490	490	490
Max. axial load (N) *4		196	196	196
Brake operating voltage		24 V_{DC} ± 10%		
Brake power consumption (W) (at 20˚C (68°F))		17.6	17.6	17.6
Brake holding torque [N·m (Min)]*2		9.5	9.5	9.5
Brake release time [ms (Max)]		50	50	50
Brake pull-in time [ms (Max)]		110	110	110
Derating rate with oil seal (%)		5	5	5
Insulation class		Class A (UL), Class B (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})		
Insulation strength		2.3 kV_{AC}, 1 sec		
Vibration grade		V15		
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)*3		
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)		
Ambient and storage humidity		20 - 90% RH (non-condensing)		
Vibration capacity		2.5 G		
IP rating		IP67 (for models using shaft seals or oil seals)		
Approvals		CE cULus		

Note:

1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C and 40˚C (32˚F and 104˚F).
   F100: 300 mm x 300 mm x 12 mm; material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.

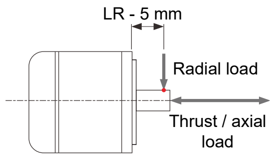


F130 motors (medium & high inertia)

ECM-		B3M-K□1310	B3M-K□1315	B3M-K□1320	B3H-L□1308	B3H-L□1313	B3H-L□1318
Rated power (kW)		1	1.5	2	0.85	1.3	1.8
Rated torque (N·m)[*1]		4.77	7.16	9.55	5.39	8.34	11.5
Max. torque (N·m)		14.3	21.48	28.65	16.17	25.02	34.5
Rated speed (rpm)		2000			1500		
Max. speed (rpm)		3000			4000		
Rated current (Arms)		3.00	4.09	5.30	3.35	3.85	5.75
Max. instantaneous current (Arms)		9.95	13.37	17.1	10.0	12.0	18.1
Change of rated power (kW/s)	w/o brake	29.21	45.69	62.25	23.4	38.6	58.5
	with brake	28.66	45.09	61.62	23.0	38.3	58.0
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	7.79	11.22	14.65	12.44	18.00	22.60
	with brake	7.94	11.37	14.80	12.62	18.14	22.80
Mechanical time constant (ms)	w/o brake	1.47	1.10	1.03	2.50	1.97	1.69
	with brake	1.50	1.12	1.04	2.54	1.99	1.71
Torque constant-KT (N·m/Arms)		1.59	1.75	1.80	1.61	2.17	2.00
Voltage constant-KE (mVrms/rpm)		58.60	63.38	65.40	59.5	77.6	70.7
Armature resistance (Ohm)		1.68	1.04	0.792	1.84	1.76	1.01
Armature inductance (mH)		16.0	11.2	8.72	10.0	11.0	6.80
Electrical time constant (ms)		9.52	10.8	11.0	5.43	6.25	6.73
Weight (kg)	w/o brake	4.9	6.0	7.0	6.0	7.0	8.0
	with brake	6.3	7.4	8.5	7.5	8.5	9.5
Max. radial load (N) [*4]		490	686	980	490	686	980
Max. axial load (N) [*4]		98	343	392	98	343	392
Brake operating voltage		24 V_{DC} ± 10%					
Brake power consumption (W) (at 20˚C (68°F))		21.5	21.5	21.5	24	24	24
Brake holding torque [N·m (Min)][*2]		10	10	10	16	16	16
Brake release time [ms (Max)]		50	50	50	60	60	60
Brake pull-in time [ms (Max)]		110	110	110	120	120	120
Derating rate with oil seal (%)		5	5	5	5	5	5
Insulation class		Class A (UL), Class B (CE)			Class F (UL), Class F (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})					
Insulation strength		2.3 kV_{AC}, 1 sec					
Vibration grade		V15					
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]					
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)					
Ambient and storage humidity		20 - 90% RH (non-condensing)					
Vibration capacity		2.5 G					
IP rating		IP67 (for models using shaft seals or oil seals)					
Approvals							

Note:

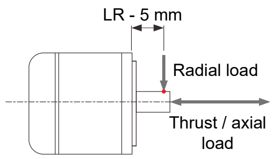
1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C and 40˚C (32˚F and 104˚F). F130: 400 mm x 400 mm x 20 mm; material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



F180 motors (medium inertia)

ECM-		B3M-K□1820	B3M-L□1830	B3M-L□1845	B3M-L□1855	B3M-L□1875
Rated power (kW)		2	3	4.5	5.5	7.5
Rated torque (N·m)[*1]		9.55	19.1	28.65	35.01	47.75
Max. torque (N·m)		28.65	57.29	71.6	105	119
Rated speed (rpm)		2000	1500	1500		
Max. speed (rpm)		3000	3000	4000		
Rated current (Arms)		5.7	9.1	13.3	15.3	22.1
Max. instantaneous current (Arms)		18.1	29.45	35.35	49.29	56.68
Change of rated power (kW/s)	w/o brake	31.33	68.02	121	124	169
	with brake	30.02	66.45	119	122	167
Rotor inertia (× 10^{-4} kg·m^2)	w/o brake	29.11	53.63	67.73	98.88	134.95
	with brake	30.38	54.9	69.15	100.1	136.24
Mechanical time constant (ms)	w/o brake	1.83	1.21	1.07	1.01	1.01
	with brake	1.91	1.24	1.09	1.02	1.02
Torque constant-KT (N·m/Arms)		1.68	2.10	2.15	2.29	2.16
Voltage constant-KE (mVrms/rpm)		63.2	75.8	78.8	81.8	77.4
Armature resistance (Ohm)		0.636	0.344	0.255	0.182	0.120
Armature inductance (mH)		9.36	6.08	4.68	3.48	2.27
Electrical time constant (ms)		14.72	17.67	18.4	19.1	18.9
Weight (kg)	w/o brake	10	13.9	16.5	21.2	27.2
	with brake	13.7	17.6	20.2	24.9	30.9
Max. radial load (N) [*4]		1470	1470	1470	1764	1764
Max. axial load (N) [*4]		490	490	490	588	588
Brake operating voltage		24 V_{DC} ± 10%				
Brake power consumption (W) (at 20˚C (68°F))		31	31	31	31	31
Brake holding torque [N·m (Min)][*2]		25	25	55	55	55
Brake release time [ms (Max)]		30	30	50	50	50
Brake pull-in time [ms (Max)]		120	120	150	150	150
Derating rate with oil seal (%)		5	5	0	0	0
Insulation class		Class A (UL), Class B (CE)		Class F (UL), Class F (CE)		
Insulation resistance		100 MΩ min. (at 500 V_{DC})				
Insulation strength		2.3 kV_{AC}, 1 sec				
Vibration grade		V15				
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]				
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)				
Ambient and storage humidity		20 - 90% RH (non-condensing)				
Vibration capacity		2.5 G				
IP rating		IP67 (for models using shaft seals or oil seals)				
Approvals		CE cULus				

Note:
1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C and 40˚C (32˚F and 104˚F). F180: 550 mm x 550 mm x 30 mm; material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.

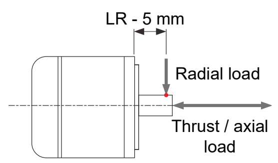


A

F220 motors (medium inertia)

ECM-		B3M-L□221B	B3M-L□221F
Rated power (kW)		11	15
Rated torque (N·m)[*1]		70.03	95.49
Max. torque (N·m)		175	238.5
Rated speed (rpm)		1500	
Max. speed (rpm)		4000	
Rated current (Arms)		21.2	29.2
Max. instantaneous current (Arms)		56.5	77
Change of rated power (kW/s)	w/o brake	162	228
	with brake	162	227
Rotor inertia (× 10^{-4}kg·m^2)	w/o brake	302.2	400
	with brake	303.1	400.9
Mechanical time constant (ms)	w/o brake	1.03	0.94
	with brake	1.04	0.94
Torque constant-KT (N·m/Arms)		3.30	3.27
Voltage constant-KE (mVrms/rpm)		118	118
Armature resistance (Ohm)		0.127	0.0862
Armature inductance (mH)		3.69	2.43
Electrical time constant (ms)		29.1	28.2
Weight (kg)	w/o brake	50.9	62.1
	with brake	58.2	69.4
Max. radial load (N)[*4]		3300	3300
Max. axial load (N)[*4]		1100	1100
Brake operating voltage		24 V_{DC} ± 10%	
Brake power consumption (W) (at 20˚C (68°F))		32	32
Brake holding torque [N·m (Min)][*2]		115	115
Brake release time [ms (Max)]		100	100
Brake pull-in time [ms (Max)]		300	300
Derating rate with oil seal (%)		0	0
Insulation class		Class F (UL), Class F (CE)	
Insulation resistance		100 MΩ min. (at 500 V_{DC})	
Insulation strength		2.3 kV_{AC}, 1 sec	
Vibration grade		V15	
Ambient temperature		-20˚C to +60˚C (-4°F to +140°F)[*3]	
Storage temperature		-20˚C to +80˚C (-4°F to +176°F)	
Ambient and storage humidity		20 - 90% RH (non-condensing)	
Vibration capacity		2.5 G	
IP rating		IP67 (for models using shaft seals or oil seals)	
Approvals		CE cULus	

Note:
1. The rated torque is the continuous permissible torque when the servo motor mounted with the heat sink of the following dimensions is operating in a temperature range of 0˚C and 40˚C (32˚F and 104˚F). F220: 650 mm x 650 mm x 35 mm; material: aluminum
2. The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3. If the ambient temperature is over 40˚C (104°F), refer to Section A.2.3 Power derating curves of the ECM-B3 motors.
4. Follow the load specification for the motor shaft during operation. The load for the motor shaft is defined as follows.



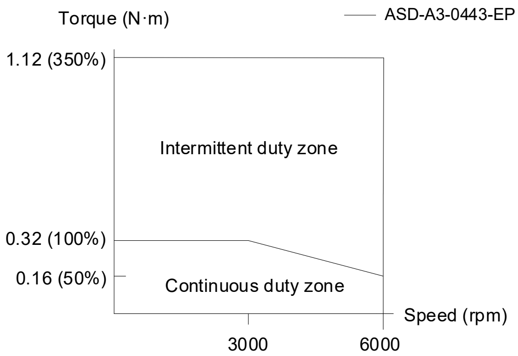
A.2.2 Torque features (T-N curves) of the ECM-B3 motors

A.2.2.1 220V models

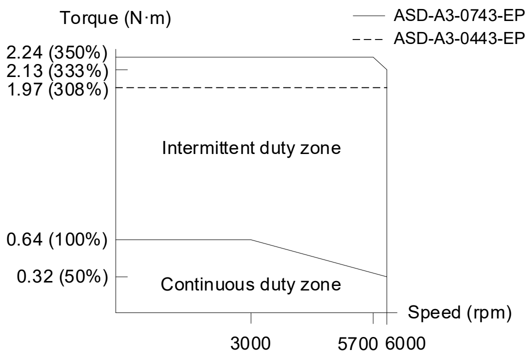
F80 and below motors

A

Only the servo drive models specified in the following diagrams are compatible with the 220V motors with standard or bulkhead receptacles.



