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Delta ASDA-A3 Series Servo Drive User Manual

Delta ASDA-A3 Series Servo Drive User Manual

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Preface

Thank you for purchasing this product. This manual provides information about the ASDA-A3 series servo drive (A3) and the ECM-A3 series servo motor.

This manual includes:

- Installation and inspection of servo drive and servo motor
- Servo structure and wiring diagram
- Instructions for trial operation
- Instructions for servo tuning
- Description of parameters
- Description of communication protocol
- Troubleshooting
- Inspection and maintenance

ASDA-A3 product features:

Delta has developed a new control algorithm that enables you to easily overcome the problems of a lack of stiffness or flexibility in the machine structure. The new automatic tuning function is more user-friendly and allows you to complete tuning easily. In addition, you can use the gain adjustment function to improve the performance of the drive. Its compact design can reduce the space required inside the cabinet. The smaller design of the new generation of the ECM-A3 series servo motor can also meet the need to reduce equipment structures' size and weight.

How to use this manual:

You can use this manual as a reference when installing, setting up, using, and maintaining the servo drive. Before initiating the tuning or setup process, please read through Chapters 1 to 5. You can also use the Table of Contents and the Index to quickly locate the information you need.

DELTA technical services:

Please consult your DELTA equipment distributor or DELTA Customer Service Center if you encounter any problems.

Safety Precautions

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

The ASDA-A3 series are used in industrial applications and should be installed in the control box.
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. May cause severe or fatal injuries to personnel if the instructions are not followed.
	Warning. May cause moderate injury to personnel, or lead to severe damage or even malfunction of the product if the instructions are not followed.
	Absolutely prohibited activities. May cause serious damage or even malfunction of the product if the instructions are not followed.

Inspection

Please follow the instructions when using the A3 servo drive and servo motor, or it may cause fire or malfunction.

Installation

Do not expose the product to an environment containing water, corrosive gas, inflammable gas...etc., or it may result in electric shock or fire.

Wiring

- 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 source to the motor output terminals U, V, and W, or it may cause personnel injury or fire.
- Please tighten the screws of the power and motor output terminals, or it may cause fire.
- Please refer to description of wire selection in Chapter 3 to prevent any danger.

Operation

- Before operating, please change the 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.
- Before the machine starts to operate, please ensure that the emergency stop can be activated at any time.
- When applying power, please make sure the motor is not rotating because of inertia of the machine or other causes.

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

- To avoid accidents, please remove all units during the first test run, so that the motor is operating without any load.
- If you fail to operate the machine properly after connecting the servo motor to the equipment, it may damage the equipment and lead to personnel injury.
- In order to reduce the danger, it is strongly recommended that you check if the 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 Inspection

- 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.
- Do not touch the ground terminal within 10 minutes after turning off the power, or the residual voltage may cause electric shock.
- Do not disassemble the motor, or it may cause electric shock or personnel injury.
- Do not change the wiring when the power is on, or it may cause electric shock or personnel injury.
- Only qualified electricians can install, wire, and maintain the servo drive and servo motor.

Main Circuit Wiring

- 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).
- Please use stranded wires and multi-core shielded-pair wires for signal cables and encoder feedback cables. The maximum length of signal input cable is 3 meters (9.84 feet) and the maximum length of feedback cable is 20 meters (65.62 feet).
- The high voltage may remain in the servo drive immediately after the power is turned off. Please wait for 10 minutes before touching the terminals.

Do not repeatedly turn the power on and off. If it is necessary to turn the power on and off, make sure that you wait one minute at least before turning the power on or off again.

Terminal Wiring of the Main Circuit

- When wiring the servo drive, please remove the terminal blocks from the servo drive.
- Insert only one electric wire per terminal socket.
- When inserting the electric wires, do not short circuit the adjacent conductors.
- Before connecting to the power source, please inspect and ensure that the wiring is correct.

Leakage Current

- 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 one of the following specifications to ensure proper grounding:
  1. Copper wire cross-sectional area is at least 10 mm^2.
  2. Aluminum wire cross-sectional area is at least 16 mm^2.
- Failure to comply with the specifications may result in personnel injury.
- Before applying power, please inspect and ensure that the wiring is correct.

Note: the content of this manual may be revised without prior notice, please download the latest version from Delta's website (http://www.deltaww.com).

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1 Product Overview

Before using the ASDA-A3 series servo drive, pay attention to the description of the inspection, nameplate, and model type. You can find a suitable motor model for your A3 servo drive in the table in Section 1.3.

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1.2.1 Nameplate information ····· 1-3
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1.4 Description of the drive interface ····· 1-10
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1.4.3 A3-F models ····· 1-12

1.1 Components of the servo set

A complete servo set includes:

(1) A servo drive and a servo motor.

(2) A UVW motor power cable: one end of the U, V, and W wires connects to the servo drive and the other end to the motor (optional purchase).

(3) A green ground wire: it connects to the ground terminal of the servo drive (optional purchase).

(4) An encoder cable: one end of it connects to the encoder and the other end to the CN2 on the servo drive (optional purchase).

(5) A communication type converter box (optional purchase).

(6) A 26-pin connector for the communication type converter box (optional purchase).

(7) A 50-pin connector for CN1 (optional purchase).

(8) A 6-pin connector for CN2 (optional purchase).

(9) An RJ45 connector for CN3, which you use for general (RS-485) and high-speed (CANopen) communication (optional purchase).

(10) A 4-pin connector for CN4 (Mini USB connector) (optional purchase).

(11) Power supply for the servo drive:

Model	Control circuit	Main circuit
100 W - 3 kW	L_{1C}, L_{2C}, P1, P2, ⊖ quick connector	R, S, T quick connector

(12) A 3-pin quick connector (U, V, W).

(13) A 3-pin quick connector (P3, D, C).

(14) A plastic lever.

(15) Two metal pieces for short-circuiting the terminal block.

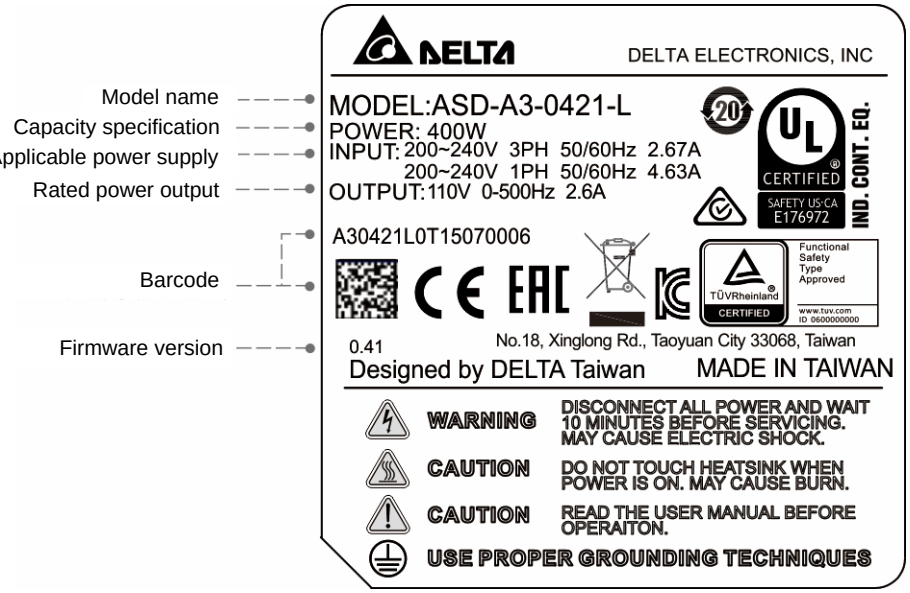
(16) An installation instruction sheet.

1.2 Model overview

1.2.1 Nameplate information

ASDA-A3 series servo drive

■ **Nameplate information**



■ **Serial number**

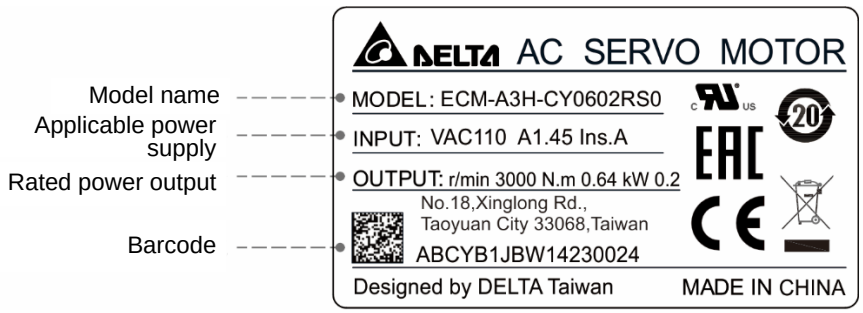
A30421L0	T	15	07	0006
(1)	(2)	(3)	(4)	(5)

(1) Model name
(2) Manufacturing plant (T: Taoyuan; W: Wujiang)
(3) Year of production (15: year 2015)
(4) Week of production (from 1 to 52)
(5) Serial number (production sequence in a week, starting from 0001)

1

ECM-A3 series servo motor

■ Nameplate information



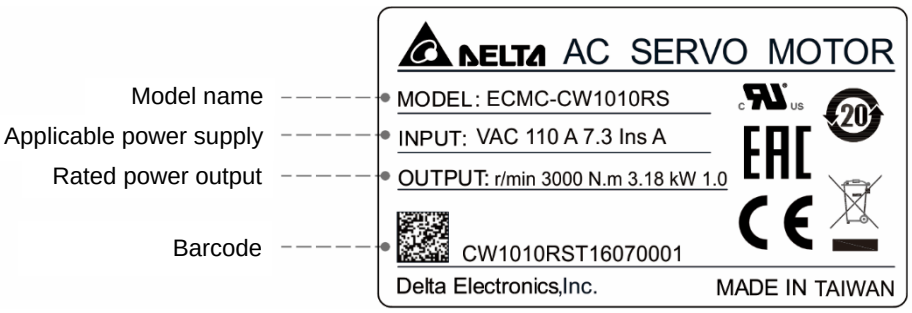
■ Serial number

ABCYB1JB	W	14	23	0024
(1)	(2)	(3)	(4)	(5)

(1) Model name
(2) Manufacturing plant (T: Taoyuan; W: Wujiang)
(3) Year of production (14: year 2014)
(4) Week of production (from 1 to 52)
(5) Serial number (production sequence in a week, starting from 0001)

ECMC series servo motor

■ Nameplate information



■ Serial number

CW1010RS	T	16	07	0001
(1)	(2)	(3)	(4)	(5)

(1) Model name
(2) Manufacturing plant (T: Taoyuan; W: Wujiang)
(3) Year of production (16: year 2016)
(4) Week of production (from 1 to 52)
(5) Serial number (production sequence in a week, staring from 0001)

1.2.2 Model explanation

ASDA-A3 servo drive

ASD – A3 – 04 21 – L
(1) (2) (3) (4) (5)

(1) Product name

AC Servo Drive

(2) Series

A3

(3) Rated power output

Code	Specification	Code	Specification	Code	Specification
01	100 W	07	750 W	20	2.0 kW
02	200 W	10	1.0 kW	30	3.0 kW
04	400 W	15	1.5 kW	-	-

(4) Input voltage and phase

21: 220V, single- / three-phase

23: 220V, three-phase

(5) Model type

Code	Pulse input	RS-485	CANopen	Full-closed loop control	Analog voltage control	DMCNET	E-CAM	STO
L	○	○	×	○	○	×	○	×
M	○	○	○	○*	○	×	○	○
F	×	×	×	○*	×	○	○	×

Note: columns with an * means that this function is going to be added.

1

ECM-A3 series servo motor

ECM	-	A	3	H	-	C	Y	06	04	R	S	1
(1)		(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)	(10)	(11)

(1) Product name

ECM: Electronic Communication Motor

(2) Servo type

A: High precision servo motor

(3) Series

3: A3 series

(4) Inertia

H: high inertia

L: low inertia

(5) Rated voltage and speed

C: 220V and 3,000 rpm

(6) Encoder type

Y: 24-bit absolute optical encoder (resolution of single turn: 24-bit; resolution of multiple turns: 16-bit)

1: 24-bit single-turn absolute optical encoder

G: 16-bit single-turn absolute magnetic encoder

2*: 24-bit single-turn absolute magnetic optical encoder

A*: 24-bit absolute magnetic optical encoder (resolution of single turn: 24-bit; resolution of multiple turns: 16-bit)

Note: models with an * means that this type of encoder is coming soon.

(7) Motor frame size

04: 40 mm

06: 60 mm

08: 80 mm

(8) Rated power output

Code	Specification	Code	Specification
0F	50 W	04	400 W
01	100 W	07	750 W
02	200 W	-	-

(9) Shaft type and oil seal

	w/o brake w/o oil seal	with brake w/o oil seal	w/o brake with oil seal	with brake with oil seal
Round shaft (with fixed screw holes)	-	-	C	D
Keyway (with fixed screw holes)	P	Q	R	S

(10) Shaft diameter

S: standard

7: specific (14 mm)

(11) Special code

1: standard products

1

ECMC series servo motor

ECM C – C W 13 08 R S

(1) (2) (3) (4) (5) (6) (7) (8)

(1) Product name

ECM: Electronic Communication Motor

(2) Servo type

C: high precision AC servo motor (suitable for CNC applications)

(3) Rated voltage and speed

C: 220V and 3,000 rpm

E: 220V and 2,000 rpm

F: 220V and 1,500 rpm

(4) Encoder type

W: 22-bit absolute encoder (resolution of single turn: 22-bit; resolution of multiple turns: 16-bit)

(5) Motor frame size

10: 100 mm

13: 130 mm

18: 180 mm

(6) Rated power output

Code	Specification	Code	Specification
08	850 W	18	1.8 kW
10	1.0 kW	20	2.0 kW
13	1.3 kW	30	3.0 kW
15	1.5 kW	-	-

(7) Shaft type and oil seal

	w/o brake w/o oil seal	with brake w/o oil seal	w/o brake with oil seal	with brake with oil seal
Round shaft (with fixed screw holes)	-	-	C	D
Keyway (with fixed screw holes)	-	-	R	S

(8) Shaft diameter

S: standard

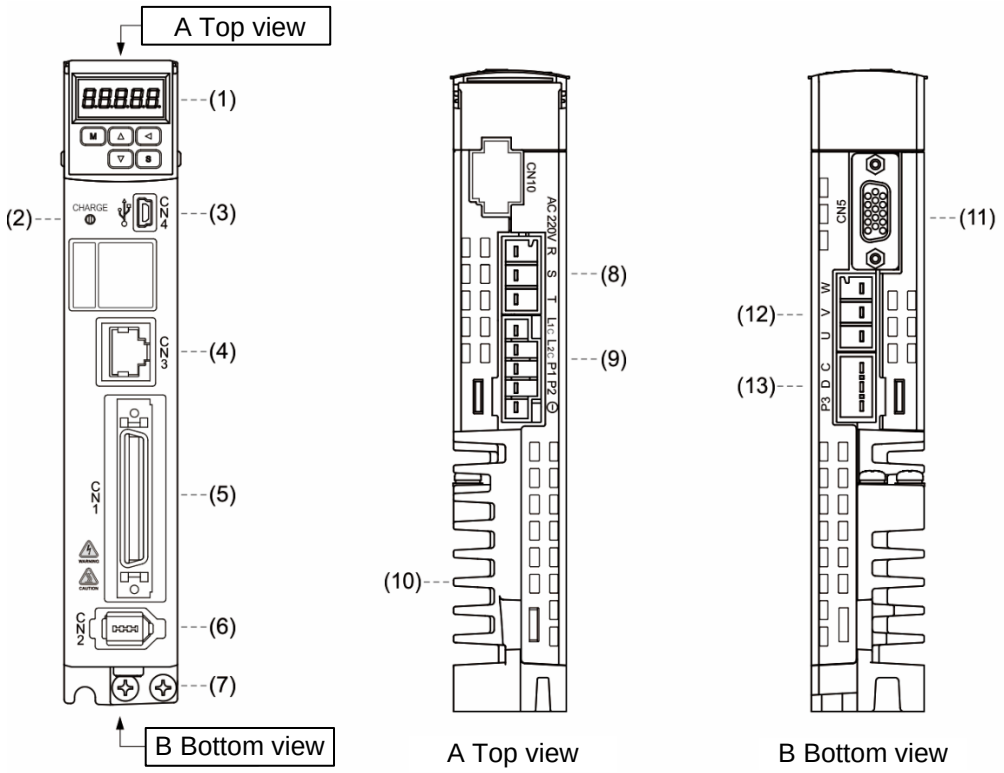
1.3 ASDA-A3 servo drive and motor

Motor							Servo drive		
Series		Power	Output (W)	Model number	Rated current (Arms)	Max. instan-taneous current (Arms)	Model number	Conti-nuous output current (Arms)	Max. instan-taneous output current (Arms)
Low inertia	ECM-A3L 3000 rpm	Single- / three-phase	50	ECM-A3L-C□040F□□1	0.66	2.82	ASD-A3-0121	0.9	3.54
			100	ECM-A3L-C□0401□□1	0.9	3.88			
			200	ECM-A3L-C□0602□□1	1.45	6.2	ASD-A3-0221	1.55	7.07
			400	ECM-A3L-C□0604□□1	2.65	10.1	ASD-A3-0421	2.6	10.61
			400	ECM-A3L-C□0804□□1	2.6	10.6			
			750	ECM-A3L-C□0807□□1	5.1	20.6	ASD-A3-0721	5.1	21.21
Medium inertia	ECMC-C 3000 rpm	Single- / three-phase	1000	ECMC-C□1010□□	7.3	21.9	ASD-A3-1021	7.3	24.75
	ECMC-E 2000 rpm	Single- / three-phase	1000	ECMC-E□1310□□	5.6	16.8			
			1500	ECMC-E□1315□□	8.3	24.9	ASD-A3-1521	8.30	35.36
			2000	ECMC-E□1320□□	11.01	33	ASD-A3-2023	13.40	53.03
			2000	ECMC-E□1820□□	11.22	33.7			
			3000	ECMC-E□1830□□	16.1	48.3	ASD-A3-3023	19.40	70.71
	ECMC-F 1500 rpm	Three-phase	3000	ECMC-F□1830□□	19.4	58.2			
High inertia	ECM-A3H 3000 rpm	Single- / three-phase	50	ECM-A3H-C□040F□□1	0.64	2.59	ASD-A3-0121	0.9	3.54
			100	ECM-A3H-C□0401□□1	0.9	3.64			
			200	ECM-A3H-C□0602□□1	1.45	5.3	ASD-A3-0221	1.55	7.07
			400	ECM-A3H-C□0604□□1	2.65	9.8	ASD-A3-0421	2.6	10.61
			400	ECM-A3H-C□0804□□1	2.6	9.32			
			750	ECM-A3H-C□0807□□1	4.61	16.53	ASD-A3-0721	5.1	21.21
	ECMC-F 1500 rpm	Single- / three-phase	850	ECMC-F□1308□□	7.1	19.4	ASD-A3-1021	7.3	24.75
			1300	ECMC-F□1313□□	12.6	38.6	ASD-A3-2023	13.40	53.03
			1800	ECMC-F□1318□□	13	36			

Note: in the servo motor model name, □1 represents the encoder type; □2 represents the brake or keyway / oil seal type; □3 represents the shaft diameter.

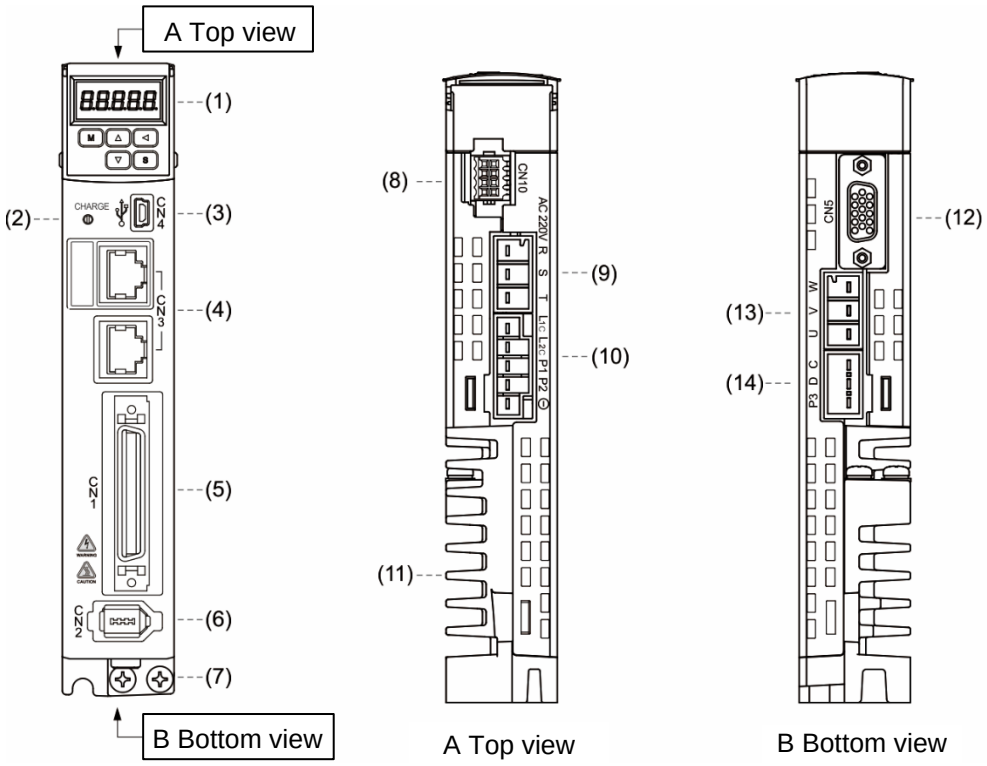
1.4 Description of the drive interface

1.4.1 A3-L models



No.	Description	No.	Description
(1)	7-segment display.	(7)	Ground terminal: connects to the ground wire for the power and servo motor.
(2)	CHARGE: power indicator.	(8)	RST main circuit terminal: connects to a three-phase power supply (200 - 230 V_{AC}, 50 / 60 Hz).
(3)	CN4 - Mini USB connector: connects to PC.	(9)	L_{1C}, L_{2C} control circuit terminal: for single- / three-phase power supply (200 - 230 V_{AC}, 50 / 60 Hz).
(4)	CN3 - RS-485 connector: connects to the controller and communication ports.	(10)	Heat sink: for securing the servo drive and heat dissipation.
(5)	CN1 - I/O signal interface: connects to PLC and controls I/O.	(11)	CN5 - Position feedback connector.
(6)	CN2 - Encoder connector: connects to the encoder.	(12)	UVW motor power output: connects to the motor power connector (UVW). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(13)	Regenerative resistor: Install the external regenerative resistor: P3 and C contacts connect to the resister; P3 and D contacts are left open. To use the built-in regenerative resistor: P3 and C contacts are left open; P3 and D contacts are short-circuited (connected). Connect the external regenerative brake unit: P3 and ⊖ contacts connect to the brake unit; P3 & C contacts and P3 & D contacts are left open.		

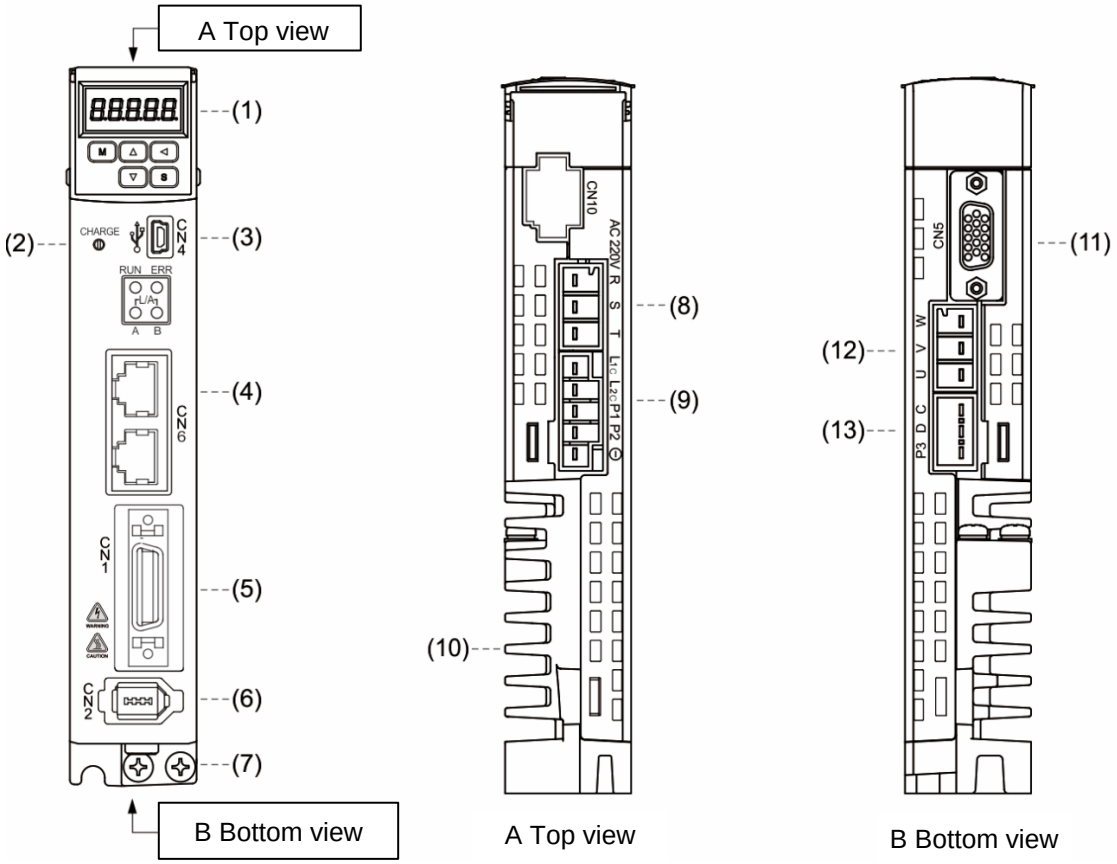
1.4.2 A3-M models



No.	Description	No.	Description
(1)	7-segment display.	(8)	CN10 - STO (Safe Torque Off).
(2)	CHARGE: power indicator.	(9)	RST main circuit terminal: connects to a three-phase power supply (200 - 230 V_{AC}, 50 / 60 Hz).
(3)	CN4 - Mini USB connector: connects to PC.	(10)	L_{1C}, L_{2C} control circuit terminal: for single- / three-phase power supply (200 - 230 V_{AC}, 50 / 60 Hz).
(4)	CN3 - RS-485 and high-speed communication connector: connects to the controller and communication ports.	(11)	Heat sink: for securing the servo drive and heat dissipation.
(5)	CN1 - I/O signal interface: connects to PLC and controls I/O.	(12)	CN5 - Position feedback connector.
(6)	CN2 - Encoder connector: connects to the encoder.	(13)	UVW motor power output: connects to the motor power connector (UVW). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(7)	Ground terminal: connects to the ground wire for the power and servo motor.	(14)	Regenerative resistor: Install the external regenerative resistor: P3 and C contacts connect to the resister; P3 and D contacts are left open. To use the built-in regenerative resistor: P3 and C contacts are left open; P3 and D contacts are short-circuited (connected). Connect the external regenerative brake unit: P3 and ⊖ contacts connect to the brake unit; P3 & C contacts and P3 & D contacts are left open.

1

1.4.3 A3-F models



No.	Description	No.	Description
(1)	7-segment display.	(7)	Ground terminal: connects to the ground wire for the power and servo motor.
(2)	CHARGE: power indicator.	(8)	RST main circuit terminal: connects to a three-phase power supply (200 - 230 V_{AC}, 50 / 60 Hz).
(3)	CN4 - Mini USB connector: connects to PC.	(9)	L_{1C}, L_{2C} control circuit terminal: for single- / three-phase power supply (200 - 230 V_{AC}, 50 / 60 Hz).
(4)	CN6 - DMCNET connector: connects to the controller and communication ports.	(10)	Heat sink: for securing the servo drive and heat dissipation.
(5)	CN1 - I/O signal interface: connects to PLC and controls I/O.	(11)	CN5 - Position feedback connector
(6)	CN2 - Encoder connector: connects to the encoder.	(12)	UVW motor power output: connects to motor power connector (UVW). Do not connect to the main circuit power. Incorrect wiring will cause damage to the servo drive.
(13)	Regenerative resistor: Install the external regenerative resistor: P3 and C contacts connect to the resister; P3 and D contacts are left open. To use the built-in regenerative resistor: P3 and C contacts are left open; P3 and D contacts are short-circuited (connected). Connect the external regenerative brake unit: P3 and ⊖ contacts connect to the brake unit; P3 & C contacts and P3 & D contacts are left open.		

Installation 2

Please follow the instructions in this chapter during installation. This chapter includes information about the circuit breaker, fuse, EMI filter selection, and the regenerative resistor.

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2.2 Ambient installation conditions ····· 2-3
2.3 Mounting direction and space ····· 2-4
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Precautions:

If the connection between the servo drive and servo motor is over 20 meters (65.61 feet), increase the gauge of the UVW connecting wire and the encoder cable. Refer to Section 3.1.6 for the wire specification.

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 the instructions below for storage. While the product is temporarily not in use:

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

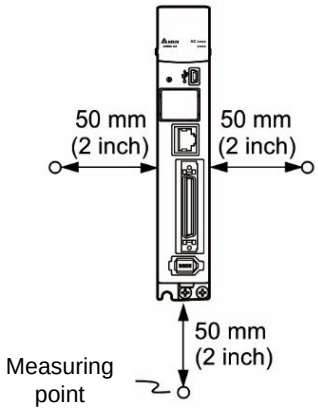
2.2 Ambient installation conditions

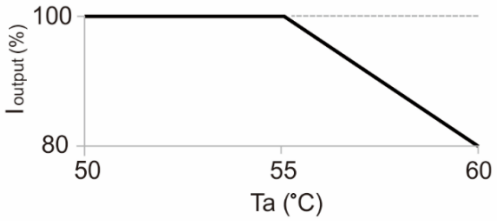
WARNING

A3 servo drive: the environment should be free of devices that generate excessive heat; no 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 interference of electromagnetic noise.

Motor: the ambient temperature for the motor location should be between 0°C (32°F) and 40°C (104°F). The environment should be free of devices that generate excessive heat; no water, vapor, dust, and oily dust; no corrosive and inflammable gas or liquids; no airborne dust or metal particles.

The ambient temperature of the operating environment for the servo drive is 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, the suggested temperature of the operating environment should be under 45°C (113°F) to ensure the servo drive's performance. Mount the product vertically in the distribution board (see the illustration of the correct mounting direction in Section 2.3) and install a fan on the board 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 55°C (131°F), and the servo drive must be kept clear of heat sources. Make sure the size of the distribution board and its ventilation condition can prevent the internal electrical devices from overheating. Please also check if the vibration of the machine affects the electrical devices of the distribution board.





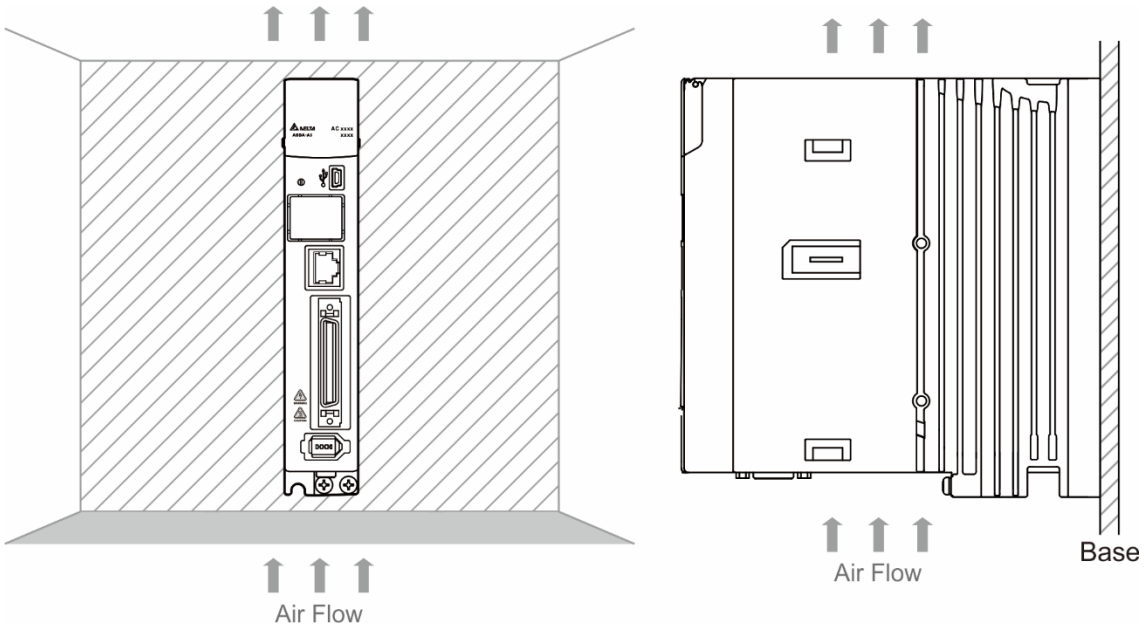
I output (%) is the output current percentage;
Ta is the operating temperature

Note: the maximum operating temperature for the models of 750 W (or above) is up to 60°C (140°F), but the output current declines as shown above; the maximum operating temperature for the models of 400 W (or below) is only up to 55°C (131°F).

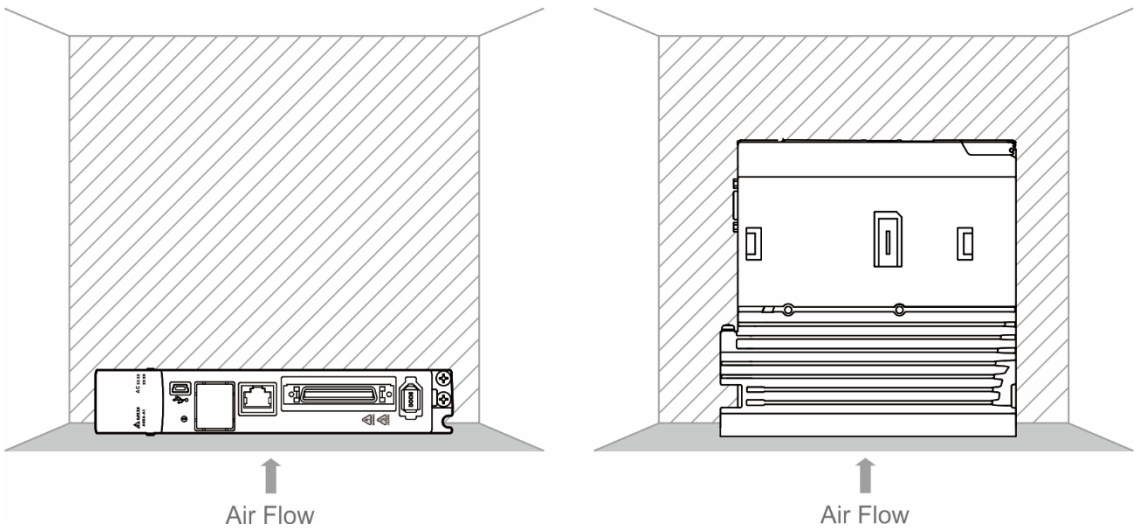
2.3 Mounting direction and space

Precautions:

- Mount the servo drive in the correct direction according to the illustration below 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 machine malfunction.
- Do not block the ventilation holes of the servo drive, and do not mount it in the incorrect direction, or it may result in machine malfunction.



Correct



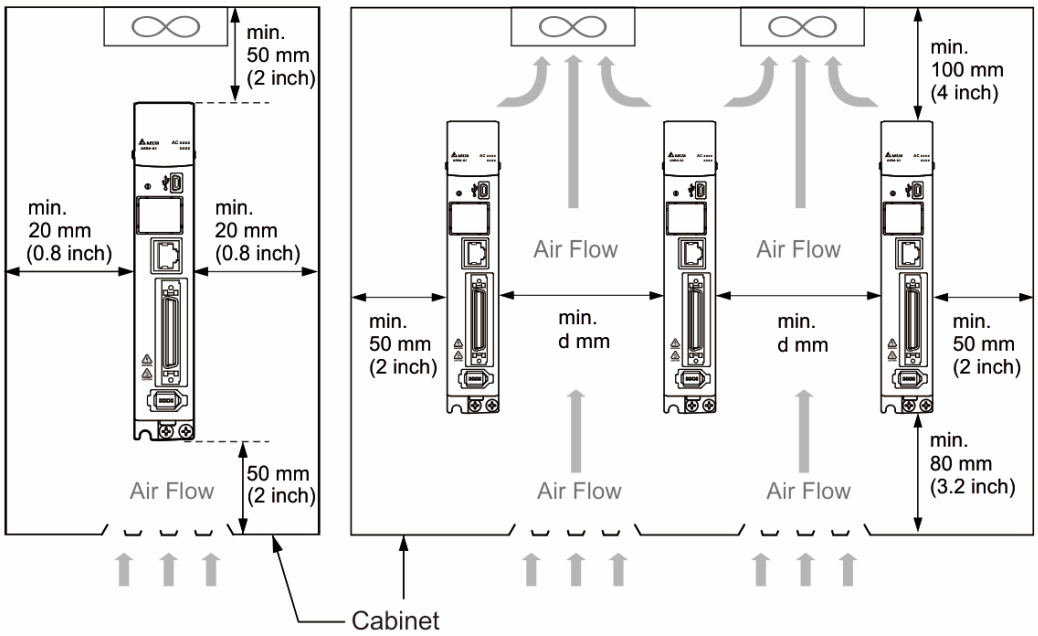
Incorrect

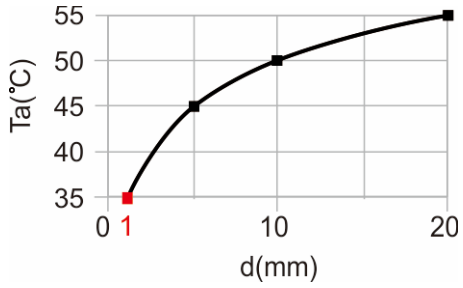
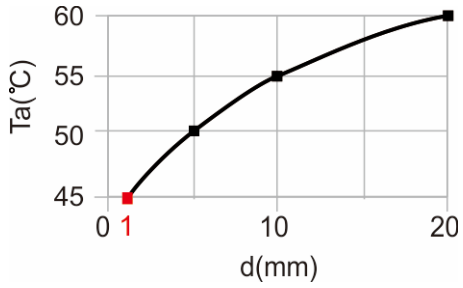
Heat dissipation requirements

In order to have adequate air flow for ventilation, follow the suggested clearances when installing one or more servo drives (refer to the following diagrams). Avoid mounting one servo drive above one another. Keep the bottom of the servo drive clear because the generated heat rises and causes higher temperature for the drives mounted above.

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

One servo drive **Multiple servo drives**



Servo drive model	Cooling method	Minimum distance (d) corresponding to the operating temperature (Ta) *Considering the assembly tolerances, the servo drive requires a minimum clearance of 1 mm
ASD-A3-0121-☐ ASD-A3-0221-☐ ASD-A3-0421-☐	Natural cooling	
ASD-A3-0721-☐ ASD-A3-1021-☐ ASD-A3-1521-☐ ASD-A3-2023-☐ ASD-A3-3023-☐ ASD-A3-4523-☐ ASD-A3-5523-☐ ASD-A3-7523-☐ ASD-A3-1B23-☐ ASD-A3-1F23-☐	Natural cooling plus forced cooling	

Note: the maximum operating temperature for the models of 750 W (or above) is up to 60°C (140°F), but the output current declines; the maximum operating temperature for the models of 400 W (or below) is only up to 55°C (131°F).

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 operation manual. For your safety and correct use, read the manual, specifications, and precautions for the motor carefully before connecting the motor to any equipment.

The safety precautions are as follows:

Handling, mounting, and storage

- When removing or installing a servo motor, hold the whole motor instead of holding the cable or only the motor shaft.
- Do not hit the motor shaft. Impact force will damage the shaft and the encoder that is attached at the rear end of shaft.
- Keep the axial or radial shaft load 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 and apply rustproof oil every three months 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 steps to avoid electromagnetic interference, vibration, and abnormal temperature changes.

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 that the motor wiring and the voltage of the motor brake are correct. Also, make sure that the wiring of the encoder signal and power 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 component test because it will damage the encoder.
- When the motor or brake is undergoing high-voltage component tests, cut off the power supply for the controller. You should perform this kind of test only when necessary so as to protect the product lifespan.

Operation

- AC servo motor operation is controlled by the servo drive. Do not directly connect a commercial type 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's operation temperature 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 rather than stopping the motor. Caution: the built-in brake is not a device for safely stopping the machine. Please 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°. When a motor with a brake is operating, the brake lining sometimes generates a noise (a swishing or clicking sound), which is caused by the structure of brake module, not a malfunction. It will not affect the motor's function.
- When using a servo motor with a brake, do not use the 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 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:

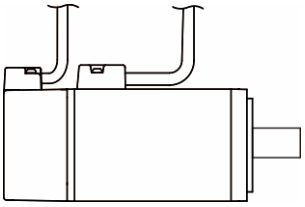
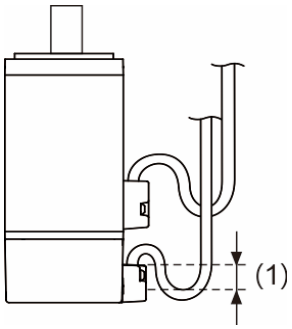
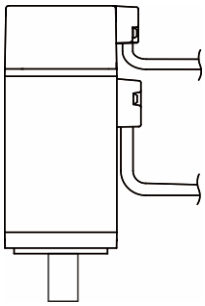
Possible causes	Checking methods	Handling measures
There is a source of vibration in the connecting component.	Check if there is any foreign object, damage, or deformation in the movable parts of the connecting component.	Replace the connecting component (such as the coupling) or contact the manufacturer.
The encoder is subject to excessive vibration / 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 is 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 causes	Checking methods	Handling measures
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 are other objects (such as paint, gasket) between the mounting surface and motor surface resulting in poor heat dissipation. Remove the object or use other methods to help heat dissipation (such as forced air cooling for the servo motor).

2.4.2 Mounting directions and precautions for the servo motor

You can install the servo motor horizontally or vertically.

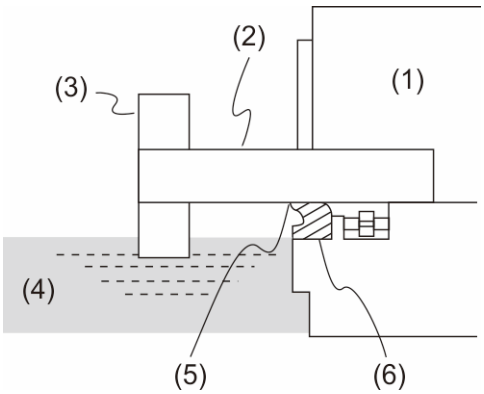
Mounting direction	Precautions
Horizontal 	If you are using a servo motor with an oil seal, refer to Section 2.4.5 for oil and water prevention measures for the servo motor.
Vertical - shaft end up 	■ Do not use servo motors with oil seals in the vertical direction. ■ When wiring, you need to install an oil trap (marked as (1) in the figure on the left) to prevent 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 install gears on the servo motor, follow the manufacturer's instructions for installation.

2.4.3 Precautions for using oil seal servo motors

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

1. In the operating environment, keep the oil level lower than the oil seal lip.



(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.
4. The oil seal cannot be lower than the oil level; otherwise the oil will enter the servo motor and cause damage to the motor.

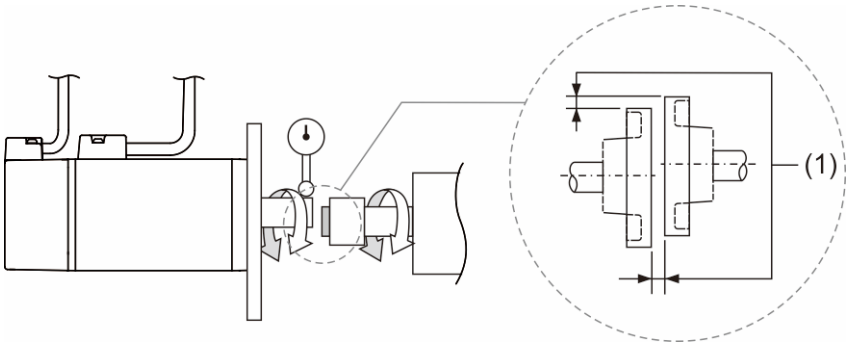
2.4.4 Precautions for using couplings

Caution:

It is suggested to use flexible couplings specifically designed for servo motors, especially double spring couplings, which provide some buffer tolerance during eccentric motion and deflection. Please select couplings of appropriate size for the operating conditions. Improper use or connection may cause damage.

1. The rustproof coating or oil on the motor shaft must be wiped off.
2. If you use a servo motor with a keyway, install the attached key or a key matching the specified dimensions on the motor shaft.

   Note: when you install the key on the motor, do not apply excessive impact force to the keyway or motor shaft.
3. Use dial gauge or other methods to ensure the centering precision is within specifications. If you cannot use the dial gauge or other methods, slide the coupling along both axes and adjust it until it does not get stuck.



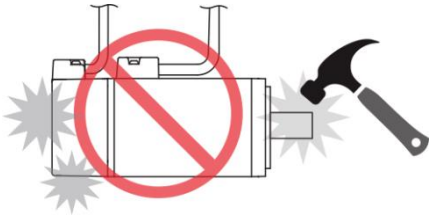
(1) The distance is measured at four different positions on the circumference for the centering precision. The difference between the maximum and minimum measurements should be 0.03 mm or less; even within this range, you can make adjustments to increase the centering precision.

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

4. Servo motor shaft installation safety precautions

   (1) When connecting the shaft, make sure that the required centering precision is reached. If the shaft is not correctly centered, vibration may damage the bearings and encoder.

   (2) When installing the coupling, do not apply excessive force to the shaft. Also, do not apply excessive force to the area around the encoder, as the impact may damage the encoder.



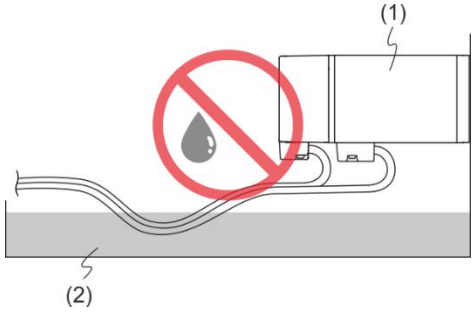
   (3) If the coupling makes any abnormal noise, realign the shaft until the noise disappears.

   (4) Ensure the axial load and radial load are within specifications. Refer to the specifications for the maximum axial load (N) and maximum radial load (N) for each servo motor.

2.4.5 Oil and water prevention measures for the servo motor

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

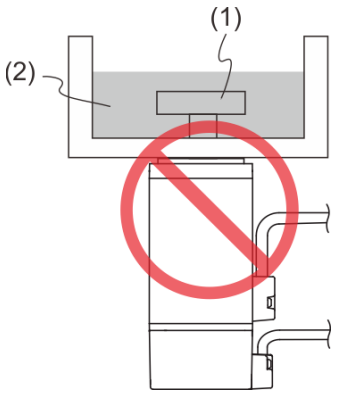
1. Do not submerge the cable in oil or water.



(1) Servo motor; (2) Oil

2

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



(1) Gear; (2) Oil

4. Do not use the servo motor in an environment with cutting fluids. Depending on the type of cutting fluids, sealing materials, coated colloids, cables, or other components may be affected or even deteriorated.
5. 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 above 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

1. 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.
2. The heat generated during the 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.
3. 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, affect noise immunity, and result in malfunction.

2.5 Specifications for the circuit breaker and fuse

Servo drive model	Circuit breaker	Fuse (Class T)
ASD-A3-0121-☐	5A	5A
ASD-A3-0221-☐	5A	5A
ASD-A3-0421-☐	10A	10A
ASD-A3-0721-☐	10A	20A
ASD-A3-1021-☐	15A	25A
ASD-A3-1521-☐	20A	40A
ASD-A3-2023-☐	30A	50A
ASD-A3-3023-☐	30A	70A

Note:

1. In the servo drive model column, ☐ represents the model code.
2. Operation mode: general.
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 Type B residual-current device with time delay if the system ground wire may contain DC electricity.
5. Use the fuse and circuit breaker that comply with the UL / CSA standard.

2.6 Ferrite ring

The removable or round-shaped 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. Use the ferrite ring to optimize signal transmission and suppress high-frequency noise, which can reduce high-frequency interference in the power and signal cables.

Ferrite ring model	Applicable servo drive model
ASD-ACFC7K00	ASD-A3-4523-☐, ASD-A3-5523-☐, ASD-A3-7523-☐, ASD-A3-1B23-☐, ASD-A3-1F23-☐
	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 column, ☐ represents the model code.

2

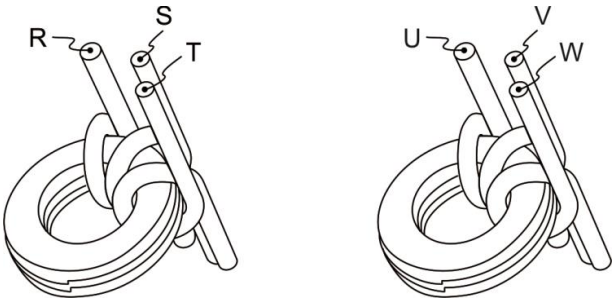
Installation precautions

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 (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 between the power circuit and 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.

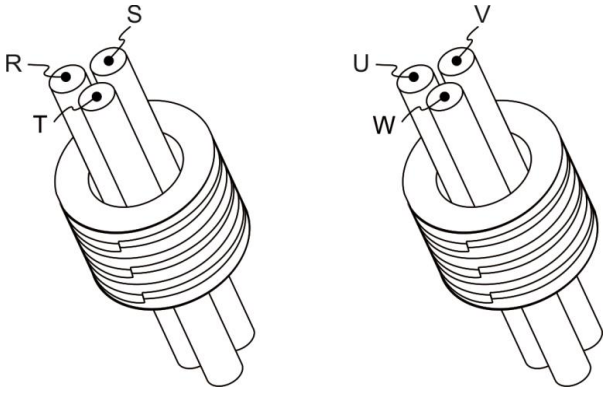
The ferrite ring causes eddy current losses to high-frequency signals and transforms them into heat when suppressing common-mode interference. The ferrite ring acts as a low-pass filter to effectively suppress high-frequency noise and ensure the stability of the circuit while the impedance to low-frequency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

1. For A3-220V model (4.5 kW - 7.5 kW)



2. For A3-220V model (11 kW - 15 kW)

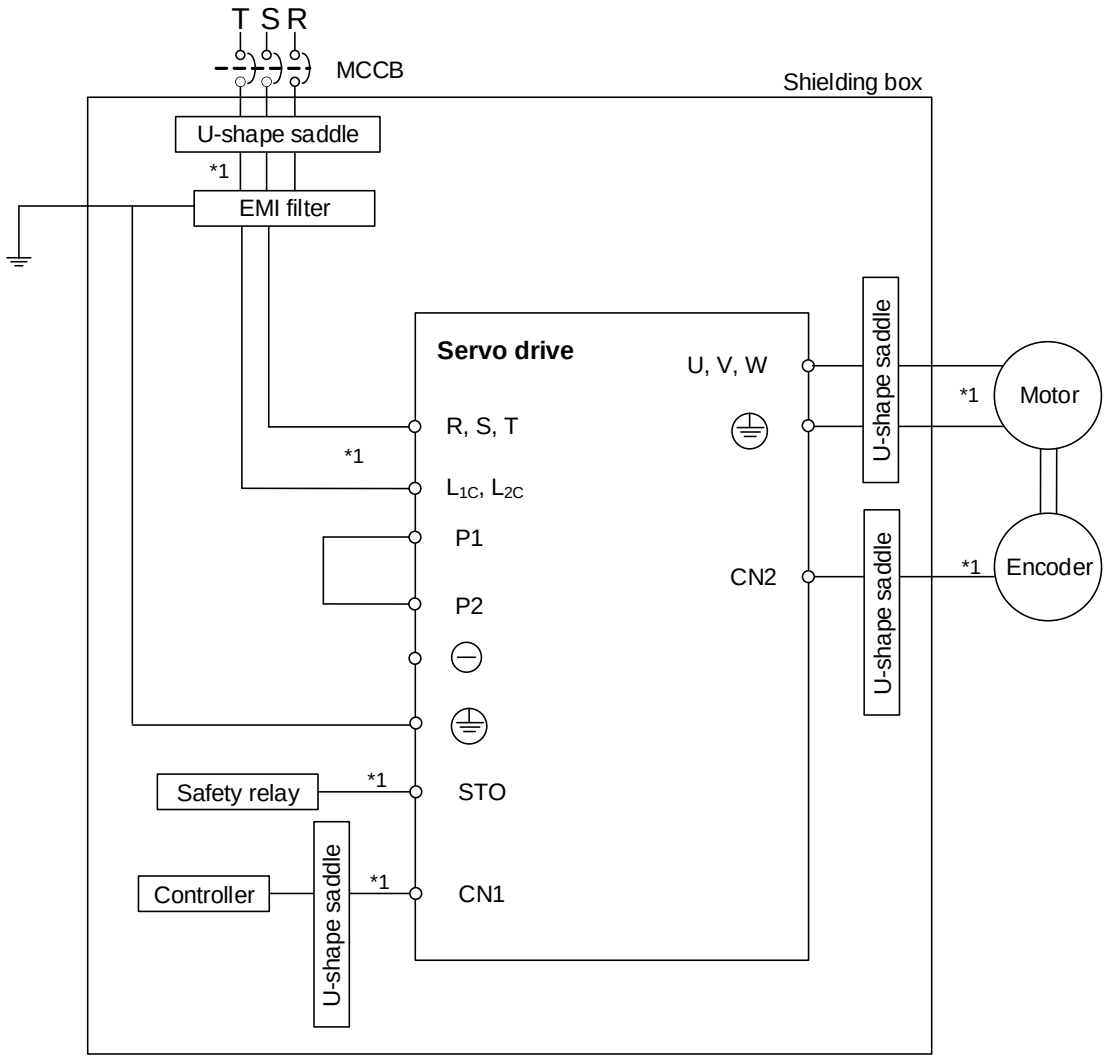


Note:

1. Refer to Section 3.1.4 for the selection of the motor power cable.
2. Only the motor power cable or power cable can run through the ferrite ring. If needed, prepare extra ferrite rings for grounding.
3. An EMI filter may be required for absorbing radiation when using a longer motor power cable.

2.7 Installation requirements for EMC

This section illustrates the installation requirements for passing the EMC test. Please note that the EMC rating varies based on the installation structure or wiring. Delta servo products are designed in accordance with the specifications of the EMC test. Refer to the following diagram for the standard installation.



Note:

*1. Use shielded wires.

2.7.1 EMI filters

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

Power	Servo drive model	Recommended EMI filter	
		1PH	3PH
100 W	ASD-A3-0121-☐	EMF023A21A	EMF10AM23A
200 W	ASD-A3-0221-☐	EMF023A21A	EMF10AM23A
400 W	ASD-A3-0421-☐	EMF023A21A	EMF10AM23A
750 W	ASD-A3-0721-☐	EMF023A21A	EMF10AM23A
1000 W	ASD-A3-1021-☐	EMF023A21A	EMF10AM23A
1500 W	ASD-A3-1521-☐	EMF023A21A	EMF24AM23B
2000 W	ASD-A3-2023-☐	-	EMF24AM23B
3000 W	ASD-A3-3023-☐	-	EMF24AM23B

Note: in the servo drive model column, ☐ represents the model code.

General precautions for installation

To ensure the best performance of the EMI filter, apart from the instruction and wiring of the servo drive, refer 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 to install one servo drive with one EMI filter.

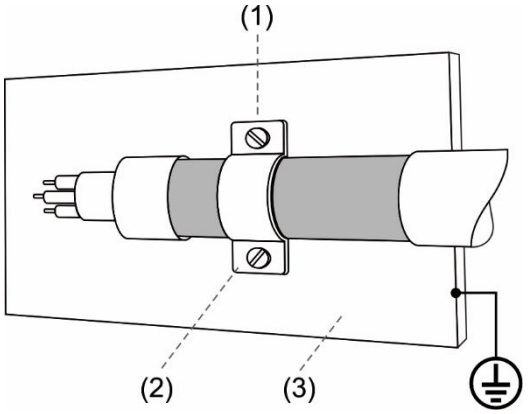
More specifications for mounting the servo drive are listed below:

1. EN61000-6-4 (2001)
2. EN61800-3 (2004) PDS of category C2
3. EN55011+A2 (2007) Class A Group 1

Motor cable selection and installation precautions

The selection of motor cable (refer to Appendix B Accessories) and installation accuracy determine the performance of the EMI filter. Follow the precautions below:

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



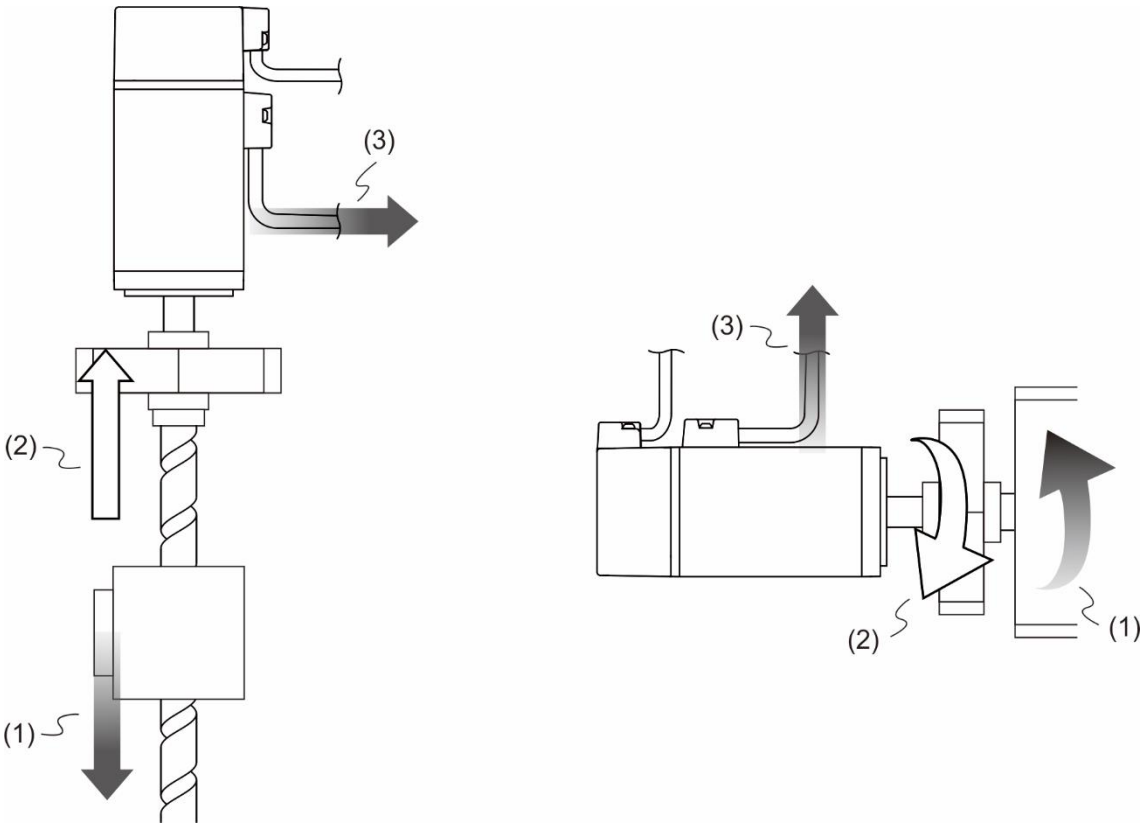
(1) Remove the protective paint on the U-shape saddle and metal plate to ensure good contact.

(2) U-shape saddle

(3) Well-grounded metal plate

2.8 Selecting the regenerative resistor

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, it is consumed by a regenerative resistor. The servo drive has a built-in regenerative resistor; you can also use an external regenerative resistor if needed.



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

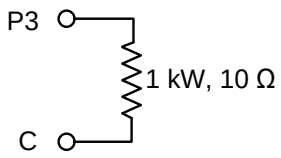
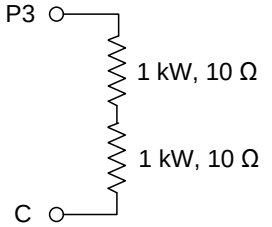
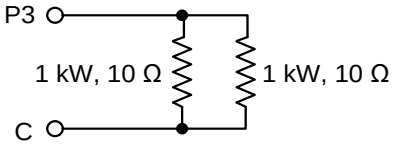
Specifications of the built-in regenerative resistor in the ASDA-A3 are as follows:

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 (P1.052) (Ohm)	Capacity (P1.053) (Watt)		
0.1	-	-	-	60
0.2	-	-	-	60
0.4	100	40	20	60
0.75	100	40	20	60
1.0	100	40	20	30
1.5	100	40	20	30
2.0	20	80	40	15
3.0	20	80	40	15

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

1. Choose the correct 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. For general applications, you can connect more than one resistor in series. If the value (from resistors connected in series) exceeds the rated range, you can reduce the value by connecting the resistors in parallel. If you want to connect the resistors in parallel to increase the power of the regenerative resistors, make sure the resistance value meets the requirements.

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

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

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

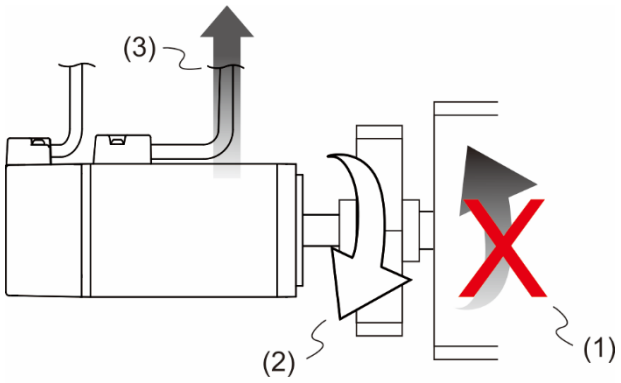
2

When installing an external regenerative resistor, connect the resistor to P3 and C contacts, and P3 and D contacts are left open. It is recommended that you choose external regenerative resistors of the resistance values specified in the table on page 2-18. For easy calculation of the regenerative resistor capacity, except for the energy consumed by IGBT, there are two ways provided to calculate the capacity 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.

Servo drive (kW)		Motor	Rotor inertia ($\times 10^{-4}$kg.m^2)	Regenerative energy generated when the motor decelerates from the rated speed to 0 without load Eo (joule)	Maximum regenerative energy of the capacitance Ec (joule)
Low inertia	0.1	ECM-A3L-C□040F□□1	0.0229	0.11	8.42
	0.1	ECM-A3L-C□0401□□1	0.04	0.20	8.42
	0.2	ECM-A3L-C□0602□□1	0.09	0.45	8.42
	0.4	ECM-A3L-C□0604□□1	0.15	0.74	8.42
	0.4	ECM-A3L-C□0804□□1	0.352	1.74	8.42
	0.75	ECM-A3L-C□0807□□1	0.559	2.76	26.21
Medium inertia	1.0	ECMC-C□1010□□	2.65	13.1	26.21
	1.0	ECMC-E□1310□□	8.41	18.48	26.21
	1.5	ECMC-E□1315□□	11.2	24.62	26.21
	2.0	ECMC-E□1320□□	14.6	32.09	34.94
	2.0	ECMC-E□1820□□	34.7	76.26	34.94

Servo drive (kW)		Motor	Rotor inertia ($\times 10^{-4}$kg.m^2)	Regenerative energy generated when the motor decelerates from the rated speed to 0 without load Eo (joule)	Maximum regenerative energy of the capacitance Ec (joule)
	3.0	ECMC-E[1]1830[2][3]	55	120.88	34.94
	3.0	ECMC-F[1]1830[2][3]	55	67.99	34.94
High inertia	0.1	ECM-A3H-C[1]040F[2][3]1	0.0455	0.23	8.42
	0.1	ECM-A3H-C[1]0401[2][3]1	0.0754	0.37	8.42
	0.2	ECM-A3H-C[1]0602[2][3]1	0.25	1.24	8.42
	0.4	ECM-A3H-C[1]0604[2][3]1	0.45	2.23	8.42
	0.4	ECM-A3H-C[1]0804[2][3]1	0.92	4.55	8.42
	0.75	ECM-A3H-C[1]0807[2][3]1	1.51	7.47	26.21
	1.0	ECMC-F[1]1308[2][3]	13.6	16.81	26.21
	2.0	ECMC-F[1]1313[2][3]	20	24.73	26.21
	2.0	ECMC-F[1]1318[2][3]	24.9	30.78	26.21

Note:

1. In the motor column, [1] represents the encoder type.
2. In the motor column, [2] represents the brake or keyway / oil seal type.
3. In the motor column, [3] represents the shaft diameter.
4. Models with an * means that this type of motor is coming soon.

Assume that the load inertia is N times the motor inertia, and when the motor decelerates from 3,000 rpm to 0, the regenerative energy is (N+1) × Eo and the regenerative resistor needs to consume (N+1) × Eo - Ec joules. Assume that the reciprocating motion cycle is T sec, then the required power of regenerative resistor = 2 × ((N+1) × Eo – Ec) / T. The calculation is as follows:

Step	What to do	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 operation cycle (T).	Manual input.
3	Set the rotation speed (wr).	Manual input or read the status with P0.002.
4	Set the load / motor inertia ratio (N).	Manual input or read the status with P0.002.
5	Calculate the maximum regenerative energy (Eo).	Eo = J * wr^2/182
6	Find the regenerative energy that can be absorbed by the capacitor (Ec).	Refer to the table above.
7	Calculate the required capacity of the regenerative resistor.	2 × ((N+1) × Eo - Ec) / T

2

Example:

For the motor ECM-A3L-CY0604RS1 (400 W), the reciprocating motion cycle is T = 0.4 sec. Its maximum rotation speed is 3,000 rpm and the load inertia is 15 times of the motor inertia.

Servo drive (kW)	Motor	Rotor inertia J (× 10^{-4}kg.m^2)	Regenerative energy generated when the motor decelerates from the rated speed to 0 without load Eo (joule)	Maximum regenerative energy of the capacitance Ec (joule)
0.4	ECM-A3L-CY0604RS1	0.15	0.74	8.42

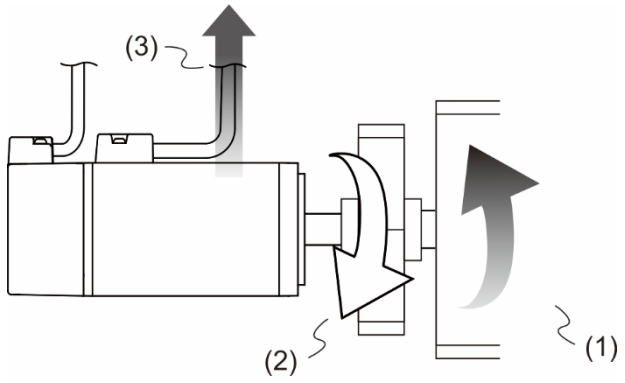
Find the maximum regenerative energy: Eo = 0.74 joules (from the table above).

Find the regenerative energy that can be absorbed by the capacitor: Ec = 8.42 joules (from the table above).

The required capacity of the regenerative resistor = $\frac{2\times((N+1)\times E_0-E_C)}{T} = \frac{2\times((15+1)\times 0.74-8.42)}{0.4}$ = 17.1 W.

From the calculation above, the required power of the regenerative resistor is 17.1 W, which is smaller than the specified capacity. In this case, a built-in 40 W regenerative resistor 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 power 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, the motor does positive work and the motor's torque direction is identical to the rotation direction. However, in some instances, 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 DC Bus is full and cannot store more energy, this energy is consumed by the regenerative resistor.

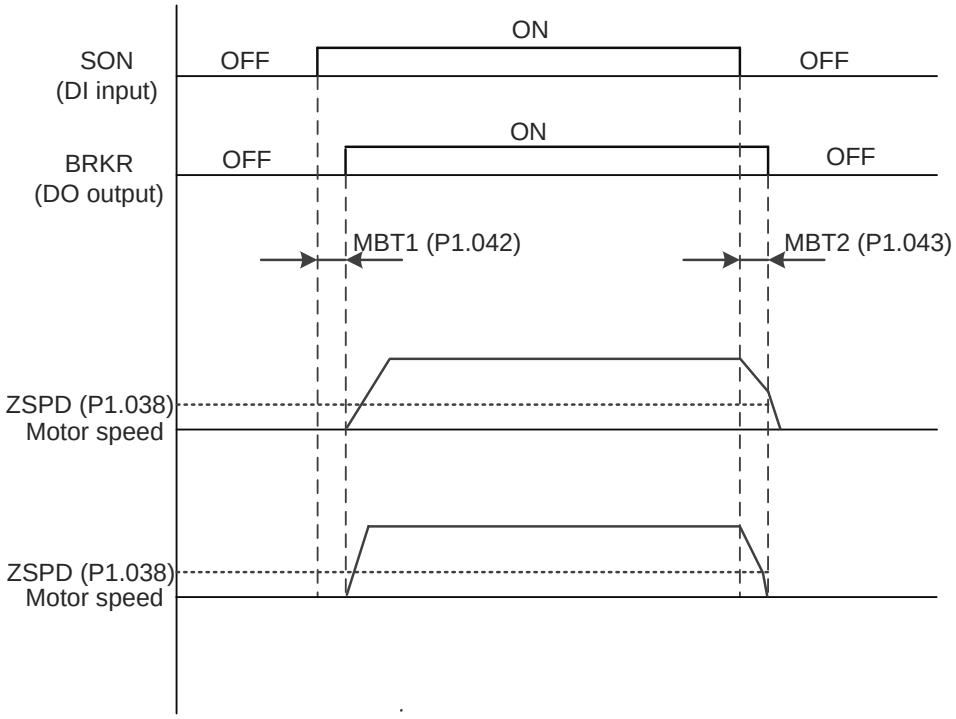
Example:

For a 400 W motor (ECM-A3L-CY0604RS1), and the torque of the external load is +70% of the rated torque (1.27 N-m) with rotation speed up to 3,000 rpm, the required external regenerative resistor is: $2 \times (0.7 \times 1.27) \times (\frac{3000 \times 2 \times \pi}{60})$ = 558 W. So, a regenerative resistor of 560 W and 40 Ω is needed.

2.9 The use of braking

A brake is usually used for motions in Z-axis direction because gravity causes the mechanism to fall. A brake can prevent the mechanism 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) to set the delay time.

Timing diagram of brake control:

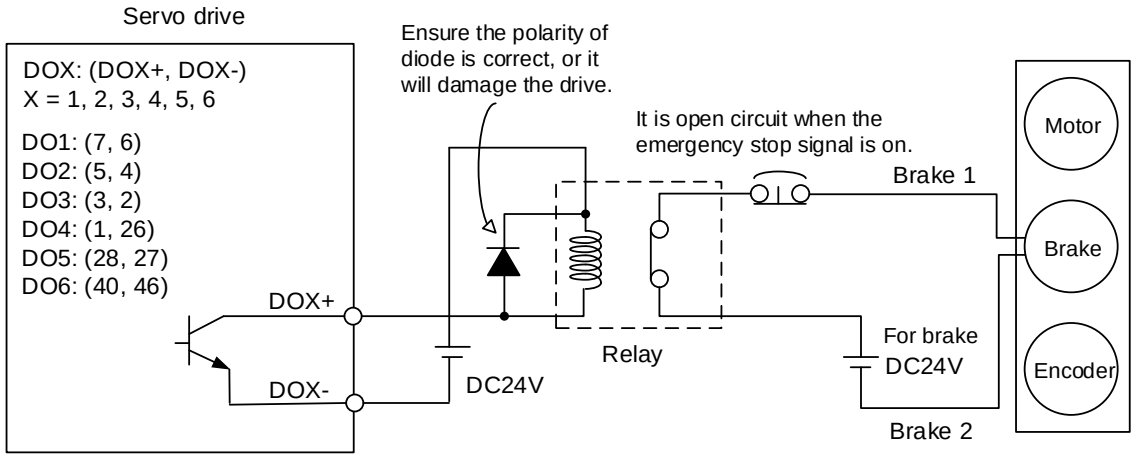


Output timing of the BRKR signal:

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).

2

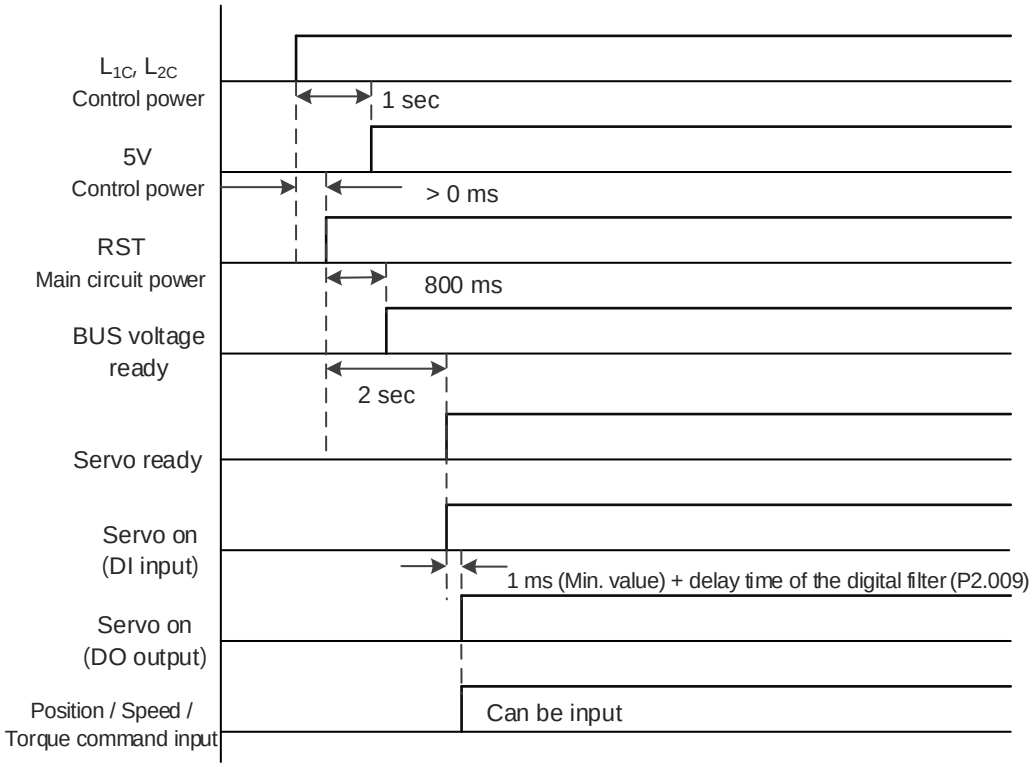
Wiring of the brake:



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. Please note that there is no polarity for the brake coil.

Timing diagram of control power and main power:



Calculate the brake's rated current (ECM-A3L-CY0604RS1 is used as an example here).

Power consumption of the brake (20°C) = 6.5 W (refer to Appendix A Specifications),

so the brake's rated current = $\frac{6.5\ \mathrm{W}}{24\mathrm{V}}$ = 0.27 A

Wiring

3

This chapter illustrates the power supply circuit, connectors, and wiring for each mode of the ASDA-A3.

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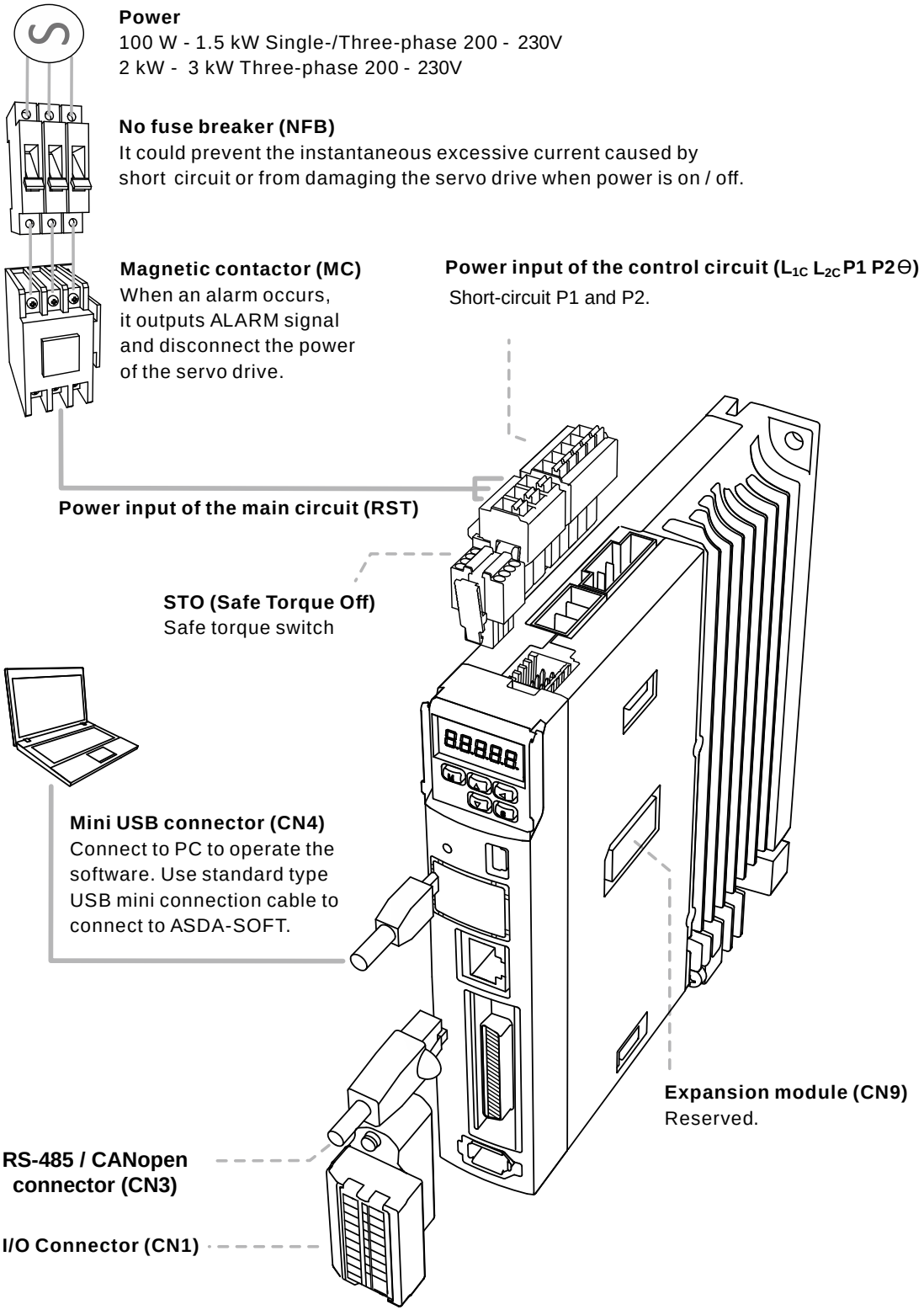
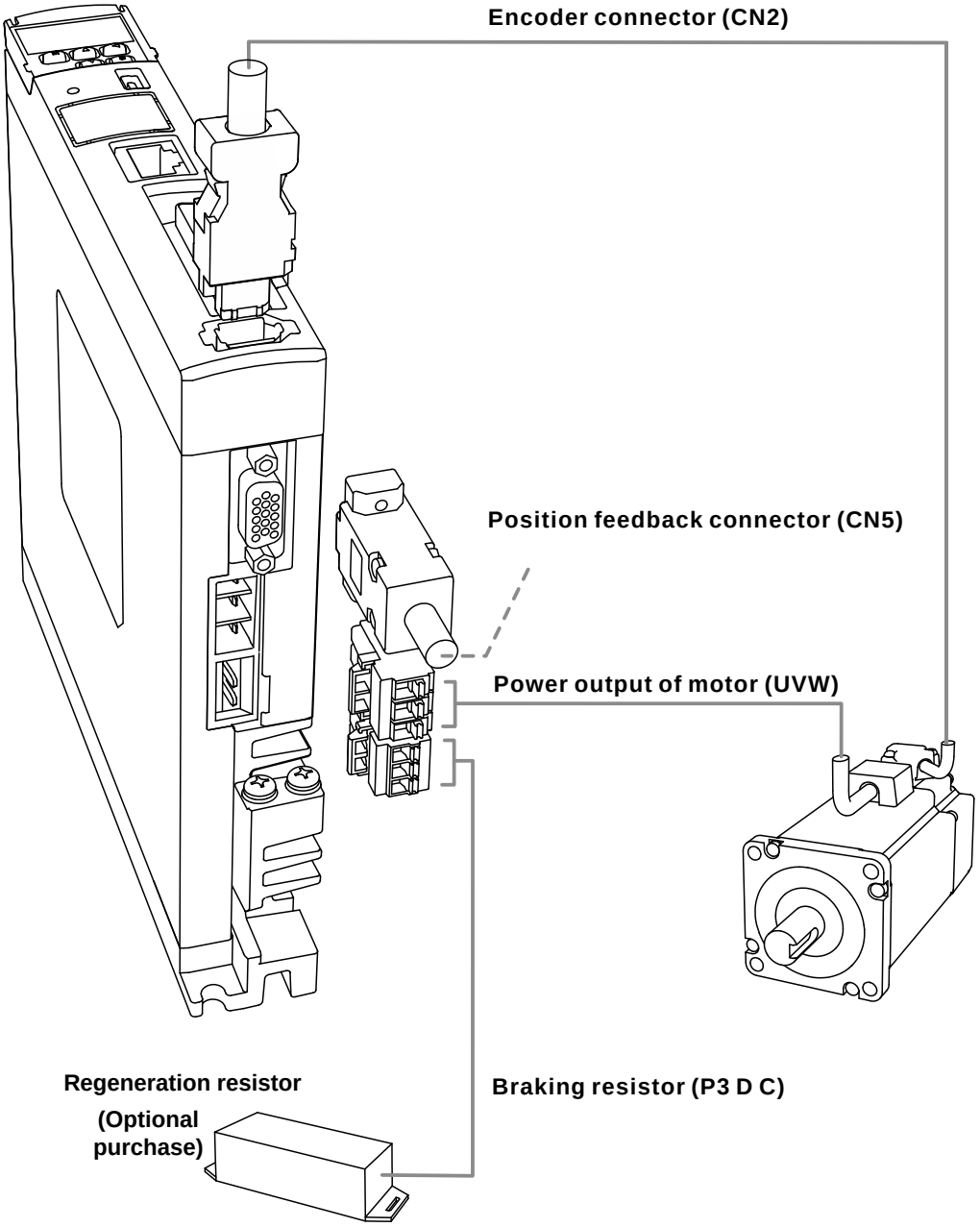
3.1 System connection

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





Installation safety precautions:

1. Make sure the power and wiring connections between the R, S, T, and L_{1C}, L_{2C} are correct. Refer to Appendix A Specifications for the correct voltage input to avoid any damage to the servo drive and dangerous operating conditions.
2. Make sure the UVW terminal block is correctly wired to avoid abnormal operation of the motor.
3. When installing an external regenerative resistor, P3 and D contacts should be left open, and the external regenerative resistor should connect to P3 and C contacts. When using the built-in regenerative resistor, P3 and D contacts should be short-circuited, and P3 and C contacts should be left open.
4. When an alarm occurs or the system is under emergency stop status, use DO.ALARM or DI.WARN to disconnect the power at the magnetic contactor (MC) so as to power off the servo drive.

3.1.2 Connectors and terminal blocks

Symbol	Name	Description
L_{1C}, L_{2C}	Power input for the control circuit	Connect to single-phase AC power (refer to the model specification for the proper input voltage).
P1, P2	-	Short-circuit P1 and P2.
R, S, T	Power input for the main circuit	Connect to three-phase AC power (refer to the model specification for the proper input voltage).
U, V, W, FG	Motor power connector	Connect to the servo motor.

Symbol	Wire color	Description
U	Red	A three-phase main power cable for the motor.
V	White	
W	Black	
FG	Green	Connect to the ground terminal ⏚ for the servo drive.

Symbol	Name	Description	
P3, D, C, ⊖	Regenerative resistor terminal or braking unit	Use the built-in resistor	P3 and D contacts are short-circuited, and P3 and C contacts are left open.
		Use an external resistor	P3 and C contacts connect to the resistor, and P3 and D contacts are left open.
		Use an external braking unit	Connect the external braking unit to P3 and ⊖ of the servo drive. P3 & D contacts and P3 & C contacts are left open.
⏚	Ground terminal	Connect to the ground wire for the power and servo motor.	
CN1	I/O connector (optional purchase)	Connect to the controller. Refer to Section 3.3 for more information.	
CN2	Connector for the encoder (optional purchase)	Connect to the encoder or converter box. Refer to Section 3.4 for more information.	
CN3	Connector of RS-485 and CANopen (optional purchase)	For RS-485 and CANopen. Refer to Section 3.5 for more information.	
CN4	Mini USB connector (optional purchase)	Connect to PC or notebook. Refer to Section 3.6 for more information.	
CN5	Position feedback connector (optional purchase)	Connect to an external linear scale or encoder for full-closed loop and motor feedback. Refer to Section 3.8 for more information.	
CN6	DMCNET connector (optional purchase)	For DMCNET communication. Refer to Section 3.8 for more information.	
CN9	Expansion module	Reserved.	
CN10	STO	Connect to STO. Refer to Section 3.9 for more information.	
CN11	Reserved	Reserved.	
CN12	Reserved	Reserved.	

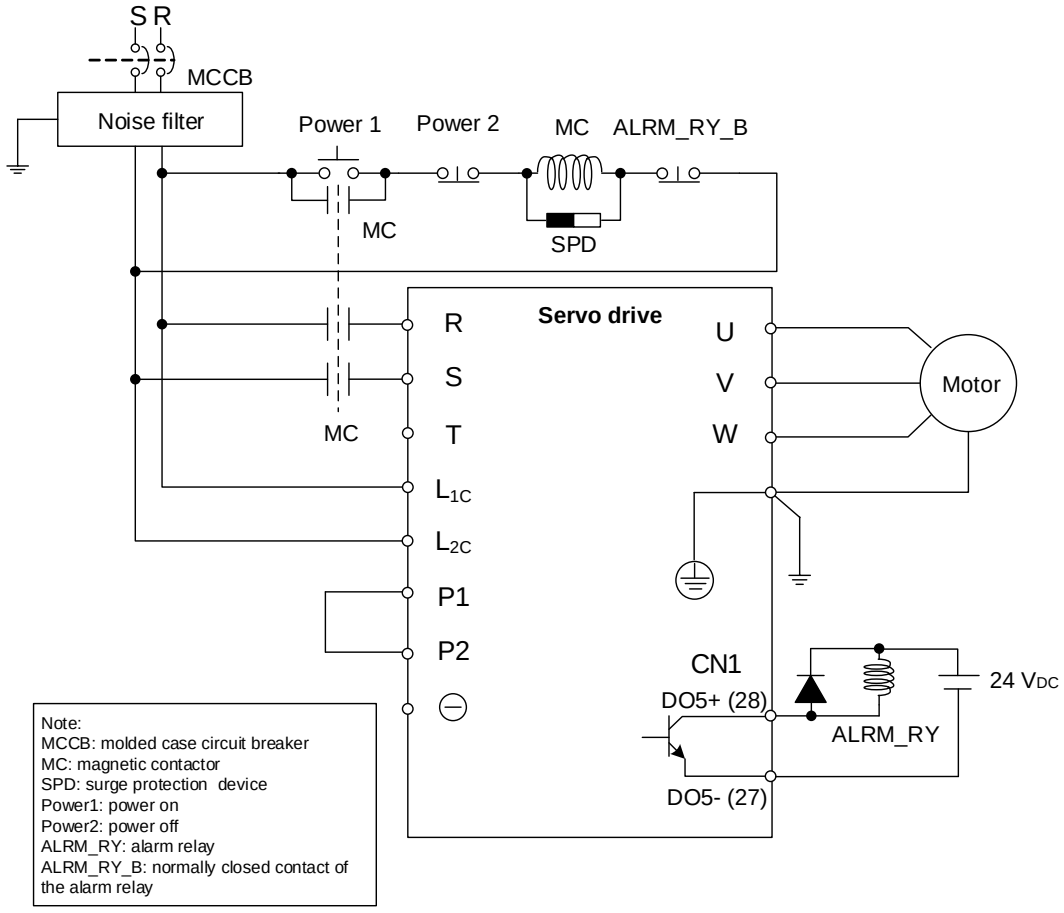
Pay special attention to the following when wiring:

1. When the power is off, do not touch R, S, T and U, V, W since the capacitance inside the servo drive can still contain a dangerously large amount of electric charge. Wait until the charging light is off.
2. Separate R, S, T and U, V, W from other wires. The separation should be at least 30 cm (11.8 inches).
3. If the connection cable for CN2 (encoder) or CN5 (position feedback connector) is not long enough, use a shielded twisted-pair cable that conforms to UL2464 specifications. If it is over 20 meters (65.62 ft), choose a signal cable with the diameter two times greater to avoid excessive signal attenuation.
4. When using RS-485, CAN, and DMCNET, use the standard shielded twisted-pair cable to ensure the communication quality.
5. When selecting the wires, refer to Section 3.1.6.
6. Do not use any external capacitor, or it might damage the servo drive.

3.1.3 Wiring for power supply

There are two methods for wiring the power supply: single-phase and three-phase. In the following diagram, Power 1 is normally open, and Power 2 and ALRM_RY_B are normally closed. MC (magnetic contactor) is the power relay and the contact for the main power circuit.

■ Wiring method for single-phase power supply (for models of 1.5 kW and below)



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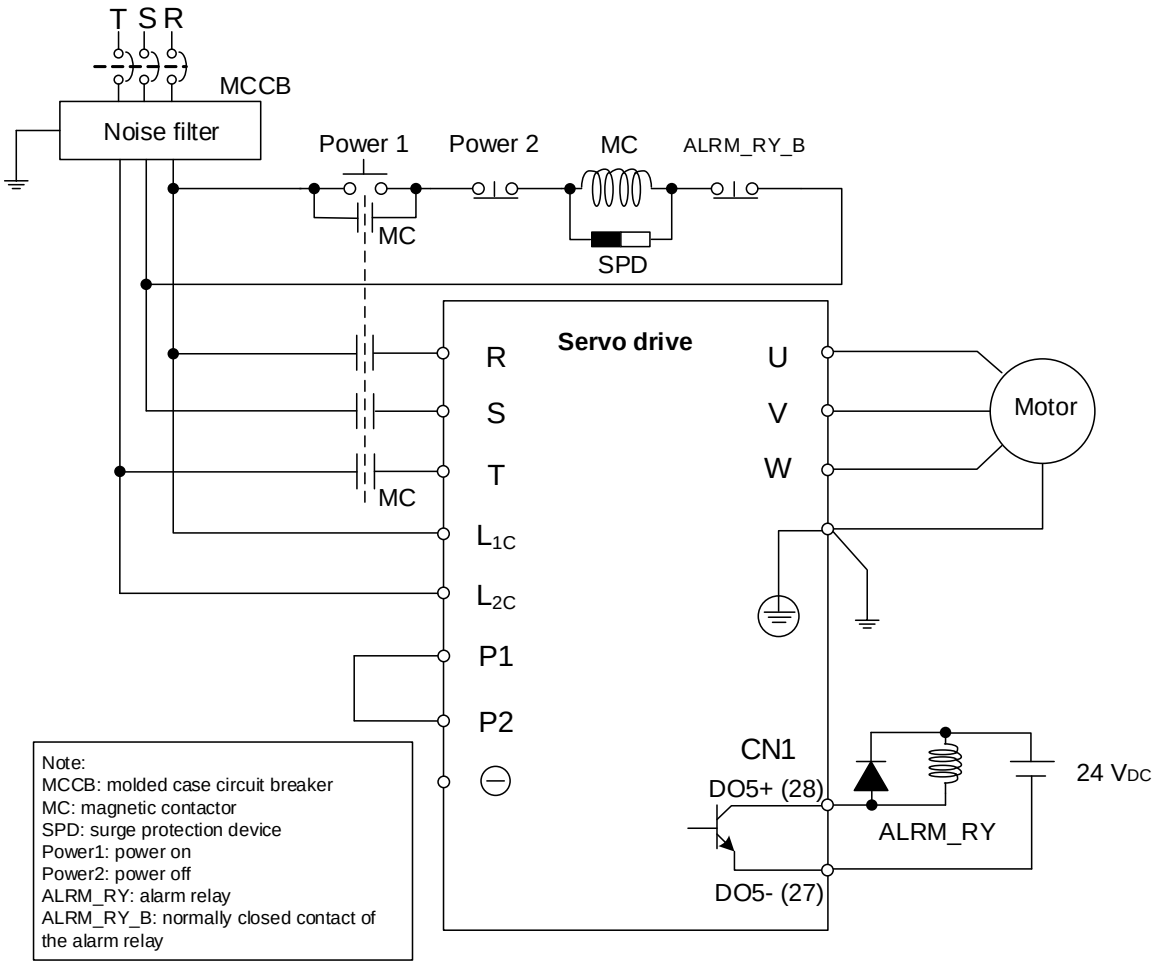
■ Wiring method for three-phase power supply (for all series)



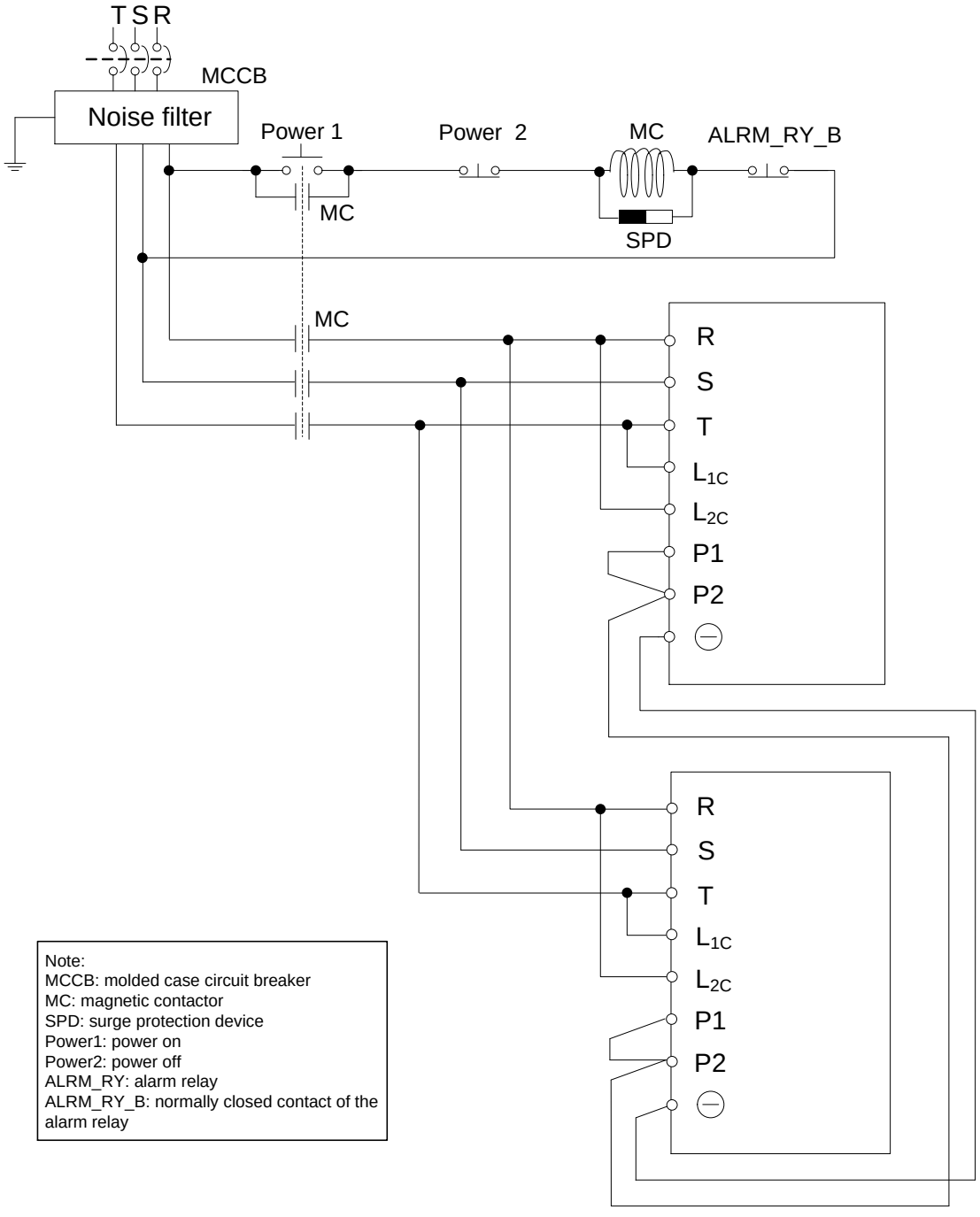
■ Connecting multiple servo drives (in series)

Using a common DC-BUS can increase the efficiency of the regenerative energy.

For instance, while one of the axes is decelerating, the regenerative energy can supply other axes. If you need to connect servo drives of different power levels, only models of similar power levels can be connected; moreover, the regenerative resistor (or braking unit) should connect to the servo drive with a higher power level.

Example (a servo system only allows servo drives with two different power levels)

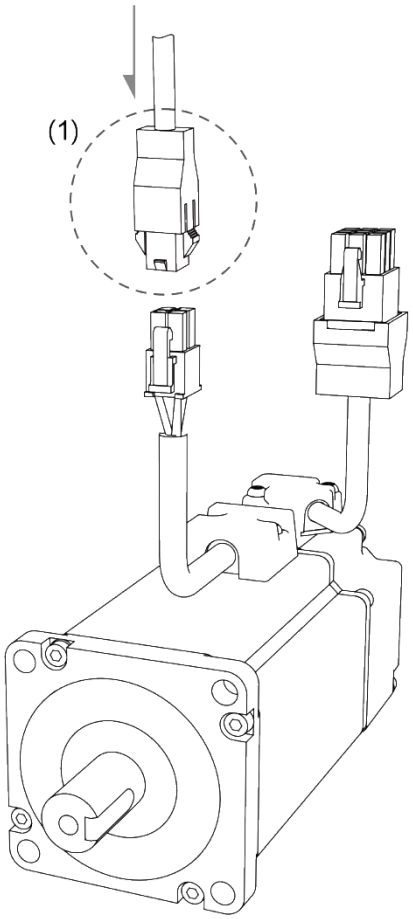
1. If there is a 400 W servo drive in the system, you can connect a 200 W servo drive, and the regenerative resistor (or braking unit) should connect to the 400 W servo drive.
2. If there is a 400 W servo drive in the system, you can connect a 750 W servo drive, and the regenerative resistor (or braking unit) should connect to the 750 W servo drive.



Note:
MCCB: molded case circuit breaker
MC: magnetic contactor
SPD: surge protection device
Power1: power on
Power2: power off
ALRM_RY: alarm relay
ALRM_RY_B: normally closed contact of the alarm relay

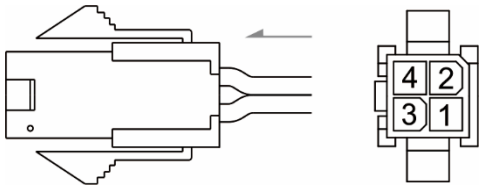
3

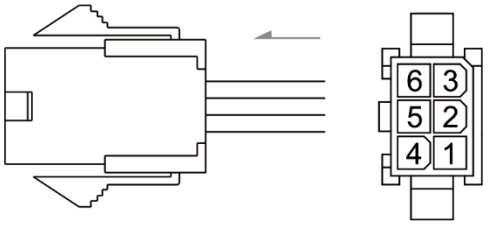
3.1.4 UVW connectors for the ASDA-A3 servo drive



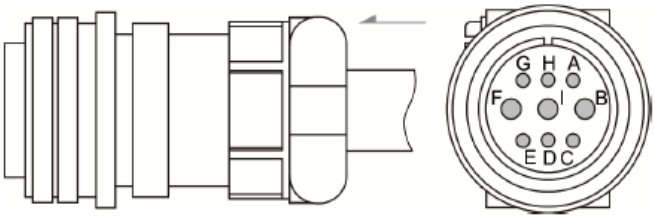
Note: pin assignments of the A3 and A2 models are the same. For easier wiring, A3's connector illustration (angle of viewing) is changed, which is different from that of A2.

Refer to the following table for UVW connector specifications.

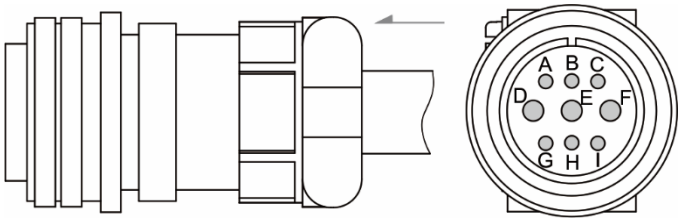
Motor model	UVW connector					
ECM-A3□1-C□2040F□3□4 (50 W) ECM-A3□1-C□2040□3□4 (100 W) ECM-A3□1-C□2060□3□4 (200 W) ECM-A3□1-C□2060□3□4 (400 W) ECM-A3□1-C□2080□3□4 (400 W) ECM-A3□1-C□2080□3□4 (750 W)						
	Pin assignment					
	U (Red)	V (White)	W (Black)	CASE GROUND (Green / Yellow)	BRAKE1 (Note)	BRAKE2 (Note)
	1	2	3	4	-	-

Motor model	UVW connector
ECM-A3[1]-C[2]040F[3][4] (50 W) ECM-A3[1]-C[2]0401[3][4] (100 W) ECM-A3[1]-C[2]0602[3][4] (200 W) ECM-A3[1]-C[2]0604[3][4] (400 W) ECM-A3[1]-C[2]0804[3][4] (400 W) ECM-A3[1]-C[2]0807[3][4] (750 W)	

Pin assignment					
U (Red)	V (White)	W (Black)	CASE GROUND (Green / Yellow)	BRAKE1 (Note)	BRAKE2 (Note)
1	2	4	5	3	6

Motor model	UVW connector
ECMC-F[2]1308[3][4] (850 W) ECMC-C[2]1010[3][4] (1000 W) ECMC-E[2]1310[3][4] (1000 W) ECMC-F[2]1313[3][4] (1300 W) ECMC-E[2]1315[3][4] (1500 W) ECMC-F[2]1318[3][4] (1800 W) ECMC-E[2]1320[3][4] (2000 W)	

Pin assignment					
U (Red)	V (White)	W (Black)	CASE GROUND (Green / Yellow)	BRAKE1 (Note)	BRAKE2 (Note)
F	I	B	E	G	H

Motor model	UVW connector
ECMC-E[2]1820[3][4] (2000 W) ECMC-E[2]1830[3][4] (3000 W) ECMC-F[2]1830[3][4] (3000 W)	

Pin assignment					
U (Red)	V (White)	W (Black)	CASE GROUND (Green / Yellow)	BRAKE1 (Note)	BRAKE2 (Note)
D	E	F	G	A	B

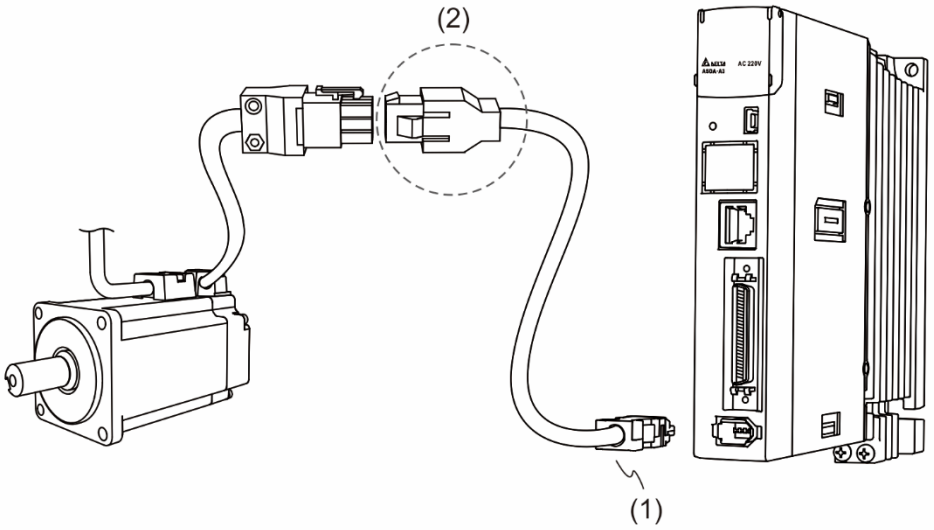
Wire selection: use a 600 V_{AC} PVC cable with the length less than 30 meters (98.43 feet). If it is longer than 30 meters (98.43 feet), refer to the voltage drop (wire impedance) to select the cable size. See Section 3.1.6 for more information.

Note:

1. In the motor model column, [1] represents the motor inertia, [2] represents the encoder type, [3] represents the brake or keyway / oil seal type, and [4] represents the shaft diameter.
2. The brake coil has no polarity. Its pin symbols are BRAKE 1 & BRAKE2.
3. Power supply for the brake is 24 V_{DC}. Do not share the same power supply with control signals.
4. Color of brake cable F40 - F86: brown and blue; color of brake cable F100 or above: red and black.

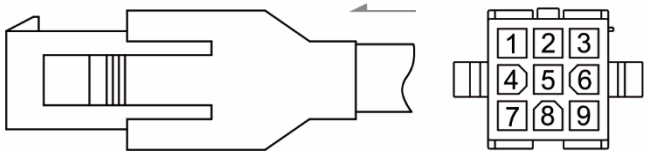
3.1.5 Specification for the encoder connector

Encoder connection (Diagram 1): Quick connector

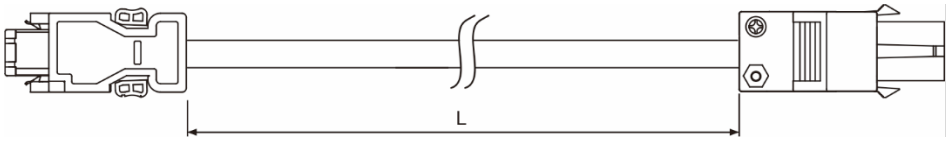


(1) CN2 connector (2) Quick connector (male)

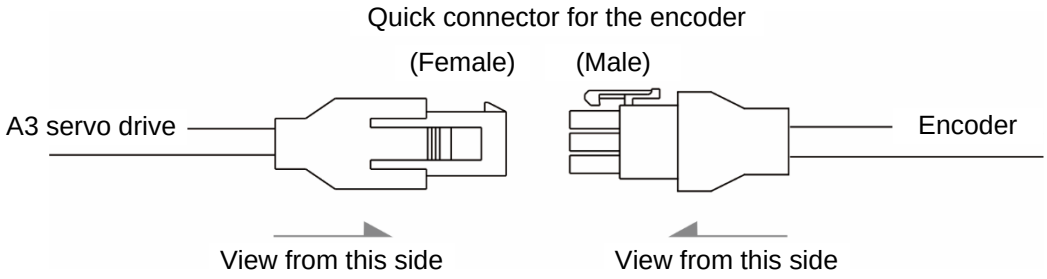
Note: the diagram shows the connection between the servo drive and the encoder, and it is not drawn to scale. The specification is subject to change depending on the selected servo drive and motor models.

Motor model	Quick connector (male)
ECM-A3[1]-C[2]040F[3][4] (50 W) ECM-A3[1]-C[2]0401[3][4] (100 W) ECM-A3[1]-C[2]0602[3][4] (200 W) ECM-A3[1]-C[2]0604[3][4] (400 W) ECM-A3[1]-C[2]0804[3][4] (400 W) ECM-A3[1]-C[2]0807[3][4] (750 W)	

Specifications and pin assignment for the incremental encoder connector



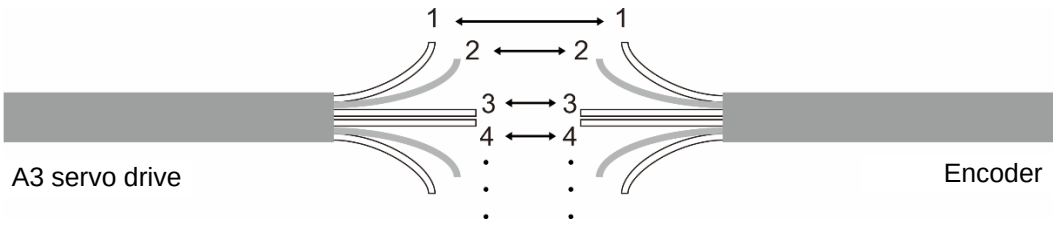
Model name	L	
	mm	inch
ACS3-CAEF1003	3000 ± 50	118 ± 2
ACS3-CAEF1005	5000 ± 50	197 ± 2
ACS3-CAEF1010	10000 ± 100	394 ± 4
ACS3-CAEF1020	20000 ± 100	788 ± 4



1 White T+	2 Reserved	3 Reserved
4 White/Red T-	5 Reserved	6 Reserved
7 Brown DC+5V	8 Blue GND	9 Shield

3 Reserved	2 Reserved	1 White T+
6 Reserved	5 Reserved	4 White/Red T-
9 Shield	8 Blue GND	7 Brown DC+5V

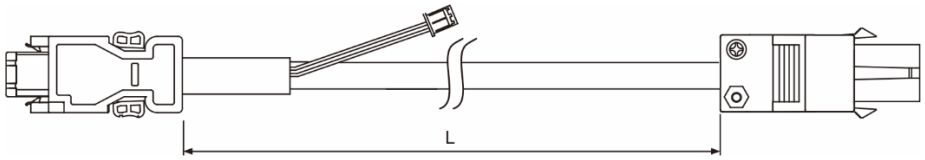
The wire color for the ASDA-A3 servo drive is for reference only. Refer to the actual servo drive.



To directly connect the wires without using the connectors, wire them according to the corresponding wire number (shown above). For example, connect wire No. 1 of the servo drive to No. 1 of the motor encoder; connect wire No. 2 of the servo drive to wire No. 2 of the motor encoder, and so on. Number the wires of the servo drive in sequence and then connect them to the encoder.

3

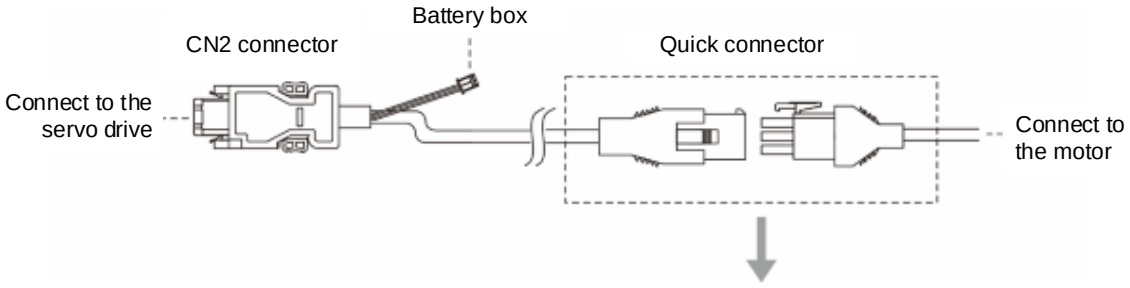
Specification and pin assignment for the absolute encoder connector

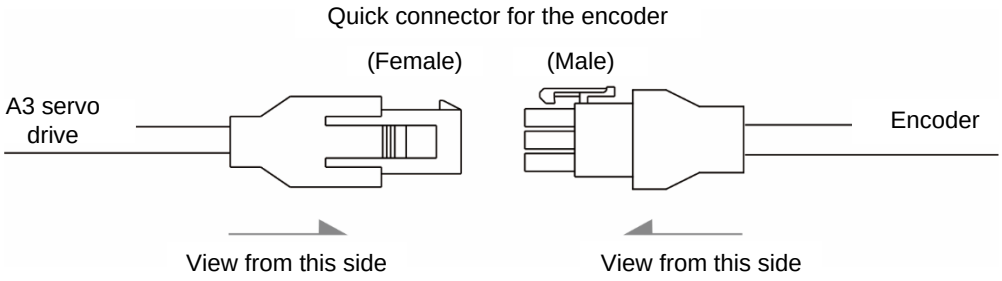


Model name	L	
	mm	inch
ACS3-CAEB1003	3000 ± 50	118 ± 2
ACS3-CAEB1005	5000 ± 50	197 ± 2
ACS3-CAEB1010	10000 ± 100	394 ± 4
ACS3-CAEB1020	20000 ± 100	788 ± 4

Connection method:

Caution Please wire as the following instructions. Incorrect wiring may cause battery explosion.



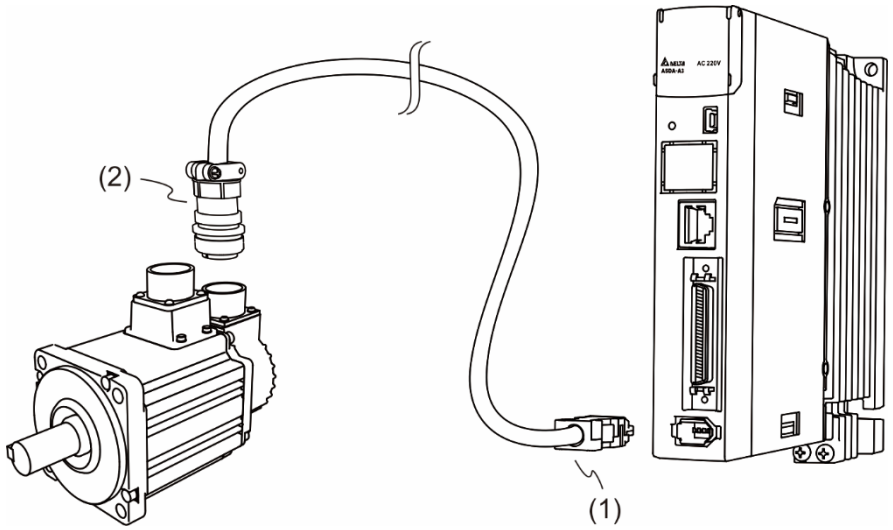


1 White T+	2 Red BAT+	3 Reserved
4 White/Red T-	5 Black BAT-	6 Reserved
7 Brown DC+5V	8 Blue GND	9 Shield

3 Reserved	2 Black BAT+	1 White T+
6 Reserved	5 Black/Red BAT-	4 White/Red T-
9 Shield	8 Blue GND	7 Brown DC+5V

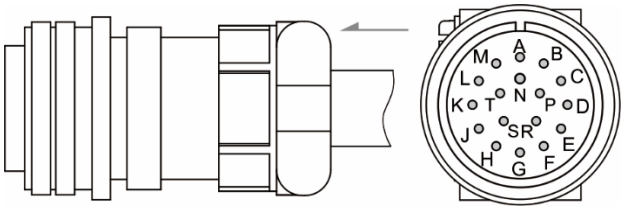
Note: the wire color of the ASDA-A3 servo drive is for reference only. Refer to the actual servo drive.

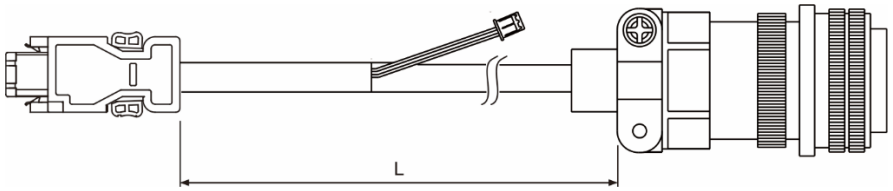
Encoder connection (Diagram 2): Military connector



(1) CN2 connector (2) Military encoder

Note: the diagram shows the connection between the servo drive and the encoder, and it is not drawn to scale. The specification is subject to change depending on the selected servo drive and motor models.

Motor model	Military connector
ECMC-F2 1308 3 4 ECMC-C2 1010 3 4 ECMC-E2 1310 3 4 ECMC-E2 1315 3 4 ECMC-E2 1320 3 4 ECMC-F2 1313 3 4 ECMC-F2 1318 3 4 ECMC-E2 1820 3 4 ECMC-E2 1830 3 4 ECMC-F2 1830 3 4	

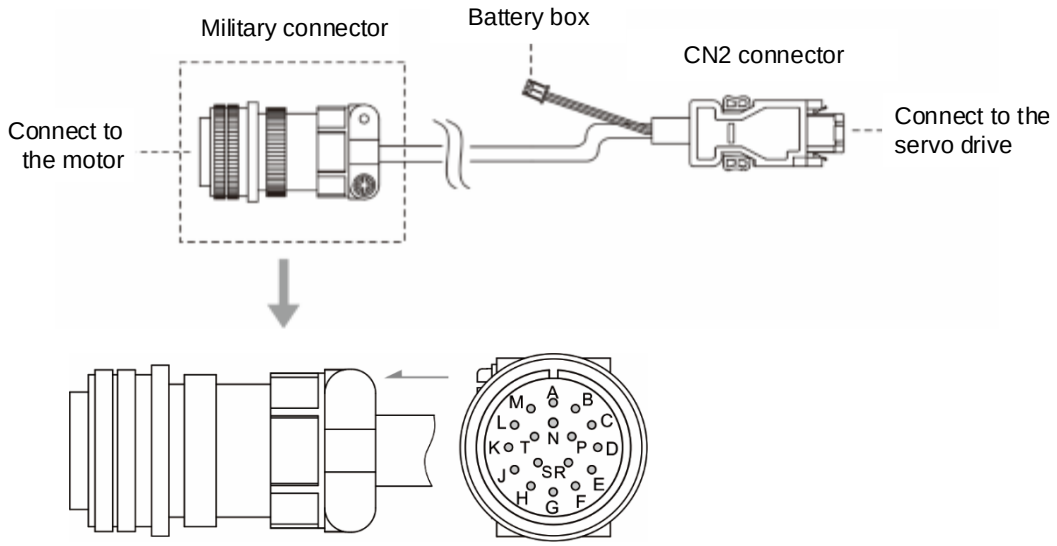


Model name (military)	Straight	L	
		mm	inch
ACS3-CAEB3003	3106A-20-29S	3000 ± 50	118 ± 2
ACS3-CAEB3005	3106A-20-29S	5000 ± 50	197 ± 2
ACS3-CAEB3010	3106A-20-29S	10000 ± 100	394 ± 4
ACS3-CAEB3020	3106A-20-29S	20000 ± 100	788 ± 4

3

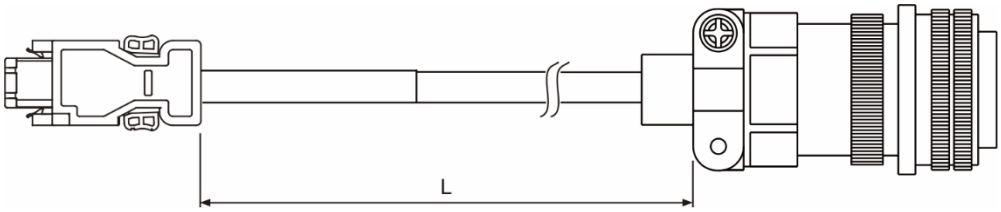
Connection method:

Caution Please wire as the following instructions. Incorrect wiring may cause battery explosion.



Pin No.	Symbol	Color
A	T+	White
B	T-	White / Red
C	BAT+	Red
D	BAT-	Black
S	DC+5V	Brown
R	GND	Blue
L	BRAID SHIELD	-

Note: if using an incremental type of encoder, connecting BAT+ and BAT- is not required.



Model name (military)	Straight	L	
		mm	inch
ACS3-CAEF3003	3106A-20-29S	3000 ± 50	118 ± 2
ACS3-CAEF3005	3106A-20-29S	5000 ± 50	197 ± 2
ACS3-CAEF3010	3106A-20-29S	10000 ± 100	394 ± 4
ACS3-CAEF3020	3106A-20-29S	20000 ± 100	788 ± 4

3.1.6 Wire selection

Refer to the requirements for doubling, and note the recommended wire for connectors and signal wiring for ASDA-A3 as listed in the following tables:

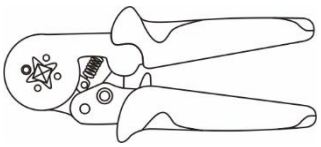
Note:

1. The shield should connect to the ⏚ phase of SHIELD.
2. When wiring, use the wires suggested in this section to avoid danger.

■ No doubling: single wire for one terminal

Terminal illustration:

Crimping tool (Delta part number: 3150165700):



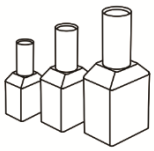
Servo drive and corresponding servo motor		Power cable - wire diameter (AWG)				
		U, V, W	P3, C	L_{1C}, L_{2C}, R, S, T, P1, P2		
				Bare wire	Crimping	Terminal type / part name
ASD-A3-0121	ECM-A3[1]-C[2]040F	18 AWG	14 AWG	12 – 24 AWG	14 – 24 AWG	DN02512D (14 AWG)
	ECM-A3[1]-C[2]0401					
ASD-A3-0221	ECM-A3[1]-C[2]0602			12 – 22 AWG	14 – 22 AWG	DN01512D (16 AWG)
ASD-A3-0421	ECM-A3[1]-C[2]0604			12 – 20 AWG	14 – 20 AWG	DN00712D (18 - 24 AWG)
	ECM-A3[1]-C[2]0804					
ASD-A3-0721	ECM-A3[1]-C[2]0807			12 – 16 AWG	14 – 16 AWG	DN02512D (14 AWG) DN01512D (16 AWG)
ASD-A3-1021	ECMC-F[2]1308	16 AWG	14 AWG	12 – 14 AWG	14 AWG	DN02512D
	ECMC-C[2]1010					
	ECMC-E[2]1310					
ASD-A3-1521	ECMC-E[2]1315			Single-phase: 14 AWG Three-phase: 12 – 14 AWG	Single-phase: N/A Three-phase: 14 AWG	Single-phase: N/A Three-phase: DN02512D
ASD-A3-2023	ECMC-E[2]1320	12 AWG		10 – 14 AWG	12 – 14 AWG	DN04012D (12 AWG) DN02512D (14 AWG)
	ECMC-F[2]1313					
	ECMC-F[2]1318					
	ECMC-E[2]1820					
ASD-A3-3023	ECMC-E[2]1830			10 – 12 AWG	12 AWG	DN04012D
	ECMC-F[2]1830					

Note: in the servo motor model, [1] represents the motor inertia and [2] represents the encoder type.

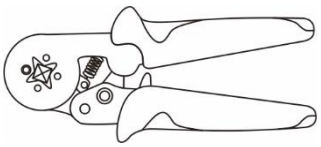
3

■ Doubling: two wires for one terminal

Terminal illustration:



Crimping tool (Delta part number: 3150165700):



Servo drive and corresponding servo motor		Power cable - wire diameter (AWG)				
		U, V, W	P3, C	L_{1C}, L_{2C}, R, S, T, P1, P2		
				Bare wire	Crimping	Terminal type / part name
ASD-A3-0121	ECM-A3[1]-C[2]040F	18 AWG	14 AWG	16 – 24 AWG	16 – 24 AWG	DN01512B
	ECM-A3[1]-C[2]0401					
ASD-A3-0221	ECM-A3[1]-C[2]0602			16 – 22 AWG	16 – 22 AWG	
ASD-A3-0421	ECM-A3[1]-C[2]0604			16 – 20 AWG	16 – 20 AWG	
	ECM-A3[1]-C[2]0804					
ASD-A3-0721	ECM-A3[1]-C[2]0807			16 AWG	16 AWG	
ASD-A3-1021	ECMC-F[2]1308	16 AWG	14 AWG	N/A	N/A	N/A
	ECMC-C[2]1010					
	ECMC-E[2]1310					
ASD-A3-1521	ECMC-E[2]1315					
ASD-A3-2023	ECMC-E[2]1320	12 AWG		16 – 20 AWG	16 – 20 AWG	DN02513B
	ECMC-F[2]1313					
	ECMC-F[2]1318			14 AWG	14 AWG	
	ECMC-E[2]1820					
ASD-A3-3023	ECMC-E[2]1830			N/A	N/A	N/A

Note: in the servo motor model, [1] represents the motor inertia and [2] represents the encoder type.

Servo drive model	Encoder cable - wire diameter mm² (AWG)			
	Size	Number	Specification	Standard length
ASD-A3-0121	Refer to Note 5.	2C+2P	L = 3 - 20 m (UL2464) L = 21 - 50 m (UL20276)	L = 3 - 20 m (9.84 ft - 65.6 ft) L = 21 - 50 m (68.9 ft - 164 ft)
ASD-A3-0221				
ASD-A3-0421				
ASD-A3-0721				
ASD-A3-1021				
ASD-A3-1521				
ASD-A3-2023				
ASD-A3-3023				

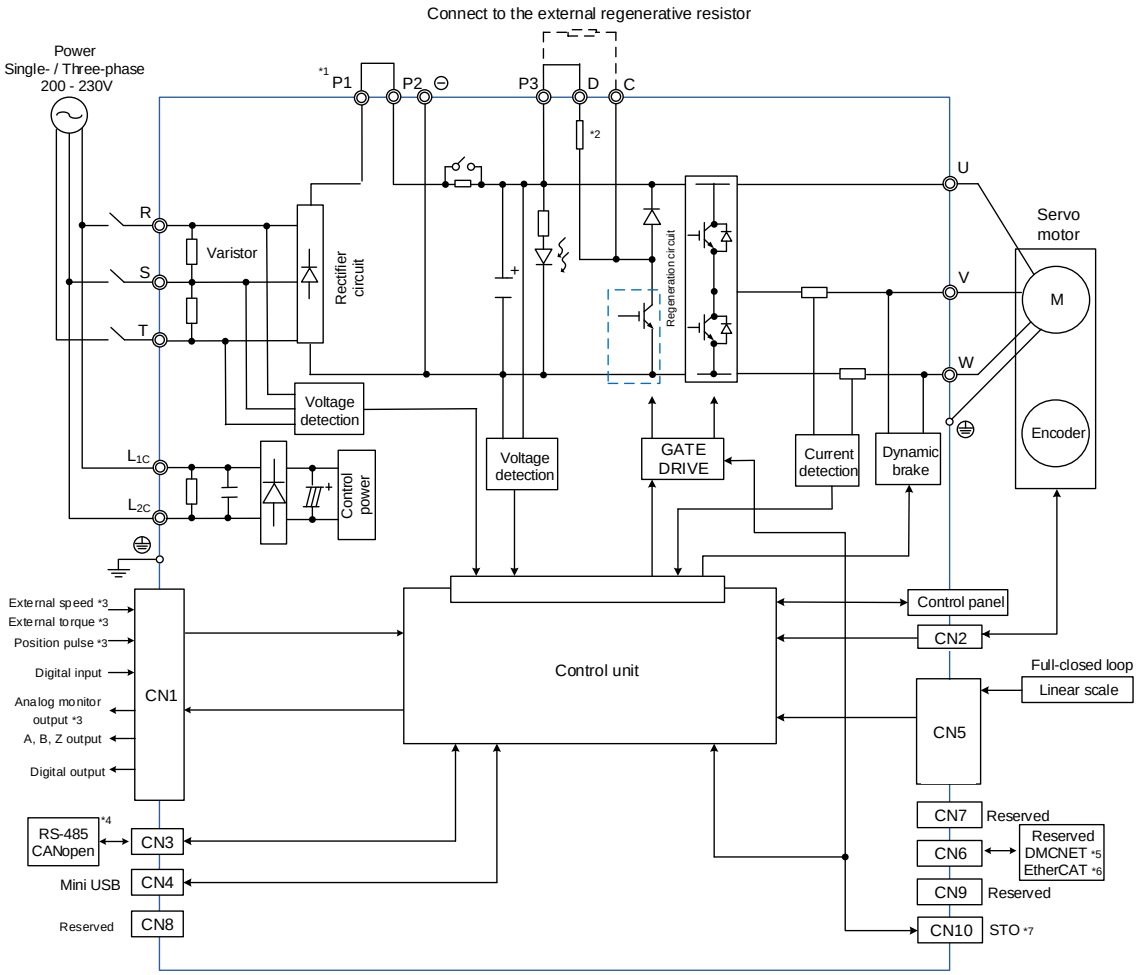
Note:

1. Use a shielded twisted-pair cable for wiring the encoder to reduce the noise interference.
2. The shield should connect to the ⏚ phase of SHIELD.
3. When wiring, use the wires suggested in this section to avoid danger.
4. Specification of brake cable F40 - F86: AWG22; specification of brake cable F100 or above: AWG20.
5. When the encoder cable length is 3 - 20 m (9.84 - 65.62 ft), 0.324 mm²-2C (AWG22-2C) is +5V and grounded, and 0.205 mm²-2P (AWG24-2P) is the signal cable.

   When the encoder cable length is 21 - 50 m (68.9 - 164.04 ft), 1.31 mm²-2C (AWG16-2C) is +5V and grounded, and 0.128 mm²-2P (AWG26-2P) is the signal cable.

3.2 Wiring diagram for the servo system

Models of 400 W and below



Note:

*1. Short-circuit P1 and P2 as illustrated in the diagram.

*2. Models of 200 W and below without built-in regenerative resistor; models of 400 W with built-in regenerative resistor.

*3. Functions that are not provided by A3-F and A3-E.

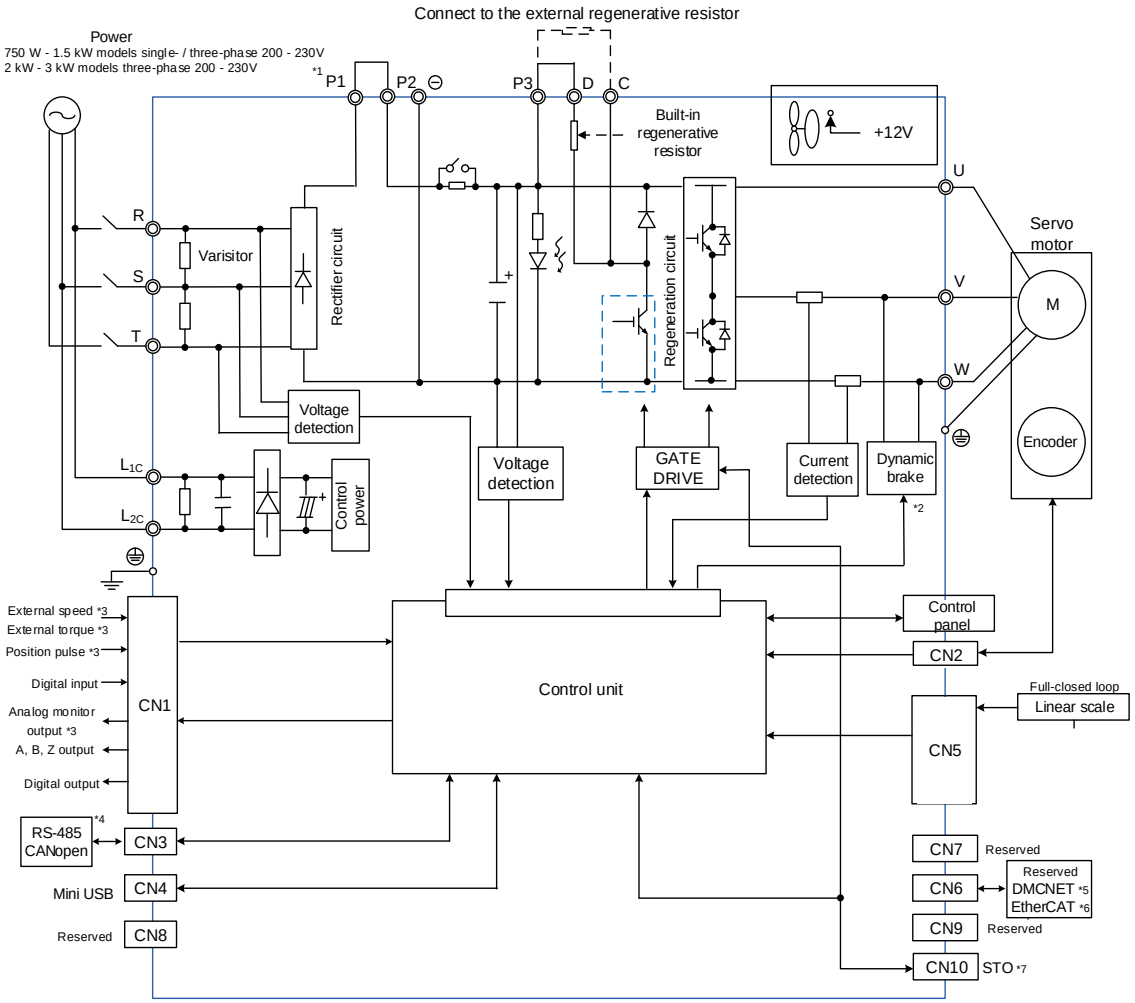
*4. Serial communication (RS-485) is available on A3-L and A3-M only; CANopen is available on A3-M only.

*5. DMCNET is available on A3-F only.

*6. EtherCAT is available on A3-E only.

*7. STO function is available on A3-M and A3-E only.

Models of 750 W – 3 kW (with built-in regenerative resistor and fan)



Note:

*1. Short-circuit P1 and P2 as illustrated in the diagram.

*2. The dynamic brakes of 2 kW – 3 kW models are three-phase and UVW is short-circuited.

*3. Functions that are not provided by A3-F and A3-E.

*4. Serial communication (RS-485) is available on A3-L and A3-M only; CANopen is available on A3-M only.

*5. DMCNET is available on A3-F only.

*6. EtherCAT is available on A3-E only.

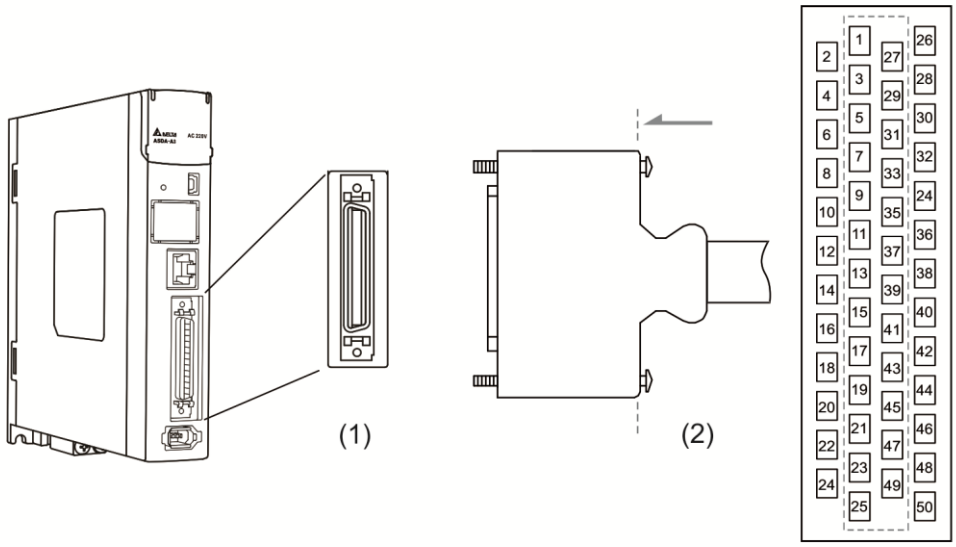
*7. STO function is available on A3-M and A3-E only.

3.3 Wiring for CN1 (I/O signal)

3.3.1 CN1 I/O connector (for A3-L and A3-M series)

3

The ASDA-A3 allows you to define 10 digital input (DI) points and 6 digital output (DO) points to provide highly flexible communication between the servo drive and the controller. For more information, refer to Section 3.3.5. In addition, differential type output signals for encoder A+, A-, B+, B-, Z+, and Z- are provided. Analog torque command input, analog speed / position command input, and pulse position command input are also available. The pin assignments are shown as follows:



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

Pin assignment:

Pin	Signal	Description	Pin	Signal	Description	Pin	Signal	Description
1	DO4+	Digital output	18	T_REF	Analog torque input	35	PULL HI_S (Sign)	External power input of Sign pulse
2	DO3-	Digital output	19	GND	Ground for analog / differential output signal	36	SIGN	Position sign (+)
3	DO3+	Digital output	20	NC	Not in use	37	/SIGN	Position sign (-)
4	DO2-	Digital output	21	OA	Encoder A pulse output	38	DI10-	Digital input
5	DO2+	Digital output	22	/OA	Encoder /A pulse output	39	PULL HI_P (Pulse)	External power input of pulse
6	DO1-	Digital output	23	/OB	Encoder /B pulse output	40	DO6-	Digital output
7	DO1+	Digital output	24	/OZ	Encoder /Z pulse output	41	/PULSE	Position pulse (-)
8	DI4-	Digital input	25	OB	Encoder B pulse output	42	V_REF	Analog command input speed / position (+)
9	DI1-	Digital input	26	DO4-	Digital output	43	PULSE	Position pulse (+)
10	DI2-	Digital input	27	DO5-	Digital output	44	GND	Ground for analog / differential output signal
11	COM+	Power input (24V ± 10%)	28	DO5+	Digital output	45	NC	Not in use
12	GND	Ground for analog / differential output signal	29	DI9-	Digital input	46	DO6+	Digital output
13	GND	Ground for analog / differential output signal	30	DI8-	Digital input	47	NC	Not in use
14	NC	Not in use	31	DI7-	Digital input	48	OCZ	Encoder Z pulse open-collector output
15	MON2	Analog monitor output 2	32	DI6-	Digital input	49	NC	Not in use
16	MON1	Analog monitor output 1	33	DI5-	Digital input	50	OZ	Encoder Z pulse line-driver output
17	NC	Not in use	34	DI3-	Digital input	-	-	-

Note: NC represents “No connection”, which is for internal use only. Do not connect to NC, or it may damage the servo drive.

3.3.2 Signal explanation for connector CN1 (for A3-L and A3-M series)

The following table details the signals listed in the previous section.

General signals:

Signal		Pin No.	Description	Wiring method (refer to Section 3.3.3)
Analog command (input)	V_REF	42	(1) When the motor speed command is set to -10V to +10V, it means the rotation speed is -3000 to +3000 rpm (default). You can set the corresponding range with parameters. (2) When the motor position command is set to -10V to +10V, it means the range of the rotation position is -3 to +3 cycles (default).	C1
	T_REF	18	When the motor torque command is set to -10V to +10V, it means the rated torque is -100% to +100%.	C1
Analog monitor (output)	MON1 MON2	16 15	The operation status of motor can be displayed in analog voltage, such as speed and current. This servo drive provides 2 output channels. You can select the data to be monitored with P0.003. This signal is based on the power ground.	C2
Position pulse (input)	PULSE /PULSE	43 41	Position pulse can be sent by Line Driver (single-phase max. frequency 4 MHz) or open collector (single-phase max. frequency 200 kHz). Three command types can be selected with P1.000, CW/CCW pulse, pulse and direction, and A/B pulse. If open collector type is used when sending position pulses, CN1 should be connected to an external power supply for pull high.	C3/C4
	SIGN /SIGN	36 37		
	PULL HI_P PULL HI_S	39 35		
Position pulse (output)	OA /OA	21 22	Encoder signal A, B, and Z output (Line Driver).	C9/C10
	OB /OB	25 23		
	OZ /OZ	50 24		
	OCZ	48	Encoder Z pulse output (Open collector).	C11
Power	COM+	11	NPN: COM+ is for DI voltage input and requires an external power supply (24V ± 10%). PNP: COM+ is for DI voltage input (negative end) and also requires an external power supply (24V ± 10%).	-
	GND	12, 13, 19, 44	GND for analog signal and differential output signal.	
Other	NC	14	No connection. This is for internal use only. Do not connect to NC, or it may damage the servo drive.	

There are various operation modes available (refer to Section 6.1) and the I/O configuration differs for each mode. The ASDA-A3 provides user-defined I/O for you to set functions according to the application requirements. See Chapter 8 and refer to Table 8.1 Digital input (DI) descriptions and Table 8.2 Digital output (DO) descriptions. The default DI/DO signal configuration for each operation mode includes the most commonly used functions and meets the requirements for general applications.

See the following table for the default DI signal of each control mode:

DI	Control mode								
	PT	PR	S/Sz	T/Tz	PT-S	PT-T	PR-S	PR-T	S-T
	Default signal	Default signal	Default signal	Default signal	Default signal	Default signal	Default signal	Default signal	Default signal
1	0x01	0x01	0x01	0x01	0x01	0x01	0x01	0x01	0x01
	SON	SON	SON	SON	SON	SON	SON	SON	SON
2	0x04	0x08	0x09	0x10	0x04	0x04	0x08	0x08	-
	CCLR	CTRG	TRQLM	SPDLM	CCLR	CCLR	CTRG	CTRG	
3	0x16	0x11	0x14	0x16	0x14	0x16	0x11	0x11	0x14
	TCM0	POS0	SPD0	TCM0	SPD0	TCM0	POS0	POS0	SPD0
4	0x17	0x12	0x15	0x17	0x15	0x17	0x12	0x12	0x15
	TCM1	POS1	SPD1	TCM1	SPD1	TCM1	POS1	POS1	SPD1
5	0x02	0x02	0x02	0x02	-	-	0x14	0x16	0x16
	ARST	ARST	ARST	ARST	-	-	SPD0	TCM0	TCM0
6	0x22	0x22	0x22	0x22	-	-	0x15	0x17	0x17
	NL	NL	NL	NL			SPD1	TCM1	TCM1
7	0x23	0x23	0x23	0x23	0x18	0x20	0x18	0x20	0x23
	PL	PL	PL	PL	S-P	T-P	S-P	T-P	PL
8	0x21	0x21	0x21	0x21	0x21	0x21	0x21	0x21	0x21
	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS	EMGS
9	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-

Note:

1. Refer to the C7/C8 figures in Section 3.3.5 for wiring.
2. Set P1.001.U to 1. After cycling the power to the servo drive, reset the signals to the default values of each corresponding mode.
3. Description of each DI signal:

Signal	Description	Signal	Description	Signal	Description
SON	Servo is activated	NL	Negative limit	PL	Positive limit
CCLR	Pulse clear	ARST	Alarm reset	EMGS	Emergency stop

Signal	Description	Signal	Description	Signal	Description
CTRG	Internal position command triggered	TCM0	Torque command 0	TCM1	Torque command 1
TRQLM	Torque limit	SPD0	Speed selection 0	SPD1	Speed selection 1
SPDLM	Speed limit	POS0	Internal position selection 0	POS1	Internal position selection 1
S-P	Switch S and P mode	T-P	Switch T and P mode	-	-

See the following table for the default DO signal of each control mode:

DO	PT / PR / Communication		Speed / Torque		Wiring method (refer to Section 3.3.5)
	Default	Signal	Default	Signal	
DO1	0x01	SRDY	0x01	SRDY	C5/C6
DO2	0x03	ZSPD	0x03	ZSPD	
DO3	0x09	HOME	0x04	TSPD	
DO4	0x05	TPOS	0x05	TPOS	
DO5	0x07	ALRM	0x07	ALRM	
DO6	-	-	-	-	

Note:

Description of each DO signal:

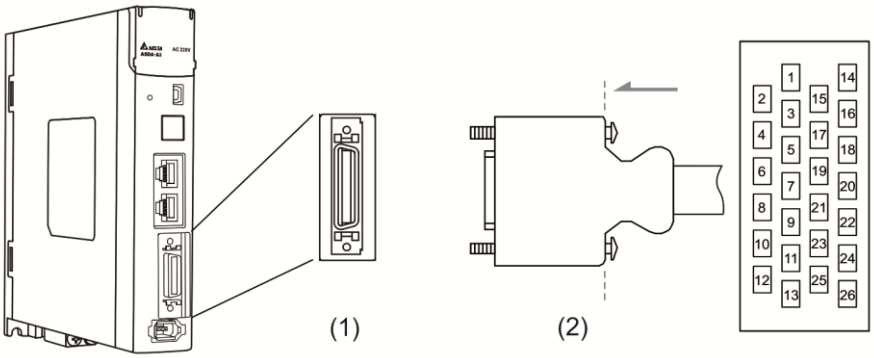
Signal	Description	Signal	Description	Signal	Description
SRDY	Servo ready	HOME	Homing completed	TSPD	Target speed reached
ZSPD	Zero motor speed	TPOS	Target position reached	ALRM	Servo alarm

If the default DI/DO functions cannot meet the application requirements, set the functions of DI1 - 10 and DO1 - 6 with the corresponding parameters listed in the following table. That is, you can specify the DI/DO functions by setting DI or DO code to the corresponding parameters.

Signal		Pin No.	Corresponded parameter	Signal		Pin No.	Corresponded parameter
Standard DI	DI1-	9	P2.010	Standard DI	DI6-	32	P2.015
	DI2-	10	P2.011		DI7-	31	P2.016
	DI3-	34	P2.012		DI8-	30	P2.017
	DI4-	8	P2.013		DI9-	29	P2.036
	DI5-	33	P2.014		DI10-	38	P2.037
Standard DO	DO1+	7	P2.018	Standard DO	DO4+	1	P2.021
	DO1-	6			DO4-	26	
	DO2+	5	P2.019		DO5+	28	P2.022
	DO2-	4			DO5-	27	
	DO3+	3	P2.020		DO6+	46	P2.041
	DO3-	2			DO6-	40	

3.3.3 CN1 I/O connector (for A3-F series)

The A3-F allows you to define 7 digital input (DI) points and 4 digital output (DO) points to provide highly flexible communication between the servo drive and the controller. For more information, refer to Section 3.3.5. In addition, differential type output signals for encoder A+, A-, B+, B-, Z+, and Z- are provided. The pin assignments are shown as follows.



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

Pin assignment:

Pin	Signal	Description	Pin	Signal	Description	Pin	Signal	Description
1	DO1+	Digital output	10	DI4-	Digital input	19	OB	Encoder B pulse output
2	DO1-	Digital output	11	DI5-	Digital input	20	/OB	Encoder /B pulse output
3	DO2+	Digital output	12	DI6-	Digital input	21	OZ	Encoder Z pulse output
4	DO2-	Digital output	13	DI7-	Digital input	22	/OZ	Encoder /Z pulse output
5	NC	Not in use	14	NC	Not in use	23	DO4+	Digital output
6	COM+	Power input (24V ± 10%)	15	NC	Not in use	24	DO4-	Digital output
7	DI1-	Digital input	16	GND	Ground for differential output signal	25	DO3+	Digital output
8	DI2-	Digital input	17	OA	Encoder A pulse output	26	DO3-	Digital output
9	DI3-	Digital input	18	/OA	Encoder /A pulse output	-	-	-

Note: NC represents “No connection”, which is for internal use only. Do not connect to NC, or it may damage the servo drive.

3.3.4 Signal explanation for connector CN1 (for A3-F series)

The following table details the signals listed in the previous section.

3

General signals:

Signal		Pin No.	Description	Wiring method (refer to Section 3.3.5)
Position pulse (output)	OA /OA	17 18	Encoder signal A, B, and Z output (Line Driver).	C9/C10
	OB /OB	19 20		
	OZ /OZ	21 22		
Power	COM+	6	NPN: COM+ is for DI voltage input and requires an external power supply (24V ± 10%). PNP: COM+ is for DI voltage input (negative end) and also requires an external power supply (24V ± 10%).	-
	GND	16	GND for differential output signal.	
Other	NC	14, 15	No connection. This is for internal use only. Do not connect to NC, or it may damage the servo drive.	

The A3-F provides user-defined I/O for you to set functions according to the application requirements. See Chapter 8 and refer to Table 8.1 Digital input (DI) descriptions and Table 8.2 Digital output (DO) descriptions. The default DI/DO signal configuration for each operation mode includes the most commonly used functions and meets the requirements for general applications.

See the following table for the default DI signal of each control mode:

DI	Control mode: DMCNET	
	Default	Signal
1	0x00	-
2	0x00	-
3	0x00	-
4	0x24	ORGP
5	0x22	NL
6	0x23	PL
7	0x21	EMGS

Note: refer to the C7/C8 figures in Section 3.3.5 for wiring.

See the following table for the default DO signal of each control mode:

DO	DMCNET		Wiring method (refer to Section 3.3.5)
	Signal	Description	
DO1	SRDY	Servo ready	C5/C6
DO2	-	-	
DO3	-	-	
DO4	ALRM	Alarm reset	

If the default DI/DO function cannot meet the application requirement, specify the DI/DO functions by setting DI or DO code to the corresponding parameters.

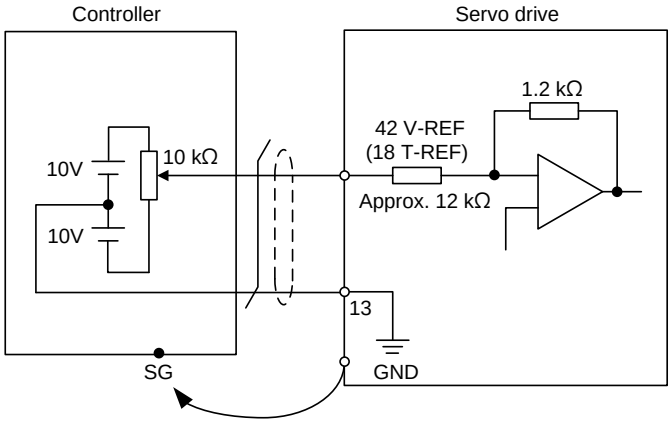
Signal		Pin No.	Corresponded parameter	Signal		Pin No.	Corresponded parameter
Standard DI	DI1-	7	P2.010	Standard DI	DI5-	11	P2.014
	DI2-	8	P2.011		DI6-	12	P2.015
	DI3-	9	P2.012		DI7-	13	P2.016
	DI4-	10	P2.013		-	-	-

Signal		Pin No.	Corresponded parameter	Signal		Pin No.	Corresponded parameter
Standard DO	DO1+	1	P2.018	Standard DO	DO3+	25	P2.020
	DO1-	2			DO3-	26	
	DO2+	3	P2.019		DO4+	23	P2.021
	DO2-	4			DO4-	24	

3.3.5 Wiring diagrams (CN1)

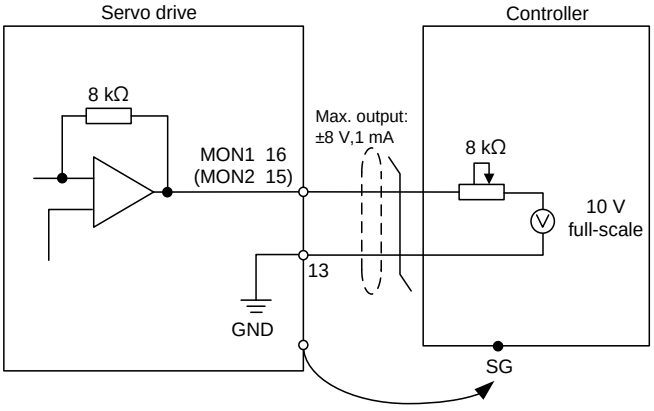
The valid voltage for the analog speed command and the analog torque command is between -10V and +10V. You can set the command value that corresponds to the voltage range with the relevant parameters.

C1: input for speed / torque (force) analog command



Note: this is not supported by the A3-F.

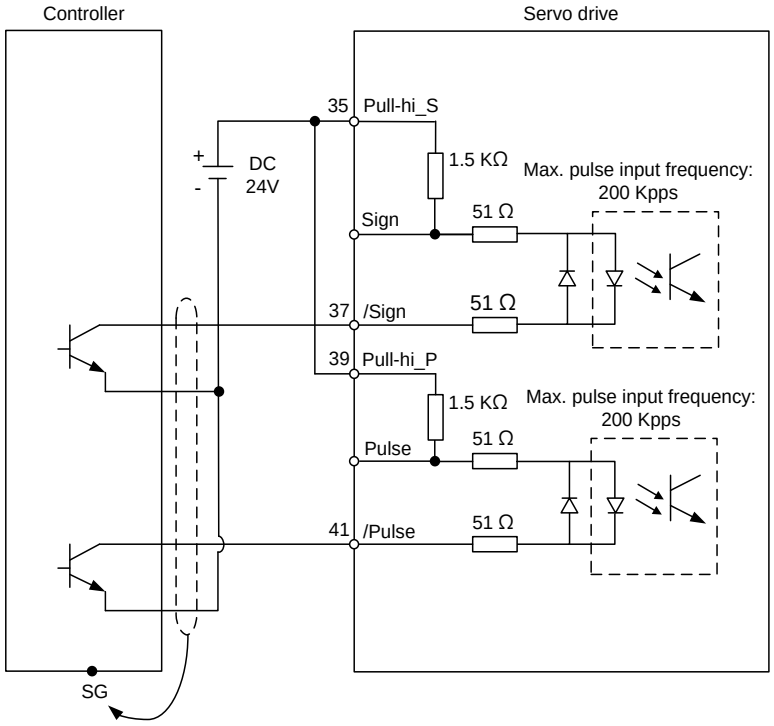
C2: output for analog monitoring command (MON1 and MON2)



Note: this is not supported by the A3-F.

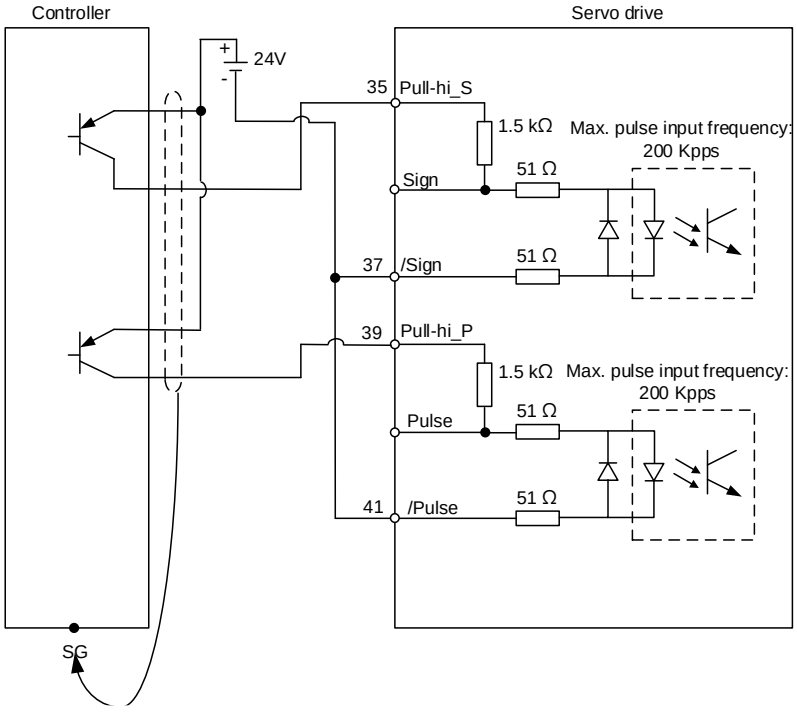
You can input the Pulse command with the open collector or line driver. The maximum input pulse for the line driver is 4 Mpps and 200 kpps for the open collector.

C3-1: the source for the pulse input is open collector NPN type equipment, which uses the external power supply.



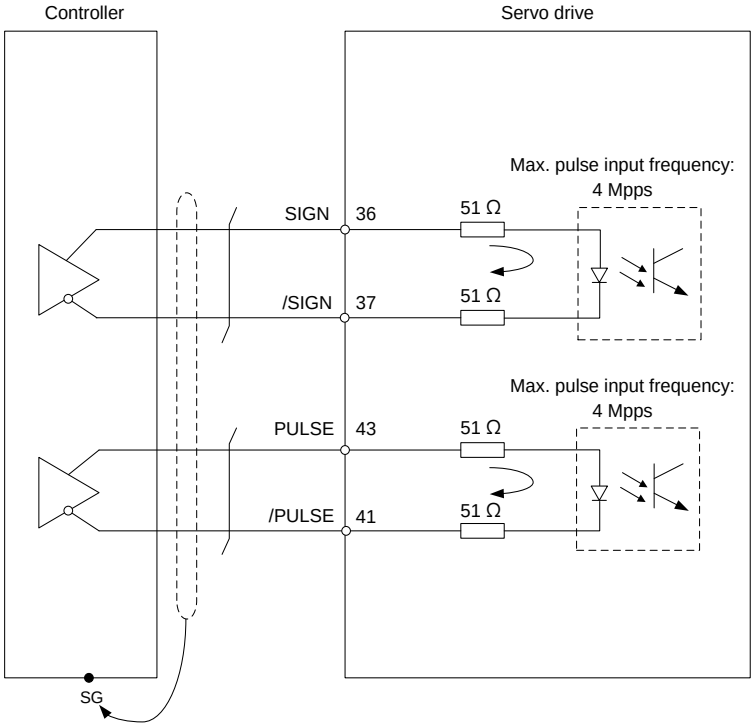
Note: this is not supported by the A3-F.

C3-2: the source for the pulse input is open collector PNP type equipment, which uses the external power supply.



Note: this is not supported by the A3-F.

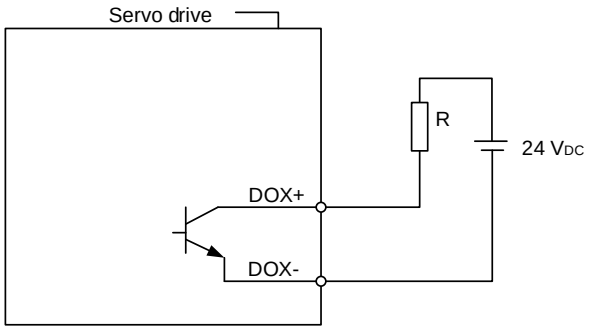
C4: pulse input (Line driver) can only be used with 2.8V – 3.6V power systems. Do not use it with 24V power.



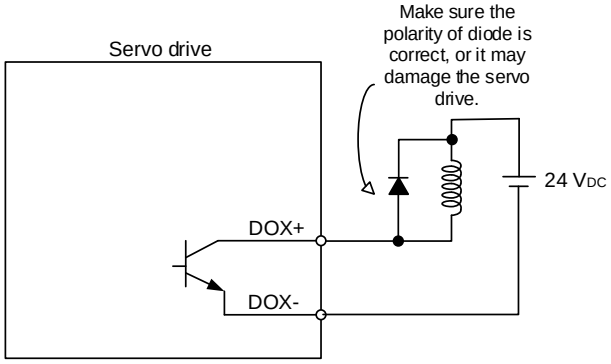
Note: this is not supported by the A3-F.

When the drive connects to an inductive load, you must install the diode (permissible current: below 40 mA; surge current: below 100 mA; maximum voltage: 30V).

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.



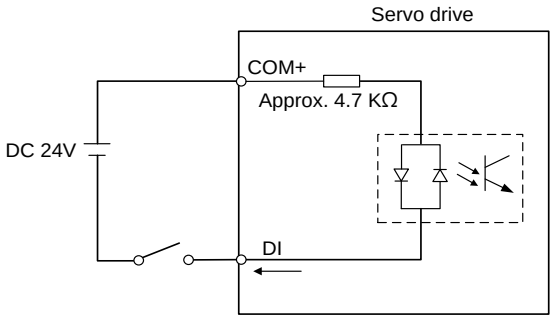
DI wiring - Input signals by relay or open collector transistor.

Conditions of DI On / Off:

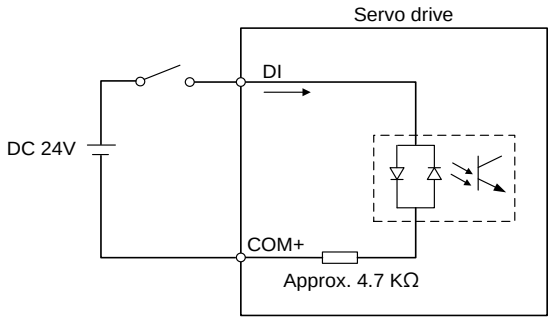
ON: 15V – 24V; condition: input current = 8 mA.