ECM-B3L-C☐0401☐☐☐

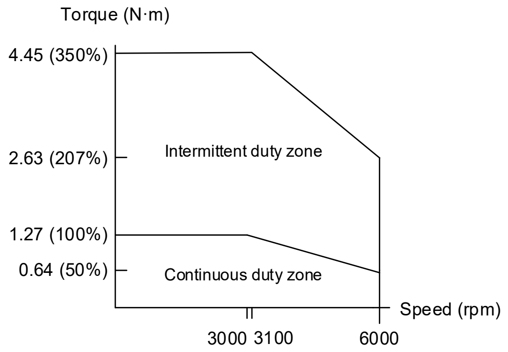


ECM-B3M-C☐0602☐☐☐

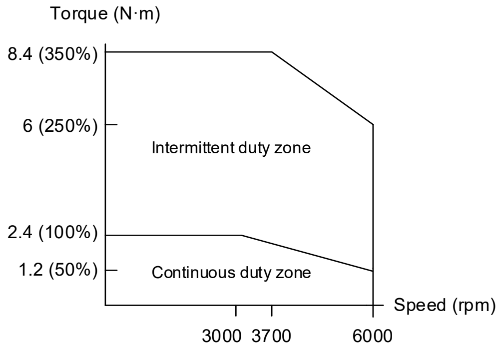
A

A.2.2.2 400V models

F80 and below motors

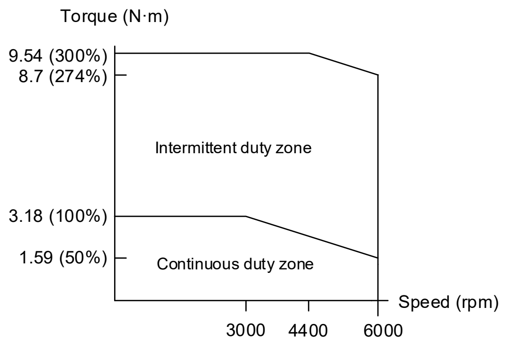


ECM-B3M-J□0604□□□

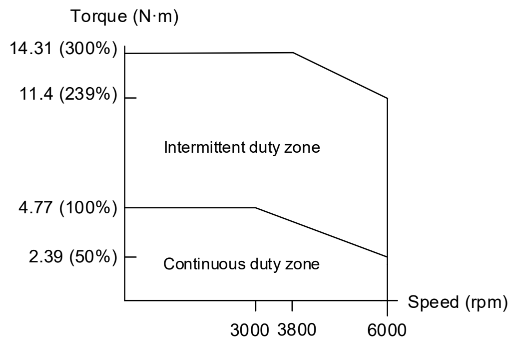


ECM-B3M-J□0807□□□

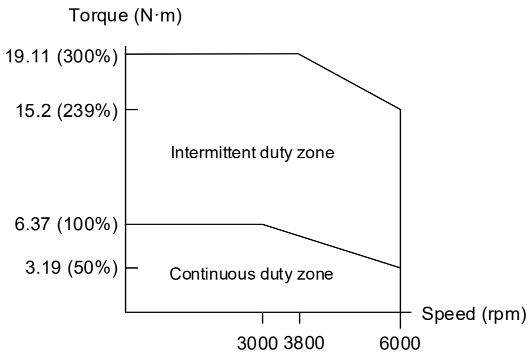
F100 motors



ECM-B3M-J□1010□□□

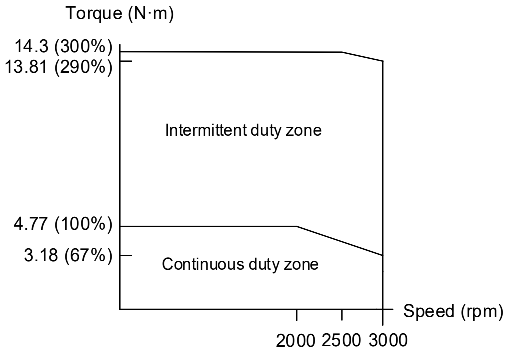


ECM-B3M-J□1015□□□

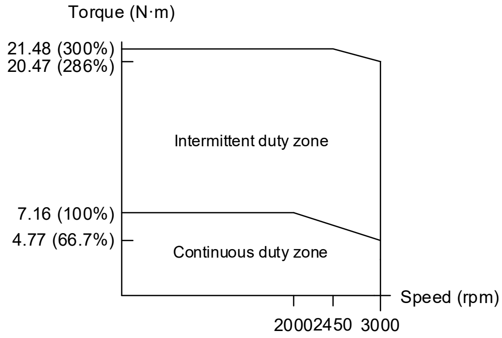


ECM-B3M-J□1020□□□

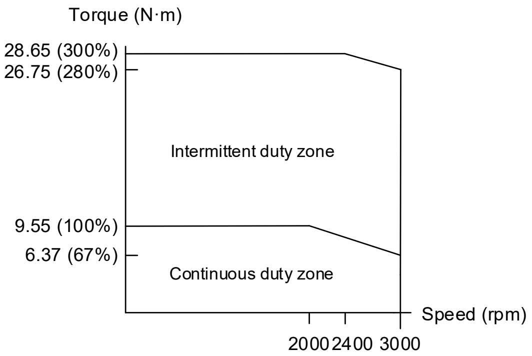
F130 motors



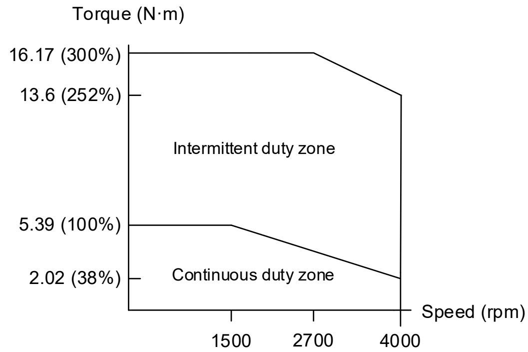
ECM-B3M-K□1310□□□



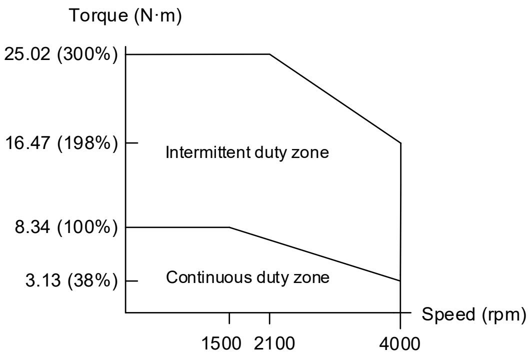
ECM-B3M-K□1315□□□



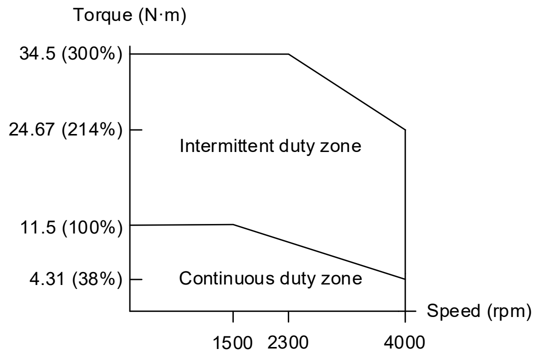
ECM-B3M-K□1320□□□



ECM-B3H-L□1308□□□

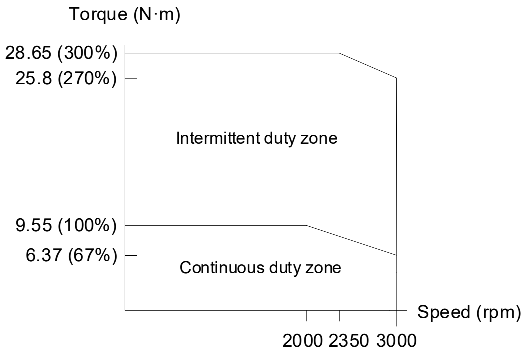


ECM-B3H-L□1313□□□

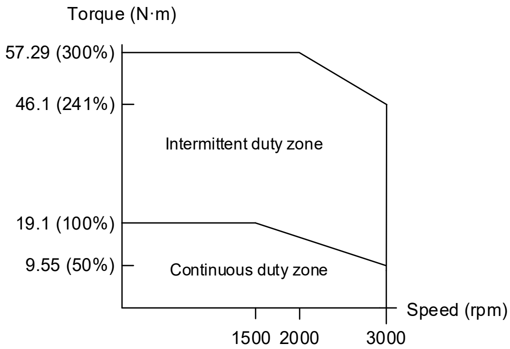


ECM-B3H-L□1318□□□

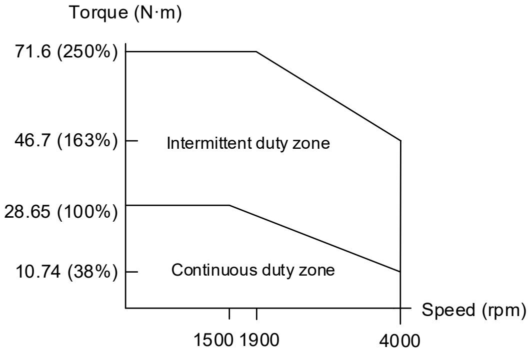
F180 motors



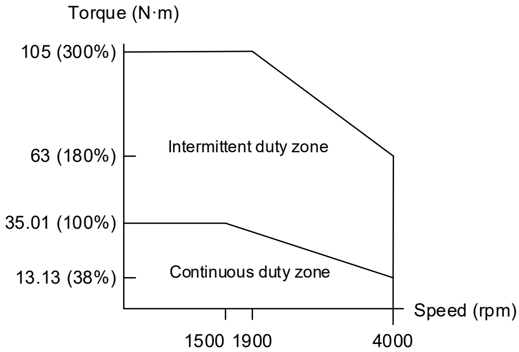
ECM-B3M-K□1820□□□



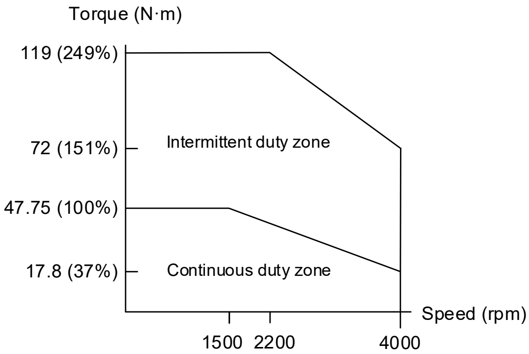
ECM-B3M-L□1830□□□



ECM-B3M-L□1845□□□

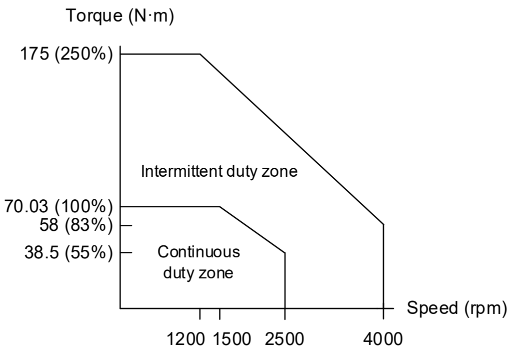


ECM-B3M-L□1855□□□

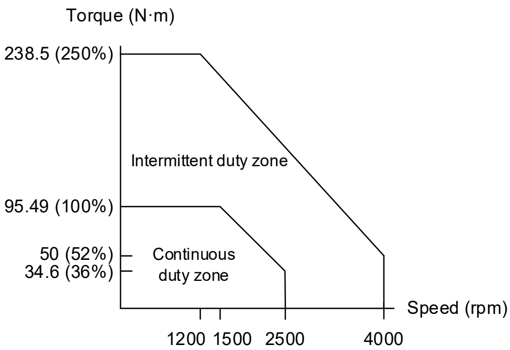


ECM-B3M-L□1875□□□

F220 motors

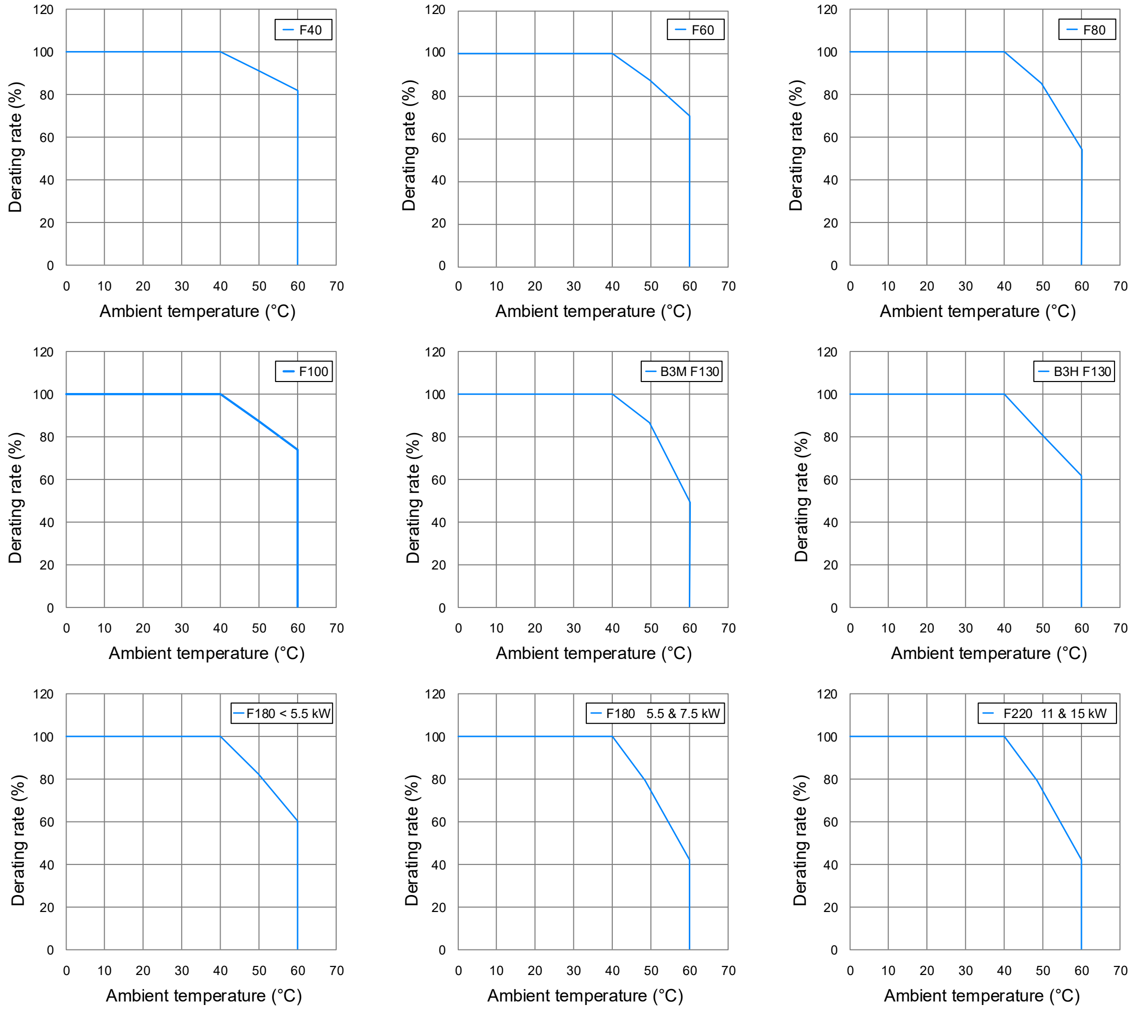


ECM-B3M-L□221B□□□



ECM-B3M-L□221F□□□

A.2.3 Power derating curves of the ECM-B3 motors



Note: the preceding specifications are applicable to 220V and 400V models.

A.2.4 Overload features

A

Definition of overload protection

The overload protection prevents the motor from overheating.

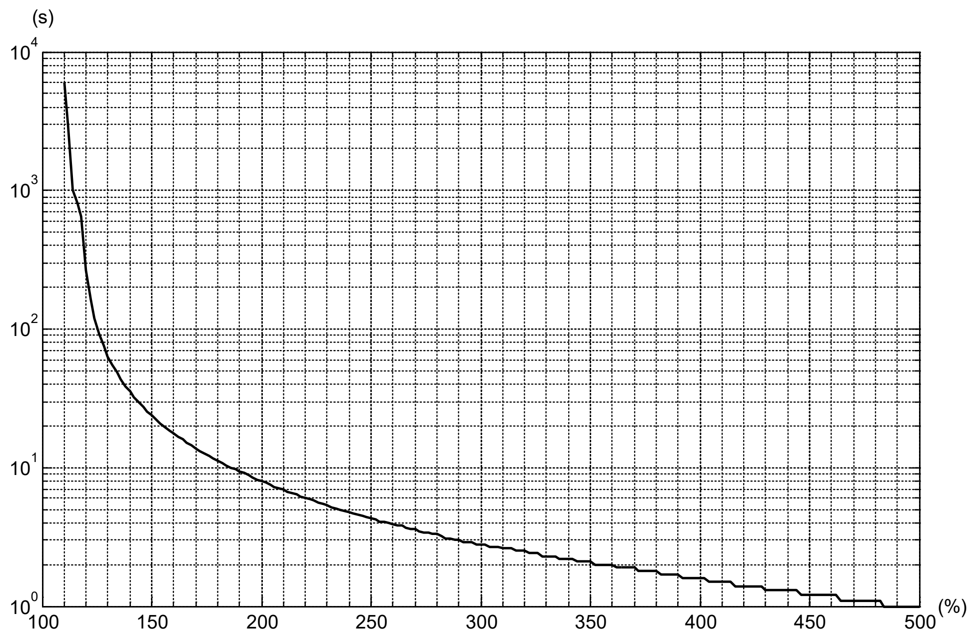
Causes of overload

1. The motor’s operating torque exceeds the rated range and the operating time is too long.