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

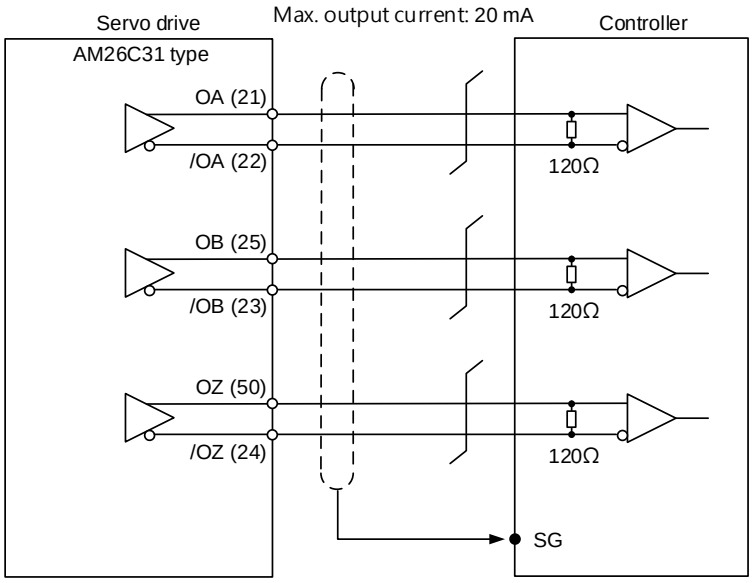
C7: NPN transistor (SINK mode)



C8: PNP transistor (SOURCE mode)



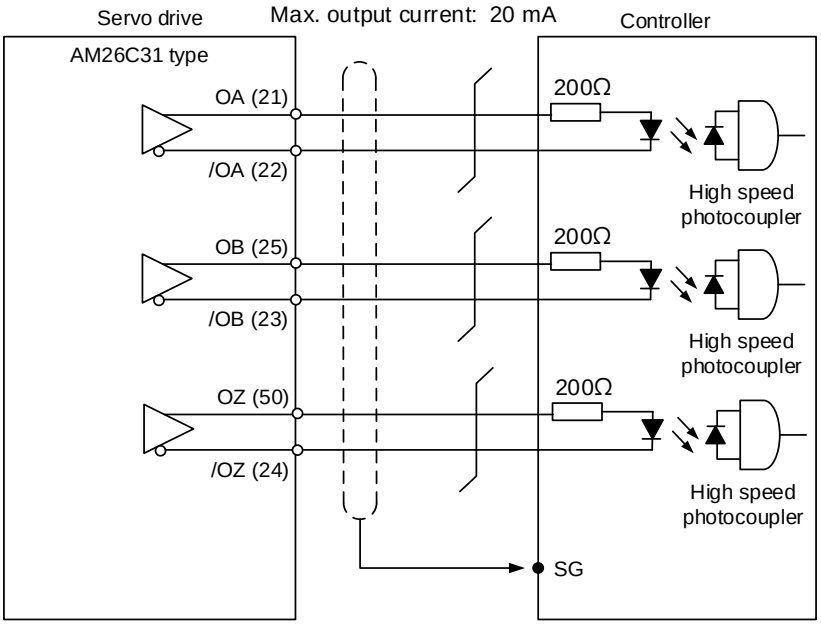
C9: output for encoder position signal (Line driver)



Note:

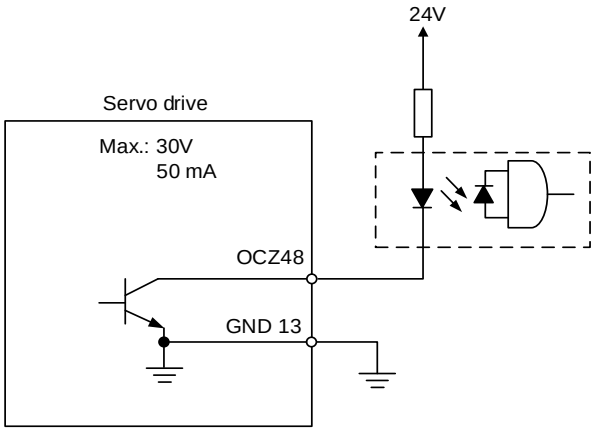
1. A3-F pins: OA (17), /OA (18), OB (19), /OB (20), OZ (21), and /OZ (22).
2. It is suggested that you connect the two GND for the controller and servo drive in parallel when the voltage deviation between the controller and the servo drive is too great.

C10: output for encoder position signal (Opto-isolator)



Note: A3-F pins: OA (17), /OA (18), OB (19), /OB (20), OZ (21), and /OZ (22).

C11: encoder OCZ output (open collector Z pulse output)

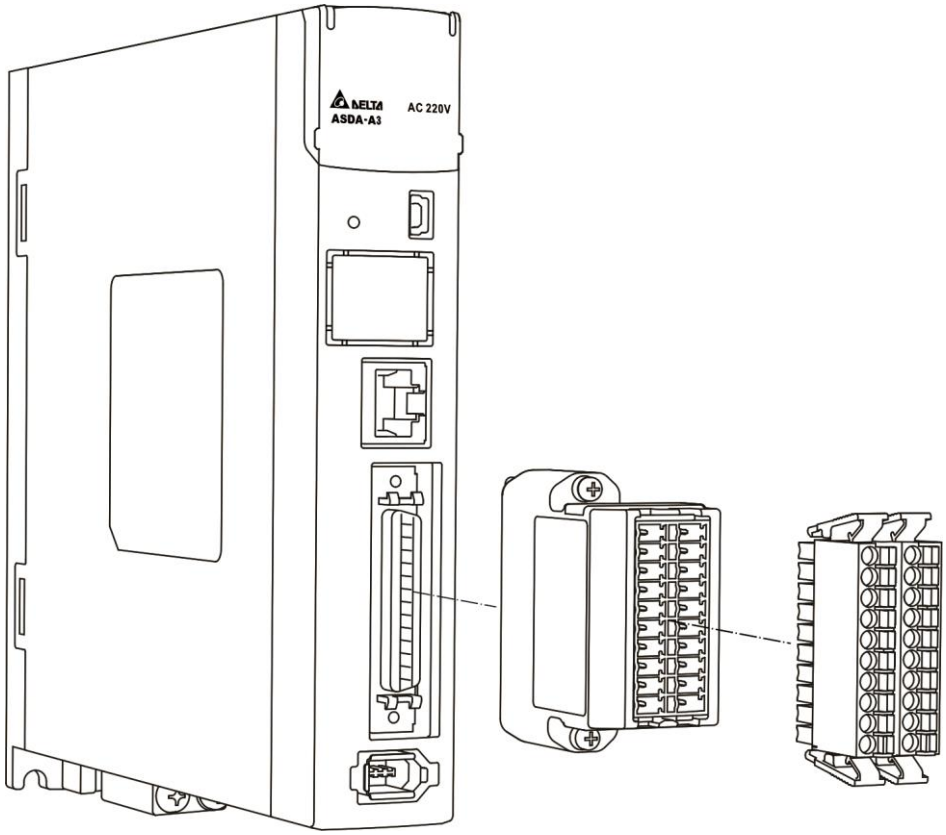


Note: this is not supported by the A3-F.

3.3.6 Application: using the CN1 quick connector for wiring

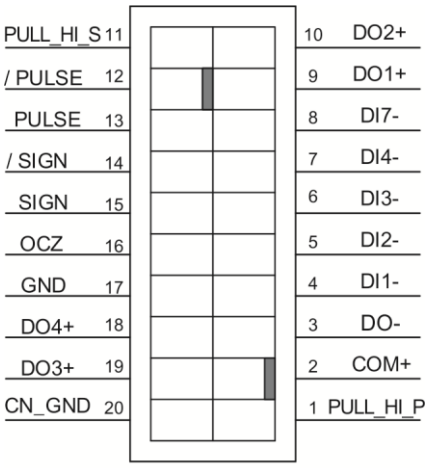
The CN1 quick connector (ACS3-IFSC5020) is designed for easy wiring. It can be used with the ASDA-A3 series servo drive and can satisfy the needs of different DI/O applications. It is a good choice if you do not want to solder the wires. Its spring terminal blocks prevent vibration from loosening the wire. It includes five digital inputs, four digital outputs, differential pulse command inputs, and Z phase open-collector outputs.

Note: select the quick connector ASD-IF-SC2616 for the A3-F series servo drive.

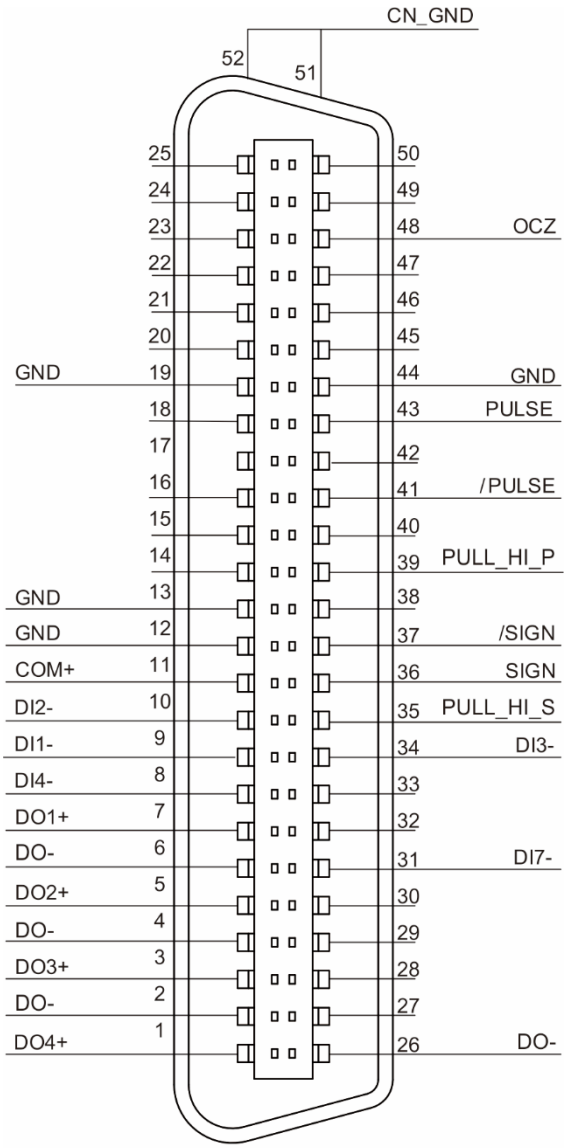


3

Pin assignment for the CN1 quick connector (J2 and J1):



J2

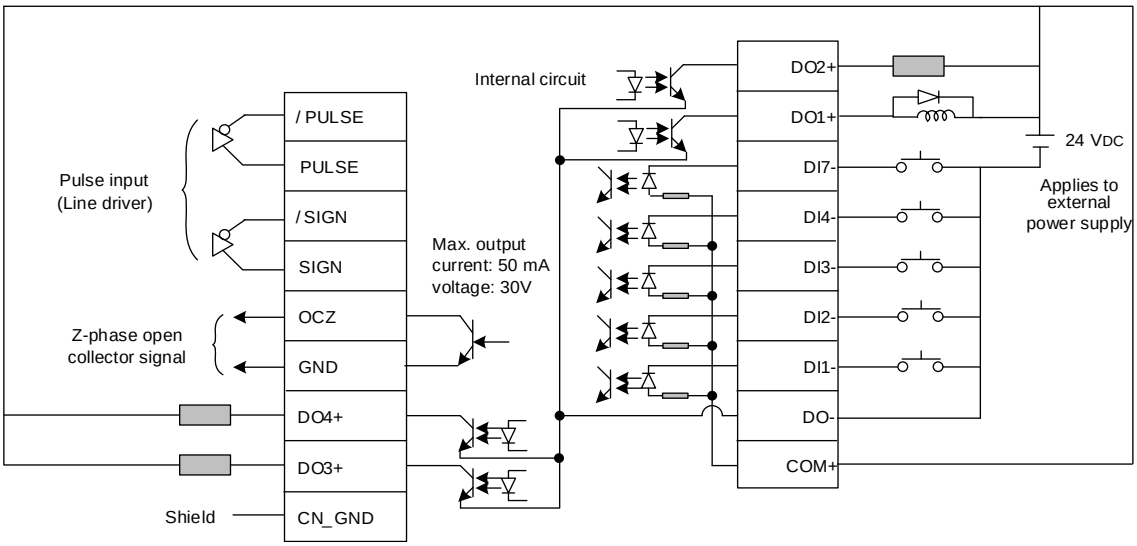


J1

J2-PIN	Signal	J1-PIN
1	PULL_HI_P	39
2	COM+	11
3	DO-	2, 4, 6, 26
4	DI1-	9
5	DI2-	10
6	DI3-	34
7	DI4-	8
8	DI7-	31
9	DO1+	7
10	DO2+	5
11	PULL_HI_S	11
12	/PULSE	41
13	PULSE	43
14	/SIGN	37
15	SIGN	36
16	OCZ	48
17	GND	12, 13, 19, 44
18	DO4+	1
19	DO3+	3
20	CN_GND	51, 52

Note: NC represents “No connection”.

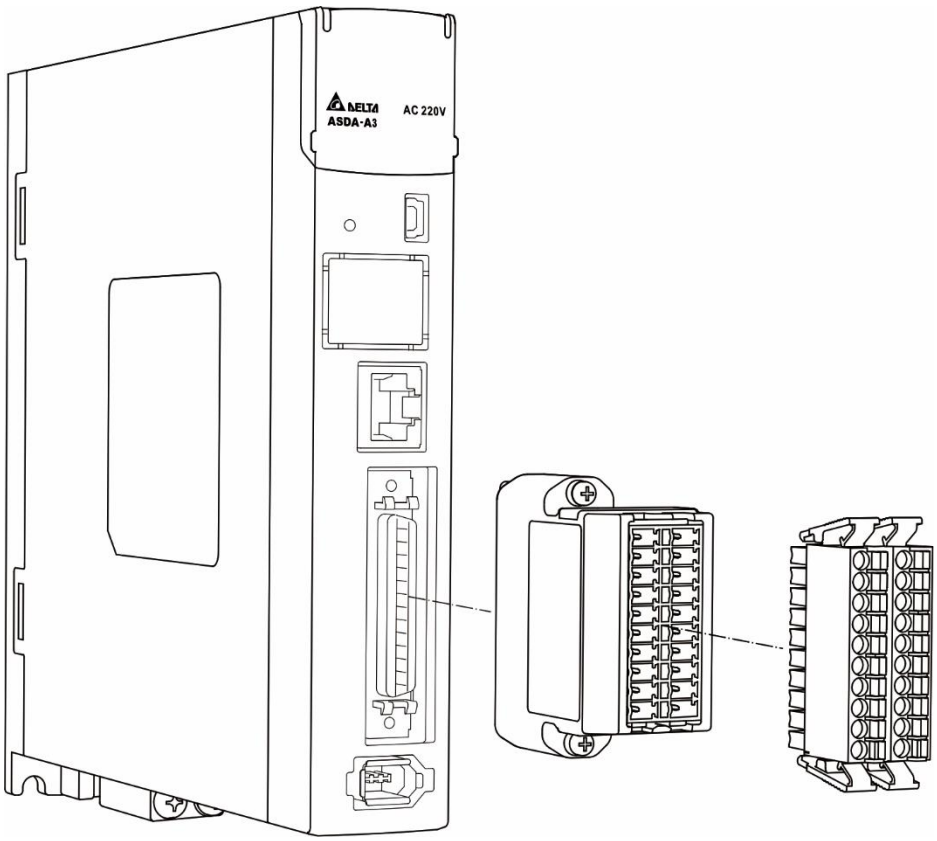
Wiring example:



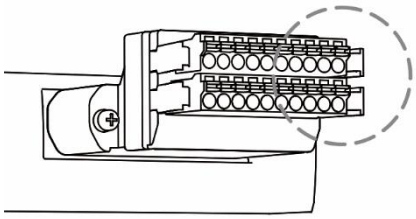
3

Wiring for CN1 quick connector and installation:

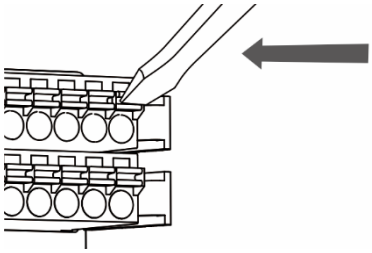
Installation



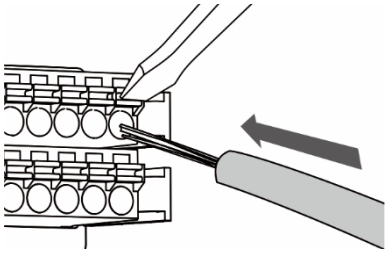
Wiring



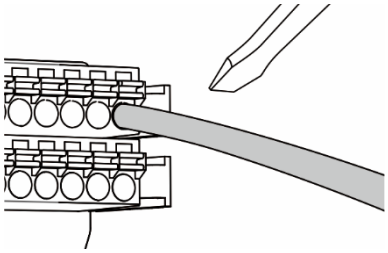
(1) The CN1 quick connector has multiple spring terminals. Determine which terminal is to be wired in advance.



(2) Use a flathead screwdriver to press the spring down to open the pin.



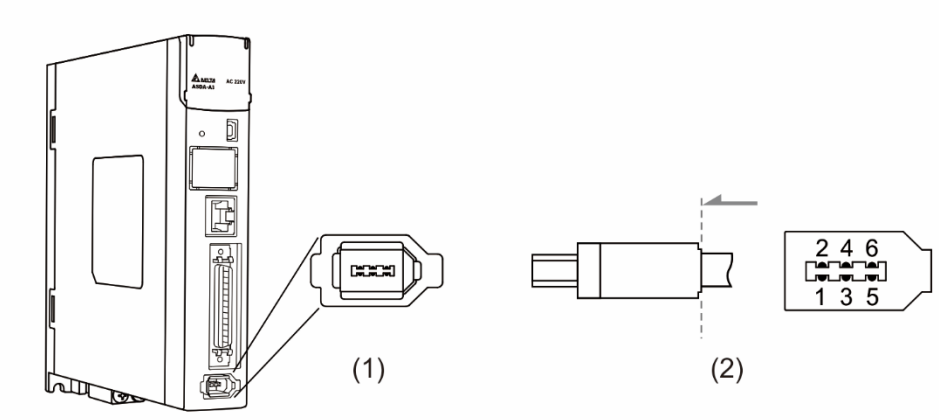
(3) Insert the stripped wire into the pin.



(4) Withdraw the screwdriver to complete the wiring.

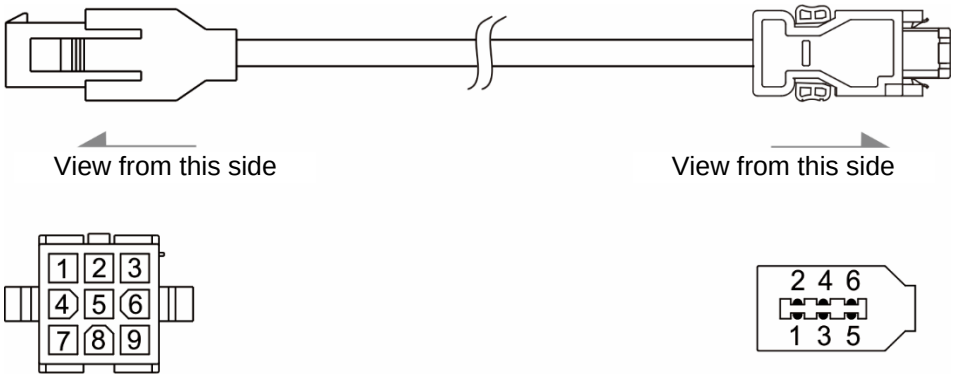
3.4 Wiring for the CN2 encoder connector

The CN2 encoder signal connector is shown as follows:

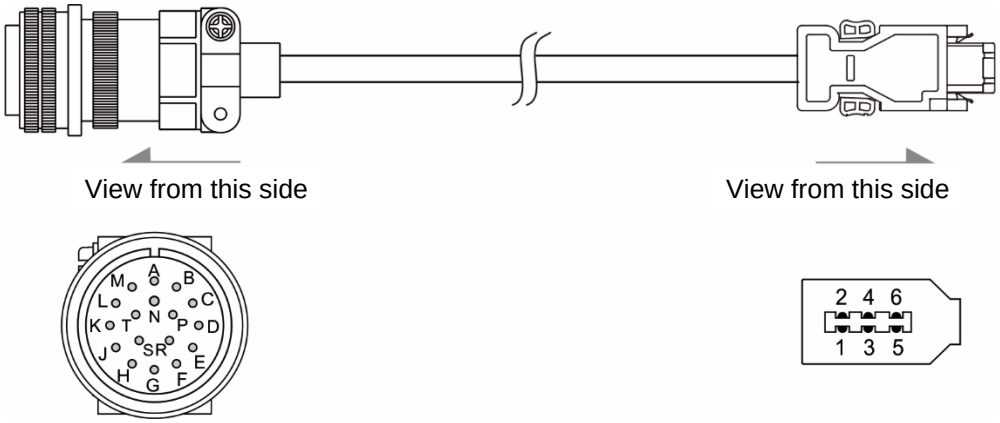


(1) CN2 connector (female) (2) CN2 connector (male)

Quick connector ends:



Military connector ends:

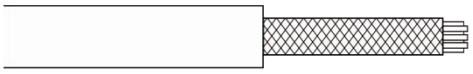


CN2 pin assignment:

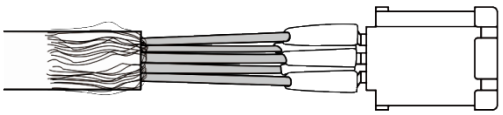
The end that connects to the encoder			The end that connects to the servo drive		
Military connector	Quick connector	Color	Pin No.	Signal	Description
A	1	White	5	T+	Serial communication signal (+)
B	4	White / Red	6	T-	Serial communication signal (-)
S	7	Brown	1	+5V	+5V power supply
R	8	Blue	2	GND	Power ground
L	9	-	Case	Shielding	Shielding

Note: when using an absolute encoder, the battery supplies power directly to the encoder. Thus, wiring to the CN2 connector of the servo drive is not required. Refer to the wiring description in Section 3.1.5 Specification for the encoder connector for details.

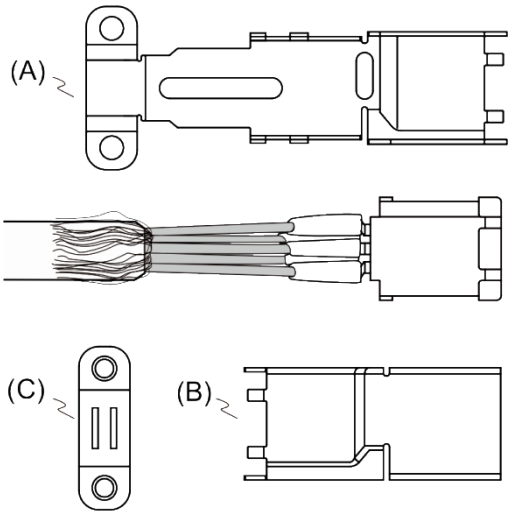
Connecting shielded wire to the CN2 encoder connector is shown as follows:



Step 1:
Cut through the cable and expose the shielding. The exposed wire length should be 20 – 30 mm (0.79 - 1.18 inches).

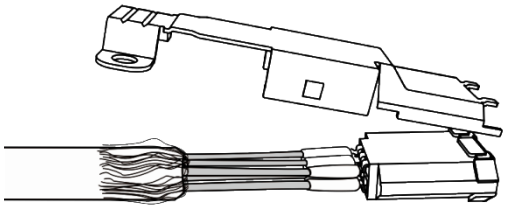


Step 2:
Spread the metal shielding and fold it back. Refer to the CN2 pin assignment (see the table above) to connect the pins.

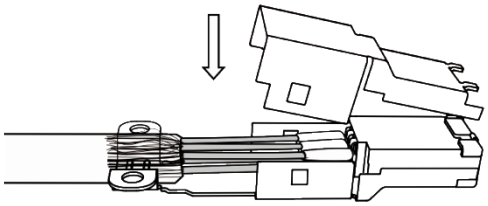


Step 3:
You need the following items to assemble the connector:
(A) Big metal case
(B) Small metal case
(C) Metal ring

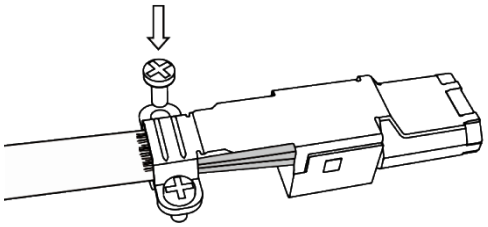
(Continued)



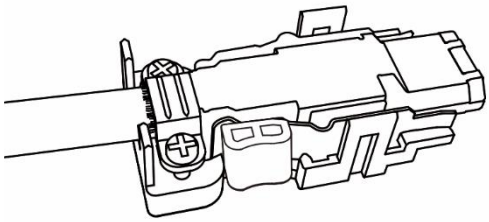
Step 4:
Place the metal case to cover the exposed wire shielding. Make sure the shielding is completely covered to maintain the integrity of the shielding.



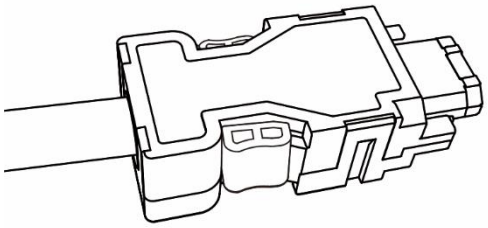
Step 5:
Fasten the other side of the metal case.



Step 6:
Tighten the screws of the metal case.



Step 7:
Fit one side of the plastic case over the connector.



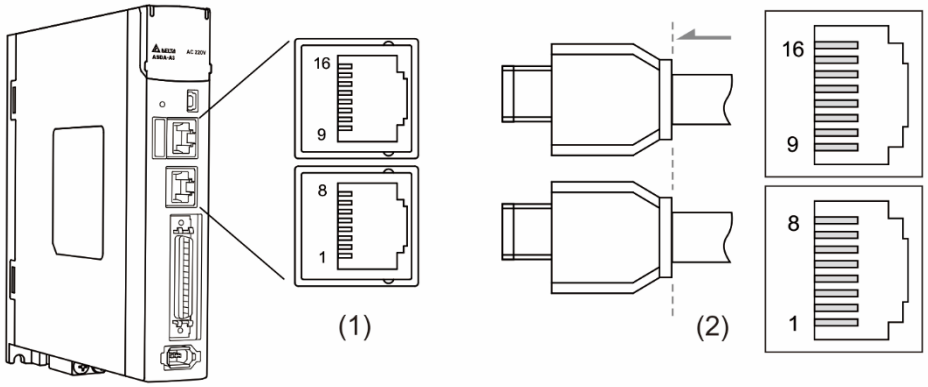
Step 8:
Place and fasten the other side of the case to complete the connector.

3.5 Wiring for the CN3 connector (RS-485 / high-speed communication)

When the servo drive is connected to the PC via CN3, you can operate the servo drive, PLC, or HMI through MODBUS using the assembly language. The CN3 connector supports two commonly used communication interfaces, RS-485 and CAN. This enables you to connect multiple servo drives simultaneously.

Note:

1. A3-L: single port (Pin 1 – Pin 8); supports RS-485 only and does not support high-speed communication (CANopen).
2. A3-M: dual ports; supports both RS-485 and high-speed communication (CANopen).



(1) CN3 connector (female) (2) CN3 connector (male)

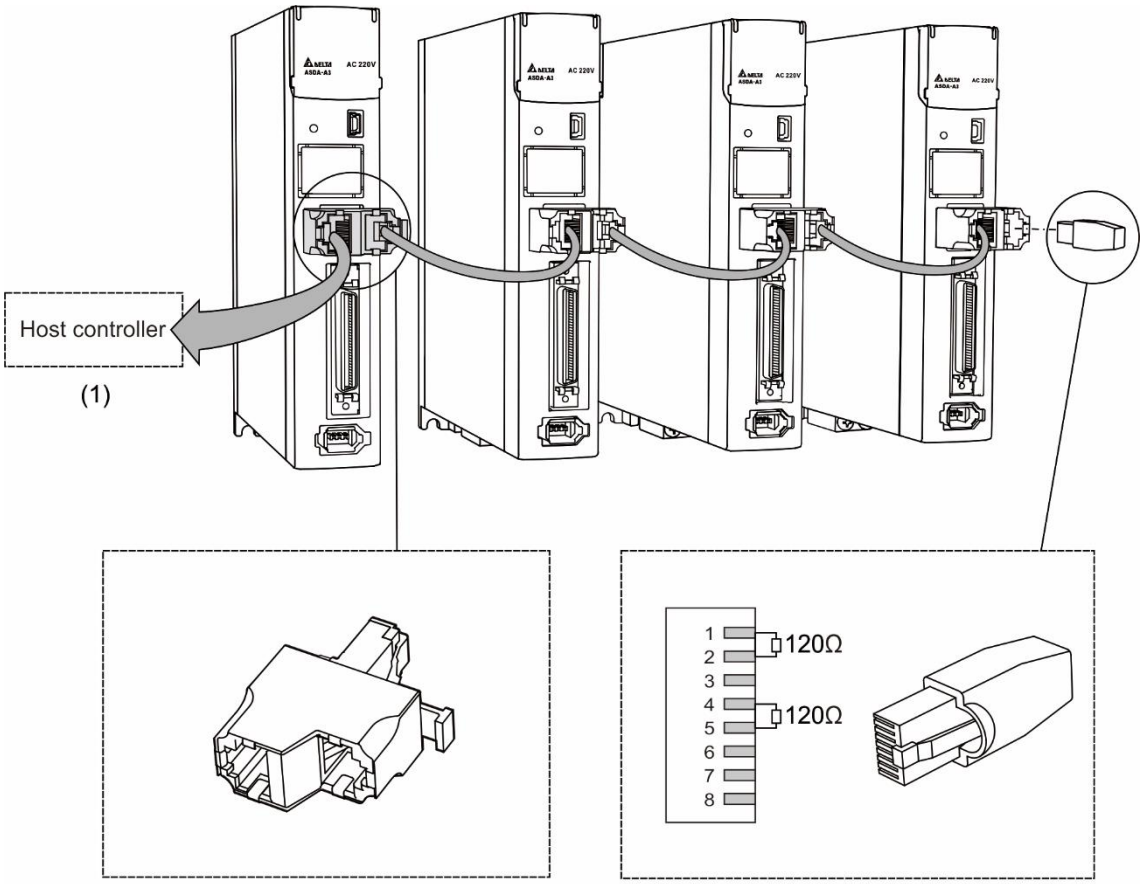
Pin assignment (same for both connectors):

Pin No.	Signal	Description
1	CAN_H	CAN_H bus line (dominant high)
2	CAN_L	CAN_L bus line (dominant low)
3, 7	GND_ISO	Signal GND
4	RS-485-	The servo drive transmits the data to differential terminal (-).
5	RS-485+	The servo drive transmits the data to differential terminal (+).
6, 8	-	-
9	CAN_H	CAN_H bus line (dominant high)
10	CAN_L	CAN_L bus line (dominant low)
11, 15	GND_ISO	Signal GND
12	RS-485-	The servo drive transmits the data to differential terminal (-).
13	RS-485+	The servo drive transmits the data to differential terminal (+).
14, 16	-	-

Note: refer to Chapter 9 for the RS-485 wiring.

3

Connecting multiple servo drives:



(1) Connect to the controller / PLC (2) Modbus connector (3) Wiring for CAN / RS-485 terminal resistor

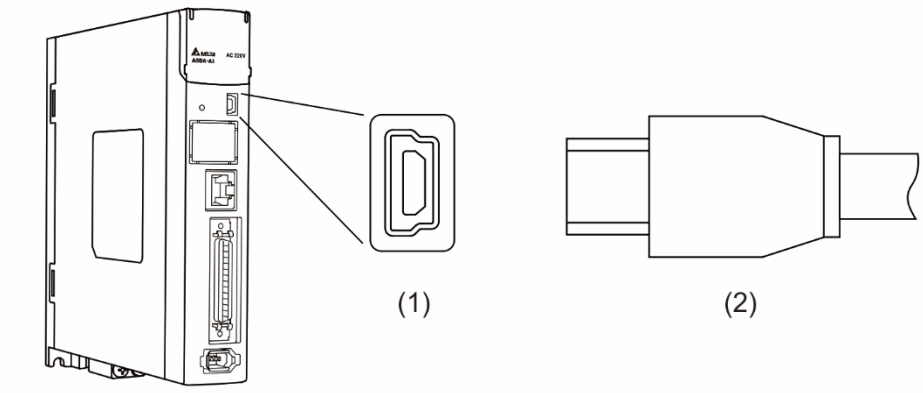
Note:

1. This supports up to 32 axes via RS-485 with the CANopen cable length up to 30 m (98.43 ft).
   The communication quality and the connectable axes are determined by the controller's specifications, quality of wires, grounding, interference, and whether a shielded twisted-pair cable is used.
2. It is suggested to use a terminal resistor of 120Ω (Ohm) and 0.5 W (or more).
3. To connect multiple servo drives in parallel, use CAN / RS-485 connectors as shown above, and put the terminal resistor in the last servo drive.

3.6 CN4 serial connector (Mini USB)

CN4 is a serial connector that connects to a PC and allows you to operate the servo drive with the software. This is a Type B Mini USB that is compatible with the USB 2.0 specification.

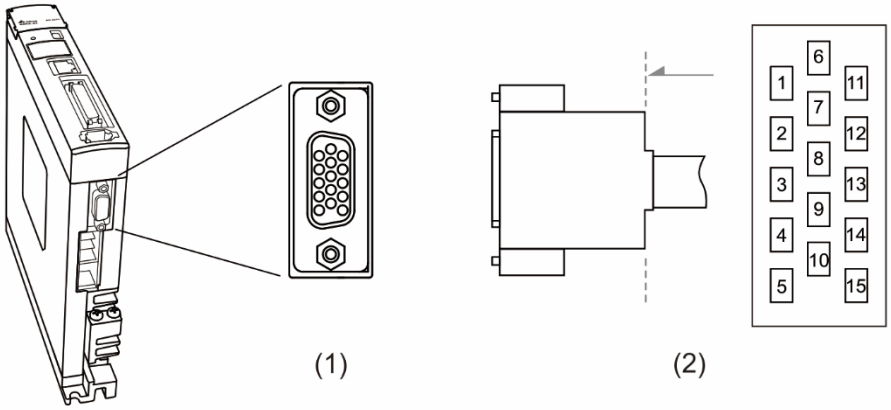
Note: when there is high interference during operation, it is suggested that you install the USB isolator. (Delta part number: UC-ADP01-A)



(1) USB connector (female) (2) USB connector (male)

3.7 CN5 connector (for machine position feedback, applicable to full-closed loop)

The CN5 connects to the external linear scale or the encoder (A, B, and Z) and forms a full-closed loop with the servo system.



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

Pin assignment:

Pin No.	Signal	Description
1	Opt_/Z	/Z phase input
2	Opt_/B	/B phase input
3	Opt_B	B phase input
4	Opt_A	A phase input
5	Opt_/A	/A phase input
6	GND	Encoder grounding
7	GND	Encoder grounding
8	+5V	Encoder power
9	Opt_Z	Z phase input
10	HALL_U	Hall sensor U phase input
11	HALL_V	Hall sensor V phase input
12	HALL_W	Hall sensor W phase input
13	TEMP+	Motor temperature detection
14	TEMP-	Motor temperature detection
15	Reserved	Reserved

Note:

1. This only supports encoders with AB phase signal, power supply voltage is 5V, and maximum current consumption is 300 mA.
2. The maximum single-phase pulse frequency for the encoder is 4 MHz.
3. The motor temperature detection function supports NTC and PTC type sensors. Refer to Chapter 8 for detailed parameter settings of PM.022 and PM.024.

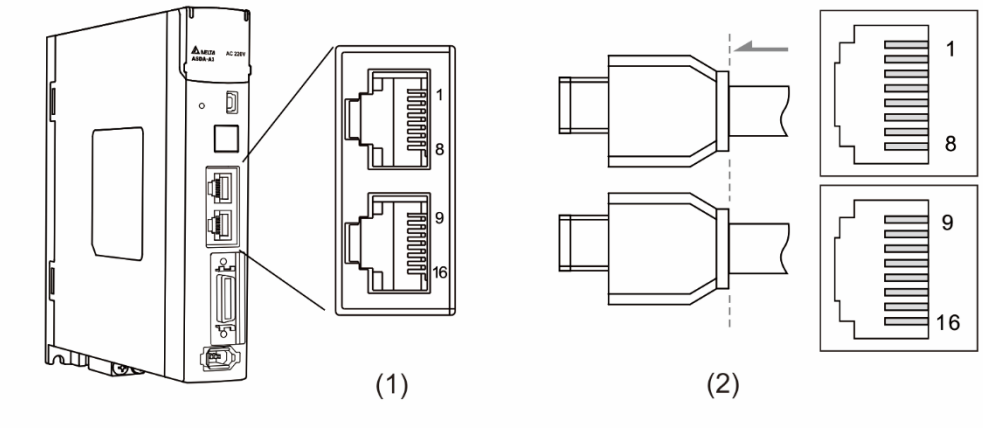
3.8 CN6 connector

3.8.1 DMCNET communication connector for wiring

The CN6 connector is a standard RJ45 connector with a shielded cable. You can use it to connect to the host controller or motion control card for controlling position, torque, and speed, as well as accessing or monitoring the servo status with Delta's DMCNET system.

You can set the station number of DMCNET with P3.000. Its maximum transmission rate is 20 Mbps. Two ports are provided for connecting multiple servo drives, with one way in and the other way out. Remember to put the terminal resistor (120Ω) in the last servo drive.

Note: DMCNET is supported by the A3-F only.



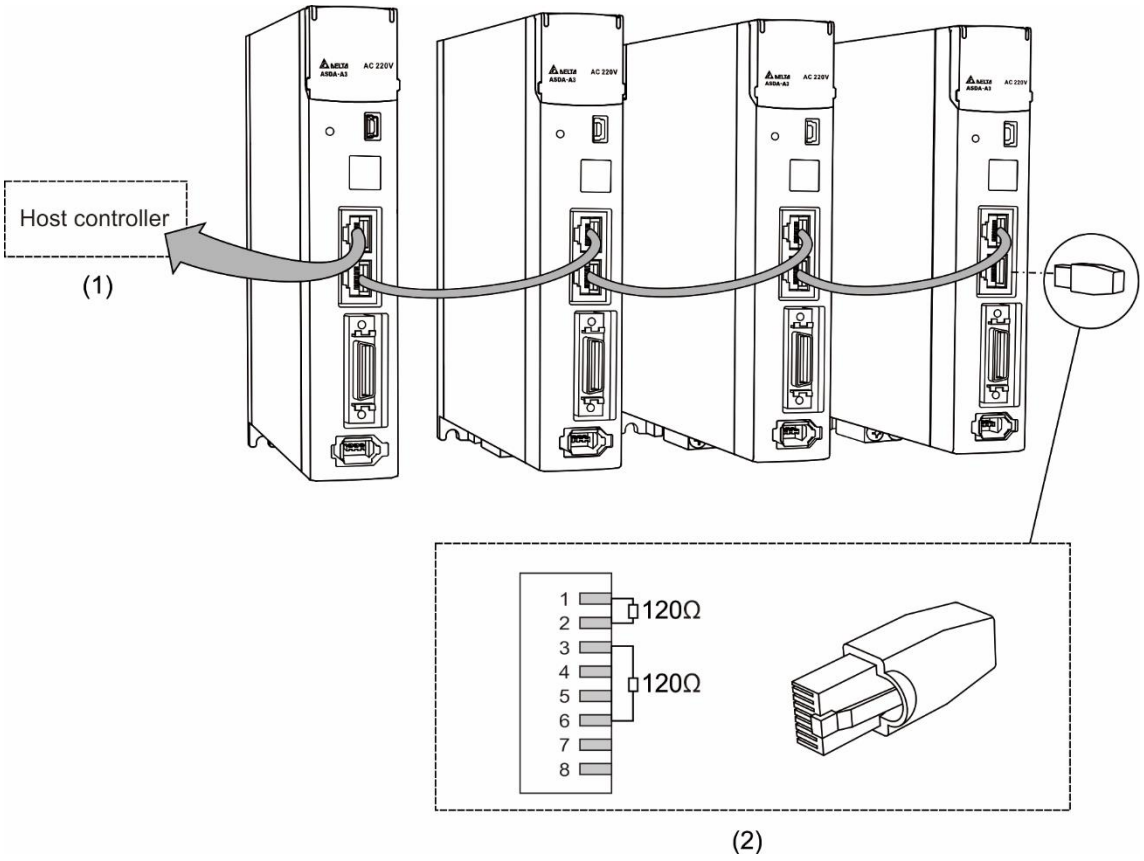
(1) CN6 connector (female) (2) CN6 connector (male)

Pin assignment:

Pin No.	Signal	Description
1, 9	DMCNET_1A	DMCNET Channel 1 bus line (+)
2, 10	DMCNET_1B	DMCNET Channel 1 bus line (-)
3, 11	DMCNET_2A	DMCNET Channel 2 bus line (+)
4, 12 5, 13	-	-
6, 14	DMCNET_2B	DMCNET Channel 2 bus line (-)
7, 15 8, 16	-	-

3

Connecting multiple servo drives:



(1) Connection to the controller / motion control card

(2) DMCNET terminal resistor (Delta part number: ASD-TR-DM0008)

Note:

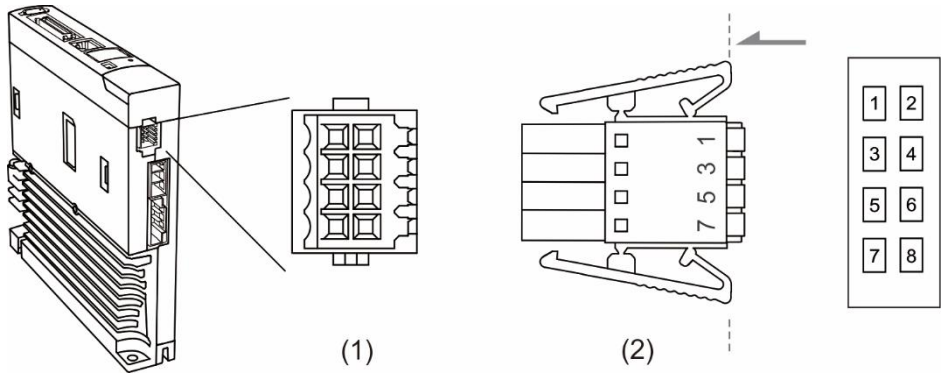
1. This supports up to 12 axes with the cable length up to 30 m (98.43 ft).
2. It is suggested to use a terminal resistor of 120Ω (Ohm) and 0.5 W (or more).
3. To connect multiple servo drives in serial, use DMCNET connectors as shown above, and put the terminal resistor in the last servo drive.

3.9 CN10 STO connector (Safe torque off)

This connector provides the STO function. More details are provided in the next section.

Note:

1. The STO function is supported by the A3-M only.
2. STO certification application is in progress.

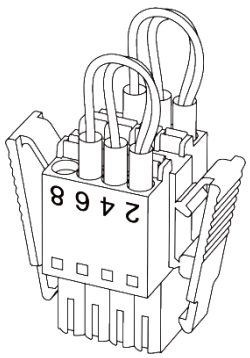


(1) CN10 STO connector (female) (2) CN10 quick connector (male)

Pin assignment:

Pin No.	Signal	Description
1	Reserved	Reserved
2	Reserved	Reserved
3	STO_A	STO input A+
4	/STO_A	STO input A-
5	STO_B	STO input B+
6	/STO_B	STO input B-
7	FDBK+	STO alarm output (+), BJT Output Max. rating: 80 V_{DC}, 0.5 A
8	FDBK-	STO alarm output (-), BJT Output Max. rating: 80 V_{DC}, 0.5 A

If you do not need the STO function, plug in the STO connector that comes with the servo drive. The wiring has been done as shown in the figure on the right. If this connector has been disassembled, refer to Section 3.10 STO function (Safe torque off) for wiring information.



3.10 STO function (Safe torque off)

3.10.1 Introduction to STO

Once the STO function is enabled, the servo drive stops supplying current to the motor, cutting off the power supply and torque force. Do not repeatedly use this function for it does not stop the motor with active force.

Note:

1. The STO function is supported by the A3-M only.
2. STO certification application is in progress.

3.10.2 The potential danger of STO

After the STO function is enabled, the motor is no longer controlled by the servo motor.
Thus, take all the potential danger resulted from enabling the STO function into consideration.
Delta is not liable for mechanical damage and personnel injury if you fail to observe the following instructions:

1. For a safety circuit design, make sure the selected components conform to the safety specifications.
2. Before installation, read the safety instructions in the STO-related user manual for the components you use.
3. Do not touch the servo drive when the STO function is enabled. Although the power to the motor is cut off, there is residual electricity since the power supply is not completely removed from the servo drive. When maintaining the servo drive, use the molded case circuit breaker (MCCB) or magnetic contactor (MC) to cut off the power.
4. When the STO function is enabled, the servo drive can no longer control, stop, or decelerate the motor.
5. After the STO function is enabled, the servo drive no longer controls the motor, but the motor can still be moved by other external forces.
6. The feedback monitoring output signal (FDBK) is only for inspecting the STO function status rather than for safety output.
7. The STO function must be powered by the safety extra-low voltage (SELV) power source with reinforced insulation.
8. Power the STO signals with single power supply, or the leakage current will result in STO malfunction.

3.10.3 Specifications of STO

The ASDA-A3 series servo drive conforms to the following safety specifications:

Item	Description	Standard	Safety data
SFF	Safe failure fraction	IEC61508	Channel1: 80.08% Channel2: 68.91%
HFT (Type A subsystem)	Hardware fault tolerance	IEC61508	1
SIL	Safety integrity level	IEC61508	SIL2
		IEC62061	SILCL2
PFH	Probability of dangerous failure per hour [h^{-1}]	IEC61508	9.56×10^{-10}
PFD_{av}	Average probability of failure on demand	IEC61508	4.18×10^{-6}
Category	Category	EN954-1	Category 3
PL	Performance level	ISO13849-1	d
$MTTF_d$	Mean time to dangerous failure	ISO13849-1	High
DC	Diagnostic coverage	ISO13849-1	Low

3.10.4 How does the STO function work?

The STO function controls the motor current by two individual circuits. It cuts off the power supply to the motor when needed, after which the motor is free from torque force. When an STO alarm occurs, determine the alarm type according to the pin status of the feedback monitor signal (FDBK). The following table details how this function works.

Description of action and feedback status

Signal	Safety signal source	Status of opto-isolator			
STO	STO_A ~ / STO_A	ON	ON	OFF	OFF
	STO_B ~ / STO_B	ON	OFF	ON	OFF
Servo drive output status		Ready	Torque off (STO_B lost)	Torque off (STO_A lost)	Torque off (STO mode)
Feedback monitor signal (FDBK status)		Open	Close	Open	Open
Alarm		N/A	AL500	AL501	AL502

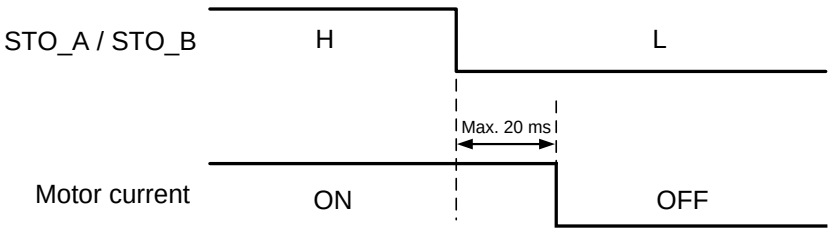
Note:

1. ON = 24V; OFF = 0V.
2. Open = open circuit; Close = short circuit.
3. The status of the feedback monitor signal switches immediately based on the safety signal source changes.
4. Contact the distributor if AL503 occurs. Refer to Chapter 13 Troubleshooting for more details.

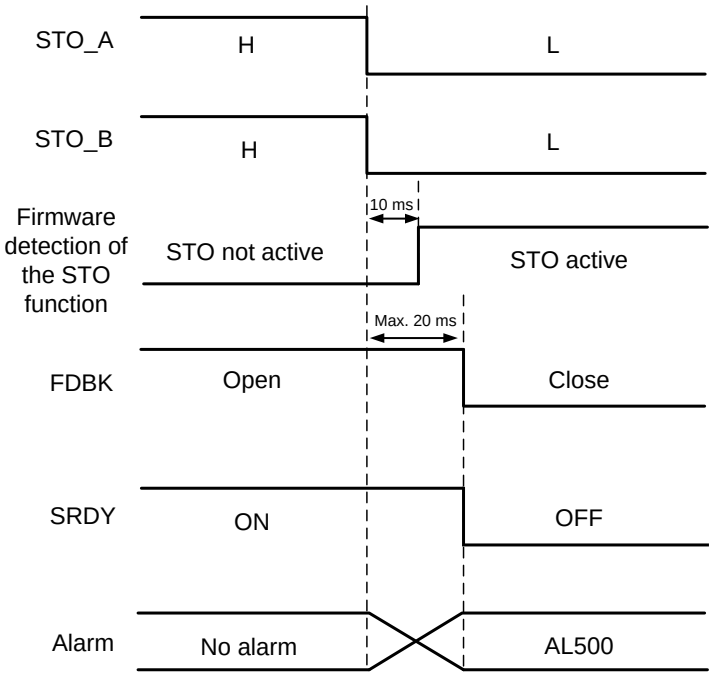
3.10.4.1 Activation status

STO reaction time:

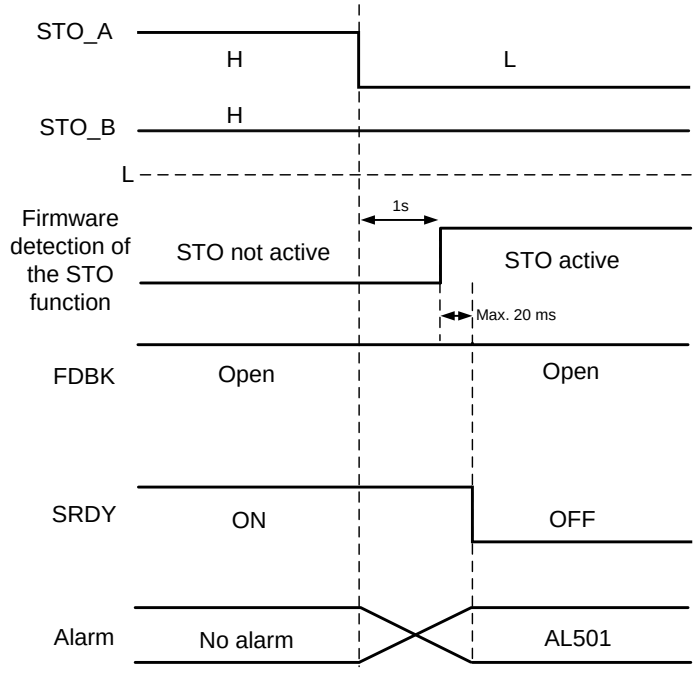
When one of the safety signal source is low, the circuit cuts off the motor current within 20 ms.



AL500: see the following diagram. When the motor runs normally, but both STO_A and STO_B signals are low for 10 ms at the same time, the firmware disables the drive (Servo Off) and triggers AL500.



AL501 / AL502: see the following diagram. When the motor runs normally, but one of the safety signal source is low for 1 s, the firmware disables the drive (Servo Off) and triggers AL501 or AL502. The following diagram illustrates AL501.



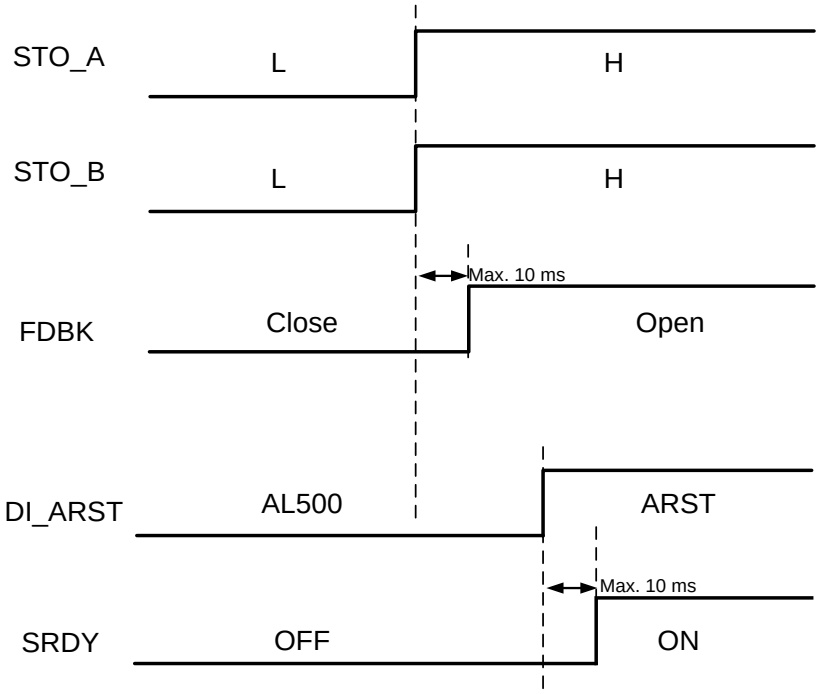
Note:

1. When the STO_A signal is low, AL501 occurs; when the STO_B signal is low, AL502 occurs.
2. Contact the distributor if AL503 occurs.
3. Refer to Section 3.10.4 for the FDBK signal.

3

3.10.4.2 Deactivation status

When both safety signal sources switch back to high, the alarm will not be cleared automatically. Of all the STO alarms, only AL500 can be cleared with DI_ARST.

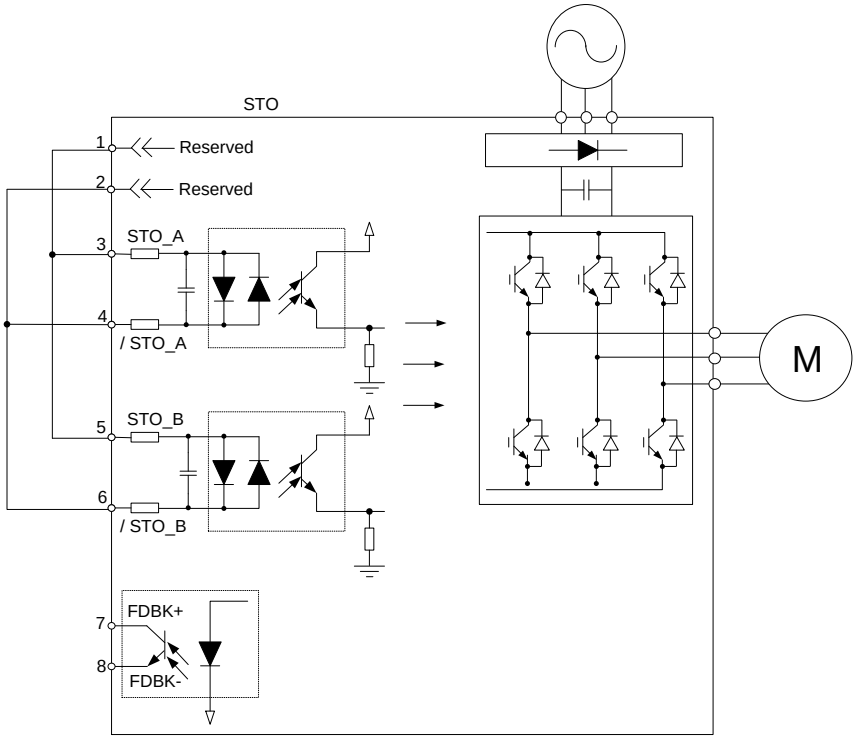


Note: refer to Section 3.10.4 for the FDBK signal.

3.10.5 Wiring for STO

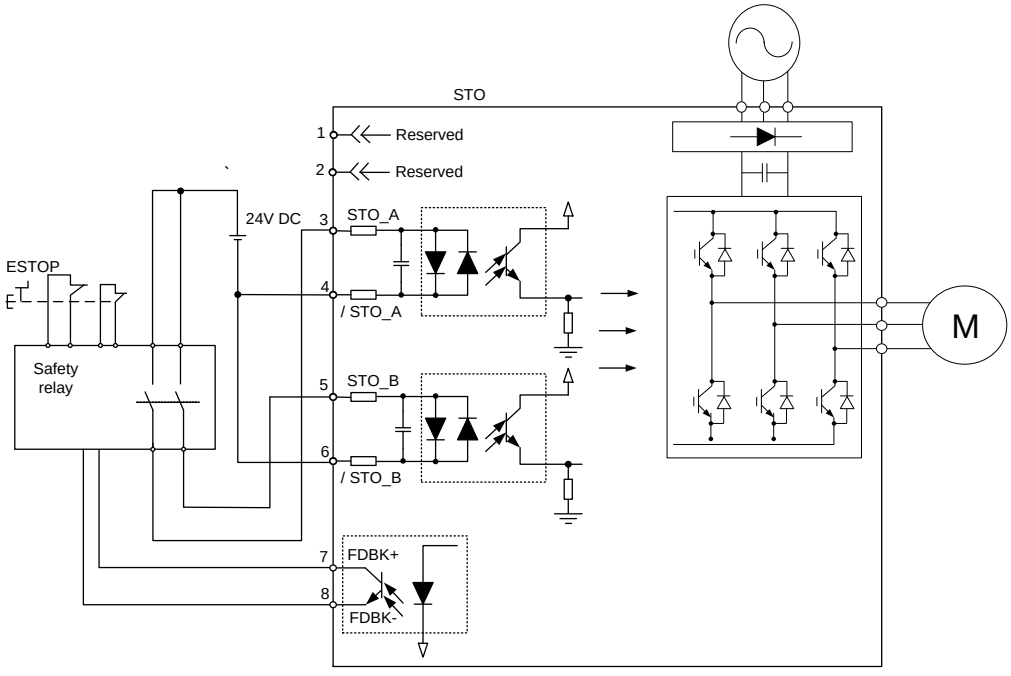
3.10.5.1 Not using the STO function

You can short-circuit the connector or plug in the short-circuit connector that comes with the servo drive.



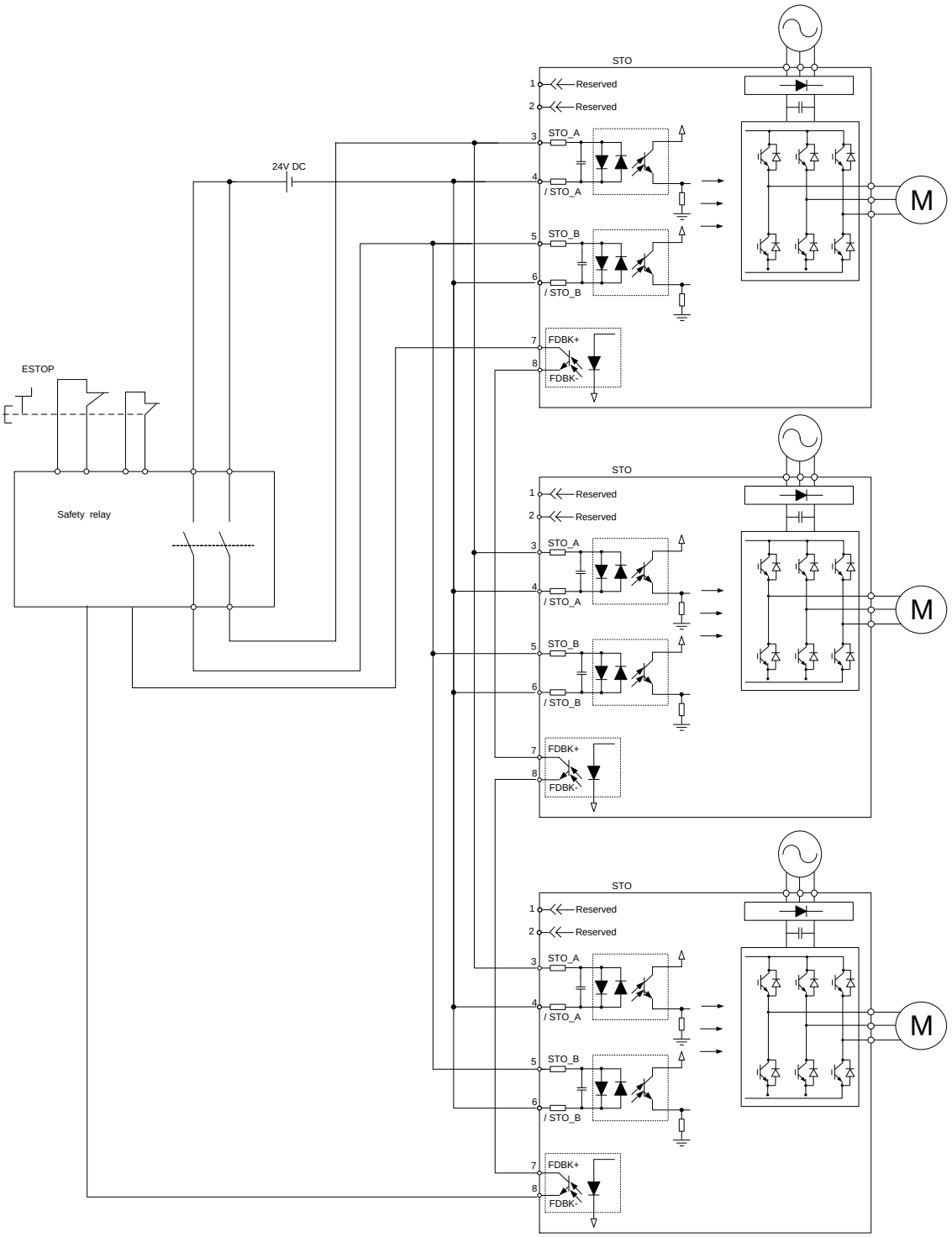
3.10.5.2 Single drive module

To use a safety relay to trigger the STO function, connect the wiring as shown in the following diagram:



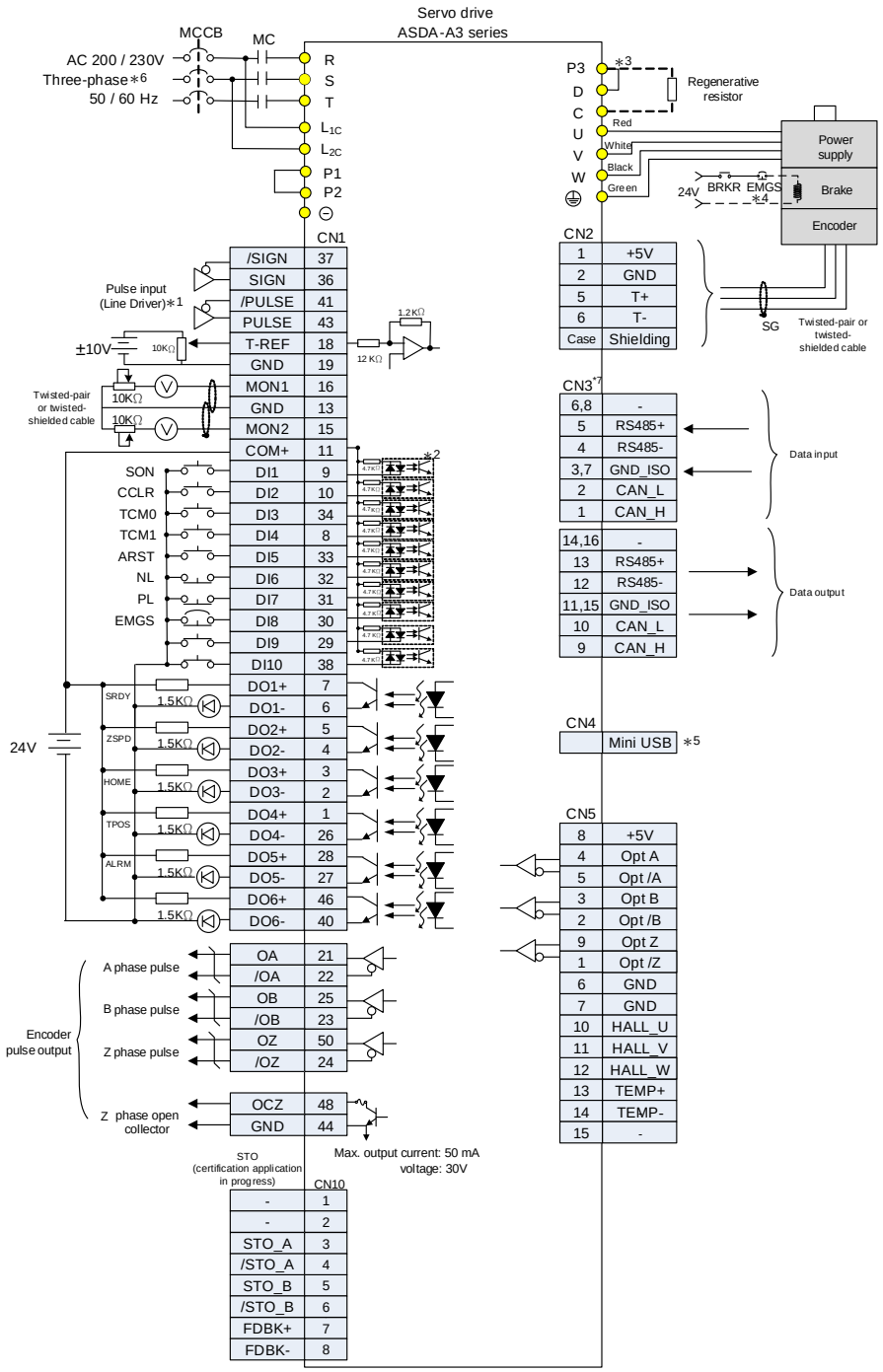
3.10.5.3 Multiple drive modules

In the multiple drive modules system, after multiplying PFD and PFH by the number of drives, the value must not exceed the specified safety value.



3.11 Standard wiring example

3.11.1 Position (PT) control mode



Note:

*1. Refer to Section 3.3.5 for C4 wiring diagram.

*2. Refer to Section 3.3.5 for wiring diagram C7 SINK / C8 SOURCE.

*3. Models of 200 W and below have no built-in brake resistor.

*4. The brake coil has no polarity.

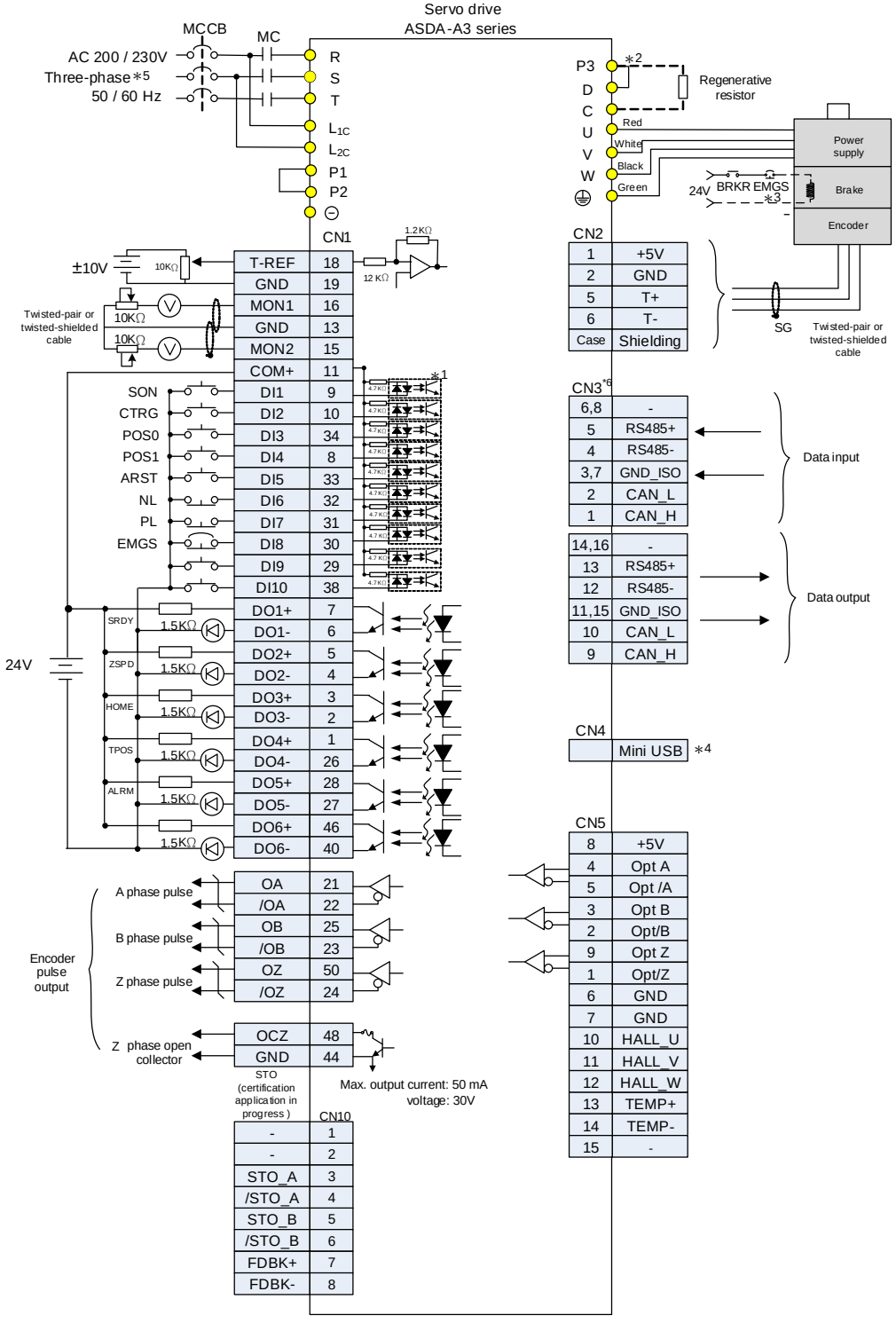
*5. Connect to Mini USB (for PC communication).

*6. Models of 1.5 kW and below can use single-phase power supply.

*7. Only the A3-L models do not have dual ports.

3

3.11.2 Position (PR) control mode



Note:

*1. Refer to Section 3.3.5 for wiring diagram C7 SINK / C8 SOURCE.

*2. Models of 200 W and below have no built-in brake resistor.

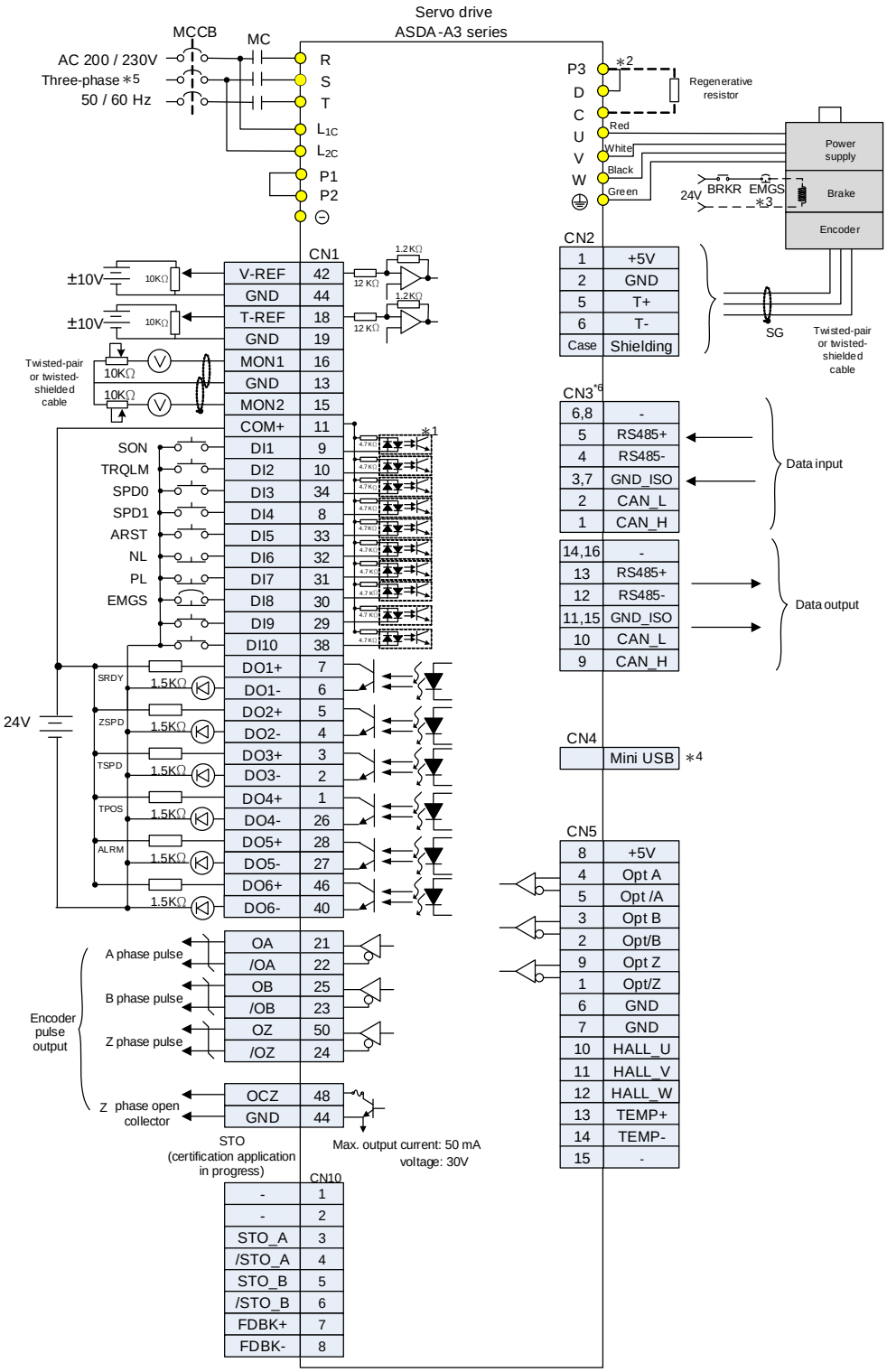
*3. The brake coil has no polarity.

*4. Connect to Mini USB (for PC communication).

*5. Models of 1.5 kW and below can use single-phase power supply.

*6. Only the A3-L models do not have dual ports.

3.11.3 Speed control mode



Note:

*1. Refer to Section 3.3.5 for wiring diagram C7 SINK / C8 SOURCE.

*2. Models of 200 W and below have no built-in brake resistor.

*3. The brake coil has no polarity.

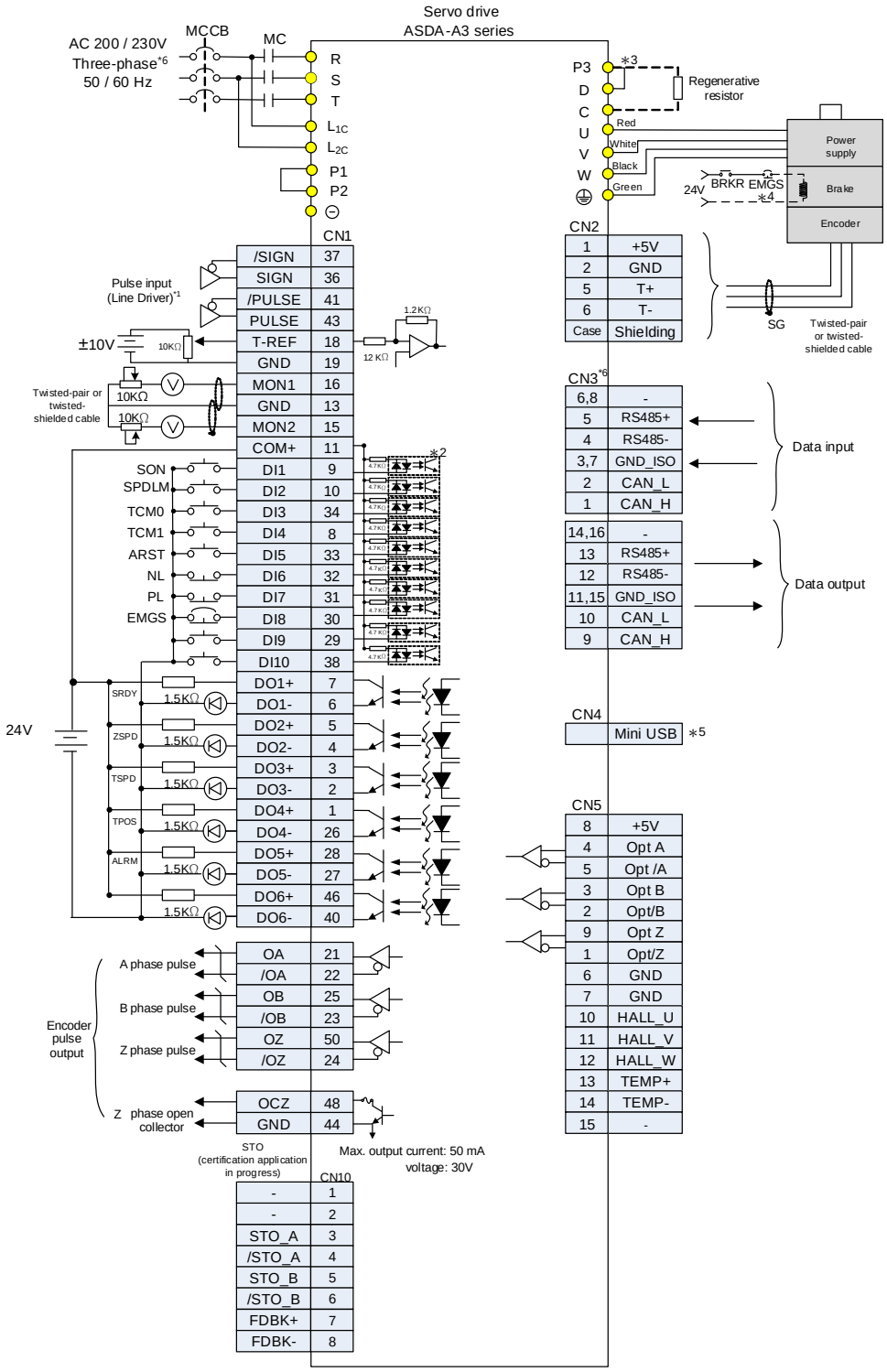
*4. Connect to Mini USB (for PC communication).

*5. Models of 1.5 kW and below can use single-phase power supply.

*6. Only the A3-L models do not have dual ports.

3

3.11.4 Torque control mode



Note:

*1. Refer to Section 3.3.5 for wiring diagram C7 SINK / C8 SOURCE.

*2. Models of 200 W and below have no built-in brake resistor.

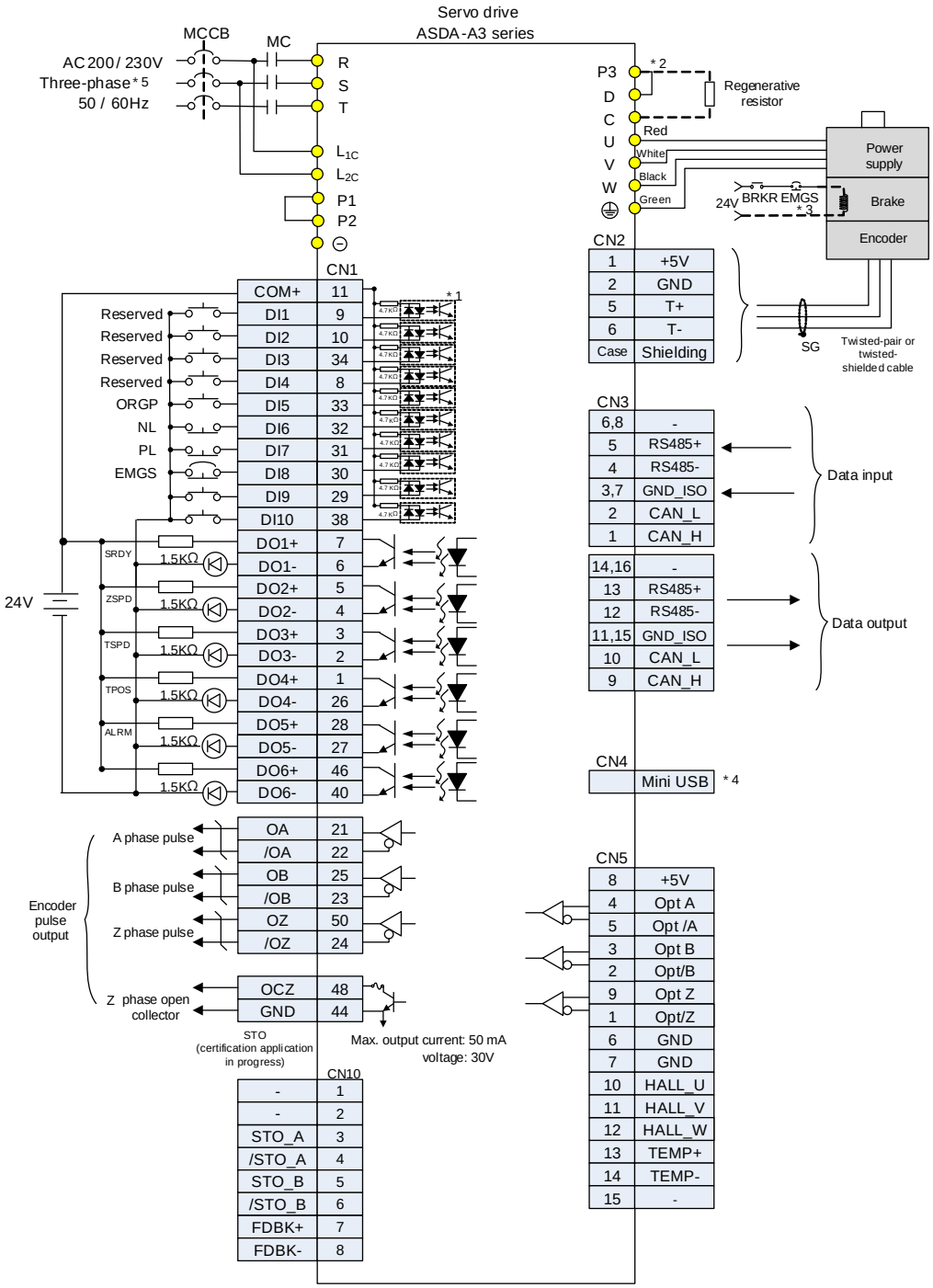
*3. The brake coil has no polarity.

*4. Connect to Mini USB (for PC communication).

*5. Models of 1.5 kW and below can use single-phase power supply.

*6. Only the A3-L models do not have dual ports.

3.11.5 Communication mode (CANopen)



Note:

*1. Refer to Section 3.3.5 for wiring diagram C7 SINK / C8 SOURCE.

*2. Models of 200 W and below have no built-in brake resistor.

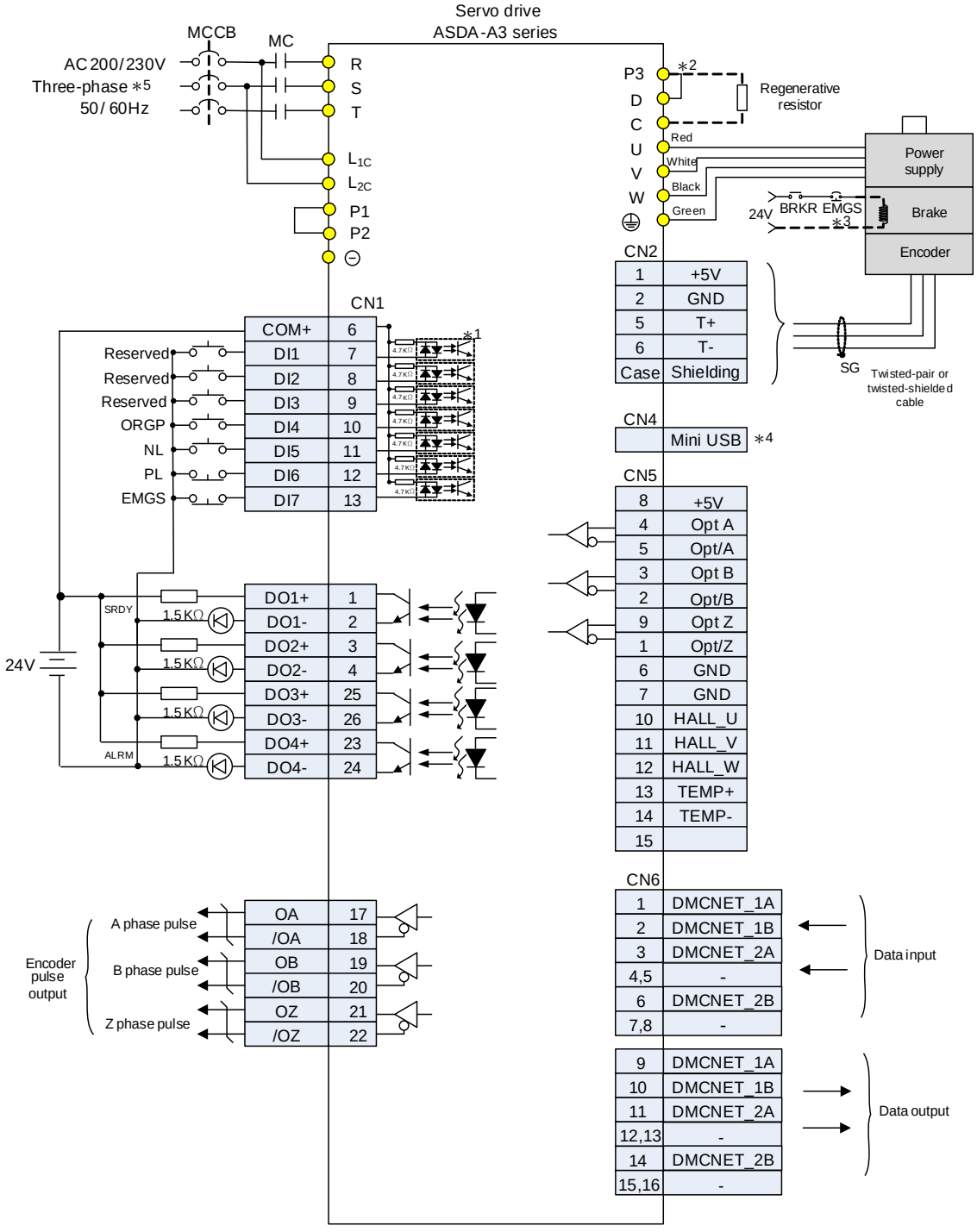
*3. The brake coil has no polarity.

*4. Connect to Mini USB (for PC communication).

*5. Models of 1.5 kW and below can use single-phase power supply.

3

3.11.6 Communication mode (DMCNET)



Note:

*1. Refer to Section 3.3.5 for wiring diagram C7 SINK / C8 SOURCE.

*2. Models of 200 W and below have no built-in brake resistor.

*3. The brake coil has no polarity.

*4. Connect to Mini USB (for PC communication).

*5. Models of 1.5 kW and below can use single-phase power supply.

Test Operation and Panel Display

4

This chapter describes the panel display of ASDA-A3 series servo drive, as well as its operation and testing.

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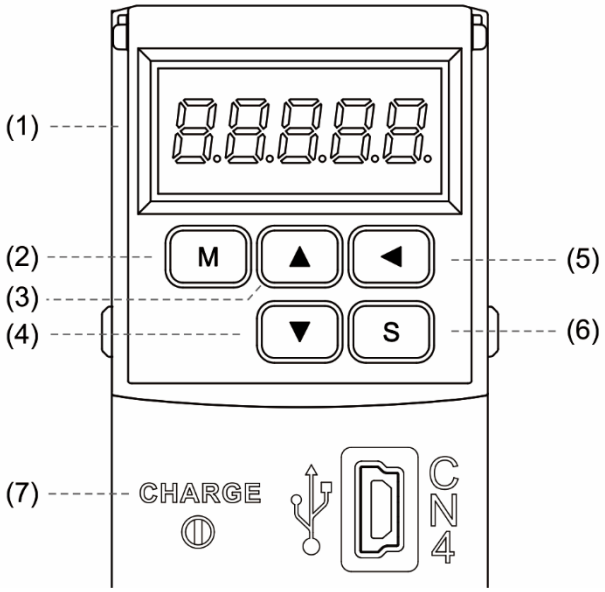
4.1 Panel description



(1) Display: 5-digit, 7-segment LED displays the monitoring values, parameters, and setting values.

(2) MODE key: switches the display among Monitoring mode, Parameter mode, and Alarm mode. In Editing mode, press the MODE key to switch back to Parameter mode.

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

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

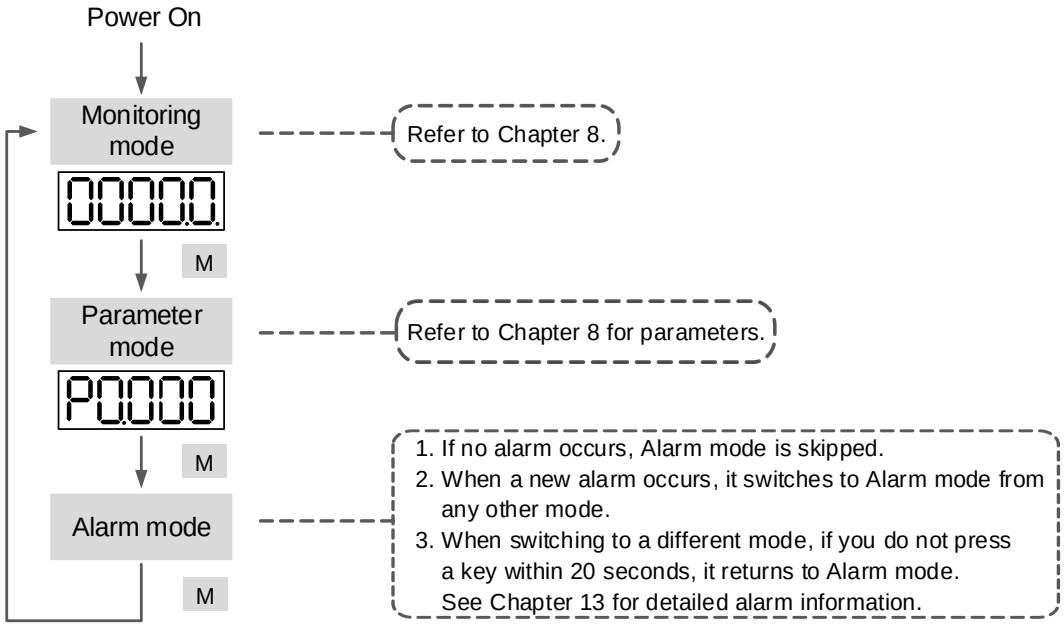
(5) SHIFT key: in Parameter mode, press this key to change the group number. In Editing mode, moving the flashing (selected) digit to the left lets you adjust the higher setting bit. You can switch the display of high / low digits in Monitoring mode.

(6) SET key: displays and stores the parameter value. In Monitoring mode, pressing the SET key switches between decimal and hexadecimal display. In Parameter mode, pressing the SET key switches to Editing mode.

(7) Charge LED: the Charge LED indicator is on when the power is applied to the circuit.

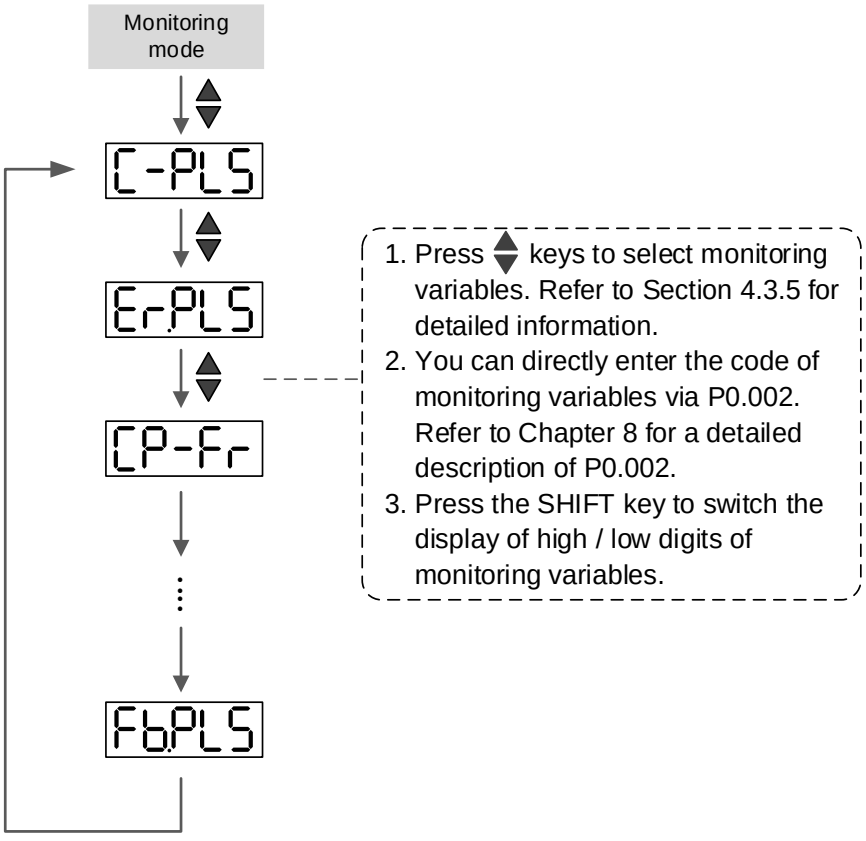
4.2 Parameter setting procedure

Switching modes:



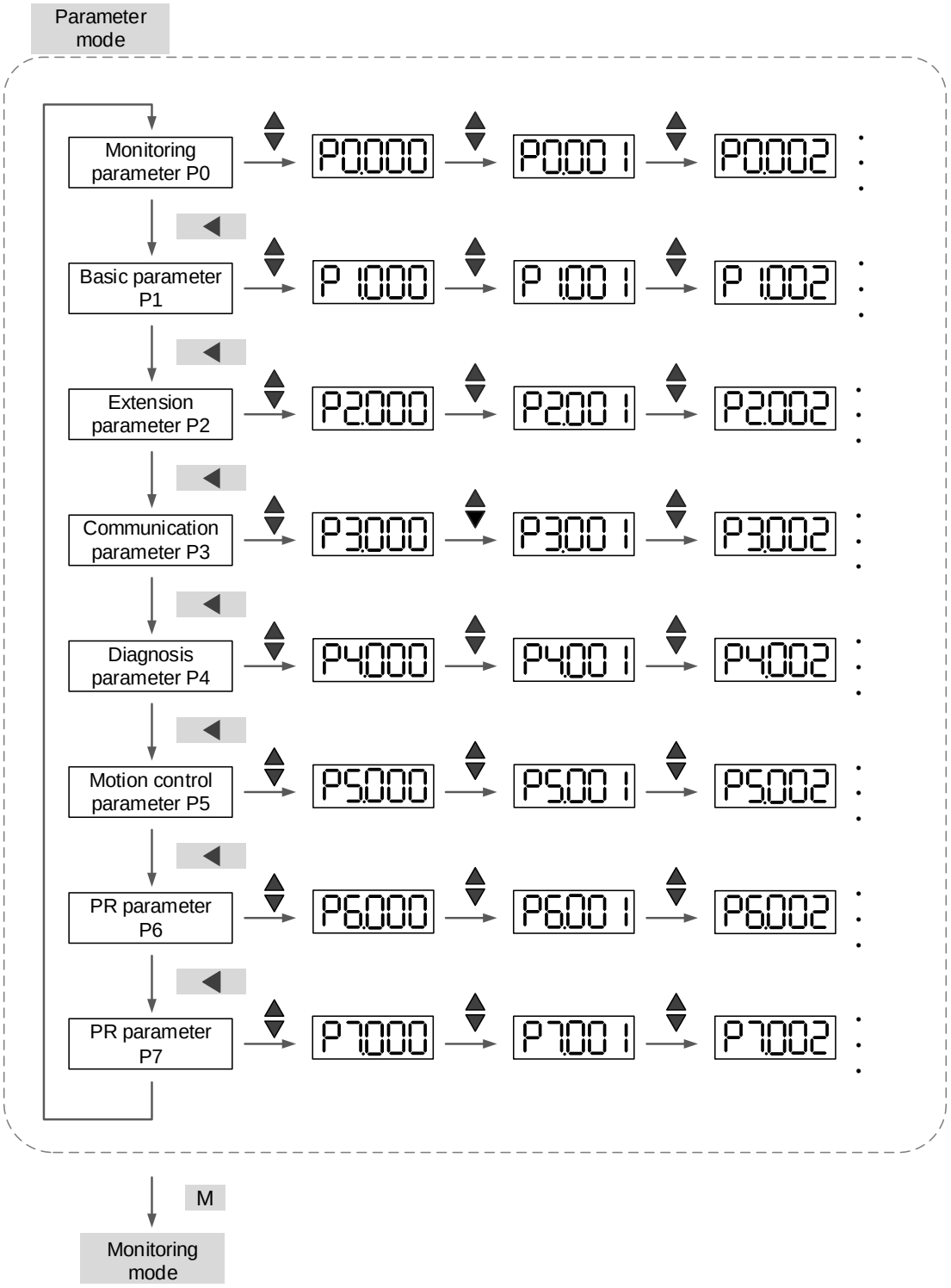
Operating in each mode:

Monitoring mode

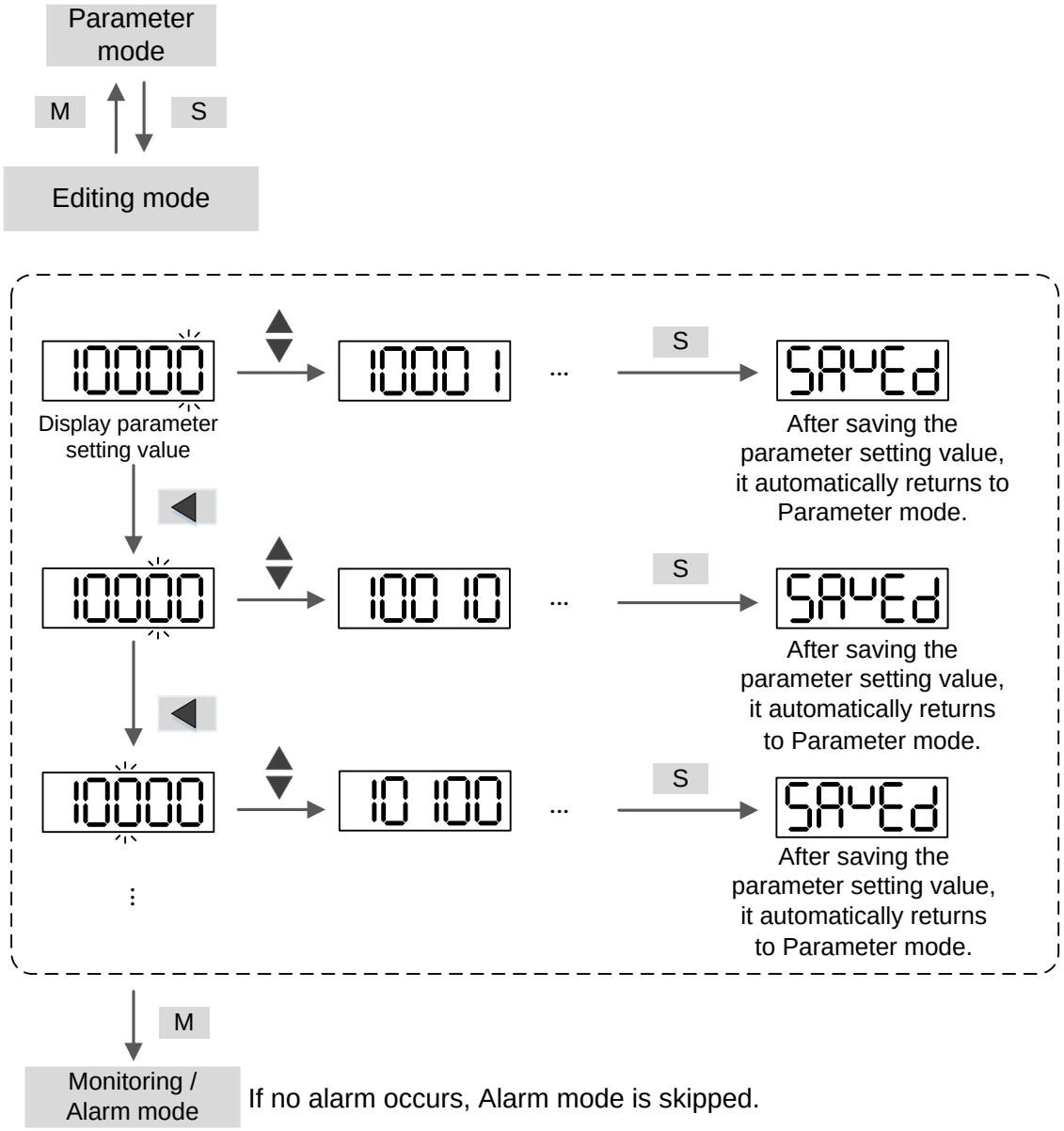


4

Parameter mode



Editing mode

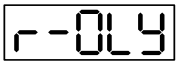
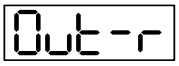
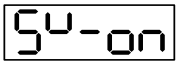
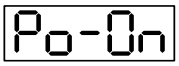


If no alarm occurs, Alarm mode is skipped.

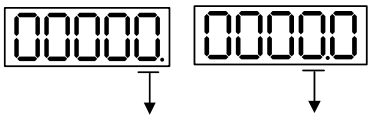
4.3 Status display

4.3.1 Save the setting display

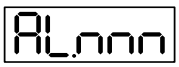
When you complete the parameter setting, press the SET key to save the parameters. The panel displays the status for one second.

Displayed symbol	Description
	Correctly saved the setting value (Saved).
	Read-only and write-protected parameter (Read-only).
	Entered the wrong password or did not enter a password (Locked).
	Entered an incorrect setting value or the reserved setting value (Out of Range).
	You cannot enter a value when in the Servo On state (Servo On).
	Changes to the parameter take effect after cycling the power to the servo drive (Power On).

4.3.2 Display the decimal point

Displayed symbol	Description
	High byte / low byte indication: this indicates the current high byte or low byte when the data is displayed in decimal format (32 bits).
	Negative sign: the two decimal points on the left represent the negative sign when the data is displayed in decimal format (16 or 32 bits). In hexadecimal format, it only shows positive values.

4.3.3 Alarm messages

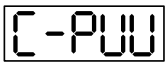
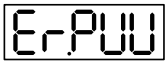
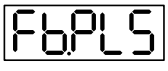
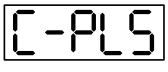
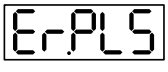
Displayed symbol	Description
	When an alarm occurs, the servo drive shows 'AL' as the alarm symbol and 'nnn' as the alarm code. Refer to Chapter 8 Parameters for a detailed description of P0.001 or Chapter 13 Troubleshooting for alarm details.

4.3.4 Positive and negative sign setting

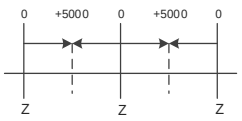
Displayed symbol	Description
	In Editing mode, press the UP and DOWN keys to change the displayed value. Press the SHIFT key to change the selected value (the selected value is flashing).
	Press the SHIFT key for 2 seconds to switch between the positive (+) and negative (-) signs. If the parameter value is out of range after switching the positive or negative sign, then the servo drive automatically resets it to the original value.

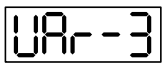
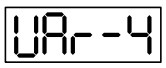
4.3.5 Monitoring display

When you apply power to the drive, the display shows the monitoring displayed symbol for one second, and then enters Monitoring mode. In Monitoring mode, press the UP and DOWN keys to change the monitoring variables. Or you can directly change the setting value of P0.002 to specify the monitoring code. When powered, the default monitoring code is set to the value of P0.002. For example, the value of P0.002 is 4. When the drive is powered, it displays the monitoring symbol C-PLS first, and then shows the input number of pulse commands. Refer to the following table for more information.

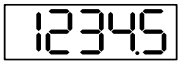
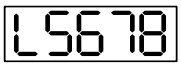
P0.002 setting value	Monitoring displayed symbol	Description	Unit
0		Motor feedback pulse number (after the scaling of E-Gear ratio) (user unit)	[user unit]
1		Input number of pulse commands (after the scaling of E-Gear ratio) (user unit)	[user unit]
2		The deviation between control command pulse and feedback pulse number (user unit)	[user unit]
3		Motor feedback pulse number (encoder unit)	[pulse]
4		Input number of pulse commands (before the scaling of E-Gear ratio) (encoder unit)	[pulse]
5		Error pulse number (after the scaling of E-Gear ratio) (encoder unit)	[pulse]
6		Input frequency of pulse commands	[kpps]
7		Motor speed	[rpm]

4

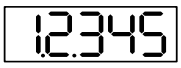
P0.002 setting value	Monitoring displayed symbol	Description	Unit
8	CSPd1	Speed command	[Volt]
9	CSPd2	Speed command	[rpm]
10	C-t91	Torque command	[Volt]
11	C-t92	Torque command	[%]
12	AUG-L	Average torque	[%]
13	PE-L	Peak torque	[%]
14	U buS	Main circuit voltage	[Volt]
15	J-L	Load / motor inertia ratio Note: if it shows 13.0, it means the actual inertia is 13.	[1 times]
16	IGbtt	IGBT temperature	[°C]
17	rSnFr	Resonance frequency (low byte is the first resonance and high byte is the second one).	[Hz]
18	dIFF2 	The absolute pulse number of encoder Z phase equals the homing value, 0. It is +5000 or -4999 pulses when the motor rotates in the forward or reverse direction.	-
19	MAP1	Mapping parameter #1: shows the content of parameter P0.025 (specify the mapping target by P0.035)	-
20	MAP2	Mapping parameter #2: shows the content of parameter P0.026 (specify the mapping target by P0.036)	-
21	MAP3	Mapping parameter #3: shows the content of parameter P0.027 (specify the mapping target by P0.037)	-
22	MAP4	Mapping parameter #4: shows the content of parameter P0.028 (specify the mapping target by P0.038)	-
23	UAr-1	Monitoring variable #1: shows the content of parameter P0.009 (specify the monitoring variable code by P0.017)	-
24	UAr-2	Monitoring variable #2: shows the content of parameter P0.010 (specify the monitoring variable code by P0.018)	-

P0.002 setting value	Monitoring displayed symbol	Description	Unit
25		Monitoring variable #3: shows the content of parameter P0.011 (specify the monitoring variable code by P0.019)	-
26		Monitoring variable #4: shows the content of parameter P0.012 (specify the monitoring variable code by P0.020)	-

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

Example of the displayed value	Description	
(Dec)	16 bits	If the value is 1234, it displays 01234 (in decimal format).
(Hex)		If the value is 0x1234, it displays 1234 (in hexadecimal format; the first digit does not show).
 (Dec high) (Dec low)	32 bits	If the value is 1234567890, the display of the high byte is 1234.5 and displays 67890 as the low byte (in decimal format).
(Hex high)  (Hex low)		If the value is 0x12345678, the display of the high byte is h1234 and displays L5678 as the low byte (in hexadecimal format).

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

Example of the displayed value	Description
	If the value is -12345, it displays as 1.2.345 (only in decimal format; there is no positive or negative sign for hexadecimal format display).

Note:

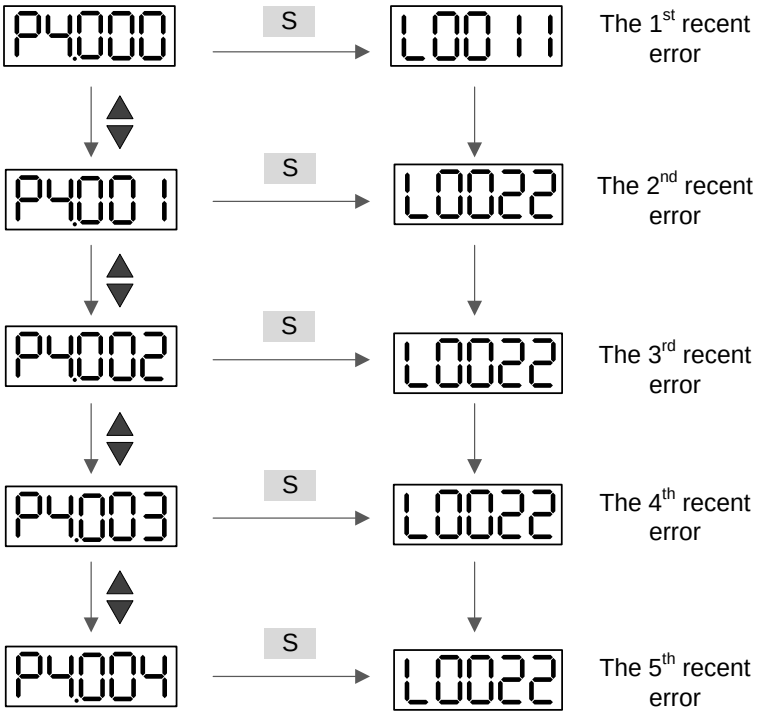
1. Dec means the value is displayed in decimal format; Hex represents hexadecimal format.
2. The display shown above is applicable in both Monitoring mode and Editing mode.
3. When all monitoring variables are 32 bits, you can switch the high / low bit and the display method (Dec / Hex). As described in Chapter 8, each parameter only supports one display method and cannot be switched.

4.4 General functions

4.4.1 Operation of fault record display

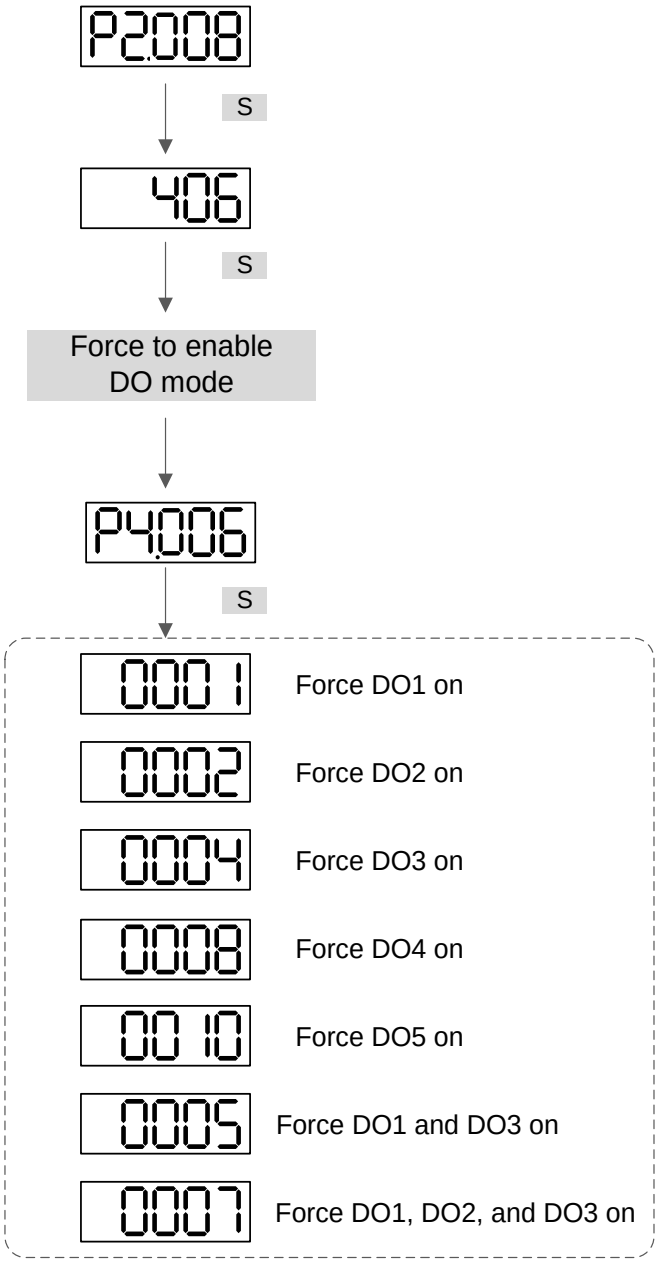
4

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



4.4.2 Force DO on

You can switch to the Diagnosis mode by the following steps. Set P2.008 to 406 and enable the function to force DO on. Then, set the DO by binary method with P4.006. When the parameter value is 2, it forces DO2 on. When the value is 5, it forces DO1 and DO3 on. No data is retained in this mode. The mode returns to the normal DO mode after cycling the power. You can also set P2.008 to 400 to switch to the normal DO mode.

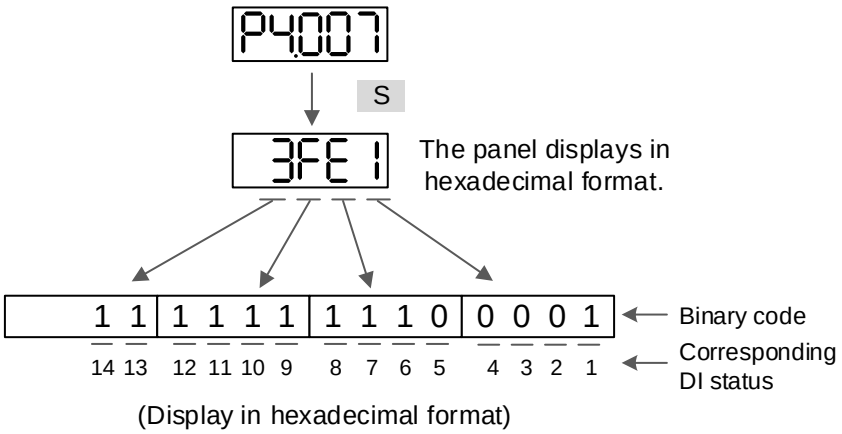


Note: P4.006 is displayed in hexadecimal format. Therefore, it does not show the fifth 0.

4.4.3 Digital input diagnosis operation

You can switch to the Diagnosis mode by the following steps. When DI1 – DI10 are triggered by the external signal, the panel shows the corresponding signal in bit. When it shows 1, it means the DI is on.

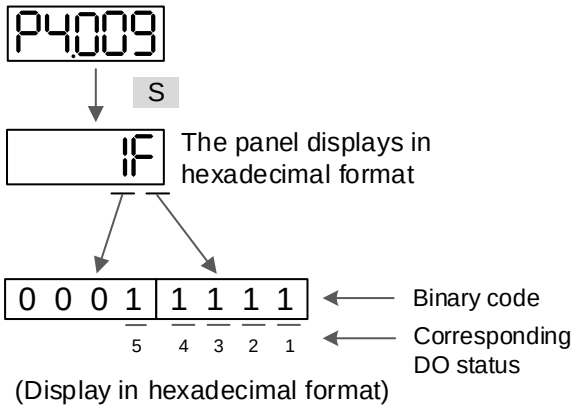
For example, if it shows 3FE1, E is in hexadecimal format; it will be 1110 when it transfers to binary format. Then, DI6 – DI8 are on.



4.4.4 Digital output diagnosis operation

You can switch to the Diagnosis mode by the following steps. When DO1 – DO5 are triggered by the output signal, the panel shows the corresponding signal in bit. When it shows 1, it means the DO is on.

For example, if it shows 1F, F is in hexadecimal format; it will be 1111 when it transfers to binary format. Then, DO1 – DO4 are on.



4.5 Testing

This section is divided into two parts. The first part introduces testing without load and the second part describes testing when running the servo motor with load. To avoid danger, operate the servo motor without load first.

4.5.1 Testing without load

Remove the load from the servo motor, including coupling on the shaft and accessories, to avoid any damage to the servo drive or machine. This prevents the disassembled parts of the motor shaft from falling off and possibly causing personnel injury or equipment damage during operation. Run the motor without load first to see if the servo motor can run during normal operation.

Caution: in order to prevent danger, it is strongly recommended that you check if the motor can operate normally without load first. Then, try operating the motor with load.

Check the following items carefully before operation.

Inspection before operation (without power)	■ Check for any obvious visible damage. ■ 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 electrically conductive objects, including metal (such as 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 if 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 if the power indicator and LED display work properly. ■ The 7.5 kW model is controlled by PWM. When the temperature is lower than 40°C (104°F), the fan stops running.

4.5.2 Apply power to A3 servo drive

Follow the instructions below.

4

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 green wires respectively. If the wiring is incorrect, the motor cannot work properly. The motor ground cable FG must connect to the drive's ground terminal. Refer to Sections 3.1 – 3.2 for wiring.
   (2) The encoder cable for the motor is correctly connected to CN2: if you only want to use the JOG function, connecting CN1 and CN3 is not necessary. Refer to Sections 3.1 and 3.4 for the wiring for CN2.

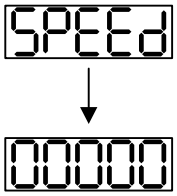
Caution: do not connect the power (R, S, T) to the output terminal (U, V, W) of A3 servo drive, or it may damage the servo drive.

2. Connect the power circuit for the servo drive:
   200V servo drive: connect the power to the servo drive. Refer to Section 3.1.3 for power wiring.
3. Turn on the power:
   220V servo drive supply: apply power, including to the control circuit (L_{1C}, L_{2C}) and main circuit (R, S, T).

When the power is on, the display of the servo drive shows:

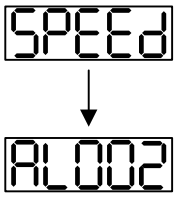
The default digital inputs (DI6 – DI8) are the signal for negative limit (NL), positive limit (PL), and emergency stop (EMGS). If DI6 – DI8 are not used, you must change the values of P2.015 – P2.017, which you can set to 0 (disable the DI function) or some other value for a different function.

If the servo drive status displays the P0.002 setting as the motor speed (07), then the screen display shows:



When the panel displays no text, check if the control circuit power is undervoltage.

- When the screen displays:



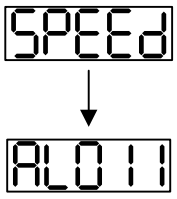
Overvoltage warning:

This means the voltage input from the main circuit is higher than the rated range or a power input error has occurred (incorrect power system).

Corrective action:

1. Use the voltmeter to measure the input voltage from the main circuit, and ensure it is within the rated range.
2. Use the voltmeter to measure if the power system complies with the specifications.

- When the screen displays:



Encoder error warning:

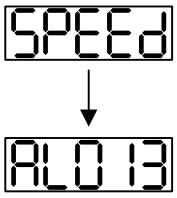
Check that the motor encoder is securely connected and the wiring is correct.

Corrective action:

1. Make sure the wiring is following the instructions in the user manual.
2. Check the encoder connector.
3. Check for loose wiring.
4. Check for damage to the encoder

4

- When the screen displays:



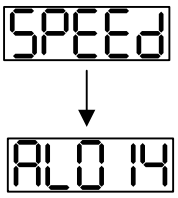
Emergency stop warning:

Check if any of the digital inputs DI1 – DI10 are set to emergency stop (EMGS).

Corrective action:

1. If you do not want to set the emergency stop (EMGS) as one of the digital inputs, make sure none of the digital inputs DI1 – DI10 are set to emergency stop (EMGS) (make sure that none of the parameters, P2.010 – P2.017, P2.036, and P2.037, are set to 21).
2. If the emergency stop (EMGS) 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).

- When the screen displays:



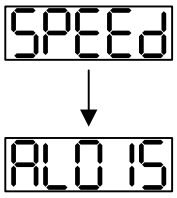
Negative limit error warning:

Check if any of the digital inputs DI1 – DI10 are set to negative limit (NL) and that DI is not on.

Corrective action:

1. If you do not want to set the negative limit (NL) as one of the digital inputs, make sure none of the digital inputs DI1 – DI10 are set to negative limit (NL) (make sure that none of the parameters, P2.010 – P2.017, P2.036, and P2.037, are set to 22).
2. If the negative limit (NL) 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).

- When the screen displays:



Positive limit error warning:

Check if any of the digital inputs DI1 – DI10 are set to positive limit (PL) and that DI is not on.

Corrective action:

1. If you do not want to set the positive limit (PL) as one of the digital inputs, make sure none of the digital inputs DI1 - DI10 are set to positive limit (PL) (make sure that none of the parameters, P2.010 – P2.017, P2.036, and P2.037, are set to 23).
2. If the positive limit (PL) 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).

- When the screen displays:

Overcurrent warning.

Corrective action:

1. Check the connection between the motor and servo drive.
2. Check if the conducting wire is short-circuited. Fix the short circuit and prevent any metal conductors from being exposed.

- When the screen displays:

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Undervoltage warning.

Corrective action:

1. Check if the main circuit wiring is correct.
2. Use a voltmeter to make sure that the main circuit voltage is normal.
3. Use the voltmeter to measure if the power system complies with the specifications.

Note: during power on or in the Servo On state (without issuing any commands), if an alarm occurs or any abnormal display appears, please contact the distributors.

4.5.3 JOG trial run without load

It is easy to test the motor and servo drive using a JOG trial run without load since no extra wiring is needed. For safety reasons, it is recommended to set JOG at low speed. Follow the steps below:

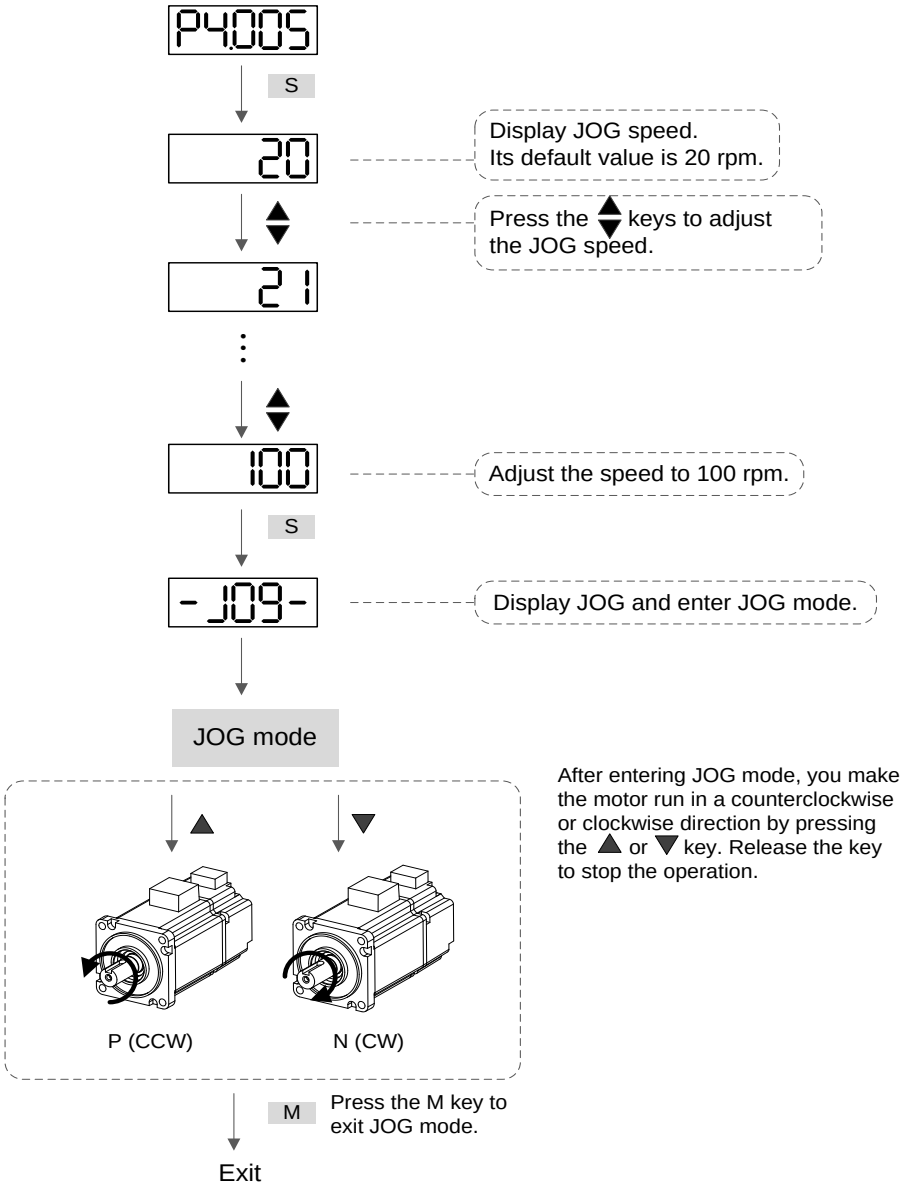
Step 1: JOG trial run is available only when the servo drive is in the Servo On state. The drive can be forced into the Servo On state by setting P2.030 to 1 or with the host controller (the communication mode does not support using the panel to operate the JOG trial run).

Step 2: set JOG speed (unit: rpm) with P4.005. Press the S key to display the JOG speed. The default is 20 rpm.

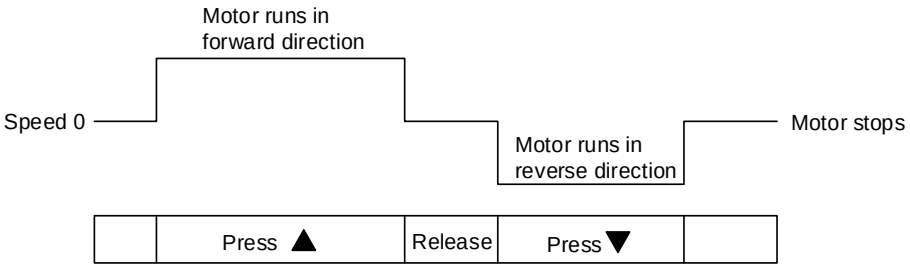
Step 3: press the ▲ or ▼ key to adjust the JOG speed. In the following example, the speed is set to 100 rpm.

Step 4: press the S key to display JOG and enter JOG mode.

Step 5: press the M key after completing the trial run to exit JOG mode.



The following shows the JOG timing diagram:



If the motor does not run, check if the wiring between U, V, W and encoder cable is correct.
If the motor runs abnormally, check if the U, V, W phase sequence is correct.

4.5.4 Trial run without load (Speed mode)

Before starting the trial run without load, firmly secure the motor base to avoid any danger caused by force generated by the motor during speed changes.

Step 1: set the control mode of the servo drive to Speed mode. Set P1.001 to 2 for Speed mode. Then cycle the power to the servo drive.

Step 2: in Speed mode, the following table lists the digital input settings for the trial run:

Digital input	Parameter setting value	Symbol	Function description	CN1 Pin No.
DI1	P2.010 = 101	SON	Servo activated	DI1- = 9
DI2	P2.011 = 109	TRQLM	Torque limit	DI2- = 10
DI3	P2.012 = 114	SPD0	Speed selection	DI3- = 34
DI4	P2.013 = 115	SPD1	Speed selection	DI4- = 8
DI5	P2.014 = 102	ARST	Alarm reset	DI5- = 33
DI6	P2.015 = 0	-	DI disabled	-
DI7	P2.016 = 0	-	DI disabled	-
DI8	P2.017 = 0	-	DI disabled	-
DI9	P2.036 = 0	-	DI disabled	-
DI10	P2.037 = 0	-	DI disabled	-
VDI11	P2.038 = 0	-	DI disabled	-
VDI12	P2.039 = 0	-	DI disabled	-
VDI13	P2.040 = 0	-	DI disabled	-

This table shows the settings that disable the negative limit (DI6), positive limit (DI7), and emergency stop (DI8) functions. Thus, parameters P2.015 – P2.017 and P2.036 – P2.040 are set to 0 (disabled); you can program the digital inputs of Delta's servo drive. When programming the digital inputs for the servo drive, refer to the DI code descriptions.

The default setting includes the negative limit, positive limit, and emergency stop functions; therefore, if any alarm occurs after you complete the settings, cycle the power to the servo drive or set DI5 to on to clear the alarm. Please refer to Section 4.5.

The Speed command selection is determined by SPD0 and SPD1. See the table below.

Speed command number	CN1 DI signal		Command source	Content	Range
	SPD1	SPD0			
S1	0	0	External analog command	Voltage difference between V-REF and GND	-10V to +10V
S2	0	1	Internal register parameter	P1.009	-60000 to +60000
S3	1	0		P1.010	-60000 to +60000
S4	1	1		P1.011	-60000 to +60000

0: means the switch is open (off).

1: means the switch is closed (on).

The parameter setting range of the internal register is from -60000 to +60000. Speed setting = setting value x 0.1 rpm. For example, P1.009 = +30000, speed setting = +30000 X 0.1 rpm = +3000 rpm.

Command setting for the speed register:

Set P1.009 to +30000.

Set P1.010 to +1000.

Set P1.011 to -30000.

Motor's running direction:

Input command	Rotation direction
+	CCW (forward direction)
-	CW (reverse direction)

Step 3:

1. Switch on DI1 and the drive is in the Servo On state.
2. When both Speed commands of DI3 (SPD0) and DI4 (SPD1) are off, that means it executes the S1 command. The motor rotates according to analog voltage command.
3. When DI3 (SPD0) is on, that means it executes the S2 command. The rotation speed is 3000 rpm.
4. When DI4 (SPD1) is on, that means it executes the S3 command. The rotation speed is 100 rpm.
5. When both DI3 (SPD0) and DI4 (SPD1) are on, that means it executes the S4 command. The rotation speed is -3000 rpm.
6. You can repeatedly execute steps 3, 4, and 5.
7. If you want to stop the motor, switch off DI1 (Servo Off).

4.5.5 Trial run without load (Position mode)

Before starting the trial run without load, firmly secure the motor base to avoid any danger caused by the force generated by the motor during speed changes.

Step 1: set the control mode of the servo drive to Position mode. Set P1.001 to 1 for Position mode. Then cycle the power to the servo drive.

Step 2: in Position mode, the following table lists the digital input settings for the trial run:

Digital input	Parameter setting value	Symbol	Function description	CN1 Pin No.
DI1	P2.010 = 101	SON	Servo activated	DI1- = 9
DI2	P2.011 = 108	CTRG	Command triggered	DI2- = 10
DI3	P2.012 = 111	POS0	Position selection	DI3- = 34
DI4	P2.013 = 112	POS1	Position selection	DI4- = 8
DI5	P2.014 = 102	ARST	Alarm reset	DI5- = 33
DI6	P2.015 = 0	-	DI disabled	-
DI7	P2.016 = 0	-	DI disabled	-
DI8	P2.017 = 0	-	DI disabled	-
DI9	P2.036 = 0	-	DI disabled	-
DI10	P2.037 = 0	-	DI disabled	-
VDI11	P2.038 = 0	-	DI disabled	-
VDI12	P2.039 = 0	-	DI disabled	-
VDI13	P2.040 = 0	-	DI disabled	-

This table shows the settings that disable the negative limit (DI6), positive limit (DI7), and emergency stop (DI8) functions. Thus, parameters P2.015 – P2.017 and P2.036 – P2.040 are set to 0 (disabled); you can program the digital inputs of Delta's servo drive. When programming the digital inputs for the servo drive, refer to the DI code descriptions.

The default setting includes the negative limit, positive limit, and emergency stop functions; therefore, if any alarm occurs after you complete the settings, cycle the power to the servo drive or set DI5 to on to clear the alarm. Please refer to Section 4.5.

4

Refer to Section 3.10.2 for the wiring for Position (PR) control mode. Please see the table below for the 99 sets for PR and the Position commands (POS0 – POS6):

Position command	POS6	POS5	POS4	POS3	POS2	POS1	POS0	CTRG	Corresponding parameter
Homing	0	0	0	0		0	0	↑	P6.000
									P6.001
PR1	0	0		0	0	0	1	↑	P6.002
									P6.003
~									~
PR50	0	1	1	0	0	1	0	↑	P6.098
									P6.099
PR51	0	1	1	0	0	1	1	↑	P7.000
									P7.001
~									~
PR99	1	1	0	0	0	1	0	↑	P7.098
									P7.099

0: means the switch is open (off).

1: means the switch is closed (on).

You can set the 99 sets of PR (P6.000 – P7.099), which you can also set for absolute position commands.

Tuning

5

This chapter contains information about the auto tuning procedure and the three gain adjustment modes. Advanced users can also tune the servo system using the manual mode.

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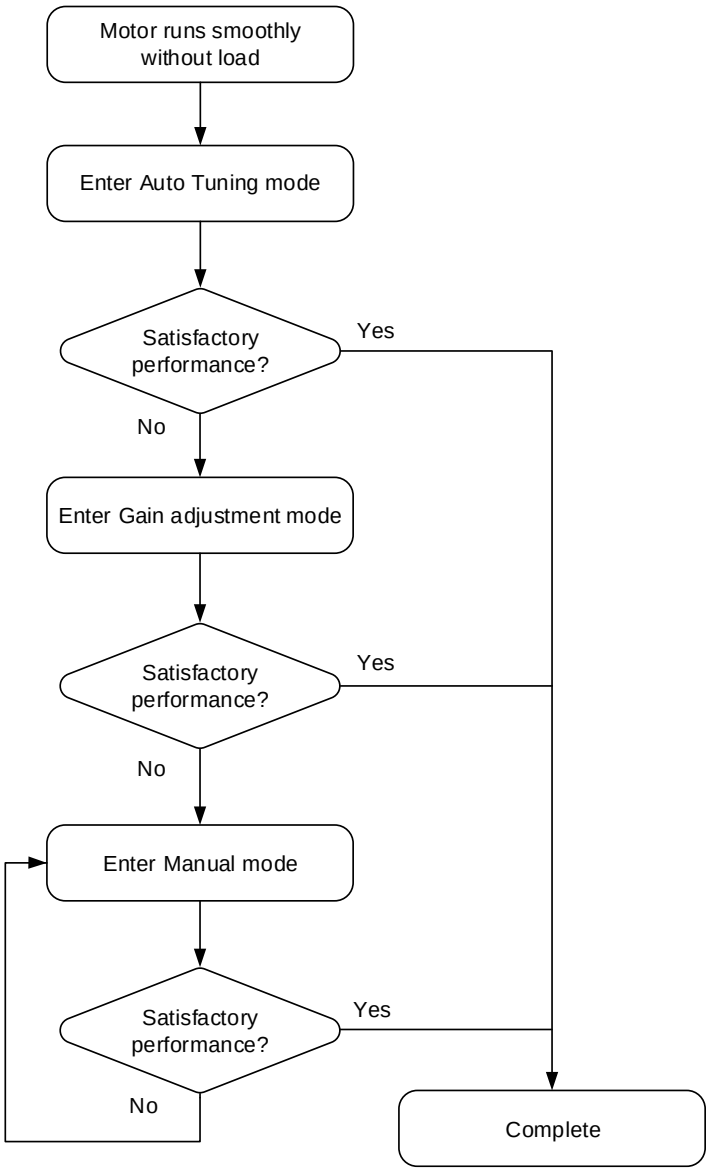
5.1 Tuning procedure and the applied mode

5.1.1 Flowchart of the tuning procedure

5

You can tune the servo drive by following the flowchart below. First, start from the Auto Tuning mode. If you are not satisfied with the system's performance, you can use Gain adjustment modes 1, 2, 3, or Manual mode for tuning the servo system.



5.1.2 Tuning modes

P2.032 setting 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	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		

Note:

1. Refer to the parameter list in Section 5.2 Auto tuning for the parameter functions.
2. When the two dimensional 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.

5.2 Auto tuning

5

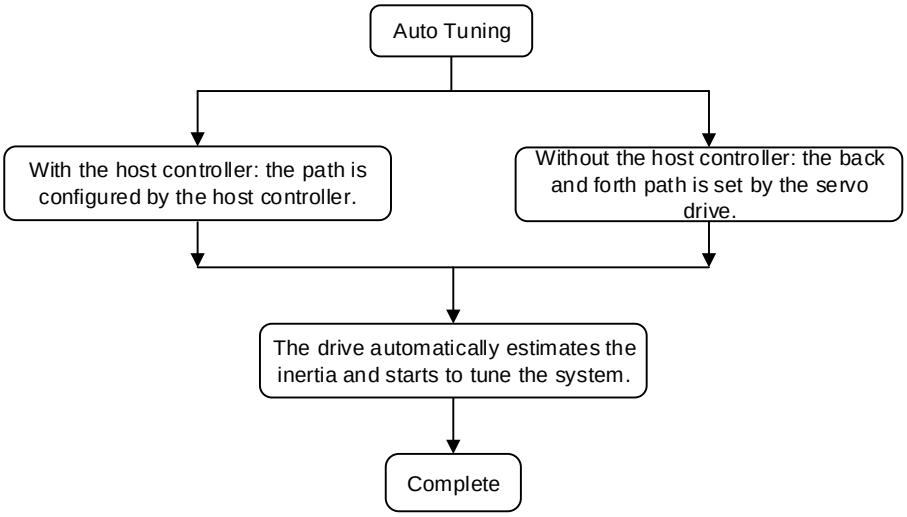
The Auto Tuning function provided by the ASDA-A3 enables the system to perform real-time machine inertia estimation and upload the corresponding tuning parameters to the servo drive. You can start auto tuning with ASDA-Soft (software) or with the drive panel. The following table lists the parameters that change according to the results of auto tuning.

Gain related parameters	
Parameter No.	Function
P1.037	Load inertia ratio and load weight ratio of servo motor
P2.000	Position control gain
P2.004	Speed control gain
P2.006	Speed integral compensation
P2.031	Bandwidth response level
P2.032	Gain adjustment mode
P2.089	Command response gain (enabling the two dimensional control function (P2.094 [Bit12] = 1) is required)
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-

Filter and resonance suppression parameters	
Parameter No.	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)
P2.023	Notch filter frequency (1)
P2.024	Notch filter attenuation level (1)
P2.025	Resonance suppression low-pass filter
P2.043	Notch filter frequency (2)
P2.044	Notch filter attenuation level (2)
P2.045	Notch filter frequency (3)
P2.046	Notch filter attenuation level (3)
P2.049	Speed detection filter and jitter suppression
P2.098	Notch filter frequency (4)
P2.099	Notch filter attenuation level (4)
P2.101	Notch filter frequency (5)
P2.102	Notch filter attenuation level (5)

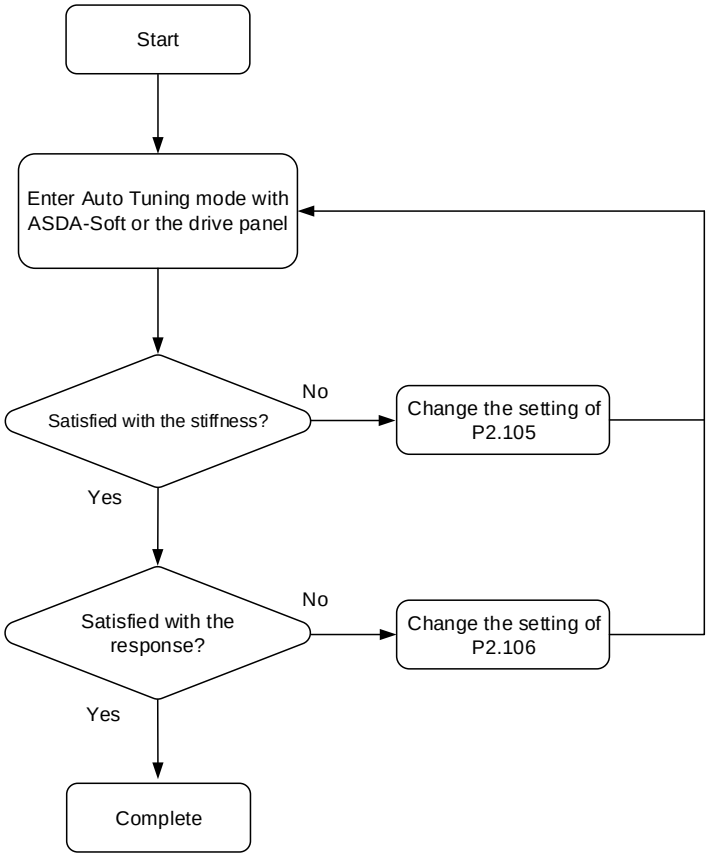
5.2.1 Flowchart of auto tuning

You can complete auto tuning with the drive panel or ASDA-Soft. The Auto Tuning function in the A3 servo drive helps you to find the most suitable parameters for your system according to the machine characteristics.



Note: when the path is configured by the host 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 response and stiffness in Auto Tuning mode. See the flowchart below.

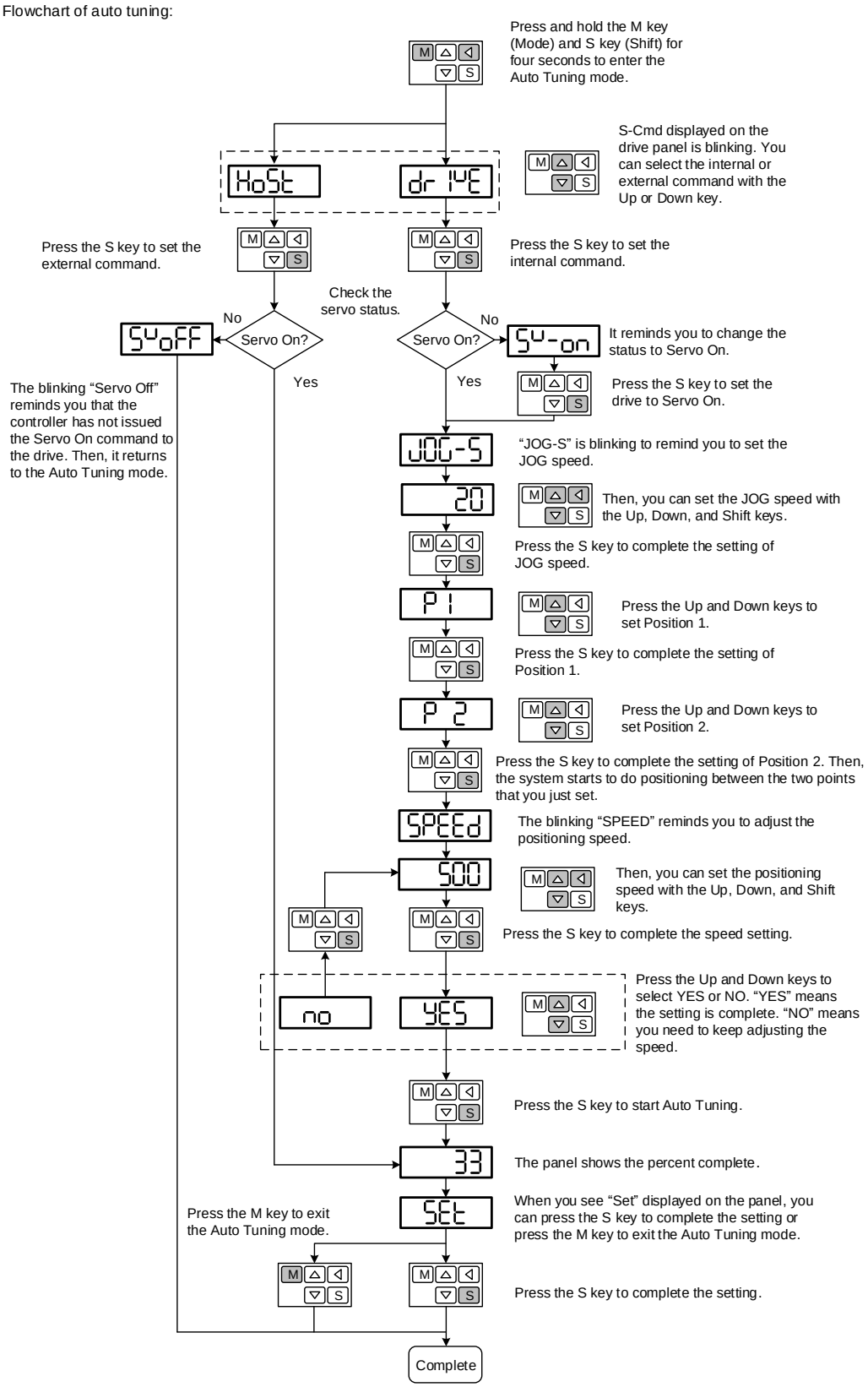


5.2.2 Auto tuning through the drive panel

With the tuning procedure below, you can complete auto tuning with the drive panel. Make sure the emergency stop, positive and negative limit switches work properly before you start to tune the system.

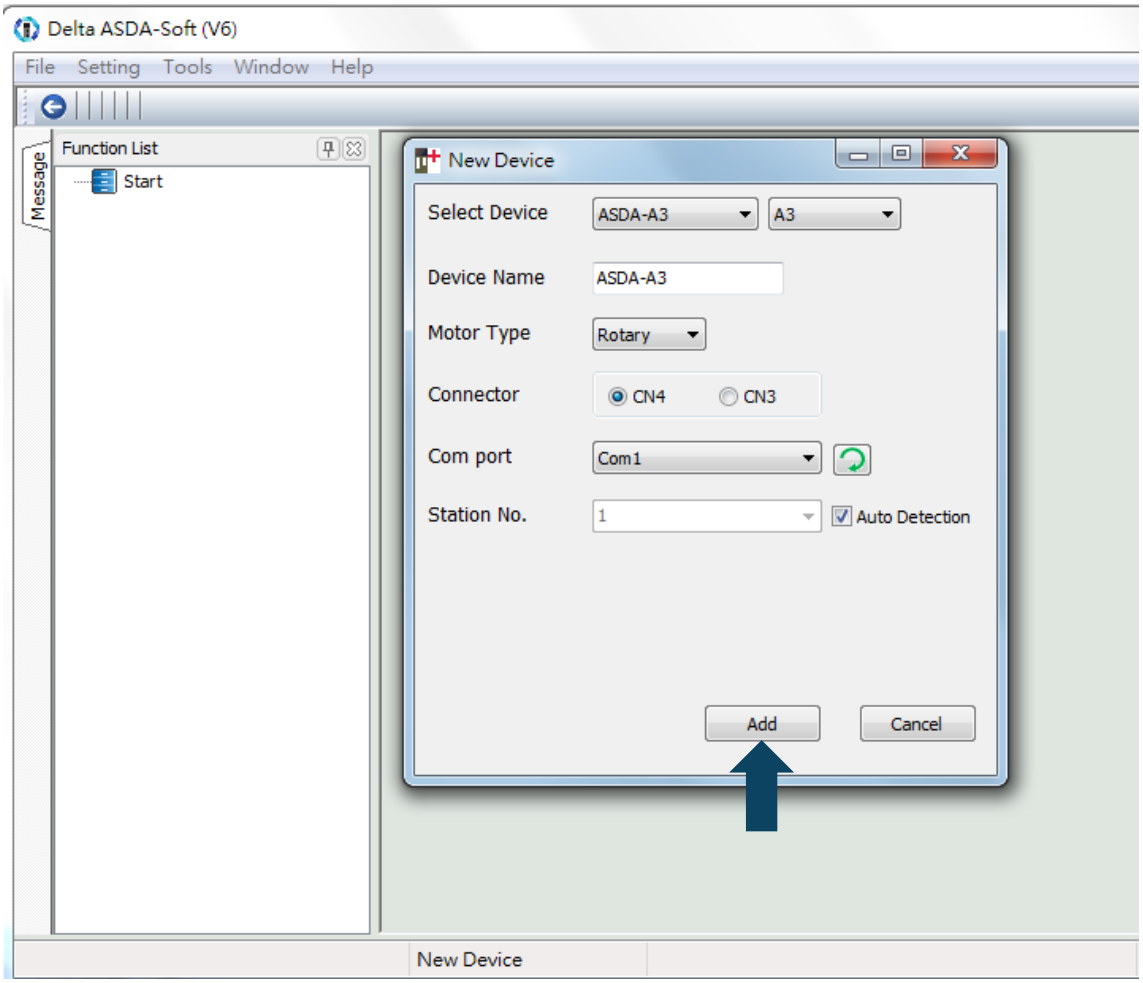
5

Flowchart of auto tuning:



5.2.3 Auto tuning with ASDA-Soft (software)

Instead of using the drive panel, you can use ASDA-Soft to complete auto tuning. Please go to Delta's website (http://www.deltaww.com/) to download ADSA-Soft for free. Install the software and open the executable file (.exe), then you can see the screen shown below.



Make sure your ASDA-A3 servo drive, servo motor, and power are all properly connected. Then click **Add** to connect to the servo drive with ASDA-Soft.

5

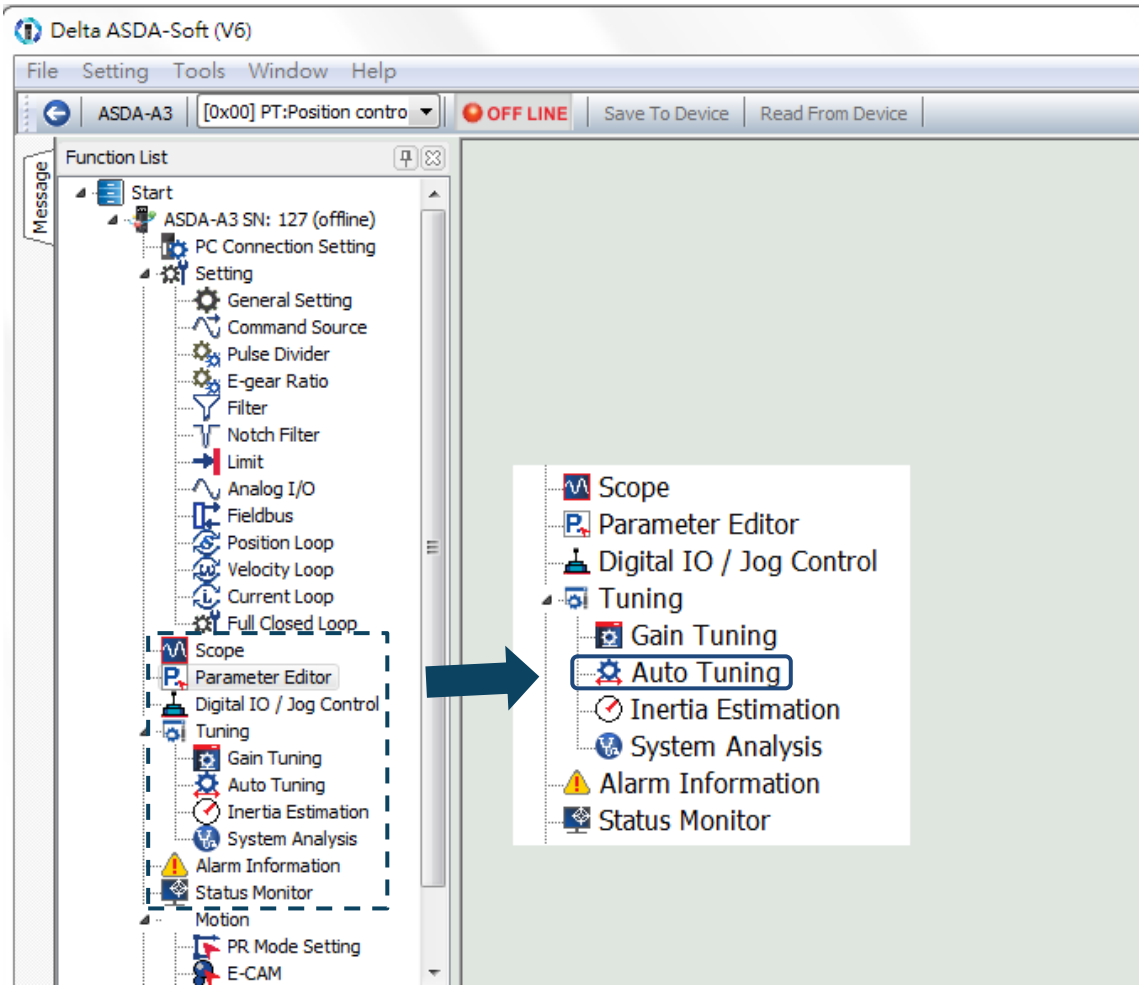
There are two types of auto-tuning procedure, one using the host controller and the other using the servo drive. Both procedures are described below.

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

Step 1:

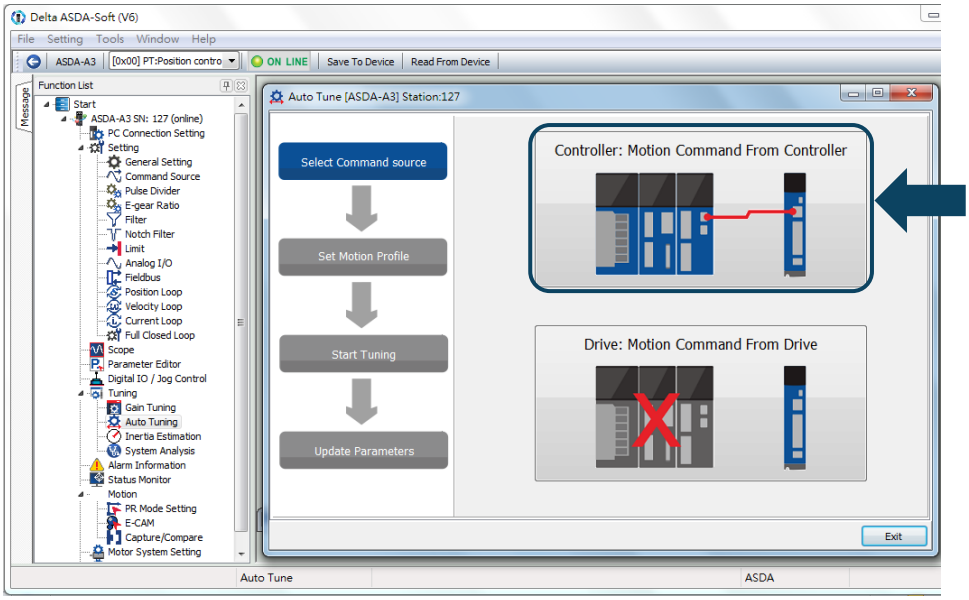
When the computer is connected to the controller, the program window appears as below.

Click **Auto Tuning** in the Function List tree view.



Step 2:

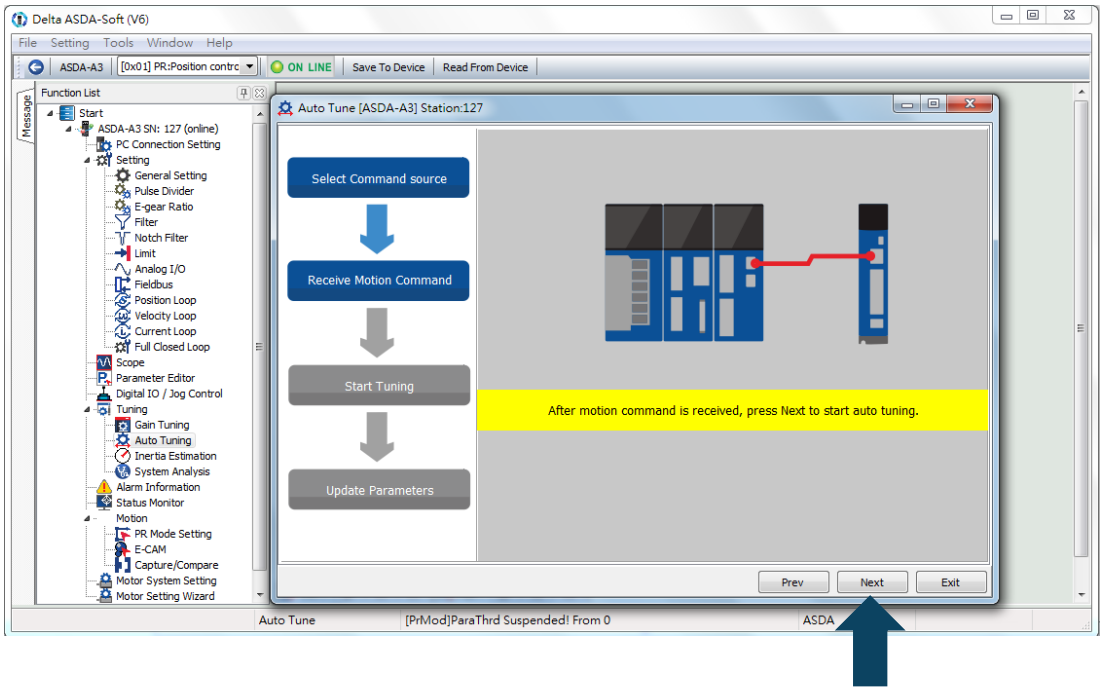
Click **Controller: Motion Command From Controller** and make sure the motion / machining path is set correctly.



Suggestions: you should set the motor to operate at least one cycle in both forward and backward directions. The delay time for reaching the positions in both forward and backward directions should not be less than 1,000 ms with the running speed no less than 500 rpm.

Step 3:

Please repeatedly start and run the motor with the path you just set. Before running the motor, make sure no one is standing close to the machinery. Then, click **Next**.



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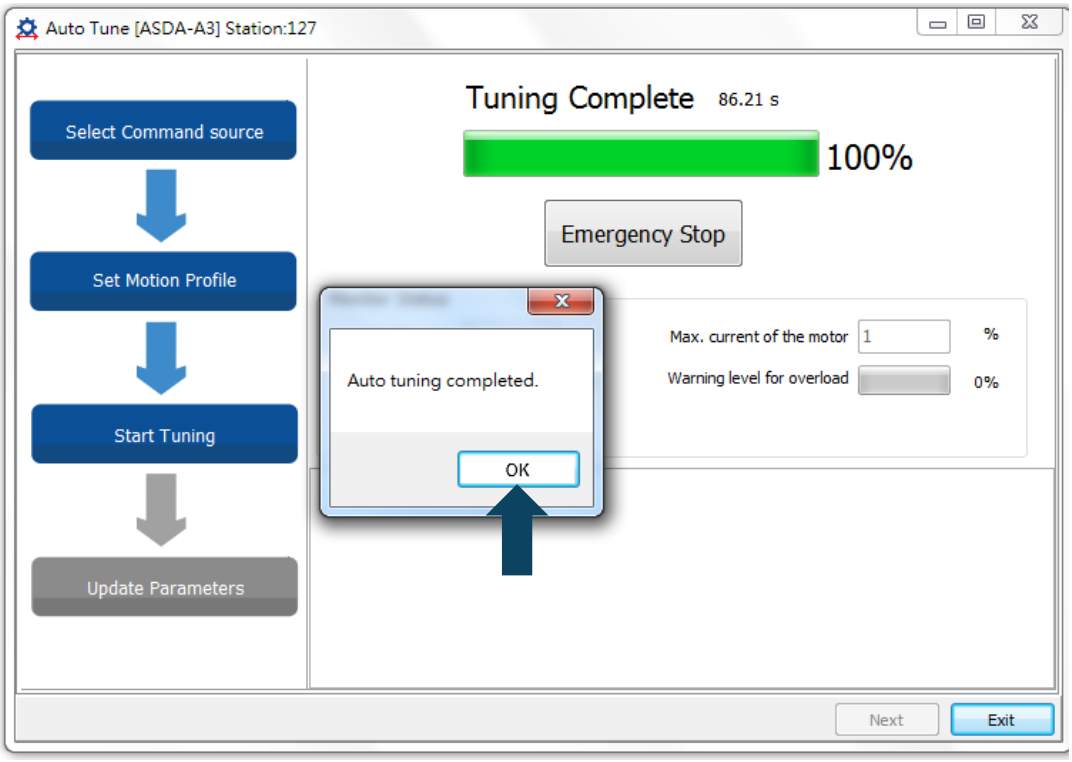
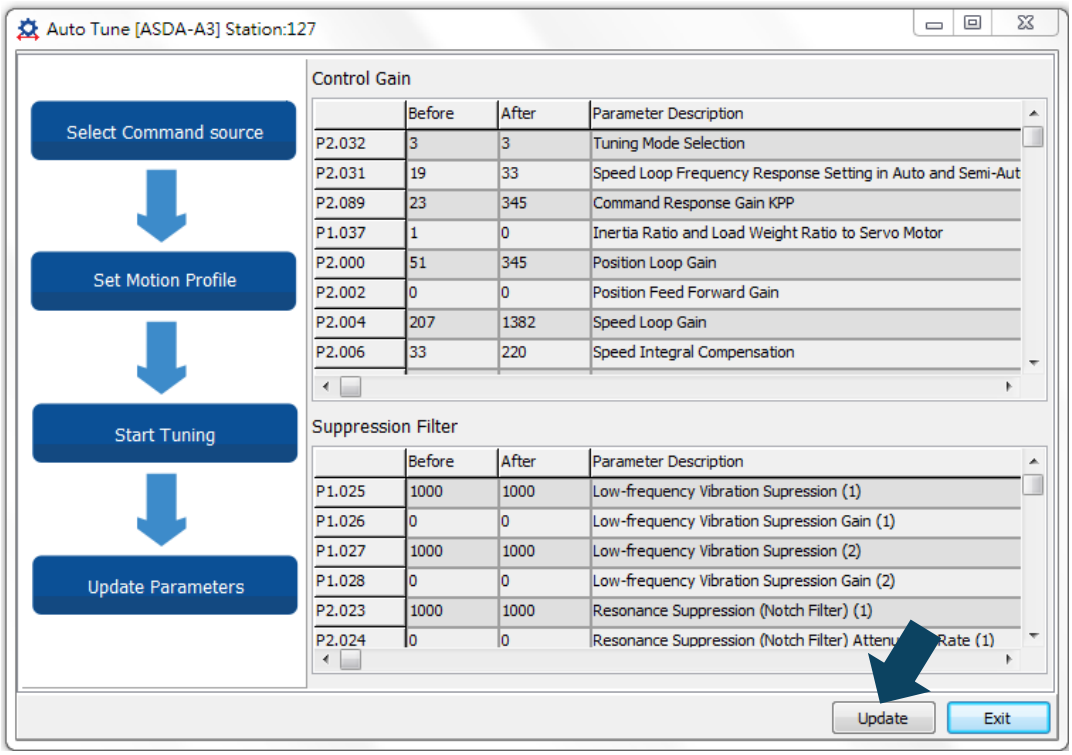
Wait until the tuning progress bar reaches 100%, after which a window with “Auto tuning completed” appears. Click **OK** to continue.



The screen shows a table comparing the parameters before and after being changed by auto tuning.



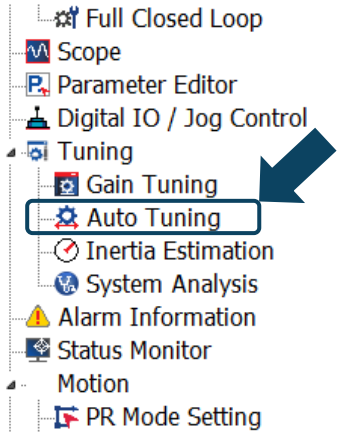
Click **Update** to complete auto tuning.

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

Step 1:

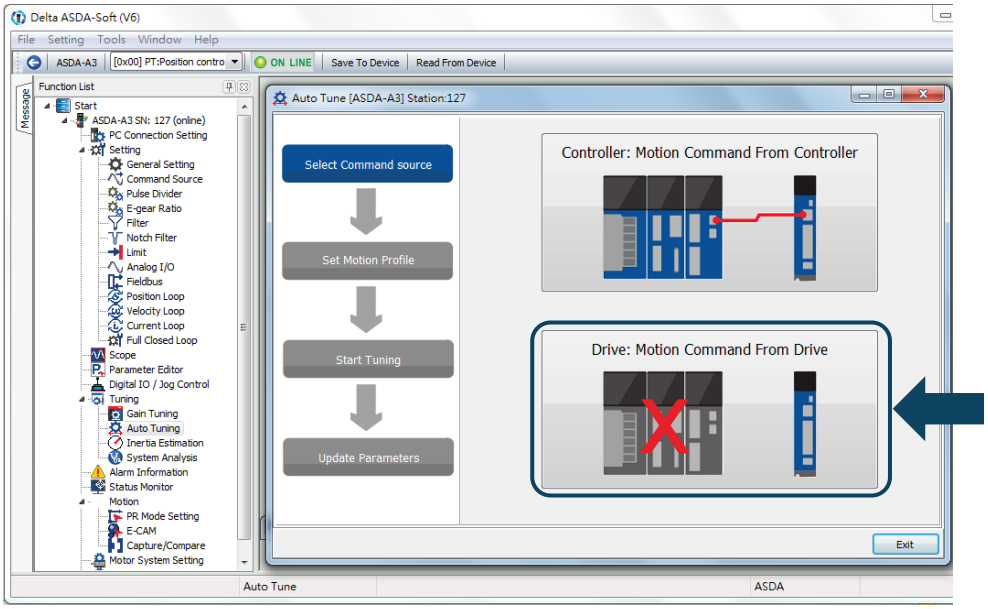
When the computer is connected to the servo drive, the program window appears as below.

Click **Auto Tuning** from the Function List tree view.



Step 2:

Click **Drive: Motion Command From Drive** to start the Auto Tuning procedure.



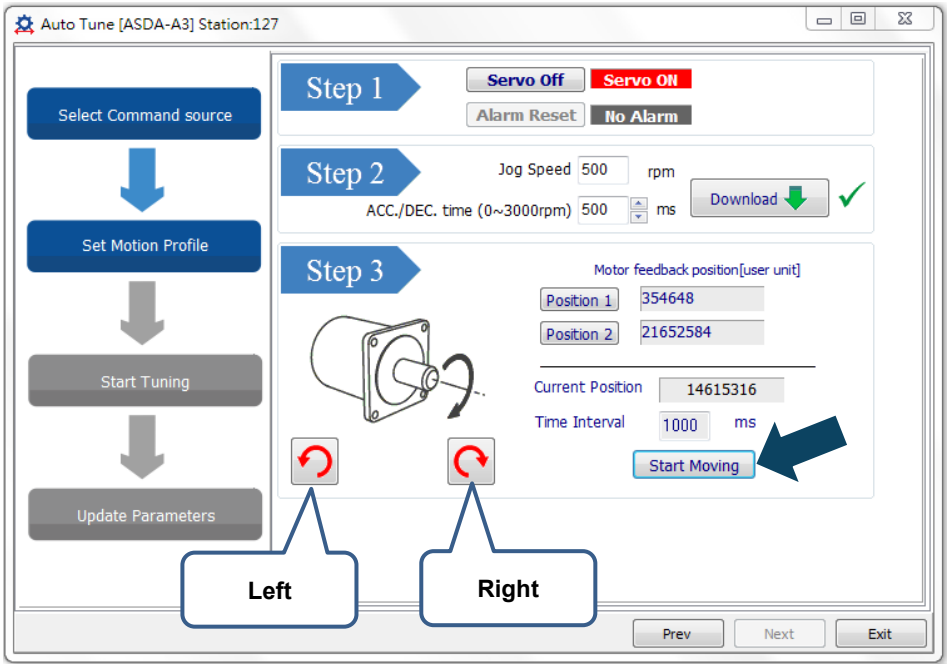
Follow the steps below to set the motor running path:

1. Set the system to Servo On state.
2. Set the acceleration / deceleration time and jog speed. The default setting for acceleration / deceleration time is 500 ms. Set the jog speed to no less than 500 rpm. Then click **Download**.

5

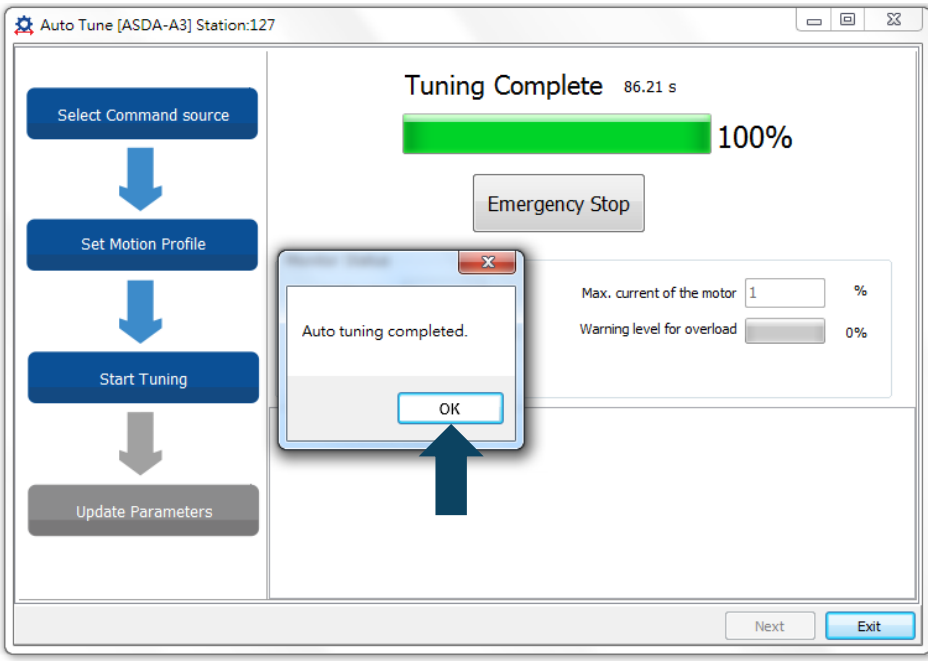
3. After you set the motor's running path, you can use the Left or Right button to run the motor to Position 1 and Position 2. Then, click **Start Moving** to run between two positions. The motor moves to Position 1 and Position 2 in the forward and backward directions.

Before running the motor, make sure no one is standing close to the machinery.

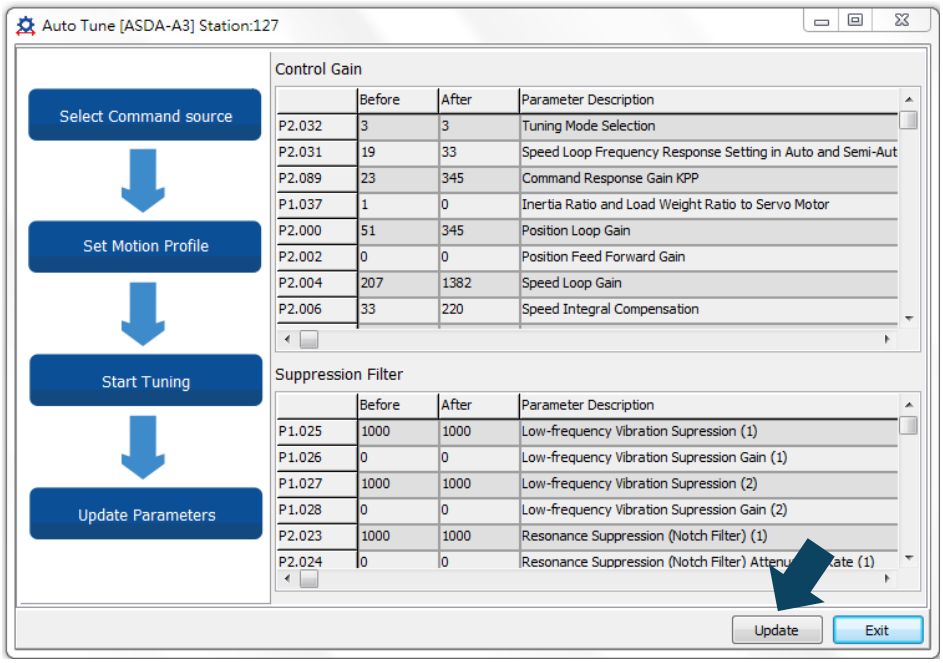


Step 3:

Wait until the tuning progress bar reaches 100%, after which a window with "Auto tuning completed" appears. Click **OK** to continue.



The screen shows a table comparing the parameters before and after being changed by auto tuning.

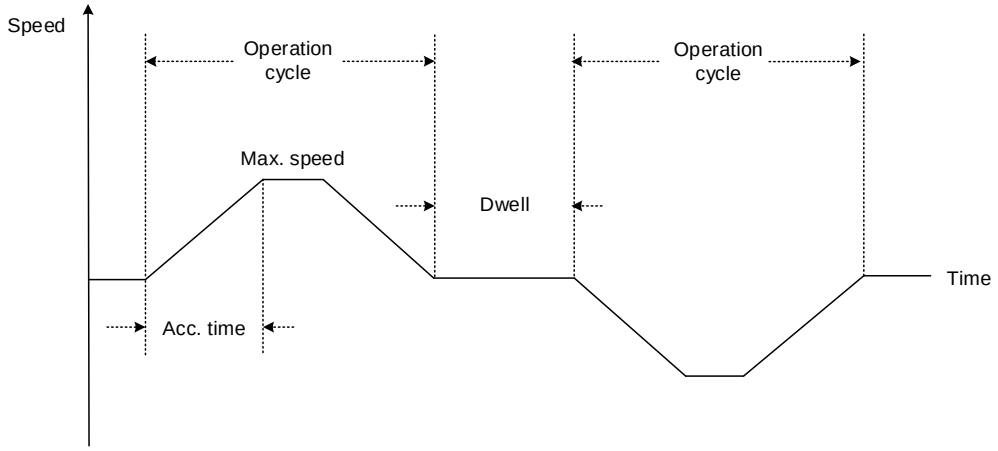


Click **Update** to complete auto tuning.

5

5.2.4 Alarms related to auto tuning

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

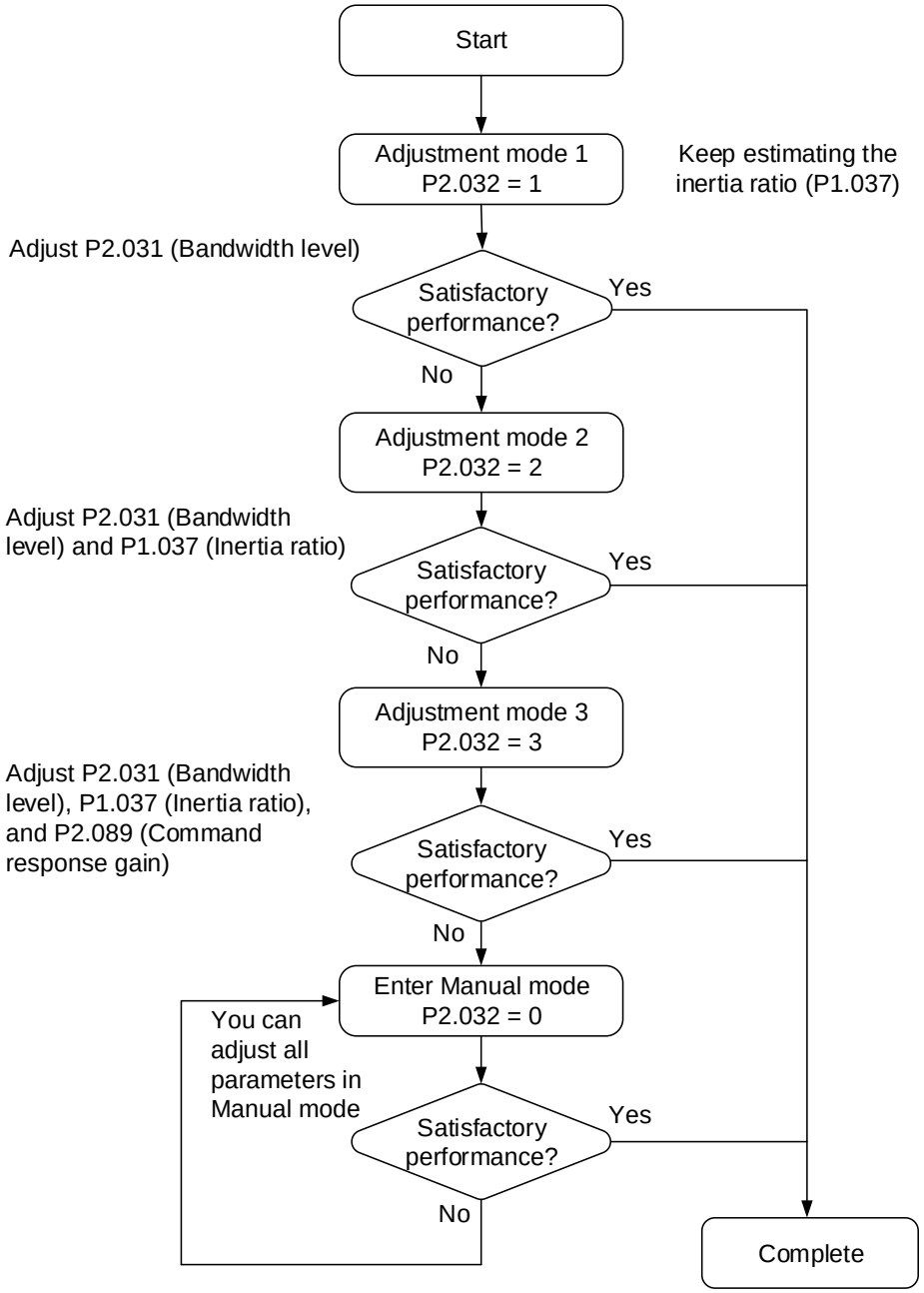


Display	Alarm name
AL08A	Auto-tuning function - command error
AL08B	Auto-tuning function - pause time is too short
AL08C	Auto-tuning function - inertia estimation error

5.3 Tuning mode

Apart from the Auto Tuning function described above, there are three other tuning modes you can use to fine tune the system. You can then easily complete tuning by increasing or decreasing the bandwidth response level (P2.031). Follow the tuning procedure in Section 5.1.

5.3.1 Flowchart of Gain adjustment mode



5.3.2 Gain adjustment mode 1

In this mode, the servo drive continues to estimate the machine inertia and updates the value of parameter P1.037.

P2.032 setting value	Adjustment mode	Inertia estimation	Parameter	
			Manual	Auto
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

Requirements for inertia estimation:

1. The motor accelerates from 0 rpm to 3000 rpm within 1.5 seconds.
2. It is suggested to set the speed to 500 rpm or higher. The lowest speed should be no less than 200 rpm.
3. The load inertia should be less than 50 times the motor inertia.
4. The change in the inertia ratio cannot be too great.

5.3.3 Gain adjustment mode 2

When Gain adjustment mode 1 cannot meet your need, you can try Gain adjustment mode 2 to tune the servo system. In Gain adjustment mode 2, the system does not automatically estimate the inertia. You must set the correct machine inertia in parameter P1.037.

P2.032 setting value	Adjustment mode	Inertia estimation	Parameter	
			Manual	Auto
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

Inertia estimation is applicable to most applications. However, when the machine does not comply with the requirements for inertia estimation, you have to set the correct inertia ratio in parameter P1.037.

5.3.4 Gain adjustment mode 3

If Gain adjustment modes 1 and 2 cannot meet your need, you can try Gain adjustment mode 3 to tune the servo system. Parameter P2.089 (Command response gain) is available 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 parameter value too high, it might cause overshoot and machinery vibration. This function is only available when changing the command, such as the acceleration / deceleration application. However, when the two dimensional 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.

P2.032 setting value	Adjustment mode	Inertia estimation	Parameter	
			Manual	Auto
3	Gain adjustment mode 3	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

5

5.3.5 Setting the bandwidth response level (stiffness)

You can use parameter P2.031 to tune the servo system in an easier and user-friendly way. With the fixed inertia ratio, when you increase the bandwidth level (P2.031), the servo's bandwidth increases as well. If resonance occurs, lower the parameter value by one or two bandwidth levels (you should adjust the bandwidth level according to the actual situation). For instance, if the value of P2.031 is 30, you can reduce the bandwidth level to 28. When you adjust the value of this parameter, the servo system automatically adjusts the corresponding parameters, such as P2.000 and P2.004.

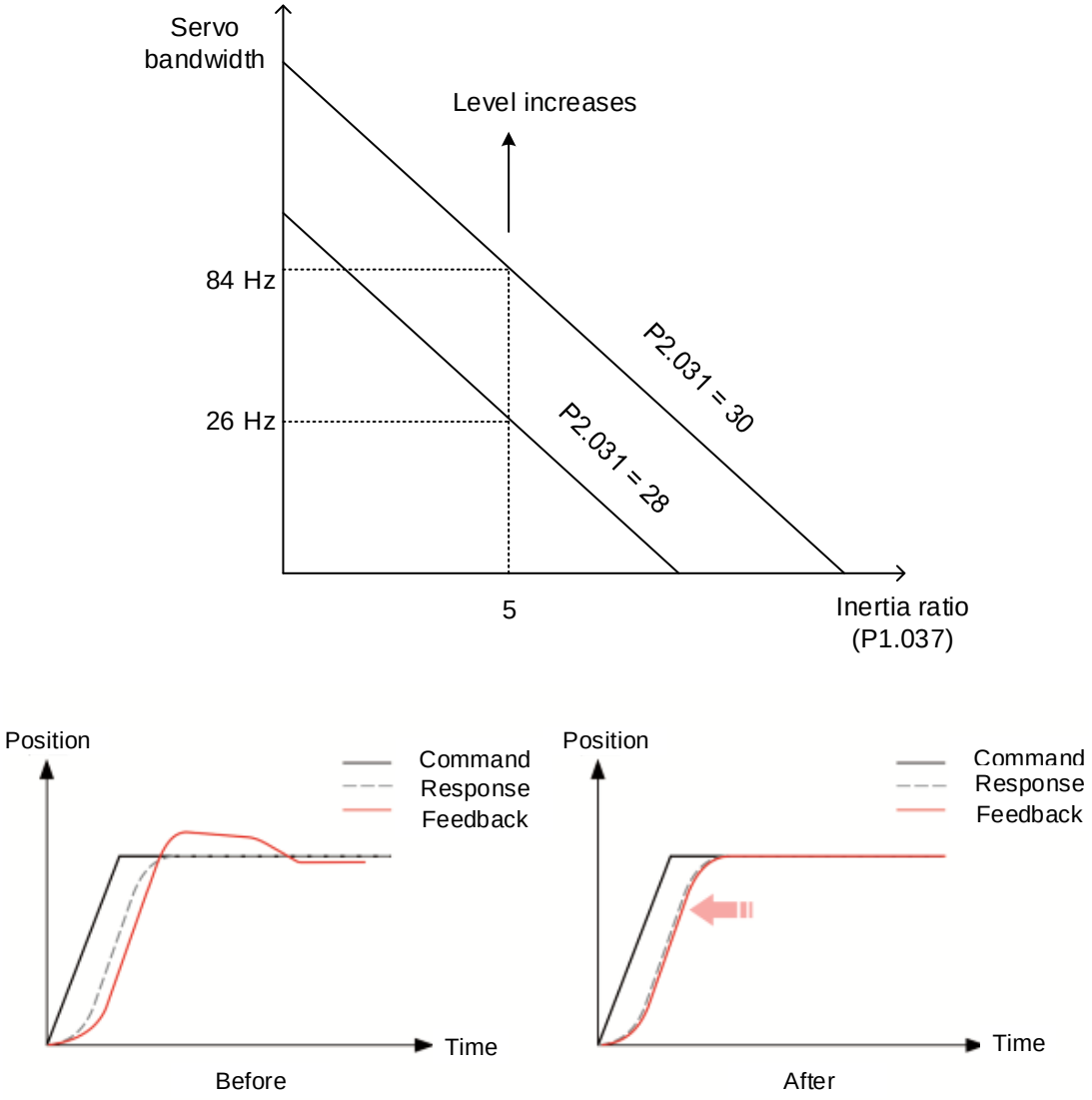


Figure 5.3.5.1 Adjust the bandwidth level

5.3.6 Setting the command response gain (response)

You can use parameter P2.089 to adjust the response. Increasing the gain can minimize the deviation between the position command and command response in the intermittent duty zone. Before adjusting the value of P2.089, first enable the two dimensional control function (set P2.094 to 0x1000).

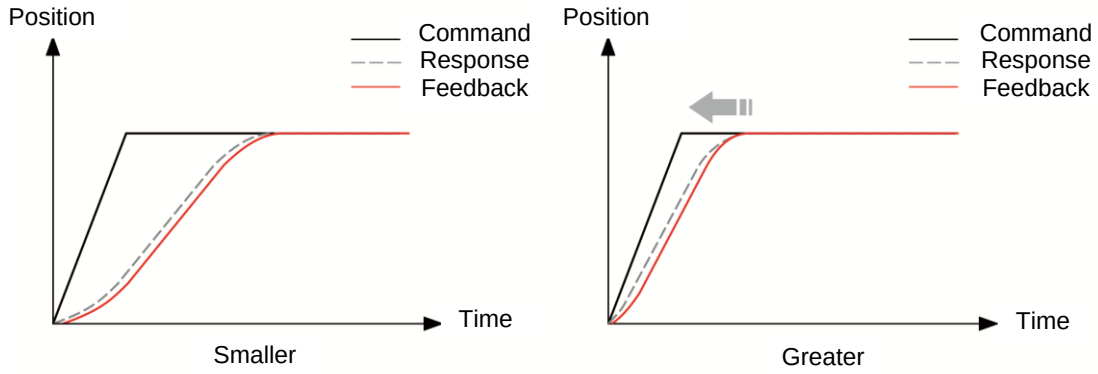


Figure 5.3.6.1 Adjust the response gain

5.4 Tuning in manual mode

The selection of the position or speed response bandwidth should be determined by the machine 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 might cause mechanical resonance. Thus, machinery with higher stiffness is used to solve this problem. When the response bandwidth 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.

- Position control gain (KPP, parameter P2.000)

  This parameter determines the response of the position loop. The bigger the KPP value, the higher the response 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 the machinery to vibrate or cause overshoot when positioning.
  The calculation of position loop response bandwidth is as follows:

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

- Speed control gain (KVP, parameter P2.004)

  This parameter determines the response of the speed control loop. The bigger the KVP value, the higher the response bandwidth of the speed loop and the lower the following error. However, if you set the value too high, it can cause mechanical resonance.
  The response bandwidth of the speed loop must be 4 to 6 times higher than that of the position loop; otherwise, it can cause the machinery to vibrate or cause overshoot when positioning. The calculation of speed loop response bandwidth is as follows:

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

  JM: motor inertia; JL: load inertia; P1.037: 0.1 (times)

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

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

- Speed integral compensation (KVI, parameter P2.006)

  The higher the KVI value, the better the elimination of the deviation. However, if you set the value too high, it can cause the machinery to vibrate. It is suggested that you set the value as follows:

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

- Low-pass filter for resonance suppression (NLP, parameter P2.025)

  A high inertia ratio reduces the response bandwidth of the speed loop. Therefore, you must increase the KVP value to maintain the response bandwidth. Increasing the KVP value might cause sound due to mechanical resonance. Please use this parameter to eliminate the noise from resonance. The higher the value, the better the capability for reducing high-frequency noise. However, if you set the value too high, it can cause instability in the speed loop and overshoot in positioning. It is suggested that you set the value as follows:

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

- Anti-interference gain (DST, parameter P2.026)

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

  Note: to use this parameter, disable the two dimensional control function (set P2.094 [Bit 12] to 0).

- Position feed forward gain (PFG, parameter P2.002)

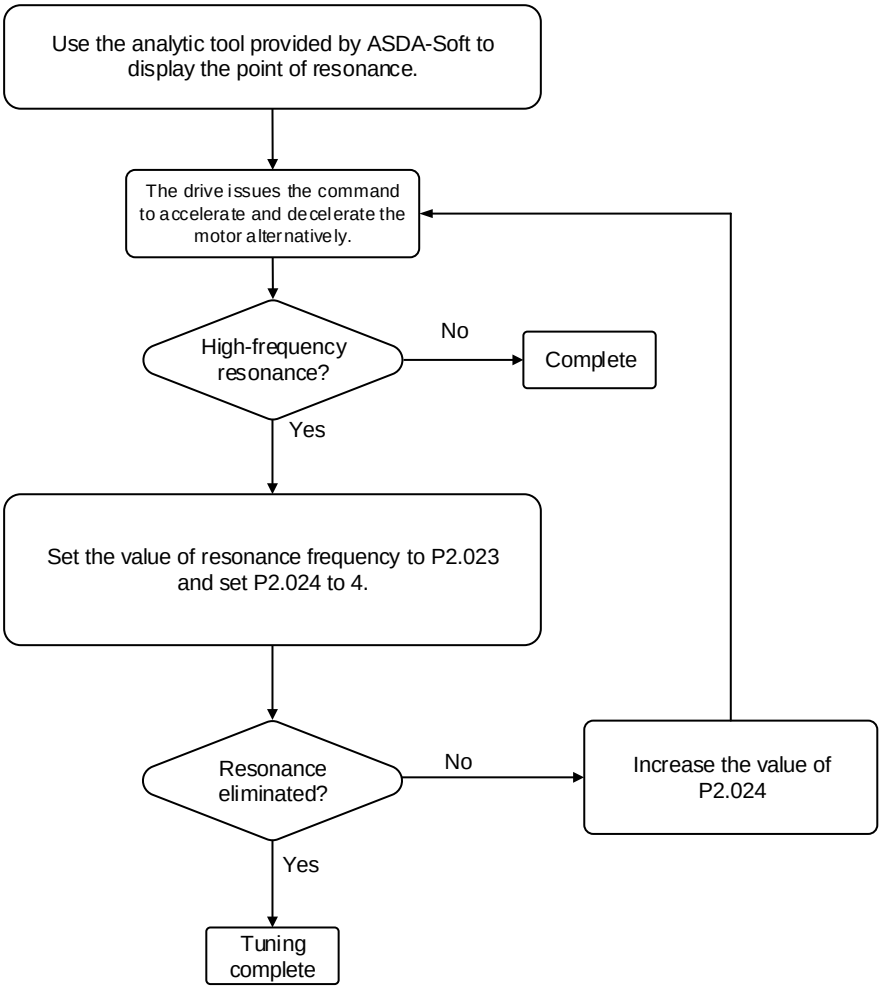
  This parameter can reduce the position error and shorten the settling time. However, if you set the value too high, it might cause overshoot in positioning. If the setting of the E-Gear ratio is larger than 10, it might cause noise as well.

  Note: to use this parameter, disable the two dimensional control function (set P2.094 [Bit 12] to 0).

5.5 Mechanical resonance suppression

5

Five sets of notch filters are provided to suppress mechanical resonances. You can set all five to auto resonance suppression with parameter P2.047 or manually set the resonance suppression with ASDA-Soft. See the following flowchart of manual adjustment.



6 Operation Mode

This chapter describes the operation of each control mode, including gain adjustment and filters. For Position mode, you use the external pulse and commands from the internal registers. For Speed mode and Torque mode, apart from the commands from the internal registers, you can also control the servo drive by the analog voltage input. In addition to Single mode, Dual mode is also available for meeting the application requirements.

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6.1 Selecting the operation mode

This servo drive provides three basic operation modes: Position, Speed, and Torque.
The available communication modes are CANopen, DMCNET, and EtherCAT. For the basic operation mode, you can choose from Single mode, Dual mode, and Multi-mode. The following table lists all the available modes.

Mode		Short name	Code	Description
Single mode	Position mode (Terminal block input)	PT	00	The servo drive receives the Position command and commands the motor to run to the target position. The Position command is communicated through the terminal block and the signal type is pulse.
	Position mode (Register input)	PR	01	The servo drive receives the Position command and commands the motor to run to the target position. Position commands are issued from the internal registers (100 sets in total). You can select the register number with DI signals or through communication.
	Speed mode	S	02	The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command is issued from the internal registers (3 sets in total) or by analog voltage (-10V to +10V) which is communicated through the terminal block. You select the command with DI signals.
	Speed mode (No analog input)	Sz	04	The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command can only be issued from the internal registers (3 sets in total) instead of through the external terminal block. You select the command with DI signals.
	Torque mode	T	03	The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque command is issued from the internal registers (3 sets in total) or by analog voltage (-10V to +10V) which is communicated through the terminal block. You select the command with DI signals.
	Torque mode (No analog input)	Tz	05	The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque command can only be issued from the internal registers (3 sets in total) instead of through the external terminal block. You select the command with DI signals.
Dual mode		PT-S	06	You can switch PT and S modes with DI signals.
		PT-T	07	You can switch PT and T modes with DI signals.
		PR-S	08	You can switch PR and S modes with DI signals.
		PR-T	09	You can switch PR and T modes with DI signals.
		S-T	0A	You can switch S and T modes with DI signals.
		-	0B	Reserved.
		Communication	0C	DMCNET mode
				CANopen mode
				EtherCAT mode
		PT-PR	0D	You can switch PT and PR modes with DI signals.

(Continued)

Mode	Short name	Code	Description
Multi-mode	PT-PR-S	0E	You can switch PT, PR, and S modes with DI signals.
	PT-PR-T	0F	You can switch PT, PR, and T modes with DI signals.

Here are the steps to switch the operation mode:

1. Switch the servo drive to Servo Off status. You can do this by setting DI.SON to off.
2. Set P1.001 and refer to the code listed above for the mode selection.
3. After setting the parameter, cycle power to the servo drive.

The following sections describe the operation of each mode, including the mode structure, command source, selection and processing of the command, and gain adjustment.

6.2 Position mode

Two input modes for position control are available on the ASDA-A3: external pulse (PT mode) and internal register (PR mode). In PT mode, the ASDA-A3 servo drive receives the pulse command for direction (motor runs forward or reverse). You can control the rotation angle of the motor with the input pulse. The ASDA-A3 can receive pulse commands of up to 4 Mpps.

You can also accomplish position control using the internal register (PR mode) without the external pulse command. The ASDA-A3 provides 100 command registers with two input modes. You can set the 100 registers first before switching the drive to Servo On status and then set DI.POS0 – DI.POS6 of CN1 for the switch. Or, you can directly set the register values through communication.

6.2.1 Position command in PT mode

The PT Position command is the pulse input from the terminal block. There are three pulse types and each type has positive and negative logic that you can set in parameter P1.000. Refer to Chapter 8 for more details.

Parameter	Function
P1.000	External pulse input type

6.2.2 Position command in PR mode

The PR command source is the 100 built-in command registers, (P6.000, P6.001) – (P7.098, P7.099). You can use DI (0x11) – (0x1C) (POS0 – POS6 of CN1) to select one of the 100 sets as the Position command and trigger the command with DI.CTRG (0x08). See the following table for more detail.

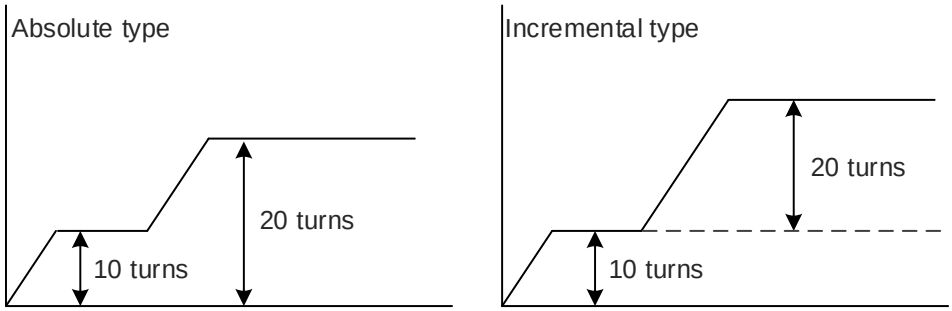
Position command	POS6	POS5	POS4	POS3	POS2	POS1	POS0	CTRG	Setting parameter
Homing	0	0	0	0	0	0	0	↑	P6.000
									P6.001
P1	0	0	0	0	0	0	1	↑	P6.002
									P6.003
…									…
P50	0	1	1	0	0	1	0	↑	P6.098
									P6.099
P51	0	1	1	0	0	1	1	↑	P7.000
									P7.001
…									…
P99	1	1	0	0	0	1	1	↑	P7.098
									P7.099

Status of POS0 – POS6: 0 means that DI is off (the circuit is open); 1 means that DI is on (the circuit is closed).

CTRG↑: this indicates the moment that DI is switched from off to on.

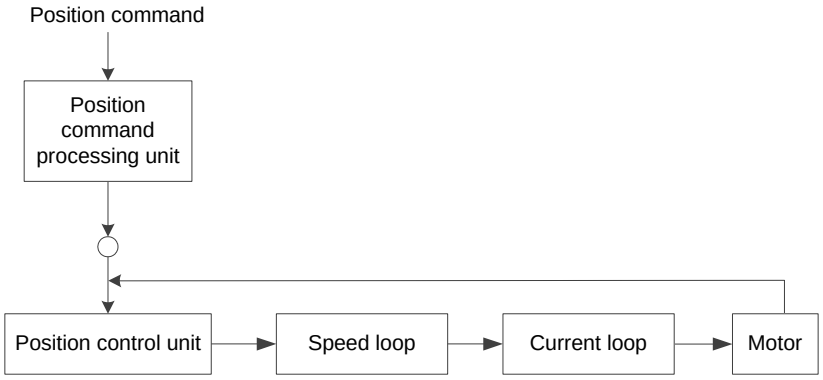
6

There are many applications for both absolute type and incremental type registers. For example, assume the Position command P1 is 10 turns and P2 is 20 turns. P1 is issued first and P2 comes second. The following diagram shows the difference between absolute and incremental positioning.

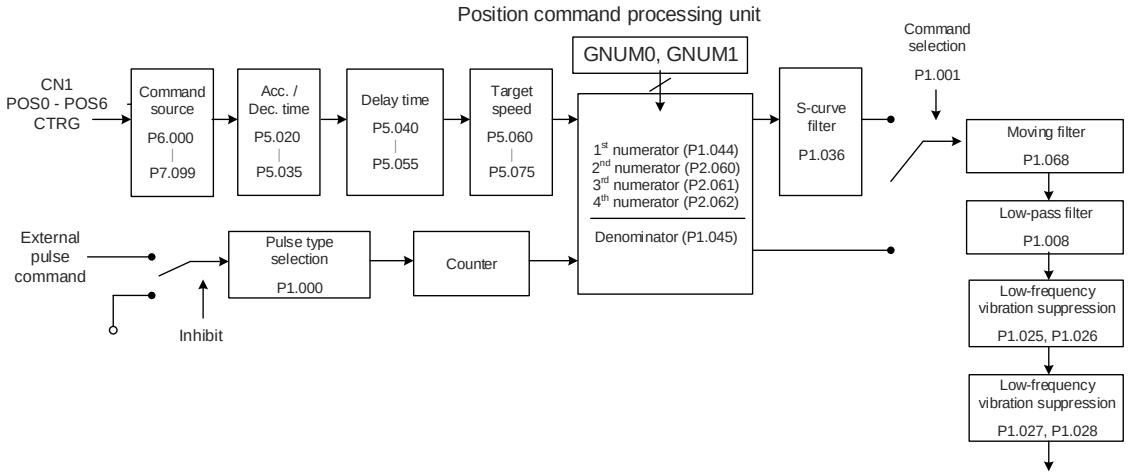


6.2.3 Control structure of Position mode

The basic control structure is shown in the following flowchart:



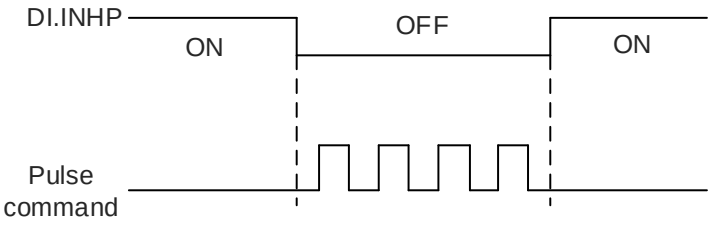
For better control, the pulse signals are processed by the Position command processing unit. The structure is shown in the diagram below.



The upper path of the above diagram is the PR mode and the lower one is the PT mode that you can select with P1.001. You can set E-Gear ratio in both modes to adjust the positioning resolution. In addition, you can use either a moving filter or low-pass filter to smooth the command (described below).

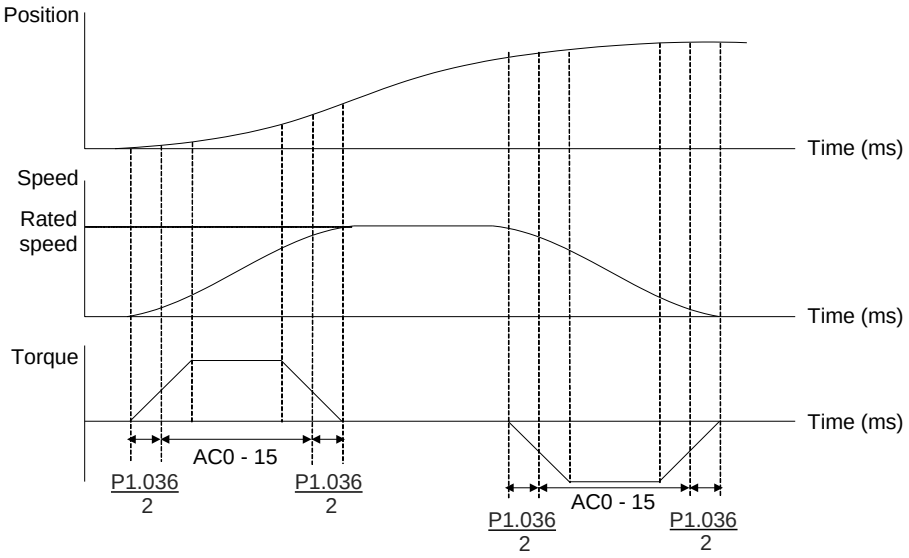
The Pulse Command Input Inhibit (INHP) function

In PT mode, when DI.INHP is on, the servo drive stops receiving external pulse commands and the motor stops running. As this function is only supported by DI8, setting P2.017 (DI8) to 0x45 (DI.INHP) is required.

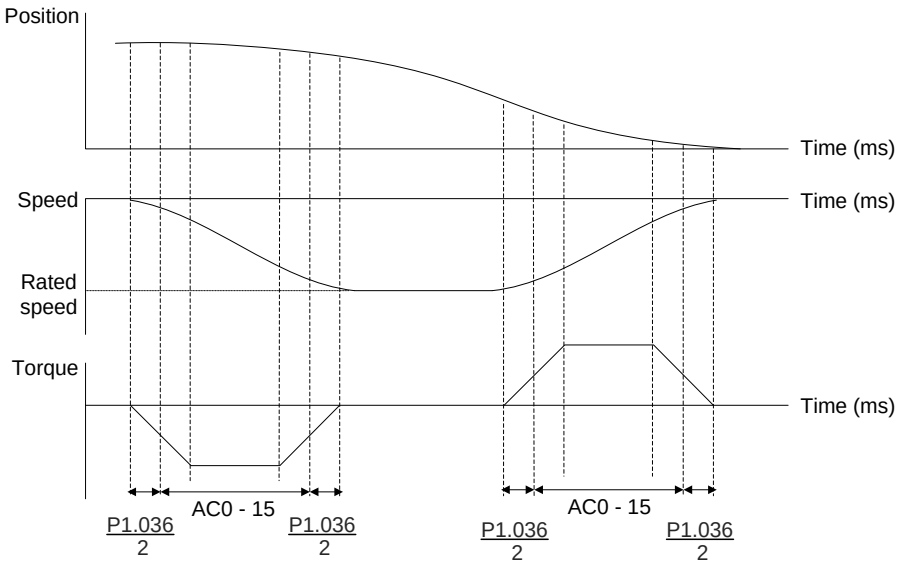


6.2.4 S-curve filter (Position)

The S-curve filter smoothes the motion command in PR mode. The filter makes the speed and acceleration continuous and reduces jerking, resulting a smoother mechanical operation. If the load inertia increases, the motor operation is influenced by friction and inertia when the motor starts or stops rotating. Setting a larger acceleration / deceleration constant for the S-curve (TSL) and the acceleration / deceleration time in P5.020 – P5.035 can increase the smoothness of operation. When the Position command source is pulse, the speed and angular acceleration are continuous, and the S-curve filter is not necessary.



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



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

Refer to Chapter 8 for detailed descriptions of the relevant parameters.

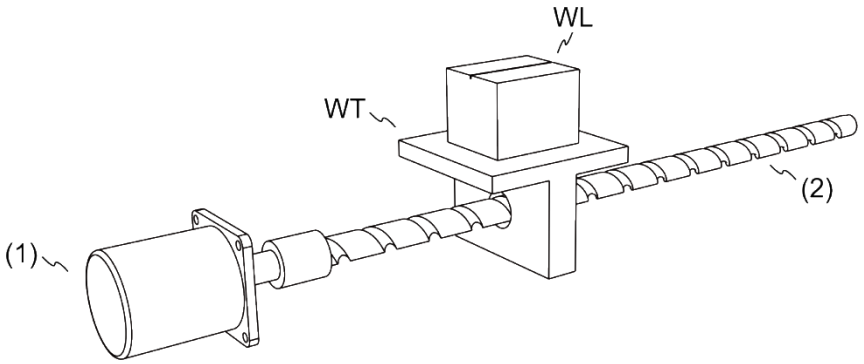
Parameter	Function
P1.036	S-curve acceleration / deceleration constant
P5.020 – P5.035	Acceleration / deceleration times (Number #0 – 15)

6.2.5 Electronic gear ratio (E-Gear ratio)

The resolution of ASDA-A3 is 24 bits, which means that it generates 16777216 pulses per motor rotation. Regardless of the encoder resolution (17-bit, 20-bit, or 22-bit), the E-Gear ratio is set according to the 24-bit resolution of ASDA-A3 servo drive.

When E-Gear ratio is 1, it generates 16777216 pulses per motor rotation; when you set the ratio to 0.5, then every two pulses from the command (controller) corresponds to one pulse for the motor. However, larger E-Gear ratio might create a sharp corner in the profile and lead to a high jerk. To solve this problem, you can apply an S-curve acceleration / deceleration filter or a low-pass filter to reduce the jerk.

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



(1) Motor (2) Ball screw pitch: 3 mm (equals 3000 μm)

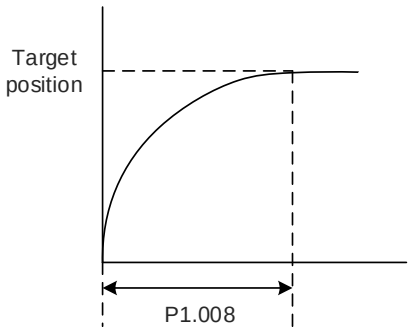
WL: workpiece; WT: platform

	Gear ratio	Moving distance per 1 pulse command
E-Gear is not applied	$=\frac{1}{1}$	$=\frac{3000\frac{\mu m}{rev}}{16777216\frac{Pulse}{rev}}\times\frac{1}{1}=\frac{3000}{16777216}\quad(\text{Unit}:\frac{\mu m}{Pulse})$
E-Gear is applied	$=\frac{16777216}{3000}$	$=\frac{3000\frac{\mu m}{rev}}{16777216\frac{Pulse}{rev}}\times\frac{16777216}{3000}=1\quad(\text{Unit}:\frac{\mu m}{Pulse})$

Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P1.044	E-Gear ratio (numerator) (N1)
P1.045	E-Gear ratio (denominator) (M)

6.2.6 Low-pass filter



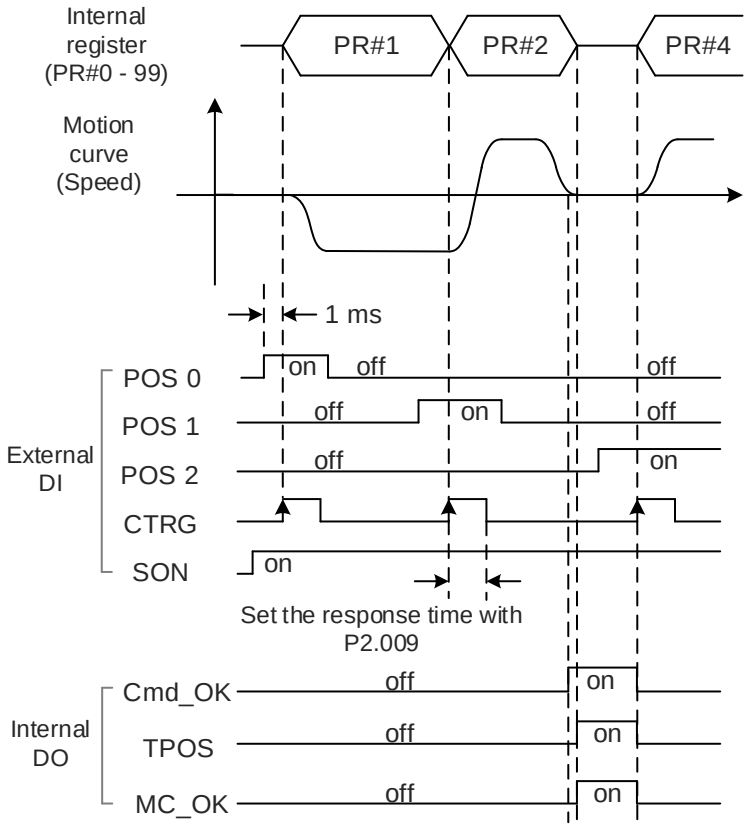
Refer to Chapter 8 for detailed descriptions of the relevant parameter.

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

6.2.7 Timing diagram of PR mode

In PR mode, the Position command is issued with the DI signals (POS0 – POS6 and CTRG) for CN1. Refer to Section 6.2.2 for information about the DI signal and its selected register.

The timing diagrams are shown below.



Note: Cmd_OK is on when the PR command completes; TPOS is on when the error is smaller than value set by P1.054; MC_OK is on when Cmd_OK and TPOS are both on.

6.2.8 Gain adjustment of the position loop

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

■ Auto adjustment:

The ASDA-A3 servo drive provides an Auto Tuning function that allows you to easily complete the gain adjustment. Refer to Chapter 5 Tuning for a detailed description.

■ Manual adjustment:

Before setting the position control unit, you have to manually set the speed control unit (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).

Description of the position control gain and position feed forward gain:

1. Position control gain: the higher the gain, the larger bandwidth for the position loop response.
2. Position feed forward gain: reduces the deviation of phase delay.

Please note that the position loop bandwidth should not be larger than the speed loop bandwidth.

Calculation: $fp \le \frac{fv}{4}$ (fv: response bandwidth of speed loop (Hz); fp: response bandwidth of position loop (Hz).)

$KPP = 2 \times \pi \times fp$

Example: if the desired position bandwidth is 20 Hz, then adjust KPP (P2.000) to 125 ($2 \times \pi \times 20\ Hz = 125$).

Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P2.000	Position control gain
P2.002	Position feed forward gain

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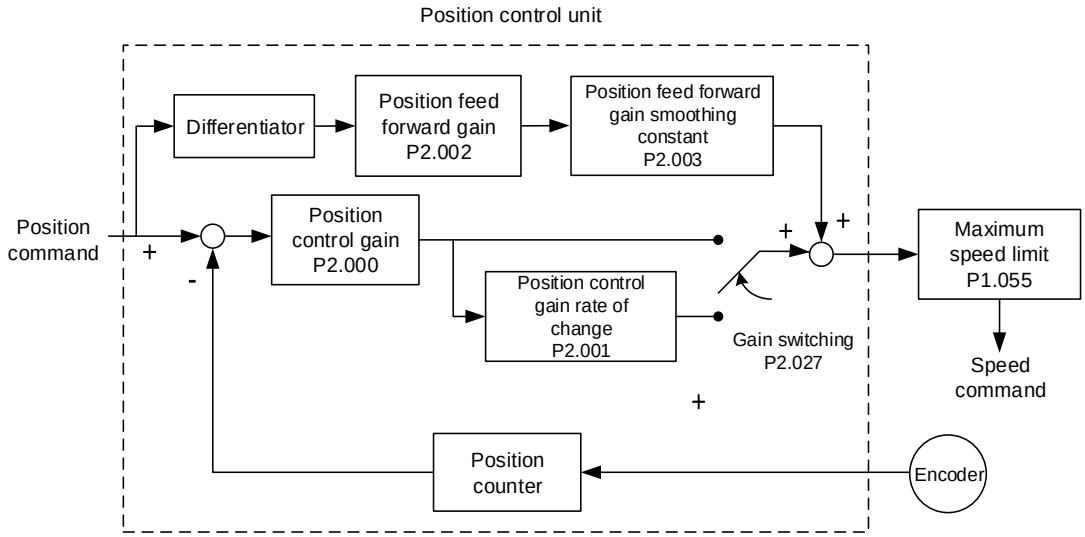
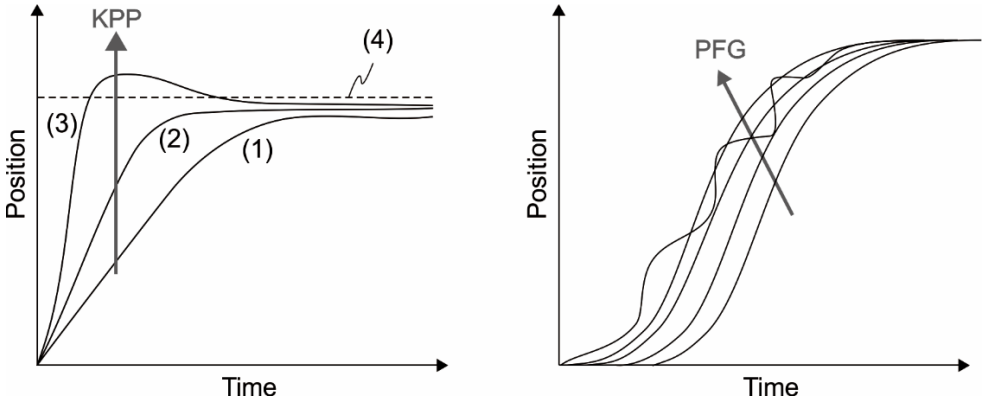


When you set the value of KPP (P2.000) too high, the bandwidth for the position loop is increased and the phase margin is reduced. Meanwhile, the rotor rotates and vibrates in the forward and reverse directions. In this case, you have to decrease the KPP value until the rotor stops vibrating. When the external torque is too high, the low value for KPP cannot meet the demand of reducing the position following error. In this case, increasing the position feed forward gain, PFG (P2.002), can effectively reduce the position following error.



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

6.2.9 Low-frequency vibration suppression in Position mode

If the machine is too flexible, vibration persists even when the motor stops after executing the positioning command. The low-frequency vibration suppression function can reduce the machine vibration. The suppression range is between 1.0 Hz and 100.0 Hz. Both auto and manual functions are available.

Auto function

If you have difficulty finding the resonance frequency, you can enable the auto low-frequency vibration suppression function, which searches for the specific resonance frequency. If you set P1.029 to 1, the system disables this function automatically and starts to search the vibration frequency. When the detected resonance frequency remains at the same level, it automatically sets P1.029 to 0 and sets P1.025 to the first frequency and sets P1.026 to 1. It sets P1.027 to the second frequency and then sets P1.028 to 1. If P1.029 is automatically reset to 0, but the low-frequency vibration persists, check if P1.026 or P1.028 is enabled. 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 the vibration frequency again. Note that when you set the detection level too low, it might detect noise as low-frequency vibration.

The diagram of the basic control structure is shown in the following flowchart:

Note:

1. When the values of P1.026 and P1.028 are both 0, it means that the frequency cannot be found, probably because the detection level is set too high so that the low-frequency vibration is not detected.
2. When the values of P1.026 or P1.028 are greater than 0 and the vibration is not reduced, it is probably because the detection level is set too low, and the system detects noise or other frequency as low-frequency vibration.
3. When the auto suppression procedure completes, but the vibration persists, you can manually set P1.025 or P1.027 to suppress the vibration if you have identified the low frequency.

Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P1.029	Auto low-frequency vibration suppression mode
P1.030	Low-frequency vibration detection

P1.030 sets the detection range for the magnitude of low-frequency vibration. When the frequency is not detected, it is probably because you set the value of P1.030 too high and it exceeds the vibration range. In this case, it is suggested that you decrease the value of P1.030. Please note that if the value is set too small, the system might detect noise as the resonance vibration frequency. You can also use a software scope to observe the range of position error (pulse) between the upper and lower magnitude of the curve to adjust the value of P1.030.

Manual Setting

There are two sets of low-frequency vibration suppression: one is parameters P1.025 – P1.026 and the other is parameters P1.027 – P1.028. You can use these two sets of low-frequency vibration suppression parameters to reduce two different frequency vibrations. Use parameters P1.025 and P1.027 to suppress the low-frequency vibration. The function works only when the low-frequency vibration setting is close to the real vibration frequency. Use parameters 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 parameters P1.026 and P1.028 are 0, which means the two filters are disabled by default.

Refer to Chapter 8 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)

6.3 Speed mode

There are two kinds of command sources: analog input and internal register (parameters). The Analog command controls the motor speed by scaled external voltage input. The command register input controls the speed in two ways. The first is to set different speed values in three command registers and then switch the speed by using DI.SPD0 and DI.SPD1 for CN1. The second is to change the value in the register through communication. In order to deal with the problem of non-continuous speed when switching registers, you can use the S-curve acceleration / deceleration filter.

You need to manually set the parameters when using Manual mode, so in this mode, all auto or auxiliary functions are disabled. In Gain adjustment mode, you can estimate the load inertia or tune the response as well as the bandwidth. The parameter values you set at this time are regarded as the default values.

6.3.1 Selecting the Speed command source

There are two types of Speed command sources: analog voltage and internal register (parameters). You can select the source with DI signals for CN1. See the following table for the command source selection:

Speed command number	CN1 DI signal		Command source			Content	Range
	SPD1	SPD0					
S1	0	0	Mode	S	External analog signal	Voltage difference between V-REF and GND	-10V to +10V
				Sz	N/A	Speed command is 0	0
S2	0	1	Register parameters			P1.009	-60000 to 60000
S3	1	0				P1.010	-60000 to 60000
S4	1	1				P1.011	-60000 to 60000

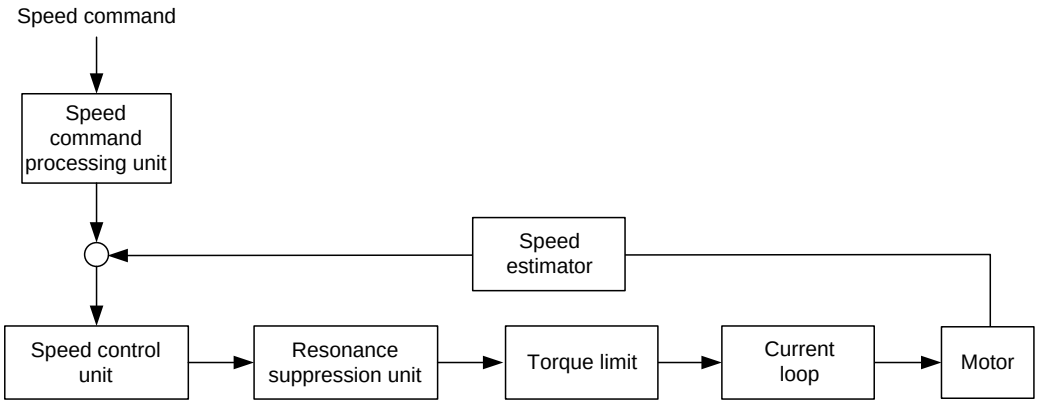
- Status of SPD0 – SPD1: 0 means that DI is off (the circuit is open); 1 means that DI is on (the circuit is closed).
- When both SPD0 and SPD1 are 0, if it is in Sz mode, the command is 0. Thus, if the Speed command using analog voltage is not required, you can use Sz mode to address the problem of zero drift in the voltage. If it is in S mode, the command is the voltage difference between V-REF and GND. The range of the input voltage is between -10V and +10V, and you can adjust the corresponding speed (P1.040).
- When either one of SPD0 and SPD1 is not 0, the Speed command comes from the internal register. The command is activated once the status of SPD0 – SPD1 is switched. There is no need to use DI.CTRG for triggering.

- The parameter setting range (internal register) is -60000 to +60000. Rotation speed = setting value x unit (0.1 rpm). For example, if P1.009 = +30000, then rotation speed = +30000 x 0.1 rpm = +3000 rpm

You can use the Speed command in Speed mode (S or Sz) as well as in Torque mode (T or Tz) to set the speed limit.

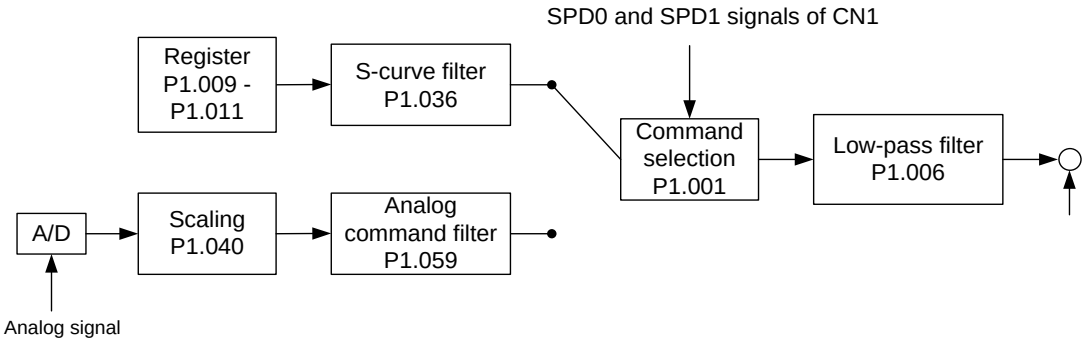
6.3.2 Control structure of Speed mode

The basic control structure is shown in the following flowchart:



The Speed command processing unit selects the command source (see Section 6.3.1), including the scaling parameter (P1.040) for rotation speed and S-curve parameter for smoothing the speed. The Speed control unit manages the gain parameters for the servo drive and calculates the current command for servo motor in real-time. The Resonance suppression unit suppresses the resonance of the machine.

The following diagram introduces the function of Speed command processing unit.
Its structure is shown below.



The upper path is the command from the register and the lower one is the command from the external analog voltage that you can select with the status of SPD0 and SPD1, and P1.001 (S or Sz). In this condition, the S-curve and low-pass filters are applied to achieve a smoother response.

6.3.3 Smooth Speed command

S-curve filter

During the process of acceleration or deceleration, the S-curve filter uses the three-stage acceleration curve and creates a smoother motion trajectory. It avoids jerk (rapid change of acceleration), resonance, and noise caused by abrupt speed variation. You can use the S-curve acceleration constant (TACC) to adjust the slope of the change in acceleration; the S-curve deceleration constant (TDEC) adjusts the slope of the change in deceleration; and the S-curve acceleration / deceleration constant (TSL) improves the status of motor activating and stopping. This can also calculate the total time for executing the command. T (m) indicates the operation time and S (rpm) indicates the absolute Speed command, which is the absolute value of the initial speed minus the end speed.

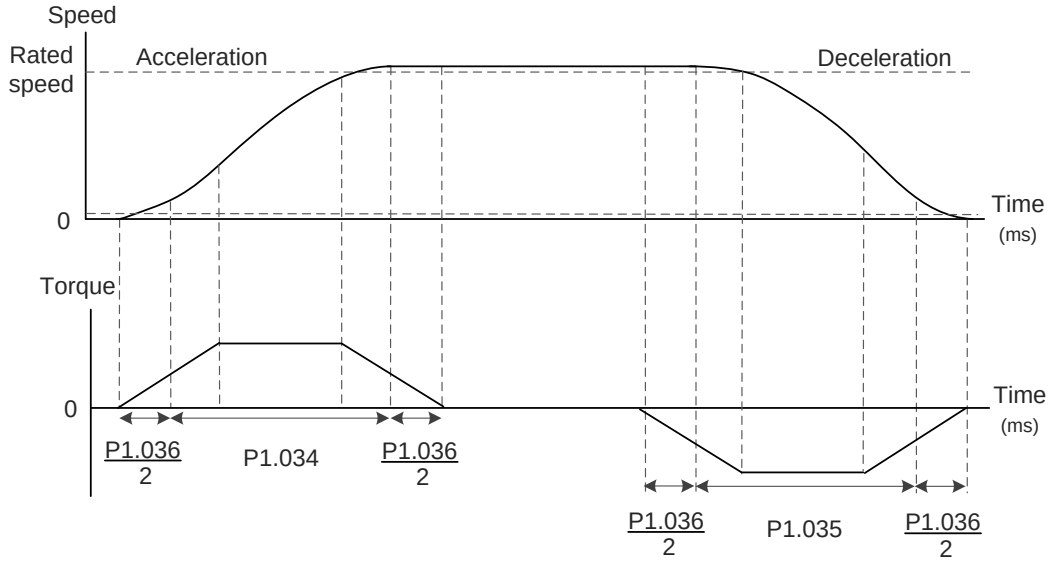


Figure 6.3.3.1 S-curve and time setting

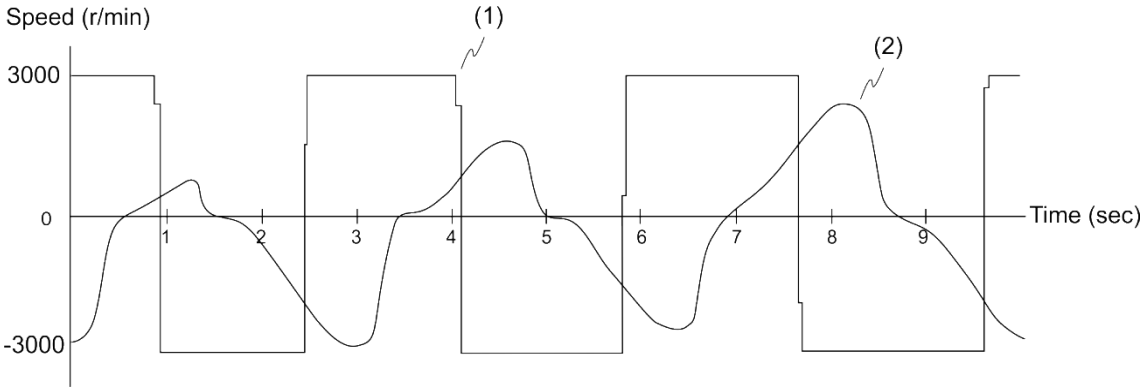
Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P1.034	S-curve acceleration constant
P1.035	S-curve deceleration constant
P1.036	S-curve acceleration / deceleration constant

6

Analog Speed command filter

The Analog Speed command filter helps to stabilize the motor operation when the analog input signal (speed) changes rapidly.



(1) Analog Speed command; (2) Motor speed

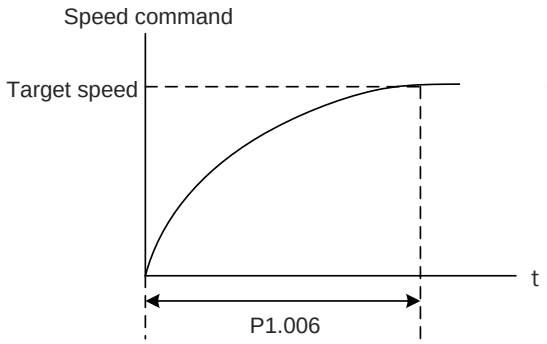
The Analog Speed command filter smoothes the analog input signal. Its time program is the same as the S-curve filter at normal speed. Also, the speed and acceleration curves are both continuous. The above graph shows the curve of the Speed command and the motor speed when you apply the Analog Speed command filter. In the diagram above, the slopes of the Speed command in acceleration / deceleration are different. You can adjust the time setting (P1.034, P1.035, and P1.036) according to the actual application to improve the performance.

Low-pass filter for speed commands

You usually use the low-pass filter to remove unwanted high-frequency response or noise so that the speed change is smoother.

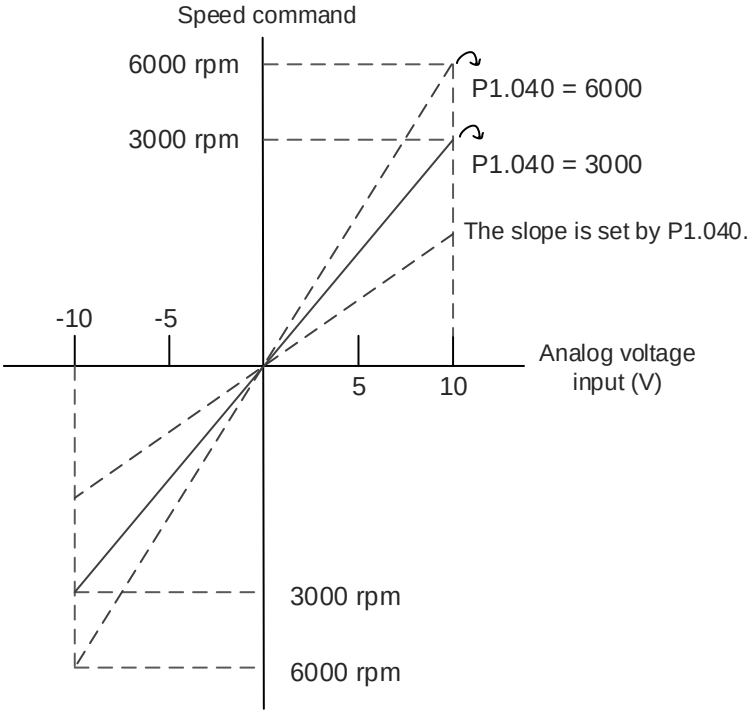
Refer to Chapter 8 for detailed descriptions of the relevant parameter.

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



6.3.4 Scaling of the analog command

In Analog mode, you control the motor's Speed command by the analog voltage difference between V_REF and VGND. Use parameter P1.040 (maximum rotation speed for Analog Speed command) to adjust the slope of the speed change and its range.

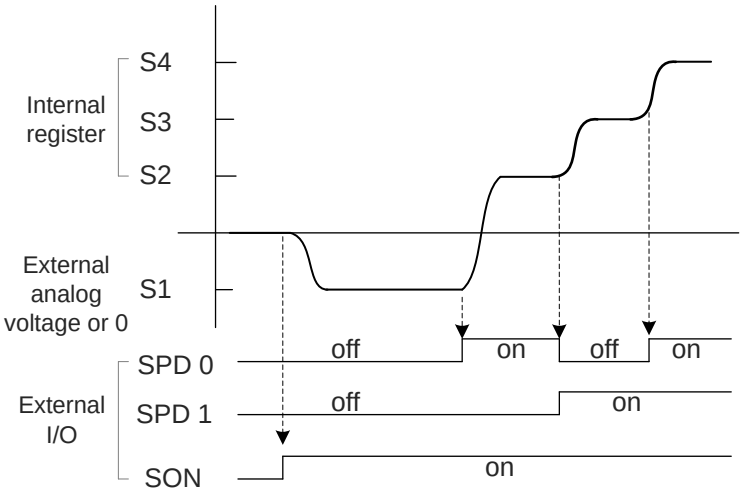


Refer to Chapter 8 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.040	Maximum rotation speed for Analog Speed command

6

6.3.5 Timing diagram of Speed mode

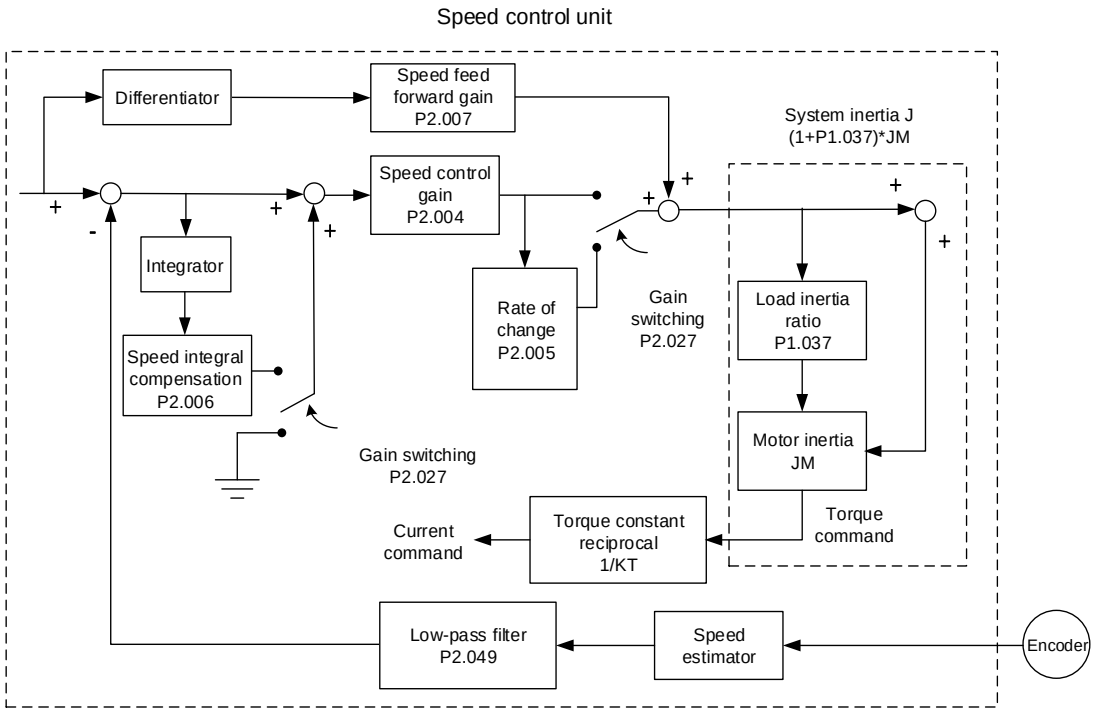


Note:

1. “off” means that DI is off (the circuit is open); “on” means that DI is on (the circuit is closed).
2. When it is in Sz mode, the Speed command S1 = 0; when it is in S mode, the Speed command S1 is the external analog voltage input.
3. In Servo On state, the command is selected according to the status of SPD0 – SPD1.

6.3.6 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 types of gain. You can adjust the gain manually or use the two gain adjustment modes provided.

Manual: you need to manually set the parameters, and all auto or auxiliary functions are disabled.

Gain adjustment mode: refer to Chapter 5 Tuning.

Manual mode

When you set P2.032 to 0, you also set the speed control gain (P2.004), speed integral compensation (P2.006), and speed feed forward gain (P2.007).

Speed control gain: the higher the gain, the larger the bandwidth for the speed loop response.

Speed integral compensation: increasing this gain increases the low frequency rigidity and reduces the steady-state error. However, the phase margin is smaller. If you set this gain too high, you reduce the system stability.

Speed feed forward gain: reduces the deviation of phase delay.

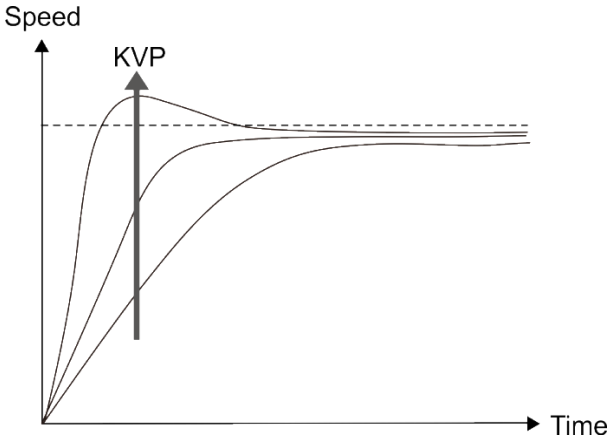
Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P2.004	Speed control gain (KVP)
P2.006	Speed integral compensation (KVI)
P2.007	Speed feed forward gain (KVF)

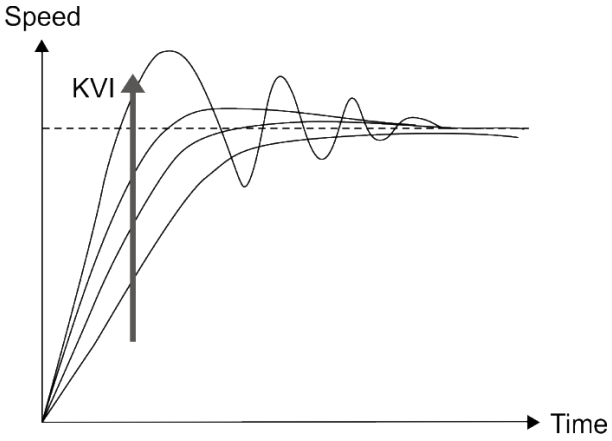
Theoretically, a stepping response can be used to explain proportional gain (KVP), integral gain (KVI), and feed forward gain (KVF). Here, the time domain is used to illustrate the basic principle.

6

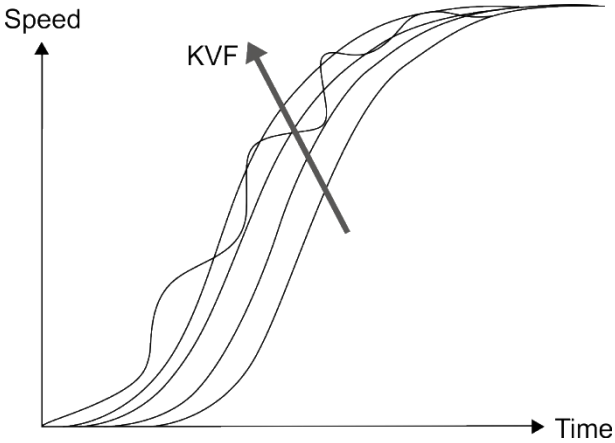
Time domain



The higher the KVP value, the larger the bandwidth. The time of the speed increase will also be shorter. However, if the value is set too high, the phase margin is too small. The effect is not as good as KVI for the steady-state error but is better for the effect on 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. 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. But a KVF value that is set too high also causes vibration.

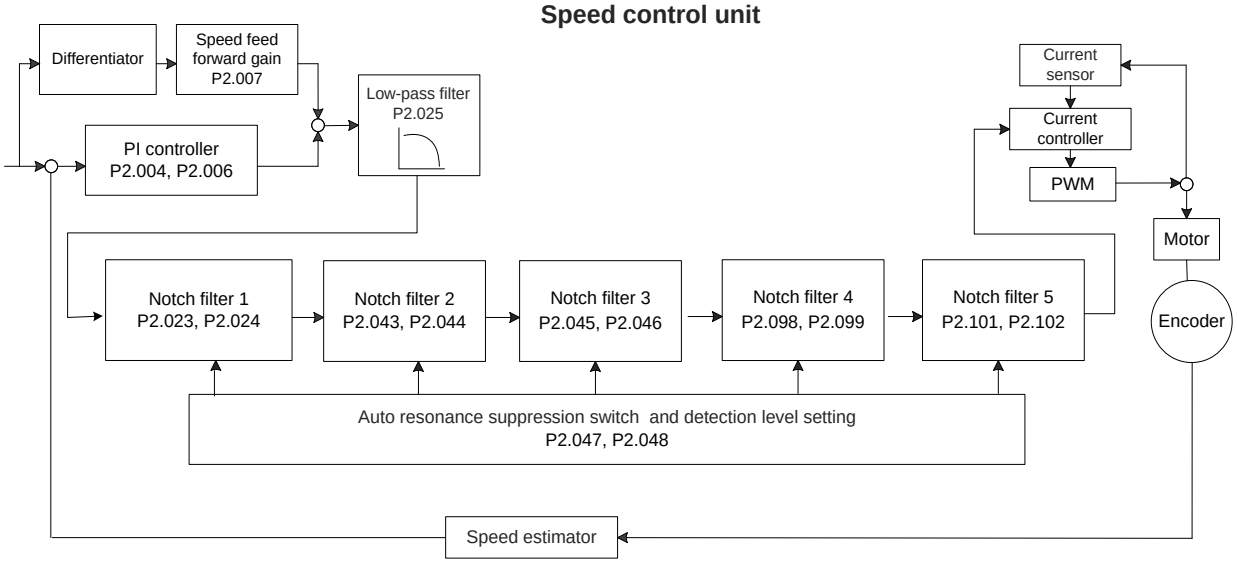
6.3.7 Resonance suppression unit

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, you can use the low-pass filter (parameter P2.025) and Notch filter (parameters 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 8 for detailed descriptions of the relevant parameters.

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

Speed control unit

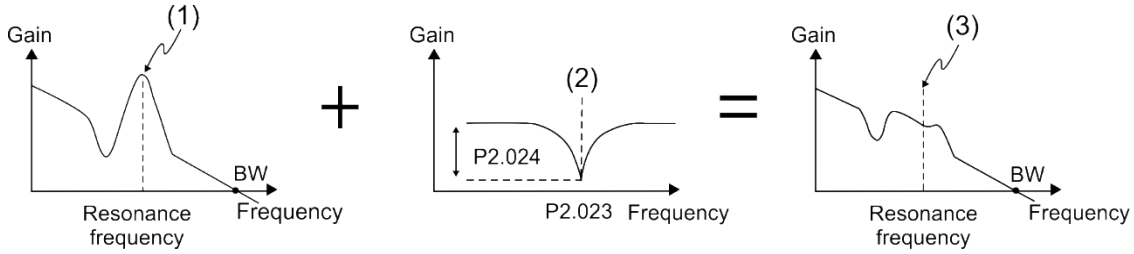


The ASDA-A3 provides two types of resonance suppression: one is the Notch filter and the other is the low-pass filter. See the following diagrams for the results of using these filters.

System open-loop gain with resonance:

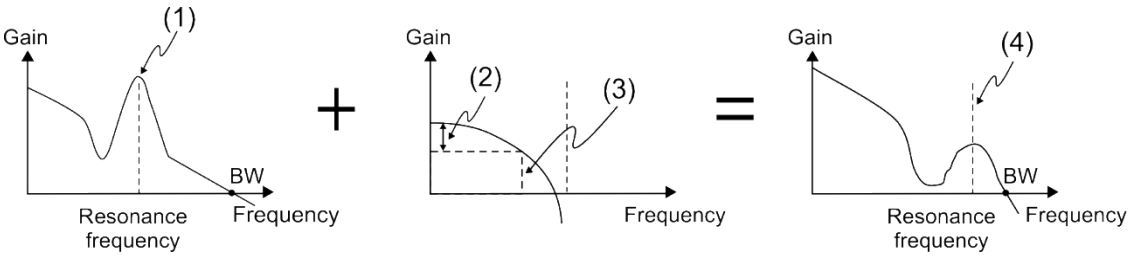
6

■ Notch filter



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

■ Low-pass filter

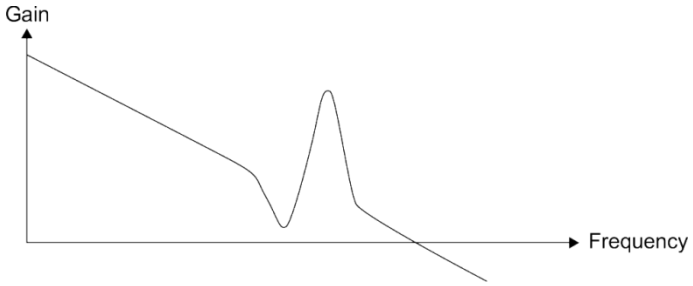


(1) Resonance point; (2) Attenuation rate (-3 dB); (3) Low-pass filter (Cutoff frequency of low-pass filter = 1000 / P2.025 Hz); (4) Resonance point suppressed by the low-pass filter

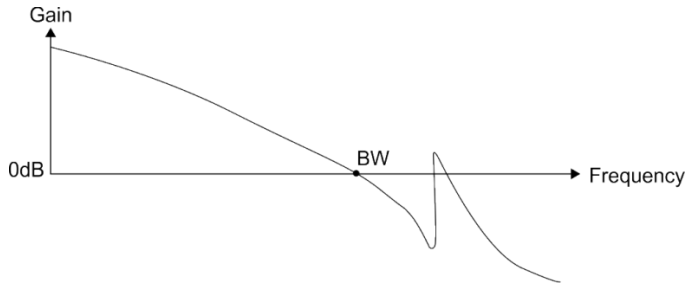
To conclude from these two examples, if you increase the value of P2.025 from 0, the bandwidth (BW) becomes smaller. Although it solves the problem of resonance, it also reduces the response bandwidth and phase margin, and thus the system becomes unstable.

If you know the resonance frequency, you can suppress the resonance by using the Notch filter, which is better than using the low-pass filter in this condition. If the resonance frequency drifts significantly with time or due to other causes, using the Notch filter is not suggested.

System open-loop gain with resonance:



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



If you know the resonance frequency, the Notch filter can eliminate the resonance directly.
The frequency range of the notch filter is 50 – 5000 Hz and the suppression strength is 0 – 40 dB.
If the frequency does not meet the Notch filter conditions, then using the low-pass filter to reduce the resonance is suggested.

6.4 Torque mode

Torque control mode (T or Tz) is suitable for torque control applications, such as printing machines and winding machines. There are two kinds of command sources: analog input and internal register (parameters). The analog command input uses scaled external voltage to control the torque of the motor while the register uses the internal parameters (P1.012 – P1.014) for the Torque command.

6.4.1 Selecting the Torque command source

External analog voltage and internal parameters are the two Torque command sources.
You select the command source with DI signals for CN1. See the table below for more detail.

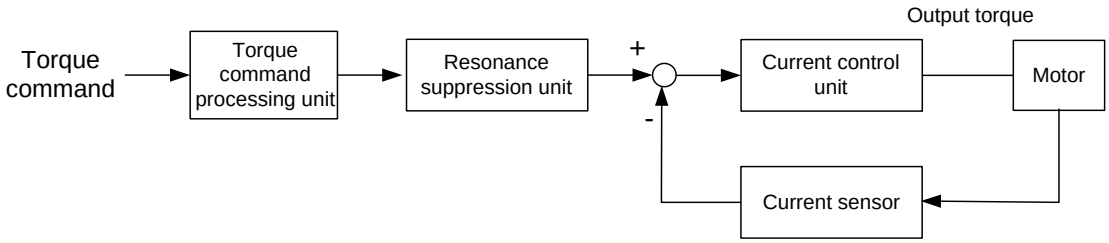
Torque command number	CN1 DI signal		Command source			Content	Range
	TCM1	TCM0					
T1	0	0	Mode	T	External analog signal	Voltage difference between T_REF and GND	-10V to +10V
				Tz	N/A	Torque command is 0	0
T2	0	1	Register parameters			P1.012	-400% to +400%
T3	1	0				P1.013	-400% to +400%
T4	1	1				P1.014	-400% to +400%

- Status of TCM0 – TCM1: 0 means that DI is off (the circuit is open); 1 means that DI is on (the circuit is closed).
- When both TCM0 and TCM1 are 0, if it is in Tz mode, then the command is 0. If there is no need to use the analog voltage for the Torque command, then Tz mode is applicable and can avoid the problem of zero voltage drift. If it is in T mode, then the command is the voltage difference between T_REF and GND. Its input voltage range is -10V to +10V, which means you can adjust the corresponding torque (P1.041).
- When either one of TCM0 or TCM1 is not 0, the internal parameters become the source for the Torque command. The command is executed after TCM0 – TCM1 are switched. There is no need to use DI.CTRG for triggering.

You can use the Torque command in Torque mode (T or Tz) and Speed mode (S or Sz).
When it is in Speed mode, you can think of it as the command input for the torque limit.

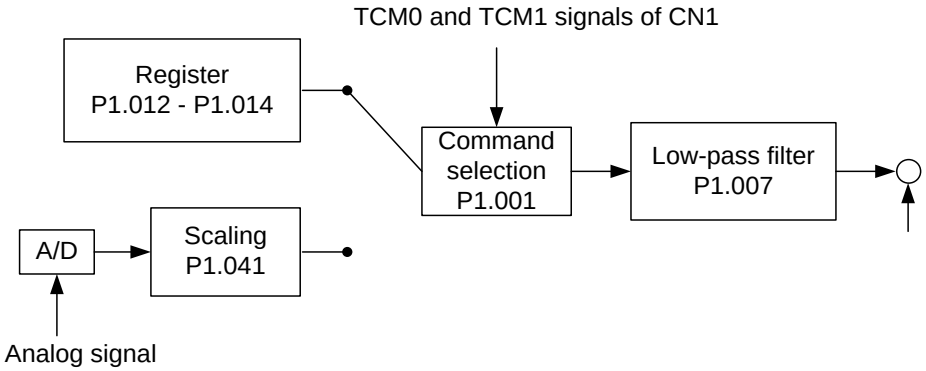
6.4.2 Control structure of Torque mode

The basic control structure is shown in the following flowchart:



The Torque command processing unit selects the command source (see Section 6.4.1), including the scaling parameter (P1.041) for rotation speed and S-curve parameter for smoothing the torque. The current control unit manages the gain parameters for the servo drive and calculates the current for servo motor in real-time; you can only set this by commands.

The structure of torque command processing unit is as follows:

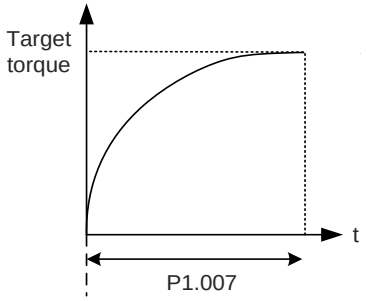


The upper path is the command from the register and the lower one is the command from the external analog voltage that you can select with the status of TCM0 and TCM1, and P1.001 (T or Tz). You can adjust the torque with the analog voltage scaling (P1.041) and you can smooth the response with the low-pass filter (P1.007).

6.4.3 Smooth Torque command

Refer to Chapter 8 for detailed descriptions of the relevant parameter.

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

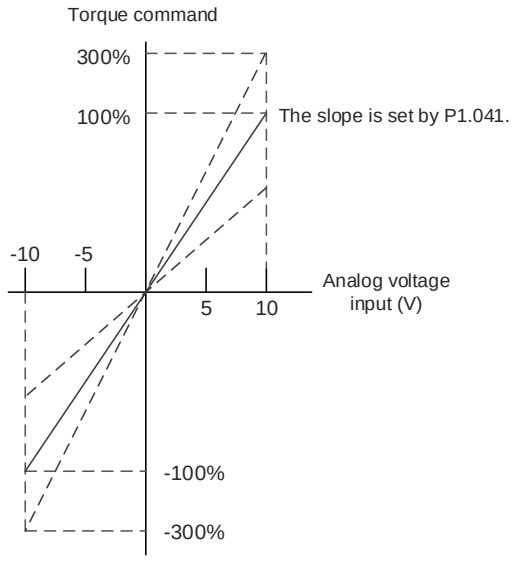


6.4.4 Scaling of the analog command

The Torque command is controlled by the analog voltage difference between T_REF and GND. You can adjust the torque slope and its range with parameter P1.041.

For example:

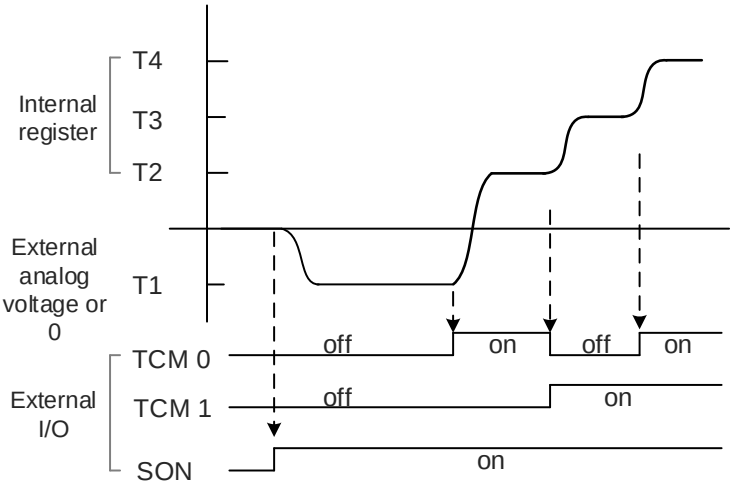
1. If you set P1.041 to 100 and the external input voltage is 10V, the Torque command is 100% of the rated torque.
2. If you set P1.041 to 300 and the external input voltage is 10V, the Torque command is 300% of the rated torque.



Refer to Chapter 8 for detailed descriptions of the relevant parameter.

Parameter	Function
P1.041	Maximum output for analog Torque command

6.4.5 Timing diagram of Torque mode



Note:

1. “off” means that DI is off (the circuit is open); “on” means that DI is off (the circuit is closed).
2. When in Tz mode, the Torque command T1 = 0; when in T mode, the Torque command T1 is the external analog voltage input.
3. In Servo On state, the command is selected according to the status of TCM0 – TCM1.

6.5 Dual mode

Apart from the single mode for position, speed, and torque, there are also eight dual / multiple modes available for operation (see Section 6.1).

6

Mode	Short name	Code	Description
Dual mode	PT-S	06	PT and S can be switched with DI signal, S_P.
	PT-T	07	PT and T can be switched with DI signal, T_P.
	PR-S	08	PR and S can be switched with DI signal, S_P.
	PR-T	09	PR and T can be switched with DI signal, T_P.
	S-T	0A	S and T can be switched with DI signal, S_T.
	PT-PR	0D	PT and PR can be switched with DI signal, PT_PR.
Multi-mode	PT-PR-S	0E	PT, PR, and S can be switched with DI signals, S_P and PT_PR.
	PT-PR-T	0F	PT, PR, and T can be switched with DI signals, T_P and PT_PR.

Sz and Tz dual mode is not supported. To avoid occupying too many digital inputs in dual mode, Speed and Torque modes can use the external analog voltage as the command source to reduce the use of DI points (SPD0, SPD1 or TCM0, TCM1). In addition, Position mode can use the pulse input to reduce the use of DI points (POS0, POS1, POS2, POS3, POS4, POS5, and POS6). Refer to Section 3.3.2 for the table of DI/O default value in each mode.

If you want to change the settings, the DI/O signals in correspondence with the pins are defined as above in Section 3.3.4.

6.5.1 Speed / Position dual mode

PT-S and PR-S are available in Speed / Position dual mode. The command source for PT-S comes from the external pulse while the source for PR-S comes from the internal parameters (P6.000 – P7.027). You can control the Speed command with the external analog voltage or the internal parameters (P1.009 – P1.011). The switch for Speed / Position mode is controlled by DI.S-P (0x18). The switch for PT and PR for Position mode is controlled by DI.PT-PR (0x2B). Thus, you select both Position and Speed commands in PR-S mode with the DI signal.
The timing diagram is shown below.

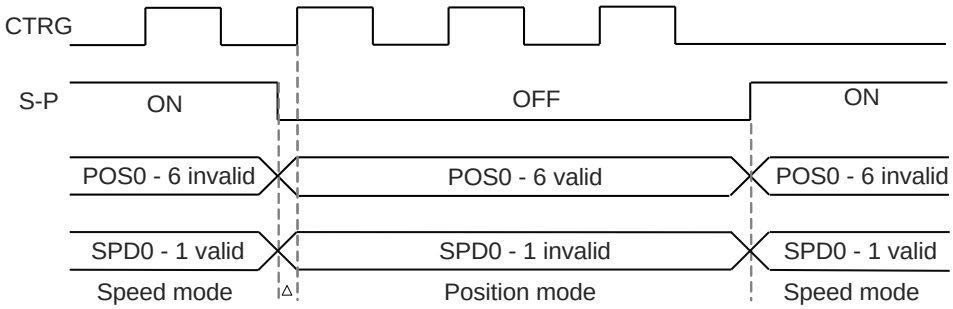


Figure 6.5.1.1 Speed / Position dual mode

In Speed mode (DI.S-P is on), you select the Speed command with DI.SPD0 and DI.SPD1. DI.CTRG is not applicable. When switching to Position mode (DI.S-P is off), since the Position command has not been issued (it waits for the rising edge of DI.CTRG), the motor stops (indicated by △ in the figure above). The Position command is controlled by DI.POS0 – DI.POS6 and triggered by the rising edge of DI.CTRG. When DI.S-P is on, it returns to Speed mode. Refer to the introduction of single mode for the DI signal and the selected commands for each mode.

6.5.2 Speed / Torque dual mode

Speed / Torque dual mode includes only the S-T mode. You control the Speed command with the external analog voltage and the internal parameters (P1.009 – P1.011), which you select with DI.SPD0 – DI.SPD1. Similarly, the source of the Torque command can be the external analog voltage or the internal parameters (P1.012 – P1.014), and is selected by DI.TCM0 – DI.TCM1. The switch between Speed and Torque modes is controlled by DI.S-T (0x19) signal. The timing diagram is shown below.

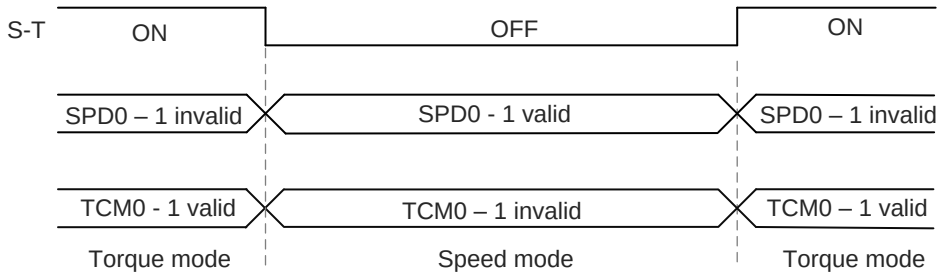


Figure 6.5.2.1 Speed / Torque dual mode

In Torque mode (DI.S-T is on), you select the Torque command with DI.TCM0 and DI.TCM1. When switching to Speed mode (DI.S-T is off), you select the Speed command with DI.SPD0 and DI.SPD1. The motor operates according to the Speed command. When DI.S-T is ON, it returns to the Torque mode. Refer to the introduction of single mode for the DI signal and the selected commands for each mode.

6.5.3 Torque / Position dual mode

Torque / Position dual mode includes PT-T and PR-T. The command source for PT-T comes from the external pulse while the source for PR-T comes from internal parameters (P6.000 – P7.027). You control the Torque command with the external analog voltage or the internal parameters (P1.012 – P1.014). The switch for Torque / Position mode is controlled by DI.T-P (0x20) signal. The switch for PT and PR for Position mode is controlled by DI.PT-PR (0x2B) signal. Thus, you select both Position and Torque commands in PR-T mode with the DI signal. The timing diagram is shown below.

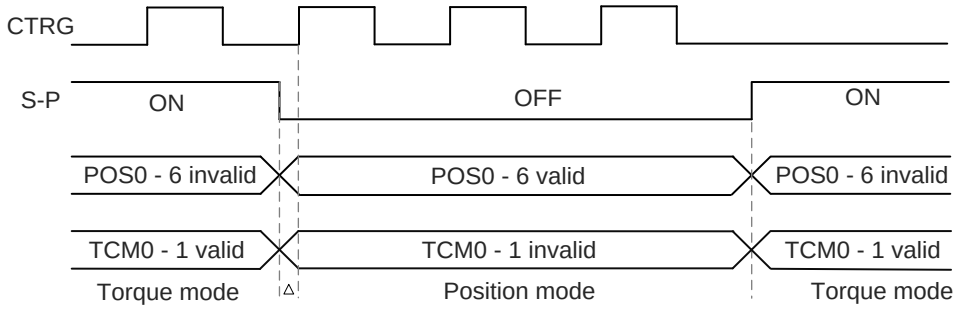


Figure 6.5.3.1 Torque / Position dual mode

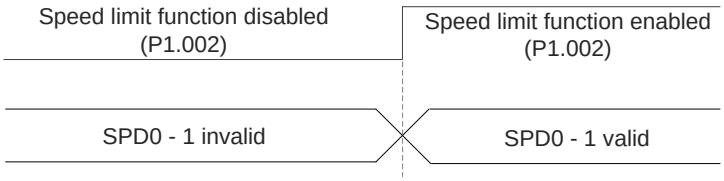
In Torque mode (DI.T-P is on), you select the Torque command with DI.TCM0 and DI.TCM1. DI.CTRG is not applicable. When switching to Position mode (DI.T-P is off), since the Position command has not been issued (it waits for the rising edge of DI.CTRG), the motor stops (indicated by △ in the figure above). When the Position command is determined by DI.POS0 – DI.POS6 and triggered by the rising edge of DI.CTRG, the motor rotates to the specified position. When DI.T-P is on, it returns to Torque mode. Refer to the introduction of single mode for the DI signal and the selected commands for each mode.

6.6 Others

6.6.1 Applying the speed limit

The maximum speed in each mode (Position, Speed, Torque) is determined by the internal parameter (P1.055). You use the same method for the Speed Limit and Speed commands. You can use either the external analog voltage or the internal parameters (P1.009 – P1.011). Refer to Section 6.3.1 for descriptions.

The speed limit is applicable only in Torque mode (T) for controlling the motor's maximum speed. If you are using the external analog voltage in Torque mode, the DI signals are available and you can set SPD0 – SPD1 for the motor speed limit value (internal parameters). If not, you can use the analog voltage input for the Speed Limit command. When you set P1.002 (disable / enable speed limit function) to 1, you enable the Speed Limit function. The timing diagram is shown below.

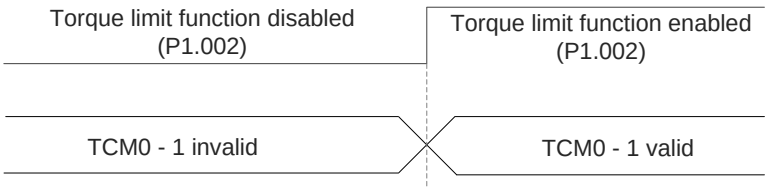


Command source selection of speed limit

6.6.2 Applying the torque limit

The methods for using the Torque Limit command and Torque command are the same. You can use either the external analog voltage or the internal parameters (P1.012 – P1.014). Refer to Section 6.4.1 for descriptions.

You can use the torque limit in Position mode (PT, PR) or Speed mode (S) to limit the motor torque output. If you are using the external pulse in Position mode or using the external analog voltage in Speed mode, the DI signals are available and you can set TCM0 – TCM1 for the torque limit value (internal parameters). If not, you can use the analog voltage input for the Torque Limit command. When you set P1.002 (disable / enable torque limit function) to 1, you enable the Torque Limit function. The timing diagram is shown below.



Command source selection of torque limit

6.6.3 Analog monitoring

You can find the required voltage signal with analog monitoring. Two analog channels are provided by the servo drive and located on terminals 15 and 16 of CN1.

Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P0.003	Analog output monitoring
P1.003	Encoder pulse output polarity
P1.004	MON1 analog monitor output proportion
P1.005	MON2 analog monitor output proportion
P4.020	Offset adjustment for analog monitor output (Ch1)
P4.021	Offset adjustment for analog monitor output (Ch2)

Example:

Specify a motor speed of 1000 rpm, which corresponds to analog voltage output of 8V with the maximum speed of 5000 rpm. The setting is as follows:

$$\text{P1.004} = \frac{\text{Required speed}}{\text{Max. speed}} \times 100\% = \frac{1000\ \text{rpm}}{5000\ \text{rpm}} \times 100\% = 20\%$$

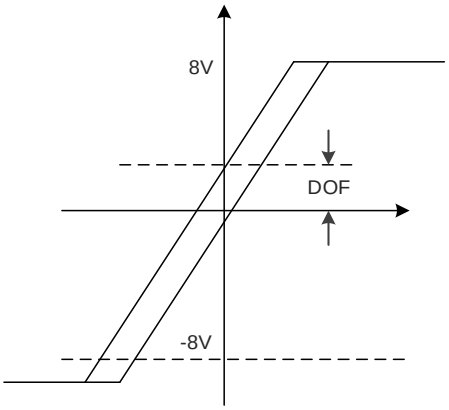
You can calculate the corresponding voltage output for the current motor speed with the formula below.

Motor speed	MON1 analog monitoring output
300 rpm	$\text{MON1= 8V } \frac{\text{Current speed}}{\text{Max. speed x } \frac{\text{P1.004}}{100}} \times 100\% = 8\text{V } \frac{300\ \text{rpm}}{5000\ \text{rpm x } \frac{20}{100}} \times 100\% = 2.4\text{V}$
900 rpm	$\text{MON1= 8V } \frac{\text{Current speed}}{\text{Max. speed x } \frac{\text{P1.004}}{100}} \times 100\% = 8\text{V } \frac{900\ \text{rpm}}{5000\ \text{rpm x } \frac{20}{100}} \times 100\% = 7.2\text{V}$

6

Voltage drift:

When voltage drift occurs, the voltage level defined as zero voltage is different from the set zero point. To fix this problem, you can use DOF1 (P4.020) and DOF2 (P4.021) to calibrate the offset voltage output. The voltage level for analog monitoring output is ±8V. If the output voltage exceeds the range, it is limited within ±8V. The resolution is approximately 10 bits, which is equivalent to 13 mV/LSB.



Motion Control 7

This chapter introduces internal motion commands in the ASDA-A3 in PR mode. In this mode, commands are generated based on the internal command of the servo drive. Various motion commands are available, including Homing, Speed, Position, Write, arithmetic operation, and Jump. Other motion control functions such as high-speed position capture (Capture), high-speed position compare (Compare) and E-Cam are also available. This chapter contains detailed description of each command type.

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7

7.1 PR mode description

In PR mode, the servo drive automatically generates the motion commands. Apart from the basic arithmetic operation commands, the ASDA-A3 saves all parameter settings in the parameter file in the servo drive. Thus changing parameter values simultaneously changes the PR commands. The ASDA-A3 provides 100 path setting sets, which include the homing method, Position command, Speed command, Jump command, Write command, Index Position command, and arithmetic operation commands.

Except for arithmetic operations, the properties and corresponding data for each PR path are set by parameters. You can find information of all PR parameters in the descriptions of Group 6 and 7 in Chapter 8. For example, PR#1 path is defined by two parameters, P6.002 and P6.003. P6.002 is for specifying the property of PR#1, such as the PR command type, whether to interrupt, and whether to auto-execute the next PR. P6.003 is subject to change based on the properties set in P6.002. If P6.002 is set to a Speed command, then P6.003 specifies the target speed. When P6.002 is set to a Jump command, then P6.003 specifies the target PR. The parameters for the PR#2 path are P6.004 and P6.005, and they work same way as P6.002 and P6.003. The same is true for the rest of PR paths. See Figure 7.1.1.

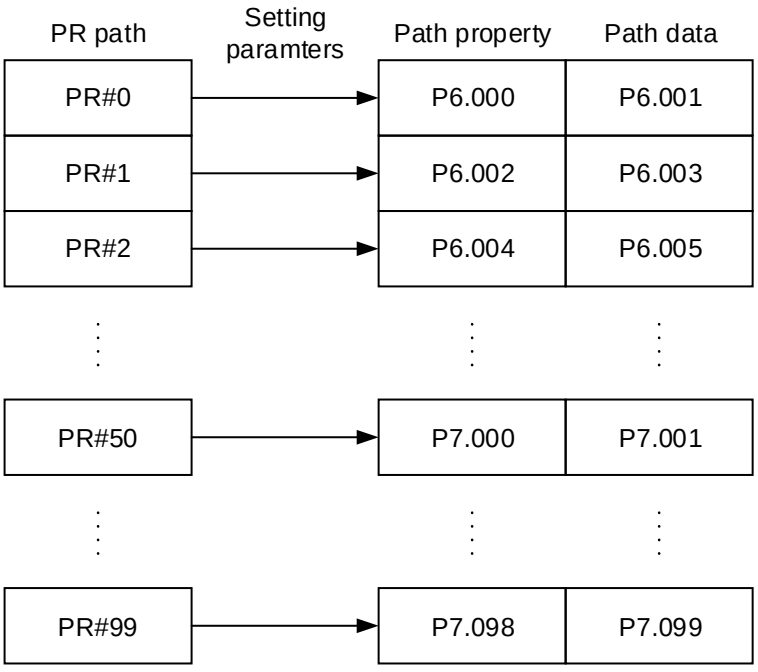


Figure 7.1.1 Setting parameters for each PR path

7

In the ASDA-Soft software, when you select the PR to be edited in PR mode, the corresponding parameters appear at the top of the window. See Figure 7.1.2. If you select PR#1 , P6.002 and P6.003 appear at the top in the editing section (see P6.002 and P6.003 in Table 7.1.1 for example). The PR property and its data content differ in accordance with the motion command type. For more information about Motion Control mode, refer to Section 7.1.3.

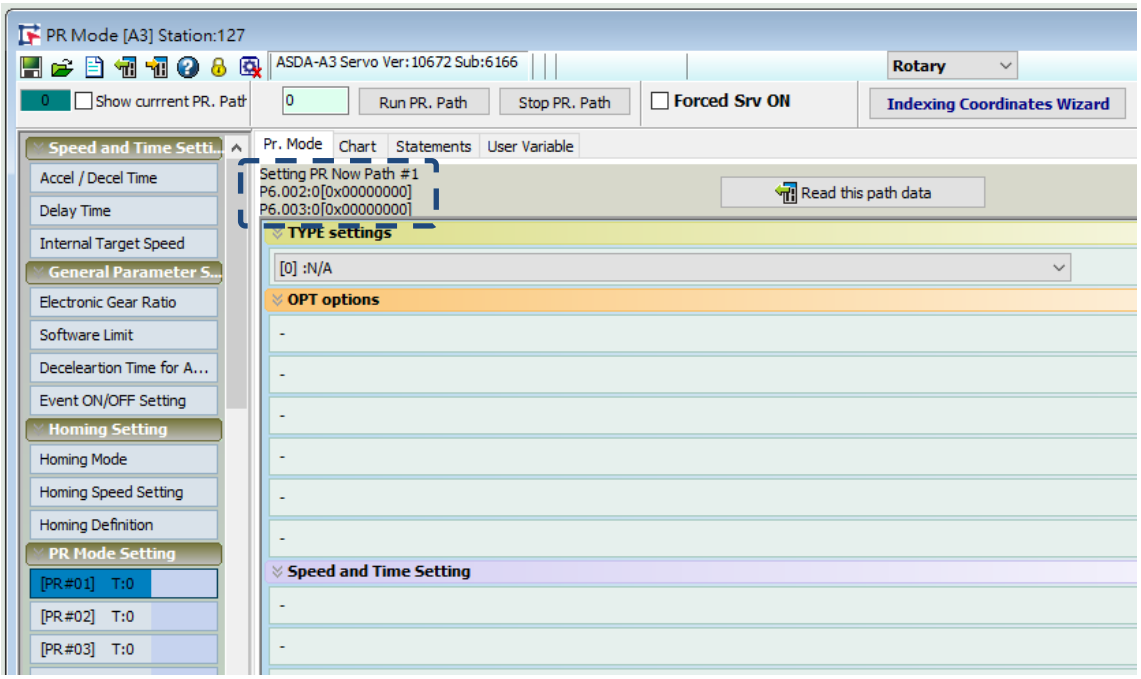


Figure 7.1.2 PR Mode interface in ASDA-Soft

Table 7.1.1 Example of PR#1 property and data content

Bit / PR#1	31 – 28	27 – 24	23 – 20	19 – 16	15 – 12	11 – 8	7 – 4	3 – 0
P6.002								TYPE
P6.003	Data content (32-bit)							

Note:

TYPE: Control command mode

TYPE No.	Command mode
1	SPEED: speed control
2	SINGLE: positioning control; stop once positioning is complete.
3	AUTO: positioning control; execute the next PR path once positioning is complete.
7	JUMP: jump to the specified path.
8	WRITE: write parameters to the specified path.
0xA	INDEX: index position control
0xB	STATEMENT: statement / arithmetic operations

ASDA-Soft version V6 provides an editing interface for PR diagrams. (see Figure 7.1.3). It is easier to set PR paths in ASDA-Soft, where you can set the options of command triggering, command types, and other properties. You must set the arithmetic operations and statements in the software.

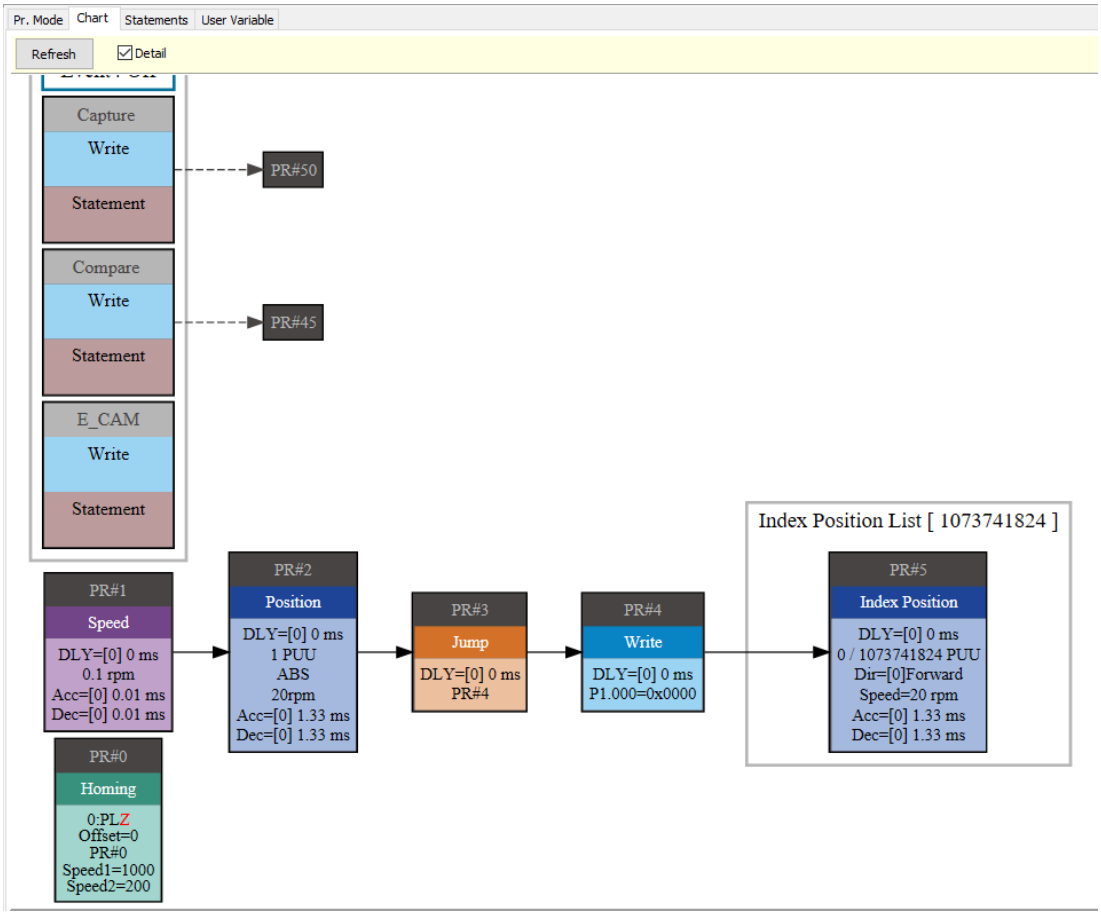
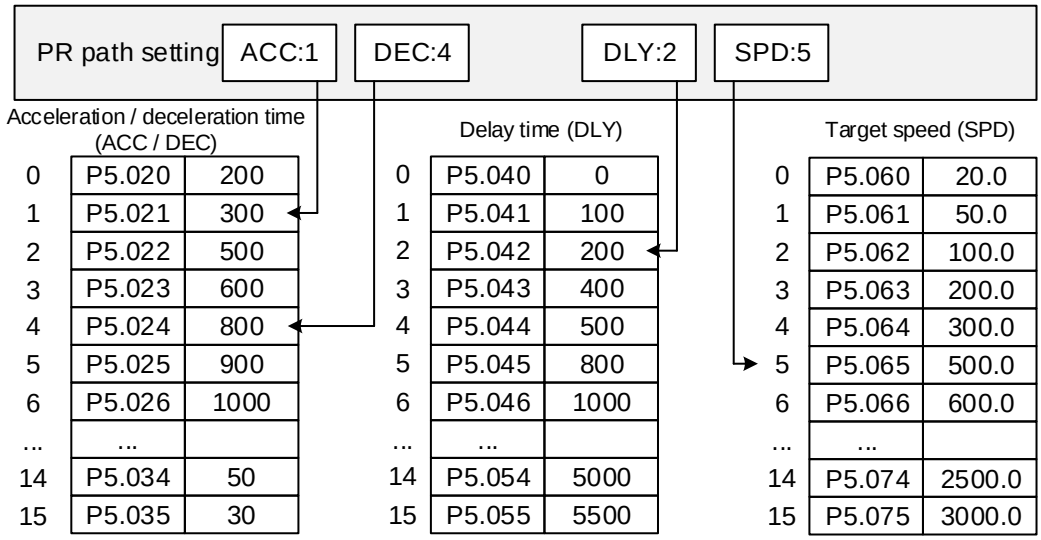


Figure 7.1.3 PR Diagram display in ASDA-Soft

7.1.1 Shared PR parameters

ASDA-A3 provides 16 acceleration and deceleration time settings (P5.020 - P5.035), 16 delay time settings (P5.040 - P5.055), and 16 target speed settings (P5.060 - P5.075) for you to set the PR paths (as shown in Figure 7.1.1.1). If you change a parameter that is used by multiple PR paths, then all PR paths using this parameter are changed as well. Please be aware of this when setting PR paths so as to avoid any danger or damage to the machine. For example, if multiple PR commands use the target speed setting from P5.060, when you change the value of P5.060, those PR commands' target speed are also changed. ASDA-Soft also provides a user-friendly interface for this shared PR parameter function (see Figure 7.1.1.2). In these data, the acceleration or deceleration time is set based on the length of time for motor to accelerate from 0 to 3000 rpm or to decelerate from 3000 rpm to 0. For instance, if acceleration time is set to 50 ms, then the target speed for the motion command is 3000 rpm, and the required duration is 50 ms. If target speed for the motion command is 1500 rpm, then the acceleration time is

25 ms. The acceleration or deceleration time is a fixed slope, so the slope does not change when you change parameter values.



0	P5.020	200
1	P5.021	300
2	P5.022	500
3	P5.023	600
4	P5.024	800
5	P5.025	900
6	P5.026	1000
...	...	
14	P5.034	50
15	P5.035	30

0	P5.040	0
1	P5.041	100
2	P5.042	200
3	P5.043	400
4	P5.044	500
5	P5.045	800
6	P5.046	1000
...	...	
14	P5.054	5000
15	P5.055	5500

0	P5.060	20.0
1	P5.061	50.0
2	P5.062	100.0
3	P5.063	200.0
4	P5.064	300.0
5	P5.065	500.0
6	P5.066	600.0
...	...	
14	P5.074	2500.0
15	P5.075	3000.0

Figure 7.1.1.1 Shared parameter data for PR paths

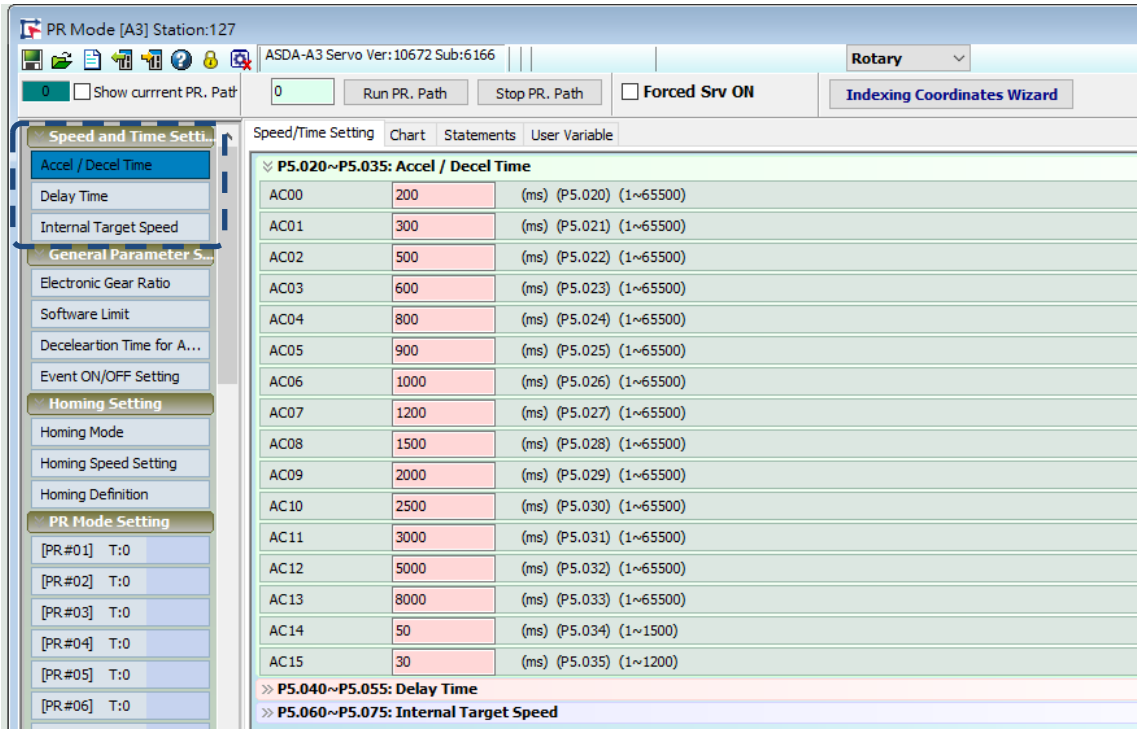


Figure 7.1.1.2 ASDA-Soft interface for shared PR parameter data

7.1.2 Monitoring variables of PR mode

The PR mode provides four monitoring variables for the servo command and feedback: command position (PUU), PR command end register, feedback position (PUU), and position error (PUU). These are described as follows:

1. Command position (PUU): monitoring variable code 001. The target position of the motion command generated per scan cycle during servo operation (updated every 1 ms), simplified as Cmd_O (Command Operation).
2. PR command end register: monitoring variable code 064. The target position of the PR command, simplified as Cmd_E (Command End). When a command is triggered, the servo drive calculates the target position and then updates to PR command end register.
3. Feedback position (PUU): monitoring variable code 000. The encoder feedback position (coordinates), simplified as Fb_PUU (Feedback PUU).
4. Position error (PUU): monitoring variable code 002. The deviation between the command position (PUU) and the feedback position (PUU), simplified as Err_PUU (Error PUU).

How these four monitoring variables work is shown in Figure 7.1.2.1. After the servo issues a Position command, the servo sets the position of Cmd_E once the target position data is acquired. The motor operates to the target position based on the PR path setting. Cmd_O calculates the amount of command deviation in each fixed cycle and sends it to the servo drive, where it is treated as a dynamic command. Fb_PUU is encoder feedback position and Err_PUU is the deviation of Cmd_O minus Fb_PUU.

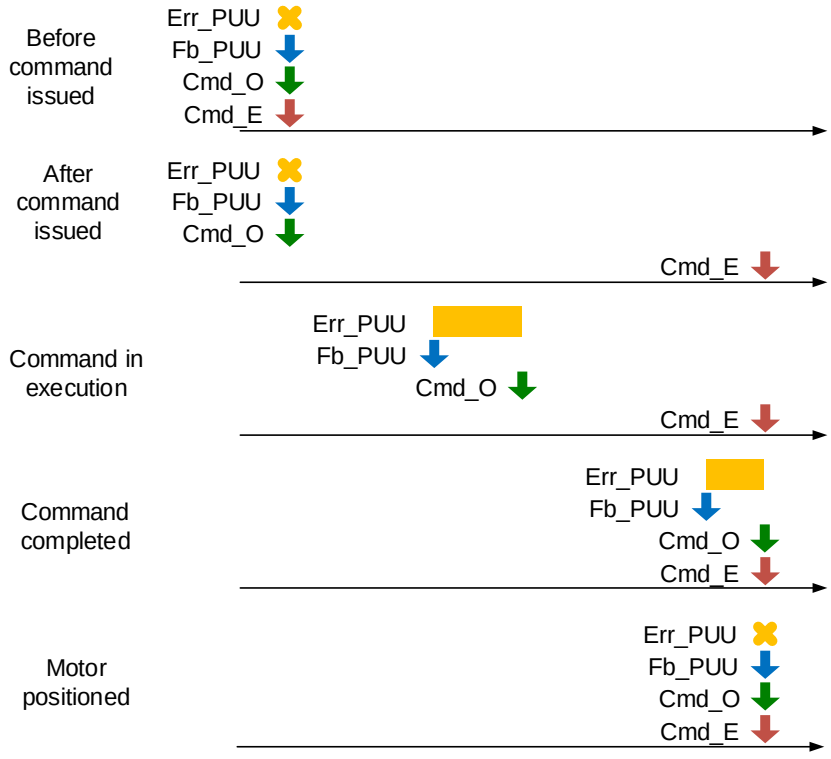


Figure 7.1.2.1 Timing diagram for PR mode monitoring variables

7

The detailed command behavior of each stage is illustrated in Figure 7.1.2.2. Cmd_E is the endpoint specified by the command; it is set when the PR path is triggered. Fb_PUU is the feedback position, which is motor's actual position. Divide this motion command into slices and take one of them as example. Cmd_O is the target of this cycle command and Err_PUU is the deviation between the target position of the cycle command and the feedback position.

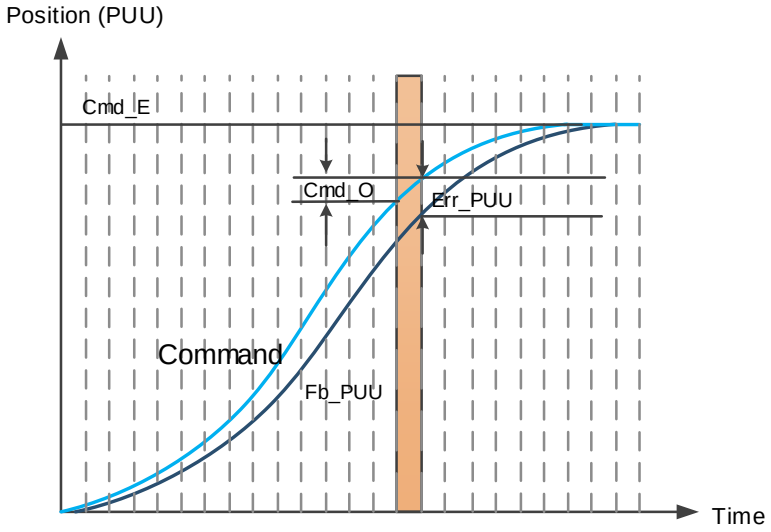


Figure 7.1.2.2 Monitoring variables status when executing a command in PR mode

You can use the digital input (DI) to call and the digital output (DO) to monitor PR paths (refer to Table 8.1 and 8.2 for DI/O function descriptions). When you trigger the motion command with DI.CTRG [0x08], the servo drive operates based on the command from the internal registers. Once the execution is complete, DO.Cmd_OK [0x15] (PR Position command complete) is set to on.

When the position deviation (pulse number) becomes smaller than the set amount in P1.054, DO.TPOS [0x05] (Motor reaches the target position) is set to on. Then, both DO signals are on and the servo outputs the MC_OK [0x17] signal to signify that it has completed this PR path. The operation is as shown in Figure 7.1.2.3. If you have set a delay time in this PR and the position deviation (pulse number) is smaller than the value of P1.054, DO.TPOS [0x05] is set to on.

When the delay time is over, DO.Cmd_OK [0x15] (PR position command complete) is set to on. After both of the above mentioned DO signals are on, DO.MC_OK [0x17] (Servo procedure complete) is set to on to signify it has completed this PR path, as shown in Figure 7.1.2.4.

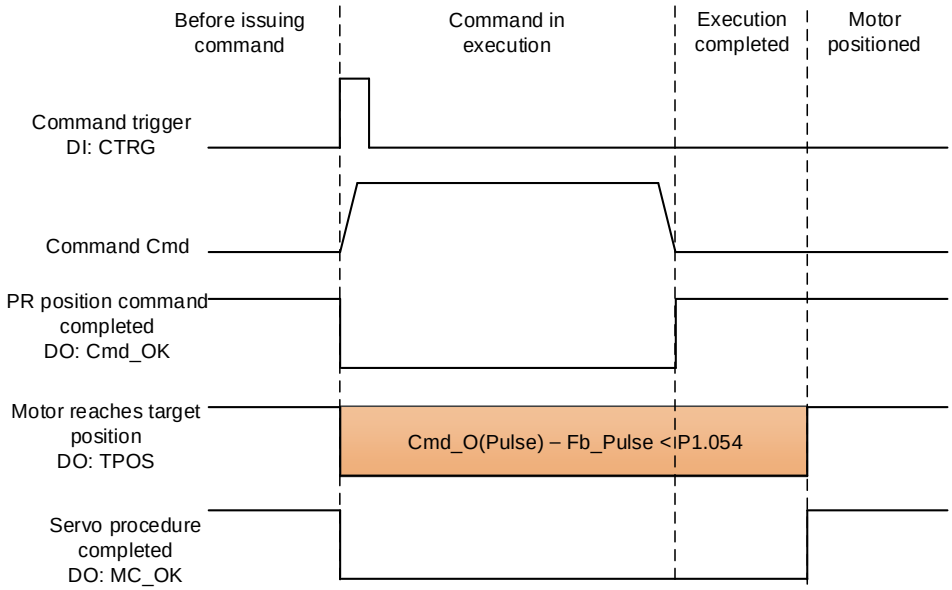


Figure 7.1.2.3 Operation of DI/DO signals in PR mode

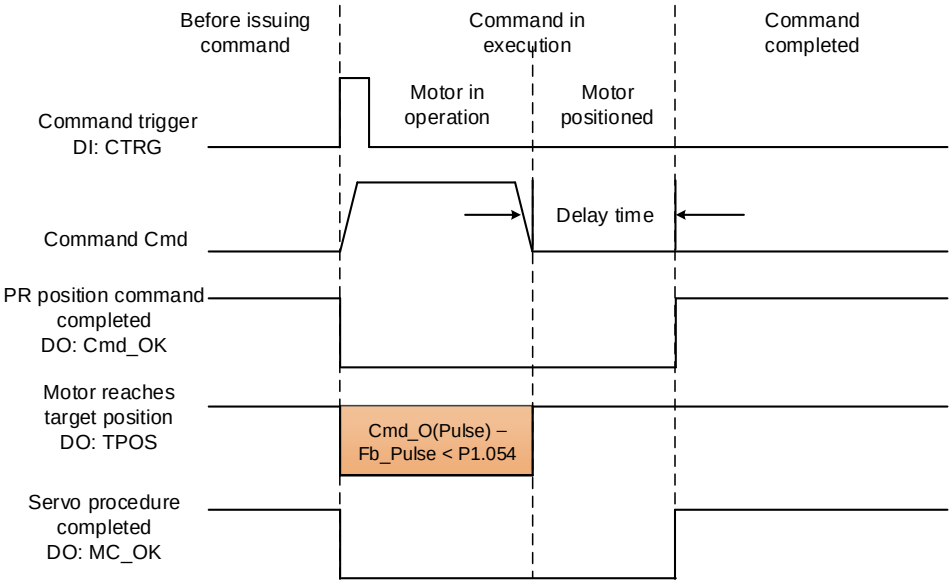


Figure 7.1.2.4 Operation of DI/DO signals in PR mode (including delay time)

7.1.3 Motion Control commands

The ASDA-A3 provides 100 path sets. Apart from the fixed homing command, you can respectively set the speed, position, path jumping, parameter writing, index position, and arithmetic operation commands. The following sections detail each command type.

7

7.1.3.1 Homing methods

The ASDA-A3 provides 11 homing methods in the PR mode, including home sensor, limit, and hard stop as the reference origin. They come with sub-selections such as whether to refer to the Z pulse and the limit signal as the trigger, with more than 30 combinations available. The homing method is specified by P5.004 and the homing definition is determined by P6.000. The function of each bit is listed as follows.

P5.004	**Homing methods**		**Address: 0508H 0509H**
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0 - 0x12A
Format:	HEX	Data size:	16-bit

Settings:

X	Homing method	Z	Limit setting
Y	Z pulse setting	U	Reserved

Definition of each setting value:

U	Z	Y	X
Reserved	Limit setting	Z pulse setting	Homing method
-	0 – 1	0 – 2	0 – A
-	-	Y = 0: return to Z pulse Y = 1: go forward to Z pulse Y = 2: do not look for Z pulse	X = 0: homing in forward direction and define the positive limit as homing origin
			X = 1: homing in reverse direction and define the negative limit as homing origin
	When reaching the limits: Z = 0: show error Z = 1: reverse direction		X = 2: homing in forward direction, ORG: OFF→ON as homing origin
			X = 3: homing in reverse direction, ORG: OFF→ON as homing origin
-	When reaching the limits: Z = 0: show error Z = 1: reverse direction	-	X = 4: look for Z pulse in forward direction and define it as homing origin
			X = 5: look for Z pulse in reverse direction and define it as homing origin

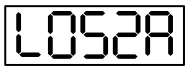
U	Z	Y	X
		Y = 0: return to Z pulse Y = 1: go forward to Z pulse Y = 2: do not look for Z pulse	X = 6: homing in forward direction, ORG: ON→OFF as homing origin
			X = 7: homing in reverse direction, ORG: ON→OFF as homing origin
	-	-	X = 8: define current position as the origin
	Z = 0: show error Z = 1: reverse direction	Y = 0: return to Z pulse Y = 2: do not look for Z pulse	X = 9: torque homing in forward direction
			X = A: torque homing in reverse direction

P6.000	Homing definition		Address: 0600H 0601H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFF6F
Format:	HEX	Data size:	32-bit

Settings:

Homing definition:

D C B A



U Z YX

A	DEC2: deceleration time selection for second homing	YX	PATH: path type
B	DLY: select 0 - F for delay time	Z	ACC: select 0 - F for acceleration time
C	N/A	U	DEC1: deceleration time selection for first homing
D	BOOT: automatically execute homing procedure	-	

- YX: PATH: path type
  0x0: Stop: homing complete and stop
  0x1 - 0x63: Auto: homing complete and execute the specified path (Path#1 - Path#99)
- Z: ACC: select 0 - F for acceleration time
  0 - F: correspond to P5.020 - P5.035
- U: DEC1: deceleration time selection for first homing
  0 - F: correspond to P5.020 - P5.035
- A: DEC2: deceleration time selection for second homing
  0 - F: correspond to P5.020 - P5.035
- B: DLY: select 0 - F for delay time
  0 - F: correspond to P5.040 - P5.055
- D: BOOT: when the servo is powered on, whether to search for origin
  0: do not execute homing
  1: execute homing automatically (servo switches to on for the first time after power on)

7

The PR Homing mode includes the function for setting the origin offset. You can define any point on the coordinate axis as the reference origin, which does not have to be 0. Once you define the reference origin, the system can create the coordinate system for the motion axis. See Figure 7.1.3.1.1. The coordinate for the reference origin is 2000 (P6.001 = 2000). The motor passes by the reference origin and then stops at coordinate 1477. From the coordinate system that it created, the system automatically calculates the position of 0 point. As soon as the PR motion command is issued, the motor moves to the specified position.

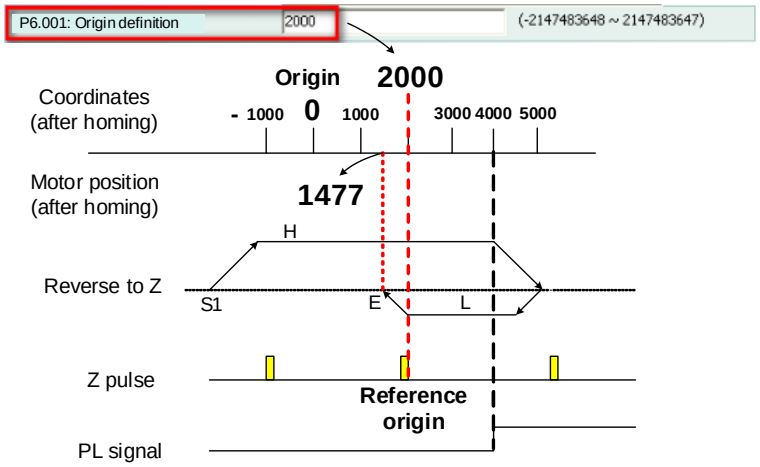


Figure 7.1.3.1.1 Origin definition

P6.001	Origin definition		Address: 0602H 0603H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

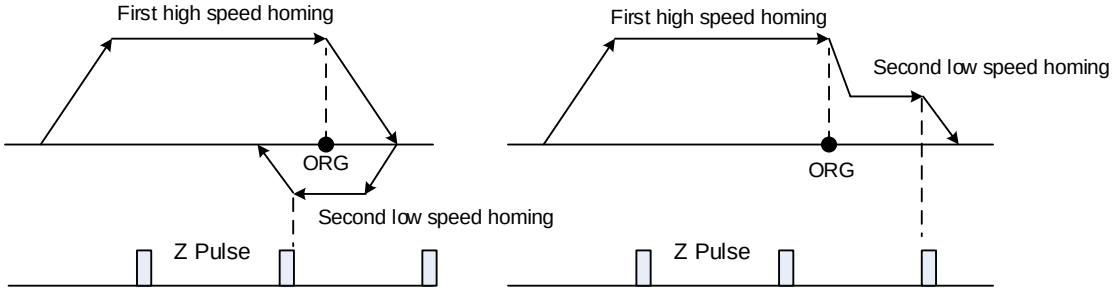
Settings:

Origin definition.

The homing procedure goes through two stages: high speed and low speed. Homing starts in high speed, seeking the reference point (such as the limit switch and ORG signal). Once the servo detects the reference point, the motor runs at low speed to find the reference point accurately (such as the Z pulse). The speeds for the two stages are defined by P5.005 and P5.006.

P5.005	High speed homing (first speed setting)			Address: 050AH 050BH
Operation interface:	Panel / software	Communication	Control mode:	PR (set with P5.004)
Default:	100.0	1000	Data size:	32-bit
Unit:	1 rpm (rotary)* 10^{-6} m/s (linear)*	0.1 rpm (rotary)* 10^{-6} m/s (linear)*		
Setting range:	0.1 - 6000.0 (rotary)* 0.1 - 15999999 (linear)*	1 - 60000 (rotary)* 1 - 15999999 (linear)*		
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings: the first speed setting for high speed homing.



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

P5.006	Low speed homing (second speed setting)			Address: 050CH 050DH
Operation interface:	Panel / software	Communication	Control mode:	PR (set with P5.004)
Default:	20.0	200	Data size:	32-bit
Unit:	1 rpm (rotary)* 10^{-6} m/s (linear)*	0.1 rpm (rotary)* 10^{-6} m/s (linear)*		
Setting range:	0.1 - 6000.0 (rotary)* 0.1 - 15999999 (linear)*	1 - 60000 (rotary)* 1 - 15999999 (linear)*		
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	150 = 1.5 rpm	-	-

Settings: the second speed setting for low speed homing.

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

7

You can set the homing parameters in the PR mode homing screen in ASDA-Soft, including the homing methods, homing definition, and homing speed (see Figure 7.1.3.1.2).

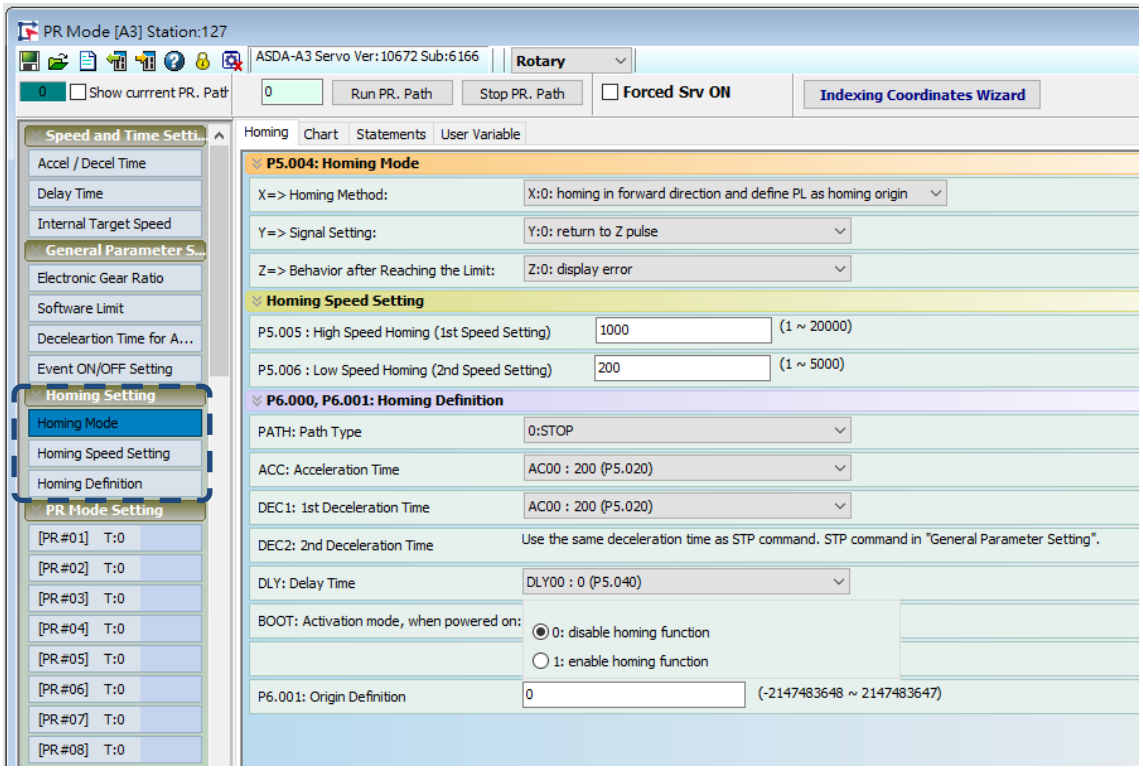
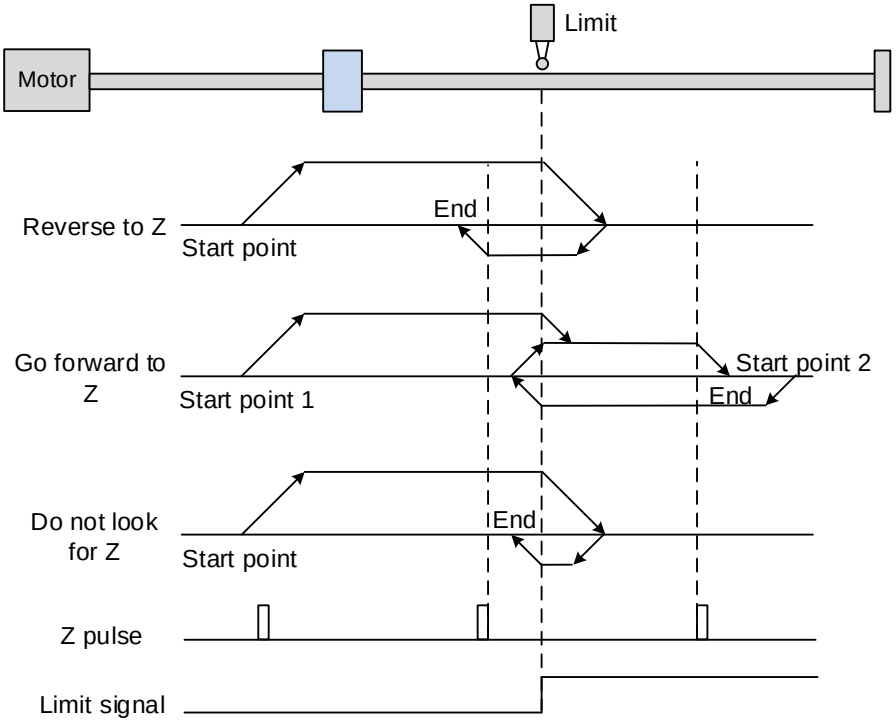


Figure 7.1.3.1.2 Homing screen in ASDA-Soft

The following describes the homing methods supported by the ASDA-A3. They can be categorized into six types based on their reference points.

1. Referencing the limit. This homing method uses the positive or negative limit as the reference point. When the limit is detected, you can choose to look for the Z pulse and use it as the reference origin. Changing the start point does not change the searching result. The ASDA-A3 always looks for the set reference point so as to correctly reset the coordinates.



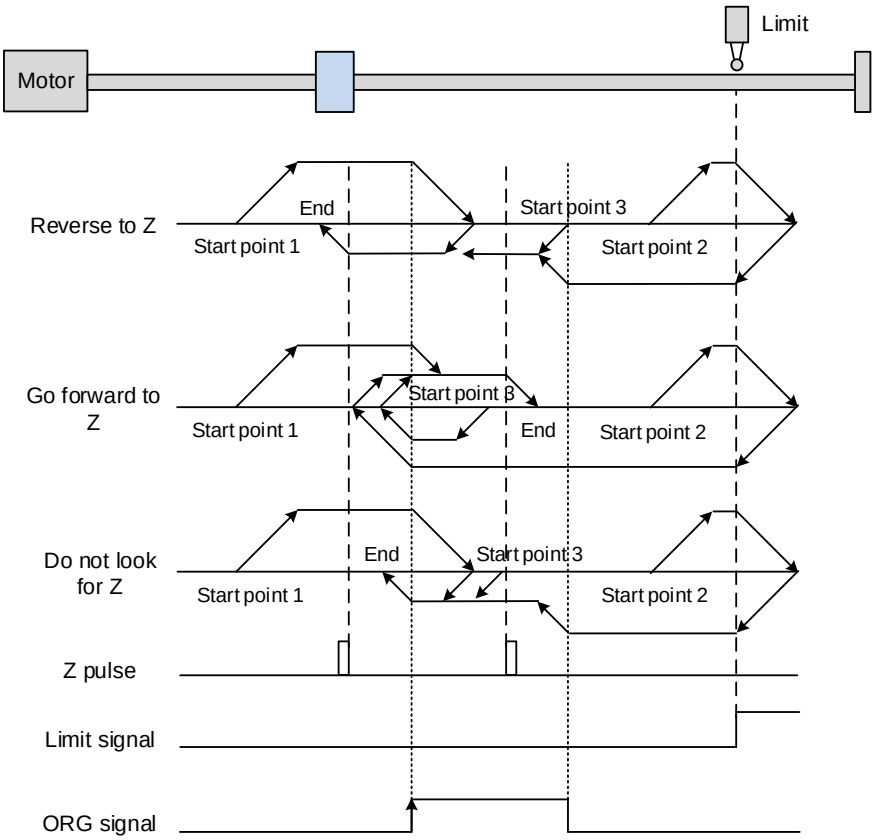
The figure above shows an example of reversing to look for the Z pulse. The servo motor operates at high speed (first speed setting) and then decelerates once it reaches the limit (rising-edge triggers the signal). Then the motor switches to low speed (second speed setting) to look for the Z pulse in the reverse direction. When the motor finds the Z pulse, it decelerates and stops, completing the homing procedure.

If you set the motor to look for the Z pulse in the forward direction and the limit signal remains un-triggered (low, Start point 1), the servo motor operates at high speed (first speed setting) and then decelerates once it reaches the limit (rising-edge triggers the signal). Then the motor switches to low speed (second speed setting) to look for the Z pulse. When the motor finds the Z pulse, it decelerates and stops, completing the homing procedure. If the setting is to look for the Z pulse and the limit signal is triggered (high, Start point 2), the servo motor returns to look for the rising-edge trigger signal at low speed (second speed setting). Once it is found, the servo motor starts to look for the Z pulse and decelerates to stop when it finds the Z pulse, completing the homing. In conclusion, the origin is at the same position after homing with the same condition regardless of the location of the start point.

If you set the motor to not look for the Z pulse, the servo motor first operates at high speed (first speed setting) and then decelerates to a stop once the rising-edge limit signal is triggered. Then the motor switches to low speed (second speed setting) to look for the rising-edge signal. Once it finds the rising-edge signal, the motor decelerates to a stop, completing the homing.

7

2. Referencing the rising-edge of the ORG signal. This method uses the rising-edge signal of the home sensor as the reference origin. You can choose whether or not to use Z pulse as the reference origin after the ORG signal is detected.



The figure above shows an example of reversing to look for the Z pulse. If the home sensor signal for the start position is un-triggered (low, Start point 1), the servo motor operates at high speed (first speed setting) until it reaches the rising-edge of ORG signal. Then it decelerates, switches to low speed (second speed setting) until the home sensor signal turns off, and starts looking for the Z pulse in the reverse direction. When the motor finds the Z pulse, it decelerates to a stop, completing the homing.

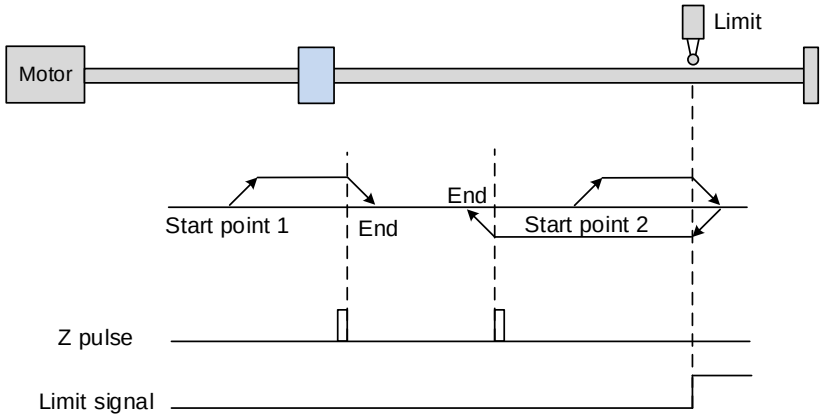
If the ORG signal at the start point is un-triggered and the current position is relatively closer to the limit switch (Start point 2), then the servo motor operates at high speed (first speed setting). You can choose whether to show an error or reverse the running direction when it reaches the limit switch. If you choose to reverse the rotation direction, the servo motor keeps rotating in reverse direction. Once the motor reaches the limit switch, it changes to low speed (second speed setting) and operates until the ORG signal switches

to low. Next, it starts to look for the Z pulse. When the motor finds the Z pulse, it decelerates to a stop, completing the homing.

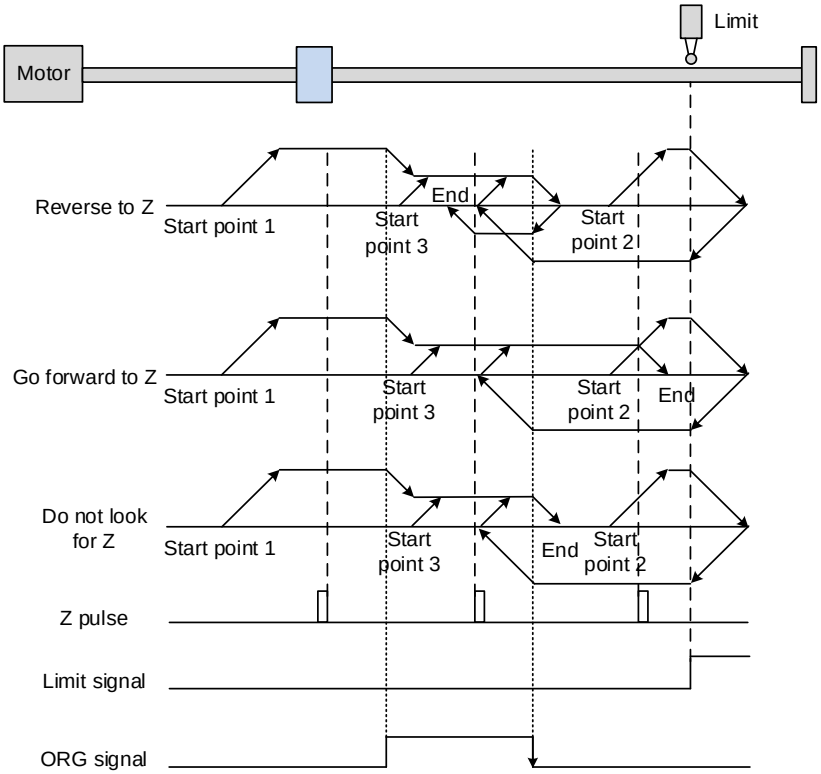
If the ORG signal at the start point is triggered (high, Start point 3), the servo motor reverses with low speed (second speed setting) and after the ORG signal switches to low, the motor returns to look for the Z pulse. Once the Z pulse is found, homing is complete.

If you set the servo motor to look for the Z pulse in the forward direction or not to look for the Z pulse (this is similar to the first method mentioned above), going in the reverse direction or not to look for the pulse Z, refer to the timing diagram above.

3. Referencing the Z pulse. This method uses the Z pulse as the reference origin. One Z pulse is generated per rotation of the motor. This method is only suitable when the operation is kept within one motor rotation.



4. Referencing the falling-edge of the ORG signal. This method uses the falling-edge signal of the home sensor as the reference origin. You can choose whether or not to use Z pulse as the reference origin after the ORG signal is detected.



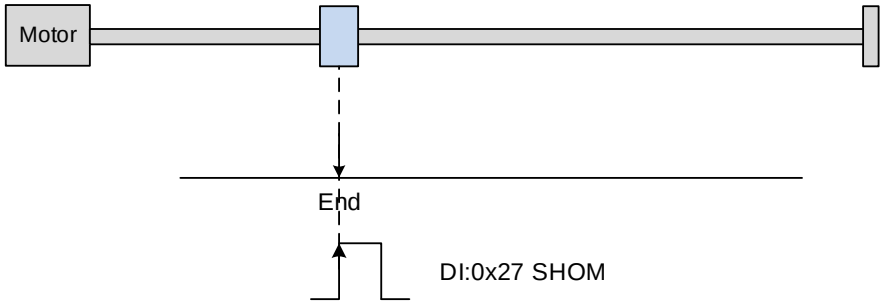
The figure above shows an example of reversing to look for the Z pulse. If the ORG signal is un-triggered at the start point (low, Start point 1), the servo motor runs at high speed (first speed setting) until reaching the rising edge of the ORG signal. Then it decelerates and switches to low speed (second speed setting) until the ORG signal is off (low). Next, it reverses to look for the Z pulse and decelerates to a stop once it finds the Z pulse, completing the homing.

If ORG signal is un-triggered at the start point and is relatively closer to the limit switch (Start point 2), the motor runs at high speed (first speed setting). You can set whether to show an error or reverse the running direction when it reaches the limit switch. If you set it to reverse direction, the motor operates in reverse to reach the ORG signal. Once it reaches the ORG signal, it decelerates and runs at low speed (second speed setting) until it reaches the falling edge of the ORG signal. Next, it reverses to look for the Z pulse and decelerates to a stop once it finds the Z pulse, completing the homing.

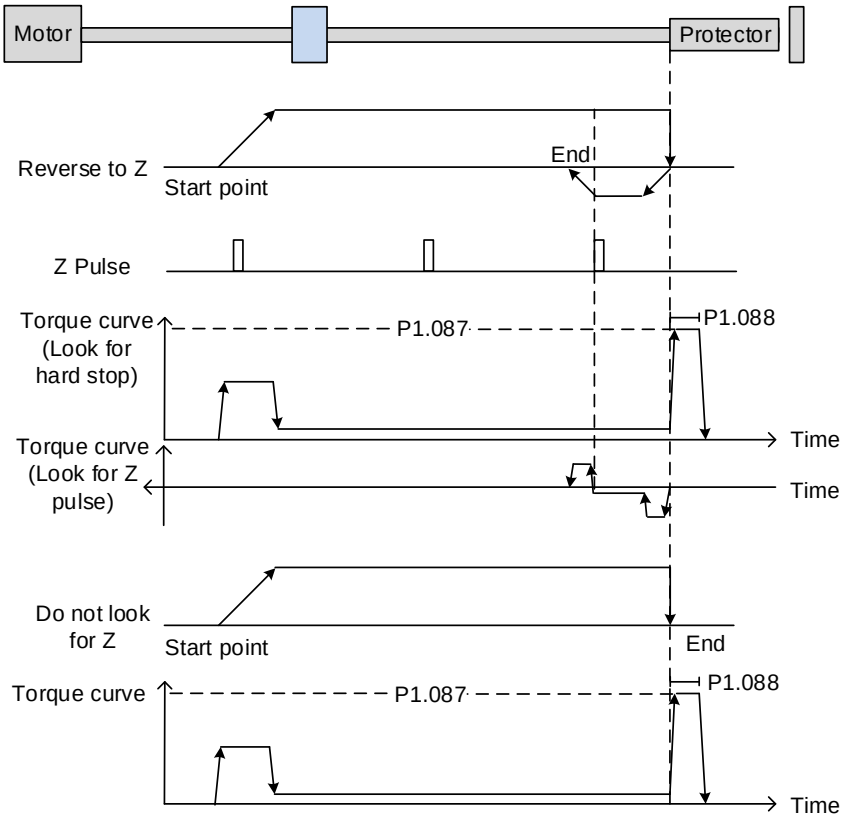
If the ORG signal is triggered at the start point (high, Start point 3), the servo motor operates at low speed (second speed setting) in the forward direction until the ORG signal switches to low. Next, it reverses to look for the Z pulse and decelerates to a stop once it finds the Z pulse, completing the homing.

If you set the servo motor to look for the Z pulse in the forward direction or not to look for the Z pulse (this is similar to the first method mentioned above), going in the reverse direction or not to look for the pulse Z, refer to the timing diagram above.

5. Referencing the current position as the origin. This method uses the motor's current position as the reference origin. As long as the homing procedure is triggered and the motor remains still, then coordinate positioning is complete.



6. Referencing the torque limit. This method uses the motor's stop position as the reference origin by referring to: the limit on the mechanism, the torque level detection (P1.087), and the level reached timer (P1.088). You can also choose whether to use the Z pulse as the reference origin.



The figure above shows an example of reversing to look for the Z pulse. The motor runs at high speed (first speed setting). Then the servo outputs a greater current to counter the

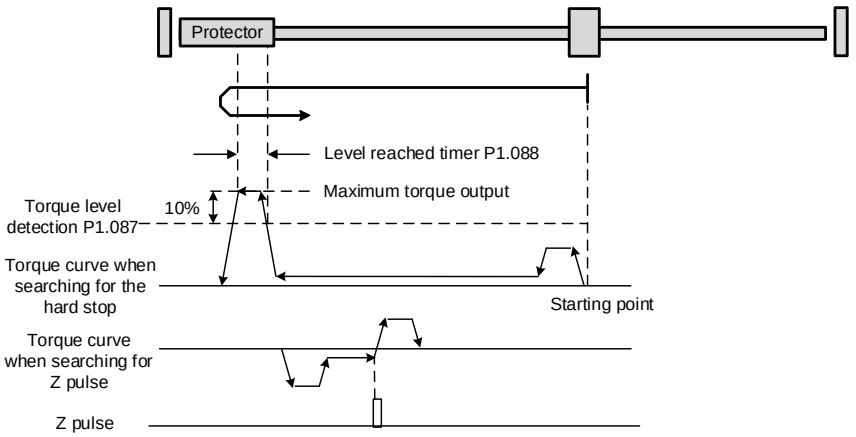
external force once the motor touches the protector. When the motor torque reaches the torque detection level (P1.087) and the output duration is longer than the level reached timer setting (P1.088), the motor runs in the reverse direction to look for the Z pulse at low speed (second speed setting). Once the motor finds the Z pulse, it decelerates to a stop, completing the homing. If you set the servo not to look for the Z pulse, the servo motor runs at high speed (first speed setting) until it touches the protector. Then the servo outputs a greater current to counter the external force. When the motor torque reaches the torque detection level (P1.087) and the output duration is longer than the level reached timer setting (P1.088), the motor stop stops, completing the homing. Pay special attention when executing the Torque homing procedure. The motor's actual maximum torque output is 10% greater than the maximum torque limit setting (P1.087), the great impact may cause damage to the machine.

The settings and descriptions for the torque level detection (P1.087) and level reached timer (P1.088) are as follows.

P1.087	Torque homing - torque level detection		Address: 01AEH 01AFH
Default:	1	Control mode:	PR
Unit:	%	Setting range:	1 - 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 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 check conditions for homing. Since the hard stops are not always the same, it is recommended to return 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%, then the maximum torque output of the motor is 60%.

P1.088	Torque homing - level reached timer		Address: 01B0H 01B1H
Default:	2000	Control mode:	PR
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.

As mentioned in Section 7.1.2, the PR mode provides four monitoring variables for you to monitor the servo commands and feedback status. These are Command position PUU (Cmd_O), PR command end register (Cmd_E), Feedback position PUU (Fb_PUU), and Position error PUU (Err_PUU). Before homing completes, the command end register (Cmd_E) cannot be calculated because the coordinate system can only be created after homing is complete, and the target position remains unknown after the Homing command is issued. This is why the status of each monitoring variables is different during homing. In Homing command's default setting, the contents of Cmd_E and Cmd_O are identical. After the servofinds the reference origin in the coordinate system, it sets the content of Cmd_E to the coordinate of the reference origin. However, once it finds the reference origin, it still requires some distance for motor to decelerate to a stop. Meanwhile, Cmd_O continues to issue commands. If no other PR commands are issued after homing (other than the Position command), the contents of the final command position (Cmd_O) and command end position (Cmd_E) will be different. See Figure 7.1.3.1.3.

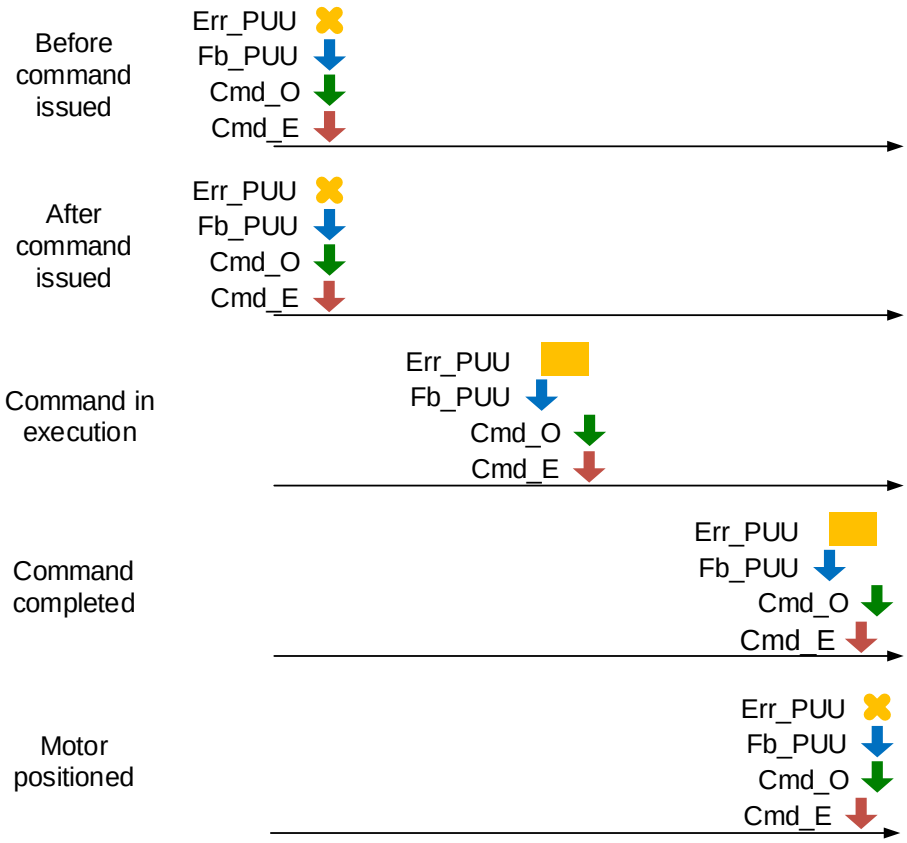


Figure 7.1.3.1.3 Homing mode and monitoring variables

7.1.3.2 Speed command

The PR mode includes a speed control function. The following parameters are available for PR speed setting: acceleration / deceleration time, delay time, and target speed. You can easily set the Speed command in the PR mode screen in ASDA-Soft. See Figure 7.1.3.2.1.

INS is an interrupt command that interrupts the previous motion command. Refer to Section 7.1.6 for more details.

AUTO is a command that automatically loads and executes the next PR path when the current PR path completes. In addition, you can set the target speed with two unit options, which are 0.1 rpm and 1 PPS ranging from -6000 rpm to 6000 rpm. ACC / DEC is the acceleration / deceleration time determined by the shared PR parameters. The software calculates and displays the required duration for accelerating from 0 to the target speed.

DLY is the delay time that is determined by the shared PR parameters. It delays the command; in other words, the delay time is the time to wait after the target speed command completes.

See Figure 7.1.3.2.2 for the effects of the parameters for the PR mode speed control. Table 7.1.3.2.1 shows the bit function when speed control is in operation.