2. The inertia ratio is too high and the motor frequently accelerates and decelerates.
3. Incorrect wiring of the power and encoder cables.
4. Incorrect servo gain setting causes resonance in the motor.
5. A motor with a built-in brake operates without the brake released.

Graph of load and operating time

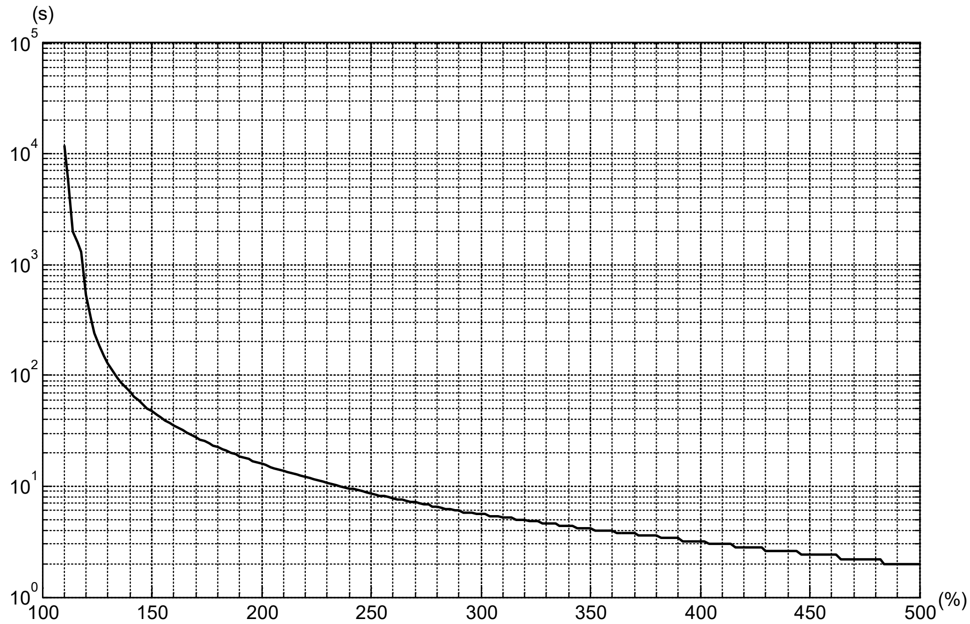
220V models: low inertia (ECM-B3L-C motors), medium inertia (ECM-B3M-C motors)

400V models: medium inertia (ECM-B3M-J motors)



Load ratio	120%	140%	160%	180%	200%	220%	240%
Operating time	263.8 s	35.2 s	17.6 s	11.2 s	8 s	6.1 s	4.8 s
Load ratio	260%	280%	300%	350%	400%	450%	500%
Operating time	3.9 s	3.3 s	2.8 s	2.1 s	1.6 s	1.2 s	1.0 s

400V models: medium inertia (ECM-B3M-K / -L motors), high inertia (ECM-B3H-L motors)

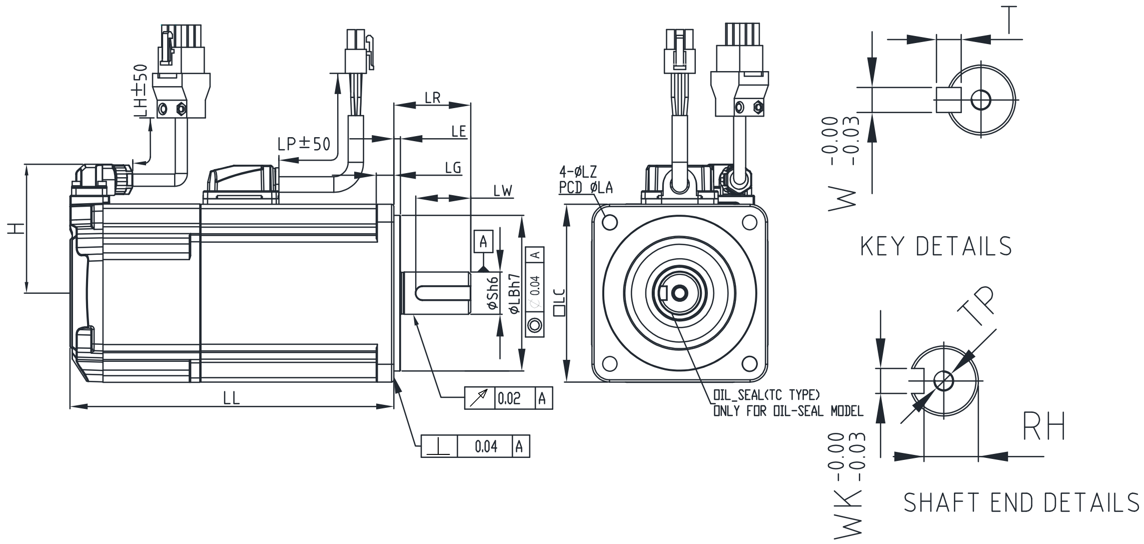


Load ratio	120%	140%	160%	180%	200%	220%	240%
Operating time	527.6 s	70.4 s	35.2 s	22.4 s	16 s	12.2 s	9.6 s
Load ratio	260%	280%	300%	350%	400%	450%	500%
Operating time	7.8 s	6.6 s	5.6 s	4.2 s	3.2 s	2.4 s	2.0 s

A.2.5 Dimensions of ECM-B3 series servo motor

A.2.5.1 220V models

F80 and below motors with cables (low & medium inertia)

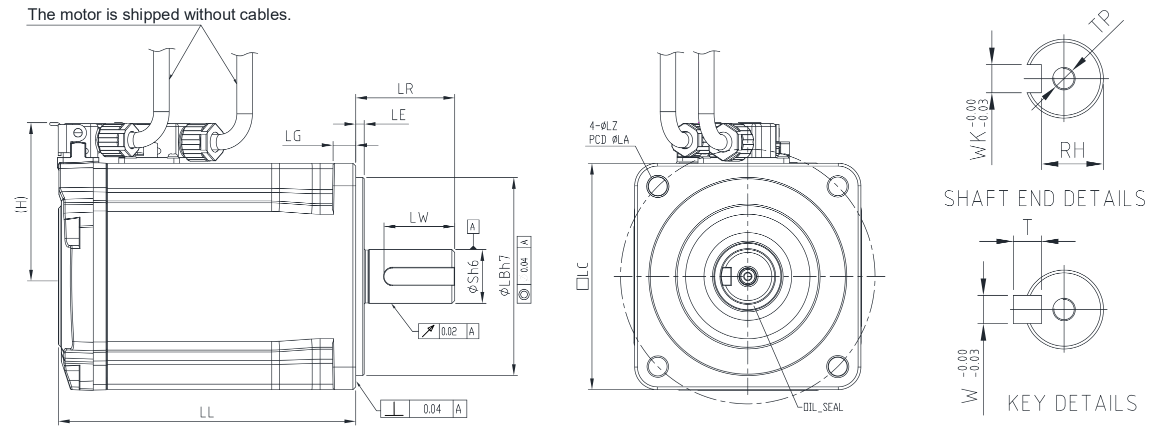


Unit: mm

ECM-	B3L-C□0401□S1	B3M-C□0602□S1
LC	40	60
LZ	4.5	5.5
LA	46	70
S	$8(^{+0}_{-0.009})$	$14(^{+0}_{-0.011})$
LB	$30(^{+0}_{-0.021})$	$50(^{+0}_{-0.025})$
LL (w/o brake)	77.6	72.5
LL (with brake)	111.7	109.4
LH	300	300
LP	300	300
H	40	48.5
LR	25	30
LE	2.5	3
LG	5	7.5
LW	16	20
RH	6.2	11
WK	3	5
W	3	5
T	3	5
TP	M3 Depth 8	M4 Depth 15

A

F80 and below motors with bulkhead receptacles (low & medium inertia)