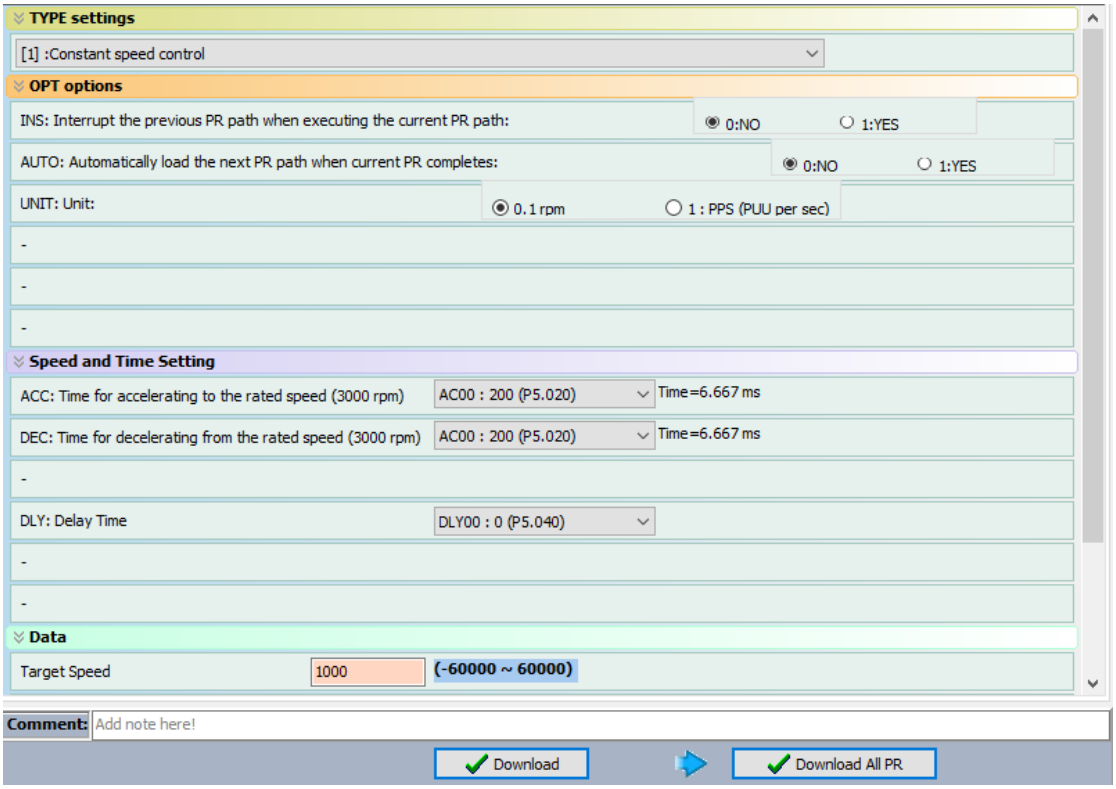


Figure 7.1.3.2.1 PR mode Speed screen in ASDA-Soft

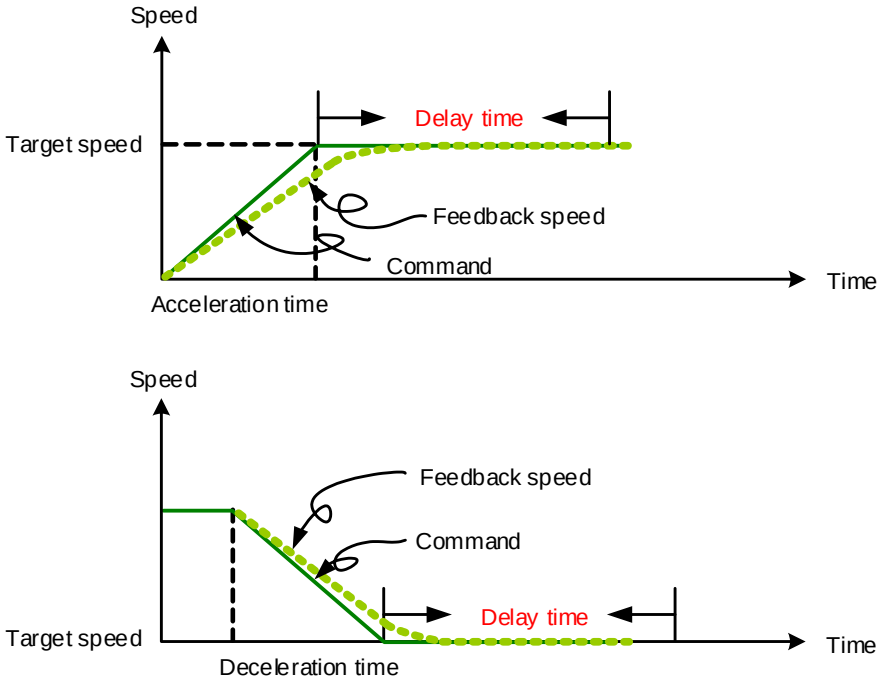


Figure 7.1.3.2.2 Parameters for PR mode speed control

Table 7.1.3.2.1 Bit function of PR speed control

PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	-	DLY	-	DEC	ACC	OPT	1
Data Content	Target speed [0.1 rpm / PPS]							

Note:

1. Y: OPT: option

BIT	3	2	1	0
Command type	-	UNIT	AUTO	INS

INS: interrupt command that interrupts the previous motion command.

AUTO: automatically load the next PR command when the current one is complete.

UNIT: speed unit selection; 0 signifies 0.1 rpm and 1 signifies PPS.

2. Z, U: ACC / DEC: acceleration / deceleration time, set by P5.020 – P5.035.

3. B: DLY: delay time, set by P5.040 – P5.055.

7.1.3.3 Position command

The PR mode includes a position control function. There are two command types: Mode 2 and Mode 3. In Mode 2 the command signifies that it stops once the command is complete. In Mode 3 the command signifies that the next PR path is automatically executed. You use the same method to set the value for these modes in ASDA-Soft. See Figure 7.1.3.3.1. In Figure 7.1.3.3.1, INS is an interrupt command that interrupts the previous motion command. OVLP stands for the overlap command that allows the next PR command to overlap the command that is currently being executed when decelerating. If you use this function, setting the delay time to 0 is suggested (refer to Section 7.1.6). ACC / DEC is the acceleration / deceleration time determined by the shared PR parameters. The software calculates and displays the required duration for accelerating from 0 to the target speed. SPD is the target speed specified by the shared PR parameters. You can choose whether it is multiplied by 0.1. DLY is the delay time specified by the shared PR parameters and it is defined by the command from the controller; in other words, once the target position is reached, the servo drive starts counting the delay time. The Position command is user-defined and its unit is PUU.

See Figure 7.1.3.3.2 for the effects of the parameters for the PR mode position control. Table 7.1.3.3.1 shows the bit function when position control is in operation.

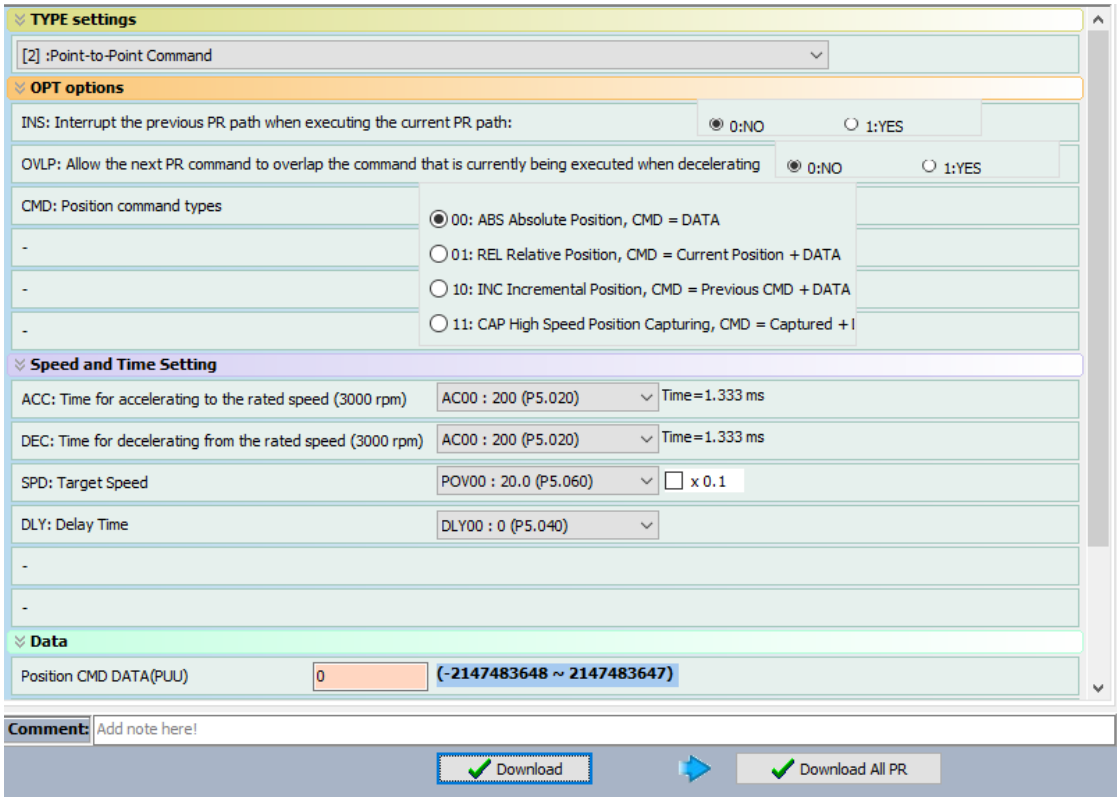


Figure 7.1.3.3.1 PR mode Position control screen in ASDA-Soft

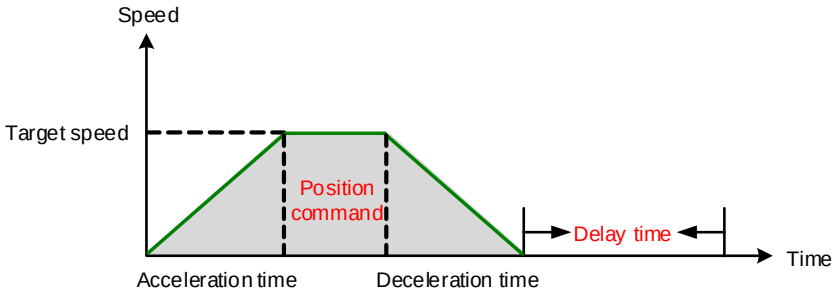


Figure 7.1.3.3.2 Parameters for PR mode position setting

There are four types of position commands for the PR mode. You can choose the position command according to the application requirements. The functions of each type are described in the following examples. Note that the condition in these examples is that a position command is still being executed and another type of command is inserted. To see how the position commands are combined, please see Figure 7.1.3.3.3.

1. Absolute position command (ABS): when executed, the target position value equals the absolute command value. In the following example, an ABS command with the value of 60000 PUU is inserted in the previous PR path with setting target position of 60000 PUU on the coordinate axis.

2. Relative position command (REL): when executed, the target position value is the motor's current position value plus the position command value. In the following example, a REL command with the value of 60000 PUU is inserted in the previous PR path. The target position is the motor's current position (20000 PUU) plus the relative position command (60000 PUU), which equals 80000 PUU on the coordinate axis. The target position specified by the original command is omitted.

3. Incremental command (INC): when executed, the target position is the previous target position value plus the current position command value. In the following example, an INC command with the value of 60000 PUU is inserted in the previous PR path. The target position is the previous target position value (30000 PUU) plus the relative position command (60000 PUU), which equals 90000 PUU on the coordinate axis. The target position specified by the previous command is combined to define the new one.

4. High-speed position capturing command (CAP): when executed, the target position is the last position acquired by the Capture function plus the position command value. Refer to Section 7.2.2 for more on the high-speed position capturing function. In the following example, a high-speed capturing command with the value of 60000 PUU is inserted in the previous PR path. The target position is the captured position value (10000 PUU) plus the relative command (60000 PUU), which equals 70000 PUU on the coordinate axis. The target position specified by the original command is omitted.

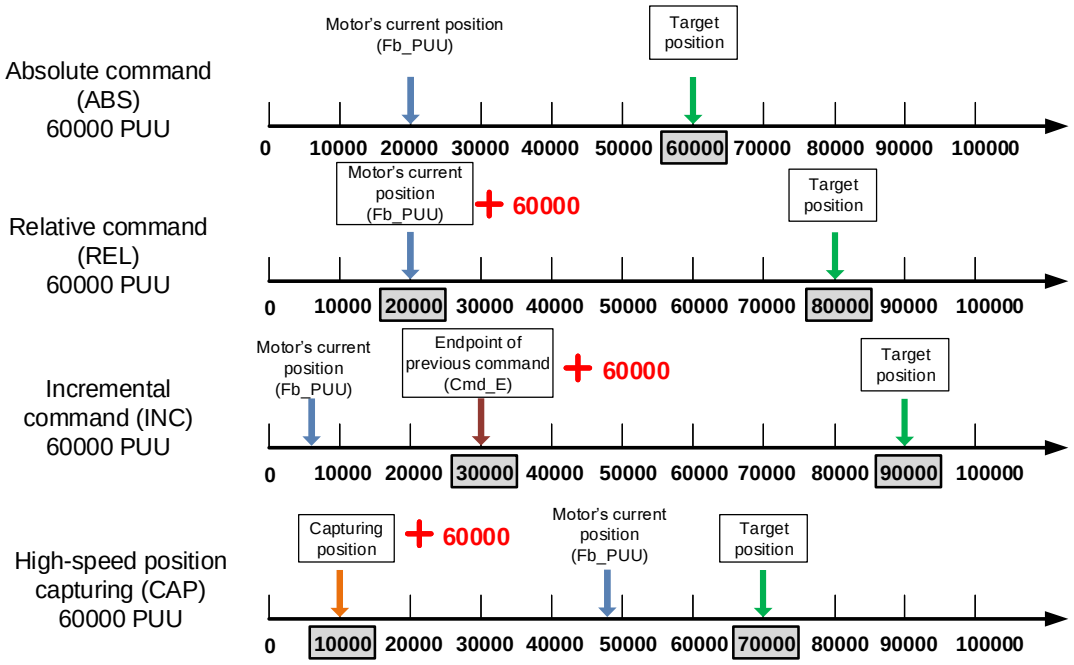


Figure 7.1.3.3.3 Four types of Position command

Table 7.1.3.3.1 Bit functions of PR position control

PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	-	DLY	SPD	DEC	ACC	OPT	2 or 3
Data Content	Target position [PUU]							

Note:

1. Y: OPT: option

BIT	3	2	1	0	Description
Command type	CMD		OVLP	INS	-
Data Content	0	0	-	-	ABS (absolute positioning)
	0	1			REL (relative positioning)
	1	0			INC (incremental positioning)
	1	1			CAP (high-speed position capturing)

INS: interrupt command that interrupts the previous motion command.

OVLP: allow overlapping of the next command

CMD: Position command selection

2. Z, U: ACC / DEC: acceleration / deceleration time set by P5.020 – P5.035.
3. A: SPD: delay time, set by P5.060 – P5.075.
4. B: DLY: delay time, set by P5.040 – P5.055.

7.1.3.4 Jump command

The PR mode includes a Jump command. It can call any PR paths or form PR paths into a loop, as shown in Figure 7.1.3.4.1. You can specify the PR path number to jump to in the PR mode screen in ASDA-Soft (see Figure 7.1.3.4.2). INS is an interrupt command that interrupts the previous motion command. Refer to Section 7.1.6 for more details. DLY is the delay time that is determined by the shared PR parameters. Once a Jump command is issued, the servo drive starts counting the delay time. Available target PR numbers are PR#00 – PR#99. Table 7.1.3.4.1 shows the bit functions when a Jump command is in operation.

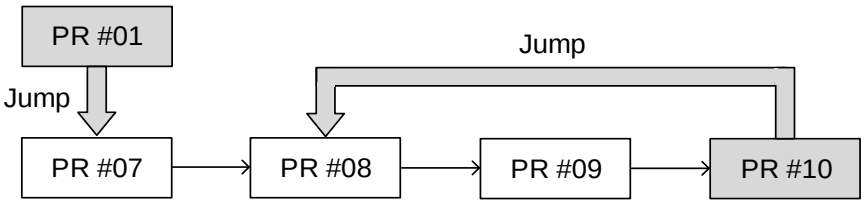


Figure 7.1.3.4.1 Jump command in PR mode

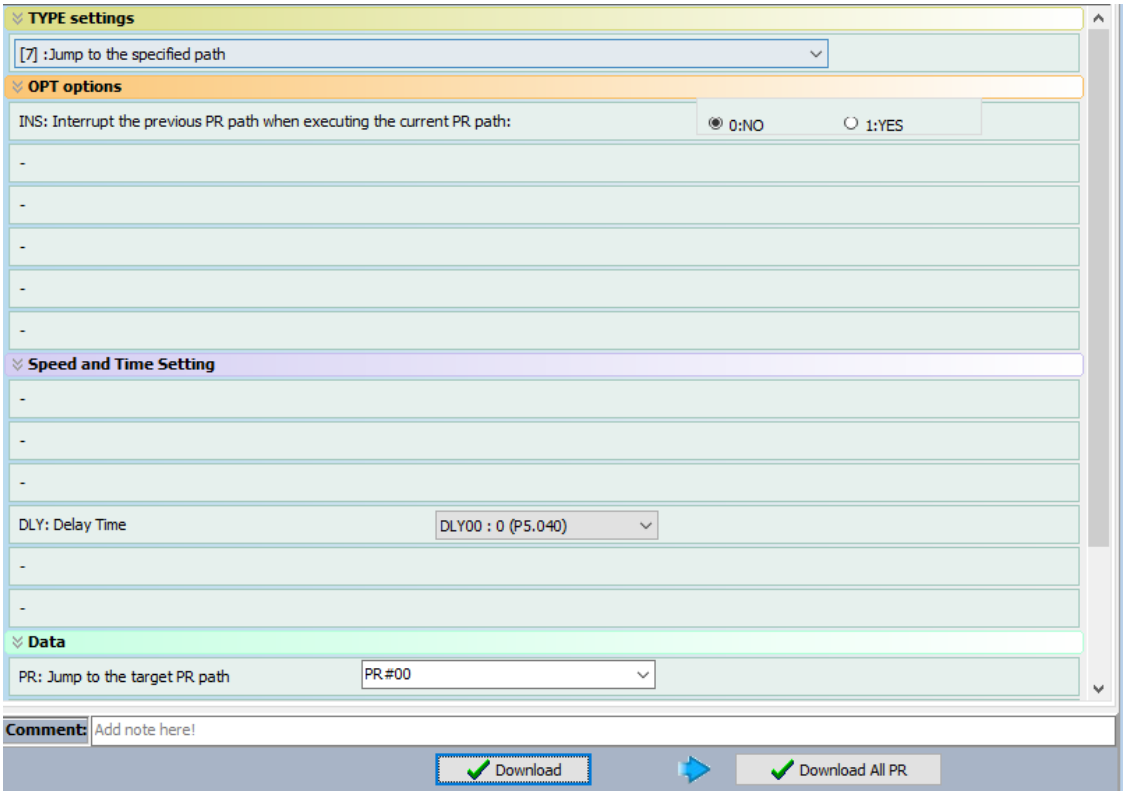


Figure 7.1.3.4.2 PR mode Jump command screen in ASDA-Soft

Table 7.1.3.4.1 Bit function of PR Jump command

PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	-	DLY	-	-	-	OPT	7
Data Content	Jump to target PR path (0 – 99)							

Note:

1. Y: OPT: option

BIT	3	2	1	0
Command type	-	-	-	INS

INS: interrupt command that interrupts the previous motion command.

2. B: DLY: delay time, set by P5.040 – P5.055.

7.1.3.5 Write command

The PR mode includes a Write command. It can write constants, parameters, data arrays, and monitoring variables to the specified parameters or to data arrays. You can write a parameter to a specified path in the PR mode screen in ASDA-Soft (see Figure 7.1.3.5.1). INS is an interrupt command that interrupts the previous motion command. Refer to Section 7.1.6 for more details. AUTO command automatically loads and executes the next PR once the current PR completes. ROM command writes parameters to both RAM and EEPROM at the same time. Writing to non-volatile memory function is also available; however, frequent usage shortens the life of the EEPROM. DLY is the delay time that is determined by the shared PR parameters. Once a Jump command is issued, the servo drive starts counting the delay time. Table 7.1.3.5.1 shows the bit function when a Write command is in operation.

Writing Target	Data source
Parameter	Constant
Data array	Parameter
-	Data array
-	Monitoring variables

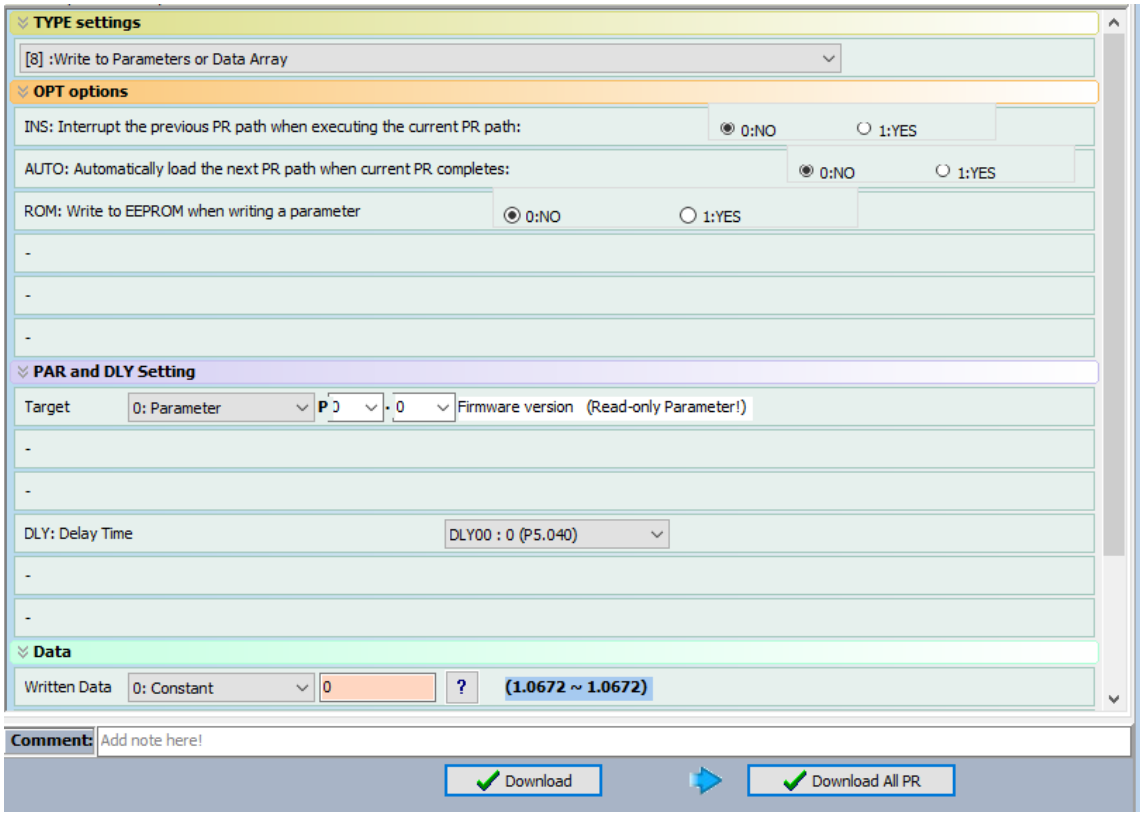


Figure 7.1.3.5.1 PR mode Write command screen in ASDA-Soft

Table 7.1.3.5.1 Bit function of PR Write command

PR parameters	D	C	B	A	U	Z	Y	X
Command type	0	SOUR_DEST	DLY	DESTINATION			OPT	8
Data Content	SOURCE							

Note:

1. Y: OPT: option

BIT	3	2	1	0
Command type	-	ROM	AUTO	INS

INS: interrupt command that interrupts the previous motion command.

AUTO: once the current PR is completed, automatically load the next command.

ROM: write data to RAM and EEPROM at the same time. This function can only write parameters.

2. B: DLY: delay time, set by P5.040 – P5.055.

3. C: SOUR_DEST: data source and data format to be written.

BIT	3	2	1	0	Description	
Command type	SOUR		-	DEST	Data source	Writing target
Data Content	0	0	0	0	Constant	Parameter
	0	1		0	Parameter	Parameter
	1	0		0	Data array	Parameter
	1	1		0	Monitoring variable	Parameter
	0	0		1	Constant	Data array
	0	1		1	Parameter	Data array
	1	0		1	Data array	Data array
	1	1		1	Monitoring variable	Data array

4. Z, U, A: DESTINATION: destination

	A	U	Z
Target: Parameter	Parameter group	Parameter Number	
Target: Data array	Data array number		

5. SOURCE: Data source setting

	D	C	B	A	U	Z	Y	X
Data source: Constant	Constant data							
Data source: Parameter	-					Parameter group	Parameter Number	
Data source: Data array	-					Data array number		
Data source: Monitoring variable	-						Monitoring variable number	

7.1.3.6 Index Position command

The PR mode includes an Index Position command, which creates an indexing coordinate system. This command positions the motor within the indexing coordinates. Unlike other feedback positions in global coordinate system, the Index Position command is able to divide the total moving distance of one index into the number of paths required by the application (see Figure 7.1.3.6.1). When using the Index Position command for motor operation, if the motor position exceeds the range, absolute position or position counter overflow occurs. Refer to the setting in Chapter 10. You can start the index positioning in the Index Coordinates Setting Wizard in the PR screen in ASDA-Soft (see Figure 7.1.3.6.2). As shown in the example, the start PR path is set to 1, the path number is set to 8, and the total moving distance is 80000 PUU. When you click **OK**, the software automatically writes position command 0 PUU to PR#01, 10000 PUU to PR#02, 20000 PUU to PR#03, and so on up to PR#08. When the index position reaches 80000 PUU, it automatically returns to 0 PUU. In addition, you can modify the index position in each PR path as needed, as shown in Figure 7.1.3.6.3. INS stands for the interrupt command that interrupts the previous motion command (see Section 7.1.6.). OVLP stands for the overlap command that allows the next PR command to overlap the command that is currently being executed when decelerating. If you use this function, setting the delay time to 0 is suggested (refer to Section 7.1.6.). DIR sets the rotation direction with options of forward rotation (always runs forward), reverse rotation (always runs backward), and the shortest distance. The movement is illustrated in Figure 7.1.3.6.4. S_LOW is the speed unit with options of 0.1 r/min or 0.01 r/min. AUTO is a command that automatically loads and executes the next PR path when the current PR completes. ACC / DEC is the acceleration / deceleration time determined by the shared PR parameters. SPD is the target speed specified by the shared PR parameters. DLY is the delay time that is determined by the command from controller; meaning that when motor reaches the target position, the servo drive starts counting the delay time. Position command is the target position of each index segment. Note that the setting range must be smaller than the total index moving distance (P2.052). Table 7.1.3.6.1 shows the bit function when an Index Position command is in operation. If you use the index function, execute homing first in order to create the coordinate system so that the origin of the motor's feedback position and that of the motor's index position can be identical. If you do not execute homing, AL237 occurs.

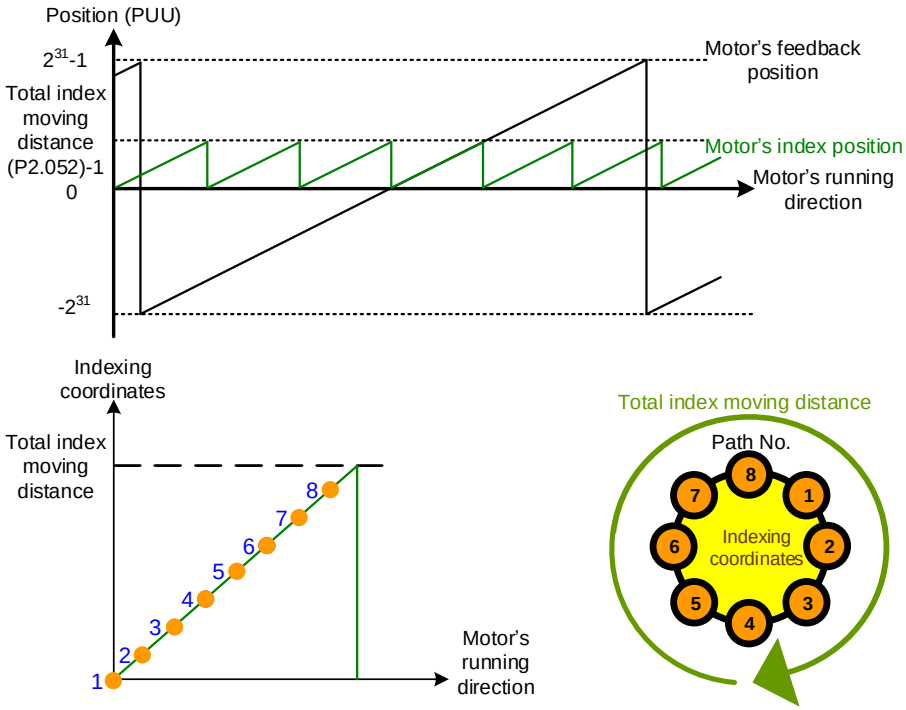


Figure 7.1.3.6.1 PR mode indexing coordinates

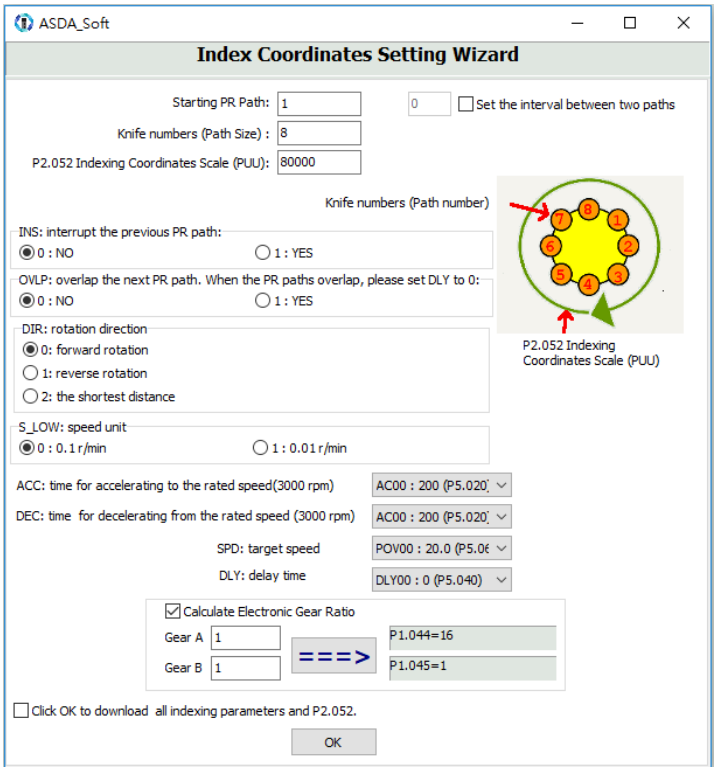


Figure 7.1.3.6.2 Index Coordinates Setting Wizard in PR mode

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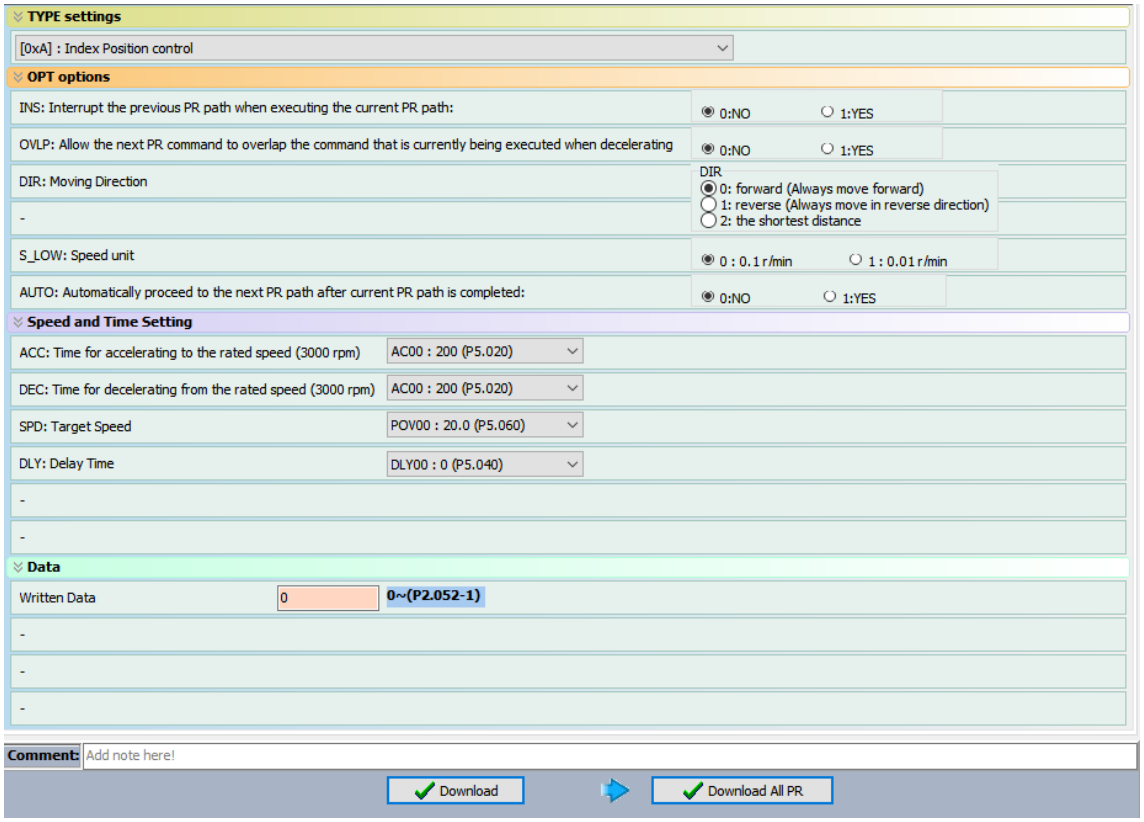

Figure 7.1.3.6.3 PR mode Index Position screen in ASDA-Soft

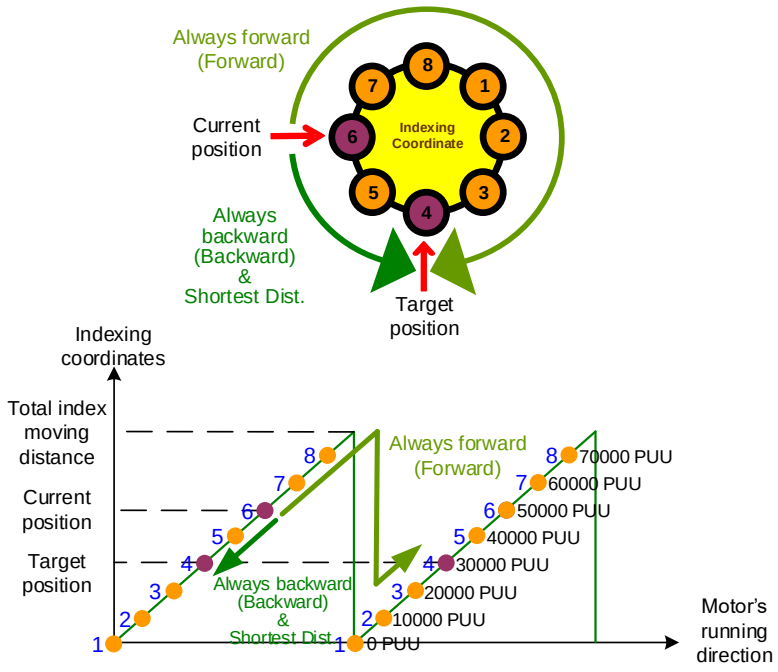

Figure 7.1.3.6.4 Motor's operation direction and indexing coordinates

Table 7.1.3.6.1 Bit function of PR Index Position command

BIT / PR parameters	D	C	B	A	U	Z	Y	X
Command type	-	OPT2	DLY	SPD	DEC	ACC	OPT	0xA
Data Content	Index Position command [PUU](0 – P2.052-1)							

Note:

1. Y: OPT: option

BIT	3	2	1	0	Description
Command type	DIR		OVLP	INS	-
Data Content	0	0	-	-	Always goes forward (Forward)
	0	1			Always goes backward (Backward)
	1	0			Shortest distance
	1	1			-

INS: interrupt command that interrupts the previous motion command.

OVLP: allow overlapping of the next command

2. C: OPT2: Option 2

BIT	3	2	1	0
Command type	-	AUTO	-	S_LOW

S_LOW: speed unit options, 0 stands for 0.1 r/min and 1 for 0.01 r/min.

AUTO: automatically load the next PR command when the current one is complete.

3. Z, U: ACC / DEC: acceleration / deceleration time set by P5.020 – P5.035.
4. A: SPD: delay time, set by P5.060 – P5.075.
5. B: DLY: delay time, set by P5.040 – P5.055.

7.1.3.7 Arithmetic operation (Statement)

The PR mode has arithmetic operations commands, including addition, subtraction, multiplication, division, AND, OR, MOD, and logic conditions. The available operands are user variables, parameters, data arrays, monitoring variables, and constants. Among them, the user variable is the register only for arithmetic operations. There are 64 sets of user variables, with a data size of 32 bits. The data size of a constant is also 32-bits. After all arithmetic operation commands are executed, you can set a jump condition in the path so that execution jumps to different PR path and then continues or stops once the operation is done. You can also use it as a loop function. The arithmetic operation commands support negative integer operations but not floating point operations. Negative integer operations are calculated by “two’s complement”. Figure 7.1.3.7.1 is the Arithmetic Operations screen in ASDA-Soft. Arithmetic operations must be created in ASDA-Soft. To avoid errors, do not use the servo panel or RS-485 for arithmetic operations. Once you complete the arithmetic operation, click **Download All PR** to write all PR paths to the servo drive.

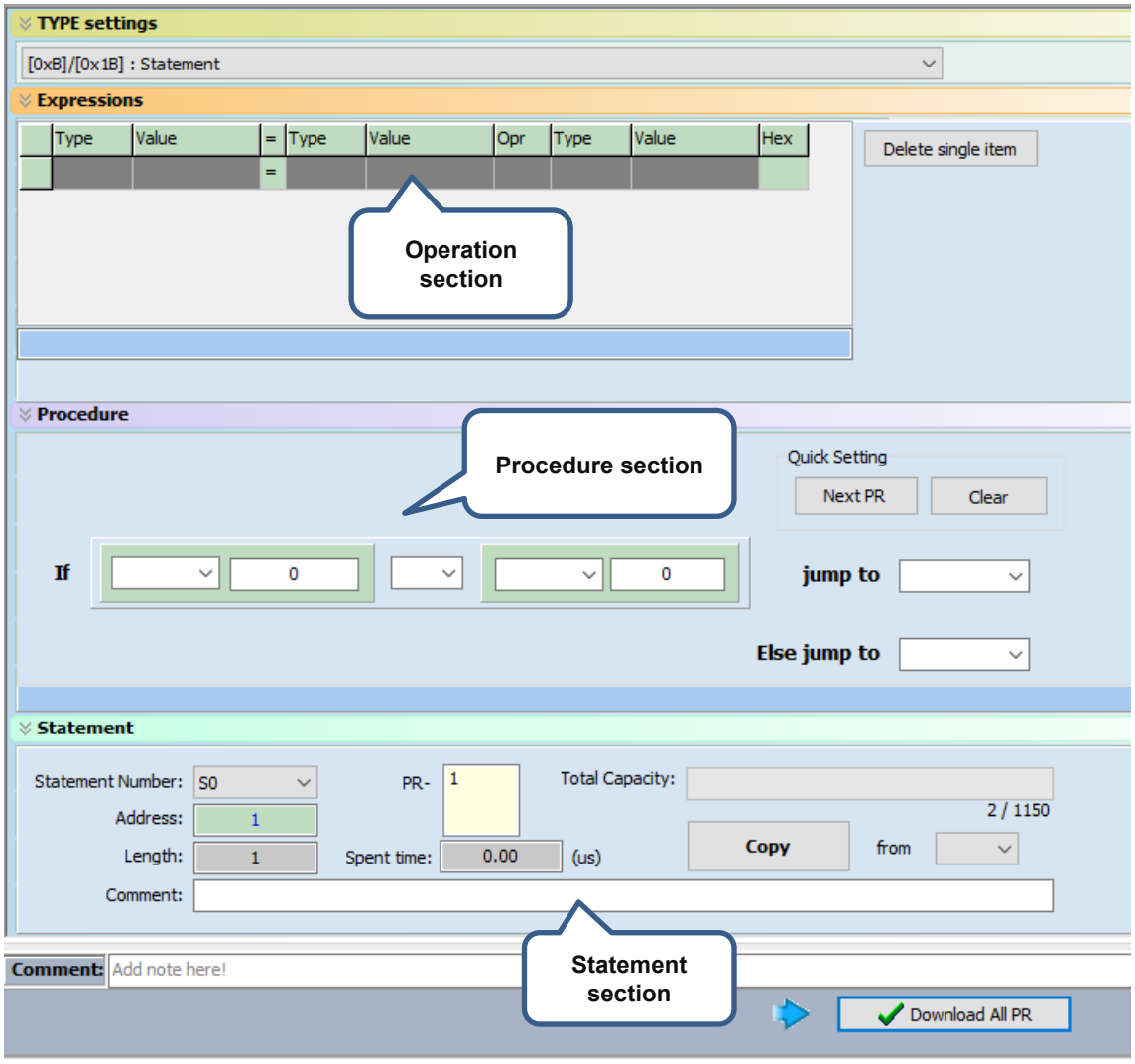

Figure 7.1.3.7.1 PR mode Arithmetic Operations screen in ASDA-Soft

1. Operation section: supports addition, subtraction, multiplication, division, AND, OR, and MOD operation as well as logical operations for multiple data. Table 7.1.3.7.1 shows the supported operators and calculation data with data format in DEC and HEX.

Table 7.1.3.7.1 Description of each field in the Operation section

Data to be written	=	Calculation data	Operator	Calculation data
User variable (User[0-63])		User variable (User[0-63])	Addition (+) Deduction (-) Multiplication (*) Division (/) Obtain remainder (%) And (&) Or (|)	User variable (User[0-63])
		Constant (Constant)		
Parameter (PX.XXX)		Data array (Arr[0-799])		Constant (Constant)
Data array (Arr[0-799])		Parameter (PX.XXX)		Data array (Arr[0-799])
		Monitoring variable (Mon[*])		

2. Procedure section: uses the IF statement to determine whether the user-defined condition is fulfilled. If true, jump to the next specified PR path; if false, jump to the other specified PR path. If you click **Next PR** in Quick Setting, the software automatically inputs the condition and then jumps to the next PR path. If you leave this section blank, then the PR procedure stops once the basic operation is done. Table 7.1.3.7.2 shows the supported data formats and operators.

Table 7.1.3.7.2 Field description for the Procedure setting section

Data format	Operator	Data format
User variable (User[0-63])	Greater than (>) Greater than or equal to (>=) Less than (<) Less than or equal to (<=) Equal to (==) Not equal to (!=)	User variable (User[0-63])
Constant (Constant)		
Data array (Arr[0-799])		Constant (Constant)
Parameter (PX.XXX)		Data array (Arr[0-799])
Monitoring variable (Mon[*])		

3. Statement section: this section includes statements and memory capacity. Statements save the data from the expression and procedure sections. Data in the expression and procedure sections of the same statement always remain identical and can be shared by multiple PR paths. If data in those two sections are different, then the data is saved to another statement. The time required to execute the statement is shown in the Spend Time field. Total Capacity shows the servo drive's memory capacity; basic operations cannot be performed if there is no memory space available. The Statements tab is shown in Figure 7.1.3.7.2. The upper section displays all the statements and the lower section displays the operations in each statement and the values.

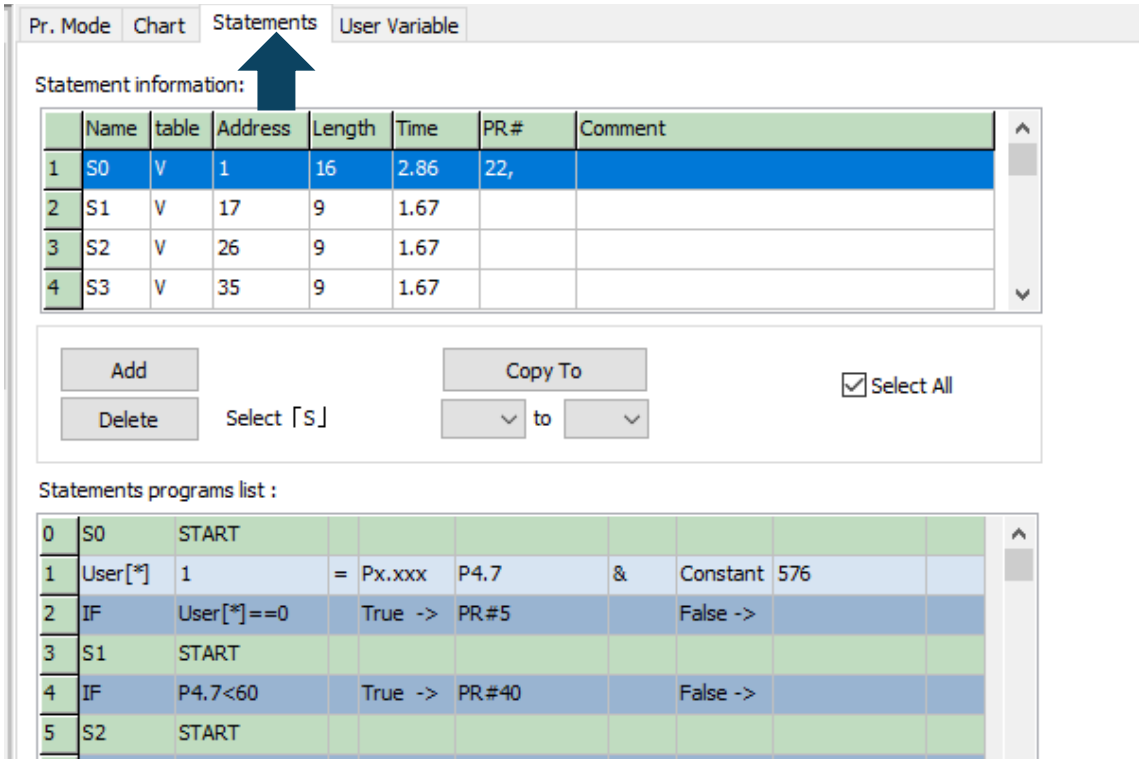

Figure 7.1.3.7.2 Statements tab in ASDA-Soft

7.1.4 Overview of the PR procedure

In the PR mode, there are seven types of commands. To understand how the PR procedure works, ASDA-Soft presents the execution order and calling sequence of all PR procedures. First, symbols and contents in the PR figure are shown. This includes five parts: number, command execution type (property), command type, next procedure command, and command information. See Figure 7.1.4.1.

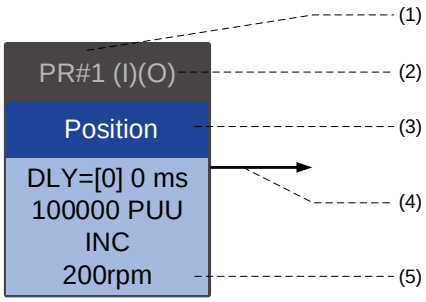

Figure 7.1.4.1 PR display

(1) Number: the PR number, ranging from PR#0 to PR#99 (100 sets of PR paths).

(2) Command execution type (property): (B) execute homing when power on; (O) command overlap; (R) write data to EEPROM; (I) command interrupt.

(3) Command type: there are seven types of PR path commands: homing, speed, position, writing, jumping, index positioning, and arithmetic operations. The color displayed in this section depends on the command type.

(4) Next procedure command: if followed by a PR command, the arrow points to the specified PR path.

(5) Command information: displays the details of this PR path. The displayed contents and color depend on the information type.

The following sections illustrate each command type and its representation.

Homing methods

In the display of homing methods, PR#0 always signifies the homing procedure, which is marked as “Homing”. See Figure 7.1.4.2.

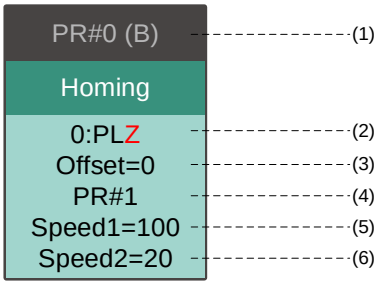

Figure 7.1.4.2 Homing methods display

(1) Activation mode (Boot): to execute homing when the drive is in Servo On state, it displays (B); if homing is not required, then no information is displayed.

(2) Method selection: homing methods and Z pulse setting are shown in the following table. Characters in red indicate the motor's position after homing; F signifies running forward; R signifies running in reverse; ORG signifies origin; CUR signifies current position; BUMP signifies the hard stop.

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Homing method	Y = 0: reverse to look for Z pulse Y = 1: go forward to look for Z pulse	Y = 2: do not look for Z pulse
X = 0: homing in forward direction with PL as the homing origin	0: PLZ	0: PL
X = 1: homing in reverse direction with NL as the homing origin	1: NLZ	1: NL
X = 2: homing in forward direction with ORG (when it switches from off to on state) as the homing origin	2: F_ORGZ	2: F_ORG
X = 3: homing in reverse direction with ORG (when it switches from off to on state) as the homing origin	3: R_ORGZ	3: R_ORG
X = 4: look for the Z pulse in forward direction with it as the homing origin	4: F_Z	
X = 5: look for the Z pulse in reverse direction with it as the homing origin	5: R_Z	
X = 6: homing in forward direction with ORG (when it switches from on to off state) as the homing origin	6: F_ORGZ	6: F_ORG
X = 7: homing in reverse direction with ORG (when it switches from on to off state) as the homing origin	7: R_ORGZ	7: R_ORG
X = 8: use the current point as the origin	8: CUR	
X = 9: Torque homing in forward direction	9: F_BUMPZ	9: F_BUMP
X = A: Torque homing in reverse direction	A: R_BUMPZ	A: R_BUMP

(3) Offset: origin offset, P6.001.

(4) Path: next PR path to be executed after homing.

(5) Homing at high speed: first homing speed, P5.005.

(6) Homing at low speed: second homing speed, P5.006.

Speed command

You can use the Speed command in any PR paths (PR#1 – PR#99). It is marked as “Speed”. See Figure 7.1.4.3.

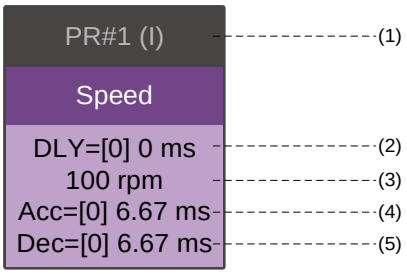

Figure 7.1.4.3 Speed command display

(1) Command execution type (property): a Speed command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.

(2) Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller; the servo drive starts counting the delay time once it reaches the target speed.

(3) Target speed: the set target speed.

(4) Acceleration time (ACC): determined by shared PR parameters; length of time to reach the target speed from stopped.

(5) Deceleration time (DEC): determined by shared PR parameters; length of time to decelerate from target speed to stopped.

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Position command

You can use the Position command in any PR paths (PR#1 – PR#99). It is marked as “Position”, and includes the options to “Stop once position control completed” and “Load the next path once position control completed”. The only difference is that “Load the next path once position control completed” shows an arrow pointing to the next PR. See Figure 7.1.4.4.

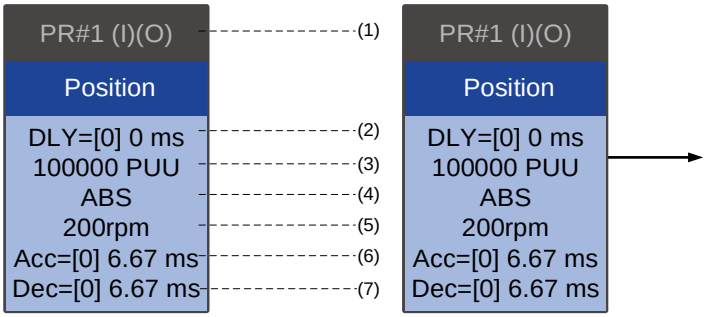

Figure 7.1.4.4 Position command display

(1) Command execution type (property): a Position command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. The Position command can overlap (OVLP) the next PR path. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.

(2) Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.

(3) Target position: the set target position.

(4) Position command type: “ABS” means absolute positioning; “REL” means relative positioning; “INC” means incremental positioning; “CAP” means high-speed position capturing.

(5) Target speed: determined by shared PR parameters.

(6) Acceleration time (ACC): determined by shared PR parameters; length of time to reach the target speed from stopped.

(7) Deceleration time (DEC): determined by shared PR parameters; length of time to decelerate from target speed to stopped.

Jump command

You can use the Jump command in any PR paths (PR#1 – PR#99). It is marked as “Jump” and followed by an arrow pointing to the next PR path. See Figure 7.1.4.5.

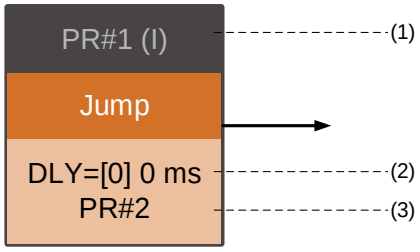

Figure 7.1.4.5 Jump command display

(1) Command execution type (property): a Jump command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.

(2) Delay time (DLY): determined by shared PR parameters.

(3) Target PR number: the set target PR number.

Write command

You can use the Write command in any PR paths (PR#1 – PR#99). It is marked as “Write”. See Figure 7.1.4.6.

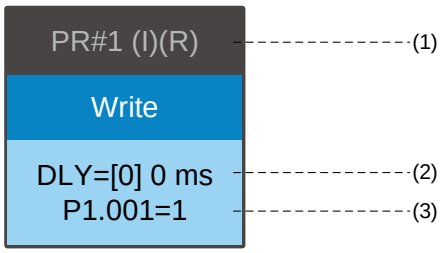

Figure 7.1.4.6 Write command display

(1) Command execution type (property): a Write command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. You can determine whether to write the data to EEPROM. If writing data to EEPROM is required, it shows (R); if not, no information is displayed.

(2) Delay time (DLY): determined by shared PR parameters.

(3) Writing target and data source: the corresponding target and data sources are shown in the following table. Note that constants can be written in DEC or HEX format.

Writing target	Data source
Parameter(PX-XXX)	Constant
Data array (Arr[#])	Parameter (PX-XXX)
-	Data array (Arr[#])
-	Monitoring variable (Mon[#])

7

Indexing position command

You can use the Indexing Position command in any PR paths (PR#1 – PR#99). The number of PR paths is determined by the index number. It is marked as “Index Position”. See Figure 7.1.4.7.

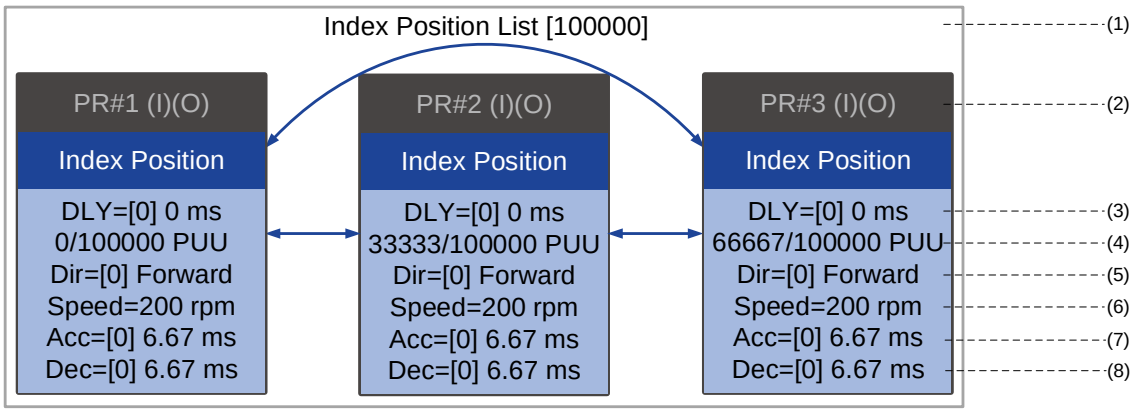

Figure 7.1.4.7 Indexing Position command display

(1) Indexing Position command section: the number of the index position. It shows the total moving distance at the top using double arrows to show that the motor can run reciprocally between each target position in each PR path.

(2) Command execution type (property): a Position command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. The Position command can overlap (OVLP) the next PR path. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.

(3) Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.

(4) Position command: the numerator is the position of this PR path; the denominator is the total moving distance of this indexing Position command, which is set by P2.052.

(5) Rotation direction (Dir): available options are “Rotation forward (Forward)”, “Rotation in reverse (Reverse)”, and “Rotation with the shortest distance (Shortest)”.

(6) Target speed: determined by shared PR parameters.

(7) Acceleration time (ACC): determined by shared PR parameters; length of time to reach the target speed from stopped.

(8) Deceleration time (DEC): determined by shared PR parameters; length of time to decelerate from target speed to stopped.

Arithmetic operation

You can use arithmetic operations and statements in any PR paths (PR#1 – PR#99). It is marked as “Statement”. When the condition is fulfilled, an arrow pointing to the next PR path appears with a solid line; if the condition is unfulfilled, an arrow pointing to the next PR appears with a dotted line; or you can choose to execute the next PR path and stop it once the execution is complete. See Figure 7.1.4.8.

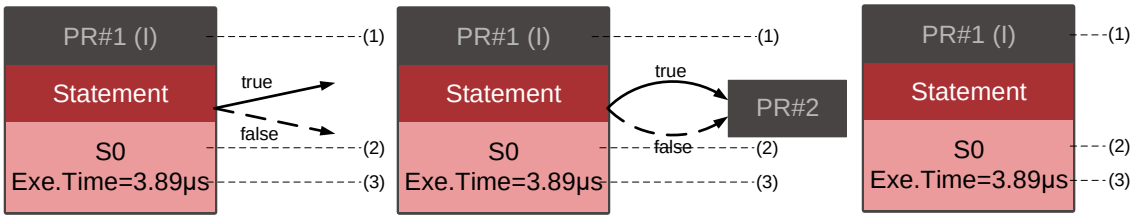

Figure 7.1.4.8 Arithmetic operation display

(1) Command execution type (property): an arithmetic operation command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.

(2) Statement number: displays the statement number used in the PR path.

(3) Execution time (Exe. Time): the time required to execute the arithmetic operation.

7.1.5 Trigger methods for the PR command

There are six types of PR trigger methods. They are DI-triggered, Event-triggered, P5.007-triggered, Capture-triggered (high-speed position capturing), Compare-triggered (high-speed position comparing), and E-Cam-triggered. You can choose the most suitable trigger method according to the applications and requirements.

7

Digital input (DI) triggering

You can choose the PR path to be executed by using the internal registers (Position command Bit0 – Bit6) and use a command to trigger the selected PR path. Before using DI-triggering commands, you must define the 8 sets of DI functions, which are [0x11]POS0, [0x12]POS1, [0x13]POS2, [0x1A]POS3, [0x1B]POS4, [0x1C]POS5, [0x1E]POS6, and [0x08]CTRG (refer to Table 8.1). You can also set this in the I/O screen in ASDA-Soft, as shown in Figure 7.1.5.1.

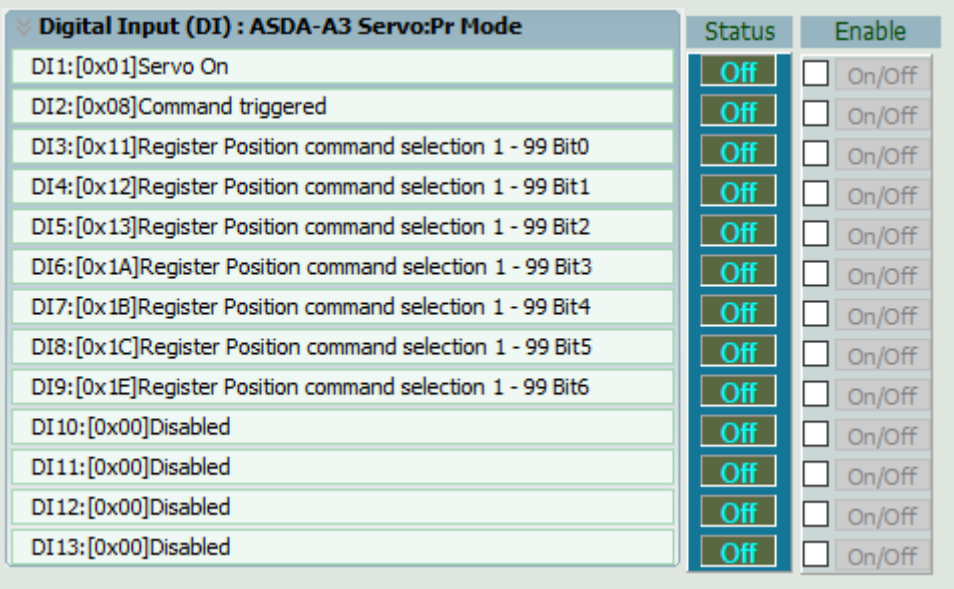

Figure 7.1.5.1 I/O screen in ASDA-Soft

Select the PR number to be executed based on the on / off status of DI.POS0 – 6 and use DI.CTRG to trigger the specified PR path. See Figure 7.1.5.1 for an example.

Table 7.1.5.1 Use DI to select the PR path to be triggered

Position command	POS 6	POS 5	POS 4	POS 3	POS 2	POS 1	POS 0	CTRG	Corresponding Parameter
Homing	0	0	0	0	0	0	0	↑	P6.000
									P6.001
PR#1	0	0	0	0	0	0	1	↑	P6.002
									P6.003
…									…
PR#50	0	1	1	0	0	1	0	↑	P6.098
									P6.099
PR#51	0	1	1	0	0	1	1	↑	P7.000
									P7.001
…									…
PR#99	1	1	0	0	0	1	1	↑	P7.098
									P7.099

In addition, there are two sets of DI for special functions: [0x27] Enable homing and [0x46] Motor stops. If the former is triggered, the servo drive executes homing based on the homing setting. If the latter is triggered, the servo drive stops the motor. You can use the I/O screen in ASDA-Soft to set these functions, as shown in Figure 7.1.5.2.

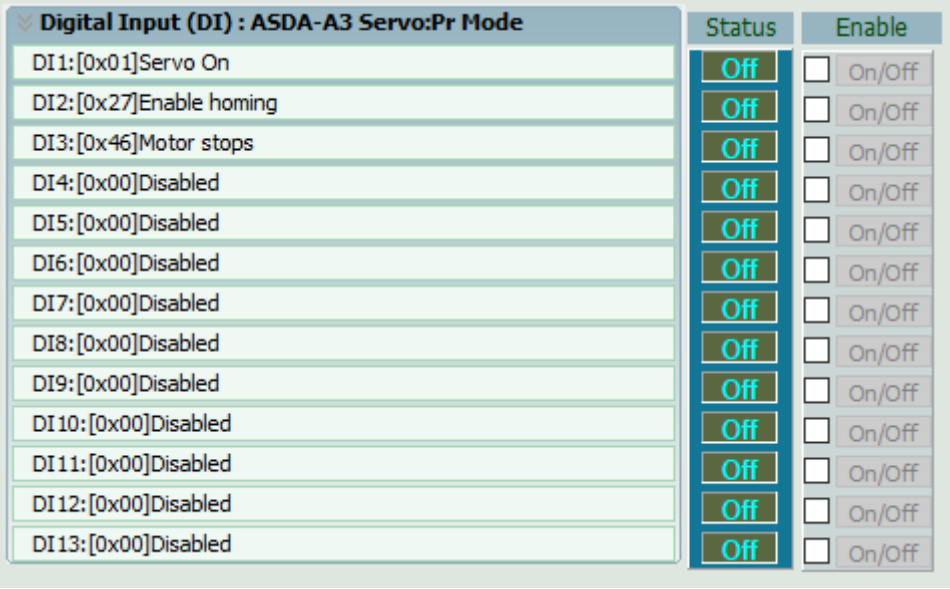

Figure 7.1.5.2 I/O screen in ASDA-Soft

7

Event triggering

You can use Event-triggered commands 1 – 4 to execute the specified PR path. You can select two types of Event triggering: rising-edge trigger and falling-edge trigger. The range of PR path numbers that you can specify is from 51 – 63 (see the example in Figure 7.1.5.3). Before using the Event-trigger for PR command, you must define the DI functions, which are [0x39] Event trigger command 1, [0x3A] Event trigger command 2, [0x3B] Event trigger command 3, and [0x3C] Event trigger command 4 (see Table 8.1). You can use the I/O screen in ASDA-Soft to set these functions. as shown in Figure 7.1.5.4.

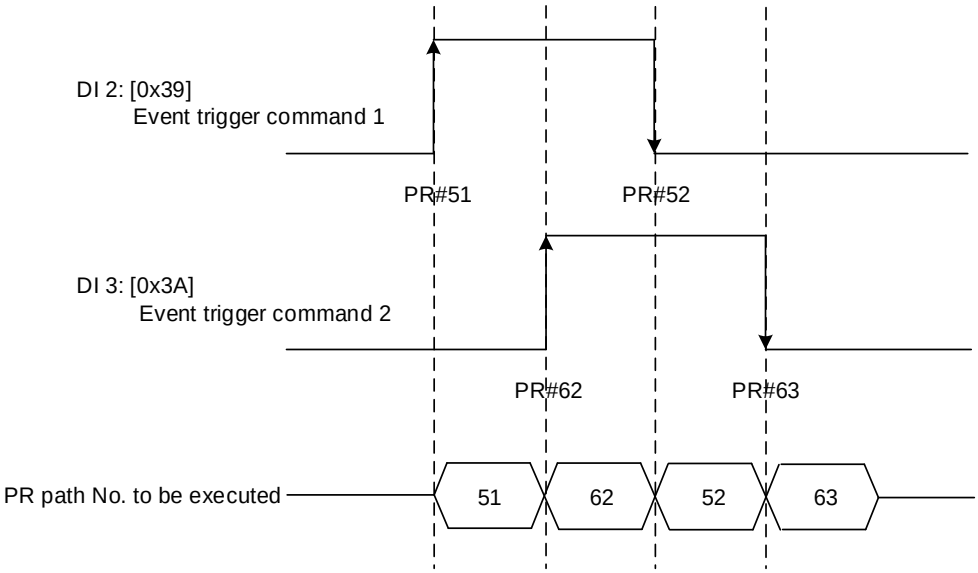

Figure 7.1.5.3 Example of Event triggering timing diagram

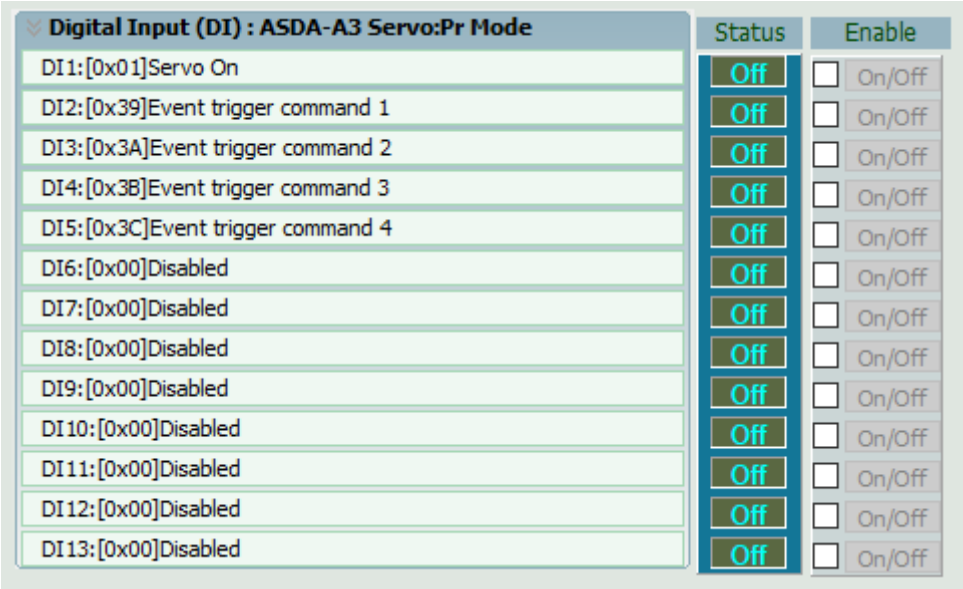

Figure 7.1.5.4 I/O screen in ASDA-Soft

You can set the rising-edge trigger of the PR path with P5.098 while you can set the falling-edge trigger with P5.099. Refer to Chapter 8 for more details. Users can use ASDA-Soft to set the event trigger of PR. See Figure 7.1.5.5.

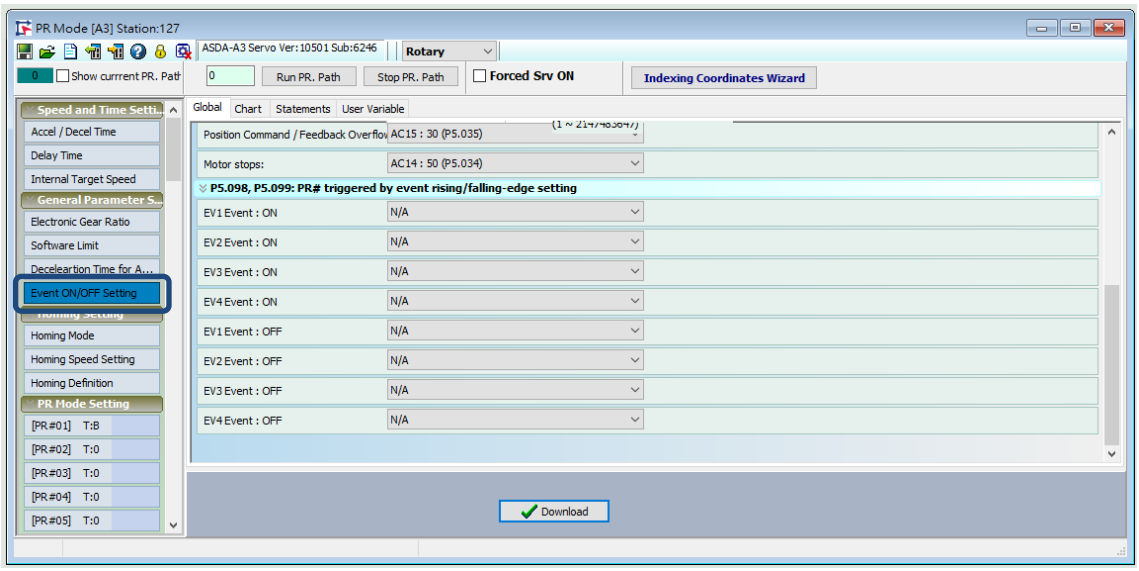

Figure 7.1.5.5 Event ON/OFF Setting screen in ASDA-Soft

PR command trigger register (P5.007)

You can write the PR number to be executed in P5.007 to make the servo drive execute the specified PR path. If you write 0 to the PR Command Trigger register, the servo drive executes homing. If you write 1 – 99 to the PR Command Trigger register, the servo drive executes the specified PR path. If you write 1000 to the PR Command Trigger register, the servo drive stops executing PR commands. You can find more information in the description of P5.007 in Chapter 8.

Special trigger method

You can use High-speed position capture (Capture), High-speed position compare (Compare), and the E-Cam function to trigger the specified PR path. When the capturing completes, you can set Bit3 of P5.039.X to trigger or not trigger PR#50, or set Bit0 of P5.059.U to trigger or not trigger PR#45 once the last data is compared. If the E-Cam disengagement setting is 2, 4, or 6, use P5.088.BA to write the PR path number. Refer to Section 7.2 for Capture, Compare, and E-Cam functions.

Trigger method	Setting bit	Trigger PR path
High-speed position capture (Capture)	P5.039.X Bit3	PR#50
High-speed position compare (Compare)	P5.059.U Bit0	PR#45
E-Cam	P5.088.BA	User-defined

7.1.6 PR procedure execution flow

The ASDA-A3 updates the command status every 1 ms. Figure 7.1.6.1 illustrates the PR procedure execution flow and how the servo drive deals with PR commands. Once a PR procedure is triggered, it goes through three units, which are PR queue, PR executor, and motion command generator.

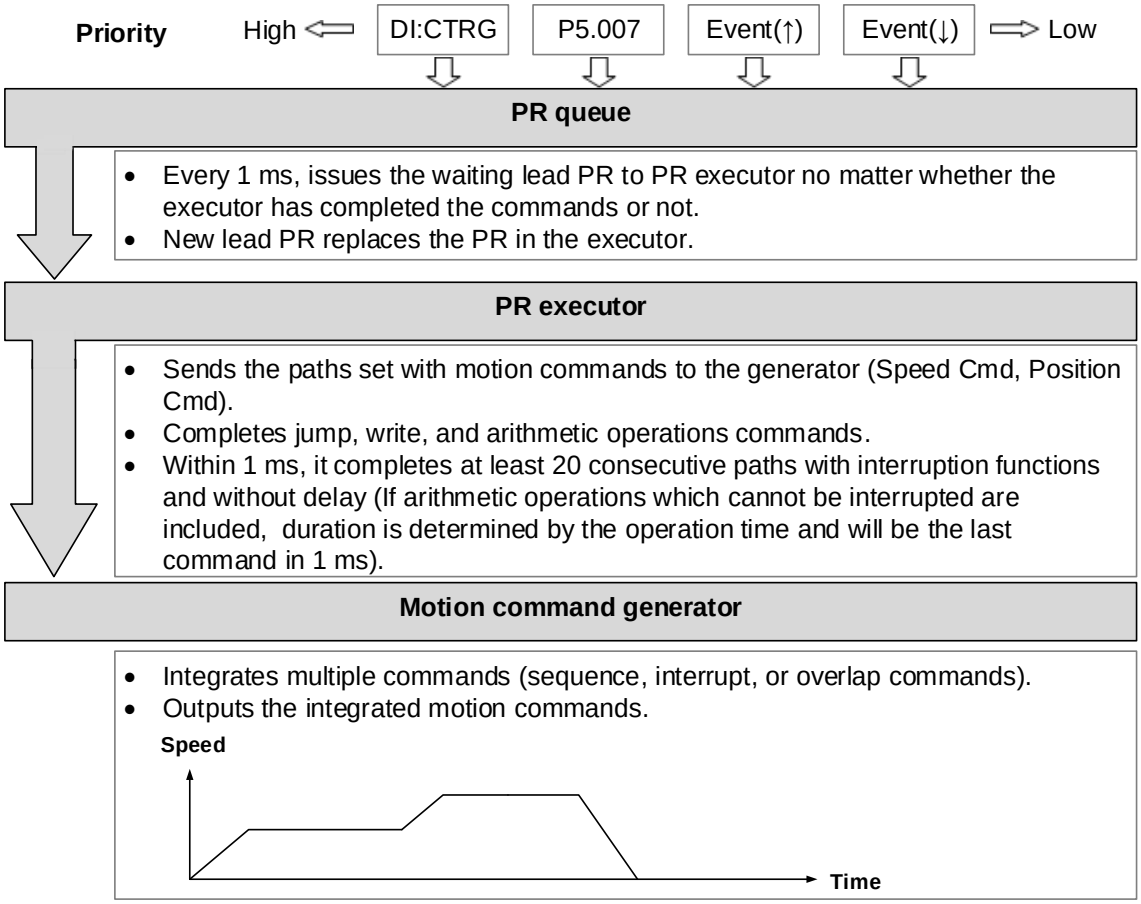

Figure 7.1.6.1 PR execution flow in the ASDA-A3

■ Trigger mechanism

The trigger mechanism is as mentioned in Section 7.1.5. There are three trigger methods. A PR procedure is executed as long as a trigger signal is output. When two different trigger methods are used for one PR procedure within the same ms, the priority is as follows: DI trigger (DI.CTRG) > PR command trigger register (P5.007) > Rising-edge event trigger (Event ↑) > Falling-edge event trigger (Event ↓). Within this ms, commands with higher priority are executed first and then the lower priority commands are arranged in the next ms. If three trigger commands are generated in the same ms, the third is not added to the PR queue.

PR queue

The triggered PR path is the lead PR. The PR group it leads goes into the PR queue to wait for prioritization. In each ms, the servo drive sends the lead PR and the PR group it leads to the PR executor with a first-in first-out method no matter whether a PR path is being executed. Therefore, as long as a PR path is triggered, the PR queue collects it and sends it to the executor.

PR Executor

Once the PR executor receives the lead PR and its PR group, the PR group that is being executed will be replaced immediately. If a PR group includes motion commands, such as Speed commands and Position commands, then the PR executor sends them to the motion command generator. PR paths with Write or Jump commands are complete at the moment when the PR executor reads the command, and thus they do not enter the generator. The arithmetic operations commands are executed when entering the PR executor; however, the execution time varies with the computing duration and the next command cannot interrupt during computing. The PR executor can consecutively complete at least 20 PR paths with interrupt commands (INS) (without delay times) within 1 ms. If there is a PR path that has not completed within 1 ms, and a new PR group is sent to the executor by the queue, the new PR group then replaces the previous PR group. In other words, instead of executing the PR group that hasn't been completed, the executor starts executing the new PR group. However, if a new PR group hasn't been sent to the executor yet after 1 ms, the executor continues to execute the unfinished PR path.

Motion command generator

Motion commands include the Speed and Position commands. The PR executor sends this type of commands to the motion command generator. This generator has a buffer for temporarily storing the next motion command and all motion commands are integrated here. Motion commands can be executed as soon as they enter the generator. If another motion command (with interrupt setting) also enters the generator, it is integrated with the current command in the generator and the integration is based on the motion command settings. The settings include whether multiple motion commands are sequence commands and whether they are set with the Overlap or Interrupt function. All integration varies with each PR path setting.

Sequence command

The configurable commands for PR paths are the motion commands, which are the Position and Speed commands. A sequence command is a motion command without an Overlap or Interrupt function. The following command starts to be executed only after the delay set in the previous command. Regarding Position commands, the delay time starts to count after the target position is reached. For Speed command, the delay time counting starts after the target speed is reached.

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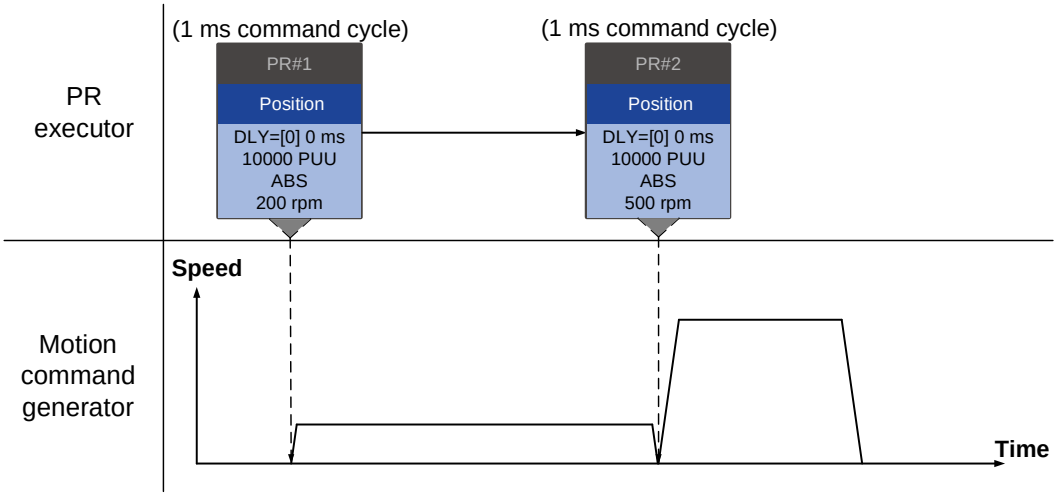
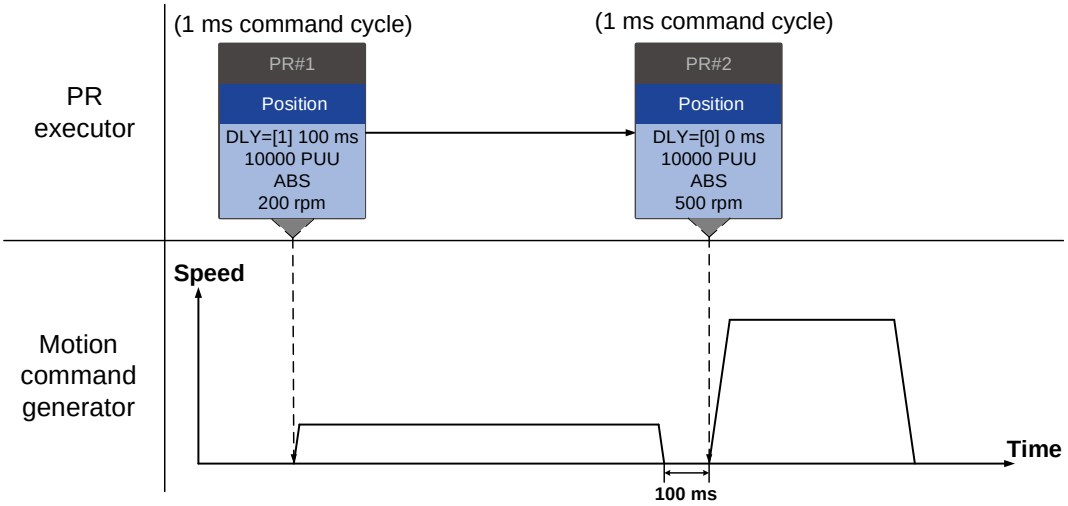
■ Position command followed by a Position command

When the PR executor receives two consecutive Position commands, if they do not have Interrupt or Overlap functions, the PR executor issues the first Position command to the motion command generator, and the generator starts the first part of position control. After the first Position command completes, if no delay time is set, the PR executor issues the second Position command for the generator to start the second part of position control (see Figure 7.1.6.2 (a)).

If the first Position command includes a delay, the PR executor starts counting the delay time right after the motor reaches the target position. Then it issues the second Position command for the generator to start the second part of position control as shown in Figure 7.1.6.2 (b).



(a) Position command without delay

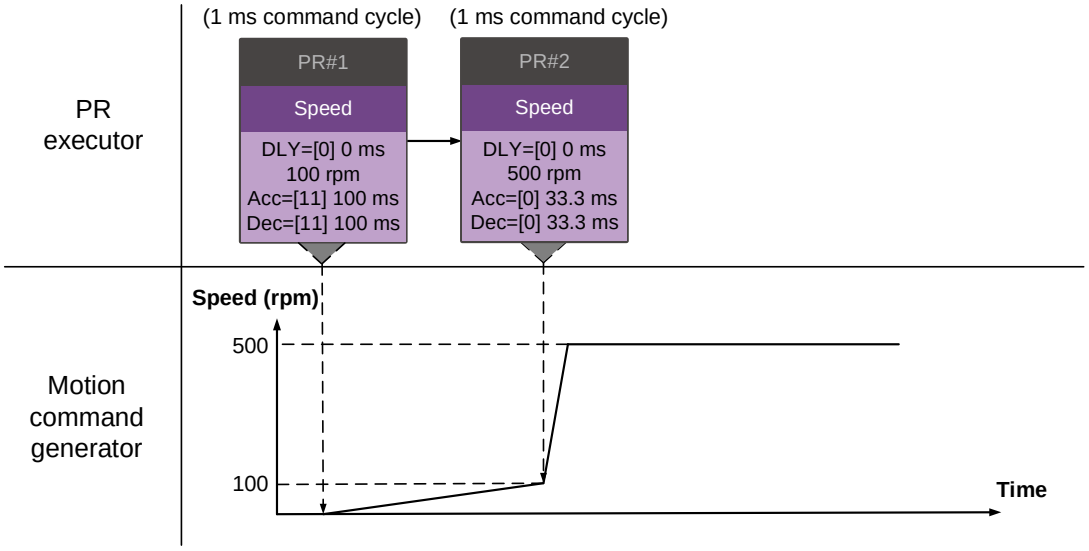


(b) Position command with delay

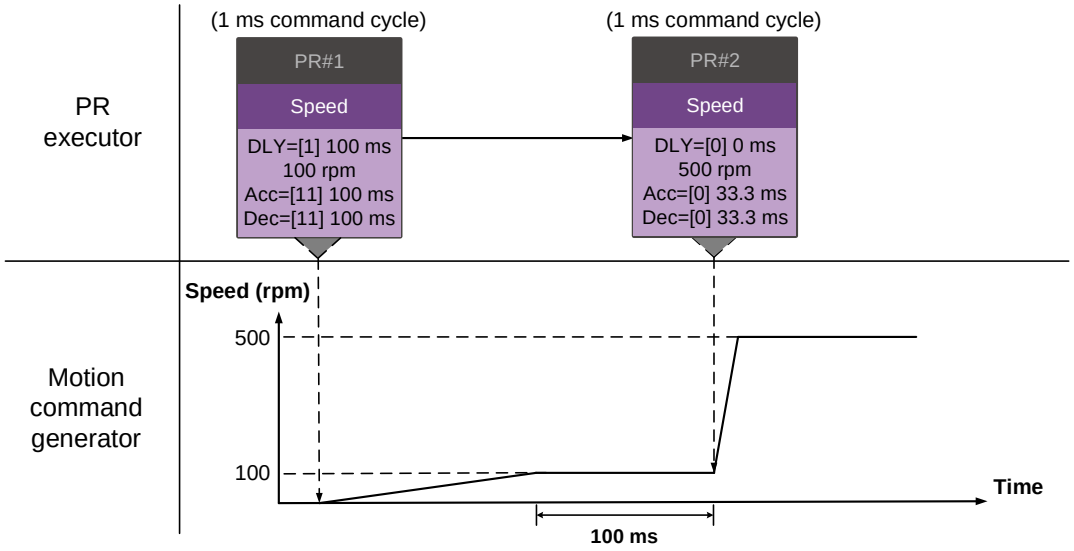
Figure 7.1.6.2 Position sequence command

■ Speed command followed by a Speed command

When the PR executor receives two consecutive Speed commands, if they do not have Interrupt or Overlap functions, the PR executor issues the first Speed command to the motion command generator, and the generator starts the first part of speed control. After the first Speed command completes, if no delay time is set, the PR executor issues the second Speed command for the generator to start the second part of speed control (see Figure 7.1.6.3 (a)).
If the first Speed command includes a delay, the PR executor starts counting the delay time right after the motor reaches the target speed. Then it issues the second Speed command for the generator to start the second part of speed control as shown in Figure 7.1.6.3 (b).



(a) Speed command without delay



(b) Speed command with delay

Figure 7.1.6.3 Speed sequence command

■ Multiple commands

The PR queue updates commands every 1 ms. For a motion command, the PR queue sends the next command to the generator only after the previous command completes. Jump or Write commands are executed in the PR queue immediately. As shown in Figure 7.1.6.4, in the first ms, the PR queue receives a Position command and it sends this command to the motion command generator, having the generator to execute the command. In the second ms, the PR queue receives a Write command and executes it immediately. In the third ms, the PR queue receives a Jump command and executes it immediately as well. These last two commands are not sent to the motion command generator since the PR queue and the generator can execute commands independently. In the fourth ms, the PR queue receives a Position command. After the first Position command is complete, the PR executor sends it to the generator and the generator starts executing it immediately.

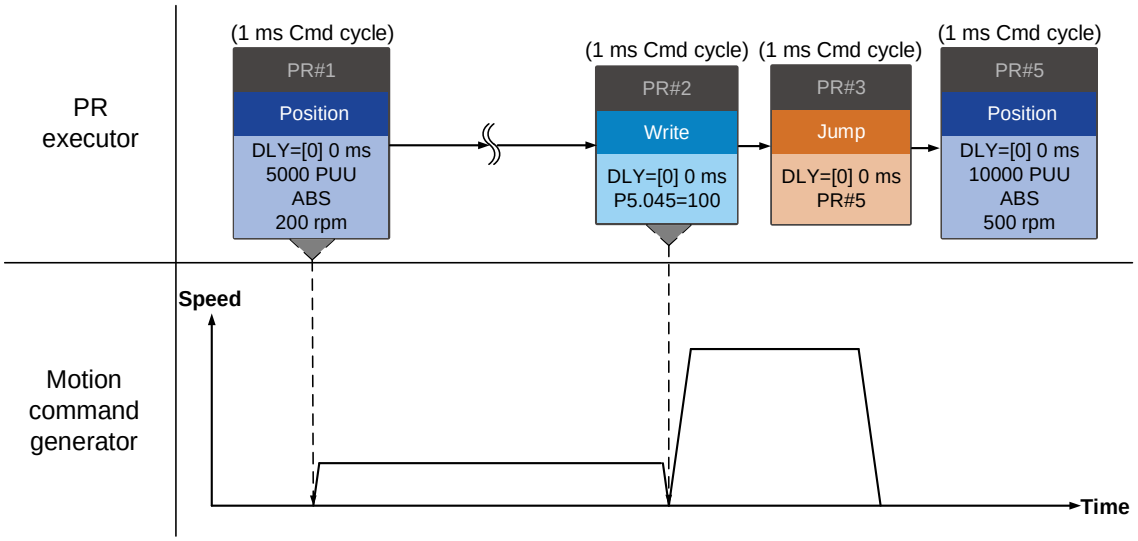


Figure 7.1.6.4 Multiple sequence commands

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Command interruption

Interruption (INS) causes a command in execution to be replaced or integrated. The results of the interruption differ based on the command types. The next command replaces or combines with the previous command. There are two types of interruption: internal and external, as shown in Figure 7.1.6.5.

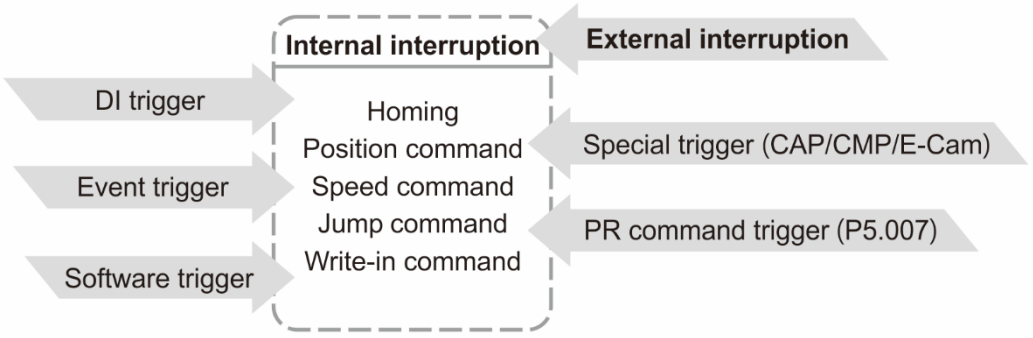


Figure 7.1.6.5 Internal and external interruption

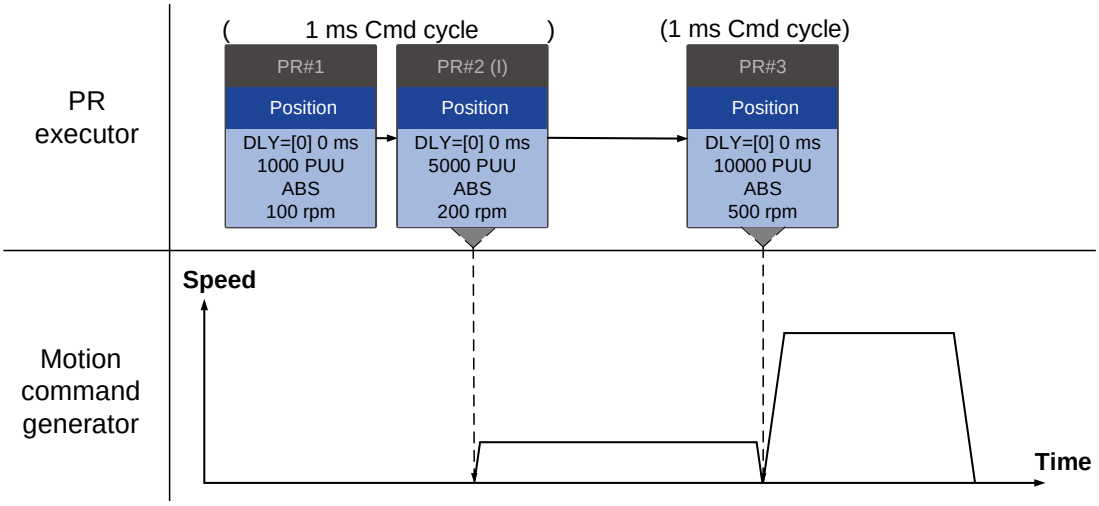
1. Internal Interruption

For a series of PR paths, if one PR path includes an AUTO function (auto-execute the next path), the system reads the next path after reading the current path. If the current path includes a delay, the next path is read after delay time is over. Meanwhile, if the next path includes an Interrupt function (which has a higher execution priority), the servo drive immediately executes the interrupt command. It replaces the un-executed part in the previous path with the next or integrates the commands in the execution of the previous path with the next.

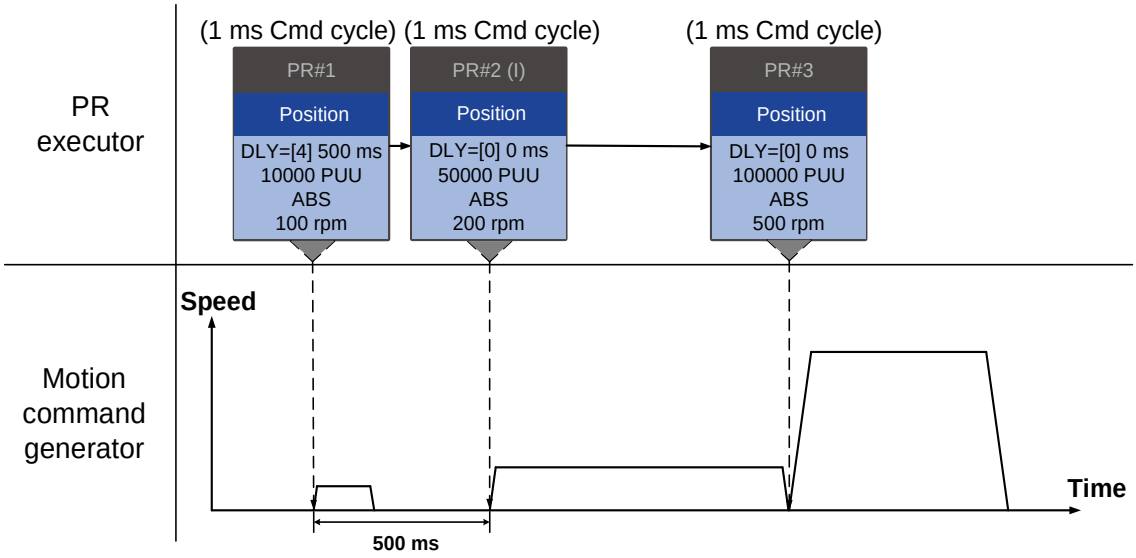
■ Position command ▶ Position command (I) ▶ Position command

When the PR executor receives three consecutive Position commands with an interrupt in the second command, the executor treats the first and the second Position commands as one PR group. Since the first Position command is not executed, the executor replaces the first command with the second. It only sends the second command to the motion command generator for execution. After the second command is complete, the executor sends the third command to the generator (see Figure 7.1.6.6 (a)).

If the first command includes a delay, then the PR executor sends the first command to the generator and then starts counting the delay time. After the delay is over, the PR executor then sends the second command and the generator starts the second part of position control. While the first command is still being executed, it is integrated with the second command. The integration is slightly different from what is described in Section 7.1.3. Refer to the following descriptions. Once the second command is complete, the executor sends the third command to the generator for execution (see Figure 7.1.6.6 (b)).



(a) Position command without delay



(b) Position command with delay

Figure 7.1.6.6 Internal interruption - Position command

The integration for internal interrupt position command is slightly different from what is described in Section 7.1.3. The way REL and INC commands work is identical. The target position is the previous target position plus the current position. See the following example. The rest of the integration method is the same as mentioned in Section 7.1.3.

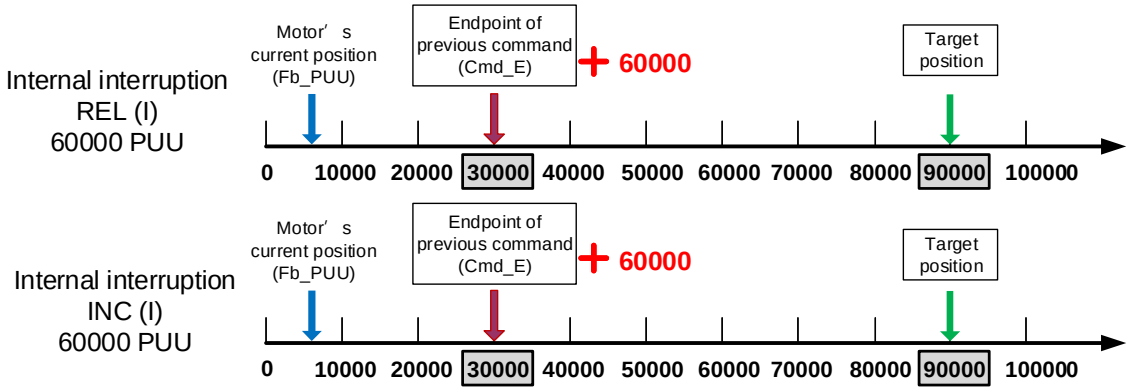
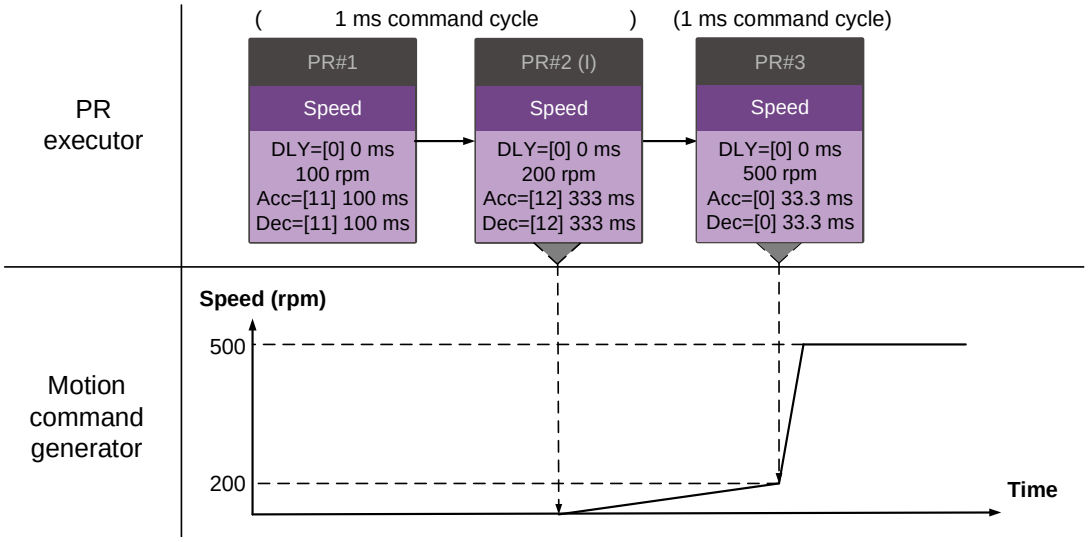


Figure 7.1.6.7 Example of relative and incremental position commands for internal interruption

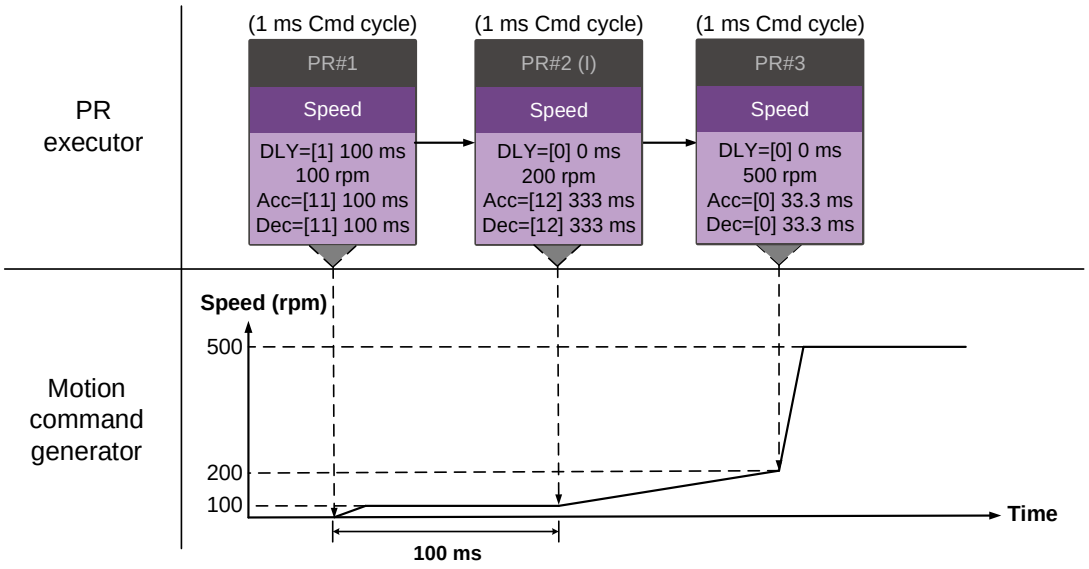
■ Speed command ▶ Speed command (I) ▶ Speed command

When the PR executor receives three consecutive Speed commands with an interrupt in the second command, the executor treats the first and the second as one PR group. Since the first Speed command is not executed, the executor replaces the first command with the second. It only sends the second command to the motion command generator for execution. After the second command is complete, the executor sends the third command to the generator (see Figure 7.1.6.8 (a)).

If the first command includes a delay, then the PR executor sends the first command to the generator and then starts counting the delay time. After the delay is over, it then sends the second command and the generator starts the second part of speed control. While the first command is still being executed, it is integrated with the second command. Once the second command is complete, the executor sends the third to the generator for execution (see Figure 7.1.6.8 (b)).



(a) Speed command without delay

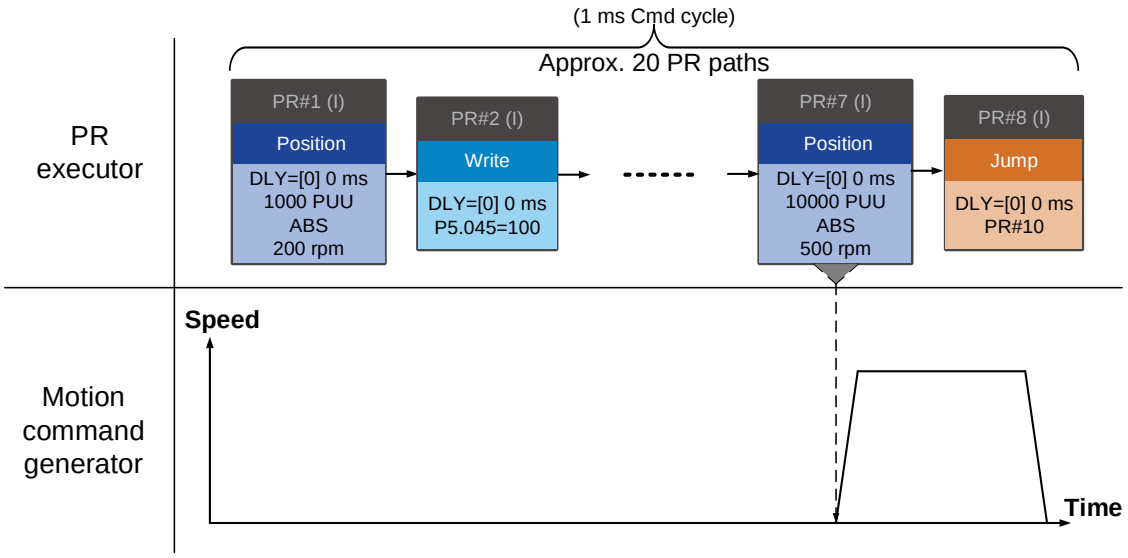


(b) Speed command with delay

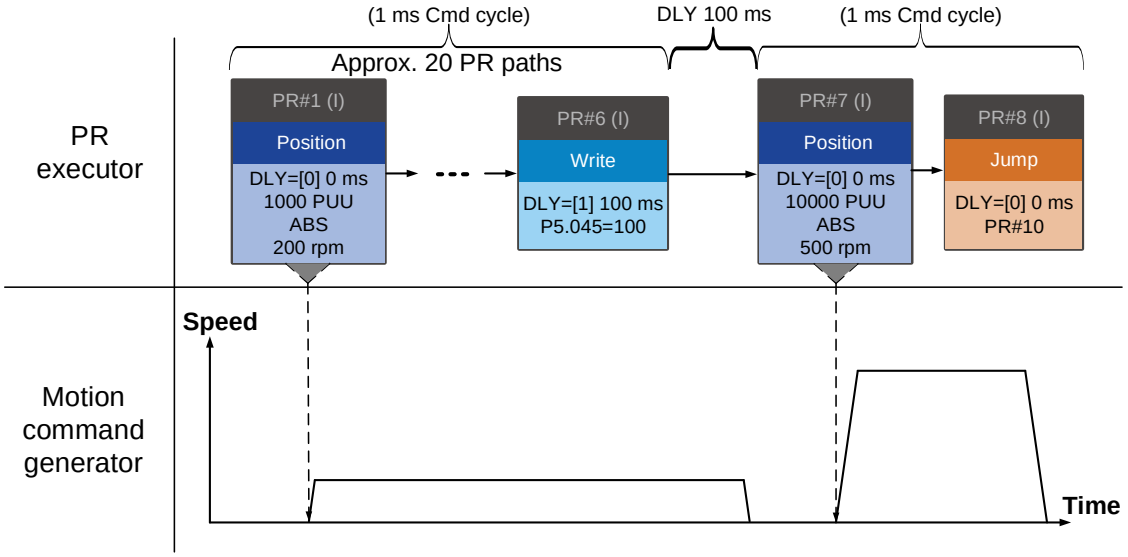
Figure 7.1.6.8 Internal interruption – Speed command

■ Multiple interrupt commands

The PR queue updates commands every 1 ms. If all PR paths include an Interrupt function, the queue can read at least 20 PR paths in 1 ms, and these paths are called a PR group.
If this PR group has multiple motion commands, the PR queue only sends the last command it receives to the motion command generator for execution. Therefore, in a PR group, only one PR path with motion command is executed. The latter motion command directly replaces the former, whereas Jump and Write commands are executed as soon as they are received by the PR queue (see Figure 7.1.6.9 (a)). If one of the PR paths includes a delay, the PR queue schedules all paths on the basis of this PR path. The prior path(s) including a delay becomes the first PR group, and what follows is the second PR group. Thus, this PR procedure can execute up to two PR paths with motion commands, as shown in Figure 7.1.6.9 (b).



(a) Multiple commands without delay



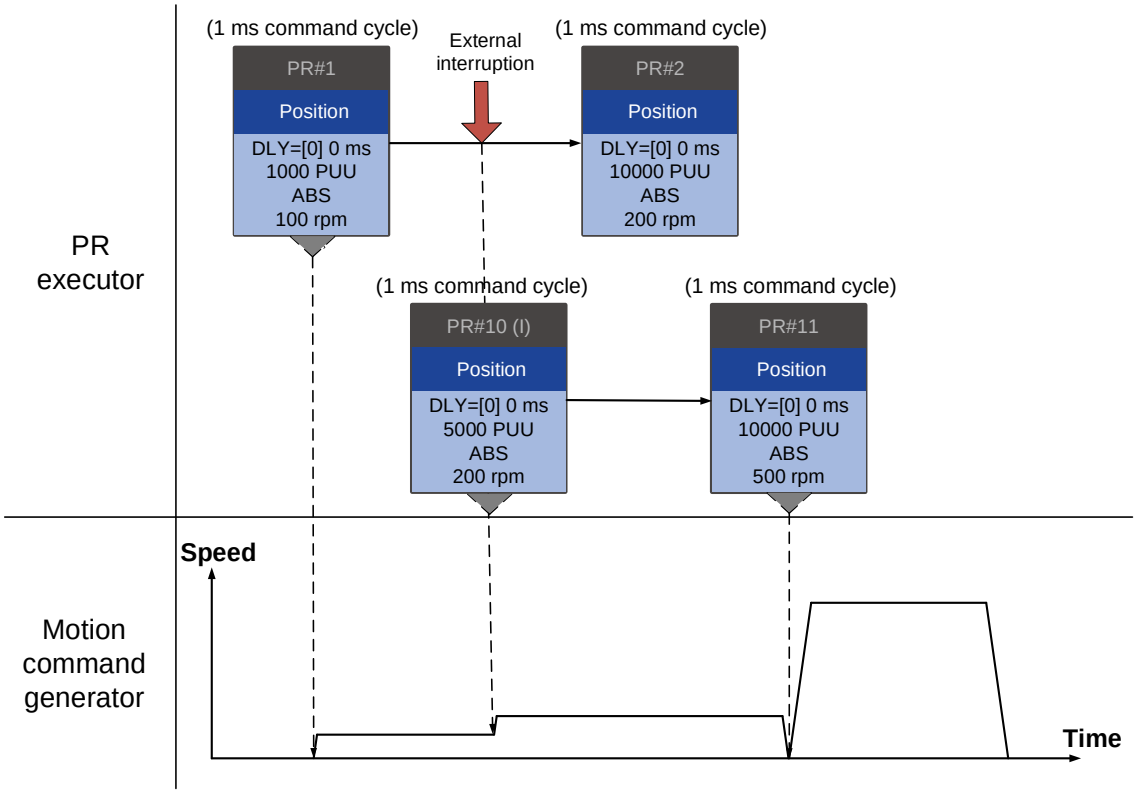
(b) Multiple commands with delay

Figure 7.1.6.9 Internal interruption – Multiple commands

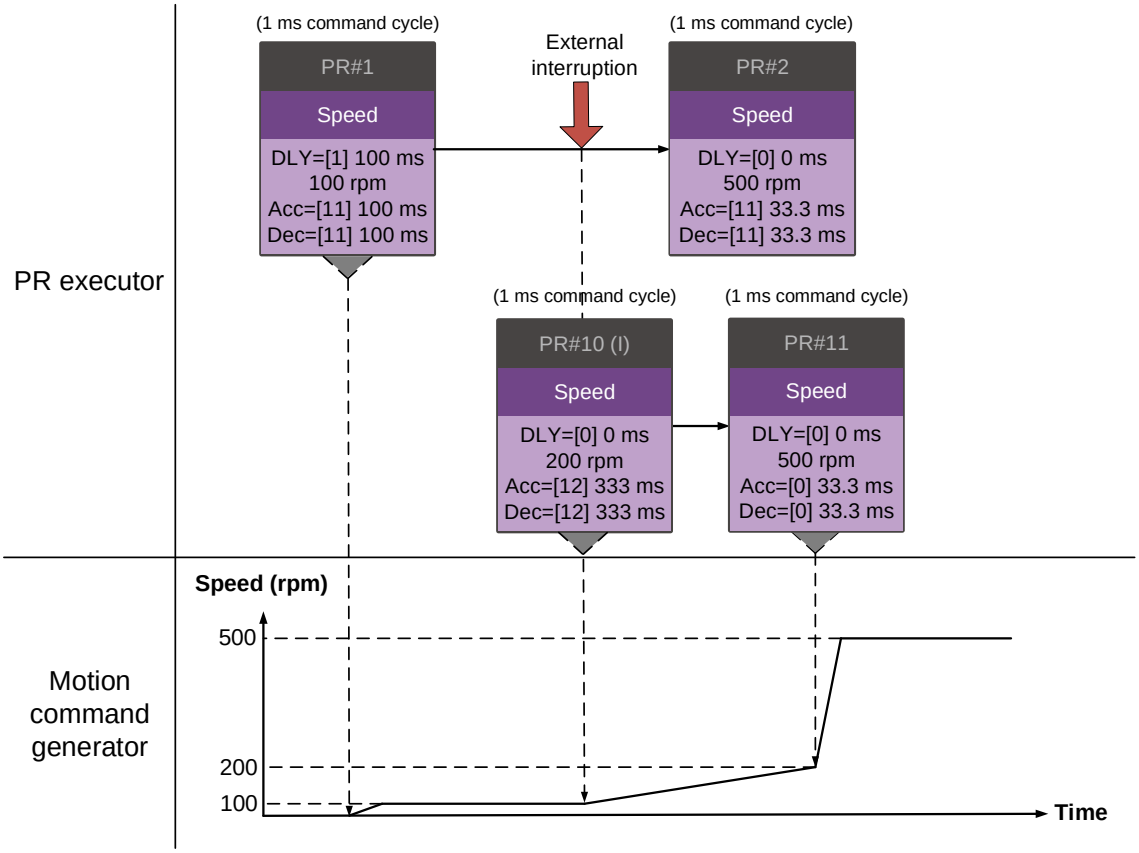
2. External Interruption

If an external interruption is encountered, it uses the PR Command trigger method to execute another PR path (refer to Section 7.1.5 for PR trigger methods). When the PR queue receives a PR path with an Interrupt function, it sends this path to the motion command generator immediately and changes the path in execution. Note that a delay does not change the result of an external interruption. That is, once the PR queue receives an external interrupt command, the motion commands in the latter part are executed by the generator and integrated with the previous commands.

The external interruption is as shown in Figure 7.1.6.10 (a). If a PR path with external interruption enters the PR executor, the executor sends this Position command immediately to the generator so that the motor can run in accordance with the interruption. The motor uses the settings that integrate with the former motion commands when running. The methods of integration are described in Section 7.1.3. Similarly, an external interruption affects Speed and Position commands the same way and the same is true for multiple commands. See Figure 7.1.6.10 (b) for an example.



(a) External interruption – Position command



(b) External interruption – Speed command

Figure 7.1.6.10 External interruption

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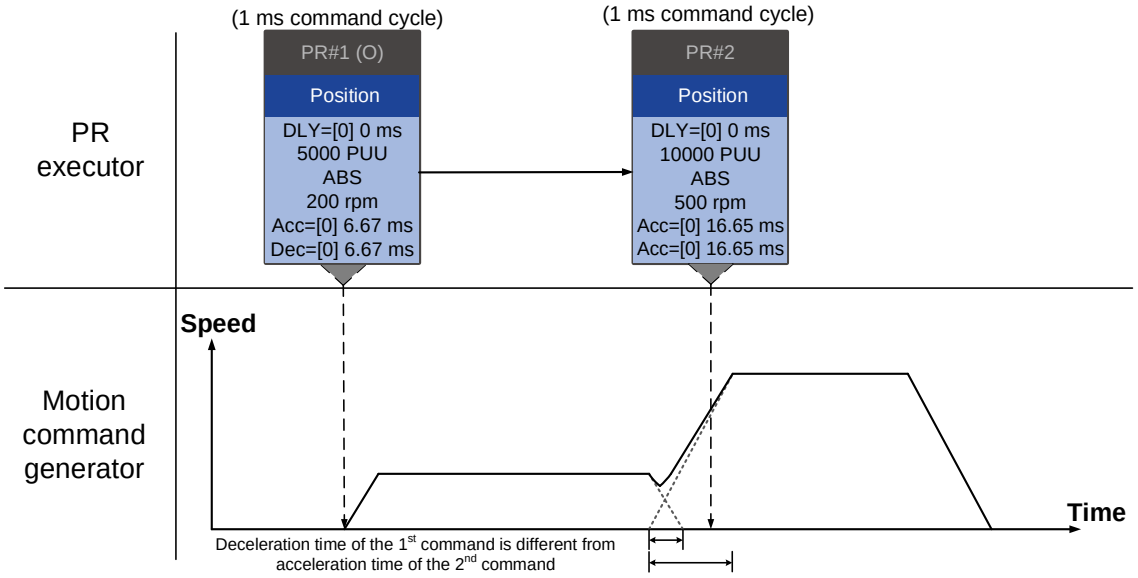
Overlap command

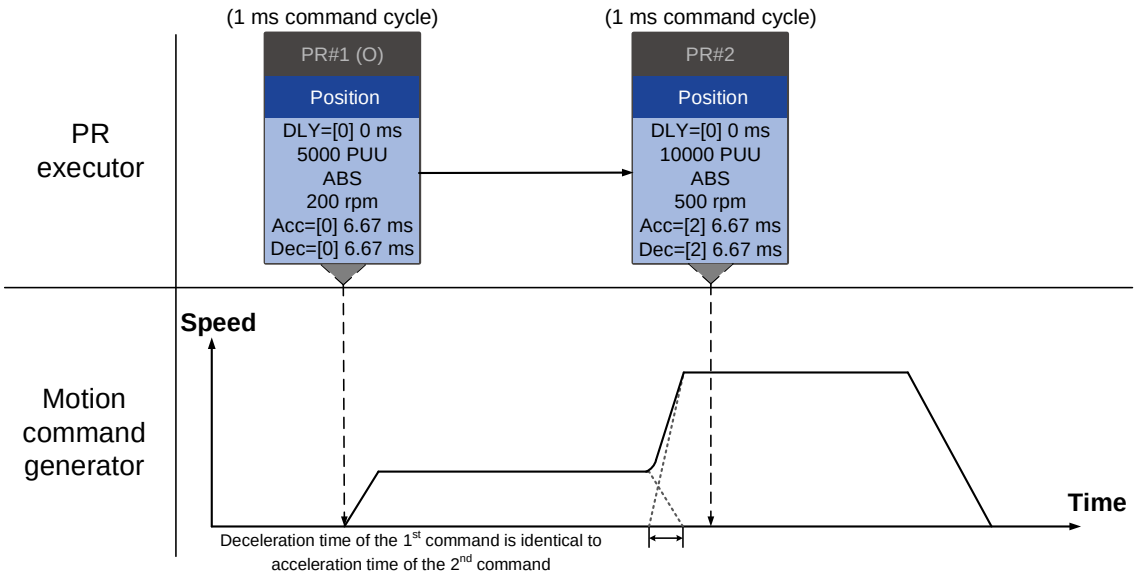
If the previous position command includes an Overlap function, it allows the next command to be executed while the previous motion is decelerating, thus achieving a continuous motion. When you use an Overlap command, the delay time is still effective. The delay time starts to count from the command's start point; however, in order to have the commands transition smoothly, setting the delay time of the previous command to 0 is suggested. In addition, if deceleration time of the previous command is identical to acceleration time of the next, the transition between commands can be very smooth, avoiding discontinuous speed during transition (see Figure 7.1.6.11). The calculation is as follows.

$$\frac{1\text{st target speed } (Spd1)}{3000} \times \text{Deceleration time } (Dec) = \frac{2\text{nd target speed } (Spd2)}{3000} \times \text{Acceleration time } (Acc)$$

An Interrupt command has a higher priority than an Overlap command. Thus, when you set an Overlap function in the current Position command, and the next motion command includes an Interrupt function, only the command with the Interrupt function is executed.



(a) Overlap command - Acceleration and deceleration time are different



(b) Overlap command - Acceleration and deceleration time are identical

Figure 7.1.6.11 Overlap command

7

Interpret PR path flow

The PR paths mentioned above include commands such as Sequence, Interrupt, and Overlap. The replacement, integration, and overlapping for commands have different behavior depending on the settings. The suggested steps to interpret the PR path is as follows.

1. Check the command sequence. Check whether there are delay time (DLY) and interrupt (INS) commands because these two types change the command execution sequence.
2. Find the lead PR and identify each PR group of 1 ms.
3. In each PR group of 1 ms, only the last motion command is executed. The Jump and Write commands are immediately executed in the PR executor.
4. Position commands are combined based on the principle described in Section 7.1.3.3.

Statement (Arithmetic operation)

You can regard Statement commands as combinations of Write commands and Jump commands. Thus, the execution priority is the same as these two types of commands, which are executed by the PR executor. Statement commands can interrupt the previous command but cannot be interrupted by the following command. This ensures that all statements are executed before the PR paths enter the PR queue. In addition, whether there is an interrupt command in the next PR path determines the statement execution duration in the command cycle. If the following PR has no interruption setting (see Figure 7.1.6.12):

The arithmetic operation only takes 3.89 μs, but it still takes a complete cycle of 1 ms. The Jump PR number in the Statement is executed in the next ms. If the Jump PR number specified in the Statement has the interruption setting (as shown in Figure 7.1.6.13), this Jump command is executed only when the Statement is completely executed (which is after 3.89 μs). Using P5.007 to trigger other PR paths is not applicable in the arithmetic operation area in the Statement.

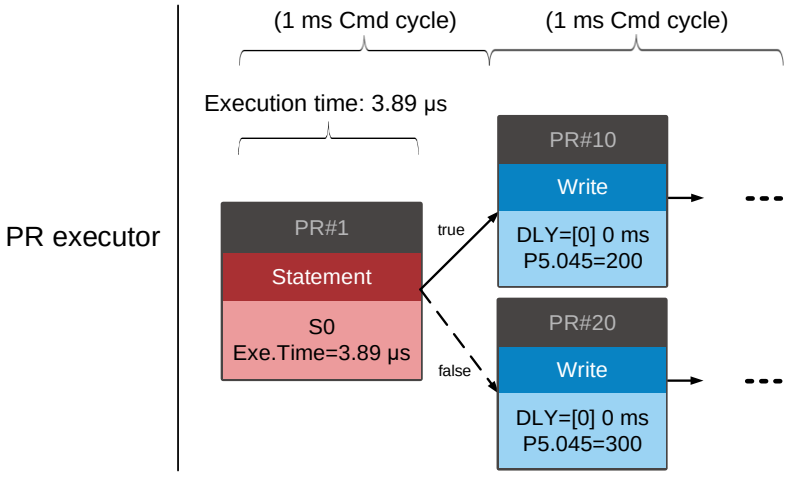


Figure 7.1.6.12 Multiple commands with arithmetic operations

(followed by a PR path without interrupt command)

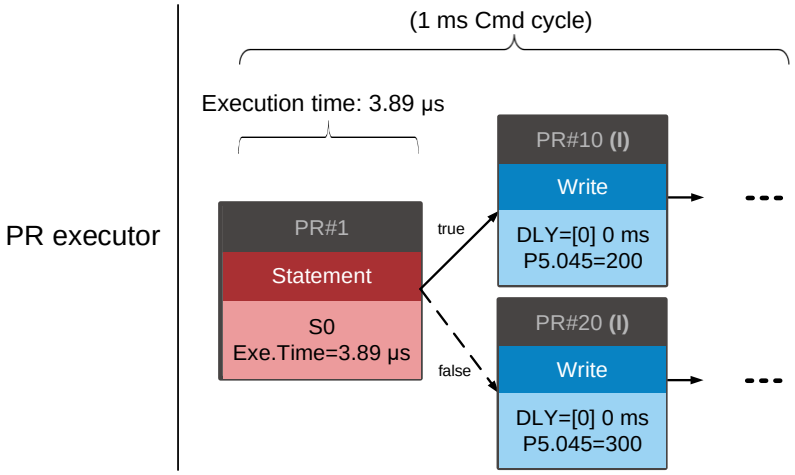


Figure 7.1.6.13 Multiple commands with arithmetic operations

(followed by a PR path with interrupt command)

7.2 Application of motion control

Applications of motion control in the ASDA-A3 include high-speed position capture (Capture), high-speed position compare (Compare), and E-Cam. High-speed position capture uses digital input (DI7) to instantly capture the motor's feedback position and store this position in the data array. For high-speed position compare, it writes the specified motor position to the data array and outputs a high-speed digital signal (DO4) once the motor feedback position reaches this specified position. The purpose of E-Cam is to create an E-Cam curve according to the correlation between the Master and the Slave, and then store the curve in the data array.
The Slave axis refers to the Master axis' position and moves to the position specified by the E-Cam. You can find more details about the setting and how it works in the following sections.

7.2.1 Data array

The data array can store up to 800 32-bit data (0 - 799). You can use it to store the high-speed position capture data and high-speed position compare data as well as the E-Cam curves.
To prevent overwriting or accidentally changing any data, properly segment the space for these three functions as their individual spaces are not defined by default. Set P2.008 to 30 and then 35 or use ASDA-Soft to write the data to EEPROM; otherwise, the data in RAM is not saved after you turn the power off. ASDA-Soft includes a user-friendly screen for reading and writing the data array. See the following figure.

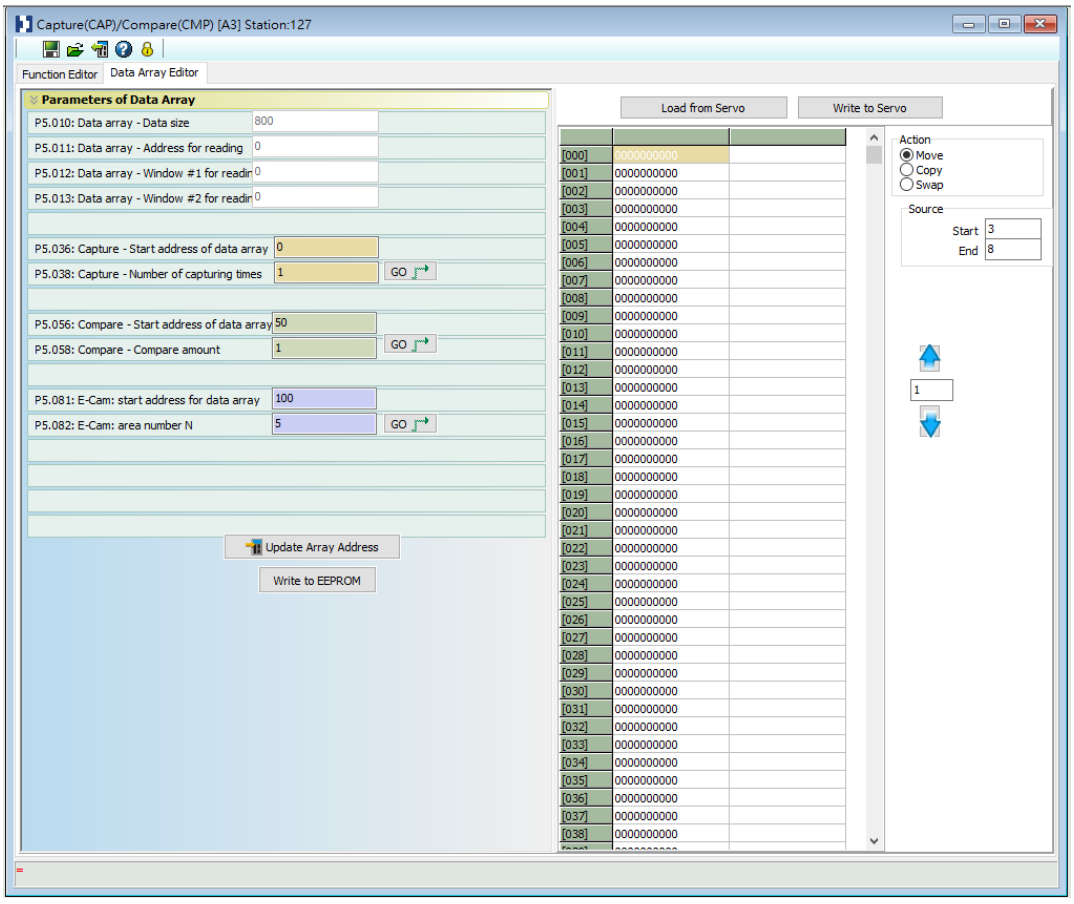


Figure 7.2.1.1 Data Array screen in ASDA-Soft

You can use the panel, communication, or ASDA-Soft to read data from or write data to the data array. Regardless of the methods, they are completed by parameter settings. The first parameter group for reading and writing the data array is P5.011, P5.012, and P5.013. P5.011 specifies the address for reading and writing the data array. P5.012 and P5.013 are for reading and writing the actual data contents. You can use both to read and write, but the behaviors after reading and writing differ. Refer to Table 7.2.1.1 for more information. The second parameter group for reading and writing the data array is P5.011 and P5.100 – P5.103. P5.011 specifies the address for reading and writing the data array. P5.100 reads data from or writes data to the data array address set by P5.011. P5.101 reads data from or writes data to the data array address following the address set by P5.011. P5.102 and P5.103 work the same way. If the address value accumulates and exceeds the maximum of 799, the returned address is 0. You can find more details in Table 7.2.1.2.

Table 7.2.1.1 Group 1 - reading and writing the data array

Parameter	Description		
P5.011 Address for reading / writing	Specify the address for reading from or writing to the data array		
Window for reading / writing	by	Behavior after reading	Behavior after writing
P5.012 Window #1 for reading / writing	Panel	**Value of P5.011 does not add 1**	Value of P5.011 adds 1
	Communication / ASDA-Soft	Value of P5.011 adds 1	Value of P5.011 adds 1
P5.013 Window #2 for reading / writing	Panel	Value of P5.011 adds 1	**Cannot be written with the drive panel**
	Communication / ASDA-Soft	Value of P5.011 adds 1	Value of P5.011 adds 1

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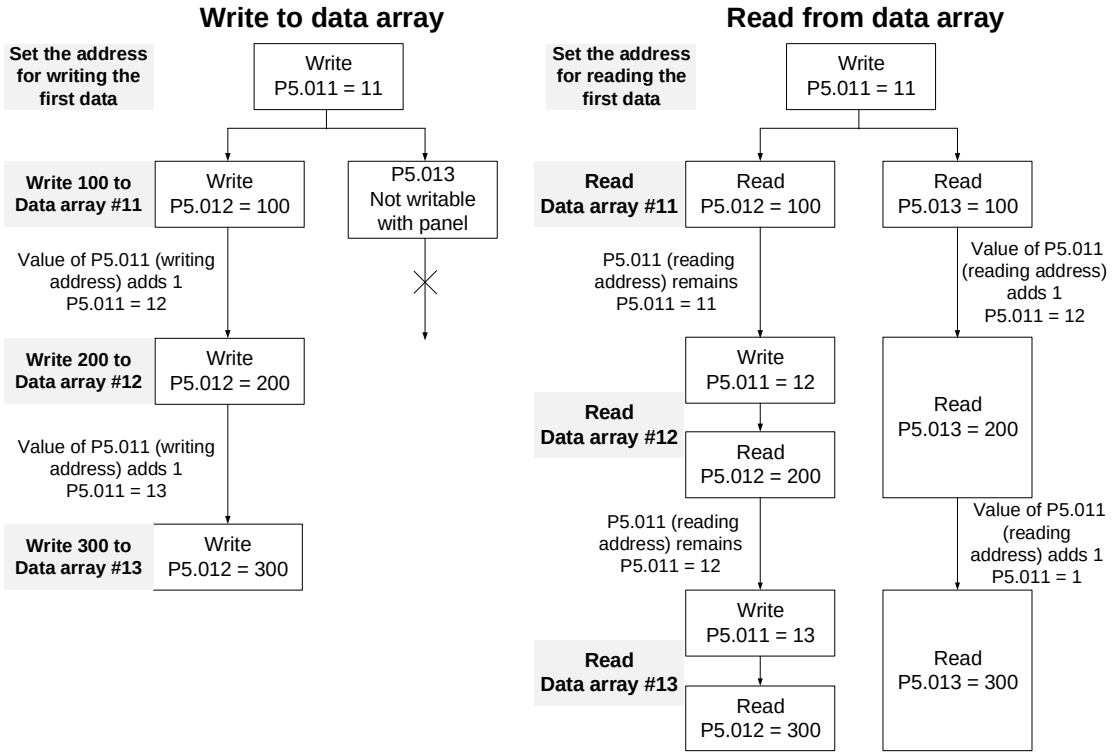
- Example: when using the drive panel or communication for reading from or writing to the data array, input values to the data array address in sequence as follows: Data array #11 = 100, Data array #12 = 200, Data array #13 = 300. Then the data is read in sequence.

1. Read / write via panel:



2. Read / write using communication

To read from or write to the data array through Modbus, use the communication command 0x10 to write consecutively, 0x06 to write single data, and 0x03 to read consecutively. First, use a consecutive writing command to write 100 to Data array #11, 200 to Data array #12, and 300 to Data array #13. When reading, use a single data writing command to set the start address as Data array #11, then use a consecutive reading command to read P5.011 – P5.013 (Data array #11 and #12). This reads two values, so P5.011 is incremented by 2 and then it reads Data array #13.

Writing to the data array									
Packet	Communi-cation Cmd	Start address	Data size	P5.011		P5.012		P5.013	
				Low bit	High bit	Low bit	High bit	Low bit	High bit
1	0x10	P5.011	6 words	11	0	100	0	200	0
2	0x10	P5.011	6 words	13	0	300	0	0	0
Reading the data array									
Packet	Communi-cation Cmd	Start address	Data size	P5.011		P5.012		P5.013	
				Low bit	High bit	Low bit	High bit	Low bit	High bit
4	0x06	P5.011	-	11	0	-	-	-	-
5	0x03	P5.011	6 words	11	0	100	0	200	0
6	0x03	P5.011	6 words	13	0	300	0	0	0

Table 7.2.1.2 Group 2 – reading and writing the data array

Parameter	Description	Example 1		Example 2	
P5.011 Address for reading / writing	Specify the address for reading from or writing to the data array	200		797	
Window for reading / writing	Description	Example 1		Example 2	
		Address	Content	Address	Content
P5.100 Window #3 for reading / writing	Read from or write to the address specified by P5.011.	200	1234	797	5678
P5.101 Window #4 for reading / writing	Read from or write to the first address following the address specified by P5.011.	201	2345	798	6789
P5.102 Window #5 for reading / writing	Read from or write to the second address following the address specified by P5.011.	202	3456	799	7890
P5.103 Window #6 for reading / writing	Read from or write to the third address following the address specified by P5.011.	203	4567	x	0

7.2.2 High-speed position capture function (Capture)

The high-speed position capture function (CAP) uses the external-triggered high speed digital input DI7 (with execution time of only 5 μs) to capture the position data of the motion axis and store it in the data array for further motion control. As the Capture function is executed by the hardware, there is no lag in the software, and it is able to capture the motion axis' position accurately. While the Capture function is enabled, the servo drive sends a DI7 signal for the capture signal (D17 is not user-defined).

The flow chart for high-speed position capturing is shown in Figure 7.2.2.1. The relevant parameters are defined as follows. P5.036 sets the start position in the data array for storing the captured data; if it is not set, the default start position is #0. P5.038 sets the capturing amount. The amount has to be greater than 0, otherwise the Capture function is not executed. P1.019.X enables the cycle mode. When the last data is captured, the capturing amount is reset to 0 (P5.038 = 0), and the next cycle starts automatically to capture the set capturing amount. However, the start position for storing the captured position data is still determined by P5.036; that is, the captured data in the previous cycle is replaced by the data captured in the next cycle. P5.039 enables and disables the Capture function and other settings. See the following table for more information. To capture multiple position data, use P1.020 to set the masking range for capturing. This prevents the same position data being captured repeatedly because capturing more than once is not allowed in the masked area. You can set the Capture function in ASDA-Soft, as shown in Figure 7.2.2.2.

P5.039	bit	Function	Description
X	0	Enable Capture function	When P5.038 > 0 and bit 0 = 1, the capturing starts and DO.CAP_OK is off. Each time a position is captured, the value of P5.038 is decremented by 1. When P5.038 = 0, it means the capturing is finished, DO.CAP_OK is on, and bit 0 is reset to 0. If bit 0 is already 1, the written value must not be 1; you must write 0 to disable the Capture function.
	1	Reset position when first data is captured	If bit 1 = 1, after the first data is captured, set the Capture axis' position to the value of P5.076.
	2	Enable Compare function after first data is captured	If bit 2 = 1, when the first data is captured, enable the Compare function (P5.059.X bit 0 = 1 and P5.058 resets to the previous value). If the Compare function is already enabled, then this bit function is invalid.
	3	Execute PR#50 after the last data is captured	If bit 3 = 1, execute PR#50 once all data are captured.
Y	-	Source of Capture axis	0: disabled 1: CN5 2: CN1 (pulse command) 3: CN2
Z	-	Trigger logic	0: NO (normally open) 1: NC (normally closed)
U	-	Minimum trigger interval (ms)	-

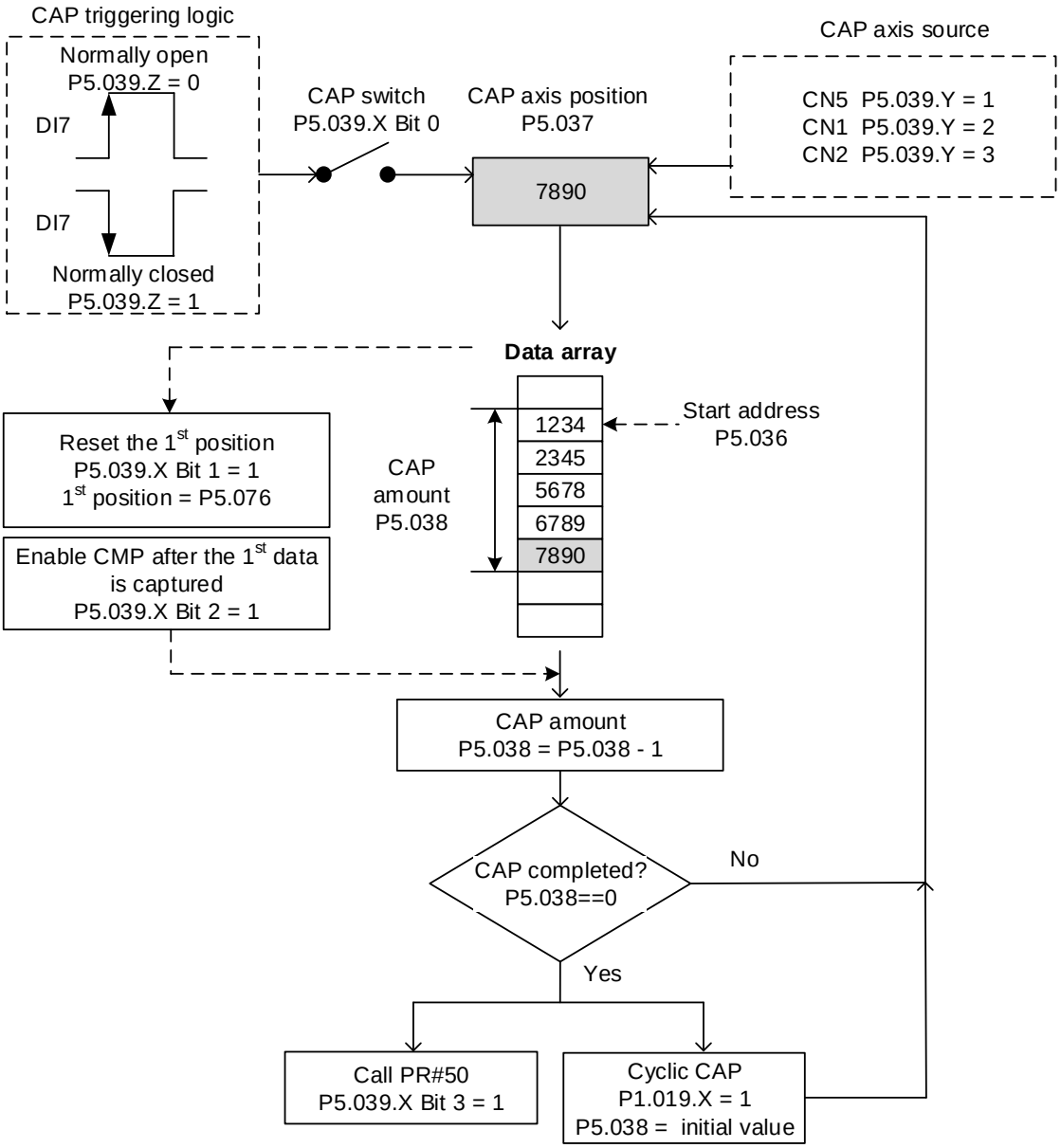


Figure 7.2.2.1 Flow chart for high-speed position capturing

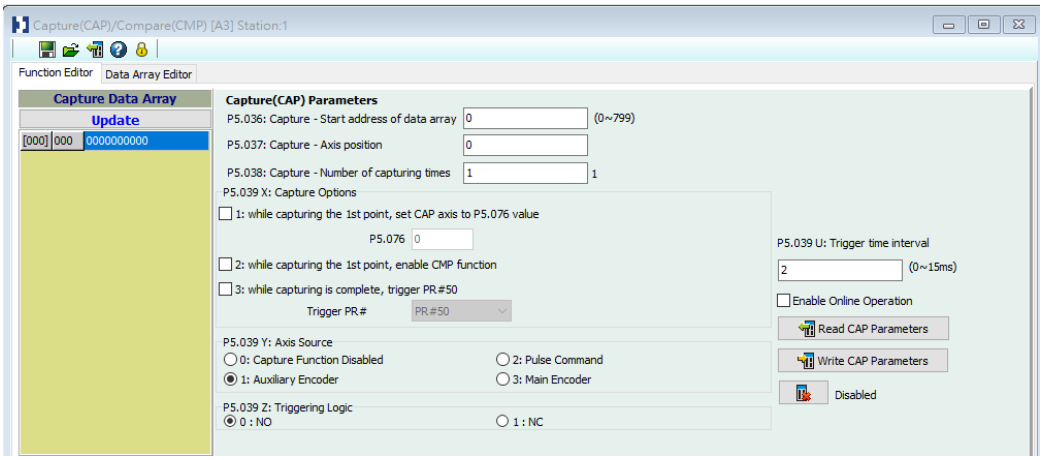


Figure 7.2.2.2 Capture function screen in ASDA-Soft

It is suggested that you use the PR path programming to use the motion commands with the Capture function. You can use Write commands to set the high-speed position capture function, as well as to execute motion commands once capturing is complete. See the example in Figure 7.2.2.3. PR#1 confirms that the Capture function is disabled (P5.039.X Bit 0 = 0). PR#2 sets the start position of data array to #100. PR#3 sets the capturing amount to 3. PR#4 sets the capturing axis' position to 0 for the first capture point. PR#5 sets the cyclic capture mode with delay time of 1 ms to ensure that the next PR path can be executed with the Capture function. PR#6 enables the Capture function and resets the first point; and once completed, continue executing PR#50. This selects CN2 as the capturing axis, using 'normally closed' contact as the trigger logic with a trigger interval of 2 ms. PR#7 sets the Speed command to 50 rpm. PR#50 sets the capture Position command to 50000 PUU. Once the command is complete, continue to PR#51 with the Speed command setting at 50 rpm.

From Figure 7.2.2.4, you can see that after DI7 is triggered, the capturing axis is reset to 0 and the data stored in data array #100 because the Reset function for the first point is enabled and P5.076 is set to 0. At the moment DI7 is triggered the second and third time, the position data is written to the data array #101 and #102. Once the first capture cycle is complete, DO: [0x16]CAP is set to on and then PR#50 (high-speed position capture command) and PR#51 (motion with fixed speed) are executed. Then, the servo drive continues executing the next cycle; meanwhile, DO: CAP is set to off when the procedure is complete and the capturing amount is set to 3. When DI7 is triggered for the fourth time, the capture axis' position is not reset; the position data of the capturing axis is written to #100 again. Therefore, the data written in the previous cycle is replaced. At the moment DI7 is triggered the fifth and sixth time, the position data is written to the data array #101 and #102. Once the second capture cycle is complete, DO: [0x16]CAP is set to on and then PR#50 (high-speed position capture command) and PR#51 (motion with fixed speed) are executed.

When using Cyclic Capture mode (P1.019.X = 1), the Reset function is only valid for the first cycle. Executing the PR path is valid for every cycle; in other words, every time a cycle ends, PR#50 is executed. The first position data captured in every cycle is written to the data array set by P5.036, and then the other data is written in sequence. So, position data written in the previous cycle is always replaced by the position data of the next cycle.

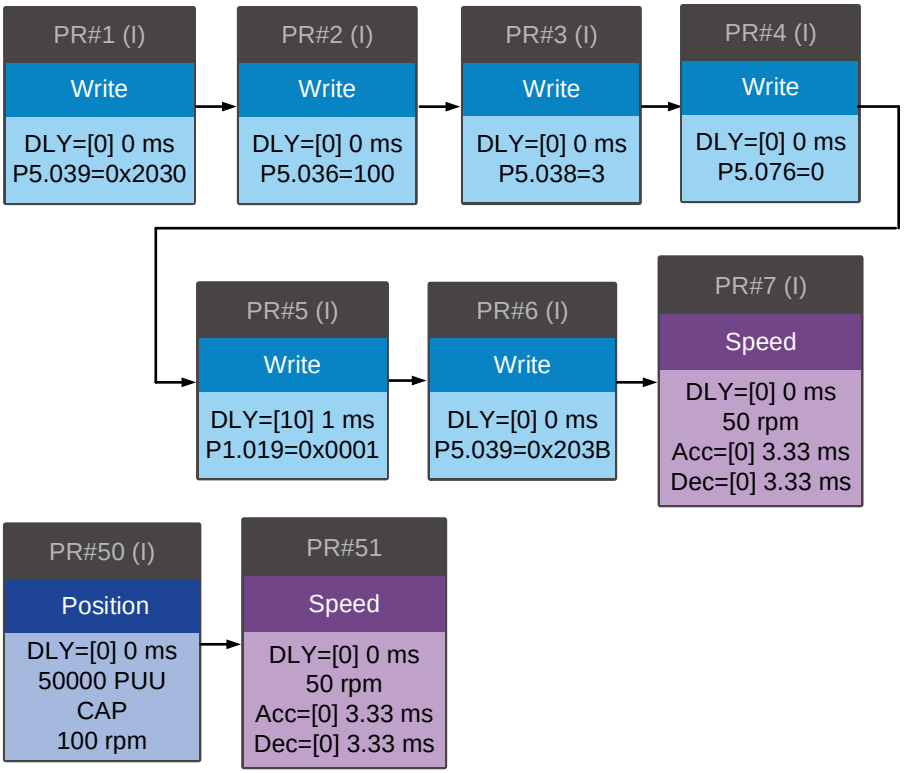


Figure 7.2.2.3 PR path with application of high-speed capture function

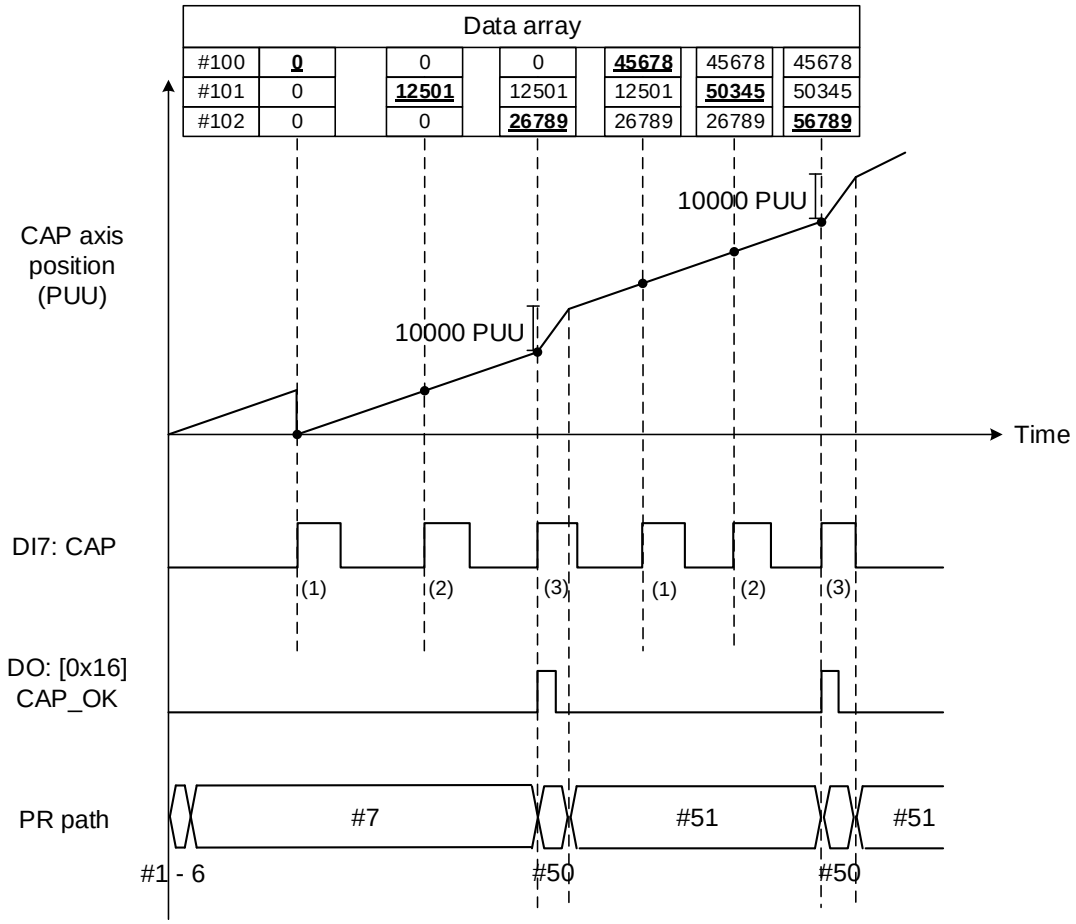


Figure 7.2.2.4 Application example for high-speed capture function

7.2.3 High-speed position compare function (Compare)

The high-speed position compare function (CMP) compares the instant position feedback of the motion axis with the value saved in the data array. When the compare condition is fulfilled, a high-speed digital signal DO4 (with execution time of only 5 μs) is sent immediately for motion control. As the Compare function is executed by the hardware, there is no lag in the software, and the position compare is more accurate on high speed motion axes. While the Compare function is enabled, the servo drive outputs a DO4 signal (DO4 is not user-defined).

As shown in Figure 7.2.3.1 Flow chart for the high-speed position compare function, P5.056 sets the start position in the data array for comparing (default is #50 in the data array). You must write the position data to be compared to the data array before comparing. P5.058 sets the comparing amount. The amount has to be greater than 0, otherwise the Compare function is not executed. P5.059 enables and disables the Compare function and other settings. See the following table for more information. Note that when the comparing source is CN2, the pulse resolution of the comparing axis is set by P1.046 (numerator) and P1.097 (denominator) with default values of 2500 and 0 respectively; that is, the moving distance of the comparing axis is 10000 PUU per rotation of motor. The comparing position in the data array can be shifted using P1.023 (non-volatile) and P1.024 (volatile). You can reset P1.024 to 0 after the shift, and you can enable this function with P1.019.Z. You can also set the Compare function in ASDA-Soft, as shown in Figure 7.2.3.2.

P5.059	bit	Function	Description
X	0	Enable high-speed position compare function	When P5.058 > 0 and bit 0 = 1, the comparing starts. Each time a point is compared, the value of P5.058 is decremented by 1. When P5.058 = 0, it means the comparing is finished, and bit 0 is reset to 0. If bit 0 is already 1, the written value must not be 1; you must write 0 to disable the Compare function.
	1	Cycle mode	If bit 1 = 1, after all comparing is complete, P5.058 resets to the setting value and then the compare procedure starts again.
	2	Enable Capture function after data compared	If bit 2 = 1, after all comparing is complete, enable the Capture function (P5.039.X bit 0 = 1 and set the previous value to P5.038 as the data size to be captured). If the Capture function is already enabled, then this bit function is invalid.
	3	Reset position for the comparing axis to 0	If bit 3 = 1, set P5.057 to 0 once all comparing is complete, the position for the comparing axis is reset to 0.
Y	-	Source setting of comparing axis	0: capturing axis 1: CN5 2: CN1 (pulse command) 3: CN2 When the source of Compare is the Capture axis, the source of Capture (P5.039.Y) cannot be changed.. If CN2 is selected as the source, the pulse resolution is determined by P1.046 and P1.097 (Encoder pulse number output setting).
Z	-	Trigger logic	0: NO (normally open) 1: NC (normally closed)
U	-	Trigger PR path	If bit 0 = 1, PR#45 is triggered once the last data is compared.
CBA	-	Pulse output duration (ms)	-

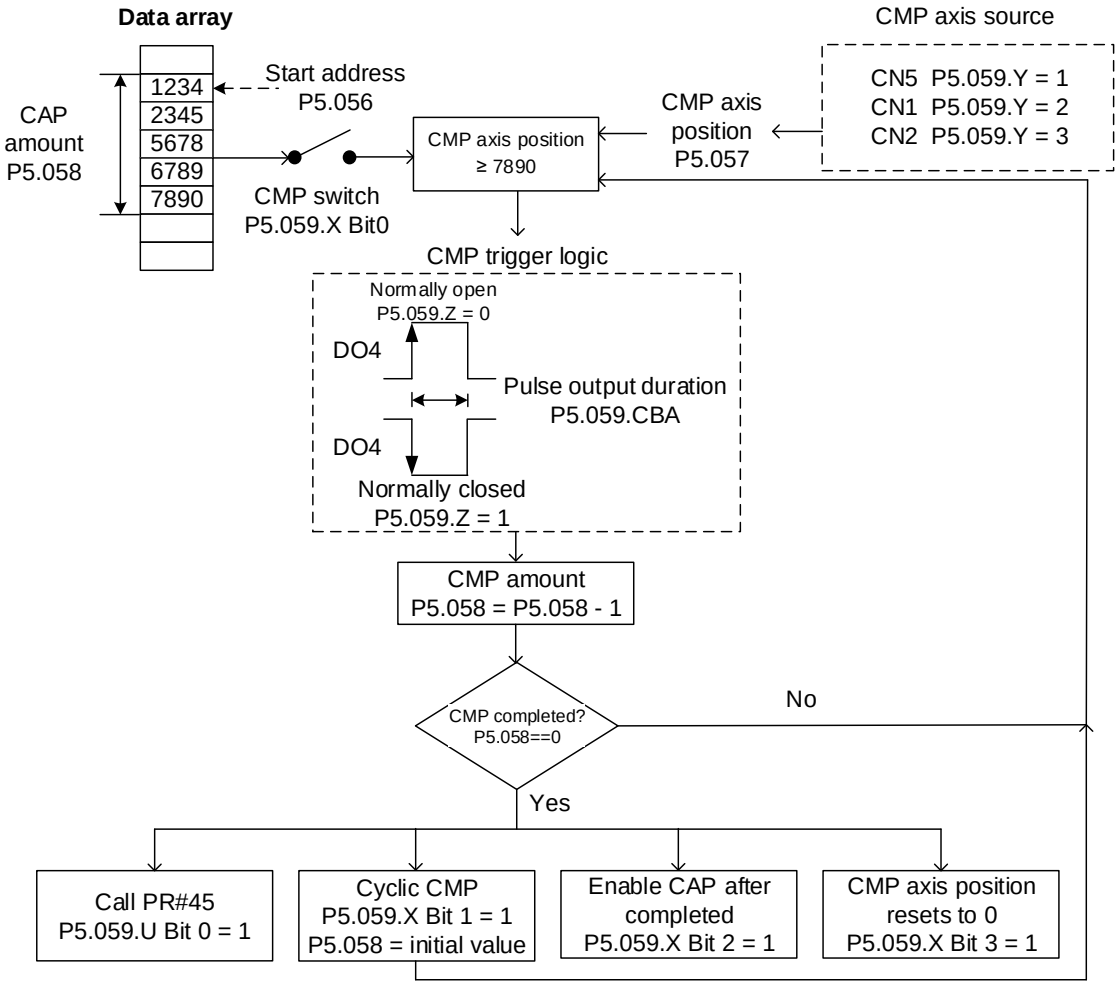


Figure 7.2.3.1 Flow chart for the high-speed position Compare function

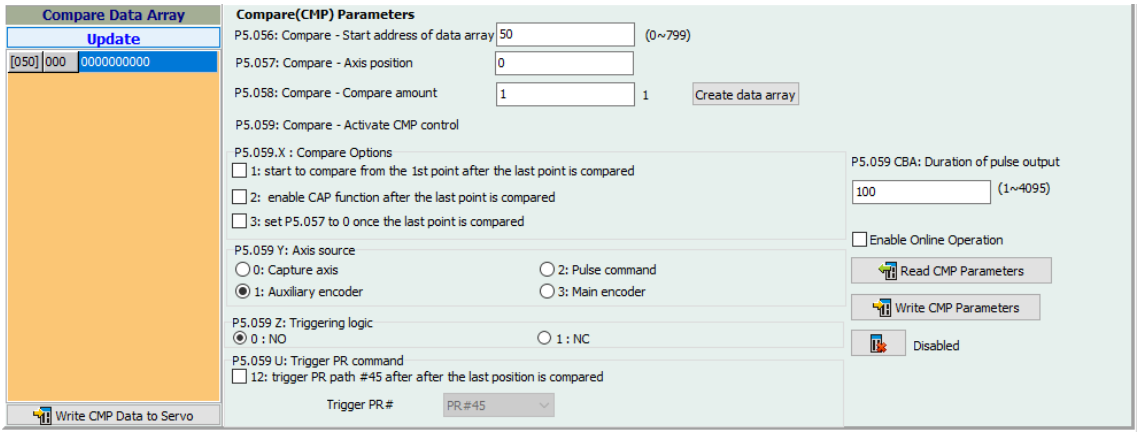


Figure 7.2.3.2 Compare Function screen in ASDA-Soft

It is suggested that you use PR path programming to use motion commands with the Compare function. You can use Write commands to edit the contents of the data array and set the high-speed position Compare function, as well as executing the motion command. As shown in Figure 7.2.3.3, you set the numerator (P1.046) and denominator (P1.097) for the encoder's pulse output (the default is based on the comparing axis running 10000 pulses per rotation of the motor). PR#1 - 3 use Write commands to edit data array #50 - 52. PR#4 confirms that the Compare function is disabled (P5.039.X Bit 0 = 0). PR#5 sets the start position to #50. PR#6

7

sets the comparing amount to 3. PR#7 resets the compare axis position to 0 and sets a delay of 1 ms to ensure that the PR path using the Compare function can be executed. PR#8 enables the Compare function in Cycle mode which resets the comparing axis to 0 after the comparison is complete, and executes PR#45. It selects CN2 as the capturing axis source, setting 'normally closed' as the trigger logic with pulse output duration of 100 ms. PR#9 sets the Speed command to 50 rpm. PR#45 sets the Incremental command to 50000 PUU and then PR#46 keeps the Speed command setting at 50 rpm.

From Figure 7.2.3.4, you see that when the comparing axis runs to 20000 pulses, it is identical to the contents of data array #50 and the first DO4 is set to on. When the comparing axis runs to 30000 pulses, it is identical to the contents of data array #51 and the second DO4 is set to on. When the comparing axis runs to 40000 pulses, it is identical to the contents of data array #52 and the third DO4 is set to on. Once the first cycle completes, the comparing axis resets to 0 and executes PR#45 (Incremental command 50000 PUU), which is equivalent to a half turn of the motor. Therefore, the comparing axis outputs 5000 pulses, and after the position command completes, it executes the Speed command. Then the next comparing cycle starts This is the same as the first cycle, and the comparing axis outputs DO4 signal at 20000, 30000, and 40000 pulses respectively and then it resets to 0 and executes PR#45.

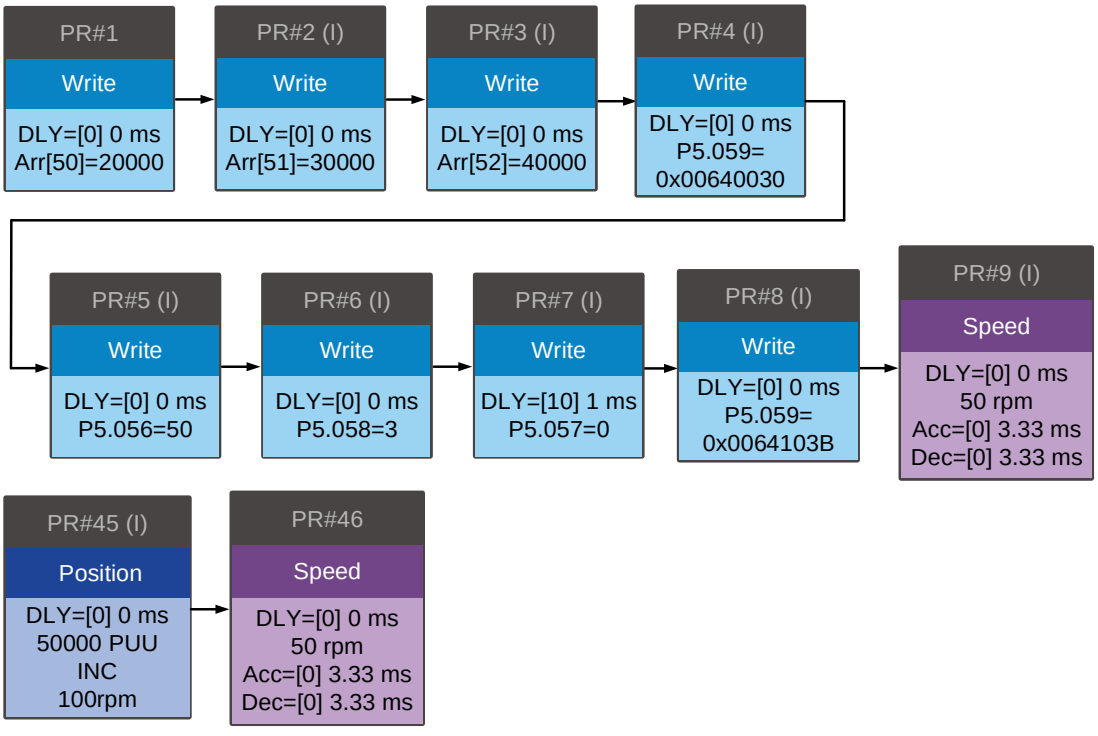


Figure 7.2.3.3 PR path using the Compare function

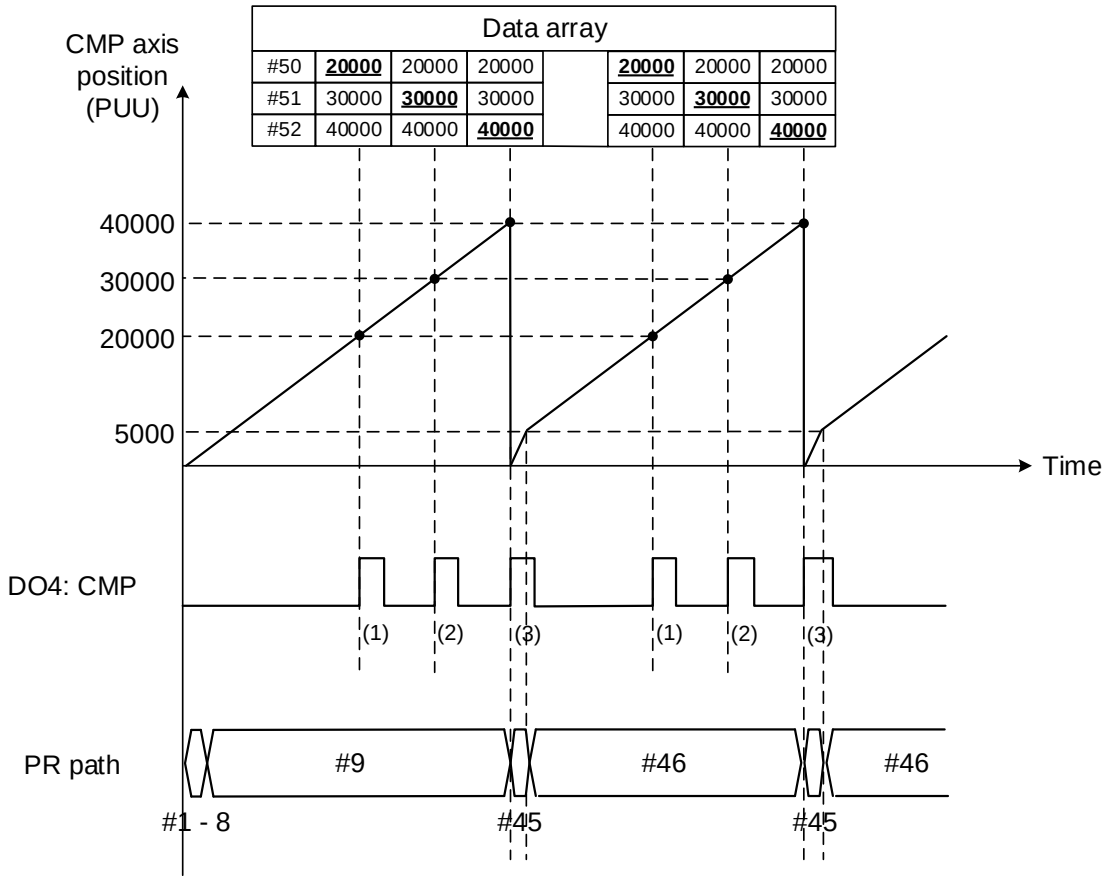
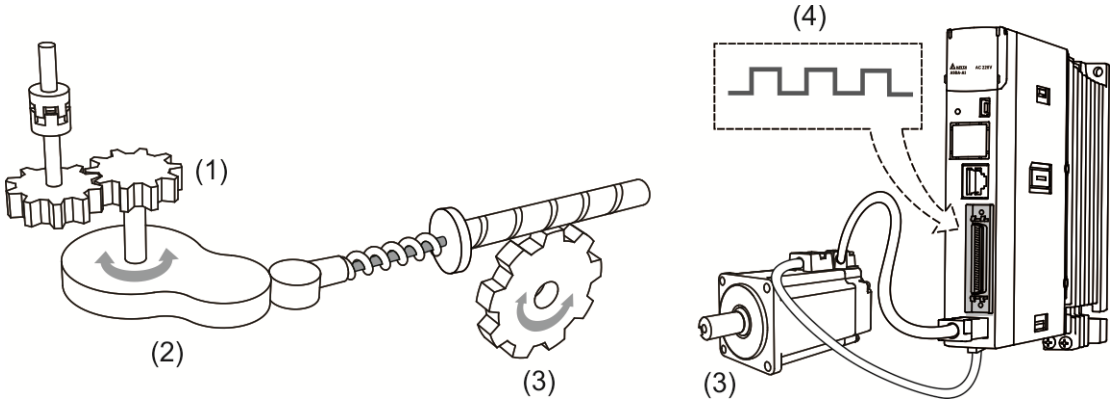


Figure 7.2.3.4 Timing of the Compare function

7.3 E-Cam

The E-Cam system uses the mathematical formula to plan the relative following motion path based on the master-slave operation, which can replace the actual mechanical cams and overcome the limitation of the mechanical cam shapes. You can use the E-Cam function as long as it is a master-slave application and their positions can translate into a mathematical formula. The mechanical cam and E-Cam are shown in Figure 7.3.1.