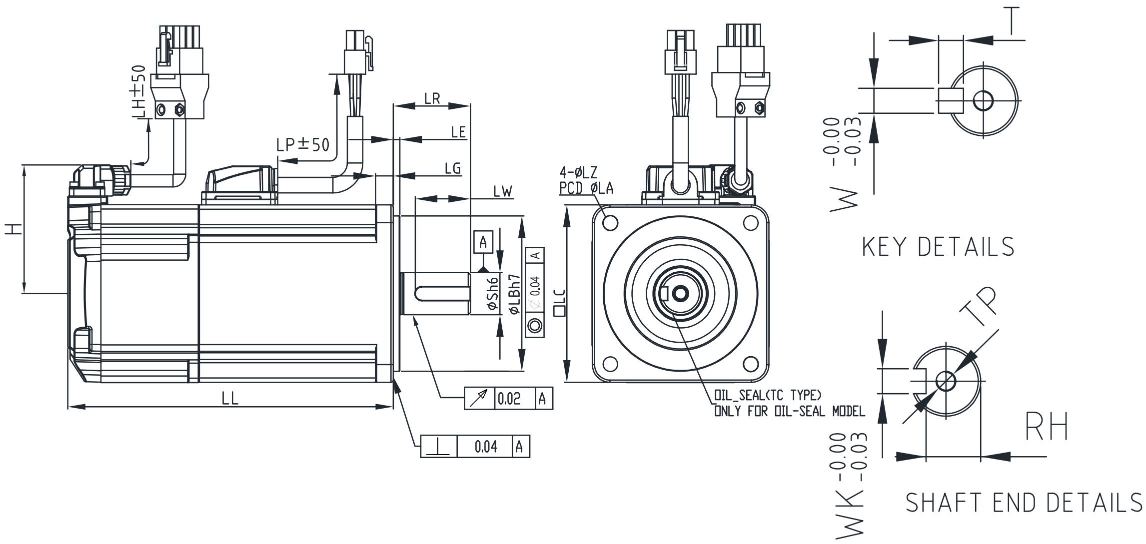
Unit: mm

ECM-	B3L-C□0401□B1	B3M-C□0602□B1
LC	40	60
LZ	4.5	5.5
LA	46	70
S	$8(^{+0}_{-0.009})$	$14(^{+0}_{-0.011})$
LB	$30(^{+0}_{-0.021})$	$50(^{+0}_{-0.025})$
LL (w/o brake)	76.2	72.5
LL (with brake)	107.7	104.4
LH	300	300
LP	300	300
H	34	44
LR	25	30
LE	2.5	3
LG	5	7.5
LW	16	20
RH	6.2	11
WK	3	5
W	3	5
T	3	5
TP	M3 Depth 8	M4 Depth 15

A

A.2.5.2 400V models

F80 and below motors with cables (medium inertia)

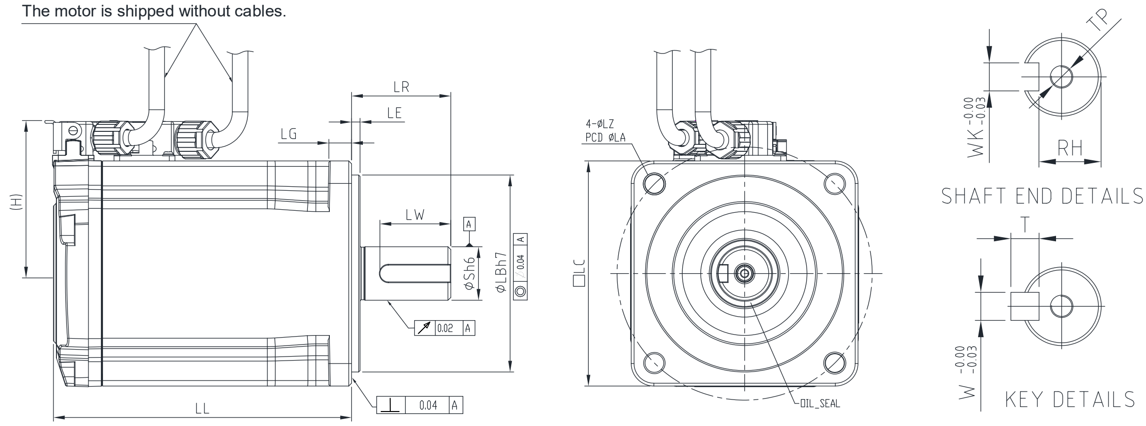


Unit: mm

ECM-	B3M-J□0604□S1	B3M-J□0807□S1
LC	60	80
LZ	5.5	6.6
LA	70	90
S	$14(^{+0}_{-0.011})$	$19(^{+0}_{-0.013})$
LB	$50(^{+0.000}_{-0.025})$	$70(^{+0.000}_{-0.030})$
LL (w/o brake)	91	105.2
LL (with brake)	127.9	144.8
LH	300	300
LP	300	300
H	48.5	58.5
LR	30	35
LE	3	3
LG	7.5	8
LW	20	25
RH	11	15.5
WK	5	6
W	5	6
T	5	6
TP	M4 Depth 15	M6 Depth 20

F80 and below motors with bulkhead receptacles (medium inertia)

The motor is shipped without cables.

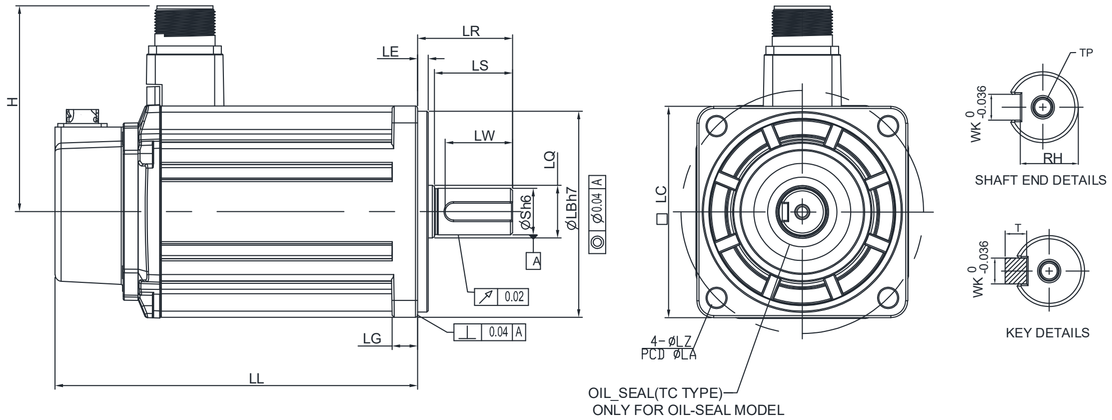


Unit: mm

ECM-	B3M-J□0604□B1	B3M-J□0807□B1
LC	60	80
LZ	5.5	6.6
LA	70	90
S	$14(^{+0}_{-0.011})$	$19(^{+0}_{-0.013})$
LB	$50(^{+0}_{-0.025})$	$70(^{+0}_{-0.030})$
LL (w/o brake)	91	105.2
LL (with brake)	122.9	140.8
LH	300	300
LP	300	300
H	44	54
LR	30	35
LE	3	3
LG	7.5	8
LW	20	25
RH	11	15.5
WK	5	6
W	5	6
T	5	6
TP	M4 Depth 15	M6 Depth 20

A

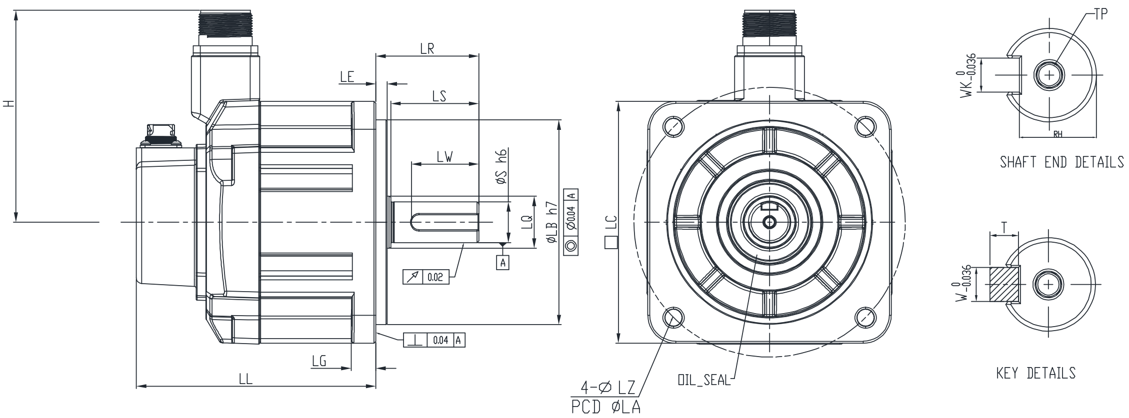
F100 motors (medium inertia)



Unit: mm

ECM-	B3M-J□1010□S1	B3M-J□1015□S1	B3M-J□1020□S1
LC	100	100	100
LZ	9	9	9
LA	115	115	115
S	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$
LB	$95(^{+0}_{-0.03})$	$95(^{+0}_{-0.03})$	$95(^{+0}_{-0.03})$
LL (w/o brake)	141.8	156.8	171.8
LL (with brake)	179.9	194.9	209.9
H	97.4	97.4	97.4
LS	37	37	37
LR	45	45	45
LQ	25	25	25
LE	5	5	5
LG	12	12	12
LW	32	32	32
RH	18	18	18
WK	8	8	8
W	8	8	8
T	7	7	7
TP	M6 Depth 12	M6 Depth 12	M6 Depth 12

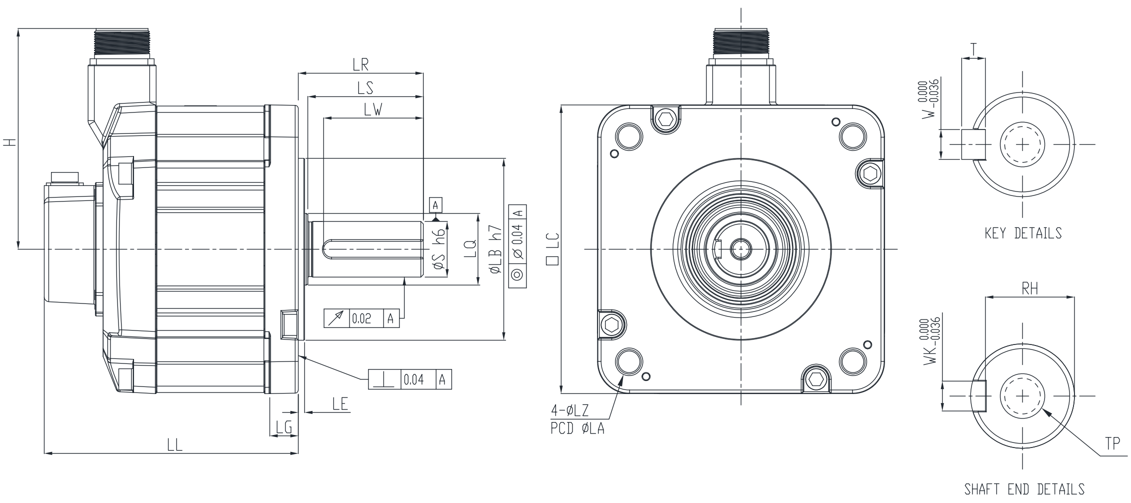
F130 motors (medium & high inertia)



Unit: mm

ECM-	B3M-K□1310□S1	B3M-K□1315□S1	B3M-K□1320□S1	B3H-L□1308□S1	B3H-L□1313□S1	B3H-L□1318□S1
LC	130	130	130	130	130	130
LZ	9	9	9	9	9	9
LA	145	145	145	145	145	145
S	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$
LB	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$
LL (w/o brake)	127.9	139.9	151.9	127.9	139.9	151.9
LL (with brake)	168.5	180.5	192.5	168.5	180.5	192.5
H	115	115	115	115	115	115
LS	47	47	47	47	47	47
LR	55	55	55	55	55	55
LQ	28	28	28	28	28	28
LE	6	6	6	6	6	6
LG	12.5	12.5	12.5	12.5	12.5	12.5
LW	36	36	36	36	36	36
RH	18	18	18	18	18	18
WK	8	8	8	8	8	8
W	8	8	8	8	8	8
T	7	7	7	7	7	7
TP	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12	M6 Depth 12

F180 motors (medium inertia)