(1) Master axis input; (2) Mechanical cam; (3) Slave axis output; (4) E-Cam master axis input

Figure 7.3.1 Mechanical cam and E-Cam

The E-Cam function is only available in PR mode (P1.001 = 1). The slave axis operates based on the cam curve; the positions of the master and slave correspond to a mathematical function. The master axis sends pulses to the slave axis so the slave axis runs according to the corresponding E-Cam curve, as shown in Figure 7.3.2. P5.088.X can enable or disable the E-Cam function. When this function is enabled, the servo drive determines the clutch engagement and disengagement timings. Figure 7.3.3 introduces the E-Cam parameters with a mechanical cam illustration. See the detailed settings in the following section.

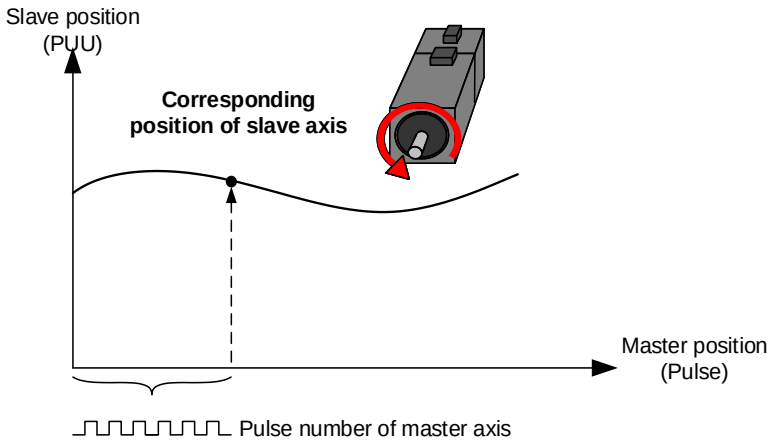
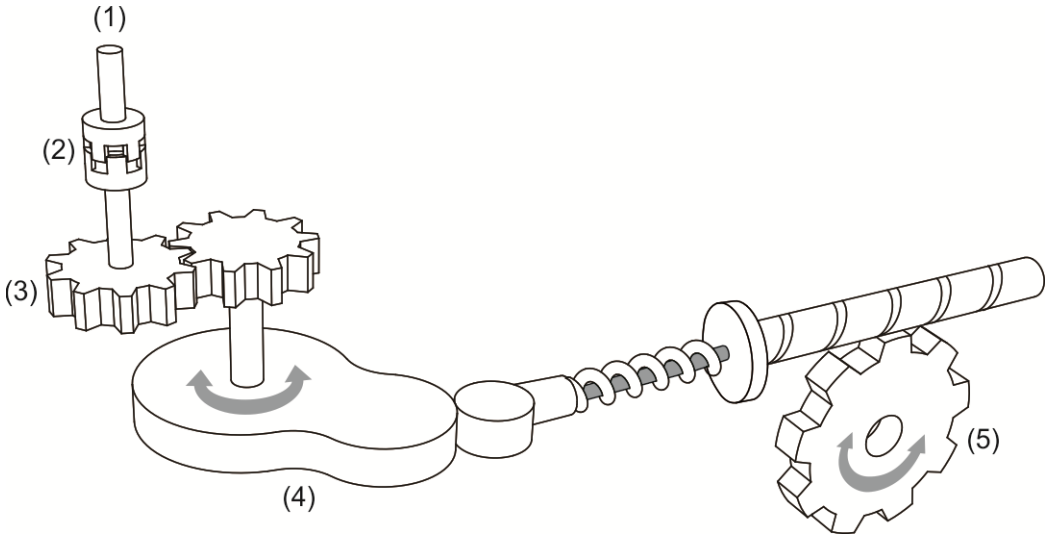


Figure 7.3.2 E-Cam curve



(1) Master axis: P5.088.Y: command source for the master axis
(2) Clutch: P5.088.UZ, P5.087, and P5.089: engagement and disengagement timing control
(3) E-Gear of master axis: P5.083 and P5.084: command pulse resolution
(4) E-Cam curve: P5.081, P5.082, and P5.085: position correlations of master and slave axes; P5.019: scaling
(5) E-Gear of slave axis: P1.044 and P1.045: output signal resolution

Figure 7.3.3 Use E-Cam servo parameters to simulate mechanical cams

7.3.1 Source signal for the master axis

When using the E-Cam function, you must specify the signal source for the master axis, which can be the encoder, controller, or servo drive. The ASDA-A3 servo drives support seven source types for the master axis. You can use P5.088.Y to select the master axis signal source and monitor the master axis position with P5.086.

1. Capture axis: when P5.088.Y = 0, it uses the source set in P5.039.Y (Capture function source) as the master axis signal source. You can read the value of P5.037 to acquire the master axis position.
2. Encoder: when P5.088.Y = 1, it uses CN5 external encoder signals as the master axis signal source. You can read the value of P5.017 to acquire the master axis position.
3. Pulse input: when P5.088.Y = 2, it uses pulses input through CN1 as the master axis signal source. You can read the value of P5.018 to acquire the master axis position.
4. PR command: when P5.088.Y = 3, it uses the PR motion control command as the master axis signal source.
5. Time axis (1 ms): when P5.088.Y = 4, it uses the pulse signal generated per ms from the servo drive as the master axis signal source.
6. Synchronous Capture axis: when P5.088.Y = 5, it uses the signals processed by the Capture function as the master axis signal source. This is mainly for adjusting the relative positions between the master and slave axes so as to keep all phases synchronous, such as mark tracking during cutting. Please refer to Section 7.3.7.
7. Analog speed channel: when P5.088.Y = 6, it uses the analog speed command as the master axis signal source; 10V corresponds to the frequency of 1 M pulse/s.

ASDA-A3 provides two sets of DO, [0x18] CAM_AREA1 and [0x1A] CAM_AREA2, which specify the current E-Cam operation position (in respect of the master axis). The first set is set by P5.090 and P5.091; the second set is set by P2.078 and P2.079, as shown in Figure 7.3.1.1. For detailed settings, refer to Chapter 8.

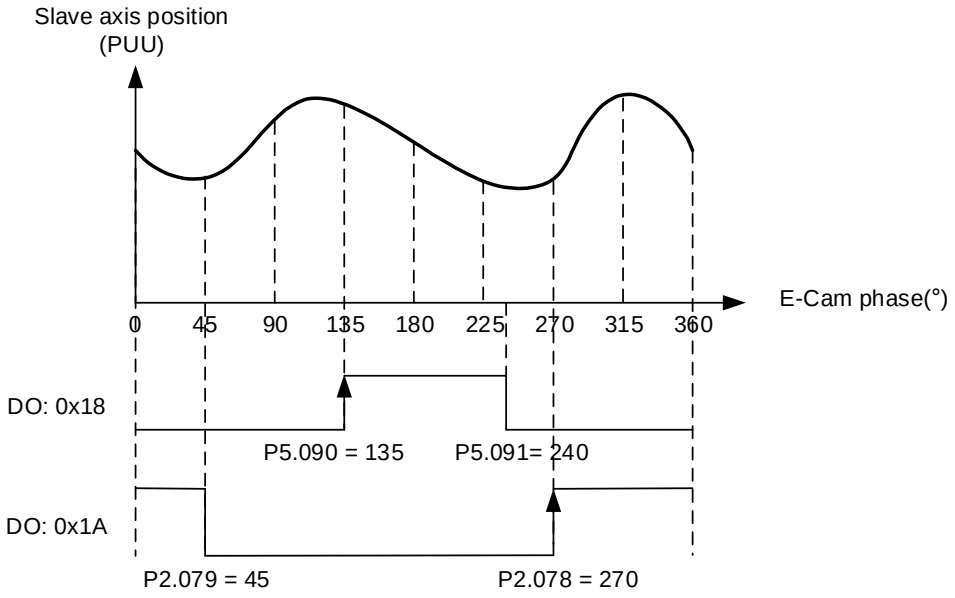


Figure 7.3.1.1 DO is on when the clutch engages

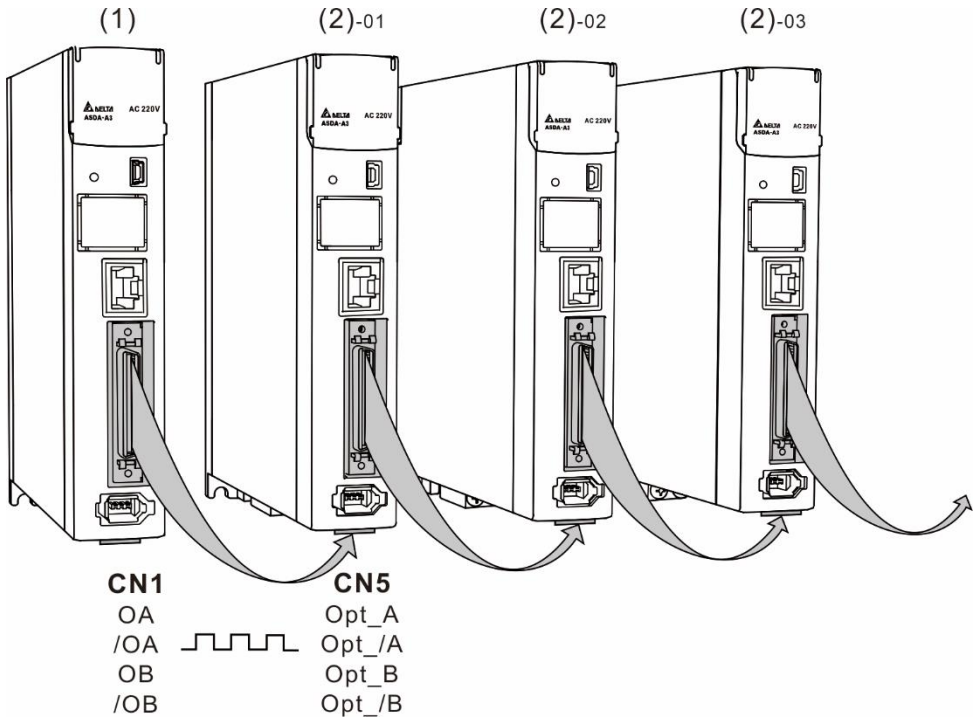
To get the data for the master axis, use four monitoring variables, which are Accumulative pulse of master axis, Incremental pulse of master axis, Pulse of master axis (lead pulse), and Position of master axis. The following is the detail description for the four monitoring variables.

1. Accumulative pulse of master axis: monitoring variable code 059(3Bh); the accumulative pulse number of the E-Cam master axis. Same as P5.086.
2. Incremental pulse of master axis: monitoring variable code 060(3Ch); the incremental pulse number of the E-Cam master axis generated per 1 ms.
3. Pulse of master axis (lead pulse): monitoring variable code 061(3Dh); when the clutch is engaged, the master axis disengagement pulse number (P5.089) decrements to 0 and then the clutch disengages; when the clutch is disengaged, the master axis lead pulse number (P5.087 or P5.092) decrements to 0 and then the clutch engages.
4. Position of master axis: monitoring variable code 062(3Eh); the position of the E-Cam master axis.

Pulse by-pass function

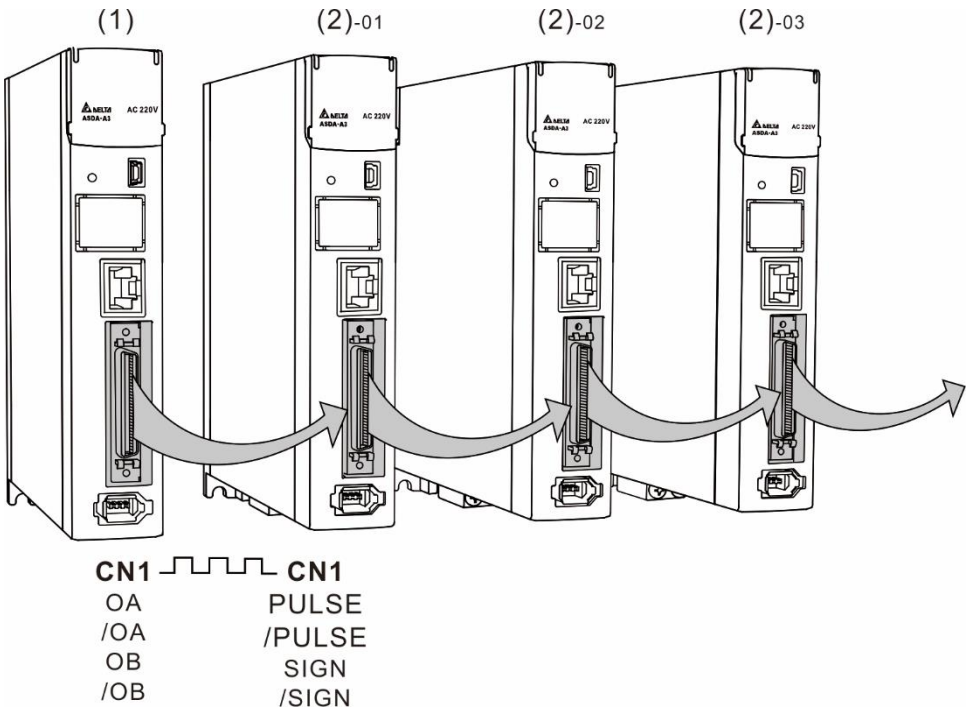
When using the E-Cam and pulse by-pass functions, the servo drive can receive pulse signals and send these signals to the next servo axis, so multiple slave axes can refer to the same master axis signals. In addition, signals transmitted through the servo drives are not attenuated because the servo drive amplifies the signals to the strength they should have during output. For example, if the signal input is 4.5V, it becomes 5V when output. Since there is electrical resistance in the wire, take the signal attenuation into account and use twisted-pair shielded wires. If the signals transmitted to the servo drive are attenuated to the level that the servo cannot identify, use a cable with thicker gauge or a shorter signal cable. If not considering the signal delay caused by cables, the delay time of each servo drive is 50 ns.

On the ASDA-A3 servo drives, the pulse output pins are OA, /OA, OB, and /OB of CN1 only; pulses can be input through CN1 or CN5 to the servo drive. Use P1.074.Y to set the output signal source for the servo drive. If selecting CN5 as the pulse input channel, as shown in Figure 7.3.1.2, then you must set P1.074.Y to 1 for each slave axis (servo drive) to have CN5 receive pulses. If selecting CN1 as the pulse input channel, as shown in Figure 7.3.1.3, then you must set P1.074.Y to 2 for each slave axis (servo drive) to have CN1 receive pulses.



(1) Master axis; (2) Slave axes 1, 2, and 3.

Figure 7.3.1.2 Pulse by-pass function: CN1 output / CN5 input



(1) Master axis; (2) Slave axes 1, 2, and 3.

Figure 7.3.1.3 Pulse by-pass function: CN1 output / CN1 input

7.3.2 Clutch engagement and disengagement

When the E-Cam function is enabled, the E-Cam clutch status determines whether the slave axis operates based on the signals sent from the master axis. While cams are engaged, the slave axis operates according to the received master axis pulses and the E-Cam curve; when cams are disengaged, the slave axis does not operate according to the E-Cam curve even if it receives the master axis pulses. The clutch engagement and disengagement timings are described as follows.

Clutch engagement condition

After the E-Cam function is enabled, the slave axis operates according to the master axis signals and E-Cam curve only when the clutch is engaged as shown in Figure 7.3.2.1. The timing for clutch engagement can be specified with P5.088.Z. The ASDA-A3 provides three condition options for clutch engagement timing:

1. Engage immediately (P5.088.Z = 0): the clutch engages immediately as soon as the E-Cam function is enabled. The slave axis operates according to the E-Cam curve and the master axis signals.
2. Engagement control with DI (P5.088.Z = 1): trigger DI.[0x36]CAM to have the clutch engaged. When this DI is triggered, the clutch remains engaged until the disengagement condition is met.
3. Engagement control with high-speed capturing (P5.088.Z = 2): when the master axis source is the Capture axis and the first position data is captured, input a signal from DI7 to have the clutch engaged immediately. Different from triggering DI.[0x36]CAM for clutch engagement, the high-speed capturing function only takes 5 μs to have the clutch engaged using the DI7, making the system timing control more precise.

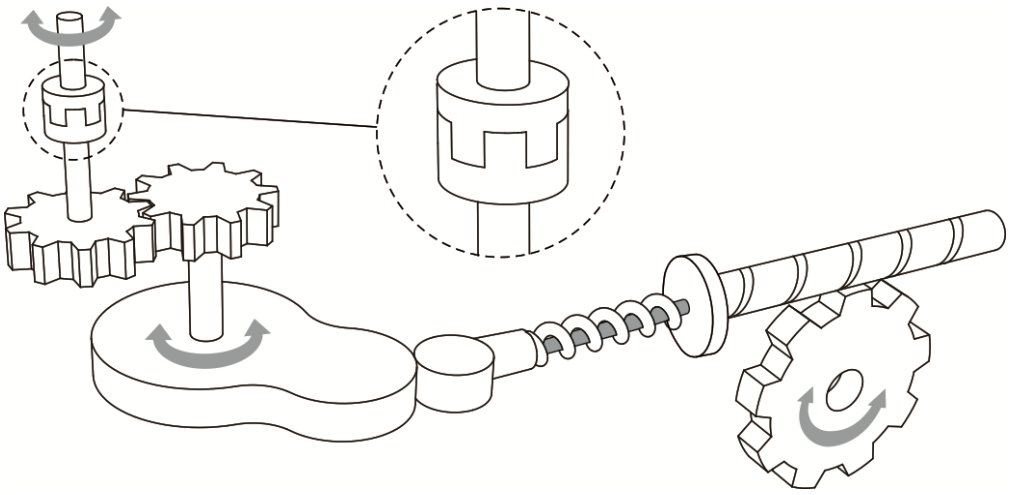


Figure 7.3.2.1 Clutch engagement

In addition, you can use P5.087 to set the initial lead pulse of the master axis before engagement. That is, once the engagement condition is met, the master axis needs to reach the set lead pulse number first and then the clutch is engaged as shown in Figure 7.3.2.2.

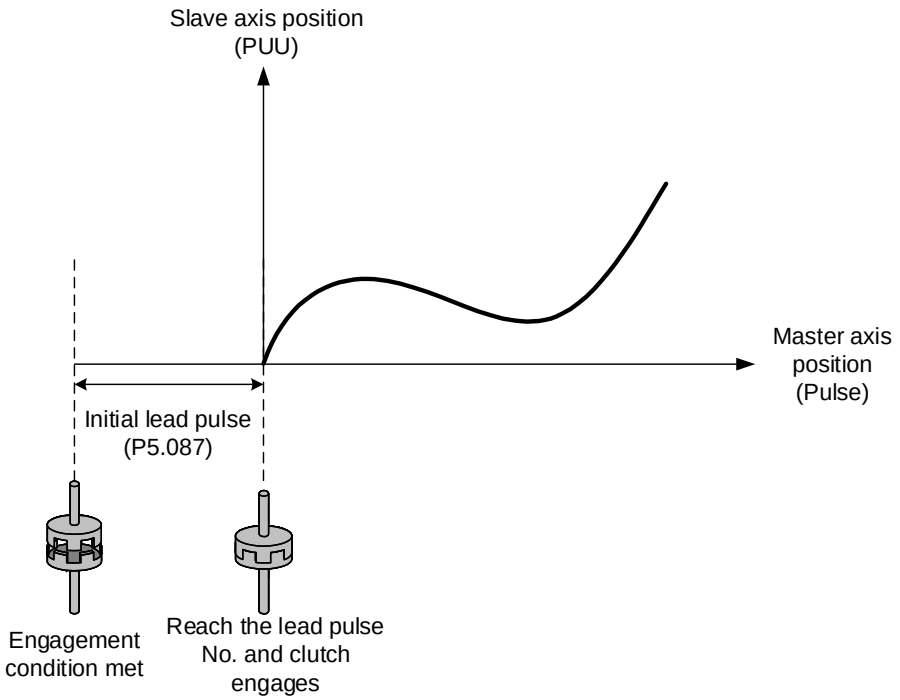


Figure 7.3.2.2 Initial lead pulse before clutch engagement

Clutch disengagement condition

When the E-Cam function is enabled and the clutch is engaged, the slave axis operates based on the E-Cam curve and master axis signals. When the slave axis completes the motion, you can directly disable the E-Cam function or disengage the clutch to stop the slave axis motion. While the clutch is disengaged, the slave remains stationary regardless of the master axis motion as shown in Figure 7.3.2.3.

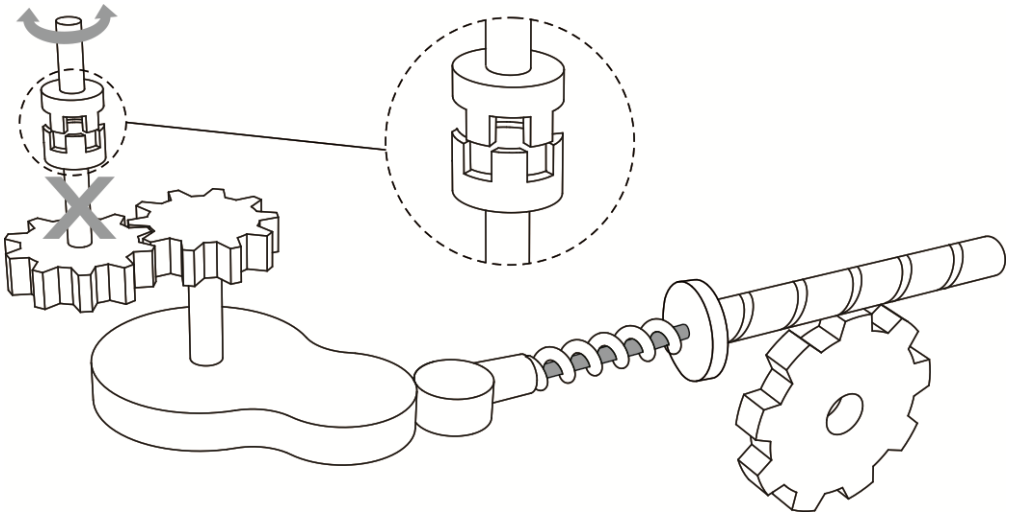


Figure 7.3.2.3 Clutch disengagement

You can use P5.088.U to select the disengagement condition depending on the applications. The ASDA-A3 provides five condition options for clutch disengagement timing.

1. Remain engaged (P5.088.U = 0): the clutch remains engaged unless the E-Cam function is disabled.
2. Disengagement control with DI (P5.088.U = 1): switch the DI.[0x36]CAM to off to have the clutch disengaged. When this DI remains off, the clutch remains disengaged and the E-Cam system is in stop state.
3. Immediate stop after disengagement (P5.088.U = 2): when the clutch is engaged and the pulse number of the master axis reaches the value set in P5.089, the clutch disengages, the slave axis stops immediately, and the E-Cam system is in stop state as shown in Figure 7.3.2.4. This function is suitable for applications that require the slave axis to accurately stop at the specified position.

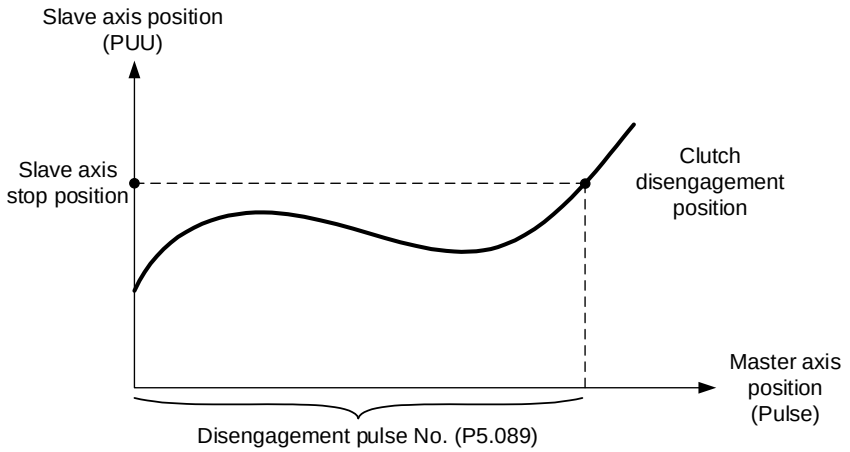


Figure 7.3.2.4 Disengagement timing: slave axis stops right after clutch disengagement

4. Decelerate to stop after disengagement (P5.088.U = 6): when the clutch is engaged and the pulse number of the master axis reaches the value set in P5.089, the clutch disengages, the slave axis decelerates to stop, and the E-Cam system is in stop state as shown in Figure 7.3.2.5. This function is suitable for applications that require the slave axis to slowly decelerate to stop.

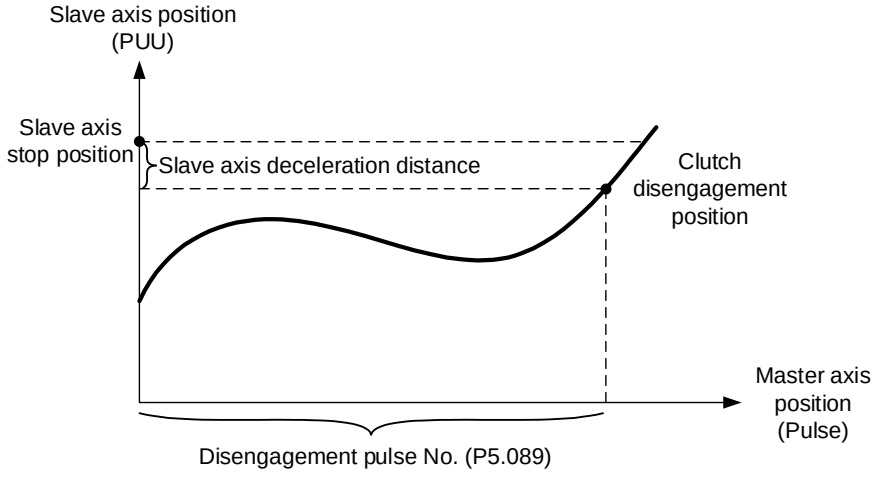


Figure 7.3.2.5 Disengagement timing: slave axis decelerates to stop after clutch disengagement

5. Enter cyclic mode after disengagement (P5.088.U = 4): when the clutch is engaged and the pulse number of the master axis reaches the value set in P5.089, the clutch disengages and the master and slave axes enter the cyclic mode. Then, the E-Cam system goes into the
pre-engage state and waits for the master axis pulse to reach the number set in P5.092. Next, the clutch re-engages and operation of the next cycle starts. See Figure 7.3.2.6.

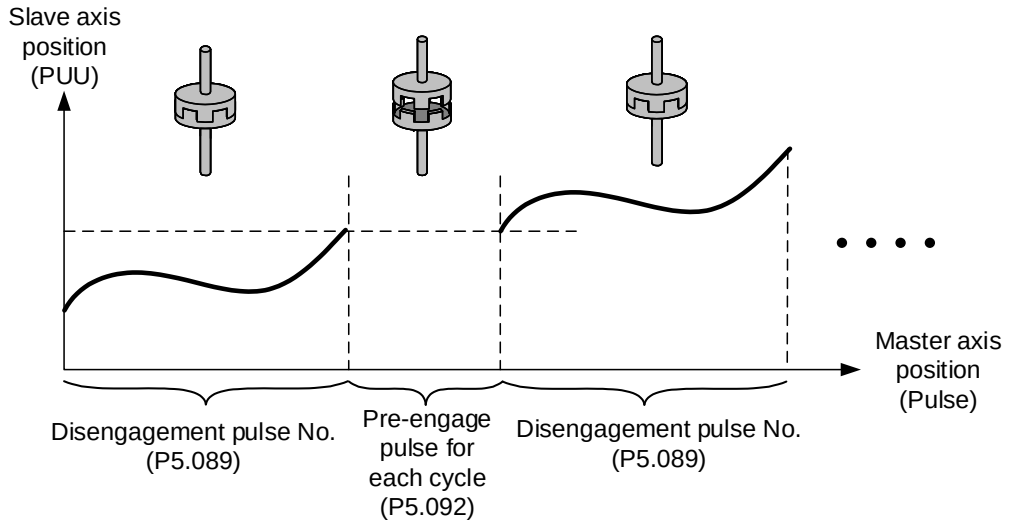


Figure 7.3.2.6 Disengagement timing: cyclic mode

Note that the “pre-engage pulse for each cycle” and the “initial lead pulse” are different. The “initial lead pulse” is valid only for the first engagement whereas the “pre-engage pulse for each cycle” is effective before each engagement cycle. You can see how these two work together in Figure 7.3.2.7.

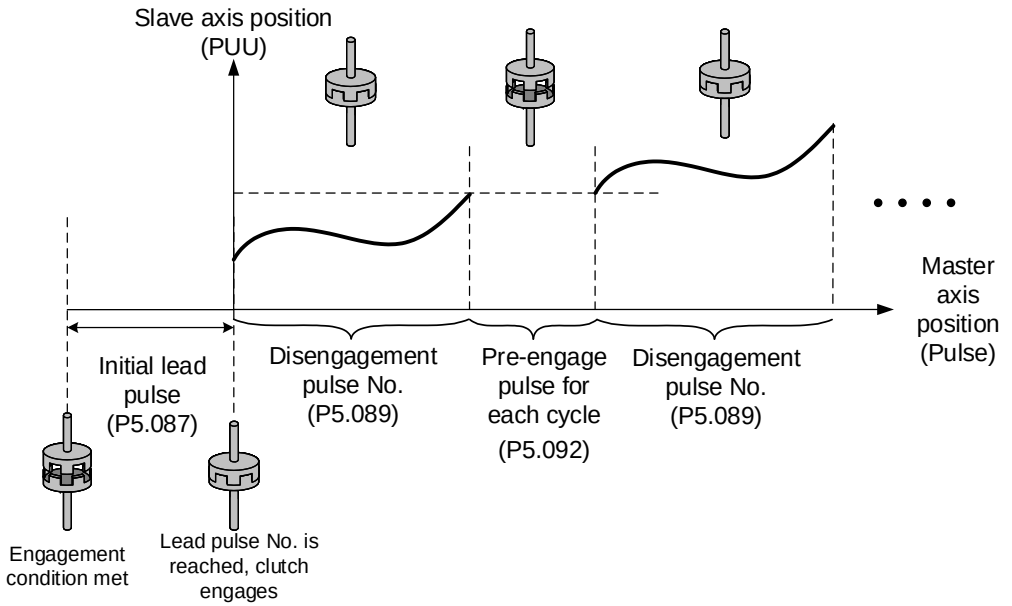


Figure 7.3.2.7 “Initial lead pulse” and “Pre-engage pulse for each cycle”

7

There are three available options for disengagement timing (choose one of the following): “Immediate stop after disengagement”, “Decelerate to stop after disengagement”, or “Enter cyclic mode after disengagement” (P5.088.U = 2, 6, or 4). If you select the disengagement options such as “Disengagement control with DI”, “Immediate stop after disengagement”, or “Decelerate to stop after disengagement” (P5.088.U = 1, 2, or 6), you can activate the function for disabling the E-Cam after clutch disengagement (P5.088.U = 8). This is the same as setting P5.088.X to 0; however, you cannot set it individually; you need to use one of the three options (P5.088.U = 1, 2, or 6) when setting P5.088.U to 8. You can stop the slave axis by disengaging the clutch or disabling the E-Cam. Regardless of the current state of the E-Cam system (stop, engaged, or disabled), you need to enable the E-Cam function to operate it. When the clutch is disengaged, although the slave axis is stopped, the slave axis continues to monitor the signals sent from the master axis as the E-Cam system remains operating. Settings for clutch disengagement timing and disabling E-Cam function are as follows:

P5.088.U value	Clutch disengagement condition	System status after disengagement
0	Condition 0: remains engaged	-
1	Condition 1: disengages when DI (DI: 0x36) is off	0: stop
2	Condition 2: disengages when the master axis pulse number reaches the setting value of P5.089, and the slave axis stops immediately	0: stop
3	Condition 1 + Condition 2: disengages when DI (DI: 0x36) is off or when the master axis pulse number reaches the setting value of P5.089, and the slave axis stops immediately	0: stop
4	Condition 4: disengages when the master axis pulse number reaches the setting value of P5.089 and the master and slave axes enters the cyclic mode. When the pre-engaged pulse number for each cycle (P5.092) is reached, the clutch re-engages	2: pre-engage
5	Condition 1 + Condition 4: E-Cam enters the cyclic mode, but disengages when DI (DI: 0x36) is off	0: stop 2: pre-engage
6	Condition 6: disengages when the master axis pulse number reaches the setting value of P5.089, and the slave axis decelerates to stop	0: stop
7	Condition 1 + Condition 6: disengages when DI (DI: 0x36) is off or when the master axis pulse number reaches the setting value of P5.089, and the slave axis decelerates to stop	0: stop
8	Condition 8: set other disengagement conditions first, and the E-Cam function is disabled after the clutch disengages	-
9	Condition 1 + Condition 8: disengages when DI (DI: 0x36) is off and the E-Cam function is disabled	0: stop and disable the E-Cam function
A	Condition 2 + Condition 8: disengages when the master axis pulse number reaches the setting value of P5.089, the slave axis stops immediately, and the E-Cam function is disabled	0: stop and disable the E-Cam function
B	Condition 1 + Condition 2 + Condition 8: disengages when DI (DI: 0x36) is off or when the master axis pulse number reaches the setting value of P5.089, the slave axis stops immediately, and the E-Cam function is disabled	0: stop and disable the E-Cam function
C	Reserved	-
D	Condition 1 + Condition 4 + Condition 8: disengages when DI (DI: 0x36) is off and the E-Cam function is disabled, otherwise the system operates according to the condition of P5.088.U = 4	0: stop 2: pre-engage and disable the E-Cam function

P5.088.U value	Clutch disengagement condition	System status after disengagement
E	Condition 6 + Condition 8: disengages when the master axis pulse number reaches the setting value of P5.089, the slave axis decelerates to stop, and the E-Cam function is disabled	0: stop and disable the E-Cam function
F	Condition 1 + Condition 6 + Condition 8: disengages when DI (DI: 0x36) is off or when the master axis pulse number reaches the setting value of P5.089, the slave axis decelerates to stop, and the E-Cam function is disabled	0: stop and disable the E-Cam function

Note: for the system status after disengagement, refer to the following sections.

You can choose one of the three disengagement conditions for the PR path after the clutch disengagement, which are “Immediate stop after disengagement”, “Decelerate to stop after disengagement”, and “Enter cyclic mode after disengagement” (P5.088.U = 2, 6, or 4). Write the PR number in hexadecimal to P5.088.BA. If this value is 0, it means no PR path is executed after the **disengagement**. In addition, if you use the setting “Enter cyclic mode after disengagement (P5.088.U = 4)” and specify the following PR path, as the E-Cam function does not have an interruption setting, the slave axis carries on to the next cycle until the motion set in the PR path is complete.

7

E-Cam system status

The E-Cam system has three states, Stop, Engage, and Pre-engage. When the E-Cam function is enabled, you can use P5.088.D to promptly monitor the system's current status. The following section explains each state, as shown in Figure 7.3.2.8.

1. Stop state (P5.088.D = 0): the clutch is disengaged and the system continues to check the engagement condition (P5.088.Z). If the engagement condition is met and the initial lead pulse (P5.087) is not set, the clutch engages. If you have set the initial lead pulse, the system enters the Pre-engage state. When the E-Cam function is disabled, the system is also in the stop state.
2. Engage state (P5.088.D = 1): the clutch is engaged and the system continues to check the disengagement condition (P5.088.U). If one of the three disengagement conditions, "Disengagement control with DI", "Immediate stop after disengagement, or "Decelerate to stop after disengagement" (P5.088.U = 1, 2, or 6) is met, the system is stopped. If the condition "Enter cyclic mode after disengagement (P5.088.U = 4)" is met, the system enters the Pre-engage state.
3. Pre-engage state (P5.088.D = 2): the clutch is disengaged. If pulses from the master axis reach the initial lead pulse number or the pre-engaged pulse number for each cycle, the clutch engages and the system enters the Engage state.

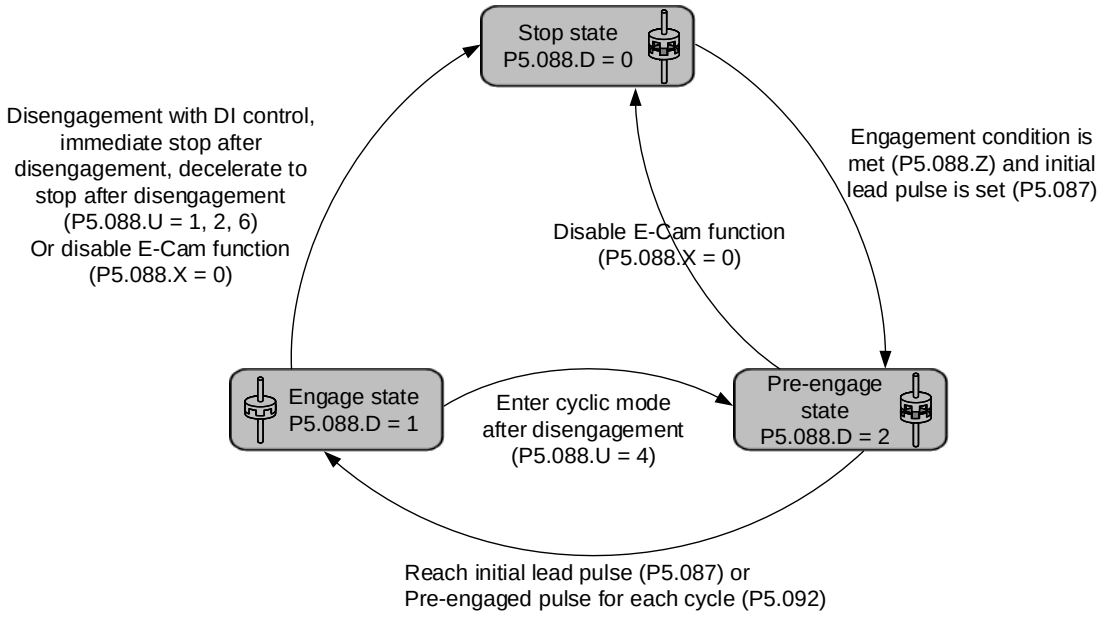
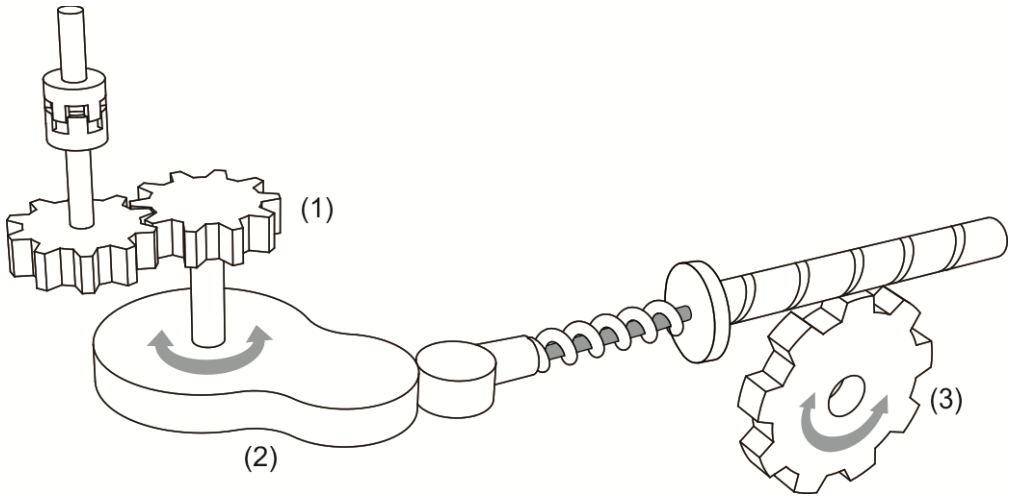


Figure 7.3.2.8 E-Cam system status

7.3.3 E-Cam gears and curve scaling

In the E-Cam system, two sets of E-Gears can determine the E-Cam motion, which are E-Gears of the master axis and E-Gears of the slave axis. The E-Gears of the slave axis is the same as that of the whole servo system. Their E-Gear settings are both determined by P1.044 and P1.045. Changing this E-Gear ratio will change the E-Cam motion and motion commands in PT and PR modes as well. Therefore, if you need to change the E-Cam curve scaling, changing P1.044 and P1.045 is not suggested.

The E-Gear of the master axis is only for the E-Cam system and can change the pulse command resolution of the master axis. The setting parameters are P5.083 and P5.084. When the slave axis receives the pulse number defined by P5.084 from the master axis, E-Cam rotates the number of cycles defined by P5.083 (one cycle of E-Cam = rotate from 0° – 360°).



(1) E-Gear of master axis: P5.083 and P5.084 for command pulse resolution
(2) E-Gear curve: P5.019 for scaling
(3) E-Gear of slave axis: P1.044 and P1.045 for output signal resolution

Figure 7.3.3.1 E-Cam gear ratio

7

The following example illustrates how the command resolution is adjusted: assume that the original master axis pulse number for one cycle is 10000 pulses as shown in Figure 7.3.3.2. If this master axis E-Gear ratio becomes larger (P5.084 increases or P5.083 decreases), then the master axis pulse unit corresponds to a narrower E-Cam phase, making the master axis pulse command resolution higher. When the master axis E-Gear ratio becomes smaller (P5.084 decreases or P5.083 increases), the master axis pulse unit corresponds to a wider E-Cam phase, making the master axis pulse command resolution lower. In common applications, P5.083 is set to 1 and P5.084 is for specifying the required master axis pulse number for the E-Cam to operate one cycle. If the required master axis pulse number has decimal places, you can adjust the value of P5.083. For example, when the required master axis pulse for operating one cycle is 517.5, you can set P5.083 to 2 and P5.084 to 1035.

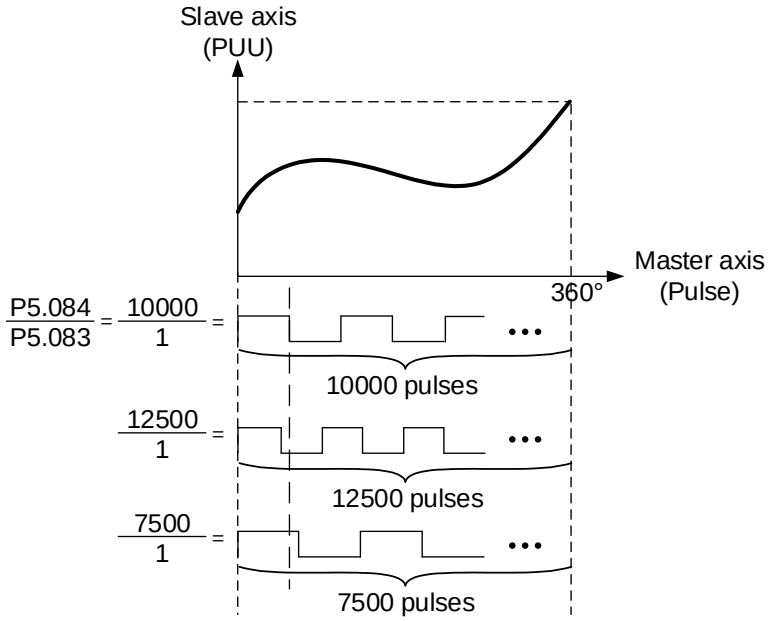


Figure 7.3.3.2 E-gear ratio for E-Cam

To change the slave axis motion path proportionally in E-Cam applications, it is suggested to use P5.019 to scale the E-Cam curve. This parameter is only effective to the E-Cam system and does not affect other motions in the servo system. As shown in Figure 7.3.3.3, if P5.019 = 2, the output curve of the slave axis is two times of the original. If P5.019 = 0.5, the output curve of the slave axis is 0.5 times of the original. If P5.019 = -1, the positive and negative outputs of the slave axis are reversed.

P5.088.X Bit 2 can specify the effective timing for the E-Cam curve scaling with the options of taking effect immediately and after clutch re-engagement. For example, after adjusting the cutting length in flying shear applications, you can use this parameter to determine when to make the modified E-Cam curve scaling take effect. If the clutch is set to remain engaged and modifying the cutting length is required, set P5.088.X Bit 2 to 1 (modified E-Cam curve scaling

is effective immediately). Do not modify P5.088 during cutting, or the machine might be damaged.

If you set P5.088.X Bit 2 to 0 to have the modified E-Cam curve scaling take effect upon the next engagement, then the cutting length changes upon the next clutch engagement. For details about flying shear applications, refer to Section 7.3.8.

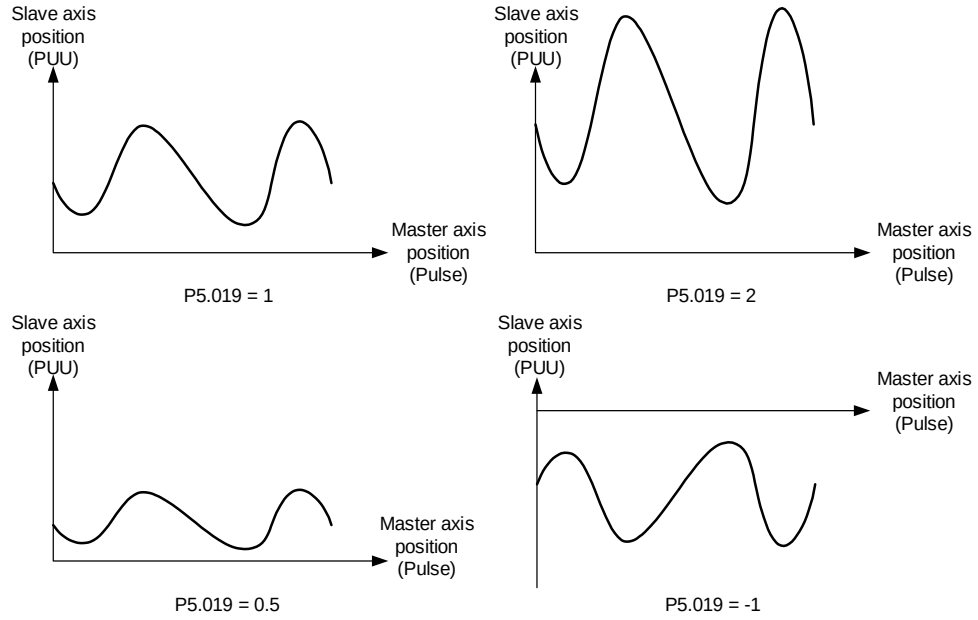
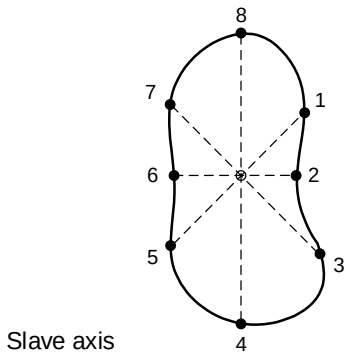


Figure 7.3.3.3 E-Cam curve scaling

7.3.4 E-Cam curve

E-Cam curve is created by the mathematic function based on positions of the master and slave axes. There are various ways to create the table. You can use mathematic tools (software) or use the tabulation interface for industry-specific applications provided in ASDA-Soft. Regardless of the tabulation methods, the software coverts the mathematic function into position data and stores them in the data array. One E-Cam curve can have up to 721 sets of data (divided 720 times). It means the highest resolution is 0.5 degrees. As long as the total point number is within the data array's maximum 800, the array can store multiple E-Cam curves. The slave axis curve between two data points will be interpolated with a cubic curve to smooth the motion at each point.

See Figure 7.3.4.1 for example. If using E-Cams to replace mechanical cams, divide the mechanical cam into several segments. The more the segments, the higher the precision. In this example, the cam is divided into 8 segments, and each interval is 45 degrees (this is for reference only; you need to delicately segment the cam in the actual application, or the path will be distorted). Then, enter the distance between the cam shaft and the points (1 – 8) on the cam edge to the data array. The start point 0 degree and the last point 360 degrees are identical but you must enter both of the two points to the data array so the the E-Cam can completely go around the mechanical cam for one cycle. Therefore, you need to enter 9 sets of data to complete the E-Cam curve table.



Point	Data array	
1	#50	30000
2	#51	20000
3	#52	40000
4	#53	45000
5	#54	30000
6	#55	20000
7	#56	20000
8	#57	50000
1	#58	30000

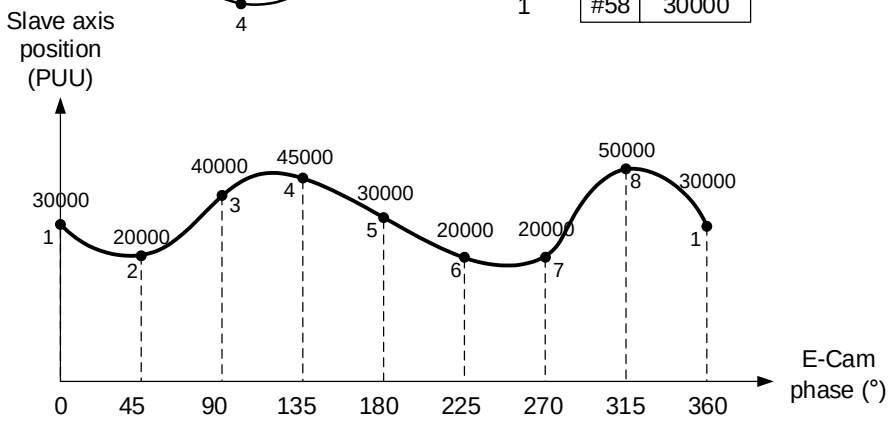


Figure 7.3.4.1 Example of creating E-Cam curve table

You can use ASDA-Soft to create the E-Cam curve. Click **E-CAM** in the software function list and the E-CAM Editor appears, as shown in Figure 7.3.4.2.

In the first page of the editing window, select the method to create the E-Cam curve table. There are seven options, [Manual], [Speed Fitting], [Rotary Shear - W/O Sync. Zone], [Rotary Shear - Fixed Sync. Zone], [Rotary Shear - Adjustable Sync. Zone], [Cubic Curve], and [Rotary Shear - Printing Machine].

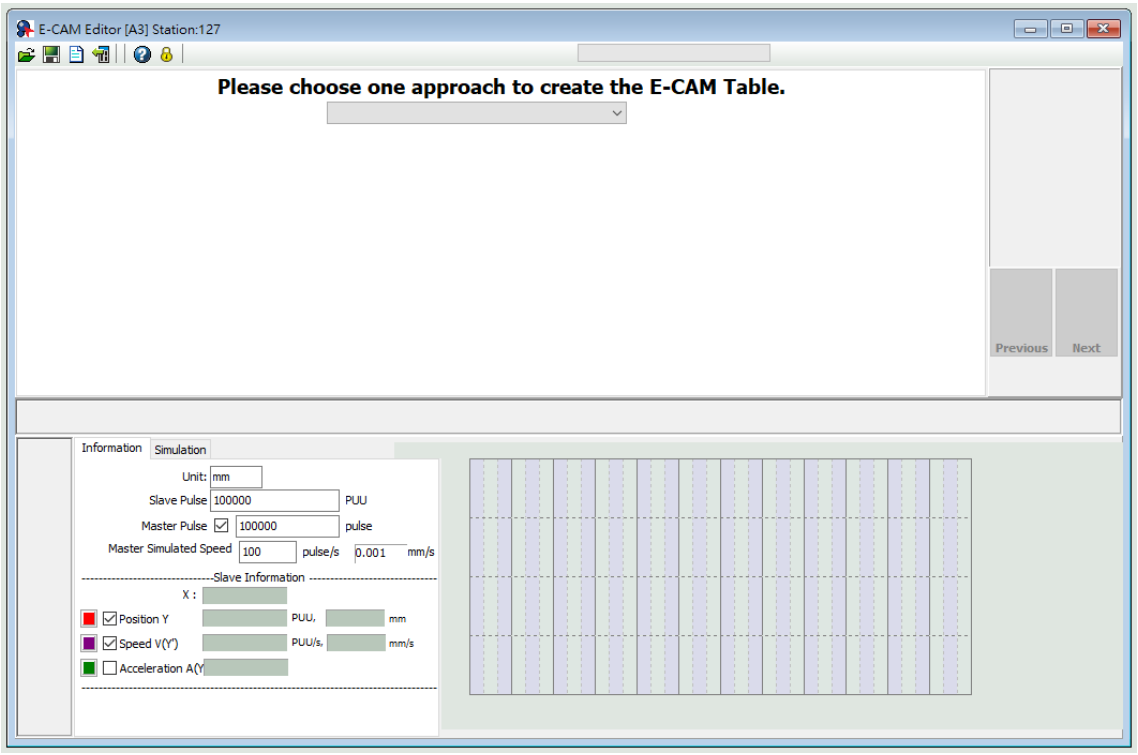


Figure 7.3.4.2 ASDA-Soft E-Cam setting interface

Manual

When you use other software to create the table, the software presents the final results with position data and then imports these data to the table to complete the E-Cam curve. As the example shown in Figure 7.3.4.1, the mechanical cams can be replaced by E-Cams. It creates the E-Cam curve by using the angles of the mechanical cams corresponding to the distances between the cam shaft and edge, which is to establish the correlation of the angles and slave axis positions. The setting interface for manually creating E-Cam tables in ASDA-Soft is shown in Figure 7.3.4.3. The following illustrates the steps to manually create the table:

1. Set the E-Cam segment number: an E-Cam can be divided into up to 720 segments (721 points). For a 360-degree cycle, every 0.5 degrees corresponds to a slave axis position. The more the points, the higher the resolution and the more delicate the curve. Appropriately allocate the resources for the curve resolution and data array to set the E-Cam segment number.
2. Create curve table: after setting the E-Cam segment number, click **Create Table**, and the software equally segments the 360-degree E-Cam and automatically fills in the angle data

to the table. When you set n points for the E-Cam segment number, the table has n+1 columns.

3. Fill in the slave axis positions: fill in the corresponding position in PUU for each segment. Click **Draw**. The software automatically generates a simulated E-Cam curve and cam position, speed, and acceleration curve. When manually creating the table, pay more attention to the speed continuation of the slave axis to avoid machine vibration or motor overload caused by speed discontinuation.
4. Download E-Cam curve: once the E-Cam curve is confirmed, click **Download Table** to write the E-Cam curve to the data array. If you click **Write Table Data to EEPROM**, the data array is written to EEPROM and is non-volatile.

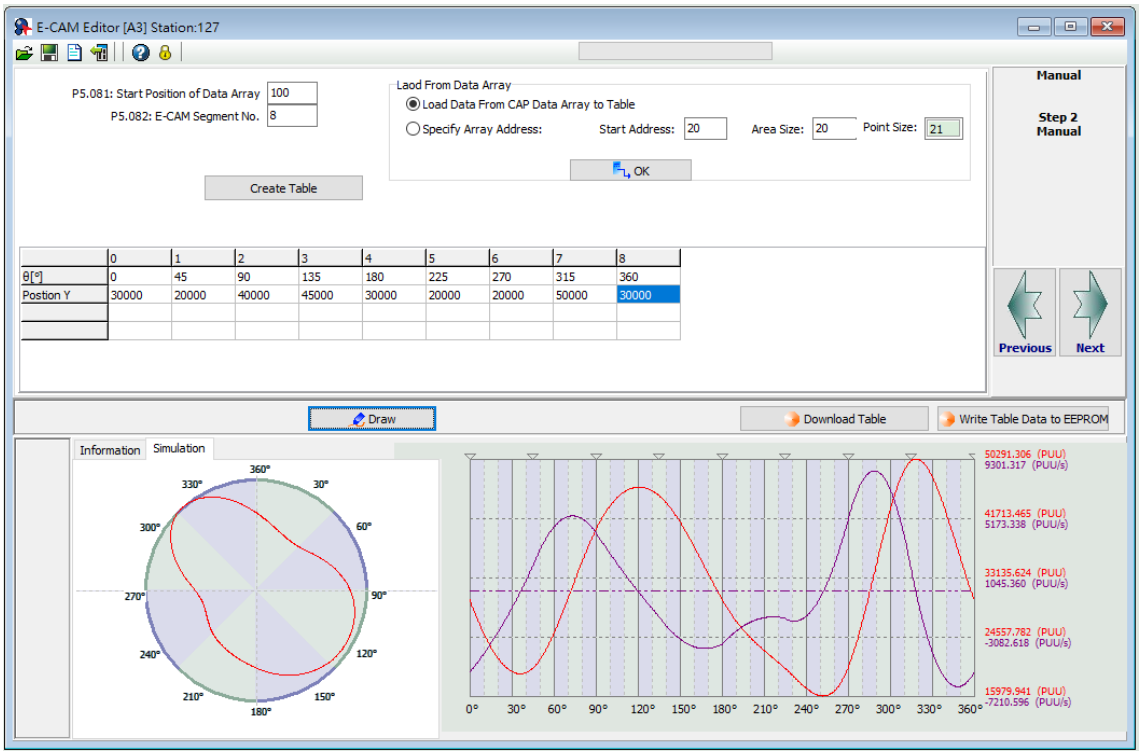


Figure 7.3.4.3 ASDA-Soft Manual setting interface for creating E-Cam table

When using a third-party software (such as Excel) to create the table, save all position data as a text file (.txt) and use the Space, Tab, Enter keys, vertical bar “|”, or a comma “,” to separate the position data of each point.

If you start the E-CAM Editor in ASDA-Soft and choose to manually create the table, specify the E-Cam segment number (P5.082), and click **Create Table**, then the table displays the E-Cam phase corresponding to the E-Cam segments. Right-click the table, select **Import points**, and then click **Browse** after the window for importing point data appears. Open the text file that has been saved, and select the separator you use in the saved file for **Separate symbol**. Then, click **OK** to complete loading the text file. Next, click **Draw** to have the software generate the E-Cam curve based on the E-Cam positions. You can also export the position data as a text file.

Right-click the table, and select **Batch change the values**, including increment, decrement, addition (+), deduction (-), multiplication (*), division (/), copy, and exchange functions for users to change the E-Cam curve quickly. There are also functions for inserting and deleting single position data on the right-click menu. The setting interface for creating E-Cam tables with a third-party software in ASDA-Soft is shown in Figure 7.3.4.4.

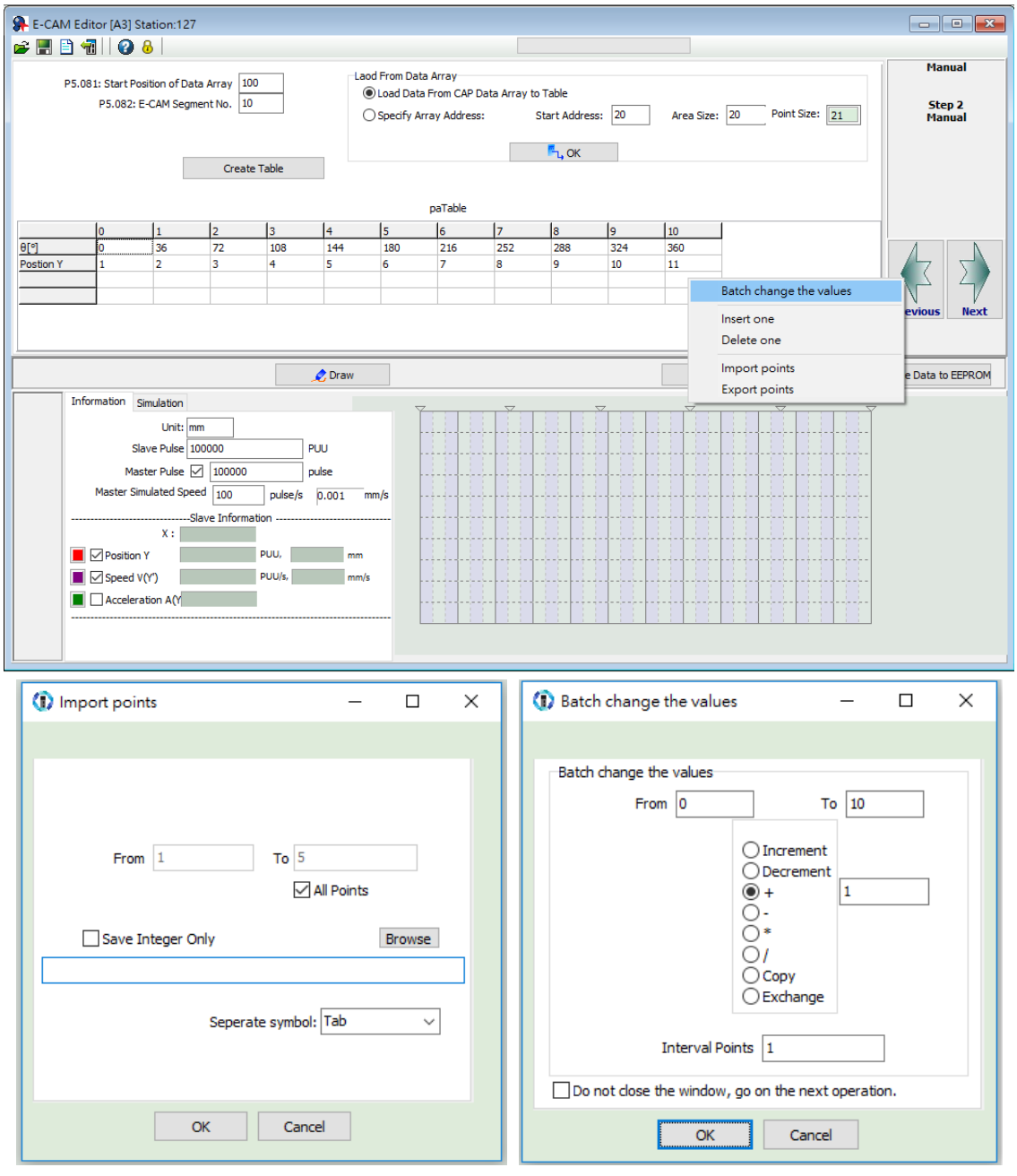


Figure 7.3.4.4 Use third-party software to create E-Cam curves

Speed Fitting

When the application requires the motions of both the master and slave axes to keep the same speed or have the same correspondence relations, you can use the speed fitting method to create the E-Cam curve. With this method, the E-Cam cycle is divided into five zones, which are the waiting, acceleration, synchronous speed, deceleration, and stop zones as shown in Figure 7.3.4.5. You can adjust the proportion of each zone as needed.

This E-Cam curve is designed based on the positions. It plans the corresponding speed of the master and slave axes based on the relationship between the position change and speed within a given time. The setting interface for creating E-Cam curves with the speed fitting method in ASDA-Soft is shown in Figure 7.3.4.6. Steps to create the table with the speed fitting method are as follows:

1. Plan the E-Cam curve: determine the proportions of the waiting, acceleration, synchronous speed, deceleration, and stop zones within an E-Cam cycle.
2. Set the total moving distance (lead): set the total moving distance of the slave axis within one cycle in the unit of PUU.
3. Set the S-curve: set smoothness at the transition points of the position curve. The higher the value, the smoother the motor acceleration or deceleration, and the longer the operation cycle. The S-curve setting value is usually the same or smaller than the stop zone point number.
4. Download E-Cam curve: once the E-Cam curve is confirmed, click **Download Table** to write the E-Cam curve to the data array. If you click **Write Table Data to EEPROM**, the data array is written to EEPROM and is non-volatile.

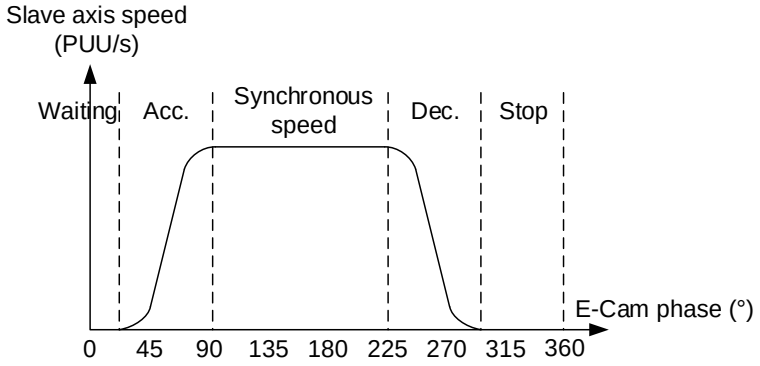


Figure 7.3.4.5 Speed fitting zone definition

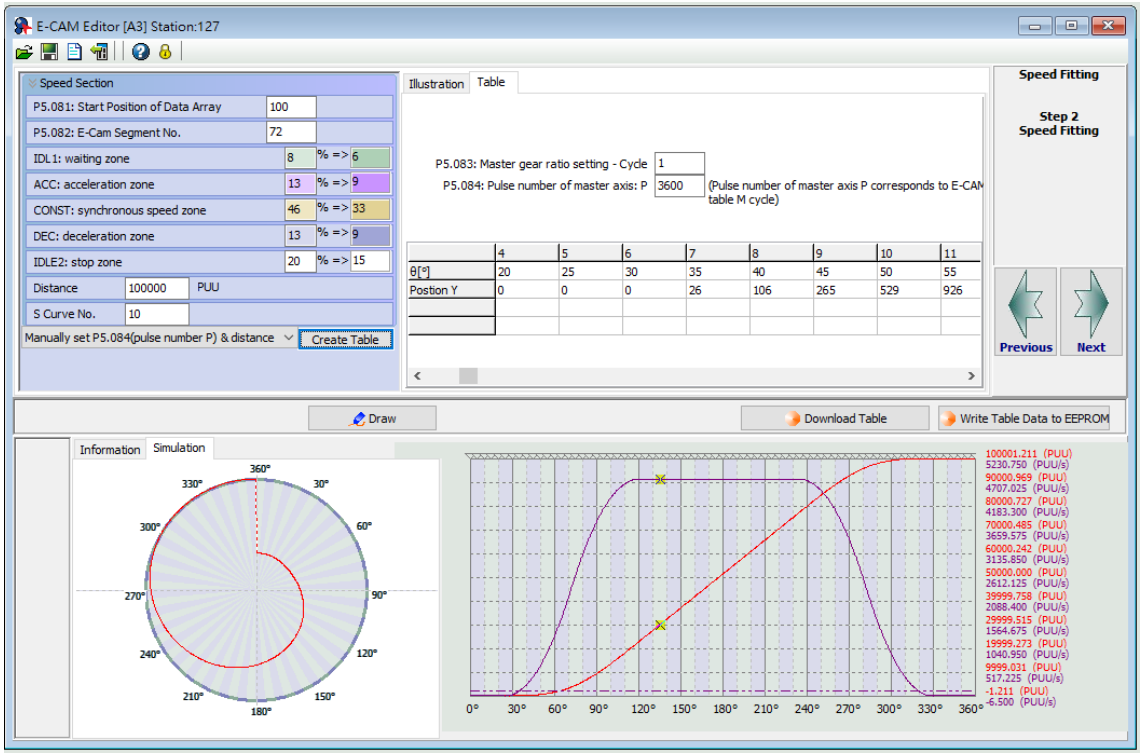


Figure 7.3.4.6 ASDA-Soft Speed fitting setting interface for creating E-Cam table

7

Cubic Curve

If the master and slave axes operate only based on the corresponding positions, such as the point-to-point relation, you can use the cubic curve method to create an E-Cam curve. If using the cubic curve method to create the table, simply enter the E-Cam phase and the corresponding slave axis positions to have the tabulation tool automatically connect the points and optimize the curve. In some applications, you might need a point-to-point cam motion trajectory such as a constant line or curve, then you can use the cubic curve method to modify the curve, and set the start angle N1 (the angle departing from the start point) and the end angle N2 (the angle arriving at the target point) as needed, as shown in Figure 7.3.4.7. There are three types of curves for creating the table:

1. Constant speed: a constant-speed linear trajectory connecting two sets of cam point data; the start and end angles are unadjustable.
2. Uniform acceleration: a uniform incremental or decremental curve in single direction. Only the start angle is adjustable.
3. Cubic curve: the start and end angles are both adjustable. Changing the angles also changes the speed when departing from the start point and arriving at the target point. Note that improper angle setting leads to drastic speed change which causes machine vibration.

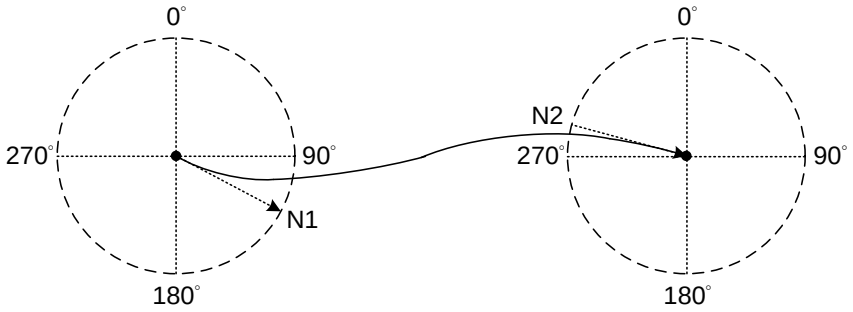


Figure 7.3.4.7 Start angle and end angle

Figure 7.3.4.8 is the cubic curve setting interface for creating E-Cam tables in ASDA-Soft. The steps to create the table with the cubic curve method are as follows:

1. Set the E-Cam curve: set the E-Cam phase, slave axis position, curve type, start and end angles in Cubic Data. You can drag the transition points in the cubic curve simulation to change the corresponding data of each point. When you drag, insert, or delete the transition points, the corresponding cubic data contents are promptly changed. However, if you directly enter or select the desired content in the cubic data, you must click **Create Cubic Curve** to change the cubic curve simulation.
2. E-Cam table setting: when completing the transition point setting, set the sampling angle and click **Convert to E-Cam table**, so the software will fill in the sampling data to the E-Cam table. The more the sampling points, the more accurate the cam shapes. If the setting value for the slave axis is too small, vibration might occur because the decimal

value is rounded off. Use P5.019, E-Cam curve scaling, to keep decimals in the table to reduce zigzags of the curve and generate an E-Cam with higher precision.

3. Download E-Cam curve: make sure the E-Cam curve is correct and click **Download Table** to write the E-Cam curve to the data array. If you click **Write Table Data to EEPROM**, the data array is written to EEPROM and is non-volatile.

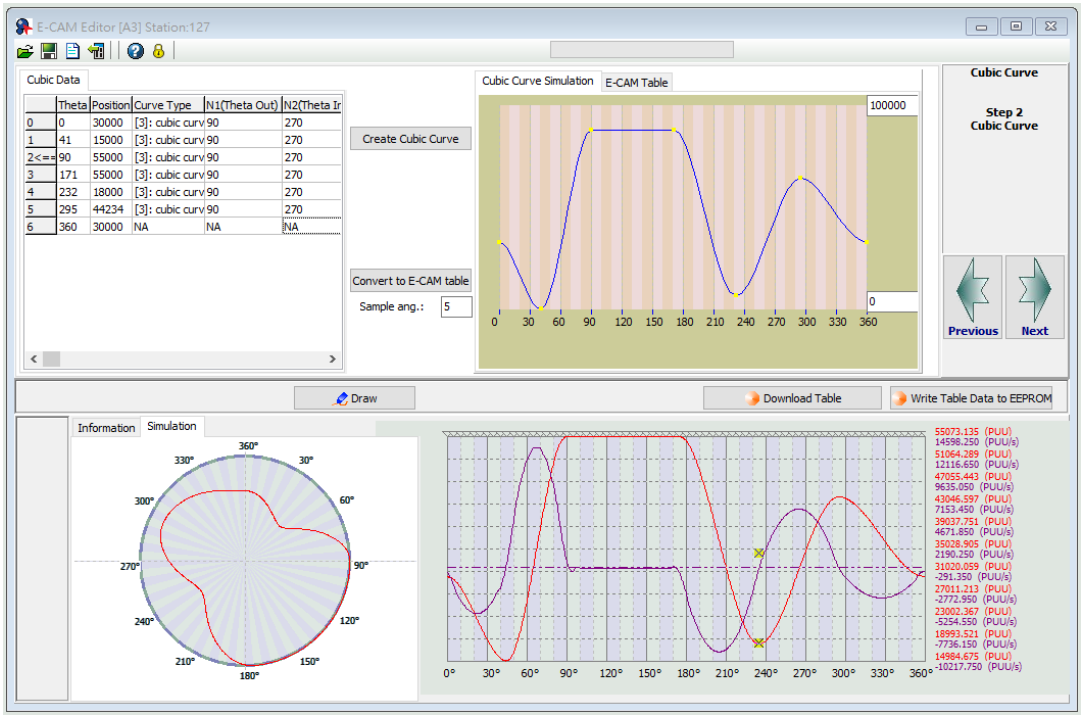


Figure 7.3.4.8 ASDA-Soft Cubic curve setting interface for creating E-Cam table

Create E-Cam table for rotary shear applications

For rotary shear applications, ASDA-Soft provides three methods for creating rotary shear curves, [Rotary Shear - W/O Syn. Speed Zone], [Rotary Shear - Fixed Sync. Zone], and [Rotary Shear - Adjustable Sync. Zone]. The only difference between these methods is the synchronous speed zone for the master and slave axes, which is adjusted based on the types of the machining cutter and motion. [Rotary Shear - Printing Machine] is for creating curves for printing machines. In addition, you can also use Macros #6 and #7 to create E-Cam curves for the rotary shear. For detailed settings, refer to Section 7.3.7.

7.3.5 E-Cam curve and PR command overlapping

When the E-Cam curve is operating, if you trigger a PR path of incremental position command, the E-Cam command is overlapped with the PR command. As shown in the upper part of Figure 7.3.5.1, the moving direction of the slave axis is the same as that set in the incremental position command. When the slave axis is moving at 300 rpm and you trigger an incremental position command with the target speed of 200 rpm in the same direction, the slave axis overlaps the PR incremental position command with the E-Cam command and completes the 5000 PUU incremental position command at the target speed of 500 rpm. As shown in the lower part of Figure 7.3.5.1, the moving direction of the slave axis is opposite to that set in the incremental position command. When the slave axis is moving at 300 rpm and you trigger an incremental position command with the target speed of 200 rpm in the reverse direction, the slave axis executes the E-Cam command at the target speed of 100 rpm. Then, it resumes the original speed after the incremental position command of -5000 PUU is executed completely.

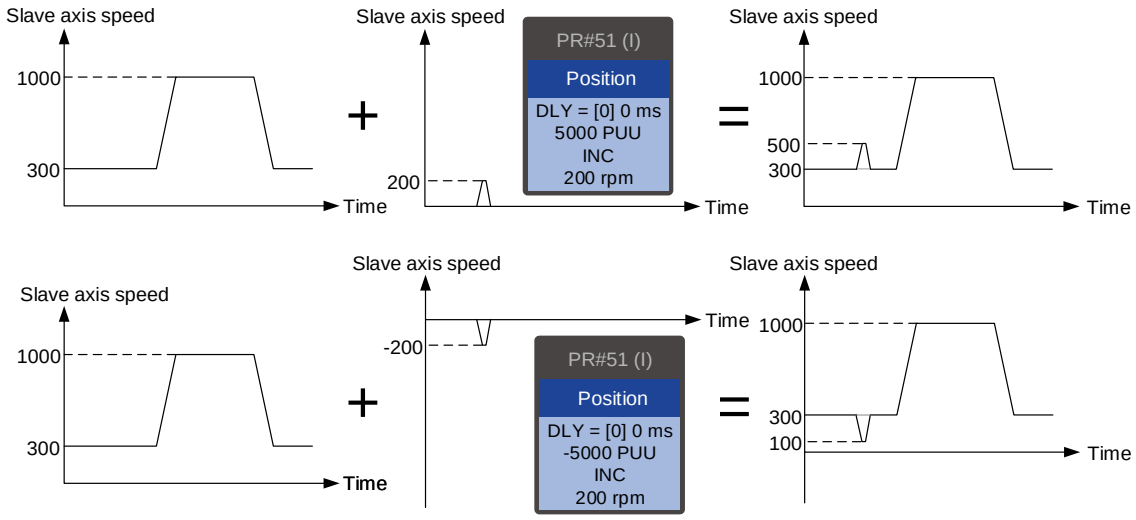


Figure 7.3.5.1 Overlapping of E-Cam command and PR incremental position command

To change the E-Cam phase when E-Cam is operating, use the PR incremental position command. Both the phase alignment function and macro for the rotary shear, which align the E-Cam phase, are completed by this command overlapping method. For more about this function, refer to Sections 7.3.7 and 7.3.9.

Take the triple-axis synchronous printing machine shown in Figure 7.3.5.2 for example. The material feeder is the master axis sending pulse signals to have the three slave axes operate based on the same E-Cam curve. Generally, the E-Cam phases of the three axes must be consistent. If inconsistent, use the command overlapping function to correct the E-Cam phase. To shift the phase in the forward direction, set the forward incremental command. To shift the phase in the reverse direction, set the reverse incremental command.

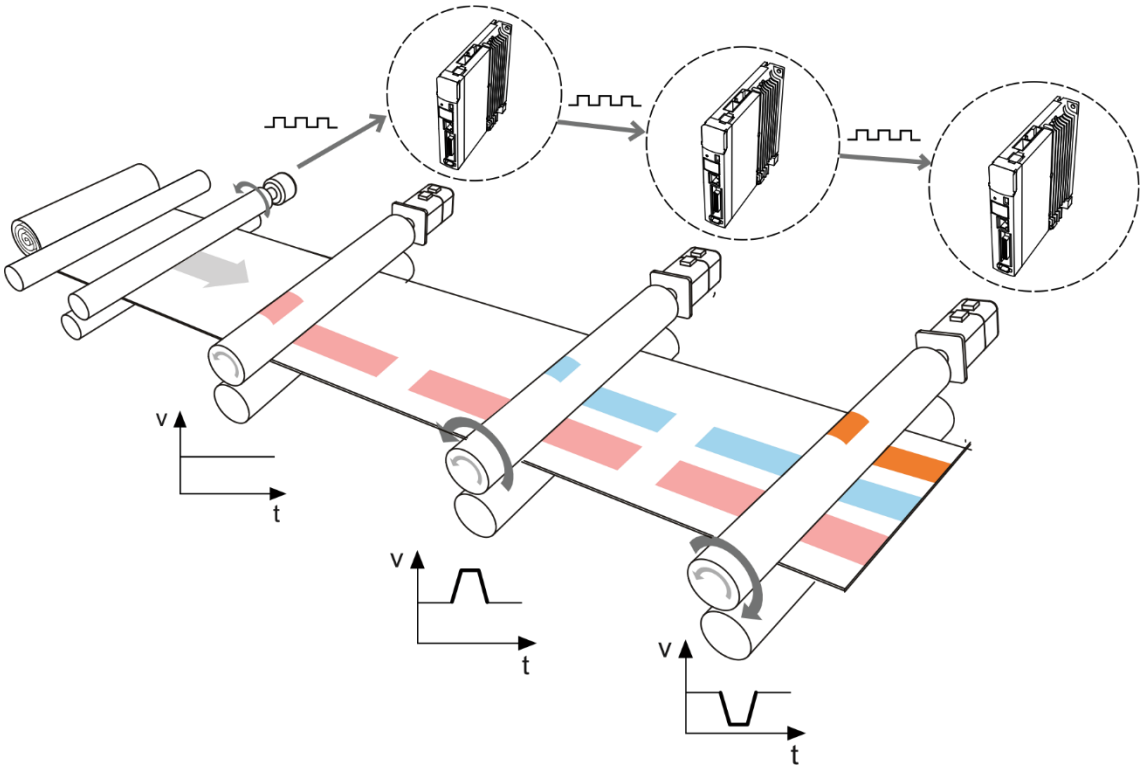


Figure 7.3.5.2 E-Cam phase alignment function

7.3.6 Troubleshooting for E-Cam

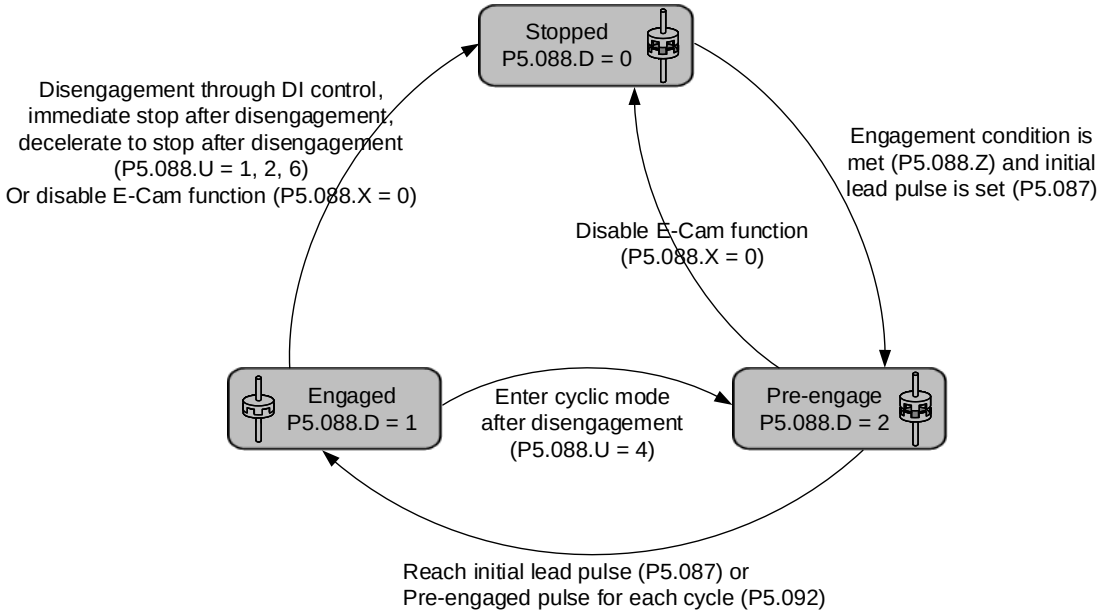
If the E-Cam cannot operate normally, follow these steps to troubleshoot:

1. Servo drive control mode: make sure the control mode is PR mode and the system is in the Servo On state.
2. Pulse source of master axis: check the setting of P5.088.Y for the source of the master axis. Use P5.086 or monitoring variable 059 to read the pulse count of the master axis.
   If selecting CN1 as the input connector, use P5.018 to monitor the pulse count; if selecting CN5 as the input connector, use P5.017 to monitor the pulse count.
3. E-Cam curve: read the E-Cam curve data in the data array. Make sure the E-Cam curve is correct and check the settings for P5.081 (the start address of the E-Cam data array) and P5.082 (E-Cam segment number).
4. E-Cam gear ratio and scaling of E-Cam curve: check the master axis E-Gear ratio (P5.084 / 5.083) and the slave axis E-Gear ratio (P1.044 / P1.045). Check the E-Cam curve scaling (P5.019). If the proportion is set too small, the motor operation is too subtle to be monitored even when E-Cam is operating. In this case, use the scope in the ASDA-Soft to see if the motor is slightly rotating.
5. Clutch status: read P5.088.D to obtain the current status of the clutch.

   If P5.088.D = 0, it means the clutch is disengaged. Check the engagement setting (P5.088.Z).

   If P5.088.D = 1, it means the clutch is engaged and the slave axis operates based on the pulses from the master axis. If the disengagement condition is determined by the DI (P5.088.U = 1), check the timing for triggering the DI to on and off. If the disengagement condition is set to “Immediate stop after disengagement” (P5.088.U = 2) or “Decelerate to stop after disengagement” (P5.088.U = 6), check the pulse number of disengaging time (P5.089).

6. If P5.088.D = 2, it means the clutch is in the pre-engage status. Check the setting for the initial lead pulse before engaged (P5.087). The clutch engages only when receiving the set number of pulses in the forward direction from the master axis. If the received pulses are in the reverse direction, modify the setting according to the master axis pulse source:
   (a) Master axis pulse source: change the encoder output polarity for the servo drive (P1.003).
   (b) Master axis pulse input from CN5: change the auxiliary encoder feedback direction (P1.074.Z).
   (c) Master axis pulse input from CN1: directly modify the wirings by exchanging the wirings for the A and B phase signals.



7.3.7 Rotary Shear

The rotary shear system is a system that combines the material feeder and cutter; the cutter cuts simultaneously when materials are fed as shown in Figure 7.3.7.1. Similar systems are widely used in different applications, such as cutting machines, printing machines, and packing machines. In this example, the material feeder is the master axis in the E-Cam system. When the master axis operates, it simultaneously sends pulse commands to the slave axis (cutter).

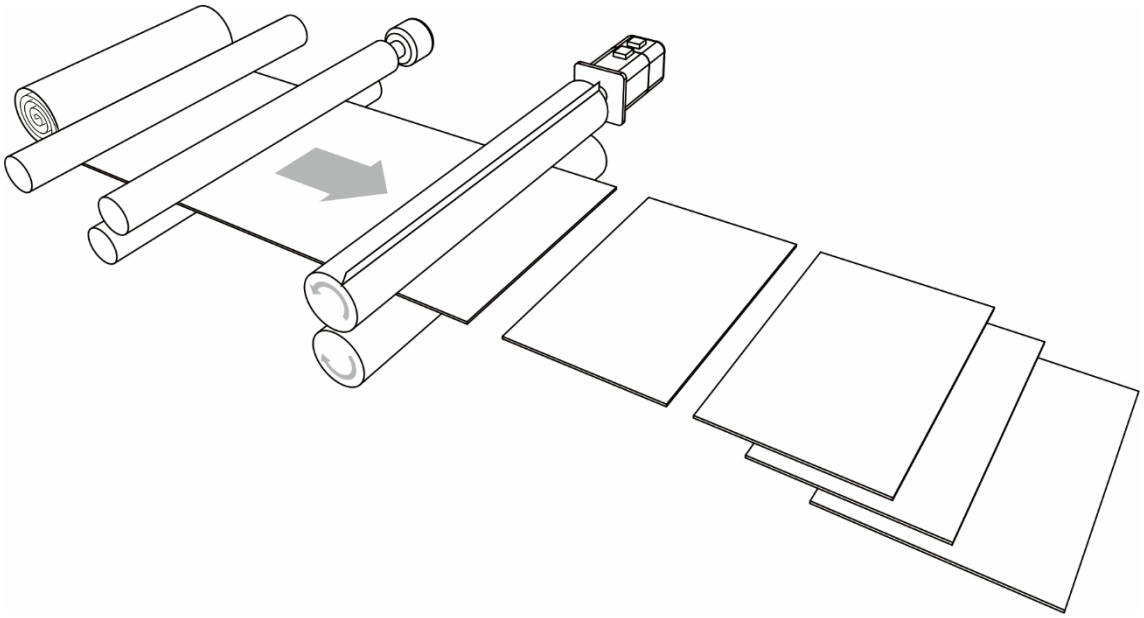
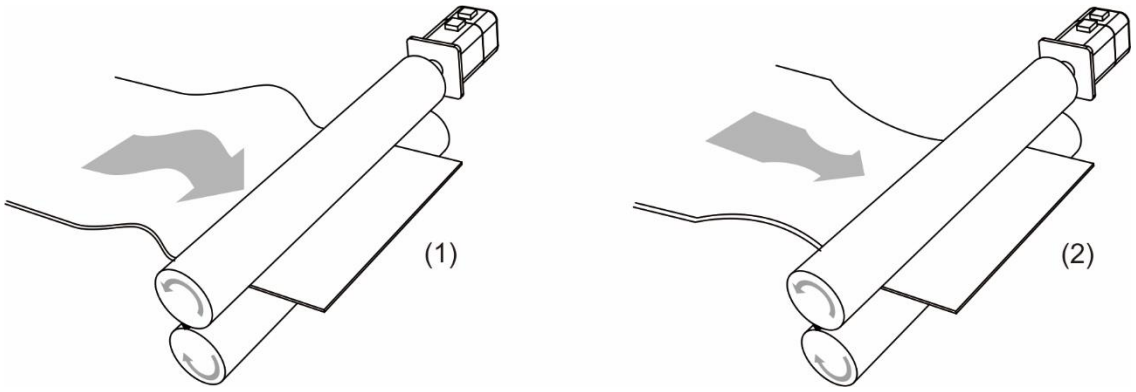


Figure 7.3.7.1 Rotary shear system - cutting machine

Apart from the requirement for calculating the correct cutting length, the operation speeds of both the material feeder and cutter have to be the same during cutting. This stage in the E-Cam curve is called the synchronous speed zone. During cutting, if the material feeder runs too fast, the material might be crushed or piled in front of the cutters, as shown in Figure 7.3.7.2 (1).
If the feeder runs too slow, the cutter might over-stretch the material, causing the distortion of the material as shown in Figure 7.3.7.2 (2).



(1) Material feeder runs too fast; (2) Material feeder runs too slow

Figure 7.3.7.2 Inconsistent speed in synchronous speed zone for cutting machine operation

E-Cam curve

In the E-Cam curve for the rotary shear system, apart from the requirement that the cutter cuts at the right position, it is important that the master axis and slave axis run at the same speed, which means the relative speed is zero, so the the materials are not over-stretched when cutting. In terms of cutters, wider cutters require larger synchronous speed zone (as shown in Figure 7.3.7.3). The proportion of this zone is determined by the cutting length instead of the cutter width, as shown in Figure 7.3.7.4.

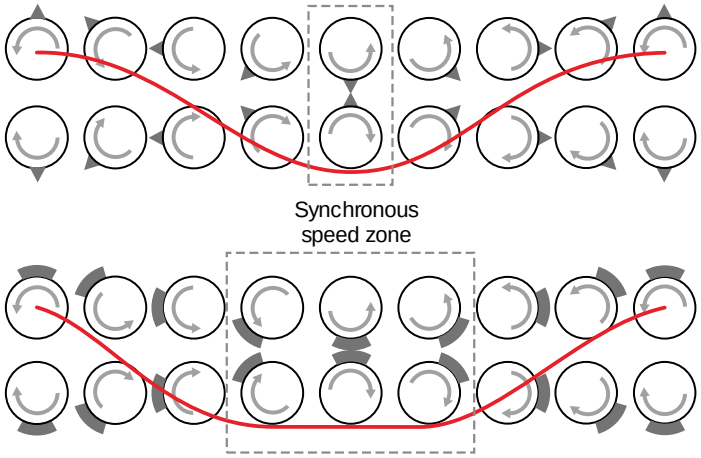


Figure 7.3.7.3 Cutter type and synchronous speed zone

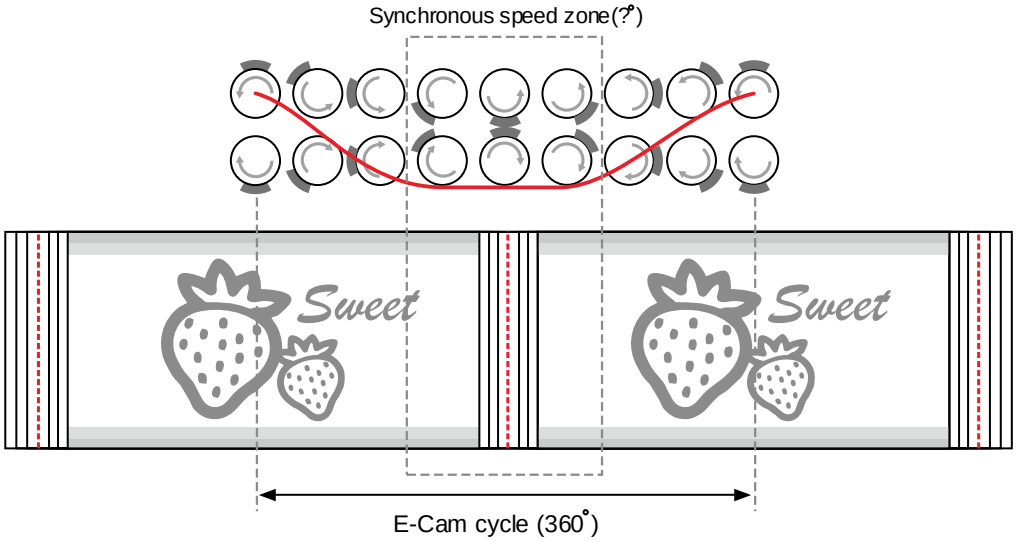
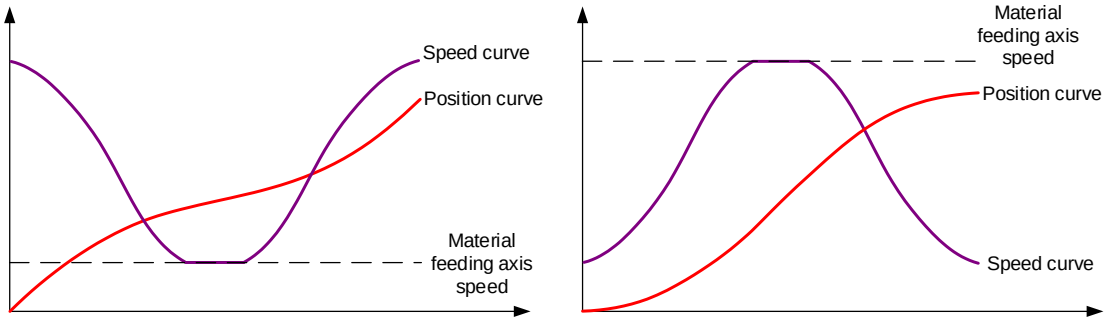


Figure 7.3.7.4 Definition of synchronous speed zone

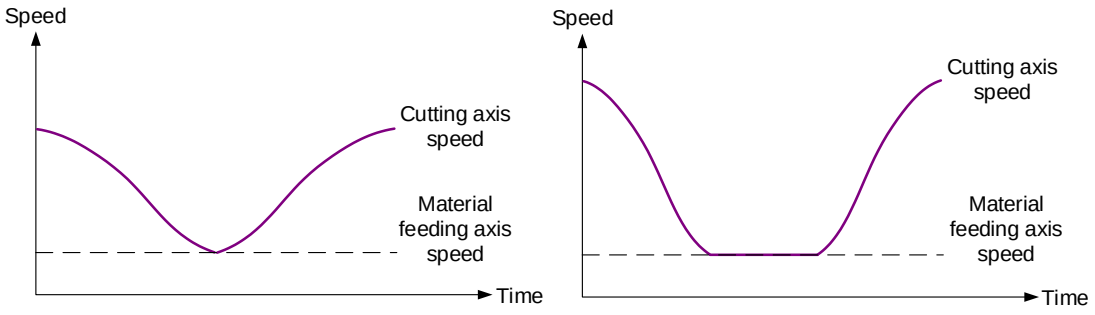
For E-Cam curves used in the rotary shear applications, apart from the requirements of synchronous speed and fixed length, the speed has to be stable. The arc length between cutter ends (Figure 7.3.7.8) and the cutting length proportion will determine the speed variation. The larger the value, the greater the variation. If each arc length between cutters is longer than the cutting length, the motor speed is faster than the master axis before entering the synchronous speed zone. So, the motor needs to decelerate to the master axis speed, as shown in Figure 7.3.7.5 (a). If the arc length between cutters is shorter than the cutting length, the motor speed is slower than the master axis before entering the synchronous speed zone. Therefore, the motor needs to accelerate to the master axis speed, as shown in Figure 7.3.7.5 (b).



(a) Arc length between cutter ends > cutting length (b) Arc length between cutter ends < cutting length

Figure 7.3.7.5 Correlations between the cutting length, speed, and arc length between cutter ends

You can adjust the cutting length by changing the cutter rotation speed. However, the larger the synchronous speed zone, the less flexibility to adjust the cutting length. As shown in Figure 7.3.7.6, the cutting length is the same, meaning the rotation distances of the pointed cutter and wide blade cutter are the same (measure of the speed curve area). When you use a wide blade cutter, the non-synchronous speed zone is larger and requires an abrupt acceleration or deceleration, which may easily make the motor reach the maximum torque limit. When the cutter cannot cut the material with a shorter length due to the cutter speed or the maximum current limit, increase the cutter number to shorten the operation distance per cutting, making the cutter slower and the current output lower.



(a) Pointed cutter
(small synchronous speed zone)

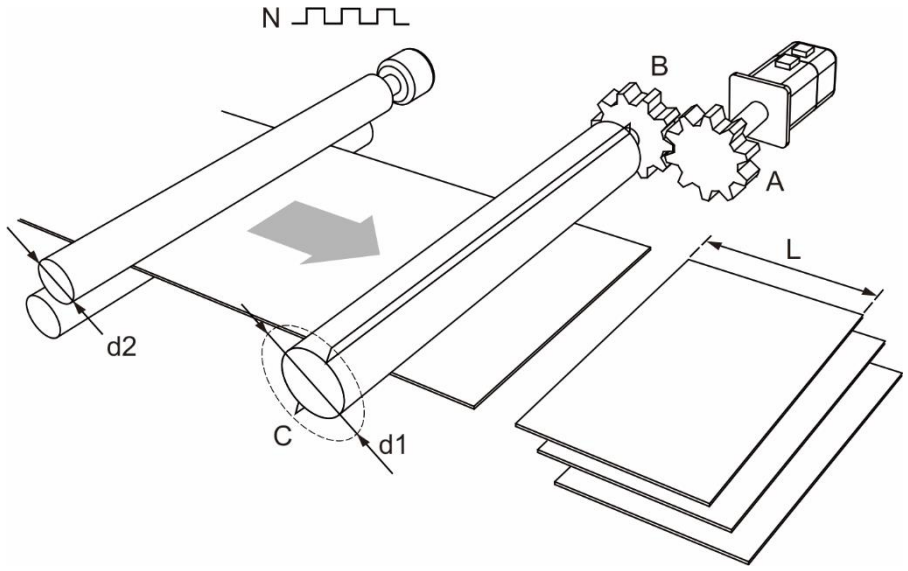
(b) Wide blade cutter
(large synchronous speed zone)

Figure 7.3.7.6 Size of the synchronous speed zone and motor speed

To avoid drastic speed change during operation, when plotting the system, take the arc length between cutter ends, cutting length, and the synchronous speed zone into consideration. The synchronous speed zone is fixed based on the machining requirements for the materials; whereas the cutting length is determined by the acceleration and deceleration zones. Therefore, in addition to the cutter diameter, the cutter number can determine the speed and alleviate the speed variation caused by the acceleration or deceleration of the motor, which makes the system operation smoother. You can also use a lower power motor to have a more cost-effective servo system.

Create an E-Cam curve

You can plot the E-Cam curve for the rotary shear system through ASDA-Soft or macros of the servo drive. There are four methods to create E-Cam curves for rotary shear applications. [Rotary Shear - W/O Sync. Zone], [Rotary Shear - Fixed Sync. zone], and [Rotary Shear - Adjustable Sync. Zone] are designed for common rotary shear applications. The differences among the three are whether there is a synchronous speed zone and whether this zone is adjustable. [Rotary Shear - Printing Machine] is specially designed for creating curves for printing machines. Two macros provided by the servo drive are available for creating E-Cam curves. Macro #6 can create E-Cam curves with fixed synchronous speed zone and Macro #7 can create E-Cam curves with adjustable synchronous speed zone for rotary shear applications. The required setting parameters and the rotary shear mechanical structure are shown in Figure 7.3.7.7.



N: pulse number per encoder revolution
A: gear teeth number of the motor; B: gear teeth number of the cutter
L: cutting length; C: number of cutters
d1: cutter diameter; d2: encoder diameter

Figure 7.3.7.7 Mechanical structure of rotary shear

■ Create E-Cam curves without synchronous speed zone

This kind of E-Cam curve is only suitable for applications using pointed cutters and can only be created by ASDA-Soft. The setting interface is shown in Figure 7.3.7.8. The specification settings for the rotary shear are as follows:

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1. Gear teeth ratio: set the gear teeth number of the motor (A) and gear teeth number of the cutter (B).
2. Number of cutters (C): set the cutter number based on the rotary shear mechanism.
3. Cutter diameter (d1): set the cutter diameter based on the rotary shear mechanism. The cutter radius is the distance from the cutter shaft center to the cutter end; the cutter diameter is two times of the cutter radius. This value does not change with the cutter number and the software will calculate the circumference drawn by the cutter end.
4. Encoder diameter (d2) and encoder pulse number (N): set the diameter and pulse per encoder revolution. The command resolution can be calculated with these two values. If you know the master axis' gear ratio, entering the encoder diameter and pulse number are not required. You can simply input the values for P5.083 and P5.084.
5. PUU number per motor revolution: set the PUU number per motor revolution (slave axis) after being calculated with the E-Gear ratio (P1.044 / P1.045).
6. Cutting length (L): set the material cutting length. To avoid generating an unsuitable rotary shear curve, the software automatically limits the cutting length by referring to the ratio (R) of the cutting length (L) and the arc length between cutter ends (a); R = L / a; R = 0.3 – 3.

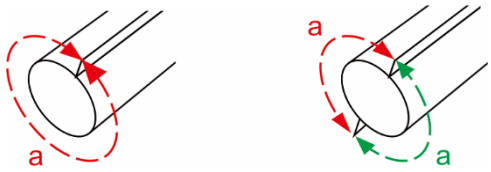

Figure 7.3.7.8 Arc length between cutter ends

7. Speed compensation (V_c): in some rotary shear applications, the speeds of the master and cutter axis are different during cutting; so you can use speed compensation to change the speed of the cutter axis. In the cutting zone, if the speed compensation value is positive, the cutter axis speed is faster than the master axis; if the speed compensation value is negative, the cutter axis speed is slower than the master axis.

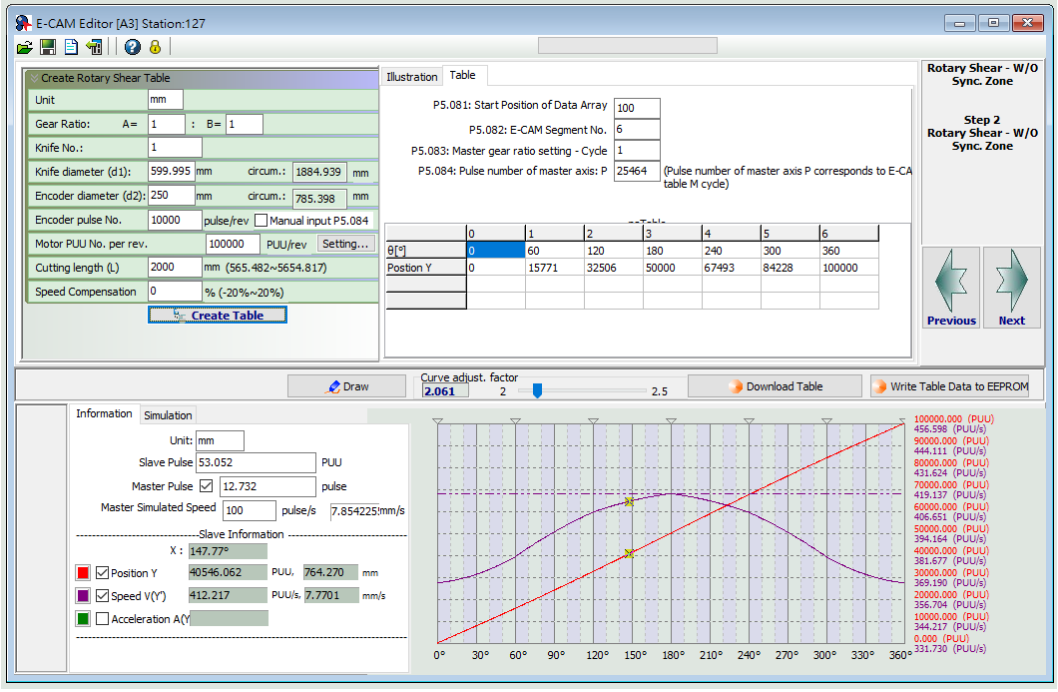

Figure 7.3.7.9 ASDA-Soft setting interface for [Rotary Shear - W/O Sync. Zone]

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■ Create E-Cam curve with fixed synchronous speed zone

This method allows you to create a rotary shear curve with fixed synchronous speed zone, which range is fixed to 51°. You can use ASDA-Soft to create the table, which parameter setting is similar to the curve for rotary shears without synchronous speed zone, as shown in Figure 7.3.7.10. The software automatically limits the cutting length by referring to the ratio (R) of the cutting length (L) and the arc length between cutter ends (a); R = L / a; R = 0.07 - 2.5.

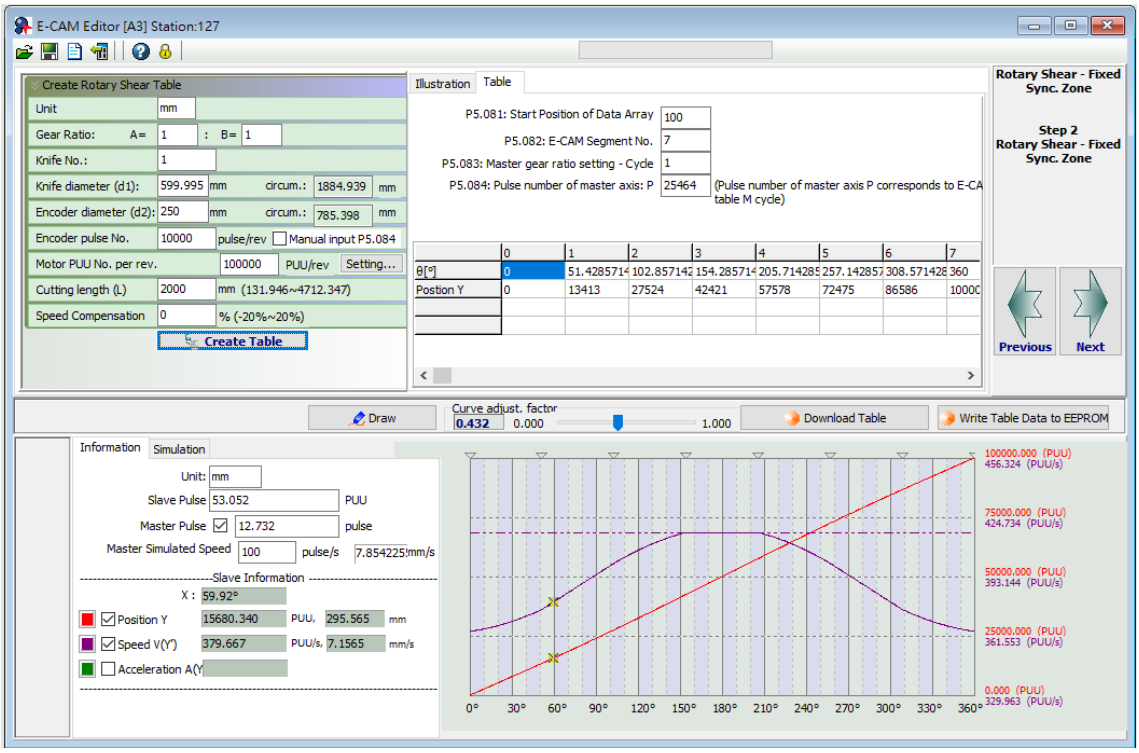

Figure 7.3.7.10 ASDA-Soft setting interface for [Rotary Shear- Fixed Sync. Zone]

You can use Macro #6 of the servo drive to create the table with the same method and the curve created is the same as that generated with ASDA-Soft. The advantage of using the macro to create an E-Cam curve is that when changing the cutting length is required, you can create a new curve simply by modifying the parameters. It is very friendly for those applications that require frequent modification of the cutting length. The setting steps are as follows:

1. Set the start position for the data array: use P5.081 to specify the data array start position for E-Cam and use P5.085 to set the E-Cam's segment number for clutch engagement. When using Macro #6, P5.082 E-Cam segment number can only be 7, which means the curve resolution is 51° and the synchronous speed zone is also 51°.
2. Set the system E-Gear ratio: set the system E-Gear ratio with P1.044 and P1.045.
3. Set the E-Cam's gear ratio and curve scaling: set the pulse number required for the cutting length, which is P5.083 = 1 and P5.084 = $\frac{\text{Pulse number per turn of the master axis encoder } N}{\pi \times \text{master axis encoder diameter } d2(mm)} \times \text{Cutting length } L(mm)$. Use P5.019 to specify the E-Cam curve scaling.

4. Set parameters for creating the E-Cam curve table:

   P5.094 = Motor gear teeth number (A) × Cutter number (C)

   P5.095 = Cutter gear teeth number (B)

   P5.096 = $\frac{\text{Cutting length } L(mm)}{\pi \times \text{cutter diameter } d1(mm)} \times \text{Cutter number } C \times \text{Speed compensation } V_C \times 1000000$.

   If V_c = 1, there is no speed compensation. If V_c = 0.9, the speed of the cutter axis in the synchronous speed zone is 0.9 times of the master axis speed. If V_c = 1.1, the speed of the cutter axis in the synchronous speed zone is 1.1 times of the master axis speed.

5. Enable Macro #6: write 0x0006 to P5.097 to enable Macro #6. Read P5.097 and if it returns 0x1006, it means using macro for table creation is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure code	Description
0xF061	When the clutch is engaged, the E-Cam table cannot be created.
0xF062	Data of P5.094 exceeds the range (1 - 65535).
0xF063	Cutter number set in P5.095 exceeds the range (1 - 65535).
0xF064	Data of P5.096 exceeds the range (300000 - 2500000).
0xF065	P5.081 data array start position exceeds the array length.
0xF066	P5.082 E-Cam segment number must be set to 7.
0xF067	The set values of P1.044 and P1.045 for the E-Gear ratio are too high. Decrease the values of P1.044 and P1.045, but maintain the same ratio, for example: adjust 167772160 : 1000000 to 16777216 : 100000.

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■ Create E-Cam curve with adjustable synchronous speed zone

This table creation method is for generating an E-Cam curve with adjustable synchronous speed zone. You can use ASDA-Soft to create the table. The parameter setting for the rotary shear curve is similar to the setting of that without the synchronous speed zone, as shown in Figure 7.3.7.11. The software automatically limits the cutting length by referring to the ratio (R) of the cutting length (L) and the arc length between cutter ends (a); R = L / a.

1.88 > R × Speed compensation (V_c).

The difference from the rotary shear curves without the synchronous speed zone is you can plot the acceleration, synchronous speed, and S-curve zones for the curves with adjustable synchronous speed zone. If the deceleration zone size is the same as the acceleration zone, the software defines the remaining part as the waiting zone.

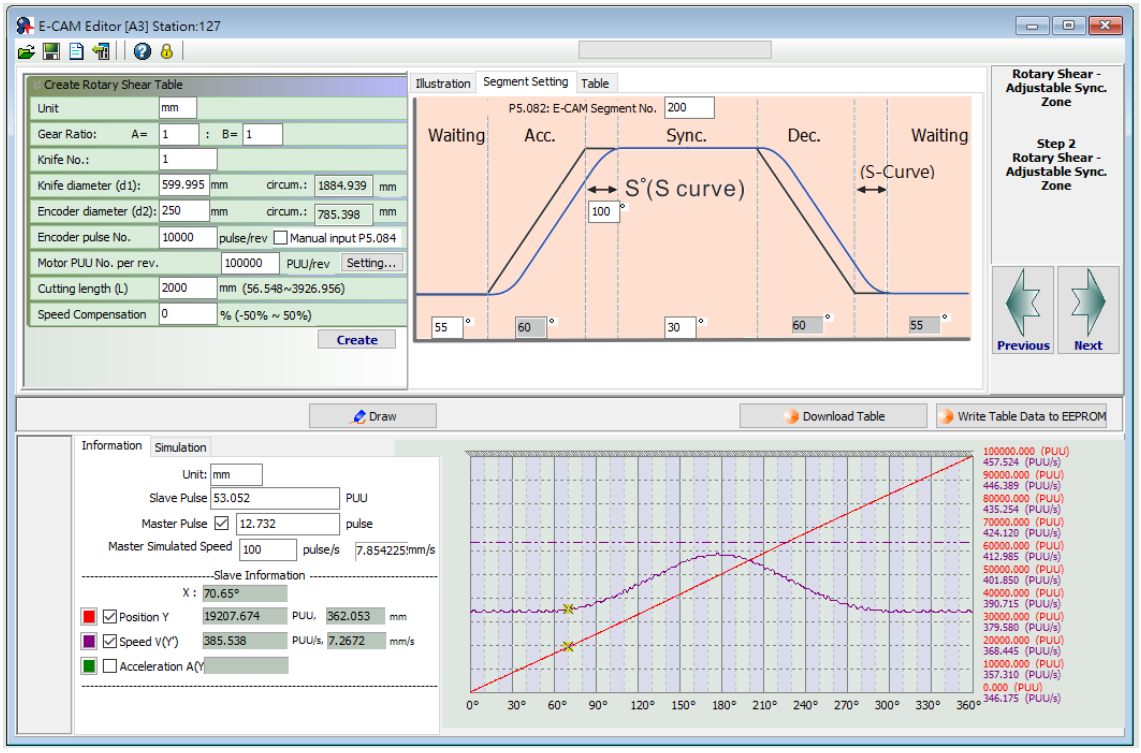


Figure 7.3.7.11 ASDA-Soft setting interface for [Rotary Shear - Adjustable Sync. Zone]

You can use Macro #7 of the servo drive to create the table with the same method. The advantage of using the macro to create an E-Cam curve is that when changing the cutting length is required, you can create a new curve simply by modifying the parameters. It is very friendly for those applications that require frequent modification of the cutting length. The setting steps are as follows:

1. Set the start position for the data array: use P5.081 to specify the data array start position for E-Cam and use P5.085 to set the E-Cam's segment number for clutch engagement. When using Macro #7, the range of E-Cam segment (P5.082) is 30 – 72. It is suggested to set segment to 72 for the optimal resolution of 5°.
2. Set the system E-Gear ratio: set the system E-Gear ratio with P1.044 and P1.045.
3. Set the E-Cam's gear ratio and curve scaling: set the pulse number required for the cutting length, which is P5.083 = 1 and P5.084 = $\frac{\text{Pulse number per turn of the master axis encoder } N}{\pi \times \text{master axis encoder diameter } d2(mm)} \times \text{Cutting length } L(mm)$. Use P5.019 to specify the E-Cam curve scaling.
4. Set the parameters for the E-Cam curve zones: specify the size of the waiting, acceleration, synchronous speed, and S-curve zones. P5.093.DCBA sets the S-curve level (S) with the range of 1 - 4; the calculation for the corresponding angle (S°) is as follows. P5.093.UZYX sets the angle (W) of the waiting zone with the range of -1° to 170° in hexadecimal. If you enter -1 (0xFFFF), it means the cutter speed is 0 in the waiting zone and the angle for the waiting zone is calculated by the servo drive. P5.094 sets the angle (Y) of the synchronous speed zone with the range of 0° - 330° in decimal format. The acceleration zone is automatically calculated by the servo drive, as shown in the following formula.

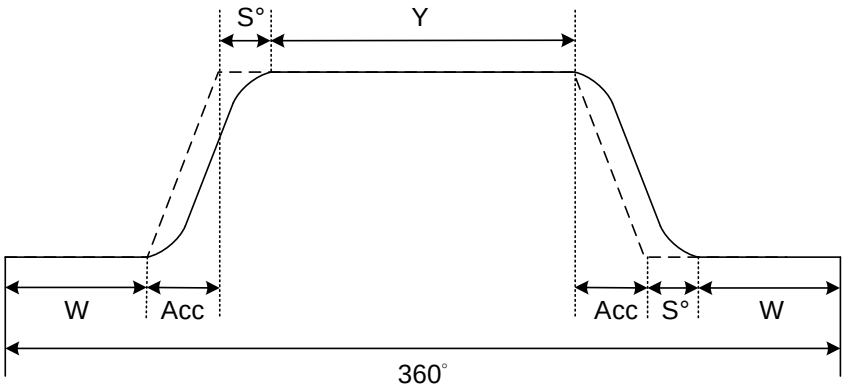
$$S° = \frac{2^S \times 360°}{\text{E} - \text{Cam segment number } P5.082}$$

$$360° = 2W + 2Acc + 2S° + Y$$

As the synchronous speed zone is adjustable, there are limitations when using Macro #7 to create the waiting zone of the E-Cam curve. The conditions are as follows.

$$\widehat{W}(\text{minimum waiting zone}) = 180° + \frac{360°}{P5.082} - \frac{360°}{R} + \frac{Y}{2}$$

If the waiting zone (W) < minimum waiting zone ($\widehat{W}$), the error 0xF07A occurs, and you must increase the waiting zone or decrease the synchronous speed zone. If the waiting zone (W) = minimum waiting zone ($\widehat{W}$), the cutter speed is 0 at the waiting zone. If the waiting zone (W) > minimum waiting zone ($\widehat{W}$), the cutter axis speed is greater than 0 at the waiting zone.



5. Set the parameters for creating the E-Cam curve table: P5.095.DCBA = Motor gear teeth number (A) × cutter number (C) in decimal format. P5.095.UZYX = Cutter gear teeth number (B) in decimal format. For example, if the motor gear teeth number A = 10, cutter number C = 1, and cutter gear teeth number B = 1, then P5.095 = 0x000A0001 (HEX), and you need set P5.095 to 655361 (DEC); P5.096 = $\frac{\text{Cutting length } L(mm)}{\pi \times \text{cutter diameter } d1(mm)} \times$ $\text{Cutter number } C \times \text{Speed compensation } V_C \times 1000000$. If V_c = 1, there is no speed compensation. If V_c = 0.9, the speed of the cutter axis in the synchronous speed zone is 0.9 times of the master axis speed. If V_c = 1.1, the speed of the cutter axis in the synchronous speed zone is 1.1 times of the master axis speed.

6. Enable Macro #7: write 0x0007 to P5.097 to enable Macro #7. Read P5.097 and if it returns 0x1007, it means using macro for table creation is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure code	Description
0xF071	When the clutch is engaged, the E-Cam table cannot be created.
0xF072	Degree of synchronous area of P5.094 exceeds the range (0 - 330).
0xF073	S-curve level of P5.093.DCBA (HEX) exceeds the range (1 - 4).
0xF074	Degree of waiting zone of P5.093.UZYX (HEX) exceeds the range (-1 to 170).
0xF075	Data of P5.096 exceeds the range (50000 - 5000000).
0xF076	E-Cam segment number of P5.082 exceeds the range (30 - 72).
0xF077	P5.081 data array start position exceeds the array length.
0xF078	The set values of P1.044 and P1.045 for the E-Gear ratio is too high. Decrease the values of P1.044 and P1.045, but maintain the same ratio, for example: adjust 167772160 : 1000000 to 16777216 : 100000.
0xF079	Acceleration degree is too small. Decrease the value for the waiting zone, synchronous speed zone, or S-curve level.
0xF07A	Waiting zone < minimum waiting zone. Increase the value for the waiting zone or decrease the value for the synchronous speed zone.

The following method helps you to test the maximum border condition and create the E-Cam curve successfully when using the HMI or controller to create the E-Cam table.

If the ratio (R) of the cutting length (L) and the arc length between cutter ends (a) is 0.05 - 1.09 (R = 0.05 - 1.09), and the E-Cam segment number P5.082 = 72, follow the parameter setting procedure to create the table with Macro #7.

1. Set the waiting zone (W) and synchronous speed zone (Y) based on the S-curve level:

S-curve level (S)	Range of waiting zone (W) and synchronous speed zone (Y)
1	0° ≤ W ≤ 75°; 0° ≤ Y ≤ 150°
	0° ≤ 2W+Y ≤ 300°
2	0° ≤ W ≤ 70°; 0° ≤ Y ≤ 150°
	0° ≤ 2W+Y ≤ 290°
3	0° ≤ W ≤ 55°; 0° ≤ Y ≤ 110°
	0° ≤ 2W+Y ≤ 220°
4	0° ≤ W ≤ 25°; 0° ≤ Y ≤ 30°
	0° ≤ 2W+Y ≤ 80°

2. Write the corresponding parameters: P5.093.DCBA = S-curve level (S); P5.093.UZYX = Angle of the waiting zone (W) set in hexadecimal; P5.094 = Synchronous speed zone (Y); other parameter settings for curve table creation are the same as Step 5 mentioned above. Set P5.097 to 7 to enable Macro #7.

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If the ratio (R) of the cutting length (L) and the arc length between cutter ends (a) is 1.1 - 5 (R = 1.1 - 5), and the E-Cam segment number P5.082 = 72, follow the parameter setting procedure to create the table with Macro #7.

1. Set the S-curve level: use macro parameter P5.093.DCBA to set the S-curve level (S) with the range of 1 - 4.
2. Set the synchronous speed zone: use macro parameter P5.094 to set the angle of the synchronous speed zone (Y). Its angle must be greater than 0. As shown in the following formula, when the synchronous speed zone (Y_{Max}) is less than 0 degree, decrease the S-curve level.

$$Y_{Max} = \frac{360}{R} - 5 \times (3 + 2^{s+1}) \geq 0$$

3. Set the waiting zone: use macro parameter P5.093.UZYX in hexadecimal to set the angle of the waiting zone (W). The calculation is as follows.

$$W\ \ (Hex) = 180 - \frac{180}{R} - \frac{5 \times (2^{s+1} - 1)}{2}$$

When cutting, if the cutter speed is faster than the material feeder, it means the speed compensation (V_c) is greater than 1. Proceed to Step 4 and re-plan the synchronous speed and waiting zones based on the speed compensation requirements. If the cutter is slower than the material feeder, it means the speed compensation is equal to or less than 1. Proceed to Step 6, set the mechanism related parameters, and enable Macro #7 to complete the E-Cam curve creation.

4. Taking adjusting the cutter speed as the priority, set the required maximum speed compensation and use this compensation value to re-calculate the Sync zone (Y_{new}) and the Waiting zone (W_{new}). Taking the Sync zone size as the priority, set the Sync zone (Y_{new}) and use the size of this Sync zone to re-calculate the speed compensation value and the Waiting zone (W_{new}). Refer to the following formulas to calculate the synchronous speed zone and speed compensation value.

Priority	Calculation 1	Calculation 2
Adjust cutter speed	Use the speed compensation (V_c) to calculate the variation of the Sync zone (ΔY): $\Delta Y = \frac{360}{R} \times \left(1 - \frac{1}{V_c}\right)$	New Sync zone size (Y_{new}): $Y_{new} = Y - \Delta Y$
Sync zone size	Use the new Sync zone size (Y_{new}) to calculate the variation of the Sync zone (ΔY): $Y > Y_{new}$ $\Delta Y = Y - Y_{new}$ $Y_{new} \geq P5.094 \geq 0$	Speed compensation (V_c): $V_c = \frac{360}{360 - \Delta Y \times R}$

5. Set the new waiting zone size: use the macro parameter P5.093.UZYX in hexadecimal to set the re-calculated waiting zone angle (W_{new}), as shown in the following formula.

$$W_{new} = W + \frac{\Delta Y}{2}$$

6. Set the parameters related to the mechanism and enable Macro #7: use the macro parameter P5.095.DCBA in hexadecimal to set the motor gear number (A) × Cutter number (C). Use the macro parameter P5.095.UZYX in hexadecimal to set the cutter gear number (B). Set P5.096 to 1000000 × Ratio of the cutting length and arc length between two cutter ends (R) × Speed compensation (V_c). Set P5.097 = 0x0007 to enable Macro #7 to complete the E-Cam curve for the adjustable synchronous speed zone.

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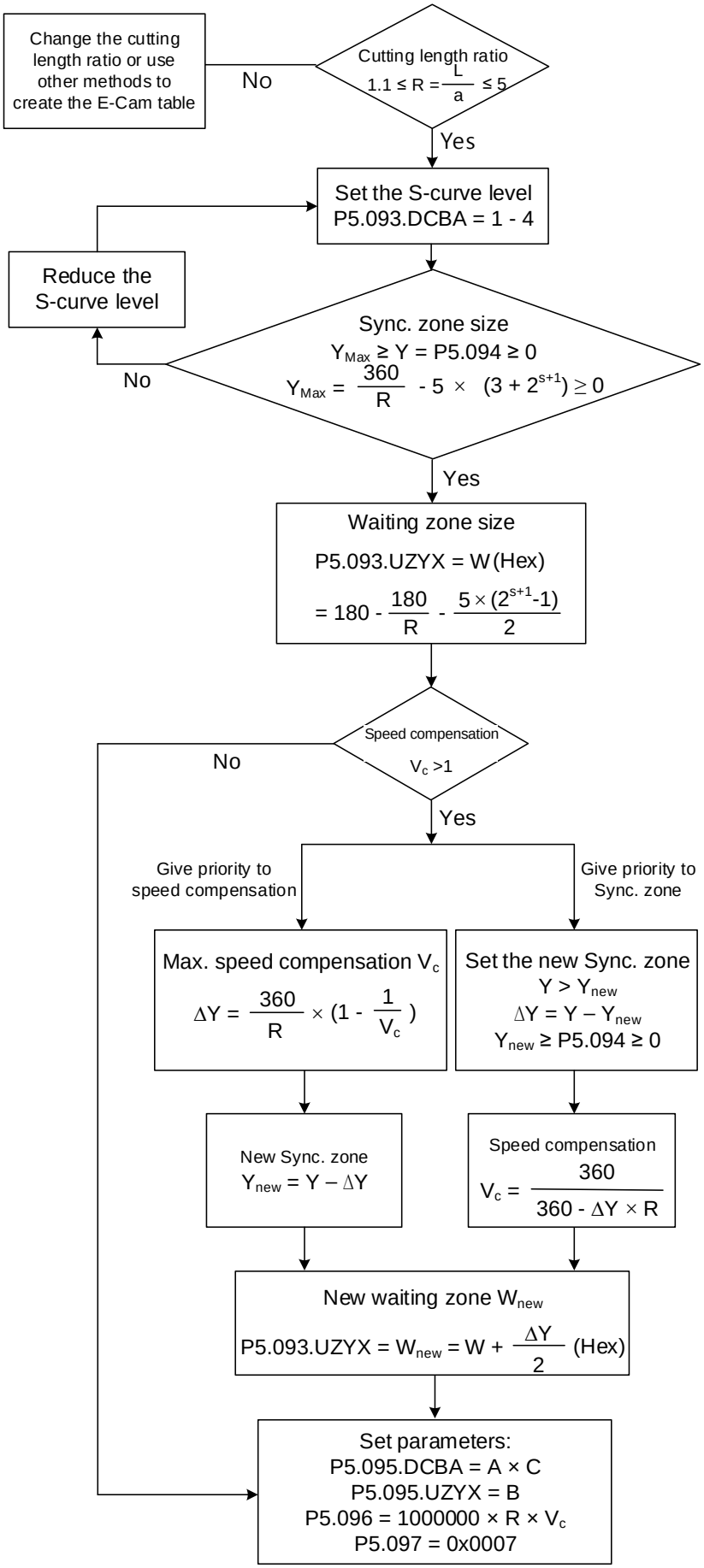
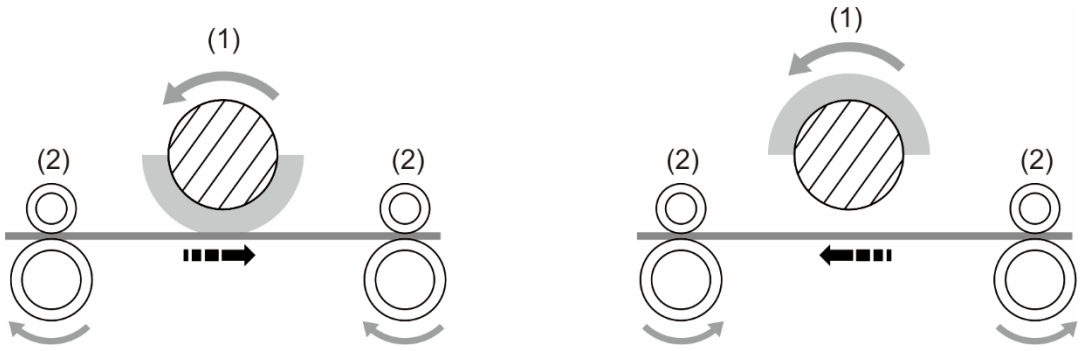

Change the cutting length ratio or use other methods to create the E-Cam table
No
Cutting length ratio
$1.1 \le R = \frac{L}{a} \le 5$
Yes
Set the S-curve level
P5.093.DCBA = 1 - 4
Reduce the S-curve level
No
Sync. zone size
$Y_{Max} \ge Y = P5.094 \ge 0$
$Y_{Max} = \frac{360}{R} - 5 \times (3 + 2^{s+1}) \ge 0$
Yes
Waiting zone size
P5.093.UZYX = W (Hex)
$= 180 - \frac{180}{R} - \frac{5 \times (2^{s+1}-1)}{2}$
Speed compensation
$V_c > 1$
No
Yes
Give priority to speed compensation
Give priority to Sync. zone
Max. speed compensation V_c
$\Delta Y = \frac{360}{R} \times (1 - \frac{1}{V_c})$
Set the new Sync. zone
$Y > Y_{new}$
$\Delta Y = Y - Y_{new}$
$Y_{new} \ge P5.094 \ge 0$
New Sync. zone
$Y_{new} = Y - \Delta Y$
Speed compensation
$V_c = \frac{360}{360 - \Delta Y \times R}$
New waiting zone W_{new}
$P5.093.UZYX = W_{new} = W + \frac{\Delta Y}{2}$ (Hex)
Set parameters:
P5.095.DCBA = A × C
P5.095.UZYX = B
P5.096 = 1000000 × R × V_c
P5.097 = 0x0007

■ Create E-Cam curve for periodic intermittent printer

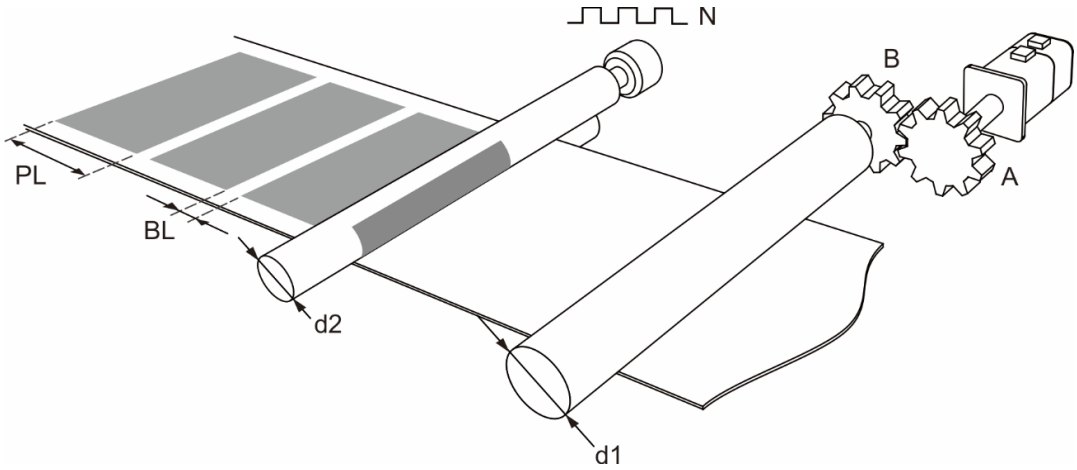
Use this type of E-Cam curve when the printing material length is limited and full print cannot be carried out. This type of curve helps to save the material, decreasing the interval between each print pattern by retracting the material when the printing plate detaches from the material. In the case of paper printing, the printing axis rotates at a fixed speed in a single direction. When the printing plate and paper come into contact, the paper and printing axis starts printing with the same linear speed, as shown in Figure 7.3.7.12 (a). Once the printing motion stops and during the interval when the printing plate and paper are separated, the drive roll starts to decelerate and move in the opposite direction until reaching the specified zone, as shown in Figure 7.3.7.12 (b). Afterwards, the drive roll resumes operation in the printing direction. When the printing plate and paper come into contact again, the paper and printing axis resume a synchronous relation and make the next print. Regarding the E-Cam curve for intermittent printing machines, the parameters that you must set and the corresponding relation with the printing machine mechanical structure are shown in Figure 7.3.7.13.



(a) Printing motion (b) Retraction motion

(1) Printing axis; (2) Drive roll

Figure 7.3.7.12 Intermittent printing machine



N: number of pulses per printing axis revolution
A: number of gear teeth on motor; B: number of gear teeth on material feeder
PL: print length; BL: blank length
d1: drive roll diameter; d2: printing axis diameter

Figure 7.3.7.13 Printing machine mechanical structure

You can create the E-Cam curve table for intermittent printer by using the ASDA-Soft software. Figure 7.3.7.14 shows the user setting interface. The printer specification settings are as follows.

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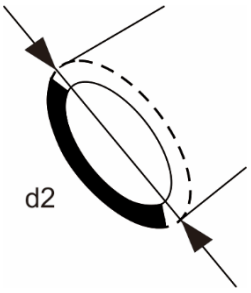
1. Gear ratio: set the number of motor gear teeth (A) and number of material feeder gear teeth (B).
2. Print length (PL) and blank length (BL): set the print length and blank length.
3. Drive roll diameter (d1): set the drive roll diameter for conveying the material.
4. Printing axis diameter (d2) and printing axis pulse number (N): set the diameter of master printing axis and number of pulses per revolution.



5. Number of PUU per motor revolution: set the number of PUU per motor revolution of the drive roll after E-Gear ratio conversion (P1.044 / P1.045).

The ratio of printing axis circumference to printing zone length ($R = \frac{\pi \times d2}{PL+BL}$) must exceed 1 when using E-Cam curves for intermittent printing machines in order to save the material. Calculate the synchronous speed zone angle with the formula $Y = \frac{PL}{\pi \times d2} \times 360°$. You can also adjust the waiting zone angle and S-curve angle in the advanced settings. Increase the angle for the synchronous speed zone to increase the zone size. This ensures the printing axis and drive roll are in the uniform operation speed and stable during printing motions to achieve higher quality printing.

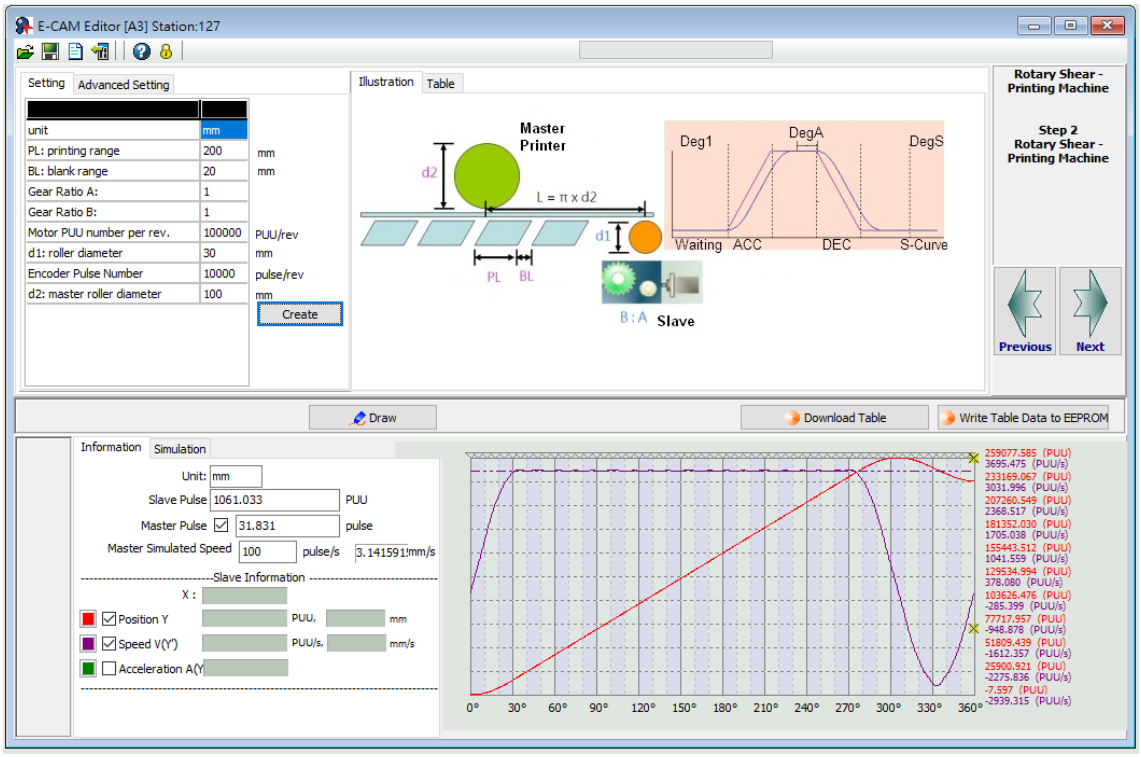


Figure 7.3.7.14 ASDA-Soft rotary shear - intermittent printing machine setting interface

Synchronous Capture axis

In rotary shear applications, the system needs to automatically compensate the mechanical or material differences in order to ensure the cutting spot is correct. Delta servo drive provides 2 types of compensation functions, synchronous Capture axis and E-Cam phase alignment. The introduction of the synchronous Capture axis is as follows. After the external sensor detects the alignment mark, it sends the digital input signal (DI7) to the slave servo axis through the hardware wiring. The servo drive compensates the position error according to the deviation between the set pulse number and the pulse number actually received, and then corrects the cutting or packing positions until it is within the set zone. You can use the synchronous Capture axis for compensation if deformation and slippage occur in either the cutter or film of the packing machine. Reasons that may cause inaccurate cutting are as follows:

1. Loss of pulse: unstable pulse output from the master axis or the slave axis is unable to properly receive pulses from the master axis due to noise or other factors.
2. Errors accumulated over long periods of time: significant calculation error due to the number of pulses accumulated over long periods of time.
3. Material slippage: relative slippage between material and roller causing inaccurate cutting length.
4. Nature of the material: different tension between materials wound onto the inner circle and outer circle.
5. Tension mechanism causing material deformation: material deformed due to tension mechanism of the machine causing inaccurate cutting length.
6. Alignment mark position: printing or other factors may cause inconsistent spacing between marks.

■ Compensation mechanism of synchronous Capture axis

The servo drive uses the deviation between the pulse number within two marks set in P5.078 and the actual received pulses within two marks as the basis for correction. Next, the servo drive calculates the pulse number of the synchronous Capture axis and regards it as the source for the master axis. The deviation is saved in P5.079. You can directly write the deviation into this parameter to shift the cutting or packaging spot. You can also shift the cutting or packaging spot by writing the shift compensation deviation in P1.016, so that the cutting or packing spot shifting amount is value of P5.079 plus P1.016. During synchronous Capture axis operation, the deviation in P5.079 remains within a small range. If the deviation increases constantly, it may be caused by mechanism deviation, signal interference or inappropriate parameter settings. In this case, set the correction rate and correction rate filter with P5.080 and P1.015. The larger the correction rate, the faster the synchronous deviation is corrected to 0, but the speed changes more drastically. In contrast, the smaller the correction rate, the slower the synchronous deviation is corrected to 0, and the speed changes more moderately. The compensation mechanism is shown in Figure 7.3.7.15.

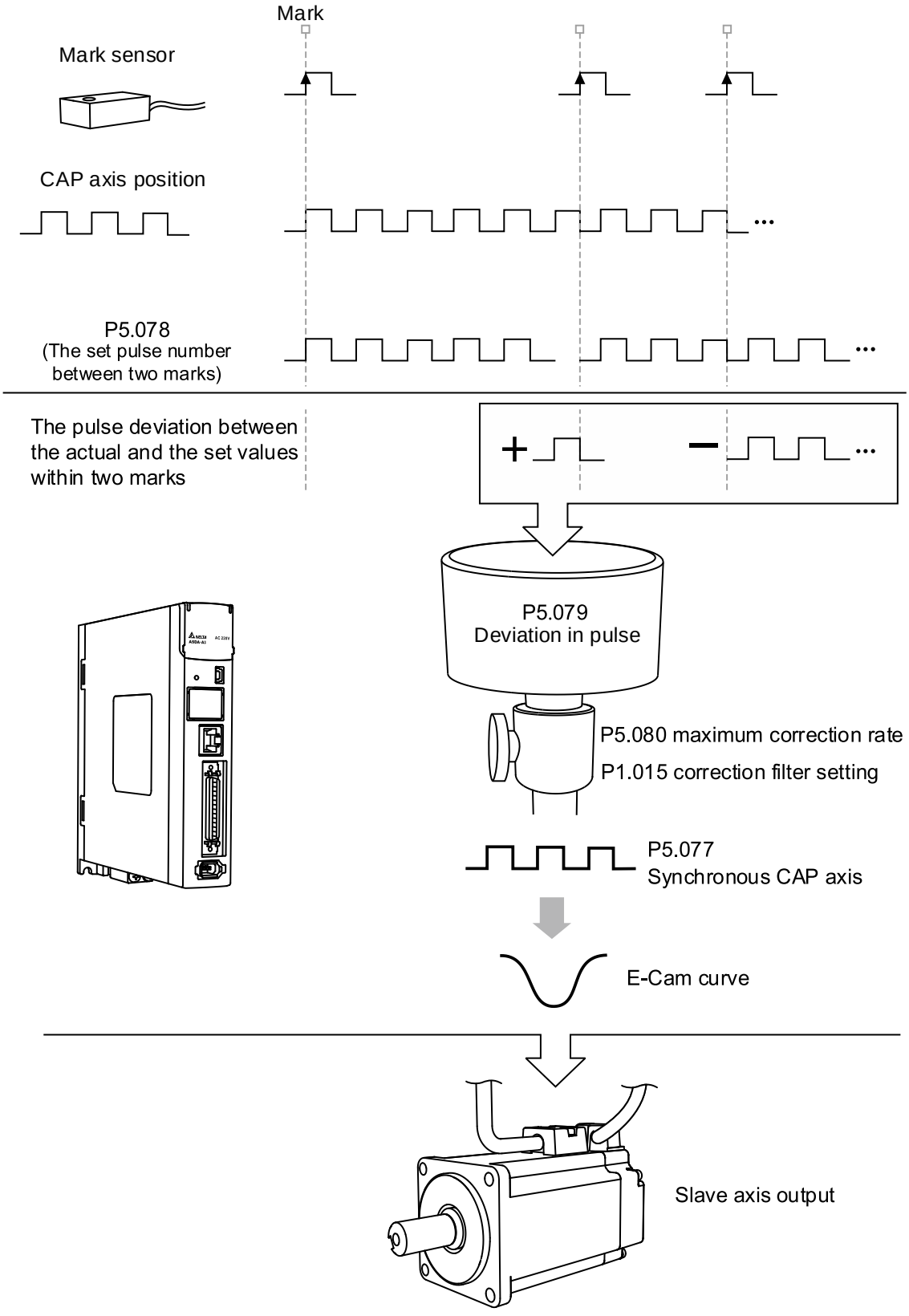


Figure 7.3.7.15 Synchronous Capture axis compensation

The formula for the synchronous Capture axis correction rate is as follows. You can use P5.080 to modify the correction rate.

$$(100 - P5.080)\% < \text{Correction rate} = \frac{\text{Sync CAP axis output pulse}}{\text{Sync CAP axis input pulse}} < (100 + P5.080)\%$$

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The synchronous Capture axis is for correcting the accumulated deviation. Use the mean filter if immediate correction for the subtle deviation is necessary. The correction filter P1.015 can set the range for enabling the filter. If the error is within the set range, the filter is enabled. If the error is greater than the set value of P1.015, it means E-Cam deviation is too great and must be corrected immediately instead of being filtered. Its operation is shown in Figure 7.3.7.16.

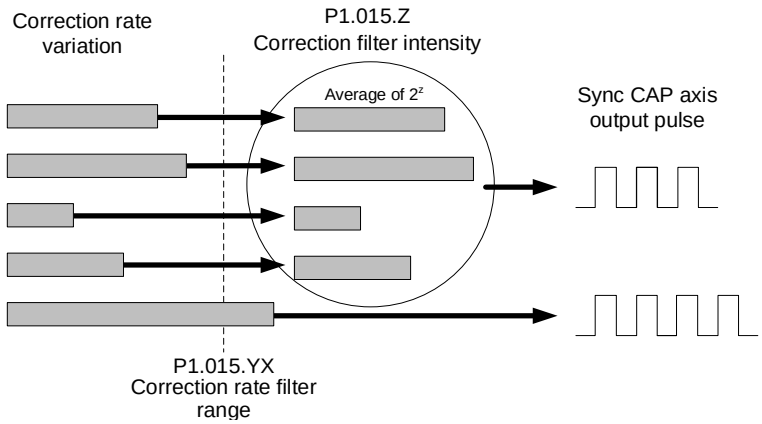
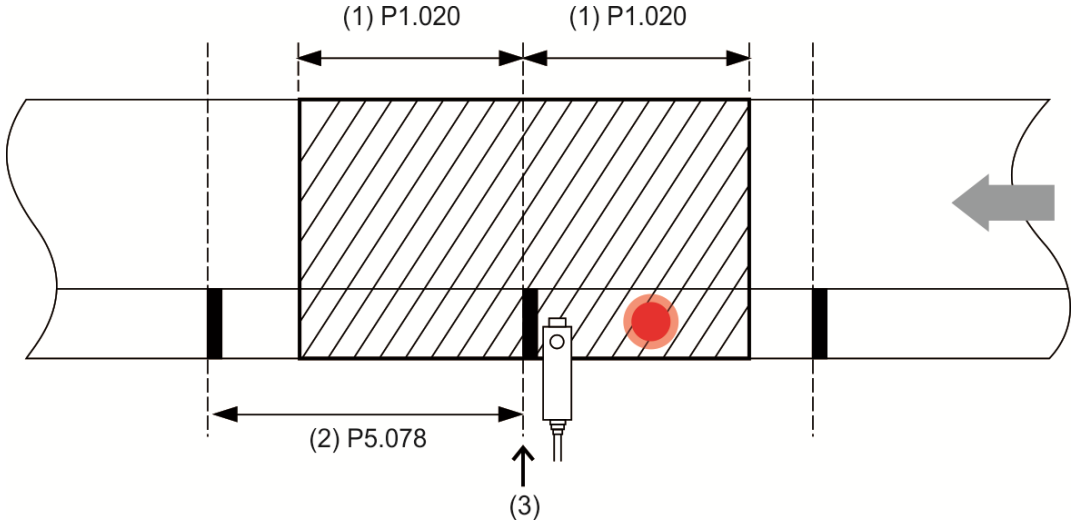


Figure 7.3.7.16 Correction filter of synchronous Capture axis

When the mark printing quality is inferior or there is a stain on the non-mark reading area, the synchronous Capture axis can perform the masking function with high speed position capturing. To avoid misreading the mark due to stains, use P1.020 to specify the distance in pulses for disabling the Capture function before and after reading the mark reading area, as shown in Figure 7.3.7.17.



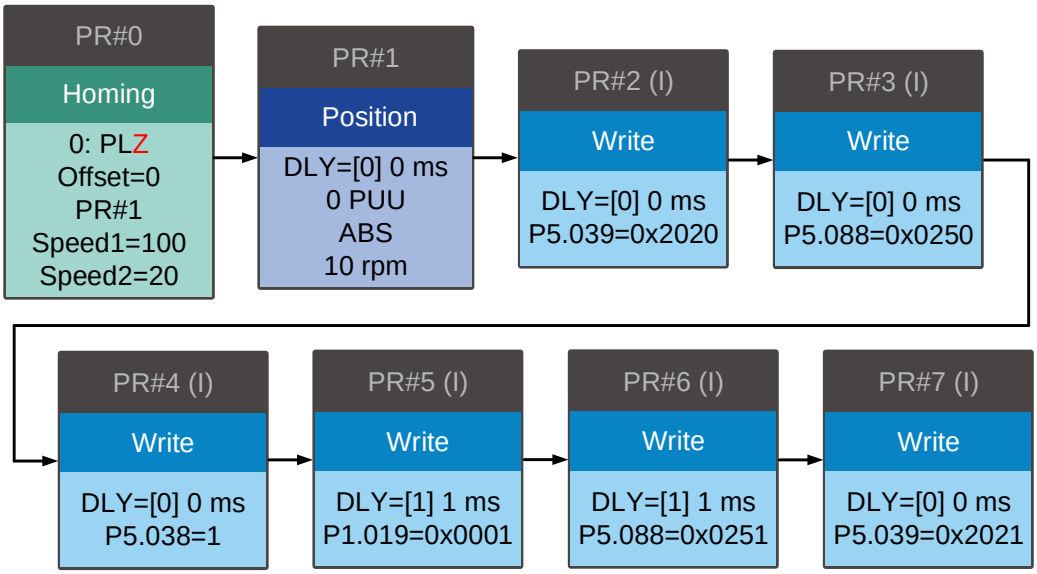
(1) P1.020 masking pulse number
(2) P5.078 pulse number between two marks
(3) Capture the mark and mask the area

Figure 7.3.7.17 Capture masking function

■ Settings for synchronous Capture axis

Before using the synchronous Capture axis, set the parameters for E-Cam, E-Cam curves, and the synchronous Capture axis. Next, use PR commands to enable the Capture and E-Cam functions. The settings are as follows.

1. Create and download the E-Cam curve to the servo drive.
2. Set the E-Gear ratio: including the system E-Gear ratio (P1.044 and P1.045), E-Cam gear ratio (P5.083 and P5.084), and E-Cam curve scaling (P5.019).
3. Relevant settings for E-Cam: start address for data array (P5.081), segment number N (P5.082), and engaged segment number (P5.085).
4. Relevant settings for high speed position capturing (Capture) : start address of data array (P5.036) and masking range (P1.020).
5. Set the homing methods.
6. Relevant settings for synchronous Capture axis: the interval between each synchronous Capture action (P5.078) must be equal to the received pulse number per E-Cam cycle (P5.084 / P5.083), maximum correction rate (P5.080), and correction filter (P1.015).
7. Set the PR command to enable the Capture and E-Cam functions: PR#0 executes the homing procedure. PR#1 uses the absolute position command to move the motor to the origin. Disable the Capture and E-Cam functions before using the PR command to set their parameters, such as the case in PR#2 and PR#3. PR#4 sets the capturing amount. PR#5 enables the cyclic capturing mode. PR#6 enables the E-Cam function, uses the synchronous Capture axis as the source for the master axis, and executes the capturing action based on the clutch engagement timing. PR#7 enables the Capture function and sets the pulse source.



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E-Cam phase alignment

The E-Cam phase alignment function is another compensation method provided by the servo drive. You need to first set the phase for the E-Cam phase alignment and the compensation detection position for the external sensor. In each cycle, everytime the E-Cam operates to the detection position of the external sensor, the servo drive starts comparing the actual phase with the correct phase and then calculates the deviation of the slave axis. Then, the servo drive writes this deviation amount to the PR program for immediate or later compensation (user-defined), which is completed with the E-Cam and PR command overlapping function introduced in Section 7.3.5. The compensation mechanism for the E-Cam phase alignment is shown in Figure 7.3.7.18.

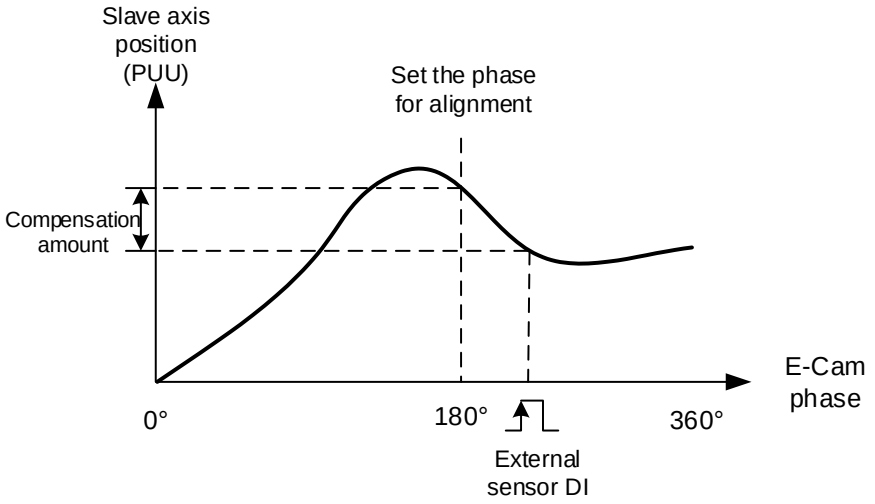

Figure 7.3.7.18 Compensation mechanism for phase alignment

■ E-Cam phase alignment setting steps

When using the E-Cam phase alignment compensation, set the parameters for the DI (digital input), phase alignment position, and compensation level. The flow chart is shown in Figure 7.3.7.20 The steps to set the E-Cam phase alignment function are as follows.

1. Presetting: create and download the E-Cam curve to the servo drive. Set the E-Gear ratio, including the system E-Gear ratio (P1.044 and P1.045), E-Cam gear ratio (P5.083 and P5.084), and E-Cam curve scaling (P5.019). Complete the settings relevant to the E-Cam, including the start address of the data array (P5.081), E-Cam segment number (P5.082), and the E-Cam segment number for engagement (P5.085).
2. DI relevant settings: connect the external sensor with the DI point. Define this DI as [0x35]ALGN. Since both the DI and the sensor have delay, the captured phase position might also delay. Use P2.074 to set the delay time compensation of the DI as follows:

$$P2.074 = P2.009\ \ (\text{DI filter time}) + \text{Sensor delay time}$$

To prevent mistakenly triggering the DI, set P2.073.DC in hexadecimal to specify the masking zone proportion (%). The master axis pulse must exceed the masking area before the next phase alignment starts. This function is only applicable to the applications with forward direction pulse input.

The formula is as follows:

$$\text{Masking zone (pulse)} = \frac{\text{P5.084}}{\text{P5.083}} \times \text{P2.073.DC(\%)}$$

3. E-Cam phase alignment setting: P2.075 sets the alignment position for E-Cam phase alignment. The unit is the pulse number of the master axis, which corresponds to the specified E-Cam phase after conversion. For example, if the pulse number per E-Cam curve cycle is 36000, then P5.083 = 1 and P5.084 = 36000. If you set P2.075 to 18000, then upon the DI receives the signal, the system starts comparing the slave axis' actual position and the set E-Cam position of 180° and then calculates the required compensation value. If you set P2.075 to 10000, when the DI receives the signal, the system starts comparing the slave axis' actual position and the set E-Cam position of 100° and then calculates the required compensation value. Use the monitoring variable 063(3Fh) to monitor the slave axis' actual position.
4. Filter setting: to keep the operation smooth and decrease the position deviation caused by the noise of the external sensor, when the distances between each mark read by the sensor are equal, you can use the filter to improve the stability of the phase alignment. P2.073.YX specifies the filter range (%) in hexadecimal. If the deviation is smaller than this set value, the filter function is effective. If the deviation is greater than this value, it means the deviation is greater and requires immediate compensation. P2.076.Y specifies the filter intensity. This works the same way as P1.015.Z, the correction filter intensity of the synchronous Capture axis, which setting value is suggested to be less than 3. Refer to Figure 7.3.7.15. Use the monitoring variable 085(55h) to monitor the E-Cam phase deviation in percentage, which unit is 0.1%. If this value is 10, it means the deviation is 1%, which is 3.6°.
5. Compensation direction setting: P2.076.UZ specifies the allowable forward alignment rate in hexadecimal. Set it to 0% to perform the alignment always in the reverse direction; set 50% to align the phase with the shortest path; set 100% to perform the alignment always in the forward direction. When you select "always forward" or "always reverse" for the alignment, you must set the maximum correction rate to avoid excessive compensation. Generally, using the shortest path for alignment is recommended. If the application has set the reverse inhibit condition and the deviation is sometimes positive and sometimes negative, use with P1.022.U the reverse inhibit function.
6. Maximum correction rate setting: when the alignment deviation is too great, the compensation amount might thus be great which causes motor vibration or even overload. P2.073.UZ in hexadecimal sets the maximum correction rate and gradually compensates the deviation in stages to alleviate the motor vibration, but it requires longer time to complete the alignment compensation. The formula for maximum correction amount per time is as follows:

$$\text{Max.correction rate per time (pulse)} = \frac{\text{P5.084}}{\text{P5.083}} \times \text{P2.073.UZ(\%)}$$

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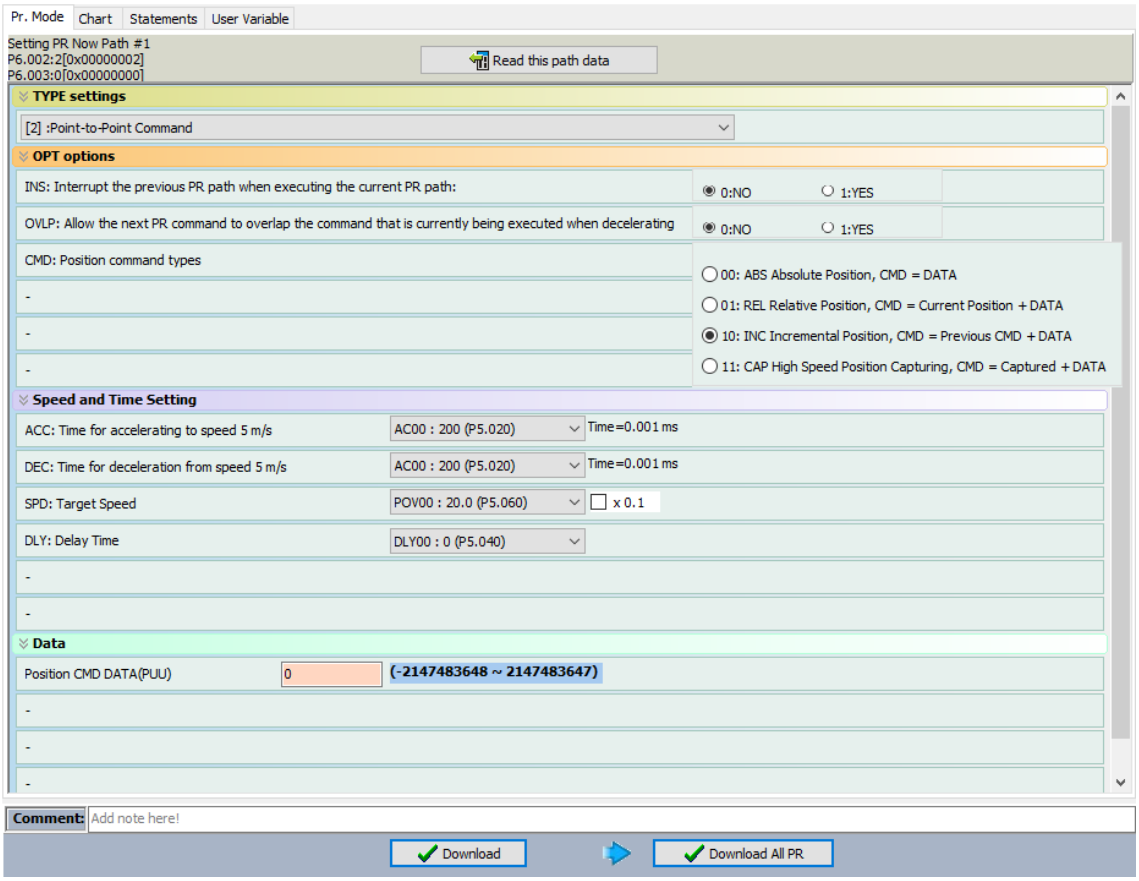
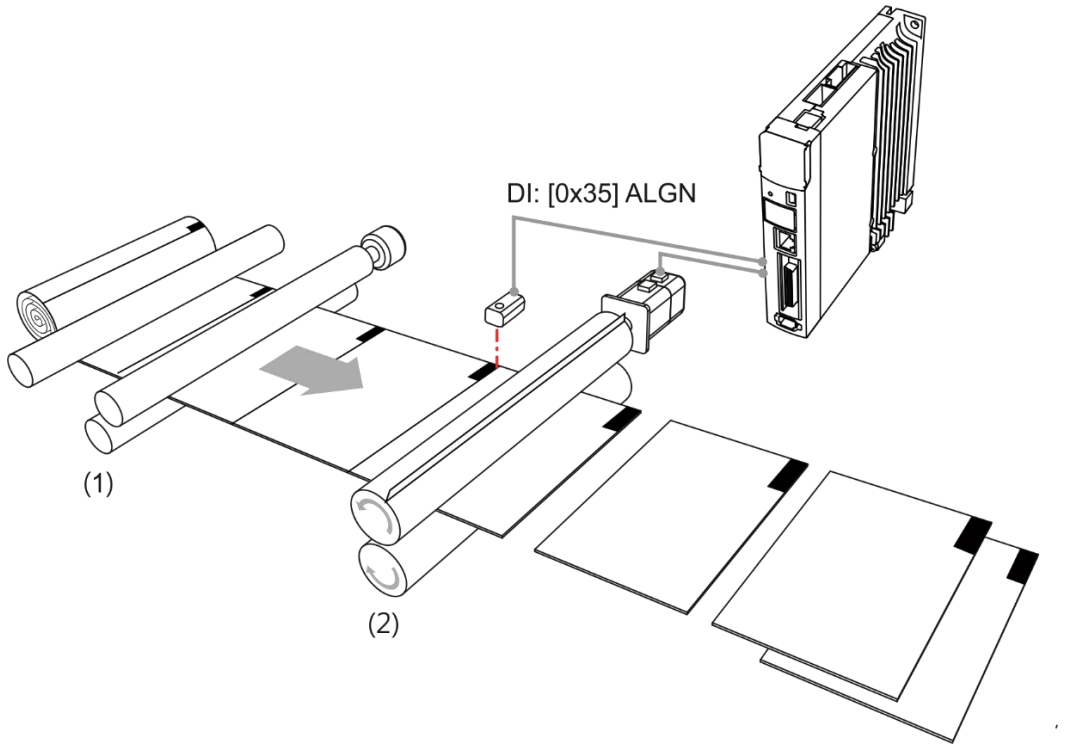
7. PR path setting: the compensation amount for the slave axis is stored in the PR number specified by P2.073.BA. When the slave axis requires compensation, the system can trigger this PR path at the proper timing. When using the E-Cam phase alignment function, set the following for the specified PR: [Point-to-Point Command], [INC Incremental position], [OVLP: allow the next PR command to overlap the command that is currently executed when decelerating], and the appropriate speed and acceleration. Setting the position command is not required because it is automatically set by the E-Cam phase alignment function.