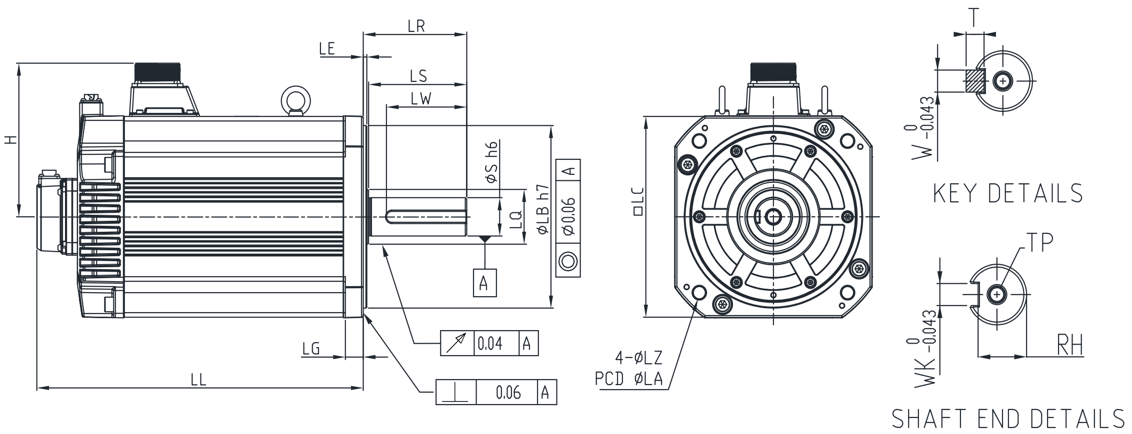


Unit: mm

ECM-	B3M-K□1820□S1	B3M-L□1830□S1	B3M-L□1845□S1	B3M-L□1855□31	B3M-L□1875□31
LC	180	180	180	180	180
LZ	13.5	13.5	13.5	13.5	13.5
LA	200	200	200	200	200
S	35($^{+0}_{-0.016}$)	35($^{+0}_{-0.016}$)	35($^{+0}_{-0.016}$)	42($^{+0}_{-0.016}$)	42($^{+0}_{-0.016}$)
LB	114.3($^{+0}_{-0.035}$)	114.3($^{+0}_{-0.035}$)	114.3($^{+0}_{-0.035}$)	114.3($^{+0}_{-0.035}$)	114.3($^{+0}_{-0.035}$)
LL (w/o brake)	137.5	160.5	174	218	260.1
LL (with brake)	189.5	212.5	226	265	307.1
H	139	139	139	144.5	144.5
LS	73	73	73	108.5	108.5
LR	79	79	79	113	113
LQ	45	45	45	45	45
LE	4	4	4	4	4
LG	18	18	18	18	18
LW	63	63	63	90	90
RH	30	30	30	37	37
WK	10	10	10	12	12
W	10	10	10	12	12
T	8	8	8	8	8
TP	M12 Depth 25	M12 Depth 25	M12 Depth 25	M16 Depth 32	M16 Depth 32

A

F220 motors (medium inertia)



Unit: mm

ECM-	B3M-L□221B□31	B3M-L□221F□S1
LC	220	220
LZ	13.5	13.5
LA	235	235
S	$42(^{+0}_{-0.016})$	$55(^{+0.03}_{-0.011})$
LB	$200(^{+0}_{-0.046})$	$200(^{+0}_{-0.046})$
LL (w/o brake)	331.7	378.7
LL (with brake)	365.6	412.6
H	168.3	168.3
LS	110	110
LR	116	116
LQ	60	60
LE	4	4
LG	20	20
LW	90	90
RH	37	49
WK	12	16
W	12	16
T	8	10
TP	M16 Depth 32	M20 Depth 40

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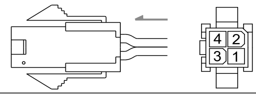
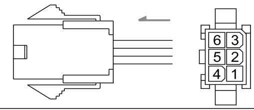
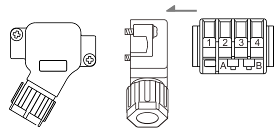
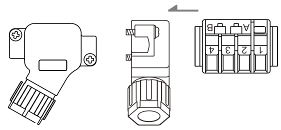
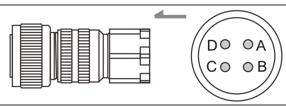
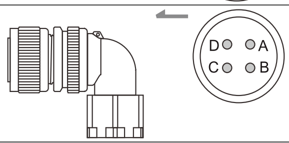
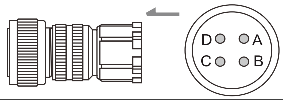
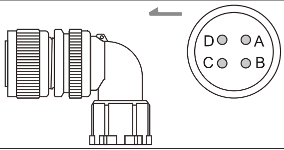
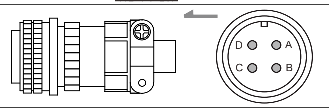
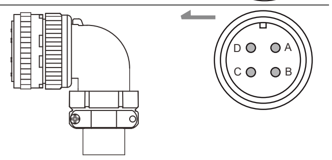
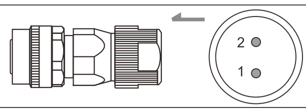
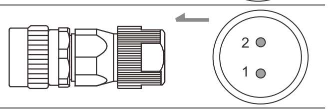
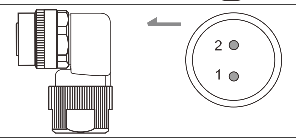
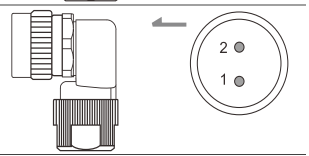
Accessories Appendix B

This chapter is a guide to select the accessories. See the cable and connector selection tables in the catalog for details.

B

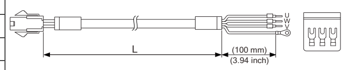
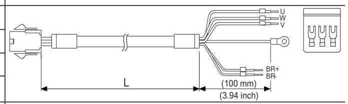
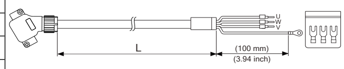
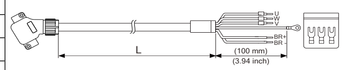
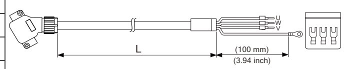
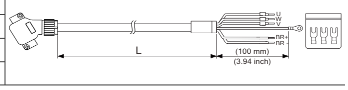
B.1 Power connector

Motor series	Frame size & power	Applicable model	Connector: Type	Connector: UVW	Connector: Brake	Connector: IP rating	Model number	Illustration
ECM-B3	F40 - F80	220V 400V	Standard	●	-	IP20	ACS3-CAPW1000	
		220V 400V	Standard	●	●	IP20	ACS3-CAPW2000	
ECM-B3	F40 - F80	220V 400V	Bulkhead - cable exit direction towards motor shaft	●	●	IP67	ACS3-AFPWSS00	
		220V 400V	Bulkhead - cable exit direction towards encoder	●	●	IP67	ACS3-ABPWSS00	
	F100 - F130	400V	Military - straight 3106A-18-10S	●	-	IP67	ACS3-CAPWA000	
		400V	Military - right angle 3108A-18-10S	●	-	IP67	ACS3-CRPWA000	
	F180 4.5 kW or below	400V	Military - straight 3106A-22-22S	●	-	IP67	ACS3-CAPWC000	
		400V	Military - right angle 3108A-22-22S	●	-	IP67	ACS3-CRPWC000	
	F180 5.5 kW or above & F220	400V	Military - straight 3106A-32-17S	●	-	IP42	ACS3-CAPWE000	
		400V	Military - right angle 3108A-32-17S	●	-	IP42	ACS3-CRPWE000	
	F100 - F220	400V	Military - straight CMV1-SP2S [bayonet]	-	●	IP67	ACS3-CABRA000	
		400V	Military - straight [threaded, M17.5]	-	●	IP67	ACS3-CABRM000	
		400V	Military - right angle CMV1-AP2S [bayonet]	-	●	IP67	ACS3-CRBRA000	
		400V	Military - right angle [threaded, M17.5]	-	●	IP67	ACS3-CRBRM000	

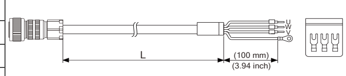
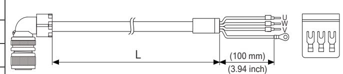
Note: motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.9 for details.

B.2 Power cable

B.2.1 F40 - F80 motors

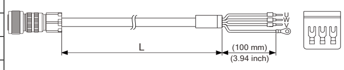
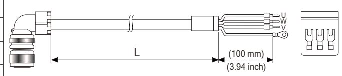
Motor series	Applicable model	Connector type	Wire spec. AWG (mm²) UVW	Wire spec. AWG (mm²) Brake	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	220V 400V w/o brake	Standard	18 (0.82)	-	3000 ± 50 (118 ± 2)	ACS3-CAPW3103	ACS3-CAPF3103	
					5000 ± 50 (197 ± 2)	ACS3-CAPW3105	ACS3-CAPF3105	
					10000 ± 100 (394 ± 4)	ACS3-CAPW3110	ACS3-CAPF3110	
					20000 ± 100 (787 ± 4)	ACS3-CAPW3120	ACS3-CAPF3120	
	220V 400V with brake	Standard	18 (0.82)	22 (0.32)	3000 ± 50 (118 ± 2)	ACS3-CAPW2103	ACS3-CAPF2103	
					5000 ± 50 (197 ± 2)	ACS3-CAPW2105	ACS3-CAPF2105	
					10000 ± 100 (394 ± 4)	ACS3-CAPW2110	ACS3-CAPF2110	
					20000 ± 100 (787 ± 4)	ACS3-CAPW2120	ACS3-CAPF2120	
	220V 400V w/o brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	-	3000 ± 50 (118 ± 2)	ACS3-AFPWSA03	ACS3-AFPRSA03	
					5000 ± 50 (197 ± 2)	ACS3-AFPWSA05	ACS3-AFPRSA05	
					10000 ± 100 (394 ± 4)	ACS3-AFPWSA10	ACS3-AFPRSA10	
					20000 ± 100 (787 ± 4)	ACS3-AFPWSA20	ACS3-AFPRSA20	
	220V 400V with brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	24 (0.21)	3000 ± 50 (118 ± 2)	ACS3-AFPWSB03	ACS3-AFPRSB03	
					5000 ± 50 (197 ± 2)	ACS3-AFPWSB05	ACS3-AFPRSB05	
					10000 ± 100 (394 ± 4)	ACS3-AFPWSB10	ACS3-AFPRSB10	
					20000 ± 100 (787 ± 4)	ACS3-AFPWSB20	ACS3-AFPRSB20	
	220V 400V w/o brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	-	3000 ± 50 (118 ± 2)	ACS3-ABPWSA03	ACS3-ABPRSA03	
					5000 ± 50 (197 ± 2)	ACS3-ABPWSA05	ACS3-ABPRSA05	
					10000 ± 100 (394 ± 4)	ACS3-ABPWSA10	ACS3-ABPRSA10	
					20000 ± 100 (787 ± 4)	ACS3-ABPWSA20	ACS3-ABPRSA20	
	220V 400V with brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	24 (0.21)	3000 ± 50 (118 ± 2)	ACS3-ABPWSB03	ACS3-ABPRSB03	
					5000 ± 50 (197 ± 2)	ACS3-ABPWSB05	ACS3-ABPRSB05	
					10000 ± 100 (394 ± 4)	ACS3-ABPWSB10	ACS3-ABPRSB10	
					20000 ± 100 (787 ± 4)	ACS3-ABPWSB20	ACS3-ABPRSB20	

B.2.2 F100 - F130 motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²) UVW	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	400V w/o brake with brake Note	Military - straight 3106A-18-10S	16 (1.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWA203	ACS3-CAPFA203	
				5000 ± 50 (197 ± 2)	ACS3-CAPWA205	ACS3-CAPFA205	
				10000 ± 100 (394 ± 4)	ACS3-CAPWA210	ACS3-CAPFA210	
				20000 ± 100 (787 ± 4)	ACS3-CAPWA220	ACS3-CAPFA220	
			14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CAPWA303	ACS3-CAPFA303	
				5000 ± 50 (197 ± 2)	ACS3-CAPWA305	ACS3-CAPFA305	
				10000 ± 100 (394 ± 4)	ACS3-CAPWA310	ACS3-CAPFA310	
				20000 ± 100 (787 ± 4)	ACS3-CAPWA320	ACS3-CAPFA320	
	400V w/o brake with brake Note	Military - right angle 3108A-18-10S	16 (1.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWA203	ACS3-CRPFA203	
				5000 ± 50 (197 ± 2)	ACS3-CRPWA205	ACS3-CRPFA205	
				10000 ± 100 (394 ± 4)	ACS3-CRPWA210	ACS3-CRPFA210	
				20000 ± 100 (787 ± 4)	ACS3-CRPWA220	ACS3-CRPFA220	
			14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CRPWA303	ACS3-CRPFA303	
				5000 ± 50 (197 ± 2)	ACS3-CRPWA305	ACS3-CRPFA305	
				10000 ± 100 (394 ± 4)	ACS3-CRPWA310	ACS3-CRPFA310	
				20000 ± 100 (787 ± 4)	ACS3-CRPWA320	ACS3-CRPFA320	

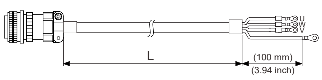
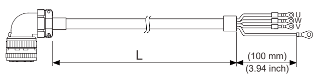
Note: for models with brake, you need to purchase the brake cable listed in Section B.2.5.

B.2.3 F180 4.5 kW or below motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²) UVW	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	400V w/o brake with brake Note	Military - straight 3106A-22-22S	14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CAPWC303	ACS3-CAPFC303	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC305	ACS3-CAPFC305	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC310	ACS3-CAPFC310	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC320	ACS3-CAPFC320	
			12 (3.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWC403	ACS3-CAPFC403	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC405	ACS3-CAPFC405	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC410	ACS3-CAPFC410	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC420	ACS3-CAPFC420	
			10 (5.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWC503	ACS3-CAPFC503	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC505	ACS3-CAPFC505	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC510	ACS3-CAPFC510	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC520	ACS3-CAPFC520	
			8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CAPWC603	ACS3-CAPFC603	
				5000 ± 50 (197 ± 2)	ACS3-CAPWC605	ACS3-CAPFC605	
				10000 ± 100 (394 ± 4)	ACS3-CAPWC610	ACS3-CAPFC610	
				20000 ± 100 (787 ± 4)	ACS3-CAPWC620	ACS3-CAPFC620	
	400V w/o brake with brake Note	Military - right angle 3108A-22-22S	14 (2.1)	3000 ± 50 (118 ± 2)	ACS3-CRPWC303	ACS3-CRPFC303	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC305	ACS3-CRPFC305	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC310	ACS3-CRPFC310	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC320	ACS3-CRPFC320	
			12 (3.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWC403	ACS3-CRPFC403	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC405	ACS3-CRPFC405	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC410	ACS3-CRPFC410	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC420	ACS3-CRPFC420	
			10 (5.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWC503	ACS3-CRPFC503	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC505	ACS3-CRPFC505	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC510	ACS3-CRPFC510	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC520	ACS3-CRPFC520	
			8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CRPWC603	ACS3-CRPFC603	
				5000 ± 50 (197 ± 2)	ACS3-CRPWC605	ACS3-CRPFC605	
				10000 ± 100 (394 ± 4)	ACS3-CRPWC610	ACS3-CRPFC610	
				20000 ± 100 (787 ± 4)	ACS3-CRPWC620	ACS3-CRPFC620	

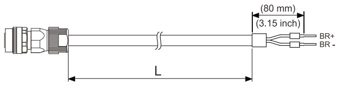
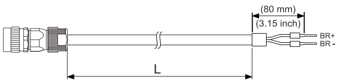
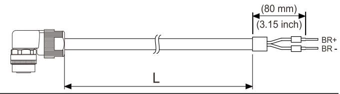
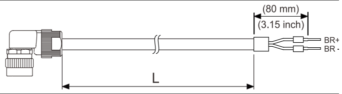
Note: for models with brake, you need to purchase the brake cable listed in Section B.2.5.

B.2.4 F180 5.5 kW or above & F220 motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²) UVW	Length (L) mm (inch)	Model number Standard	Model number Flexible	Illustration
ECM-B3	400V w/o brake with brake Note	Military - straight 3106A-32-17S	8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CAPWE603	ACS3-CAPFE603	
				5000 ± 50 (197 ± 2)	ACS3-CAPWE605	ACS3-CAPFE605	
				10000 ± 100 (394 ± 4)	ACS3-CAPWE610	ACS3-CAPFE610	
				20000 ± 100 (787 ± 4)	ACS3-CAPWE620	ACS3-CAPFE620	
			6 (13.3)	3000 ± 50 (118 ± 2)	ACS3-CAPWE703	ACS3-CAPFE703	
				5000 ± 50 (197 ± 2)	ACS3-CAPWE705	ACS3-CAPFE705	
				10000 ± 100 (394 ± 4)	ACS3-CAPWE710	ACS3-CAPFE710	
				20000 ± 100 (787 ± 4)	ACS3-CAPWE720	ACS3-CAPFE720	
			4 (21.2)	3000 ± 50 (118 ± 2)	ACS3-CAPWE803	ACS3-CAPFE803	
				5000 ± 50 (197 ± 2)	ACS3-CAPWE805	ACS3-CAPFE805	
				10000 ± 100 (394 ± 4)	ACS3-CAPWE810	ACS3-CAPFE810	
				20000 ± 100 (787 ± 4)	ACS3-CAPWE820	ACS3-CAPFE820	
	400V w/o brake with brake Note	Military - right angle 3108A-32-17S	8 (8.4)	3000 ± 50 (118 ± 2)	ACS3-CRPWE603	ACS3-CRPFE603	
				5000 ± 50 (197 ± 2)	ACS3-CRPWE605	ACS3-CRPFE605	
				10000 ± 100 (394 ± 4)	ACS3-CRPWE610	ACS3-CRPFE610	
				20000 ± 100 (787 ± 4)	ACS3-CRPWE620	ACS3-CRPFE620	
			6 (13.3)	3000 ± 50 (118 ± 2)	ACS3-CRPWE703	ACS3-CRPFE703	
				5000 ± 50 (197 ± 2)	ACS3-CRPWE705	ACS3-CRPFE705	
				10000 ± 100 (394 ± 4)	ACS3-CRPWE710	ACS3-CRPFE710	
				20000 ± 100 (787 ± 4)	ACS3-CRPWE720	ACS3-CRPFE720	
			4 (21.2)	3000 ± 50 (118 ± 2)	ACS3-CRPWE803	ACS3-CRPFE803	
				5000 ± 50 (197 ± 2)	ACS3-CRPWE805	ACS3-CRPFE805	
				10000 ± 100 (394 ± 4)	ACS3-CRPWE810	ACS3-CRPFE810	
				20000 ± 100 (787 ± 4)	ACS3-CRPWE820	ACS3-CRPFE820	

Note: for models with brake, you need to purchase the brake cable listed in Section B.2.5.

B.2.5 Brake cables for F100 - F220 motors

Motor series	Applicable model	Connector type	Wire spec. AWG (mm^2)	Length (L) mm (inch)	Model number		Illustration
			Brake		Standard	Flexible	
ECM-B3	400V with brake	Military - straight CMV1-SP2S [bayonet]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CABRA103	ACS3-CABFA103	
				5000 ± 50 (197 ± 2)	ACS3-CABRA105	ACS3-CABFA105	
				10000 ± 100 (394 ± 4)	ACS3-CABRA110	ACS3-CABFA110	
				20000 ± 100 (787 ± 4)	ACS3-CABRA120	ACS3-CABFA120	
		Military - straight [threaded, M17.5]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CABRM103	ACS3-CABFM103	
				5000 ± 50 (197 ± 2)	ACS3-CABRM105	ACS3-CABFM105	
				10000 ± 100 (394 ± 4)	ACS3-CABRM110	ACS3-CABFM110	
				20000 ± 100 (787 ± 4)	ACS3-CABRM120	ACS3-CABFM120	
		Military - right angle CMV1-AP2S [bayonet]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CRBRA103	ACS3-CRBFA103	
				5000 ± 50 (197 ± 2)	ACS3-CRBRA105	ACS3-CRBFA105	
				10000 ± 100 (394 ± 4)	ACS3-CRBRA110	ACS3-CRBFA110	
				20000 ± 100 (787 ± 4)	ACS3-CRBRA120	ACS3-CRBFA120	
		Military - right angle [threaded, M17.5]	20 (0.52)	3000 ± 50 (118 ± 2)	ACS3-CRBRM103	ACS3-CRBFM103	
				5000 ± 50 (197 ± 2)	ACS3-CRBRM105	ACS3-CRBFM105	
				10000 ± 100 (394 ± 4)	ACS3-CRBRM110	ACS3-CRBFM110	
				20000 ± 100 (787 ± 4)	ACS3-CRBRM120	ACS3-CRBFM120	

Note: motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.9 for details.

B.3 Power conversion cable / counterpart connector (for motors with bulkhead receptacles)

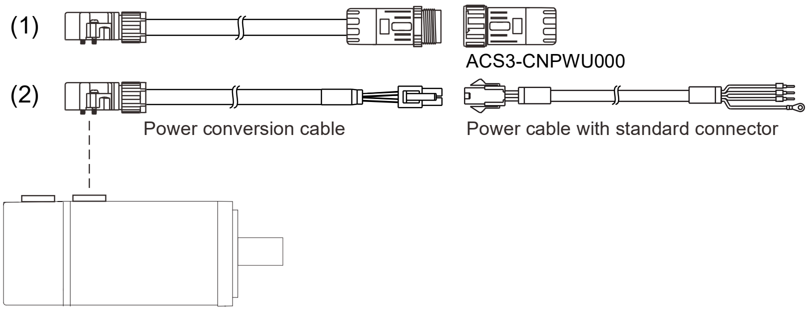
B

The power conversion cable is for connecting the motor with bulkhead receptacles to a non-bulkhead power connector. The following illustrates where it is installed.

Connection methods:

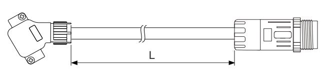
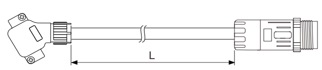
(1) Power conversion cable with waterproof connector + counterpart to waterproof connector; you need to make a cable by yourself.

(2) Power conversion cable with standard connector + power cable with standard connector

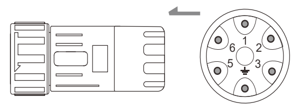


B.3.1 F40 - F80 motors

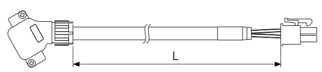
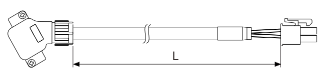
■ Power conversion cable with waterproof connector (IP67 rated): when mating the connector to the counterpart, ensure they are fully locked and meet the IP67 standard.

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²)		Length (L) mm (inch)	Model number		Illustration
			UVW	Brake		Standard	Flexible	
ECM-B3	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-AFESSW0C	ACS3-AFEFSW0C	
	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-ABESSW0C	ACS3-ABEFSW0C	

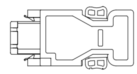
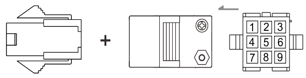
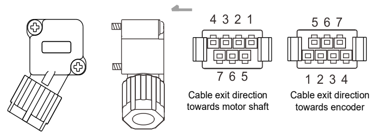
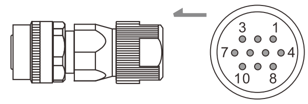
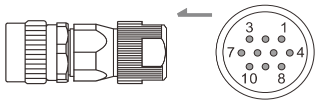
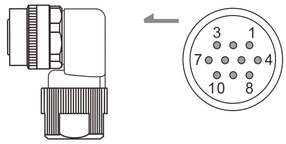
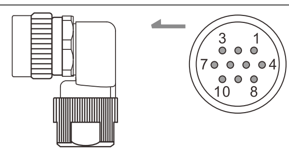
■ Counterpart to the preceding waterproof connector

Motor series	Frame size	Applicable model	Connector				Model number	Illustration
			Type	UVW	Brake	IP rating		
-	F40 - F80	220V 400V w/o brake with brake	Dedicated conversion connector	●	●	IP67	ACS3-CNPWU000	

■ Power conversion cable with standard connector (not IP67 rated): do not use the cable in an environment which is exposed to oil or water.