8. E-Cam phase alignment setting: it is set by P2.076.X. P2.076.X Bit 0 enables or disables the alignment function. After this function is enabled, it starts operating as soon as the servo drive receives the DI signal. P2.076.X Bit 1 sets whether to immediately trigger the PR command and calls this PR command when the clutch disengages (P5.088.BA). P2.076.X Bit 2 selects the phase alignment method depending on whether the mark is on the compensated motion axis.

If the mark is on the non-compensation motion axis and when E-Cam phase alignment is operating, the following mark position is unchanged. If the mark is on the compensation motion axis and when E-Cam phase alignment is operating, the following mark position is changed, as shown in Figure 7.3.7.19.

(a) Mark on the non-compensation motion axis (P2.076.X Bit 2 = 0)



(b) Mark on the compensation motion axis (P2.076.X Bit 2 = 1)

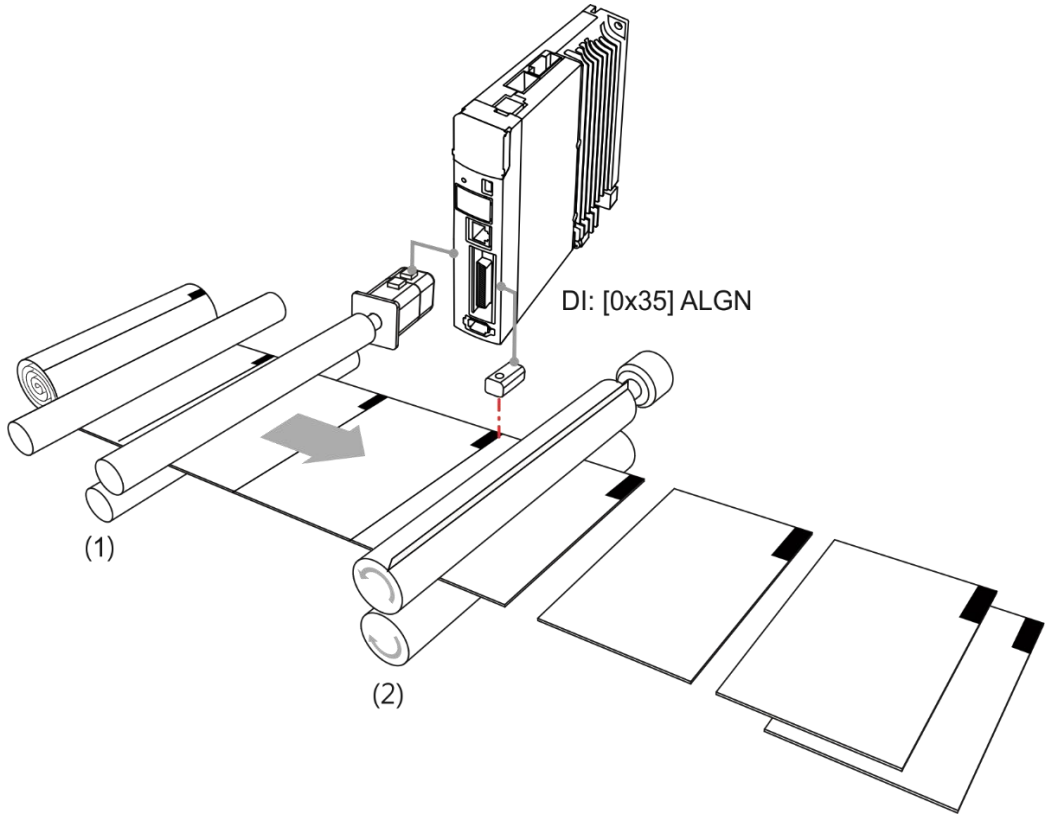


Figure 7.3.7.19 E-Cam phase alignment

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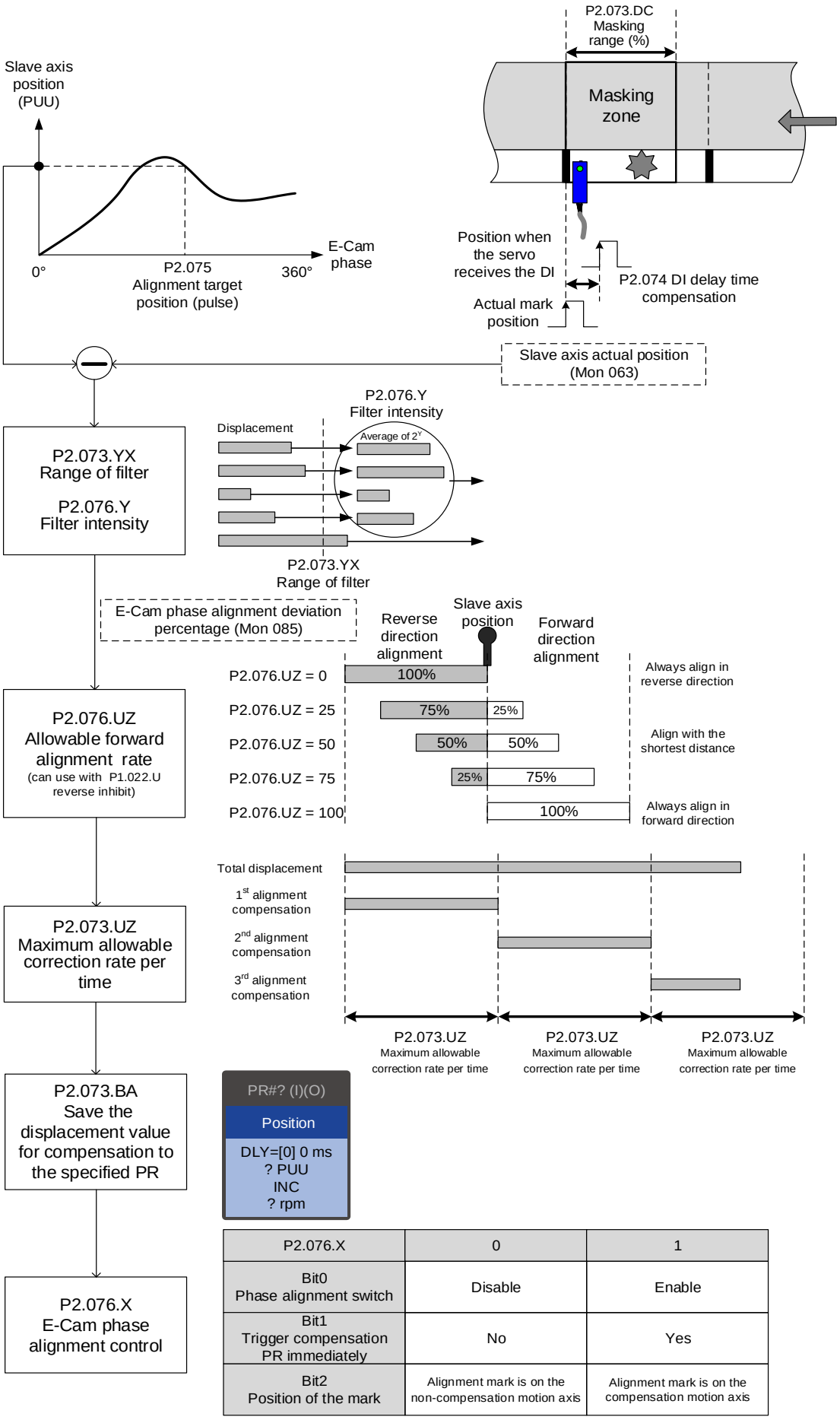


P2.076.X	0	1
Bit0 Phase alignment switch	Disable	Enable
Bit1 Trigger compensation PR immediately	No	Yes
Bit2 Position of the mark	Alignment mark is on the non-compensation motion axis	Alignment mark is on the compensation motion axis

Figure 7.3.7.20 Phase alignment setting procedure

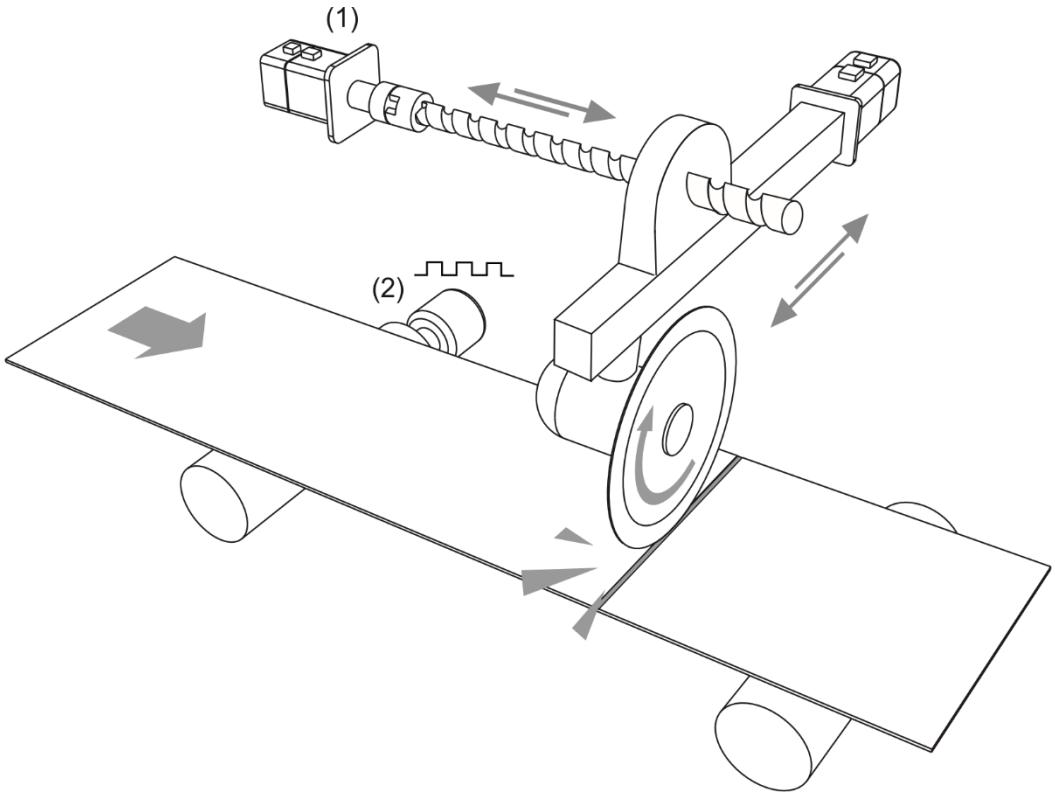
Differences between positioning with synchronous Capture axis and E-Cam phase alignment

The synchronous Capture axis and E-Cam phase alignment are both commonly used compensation approaches for the rotary shear system. In real applications, you can use these two together. The feature differences of the two are as follows.

Item	Synchronous Capture axis	E-Cam phase alignment
Correction method	Corrects master axis pulses.	Uses the PR incremental position command to correct the slave axis position.
Digital input (DI)	High-speed DI7 (CAP) only.	Uses DI.ALGN most of the time. Uses Macro #E if using high-speed DI7 (CAP) is required.
Marking position	On the non-compensation motion axis.	On any of the axes (compensation or non-compensation).
Equal space marking	Available.	Available and can be used with the filter.
Random marking	Not available.	When using the high-speed DI7 (CAP) with Macro #E, using the filter is not suggested. Keep the distance between the sensor and cutter within the cutting length per cut.

7.3.8 Flying Shear

The flying shear system is a dynamic cutting system of which feeder continues to operate. Therefore, the cutting and feeding axes have to be synchronous during cutting. The synchronous speed duration should allow the cutter to finish cutting and return to the right position to avoid damaging the cutter or materials, as shown in Figure 7.3.8.1. Common applications include cutting machines, filling machines, and labeling machines. Different from rotary shear, the compensation methods using synchronous Capture axis and phase alignment are not applicable to flying shear applications. This avoids machine damage caused by the compensation in the synchronous area.



(1) Cutting axis (slave axis); (2) Material feeder (master axis)

Figure 7.3.8.1 Flying shear system

The application of flying shear is divided into two types according to the clutch engagement time. The first type is fully engaged. Its E-Cam curve includes the acceleration zone, synchronous speed zone, deceleration zone, and reset zone. The slave axis is completely controlled by the E-Cam system. The second type is partially engaged: the E-Cam operation is triggered by the signal, and the E-Cam curve has no reset zone. After one cycle of E-Cam operation, the clutch disengages and uses the PR command to reset. Then, the E-Cam waits for the next trigger signal. As shown in Figure 7.3.8.2 using a cutting machine as an example, the material feeder is the master axis and the cutting axis is the slave axis. The feeder maintains at a constant speed, and the cutting axis operates according to the E-Cam curve or PR command.

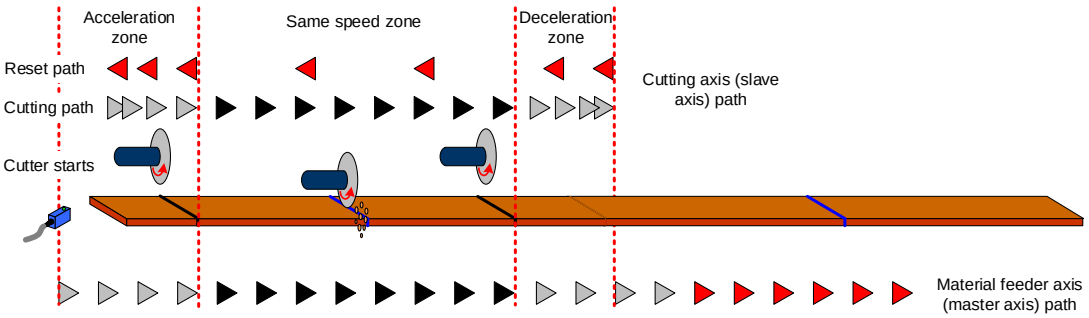


Figure 7.3.8.2 Cutting path and operation cycle of the cutting machine

Fully engaged

The fully engaged E-Cam application is suitable for cutting operations without marks. Its E-Cam curve includes the acceleration zone, synchronous speed zone, deceleration zone, and reset zone. The master axis operates at a constant speed. The slave axis operates according to the E-Cam curve and the cutting is complete in the synchronous speed zone. In each cycle, the slave axis starts from the acceleration zone. To avoid wasting materials in the first cycle, set the initial lead pulse before engaged (P5.087). The setting value is the total pulse number of the synchronous speed zone, deceleration zone, and reset zone. If the cutting sensor and material are not aligned during the first cutting, you need to add the offset pulse number of the sensor.

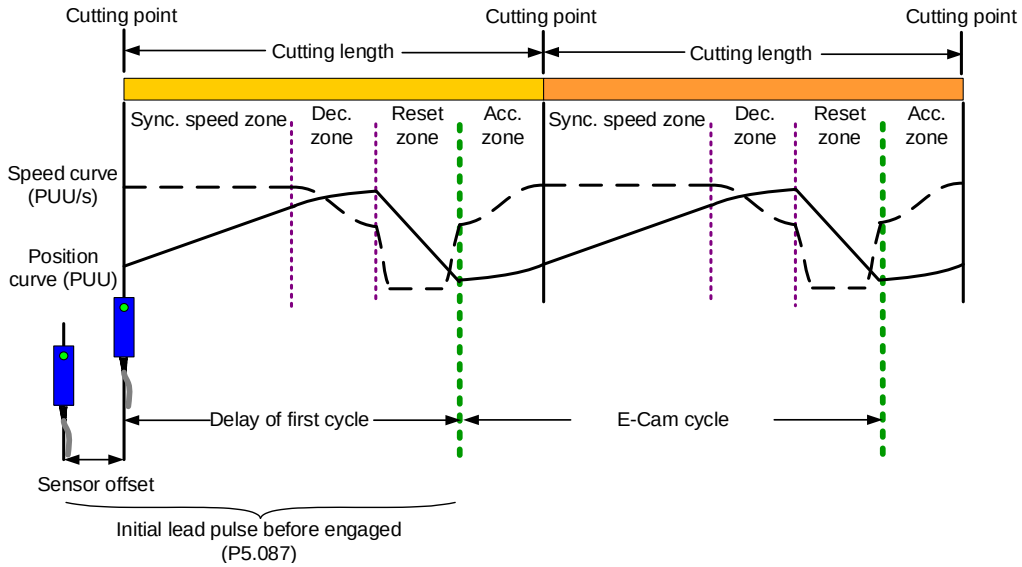


Figure 7.3.8.3 Fully engaged E-Cam cycle of the cutting machine

You can use the “Speed Fitting Creation” in ASDA-Soft to create the E-Cam curve. However, this method can only generate E-Cam curves with single operation direction. You need to create the curves for the cutting zone and reset zone respectively. Then, combine the two curves with the “Manually create a table” function. The operation steps are as follows:

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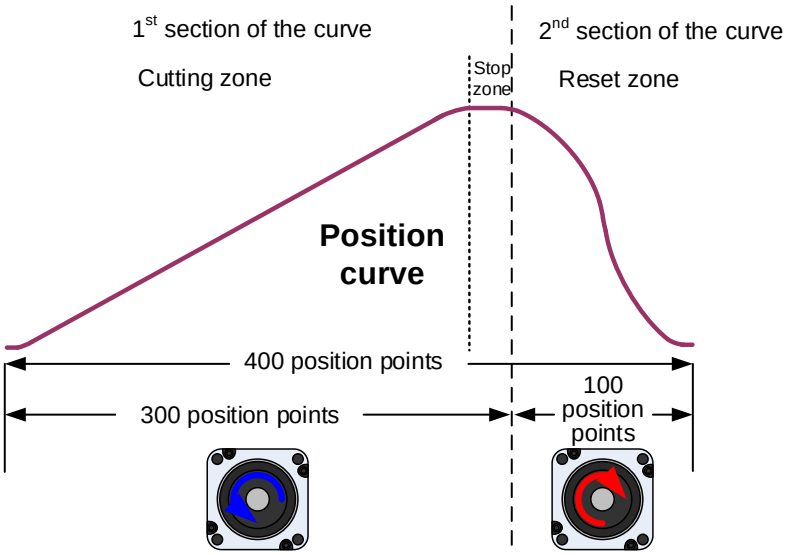
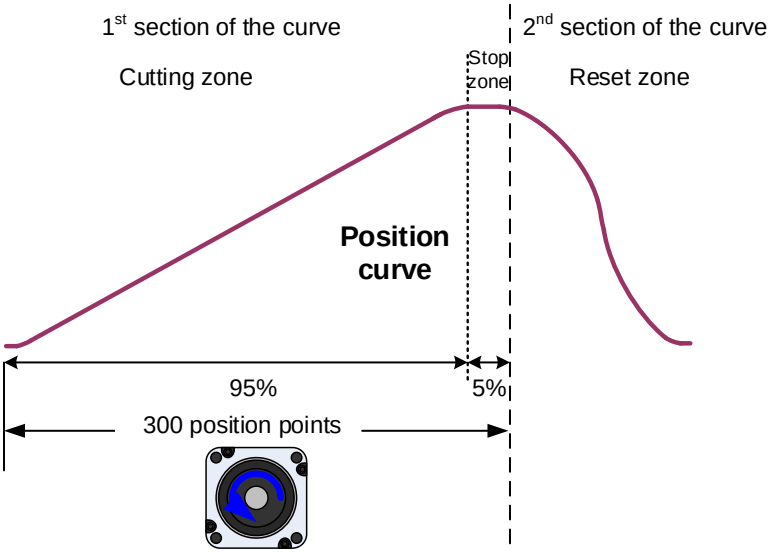
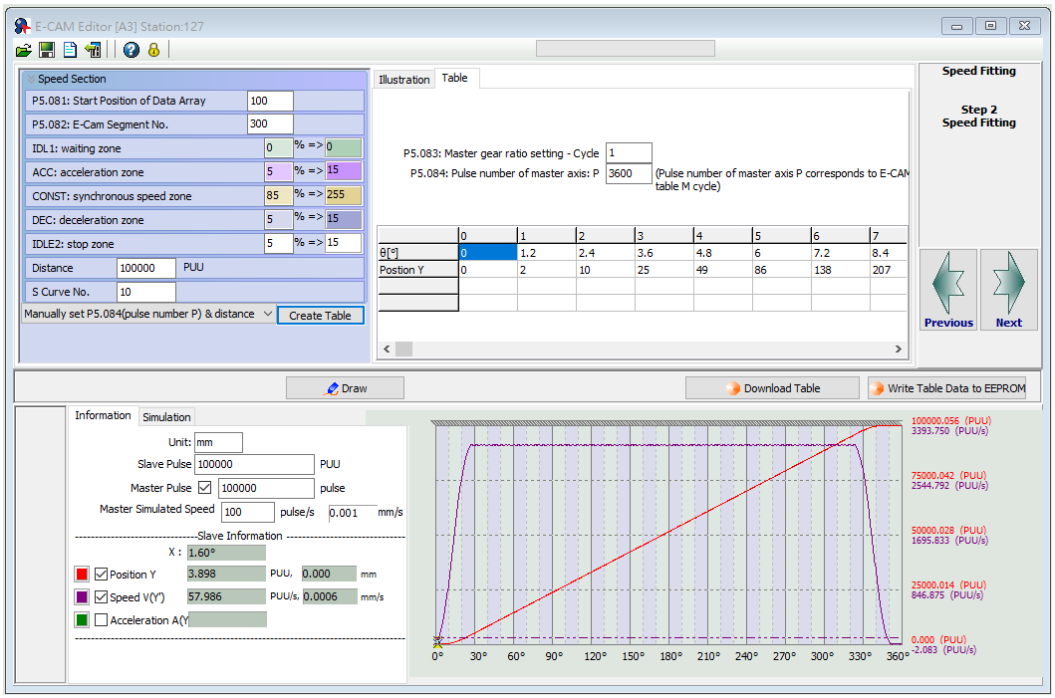
1. Curve planning: segment the cutting zone, stop zone, and reset zone. Because the cutting zone is in the first segment of the curve, there will be more position points plotted in the first segment to ensure the flying shear can complete the cutting in the cutting zone. In the following example, the cutting zone and stop zone are segmented as the first section of the curve with 300 position points. The second section of the curve is the reset zone with 100 position points. So, the curve is composed of 400 position points.



2. Plan and create the first section of the E-Cam curve: this section has a total of 300 position points including the cutting zone and stop zone, so set the E-Cam segment number N (P5.082) to 300. This example sets the cutting zone to 95% (including acceleration zone of 5%, synchronous speed zone of 85%, and deceleration zone of 5%) which is 285 position points. The stop zone is 5%, which is 15 position points. After setting the required lead distance of the slave axis, click **Create Table**.





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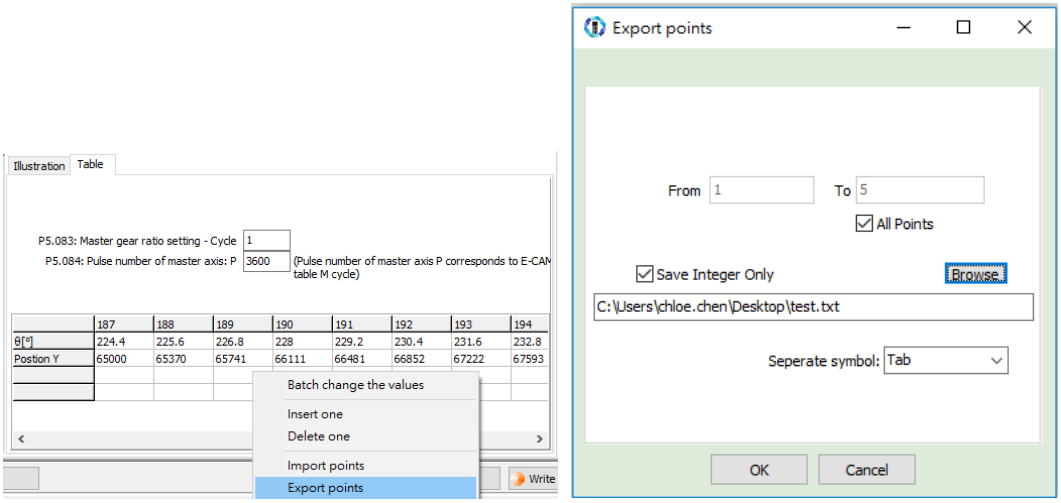
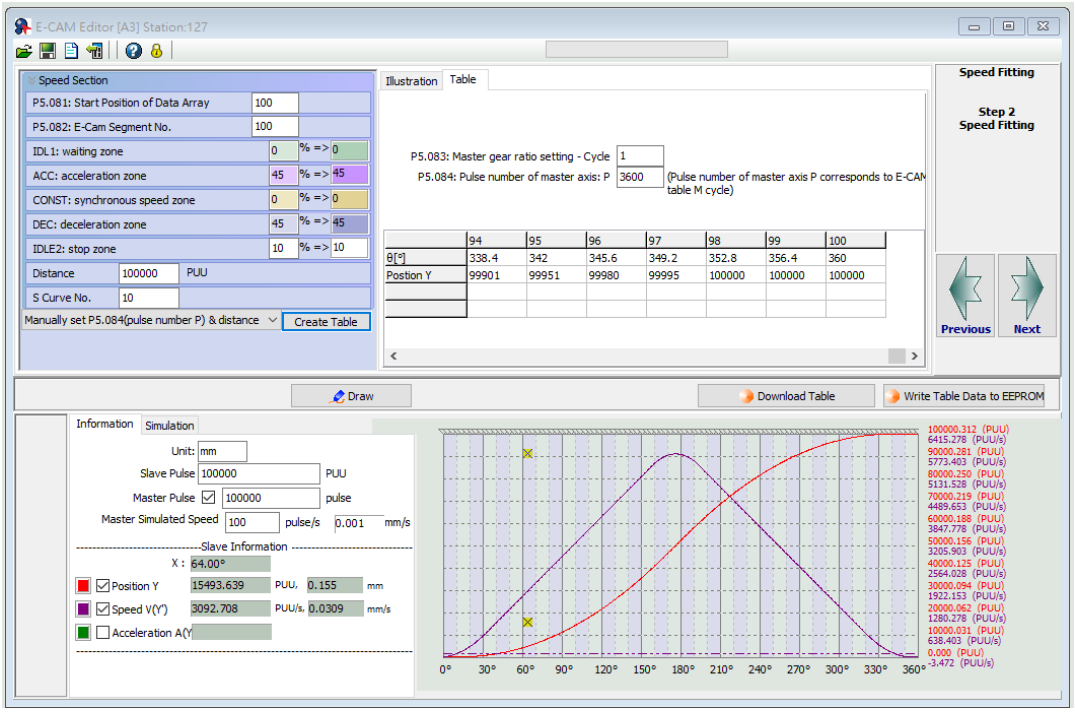
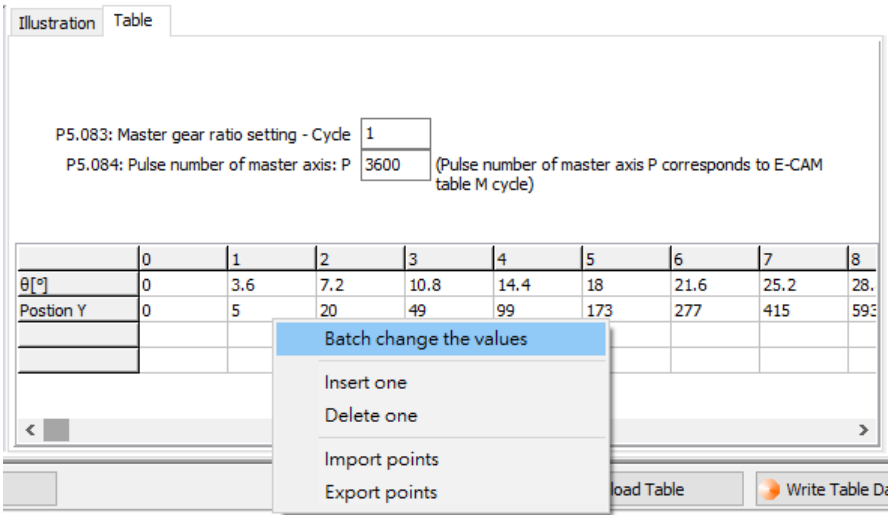
3. Export the curve data of the first section: right-click on the table, select **Export points** and a window appears. Select the check box for **All points** and specify the saving location, then click **OK** to save.

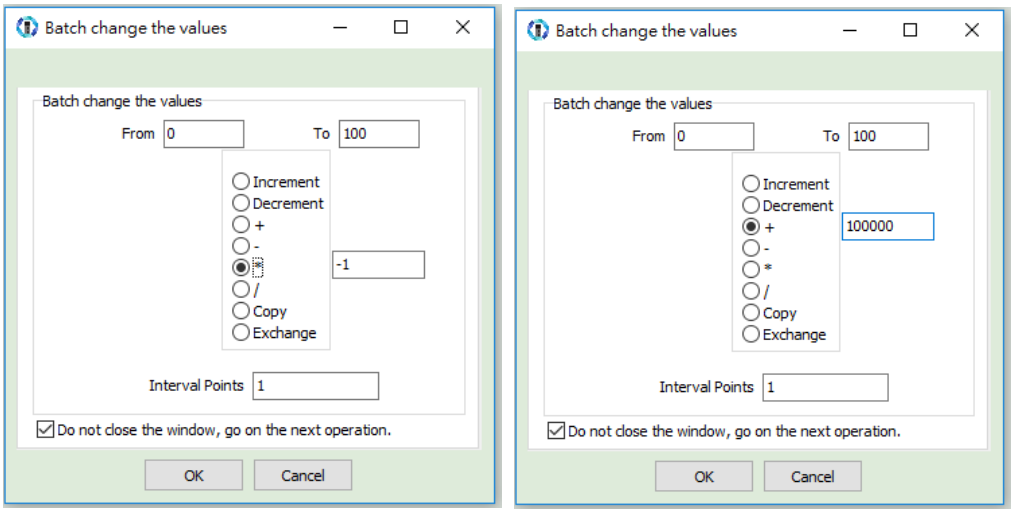


4. Plan and create the second section of the E-Cam curve: the reset zone has 100 position points in total. You must set the E-Cam segment number N (P5.082) to 100. Since the curves created by this function are all in forward direction, you must first create a curve, and then reverse it to complete the curve for the reset zone.



After creating the forward direction E-Cam curve, right-click on the table, select **Quick Input Edit**, and fill in 0 to 200 in the pop-up window. Select "*" (multiplication), fill in "-1", and select the check box for **Don't close, continue the next operation**, then the curve direction reverses from forward to backward. Then, select "+" (plus), fill in "100000" for the lead distance of 100,000 PUU, so that the initial value of this curve section smoothly coincides with the final value of the previous curve section. Click **OK**, then click on **Draw** to complete the reversed direction of the curve.





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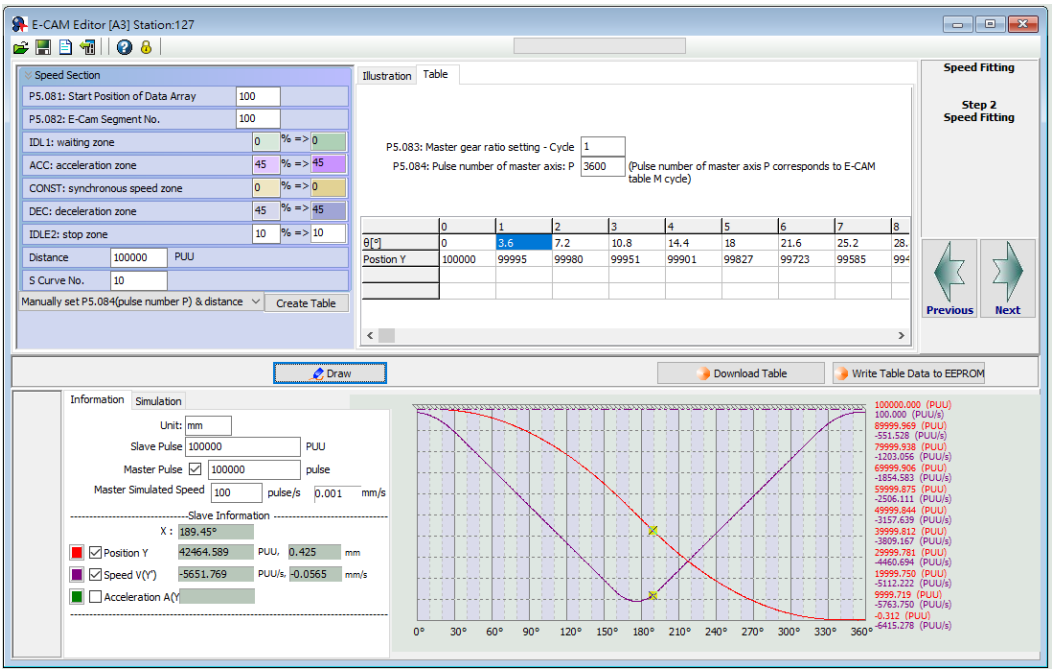
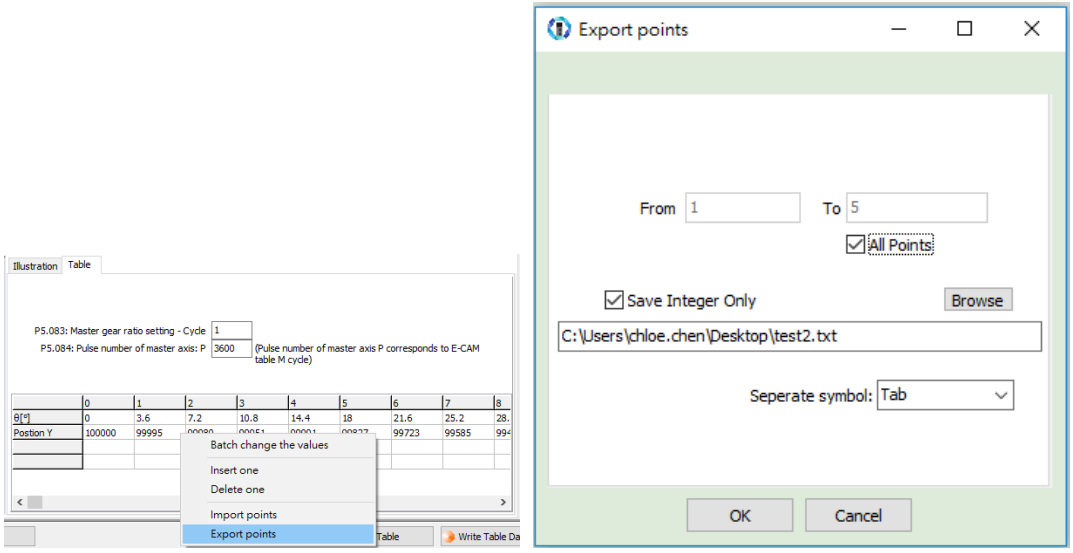
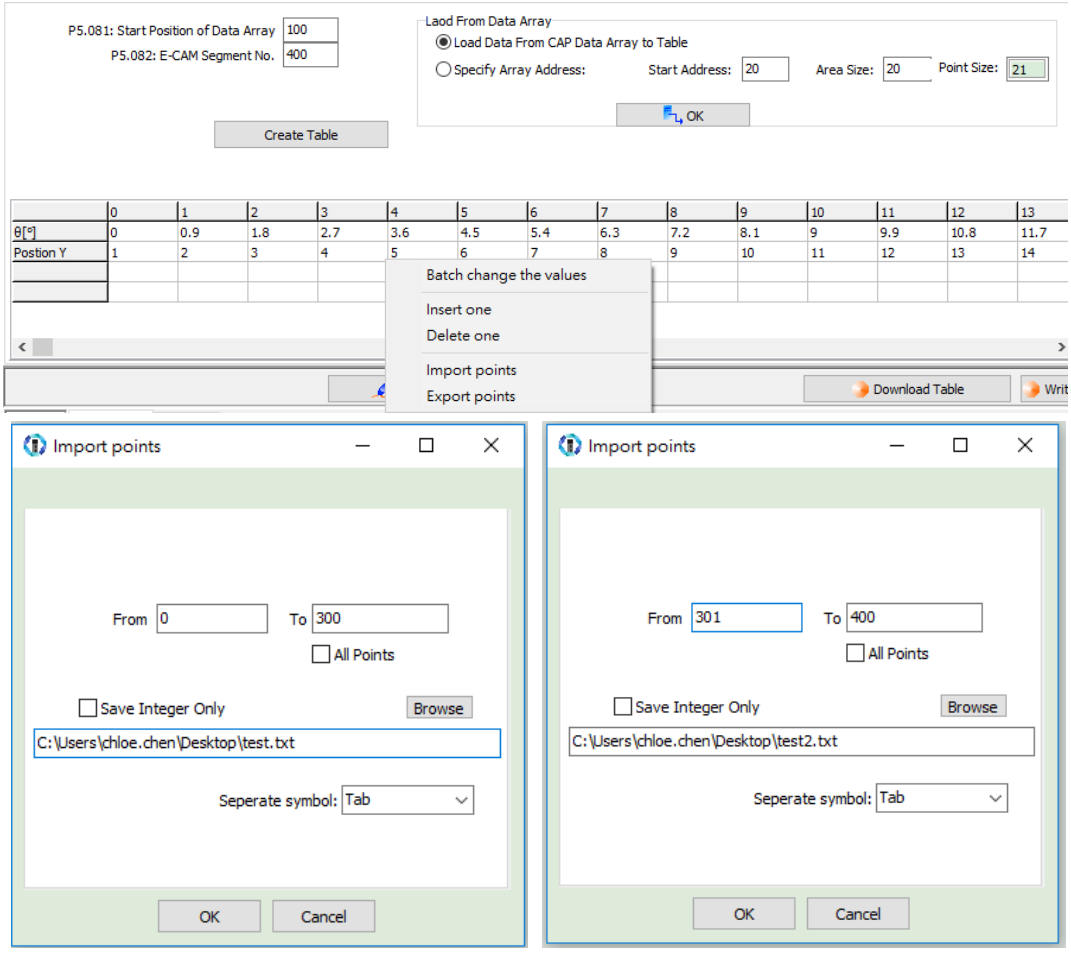


5. Export the curve data of the second section: right-click on the table, select **Export points** and a window appears. Select the check box for **All points** and specify the save location, then click **OK** to save.



6. Combine E-Cam curves: use "Manually create a table". The E-cam curve has a total of 400 position points, so you need to set the E-Cam segment number N (P5.082) to 400. Click **Create Table** and a table of 400 position points is generated. Right-click on the table, select **Import points**, fill in “1” to “300” in the pop-up window, select the first section of the curve, then click **OK**. Follow the same steps as previous, but fill in “301” to “400” in the pop-up window, select the second section of the curve, then click **Draw** to complete the E-Cam curve of the fully engaged mode.



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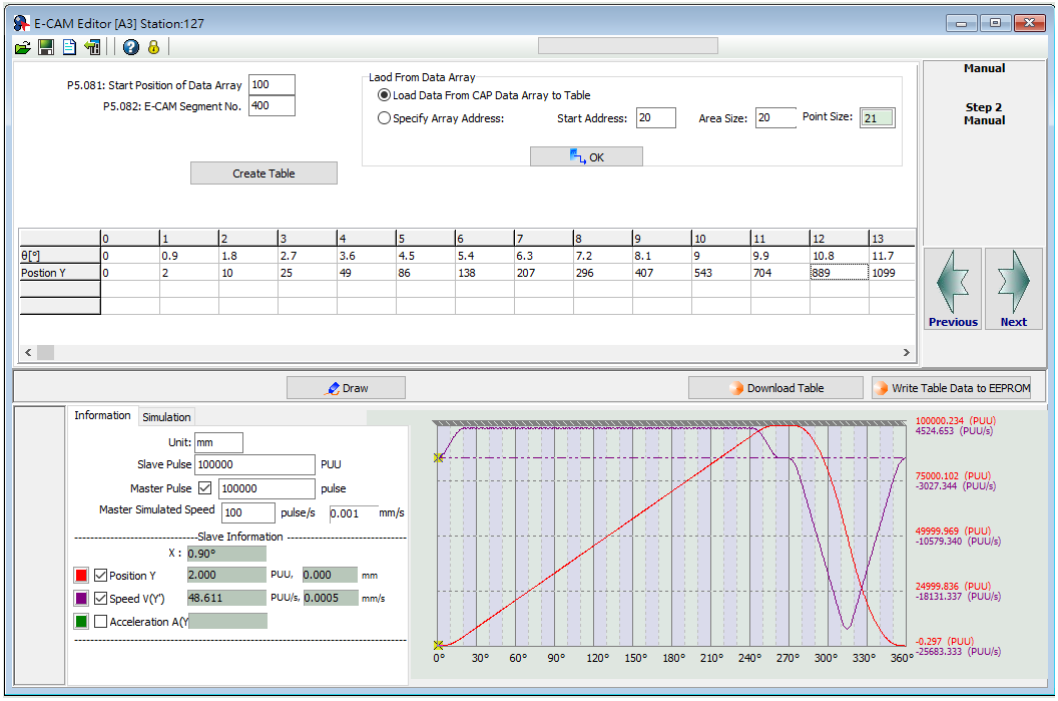
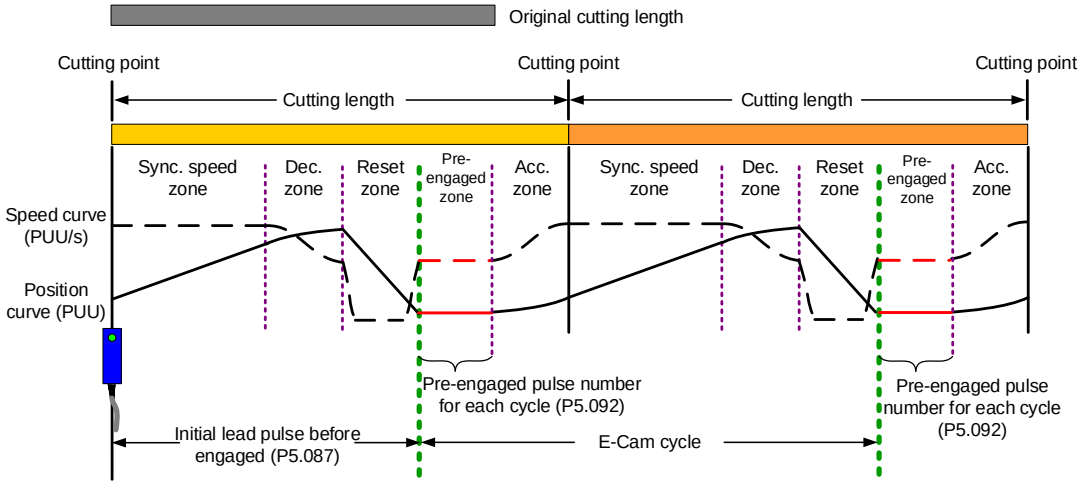


The operation of the fully engaged mode is based on the E-Cam curve. The E-Cam curve is more complex and more difficult to create, so if the cutting length changes, you can only modify the cutting length by setting the pre-engaged pulse number for each cycle (P5.092) or adjust the E-Cam gear ratio (P5.084 / P5.083) and curve scaling (P5.019).

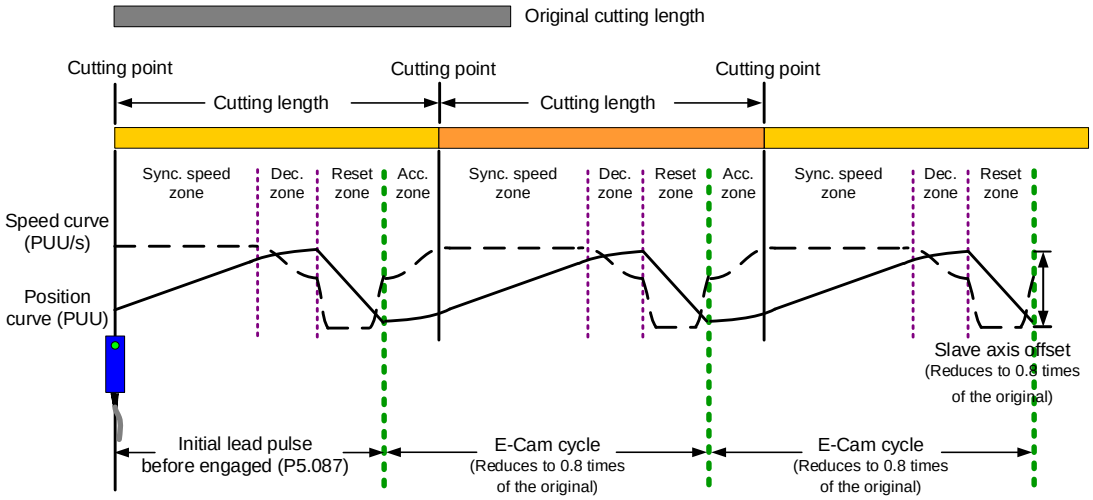
■ Cutting length is greater than the E-Cam curve operating length

Select to enter cyclic mode after disengaging (P5.088.U = 4) and set the pre-engaged pulse number for each cycle (P5.092). When the E-Cam enters the pre-engaged status, the material feeder continues operating, but the cutting axis stops. The cutting axis resumes operation until the pre-engaged pulse number for each cycle is met. The greater the pre-engaged pulse number for each cycle, the longer the cutting length.



■ Cutting length is less than the E-Cam curve operating length

Reduce the E-Cam master axis pulse number and slave axis moving distance proportionally. For example, if you reduce the master axis pulse number for each cycle (P5.084 / P5.083) to 0.8 times of the original, the moving distance of the slave axis should also reduce 0.8 times. You can use the E-Cam curve scaling (P5.019) to reduce the setting by 0.8 times to shorten the cutting length. However, this method also reduces the synchronous speed zone, so make sure that the cutting action can be completed in the synchronous speed zone. This method is not recommended for applications when the cutting length is greater than the E-Cam curve operating length. Because when you increase the moving distance of the slave axis, the machine may not have sufficient distance to complete the slave axis motion which can lead to collision.



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Partially engaged

This is applicable for cutting operations with or without marks. For the cutting operation with marks, use the Capture function to have the E-Cam engaged. For the cutting without marks, use the Compare function to generate virtual marks for the Capture function to capture the position data. The E-Cam curve includes the acceleration zone, synchronous speed zone, and deceleration zone. After the E-Cam curve (acceleration, synchronous speed, deceleration zones) is executed, the clutch disengages. The reset zone is completed with a PR command and then it waits for the next trigger signal to have the clutch engaged. With this method, you can create an E-Cam curve with a larger synchronous speed zone based on the maximum moving distance of the cutter. This is suitable for applications with the cutting length smaller than the waiting zone. For applications with the cutting length greater than the maximum moving distance of the cutter, disengage the E-Cam and have the material feeder continue to operate, and then the E-Cam re-engages when the servo receives the trigger signal.

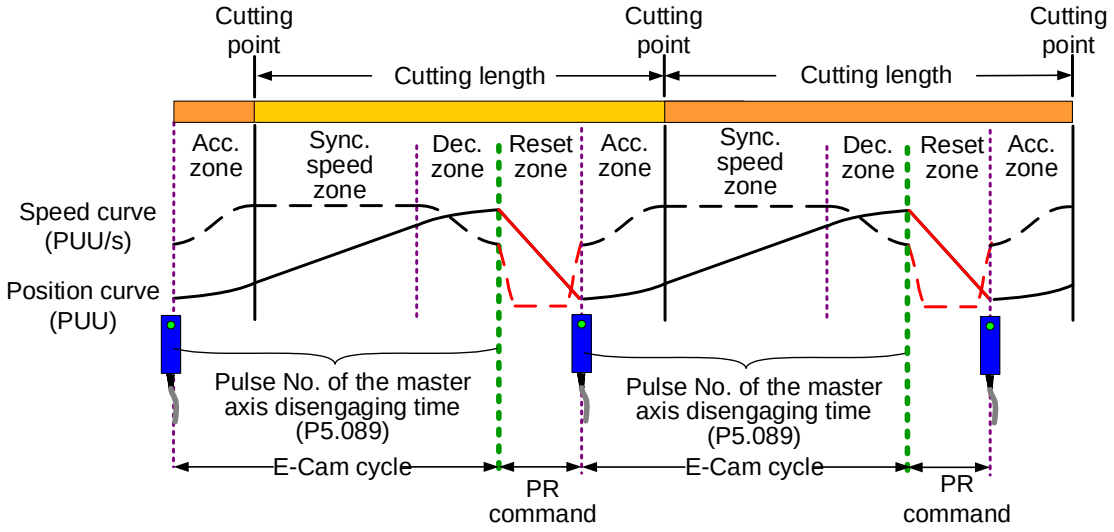


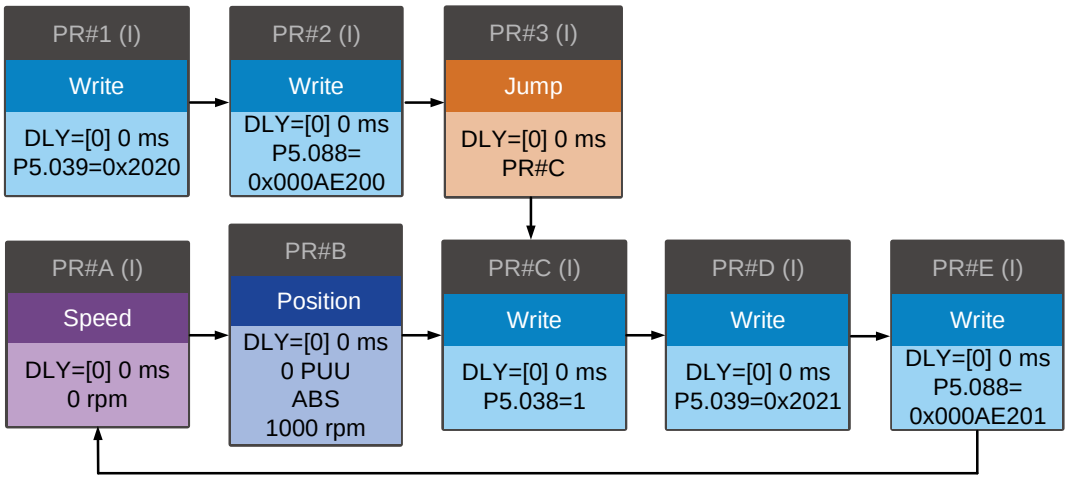
Figure 7.3.8.4 E-Cam cycle of the partially engaged cutting machine

After creating an E-Cam curve based on the maximum moving distance of the cutting axis, set the master pulse number of disengaging time (P5.089) according to the cutting length. After reaching the disengaging pulse number or receving the cutting complete signal, the clutch disengages and continues with a zero-speed PR speed command to stop the cutter. Then, it uses another PR position command to return the cutter to the initial position, as shown in Figure 7.3.8.5. The setting methods are as follows:

1. Master axis signal source: set P5.088.Y to 0; it means the source of the master axis is the capturing axis. In the Capture function, this capturing axis refers to the setting of P5.039.Y for the signal source of the master axis.
2. Engagement condition: set P5.088.Z to 2; it means the clutch engages as soon as the first data is captured and the signal is input through DI7 to the servo drive.
3. Disengagement condition: set P5.088.U to E; it means the clutch disengages when the master axis pulse number reaches the pulse number set in P5.089, the slave axis decelerates to stop, and the E-Cam function is disabled.
4. To set the subsequent PR procedure after the clutch disengages, set the PR number to be executed in P5.088.BA in hexadecimal.
5. Set the PR procedures:

   Procedure 1: set the PR commands for execution when the cutting machine is activated. PR#1 confirms the Capture function is disabled. PR#2 confirms the E-Cam function is disabled. PR#3 jumps to PR#C. PR#C sets the capturing amount to 1. PR#D enables the Capture function. PR#E enables the E-Cam function.

   Procedure 2: set the subsequent PR commands after the clutch disengages. PR#A sets the zero-speed command to stop the cutting axis. PR#B sets the position command to return the cutting axis to the initial position.



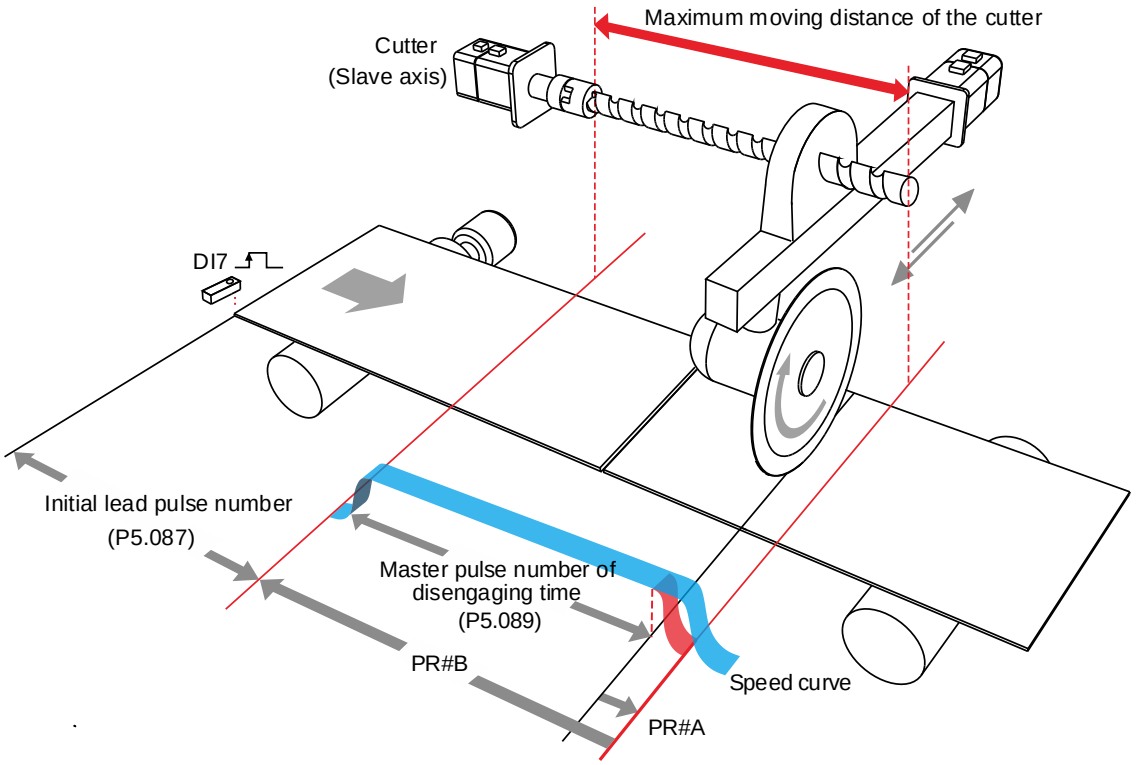


Figure 7.3.8.5 Operation of partially engaged cutting axis

7.3.9 Macro

In real applications, the macro commands cater to different needs during E-Cam operation, such as the requirements for stopping and resuming the operation after an alarm occurs, the phase alignment at the initial operation stage, or phase modification and pausing the cycle during operation. You can use the following macros to complete the tasks. Use P5.097 to enable the macro. Input the values for P5.093 - P5.096 based on the macro requirements.

Macro	Function	Application requirement
Macro #5	Sets the pulse number for the master axis gear ratio (P5.084) and the pulse number for disengagement (P5.089) as the same.	The cams disengage after one cycle.
Macro #8	When the clutch engages, the E-Cam curve scaling (P5.019) takes effect one time.	Prompt change in scaling.
Macro #C	When the clutch engages, sets the master axis pulse phase when the motor remains unmoved.	Precise control of the clutch engagement position.
Macro #D	When the slave axis position is not in the corresponding E-Cam curve, calculates the position correction amount and writes this amount to the PR incremental position command.	Slave axis position offset correction for E-Cam cycles.
Macro #E	Uses high-speed DI7 to perform E-Cam phase alignment, calculates the compensation amount, and writes this amount to the PR incremental position command.	Non-cyclic marking function.
Macro #F	When the master axis stops and the clutch disengages, moves the slave axis to the specified position and then back to the original position.	Evacuating the damaged material due to miscutting.
Macro #10	Carries on the operation after the slave axis stops for one cycle.	Empty pack prevention mechanism.

Macro #C - change the engagement position and operate in forward direction until the disengagement condition is met

When the clutch is engaged, this macro immediately changes the master axis position and automatically calculates the remaining pulse number in the cycle. When the E-Cam cycle is complete, the clutch disengages based on the set disengagement condition (P5.088.U).
This macro can be used for setting the initial engagement position for the master axis and you can select any of the master axis position to engage. The precision level is higher when you use Macro #C than using P5.085 to select the section from the E-Cam table for engagement. When using this macro, the master axis should stay stationary. Wait for the macro to complete before operating the master axis. The operation is shown in Figure 7.3.9.1.

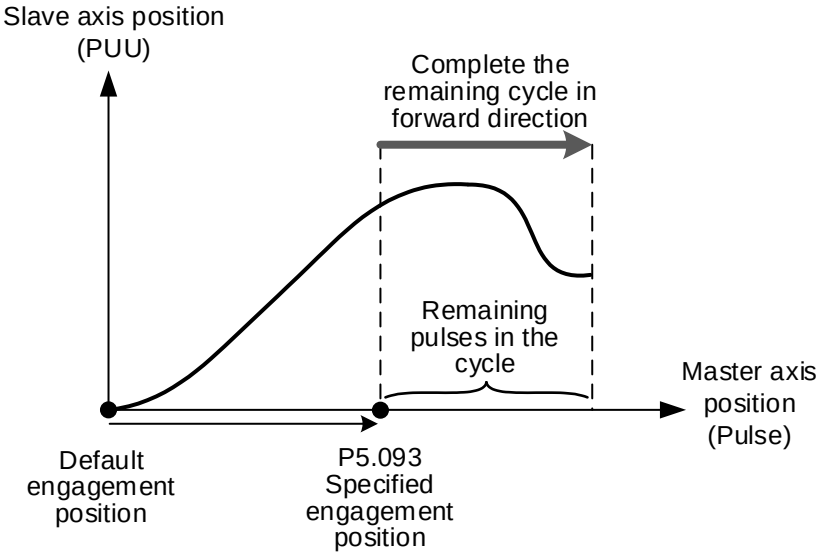


Figure 7.3.9.1 Macro #C operation

Setting steps:

1. The E-Cams engage and the master axis stops.
2. Set the disengagement condition (P5.088.U).
3. Set the engagement position: use P5.093 to write the master axis engagement position (pulse) in hexadecimal and use monitoring variable 062(3Eh) to monitor the current master axis position. The specified range for the new engagement master axis position is:

$$0 \leq \text{P5.093(Pulse)} < \frac{\text{P5.084}}{\text{P5.083}}$$

4. Enable Macro #C: set P5.097 = 0x000C to enable Macro #C. Read P5.097 and if it returns 0x100C, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure code	Description
0xF0C1	When executing this macro command, the clutch is not in the engaged status.
0xF0C2	The engagement position specified in P5.093 exceeds the range (must be $\geq$ 0).
0xF0C3	The engagement position specified in P5.093 exceeds the range (must be $<$ $\frac{P5.084}{P5.083}$).

Macro #D - calculate the deviation between the current slave axis position and index coordinate for PR positioning

When the slave axis position is not at the E-Cam curve corresponding position, this macro finds the slave axis position corresponding to the master axis position. Next, it calculates the deviation between this value and the current motor position, and writes the deviation to the PR incremental position command. You can trigger the specified PR and move the motor of the slave axis to the position corresponding to the master axis position. This macro is suitable for the cyclic motion which starts from the same point. In other words, the mechanism returns to the start point each cycle; and the slave axis moving distance is the same as the total index moving distance. You can monitor the index coordinate in PUU with monitoring variable 091(5Bh). The operation is shown in Figure 7.3.9.2.

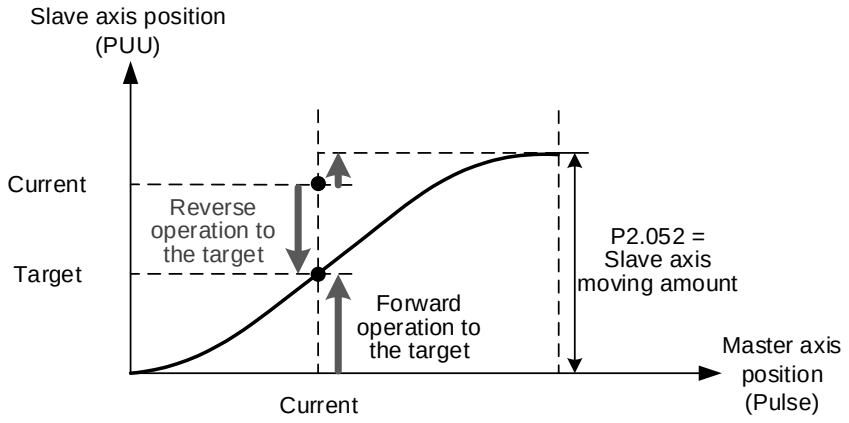
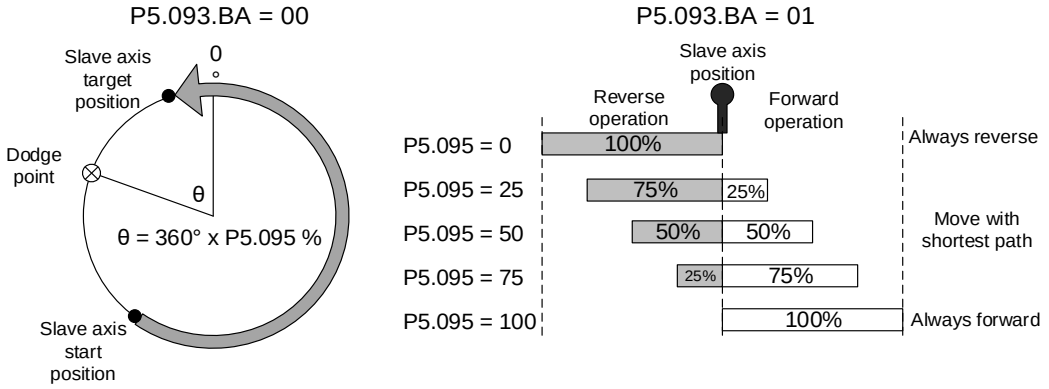


Figure 7.3.9.2 Macro #D operation

Setting steps:

1. Set P5.088.X Bit1 to 1 to keep the clutch engaged when Servo Off and engage the E-Cam.
2. Set the total index moving distance to equal the moving distance of the slave axis per cycle (P2.052 = slave axis moving distance ECAM_H).
3. Set the E-Cam scaling to 1 (P5.019 = 1).

4. Set the initial engagement position: align the start point of 0 degree in the E-Cam curve table with the index coordinate origin.
5. Set the PR number to save the deviation: specify PR#1 - 99 in hexadecimal.
   Set P5.093.YX = 0x01 - 0x63, and set this PR as an incremental position command.
6. Select the direction control type: set P5.093.BA = 00 to use the dodge point for controlling the forward and reverse directions. Set P5.093.BA = 01 to use the allowable forward rate for controlling the forward and reverse directions.
7. Set the reverse inhibit function: set P5.093.CD = 0 to disable the reverse inhibit function. Set P5.093.CD = 1 to enable the reverse inhibit function.
8. Set the dodge point or allowable forward rate: if using the dodge point for direction control, set P5.095 to 0 - 100% for the dodge position. If using the allowable forward rate for direction control, set P5.095 to 0 - 100% as the allowable forward rate. Refer to the following figure.



9. Enable Macro #D: set P5.097 = 0x000D to enable Macro #D. Read P5.097 and if it returns 0x100D, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure code	Description
0xF0D1	When executing this macro command, the clutch is not in the engaged status.
0xF0D2	PR number specified by P5.093.YX exceeds the range (0x01 - 0x63).
0xF0D3	P5.095 the dodge point or allowable forward rate exceeds the range (0 - 100%).
0xF0D5	Position correction value does not exist. This macro command might be triggered twice.
0xF0D6	E-Cam did not remain engaged when servo is off, so when servo switches to the on state again, E-Cam is not engaged.
0xF0D7	Slave axis moving distance does not equal the total index moving distance (ECAM_H ≠ P2.052).
0xF0D8	E-Cam curve scaling does not equal 1 (P5.019 ≠ 1).
0xF0D9	P5.093.BA forward / reverse direction setting exceeds the range (00 - 01).
0xF0DA	P5.093.DC reverse inhibit setting exceeds the range (00 - 01).
0xF0DB	The reverse inhibit function has failed. Do not use macro command #D and #10 consecutively.

Macro #E - PR positioning using E-Cam correction amount

When the clutch engages, this macro sets the master axis engagement position (pulse) and calculates the required correction amount for the slave axis to complete positioning for one time. Next, it writes this correction amount to the PR incremental position command to execute. You can trigger this PR command to have the slave axis operate to the corresponding target position at the proper time. In actual applications, you can connect the external sensor to the servo drive DI, and use an event trigger to enable Macro #E. Then, the macro calculates the correction amount and writes this value to the specified PR program. This macro is suitable for applications with random markings. The operation is shown in Figure 7.3.9.3.

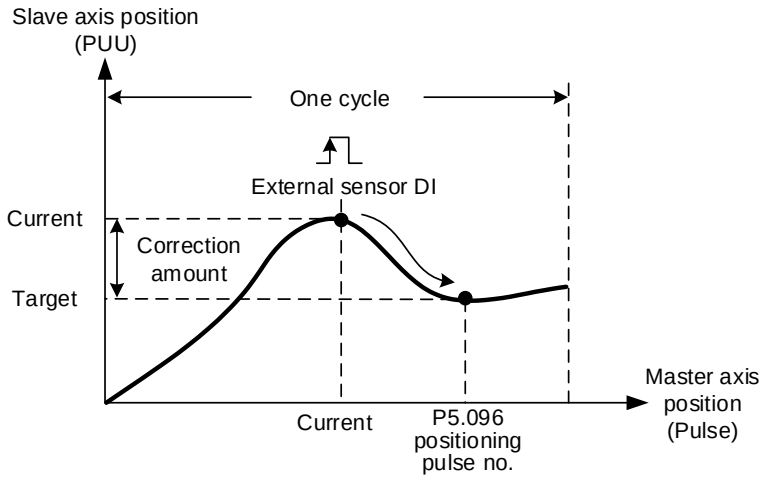
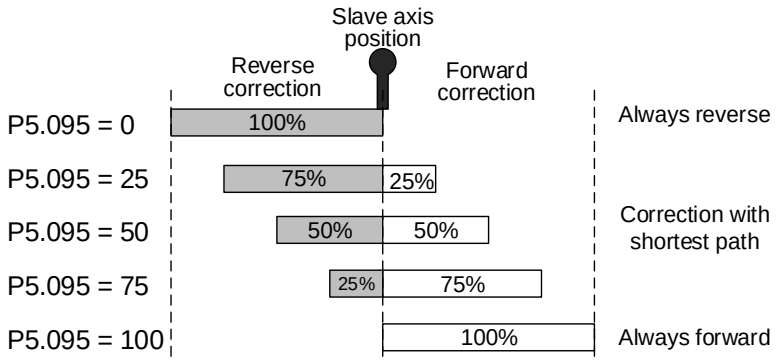


Figure 7.3.9.3 Operation of Macro #E

Setting steps:

1. Engage the clutch.
2. Set the PR number to save the correction amount: specify PR#1 - 99 in hexadecimal. Set P5.093.YX = 0x01 - 0x63, and set this PR as an incremental position command.
3. Set the maximum correction rate: specify the maximum correction rate of 0 - 100% in hexadecimal. When P5.093.UZ = 0x00 - 0x64%, it limits the correctable range to avoid over-correction per time and causing machine vibration.
4. Set the PR trigger timing: set P5.093.A to 1 to immediately trigger the PR command for correction. Set P5.093.A to 0 to manually trigger the PR command.
5. Set the mark position: set P5.093.B to 0 to mark on other motion axis and the following mark positions are not changed when positioning. Set P5.093.B to 1 to mark on the motion axis for compensation, but this changes the following mark positions when positioning.
6. Set the triggering method: set P5.093.C to 0 to use the general DI with event triggering. Set P5.093.C to 1 to use the high speed DI7 with Capture function as the triggering method; meanwhile, set the pulse source of the master axis (P5.088.Y = 0) as the Capture axis. When the last position data is captured, execute PR#50 (P5.039.X Bit3 = 1) to perform the compensation. This is suitable for high precision applications.

7. Set the compensation for the DI time delay: set P5.094 as -25000 to 25000 (μs) to compensate the delay time for the sensor and the signal transmission.
8. Set the allowable forward rate: set P5.095 to 0 - 100% to specify the allowable forward rotation rate.



9. Set the positioning pulse number: use P5.096 to set the pulse number (position) of the master axis for positioning. The setting range is as follows:

$$0 \leq \text{P5.096(Pulse)} < \frac{\text{P5.084}}{\text{P5.083}}$$

10. Enable Macro #E: set P5.097 = 0x000E to enable Macro #E. Read P5.097 and if it returns 0x100E, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure code	Description
0xF0E1	When executing this macro command, the clutch is not in the engaged status.
0xF0E2	PR number specified by P5.093.YX exceeds the range (0x01 - 0x63).
0xF0E3	P5.093.UZ maximum correctable rate exceeds the range (0x00 - 0x64%).
0xF0E4	P5.094 DI delay time compensation exceeds the range (-25000 to 25000 μs).
0xF0E5	P5.095 allowable forward rate exceeds the range (0 - 100%).
0xF0E6	P5.096\ pulse number (position) of the master axis for positioning exceeds the range ($0 \leq$ P5.096 $< \frac{\text{P5.084}}{\text{P5.083}}$).
0xF0E7	P5.093 setting value exceeds the range (0x0000 - 0x0111).
0xF0E8	When using DI7 with the Capture function for triggering (P5.093.C = 1), the Capture axis has to be the source pulse of the master axis (P5.088.Y = 0).
0xF0E9	When using DI7 with the Capture function for triggering (P5.093.C = 1), execute PR#50 (P5.039.X Bit3 = 1) for compensation after the last data is captured.

Macro #F - use the deviation between the current slave axis position and the target position for PR positioning

When the master axis stops but the E-Cams remain engaged, this macro can move the slave axis to the specified position and then return it to the original position. The specified position is specified with the master axis pulse number. After Macro #F is triggered, the servo calculates the required moving amount for the slave axis to move to the specified position and writes this moving amount to the two PR incremental position commands (onward and return trips). Trigger the onward trip PR command, and the slave axis moves to the target position. Trigger the return PR command, and the slave axis returns to the original position. This macro is suitable for applications that require moving the slave axis while the system or the master axis is stopped. The operation is shown in Figure 7.3.9.4.

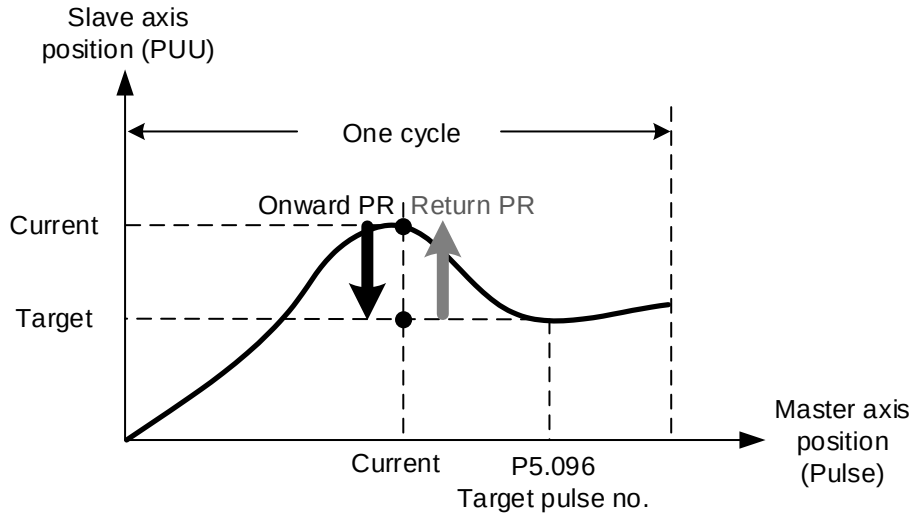


Figure 7.3.9.4 Macro #F operation

Setting steps:

1. The master axis stops and the clutch is engaged.
2. Set the onward and return trip PR numbers: specify any of the PR from PR#1 - 99 in hexadecimal as the onward trip PR command. Set P5.093.YX = 0x01 - 0x63 and set this PR as the incremental position command. Set any of the PR from PR#1 - 99 as the return trip PR command. Set P5.093.UZ = 0x01 - 0x63 and set this PR as the incremental position command. Do not use the same PR number at the same time.

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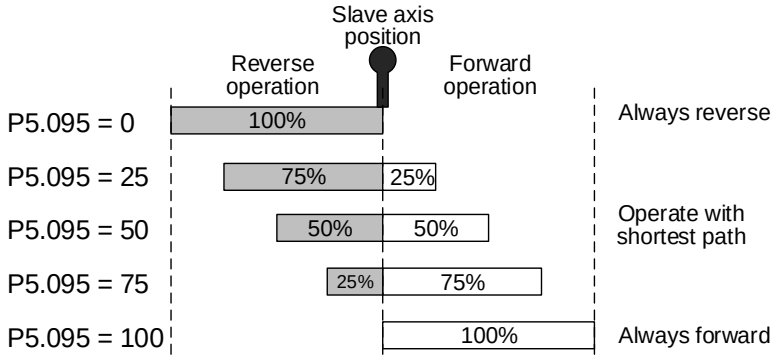
3. Set the allowable forward rate: set P5.095 to 0 - 100% to specify the allowable forward rotation rate.



4. Set the target pulse number: use P5.096 to specify the master axis pulse number of the target position, which range is as follows:

$$0 \leq \text{P5.096(Pulse)} < \frac{\text{P5.084}}{\text{P5.083}}$$

5. Enable Macro #F: set P5.097 = 0x000F to enable Macro #F. Read P5.097 and if it returns 0x100F, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure code	Description
0xF0F1	When executing this macro command, the clutch is not in the engaged status.
0xF0F2	PR number of onward trip specified by P5.093.YX exceeds the range (0x01 - 0x63).
0xF0F3	PR number of return trip specified by P5.093.UZ exceeds the range (0x01 - 0x63).
0xF0F5	P5.095 allowable forward rate exceeds the range (0 - 100%).
0xF0F6	P5.096 master axis pulse number of the target position exceeds the range ($0 \leq$ P5.096 $< \frac{\text{P5.084}}{\text{P5.083}}$).

Macro #10 - the slave axis immediately pauses for one cycle

When the clutch is engaged and the slave axis operates in forward direction, this macro can stop one cycle of the slave axis operation and then the operation resumes. To stop for multiple cycles, consecutively trigger Macro #10 for a number of times. The servo drive records the number of times Macro #10 is triggered and the slave axis will stop for the number of cycles accordingly. When using this macro, use P1.022 PR special filter and set P1.022.YX acceleration time limit (the required time for the motor to accelerate from 0 to 3000 rpm, which range is 10 - 1270 ms). If the acceleration or deceleration time is shorter than the acceleration time limit, then the filter takes effect and smooths the acceleration or deceleration process, preventing the command from changing too drastically and machine vibration. The following error caused by the smooth command will be compensated after the command changes become moderate, so the final position does not deviate. This macro is usually used for the empty pack prevention function on the packing machine. The operation is shown in Figure 7.3.9.5.

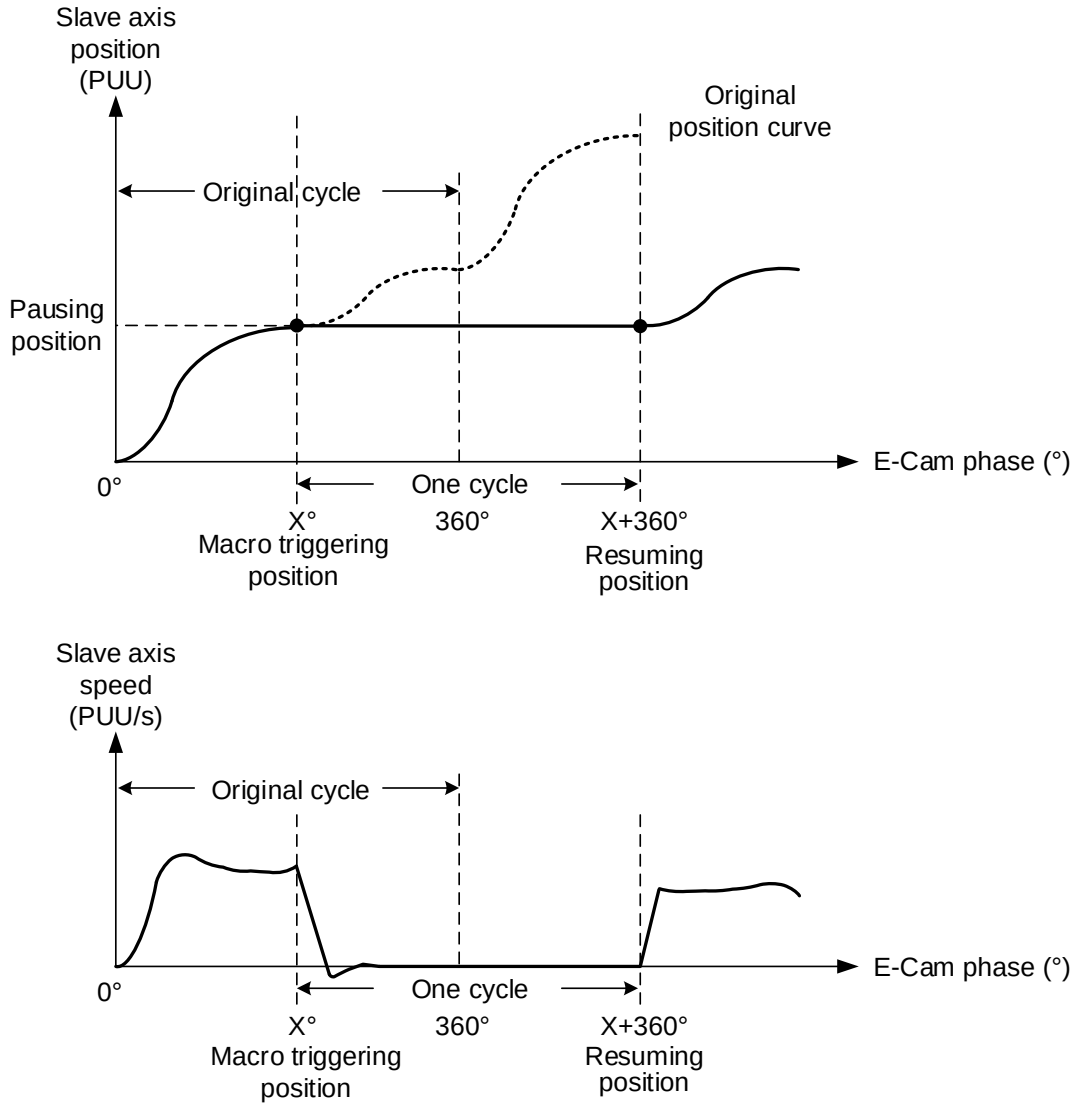


Figure 7.3.9.5 Macro #10 operation

Setting steps:

1. Engage the clutch.
2. Set P1.022.YX the acceleration time limit. If the reverse inhibit is required, set P1.022.U.
3. Enable Macro #10: set P5.097 = 0x0010 to enable Macro #10. Read P5.097 and if it returns 0x1010, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure code	Description
0xF101	When executing this macro command, the clutch is not in the engaged status.
0xF102	Set P5.093 to 0.
0xF103	The slave axis must operate in forward direction. Check the E-Cam curve and P5.019 E-Cam curve scaling.
0xF104	Accumulated pause distance exceeds 2^{31}. Do not execute this macro command consecutively.

Note: this function is accumulative. If the command is triggered for N times consecutively, it pauses the E-Cam for N cycles. Note that the accumulated pause distance cannot exceed the range. When the pause cycle is complete, the slave axis continues to operate and the accumulated pause distance is cleared to 0.

7.3.10 Auxiliary function

Following error compensation

There are two factors causing the following error. The first is the servo error, which is generated by the position loop and can be eliminated by the position integral compensation (P2.053). The second is the command processing delay, which is the delay caused by the filter or command. For the general point-to-point motion, the servo waits for the positioning complete signal and then proceed to the next command. This does not generate too much following error and affect the motion. However, for E-Cam applications, you must reduce the following error, or the E-Cam phase can deviate, and thus reducing the machining precision.

To enable the following error compensation function, set P1.036 to 1. Meanwhile, set P1.008 (Position command smoothing constant) to 0 ms. Enable the position command moving filter (P1.068) and set the value to less than 10 ms. Set the position integral compensation (P2.053) to less than 50. If you are not satisfied with the performance in the acceleration or deceleration stage, adjust the command response gain (P2.089) to reduce the following error. To have better performance in the synchronous speed zone, set the additional compensation time (P1.017) to compensate the deviation. The formula is as follows.

Compensation distance = P1.017 (additional compensation time) × current motor speed

Excluding the following error caused by the machine, if the error is proportional to the speed (for example: 100 rpm with an error of 0.01%; 1000 rpm with an error of 0.1%), it could be caused by the electrical delay. In this case, use P1.018 and P1.021 to compensate the E-Cam phase. The compensation mechanism is as follows.

Compensation amount (pulse) = P1.018 (compensation time) x [Master axis pulse frequency (Kpps) – P1.021 (Minimum frequency of pulse compensation for the E-Cam master axis)]

The master axis pulse frequency can be monitored with monitoring variable 060(3Ch), which value has to be greater than the minimum compensation frequency.

Virtual master axis

During E-Cam operation, if there is a following error in the slave axis, use the virtual master axis to correct the cam phase. Virtual master axis operation is as shown in Figure 7.3.10.1.

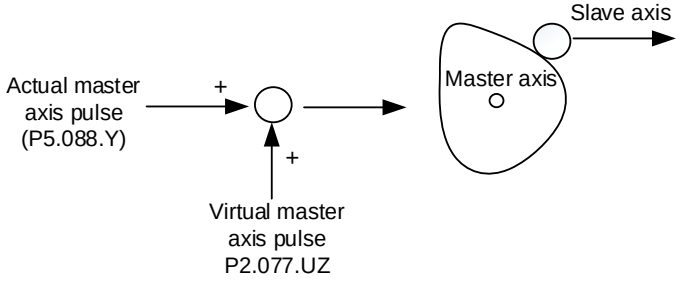


Figure 7.3.10.1 Virtual master axis operation

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Use P2.077 to set the virtual master axis function. P2.077.X can mask the actual master axis pulses and determine how the virtual master axis pulses are generated, as shown in the following table.

X	Function	Actual master axis pulse	Virtual master axis pulse	Description
0	Function disabled	Receive actual master axis pulse	Disable	Slave axis operates based on the actual master axis pulses.
1	Mask the master axis pulses	Masked		Slave axis stops operating, but the masked master axis pulse number continues to be stored in the internal variable.
2	Continuous forward running		Enable	Command source is the virtual pulse frequency set in P2.077.UZ (unit: Kpps). This virtual pulse function continues to operate. To stop it, set X to 1.
3	Continuous reverse running			
4	Forward JOG			Command source is the virtual pulse number set in P2.077.UZ (unit: pulse). This function only refers to the pulse number set in P2.077.UZ.
5	Reverse JOG			
6 - 8	-	-	-	-
9	Master axis pulse masked	Receive actual master axis pulse	Disable	Slave axis operates based on the actual master axis pulses. The master axis pulse number continues to be stored in the internal variable.
A	Continuous forward running		Enable	Command source is the frequency transmitted by the actual master axis (P5.088 Y) plus the virtual pulse frequency in Kpps set by P2.077.UZ. This virtual pulse function continues to operate. To stop it, set X to 9.
B	Continuous reverse running			
C	Forward JOG			Command source is the pulse transmitted by the actual master axis (P5.088.Y) plus the virtual pulse number in pulses set by P2.077.UZ. This function is often used for dynamic adjustment.
D	Reverse JOG			

P2.077.Y sets whether to write the pulse number of the virtual master axis to P5.087 (initial lead pulse before engaged).

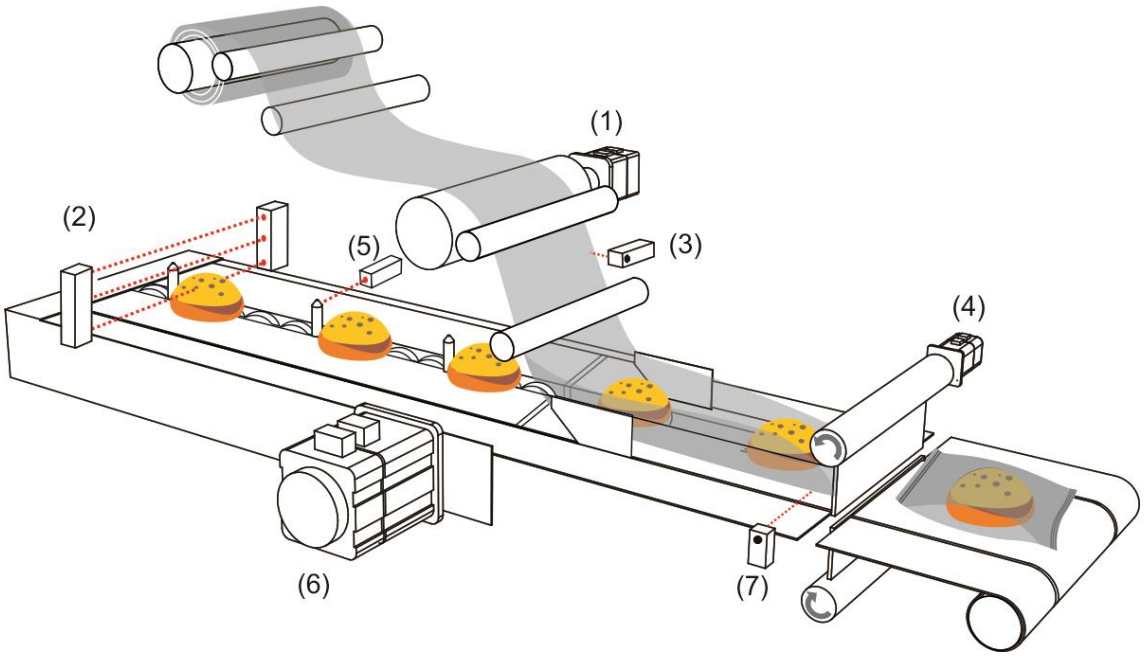
- When the setting of P2.077.Y is changed from 0 to 1, write the pulse number of the virtual master axis to P5.087.
- When the setting of P2.077.Y is changed from 0 to 2, write the pulse number of the virtual master axis to P5.087 and store in EEPROM as non-volatile data.
- When the setting of P2.077.Y is changed from 0 to 7, write the pulse number of the virtual master axis plus the pulse number of one cycle to P5.087 and store in EEPROM as non-volatile data. The value written to P5.087 has to be positive. When the pulse number of the virtual master axis is negative, the system automatically makes it a positive number by adding the master axis pulses of one or multiple cycles and then write this value to P5.087.
- The virtual master pulse number set in P2.077.UZ is hexadecimal. If selecting continuous forward or reverse operation, the unit is Kpps. If selecting jog operation in forward or reverse direction, the unit is pulse.

7.3.11 Horizontal packing machine applications

Horizontal packing machine mainly uses the rotary shear applications and phase compensation in the E-Cam system to have the cutter cut the wrap at the right spot. The rotary shear system can generate suitable E-Cam curves based on the initial mark position, cutter width, and cutting length and time so it can cut precisely. With the auxiliary functions such as empty pack prevention, miscutting prevention, you can avoid material waste or machine damage caused by miscutting. The phase compensation function is to deal with issues such as inadequate tension adjustment of the wrap, inconsistent length between marks, and slipping during transmission. With this function, the cutter is able to quickly complete positioning and return to the correct cutting spot.

System scheme

There are two parts in the packing machine system, the master axis (controller) and three slave axes (conveyor, wrap feeder, and heat sealer with cutter). The controller is the pulse source for the master axis. It outputs the pulse signals to the slave axis and performs logic condition check for the auxiliary function. The main function for the chain conveyor is to convey the contents to be packed to the work station. The main function for the wrap feeder is to feed the wrap to the work station for packing the content. The heat sealer with cutter is to seal and cut, which is the final step of packing. See Figure 7.3.11.1.



(1) Wrap feeder (slave axis)
(2) Empty pack detection sensor
(3) Mark sensor for E-Cam phase alignment
(4) Heat sealer with cutter (slave axis)
(5) Mark sensor for synchronous Capture axis
(6) Chain conveyor (slave axis)
(7) Sensor for avoiding miscutting

Figure 7.3.11.1 Horizontal packing machine

- Controller (master axis)

  The controller controls the operation mechanism for the horizontal packing machine and judges the logic for the auxiliary function. In addition, the controller is the pulse source for the master axis and it sends stable pulse signals to the slave axes, and the slave axes operate based on these pulse signals.

- Chain conveyor (slave axis)

  This axis conveys the contents to be packed. The two slaves (wrap feeder and heat sealer with cutter) mentioned in the following sections perform E-Cam phase alignment based on the marking on this chain conveyor.

- Wrap feeder (slave axis)

  This axis feeds the packing wraps. The feeding of the packing wrap has to be smooth. For example, the tension output by the mechanism cannot be too great, or the packing wrap can be over-extended. However, if the tension is not high enough, slippery on the wrap feed roller might occur. When any of these two circumstances occurs, it means the output master pulses do not match the packing film length. In this case, use the phase alignment compensation function provided by the servo drive for correction.

- Heat sealer with cutter (slave axis)

  The design for the heat sealer with cutter needs to take the proportion of the cutting length and cutting interval into consideration. If the cutting length is too short, it can cause a drastic change in cutter rotation speed or the motor torque might exceed the output limit. So, you can consider to increase the cutter number to reduce the cutter interval, making the rotation speed smoother. For packing machine applications, the cutter has both the heat sealing and cutting functions, thus when plotting the E-Cam curves, the synchronous speed zone has to be greater for the cutter to complete the cutting and heat sealing.

Servo system setting

■ Framework

The controller outputs the pulse signals to the chain conveyor. When the chain conveyor delivers the packing contents, it uses the pulse by-pass function built in the servo drive to transmit the pulses to other slave axes at the same time, so the master axis can send pulses to other slave axes with the slave servos. The delay time for each axis is 50 ns and the pulse signal does not attenuate during transmission.

To use the E-Cam phase alignment function, install the mark sensor on the wrap feeder and use DI: [0x35]ALGN to correct the E-Cam phase. The mark sensor for the synchronous Capture axis is installed on the chain conveyor and sends the signals through the high-speed input point (DI7) to the servo drives controlling the wrap feeder and cutter. In other words, the synchronous Capture axis provides the source pulses for E-Cam master axis of these two servo drives.
The electrical framework is as shown in Figure 7.3.11.2.

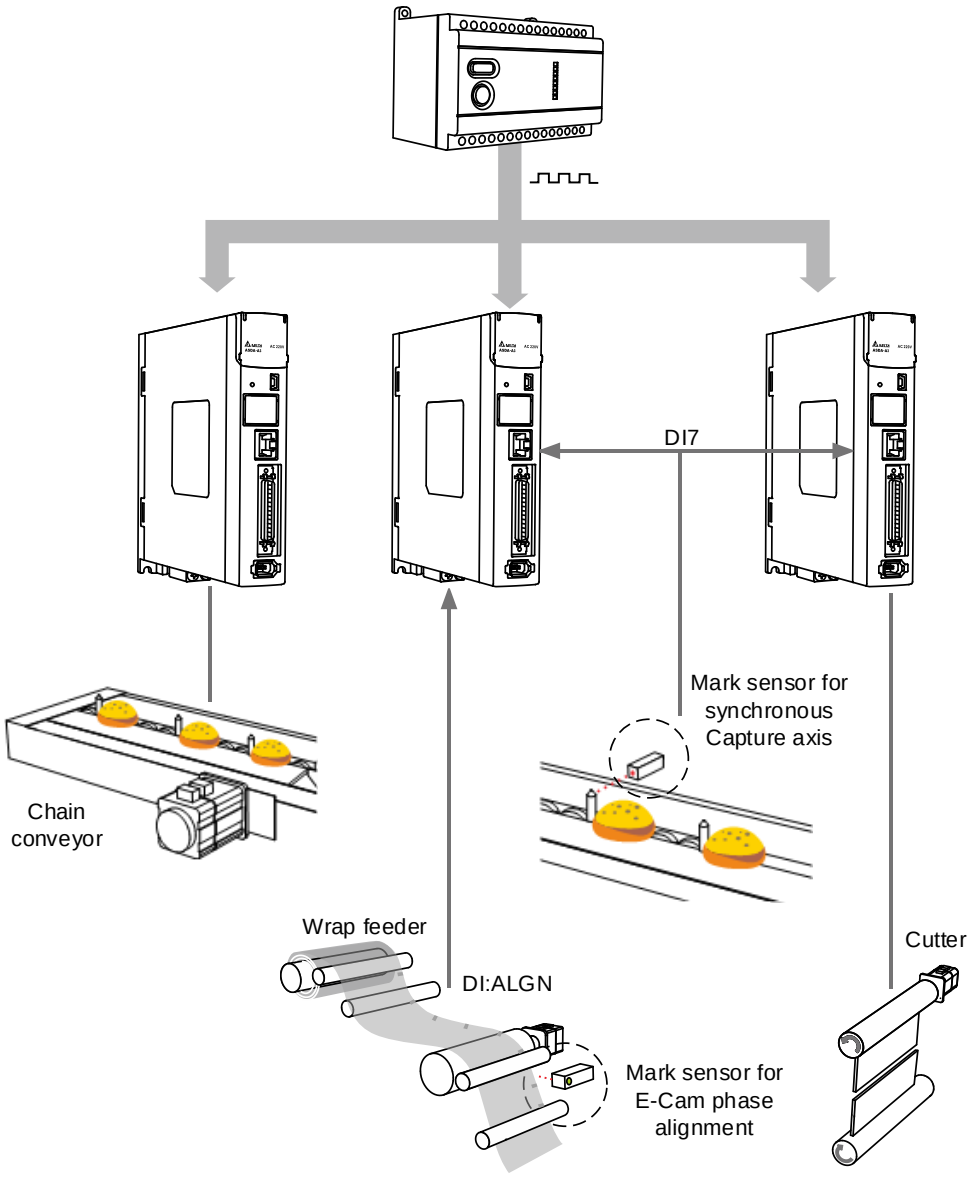


Figure 7.3.11.2 Horizontal packing machine framework

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You can install a sensor on the packing machine to avoid empty packs or miscutting the content when the content is in the wrong position. In the empty pack prevention mechanism, the empty pack detection sensor is installed on the chain conveyor and sends signals to the controller. Next, the controller counts and calculates the timings for triggering the empty pack PR path of the two slave axes and enabling Macro #10, thus avoiding generating empty packs.

For the miscutting prevention mechanism, install the miscutting detection sensor on the cutting device. By doing so, the sensor can directly return the signals to the servo drive controlling the cutter through the digital input point. When detecting the packing content position error, the sensor triggers the miscutting prevention PR path and enables Macro #F to avoid damages to the machine or cutter caused by content position errors while cutting.

The electrical framework for empty pack prevention and miscutting prevention is as shown in Figure 7.3.11.3. When an error occurs and causes the machine to stop and the slave axis actual position is inconsistent with the E-Cam phase, use Macro #D to re-align the E-Cam phase.

Details about the error detection mechanisms are described in the following sections (Empty pack prevention mechanism, Miscutting prevention mechanism, and Reset mechanism after alarm stops).

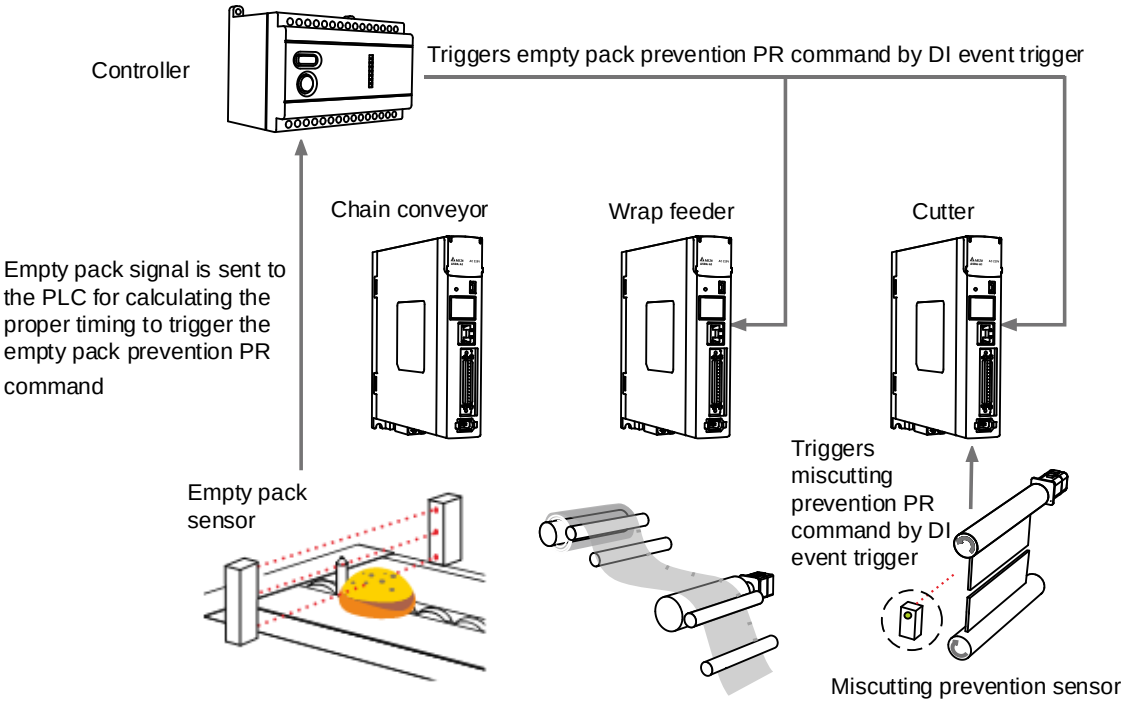

Figure 7.3.11.3 Horizontal packing machine error detection framework

■ E-Cam curve plotting

On the horizontal packing machine, the chain conveyor, wrap feeder, and cutter all require E-Cam curve settings. Both the chain conveyor and wrap feeder follow the master axis pulses for constant speed motion, which makes the E-Cam curve a slope. You can complete the setting with ASDA-Soft. Regarding the cutter axis with heat sealer, use [Rotary shear - adjustable sealing zone] in the ASDA-Soft to complete its E-Cam curve.

1. Cutter axis: select [Rotary shear - adjustable sealing zone] in the ASDA-Soft and fill in the packing machine specifications in the table, as shown in the following example.
   For detailed settings, refer to Section 7.3.7. In this example, the master pulse number is automatically calculated by the software, which means the E-Gear ratio P5.084 = 79577 and P5.083 = 1. Set the E-Gear ratio P1.044 = 16777216 and P1.045 = 100000.

Motor gear number (A)	1
Cutter gear number (B)	5
Cutter number	1
Cutter diameter (d1)	200 mm
Encoder diameter (d2)	20 mm
Pulse per encoder revolution (N)	10000
Cutting length (L)	500 mm

2. Wrap feeder: select [Manually create a table] in the ASDA-Soft. See the following example. The roll diameter for dragging the packing wrap is 20 mm, so the wrap feeder feeds the wrap of 62.83 mm per roll revolution. A cutting length of 500 mm requires 50,000 PUU. Every time the mechanism operates 50,000 PUU, the motor operates 250,000 PUU. In this case, set the E-Gear ratio P1.044 = 16777216 and P1.045 = 50000 and create a constant speed E-Cam curve with a total lead of 250,000 PUU. The E-Cam gear ratio of this axis must be consistent with the cutter axis, which means P5.084 = 79577 and P5.083 = 1.

Cam phase (°)	0	72	144	216	288	360
Cutter axis position (PUU)	0	20000	40000	60000	80000	100000

3. Chain conveyor axis: select [Manually create a table] in the ASDA-Soft. See the following example. If the command resolution is 1 mm corresponding to 100 PUU, then each chain interval of 500 mm requires 50,000 PUU.

Cam phase (°)	0	72	144	216	288	360
Cutter axis position (PUU)	0	20000	40000	60000	80000	100000

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■ Synchronous Capture axis

The slave axis of the horizontal packing machine operates based on the received pulses from the master axis. If the slave axis does not receive the pulses as it is set, then the slave axis is not able to cut and pack correctly. For example, when the master axis sends 10,000 pulses, the cutter cuts with the correct cutting length. When the master axis sends 10,000 pulses but the cutter receives 11,000 pulses, the cutter starts cutting upon receiving the 10,000th pulse, thus the actual cutting length will be shorter than the correct cutting length. When the master axis sends 10,000 pulses but the cutter only receives 9,000 pulses, the cutter waits and starts cutting only after it receives the 10,000th pulse, thus the actual cutting length will be longer than the correct cutting length.

To solve this problem, you can have the servo drive compare the set pulse number between two marks and the pulse number actually received, and then adjust the cutting length based on this deviation. In this example, the servo drive compares the actual pulse number transmitted through DI7 (the high-speed digital input point) between two triggers and the set master pulse number. Then, the pulse correction function will refer to this pulse difference to correct the signal. The corrected signal becomes the source for the synchronous Capture axis. And this synchronous Capture axis is regarded as the pulse source for the master axis to drive the slave axes. In addition, the pulse number from the master axis corresponding to the slave axis changes with the synchronous Capture axis. For detailed settings, refer to Section 7.3.7.

■ E-Cam phase alignment

First set the position for the phase alignment. The servo drive calculates the deviation between the actual position and the set position every operation cycle and makes correction. When the E-Cam phase alignment sensor reads the mark, it sends the signal to the DI point of the servo drive. Meanwhile, the servo drive examines whether the master axis is at the set position and calculates the displacement between the slave axis for correction. In this example, if the E-Cam requires 79,577 pulses from the master to operate one cycle, then P5.084 = 79577 and P5.083 = 1. The master axis pulse number is 30,000 when the system reads the positioning signal. When the packing machine starts operating and after the mark signal is sent to the servo drive, if the master pulse number is 29,000, then the servo drive knows that there is a deviation of 1,000 master axis pulses from the target. The servo drive calculates the position error of the slave axis based on this deviation and writes this correction amount to the PR program. The servo drive triggers the PR commands when the set conditions are fulfilled and completes the E-Cam phase alignment by overlapping the commands. For detailed settings, refer to Section 7.3.7.

■ Empty pack prevention mechanism

In packing machine applications, when the slave axes (wrap feeder and cutter) operate one cycle, the master axis (chain conveyor) travels one fixed packing distance. Use the two sets of E-Cam DO, [0x18]CAM_AREA1 and [0x1A]CAM_AREA2, to set the empty pack detection position and the slave axis pausing position.

First set of DO: [0x18]CAM_AREA1:

When DO.CAM_AREA1 signal is on, the controller has to read the signal from the empty pack prevention sensor. If the sensor sends a signal, it means there is a packing content on the chain conveyor within this packing distance. If the sensor sends no signal, it means there is no packing content within this packing distance and requires to enable the empty pack prevention mechanism. Set the distance between the detection spot and the cutting spot for the controller. If the detection spot is 5 fixed packing distances away from the cutting spot, then the controller needs to complete the packing for the previous five packs. After the second set of DO.CAM_AREA2 is on, it calls the PR command to execute Macro #10 to enable the empty pack prevention mechanism.

Second set of DO: [0x1A]CAM_AREA2:

It is for setting the slave axis pause position. Generally, this setting should not affect the master axis motion. It is suggested that the slave axis pauses at the 0° position in the E-Cam curve. Since the slave axis requires to accelerate from a stop to the operation stage, you can use the acceleration curve to have the slave axis follow the E-Cam curve closely after resuming operation.

For the empty pack prevention mechanism, it uses the controller to call the PR command for the two slave axes, which executes Macro #10. When executed, these two slave axes pause for one E-Cam cycle and then resume the operation in the next cycle. If there are two consecutive empty packs, the mechanism can trigger Macro #10 for two consecutive times. When using this function, use the PR special filter (P1.022) to avoid drastic speed change of the slave axes. The operation is shown in Figure 7.3.11.4.

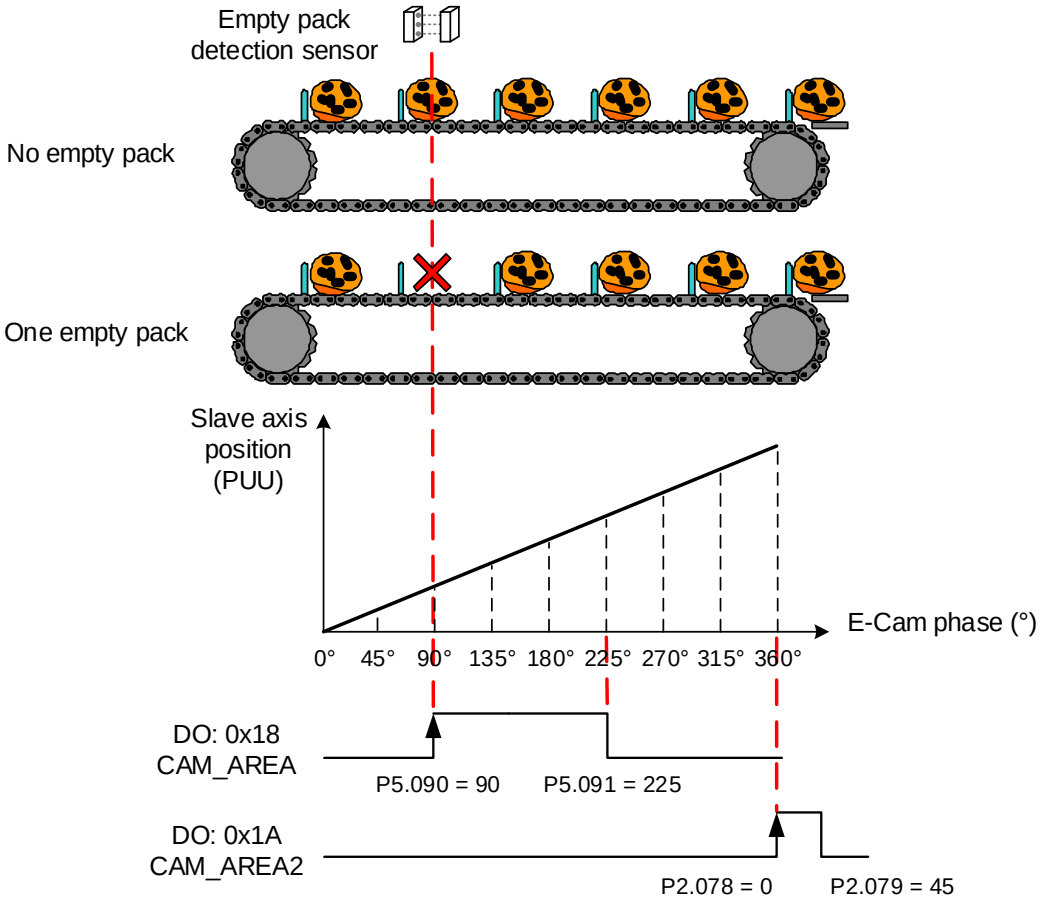

Figure 7.3.11.4 Empty pack prevention mechanism

■ Miscutting prevention mechanism

Sometimes the position of the packing content shifts on the chain conveyor, so the cutter might cut the content, causing damage to the cutter or machine. To avoid this issue, install a sensor for preventing miscutting. When the sensor detects no packing contents, it means the content is not in the right position and the miscutting prevention mechanism needs to be activated. To use this mechanism, set the following conditions: the clutch remains engaged when Servo Off, the E-Cam curve scaling (P5.019) starts taking effect upon the next engagement, and return to the pre-engage status after disengagement.

When the first set of DO: CAM_AREA1 is rising-edge triggered and the sensor detects no packing content, use the DI event to trigger the PR path and activate the miscutting prevention mechanism. Use Macro #F to calculate the deviation between the cutter axis current position and the target position, and write this deviation data to the specified PR number. Set the E-Cam curve scaling (P5.019) to 0 and use Macro #8 to activate the scaling setting. When the master axis keeps operating and the clutch is engaged, the cutter will pause because the scaling setting is 0. After Macro #8 is triggered, the E-Cam curve scaling (P5.019) is reset to the original value. Meanwhile, execute the PR incremental position command specified in Macro #F to return the cutter to the specified position and wait for the pre-enagagement cycle to complete, then the cutter keeps operating when it is re-engaged.

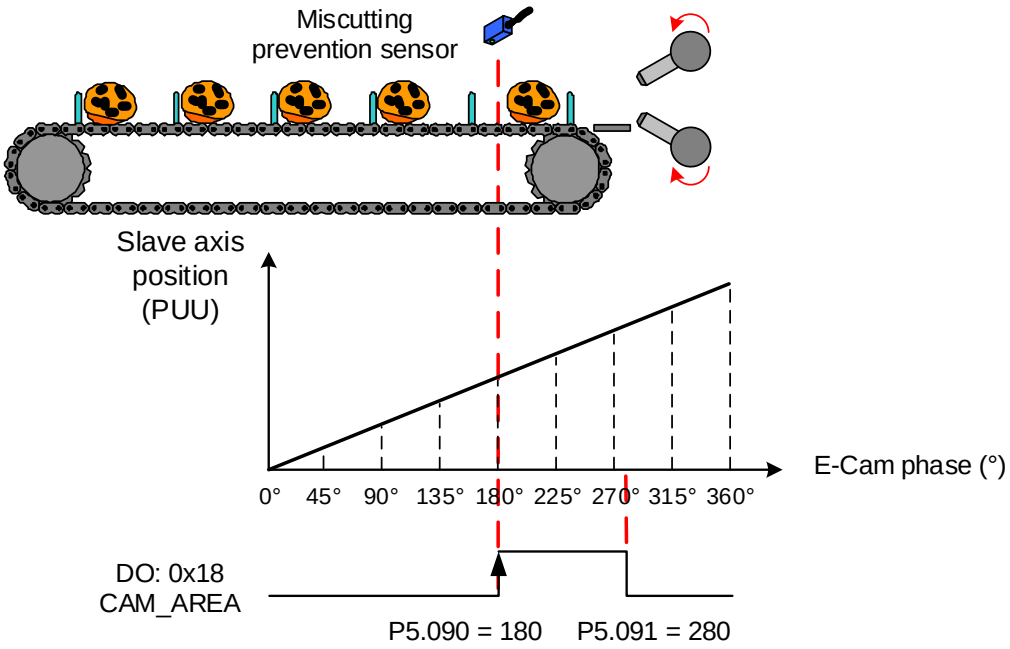

Figure 7.3.11.5 Miscutting prevention mechanism

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■ Reset mechanism after alarm stops

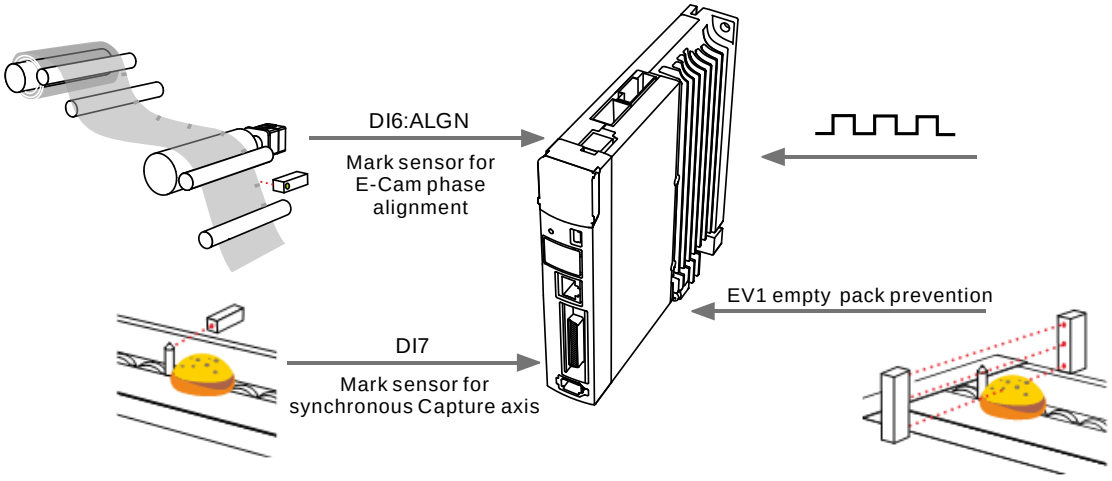
When the packing machine stops because of the alarm, the E-Cam phase might shift because of the external force or other factors. Correct the E-Cam phase before restarting the machine so it can cut and pack correctly. The wrap feeder has the E-Cam phase alignment function which can automatically complete the alignment by reading the mark positions. For the cutter axis, use Macro #D to complete the phase alignment before the machine resumes operation. Macro #D calculates the deviation between the cutter current position and the target position corresponding to the master axis. Then, it writes the deviation data to the specified PR incremental position command and triggers this PR command to complete the E-Cam phase alignment.

■ Manually adjust the slave axis

To manually adjust the packing wrap to the position near the cutting spot, use the virtual pulses (P2.077) to fine-tune the positions of the wrap feeder and cutter axes, so the machine can perform the first cut at the correct position. To adjust the slave axis position during packing machine operation, you can also use the virtual pulse function to fine-tune the position. In the virtual pulse function, you can select whether to mask the master pulses and the virtual pulse compensation type. For detailed settings, refer to Section 7.3.10.

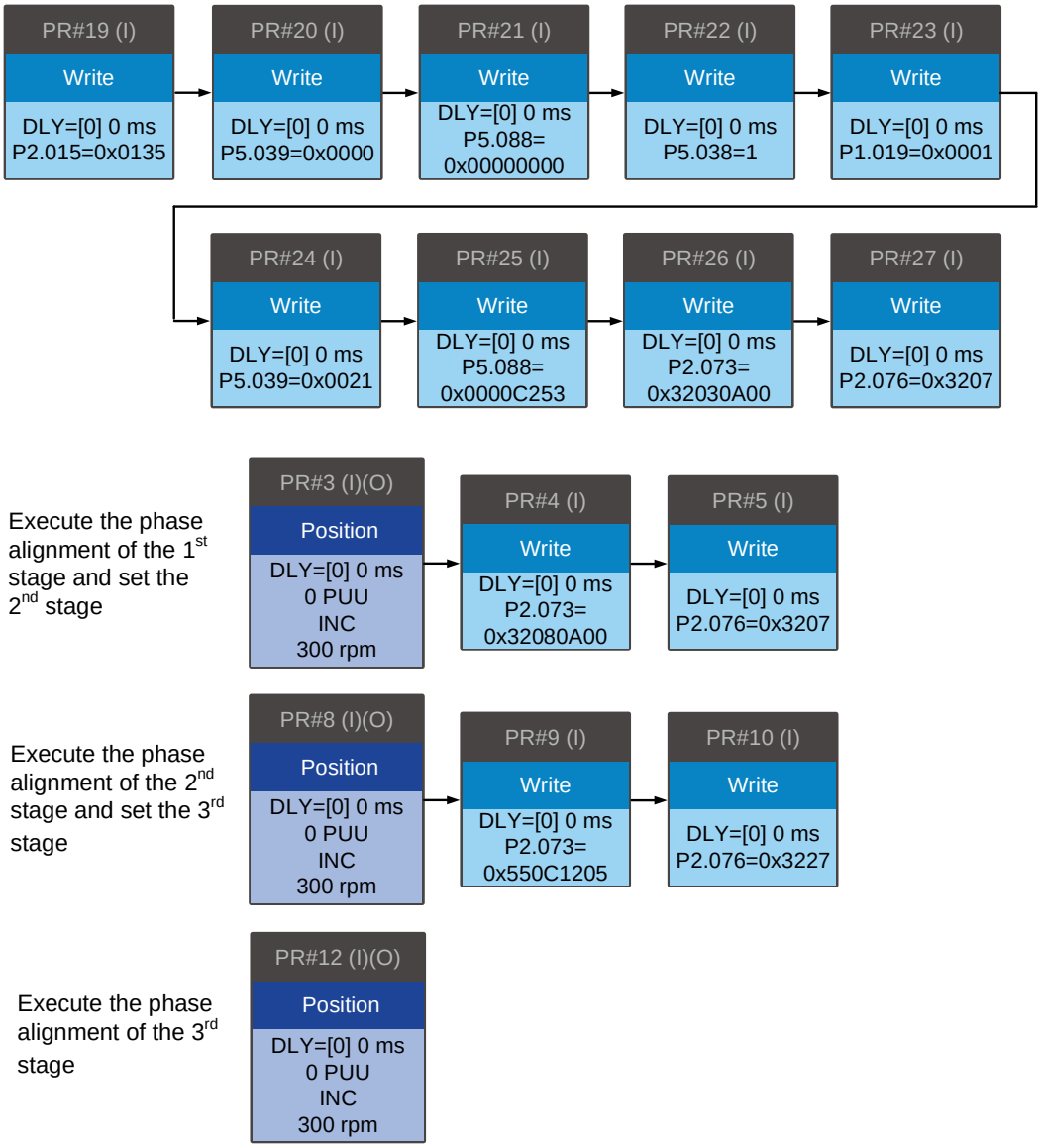
PR program settings

■ **Wrap feeder**



1. Setting for synchronous Capture axis and E-Cam phase alignment:

   The steps for enabling the E-Cam have to include settings for the synchronous Capture axis and E-Cam phase alignment. See the following figure. PR#20 - 25 set the synchronous Capture axis and enable the E-Cam. PR#19 and PR#26 - 27 set the E-Cam phase alignment and the following PR commands are the correction settings for phase alignment of the three stages.



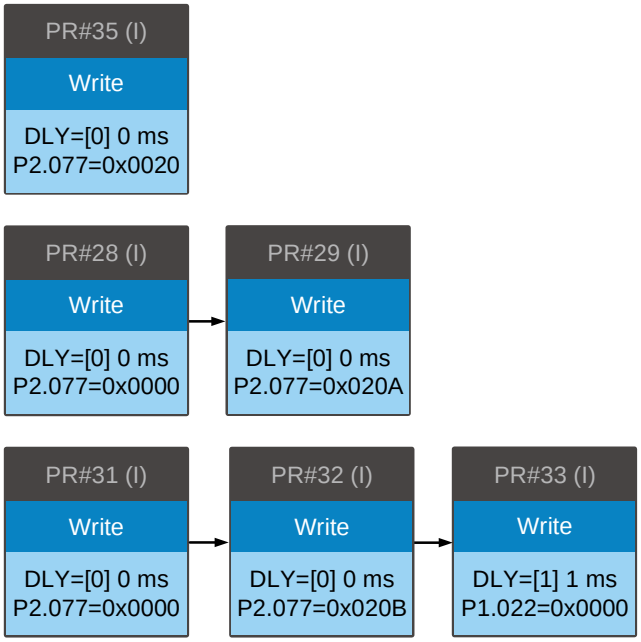
The function for each PR command is as follows.

PR#19	Specifies DI6 as the mark reading signal (input to the servo drive) for E-Cam phase alignment.
PR#20 PR#21	Disables the Capture and E-Cam functions. Disable the capturing and E-Cam functions before using the PR commands to set the parameters for high-speed position capturing and E-Cam.
PR#22	Sets the amount to capture.
PR#23	Enables the Cyclic Capture mode.
PR#24	Enables the high-speed Capture function and sets the pulse source.

PR#25	Enables the E-Cam function. Sets the synchronous Capture axis as the source for the master axis. Regards the capturing action as the clutch engagement timing. Sets the clutch to remain engaged when an alarm occurs or the servo is off and enter the cyclic mode after the clutch disengages.
PR#26	Sets the E-Cam phase alignment of the first stage. Disables the filter function, sets the maximum correction rate to 10% and the masking range of 50%, and writes the correction amount to PR#3.
PR#27	Sets and enables the E-Cam phase alignment of the first stage. Sets the allowable forward rate to 50% and immediately triggers the correction PR command.
PR#3	Uses the incremental position command to correct the phase for the first time.
PR#4	Sets the E-Cam phase alignment of the second stage, which is the same as the the first stage. Writes the correction amount to PR#8.
PR#5	Sets and enables the E-Cam phase alignment of the second stage, which setting is the same as that of the first stage.
PR#8	Uses the incremental position command to correct the phase for the second time.
PR#9	Sets the E-Cam phase alignment of the third stage. Enables the filter function when the correction amount is less than 5%. Sets the maximum correction rate to 18% and the masking range of 85%, and writes the correction amount to PR#12.
PR#10	Enables the E-Cam phase alignment of the second stage. Sets the allowable forward rate to 50% and the filter volume to 2. Immediately triggers the correction PR command.
PR#12	Uses the incremental position command to correct the phase for the third time.

2. Function for manually adjusting the wrap:

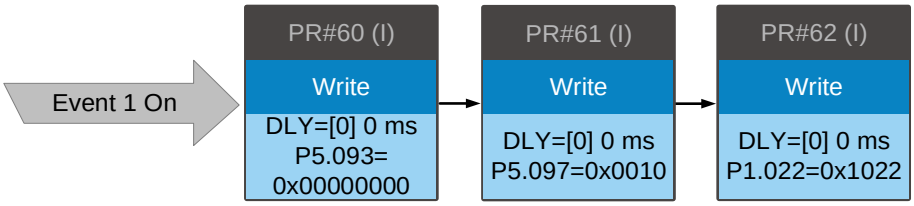
This function allows you to manually adjust the wrap in both forward or reverse directions.



PR#28 PR#29	Forward adjustment. PR#28 confirms the virtual master axis function is disabled. PR#29 sets to continuously receive pulses from the master axis and the virtual master axis continues to send pulses at 2 Kpps.
PR#31 PR#32 PR#33	Reverse adjustment. PR#31 confirms the virtual master axis function is disabled. PR#32 sets to continuously receive pulses from the master axis and the virtual master axis continues to send pulses at -2 Kpps. PR#33 disables the reverse inhibit function. If the fine tuning is complete, execute PR#35 to disable the virtual master axis.

3. Empty pack prevention:

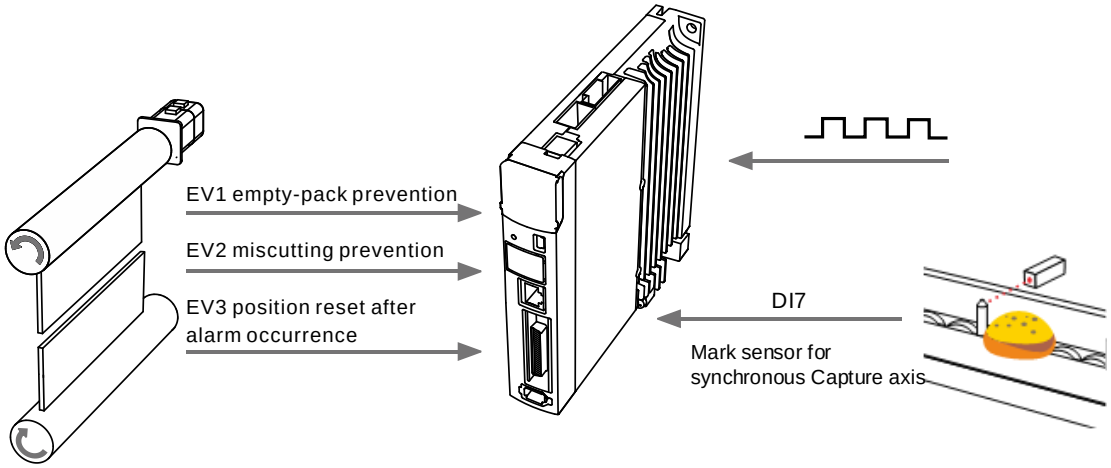
When the empty pack sensor does not detect the packing content, it uses the DI event trigger to enable the function to avoid empty packs.



PR#60	Rising-edge triggers Event 1 to set the macro parameter P5.093 to 0.
PR#61	Executes Macro #10 to immediately stop the wrap feeder operation for one cycle.
PR#62	Inhibits the reverse operation and enables the filter when the acceleration or deceleration time is less than 340 ms.

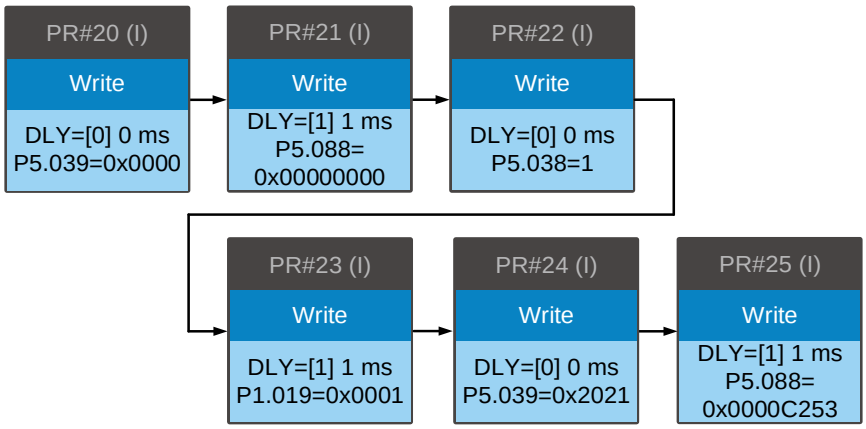
7

■ **Heat sealer with cutter**



1. Settings for synchronous Capture axis:

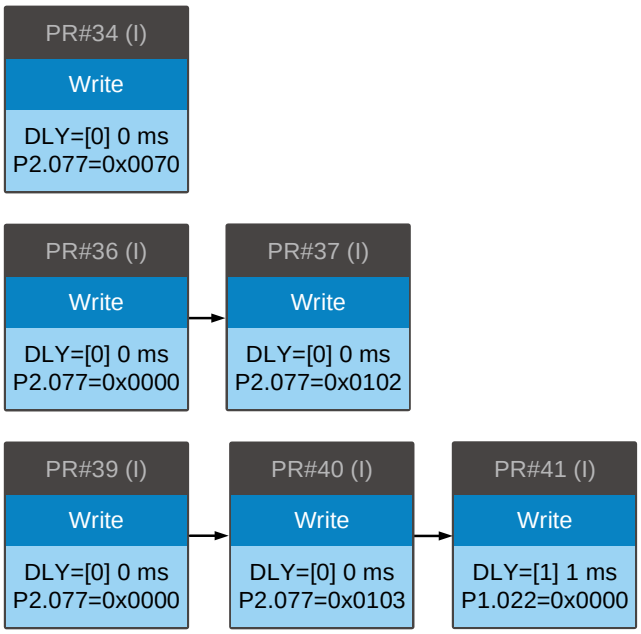
   Enable the synchronous Capture axis when enabling the E-Cam.



PR#20 PR#21	Disables the Capture and E-Cam functions. Disable the capturing and E-Cam functions before using the PR commands to set the parameters for high-speed position capturing and E-Cam.
PR#22	Sets the amount to capture.
PR#23	Enables the Cyclic Capture mode.
PR#24	Enables the high-speed Capture function and sets the pulse source.
PR#25	Enables the E-Cam function. Sets the synchronous Capture axis as the source for the master axis. Regards the capturing action as the clutch engagement timing. Sets the clutch to remain engaged when an alarm occurs or the servo is off, enter the cyclic mode after the clutch disengages, and reduce the speed variation to that of the pre-engage status.

2. Function for manually adjusting the cutter positioning:

The manual positioning function allows adjustments in both forward and reverse directions.



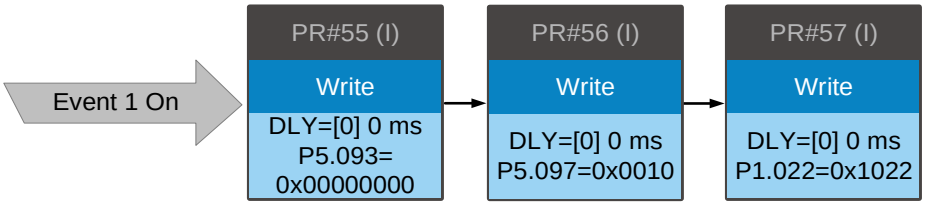
PR#36 PR#37	Forward adjustment. PR#36 confirms the virtual master axis function is disabled. PR#37 sets the master axis pulses to mask and the virtual master axis continues to send pulses at 1 Kpps.
PR#39 PR#40 PR#41	Reverse adjustment. PR#39 confirms the virtual master axis function is disabled. PR#40 sets the master axis pulses to mask and the virtual master axis continues to send pulses at -1 Kpps. PR#41 disables the reverse inhibit function.

If the positioning is complete, execute PR#34 to disable the virtual master axis function.

To prevent the cutter from cutting before the wrap arrives the target position, write the virtual master axis pulse number plus pulses of one cycle to EEPROM. This ensures the cutter cuts only when the wrap reaches the right position.

3. Empty pack prevention:

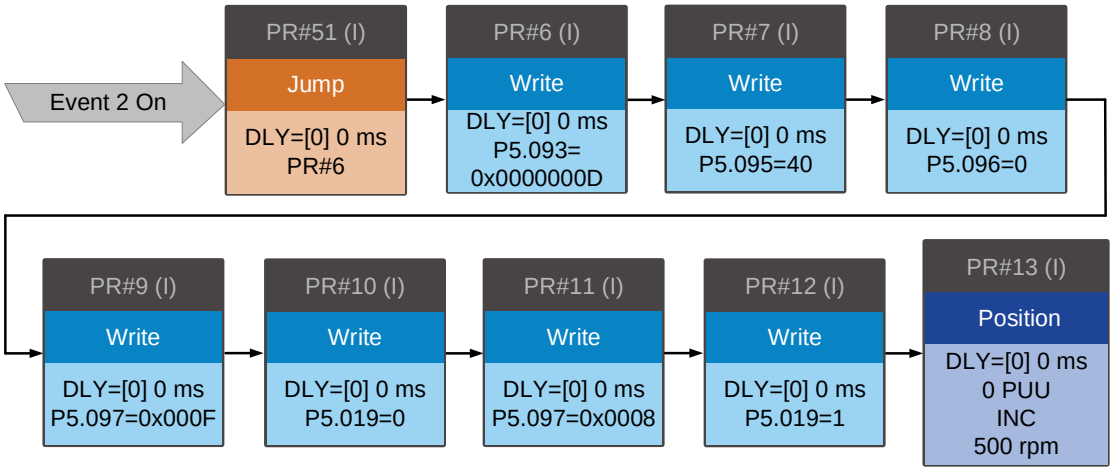
When the empty pack sensor does not detect the packing content, it uses the DI event trigger to enable the function to avoid empty packs.



PR#55	Rising-edge triggers Event 1 to set the macro parameter P5.093 to 0.
PR#56	Executes Macro #10 to immediately stop the wrap feeder operation for one cycle.
PR#57	Inhibits the reverse operation and enables the filter when the acceleration or deceleration time is less than 340 ms.

4. Miscutting prevention:

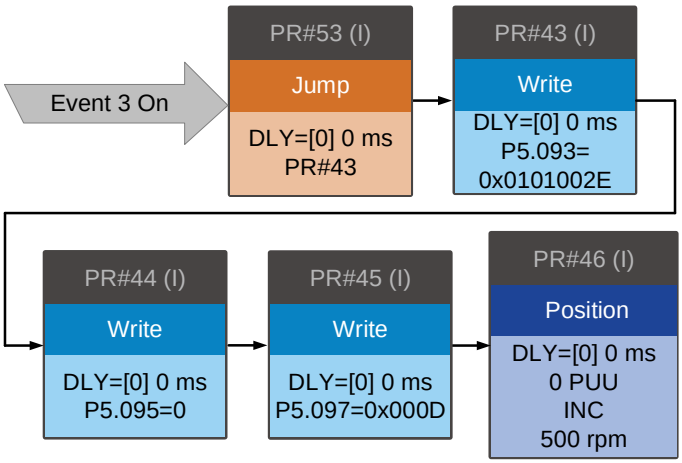
When the sensor for preventing miscutting does not detect the packing contentcontents in the package, it uses the DI event trigger to enable the miscutting prevention function.



PR#51	Rising-edge triggers Event 2 to trigger the jump procedure to jump to PR#6.
PR#6	Writes the deviation between the E-Cam current position and the target position to PR#13.
PR#7	Sets the allowable forward rate to 40%.
PR#8	Sets the target position as the position when the master axis pulse is 0.
PR#9	Executes Macro #F to calculate the deviation between the E-Cam current position and target position.
PR#10	Sets the E-Cam scaling to 0.
PR#11	Executes Macro #8 to have PR#10 immediately take effect so the cutter stops operating.
PR#12	Resets the scaling to default.
PR#13	Uses the incremental position command to have the cutter operate to the target position.

5. Reset after alarm:

After the alarm is cleared, the cutter has to return to where it was before the alarm occurrence. Use the DI event trigger to enable Macro #D, set the indexing coordinates scale (P2.052) as the moving amount of one cutter cycle, and set E-Cam curve scaling (P5.019) to 1.



PR#53	Rising-edge triggers Event 3 to trigger the jump procedure to jump to PR#43.
PR#43	Writes the deviation between the position before the alarm occurrence and the current position to PR#46. Sets to inhibit the reverse operation.
PR#44	Sets the allowable forward rate to 0%.
PR#45	Executes Macro #D to calculate the deviation between the position before the alarm occurrence and the current position.
PR#46	Uses the incremental position command to move the cutter back to the position before the alarm occurrence.

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Parameters

8

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

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8.3 Parameter descriptions ····· 8-12
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8.1 Parameter definitions

The servo drive parameters are divided into nine 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 6: PR parameters (Example: P6.xxx)

Group 7: PR parameters (Example: P7.xxx)

Group M: Motor parameters (Example: PM.xxx)

Control mode description:

PT: Position control (command input through terminal block)

PR: Position control (command sent from internal register)

S: Speed control

T: Torque control

DMC: DMCNET control

Special symbol description:

Icon of parameter property	Description
★	Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.
▲	Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.
●	Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.
■	Parameter resets to its default value after cycling the power. For example, P3.006.

8.2 List of parameters

Monitor and general output parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P0.000★	Firmware version	Factory setting	-	O	O	O	O
P0.001■	Current drive alarm code (seven-segment display)	-	-	O	O	O	O
P0.002	Drive status	1	-	O	O	O	O
P0.003	Analog output monitoring	0x0000	-	O	O	O	O
P0.008★	Total servo drive operation time	0	hour	O	O	O	O
P0.009★■	Status monitoring register 1	-	-	O	O	O	O
P0.010★■	Status monitoring register 2	-	-	O	O	O	O
P0.011★■	Status monitoring register 3	-	-	O	O	O	O
P0.012★■	Status monitoring register 4	-	-	O	O	O	O
P0.013★■	Status monitoring register 5	-	-	O	O	O	O
P0.017	Select content displayed by status monitoring register 1	0	-	O	O	O	O
P0.018	Select content displayed by status monitoring register 2	0	-	O	O	O	O
P0.019	Select content displayed by status monitoring register 3	0	-	O	O	O	O
P0.020	Select content displayed by status monitoring register 4	0	-	O	O	O	O
P0.021	Select content displayed by status monitoring register 5	0	-	O	O	O	O
P0.025■	Mapping parameter #1	-	-	O	O	O	O
P0.026■	Mapping parameter #2	-	-	O	O	O	O
P0.027■	Mapping parameter #3	-	-	O	O	O	O
P0.028■	Mapping parameter #4	-	-	O	O	O	O
P0.029■	Mapping parameter #5	-	-	O	O	O	O
P0.030■	Mapping parameter #6	-	-	O	O	O	O
P0.031■	Mapping parameter #7	-	-	O	O	O	O
P0.032■	Mapping parameter #8	-	-	O	O	O	O
P0.035	Target setting for mapping parameter P0.025	-	-	O	O	O	O
P0.036	Target setting for mapping parameter P0.026	-	-	O	O	O	O
P0.037	Target setting for mapping parameter P0.027	-	-	O	O	O	O
P0.038	Target setting for mapping parameter P0.028	-	-	O	O	O	O
P0.039	Target setting for mapping parameter P0.029	-	-	O	O	O	O
P0.040	Target setting for mapping parameter P0.030	-	-	O	O	O	O
P0.041	Target setting for mapping parameter P0.031	-	-	O	O	O	O
P0.042	Target setting for mapping parameter P0.032	-	-	O	O	O	O
P0.046★■	Servo drive digital output (DO) status	0x0000	-	O	O	O	O

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Monitor and general output parameters (continued)

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P1.101■	Analog monitor output voltage 1	0	mV	O	O	O	O
P1.102■	Analog monitor output voltage 2	0	mV	O	O	O	O

(★) Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.
(▲) Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.
(●) Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.
(■) Parameter resets to its default value after cycling the power. For example, P3.006.

Filter and resonance suppression parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P1.006	Speed command smoothing constant (low-pass filter)	0	ms	-	-	O	-
P1.007	Torque command smoothing constant (low-pass filter)	0	ms	-	-	-	O
P1.008	Position command smoothing constant (low-pass filter)	0	10 ms	O	O	-	-
P1.025	Low-frequency vibration suppression frequency (1)	1000	0.1 Hz	O	O	-	-
P1.026	Low-frequency vibration suppression gain (1)	0	-	O	O	-	-
P1.027	Low-frequency vibration suppression frequency (2)	1000	0.1 Hz	O	O	-	-
P1.028	Low-frequency vibration suppression gain (2)	0	-	O	O	-	-
P1.029	Auto low-frequency vibration suppression mode	0	-	O	O	-	-
P1.030	Low-frequency vibration detection	800	pulse	O	O	-	-
P1.034	S-curve acceleration constant	200	ms	-	-	O	-
P1.035	S-curve deceleration constant	200	ms	-	-	O	-
P1.036	S-curve acceleration / deceleration constant	0	ms	-	O	O	-
P1.062	Percentage of friction compensation	0	%	O	O	O	-
P1.063	Constant of friction compensation	1	ms	O	O	O	-
P1.068	Position command - moving filter	4	ms	O	O	-	-
P1.075	Low-pass filter time constant for full- / half-closed loop control	100	ms	O	-	-	-
P1.089	First set of vibration elimination - anti-resonance frequency	4000	0.1 Hz	O	O	-	-
P1.090	First set of vibration elimination - resonance frequency	4000	0.1 Hz	O	O	-	-
P1.091	First set of vibration elimination - resonance difference	10	0.1 dB	O	O	-	-
P1.092	Second set of vibration elimination - anti-resonance frequency	4000	0.1 Hz	O	O	-	-
P1.093	Second set of vibration elimination - resonance frequency	4000	0.1 Hz	O	O	-	-
P1.094	Second set of vibration elimination - resonance difference	10	0.1 dB	O	O	-	-
P2.023	Notch filter frequency (1)	1000	Hz	O	O	O	O
P2.024	Notch filter attenuation level (1)	0	-dB	O	O	O	O

Filter and resonance suppression parameters (continued)

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P2.043	Notch filter frequency (2)	1000	Hz	O	O	O	O
P2.044	Notch filter attenuation level (2)	0	-dB	O	O	O	O
P2.045	Notch filter frequency (3)	1000	Hz	O	O	O	O
P2.046	Notch filter attenuation level (3)	0	-dB	O	O	O	O
P2.047	Auto resonance suppression mode	0x0001	-	O	O	O	O
P2.048	Auto resonance detection level	100	-	O	O	O	O
P2.025	Resonance suppression low-pass filter	1.0 (panel / software)	1 ms (panel / software)	O	O	O	O
		10 (communication)	0.1 ms (communication)				
P2.049	Speed detection filter and jitter suppression	1.0 (panel / software)	1 ms (panel / software)	O	O	O	O
		10 (communication)	0.1 ms (communication)				
P2.095	Notch filter bandwidth (1)	5	-	O	O	O	O
P2.096	Notch filter bandwidth (2)	5	-	O	O	O	O
P2.097	Notch filter bandwidth (3)	5	-	O	O	O	O
P2.098	Notch filter frequency (4)	1000	Hz	O	O	O	O
P2.099	Notch filter attenuation level (4)	0	-dB	O	O	O	O
P2.100	Notch filter bandwidth (4)	5	-	O	O	O	O
P2.101	Notch filter frequency (5)	1000	Hz	O	O	O	O
P2.102	Notch filter attenuation level (5)	0	-dB	O	O	O	O
P2.103	Notch filter bandwidth (5)	5	-	O	O	O	O

Gain and switching parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P1.037	Load inertia ratio or total weight	6.0 (panel / software)	1 times, 1 kg (panel / software)	O	O	O	O
		60 (communication)	0.1 times, 0.1 kg (communication)				
P2.000	Position control gain	35	rad/s	O	O	-	-
P2.001	Position control gain rate of change	100	%	O	O	-	-
P2.002	Position feed forward gain	50	%	O	O	-	-
P2.003	Position feed forward gain smoothing constant	5	ms	O	O	-	-
P2.004	Speed control gain	500	rad/s	O	O	O	O
P2.005	Speed control gain rate of change	100	%	O	O	O	O
P2.006	Speed integral compensation	100	rad/s	O	O	O	O
P2.007	Speed feed forward gain	0	%	O	O	O	O
P2.026	Anti-interference gain	0	rad/s	O	O	O	O
P2.027	Gain switching condition and method selection	0x0000	-	O	O	O	O
P2.028	Gain switching time constant	10	ms	O	O	O	O

8

Gain and switching parameters (continued)

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P2.029	Gain switching condition	16777216	pulse kpps rpm	O	O	O	O
P2.031	Bandwidth response level	19	-	O	O	O	O
P2.032	Gain adjustment mode	0x0001	-	O	O	O	O
P2.053	Position integral compensation	0	rad/s	O	O	O	O
P2.089	Command response gain	25	rad/s	O	O	-	-
P2.094▲	Special bit register 3	0x1000	-	O	O	O	-
P2.104	P/PI torque switching command condition	800	%	O	O	O	-
P2.105	Automatic gain adjustment level 1	11	-	O	O	-	-
P2.106	Automatic gain adjustment level 2	2000	pulse	O	O	-	-
P2.112▲	Special bit register 4	0x0008	-	O	O	O	-

(★) Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.
(▲) Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.
(●) Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.
(■) Parameter resets to its default value after cycling the power. For example, P3.006.

Position control parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P1.001●	Input for control mode and control command	0x0000 0x000B	-	O	O	O	O
P1.002▲	Speed and torque limits	0x0000	-	O	O	O	O
P1.003	Encoder pulse output polarity	0x0000	-	O	O	O	O
P1.012 - P1.014	Internal torque limits 1 - 3	100	%	O	O	O	O
P1.044▲	E-Gear ratio (numerator) (N1)	16777216	pulse	O	O	-	-
P1.045▲	E-Gear ratio (denominator) (M)	100000	pulse	O	O	-	-
P1.046▲	Encoder pulse number output (OA, OB)	2500	pulse	O	O	O	O
P1.055	Maximum speed limit	Rated speed of each model	rpm (rotary) mm/s (linear)	O	O	O	O
P1.097▲	Encoder output denominator (OA, OB)	0	-	O	O	O	O
P5.003	Deceleration time for auto-protection	0xEEEFEEFF	-	-	O	O	O
P5.020 - P5.035	Acceleration / deceleration times	Refer to the description of each parameter	ms	O	O	-	-
P5.016■	Axis position - CN2	0	PUU	O	O	O	O
P5.017	Axis position - CN5	0	pulse	O	O	O	O
P5.018	Axis position - Pulse command	0	pulse	O	O	O	O

Position control parameters - external pulse control command (PT mode)

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P1.000▲	External pulse input type	0x1042	-	O	-	-	-
P2.060	E-Gear ratio (numerator) (N2)	16777216	pulse	O	-	-	-
P2.061	E-Gear ratio (numerator) (N3)	16777216	pulse	O	-	-	-
P2.062	E-Gear ratio (numerator) (N4)	16777216	pulse	O	-	-	-

Position control parameters - internal register control command (PR mode)

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P5.008	Forward software limit	2147483647	PUU	-	O	-	-
P5.009	Reverse software limit	-2147483648	PUU	-	O	-	-
P6.002 - P7.099	Internal Position commands 1 - 99	0	-	-	O	-	-
P5.060 - P5.075	Internal Position commands control the movement speeds from 0 - 15	20 - 3000 (panel / software)	1 rpm (rotary) 10^{-6} m/s (linear) (panel / software)	-	O	-	-
		200 - 30000 (communication)	0.1 rpm (rotary) 10^{-6} m/s (linear) (communication)				
P5.004	Homing methods	0x0000	-	-	O	-	-
P5.005	High speed homing (first speed setting)	100 (panel / software)	1 rpm (rotary) 10^{-6} m/s (linear) (panel / software)	-	O	-	-
		1000 (communication)	0.1 rpm (rotary) 10^{-6} m/s (linear) (communication)	-	O	-	-
P5.006	Low speed homing (second speed setting)	20 (panel / software)	1 rpm (rotary) 10^{-6} m/s (linear) (panel / software)	-	O	-	-
		200 (communication)	0.1 rpm (rotary) 10^{-6} m/s (linear) (communication)	-	O	-	-
P5.007■	Trigger Position command (PR mode only)	0	-	-	O	-	-
P5.040 - P5.055	Delay times after position reached	0 - 5500	ms	-	O	-	-
P5.098	PR# triggered by event rising-edge	0x0000	-	-	O	-	-
P5.099	PR# triggered by event falling-edge	0x0000	-	-	O	-	-
P5.015■	PATH#1 - PATH#2 volatile setting	0x0000	-	-	O	-	-

(★) Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.
(▲) Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.
(●) Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.
(■) Parameter resets to its default value after cycling the power. For example, P3.006.

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Speed control parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P1.001●	Input for control mode and control command	0x0000 0x000B	-	O	O	O	O
P1.002▲	Speed and torque limits	0x0000	-	O	O	O	O
P1.003	Encoder pulse output polarity	0x0000	-	O	O	O	O
P1.046▲	Encoder pulse number output (OA, OB)	2500	pulse	O	O	O	O
P1.055	Maximum speed limit	Rated speed of each model	rpm (rotary) mm/s (linear)	O	O	O	O
P1.009 - P1.011	Internal Speed commands 1 - 3	1000 - 3000	0.1 rpm (rotary) 10^{-6} m/s (linear)	-	-	O	O
P1.012 - P1.014	Internal torque limits 1 - 3	100	%	O	O	O	O
P1.040	Maximum rotation speed for analog Speed command	3000	rpm	-	-	O	O
P1.041▲	Maximum output for analog Torque command	100	%	O	O	O	O
P1.076▲	Maximum speed for encoder output (OA, OB)	5500	rpm (rotary) 10^{-3} ms (linear)	O	O	O	O

Torque control parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P1.001●	Input for control mode and control command	0x0000 0x000B	-	O	O	O	O
P1.002▲	Speed and torque limits	0x0000	-	O	O	O	O
P1.003	Encoder pulse output polarity	0x0000	-	O	O	O	O
P1.046▲	Encoder pulse number output (OA, OB)	2500	pulse	O	O	O	O
P1.055	Maximum speed limit	Rated speed of each model	rpm (rotary) mm/s (linear)	O	O	O	O
P1.009 - P1.011	Internal speed limits 1 - 3	1000 - 3000	0.1 rpm (rotary) 10^{-6} m/s (linear)	-	-	O	O
P1.012 - P1.014	Internal Torque commands 1 - 3	100	%	O	O	O	O
P1.040	Maximum rotation speed for analog Speed command	3000	rpm	-	-	O	O
P1.041▲	Maximum output for analog Torque command	100	%	O	O	O	O

Planning of digital input / output pin and output parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P0.053	General range compare digital output - filter time	0x0000	-	O	O	O	O
P0.054	General range compare digital output - first lower limit	0	-	O	O	O	O
P0.055	General range compare digital output - first upper limit	0	-	O	O	O	O

Planning of digital input / output pin and output parameters (continued)

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P0.056	General range compare digital output - second lower limit	0	-	O	O	O	O
P0.057	General range compare digital output - second upper limit	0	-	O	O	O	O
P0.058	General range compare digital output - third lower limit	0	-	O	O	O	O
P0.059	General range compare digital output - third upper limit	0	-	O	O	O	O
P0.060	General range compare digital output - fourth lower limit	0	-	O	O	O	O
P0.061	General range compare digital output - fourth upper limit	0	-	O	O	O	O
P2.009	Response filter time of DI	2	ms	O	O	O	O
P2.010	DI1 functional planning	0x0101	-	O	O	O	O
P2.011	DI2 functional planning	0x0104	-	O	O	O	O
P2.012	DI3 functional planning	0x0116	-	O	O	O	O
P2.013	DI4 functional planning	0x0117	-	O	O	O	O
P2.014	DI5 functional planning	0x0102	-	O	O	O	O
P2.015	DI6 functional planning	0x0022	-	O	O	O	O
P2.016	DI7 functional planning	0x0023	-	O	O	O	O
P2.017	DI8 functional planning	0x0021	-	O	O	O	O
P2.018	DO1 functional planning	0x0101	-	O	O	O	O
P2.019	DO2 functional planning	0x0103	-	O	O	O	O
P2.020	DO3 functional planning	0x0109	-	O	O	O	O
P2.021	DO4 functional planning	0x0105	-	O	O	O	O
P2.022	DO5 functional planning	0x0007	-	O	O	O	O
P2.036	DI9 functional planning	0x0000	-	O	O	O	O
P2.037	DI10 functional planning	0x0000	-	O	O	O	O
P2.038	VDI11 functional planning	0x0000	-	O	O	O	O
P2.039	VDI12 functional planning	0x0000	-	O	O	O	O
P2.040	VDI13 functional planning	0x0000	-	O	O	O	O
P2.041	DO6 functional planning	0x0000	-	O	O	O	O
P1.038	Zero speed range	10.0 (panel / software)	1 rpm (panel / software)	O	O	O	O
		100 (communication)	0.1 rpm (communication)				
P1.039	Target speed detection level	3000	rpm	O	O	O	O
P1.042	Enable delay time for magnetic brake	0	ms	O	O	O	O
P1.043	Disable delay time for magnetic brake	0	ms	O	O	O	O
P1.047	Speed reached (DO.SP_OK) range	10	rpm	-	-	O	-
P1.054	Pulse range for position reached	167772	pulse	O	O	-	-
P1.056	Motor output overload warning level	120	%	O	O	O	O

(★) Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.
(▲) Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.
(●) Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.
(■) Parameter resets to its default value after cycling the power. For example, P3.006.

8

Communication parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P3.000●	Address	0x007F	-	O	O	O	O
P3.001●	Transmission speed	0x0203	-	O	O	O	O
P3.002	Communication protocol	0x0006	-	O	O	O	O
P3.003	Communication error handling	0x0000	-	O	O	O	O
P3.004	Communication timeout	0	sec	O	O	O	O
P3.006■	Digital input (DI) control switch	0x0000	-	O	O	O	O
P3.007	Communication response delay time	0	0.5 ms	O	O	O	O
P3.009	Communication synchronization	0x5055 (CANopen)	-	-	-	-	-
		0x3511 (DMCNET)	-	-	-	-	-
P3.010	CANopen / DMCNET protocol	0x0000	-	-	-	-	-
P3.011	CANopen / DMCNET options	0x0000	-	-	-	-	-
P3.012	CANopen / DMCNET support	0x0000	-	-	-	-	-

Diagnosis parameters

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P4.000★	Fault record (N)	0x00000000	-	O	O	O	O
P4.001★	Fault record (N-1)	0x00000000	-	O	O	O	O
P4.002★	Fault record (N-2)	0x00000000	-	O	O	O	O
P4.003★	Fault record (N-3)	0x00000000	-	O	O	O	O
P4.004★	Fault record (N-4)	0x00000000	-	O	O	O	O
P4.005	Servo motor JOG control	20	rpm	O	O	O	O
P4.006■	Digital output register (readable and writable)	0x0000	-	O	O	O	O
P4.007	Multi-function for digital input	0x0000	-	O	O	O	O
P4.008★	Input status of servo drive panel (read-only)	-	-	O	O	O	O
P4.009★	Digital output status (read-only)	-	-	O	O	O	O
P4.010▲■	Adjustment function	0	-	O	O	O	O
P4.011	Analog speed input (1) offset adjustment	Factory setting	-	O	O	O	O
P4.012	Analog speed input (2) offset adjustment	Factory setting	-	O	O	O	O
P4.013	Analog torque input (1) offset adjustment	Factory setting	-	O	O	O	O
P4.014	Analog torque input (2) offset adjustment	Factory setting	-	O	O	O	O
P4.015	Current encoder (V1 phase) offset adjustment	Factory setting	-	O	O	O	O
P4.016	Current encoder (V2 phase) offset adjustment	Factory setting	-	O	O	O	O
P4.017	Current encoder (W1 phase) offset adjustment	Factory setting	-	O	O	O	O
P4.018	Current encoder (W2 phase) offset adjustment	Factory setting	-	O	O	O	O
P4.019	IGBT NTC adjustment level (cannot reset)	Factory setting	-	O	O	O	-

Diagnosis parameters (continued)

Parameter No.	Function	Default value	Unit	Control mode			
				PT	PR	S	T
P4.020	Offset adjustment for analog monitor output (Ch1)	0	mV	O	O	O	O
P4.021	Offset adjustment for analog monitor output (Ch2)	0	mV	O	O	O	O
P4.022	Analog speed input offset	0	mV	-	-	O	-
P4.023	Analog torque input offset	0	mV	-	-	-	O

(★) Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.
(▲) Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.
(●) Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.
(■) Parameter resets to its default value after cycling the power. For example, P3.006.

8.3 Parameter descriptions

P0.xxx Monitoring parameters

8

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 13.1 Alarm list.

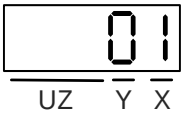
P0.002	Drive status		Address: 0004H 0005H
Default:	1	Control mode:	All
Unit:	-	Setting range:	-300 to +127
Format:	DEC	Data size:	16-bit

Settings:

The panel displays some parameters. 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 8.3 Monitoring variables descriptions.

P0.003	Analog output monitoring		Address: 0006H 0007H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 77
Format:	HEX	Data size:	16-bit

Settings:



- X: MON2
- Y: MON1
- UZ: reserved

MON1 and MON2 value	Description	MON1 and MON2 value	Description
0	Motor speed (+/- 8 volts / Maximum speed)	4	Torque command (+/- 8 volts / Maximum Torque command)
1	Motor torque (+/- 8 volts / Maximum torque)	5	VBUS voltage (+/- 8 volts / 450V)
2	Pulse command frequency (+8 volts / 4.5 Mpps)	6	Analog output voltage is the set value of P1.101
3	Speed command (+/- 8 volts / Maximum Speed command)	7	Analog output voltage is the set value of P1.102

Note: refer to P1.004 and P1.005 for the proportional setting for the analog output voltage.

For example: when you set P0.003 to 01 (MON1 is the analog output of motor speed; MON2 is the analog output of motor torque):

MON1 output voltage = $8 \times \frac{\text{Motor speed}}{(\text{Maximum speed} \times \frac{P1.004}{100})}$ (Unit: volts)

MON2 output voltage = $8 \times \frac{\text{Motor torque}}{(\text{Maximum torque} \times \frac{P1.005}{100})}$ (Unit: volts)

P0.004 - P0.007	Reserved

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

Settings:

Displays the total servo drive operation and Servo On time. The unit is in hours and durations of less than 1 hour are not recorded. The recorded hours are saved when the servo power is off.

D C B A

U Z Y X

DCBA	Servo On time	UZYX	Servo power applied time
h	High bit	L	Low bit

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 for monitoring in P0.017 with the drive panel or communication. Refer to P0.002.

The communication port reads the communication address to get the status.

For example, if you set P0.017 to 3 to access P0.009, the panel displays the total number of feedback pulses of the motor encoder. If accessing the data through MODBUS communication, it reads two 16-bit values (0012H and 0013H) as a single 32-bit value. (0013H : 0012H) = (Hi-word : Low-word). Set P0.002 to 23 and the panel displays VAR-1 as 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 monitored in P0.018 through the drive panel or communication. Please refer to P0.002. The communication port reads the communication address to get the status. Set P0.002 to 24 and the panel displays VAR-2 as 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 monitored in P0.019 through the drive panel or communication. Please refer to P0.002. The communication port reads the communication address to get the status. Set P0.002 to 25 and the panel displays VAR-3 as 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 monitored in P0.020 through the drive panel or communication. Please refer to P0.002. The communication port reads the communication address to get the status. Set P0.002 to 26 and the panel displays VAR-4 as 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 monitored in P0.021 through the drive panel or communication. Please refer to P0.002.

The communication port reads the communication address to get the status.

P0.014 - P0.016	Reserved

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

Settings:

Refer to Table 8.3 for the available values.

For example, if you set P0.017 to 07, then reading P0.009 displays the motor speed (rpm).

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

Settings:

Refer to Table 8.3 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:	0 - 127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 8.3 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:	0 - 127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 8.3 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:	0 - 127
Format:	DEC	Data size:	16-bit

Settings:

Refer to Table 8.3 for the available values.

P0.022 - P0.024	Reserved

P0.025■	Mapping parameter #1		Address: 0032H 0033H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the corresponding parameter P0.035
Format:	HEX	Data size:	32-bit

Settings:

You can continuously read and write parameters faster if they are not in the same group. Use P0.035 to specify the mapping parameter number with the panel or communication. The value of the parameter that is specified by P0.035 is shown in P0.025. Refer to P0.035 for its settings.

P0.026■	Mapping parameter #2		Address: 0034H 0035H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the corresponding parameter P0.036
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:	Determined by the corresponding parameter P0.037
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:	Determined by the corresponding parameter P0.038
Format:	HEX	Data size:	32-bit

Settings:

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

P0.029■	Mapping parameter #5		Address: 003AH 003BH
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the corresponding parameter P0.039
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:	Determined by the corresponding parameter P0.040
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:	Determined by the corresponding parameter P0.041
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:	Determined by the corresponding parameter P0.042
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:	Determined by the communication address of the parameter group
Format:	HEX	Data size:	32-bit

Settings:

The formats of the high-bit parameter (PH) and the low-bit parameter (PL) are:

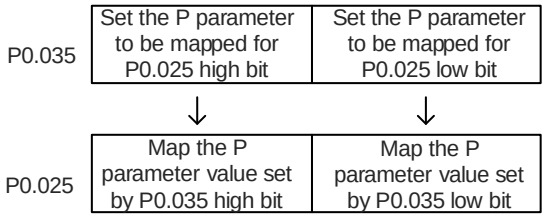
D C BA

U Z YX

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
h	High bit	L	Low bit

Select the data block to access the parameter corresponding to register 1. The mapping value is 32 bits and can map to two 16-bit parameters or one 32-bit parameter.