Motor series	Applicable model	Connector type	Wire spec. AWG (mm²)		Length (L) mm (inch)	Model number		Illustration
			UVW	Brake		Standard	Flexible	
ECM-B3	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards motor shaft	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-AFPWSB0C	ACS3-AFPRSB0C	
	220V 400V w/o brake with brake	Bulkhead - cable exit direction towards encoder	20 (0.52)	24 (0.21)	300 ± 20 (11.8 ± 0.8)	ACS3-ABPWSB0C	ACS3-ABPRSB0C	

B.4 Encoder connector

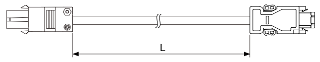
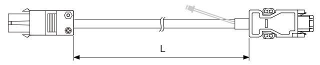
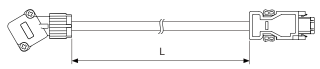
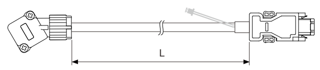
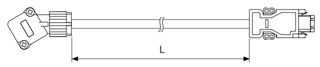
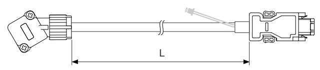
Motor series	Frame size	Connector type	IP rating	Model number	Illustration
ECM-B3	-	For connecting to the servo drive end	-	ACS3-CNENC200	
	F40 - F80	Standard	IP20	ACS3-CAEN0000	
ECM-B3	F40 - F80	Bulkhead - cable exit direction towards motor shaft	IP67	ACS3-AFEASA00	 The preceding figure illustrates the difference between the two cable exit directions; only one wiring terminal is attached.
		Bulkhead - cable exit direction towards encoder			
	F100 - F220	Military - straight CMV1-SP10S [bayonet]	IP67	ACS3-CAENA000	
		Military - straight [threaded, M17.5]	IP67	ACS3-CAENM000	
		Military - right angle CMV1-AP10S [bayonet]	IP67	ACS3-CRENA000	
		Military - right angle [threaded, M17.5]	IP67	ACS3-CRENM000	

Note: motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.9 for details.

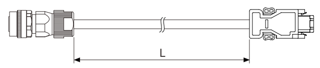
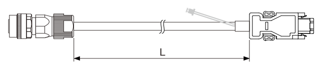
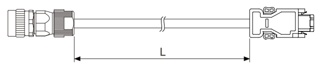
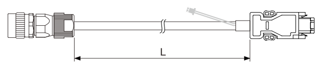
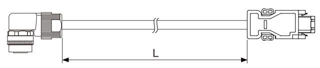
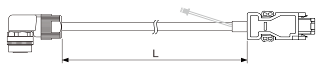
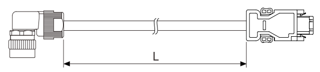
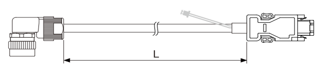
B

B.5 Encoder cable

B.5.1 F40 - F80 motors

Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number		Illustration
				Standard	Flexible	
ECM-B3	Standard	Incremental	3000 ± 50 (118 ± 2)	ACS3-CAEN0103	ACS3-CAEF0103	
			5000 ± 50 (197 ± 2)	ACS3-CAEN0105	ACS3-CAEF0105	
			10000 ± 100 (394 ± 4)	ACS3-CAEN0110	ACS3-CAEF0110	
			20000 ± 100 (787 ± 4)	ACS3-CAEN0120	ACS3-CAEF0120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CAEA0103	ACS3-CAEB0103	
			5000 ± 50 (197 ± 2)	ACS3-CAEA0105	ACS3-CAEB0105	
			10000 ± 100 (394 ± 4)	ACS3-CAEA0110	ACS3-CAEB0110	
			20000 ± 100 (787 ± 4)	ACS3-CAEA0120	ACS3-CAEB0120	
ECM-B3	Bulkhead - cable exit direction towards motor shaft	Incremental	3000 ± 50 (118 ± 2)	ACS3-AFEASI03	ACS3-AFERSI03	
			5000 ± 50 (197 ± 2)	ACS3-AFEASI05	ACS3-AFERSI05	
			10000 ± 100 (394 ± 4)	ACS3-AFEASI10	ACS3-AFERSI10	
			20000 ± 100 (787 ± 4)	ACS3-AFEASI20	ACS3-AFERSI20	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-AFEASA03	ACS3-AFERSA03	
			5000 ± 50 (197 ± 2)	ACS3-AFEASA05	ACS3-AFERSA05	
			10000 ± 100 (394 ± 4)	ACS3-AFEASA10	ACS3-AFERSA10	
			20000 ± 100 (787 ± 4)	ACS3-AFEASA20	ACS3-AFERSA20	
	Bulkhead - cable exit direction towards encoder	Incremental	3000 ± 50 (118 ± 2)	ACS3-ABEASI03	ACS3-ABERSI03	
			5000 ± 50 (197 ± 2)	ACS3-ABEASI05	ACS3-ABERSI05	
			10000 ± 100 (394 ± 4)	ACS3-ABEASI10	ACS3-ABERSI10	
			20000 ± 100 (787 ± 4)	ACS3-ABEASI20	ACS3-ABERSI20	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-ABEASA03	ACS3-ABERSA03	
			5000 ± 50 (197 ± 2)	ACS3-ABEASA05	ACS3-ABERSA05	
			10000 ± 100 (394 ± 4)	ACS3-ABEASA10	ACS3-ABERSA10	
			20000 ± 100 (787 ± 4)	ACS3-ABEASA20	ACS3-ABERSA20	

B.5.2 F100 - F220 motors

Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number		Illustration
				Standard	Flexible	
ECM-B3	Military - straight CMV1-SP10S [bayonet]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CAENA103	ACS3-CAEFA103	
			5000 ± 50 (197 ± 2)	ACS3-CAENA105	ACS3-CAEFA105	
			10000 ± 100 (394 ± 4)	ACS3-CAENA110	ACS3-CAEFA110	
			20000 ± 100 (787 ± 4)	ACS3-CAENA120	ACS3-CAEFA120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CAEAA103	ACS3-CAEBA103	
			5000 ± 50 (197 ± 2)	ACS3-CAEAA105	ACS3-CAEBA105	
			10000 ± 100 (394 ± 4)	ACS3-CAEAA110	ACS3-CAEBA110	
			20000 ± 100 (787 ± 4)	ACS3-CAEAA120	ACS3-CAEBA120	
	Military - right angle [threaded, M17.5]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CAENM103	ACS3-CAEFM103	
			5000 ± 50 (197 ± 2)	ACS3-CAENM105	ACS3-CAEFM105	
			10000 ± 100 (394 ± 4)	ACS3-CAENM110	ACS3-CAEFM110	
			20000 ± 100 (787 ± 4)	ACS3-CAENM120	ACS3-CAEFM120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CAEAM103	ACS3-CAEBM103	
			5000 ± 50 (197 ± 2)	ACS3-CAEAM105	ACS3-CAEBM105	
			10000 ± 100 (394 ± 4)	ACS3-CAEAM110	ACS3-CAEBM110	
			20000 ± 100 (787 ± 4)	ACS3-CAEAM120	ACS3-CAEBM120	
	Military - straight CMV1-AP10S [bayonet]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CRENA103	ACS3-CREFA103	
			5000 ± 50 (197 ± 2)	ACS3-CRENA105	ACS3-CREFA105	
			10000 ± 100 (394 ± 4)	ACS3-CRENA110	ACS3-CREFA110	
			20000 ± 100 (787 ± 4)	ACS3-CRENA120	ACS3-CREFA120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CREAA103	ACS3-CREBA103	
			5000 ± 50 (197 ± 2)	ACS3-CREAA105	ACS3-CREBA105	
			10000 ± 100 (394 ± 4)	ACS3-CREAA110	ACS3-CREBA110	
			20000 ± 100 (787 ± 4)	ACS3-CREAA120	ACS3-CREBA120	
	Military - right angle [threaded, M17.5]	Incremental	3000 ± 50 (118 ± 2)	ACS3-CRENM103	ACS3-CREFM103	
			5000 ± 50 (197 ± 2)	ACS3-CRENM105	ACS3-CREFM105	
			10000 ± 100 (394 ± 4)	ACS3-CRENM110	ACS3-CREFM110	
			20000 ± 100 (787 ± 4)	ACS3-CRENM120	ACS3-CREFM120	
		Absolute	3000 ± 50 (118 ± 2)	ACS3-CREAM103	ACS3-CREBM103	
			5000 ± 50 (197 ± 2)	ACS3-CREAM105	ACS3-CREBM105	
			10000 ± 100 (394 ± 4)	ACS3-CREAM110	ACS3-CREBM110	
			20000 ± 100 (787 ± 4)	ACS3-CREAM120	ACS3-CREBM120	

Note: motors with bayonet receptacles are not compatible with threaded military connectors. See Section B.9 for details.

B.6 Encoder conversion cable / counterpart connector (for motors with bulkhead receptacles)

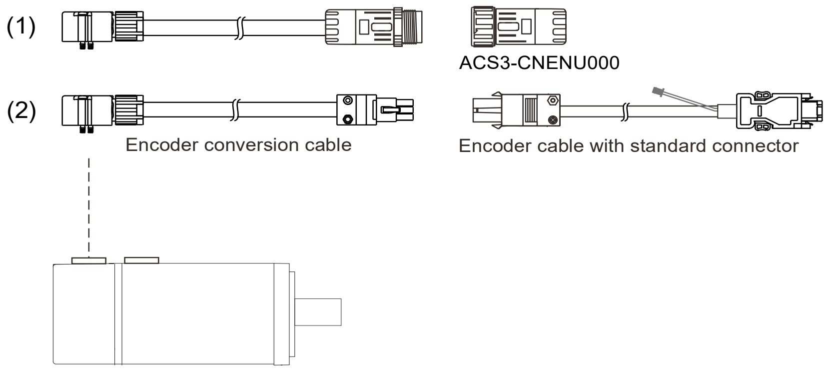
B

The encoder conversion cable is for connecting the motor with bulkhead receptacles to a non-bulkhead encoder connector. The following illustrates where it is installed.

Connection methods:

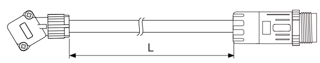
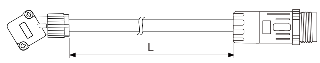
(1) Encoder conversion cable with waterproof connector + counterpart to waterproof connector; you need to make the cable by yourself.

(2) Encoder conversion cable with standard connector + encoder cable with standard connector.

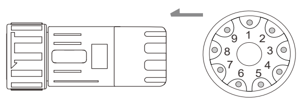


B.6.1 F40 - F80 motors

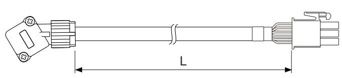
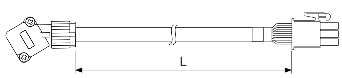
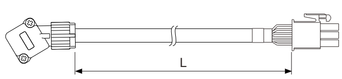
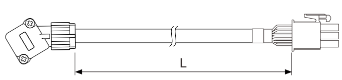
- Encoder conversion cable with waterproof connector (IP67 rated): when mating the connector to the counterpart, ensure they are fully locked and meet the IP67 standard.

Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number		Illustration
				Standard	Flexible	
ECM-B3	Bulkhead - cable exit direction towards motor shaft	Incremental Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-AFENSW0C	ACS3-AFEBSW0C	
	Bulkhead - cable exit direction towards encoder	Incremental Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-ABENSW0C	ACS3-ABEBSW0C	

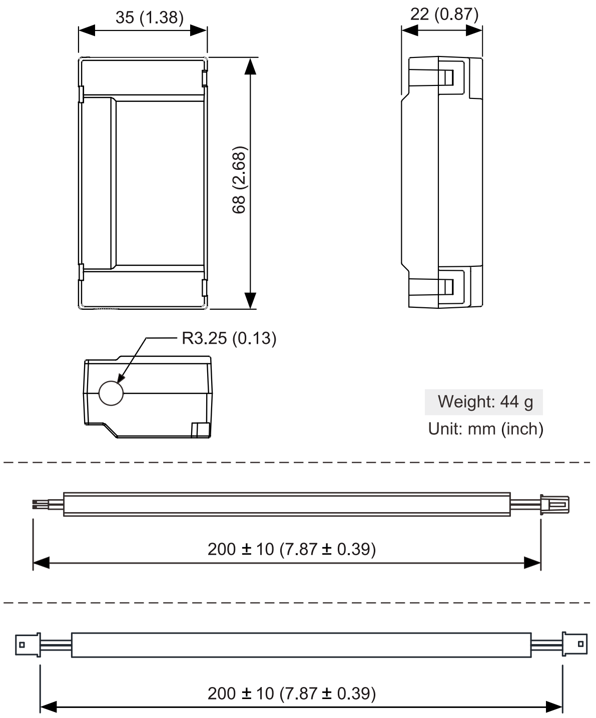
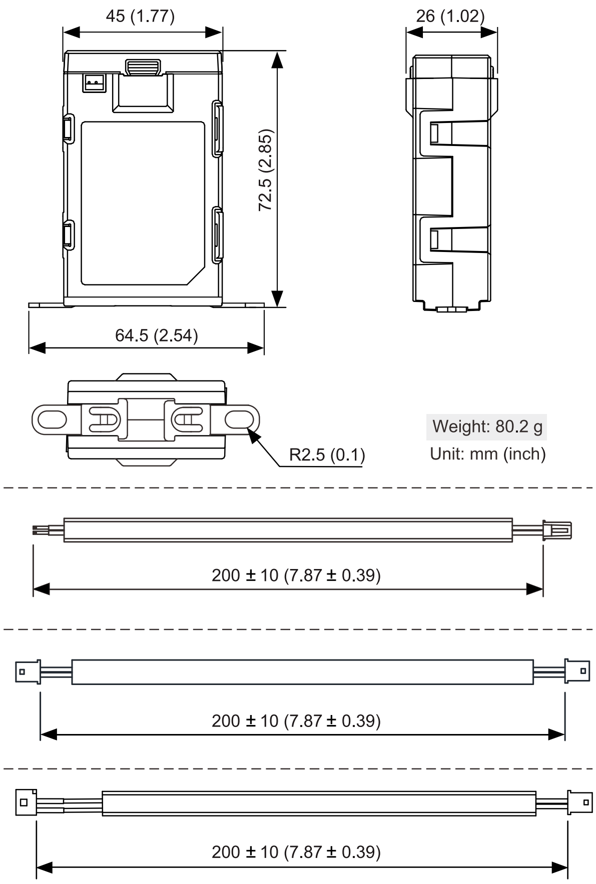
- Counterpart to the preceding waterproof connector

Motor series	Frame size	Connector type	IP rating	Model number	Illustration
-	F40 - F80	Dedicated conversion connector	IP67	ACS3-CNENU000	

- Encoder conversion cable with standard connector (not IP67 rated): do not use the cable in an environment which is exposed to oil or water.

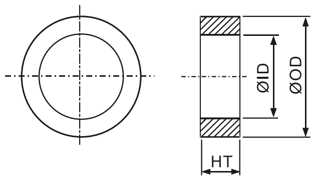
Motor series	Connector type	Encoder type	Length (L) mm (inch)	Model number		Illustration
				Standard	Flexible	
ECM-B3	Bulkhead - cable exit direction towards motor shaft	Incremental	300 ± 20 (11.8 ± 0.8)	ACS3-AFEASI0C	ACS3-AFERSI0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-AFEASI0E	ACS3-AFERSI0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-AFEASI0G	ACS3-AFERSI0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-AFEASI0J	ACS3-AFERSI0J	
		Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-AFEASA0C	ACS3-AFERSA0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-AFEASA0E	ACS3-AFERSA0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-AFEASA0G	ACS3-AFERSA0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-AFEASA0J	ACS3-AFERSA0J	
	Bulkhead - cable exit direction towards encoder	Incremental	300 ± 20 (11.8 ± 0.8)	ACS3-ABEASI0C	ACS3-ABERSI0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-ABEASI0E	ACS3-ABERSI0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-ABEASI0G	ACS3-ABERSI0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-ABEASI0J	ACS3-ABERSI0J	
		Absolute	300 ± 20 (11.8 ± 0.8)	ACS3-ABEASA0C	ACS3-ABERSA0C	
			500 ± 20 (19.7 ± 0.8)	ACS3-ABEASA0E	ACS3-ABERSA0E	
			700 ± 30 (27.6 ± 1.2)	ACS3-ABEASA0G	ACS3-ABERSA0G	
			900 ± 30 (35.4 ± 1.2)	ACS3-ABEASA0J	ACS3-ABERSA0J	

B.7 Battery box

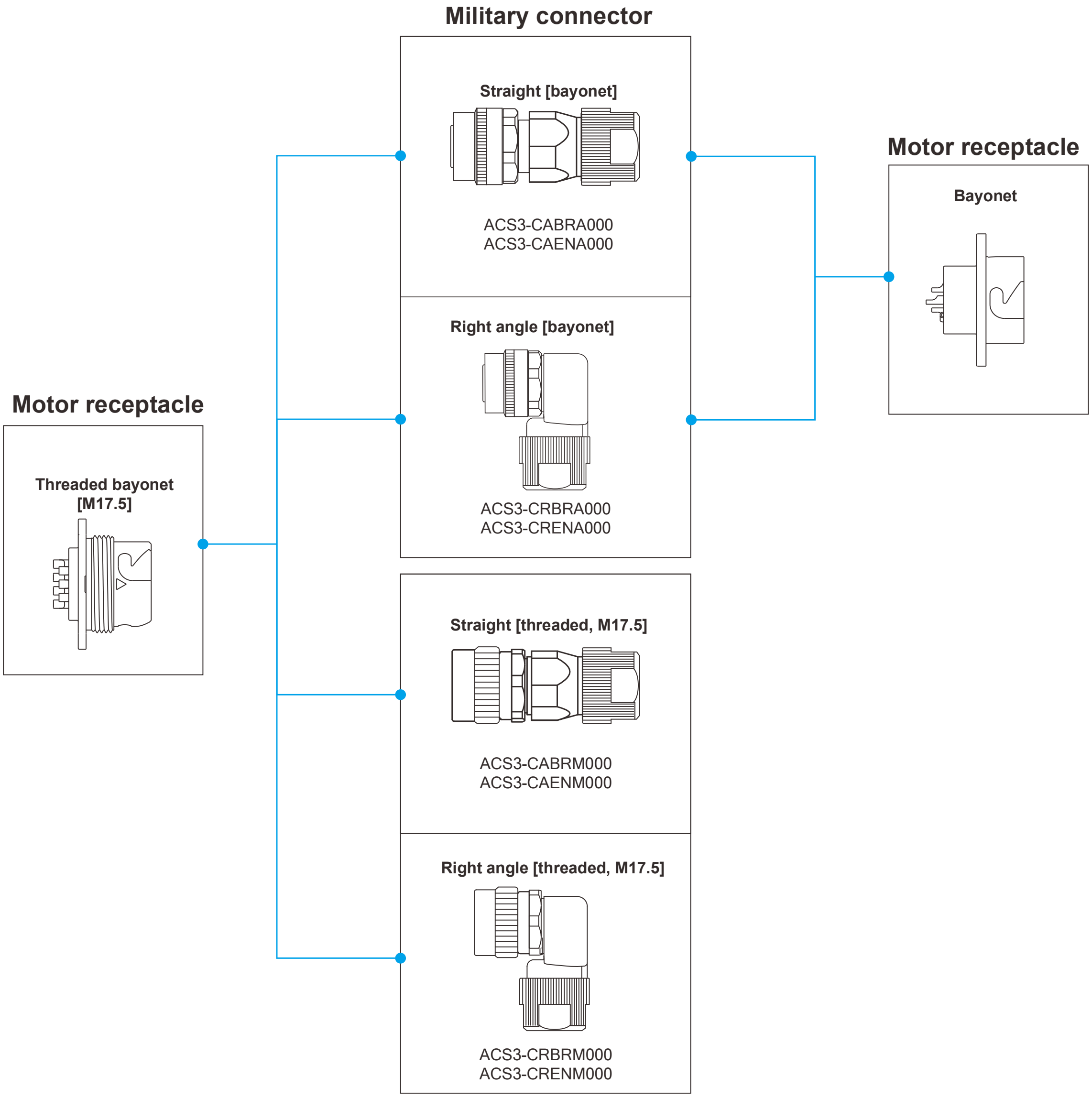
Model number	Description	Illustration
ASD-MDBT0100	Single battery box (including one battery and two cables)	
ASD-MDBT0200	Dual battery box (including two batteries and three cables)	

B

B.8 Ferrite ring

Model number	Description	Illustration	
ASD-ACFC7K00	For suppressing high-frequency interference signals		
		Item	mm (inch)
		ΦOD (outer diameter)	68.0 ± 0.6 (2.68 ± 0.02)
		ΦID (inner diameter)	44.0 ± 0.6 (1.73 ± 0.02)
		HT (height)	13.5 ± 0.5 (0.53 ± 0.02)

B.9 Selection of brake / encoder connectors or cables for F100 - F220 motors



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Using the Safety Functions Module

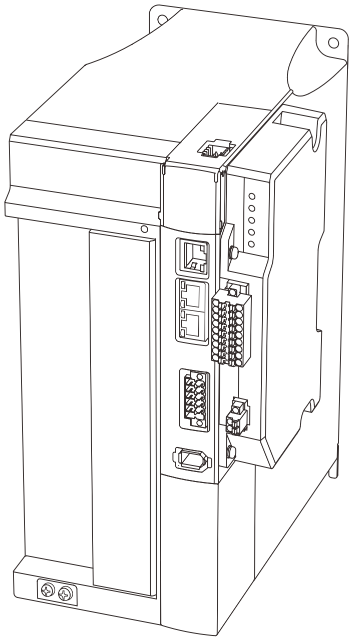
Appendix C

This chapter provides an overview of the precautions for using the safety functions module with the A3-EP servo drive. For detailed information about the safety functions module, refer to the Delta ACS3-SF Safety Functions Module User Manual.

C

C.1 Safety functions

After the safety functions module is installed, the A3-EP servo drive can use the following safety functions.



Function type	Abbreviation	Function name
Safe stop functions	STO	Safe Torque Off
	SS1-t	Safe Stop 1 time controlled
	SS1-r	Safe Stop 1 ramp monitored
	SS2-t	Safe Stop 2 time controlled
	SS2-r	Safe Stop 2 ramp monitored
Safe monitoring functions	SOS	Safe Operating Stop
	SLS	Safely-limited Speed
	SMS	Safe Maximum Speed
	SSM	Safe Speed Monitor
	SLI	Safely-limited Increment
	SDI	Safe Direction
	SLP	Safely-limited Position
Safe output function	SBC	Safe Brake Control
Auxiliary function	SBT	Safe Brake Test

C.2 Preliminary checks and settings

C.2.1 Firmware version

The drive firmware version must be v1.0105 or above to support the safety functions module.

C.2.2 Plugging in the STO connector

When the safety functions module is installed, the drive’s STO function is no longer available, and you can only use the STO function provided by the safety functions module. Plug the included STO connector into the CN10 port of the drive.

C.2.3 Magnetic brake control signal

The safety functions module has the built-in SBC function, and the module can supply power to the magnetic brake through the CN13 port. Therefore, no external power is needed, and the DO.BRKR signal is not required for controlling the magnetic brake.

C.2.4 Parameter settings

Set these parameters when using the safety functions module. Refer to the Delta ACS3-SF Safety Functions Module User Manual for details.

Parameter No.	Parameter name	Usage
P1.100	Safety functions module setting	Set P1.100 based on the use of the safety functions module.
P1.120	STO deactivation settings	Set P1.120 to 2.
P3.029	FSoE address	Set P3.029 when using the safety functions module in EtherCAT communication (FSoE) mode.

C.3 Safety function state display

State displays of the servo drive and safety functions module are as follows.

Display symbol	Description
-Sto-	STO state. When P1.120 is 0 or 2, if the STO function is activated, the panel displays this symbol instead of "AL500".
S.InIt	Initialization of the safety functions module is not complete.
SM-oK.	Initialization of the safety functions module is complete.
PArU.d.	Parameter of the safety functions module is being updated.
S.POSU.	Home position of the safety functions module is not set.
S.POSd.	Home position of the safety functions module is being diagnosed.
-Sbt-	SBT is in execution.

C.4 Alarms

AL560 - AL5CF are safety functions module alarms. For details, refer to the Delta Drive Safety software or the Delta ACS3-SF Safety Functions Module User Manual. These alarms are classified as follows.

Display	Brief description	How to clear the alarm?
AL560 - AL56C	Major system error of the safety functions module.	Cycle power on the servo drive.
AL570 - AL57F	Communication error between the safety functions module and the servo drive.	
AL580 - AL58F	Hardware error of the safety functions module.	
AL5A0 - AL5AF	Communication error between the safety functions module and the servo drive or the encoder.	
AL5BF	The state after parameter reset.	
AL5C0 - AL5CF	Position or speed data read by the safe monitoring functions is in error.	Follow the troubleshooting methods of the safety functions module. The troubleshooting methods of the servo drive are not applicable.

Note: refer to the Delta ACS3-SF Safety Functions Module User Manual for the supported alarms.

Revision History

Release date	Version	Chapter	Revision contents
October, 2024	V1.0 (First edition)	-	-

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