P0.035: (Mapping parameter: P0.035; Mapping content: P0.025)

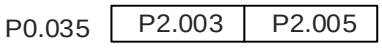


1. When PH ≠ PL, it indicates that the content of P0.025 includes two 16-bit parameters.

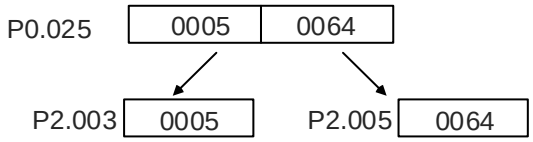
   Example: Target: set P2.003 to 0 in the mapping parameter and set P2.005 to 100.

   Setting: set the P0.035 high bit to 0203 (P2.003) and low bit to 0205 (P2.005).

   Thus, P0.035 = 0x02030205.



Write: in the mapping content, set P0.025 to 0x00050064, and the values of P2.003 and P2.005 are:

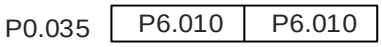


2. When PH = PL = P, it indicates that the content of P0.025 includes one 32-bit parameter.

Example: Target: set P6.010 to 0x00050064 in the mapping parameter.

Setting: set both the high bit and low bit of P0.035 to 060A (P6.010).

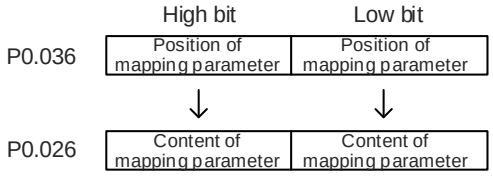
Thus, P6.010 = 0x060A060A.



Write: in the mapping content, set P0.025 to 0x00050064 and P6.010 changes immediately.

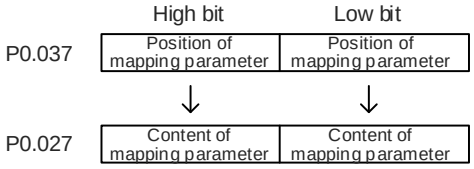
P0.036	Target setting for mapping parameter P0.026		Address: 0048H 0049H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the communication address of the parameter group
Format:	HEX	Data size:	32-bit

Settings:



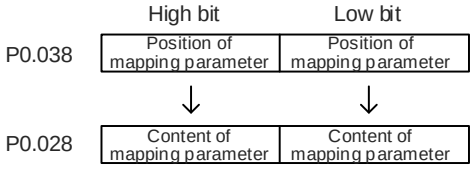
P0.037	Target setting for mapping parameter P0.027		Address: 004AH 004BH
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the communication address of the parameter group
Format:	HEX	Data size:	32-bit

Settings:



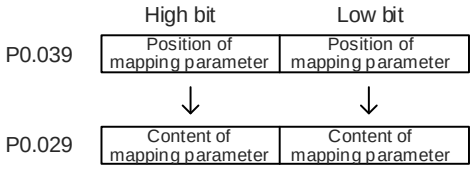
P0.038	Target setting for mapping parameter P0.028		Address: 004CH 004DH
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the communication address of the parameter group
Format:	HEX	Data size:	32-bit

Settings:



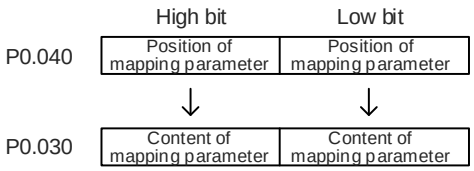
P0.039	Target setting for mapping parameter P0.029		Address: 004EH 004FH
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the communication address of the parameter group
Format:	HEX	Data size:	32-bit

Settings:



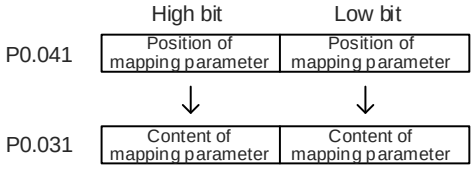
P0.040	Target setting for mapping parameter P0.030		Address: 0050H 0051H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the communication address of the parameter group
Format:	HEX	Data size:	32-bit

Settings:



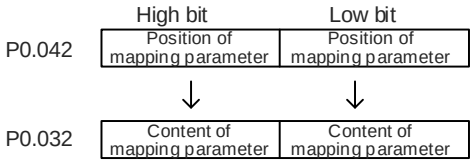
P0.041	Target setting for mapping parameter P0.031		Address: 0052H 0053H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Determined by the communication address of the parameter group
Format:	HEX	Data size:	32-bit

Settings:



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

Settings:



P0.043	Reserved

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

Settings:

This setting is the same as P0.009.

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

Settings:

This setting is the same as P0.017.

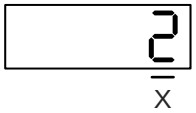
P0.046★■	Servo drive digital output (DO) status		Address: 005CH 005DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x00 - 0xFF
Format:	HEX	Data size:	16-bit

Settings:

Bit	Function	Bit	Function
0	SRDY (servo ready)	8	HOME (homing completed)
1	SON (servo activated)	9	OLW (early warning for motor overload)
2	ZSPD (zero speed detection)	10	WARN (This DO is on when servo warning, CW, CCW, EMGS, undervoltage, or communication error occurs.)
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 (magnetic brake control output)	15	Reserved

P0.049■	Update encoder absolute position		Address: 0062H 0063H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x00 - 0x02
Format:	HEX	Data size:	16-bit

Settings:



■ X: command processing

0: N/A

1: update the encoder data of P0.050 - P0.052.

2: update P0.050 - 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.

P0.050★■	Absolute coordinate system status		Address: 0064H 0065H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x00 - 0x1F
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 0: 1 means the absolute position is lost; 0 means normal.

Bit 1: 1 means the battery is undervoltage; 0 means normal.

Bit 2: 1 means the absolute multiple turns is overflowing; 0 means normal.

Bit 3: 1 means the PUU is overflowing; 0 means normal.

Bit 4: 1 means the absolute coordinate has not been set; 0 means normal.

Bit 5 - Bit 15: reserved (0).

P0.051★■	Encoder absolute position - multiple turns		Address: 0066H 0067H
Default:	0	Control mode:	All
Unit:	rev	Setting range:	-32768 to +32767
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 number of turns of the encoder (absolute position). When you set P2.070 [Bit 1] to 0 for reading the PUU number, this parameter becomes invalid and displays 0.

P0.052★■	Encoder absolute position - pulse number or PUU within single turn		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 pulse number of the encoder's absolute position 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.

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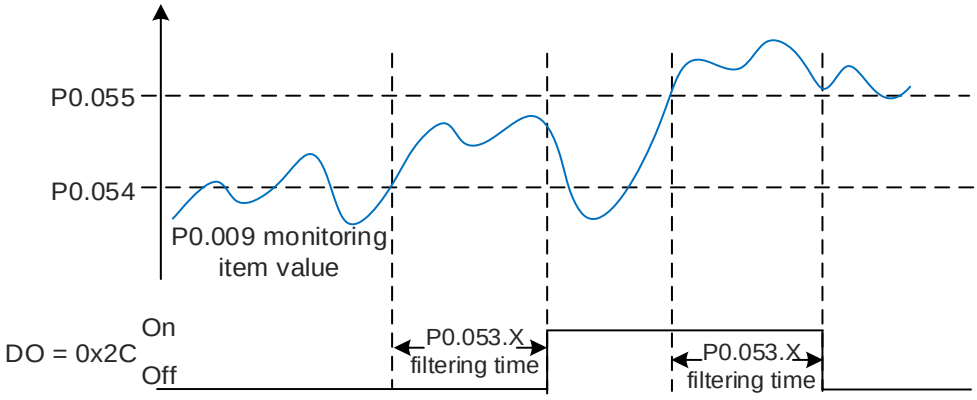
P0.053	General range compare digital output - filter time		Address: 006AH 006BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

- X: first filter time
- Y: second filter time
- Z: third filter time
- U: fourth filter time

Note: the minimum filter time is 1 ms (set value 0 = 1 ms; 1 = 2 ms; 2 = 3 ms; ...; F = 16 ms).

Example of the first filter:



P0.054	General range compare digital output - first lower limit		Address: 006CH 006DH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Before using this function, set the digital output function to [0x2C] (first set of general range comparison) and the monitoring items of P0.017. When the monitoring item value of P0.009 is within the range set by P0.054 and P0.055, and after the filtering time set by P0.053.X, this digital output status is on.

P0.055	General range compare digital output - first upper limit		Address: 006EH 006FH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P0.054.

P0.056	General range compare digital output - second lower limit		Address: 0071H 0072H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Before using this function, set the digital output function to [0x2D] (second set of general range comparison) and the monitoring items of P0.018. When the monitoring item value of P0.010 is within the range set by P0.056 and P0.057, and after the filtering time set by P0.053.Y, this digital output status is on.

P0.057	General range compare digital output - second upper limit		Address: 0073H 0074H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P0.056.

P0.058	General range compare digital output - third lower limit		Address: 0075H 0076H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Before using this function, set the digital output function to [0x2E] (third set of general range comparison) and the monitoring items of P0.019. When the monitoring item value of P0.011 is within the range set by P0.058 and P0.059, and after the filtering time set by P0.053.Z, this digital output status is on.

P0.059	General range compare digital output - third upper limit		Address: 0077H 0078H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P0.058.

P0.060	General range compare digital output - fourth lower limit		Address: 0079H 007AH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Before using this function, set the digital output function to [0x2F] (fourth set of general range comparison) and the monitoring items of P0.020. When the monitoring item value of P0.012 is within the range set by P0.060 and P0.061, and after the filtering time set by P0.053.U, this digital output status is on.

P0.061	General range compare digital output - fourth upper limit		Address: 007BH 007CH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P0.060.

P0.062	Reserved

P0.063	Duration of voltage exceeding 400V		Address: 007EH 007FH
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0x00000000 - 0x7FFFFFFF
Format:	DEC	Data size:	32-bit

Settings:

Records the total time during which the voltage of the servo drive exceeded 400V.

P0.064 - P0.068	Reserved

P1.xxx Basic parameters

P1.000▲	External pulse input type		Address: 0100H 0101H
Default:	0x1042	Control mode:	PT
Unit:	-	Setting range:	0x0000 - 0x11F2
Format:	HEX	Data size:	16-bit

Settings:

X	Command source	Z	Logic type	UY	Filter width

■ X: command source

0: AB phase pulse (4x)

1: clockwise and counterclockwise pulse

2: pulse + symbol

Others: reserved

■ Z: logic type

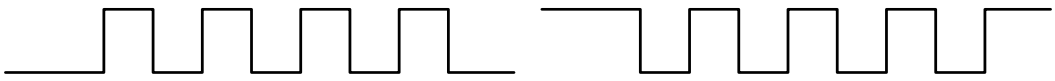
0: positive logic

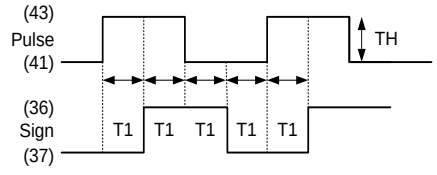
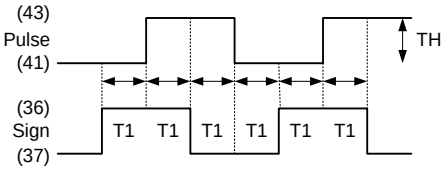
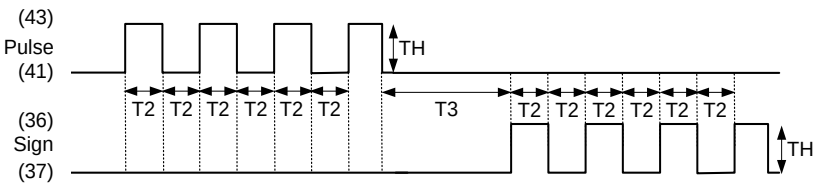
1: negative logic

Digital circuits use 0 and 1 to represent the high and low voltage levels. In positive logic, 1 represents high voltage and 0 represents low voltage; in negative logic, 1 represents low voltage and 0 represents high voltage.

Example:

Positive logic Negative logic



Logic type	Pulse type	Pulse input	
		Forward	Reverse
Z = 0	X = 0	Pulse phase lead	Pulse phase lag
			
	X = 1		

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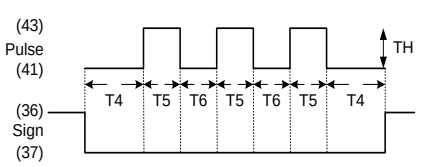
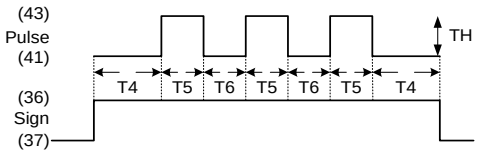
Logic type	Pulse type	Pulse input	
		Forward	Reverse
Z = 0	X = 2	Sign = low	Sign = high
			

Pulse specification	Maximum input frequency	Minimum allowed time width					
		T1	T2	T3	T4	T5	T6
Differential signal	4 Mpps	62.5 ns	125 ns	250 ns	200 ns	125 ns	125 ns
Open-collector	200 Kpps	1.25 μs	2.5 μs	5 μs	5 μs	2.5 μs	2.5 μs

Pulse specification	Maximum input frequency	Voltage	Forward current
Differential signal	4 Mpps	5V	< 25 mA
Open-collector	200 Kpps	24V (maximum)	< 25 mA

■ UY: filter width setting

If the pulse frequency is too high, causing a pulse width smaller than the filter width, then this pulse gets filtered out as noise. Therefore, set the filter width smaller than the actual pulse width.

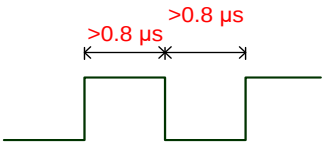
You should set the filter width as 4 times smaller than the actual pulse width.

Y value	U = 0 Unit: μs (kHz)	U = 1 Unit: μs (kHz)
0	No filter function	No filter function
1	2 (250)	0.2 (2500)
2	3 (166)	0.3 (1666)
3	4 (125)	0.4 (1250)
4	5 (100)	0.5 (1000)
5	6 (83)	0.6 (833)
6	7 (71)	0.7 (714)
7	8 (62)	0.8 (625)
8	9 (55)	0.9 (555)
9	10 (50)	1 (500)
A	11 (45)	1.1 (454)
B	12 (41)	1.2 (416)
C	13 (38)	1.3 (384)
D	14 (35)	1.4 (357)
E	15 (33)	1.5 (333)

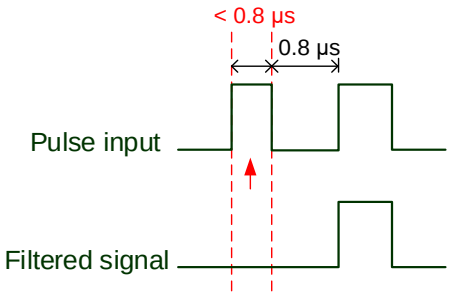
Example:

When U is set to 1 and Y is set to 1 (and filter width is therefore 0.2 μs),

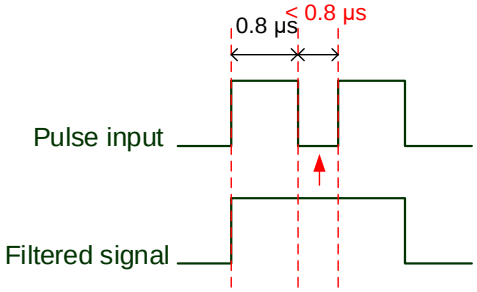
and when the high and low duty width of the command pulse are both larger than 0.8 μs (and filter width is 4 times 0.2 μs), then the pulse command is not filtered out.



When the high or low duty width of the pulse is smaller than the filter width, then it is filtered out.



If this first pulse width is smaller than 0.8 μs, it may be filtered out, and thus two input pulses will be regarded as one pulse. If this pulse width is smaller than 0.2 μs, it will be filtered out.



If this low level pulse width is smaller than 0.8 μs, it may be filtered out, and thus two input pulses will be regarded as one pulse. If this low level pulse width is smaller than 0.2 μs, it will be filtered out.

If you use a 125 ns (4 Mpps) input pulse, set the filter value Y to 0 to disable the filter function.

Note: when the high-speed pulse specification of the signal is 4 Mpps and the value of the filter is 0, then the pulse is not filtered out.

P1.001●	**Input for control mode and control command**		**Address: 0102H 0103H**
Default:	0x0000 (Model: A3-M, A3-L) 0x000B (Model: A3-F)	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x111F
Format:	HEX	Data size:	16-bit

Settings:

YX	Control mode setting	Z	Direction control	U	DIO value control

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■ YX: control mode setting

Mode	PT	PR	S	T	Sz	Tz
00	▲					
01		▲				
02			▲			
03				▲		
04					▲	
05						▲
Dual mode						
06	▲		▲			
07	▲			▲		
08		▲	▲			
09		▲		▲		
0A			▲	▲		
0B	DMCNET mode					
0C	CANopen mode					
0D	▲	▲				
Multi-mode						
0E	▲	▲	▲			
0F	▲	▲		▲		

PT: Position control mode; the command source is from the external pulse and the external analog voltage (*coming soon).

PR: Position control mode; the command source is from the 100 sets of internal registers which you can select with DI.POS0 - DI.POS6. Multiple homing methods are also available.

S: Speed control mode; the command source is from the external analog voltage and the internal register which you can select with DI.SPD0 and DI.SPD1.

T: Torque control mode; the command source is from the external analog voltage and the internal register which you can select with DI.TCM0 and DI.TCM1.

Sz: Speed control mode; the command source is from the zero speed and the internal speed register which you can select with DI.SPD0 and DI.SPD1.

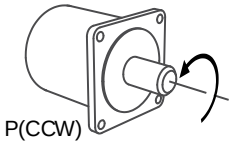
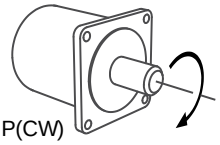
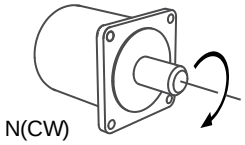
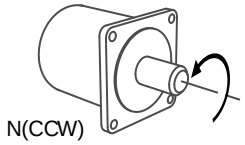
Tz: Torque control mode; the command source is from the zero torque and the internal torque register which you can select with DI.TCM0 and DI.TCM1.

Dual mode: you can switch the mode with external DI. For example, you can use DI.S-P to switch the dual mode of PT/S (control mode setting: 06). Refer to Table 8.1 for further information.

Multi-mode: you can switch the mode with external DI. For example, you can use DI.S-P and DI.PT-PR to switch the multi-mode of PT/PR/S (control mode setting: 12). Refer to Table 8.1 for further information.

CANopen 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
Forward direction		
Reverse direction		

■ U: DIO value control (volatile)

0: when switching modes, DIO settings (P2.010 - P2.022) remain the same.

1: when switching modes, DIO settings (P2.010 - P2.022) are reset to the default for each mode.

P1.002▲	**Speed and torque limits**		**Address: 0104H 0105H**
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	00 - 11
Format:	HEX	Data size:	16-bit

Settings:

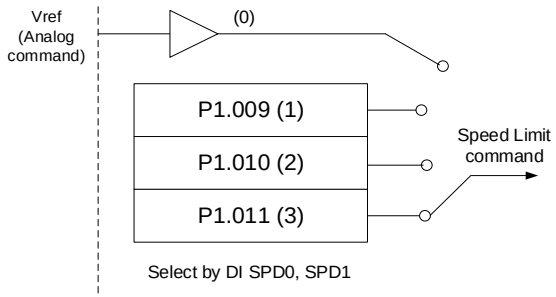
X	Disable / enable Speed Limit function	Y	Disable / enable Torque Limit function	UZ	Reserved

■ X: disable / enable Speed Limit function

0: disable Speed Limit function

1: enable Speed Limit function (only available in T and Tz modes)

See the following diagram for Speed Limit setting:



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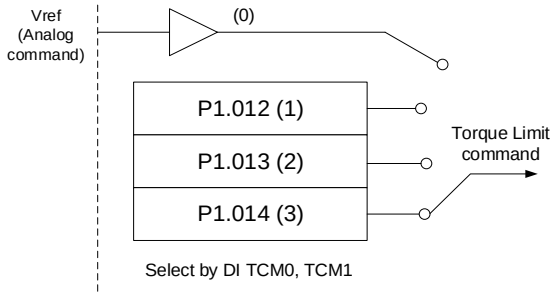
- Y: disable / enable Torque Limit function

  0: disable Torque Limit function

  1: enable Torque Limit function

  See the following diagram for Torque Limit setting:



  When using the Torque Limit function, set this parameter to 1 to limit the torque permanently without occupying a DI setting. Alternatively, you can enable or disable the limit function with DI.TRQLM, which is more flexible, but the setting then occupies a DI setting. You can enable the Torque Limit function by either P1.002 or DI.

- UZ: reserved

P1.003	Encoder pulse output polarity		Address: 0106H 0107H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 13
Format:	HEX	Data size:	16-bit

Settings:

X	Polarity of monitor analog output	Y	Polarity of encoder pulse output	UZ	Reserved

- X: polarity of monitor analog output

  0: MON1(+), MON2(+)

  1: MON1(+), MON2(-)

  2: MON1(-), MON2(+)

  3: MON1(-), MON2(-)

- Y: polarity of encoder pulse output

  0: pulse output in forward direction

  1: pulse output in reverse direction

- UZ: reserved

P1.004	MON1 analog monitor output proportion		Address: 0108H 0109H
Default:	100	Control mode:	All
Unit:	% (full scale)	Setting range:	0 - 100
Format:	DEC	Data size:	16-bit

Settings:

Refer to P0.003 for the analog output setting.

Example 1:

If the requirement is for the motor to run at 1,000 rpm, which corresponds to 8V, and its maximum speed is 5,000 rpm, then the setting is:

P1.004 = $\frac{\text{Required speed}}{\text{Maximum speed}} \times 100\% = \frac{1000\ \text{rpm}}{5000\ \text{rpm}} \times 100\% = 20\%$

Refer to the following examples for the motor's current speed and relative voltage output:

Motor speed	MON1 analog monitor output
300 rpm	MON1 = 8V $\times \frac{\text{Current speed}}{\text{Maximum speed} \times \frac{\text{P1.004}}{100}} \times 100\% = 8\text{V} \times \frac{300\ \text{rpm}}{5000\ \text{rpm} \times \frac{20}{100}} \times 100\% = 2.4\text{V}$
900 rpm	MON1 = 8V $\times \frac{\text{Current speed}}{\text{Maximum speed} \times \frac{\text{P1.004}}{100}} \times 100\% = 8\text{V} \times \frac{900\ \text{rpm}}{5000\ \text{rpm} \times \frac{20}{100}} \times 100\% = 7.2\text{V}$

P1.005	MON2 analog monitor output proportion		Address: 010AH 010BH
Default:	100	Control mode:	All
Unit:	% (full scale)	Setting range:	0 - 100
Format:	DEC	Data size:	16-bit

Settings:

Refer to P0.003 for the analog output setting.

P1.006	Speed command smoothing constant (low-pass filter)		Address: 010CH 010DH
Default:	0	Control mode:	S / Sz
Unit:	ms	Setting range:	0 - 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:	T / Tz
Unit:	ms	Setting range:	0 - 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:	PT / PR
Unit:	10 ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit
Example:	11 = 110 ms		

Settings:

0: disable this function.

P1.009	Internal Speed command 1 / internal speed limit 1		Address: 0112H 0113H
Default:	1000	Control mode:	S / Sz: internal Speed command 1 T / Tz: internal speed limit 1
Unit:	0.1 rpm (rotary motor)* μm/s (linear motor)*	Setting range:	-60000 to +60000 (rotary motor)* -15999999 to +15999999 (linear motor)*
Format:	DEC	Data size:	32-bit
Example:	Internal Speed command: 120 = 12 rpm Internal speed limit: positive and negative values are identical. Refer to the following descriptions.		

Settings:

Internal Speed command 1: first internal Speed command.

Internal speed limit 1: first internal speed limit.

Example of internal speed limit:

Speed limit value of P1.009	Valid speed range	Speed limit in forward direction	Speed limit in reverse direction
1000	-100 to +100 rpm	100 rpm	-100 rpm
-1000			

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

P1.010	Internal Speed command 2 / internal speed limit 2		Address: 0114H 0115H
Default:	2000	Control mode:	S / Sz: internal Speed command 2 T / Tz: internal speed limit 2
Unit:	0.1 rpm (rotary motor)* μm/s (linear motor)*	Setting range:	-60000 to +60000 (rotary motor)* -15999999 to +15999999 (linear motor)*
Format:	DEC	Data size:	32-bit
Example:	Internal Speed command: 120 = 12 rpm Internal speed limit: positive and negative values are identical. Refer to the following descriptions.		

Settings:

Internal Speed command 2: second internal Speed command.

Internal speed limit 2: second internal speed limit.

Example of internal speed limit:

Speed limit value of P1.010	Valid speed range	Speed limit in forward direction	Speed limit in reverse direction
1000	-100 to +100 rpm	100 rpm	-100 rpm
-1000			

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

P1.011	Internal Speed command 3 / internal speed limit 3		Address: 0116H 0117H
Default:	3000	Control mode:	S / Sz: internal Speed command 3 T / Tz: internal speed limit 3
Unit:	0.1 rpm (rotary motor)* μm/s (linear motor)*	Setting range:	-60000 to +60000 (rotary motor)* -15999999 to +15999999 (linear motor)*
Format:	DEC	Data size:	32-bit
Example:	Internal Speed command: 120 = 12 rpm Internal speed limit: positive and negative values are identical. Refer to the following descriptions.		

Settings:

Internal Speed command 3: third internal Speed command.

Internal speed limit 3: third internal speed limit.

Example of internal speed limit:

Speed limit value of P1.011	Valid speed range	Speed limit in forward direction	Speed limit in reverse direction
1000	-100 to +100 rpm	100 rpm	-100 rpm
-1000			

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

P1.012	Internal Torque command 1 / internal torque limit 1		Address: 0118H 0119H
Default:	100	Control mode:	T / Tz: internal Torque command 1 PT / PR / S / Sz: internal torque limit 1
Unit:	%	Setting range:	-400 to +400
Format:	DEC	Data size:	16-bit
Example:	Internal Torque command: 30 = 30% Internal torque limit: positive and negative values are identical. Refer to the following descriptions.		

Settings:

Internal Torque command 1: first internal Torque command.

Internal torque limit 1: first internal torque limit.

Example of internal torque limit:

Torque limit value of P1.012	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
30	-30% to +30%	30%	-30%
-30			

P1.013	Internal Torque command 2 / internal torque limit 2		Address: 011AH 011BH
Default:	100	Control mode:	T / Tz: internal Torque command 2 PT / PR / S / Sz: internal torque limit 2
Unit:	%	Setting range:	-400 to +400
Format:	DEC	Data size:	16-bit
Example:	Internal Torque command: 30 = 30% Internal torque limit: positive and negative values are identical. Refer to the following descriptions.		

Settings:

Internal Torque command 2: second internal Torque command.

Internal torque limit 2: second internal torque limit.

Example of internal torque limit:

Torque limit value of P1.013	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
30	-30% to +30%	30%	-30%
-30			

P1.014	Internal Torque command 3 / internal torque limit 3		Address: 011CH 011DH
Default:	100	Control mode:	T / Tz: internal Torque command 3 PT / PR / S / Sz: internal torque limit 3
Unit:	%	Setting range:	-400 to +400
Format:	DEC	Data size:	16-bit
Example:	Internal Torque command: 30 = 30% Internal torque limit: positive and negative values are identical. Refer to the following descriptions.		

Settings:

Internal Torque command 3: third internal Torque command.

Internal torque limit 3: third internal torque limit.

Example of internal torque limit:

Torque limit value of P1.014	Valid torque range	Torque limit in forward direction	Torque limit in reverse direction
30	-30% to +30%	30%	-30%
-30			

P1.015	E-Cam: correction filter setting for synchronous Capture axis		Address: 011EH 011FH
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0x1F5F
Format:	HEX	Data size:	16-bit

Settings:

YX	Range of filter (0 - 95%)	Z	Filter intensity (0 - F)
U	Filter function status	-	-

- YX: range of filter (0 - 95%)

  The new correction rate is calculated after the synchronous Capture axis captures the signal. If both the new and previous correction rates are less than the range (%) set in this parameter, they are filtered out. Otherwise, the error is corrected with the new correction rate.

YX	Description
00	Filter disabled
01 - 5F	If | Error | ≤ (1 - YX)%, then the filter is enabled

- Z: filter intensity (0 - F)

  When 2^(set value) times of error is captured, the average of the error is used for correction. Set to 0, and the filter is disabled. When you set the Z value higher, you can avoid drastic correction and interference caused by the sensor noise, which allows the movement to be more stable. However, setting this value too high causes the correction to not work properly. The recommended value is 3.

  Example: when the filter intensity is set to 3, the actual filter intensity = 2^3 = 8, which means that after capturing 8 times of error values, the 8 values are averaged for the correction value of the synchronous Capture axis.

- U: filter function status (read-only)

U	Filter function	Description
0	Disabled	Correction rate is out of the YX set range
1	Enabled	Correction rate is within the YX set range

P1.016■	E-Cam: error offset compensation for synchronous Capture axis		Address: 0120H 0121H
Default:	0	Control mode:	PR
Unit:	Pulse unit of master axis	Setting range:	-32768 to +32767
Format:	DEC	Data size:	16-bit

Settings:

When the synchronous Capture axis is enabled and you want to change the error pulse amount (P5.079), use this parameter to write the offset value.

Write P1.016: P5.079 = P5.079 + Write value

Read P1.016: read value = P5.079

Note: the setting value of this parameter is accumulative, which is not affected by the current error amount.

P1.017	Additional compensation time for the following error		Address: 0122H 0123H
Default:	0	Control mode:	PR
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 this is unable to accomplish by setting the position feed forward gain (P2.002) and position integral compensation (P2.053), set the additional compensation time to compensate the error amount.

Additional compensation distance = P1.017 x Motor speed

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

P1.018	E-Cam: compensation time for the pulse of E-Cam master axis		Address: 0124H 0125H
Default:	0	Control mode:	PR
Unit:	ms (minimum scale is μs)	Setting range:	-25.000 to +25.000 (includes 3 decimal places)
Format:	DEC	Data size:	16-bit

Settings:

During the operation of the E-Cam, if the mechanical factor is excluded, but the following error still exists, which may be error caused by the electrical delay. Set the compensation pulse number of the master axis to correct the E-Cam phase. If the compensation time is set to 0, it is not compensated.

Compensation pulse = P1.018 x (Pulse frequency of the E-Cam master axis (Kpps) - P1.021 (Minimum frequency of pulse compensation for the E-Cam master axis))

Note: monitor the pulse frequency of the E-Cam master axis (Kpps) with the monitoring variable 060 (3Ch).

P1.019	Capture / Compare additional function settings		Address: 0126H 0127H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0101
Format:	HEX	Data size:	16-bit

Settings:

X	Additional function for Capture	Z	Additional function for Compare
Y	Reserved	U	Reserved

■ X: additional function for Capture

Bit	3	2	1	0

Bit	Function	Description
0	Cycle mode	Set this bit to 0 to disable this function. When the number of capturing times (P5.038) is 0, capturing is complete. Set this bit to 1 to enable this function. When the number of capturing times (P5.038) is 0, it automatically resets the number of capturing times to the default setting.
1 - 3	Reserved	-

■ Z: additional function for Compare

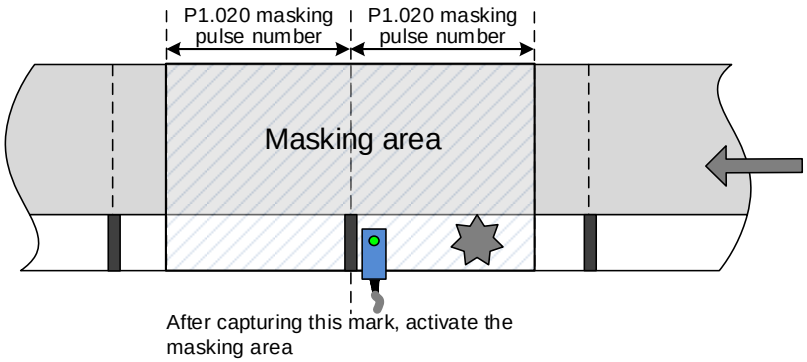
Bit	3	2	1	0

Bit	Function	Description
0	P1.024 is reset to 0 automatically	Set this bit to 0 to disable this function and the value of P1.024 remains. Set this bit to 1 to enable this function and P1.024 automatically resets to 0 after taking effect once.
1 - 3	Reserved	-

P1.020	Capture - masking range		Address: 0128H 0129H
Default:	0	Control mode:	All
Unit:	Pulse unit of capture source	Setting range:	0 to +100000000
Format:	DEC	Data size:	32-bit

Settings:

When the Capture function is enabled and set to capture multiple points (P5.038 > 1), the system stops receiving the DI captured signal within this range once the data is captured. The DI captured signal received within this range is not recognized as valid. Use this function to avoid the system seeing noise as effective signals within the non-capture range.



P1.021	E-Cam: minimum frequency of pulse compensation for the E-Cam master axis		Address: 012AH 012BH
Default:	0	Control mode:	PR
Unit:	Kpps	Setting range:	0 to +30000
Format:	DEC	Data size:	16-bit

Settings:

During the operation of the E-Cam, if the mechanical factor is excluded, but the following error still exists, which may be error caused by the electrical delay. Set the compensation pulse number of the master axis to correct the E-Cam phase.

Compensation pulse = P1.018 (Compensation time for the pulse of the E-Cam master axis) x (Pulse frequency of the E-Cam master axis (Kpps) - P1.021)

Note: monitor the pulse frequency of the E-Cam master axis (Kpps) with the monitoring variable 060 (3Ch). The pulse frequency of the E-Cam master axis (Kpps) must be greater than P1.021 to be compensated.

P1.022	PR command special filter		Address: 012CH 012DH
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0x107F
Format:	HEX	Data size:	16-bit

Settings:

XY	Acceleration / deceleration time limit (0 - 1270 ms)	Z	Reserved
U	Reverse inhibit	-	-

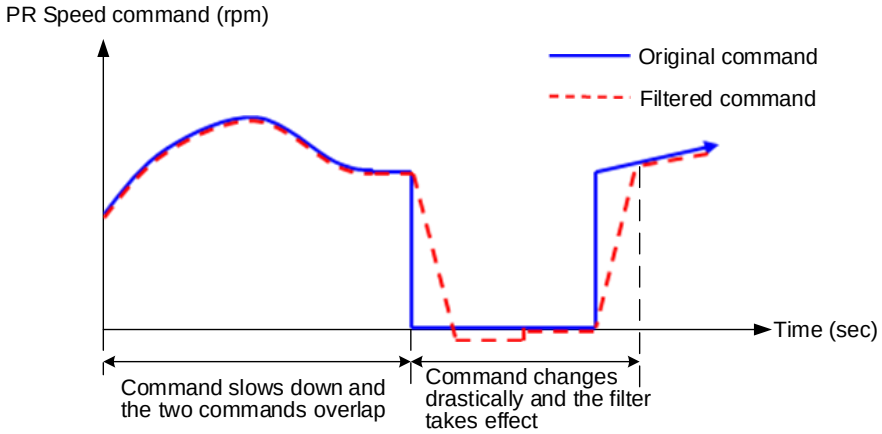
■ YX: acceleration / deceleration time limit (0 - 1270 ms)

If the PR command changes too drastically, it causes mechanical vibration. Set the acceleration / deceleration time limit (the time required for the motor to accelerate from 0 to 3,000 rpm) with this function. If the acceleration / deceleration time of the command is shorter than this limit, the filter takes effect to smooth the acceleration / deceleration which prevents the command from changing too drastically and causing mechanical vibration. When the filter is functioning, the lag caused by

the smooth command is automatically compensated after the command is smoothed, so the final position is not deviated.

Example:

Set YX to 12 and the acceleration / deceleration time limit as 180 ms (data format is HEX and unit is 10 ms). If the acceleration / deceleration time of the PR command is shorter than 180 ms, the filter takes effect; if the acceleration / deceleration time of the PR command is longer than 180 ms, the filter does not take effect.

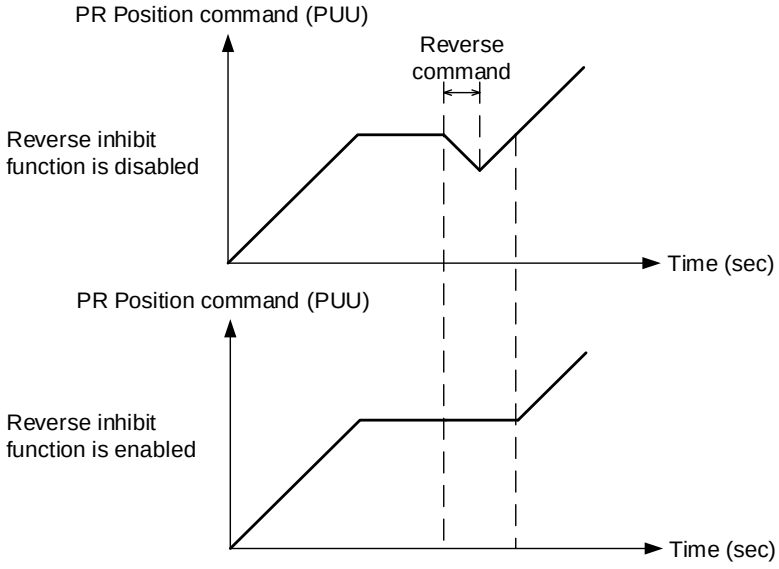


Note: if the command does not slow down, the internal position lag accumulates and triggers AL404.

- Z: reserved

- U: reverse inhibit

When the reverse inhibit function is enabled, the reverse command is inhibited. The reverse command is reserved in the servo drive and the forward command outputs after the received forward command value exceeds the reserved reverse command value.



P1.023	Compare - data translation (non-volatile)		Address: 012EH 012FH
Default:	0	Control mode:	All
Unit:	Pulse unit of compare source	Setting range:	-10000000 to +100000000
Format:	DEC	Data size:	32-bit

Settings:

When using the Compare function, add the translation value to the data array to be used as the actual comparison data:

CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024

Example:

If the data array for comparison is DATA_ARRAY[100] = 2000; P1.023 = 40; P1.024 = 0;

then the actual comparison value = 2000 + 40 = 2040.

Note: monitor CMP_DATA with the monitoring variable 037(25h).

P1.024■	Compare - data translation (reset automatically)		Address: 0130H 0131H
Default:	0	Control mode:	All
Unit:	Pulse unit of compare source	Setting range:	-32768 to +32767
Format:	DEC	Data size:	16-bit

Settings:

When using the Compare function, add the translation value to the data array to be used as the actual comparison data:

CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024

Note:

1. If P1.019.Z [Bit 0] = 1, this parameter automatically resets after taking effect.
2. Monitor CMP_DATA with the monitoring variable 037(25h).

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

Settings:

Sets the first low-frequency vibration suppression frequency. 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:	PT / PR
Unit:	-	Setting range:	0 - 9
Format:	DEC	Data size:	16-bit

Settings:

To set the gain of the first low-frequency vibration suppression, increase the value to improve the position response. If you set the value too high, the motor may not operate smoothly. The suggested value is 1. Set P1.026 to 0 to disable the first low-frequency vibration suppression filter.

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

Settings:

Sets the second low-frequency vibration suppression frequency. 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:	PT / PR
Unit:	-	Setting range:	0 - 9
Format:	DEC	Data size:	16-bit

Settings:

To set the gain of the second low-frequency vibration suppression, increase the value to improve the position response. If you set the value too high, the motor may not operate smoothly. The suggested value is 1. Set P1.028 to 0 to disable the second low-frequency vibration suppression filter.

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

Settings:

0: disable the automatic low-frequency vibration detection function.

1: disable the function automatically after vibration suppression. The value resets to 0 automatically.

Auto mode setting description:

When the value is 1, vibration suppression is in automatic mode. When the vibration 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.

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P1.030	Low-frequency vibration detection		Address: 013CH 013DH
Default:	800	Control mode:	PT / PR
Unit:	pulse	Setting range:	1 - 128000
Format:	DEC	Data size:	32-bit

Settings:

When enabling automatic vibration suppression (P1.029 = 1), the system automatically finds the detection level. The lower the value, the more sensitive the detection, but the system may also misjudge noise or treat other low-frequency vibrations as frequencies to be suppressed. If the value is high, the system is less likely to misjudge, 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:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 20
Format:	HEX	Data size:	16-bit

Settings:

X	Reserved	Y	Dynamic brake operation options	UZ	Reserved

- Y: options for using the dynamic brake when the servo is in Servo Off state or an alarm (including EMGS) occurs

  0: use dynamic brake

  1: motor runs freely

  2: use dynamic brake first, then let the motor run freely once the speed is slower than the value of P1.038

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.

P1.033	Reserved

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

Settings:

Acceleration constant:

P1.034, P1.035, and P1.036 represent the acceleration time for the Speed command from zero to the rated speed. You can set each parameter individually. When using an internal command, if you set P1.036 to 0, the acceleration and deceleration follow a trapezoid-curve; when using an analog command, P1.036 must be larger than 0 so that the acceleration and deceleration follow a trapezoid-curve.

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

Settings:

Deceleration constant:

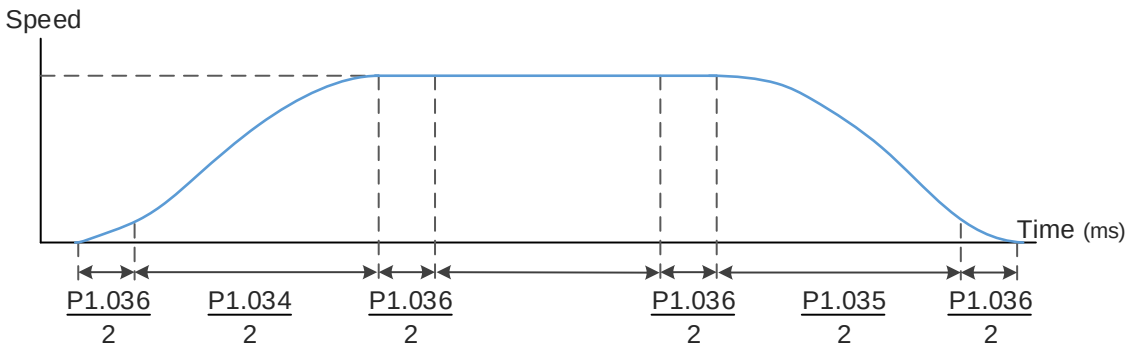
P1.034, P1.035, and P1.036 represent the deceleration time for the Speed command from the rated speed to zero. You can set each parameter individually. When using an internal command, if you set P1.036 to 0, the acceleration and deceleration follow a trapezoid-curve; when using an analog command, P1.036 must be larger than 0 so that the acceleration and deceleration follow a trapezoid-curve.

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

Settings:

0: disable this function

Acceleration / deceleration constant of S-curve:



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

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

P1.036: set 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.

Note the following error compensation:

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

P1.037	Load inertia ratio or total weight			Address: 014AH 014BH
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	6.0	60	Data size:	32-bit
Unit:	1 times (rotary motor)* kg (linear motor)*	0.1 times (rotary motor)* 0.1 kg (linear motor)*	-	-
Setting range:	0.0 - 200.0 (rotary motor)* 0.0 - 6553.5 (linear motor)*	0 - 2000 (rotary motor)* 0 - 65535 (linear motor)*		
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 times / kg	15 = 1.5 times / kg	-	-

Settings:

Rotary motor load inertia ratio (J_load / J_motor) or total weight of linear motor mover and load (M_motor + M_load).

J_motor: rotor inertia of the servo motor

J_load: total equivalent inertia of external mechanical load

M_motor: weight of the linear motor mover

M_load: total equivalent weight of external mechanical load

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

P1.038	Zero speed range			Address: 014CH 014DH
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	10.0	100	Data size:	16-bit
Unit:	1 rpm	0.1 rpm	-	-
Setting range:	0.0 - 200.0	0 - 2000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

Sets the range for the zero-speed signal (ZSPD). When the forward / reverse speed of the motor is slower than this value, the zero-speed signal is triggered and the digital output is enabled.

P1.039	Target speed detection level		Address: 014EH 014FH
Default:	3000	Control mode:	All
Unit:	rpm	Setting range:	0 - 30000 (rotary motor)* 0 - 15999 (linear motor)*
Format:	DEC	Data size:	16-bit

Settings:

When the target speed is reached, DO.TSPD is enabled. When the forward / reverse speed of the motor is faster than this value, the target speed signal is triggered and the digital output is enabled.

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

P1.040	Maximum rotation speed for analog Speed command		Address: 0150H 0151H
Default:	3000	Control mode:	S / T
Unit:	rpm	Setting range:	0 - 50000
Format:	DEC	Data size:	32-bit

Settings:

Maximum rotation speed for analog Speed command:

Speed mode:

$$\text{Speed control command} = \frac{\text{Input voltage} \times \text{Setting}}{10}$$

Set the rotation speed corresponding to 10V (maximum voltage) for the analog Speed command.

If the value is 2000 and the external voltage input is 5V, then the speed control command is 1000 rpm.

$$\text{Speed control command} = \frac{5\text{V} \times 2000\ \text{rpm}}{10} = 1000\ \text{rpm}$$

Torque mode:

$$\text{Speed limit command} = \frac{\text{Input voltage} \times \text{Setting}}{10}$$

Set the rotation speed limit corresponding to 10V (maximum voltage) for the analog speed limit.

If the value is 2000 and the external voltage input is 5V, then the speed limit command = $\frac{5\text{V} \times 2000\ \text{rpm}}{10}$ = 1000 rpm.

P1.041▲	Maximum output for analog Torque command		Address: 0152H 0153H
Default:	100	Control mode:	All
Unit:	%	Setting range:	-1000 to 1000
Format:	DEC	Data size:	16-bit

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Settings:

Maximum output for analog Torque command:

Torque mode:

$$\text{Torque control command} = \frac{\text{Input voltage} \times P1.041}{10} \text{ (Unit: \%)}$$

Set the torque corresponding to 10V (maximum voltage) for the analog Torque command. If the default value is 100 and the external voltage input is 10V, then the torque control command is 100% of the rated torque. If the external voltage input is 5V, then the torque control command is 50% of the rated torque.

When the external analog input is 10V, the torque control command = $\frac{10V \times 100}{10}$ = 100%

When the external analog input is 5V, the torque control command = $\frac{5V \times 100}{10}$ = 50%

Example:

If P1.041 = 10

When the external analog input is 10V, the torque control command = $\frac{10V \times 10}{10}$ = 10%

When the external analog input is 5V, the torque control command = $\frac{5V \times 10}{10}$ = 5%

In Speed, PT, and PR modes:

$$\text{Torque limit command} = \frac{\text{Input voltage} \times \text{Setting}}{10} \text{ (Unit: \%)}$$

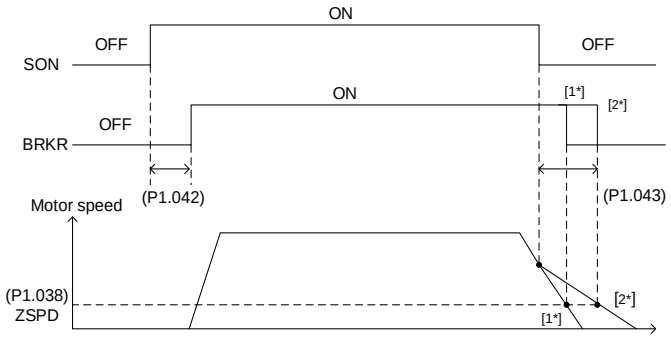
Set the torque limit corresponding to 10V (maximum voltage) for the analog torque limit.

Torque limit command = $\frac{10V \times 100}{10}$ = 100%

P1.042	Enable delay time for magnetic brake		Address: 0154H 0155H
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the delay time from Servo On status to the activation of the magnetic brake signal (DO: 0x08, BRKR).



P1.043	Disable delay time for magnetic brake		Address: 0156H 0157H
Default:	0	Control mode:	All
Unit:	ms	Setting range:	-1000 to 1000
Format:	DEC	Data size:	16-bit

Settings:

Sets the delay time from Servo Off status to the deactivation of the magnetic brake signal (DO: 0x08, BRKR). For the detailed diagram, refer to P1.042.

Note:

1. If the delay time specified in P1.038 has not passed yet and the motor speed is slower than the value of P1.038, the magnetic brake signal (BRKR) is deactivated.
2. If the delay time specified in P1.038 has passed and the motor speed is faster than the value of P1.038, the magnetic brake signal (BRKR) is deactivated.
3. If P1.043 is a negative value and the servo is off due to an alarm (except for AL022) or emergency stop, this setting does not function. This is equivalent to setting the delay time to 0.

P1.044▲	E-Gear ratio (numerator) (N1)		Address: 0158H 0159H
Default:	16777216	Control mode:	PT / PR
Unit:	pulse	Setting range:	1 to (2^{29}-1)
Format:	DEC	Data size:	32-bit

Settings:

For the E-Gear ratio setting, refer to Section 6.2.5. Refer to P2.060 - P2.062 for multiple E-Gear ratio (numerator) settings.

Note:

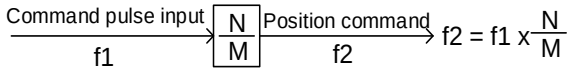
1. Do not change the setting in the Servo On state.
2. In communication mode (DMCNET / CANopen / EtherCAT), if you cycle the power to the drive, the E-Gear ratio is set to the default value of the communication protocol. Resetting to the default value results in the re-establishment of the absolute coordinate system, so you must re-do the homing procedure. If you do not want P1.044 to be reset to the default value, set P3.012.Z to 1. For details, refer to P3.012.

P1.045▲	E-Gear ratio (denominator) (M)		Address: 015AH 015BH
Default:	100000	Control mode:	PT / PR
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.

Setting of pulse input:



Command pulse input range: 1 / 4 < Nx / M < 262144.

For the E-Gear ratio setting, refer to Section 6.2.5.

Note:

1. Do not change the setting in the Servo On state.
2. In communication mode (DMCNET / CANopen / EtherCAT), if you cycle the power to the drive, the E-Gear ratio is set to the default value of the communication protocol. Resetting to the default value results in the re-establishment of the absolute coordinate system, so you must re-do the homing procedure. If you do not want P1.045 to be reset to the default value, set P3.012.Z to 1. For details, refer to P3.012.

P1.046▲	Encoder pulse number output (OA, OB)		Address: 015CH 015DH
Default:	2500	Control mode:	All
Unit:	pulse	Setting range:	20 - 53688870912
Format:	DEC	Data size:	32-bit

Settings:

Rotary motor: the number of single-phase pulse outputs per revolution; the maximum output frequency of the hardware is 19.8 MHz.

Linear motor: the number of single-phase pulse outputs per meter; the maximum output frequency of the hardware is 19.8 MHz.

Note:

The following circumstances may result in exceeding the maximum allowable output pulse frequency of the drive, causing AL018:

1. Encoder error
2. The motor speed is faster than P1.076
3. Rotary motor: if P1.074.Y = 0 and P1.097 = 0, motor speed (rpm)/60 x P1.046 x 4 > 19.8 x 10^6

   Linear motor: if P1.074.Y = 1 and P1.097 = 1, motor speed (um/s)*1000/PM.004 x P1.046 > 19.8 x 10^6

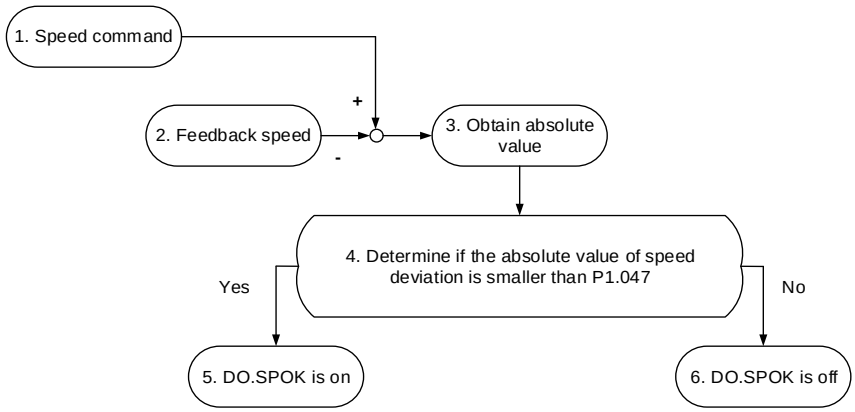
P1.047	Speed reached (DO.SP_OK) range		Address: 015EH 015FH
Default:	10	Control mode:	S / Sz
Unit:	rpm	Setting range:	0 - 300
Format:	DEC	Data size:	16-bit

Settings:

In Speed mode, when the deviation between the Speed command and the motor feedback speed is less than this parameter and the difference reaches the time set in P1.049, the digital output DO.SP_OK (DO code: 0x19) is on.

Note: when the deviation between the Speed command and the motor feedback speed exceeds the range set in P1.047, the system recalculates the duration.

Diagram:



1. Speed command: command that you input without acceleration / deceleration, not the command from the front end speed circuit. Its source is from the register.
2. Feedback speed: the actual speed of the motor which has been filtered out.
3. Obtain the absolute value.
4. Determine whether the absolute value of the speed deviation is smaller than the parameter value. If you set the parameter to 0, the output is always off. If the absolute value is smaller than the parameter, the digital output is on, otherwise it is off.

P1.048	Motion reached (DO.MC_OK) operation selection		Address: 0160H 0161H
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0x0011
Format:	HEX	Data size:	16-bit

Settings:

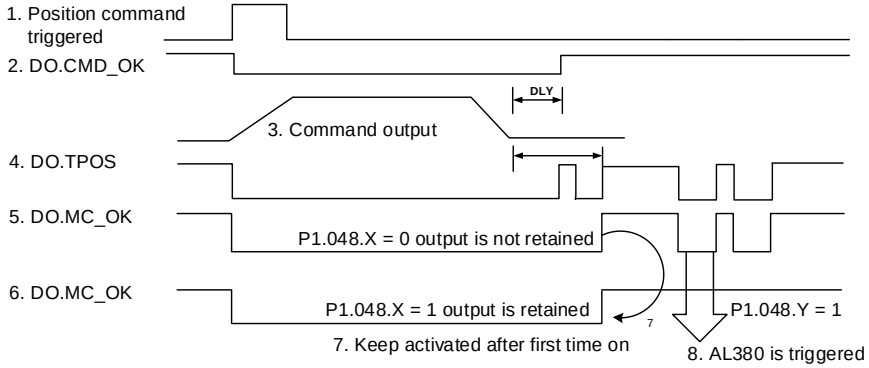
Control selection of digital output DO.MC_OK (DO code: 0x17).

X	DO output hold option	Y	Position deviation alarm AL380 option	UZ	Reserved

- X: DO output hold option
  0: output status is not retained
  1: output status is retained

- Y: position deviation alarm AL380 option
  0: AL380 not functioning
  1: AL380 functioning

Diagram:



Description:

1. Command triggered: new PR command is effective. Command 3 starts and clears signals 2, 4, 5, and 6 simultaneously. Command triggering source: DI.CTRG, DI.EV1/EV2, P5.007 (triggered through software), etc.
2. DO.CMD_OK: command 3 is complete and it can set the delay time (DLY).
3. Command output: output the profile of the Position command based on the acceleration / deceleration setting.
4. DO.TPOS: position error of the servo drive is within the range set in P1.054.
5. DO.MC_OK: Position command output and servo positioning completed, which indicate that DO.CMD_OK and DO.TPOS are both on.
6. DO.MC_OK (retains digital output status): same as 5, except that once this DO is on, its status is kept regardless of the signal 4 status.
7. Can only select either signal 5 or signal 6 to output, and the choice is specified in P1.048.X.
8. Position deviation: when number 7 occurs, if signal 4 (or 5) is off, it means the position has deviated and AL380 can be triggered. This alarm may be set with P1.048.Y.

P1.049	**Accumulated time to reach desired speed**		**Address: 0162H 0163H**
Default:	0	Control mode:	S / Sz
Unit:	ms	Setting range:	0 - 65535
Format:	DEC	Data size:	16-bit

Settings:

In Speed mode, when the deviation between the Speed command and the motor feedback speed is less than the range set in P1.047 and the difference reaches the time set in P1.049, the digital output DO.SP_OK (DO code: 0x19) is on. If the difference exceeds the range set in P1.047 at any time, 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 note.
Format:	DEC	Data size:	16-bit

Settings:

Model	Default (Ω)	Model	Default (Ω)
1.5 kW or below	100	2 - 3 kW (included)	20

Refer to the instructions for P1.053 for the setting to use when connecting the regenerative resistor through a different method.

Note: setting range for 220V

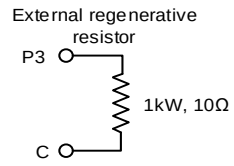
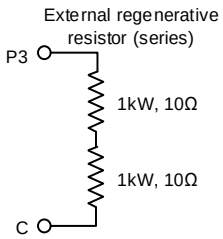
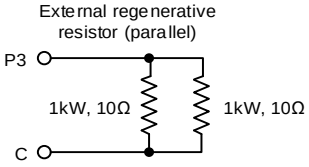
Model	Setting range	Model	Setting range
400 W or below	20 - 750	2 - 3 kW	10 - 750
750 W - 1.5 kW	20 - 750	-	-

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 - 6000
Format:	DEC	Data size:	16-bit

Settings:

Model	Default (Watt)	Model	Default (Watt)
200 W or below	0	2 - 3 kW (included)	80
400 W - 1.5 kW	40	-	-

Setting the parameter value when connecting the regenerative resistor with different methods:

External regenerative resistor	Setting
	Setting: P1.052 = 10 (Ω) P1.053 = 1000 (W)
	Setting: P1.052 = 20 (Ω) P1.053 = 2000 (W)
	Setting: P1.052 = 5 (Ω) P1.053 = 2000 (W)

P1.054	Pulse range for position reached		Address: 016CH 016DH
Default:	167772	Control mode:	PT / PR
Unit:	pulse	Setting range:	0 - 16777216
Format:	DEC	Data size:	32-bit

Settings:

In Position (PT) mode, when the deviation pulse number is smaller than the range of P1.054, DO.TPOS is on.

In Position Register (PR) mode, when the deviation between the target position and the actual motor position is smaller than the range of P1.054, DO.TPOS is on.

Example:

For a rotary motor, if P1.054 = 167772 and the deviation 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:	Rotary motor: rated speed of each model Linear motor: automatically fills in after motor identification	Control mode:	All
Unit:	Rotary motor: rpm Linear motor: mm/s	Setting range:	0 to maximum speed
Format:	DEC	Data size:	16-bit

Settings:

Sets the maximum speed of the servo motor.

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

P1.056	Motor output overload warning level		Address: 0170H 0171H
Default:	120	Control mode:	All
Unit:	%	Setting range:	0 - 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 (P1.056), the pre-warning for overload (DO is set to 0x10, OLW) occurs. If the value is over 100, this function is disabled.

P1.057	Motor hard stop (torque percentage)		Address: 0172H 0173H
Default:	0	Control mode:	All
Unit:	%	Setting range:	0 - 300
Format:	DEC	Data size:	16-bit

Settings:

Set the protection level. For the percentage of rated torque, set the value to 0 to disable the function. Set the value to 1 or above to enable the function.

P1.058	Motor hard stop (protection time)		Address: 0174H 0175H
Default:	1	Control mode:	All
Unit:	ms	Setting range:	1 - 1000
Format:	DEC	Data size:	16-bit

Settings:

Set the protection time: when the motor reaches the protection level and exceeds the protection time, AL030 occurs.

Note: this function is only suitable for non-contactable uses, such as electrical discharge machines (set P1.037 correctly).

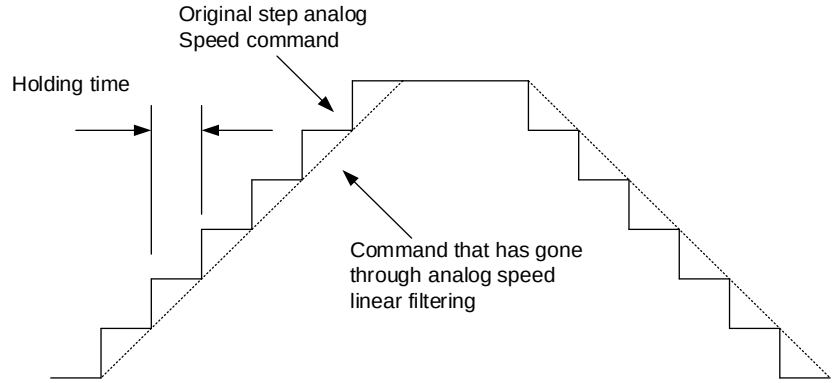
P1.059	Speed command - moving filter			Address: 0176H 0177H
Operation interface:	Panel / software	Communication	Control mode:	S
Default:	0.0	0	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Format:	One decimal	DEC	-	-
Setting range:	0.0 - 4.0	0 - 40	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

0: disable moving filter.

P1.006 is the low-pass filter and P1.059 is the moving filter. The difference between them is the moving filter can smooth the beginning and end of the step command, while the low-pass filter can only smooth the command at the end.

Therefore, if the speed loop receives the command from the controller for the position control loop, then the low-pass filter is recommended. If the setting is only for the speed control, then use the moving filter for better smoothing.



P1.060 - P1.061	Reserved

P1.062	Percentage of friction compensation		Address: 017CH 017DH
Default:	0	Control mode:	PT / PR / S / Sz
Unit:	%	Setting range:	0 - 100
Format:	DEC	Data size:	16-bit

Settings:

The level of friction compensation. For the percentage of rated torque, set the value to 0 to disable the function; set the value to 1 or above to enable the function.

P1.063	Constant of friction compensation		Address: 017EH 017FH
Default:	1	Control mode:	PT / PR / S / Sz
Unit:	ms	Setting range:	1 - 1000
Format:	DEC	Data size:	16-bit

Settings:

Set the smoothing constant of friction compensation.

P1.064	Analog position command: activation control		Address: 0180H 0181H
Default:	0x0000	Control mode:	PT
Unit:	-	Setting range:	0x0000 - 0x0011
Format:	HEX	Data size:	16-bit

Settings:

X	Setting for position command issued by the analog signal	Y	Initial position setting	UZ	Reserved

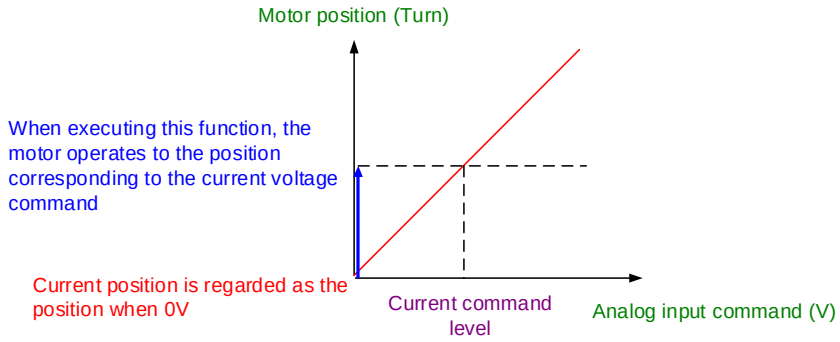
- X: setting for position command issued by the analog signal

  0: disable

  1: enable

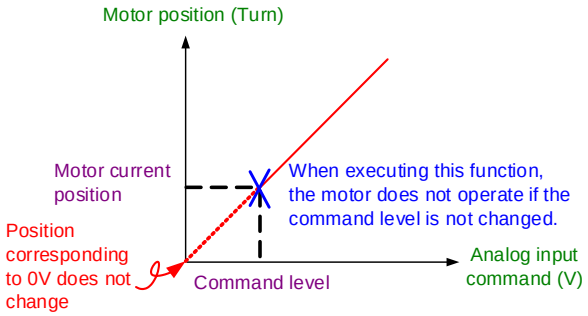
- Y: initial position setting

  0: after the servo is on, the motor regards the current position as the position when the voltage is 0V. Then the motor operates to the corresponding position according to the analog input command.



1: after the servo is on, if the command level is not changed, the motor does not operate.

The position the motor stops at is the position corresponding to the current command level.



P1.065	Smooth constant of analog Position command		Address: 0182H 0183H
Default:	1	Control mode:	PT
Unit:	10 ms	Setting range:	1 - 1000
Format:	DEC	Data size:	16-bit

Settings:

The smooth constant of analog Position command is only effective to analog Position command.

P1.066	Maximum rotation number of analog Position command			Address: 0184H 0185H
Operation interface:	Panel / software	Communication	Control mode:	PT
Default:	1.0	10	Data size:	16-bit
Unit:	1 cycle	0.1 cycle	-	-
Format:	One decimal	DEC	-	-
Setting range:	0.0 - 200.0	0 - 2000	-	-
Example:	1.5 = 1.5 cycles	15 = 1.5 cycles	-	-

Settings:

Rotation number setting when inputting the maximum voltage (10V) to the analog Position command.

If the setting on the panel is 3.0 and the external voltage input is 10V, then the Position command is +3 cycles. If the input is +5V, then the Position command is +1.5 cycles; if the input is -10V, then the Position command is -3 cycles. Position control command = Input voltage x Set value / 10

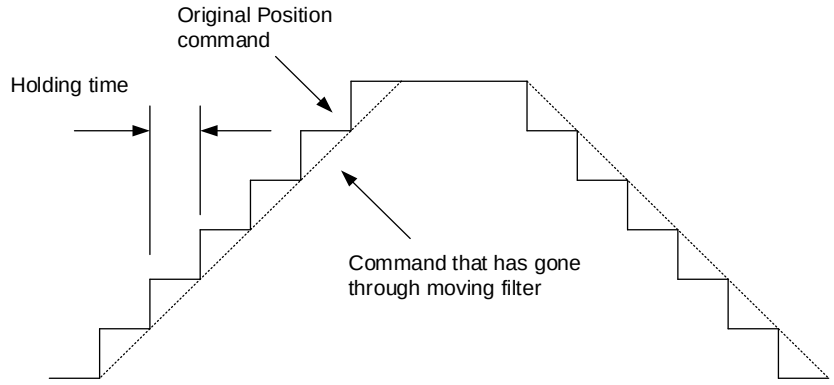
P1.067	Reserved

P1.068	Position command - moving filter		Address: 0188H 0189H
Default:	4	Control mode:	PT / PR
Unit:	ms	Setting range:	0 - 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 - P1.071	Reserved

P1.072	Resolution of linear scale for full-closed loop control		Address: 0190H 0191H
Default:	5000	Control mode:	PT
Unit:	pulse / rev	Setting range:	200 - 1280000
Format:	DEC	Data size:	32-bit

Settings:

The number of A/B pulses corresponding to a full-closed loop when the motor runs a cycle (after quadruple frequency).

P1.073	Error protection range for full-closed loop control		Address: 0192H 0193H
Default:	30000	Control mode:	PT
Unit:	pulse (based on the feedback of full-closed loop)	Setting range:	1 to (2^{31}-1)
Format:	DEC	Data size:	32-bit

Settings:

When the deviation between the A/B counter from the full-closed loop and the encoder feedback position is excessive, it may be a result from the connector being loose or other mechanical problems. When the deviation is greater than the value of P1.073, AL040 (excessive deviation of full closed-loop position control) occurs.

P1.074	Full-closed loop control for linear scale		Address: 0194H 0195H
Default:	0x0000	Control mode:	PT
Unit:	-	Setting range:	0000h - F132h
Format:	HEX	Data size:	16-bit

Settings:

X	Full-closed loop / Gantry function switch	Z	Positive / negative direction selection of linear scale feedback
Y	Selection of OA / OB / OZ output source	U	Linear scale filter function

- X: full-closed loop / Gantry function switch

  0: disable full-closed loop / Gantry function

  1: enable full-closed loop function

  2: enable synchronous control function

- Y: selection of OA / OB / OZ output source

  0: CN2 encoder is the output source

  1: CN5 encoder is the output source

  (If P1.097 = 0, the OA / OB output must be 1:1. If you need to change the output ratio, refer to the settings of P1.046 and P1.097.)

  2: CN1 pulse command is the output source

  (If P1.097 = 0, the OA / OB output must be 1:1. If you need to change the output ratio, refer to the settings of P1.046 and P1.097.)

  3: reserved

- Z: positive / negative direction selection of linear scale feedback

  0: positive direction when A phase leads B phase of linear scale

  1: positive direction when B phase leads A phase of linear scale

- U: linear scale filter function

  0: bypass

  1: 6.66 M

  2: 1.66 M

  3: 833 K

  4: 416 K

  5 - F: reserved

P1.075	Low-pass filter time constant for full- / half-closed loop control		Address: 0196H 0197H
Default:	100	Control mode:	PT
Unit:	ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

When the stiffness of the mechanical system between full- and half-closed loops is insufficient, set the proper time constant to enhance the stability of the system. In other words, temporarily create the half-closed loop effect, and after stabilizing, the full-closed loop effect is created. When the stiffness is sufficient, set to bypass. Set the value to 0 to disable the low-pass filter (bypass) function.

If the stiffness of the mechanical system is high, decrease the value of P1.075 or set the value to 0 to disable. If the stiffness of the mechanical system is low, increase the value of P1.075.

P1.076▲	Maximum speed for encoder output (OA, OB)		Address: 0198H 0199H
Default:	5500	Control mode:	All
Unit:	Rotary motor: rpm Linear motor: 10^{-3} ms	Setting range:	Rotary motor: 0 - 6000 Linear motor: 0 - 15999
Format:	DEC	Data size:	16-bit

Settings:

Input the actual maximum speed of the motor as the reference value to activate the smoothing function. When you set the value to 0, the smoothing function is disabled.

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

P1.077 - P1.080	Reserved

P1.081	Second set of maximum rotation speed for analog Speed command		Address: 01A2H 01A3H
Default:	Motor rated speed	Control mode:	S / T
Unit:	rpm / 10V	Setting range:	0 - 50000
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P1.040.

P1.082	Filter switching time between P1.040 and P1.081		Address: 01A4H 01A5H
Default:	0	Control mode:	S
Unit:	ms	Setting range:	0 - 1000 (0: disable this function)
Format:	DEC	Data size:	16-bit

Settings:

0: disable filter switching time

P1.083	Abnormal analog input voltage level		Address: 01A6H 01A7H
Default:	0	Control mode:	S
Unit:	mV	Setting range:	0 - 12000 (0: disable this function)
Format:	DEC	Data size:	16-bit

Settings:

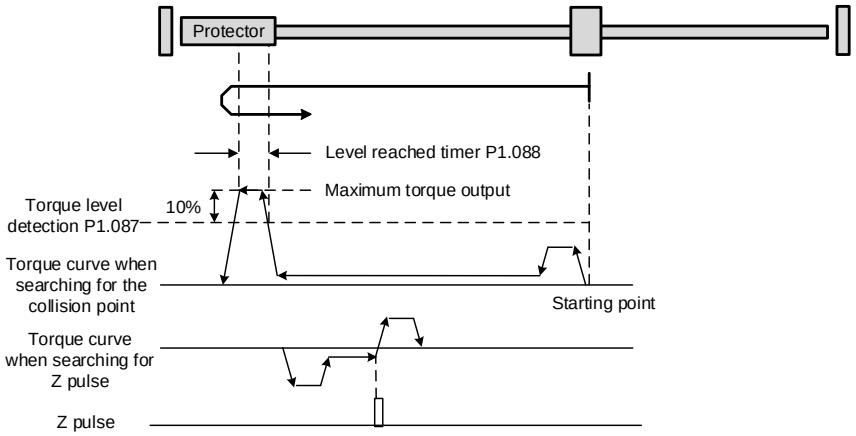
When the analog input voltage is higher than this set parameter for more than 50 ms, AL042 occurs. The comparison value for this parameter is the original analog input voltage which has not been changed by an offset value through P4.022 (analog speed input offset).

P1.084 - P1.086	Reserved

P1.087	Torque homing - torque level detection		Address: 01AEH 01AFH
Default:	1	Control mode:	PR
Unit:	%	Setting range:	1 - 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 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 to return 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%, then the maximum torque output of the motor is 60%.

P1.088	Torque homing - level reached timer		Address: 01B0H 01B1H
Default:	2000	Control mode:	PR
Unit:	ms	Setting range:	2 - 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.

P1.089	First set of vibration elimination - anti-resonance frequency		Address: 01B2H 01B3H
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10 - 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. A3 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 setting must be obtained through the system module and enabling the low-frequency analysis option is needed. For details, refer to the ASDA-Soft software instructions.

Vibration elimination takes effect only when the two dimensional control function P2.094 [Bit 12] is enabled. After enabling the two dimensional 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	First set of vibration elimination - resonance frequency		Address: 01B4H 01B5H
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10 - 4000
Format:	DEC	Data size:	16-bit

Settings:

Resonance frequency for the first set of low frequency vibration elimination.

P1.091	First set of vibration elimination - resonance difference		Address: 01B6H 01B7H
Default:	10	Control mode:	PT / PR
Unit:	0.1 dB	Setting range:	10 - 4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the first set of low frequency vibration elimination.

P1.092	Second set of vibration elimination - anti-resonance frequency		Address: 01B8H 01B9H
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10 - 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	Second set of vibration elimination - resonance frequency		Address: 01BAH 01BBH
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10 - 4000
Format:	DEC	Data size:	16-bit

Settings:

Resonance frequency for the second set of low frequency vibration elimination.

P1.094	Second set of vibration elimination - resonance difference		Address: 01BCH 01BDH
Default:	10	Control mode:	PT / PR
Unit:	0.1 dB	Setting range:	10 - 4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the second set of low frequency vibration elimination.

P1.095 - P1.096	Reserved

P1.097▲	Encoder output denominator (OA, OB)		Address: 01C2H 01C3H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 160000
Format:	DEC	Data size:	32-bit

Settings:

1. When P1.074.Y = 0 (CN2 encoder is the output source):
   (a) When P1.097 = 0, OA / OB pulse output refers to the value of P1.046. (Refer to Example 1.)
   (b) When P1.097 ≠ 0, OA / OB pulse output refers to the values of P1.046 and P1.097. (Refer to Example 2.)
2. When P1.074.Y = 1 (CN5 encoder is the output source) or 2 (CN1 pulse command is the output source):
   (a) When P1.097 = 0, OA / OB pulse output does not refer to the value of P1.046, but outputs according to the ratio of 1:1 instead.
   (b) When P1.097 ≠ 0, OA / OB pulse output refers to the values of P1.046 and P1.097. (Refer to Example 2.)

Example 1 (the value must be multiplied by 4 times the frequency):

When P1.097 = 0 and P1.046 = 2500,

OA / OB output is P1.046 multiplied by 4 times the frequency, which is 10,000 pulses.

Example 2 (the calculated value does not need to be multiplied by 4 times the frequency):

When P1.097 = 7 and P1.046 = 2500,

$$\text{OA / OB output} = \frac{2500}{7}$$

Note: the rotary motor outputs 2,500 pulses per seven revolutions; the linear motor outputs 2,500 pulses per seven meters.

P1.098	Disconnection detection protection (UVW) response time		Address: 01C4H 01C5H
Default:	0	Control mode:	All
Unit:	ms	Setting range:	0, 100 - 800
Format:	DEC	Data size:	16-bit

Settings:

When the disconnection detection protection (UVW) function is enabled (P2.065 [Bit 9] = 1), select the response time of the detection mode 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 range 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 - P1.100	Reserved

P1.101■	Analog monitor output voltage 1		Address: 01CAH 01CBH
Default:	0	Control mode:	All
Unit:	mV	Setting range:	-10000 to 10000
Format:	DEC	Data size:	16-bit

Settings:

When you set 6 for the monitor source for P0.003 [YX], then the analog monitor output voltage refers to the voltage value of P1.101.

P1.102■	Analog monitor output voltage 2		Address: 01CCH 01CDH
Default:	0	Control mode:	All
Unit:	mV	Setting range:	-10000 to 10000
Format:	DEC	Data size:	16-bit

Settings:

When you set 7 for the monitor source of P0.003 [YX], then the analog monitor output voltage refers to the voltage value of P1.102.

P1.103 - P1.110	Reserved

P1.111	Overspeed protection level		Address: 01DEH 01DFH
Default:	Maximum motor speed x 1.1	Control mode:	All
Unit:	Rotary motor: rpm Linear motor: mm/s	Setting range:	0 - 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 is triggered.

P2.xxx Extension parameters

P2.000	Position control gain		Address: 0200H 0201H
Default:	35	Control mode:	PT / PR
Unit:	rad/s	Setting range:	0 - 2047
Format:	DEC	Data size:	16-bit

Settings:

Increasing the position control gain can enhance the position response and reduce the position errors. If you set the value too high, it may cause vibration and noise.

P2.001	Position control gain rate of change		Address: 0202H 0203H
Default:	100	Control mode:	PT / PR
Unit:	%	Setting range:	10 - 500
Format:	DEC	Data size:	16-bit

Settings:

Adjust the rate of change for the position control gain according to the gain switching condition.

P2.002	Position feed forward gain		Address: 0204H 0205H
Default:	50	Control mode:	PT / PR
Unit:	%	Setting range:	0 - 100
Format:	DEC	Data size:	16-bit

Settings:

If the position control command changes position smoothly, increasing the gain value can reduce the position following errors. If it does not change smoothly, decreasing the gain value can reduce mechanical vibration. This gain parameter is disabled when the two dimensional control function is on (P2.094 [Bit 12] = 1).

P2.003	Position feed forward gain smoothing constant		Address: 0206H 0207H
Default:	5	Control mode:	PT / PR
Unit:	ms	Setting range:	2 - 100
Format:	DEC	Data size:	16-bit

Settings:

If the position control command changes position smoothly, decreasing the smoothing constant value can reduce the position following errors. If it does not change smoothly, increasing the smoothing constant value can reduce mechanical vibration.

P2.004	Speed control gain		Address: 0208H 0209H
Default:	500	Control mode:	All
Unit:	rad/s	Setting range:	0 - 8191
Format:	DEC	Data size:	16-bit

Settings:

Increasing the speed control gain can enhance the speed response. If you set the value too high, it may cause vibration and noise.

P2.005	Speed control gain rate of change		Address: 020AH 020BH
Default:	100	Control mode:	All
Unit:	%	Setting range:	10 - 500
Format:	DEC	Data size:	16-bit

Settings:

Adjust the rate of change for the speed control gain according to the gain switching condition.

P2.006	Speed integral compensation		Address: 020CH 020DH
Default:	100	Control mode:	All
Unit:	rad/s	Setting range:	0 - 1023
Format:	DEC	Data size:	16-bit

Settings:

Increasing the value of the integral speed control can enhance the speed response and reduce the deviation in speed control. 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:	All
Unit:	%	Setting range:	0 - 100
Format:	DEC	Data size:	16-bit

Settings:

If the speed control command changes speed smoothly, increasing the gain value can reduce the speed following errors. If it does not change smoothly, decreasing the gain value can reduce mechanical vibration.

P2.008■	Special parameter write-in function		Address: 0210H 0211H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 65535
Format:	DEC	Data size:	16-bit

Settings:

Special parameter write-in function:

Code	Function
10	Reset parameter (cycle the power after reset).
20	P4.010 is writable.
22	P4.011 - P4.021 are writable.
30, 35	Save Compare, Capture, and E-Cam data.
406	Enable forced DO mode.
400	When forced DO mode is enabled, switch back to the normal DO mode.

P2.009	DI response filter time		Address: 0212H 0213H
Default:	2	Control mode:	All
Unit:	ms	Setting range:	0 - 20
Format:	DEC	Data size:	16-bit

Settings:

When environmental interference is high, increasing this value can enhance the control stability.

If you set the value too high, it impacts the response time.

P2.010	DI1 functional planning		Address: 0214H 0215H
Default:	0x0101	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

- YX: input function selection

  Refer to Table 8.1.

- 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)

- U: reserved

When these parameters are modified, re-start the servo drive to ensure it functions normally. Use P3.006 to change the source for the digital signal, either through an external terminal block or with the communication parameter P4.007.

P2.011	DI2 functional planning		Address: 0216H 0217H
Default:	0x0104	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.012	DI3 functional planning		Address: 0218H 0219H
Default:	0x0116	Control mode:	All
Unit:	-	Setting range:	0 - 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:	0x0117	Control mode:	All
Unit:	-	Setting range:	0 - 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:	0x0102	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.015	DI6 functional planning		Address: 021EH 021FH
Default:	0x0022	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.016	DI7 functional planning		Address: 0220H 0221H
Default:	0x0023	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.017	DI8 functional planning		Address: 0222H 0223H
Default:	0x0021	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.018	DO1 functional planning		Address: 0224H 0225H
Default:	0x0101	Control mode:	All
Unit:	-	Setting range:	0 - 0x013F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

- YX: output function selection

  Refer to Table 8.2.

- 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)

- U: reserved

When these parameters are modified, re-start the servo drive to ensure it functions normally.

P2.019	DO2 functional planning		Address: 0226H 0227H
Default:	0x0103	Control mode:	All
Unit:	-	Setting range:	0 - 0x013F (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:	0x0109	Control mode:	All
Unit:	-	Setting range:	0 - 0x013F (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:	0x0105	Control mode:	All
Unit:	-	Setting range:	0 - 0x013F (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:	0x0007	Control mode:	All
Unit:	-	Setting range:	0 - 0x013F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.023	Notch filter frequency (1)		Address: 022EH 022FH
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 - 5000
Format:	DEC	Data size:	16-bit

Settings:

The first setting for resonance frequency. This function is disabled if P2.024 is 0. P2.043 and P2.044 are the second Notch filter parameters.

P2.024	Notch filter attenuation level (1)		Address: 0230H 0231H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 - 40
Format:	DEC	Data size:	16-bit

Settings:

The first Notch filter attenuation level. Set this parameter to 0 to disable the Notch filter. For example, an attenuation level of 5 indicates -5 dB.

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 - 100.0	0 ~ 1000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

Set the time constant for the low-pass filter for resonance suppression. Set this parameter to 0 to disable the low-pass filter.

P2.026	Anti-interference gain		Address: 0234H 0235H
Default:	0	Control mode:	All
Unit:	rad/s	Setting range:	0 - 1023
Format:	DEC	Data size:	16-bit

Settings:

Increasing this parameter can increase the damping of the speed loop and reduce the speed loop response. Setting the value of P2.026 to equal P2.006 is recommended. See the following for setting P2.026:

1. In Speed mode, increase the value of this parameter to reduce speed overshoot.
2. In Position mode, decrease the value of this parameter to reduce position overshoot.

Note: this gain parameter is disabled when the two dimensional control function is on (P2.094 [Bit 12] = 1).

P2.027	Gain switching condition and method selection		Address: 0236H 0237H
Default:	0x0000	Control mode:	Shown as follows
Unit:	-	Setting range:	0x0000 - 0x0018
Format:	HEX	Data size:	16-bit

Settings:

X	Gain switching condition	Y	Gain switching method	UZ	Reserved

- X: gain switching condition

X	Function	Control mode
0	Disable gain switching function	-
1	Signal of gain switching (DI.GAINUP) is on	All
2	In position control mode, position error is larger than P2.029	P
3	Frequency of Position command is larger than P2.029	P
4	Rotation speed of servo motor is faster than P2.029	All
5	Signal of gain switching (DI.GAINUP) is off	All
6	In position control mode, position error is smaller than P2.029	P
7	Frequency of Position command is smaller than P2.029	P
8	Rotation speed of servo motor is slower than P2.029	All

- Y: gain switching method

  0: gain rate switching

  1: integrator switching (P controller switches to PI controller)

Value	Control mode P	Control mode S	Gain switching
0	P2.000 x 100% P2.004 x 100%	P2.004 x 100%	Before switching
	P2.000 x P2.001 P2.004 x P2.005	P2.004 x P2.005	After switching
1	P2.006 x 0%; P2.026 x 0%		Before switching
	P2.006 x 100%; P2.026 x 100%		After switching

- UZ: reserved

P2.028	**Gain switching time constant**		**Address: 0238H 0239H**
Default:	10	Control mode:	All
Unit:	ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

Controls the smoothing gain. Set this parameter to 0 to disable this function.

P2.029	Gain switching condition		Address: 023AH 023BH
Default:	16777216	Control mode:	All
Unit:	pulse; Kpps; rpm	Setting range:	0 - 50331648
Format:	DEC	Data size:	32-bit

Settings:

You determine the gain switching (pulse error, Kpps, rpm) by the selection of gain switching condition (P2.027).

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 servo to Servo On state.
2 - 4	Reserved
5	This setting does not retain its value after powering off. When there is no need to save the data, this setting can avoid continually writing the parameters into EEPROM and shortening the lifetime of the EEPROM. You must set this parameter when using communication control.
6	This setting enables command simulation mode. In this mode, use the DI/O Servo On in ASDA-Soft as both the external Servo On signal and the force Servo On of the PR mode in ASDA-Soft cannot work. Also, the DSP Error (variable 0x6F) is read as 0 and P0.001 only shows the external error code (positive / negative limit, emergency stop, etc). DO.SRDY is on, commands are accepted in each mode and can be observed through the scope software, but the motor does not operate. Use this mode to examine command accuracy.
8	Back up all current parameter values to EEPROM, so that the values are retained after cycling the power. The panel displays 'to.rom' during execution. This feature can also be executed when servo is in the Servo On state.
-1, -5, -6,	Disable the functions of 1, 5, and 6.
7, -2 to -4, -7, -8	Reserved

Note: set the value to 0 during normal operation. The value returns to 0 automatically after cycling the power.

P2.031	Bandwidth response level		Address: 023EH 023FH
Default:	19	Control mode:	All
Unit:	-	Setting range:	1 - 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:	0 - 4
Format:	HEX	Data size:	16-bit

8

Settings:

The servo drive provides three 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 two dimensional 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		

Note: when the two dimensional control function is disabled (P2.094 [Bit 12] = 0), the effect of gain adjustment mode 3 is equivalent to gain adjustment mode 2, so setting P2.089 is invalid in that scenario.

P2.033	Reserved

P2.034	Speed command error warning		Address: 0244H 0245H
Default:	5000	Control mode:	S / Sz
Unit:	rpm	Setting range:	1 - 30000 (rotary motor) 1 - 15999 (linear motor)
Format:	DEC	Data size:	16-bit

Settings:

In Speed mode, this parameter sets the acceptable difference between the command speed and the feedback speed. If the difference is greater than this value, AL007 occurs.

P2.035	Excessive deviation of Position command warning		Address: 0246H 0247H
Default:	50331648	Control mode:	PT / PR
Unit:	pulse	Setting range:	1 - 1677721600
Format:	DEC	Data size:	32-bit

Settings:

In Position mode, this parameter sets the acceptable difference between the command position and the feedback position. If the difference is greater than this value, AL009 occurs.

P2.036	DI9 functional planning		Address: 0248H 0249H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.037	DI10 functional planning		Address: 024AH 024BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010.

P2.038	VDI11 functional planning		Address: 024CH 024DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.010. Virtual digital input is useful when triggering communication or when DI points are insufficient. You can set the DI to be used as soon as power is on when the contact would be normally closed for virtual digital input, such as Servo On.

P2.039	VDI12 functional planning		Address: 024EH 024FH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.038.

P2.040	VDI13 functional planning		Address: 0250H 0251H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 0x015F (last two codes are DI codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.038.

P2.041	DO6 functional planning		Address: 0252H 0253H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 0x013F (last two codes are DO codes)
Format:	HEX	Data size:	16-bit

Settings:

Refer to the description of P2.018.

P2.042	Reserved

P2.043	Notch filter frequency (2)		Address: 0256H 0257H
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 - 5000
Format:	DEC	Data size:	16-bit

Settings:

The second setting for resonance frequency. This function is disabled if P2.044 is 0.

P2.044	Notch filter attenuation level (2)		Address: 0258H 0259H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 - 40
Format:	DEC	Data size:	16-bit

Settings:

The second Notch filter attenuation level. A value of 5 indicates -5 dB. Set this parameter to 0 to disable the Notch filter.

P2.045	Notch filter frequency (3)		Address: 025AH 025BH
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 - 5000
Format:	DEC	Data size:	16-bit

Settings:

The third setting for resonance frequency. This function is disabled if P2.046 is 0.

P2.046	Notch filter attenuation level (3)		Address: 025CH 025DH
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 - 40
Format:	DEC	Data size:	16-bit

Settings:

The third Notch filter attenuation level. A value of 5 indicates -5 dB. Set this parameter to 0 to disable the 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

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Settings:

X	Auto resonance suppression function	Z	Fixed resonance suppression parameter
Y	Fixed resonance suppression parameter	U	Reserved

■ X: auto resonance suppression function

0: disable 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 resonance suppression points in 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 in 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 resonance suppression points in EEPROM (non-volatile memory for parameters). In this mode, the searching cycle continues until the 5 sets of resonance suppression parameters are set, 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 are 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 in 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 according to the following conditions: 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, set the Notch filters to use manual resonance suppression.

Bit	3	2	1	0

Bit	Function	Description
0	Notch 1 auto / manual setting	0: auto resonance suppression 1: manually set the first set of resonance suppression parameters
1	Notch 2 auto / manual setting	0: auto resonance suppression 1: manually set the second set of resonance suppression parameters
2	Notch 3 auto / manual setting	0: auto resonance suppression 1: manually set the third set of resonance suppression parameters
3	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, set the Notch filters to use manual resonance suppression.

Bit	3	2	1	0

Bit	Function	Description
0	Notch 5 auto / manual setting	0: auto resonance suppression 1: manually set the fifth set of resonance suppression parameters

Example: if P2.047 = 0x0021, and the auto resonance suppression function is enabled, 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 - 1000
Format:	DEC	Data size:	16-bit

Settings:

The smaller this parameter value, the more sensitive it is to resonance. If P2.048 is larger, the resonance sensitivity is lower; on the other hand, if P2.048 is smaller, the resonance sensitivity is higher.

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 - 100.0	0 - 1000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

Set the filter for speed estimation. Adjusting this parameter can improve the extent of the speed jitter, but when the value is too high, the phase margin affecting the speed loop decreases which makes the system unstable.

P2.050	Pulse Clear mode		Address: 0264H 0265H
Default:	0x0000	Control mode:	PT
Unit:	-	Setting range:	0 - 1
Format:	HEX	Data size:	16-bit

Settings:

Refer to Table 8.1 for digital input. Set digital input (DI) as CCLR to enable the Pulse Clear function.

If this DI is on, the accumulated position error is reset to 0.

0: DI.CCLR is rising-edge triggered.

1: DI.CCLR is level triggered.

P2.051	Reserved

P2.052▲	Indexing coordinates scale		Address: 0268H 0269H
Default:	1000000000	Control mode:	All
Unit:	PUU	Setting range:	0 - 1000000000
Format:	DEC	Data size:	32-bit

Settings:

Set the scale of the indexing coordinates, indexing command position, and indexing feedback position. If the value is too small, it may cause errors in the indexing coordinates. The ranges of values for P2.052 are:

P2.052 > 1.05 x Maximum motor speed (rpm) x $\frac{16777216}{60000}$ x $\frac{P1.045}{P1.044}$

P2.052 > 146.8 x Maximum motor speed (rpm) x $\frac{P1.045}{P1.044}$

P2.053	Position integral compensation		Address: 026AH 026BH
Default:	0	Control mode:	All
Unit:	rad/s	Setting range:	0 - 1023
Format:	DEC	Data size:	16-bit

Settings:

Increase the position control integral compensation to reduce the position steady-state errors. If the value is too high, it may cause position overshoot and noise.

P2.054▲	Synchronous speed control gain		Address: 026CH 026DH
Default:	0	Control mode:	All
Unit:	rad/s	Setting range:	0 - 8191
Format:	DEC	Data size:	16-bit

Settings:

Increase the synchronous speed control gain to enhance the speed following between two motors. If the value is too high, it may cause vibration and noise.

P2.055▲	Synchronous speed integral compensation		Address: 026EH 026FH
Default:	0	Control mode:	All
Unit:	rad/s	Setting range:	0 - 1023
Format:	DEC	Data size:	16-bit

Settings:

Increase the synchronous speed integral compensation to enhance the speed following and reduce the speed errors between two motors. If the value is too high, it may cause vibration and noise.

P2.056▲	Synchronous position integral compensation		Address: 0270H 0271H
Default:	0	Control mode:	All
Unit:	rad/s	Setting range:	0 - 1023
Format:	DEC	Data size:	16-bit

Settings:

Increase the synchronous speed integral compensation to enhance the speed following and reduce the speed errors between two motors. If the value is too high, it may cause vibration and noise. It is recommended that you set this value to the same value as P2.006.

P2.057▲	Synchronous control bandwidth		Address: 0272H 0273H
Default:	0	Control mode:	All
Unit:	Hz	Setting range:	0 - 1023
Format:	DEC	Data size:	16-bit

Settings:

If you are unsure about setting P2.054 - P2.056, set the value of synchronous control bandwidth instead so that the value corresponds to P2.054 - P2.056.

1. When the synchronous control bandwidth is greater than the servo bandwidth, the synchronous following is better.
2. When the servo bandwidth is greater than the synchronous control bandwidth, the single-axis motion following is better.

When the servo bandwidth plus the synchronous control bandwidth (P2.057) is greater than the system's allowable bandwidth, however, it causes system resonance.

Note: when increasing the bandwidth of both speed loop and synchronous control, the response of P2.025 must be faster than the setting of both bandwidths. Therefore, decrease P2.025 as needed.

P2.058	Synchronous speed error low-pass filter		Address: 0274H 0275H
Default:	0	Control mode:	All
Unit:	0.1 ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit
Example:	15 = 1.5 ms		

Settings:

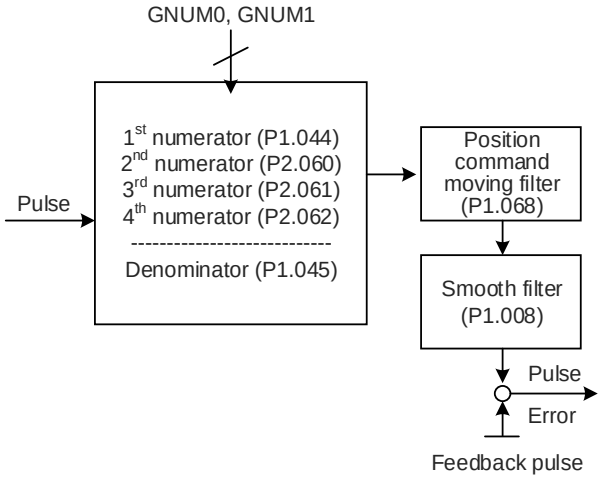
When the synchronous control is affected by low resolution, meaning that noise (less sharp and rough sound) is generated, use low-pass filter suppression. This filter must be faster than the synchronous control bandwidth.

P2.059	Reserved

P2.060	E-Gear ratio (numerator) (N2)		Address: 0278H 0279H
Default:	16777216	Control mode:	PT
Unit:	pulse	Setting range:	1 to (2^{29}-1)
Format:	DEC	Data size:	32-bit

Settings:

The numerator of the E-Gear ratio can be selected with DI.GNUM0 and DI.GNUM1 (refer to Table 8.1). If both DI.GNUM0 and DI.GNUM1 are not defined, P1.044 is the default numerator of the E-Gear ratio. Switch DI.GNUM0 and DI.GNUM1 only when the servo is stopped in order to avoid mechanical vibration.



P2.061	E-Gear ratio (numerator) (N3)		Address: 027AH 027BH
Default:	16777216	Control mode:	PT
Unit:	pulse	Setting range:	1 to (2^{29}-1)
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P2.060.

P2.062	E-Gear ratio (numerator) (N4)		Address: 027CH 027DH
Default:	16777216	Control mode:	PT
Unit:	pulse	Setting range:	1 to (2^{29}-1)
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P2.060.

P2.063 - P2.064	Reserved

P2.065	Special bit register		Address: 0282H 0283H
Default:	0	Control mode:	PT / PR / S / Sz
Unit:	-	Setting range:	0 - 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 0 - Bit 2, Bit 4, Bit 5, Bit 7, and Bit 14: reserved; set to 0.

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Bit 3: set the method for regenerative energy consumption.

0: determined by the servo's internal algorithm.

1: determined by the DC bus voltage.

Bit 6: in PT mode, set the pulse error (pulse frequency is too high) protection function.

0: enable the pulse error protection function.

1: disable the pulse error protection function.

Bit 8: U, V, W wiring error detection function.

1: enable the U, V, W wiring error detection function.

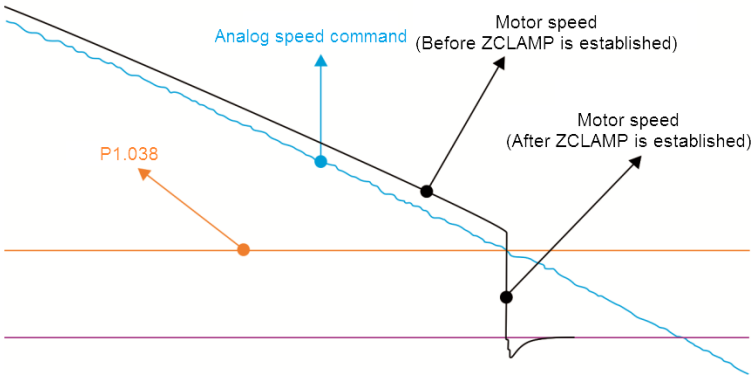
Bit 9: U, V, W wiring cut-off detection function.

1: enable the U, V, W wiring cut-off detection function.

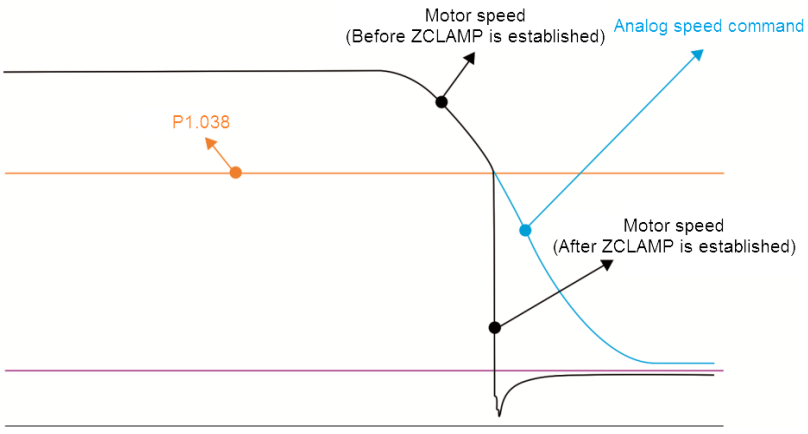
Bit 10: ZCLAMP function selection. The ZCLAMP function is enabled when the following conditions are met.

Condition 1: Speed mode; Condition 2: DI.ZCLAMP is on; Condition 3: motor speed is slower than the value of P1.038.

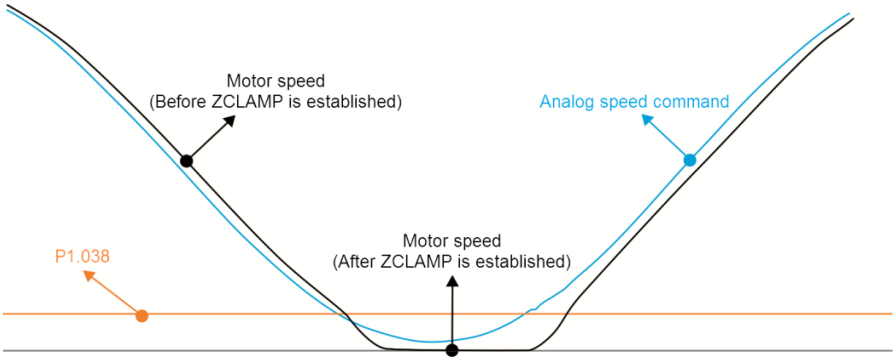
0: command source is the analog voltage. The ZCLAMP function uses the analog Speed command without acceleration / deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.

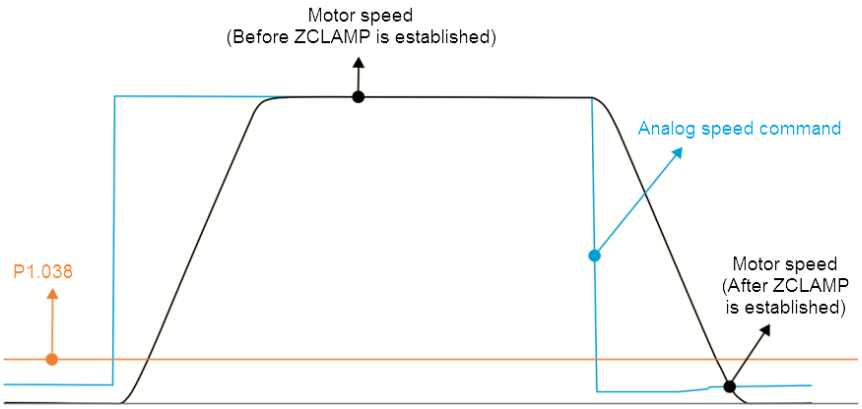


0: command source is the internal register. The ZCLAMP function uses the register Speed command with acceleration / deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.

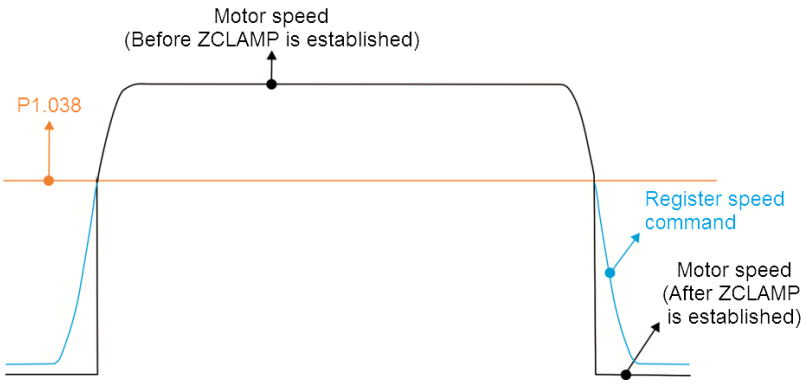


1: command source is the analog voltage. The ZCLAMP function uses the analog Speed command without acceleration / deceleration to determine if this function should be enabled. When ZCLAMP conditions are met, the motor speed decelerates to 0 rpm by S-curve deceleration. If ZCLAMP conditions are not met, the motor follows the analog Speed command through the S-curve.





1: command source is the internal register. The ZCLAMP function uses the register Speed command with acceleration / deceleration to determine if this function should be enabled. When ZCLAMP conditions are met, the motor speed becomes 0 rpm.



Bit 11: enable pulse inhibit function.

0: disable PL / NL pulse inhibit function. In PT mode, the external Position pulse command is input to the servo drive under any condition.

1: enable PL / NL pulse inhibit function. In PT mode, if PL exists, the external PL pulse is not input to the servo drive and the NL pulse command is accepted. In PT mode, if NL exists, the external NL pulse is not input to the servo drive and the PL pulse command is accepted.

Note: in DMCNET mode, if both PL and NL exist, neither pulse command is input to the servo drive.

Bit 12: loss phase detection function.

0: enable loss phase (AL022) detection.

1: disable loss phase (AL022) detection.

Bit 13: encoder output error detection function.

0: enable encoder output error (AL018) detection function.

1: disable encoder output error (AL018) detection function.

Bit 15: friction compensation mode selection.

0: if the speed is slower than the value of P1.038, the compensation value remains unchanged.

1: if the speed is slower than the value of P1.038, the compensation value becomes 0.

P2.066	Special bit register 2		Address: 0284H 0285H
Default:	0x0020	Control mode:	PT / PR / S / Sz
Unit:	-	Setting range:	0x0000 - 0x182F
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 0 - 1, Bit 3, Bit 6 - 8, Bit 10 - 15: reserved.

Bit 2: cancel low-voltage error latch function.

0: enable the low-voltage error latch function; the error is not cleared automatically.

1: disable the low-voltage error latch function; the error is cleared automatically.

Bit 4: disable AL044 detection (servo function overload warning).

0: enable AL044 detection.

1: disable AL044 detection.

Bit 5: enable AL041 detection (linear scale communication is cut off) for CN5 AB phase pulse disconnection.

0: disable AL041 detection.

1: enable AL041 detection.

Bit 9: set AL003 as an alarm or a warning.

0: set AL003 as WARN.

1: set AL003 as ALM.

P2.067	Reserved

P2.068	Following error compensation switch		Address: 0288H 0289H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0x00002101
Format:	HEX	Data size:	32-bit

Settings:

D C B A

U Z Y X

A	Reserved	X	Following error compensation switch
B	Reserved	Y	Reserved
C	Reserved	Z	DI.STP triggering method
D	Reserved	U	Reserved
h	High bit	L	Low bit

- X: following error compensation switch (functions under the condition of P1.036 > 1)

  0: disable following error compensation

  1: enable following error compensation

- Y: reserved

- Z: DI.STP triggering method

  0: DI.STP is rising-edge triggered

  1: DI.STP is level triggered

- U: reserved

P2.069●	Absolute encoder		Address: 028AH 028BH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 1
Format:	HEX	Data size:	16-bit

Settings:

U Z Y X

X	Set the operation mode	Z	Index coordinates function setting when overflow occurs
Y	Pulse command setting when absolute position is lost	U	Reserved

- X: set the operation mode

  0: incremental type; an absolute type motor can be operated as an incremental type.

  1: absolute type. This setting is only applicable to an absolute type motor. If it is used on 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*[1]: index coordinates function setting when overflow occurs

  0: index coordinates are lost when an overflow occurs.

  1: index coordinates are not affected by overflow, but absolute coordinates are not retained (AL289 and AL062 do not function).

- U: reserved

Note:

1. The current firmware does not have this feature. It is expected to have this feature added in the near future.
2. Changes to this setting are effective only after power is cycled to the servo drive.

P2.070	Read data selection		Address: 028CH 028DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x00 - 0x07
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 0: DI/DO data unit setting

0: PUU

1: pulse

Bit 1: communication data unit setting

0: PUU

1: pulse

Bit 2: overflow warning setting

0: overflow warning, including AL289 (PUU) and AL062 (pulse)

1: no overflow warning

Bit 3 - Bit 15: reserved; set to 0.

P2.071■	Absolute position homing		Address: 028EH 028FH
Default:	0x0	Control mode:	All
Unit:	-	Setting range:	0 - 1
Format:	HEX	Data size:	16-bit

Settings:

When P2.071 is 1, the current absolute position of the encoder is the home position.

Clearing this function is enabled by setting P2.008 to 271 and P2.069.X to 1.

P2.072	Reserved

P2.073	E-Cam phase alignment - operation		Address: 0292H 0293H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0x5F3F6F5F
Format:	HEX	Data size:	32-bit

Settings:

D C B A

UZ YX

BA	PR number	YX	Range of filter (0 - 95%)
DC	Masking range (0 - 95%)	UZ	Maximum allowable correction rate (0 - 100%)
h	High bit	L	Low bit

■ YX: range of filter (0 - 95%)

When DI.ALGN is triggered, the E-Cam phase alignment function is enabled. The system detects the current E-Cam position. When the difference between the current E-Cam position and its previous alignment position is less than the parameter's range as a percentage, the filter function is enabled. Otherwise, the system uses the new position to do the alignment.

YX	Description
00	Filter disabled
01 - 5F	If | Error | ≤ (1 - YX)%, then the filter is enabled

Note: using the filter allows the alignment to be more stable and reduces any position errors caused by DI noise, so the operation can be smoother.

■ UZ: maximum allowable correction rate (0 - 100%)

When phase alignment is enabled, the limitation of the maximum allowable correction rate (C) is defined as ｜C｜≤ (P5.084/P5.083) x P2.073.UZ %

Note: when the alignment error is too large, correcting this error once may cause motor vibration or overloading. Using this parameter can divide the phase alignment into several stages to smooth the process, but it may need more time to complete the phase alignment.

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- BA: PR number (PR#0 - PR#99)

  After each alignment, any shortage of pulse numbers from the slave axis is stored in a specified PR. This PR can compensate for the slave position at the appropriate timing point. If BA is set to 0, any shortage of pulse numbers is not stored in PR.

  Note: the format of this parameter is HEX. Thus, to set PR#11, write 0B to BA.

- DC: masking range (0 - 95%)

  When DI.ALGN is triggered, the next alignment action is allowed only after the increasing pulses of the master axis are greater than the masking distance (M).

  M ≥ (P5.084/P5.083) x P2.073.DC %

  Note: this masking function only allows forward pulse input and does not work for reverse pulse input.

P2.074	E-Cam phase alignment - DI delay time		Address: 0294H 0295H
Default:	0.000	Control mode:	PR
Unit:	ms (minimum scale is μs)	Setting range:	-25.000 to +25.000 (includes 3 decimal places)
Format:	DEC	Data size:	16-bit

Settings:

This parameter offsets the alignment target to resolve DI and sensor delays. The setting works as follows:

P2.074 = P2.009 (DI response filter time) + sensor's delay time

P2.075■	E-Cam phase alignment - target position		Address: 0296H 0297H
Default:	0	Control mode:	PR
Unit:	Pulse unit of master axis	Setting range:	0 to (P5.084 / P5.083) - 1
Format:	DEC	Data size:	32-bit

Settings:

Set the alignment target position for E-Cam alignment; unit: pulse unit of master axis.

Note: when the input value is within the setting range, but if changes in the value of P5.084 or P5.083 causes the value to exceed the range, this parameter is automatically reset to 0.

P2.076■	E-Cam phase alignment - control switch		Address: 0298H 0299H
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0x6FF7
Format:	HEX	Data size:	16-bit

Settings:

X	E-Cam alignment control	UZ	Pulse data when master axis performs continuous forward / reverse running or JOG function
Y	Filter intensity (0 - F)	-	-

■ X: E-Cam alignment control

Bit	3	2	1	0

Bit	Function	Description
0	Enable alignment	Set this bit to 0 to disable this function. Set this bit to 1 to enable this function. If enabled, the E-Cam phase alignment is executed when DI.ALGN is on.
1	Trigger PR immediately	The E-Cam displacement value is stored in the PR data location specified by P2.073.BA. Set this bit to 1 to trigger this PR command immediately. Set this bit to 0 and it does not trigger this PR command immediately. Use the PR command (P5.088.BA) when E-Cam disengages to execute phase alignment.
2	Position of the mark	Set this bit to 0 if the mark is on a non-compensated motion axis, as the position of the mark is not affected when aligning. Set this bit to 1 if the mark is on a compensated motion axis, as the position of the mark is affected when aligning.
3	Reserved	-

■ Y: filter intensity (0 - F)

Indicates average of 2^(value). Set to 0 to disable the filter. When the value of Y increases, the correction is slower which can avoid large amounts of correction during E-Cam adjustment. This can also avoid disturbances caused by sensor noise for a smoother operation. Setting P2.076.Y too high causes the alignment to not work properly. The recommended value is 3.

Example:

When the filter intensity is set to 3, the actual filter intensity = 2^3 = 8, which means that after capturing 8 times of error values, the 8 values are averaged for the correction value of the alignment.

■ UZ: alignment forward direction allowable rate (0 - 100%)

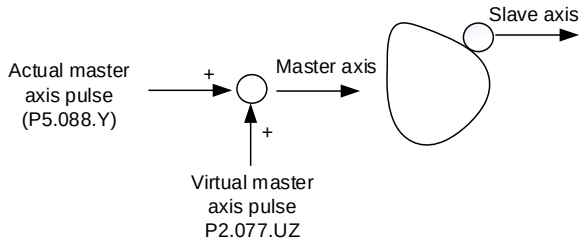
Setting value	Alignment direction	Setting value	Alignment direction
0	Backward alignment only	80	Forward 80%, backward 20%
30	Forward 30%, backward 70%	≥ 100	Forward alignment only
50	Alignment with the shortest distance	-	-

P2.077■	**E-Cam master axis - pulse masking and virtual pulse**		**Address: 029AH 029BH**
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0xFF7D
Format:	HEX	Data size:	16-bit

Settings:

X	Pulse masking function of master axis / pulse input method of master axis	UZ	Pulse data when master axis performs continuous forward / reverse running or JOG function
Y	Masking pulse adjusting lead	-	-

■ X: pulse masking function of master axis / pulse input method of master axis



X	Function	Actual master axis pulse	Virtual master axis pulse	Description
0	Function disabled	Receive actual master axis pulse	Disabled	Slave axis is driven by the actual master axis pulse.
1	Master axis pulse masked	Masked		Slave axis stops operating, but the masked master pulse continues to be stored in the internal variable.
2	Continuous forward running		Enable	Command source is the virtual pulse frequency (unit: Kpps) set by P2.077.UZ. This function continues to operate. To stop the virtual pulse, set X to 1.
3	Continuous reverse running			
4	Forward JOG			Command source is the virtual pulse number (unit: pulse) set by P2.077.UZ. This function only refers to the pulse number set by P2.077.UZ.
5	Reverse JOG			
6 - 8	-	-	-	-
9	Master axis pulse masked	Receive actual master axis pulse	Disabled	Slave axis is driven by the actual master axis pulse and the master axis pulse continues to be stored in the internal variable.
A	Continuous forward running		Enable	Command source is the frequency transmitted by the actual master axis (P5.088.Y) plus the virtual pulse frequency (unit: Kpps) set by P2.077.UZ. This function continues to operate. To stop the virtual pulse, set X to 9.
B	Continuous reverse running			
C	Forward JOG			Command source is the pulse transmitted by the actual master axis (P5.088.Y) plus the virtual pulse number (unit: pulse) set by P2.077.UZ. This function is often used for dynamic adjustment.
D	Reverse JOG			

■ Y: masking pulse / virtual pulse adjusting initial lead setting

Y	Function	Description
0	Function disabled	Virtual pulse number is not written to P5.087 (initial lead).
0→1	Write the lead	Write the virtual pulse number to P5.087 (initial lead).
0→2	Write to ROM	Write the virtual pulse number to P5.087 (initial lead) and also write to EEPROM.
0→3		
0→4	Plus one cycle	Write the virtual pulse number plus the pulse number of one cycle (P5.084 / P5.083) to P5.087 (initial lead).
0→5		
0→6	Plus one cycle and write to ROM	Write the virtual pulse number plus the pulse number of one cycle (P5.084 / P5.083) to P5.087 (initial lead) and also write to EEPROM.
0→7		
8 - 15	Reserved	-

Example:

Initial lead pulse P5.087 = 2000; pulse number of one cycle is 5000.

1. Virtual pulse number is 255. Set P2.077.Y to 1, then P5.087 = 2000 + 255 = 2255.
2. Virtual pulse number is 255. Set P2.077.Y to 4, then P5.087 = 2000 + 255 + 5000 = 7255.
3. Virtual pulse number is -2550. Set P2.077.Y to 1, then P5.087 = 2000 - 2550 + 5000 = 4450.

■ UZ: pulse data when master axis performs continuous forward / reverse running or JOG function.

Example:

Initiate masking of the actual pulse of master axis ▶ UZYX = 0x0001

Continuous forward running of master axis at 20 Kpps ▶ UZYX = 0x1402

Continuous reverse running of master axis at 32 Kpps ▶ UZYX = 0x2003

Forward JOG of master axis for 255 pulses ▶ UZYX = 0xFF04

Reverse JOG of master axis for 18 pulses ▶ UZYX = 0x1205

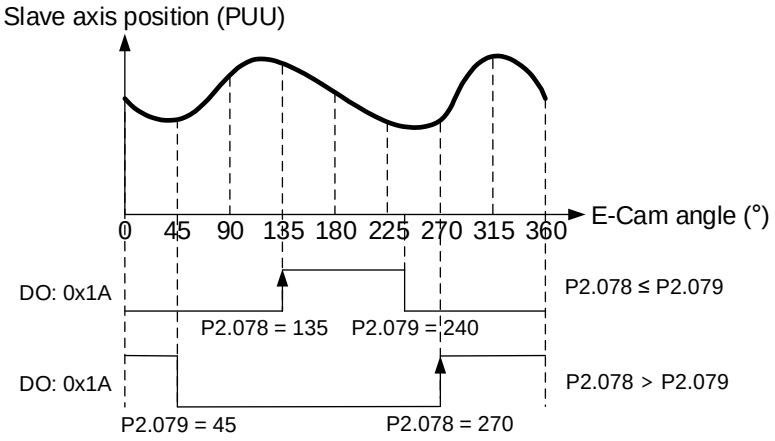
Complete and adjust for lead ▶ UZYX = 0x0020 (write to EEPROM)

Disable this function ▶ UZYX = 0x0000

P2.078	**E-Cam: DO.CAM_AREA#2 rising-edge phase**		**Address: 029CH 029DH**
Default:	270	Control mode:	PR
Unit:	degree	Setting range:	0 - 360
Format:	DEC	Data size:	16-bit

Settings:

See the correlation between DO.CAM_AREA 2 and the parameters in the following figure. When E-Cam is not engaged, this signal is always off.



P2.079	E-Cam: DO.CAM_AREA#2 falling-edge phase		Address: 029EH 029FH
Default:	360	Control mode:	PR
Unit:	degree	Setting range:	0 - 360
Format:	DEC	Data size:	16-bit

Settings:

Refer to P2.078 for the correlation between DO.CAM_AREA 2 and the parameters.

P2.080 - P2.087	Reserved

P2.088	Third-party motor special bit register		Address: 02B0H 02B1H
Default:	0x0000	Control mode:	PT / PR / S / Sz
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 - Bit 3	Reserved	-
Bit 4	Position pulse input is prohibited during initial magnetic field detection	0: receive position pulse normally 1: position pulse input is prohibited until the initial magnetic field detection is complete
Bit 5 - Bit 15	Reserved	-

P2.089	Command response gain		Address: 02B2H 02B3H
Default:	25	Control mode:	PT / PR
Unit:	rad/s	Setting range:	1 - 2000
Format:	DEC	Data size:	16-bit

Settings:

Increasing this gain speeds up the responsiveness of the Position command and shortens the tuning time, but when the gain is too large, it causes position overshoot which leads to machine jitter.

Note: enable the two dimensional control function (P2.094 [Bit 12] = 1) before adjusting this parameter.

P2.090 - P2.093	Reserved

P2.094▲	Special bit register 3		Address: 02BCH 02BDH
Default:	0x1000	Control mode:	PT / PR / S / Sz
Unit:	-	Setting range:	0x0000 - 0xF3A6
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 15 - 13	Reserved	-
Bit 12	Two dimensional control function	0: disable two dimensional control function 1: enable two dimensional control function
Bit 11 - 10	Reserved	-
Bit 9	Second set of vibration elimination	0: disable second set of vibration elimination 1: enable second set of vibration elimination (P1.092 - P1.094) Vibration elimination takes effect only when the two dimensional control function P2.094 [Bit 12] is enabled.
Bit 8	First set of vibration elimination	0: disable first set of vibration elimination 1: enable first set of vibration elimination (P1.089 - P1.091) Vibration elimination takes effect only when the two dimensional control function P2.094 [Bit 12] is enabled.
Bit 7 - 6	Reserved	-
Bit 5	Cancel AL016 IGBT overheat alarm	0: enable AL016 IGBT overheat alarm 1: disable AL016 IGBT overheat alarm
Bit 4	Dynamic brake options	0: disable new dynamic brake 1: enable new dynamic brake and force use the DC Bus voltage to determine the timing of regenerative energy consumption
Bit 3 - 0	Reserved	-

P2.095	Notch filter bandwidth (1)		Address: 02BEH 02BFH
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 - 10
Format:	DEC	Data size:	16-bit

Settings:

The first value of resonance width. 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 bandwidth (2)		Address: 02C0H 02C1H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 - 10
Format:	DEC	Data size:	16-bit

Settings:

The second value of resonance width. 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 bandwidth (3)		Address: 02C2H 02C3H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 - 10
Format:	DEC	Data size:	16-bit

Settings:

The third value of resonance width. 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 frequency (4)		Address: 02C4H 02C5H
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 - 5000
Format:	DEC	Data size:	16-bit

Settings:

The fourth value of resonance frequency. 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 attenuation level (4)		Address: 02C6H 02C7H
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 - 40
Format:	DEC	Data size:	16-bit

Settings:

The fourth Notch filter attenuation level. Set this parameter to 0 to disable the Notch filter. For example, if you set the attenuation level to 5, then the value is -5 dB.

P2.100	Notch filter bandwidth (4)		Address: 02C8H 02C9H
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 - 10
Format:	DEC	Data size:	16-bit

Settings:

The fourth value of resonance width. 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 frequency (5)		Address: 02CAH 02CBH
Default:	1000	Control mode:	All
Unit:	Hz	Setting range:	50 - 5000
Format:	DEC	Data size:	16-bit

Settings:

The fifth value of resonance frequency. 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 attenuation level (5)		Address: 02CCH 02CDH
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0 - 40
Format:	DEC	Data size:	16-bit

Settings:

The fifth Notch filter attenuation level. Set this parameter to 0 to disable the Notch filter. For example, if you set the attenuation level to 5, then the value is -5 dB.

P2.103	Notch filter bandwidth (5)		Address: 02CEH 02CFH
Default:	5	Control mode:	All
Unit:	-	Setting range:	1 - 10
Format:	DEC	Data size:	16-bit

Settings:

The fifth value of resonance width. 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	P/PI torque switching command condition		Address: 02D0H 02D1H
Default:	200	Control mode:	PT / PR / S / Sz
Unit:	%	Setting range:	1 - 800
Format:	DEC	Data size:	16-bit

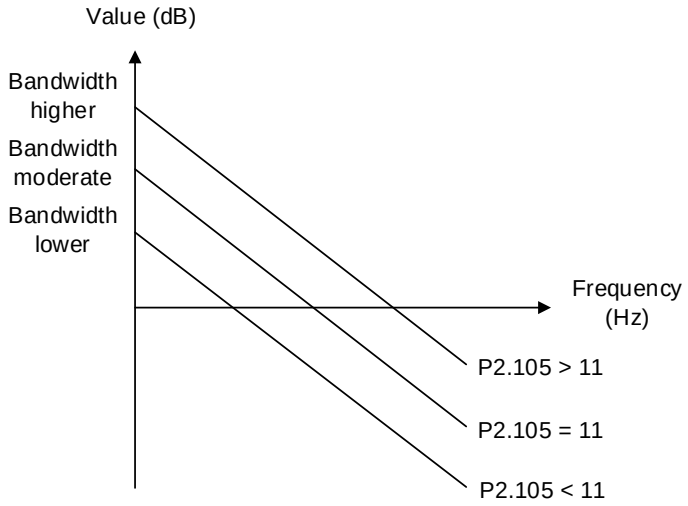
Settings:

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:	PT / PR
Unit:	-	Setting range:	1 - 21
Format:	DEC	Data size:	16-bit

Settings:

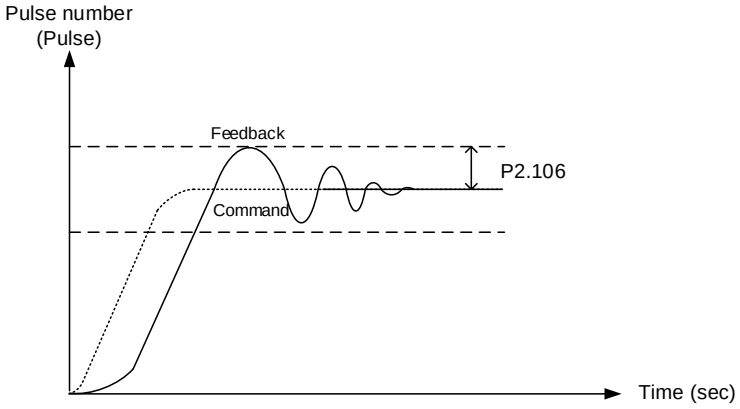
Use this parameter to adjust the bandwidth when auto-tuning. If the value is larger, the bandwidth after auto-tuning is higher, but if the bandwidth margin is insufficient, it may cause machine jitter. If the value is too low, the bandwidth after auto-tuning is lower, but the response is slower.



P2.106	Automatic gain adjustment level 2		Address: 02D4H 02D5H
Default:	2000	Control mode:	PT / PR
Unit:	Pulse number	Setting range:	1 - 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 for either the user or the machine. If the value is larger, the maximum overshoot allowed by auto-tuning is greater, but the response is faster. If the value is smaller, the maximum overshoot allowed by auto-tuning is smaller, but the response is slower.



P2.107 - P2.111	Reserved

P2.112▲	Special bit register 4		Address: 02E0H 02E1H
Default:	0x0008	Control mode:	PT / PR / S / Sz
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

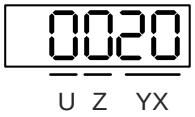
Bit	Function	Description
Bit 15 - 4	Reserved	-
Bit 3	Auto gain adjustment mode	0: reserved 1: cycle adjustment
Bit 2	Reserved	-
Bit 1	Enable AL089	0: disable AL089 1: enable AL089
Bit 0	Reserved	-

8

P3.xxx Communication parameters

P3.000●	Address		Address: 0300H 0301H
Default:	0x007F	Control mode:	All
Unit:	-	Setting range:	0x0001 - 0x007F
Format:	HEX	Data size:	16-bit

Settings:



YX	Communication address setting	UZ	Reserved

When using RS-485 to communicate, one servo drive can set only one address. Setting more than one addresses causes abnormal communications.

This address represents the absolute address of the servo drive in the communication network. It is applicable to RS-485, CANopen, and DMCNET. When the communication address of MODBUS is 0xFF, the servo drive automatically receives and replies the data regardless of the address, but P3.000 cannot be set to 0xFF.

P3.001●	Transmission speed		Address: 0302H 0303H
Default:	0x0203	Control mode:	All
Unit:	-	Setting range:	0x000 - 0x3405
Format:	HEX	Data size:	16-bit

Settings:

Transmission speed is divided into U, Z, Y, and X (hexadecimal):

	U	Z	Y	X
Communication port	DMCNET	CANopen / DMCNET	-	RS-485
Range	0 - 3	0 - 4	0	0 - 5

■ Definition of X value

0: 4800 bps	1: 9600 bps	2: 19200 bps
3: 38400 bps	4: 57600 bps	5: 115200 bps

■ Definition of Z value[*3]

0: 125 K bps	1: 250 K bps	2: 500 K bps
3: 800 K bps	4: 1.0 M bps	-

■ Definition of U value

0: use Delta's controller, such as PLC or HMI
3: use Delta's motion card

Note:

1. If this parameter is set through CANopen, only Z can be set and the others remain unchanged.
2. The communication speed of USB is set at 1.0 M bps and cannot be changed.
3. After the Z value is set, cycle the power to take effect.

P3.002	Communication protocol		Address: 0304H 0305H
Default:	0x0006	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0008
Format:	HEX	Data size:	16-bit

Settings:

Definition of each value:

0: 7, N, 2 (MODBUS, ASCII)	1: 7, E, 1 (MODBUS, ASCII)	2: 7, O, 1 (MODBUS, ASCII)
3: 8, N, 2 (MODBUS, ASCII)	4: 8, E, 1 (MODBUS, ASCII)	5: 8, O, 1 (MODBUS, ASCII)
6: 8, N, 2 (MODBUS, RTU)	7: 8, E, 1 (MODBUS, RTU)	8: 8, O, 1 (MODBUS, RTU)

P3.003	Communication error handling		Address: 0306H 0307H
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0x0001
Format:	HEX	Data size:	16-bit

Settings:

Definition of each value:

0: display warning and let motor continue operating.

1: display warning and let motor decelerate to a stop. Deceleration time is set in P5.003.B.

P3.004	Communication timeout		Address: 0308H 0309H
Default:	0	Control mode:	All
Unit:	sec	Setting range:	0 - 20
Format:	DEC	Data size:	16-bit

Settings:

If the value is not 0, communication timeout is enabled immediately. To disable this function, set the value to 0.

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:

Source of the DI controls the switch. Each bit of this parameter determines one input source of DI signal:

Bit 0 - Bit 9 correspond to DI1 - DI10. Bit 10 - Bit 12 correspond to VDI11 - VDI13.

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, please see:

DI1 - DI8: P2.010 - P2.017

DI9 - DI10: P2.036 - P2.037

VDI11 - VDI13: P2.038 - P2.040

P3.007	Communication response delay time		Address: 030EH 030FH
Default:	0	Control mode:	All
Unit:	0.5 ms	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

Delay the time of communication response from servo drive to controller.

P3.008	Reserved

P3.009	Communication synchronization		Address: 0312H 0313H
Default:	0x5055 (CANopen) 0x3511 (DMCNET)	Control mode:	CANopen / DMCNET
Unit:	-	Setting range:	Shown as follows
Format:	HEX	Data size:	16-bit

Settings:

The synchronous setting is divided into E, T, D, and M (hexadecimal):

Digit	E	T	D	M
Function	Range of synchronous error	Target value	Deadband	-
Range	1 - 9	0 - 9	0 - F	-

The slave synchronizes with the master via SYNC. The definition is as follows:

M: reserved.

D: set the size of deadband (unit: usec). If the deviation between the SYNC arrival time and the target value does not exceed the deadband, a correction is not needed.

T: target value of SYNC arrival time. The standard value is 500 usec, but you need to take the initial lead into account.

Target value = 400 + 10 x T. For example, if T = 5, the target value is 450.

E: if the deviation between the SYNC arrival time and the target value is smaller than the range, it means the synchronization is successful (unit: 10 μs).

P3.010	CANopen / DMCNET protocol		Address: 0314H 0315H
Default:	0x0000	Control mode:	CANopen / DMCNET
Unit:	-	Setting range:	0x0000 - 0xFFFF
Format:	HEX	Data size:	16-bit

Settings:

Communication protocol is divided into U, Z, Y, and X (hexadecimal):

Digit	U	Z	Y	X
Function	PDO alarm is cleared automatically or not	Torque source limited	-	-
Range	0 - 1	0 - 1	-	-

Definition is as follows:

X: reserved.

Y: reserved.

Z: torque source limited (only functions in mode B).

0: torque source limited to communication commands.

1: torque source limited to DI commands.

U*: 0: if PDO error occurs, it must be cleared by DI.ARST.

1: if PDO error disappears, it automatically clears the alarm.

Note: the current firmware does not have this feature. It is expected to have this feature added in the near future.

P3.011	CANopen / DMCNET options		Address: 0316H 0317H
Default:	0x0000	Control mode:	CANopen / DMCNET
Unit:	-	Setting range:	Shown as follows
Format:	HEX	Data size:	16-bit

Settings:

Communication setting is divided into X, Y, Z, and U (hexadecimal):

Digit	U	Z	Y	X
Function	Undefined	Undefined	Undefined	Parameter is stored in EEPROM or not
Range	0 - 1	0 - F	0 - F	0 - 1

Definition is as follows:

X: 1: when writing parameters through CANopen / DMCNET PDO, parameters are stored in EEPROM.

0: parameters are not stored in EEPROM.

Y: undefined.

Z: undefined.

U: undefined.

Note: if you set X to 1 and continuously write parameters through DMCNET PDO, it shortens the lifetime of the EEPROM.

P3.012	CANopen / DMCNET support		Address: 0318H 0319H
Default:	0x0000	Control mode:	CANopen / DMCNET
Unit:	-	Setting range:	0x0000 - 0x0111
Format:	HEX	Data size:	16-bit

Settings:

Digit	U	Z	Y	X
Function	Reserved	Load in CANopen / DMCNET values	Reserved	Reserved
Range	-	0 - 1	-	-
Control mode	-	CANopen mode 0x0B = 0x0C DMCNET mode 0x0B	-	-

There are X and Y settings (hexadecimal) for the CANopen Quick Stop mode, which is only suitable in CANopen control mode 0x0B (set P1.001 to b).

X: reserved.

Y: reserved.

Z: P parameters are overwritten by the CANopen / DMCNET parameters.

Z = 0: when cycling the power on the servo drive or resetting the communication, P parameters in the following table load the values in CANopen / DMCNET mode.

Z = 1: when cycling the power on the servo drive or resetting the communication, P parameters in the following table retain the same settings and do not load the values in CANopen / DMCNET mode.

CANopen mode:

Variables during initialization	P3.012.Z = 0	P3.012.Z = 1	Note
P1.032	0x0010	EEPROM	-
P2.035	50331648	EEPROM	-
P1.047	100	EEPROM	-
P1.049	0	EEPROM	-
P1.038	100	EEPROM	-
Home offset	0	EEPROM	Used in HM mode
P1.044	1	EEPROM	-
P1.045	1	EEPROM	-

DMCNET mode:

Variables during initialization	P3.012.Z = 0	P3.012.Z = 1	Note
P1.032	0x0010	EEPROM	-
P2.035	50331648	EEPROM	-
P1.047	100	EEPROM	-
P1.049	0	EEPROM	-
P1.038	100	EEPROM	-
Home offset	0	Undefined	Used in HM mode
Acc	200	Undefined	Used in PV and PP modes
Dec	200	Undefined	Used in PV and PP modes
Torque slope	200	Undefined	Used in PT mode
P1.044	1	EEPROM	-
P1.045	1	EEPROM	-

Methods to write parameters to EEPROM (even when the power is off):

SDO: parameters are stored in EEPROM when written.

PDO: refer to the setting of P3.011.X. (X = 1: when writing parameters throught PDO, parameters are stored in EEPROM; X = 0: when writing parameters through PDO, parameters are not stored in EEPROM.)

Note: in CANopen mode, when using OD 1010 Store Parameter and P3.012.Z = 0, the default value is different from the value shown above. Refer to CANopen Standard for further information.

P3.013 - P3.038	Reserved

P4.xxx Diagnosis parameters

P4.000★	Fault record (N)		Address: 0400H 0401H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The last abnormal status record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to CANopen / DMCNET.

P4.001★	Fault record (N-1)		Address: 0402H 0403H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The second to last abnormal status record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to CANopen / DMCNET.

P4.002★	Fault record (N-2)		Address: 0404H 0405H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The third to last abnormal status record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to CANopen / DMCNET.

P4.003★	Fault record (N-3)		Address: 0406H 0407H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The fourth to last abnormal status record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to CANopen / DMCNET.

P4.004★	Fault record (N-4)		Address: 0408H 0409H
Default:	0x00000000	Control mode:	All
Unit:	-	Setting range:	-
Format:	HEX	Data size:	32-bit

Settings:

The fifth to last abnormal status record.

Low word (LXXXX): the alarm number.

High word (hYYYY): the error code corresponding to CANopen / DMCNET.

P4.005	Servo motor JOG control		Address: 040AH 040BH
Default:	20	Control mode:	All
Unit:	rpm	Setting range:	0 - 5000 (rotary motor) 0 - 50000 (linear motor)
Format:	DEC	Data size:	16-bit

Settings:

The control methods are as follows:

1. Operation test:

   After the JOG speed is set by P4.005, the panel displays the JOG symbol. Pressing the UP key controls the JOG operation in the positive direction; pressing the DOWN key controls the JOG operation in the negative direction. Stop pressing to stop the JOG operation. If there is any error in this setting, then the motor cannot operate. The maximum JOG speed is the maximum speed of the servo motor.

2. DI control:

   If you set the DI to JOGU and JOGD (refer to Table 8.1), then the JOG operation in the positive or negative direction is controlled with this DI.

3. Communication control:

1 - 5000: JOG speed	4998: JOG operation in counterclockwise direction
4999: JOG operation in clockwise direction	0: stop operation

Note: when using communication to write values, and the frequency is high, set P2.030 to 5.

P4.006■	Digital output register (readable and writable)		Address: 040CH 040DH
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0 - 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

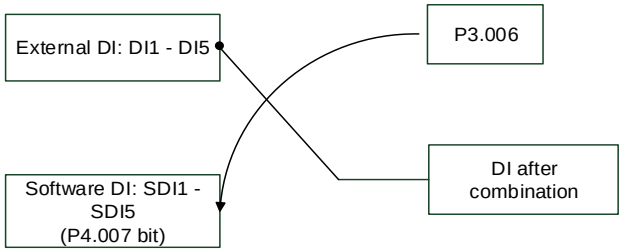
If you set P2.018 to 0x0130, then the output of DO#1 is the bit 00 status of P4.006, and so forth.

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:	0x0	Control mode:	All
Unit:	-	Setting range:	0 - 3FFF
Format:	HEX	Data size:	16-bit

Settings:

The source of the DI input signal can be the external terminal (DI1 - DI5) or the software (SDI1 - SDI5 corresponding to Bit 0 - 4 of P4.007), which is determined by P3.006. If the corresponding bit of P3.006 is 1, which means the source is the software SDI (P4.007); if the corresponding bit is 0, then the source is the hardware DI. See the following figure:



Read parameters: shows the DI status after combining external DI and software DI.

Write parameters: writes the software SDI status. This function is the same whether using 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; if the written value of P4.007 is 0x0011, it means the software SDI1 and SDI5 are on. Refer to P2.010 - P2.014 for more information on digital input pins (DI1 - DI5).

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:

Use this communication parameter to read 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:	0 - 0x1F
Format:	HEX	Data size:	16-bit

Settings:

There is no difference whether reading by panel or through communication.

P4.010▲■	Adjustment function		Address: 0414H 0415H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 5
Format:	DEC	Data size:	16-bit

Settings:

0: reserved	4: execute current encoder (W phase) offset adjustment
1: execute analog speed input offset adjustment	5: execute 1 - 4 offset adjustment
2: execute analog torque input offset adjustment	6 - 14: reserved
3: execute current encoder (V phase) offset adjustment	-

Note: the function must be enabled by setting P2.008. When adjusting, the external analog voltage wiring connected to the torque needs to be removed completely and must be in the Servo Off state.

P4.011	Analog speed input (1) offset adjustment		Address: 0416H 0417H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.012	Analog speed input (2) offset adjustment		Address: 0418H 0419H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.013	Analog torque input (1) offset adjustment		Address: 041AH 041BH
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.014	Analog torque input (2) offset adjustment		Address: 041CH 041DH
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.015	Current encoder (V1 phase) offset adjustment		Address: 041EH 041FH
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.016	Current encoder (V2 phase) offset adjustment		Address: 0420H 0421H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.017	Current encoder (W1 phase) offset adjustment		Address: 0422H 0423H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.018	Current encoder (W2 phase) offset adjustment		Address: 0424H 0425H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset. The function must be enabled by setting P2.008. Do not change the auxiliary adjustment as this parameter cannot be reset.

P4.019	IGBT NTC adjustment level (cannot reset)		Address: 0426H 0427H
Default:	Factory setting	Control mode:	All
Unit:	-	Setting range:	1 - 4
Format:	DEC	Data size:	16-bit

Settings:

Cool down the drive to 25°C before adjusting. The function must be enabled by setting P2.008.

P4.020	Offset adjustment for analog monitor output (Ch1)		Address: 0428H 0429H
Default:	0	Control mode:	All
Unit:	mV	Setting range:	-800 to 800
Format:	DEC	Data size:	16-bit

Settings:

Offset adjustment value (cannot reset). The function must be enabled by setting P2.008.

P4.021	Offset adjustment for analog monitor output (Ch2)		Address: 042AH 042BH
Default:	0	Control mode:	All
Unit:	mV	Setting range:	-800 to 800
Format:	DEC	Data size:	16-bit

Settings:

Offset adjustment value (cannot reset). The function must be enabled by setting P2.008.

P4.022	Analog speed input offset		Address: 042CH 042DH
Default:	0	Control mode:	S
Unit:	mV	Setting range:	-5000 to 5000
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset.

P4.023	Analog torque input offset		Address: 042EH 042FH
Default:	0	Control mode:	T
Unit:	mV	Setting range:	-5000 to 5000
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset.

P4.024	Level of undervoltage error		Address: 0430H 0431H
Default:	160	Control mode:	All
Unit:	V (rms)	Setting range:	140 - 190
Format:	DEC	Data size:	16-bit

Settings:

When the voltage of the DC BUS is lower than P4.024*$\sqrt{2}$, the undervoltage alarm occurs.

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 bit 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:	PR / S / T
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

The parameter setting is divided into D, C, B, A, W, Z, Y, and X (hexadecimal), including:

1. Deceleration time when the auto-protection function is enabled: OVF (DO: 0x12, Position command / feedback overflows), CTO (communication timeout, AL020), SPL, SNL, PL, and NL.
2. Deceleration time for stop command: STP

Digit	D	C	B	A	W	Z	Y	X
Function	STP	PFQS	CTO	OVF	SNL	SPL	NL	PL
Range	0 - F	0 - F	0 - F	0 - F	0 - F	0 - F	0 - F	0 - F

Use 0 - F to index the deceleration time of P5.020 - P5.035. For example: if you set X to A, then the deceleration time of PL is determined by P5.030.

P5.004	Homing methods		Address: 0508H 0509H
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0 - 0x12A
Format:	HEX	Data size:	16-bit

Settings:

X	Homing method	Z	Limit setting
Y	Z pulse setting	U	Reserved

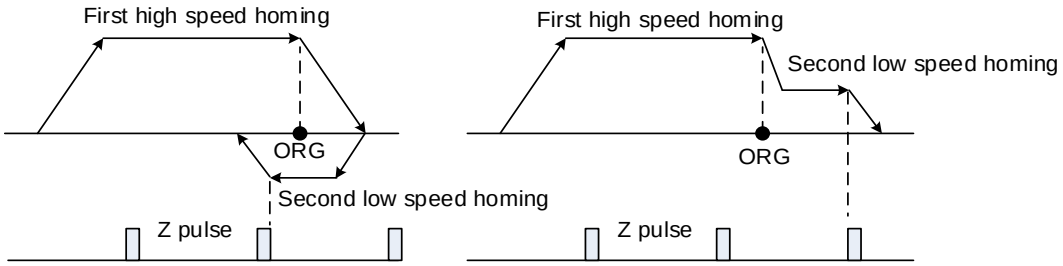
Definition of each setting value:

<table>
<tr><th>U</th><th>Z</th><th>Y</th><th>X</th></tr>
<tr><td>Reserved</td><td>Limit setting</td><td>Z pulse setting</td><td>Homing method</td></tr>
<tr><td rowspan="10">-</td><td>0 - 1</td><td>0 - 2</td><td>0 - 8</td></tr>
<tr><td rowspan="3">-</td><td rowspan="5">Y = 0: return to Z pulse
Y = 1: go forward to Z pulse
Y = 2: do not look for Z pulse</td><td>X = 0: homing in forward direction and define the positive limit as the homing origin</td></tr>
<tr><td>X = 1: homing in reverse direction and define the negative limit as the homing origin</td></tr>
<tr><td rowspan="4">When reaching the limit:
Z = 0: show error
Z = 1: reverse direction</td><td>X = 2: homing in forward direction, ORG: OFF→ON as the homing origin</td></tr>
<tr><td>X = 3: homing in reverse direction, ORG: OFF→ON as the homing origin</td></tr>
<tr><td rowspan="2">-</td><td>X = 4: look for Z pulse in forward direction and define it as the homing origin</td></tr>
<tr><td>X = 5: look for Z pulse in reverse direction and define it as the homing origin</td></tr>
<tr><td rowspan="2">Y = 0: return to Z pulse
Y = 1: go forward to Z pulse
Y = 2: do not look for Z pulse</td><td>X = 6: homing in forward direction, ORG: ON→OFF as the homing origin</td></tr>
<tr><td>X = 7: homing in reverse direction, ORG: ON→OFF as the homing origin</td></tr>
<tr><td>-</td><td>-</td><td>X = 8: define the current position as the origin</td></tr>
<tr><td rowspan="2">When reaching the limit:
Z = 0: show error
Z = 1: reverse direction</td><td rowspan="2">Y = 0: return to Z pulse
Y = 2: do not look for Z pulse</td><td>X = 9: torque homing in forward direction</td></tr>
<tr><td>X = A: torque homing in reverse direction</td></tr>
</table>

P5.005	**High speed homing (first speed setting)**			**Address: 050AH 050BH**
Operation interface:	Panel / software	Communication	Control mode:	PR (set with P5.004)
Default:	100.0	1000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.1 - 6000.0 (rotary motor)* 0.1 - 15999999 (linear motor)*	1 - 60000 (rotary motor)* 1 - 15999999 (linear motor)*		
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

The first speed setting for high speed homing.



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

P5.006	Low speed homing (second speed setting)			Address: 050CH 050DH
Operation interface:	Panel / software	Communication	Control mode:	PR (set with P5.004)
Default:	20.0	200	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.1 - 6000.0 (rotary motor)* 0.1 - 15999999 (linear motor)*	1 - 60000 (rotary motor)* 1 - 15999999 (linear motor)*		
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	150 = 1.5 rpm	-	-

Settings:

The second speed setting for low speed homing.

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

P5.007■	Trigger Position command (PR mode only)		Address: 050EH 050FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	0 - 1000
Format:	DEC	Data size:	16-bit

Settings:

Set P5.007 to 0 to start homing.

Set P5.007 to 1 - 99 to execute the specified PR procedure, which is the same as using DI.CTRG+POSn.

You cannot set P5.007 to 100 - 999 as the value exceeds the valid range.

Example: to trigger PR#2

Method 1	Trigger by DI: Register Position command selection 1 - 64 Bit 1 (DI: 0x12) + Trigger command (DI: 0x08)
Method 2	Trigger by P5.007: Set P5.007 to 2 to start executing PR#2

Write 1000 to execute stop command, which is the same as DI.STP.

When reading P5.007, if the command is incomplete, the drive reads the current command (1 - 99).

If the command is complete, the drive reads the current command +10000. If the command is complete, DO.TPOS is on, and motor position is reached, the drive reads the current command +20000.

Commands triggered by DI are also applicable.

Example:

If the value read is 3, it means PR#3 is incomplete. If the value read is 10003, it means PR#3 completed, but the motor has not reached the target position yet. If the value read is 20003, it means PR#3 completed and the motor reached the target position.

P5.008	Forward software limit		Address: 0510H 0511H
Default:	2147483647	Control mode:	PR
Unit:	PUU	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

In PR mode, if the motor rotates in the forward direction and its feedback position exceeds the value of P5.008, AL283 occurs.

P5.009	Reverse software limit		Address: 0512H 0513H
Default:	-2147483648	Control mode:	PR
Unit:	PUU	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

In PR mode, if the motor rotates in the reverse direction and its feedback position exceeds the value of P5.009, AL285 occurs.

P5.010★■	Data array - data size		Address: 0514H 0515H
Default:	-	Control mode:	All
Unit:	-	Setting range:	Read-only
Format:	DEC	Data size:	16-bit

Settings:

Data size (N x 32 bits) means size N of data array.

P5.011■	Data array - address for reading and writing		Address: 0516H 0517H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to (value set by P5.010 minus 1)
Format:	DEC	Data size:	16-bit

Settings:

Specify the address in the data array when reading and writing data. Refer to Chapter 7 for detailed instructions.

P5.012■	Data array - window #1 for reading and writing		Address: 0518H 0519H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Window #1: when reading the parameter with the panel, the value set by P5.011 does not add 1, but reading or writing by other methods adds 1. Refer to Section 7.2.1 Data array for detailed instructions.

P5.013■	Data array - window #2 for reading and writing		Address: 051AH 051BH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Window #2: when reading the parameter with the panel or reading and writing the parameter through communication, the value set by P5.011 adds 1, but the panel is write-protected. Refer to Section 7.2.1 Data array for detailed instructions.

P5.014	Reserved

P5.015■	PATH#1 - PATH#2 volatile setting		Address: 051EH 051FH
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0x0011
Format:	HEX	Data size:	16-bit

Settings:

This parameter allows you to write data to the target continuously through communication.

X	PATH#1 volatile setting	UZ	Reserved
Y	PATH#2 volatile setting	-	-

- X: PATH#1 volatile setting

  0: non-volatile

  1: volatile

- Y: PATH#2 volatile setting

  0: non-volatile

  1: volatile

P5.016■	Axis position - CN2		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 CN2 encoder, which is the monitoring variable 000(00h) + offset value.

Write: write any value to the parameter, and it neither changes the monitoring variable 000(00h) nor affects the positioning coordinate system. It is only for observation when adjusting the offset value.

P5.017	Axis position - CN5		Address: 0522H 0523H
Default:	0	Control mode:	All
Unit:	Pulse number	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Pulse count from the CN5 encoder.

P5.018	Axis position - pulse command		Address: 0524H 0525H
Default:	0	Control mode:	All
Unit:	Pulse number	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Pulse count from the pulse command.

P5.019	E-Cam curve scaling		Address: 0526H 0527H
Default:	1.000000	Control mode:	PR
Unit:	0.000001 times, which is 1 / (10^6)	Setting range:	-2147.000000 to +2147.000000
Format:	DEC	Data size:	32-bit
Example:	1100000 = 1.1 times		

Settings:

Use this parameter to magnify or reduce the E-Cam table without changing its value.

Example: the data in the table is 0, 10, 20, 30, 40, 20, magnification x 2.000000 equals the data: 0, 20, 40, 60, 80, 40, magnification x 1.000000.

This enables the operation of E-Cam with the same pulse frequency of the master axis. Magnification enlarges both the route of E-Cam operation and the speed.

Note: this parameter can be set at any time, but the time when it becomes effective is determined by P5.088.X [Bit 2].

P5.020	Acceleration / deceleration time (Number #0)		Address: 0528H 0529H
Default:	200	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

The duration of acceleration and deceleration in PR mode, which is the length of time to accelerate from 0 to 3,000 rpm.

P5.021	Acceleration / deceleration time (Number #1)		Address: 052AH 052BH
Default:	300	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.022	Acceleration / deceleration time (Number #2)		Address: 052CH 052DH
Default:	500	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.023	Acceleration / deceleration time (Number #3)		Address: 052EH 052FH
Default:	600	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.024	Acceleration / deceleration time (Number #4)		Address: 0530H 0531H
Default:	800	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.025	Acceleration / deceleration time (Number #5)		Address: 0532H 0533H
Default:	900	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.026	Acceleration / deceleration time (Number #6)		Address: 0534H 0535H
Default:	1000	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.027	Acceleration / deceleration time (Number #7)		Address: 0536H 0537H
Default:	1200	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.028	Acceleration / deceleration time (Number #8)		Address: 0538H 0539H
Default:	1500	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.029	Acceleration / deceleration time (Number #9)		Address: 053AH 053BH
Default:	2000	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.030	Acceleration / deceleration time (Number #10)		Address: 053CH 053DH
Default:	2500	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.031	Acceleration / deceleration time (Number #11)		Address: 053EH 053FH
Default:	3000	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.032	Acceleration / deceleration time (Number #12)		Address: 0540H 0541H
Default:	5000	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.033	Acceleration / deceleration time (Number #13)		Address: 0542H 0543H
Default:	8000	Control mode:	PR
Unit:	ms	Setting range:	1 - 65500
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.034	Acceleration / deceleration time (Number #14)		Address: 0544H 0545H
Default:	50	Control mode:	PR
Unit:	ms	Setting range:	1 - 1500
Format:	DEC	Data size:	16-bit

Settings:

This parameter is for the deceleration time for auto protection, and the default value of this is small (shorter deceleration time).

P5.035	Acceleration / deceleration time (Number #15)		Address: 0546H 0547H
Default:	30	Control mode:	PR
Unit:	ms	Setting range:	1 - 1200
Format:	DEC	Data size:	16-bit

Settings:

This parameter is for the deceleration time for auto protection, and the default value of this is small (shorter deceleration time).

P5.036	Capture - start address of data array		Address: 0548H 0549H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 to (value set by P5.010 minus 1)
Format:	DEC	Data size:	16-bit

Settings:

The first data Capture obtained is saved at this address in the data array. This parameter is only writable when Capture stops (refer to P5.039).

P5.037■	Capture - axis position		Address: 054AH 054BH
Default:	0	Control mode:	All
Unit:	Pulse unit of capture source	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Displays the axis position of Capture pulse source. Note that this parameter is only writable when Capture stops (refer to P5.039). If the axis source of Capture is CN2, this parameter is write-protected and the Capture axis position is the feedback position of the motor (monitoring variable 00h).

P5.038■	Capture - number of capturing times		Address: 054CH 054DH
Default:	1	Control mode:	All
Unit:	-	Setting range:	1 to (value set by P5.010 minus value set by P5.036)
Format:	DEC	Data size:	16-bit

Settings:

When Capture stops, this parameter indicates the number of data expected to be captured (readable and writable). When Capture activates, this parameter indicates the remaining number of data to be captured (read-only); each time it captures one data, the value of P5.038 decrements by 1 until the value is 0, indicating that capturing is complete.

Note: the total number of data from Compare, Capture, and E-Cam cannot exceed 800.

P5.039■	Capture - activate CAP control		Address: 054EH 054FH
Default:	0x2010	Control mode:	All
Unit:	-	Setting range:	0x0000 - 0xF13F
Format:	HEX	Data size:	16-bit

Settings:

X	Capture setting	Z	Trigger logic
Y	Axis source of Capture	U	Trigger minimum interval

■ X: Capture setting

Bit	Function	Description
0	Activate Capture	Start capturing; after finishing capturing, set to 0
1	Reset position	After capturing the first data, reset the position coordinate of the first data. The reset coordinate position is set by P5.076
2	Activate Compare	After capturing the first data, activate Compare, but this setting is invalid if Compare is already activated
3	Execute PR	Execute PR#50 after capturing is complete

■ Y: axis source of Capture

0: Capture is not working

1: CN5

2: CN1 (pulse command)

3: CN2

Note: when the source of Compare is the Capture axis, the source of Capture (P5.039.Y) cannot be changed.

- Z: trigger logic

  0: NO (normally open)

  1: NC (normally closed)

- U: trigger minimum interval (unit: ms)

Note: refer to Chapter 7 for detailed instructions for Capture.

P5.040	Delay time after position reached (Number #0)		Address: 0550H 0551H
Default:	0	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The first delay time of PR mode.

P5.041	Delay time after position reached (Number #1)		Address: 0552H 0553H
Default:	100	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The second delay time of PR mode.

P5.042	Delay time after position reached (Number #2)		Address: 0554H 0555H
Default:	200	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The third delay time of PR mode.

P5.043	Delay time after position reached (Number #3)		Address: 0556H 0557H
Default:	400	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The fourth delay time of PR mode.

P5.044	Delay time after position reached (Number #4)		Address: 0558H 0559H
Default:	500	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The fifth delay time of PR mode.

P5.045	Delay time after position reached (Number #5)		Address: 055AH 055BH
Default:	800	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The sixth delay time of PR mode.

P5.046	Delay time after position reached (Number #6)		Address: 055CH 055DH
Default:	1000	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The seventh delay time of PR mode.

P5.047	Delay time after position reached (Number #7)		Address: 055EH 055FH
Default:	1500	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The eighth delay time of PR mode.

P5.048	Delay time after position reached (Number #8)		Address: 0560H 0561H
Default:	2000	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The ninth delay time of PR mode.

P5.049	Delay time after position reached (Number #9)		Address: 0562H 0563H
Default:	2500	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The tenth delay time of PR mode.

P5.050	Delay time after position reached (Number #10)		Address: 0564H 0565H
Default:	3000	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The eleventh delay time of PR mode.

P5.051	Delay time after position reached (Number #11)		Address: 0566H 0567H
Default:	3500	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The twelfth delay time of PR mode.

P5.052	Delay time after position reached (Number #12)		Address: 0568H 0569H
Default:	4000	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The thirteenth delay time of PR mode.

P5.053	Delay time after position reached (Number #13)		Address: 056AH 056BH
Default:	4500	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The fourteenth delay time of PR mode.

P5.054	Delay time after position reached (Number #14)		Address: 056CH 056DH
Default:	5000	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The fifteenth delay time of PR mode.

P5.055	Delay time after position reached (Number #15)		Address: 056EH 056FH
Default:	5500	Control mode:	PR
Unit:	ms	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

The sixteenth delay time of PR mode.

P5.056	Compare - start address of data array		Address: 0570H 0571H
Default:	50	Control mode:	All
Unit:	-	Setting range:	0 to (value set by P5.010 minus 1)
Format:	DEC	Data size:	16-bit

Settings:

The address of data array where the first Compare data is saved. This parameter is only writable when Compare stops (refer to P5.059).

P5.057■	Compare - axis position		Address: 0572H 0573H
Default:	0	Control mode:	All
Unit:	Pulse unit of compare source	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

The axis position of the Compare pulse source. This parameter is only writable when Compare stops (refer to P5.059).

Note:

1. This parameter is write-protected when the axis source of Compare is the Capture axis (P5.059.Y = 0).
2. When the axis source of Compare is CN2, P5.057 is also write-protected. The pulse resolution is determined by P1.046. When you set P5.059.Y to CN2, this parameter is reset to the feedback position of the motor (monitoring variable 00h). When the motor feedback position is redefined due to homing or Capture, the value will be different from the parameter value. In this case, set P5.059.Y to 0 and then set P5.059.Y to 3 to reset the parameter to the motor feedback position.

P5.058■	Compare - number of comparing times		Address: 0574H 0575H
Default:	1	Control mode:	All
Unit:	-	Setting range:	1 to (value set by P5.010 minus value set by P5.056)
Format:	DEC	Data size:	16-bit

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Settings:

When Compare is not in operation, the parameter indicates the number of data expected to be compared (readable and writable). When Compare is in operation, this parameter indicates the remaining number of data to be compared (read-only). Each time it compares one data, the value of P5.058 decrements by 1 until the value is 0, indicating that comparing is complete.

P5.059■	Compare - activate CMP control		Address: 0576H 0577H
Default:	0x00640010	Control mode:	All
Unit:	-	Setting range:	0x00010000 - 0x0FFF313F
Format:	HEX	Data size:	32-bit

Settings:

D CBA

U Z Y X

CBA	Duration of pulse output (unit: 1 ms)	X	Compare setting
D	N/A	Y	Axis source of Compare
-	-	Z	Trigger logic
-	-	U	Trigger PR
h	High bit	L	Low bit

■ X: Compare setting

Bit	Function	Description
0	Activate Compare	Start comparing; after finishing comparing, set to 0
1	Cycle mode	When the number of comparing times (P5.058) is 0, it automatically resets the number of comparing times to the default setting
2	Activate Capture	After comparing is complete, activate Capture, but this setting is invalid if Capture is already activated
3	Position returns to 0	When the last data is compared, the Compare axis position (P5.057) returns to 0

■ Y: axis source of Compare

0: Capture axis

1: CN5

2: CN1 (pulse command)

3: CN2

Note: when the source of Compare is the Capture axis, the source of Capture (P5.039.Y) cannot be changed.

- Z: trigger logic

  0: NO (normally open)

  1: NC (normally closed)

- U: trigger PR

Bit	Function	Description
0	Execute PR	Execute PR#45 after comparing is complete
1 - 3	Reserved	-

- CBA: duration of pulse output (unit: 1 ms)

Note: refer to Chapter 7 for detailed instructions for Compare.

P5.060	**Target speed setting #0**			**Address: 0578H 0579H**
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	20.0	200	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	15 = 15 rpm	150 = 15 rpm	-	-

Settings:

First target speed of PR mode.

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

P5.061	**Target speed setting #1**			**Address: 057AH 057BH**
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	50.0	500	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Second target speed of PR mode.

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

P5.062	Target speed setting #2			Address: 057CH 057DH
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	100.0	1000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Third target speed of PR mode.

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

P5.063	Target speed setting #3			Address: 057EH 057FH
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	200.0	2000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Fourth target speed of PR mode.

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

P5.064	Target speed setting #4			Address: 0580H 0581H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	300.0	3000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Fifth target speed of PR mode.

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

P5.065	Target speed setting #5			Address: 0582H 0583H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	500.0	5000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Sixth target speed of PR mode.

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

P5.066	Target speed setting #6			Address: 0584H 0585H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	600.0	6000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Seventh target speed of PR mode.

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

P5.067	Target speed setting #7			Address: 0586H 0587H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	800.0	8000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Eighth target speed of PR mode.

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

P5.068	Target speed setting #8			Address: 0588H 0589H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	1000.0	10000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Ninth target speed of PR mode.

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

P5.069	Target speed setting #9			Address: 058AH 058BH
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	1300.0	13000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Tenth target speed of PR mode.

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

P5.070	Target speed setting #10			Address: 058CH 058DH
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	1500.0	15000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Eleventh target speed of PR mode.

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

P5.071	Target speed setting #11			Address: 058EH 058FH
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	1800.0	18000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Twelfth target speed of PR mode.

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

P5.072	Target speed setting #12			Address: 0590H 0591H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	2000.0	20000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Thirteenth target speed of PR mode.

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

P5.073	Target speed setting #13			Address: 0592H 0593H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	2300.0	23000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Fourteenth target speed of PR mode.

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

P5.074	Target speed setting #14			Address: 0594H 0595H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	2500.0	25000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Fifteenth target speed of PR mode.

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

P5.075	Target speed setting #15			Address: 0596H 0597H
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	3000.0	30000	Data size:	32-bit
Unit:	1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*	0.1 rpm (rotary motor)* 10^{-6} m/s (linear motor)*		
Setting range:	0.0 - 6000.0 (rotary motor)* 0.0 - 15999999 (linear motor)*	0 - 60000 (rotary motor)* 0 - 15999999 (linear motor)*		
Format:	DEC		-	-
Example:	1 = 1 rpm	10 = 1 rpm	-	-

Settings:

Sixteenth target speed of PR mode.

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

P5.076	Capture - reset position after first data		Address: 0598H 0599H
Default:	0	Control mode:	All
Unit:	Pulse unit of capture source	Setting range:	-1073741824 to +1073741823
Format:	DEC	Data size:	32-bit

Settings:

If the position reset function is enabled (P5.039.X [Bit 1] = 1), after the first position data is captured, the servo resets the coordinates of the first point, which is defined by this parameter.

P5.077■	E-Cam: position for synchronous Capture axis		Address: 059AH 059BH
Default:	0	Control mode:	All
Unit:	Pulse unit of master axis	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

This parameter indicates the position for the synchronous Capture axis, which can be used as the command source for the E-Cam master axis (P5.088.Y = 5). When Capture operates every two times, the servo calculates the error between the moving distance of this axis and the set interval between each synchronous Capture action (P5.078).

Note: monitor the moving pulse amount between two capturing actions with the monitoring variable 081(51h).

P5.078	E-Cam: interval between each synchronous Capture action		Address: 059CH 059DH
Default:	100	Control mode:	All
Unit:	Pulse unit of master axis	Setting range:	10 - 100000000
Format:	DEC	Data size:	32-bit

Settings:

Sets the moving pulse amount of the synchronous Capture axis between two capturing actions. The new value can only be written to the parameter when Capture is not in operation (P5.039.X [Bit 0] = 0).

P5.079■	E-Cam: pulse error for synchronous Capture axis		Address: 059EH 059FH
Default:	0	Control mode:	All
Unit:	Pulse unit of master axis	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

When the synchronous Capture axis is operating, the pulse error should be 0. Each time when capturing data, the synchronous axis operates and this parameter updates once. It operates as follows:

P5.079 = incremental pulse amount between two capturing actions (monitoring variable 51h) minus interval pulse number between each synchronous Capture action (P5.078). You can also write the offset of the synchronous axis to this parameter. When the synchronous Capture axis is the master axis for the rotary shear, modifying this parameter can shift the cutting position to the left or right. You can also use P1.016 (error offset compensation for synchronous Capture axis) to achieve this effect.

Note: monitor the pulse error for synchronous Capture axis with the monitoring variable 084(54h).

P5.080	E-Cam: maximum correction rate for synchronous Capture axis		Address: 05A0H 05A1H
Default:	10	Control mode:	All
Unit:	%	Setting range:	0 - 90
Format:	DEC	Data size:	16-bit

Settings:

This parameter limits the correction percentage (%) of the synchronous Capture axis. Correction rate = Pulse number output by the synchronous axis / Pulse number input by the synchronous axis.

(100 - P5.080)% < Correction rate < (100 + P5.080)%

When the correction rate is bigger, the synchronous error falls to 0 faster, but the speed change is more drastic. When the correction rate is smaller, the synchronous error becomes 0 slower, but the speed change is smoother. In the rotary shear application, after adjusting the synchronous error of P5.079, the bigger the parameter value is, the faster the cutting position reaches the target position. However, the speed will not be synchronized.

P5.081	E-Cam: start address for data array		Address: 05A2H 05A3H
Default:	100	Control mode:	PR
Unit:	-	Setting range:	0 to (800 minus value set by P5.082)
Format:	DEC	Data size:	16-bit

Settings:

The first data in the E-Cam curve table is saved at this address in the data array. This parameter can be set at any time, but will be effective only when the status changes from pre-engaged to engaged.

P5.082	E-Cam: segment number N		Address: 05A4H 05A5H
Default:	5	Control mode:	PR
Unit:	-	Setting range:	5 - 720
Format:	DEC	Data size:	16-bit

Settings:

Indicates that the E-Cam curve is divided into N segments, and the table includes N+1 data.

This parameter is only writable when E-Cam stops (P5.088.X [Bit 0] = 0). Its range must be smaller than or equal to P5.010 minus P5.081, and P5.082 x P5.084 must be smaller than or equal to 2147483647.

P5.083	E-Cam: master gear ratio setting - cycle number (M)		Address: 05A6H 05A7H
Default:	1	Control mode:	PR
Unit:	-	Setting range:	1 - 32767
Format:	DEC	Data size:	16-bit

Settings:

When the slave axis receives the pulse number defined by P5.084 from the master axis, E-Cam rotates the number of cycles defined by P5.083 (one cycle of E-Cam = rotate from 0° to 360°). This parameter is only writable when E-Cam stops (P5.088.X [Bit 0] = 0).

P5.084	E-Cam: master gear ratio setting - pulse number (P)		Address: 05A8H 05A9H
Default:	3600	Control mode:	PR
Unit:	-	Setting range:	10 - 1073741823
Format:	DEC	Data size:	32-bit

Settings:

When the slave axis receives the pulse number defined by P5.084 from the master axis, E-Cam rotates the number of cycles defined by P5.083 (one cycle of E-Cam = rotate from 0° to 360°). This parameter can be modified at any time. Its range must be the value of P5.082 x P5.083 smaller than or equal to P5.084, and P5.082 x P5.084 must be smaller than or equal to 2147483647.

P5.085	E-Cam: engaged segment number		Address: 05AAH 05ABH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	0 to (value set by P5.082 minus 1)
Format:	DEC	Data size:	16-bit

8

Settings:

Set the segment number in the curve table when E-Cam engages.

P5.086■	E-Cam: master axis position		Address: 05ACH 05ADH
Default:	0	Control mode:	PR
Unit:	Pulse unit of master axis	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Position counter of the E-Cam master axis. When E-Cam is in operation, this value increases continuously. This parameter is only writable when E-Cam stops (P5.088.X [Bit 0] = 0).

P5.087	E-Cam: initial lead pulse before engaged		Address: 05AEH 05AFH
Default:	0	Control mode:	PR
Unit:	Pulse unit of master axis	Setting range:	-1073741824 to +1073741823
Format:	DEC	Data size:	32-bit

Settings:

When the condition to engage E-Cam (P5.088.Z) is met, the pulse number from the master axis has to exceed the value of this parameter for the E-Cam to fully engage. This parameter can be written with the virtual master axis pulse function (refer to description of P2.077).

P5.088■	E-Cam: activate E-Cam control		Address: 05B0H 05B1H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x0 - 0x203FF257
Format:	HEX	Data size:	32-bit

Settings:

D C BA

U Z Y X

BA	PR path to execute	X	Activation setting of E-Cam function
C	Reserved	Y	Command source
D	E-Cam status display	Z	Engagement condition
-	-	U	Disengagement condition

Definitions are as follows:

- X: E-Cam command

Bit	Function	Description
0	E-Cam activation	0: E-Cam is disabled 1: E-Cam is enabled (relevant parameters cannot be modified once E-Cam is enabled)
1	E-Cam does not disengage when servo is off	0: when the servo is stopped by alarm or because servo is off, the clutch disengages 1: when the servo is stopped by alarm or because servo is off, the clutch remains engaged. When the servo switches to on again, E-Cam can operate directly. If E-Cam phase offset occurs, use macro command #D to let the E-Cam return to the correct position.
2	P5.019 effective time	0: modified P5.019 is effective after next engagement 1: modified P5.019 is effective immediately
3	Reserved	-

- Y: command source

  0: Capture axis

  1: CN5

  2: CN1 (pulse command)

  3: PR command

  4: time axis (1 ms)

  5: synchronous Capture axis (P5.077)

  6: analog voltage command (unit: 1M pulse/s per 10V)

- Z: engagement condition

  0: immediately

  1: trigger DI.CAM

  2: any one position data is captured

- U: disengagement condition (+ indicates multiple conditions, but 2, 4, and 6 cannot be selected at the same time)

U	Disengagement condition	Status after disengaged
0	0: remains engaged	-
1	1: disengages when DI (DI: 0x36) is off	0: stop
2	2: disengages when master axis pulse number reaches the setting value of P5.089, and slave axis stops immediately	0: stop
3	1 + 2: disengages when DI (DI: 0x36) is off or when master axis pulse number reaches the setting value of P5.089, and slave axis stops immediately	0: stop
4	4: disengages when master axis pulse number reaches the setting value of P5.089 and enters the cyclic mode. When the pre-engaged pulse number for each cycle (P5.092) is reached, the clutch re-engages.	2: pre-engage
5	1 + 4: E-Cam enters the cyclic mode, but disengages when DI (DI: 0x36) is off	0 or 2: pre-engage or stop
6	6: disengages when master axis pulse number reaches the setting value of P5.089, and slave axis decelerates to stop	0: stop
7	1 + 6: disengages when DI (DI: 0x36) is off or when master axis pulse number reaches the setting value of P5.089, and slave axis decelerates to stop	0: stop

U	Disengagement condition	Status after disengaged
8	8: set other disengagement conditions first, and the E-Cam function is disabled after the clutch disengages	-
9	1 + 8: disengages when DI (DI: 0x36) is off and the E-Cam function is disabled	0: stop and disable E-Cam
A	2 + 8: disengages when master axis pulse number reaches the setting value of P5.089, slave axis stops immediately, and the E-Cam function is disabled	0: stop and disable E-Cam
B	1 + 2 + 8: disengages when DI (DI: 0x36) is off or when master axis pulse number reaches the setting value of P5.089, slave axis stops immediately, and the E-Cam function is disabled	0: stop and disable E-Cam
C	4 + 8 (special function): eases the speed vibration when returning to the pre-engaged condition. This is generally applied when the pre-engaged pulse number for each cycle (P5.092) is 0, pulse number of disengaging time equals master gear ratio (P5.089 = P5.084)	2: pre-engage
D	1 + 4 + 8: disengages when DI (DI: 0x36) is off, otherwise operates according to the condition of P5.088.U = C	0 or 2: stop and disable E-Cam or pre-engage
E	6 + 8: disengages when master axis pulse number reaches the setting value of P5.089, slave axis decelerates to stop, and the E-Cam function is disabled	0: stop and disable E-Cam
F	1 + 6 + 8: disengages when DI (DI: 0x36) is off or when master axis pulse number reaches the setting value of P5.089, slave axis decelerates to stop, and the E-Cam function is disabled	0: stop and disable E-Cam

- BA: auto execute the specified PR path

  When the disengagement condition (P5.088.U = 2, 4, 6) is met, a PR is executed automatically. Use hexadecimal notation to specify PR#1 - 99 (01 - 63h) and 00 indicates not to continue with a PR command.

- C: reserved

- D: display engage status (read-only)

  0: stop status

  1: engaged status

  2: pre-engaged status

P5.089	E-Cam: pulse number of disengaging time		Address: 05B2H 05B3H
Default:	0	Control mode:	PR
Unit:	Pulse unit of master axis	Setting range:	-1073741824 to +1073741823
Format:	DEC	Data size:	32-bit

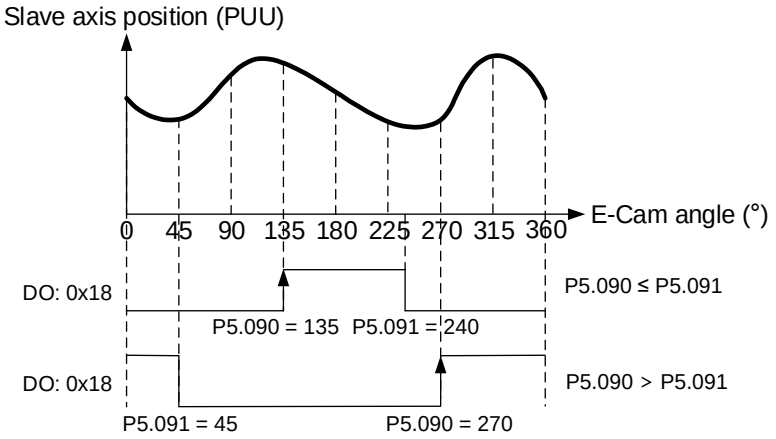
Settings:

When the pulse number of the master axis reaches the value set by P5.089, the clutch disengages based on the disengagement condition setting (P5.088.U).

P5.090	E-Cam: DO.CAM_AREA#1 rising-edge phase		Address: 05B4H 05B5H
Default:	270	Control mode:	PR
Unit:	degree	Setting range:	0 - 360
Format:	DEC	Data size:	16-bit

Settings:

See the correlation between DO.CAM_AREA 1 and the parameters in the following figure. When E-Cam is not engaged, this signal is always off.



P5.091	E-Cam: DO.CAM_AREA#1 falling-edge phase		Address: 05B6H 05B7H
Default:	360	Control mode:	PR
Unit:	degree	Setting range:	0 - 360
Format:	DEC	Data size:	16-bit

Settings:

Refer to P5.090 for the correlation between DO.CAM_AREA 1 and the parameters.

P5.092	E-Cam: pre-engaged pulse number for each cycle		Address: 05B8H 05B9H
Default:	0	Control mode:	PR
Unit:	Pulse unit of master axis	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

This parameter goes with the selection of P5.088.U = 4 (E-Cam disengages and enters the cyclic mode). After E-Cam disengages, the pre-engaged pulse number is determined by this parameter. The pulse number from the master axis has to exceed the value of this parameter for the E-Cam to re-engage.

P5.093	Motion control macro command: command parameter #4		Address: 05BAH 05BBH
Default:	0	Control mode:	All
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Before executing the macro command, set the relevant parameters in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.094	Motion control macro command: command parameter #3		Address: 05BCH 05BDH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Before executing the macro command, set the relevant parameters in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.095	Motion control macro command: command parameter #2		Address: 05BEH 05BFH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Before executing the macro command, set the relevant parameters in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.096	Motion control macro command: command parameter #1		Address: 05C0H 05C1H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Before executing the macro command, set the relevant parameters in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.097■	Motion control macro command: issue command / execution result		Address: 05C2H 05C3H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 0x099F
Format:	HEX	Data size:	16-bit

Settings:

Write to this parameter to issue a macro command; read this parameter to examine the execution result of a macro command.

If the command issues 0x0003, 0x1003 is returned if successful; and 0xF03X if unsuccessful (depending on the command description). If you execute a command that is not supported, the failure code 0xF001 is returned.

The command codes are listed in the following tables:

Command code 0x0003	**Parameter and data array protection: password setting, protection activation**
	This function can only be executed prior to activating the parameter protection function. When the protection function is activated, the failure code is returned if this function is executed repeatedly.
Macro parameters	P5.093 = parameter groups 5, 6, and 7 are write-protected 0: no protection 1: enable protection P5.094 = read protection range of parameter and data array (-1 to 7) -1: parameter groups 5, 6, 7 and data array are readable 0: parameter groups 5, 6, 7 and data array are unreadable 1: parameter groups 5, 6, 7 and data array #100 - 799 are unreadable 2: parameter groups 5, 6, 7 and data array #200 - 799 are unreadable 3: parameter groups 5, 6, 7 and data array #300 - 799 are unreadable 4: parameter groups 5, 6, 7 and data array #400 - 799 are unreadable 5: parameter groups 5, 6, 7 and data array #500 - 799 are unreadable 6: parameter groups 5, 6, 7 and data array #600 - 799 are unreadable 7: parameter groups 5, 6, 7 are unreadable, but data array is readable P5.095 = set new password (1 - 16777215) P5.096 = confirm new password (1 - 16777215)
Read the return value of P5.097 after executing the macro	Success code
	0x1003
	Failure code
	0xF031: protection function is activated and cannot be set repeatedly
	0xF032: wrong password setting, P5.095 does not equal P5.096
	0xF033: password value exceeds the allowable range (1 - 16777215)
	0xF034: protection range P5.094 exceeds the allowable range (-1 to 7)
	0xF035: protection level P5.093 exceeds the allowable range (0 - 1)

Command code 0x0004	**Parameter and data array protection: unlock protection**
	This function can only be executed when the protection function is activated. When the protection function is unlocked, the failure code is returned if this function is executed repeatedly. If the wrong password is entered, failure code 0xEnnn is returned. nnn indicates the remaining attempts to enter the password. The number decrements by 1 after each failed attempt. When the number displays 0, it indicates the maximum number of failed password attempts has been reached and it is locked. You can only reset all parameters (P2.008 = 10) to unlock.
Macro parameters	P5.096 = enter password (1 - 16777215)
Read the return value of P5.097 after executing the macro	Success code
	0x1004

Read the return value of P5.097 after executing the macro	Failure code
	0xF041: protection function is unlocked and cannot be unlocked repeatedly
	0xF043: password value exceeds the allowable range (1 - 16777215)
	0xF044: the maximum number of failed password attempts has been reached and it is locked. You can only unlock by resetting the parameters (P2.008 = 10), but this also resets all parameters to the default values.
	0xEnnn: incorrect password setting; failed to unlock nnn: remaining attempts to enter the password. The number decrements by 1 after each failed attempt. When the number displays 0, it is locked and does not allow further attempts.

Command code 0x0005	**E-Cam disengages after engaged for one cycle**
	Set the pulse number of master gear ratio (P5.084) and pulse number of disengaging time (P5.089) as the same value. With the disengagement condition (P5.088.U = 2, 4, 6) and the cycle number of master gear ratio as 1 (P5.083 = 1), E-Cam disengages after being engaged for one cycle.
Macro parameters	P5.095 = pulse number of master gear ratio
Read the return value of P5.097 after executing the macro	Success code
	0x1005
	Failure code
	0xF005: pulse number of master gear ratio (P5.084) exceeds the range. $(\mathrm{P5.082} \times \mathrm{P5.083} \leq \mathrm{P5.084} \leq \frac{2^{32}}{P5.082})$

Command code 0x0006	**Create E-Cam table: rotary shear (fixed synchronous speed zone)**
	This macro automatically calculates the data for the E-Cam table according to the macro parameters, and stores them in the data array specified by P5.081. After this macro is executed, if the above parameters have been modified, the E-Cam table must be recreated and you must execute this macro again. Data in the E-Cam table is changed after this macro is executed; thus, do not execute the macro when E-Cam is in engaged status. After this macro is executed, the E-Cam table is not stored in EEPROM automatically. In E-Cam applications, parameters (such as P5.083 and P5.084) that are irrelevant to this macro are not listed here. Set the parameters according to the actual application. Refer to Section 7.3.7 Rotary shear.
General parameters	P5.081 (start address for data array) P5.082 (E-Cam segment number) = 7, this macro is fixed to 7 segments, 8 points P1.044, P1.045 (E-Gear ratio)
Macro parameters	P5.094 = A (number of teeth on the motor) x C (cutting count) P5.095 = B (number of teeth on the cutter) P5.096 = 1000000 x R x V R (cutting length ratio, range 0.07 - 2.5) = L (target cutting length) / ℓ (perimeter of cutter) V (speed compensation, range -20% to 20%) = cutting speed / feeding speed V = 1.0: when cutting, the speed of cutter is the same as the feeding speed V = 1.1: when cutting, the speed of cutter increases 10% V = 0.9: when cutting, the speed of cutter decreases 10%, and so on
Read the return value of P5.097 after executing the macro	Success code
	0x1006
	Failure code
	0xF061: when the clutch is engaged, the E-Cam table cannot be created
	0xF062: data of P5.094 exceeds the range (1 - 65535)
	0xF063: data of P5.095 exceeds the range (1 - 65535)
	0xF064: data of P5.096 exceeds the range (300000 - 2500000)
	0xF065: P5.081 data array start position exceeds the array length
	0xF066: P5.082 E-Cam segment number must be set to 7
	0xF067: E-Gear ratio set by P1.044 and P1.045 is too high. Decrease the value of P1.044 and P1.045, but maintain the same proportions, for example: adjust 167772160 : 1000000 to 16777216 : 100000

Command code 0x0007	**Create E-Cam table: rotary shear (adjustable synchronous speed zone)**
	This macro automatically calculates the data for the E-Cam table according to the macro parameters, and stores them in the data array specified by P5.081. After this macro is executed, if the above parameters have been modified, the E-Cam table must be recreated and you must execute this macro again. Data in the E-Cam table is changed after this macro is executed; thus, do not execute this macro when E-Cam is in the engaged status. After this macro is executed, the E-Cam table is not stored in EEPROM automatically. In E-Cam applications, parameters (such as P5.083 and P5.084) that are irrelevant to this macro are not listed here. Set the parameters according to the actual application. Refer to Section 7.3.7 Rotary shear.
General parameters	P5.081 (start address for data array) P5.082 (E-Cam segment number) = N (range 30 - 72) P1.044, P1.045 (E-Gear ratio)
Macro parameters	P5.093.H (high bit)(Hex) = S (S-curve level, range 1 - 4) P5.093.L (low bit)(Hex) = W (degree of waiting zone, range -1 to 170 degrees) Complementary formula: W´ = 180 + 360/N – 360/R + Y/2 P5.093.L < W', E-Cam table is in error (failure code 0xF07A) P5.093.L = W', initial speed is 0 in E-Cam table P5.093.L > W', initial speed > 0 in E-Cam table, W must be set to -1 P5.094 = Y (degree of synchronous speed zone, range 0 - 330 degrees) P5.095.H (high bit) = A (number of teeth on the motor) x C (cutting count) P5.095.L (low bit) = B (number of teeth on the cutter) P5.096 = 1000000 x R x V (range 1.88 > R x V) R (cutting length ratio) = L (target cutting length) / ℓ (perimeter of cutter) V (speed compensation, range -20% to 20%) = cutting speed / feeding speed V = 1.0: when cutting, the speed of cutter is the same as the feeding speed V = 1.1: when cutting, the speed of cutter increases 10% V = 0.9: when cutting, the speed of cutter decreases 10%, and so on
Read the return value of P5.097 after executing the macro	Success code
	0x1007
	Failure code
	0xF071: when the clutch is engaged, the E-Cam table cannot be created
	0xF072: synchronous speed zone of P5.094 exceeds the range (0 - 330)
	0xF073: S-curve level of P5.093.H exceeds the range (1 - 4)
	0xF074: degree of waiting zone of P5.093.L exceeds the range (-1 to 170)
	0xF075: data of P5.096 exceeds the range (50000 - 5000000)
	0xF076: E-Cam segment number of P5.082 exceeds the range (30 - 72)
	0xF077: P5.081 data array start position exceeds the array length
	0xF078: E-Gear ratio set by P1.044 and P1.045 is too high. Decrease the value of P1.044 and P1.045, but maintain the same proportions, for example: adjust 167772160 : 1000000 to 16777216 : 100000
	0xF079: acceleration degree is too small. Decrease the value for the waiting zone, synchronous speed zone, or S-curve level
	0xF07A: waiting zone < minimum waiting zone. Increase the value for the waiting zone or decrease the value for the synchronous speed zone

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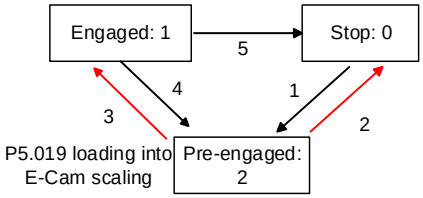
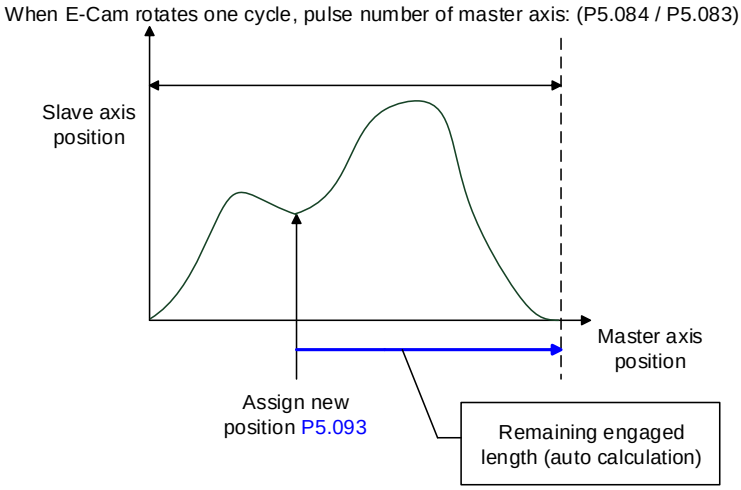
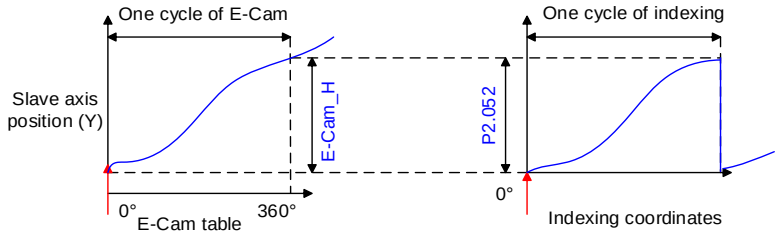
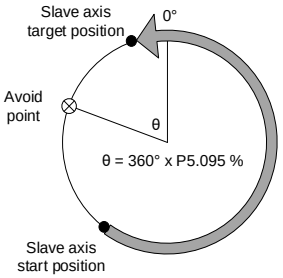
Command code 0x0008	**E-Cam curve scaling (P5.019) is effective immediately**
	This macro can be executed when the clutch is engaged, and the E-Cam scaling (P5.019) becomes effective immediately. If it is necessary to change the E-Cam scaling immediately in the application, set P5.088.X [Bit 2] to 1 or execute this macro. Otherwise, the E-Cam scaling is only loaded into the system by P5.019 at the point when E-Cam engages (see the following transition 3). It cannot be changed in the engaged condition. 
Macro parameters	N/A
Read the return value of P5.097 after executing the macro	Success code
	0x1008
	Failure code
	N/A

Command code 0x000C	**Change engaged position: rotates in forward direction until disengagement condition is met**
	This macro command can change the E-Cam position immediately even when the clutch is engaged. It automatically calculates the remaining engaged length so that E-Cam disengages according to the disengagement condition (P5.088.U) after rotating one cycle (360°) in the forward direction. E-Cam disengages when an alarm occurs or power supply is cut off. If you want E-Cam to re-engage at the last disengaged position and continue its remaining cycle, it is recommended that you record the master axis position of the last disengagement and then execute this macro command. Note that when E-Cam is disengaged, the servo position might shift slightly, causing position error when E-Cam re-engages. When using this macro command, it is recommended that you execute the macro command before operating the master axis. For setting details, refer to Section 7.3.9 Macro. 
Macro parameters	P5.093 (Hex) = specified master axis engaged position; unit: pulse number of master axis Note: monitoring variable 062(3Eh) displays the current position of the master axis.
Read the return value of P5.097 after executing the macro	Success code
	0x100C
	Failure code
	0xF0C1: when executing this macro command, E-Cam is not in engaged status
	0xF0C2: engaged position specified by P5.093 exceeds the range (the value cannot be less than 0)
	0xF0C3: engaged position specified by P5.093 exceeds the range (the value has to be less than the value of (P5.084 / P5.083))

Command code 0x000D	**Calculate the error between the current position of the slave axis and indexing coordinates for PR positioning** When the clutch is engaged and the motor is stopped due to Servo Off or an alarm, position error occurs between the actual position and the E-Cam position. After the servo switches to on again, use this macro command to automatically calculate the displacement value and write the value to the specified PR for incremental positioning. When executing this PR command, the slave axis returns to the corresponding position of the master axis position according to the positive / negative type and reverse limit. For setting details, refer to Section 7.3.9 Macro. When using this macro command: 1. Set P5.088.X [Bit 1] to 1 to keep the clutch engaged when Servo Off. 2. Height of indexing coordinate and E-Cam coordinate should be the same: P2.052 = ECAM_H (moving distance when slave axis operates one cycle) 3. E-Cam curve scaling (P5.019) must be 1.0 time. 4. When E-Cam is engaged for the first time, 0 degrees in the E-Cam table should point to the origin of the indexing coordinate. You can achieve this alignment by executing homing. 5. You can only use this macro command for a periodic cycle and when each cycle starts from the same position.  Note: 1. ECAM_H (moving distance when slave axis operates one cycle) = E-Cam table last point minus E-Cam table first point 2. Indexing coordinate = remainder of (absolute coordinate / P2.052). Monitoring variable 091 displays the current position of the indexing coordinate (PUU) 3. Use PR command via incremental positioning control
Macro parameters	P5.093 (Hex) = DCBA UZYX YX: PR number (0x01 - 0x63); invalid when value is 0 UZ = 00 BA: positive / negative type (P5.095), 0 (avoid point); 1 (allowable forward rate) DC: inhibit reverse rotation. 0 (invalid); 1 (inhibit reverse rotation) P5.095 = avoid point cycle 0 - 100(%) or allowable forward rate 0 - 100(%) 

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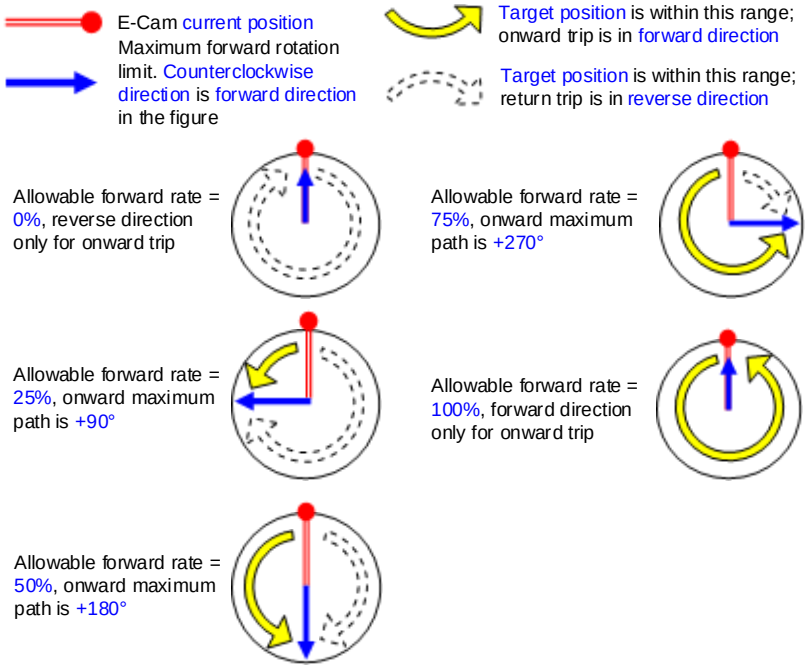
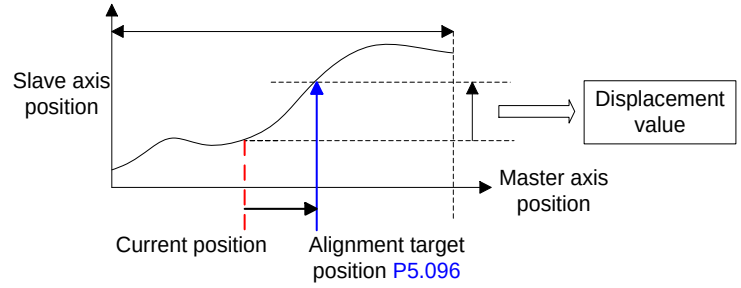
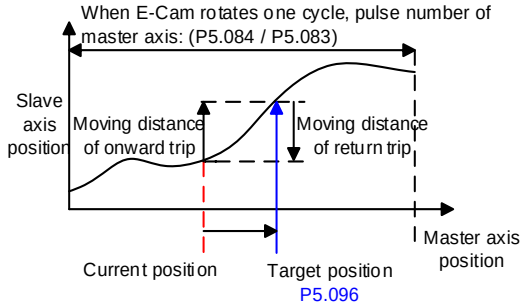
Macro parameters	
Read the return value of P5.097 after executing the macro	Success code 0x100D Failure code 0xF0D1: when executing this macro command, E-Cam is not in engaged status 0xF0D2: PR number specified by P5.093.YX exceeds the range (0x01 - 0x63) 0xF0D3: P5.095 avoid point or allowable forward rate exceeds the range (0 - 100%) 0xF0D5: position correction value does not exist. This macro command might be triggered twice 0xF0D6: E-Cam did not remain engaged when servo is off, so when servo switches to on again, E-Cam is not engaged 0xF0D7: slave axis moving distance does not equal the total index moving distance (ECAM_H ≠ P2.052) 0xF0D8: E-Cam curve scaling does not equal 1 (P5.019 ≠ 1) 0xF0D9: P5.093.BA positive / negative type setting exceeds the range (00 - 01) 0xF0DA: P5.093.DC reverse inhibit setting exceeds the range (00 - 01) 0xF0DB: the reverse inhibit function has failed. Do not use macro command #D and #10 consecutively.

Command code 0x000E	**E-Cam displacement value for PR positioning** When the clutch is engaged, set the E-Cam engaging position with this macro command and calculate the displacement value for the slave axis alignment, then write the displacement value to the specified PR for incremental positioning. Trigger this PR when needed to move the slave axis to the corresponding target position. You can use this macro command: during E-Cam operation, if you want to quickly align the E-Cam position with the mechanical referral point, you can use the sensor to trigger the DI to execute this macro command. For setting details, refer to Section 7.3.9 Macro. When E-Cam rotates one cycle, pulse number of master axis: (P5.084 / P5.083) 

Macro parameters	P5.093 = DCBA UZYX (HEX)
	YX: PR number (0x01 - 0x63); invalid when value is 0
	UZ: maximum allowable alignment correction rate (0x00 - 0x64%)
	| Alignment target position - Current position | / Pulse number of master axis when E-Cam rotates one cycle
	A: PR triggering method. 0 (manual trigger); 1 (immediate automatic trigger)
	B: position of the mark. 0 (on non-compensated motion axis); 1 (on compensated motion axis)
	C: DI channel. 0 (general DI triggering event); 1 (high-speed DI7 with Capture)
	D = 0
	P5.094 = DI time delay compensation (-25000 to +25000 μs)
	P5.095 = Allowable forward rate (0 - 100%) [Refer to macro command #D for the setting]
	P5.096 = Alignment target position; unit: pulse number of master axis (0 to (P5.084 / P5.083) -1)
	Note: monitoring variable 062(3Eh) displays the current position of the master axis.

Read the return value of P5.097 after executing the macro	Success code
	0x100E
	Failure code
	0xF0E1: when executing this macro command, E-Cam is not in engaged status
	0xF0E2: PR number specified by P5.093.YX exceeds the range (0x01 - 0x63)
	0xF0E3: P5.093.UZ maximum correction rate exceeds the range (0 - 0x64%)
	0xF0E4: P5.094 DI delay time compensation exceeds the range (-25000 to +25000 μs)
	0xF0E5: P5.095 allowable forward rate exceeds the range (0 - 100%)
	0xF0E6: P5.096 alignment target position exceeds the range (0 to (P5.084 / P5.083) -1)
	0xF0E7: P5.093 setting value exceeds the range (0x0000 - 0x0111)
	0xF0E8: when using DI7 with Capture triggering (P5.093.C = 1), the master axis pulse source must be the Capture axis (P5.088.Y = 0)
	0xF0E9: when using DI7 with Capture triggering (P5.093.C = 1), execute PR#50 (P5.039.X [Bit 3] = 1) for compensation after the last data is captured

Command code 0x000F	**Calculate the moving distance between the current and target position of the slave axis for PR positioning**
	When the clutch is engaged, this macro command calculates the moving distance between the current and target position of the slave axis and writes the value to the PR incremental position command. You can use this macro command: during E-Cam operation, if you want to move the slave axis to the specified position when the master axis stops but is still in engaged status. This macro command can calculate the moving distance of the onward trip and save the value in the specified PR incremental position command. When the master axis resumes operation, use another PR incremental position command for the moving distance of the return trip, so E-Cam returns to the original position (moving distance of onward trip + moving distance of return trip = 0). For setting details, refer to Section 7.3.9 Macro. 
Macro parameters	P5.093.L (low bit)(Hex) = UZYX YX: PR number of onward trip (0x01 - 0x63); invalid when value is 0 UZ: PR number of return trip (0x01 - 0x63); invalid when value is 0 P5.093.H (high bit)(Hex) = 0 P5.095: allowable forward rate (0 - 100%) (Refer to macro command #D for the setting.) P5.096: target position; unit: pulse number of master axis (0 to (P5.084 / P5.083) -1) Note: monitoring variable 062(3Eh) displays the current position of the master axis.

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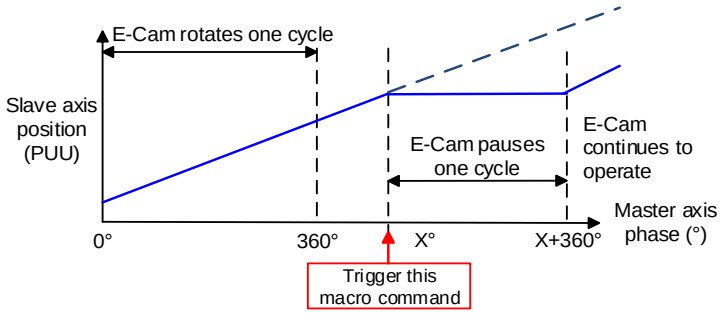
Read the return value of P5.097 after executing the macro	Success code
	0x100F
	Failure code
	0xF0F1: when executing this macro command, E-Cam is not in engaged status
	0xF0F2: PR number of onward trip specified by P5.093.YX exceeds the range (0x01 - 0x63)
	0xF0F3: PR number of return trip specified by P5.093.UZ exceeds the range (0x01 - 0x63)
	0xF0F5: P5.095 allowable forward rate exceeds the range (0 - 100%)
	0xF0F6: P5.096 target position exceeds the range (0 to (P5.084 / P5.083) -1)

Command code 0x0010	**Slave axis immediately pauses for one cycle** After the clutch is engaged, this macro command can immediately pause the slave axis for one cycle regardless of the current E-Cam position. When using this macro command, E-Cam must be the forward operation curve (including straight line), so it can pause. Use this macro command with P1.022.YX acceleration time limit and P1.022.U reverse inhibit to prevent mechanical vibration. For setting details, refer to Section 7.3.9 Macro.  Note: this function is accumulative. If the command is triggered for N times consecutively, it pauses the E-Cam for N cycles. Note that the accumulated pause distance cannot exceed 2^31, otherwise the macro command is invalid. When E-Cam resumes operation, the accumulated pause distance is cleared to 0.
Macro parameters	P5.093 (Hex) = 0x00000000
Read the return value of P5.097 after executing the macro	Success code
	0x1010
	Failure code
	0xF101: when executing this macro command, E-Cam is not in engaged status
	0xF102: value of P5.093 exceeds the range; it must be set to 0x00000000
	0xF103: slave axis must operate in the forward direction. Check the E-Cam curve and P5.019 E-Cam curve scaling
	0xF104: accumulated pause distance exceeds 2^31. Do not execute this macro command consecutively

P5.098	**PR# triggered by event rising-edge**		**Address: 05C4H 05C5H**
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0xDDDD
Format:	HEX	Data size:	16-bit

Settings:

X	PR triggered by EV1 rising-edge	Z	PR triggered by EV3 rising-edge
Y	PR triggered by EV2 rising-edge	U	PR triggered by EV4 rising-edge

- X: PR triggered when EV1 is on

  0: no action

  1 - D: execute PR# 51 - 63

- Y: PR triggered when EV2 is on

  0: no action

  1 - D: execute PR# 51 - 63

- Z: PR triggered when EV3 is on

  0: no action

  1 - D: execute PR# 51 - 63

- U: PR triggered when EV4 is on

  0: no action

  1 - D: execute PR# 51 - 63

P5.099	PR# triggered by event falling-edge		Address: 05C6H 05C7H
Default:	0x0000	Control mode:	PR
Unit:	-	Setting range:	0x0000 - 0xDDDD
Format:	HEX	Data size:	16-bit

Settings:

X	PR triggered by EV1 falling-edge	Z	PR triggered by EV3 falling-edge
Y	PR triggered by EV2 falling-edge	U	PR triggered by EV4 falling-edge

- X: PR triggered when EV1 is off

  0: no action

  1 - D: execute PR# 51 - 63

- Y: PR triggered when EV2 is off

  0: no action

  1 - D: execute PR# 51 - 63

- Z: PR triggered when EV3 is off

  0: no action

  1 - D: execute PR# 51 - 63

■ U: PR triggered when EV4 is off

0: no action

1 - D: execute PR# 51 - 63

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P5.100■	Data array - window #3 for reading and writing		Address: 05C8H 05C9H
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Window #3: when reading or writing the parameter by any method, the value set by P5.011 does not add 1.

Refer to Section 7.2.1 Data array for detailed instructions.

P5.101■	Data array - window #4 for reading and writing		Address: 05CAH 05CBH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Window #4: when reading or writing the parameter by any method, the value set by P5.011 does not add 1.

Refer to Chapter 7 Data array for detailed instructions.

P5.102■	Data array - window #5 for reading and writing		Address: 05CCH 05CDH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Window #5: when reading or writing the parameter by any method, the value set by P5.011 does not add 1.

Refer to Chapter 7 Data array for detailed instructions.

P5.103■	Data array - window #6 for reading and writing		Address: 05CEH 05CFH
Default:	0	Control mode:	All
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Window #6: when reading or writing the parameter by any method, the value set by P5.011 does not add 1.

Refer to Chapter 7 Data array for detailed instructions.

P6.xxx PR parameters

P6.000	Homing definition		Address: 0600H 0601H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFF6F
Format:	HEX	Data size:	32-bit

Settings:

Homing definition:

D C B A

U Z YX

A	DEC2: deceleration time selection for second homing	YX	PATH: path type
B	DLY: select 0 - F for delay time	Z	ACC: select 0 - F for acceleration time
C	N/A	U	DEC1: deceleration time selection for first homing
D	BOOT: execute homing automatically	-	-

- YX: PATH: path type

  0x0: Stop: homing complete and stop

  0x1 - 0x63: Auto: homing complete and execute the specified path (Path#1 - Path#99)

- Z: ACC: select 0 - F for acceleration time

  0 - F: correspond to P5.020 - P5.035

- U: DEC1: deceleration time selection for first homing

  0 - F: correspond to P5.020 - P5.035

- A: DEC2: deceleration time selection for second homing

  0 - F: correspond to P5.020 - P5.035

- B: DLY: select 0 - F for delay time

  0 - F: correspond to P5.040 - P5.055

- D: BOOT: when the drive is powered on, whether to search for the origin

  0: do not execute homing

  1: execute homing automatically (servo switches to on for the first time after applying power)

Apart from the above definitions, the related settings for homing also include:

1. P5.004 homing methods.
2. P5.005 - P5.006 speed setting of searching for the origin.
3. P6.001: ORG_DEF is the coordinate of the origin and may not be 0. This function is used as a traversal of the coordinate.

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Note:

1. After the origin is found (sensor or Z), it has to decelerate to a stop. The stop position exceeds the origin by a short distance:

   If returning to the origin is not needed, set PATH to 0.

   If returning to the origin is needed, set PATH to a non-zero value and set PABS = ORG_DEF.

   Example:

   Upon completion of P6.000 = 0x1, automatically execute Path#1.

   Set from absolute position (ABS) to 0 as the route of Path#1 (set P6.002 & P6.003).

2. If the origin is found (sensor or Z), and you want it to move an offset S and define the coordinate as P after moving, then PATH = non-zero and set ORG_DEF = P - S, and this absolute Position command = P.

P6.001	Origin definition		Address: 0602H 0603H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Origin definition.

P6.002	PATH#1 definition		Address: 0604H 0605H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Format of this parameter: (High word h) DCBA : (Low word L) UZYX

High word

D C B A

Low word

U Z Y X

A	SPD, Target speed index*1	X	TYPE, Path type
B	DLY, Delay time index	Y	OPT, Option
C	AUTO*1	Z	ACC, Acceleration time index*1
D	Reserved	U	DEC, Deceleration time index*1

Definitions are as follows:

■ YX

Y: OPT, Option				X: TYPE, Path type
Bit 3	Bit 2	Bit 1	Bit 0	
-	UNIT	AUTO	INS	1: SPEED, constant speed control.
CMD		OVLP	INS	2: SINGLE, positioning control. It stops when finished.
				3: AUTO, positioning control. It automatically loads the next path when finished.

Y: OPT, Option				X: TYPE, Path type
Bit 3	Bit 2	Bit 1	Bit 0	
-	-	-	INS	7: JUMP, jump to the specified path.
-	ROM	AUTO	INS	8: write specified parameter to specified path.
DIR		OVLP	INS	A: indexing position control.
-	-	-	-	B: statement / arithmetic operation.

TYPE path type: when executing 1 - 3, it can be interrupted and stopped by DI.STP and software limits.

INS: executing this path interrupts the previous path.

OVLP: allow overlapping of the next path. Overlapping is not allowed in Speed mode.

When overlapping in Position mode, DLY has no function.

AUTO: once current PR path is finished, automatically load the next path.

CMD: refer to Section 7.1.3 Motion Control commands.

■ UZ

U: DEC, Deceleration time	Z: ACC, Acceleration time	Corresponding parameter	Default value (ms)
0	0	P5.020	200
1	1	P5.021	300
2	2	P5.022	500
3	3	P5.023	600
4	4	P5.024	800
5	5	P5.025	900
6	6	P5.026	1000
7	7	P5.027	1200
8	8	P5.028	1500
9	9	P5.029	2000
10	10	P5.030	2500
11	11	P5.031	3000
12	12	P5.032	5000
13	13	P5.033	8000
14	14	P5.034	50
15	15	P5.035	30

■ A: SPD, target speed index

A	Corresponding parameter	Default value (ms)
0	P5.060	20
1	P5.061	50
2	P5.062	100
3	P5.063	200
4	P5.064	300
5	P5.065	500
6	P5.066	600
7	P5.067	800
8	P5.068	1000
9	P5.069	1300
10	P5.070	1500

A	Corresponding parameter	Default value (ms)
11	P5.071	1800
12	P5.072	2000
13	P5.073	2300
14	P5.074	2500
15	P5.075	3000

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- B: DLY, delay time index

B	Corresponding parameter	Default value (ms)
0	P5.040	0
1	P5.041	100
2	P5.042	200
3	P5.043	400
4	P5.044	500
5	P5.045	800
6	P5.046	1000
7	P5.047	1500
8	P5.048	2000
9	P5.049	2500
10	P5.050	3000
11	P5.051	3500
12	P5.052	4000
13	P5.053	4500
14	P5.054	5000
15	P5.055	5500

- C: AUTO: once current PR path is finished, automatically load the next path.

  This function is only enabled when X = A indexing position control.

  Description of each bit:

Bit 2	AUTO	0: disable auto function 1: once current PR path is finished, automatically load the next path
Bit 0 - 1	Reserved	-

Note: the parameter format definition [C, A, U, Z] is different from the above table when the path type is [7]: write the specified parameter to the specified path, and [8]: statement / arithmetic operation. Refer to Chapter 7 for detailed instructions.

P6.003	**PATH#1 data**		**Address: 0606H 0607H**
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

P6.002 defines the property of the target point; P6.003 defines the target position of P6.002 or the target path for the Jump command.

P6.004	PATH#2 definition		Address: 0608H 0609H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.005	PATH#2 data		Address: 060AH 060BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.006	PATH#3 definition		Address: 060CH 060DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.007	PATH#3 data		Address: 060EH 060FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.008	PATH#4 definition		Address: 0610H 0611H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.009	PATH#4 data		Address: 0612H 0613H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.010	PATH#5 definition		Address: 0614H 0615H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.011	PATH#5 data		Address: 0616H 0617H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.012	PATH#6 definition		Address: 0618H 0619H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.013	PATH#6 data		Address: 061AH 061BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.014	PATH#7 definition		Address: 061CH 061DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.015	PATH#7 data		Address: 061DH 061FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.016	PATH#8 definition		Address: 0620H 0621H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.017	PATH#8 data		Address: 0622H 0623H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.018	PATH#9 definition		Address: 0624H 0625H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.019	PATH#9 data		Address: 0626H 0627H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.020	PATH#10 definition		Address: 0628H 0629H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.021	PATH#10 data		Address: 062AH 062BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.022	PATH#11 definition		Address: 062CH 062DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.023	PATH#11 data		Address: 062EH 062FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.024	PATH#12 definition		Address: 0630H 0631H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.025	PATH#12 data		Address: 0632H 0633H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.026	PATH#13 definition		Address: 0634H 0635H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.027	PATH#13 data		Address: 0636H 0637H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.028	PATH#14 definition		Address: 0638H 0639H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.029	PATH#14 data		Address: 063AH 063BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.030	PATH#15 definition		Address: 063CH 063DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.031	PATH#15 data		Address: 063EH 063FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.032	PATH#16 definition		Address: 0640H 0641H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.033	PATH#16 data		Address: 0642H 0643H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.034	PATH#17 definition		Address: 0644H 0645H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.035	PATH#17 data		Address: 0646H 0647H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.036	PATH#18 definition		Address: 0648H 0649H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.037	PATH#18 data		Address: 064AH 064BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.038	PATH#19 definition		Address: 064CH 064DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.039	PATH#19 data		Address: 064EH 064FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.040	PATH#20 definition		Address: 0650H 0651H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.041	PATH#20 data		Address: 0652H 0653H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.042	PATH#21 definition		Address: 0654H 0655H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.043	PATH#21 data		Address: 0656H 0657H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.044	PATH#22 definition		Address: 0658H 0659H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.045	PATH#22 data		Address: 065AH 065BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.046	PATH#23 definition		Address: 065CH 065DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.047	PATH#23 data		Address: 065EH 065FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.048	PATH#24 definition		Address: 0660H 0661H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.049	PATH#24 data		Address: 0662H 0663H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.050	PATH#25 definition		Address: 0664H 0665H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.051	PATH#25 data		Address: 0666H 0667H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.052	PATH#26 definition		Address: 0668H 0669H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.053	PATH#26 data		Address: 066AH 066BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.054	PATH#27 definition		Address: 066CH 066DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.055	PATH#27 data		Address: 066EH 066FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.056	PATH#28 definition		Address: 0670H 0671H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.057	PATH#28 data		Address: 0672H 0673H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.058	PATH#29 definition		Address: 0674H 0675H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.059	PATH#29 data		Address: 0676H 0677H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.060	PATH#30 definition		Address: 0678H 0679H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.061	PATH#30 data		Address: 067AH 067BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.062	PATH#31 definition		Address: 067CH 067DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.063	PATH#31 data		Address: 067EH 067FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.064	PATH#32 definition		Address: 0680H 0681H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.065	PATH#32 data		Address: 0682H 0683H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.066	PATH#33 definition		Address: 0684H 0685H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.067	PATH#33 data		Address: 0686H 0687H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.068	PATH#34 definition		Address: 0688H 0689H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.069	PATH#34 data		Address: 068AH 068BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.070	PATH#35 definition		Address: 068CH 068CH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.071	PATH#35 data		Address: 068EH 068FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.072	PATH#36 definition		Address: 0690H 0691H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.073	PATH#36 data		Address: 0692H 0693H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.074	PATH#37 definition		Address: 0694H 0695H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.075	PATH#37 data		Address: 0696H 0697H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.076	PATH#38 definition		Address: 0698H 0699H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.077	PATH#38 data		Address: 069AH 069BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.078	PATH#39 definition		Address: 069CH 069DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.079	PATH#39 data		Address: 069EH 069FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.080	PATH#40 definition		Address: 06A0H 06A1H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.081	PATH#40 data		Address: 06A2H 06A3H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.082	PATH#41 definition		Address: 06A4H 06A5H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.083	PATH#41 data		Address: 06A6H 06A7H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.084	PATH#42 definition		Address: 06A8H 06A9H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.085	PATH#42 data		Address: 06AAH 06ABH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.086	PATH#43 definition		Address: 06ACH 06ADH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.087	PATH#43 data		Address: 06AEH 06AFH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.088	PATH#44 definition		Address: 06B0H 06B1H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.089	PATH#44 data		Address: 06B2H 06B3H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.090	PATH#45 definition		Address: 06B4H 06B5H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.091	PATH#45 data		Address: 06B6H 06B7H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.092	PATH#46 definition		Address: 06B8H 06B9H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.093	PATH#46 data		Address: 06BAH 06BBH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.094	PATH#47 definition		Address: 06BCH 06BDH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.095	PATH#47 data		Address: 06BEH 06BFH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.096	PATH#48 definition		Address: 06C0H 06C1H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.097	PATH#48 data		Address: 06C2H 06C3H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P6.098	PATH#49 definition		Address: 06C4H 06C5H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P6.099	PATH#49 data		Address: 0602H 0603H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

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Settings:

Refer to the description of P6.003.

P7.xxx PR parameters

P7.000	PATH#50 definition		Address: 0700H 0701H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.001	PATH#50 data		Address: 0702H 0703H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.002	PATH#51 definition		Address: 0704H 0705H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.003	PATH#51 data		Address: 0706H 0707H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.004	PATH#52 definition		Address: 0708H 0709H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.005	PATH#52 data		Address: 070AH 070BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.006	PATH#53 definition		Address: 070CH 070DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.007	PATH#53 data		Address: 070EH 070FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.008	PATH#54 definition		Address: 0710H 0711H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.009	PATH#54 data		Address: 0712H 0713H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.010	PATH#55 definition		Address: 0714H 0715H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.011	PATH#55 data		Address: 0716H 0717H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.012	PATH#56 definition		Address: 0718H 0719H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.013	PATH#56 data		Address: 071AH 071BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.014	PATH#57 definition		Address: 071CH 071DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.015	PATH#57 data		Address: 071EH 071FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.016	PATH#58 definition		Address: 0720H 0721H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.017	PATH#58 data		Address: 0722H 0723H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.018	PATH#59 definition		Address: 0724H 0725H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.019	PATH#59 data		Address: 0726H 0727H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.020	PATH#60 definition		Address: 0728H 0729H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.021	PATH#60 data		Address: 072AH 072BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.022	PATH#61 definition		Address: 072CH 072DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.023	PATH#61 data		Address: 072EH 072FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.024	PATH#62 definition		Address: 0730H 0731H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.025	PATH#62 data		Address: 0732H 0733H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.026	PATH#63 definition		Address: 0734H 0735H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.027	PATH#63 data		Address: 0736H 0737H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.028	PATH#64 definition		Address: 0738H 0739H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.029	PATH#64 data		Address: 073AH 073BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.030	PATH#65 definition		Address: 073CH 073DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.031	PATH#65 data		Address: 073EH 073FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.032	PATH#66 definition		Address: 0740H 0741H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.033	PATH#66 data		Address: 0742H 0743H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.034	PATH#67 definition		Address: 0744H 0745H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.035	PATH#67 data		Address: 0746H 0747H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.036	PATH#68 definition		Address: 0748H 0749H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.037	PATH#68 data		Address: 074AH 074BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.038	PATH#69 definition		Address: 074CH 074DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.039	PATH#69 data		Address: 074EH 074FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.040	PATH#70 definition		Address: 0750H 0751H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.041	PATH#70 data		Address: 0752H 0753H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.042	PATH#71 definition		Address: 0754H 0755H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.043	PATH#71 data		Address: 0756H 0757H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.044	PATH#72 definition		Address: 0758H 0759H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.045	PATH#72 data		Address: 075AH 075BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.046	PATH#73 definition		Address: 075CH 075DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.047	PATH#73 data		Address: 075EH 075FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.048	PATH#74 definition		Address: 0760H 0761H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.049	PATH#74 data		Address: 0762H 0763H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.050	PATH#75 definition		Address: 0764H 0765H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.051	PATH#75 data		Address: 0766H 0767H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.052	PATH#76 definition		Address: 0768H 0769H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.053	PATH#76 data		Address: 076AH 076BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.054	PATH#77 definition		Address: 076CH 076DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.055	PATH#77 data		Address: 076EH 076FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.056	PATH#78 definition		Address: 0770H 0771H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.057	PATH#78 data		Address: 0772H 0773H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.058	PATH#79 definition		Address: 0774H 0775H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.059	PATH#79 data		Address: 0776H 0777H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.060	PATH#80 definition		Address: 0778H 0779H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.061	PATH#80 data		Address: 077AH 077BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.062	PATH#81 definition		Address: 077CH 077DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.063	PATH#81 data		Address: 077EH 077FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.064	PATH#82 definition		Address: 0780H 0781H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.065	PATH#82 data		Address: 0782H 0783H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.066	PATH#83 definition		Address: 0784H 0785H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.067	PATH#83 data		Address: 0786H 0787H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.068	PATH#84 definition		Address: 0788H 0789H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.069	PATH#84 data		Address: 078AH 078BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.070	PATH#85 definition		Address: 078CH 078DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.071	PATH#85 data		Address: 078EH 078FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.072	PATH#86 definition		Address: 0790H 0791H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.073	PATH#86 data		Address: 0792H 0793H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.074	PATH#87 definition		Address: 0794H 0795H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.075	PATH#87 data		Address: 0796H 0797H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.076	PATH#88 definition		Address: 0798H 0799H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.077	PATH#88 data		Address: 079AH 079BH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.078	PATH#89 definition		Address: 079CH 079DH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.079	PATH#89 data		Address: 079EH 079FH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.080	PATH#90 definition		Address: 07A0H 07A1H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.081	PATH#90 data		Address: 07A2H 07A3H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.082	PATH#91 definition		Address: 07A4H 07A5H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.083	PATH#91 data		Address: 07A6H 07A7H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.084	PATH#92 definition		Address: 07A8H 07A9H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.085	PATH#92 data		Address: 07AAH 07ABH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.086	PATH#93 definition		Address: 07ACH 07ADH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.087	PATH#93 data		Address: 07AEH 07AFH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.088	PATH#94 definition		Address: 07B0H 07B1H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.089	PATH#94 data		Address: 07B2H 07B3H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.090	PATH#95 definition		Address: 07B4H 07B5H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.091	PATH#95 data		Address: 07B6H 07B7H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.092	PATH#96 definition		Address: 07B8H 07B9H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.093	PATH#96 data		Address: 07BAH 07BBH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.094	PATH#97 definition		Address: 07BCH 07BDH
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.095	PATH#97 data		Address: 07BEH 07BFH
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.096	PATH#98 definition		Address: 07C0H 07C1H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.097	PATH#98 data		Address: 07C3H 07C4H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

P7.098	PATH#99 definition		Address: 07C4H 07C5H
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 - 0xFFFFFFFF
Format:	HEX	Data size:	32-bit

Settings:

Refer to the description of P6.002.

P7.099	PATH#99 data		Address: 07C6H 07C7H
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 to +2147483647
Format:	DEC	Data size:	32-bit

Settings:

Refer to the description of P6.003.

PM.xxx Motor parameters

PM.000▲●	Motor type		Address: FD00H FD01H
Default:	0	Control mode:	All
Unit:	-	Setting range:	0 - 5
Format:	DEC	Data size:	16-bit

Settings:

Value	Motor type
0	Permanent-magnet synchronous rotary motor (SPM)
1	Reserved
2	Permanent-magnet synchronous linear motor (LM)
3 - 5	Reserved

PM.001▲■	Motor parameter automatic identification function		Address: FD02H FD03H
Default:	0	Applicable motor:	Linear motor, third-party rotary motor
Unit:	-	Setting range:	0 - 1
Format:	DEC	Data size:	16-bit

Settings:

0: disable

1: enable

Note:

1. This parameter is invalid if you are using a Delta rotary motor.
2. Rotary motor means a permanent-magnet synchronous rotary motor; linear motor means a permanent-magnet synchronous linear motor.

PM.002▲●	Motor parameter identification status		Address: FD04H FD05H
Default:	0	Applicable motor:	Linear motor, third-party rotary motor
Unit:	-	Setting range:	0 - 1
Format:	DEC	Data size:	16-bit

Settings:

0: motor identification is not complete yet

1: motor identification is complete

Note:

1. When this parameter is 0 and you switch the servo to the Servo On state, AL053 occurs to warn the user that the motor identification is not yet complete. This parameter is automatically set to 1 when the motor parameter automatic identification is complete.
2. This parameter is invalid if you are using a Delta rotary motor.

3. Rotary motor means a permanent-magnet synchronous rotary motor; linear motor means a permanent-magnet synchronous linear motor.

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PM.003▲●	Encoder type		Address: FD06H FD07H
Default:	0x0010	Applicable motor:	Linear motor, third-party rotary motor
Unit:	-	Setting range:	0x0000 - 0x1311
Format:	HEX	Data size:	16-bit

Settings:

■ X: signal type[*2]

0: square wave digital signal

1: sine wave analog signal

■ Y: Hall sensor

0: no Hall sensor

1: with Hall sensor

Note that if you select “no Hall sensor”, the motor moves slightly to detect the magnetic pole when the servo is on for the first time. This cannot be applied to Z axis without the spring installed or balancing process.

■ Z: converter box AB pulse filter[*2]

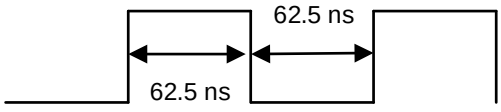
0: BYPASS

1: 16 MHz

2: 8 MHz

3: 3 MHz

Example: pulse width 16 MHz (62.5 ns)



■ U: signal source

0: CN2

1: CN5

Note:

1. Do not set this parameter if you are using a Delta rotary motor.
2. This function is coming soon.
3. Rotary motor means a permanent-magnet synchronous rotary motor; linear motor means a permanent-magnet synchronous linear motor.

PM.004▲●	Encoder resolution		Address: FD08H FD09H
Default:	-	Applicable motor:	Linear motor, third-party rotary motor
Unit:	Third-party rotary motor: Square wave digital signal: pulse/rev Sine wave analog signal*1: periods/rev Linear motor: Square wave digital signal: $10^{-3}\mu m/pulse$ Sine wave analog signal*1: $10^{-3}\mu m/period$	Setting range:	Third-party rotary motor: 128 - 268435456 (2^{28}) Linear motor: 1 - 30000
Format:	DEC	Data size:	32-bit

Settings:

Set the resolution according to the third-party encoder specifications and note the setting range based on the motor type.

Third-party rotary motor: for a square wave encoder, input the number of single-phase pulses for one revolution; for a sine wave encoder, input the number of sine waves for one revolution.

Linear motor: input the linear scale resolution.

Note:

1. Currently, the ASDA-A3 does not support sine wave analog signal (CN2 converter box), but this is expected to be added soon.
2. If the setting is incorrect, AL051 occurs.
3. Rotary motor means a permanent-magnet synchronous rotary motor; linear motor means a permanent-magnet synchronous linear motor.

PM.005 - PM.008	Reserved

PM.009▲	Electrical angle correction function		Address: FD12H FD13H
Default:	0x0000	Applicable motor:	Linear motor, third-party rotary motor
Unit:	-	Setting range:	0x0000 - 0x0012
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	Use the Hall sensor to determine whether the motor magnetic field is deviated	If the deviation between the magnetic field detected by the Hall sensor and the actual magnetic field of the motor is too large, AL055 occurs. 0: disable 1: enable
Bit 5 - Bit 15	Reserved	-

PM.010	Reserved

PM.011▲	Initial magnetic field current detection		Address: FD16H FD17H
Default:	100	Applicable motor:	Linear motor, third-party rotary motor
Unit:	%	Setting range:	0 - 300
Format:	DEC	Data size:	16-bit

Settings:

If you are using a Hall sensor, you do not need to set this parameter.

If you are not using a Hall sensor (PM.003.Y = 0), the servo automatically detects the motor magnetic field when the servo is on for the first time after powering on. Use this parameter to set the current during the motor magnetic field detection. The current affects the swaying level of the linear motor during detection, and the servo obtains the magnetic field data through the swaying. Adjust this parameter when the following condition occurs:

1. When the friction between the motor and the mechanism is too large, magnetic field detection error may occur which triggers AL052. Increase the set value of this parameter can reduce the occurrence of AL052.
2. When the linear motor sways too much, lower the set value of this parameter to reduce the swaying during magnetic field detection.

Note:

1. Initial magnetic field current detection cannot be applied to Z axis without the spring installed or balancing process. Without the spring or balancing process, the Z axis has different frictional forces in the up and down direction, which will affect the result of the magnetic field detection. In this case, you can only add a Hall sensor.
2. The gantry application requires a Hall sensor for initial magnetic field detection.

PM.012	Reserved

PM.013▲●	Third-party motor flag		Address: FD1EH FD1FH
Default:	0	Applicable motor:	All
Unit:	-	Setting range:	0 - 1
Format:	DEC	Data size:	16-bit

Settings:

1. When you are using a Delta motor, set this parameter to 0. (This parameter is automatically set to 0 when the Delta motor is connected to CN2 and the communication is successful.)
2. When you are using a third-party motor, set this parameter to 1. (This parameter is automatically set to 1 when you execute the Motor Parameter Identification Wizard with a third-party motor.)

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:	rad/s	0.001 rad/s	-	-
Setting range:	Rotary motor: 0.000 - 1023.000 Linear motor: 0.000 - 16383.000	Rotary motor: 0 - 1023000 Linear motor: 0 - 16383000		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 rad/s	1500 = 1.5 rad/s		

Settings:

Increasing the current control gain can enhance the current response and reduce the current control errors. If you set the value too high, it may cause vibration and noise. It is suggested that general users do not adjust this parameter.

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

PM.016	Current loop integral gain (ki)		Address: FD20H FD21H
Default:	0	Applicable motor:	All
Unit:	%	Setting range:	0 - 32767
Format:	DEC	Data size:	16-bit

Settings:

Increasing the current control integral can enhance the current response and reduce the current control errors. If you set the value too high, it 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:	15 - 600
Format:	DEC	Data size:	16-bit

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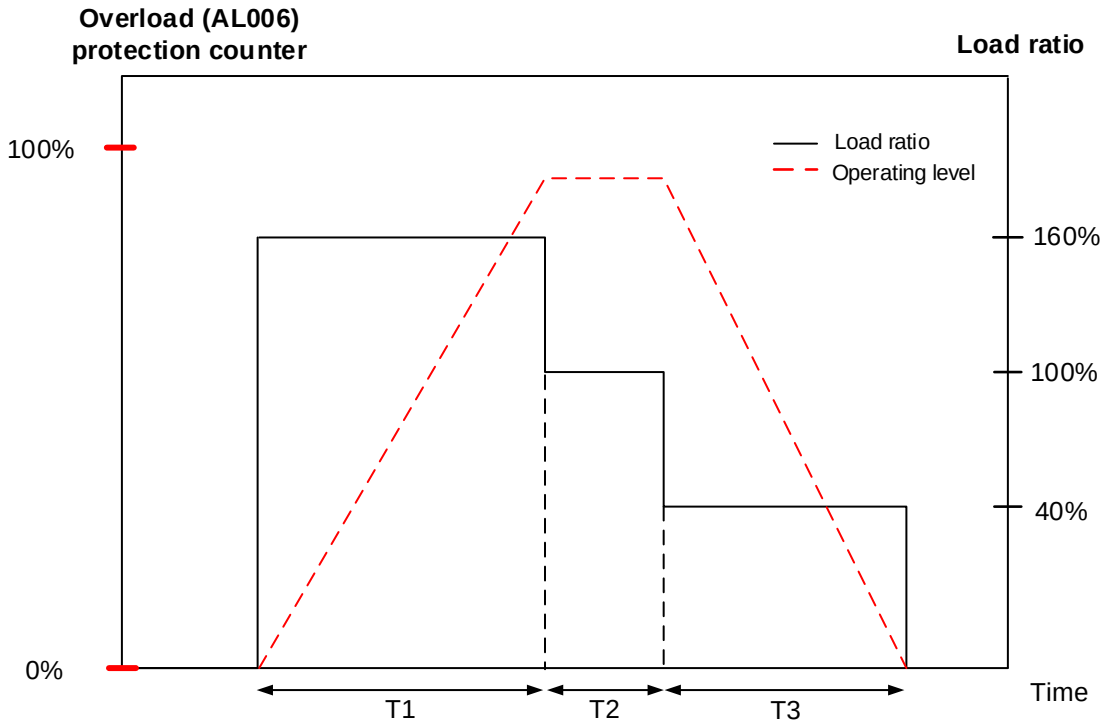
Settings:

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%	26.38 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

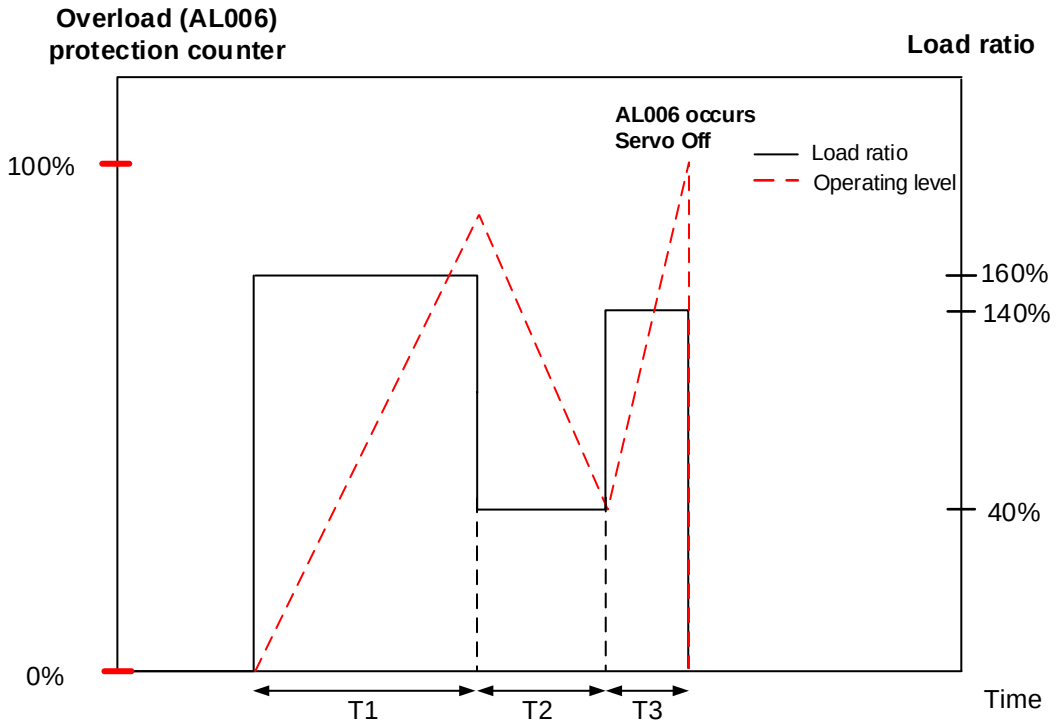
The time required for the motor protection level at the normal level to reach the overload level is called the operating time. When the protection level reaches the overload level, AL006 is triggered. The load ratio is based on 100%. When the ratio is above 100%, it is load increase gain (PM.019); when the ratio is less than 100%, it is load decrease gain (PM.020).

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 figure above, 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. If the load ratio is below 100%, you do not need to consider the operating time.

PM.020▲	Load decrease gain		Address: FD28H FD29H
Default:	100	Applicable motor:	All
Unit:	%	Setting range:	0 - 600
Format:	DEC	Data size:	16-bit

Settings:

Refer to the description of PM.019.

PM.021	Reserved

PM.022▲●	Motor temperature sensor		Address: FD2CH FD2DH
Default:	0	Applicable motor:	Linear motor, third-party rotary motor
Unit:	-	Setting range:	0 - 3
Format:	DEC	Data size:	16-bit

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Settings:

0: not connected to a motor temperature sensor

1: Delta linear motor NTC thermistor

2: NTC level thermistor

3: PTC level thermistor

Note: the connection method for the CN5 temperature sensor is to connect the two pins of the temperature sensor to Pin 13 and Pin 14 (see Section 3.7).

PM.023	Reserved

PM.024▲	Motor temperature sensor resistance		Address: FD30H FD31H
Default:	50000	Applicable motor:	Linear motor, third-party rotary motor
Unit:	ohm	Setting range:	0 - 50000
Format:	DEC	Data size:	32-bit

Settings:

This parameter is only valid when PM.022 is set to 2 or 3. Input the resistance value corresponding to the temperature according to the specifications of the connected temperature sensor. Refer to the NTC or PTC temperature and resistance value corresponding table for the resistance value.

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 - 100
Format:	DEC	Data size:	16-bit

Settings:

Input the correct information 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 information according to the specifications of the third-party permanent-magnet rotary motor. Unit conversion between Ampere peak and Ampere RMS:

$$\text{Ampere peak (Apk)} = \text{Ampere RMS (Arms)} \times \sqrt{2}$$

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 information according to the specifications of the third-party permanent-magnet rotary motor. Unit conversion between Ampere peak and Ampere RMS:

$$\text{Ampere peak (Apk)} = \text{Ampere RMS (Arms)} \times \sqrt{2}$$

PM.031▲	Permanent-magnet rotary motor rated speed		Address: FD3EH FD3FH
Default:	-	Applicable motor:	Permanent-magnet rotary motor
Unit:	rpm	Setting range:	0 - 3000
Format:	DEC	Data size:	16-bit

Settings:

Input the correct information 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 - 6000
Format:	DEC	Data size:	16-bit

Settings:

Input the correct information 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 - 65.535	0 - 65535		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 Nm/Arms	1500 = 1.5 Nm/Arms		

Settings:

Input the correct information according to the specifications of the third-party permanent-magnet rotary motor. Unit conversion between Ampere peak and Ampere RMS:

$$\text{Ampere peak (Apk)} = \text{Ampere RMS (Arms)} \times \sqrt{2}$$

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:	$10^{-4}\text{kg}\cdot m^2$	0.001*$10^{-4}\text{kg}\cdot m^2$		
Setting range:	0.000 - 2147483.647	0 - 2147483647		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5x10^{-4} $\text{kg}\cdot m^2$	1500 = 1.5x10^{-4} $\text{kg}\cdot m^2$		

Settings:

Input the correct information according to the specifications of the third-party permanent-magnet rotary motor. Unit conversion between Ampere peak and Ampere RMS:

$$\text{Ampere peak (Apk)} = \text{Ampere RMS (Arms)} \times \sqrt{2}$$

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 - 65.535	0 - 65535		
Format:	Two decimals	DEC		
Example:	1.5 = 1.5 ohm	1500 = 1.5 ohm		

Settings:

Input the correct information 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 - 655.35	0 - 65535		
Format:	Two decimals	DEC		
Example:	1.5 = 1.5 mH	150 = 1.5 mH		

Settings:

Input the correct information 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 - 2.2876	0 - 22876		
Format:	Four decimals	DEC		
Example:	1.5 = 1.5 Vrms/rpm	15000 = 1.5 Vrms/rpm		

Settings:

Input the correct information according to the specifications of the third-party permanent-magnet rotary motor.

PM.039 - PM.044	Reserved

PM.045▲●	Linear motor pole pitch			Address: FD5AH FD5BH
Operation interface:	Panel / software	Communication	Applicable motor:	Linear motor
Default:	-	-	Data size:	32-bit
Unit:	mm/360°	0.001 mm/360°		
Setting range:	1.000 - 500.000	1000 - 500000		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 mm/360°	1500 = 1.5 mm/360°		

Settings:

Input the correct information according to the specifications of the linear motor.

PM.046▲●	Linear motor rated current			Address: FD5CH FD5DH
Operation interface:	Panel / software	Communication	Applicable motor:	Linear 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 information according to the specifications of the linear motor. Unit conversion between Ampere peak and Ampere RMS:

$$\text{Ampere peak (Apk)} = \text{Ampere RMS (Arms)} \times \sqrt{2}$$

PM.047▲●	Linear motor maximum current			Address: FD5EH FD5FH
Operation interface:	Panel / software	Communication	Applicable motor:	Linear 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 information according to the specifications of the linear motor.

PM.048▲	Linear motor maximum speed		Address: FD60H FD61H
Default:	-	Applicable motor:	Linear motor
Unit:	mm/s	Setting range:	0 - 15999
Format:	DEC	Data size:	16-bit

Settings:

Input the correct information according to the specifications of the linear motor.

PM.049▲	Linear motor force constant			Address: FD62H FD63H
Operation interface:	Panel / software	Communication	Applicable motor:	Linear motor
Default:	-	-	Data size:	32-bit
Unit:	N/Arms	0.01 N/Arms		
Setting range:	0.00 - 1773.62	0 - 177362		
Format:	Two decimals	DEC		
Example:	1.5 = 1.5 N/Arms	150 = 1.5 N/Arms		

Settings:

Input the correct information according to the specifications of the linear motor.

PM.050▲	Linear motor phase resistance			Address: FD64H FD65H
Operation interface:	Panel / software	Communication	Applicable motor:	Linear motor
Default:	-	-	Data size:	32-bit
Unit:	ohm	0.001 ohm		
Setting range:	0.000 - 63.535	0 - 63535		
Format:	Three decimals	DEC		
Example:	1.5 = 1.5 ohm	1500 = 1.5 ohm		

Settings:

Input the correct information according to the specifications of the linear motor.

PM.051▲	Linear motor phase inductance			Address: FD66H FD67H
Operation interface:	Panel / software	Communication	Applicable motor:	Linear motor
Default:	-	-	Data size:	32-bit
Unit:	mH	0.01 mH		
Setting range:	0.00 - 655.35	0 - 65535		
Format:	Two decimals	DEC		
Example:	1.5 = 1.5 mH	150 = 1.5 mH		

Settings:

Input the correct information according to the specifications of the linear motor.

PM.052	Reserved

PM.053▲	Linear motor back electromotive force constant			Address: FD6AH FD6BH
Operation interface:	Panel / software	Communication	Applicable motor:	Linear motor
Default:	-	-	Data size:	16-bit
Unit:	Vrms/(m/s)	0.1 Vrms/(m/s)		
Setting range:	0.0 - 591.2	0 - 5912		
Format:	One decimal	DEC		
Example:	1.5 = 1.5 Vrms/(m/s)	15 = 1.5 Vrms/(m/s)		

Settings:

Input the correct information according to the specifications of the linear motor.

PM.054 - PM.063	Reserved

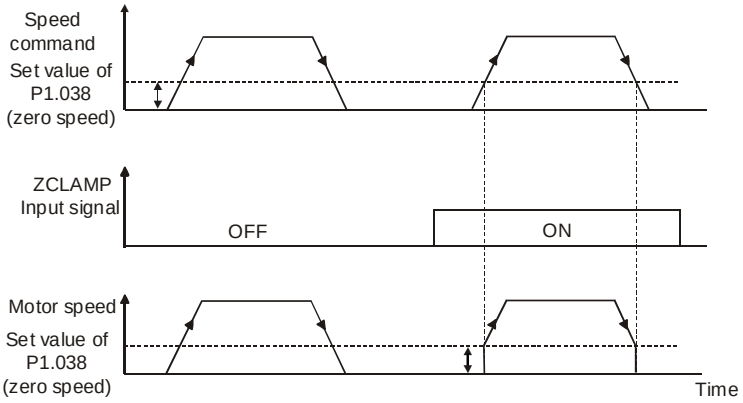
Table 8.1 Digital input (DI) descriptions

Value: 0x01			
DI name	Description	Triggering method	Control mode
SON	When this DI is on, servo is activated (Servo On).	Level triggered	All

Value: 0x02			
DI name	Description	Triggering method	Control mode
ARST	After the alarm is cleared, the drive shows that the alarm is cleared when this DI is on.	Rising-edge triggered	All

Value: 0x03			
DI name	Description	Triggering method	Control mode
GAINUP	In Speed and Position modes, when this DI is on (P2.027 set to 1), the gain switches to the original gain multiplied by the switching rate.	Level triggered	PT, PR, S

Value: 0x04			
DI name	Description	Triggering method	Control mode
CCLR	Clear pulse counter and P2.050. Set DI.CCLR to 0 to clear position pulse deviation (applicable to PT mode). When this DI is on, the accumulative pulse deviation of the drive is cleared to 0.	Rising-edge triggered, level triggered	PT, PR

Value: 0x05			
DI name	Description	Triggering method	Control mode
ZCLAMP	When the speed is slower than the setting of zero speed (P1.038), the motor stops operating when this DI is on. 	Level triggered	S

Value: 0x06			
DI name	Description	Triggering method	Control mode
CMDINV	In Speed and Torque modes, the input command is reversed when this DI is on.	Level triggered	S, Sz, T

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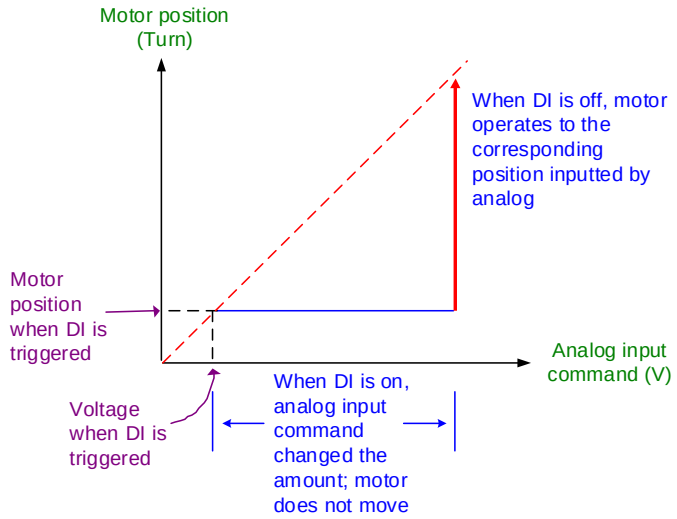
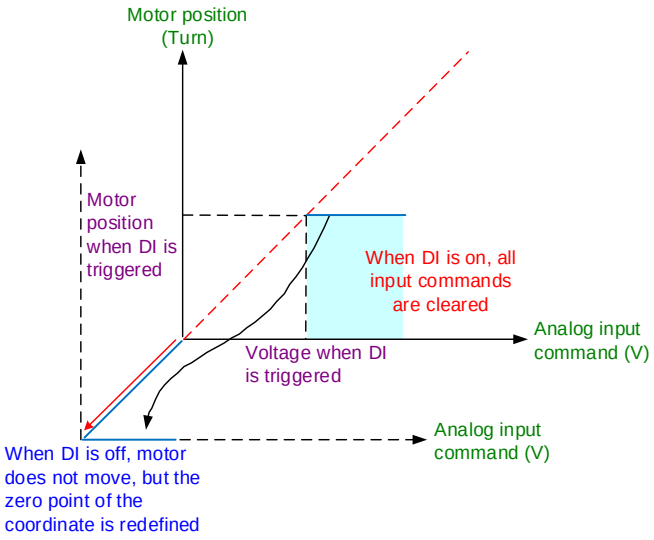
Value: 0x08			
DI name	Description	Triggering method	Control mode
CTRG	In PR mode, after selecting the PR command (POS0 - 6), the motor operates according to the command issued by the register when this DI is on.	Rising-edge triggered	PR

Value: 0x09			
DI name	Description	Triggering method	Control mode
TRQLM	In Speed and Position modes, motor torque is limited when this DI is on, and source of the limited Torque command is the internal register or analog voltage.	Level triggered	PT, PR, S

Value: 0x0A			
DI name	Description	Triggering method	Control mode
GTRY	After this DI is on, it temporarily disables the monitoring function of the gantry (synchronous motion) when P1.074 = 2 (gantry function enabled). The axis that receives this DI stops calculating and monitoring the deviation of the two axes.	Rising-edge triggered	PT

Value: 0x0C			
DI name	Description	Triggering method	Control mode
VPL	Latch function of analog Position command. If this DI is on, position of the motor is held at the current position when the DI is triggered. During this DI is on, the motor does not operate even when there is a change in the analog command. When this DI is off, the motor completes the command that was changed during the time DI was on. 	Level triggered	PT

Value: 0x0D			
DI name	Description	Triggering method	Control mode
VPRS	Clear function of analog Position command. If this DI is on, the position of the motor is held at the current position when DI is triggered. Despite the change in the analog command during DI is on, the motor remains at the current position even when the DI is off. However, the position that the motor remains at corresponds to the new analog command. Thus, the analog input command redefines the coordinate system of the motor.  	Level triggered	PT

Value: 0x0E			
DI name	Description	Triggering method	Control mode
FEC	Clear error of full-closed loop linear scale and motor encoder.	Rising-edge triggered	PT/PR full-closed loop

Value: 0x10			
DI name	Description	Triggering method	Control mode
SPDLM	In Torque mode, motor speed is limited when this DI is on, and source of the limited Speed command is the internal register or analog voltage.	Level triggered	T

Value: 0x11, 0x12, 0x13, 0x1A, 0x1B, 0x1C, 0x1E

DI name	Description	Triggering method	Control mode
POS0 POS1 POS2 POS3 POS4 POS5 POS6	PR command selection (1 - 99)	Level triggered	PR

Position command	POS 6	POS 5	POS 4	POS 3	POS 2	POS 1	POS 0	CTRG	Corresponding parameter
Homing	0	0	0	0	0	0	0	↑	P6.000 P6.001
PR 1	0	0	0	0	0	0	1	↑	P6.002 P6.003
~									
PR 50	0	1	1	0	0	1	0	↑	P6.098 P6.099
PR 51	0	1	1	0	0	1	1	↑	P7.000 P7.001
~									
PR 99	1	1	0	0	0	1	1	↑	P7.098 P7.099

Value: 0x1D

DI name	Description	Triggering method	Control mode
ABSE	When DI.ABSE is on, it is in absolute mode and can enable the functions of DI.ABSQ, DI.ABSC, DI.ABSR, DI.ABSD, and DI.ABSC at the same time. When DI.ABSE is on, the functions of DI4, DO2, and DO3 are no longer the ones assigned by the parameter. The DI4 function will be DI.ASDQ, DO2 will be DI.ABSR, and DO3 will be DI.ABSD. In addition, DI pins of DI.ABSC can be assigned by parameters.	Level triggered	All

Value: 0x1F

DI name	Description	Triggering method	Control mode
ABSC	When DI.ABSC is on, the number of turns stored in absolute encoder are cleared. But this DI is only valid when DI.ABSE is on.	Rising-edge triggered	All

Value: when DI.ABSE is on, the DI.ABSQ from DI4 replaces the DI4 function from P2.013

DI name	Description	Triggering method	Control mode
ABSQ always input by DI4	During I/O transmission, the controller sends the handshaking signal. When DI.ABSQ is off, the controller issues the request; when DI.ABSQ is on, the controller has processed the ABSD signal. This DI is only valid when DI.ABSE is on. Refer to Figure 10.3.4. for a detailed description.	Rising- and falling-edge triggered	All

Value: 0x14, 0x15

DI name	Description	Triggering method	Control mode
SPD0 SPD1	Register Speed command selection (1 - 4) Note: rotary means a permanent-magnet synchronous rotary motor; linear means a permanent-magnet synchronous linear motor.	Level triggered	S

Speed command number	DI signal of CN1 SPD1	DI signal of CN1 SPD0	Command source			Content	Range
S1	0	0	Mode	Sz	N/A	Speed command is 0	0
S2	0	1	Register parameter			P1.009	+/- 6000 rpm (rotary) +/- 15999999 (linear)
S3	1	0				P1.010	+/- 6000 rpm (rotary) +/- 15999999 (linear)
S4	1	1				P1.011	+/- 6000 rpm (rotary) +/- 15999999 (linear)

Value: 0x16, 0x17

DI name	Description	Triggering method	Control mode
TCM0 TCM1	Register Torque command selection (1 - 4)	Level triggered	T

Torque command number	DI signal of CN1 TCM1	DI signal of CN1 TCM0	Command source			Content	Range
T1	0	0	Mode	Tz	N/A	Torque command is 0	0
T2	0	1	Register parameter			P1.012	+/-400%
T3	1	0				P1.013	+/-400%
T4	1	1				P1.014	+/-400%

Value: 0x18

DI name	Description	Triggering method	Control mode
S-P	In S-P dual mode, if DI is off, it is in Speed mode; if DI is on, it is in Position mode. In PT / PR / S modes, PT or PR is selected with DI.PT-PR (0x2B).	Level triggered	Dual mode

Value: 0x19

DI name	Description	Triggering method	Control mode
S-T	In S-T dual mode, if DI is off, it is in Speed mode; if DI is on, it is in Torque mode.	Level triggered	Dual mode

Value: 0x20

DI name	Description	Triggering method	Control mode
T-P	In T-P dual mode, if DI is off, it is in Torque mode; if DI is on, it is in Position mode. In PT / PR / T modes, select PT or PR with DI.PT-PR (0x2B).	Level triggered	Dual mode

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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)	Reverse inhibit limit (contact B).	Level triggered	All

Value: 0x23			
DI name	Description	Triggering method	Control mode
PL (CCWL)	Forward inhibit limit (contact B).	Level triggered	All

Value: 0x24			
DI name	Description	Triggering method	Control mode
ORGP	During homing, when this DI is on, the servo uses this position as the homing origin. Refer to the setting of P5.004.	Rising- and falling-edge triggered	PR

Value: 0x27			
DI name	Description	Triggering method	Control mode
SHOM	During homing, when this DI is on, it activates the function to search for the origin. Refer to the setting of P5.004.	Rising-edge triggered	PR

Value: 0x2B			
DI name	Description	Triggering method	Control mode
PT-PR	Use this DI to select the command source in PT-PR dual mode or PT-PR-S multiple mode. If this DI is off, it is in PT mode; if this DI is on, it is in PR mode.	Level triggered	Dual mode

Value: 0x35			
DI name	Description	Triggering method	Control mode
ALGN	When the E-Cam phase alignment function is enabled (P2.076 [Bit 0] = 1 and P2.076 [Bit 1] = 1), it executes phase alignment when this DI is on.	Rising-edge triggered	PR

Value: 0x36			
DI name	Description	Triggering method	Control mode
CAM	E-Cam engaging control. Refer to the setting of P5.088 U, Z value.	Rising- and falling-edge triggered	PR

Value: 0x37			
DI name	Description	Triggering method	Control mode
JOGU	When this DI is on, motor jogs in the forward direction.	Level triggered	All

Value: 0x38			
DI name	Description	Triggering method	Control mode
JOGD	When this DI is on, motor jogs in the reverse direction.	Level triggered	All

Value: 0x39			
DI name	Description	Triggering method	Control mode
EV1	Event trigger command #1. Refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

Value: 0x3A			
DI name	Description	Triggering method	Control mode
EV2	Event trigger command #2. Refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

Value: 0x3B			
DI name	Description	Triggering method	Control mode
EV3	Event trigger command #3. Refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

Value: 0x3C			
DI name	Description	Triggering method	Control mode
EV4	Event trigger command #4. Refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

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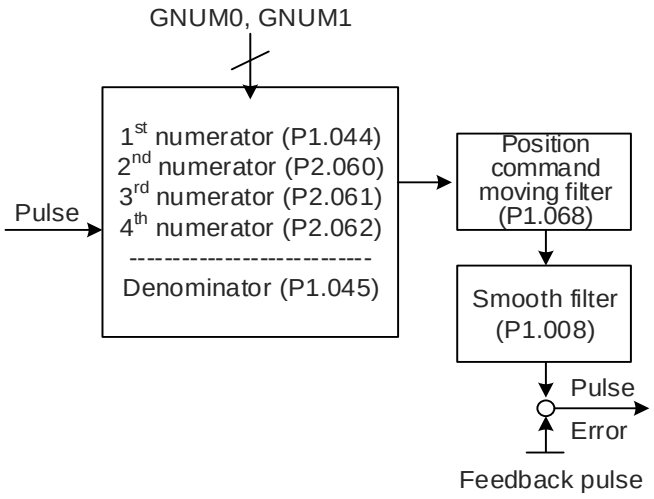
Value: 0x43, 0x44			
DI name	Description	Triggering method	Control mode
GNUM0 GNUM1	E-Gear ratio (numerator) selection 0 E-Gear ratio (numerator) selection 1 	Level triggered	PT

Value: 0x45			
DI name	Description	Triggering method	Control mode
INHP	In Position mode, the external pulse input command has no function when this DI is on. Note: this function has to be set to DI8 to ensure immediate pulse inhibition.	Level triggered	PT

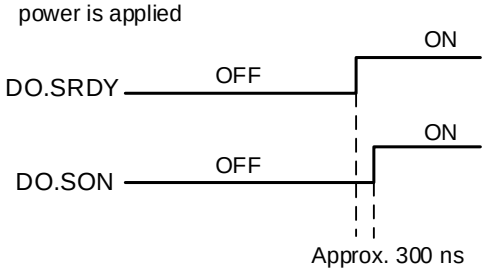
Value: 0x46			
DI name	Description	Triggering method	Control mode
STP	Motor stops.	Rising-edge triggered	PR

Value: 0x47			
DI name	Description	Triggering method	Control mode
PFQS	Use this DI to set the emergency stop for deceleration time. The value for deceleration time is same as P5.003. If this DI is triggered, AL35F occurs and the motor starts decelerating. When the speed reaches 0, AL3CF occurs and servo is switched to Servo Off. Reset the alarm to switch the drive to the Servo On state.	Rising-edge triggered	PT, PR, T, S

Note: the input function is disabled when P2.010 - P2.017 and P2.036 - P2.040 are set to 0.

Table 8.2 Digital output (DO) descriptions

Value: 0x01			
DO name	Description	Triggering method	Control mode
SRDY	When the control and main circuit power is 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. The time difference between DO.SRDY and DO.SON when the servo is on as soon as power is applied 	Level triggered	All

Value: 0x03			
DO name	Description	Triggering method	Control mode
ZSPD	When the motor speed is slower than the value of the zero speed (P1.038), this DO is on.	Level triggered	All

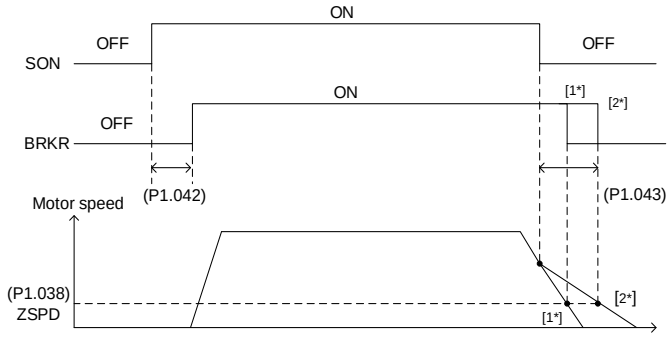
Value: 0x04			
DO name	Description	Triggering method	Control mode
TSPD	When the motor speed is faster than the target speed setting (P1.039), this DO is on.	Level triggered	All

Value: 0x05			
DO name	Description	Triggering method	Control mode
TPOS	When the deviation pulse number is smaller than the position range setting (setting value of P1.054), this DO is on.	Level triggered	PT, PR

Value: 0x06			
DO name	Description	Triggering method	Control mode
TQL	When it is in torque limit, this DO is on.	Level triggered	All (except for T and Tz)

Value: 0x07			
DO name	Description	Triggering method	Control mode
ALRM	When an alarm occurs, this DO is on. (Except for forward / reverse limit, communication error, undervoltage, and fan error.)	Level triggered	All

8

Value: 0x08			
DO name	Description	Triggering method	Control mode
BRKR	When the magnetic brake control signal is detected, adjust the settings of P1.042 and P1.043.  	Level triggered	All

Value: 0x09			
DO name	Description	Triggering method	Control mode
HOME	When homing is complete, it means the position coordinate system and position counter are defined and this DO is on. When applying power, 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; after homing is complete, this DO is on.	Level triggered	PR

Value: 0x0D			
DO name	Description	Triggering method	Control mode
ABSW	When there are absolute encoder alarms, this DO is on.	-	All

Value: 0x0E			
DO name	Description	Triggering method	Control mode
IDXD	Indexing coordinate is defined. When homing is complete, indexing coordinate is defined as well.	-	PR

Value: 0x10			
DO name	Description	Triggering method	Control mode
OLW	This DO is on when the overload level setting is reached. t_{OL} = Overload allowable time of the servo x value for the overload warning level (P1.056). When the overload accumulative time exceeds t_{OL}, it sends the overload pre-warning (OLW). However, if the overload accumulative time exceeds the overload allowable time of the servo, it sends the overload error (ALRM). For example: the value for the overload warning level is 60%. (P1.056 = 60) When the output average load of the servo drive is 200% and the output time exceeds 8 seconds, the overload alarm (AL006) occurs. t_{OL} = Duration when the output average load of the servo is 200% x value for the overload warning level = 8 sec x 60% = 4.8 sec Result: when the output average load of the servo drive is 200% for over t_{OL} = 4.8 seconds, this overload warning DO is on (DO code is set to 10). If the duration exceeds 8 seconds, then the overload alarm (AL006) occurs and sends the overload error (ALRM).	Level triggered	All

Value: 0x11			
DO name	Description	Triggering method	Control mode
WARN	Warning outputs (forward / reverse limit, communication error, undervoltage, and fan error).	Level triggered	All

Value: 0x12			
DO name	Description	Triggering method	Control mode
OVF	Position command / feedback overflows.	Level triggered	PT, PR

Value: 0x13			
DO name	Description	Triggering method	Control mode
SNL (SCWL)	Software limit (reverse limit).	Level triggered	PR

Value: 0x14			
DO name	Description	Triggering method	Control mode
SPL (SCCWL)	Software limit (forward limit).	Level triggered	PR

Value: 0x15			
DO name	Description	Triggering method	Control mode
Cmd_OK	When the Position command is complete, this DO is on. When the Position command is executing, this DO is off; after the command completes, this DO is on. This DO only indicates that the command is complete, but the motor positioning may not be complete yet. Refer to DO.TPOS.	Level triggered	PR

Value: 0x16			
DO name	Description	Triggering method	Control mode
CAP_OK	Capture procedure is complete.	Level triggered	All

Value: 0x17			
DO name	Description	Triggering method	Control mode
MC_OK	When DO.Cmd_OK and DO.TPOS are both on, then this DO is on. Refer to P1.048.	Level triggered	PR

Value: 0x18			
DO name	Description	Triggering method	Control mode
CAM_AREA1	E-Cam area 1: the master axis phase is between the values of P5.090 and P5.091.	Level triggered	PR

8

Value: 0x19			
DO name	Description	Triggering method	Control mode
SP_OK	Motor speed reaches the target speed: in Speed mode, when the deviation between the speed feedback and the command is smaller than the value of P1.047, this DO is on.	Level triggered	S, Sz

Value: 0x1A			
DO name	Description	Triggering method	Control mode
CAM_AREA2	E-Cam area 2: the master axis phase is between the values of P2.078 and P2.079.	Level triggered	PR

Value: 0x2C			
DO name	Description	Triggering method	Control mode
Zon1	First set of general range comparison: when the value of the item monitored by P0.009 ranges between the values of P0.054 and P0.055, then this DO is on.	-	All

Value: 0x2D			
DO name	Description	Triggering method	Control mode
Zon2	Second set of general range comparison: when the value of the item monitored by P0.010 ranges between the values of P0.056 and P0.057, then this DO is on.	-	All

Value: 0x2E			
DO name	Description	Triggering method	Control mode
Zon3	Third set of general range comparison: when the value of the item monitored by P0.011 ranges between the values of P0.058 and P0.059, then this DO is on.	-	All

Value: 0x2F			
DO name	Description	Triggering method	Control mode
Zon4	Fourth set of general range comparison: when the value of the item monitored by P0.012 ranges between the values of P0.060 and P0.061, then this DO is on.	-	All

Value: 0x30			
DO name	Description	Triggering method	Control mode
SPO_0	Output bit 00 of P4.006.	Level triggered	All

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

Note: the output function is disabled when P2.018 - P2.022 are set to 0.

Value: when DI.ABSE is on, DI.ABSR triggered by DO2 will replace the DO2 assigned by P2.019			
DO name	Description	Triggering method	Control mode
ABSR always output by DO2	When DO.ABSR is off, it indicates servo drive can receive request issued by DI.ABSQ; when DO.ABSR is on, it indicates after receiving the request, the data has been prepared and the ABSD data is valid so that the controller can access the ABSD data. This output is only valid when DI.ABSE is on. Refer to Figure 10.3.6.1. for a detailed description.	Level triggered	All

Value: when DI.ABSE is on, DI.ABSD triggered by DO3 will replace the DO3 assigned by P2.020			
DO name	Description	Triggering method	Control mode
ABSD always output by DO3	DO pin of ABS data. The data is valid when DO.ABSR is on. This output is only valid when DI.ABSE is on. Refer to Figure 10.3.6.1. for a detailed description.	Level triggered	All

Table 8.3 Monitoring variables descriptions

Description of monitoring variables:

Item	Description
Monitoring code	Each monitoring variable has a code, and you can use P0.002 to set the code and monitor the variable.
Format	Each monitoring variable is stored in the 32-bit format (long integer) of the servo drive.
Category	Basic variables / expansion variables: 1. Basic variables: variables (P0.002 = 0 - 26) within the cycle; in monitoring mode, use the UP / DOWN keys on the panel to display the variables. 2. Expansion variables: variables other than basic variables. (P0.002 = -80, -91, -124, -177, -178, and 27 - 127)
Monitoring method	Panel display / mapping: 1. Panel display: monitor with the panel 2. Mapping: monitor 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 variable code to monitor into P0.002 and start monitoring. Press the SHIFT key on the panel to switch between high and low digit display; Press the SET key on the panel to switch between decimal and hexadecimal display.
Mapping	1. Parameters that support monitoring variable mapping: for P0.009 - P0.013, refer to Section 8.3 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 P0.009, set P0.017 to the value to read (refer to P0.002). Read the data specified by P0.017 through communication or with the panel (set P0.002 to 23). When the panel displays “VAR-1”, it indicates the content 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; 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.

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Monitoring variables are described in the following table by the code sequence:

Code	Variable name / property	Description
000 (00h)	Feedback position (PUU) B	Current feedback position of the motor encoder. Unit: Pulse of User Unit (PUU).
001 (01h)	Position command (PUU) B	Current coordinate of the Position command. Unit: Pulse of User Unit (PUU). PT mode: number of pulse commands received by the servo drive. PR mode: absolute coordinates of the Position command.
002 (02h)	Position deviation (PUU) B	Deviation between the Position command and the feedback position. Unit: Pulse of User Unit (PUU).
003 (03h)	Feedback position (pulse) B	Current feedback position of the motor encoder. Unit: encoder unit (pulse).
004 (04h)	Position command (pulse) B	Current coordinate of the Position command. Unit: encoder unit (pulse). This is the command after the E-Gear ratio conversion.
005 (05h)	Position deviation (pulse) B	Deviation between the Position command and the feedback position. Unit: encoder unit (pulse).
006 (06h)	Pulse command frequency B	Frequency of the pulse command received by the drive. Unit: Kpps. Applicable to PT / PR modes.
007 (07h)	Speed feedback B D1 Dec	Current motor speed. Unit: 0.1 rpm. This is the speed after applying the low-pass filter, which makes it more stable.
008 (08h)	Speed command (analog) B D2 Dec	Speed command from the analog channel. Unit: 0.01 Volt.
009 (09h)	Speed command (integrated) B	Integrated Speed command. Unit: 0.1 rpm. Source includes analog, register, or position loop.
010 (0Ah)	Torque command (analog) B D2 Dec	Torque command from the analog channel. Unit: 0.01 Volt.
011 (0Bh)	Torque command (integrated) B	Integrated Torque command. Unit: percentage (%). Source includes analog, register, or speed loop.
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 consists of two groups of frequencies: F1 and F2 When monitoring from the panel, press the SHF 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.
018 (12h)	Z phase offset B Dec	Offset value between motor position and Z phase; range: -4999 to +5000. Where it overlaps with Z phase, the value is 0; the greater the value, the greater the offset.

Code	Variable name / property	Description
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 P0.020 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.
028 (1Ch)	Alarm code	Alarm code in DMCNET mode. (Applicable to A3-F)
029 (1Dh)	Auxiliary encoder feedback (PUU)	Position feedback from the auxiliary encoder. (Applicable to A3-F)
030 (1Eh)	Position deviation (PUU)	Position deviation between the position feedback and the command from the auxiliary encoder. (Applicable to A3-F)
031 (1Fh)	Main / auxiliary encoder position deviation (PUU)	Feedback position deviation between the main encoder and auxiliary encoder. (Applicable to A3-F)
035 (23h)	Indexing coordinate command	Current command for the indexing coordinates. Unit: Pulse of User Unit (PUU).
037 (25h)	Compare data of Compare	The actual Compare data is the Compare data plus a specified value: CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024.
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 / 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 P0.046. Refer to the description of this parameter.
043 (2Bh)	CAP data capturing	The latest data captured by CAP hardware. Note: CAP can continuously capture multiple points.
048 (30h)	Auxiliary encoder CNT	Pulse counts from the auxiliary encoder.
049 (31h)	Pulse command CNT	Pulse counts from the pulse command (CN1).
050 (32h)	Speed command (integrated) D1 Dec	Integrated Speed command. Unit: 0.1 rpm. Source includes analog, register, or position loop.

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Code	Variable name / property	Description
051 (33h)	Speed feedback (immediate) D1 Dec	Current actual motor speed. Unit: 0.1 rpm.
053 (35h)	Torque command (integrated) D1 Dec	Integrated Torque command. Unit: 0.1%. Source includes analog, register, or speed loop.
054 (36h)	Torque feedback D1 Dec	Current actual motor torque. Unit: 0.1%.
055 (37h)	Current feedback D2 Dec	Current actual motor current. Unit: 0.01 ampere (Amp).
056 (38h)	DC Bus voltage D1 Dec	Rectified capacitor voltage. Unit: 0.1 Volt.
059 (3Bh)	Pulse of E-Cam master axis (accumulative)	Accumulative pulse number of the E-Cam master axis. Same as P5.086.
060 (3Ch)	Pulse of E-Cam master axis (incremental)	Incremental pulse number of the E-Cam master axis. The increment per ms.
061 (3Dh)	Pulse of E-Cam master axis (lead pulse)	The lead pulse of the E-Cam master axis which determines the engagement condition. When disengaged: lead pulse = P5.087 or P5.092; when the value is 0, E-Cam engages. When engaged: lead pulse = P5.089; when the value is 0, it disengages.
062 (3Eh)	Position of E-Cam master axis	Position of the E-Cam which corresponds to the master axis pulse, and can be used to find the phase of the E-Cam. Unit: same as the master axis pulse; when the incremental pulse number of the master axis is P, E-Cam rotates M cycles (P5.083 = M, P5.084 = P).
063 (3Fh)	Position of E-Cam slave axis	Position of the E-Cam slave axis and can be found from the E-Cam table. Unit: unit used in the E-Cam table.
064 (40h)	Endpoint register of PR command	In PR mode, the endpoint of the Position command (Cmd_E).
065 (41h)	Output register of PR command	In PR mode, the accumulative output of the Position command.
067 (43h)	PR target speed	Target speed specified in the PR path. Unit: PPS (pulse per second).
068 (44h)	S-curve (input)	Input data of the S-curve filter. Effective in PR mode, E-Cam, and register Speed command.
069 (45h)	S-curve (output)	Output data of the S-curve filter. Effective in PR mode, E-Cam, and register Speed command.
072 (48h)	Speed command (analog) B D1 Dec	Speed command from the analog channel. Unit: 0.1 rpm.
081 (51h)	Synchronous Capture axis Incremental pulse input	When the synchronous Capture axis is enabled, the actual Mark distance can be measured by the received pulse number between two captures.
084 (54h)	Synchronous Capture axis Pulse number of synchronous deviation	The accumulative deviation between the actual output pulse and the target pulse when the synchronous Capture axis is enabled. This value is close to 0 if synchronization is reached.
085 (55h)	E-Cam alignment deviation percentage	The alignment error rate after filtering. Unit: 0.1%. 10 indicates 1% and the angle conversion is 360° × 1% = 3.6°.

Code	Variable name / property	Description
091 (5Bh)	Indexing coordinate feedback	Immediate feedback position of the indexing coordinates. 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 SHF 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.
112 (70h)	CANopen SYNC TS (unfiltered)	The time the servo drive receives the SYNC signal (TimeStamp). Unit: usec.
113 (71h)	CANopen SYNC TS (filtered)	The time the servo drive receives the SYNC signal that has gone through the low-pass filter. Unit: usec.
116 (74h)	Deviation between position and Z phase of auxiliary encoder (pulse)	Deviation between the current position of the auxiliary encoder and the Z phase position of the auxiliary encoder. (Applicable to A3-F)
120 (78h)	EtherCAT 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. (Applicable to A3-E)
121 (79h)	DMCNET 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. (Applicable to A3-F)
123 (7Bh)	Value returned when monitoring by panel	Monitoring value displayed when returned to the monitoring panel.
-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.
-124	Encoder temperature	Monitor the encoder temperature.
-177	CN2 Hall sensor phase sequence and Z pulse data	Use the bit to determine the UVW phase sequence of the CN2 Hall sensor and Z pulse. Bit 0: Z pulse, Bit 1: U phase, Bit 2: V phase, Bit 3: W phase.
-178	CN5 Hall sensor phase sequence and Z pulse data	Use the bit to determine the UVW phase sequence of the CN5 Hall sensor and Z pulse. Bit 0: Z pulse, Bit 1: U phase, Bit 2: V phase, Bit 3: W phase.

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MODBUS Communication 9

This chapter describes the MODBUS communication which you use for setting, reading, and writing general parameters. For the motion control network, refer to the related DMCNET, CANopen, and EtherCAT documentation. The details of ASCII, RTU, and TCP modes are also provided in this chapter.

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9.1 RS-485 communication interface (hardware)

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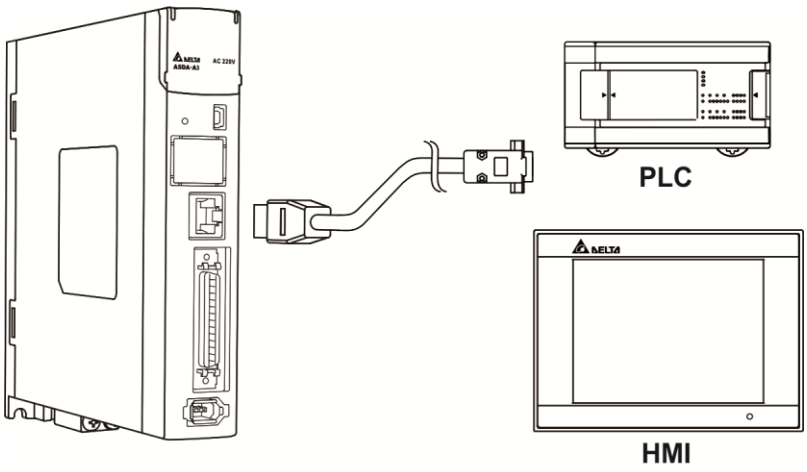
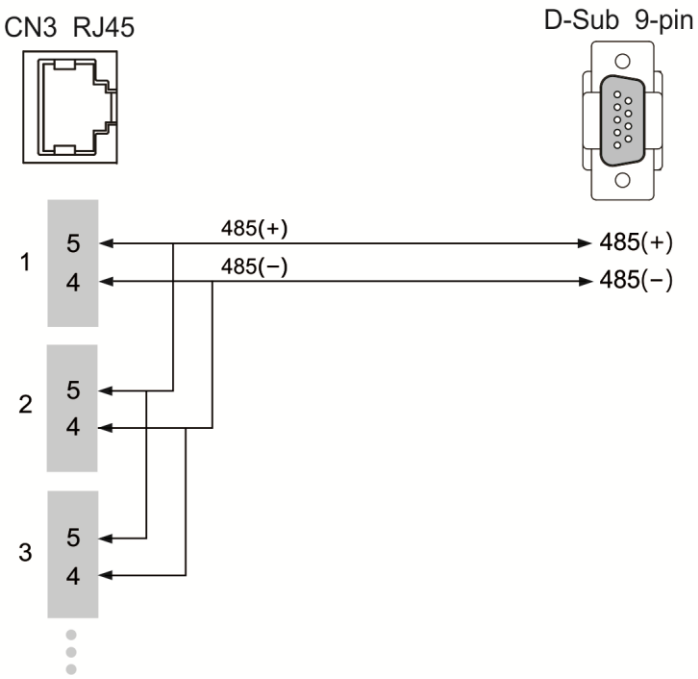
The ASDA-A3 series servo drive supports RS-485 serial communication that you can use to access and change the parameters of the servo system. See the following description of the wiring:





Note:

1. The cable length can be up to 100 meters when the servo drive is installed in a quiet environment. If the transmission speed is over 38,400 bps, a 15-meter cable is recommended to ensure data transmission accuracy.
2. The numbers on the above figure represent the pin number of each connector.
3. Use 12 V_{DC} for the power supply.
4. When using RS-485 communication, you may connect up to 32 servo drives. Install a repeater to connect more servo drives (the maximum is 127 stations).
5. Refer to Chapter 3 Wiring for CN3 pin assignment.

9.2 RS-485 communication parameter settings

The required parameters for a single servo drive connection are: P3.000 (Address), P3.001 (Transmission speed), and P3.002 (Communication protocol). P3.003 (Communication error handling), P3.004 (Communication timeout), P3.006 (Digital input (DI) control switch), and P3.007 (Communication response delay time) are optional settings.

Refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	Function
P3.000	Address
P3.001	Transmission speed
P3.002	Communication protocol

9.3 MODBUS communication protocol

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There are two modes of MODBUS network communication: ASCII (American Standard Code for Information Interchange) and RTU (Remote Terminal Unit). You can set both communication protocols (ASCII and RTU) with P3.002. The ASDA-A3 servo drive also supports these functions: accessing data (03H), writing one character (06H), and writing multiple characters (10H). Refer to the following descriptions.

Code description

ASCII mode:

In ASCII mode, data is transmitted in ASCII (American Standard Code for Information Interchange) format. For instance, when transmitting “64H” between two stations (master and slave), the master sends 36H to represent "6” and 34H to represent “4”.

The ASCII codes for the digits 0 to 9 and the characters A to F are as follows:

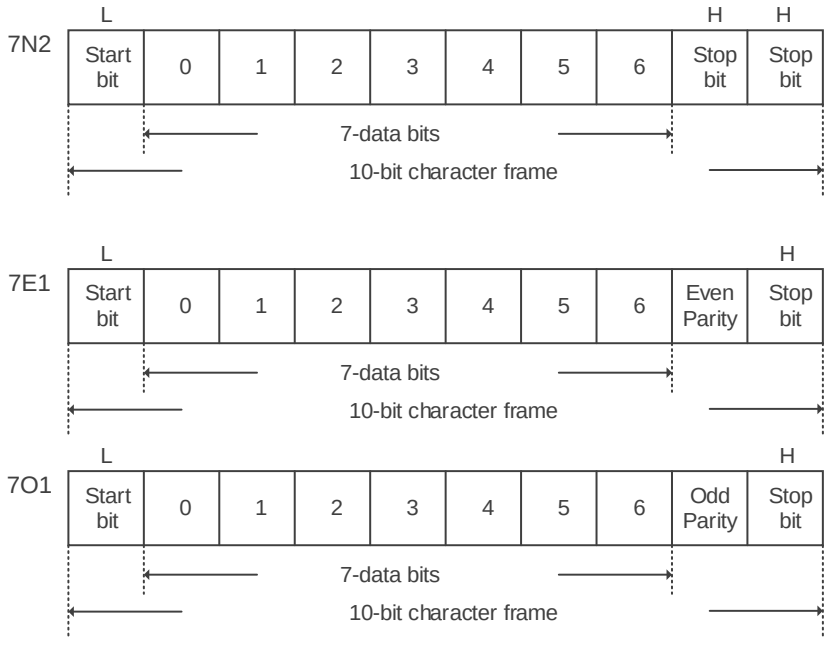
Character	‘0’	‘1’	‘2’	‘3’	‘4’	‘5’	‘6’	‘7’
ASCII code	30H	31H	32H	33H	34H	35H	36H	37H
Character	‘8’	‘9’	‘A’	‘B’	‘C’	‘D’	‘E’	‘F’
ASCII code	38H	39H	41H	42H	43H	44H	45H	46H

RTU mode:

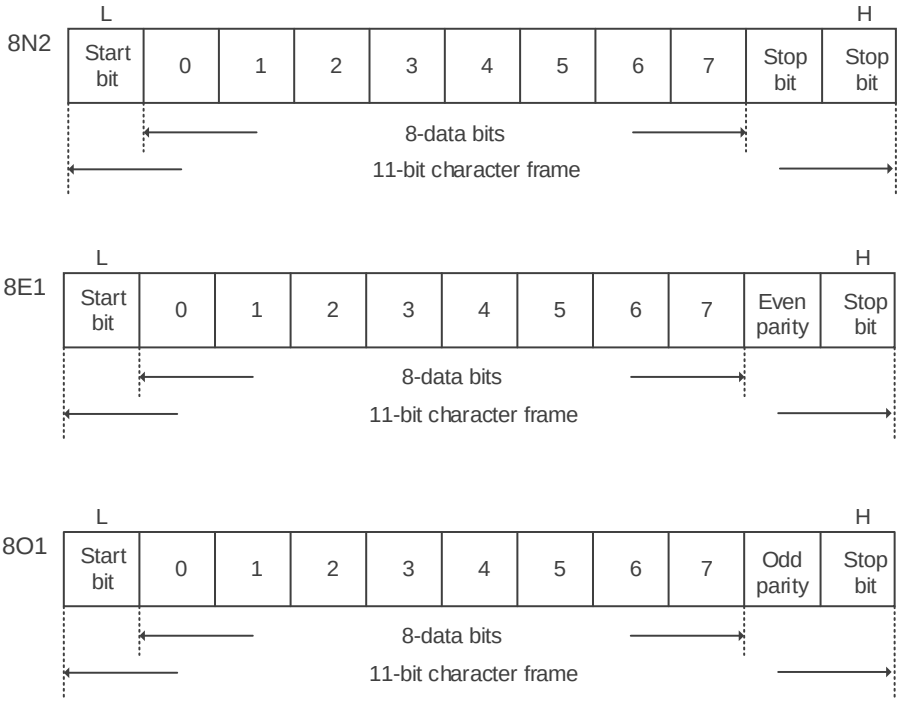
Every 8-bit data frame consists of two 4-bit characters (hexadecimal). For example, if “64H” is transmitted between two stations using RTU, it is transmitted directly, which is more efficient than ASCII mode.

Characters are encoded into the following frames and transmitted in series. The method for checking each type of frame is as follows.

10-bit character frame (for 7-bit character)



11-bit character frame (for 8-bit character)



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Communication data structure

Definitions for the data frames in the two modes are as follows:

ASCII mode:

Start	Start character ":" (3AH)
Slave Address	Communication address: 1 byte consists of 2 ASCII codes
Function	Function code: 1 byte consists of 2 ASCII codes
Data (n-1)	Data content: n word = 2n-byte consists of n x 4 ASCII codes, n ≤ 10
…….	
Data (0)	
LRC	Error check: 1 byte consists of 2 ASCII codes
End 1	End code 1: (0DH) (CR)
End 0	End code 0: (0AH) (LF)

In ASCII communication mode, the message starts with a colon ":" (ASCII code: 3AH). The ADR consists of two characters in ASCII code. The message ends with CR (Carriage Return) and LF (Line Feed). The codes for data such as communication address, function code, data content, and LRC error checking (LRC: Longitudinal Redundancy Check) are between the start character and the end code.

RTU mode:

Start	A silent interval of more than 10 ms
Slave Address	Communication address: 1 byte
Function	Function code: 1 byte
Data (n-1)	Data content: n-word = 2n-byte, n ≤ 10
…….	
Data (0)	
CRC	Error check: 1 byte
End 1	A silent interval of more than 10 ms

In RTU communication mode, the message starts and ends with silent intervals. The codes for data such as communication address, function code, data content, and CRC error checking (CRC: Cyclical Redundancy Check) are between the start and end intervals.

Example 1: function code 03H, accessing multiple words:

The master issues a command to the first slave and reads two continuous words starting from the start data address 0200H. In the response message from the slave, the content of the start data address 0200H is 00B1H, and the content of the second data address 0201H is 1F40H. The maximum allowable data in one single access is 10. The calculation of the LRC and CRC codes is described as follows.

ASCII mode:

Command Message (Master):

Start	':'
Slave Address	'0'
	'1'
Function	'0'
	'3'
Start Data Address	'0'
	'2'
	'0'
	'0'
Data Number (in words)	'0'
	'0'
	'0'
	'2'
LRC Check	'F'
	'8'
End 1	(0DH) (CR)
End 0	(0AH) (LF)

Response Message (Slave):

Start	':'
Slave Address	'0'
	'1'
Function	'0'
	'3'
Data Number (in bytes)	'0'
	'4'
Content of Start Data Address 0200H	'0'
	'0'
	'B'
	'1'
Content of the 2nd Data Address 0201H	'1'
	'F'
	'4'
	'0'
LRC Check	'E'
	'8'
End 1	(0DH) (CR)
End 0	(0AH) (LF)

RTU mode:

Command Message (Master):

Slave Address	01H
Function	03H
Start Data Address	02H (High)
	00H (Low)
Data Number (in words)	00H
	02H
CRC Check Low	C5H (Low)
CRC Check High	B3H (High)

Response Message (Slave):

Slave Address	01H
Function	03H
Data Number (in bytes)	04H
Content of Start Data Address 0200H	00H (High)
	B1H (Low)
Content of the 2nd Data Address 0201H	1FH (High)
	40H (Low)
CRC Check Low	A3H (Low)
CRC Check High	D4H (High)

Note: a silent interval of 10 ms is required before and after each transmission in RTU mode.

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Example 2: function code 06H, writing single word:

The master issues a command to the first slave and writes data 0064H to address 0200H.

The slave sends a response message to the master after writing is complete. The calculation of LRC and CRC is described as follows.

ASCII mode:

Command Message (Master):

Start	':'
Slave Address	'0'
	'1'
Function	'0'
	'6'
Start Data Address	'0'
	'2'
	'0'
	'0'
Data Content	'0'
	'0'
	'6'
	'4'
LRC Check	'9'
	'3'
End 1	(0DH) (CR)
End 0	(0AH) (LF)

Response Message (Slave):

Start	':'
Slave Address	'0'
	'1'
Function	'0'
	'6'
Start Data Address	'0'
	'2'
	'0'
	'0'
Data Content	'0'
	'0'
	'6'
	'4'
LRC Check	'9'
	'3'
End 1	(0DH) (CR)
End 0	(0AH) (LF)

RTU mode:

Command Message (Master):

Address	01H
Slave Function	06H
Start Data Address	02H (High)
	00H (Low)
Data Content	00H (High)
	64H (Low)
CRC Check Low	89H (Low)
CRC Check High	99H (High)

Response Message (Slave):

Address	01H
Slave Function	06H
Start Data Address	02H (High)
	00H (Low)
Data Content	00H (High)
	64H (Low)
CRC Check Low	89H (Low)
CRC Check High	99H (High)

Note: a silent interval of 10 ms is required before and after each transmission in RTU mode.

Example 3: function code 10H, writing multiple words:

The master issues a command to the first slave and writes data 0BB8H and 0000H to the start data address 0112H. In other words, 0BB8H is written into 0112H and 0000H is written into 0113H. The maximum allowable data in one single access is 8. The slave sends a response message to the master after the writing is complete. The calculation of LRC and CRC is described as follows.

ASCII mode:

Command Message (Master):

Start	':'
Slave Address	'0'
	'1'
Function	'1'
	'0'
Start Data Address	'0'
	'1'
	'1'
	'2'
Data Number (in words)	'0'
	'0'
	'0'
	'2'
Data Number (in bytes)	'0'
	'4'
Content of the 1st Data Frame	'0'
	'B'
	'B'
	'8'
Content of the 2nd Data Frame	'0'
	'0'
	'0'
	'0'
LRC Check	'1'
	'3'
End 1	(0DH) (CR)
End 0	(0AH) (LF)

Response Message (Slave):

Start	':'
Slave Address	'0'
	'1'
Function	'1'
	'0'
Start Data Address	'0'
	'1'
	'1'
	'2'
Data Number	'0'
	'0'
	'0'
	'2'
LRC Check	'D'
	'A'
End 1	(0DH) (CR)
End 0	(0AH) (LF)

RTU mode:

Command Message (Master):

Slave Address	01H
Function	10H
Start Data Address	01H (High)
	12H (Low)
Data Number (in words)	00H (High)
	02H (Low)
Data Number (in bytes)	04H
Content of the 1st Data Frame	0BH (High)
	B8H (Low)
Content of the 2nd Data Frame	00H (High)
	00H (Low)
CRC Check Low	FCH (Low)
CRC Check High	EBH (High)

Response Message (Slave):

Slave Address	01H
Function	10H
Start Data Address	01H (High)
	12H (Low)
Data Number (in words)	00H (High)
	02H (Low)
CRC Check Low	E0H (Low)
CRC Check High	31H (High)

Note: a silent interval of 10 ms is required before and after each transmission in RTU mode.

LRC and CRC transmission error check

The error check in ASCII mode is LRC (Longitudinal Redundancy Check) and in RTU mode, it is CRC (Cyclical Redundancy Check). See the following details.

LRC (ASCII mode):

Start	':'
Slave Address	'7'
	'F'
Function	'0'
	'3'
Start Data Address	'0'
	'5'
	'C'
	'4'
Data Number	'0'
	'0'
	'0'
	'1'
LRC Check	'B'
	'4'
End 1	(0DH) (CR)
End 0	(0AH) (LF)

To calculate the LRC: add all the bytes, round down the carry, and take the two's complement. For example: 7FH + 03H + 05H + C4H + 00H + 01H = 14CH, round down the carry 1 and take 4CH. The two's complement of 4CH is B4H.

CRC (RTU mode):

To calculate the CRC value:

Step 1: load a 16-bit register with the content of FFFFH, which is called the "CRC" register.

Step 2: (The low byte of the CRC register) XOR (The first byte of the command), and save the result in the CRC register.

Step 3: check the least significant bit (LSB) of the CRC register. If the bit is 0, shift the register one bit to the right. If the bit is 1, shift the register one bit to the right and execute (CRC register) XOR (A001H). Repeat this step 8 times.

Step 4: repeat steps 2 and 3 until all bytes have been processed. The content of the CRC register is the CRC value.

After calculating the CRC value, fill in the low word of the CRC value in the command message, and then the high word. For example, if the result of CRC calculation is 3794H, put 94H in the low word and put 37H in the high word as shown in the following table.

ARD	01H
CMD	03H
Start Data Address	01H (High)
	01H (Low)
Data Number (in words)	00H (High)
	02H (Low)
CRC Check Low	94H (Low)
CRC Check High	37H (High)

CRC program example:

This function calculates the CRC value in the C language. It needs two parameters:

```
unsigned char* data;
unsigned char length
//The function returns the CRC value as a type of unsigned integer.
unsigned int crc_chk(unsigned char* data, unsigned char length) {
     int j;
     unsigned int reg_crc=0xFFFF;

     while( length-- ) {
          reg_crc^= *data++;
          for (j=0; j<8; j++ ) {
               if( reg_crc & 0x01 ) { /*LSB(bit 0 ) = 1 */
                    reg_crc = (reg_crc >> 1)^0xA001;
               } else {
                    reg_crc = (reg_crc>>1);
               }
          }
     }
     return reg_crc;
}
```

Example of a PC communication program:

```
#include<stdio.h>
#include<dos.h>
#include<conio.h>
#include<process.h>
#define PORT 0x03F8   /*  the address of COM 1  */
#define THR 0x0000
#define RDR 0x0000
#define BRDL 0x0000
#define IER 0x0001
#define BRDH 0x0001
#define LCR 0x0003
#define MCR 0x0004
#define LSR 0x0005
#define MSR 0x0006
unsigned char rdat[60];
/* read 2 data from address 0200H of ASD with address 1 */
unsigned char
tdat[60]={':','0','1','0','3','0','2','0','0','0','0','0','2','F','8','\r','\
n'};
void main() {
int I;
outportb(PORT+MCR,0x08);      /*  interrupt enable  */
outportb(PORT+IER,0x01);          /*  interrupt as data in  */
outportb(PORT+LCR,( inportb(PORT+LCR) | 0x80 ) );
/*  the BRDL/BRDH can be access as LCR.b7 == 1  */
outportb(PORT+BRDL,12);
```

```
outportb(PORT+BRDH,0x00);
outportb(PORT+LCR,0x06);      /* set prorocol
                                  <7,E,1> = 1AH,       <7,O,1> = 0AH
                                  <8,N,2> = 07H        <8,E,1> = 1BH
                                  <8,O,1> = 0BH                    */

for( I = 0; I<=16; I++ ) {
    while( !(inportb(PORT+LSR) & 0x20) );  /*  wait until THR empty  */
    outportb(PORT+THR,tdat[I]);            /*  send data to THR  */
}
I = 0;
while( !kbhit() ) {
    if( inportb(PORT+LSR)&0x01 ) {  /*  b0==1, read data ready  */
        rdat[I++] = inportb(PORT+RDR); /*   read data from RDR  */
    }
}
}
```

9.4 Setting and accessing communication parameters

Refer to Chapter 8 for the descriptions of the parameters that you can write or read through the communication interface.

The ASDA-A3 servo drive parameters are divided into nine groups: Group 0 (Monitoring parameters), Group 1 (Basic parameters), Group 2 (Extension parameters), Group 3 (Communication parameters), Group 4 (Diagnosis parameters), Group 5 (Motion control parameters), Group 6 and Group 7 (PR parameters), and Group M (Motor parameters).

Setting parameters through communication:

You can set parameters through communication:

Group 0, except (P0.000 - P0.001), (P0.008 - P0.013), and (P0.046).

Group 1

Group 2

Group 3

Group 4, except (P4.000 - P4.004) and (P4.008 - P4.009).

Group 5, except (P5.010), (P5.016), and (P5.076).

Group 6

Group 7

Group M

Note the following additional details:

P3.001: when changing to a new communication speed, the next data is written in the new transmission speed after the new speed is set.

P3.002: when changing to a new communication protocol, the next data is written with the new communication protocol after the new protocol is set.

P4.005: JOG control parameters. Refer to Chapter 8 for detailed descriptions.

P4.006: force digital output (DO) contact control. Use this parameter to test the DO contact. Set P4.006 to 1, 2, 4, 8, 16, and 32 to test DO1, DO2, DO3, DO4, DO5, and DO6, respectively. Then, set P4.006 to 0 to complete the test.

P4.010: calibration functions. First set P2.008 to 20 (14H in hexadecimal format) to enable this function.

P4.011 - P4.021: these parameters are for adjusting the hardware offset. The parameters were adjusted before delivery, so changing these parameters is not recommended. If you need to modify these parameters, first set P2.008 to 22 (16H in hexadecimal format).

Accessing parameters through communication:

You can read the values from parameters through communication: Group 0 - Group 7, and Group M.

9.5 RS-485 communication specification

Compared with RS-232, the RS-485 communication can carry out one-to-many transmission and has better anti-interference ability. RS-485 mainly uses a balanced transmission line for signal reception and transmission. After the transmitter converts the TTL signal into a differential signal, the receiver receives the differential signal and then converts it back to the TTL signal. Since the transmission process uses the differential signal, it has better anti-interference ability. However, there are still restrictions on its use, so note the following when wiring.

- Number of stations

  CN3 can only support up to 32 servo drive stations. If your application requires more than 32 stations, install a repeater to connect more servo drives. The current maximum is 127 stations.

- Transmission distance

  The longer the transmission distance, the slower the transmission rate. The cable length can be up to 100 meters when the servo drive is installed in a quiet environment. If the required transmission speed is over 38,400 bps, a 15-meter cable is recommended to ensure data transmission accuracy.

- Transmission line

  The quality of the transmission line affects the signal transmission process. If there is interference during the transmission process, it may result in data loss. It is suggested to use a shielded twisted-pair cable as the outer layer has a shield layer of metal and grounding wire, which has better anti-interference ability.

- Bus topology

  For topology, the closer to the master station, the more stable the transmitted signal. The bus structure of RS-485 is the bus topology. The transmission line must connect from the first station to the second station, and then from the second station to the third station, and so on until the last station. RS-485 does not support star and ring topologies.

- Terminal resistor

  In the communication transmission process, if the impedance is not continuous, it causes signal reflection and signal distortion. This usually happens to the device that is configured at the end of the transmission line. If the impedance is small or even 0Ω, the signal will be reflected. To solve this problem, add a resistor of the same characteristic impedance as the cable at the end of the cable, which is called a terminal resistor. In general, the transmission line used in the RS-485 signal transmission circuit is a twisted-pair cable, and its characteristic impedance is about 120Ω, so the impedance of the terminal resistor is also 120Ω.

- Anti-interference methods

  In the signal transmission process, if there is interference, it may result in signal distortion. Therefore, it is important to eliminate interference. The elimination methods are as follows:

  1. Add a terminal resistor.
  2. Check if the servo drive is installed in a high magnetic field environment. If so, keep it as far away as possible.
  3. Use a shielded twisted-pair cable for the transmission line.
  4. When wiring, isolate the high voltage power cable from the signal line.
  5. Use a magnetic ring at the power input. For its usage, refer to Section 2.6.
  6. Add X capacitor and Y capacitor at the power input and use IEC 60384-14 certified capacitors.

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10 Absolute System

This chapter introduces the absolute servo system, including the wiring and installation of the absolute encoder, the steps to set up the system, and the procedures for initializing and operating the system for the first time.

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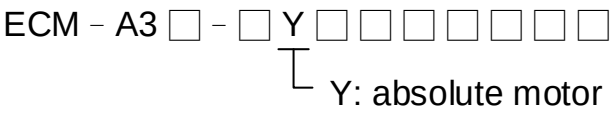
Note

A complete absolute servo system includes an ASDA-A3 servo drive, an absolute motor, and a backup battery box. The backup battery supplies power to the system so that the encoder continues to operate even when the power 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 the power is off. The absolute servo system must be used only with an absolute motor. If the servo is set up with other types of motors and the system is enabled, AL069 occurs.

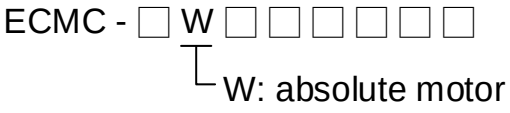
When using an absolute motor connected to power, the motor speed should not exceed 250 rpm. When operating with the battery, make sure the maximum speed does not exceed 200 rpm.

To determine whether your motor is an absolute type, check the model name as shown in the following:

ECM-A3 series servo motor



ECMC series servo motor



Install the battery correctly on the encoder. One servo drive uses one single battery box; two servo drives can share one dual battery box. Use Delta's encoder cable to connect to the battery box. See the following section for the specifications of the battery box and its accessories.

10.1 Battery box (absolute type) and wiring

10.1.1 Specifications

Precautions

Carefully read through the following safety precautions. Use batteries only in accordance with the specifications to avoid damage or dangerous conditions.

- Make sure the installation location is free of vapor, corrosive and inflammable gas.
- Correctly place the battery into the battery box to avoid short circuiting.
- Do not short-circuit the positive and negative electrodes of the battery, and do not install the battery in reverse direction.
- Do not mix new and used batteries to avoid losing power or shortening the life of the new batteries. It is suggested to replace all batteries with new ones.
- Follow the instructions when wiring the battery box to avoid dangerous conditions.

- Do not place the battery in a high-temperature environment over 100°C, as this may cause a fire or an explosion.
- The batteries are non-rechargeable. Do not charge the batteries as this may result in an explosion.
- Do not directly weld on the surface of the battery.

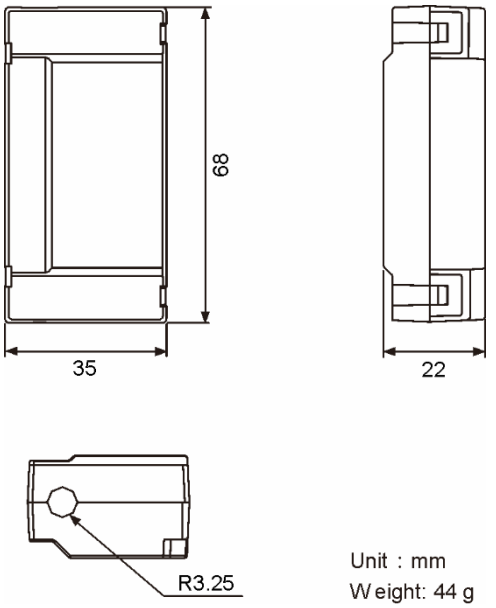
Battery specifications

Item	Li/SOCl2 Cylindrical Battery
Type	ER14505
Delta part number	ASD-CLBT0100
International standard size	AA
Standard voltage	3.6V
Standard capacity	2700 mAh
Maximum continuous discharge current	100 mA
Maximum 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

10.1.2 Battery box dimensions

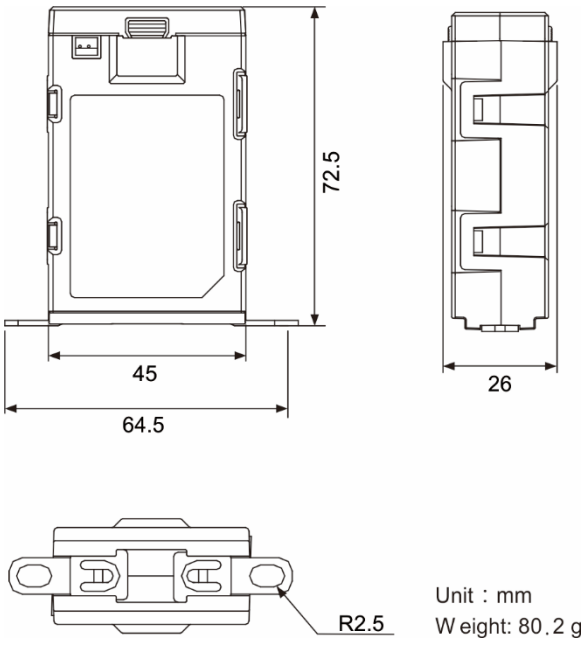
Single battery box

Delta part number: ASD-MDBT0100



Dual battery box

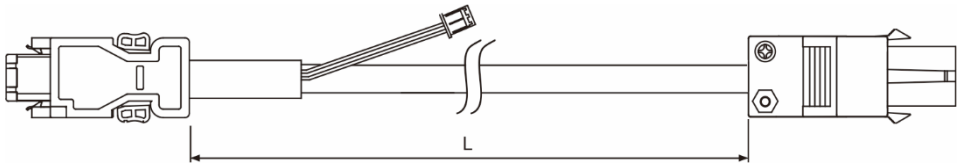
Delta part number: ASD-MDBT0200



10.1.3 Connection cable for the absolute encoder

A. Cables for quick connector

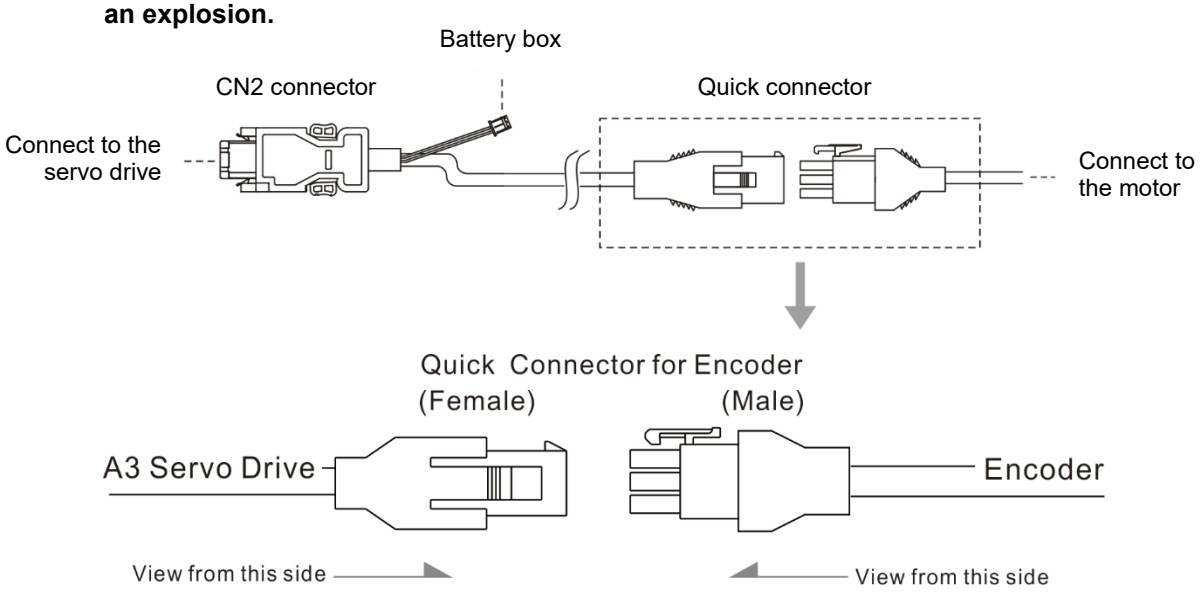
Delta part number: ACS3-CAEB1003, ACS3-CAEB1005, ACS3-CAEB1010, ACS3-CAEB1020



Title	Model name	L	
		mm	inch
1	ACS3-CAEB1003	3000 ± 100	118 ± 4
2	ACS3-CAEB1005	5000 ± 100	197 ± 4
3	ACS3-CAEB1010	10000 ± 100	394 ± 4
4	ACS3-CAEB1020	20000 ± 100	788 ± 4

Connection method:

Note Follow these instructions when connecting the cable. Incorrect wiring may result in an explosion.



1 White T+	2 Red BAT+	3 Reserved
4 White / Red T-	5 Black BAT-	6 Reserved
7 Brown DC+5V	8 Black / Black & White GND	9 Shield

3 Reserved	2 Orange BAT+	1 White T+
6 Reserved	5 Gray BAT-	4 White / Red T-
9 Shield	8 Blue GND	7 Brown DC+5V

Note: the wire colors of the ASDA-A3 servo drive are for reference only. Refer to the actual servo drive.

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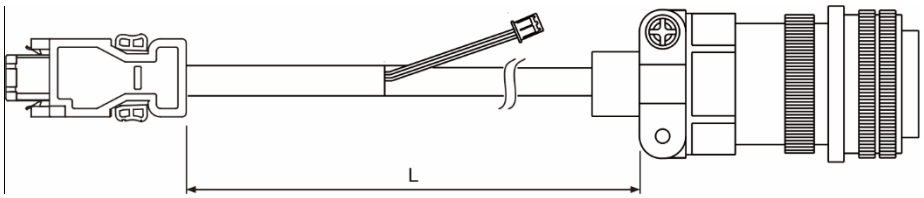
B. Cables for military connector

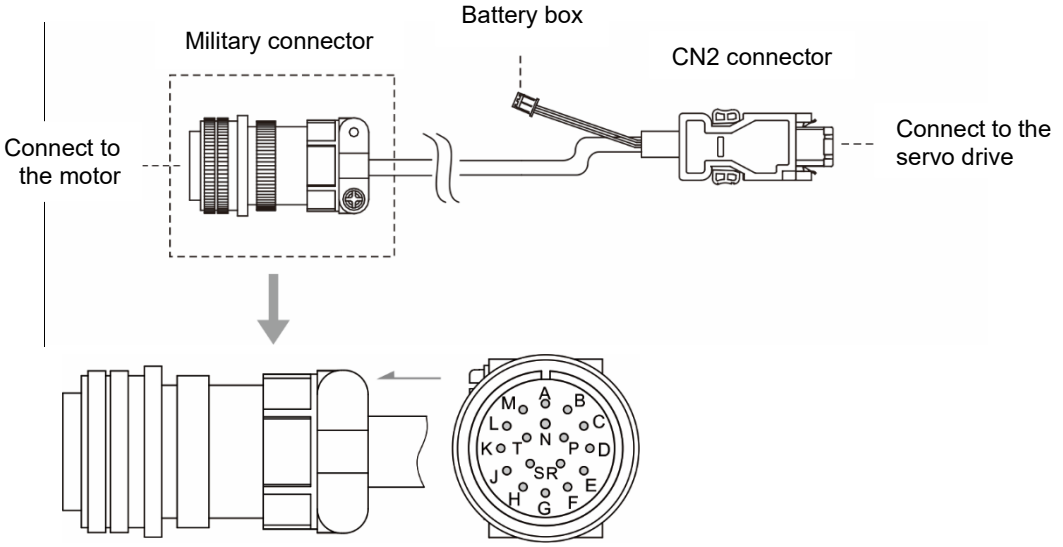
Delta part number: ACS3-CAEB3003, ACS3-CAEB3005, ACS3-CAEB3010, ACS3-CAEB3020



Title	Model name	L	
		mm	inch
1	ACS3-CAEB3003	3000 ± 100	118 ± 4
2	ACS3-CAEB3005	5000 ± 100	197 ± 4
3	ACS3-CAEB3010	10000 ± 100	394 ± 4
4	ACS3-CAEB3020	20000 ± 100	788 ± 4

Connection method:

Note Follow these instructions when connecting the cable. Incorrect wiring may result in an explosion.

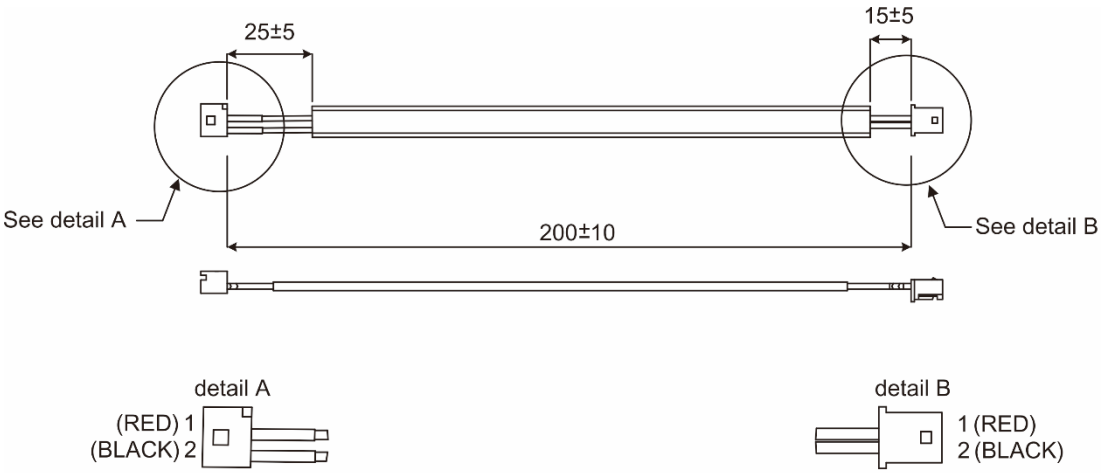


Pin No.	Terminal	Color
A	T+	White
B	T -	White / Red
C	BAT+	Red
D	BAT-	Black
S	DC+5V	Brown
R	GND	Blue
L	BRAID SHIELD	–

10.1.4 Battery box cable

Battery box cable AW (battery connection cable to the encoder; unit: mm)

Delta part number: 3864573700



Unit: mm

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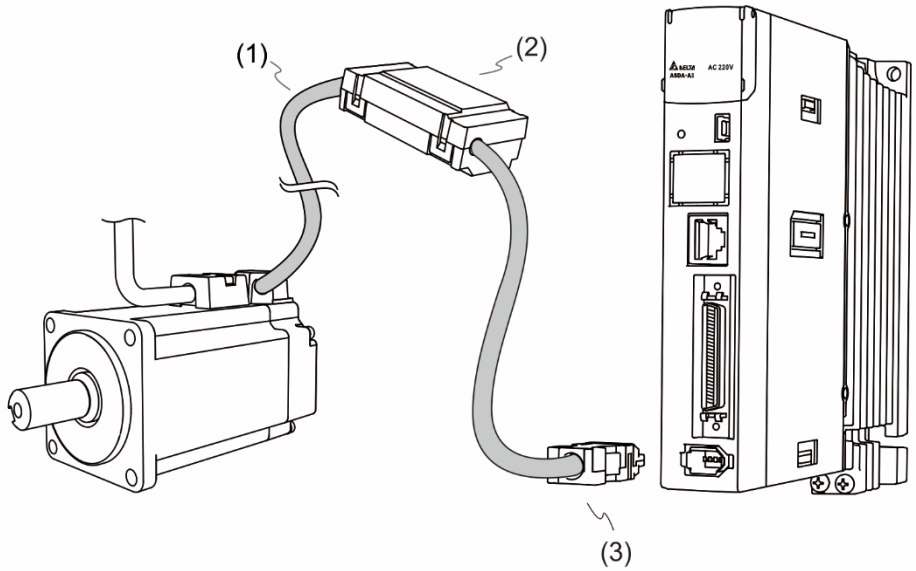
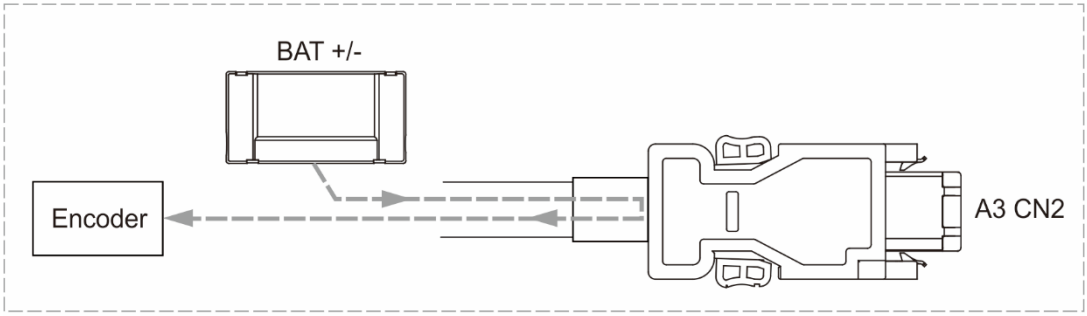
10.2 Installation

10.2.1 Installing the battery box in the servo system

Single battery box (standard wiring)





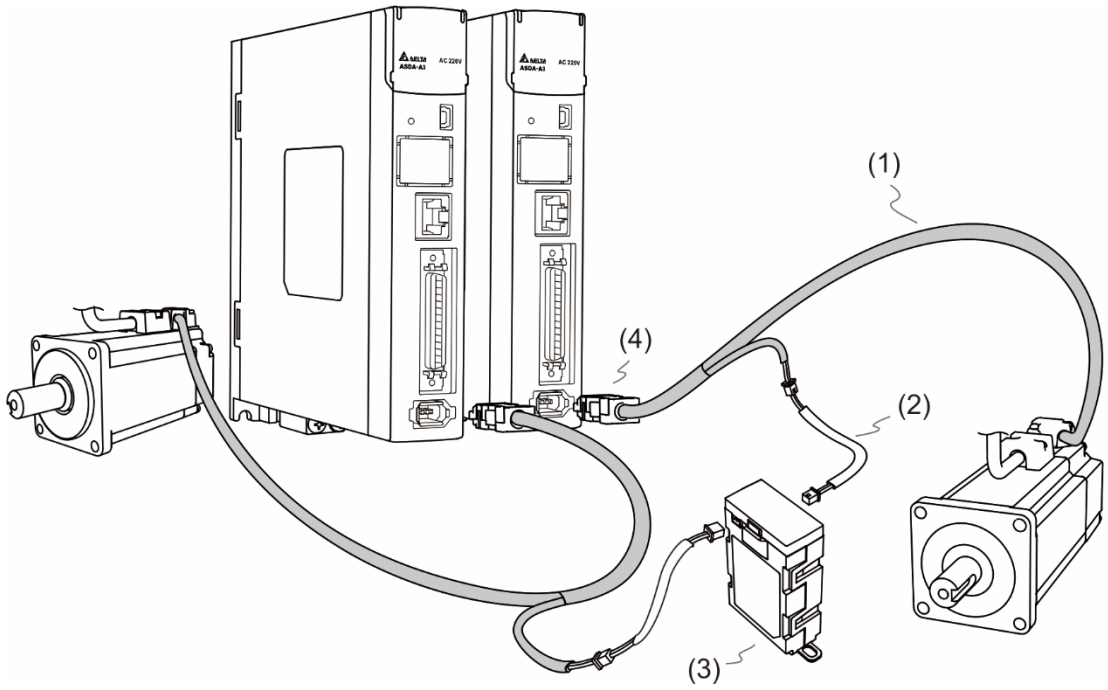
(1) Encoder cable; (2) Single battery box (absolute type); (3) CN2 connector; (4) Battery box wiring

Pin assignment of CN2 connector:

The end that connects to the encoder			The end that connects to the servo drive		
Military connector	Quick connector	Color	Pin No.	Signal	Description
A	1	White	5	T+	Serial communication signal (+)
B	4	White / Red	6	T-	Serial communication signal (-)
S	7	Brown	1	+5V	Power +5V
R	8	Blue	2	GND	Power ground
L	9	-	Case	Shielding	Shielding

Note: when using an absolute encoder, the battery supplies power directly to the encoder, so wiring the CN2 connector to the servo drive is not required. Refer to the wiring description in Section 3.1.5 Specification for the encoder connector for details.

Dual battery box (connects to CN2)



(1) Encoder cable; (2) Battery box cable AW; (3) Dual battery box (absolute type); (4) CN2 connector

10.2.2 Installing and replacing a battery

Single battery box

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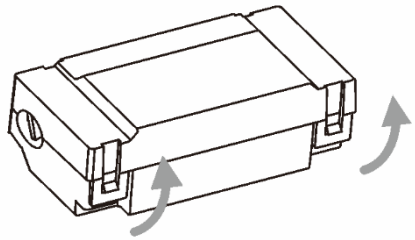
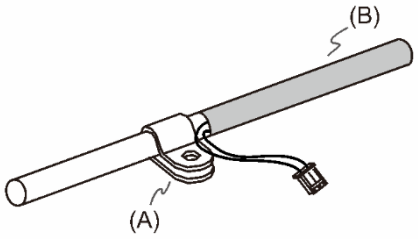


Step 1:

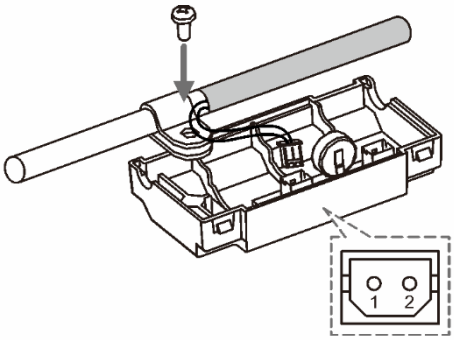
Loosen the hooks on both sides to open the lid of the battery box.



Step 2:

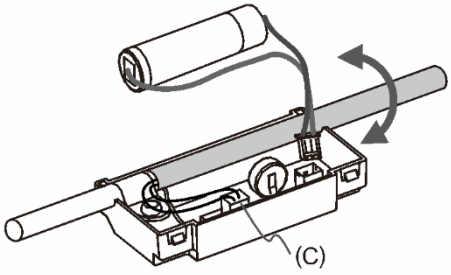
Attach the metal clip to the connection cable. Note that the metal clip should be placed close to the heat shrink.

(A) Metal clip; (B) Heat shrink



Step 3:

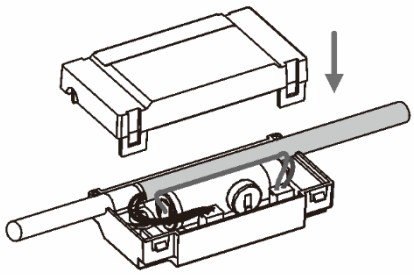
Plug in the lead wire and tighten the screw.



Step 4:

Install a new battery and connect the wire.

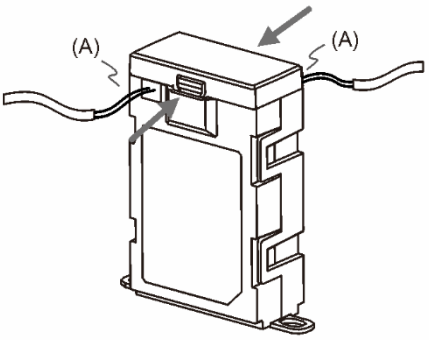
(C) Replace the battery only when the main power to the servo drive is still on. Do not remove the power cable, or else the system may lose data.



Step 5:

Place the wire into the box and fit the lid.

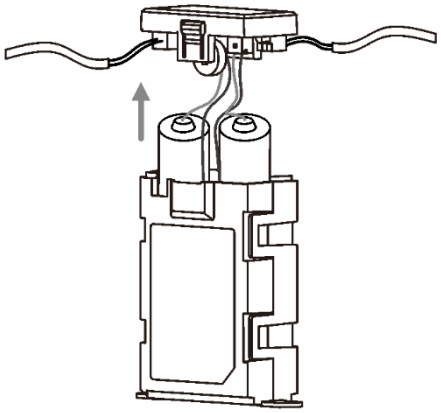
Dual battery box



Step 1:

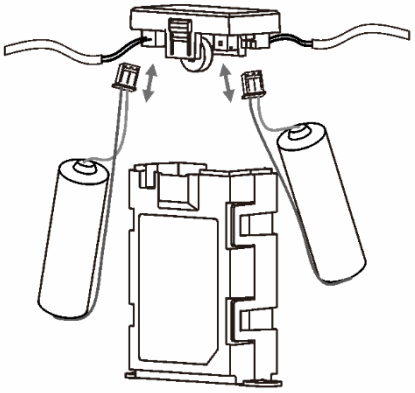
Loosen the hooks on both sides to open the lid of the battery box.

(A) Replace the batteries only when the main power to the servo drive is on. Do not remove the power cables, or else the system may lose data.



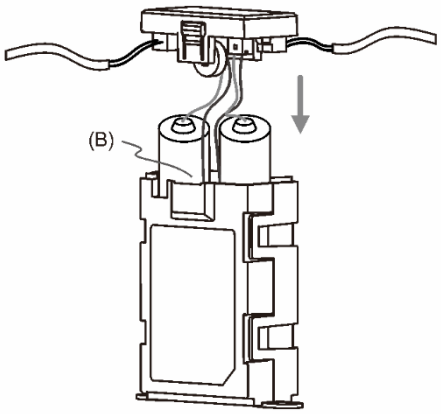
Step 2:

Lift the cover and pull out the batteries.



Step 3:

Disconnect the connectors and remove the used batteries. Replace them with new batteries and reconnect the lead wires. Replace the new batteries within ten minutes to avoid data loss.



Step 4:

Fit the lid.

(B) Place the wires toward the inside of the box so that the batteries both fit inside the box.

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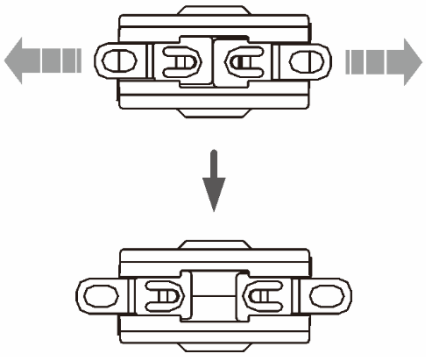
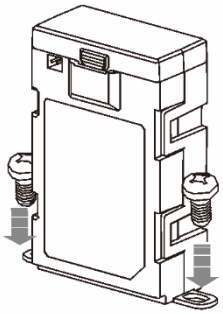


Step 5:

Pull the clips at the bottom of the battery box outwards.



Step 6:

Tighten the screws to secure the battery box.

Note:

To avoid data loss, replace the battery when any of the following circumstances occurs: 1. The servo drive shows AL061 which means the voltage is too low. Refer to Chapter 13 for more information. 2. Use P0.002 (monitoring variable 26h) to check the battery power. When it displays 31, it means the voltage is under 3.1V. When the voltage is under 2.45V, the motor's position record may be lost if the drive operates under battery power, so you need to re-establish the absolute origin coordinates after installing a new battery. Thus, it is suggested that you replace the battery when the main power to the servo drive is on.

10.3 System initialization and operating procedures

10.3.1 System initialization

After the servo system resumes operation, the controller can acquire the motor's current absolute position either with communication (such as RS-485) or DI/DO. Delta's absolute system provides two types of position value for the controller: pulse and PUU.

AL06A occurs when you initialize the absolute system for the first time because the coordinate system has not been established. Clear the alarm by setting up the coordinate system. When insufficient battery power or failure of the main power supply causes loss of the coordinate system, AL060 occurs. In the absolute system, when the number of motor rotations exceeds the range -32768 to 32767, AL062 occurs. When the PUU position value goes outside the range -2147483648 to 2147483647, AL289 occurs.

Except for the alarms mentioned above, you can use P2.070 to set up Delta's absolute servo system. You can choose not to show AL062 and AL289 if the absolute coordinate system overflows when the number of rotations exceeds the range -32768 to 32767 or when the PUU exceeds the range -2147483648 to 2147483647. For example, you might do this on a system that uses incremental commands to operate in a single direction.

P2.070 setting:

1. Establish the absolute origin coordinates. When the coordinate setting is complete, AL06A (or AL060) is automatically cleared. There are two representations to establish the controller's absolute origin coordinates: pulse number and PUU number. You can establish the absolute origin coordinates with DI/DO, parameters, or the PR homing function.
2. When the system is powered on again, the controller can access the motor's absolute position either with DI/DO or the communication function. Based on the setting of P2.070, the controller can select the requested value, either the PUU (refer to Section 10.3.3) or the pulse value of 16777216, within a single turn (refer to Section 10.3.2).

10

10.3.2 Pulse number

When the motor is running in the clockwise direction, the cycle number is expressed as a negative value. When the motor runs in the counterclockwise direction, the cycle number is expressed as a positive value. The range of the number of rotations is between -32768 and +32767, and AL062 occurs once the number exceeds the range. To clear the alarm, re-establish the absolute origin coordinates. If P2.070 has been set to ignore the AL062 alarm, then the system shows no error. If the system is operating in the counterclockwise direction and reaches 32,767 turns, the value jumps to -32768 once it reaches the target position in the next cycle, and the value keeps increasing from -32768 to 32767. When the system is operating in the clockwise direction and reaches -32,768 turns, the value jumps to 32767 once it reaches the target position in the next cycle, and the value keeps decreasing from 32767 to -32768.

In addition to the cycle counter, there are 16,777,216 pulses (0 - 16777215) in one rotation. Pay attention to the motor's running direction. You can read the cycle number and the pulse number either with communication or DI/DO. Pulse number = m (cycle number) x 16777216 + pulse number (0 - 16777215). The conversions between pulse number and PUU are as follows:
When the rotation direction is defined as CCW in P1.001, then the PUU number = pulse number × $\frac{P1.045}{P1.044}$ + P6.001.
When the rotation direction is defined as CW in P1.001, then the PUU number = (-1) × pulse number × $\frac{P1.045}{P1.044}$ + P6.001.

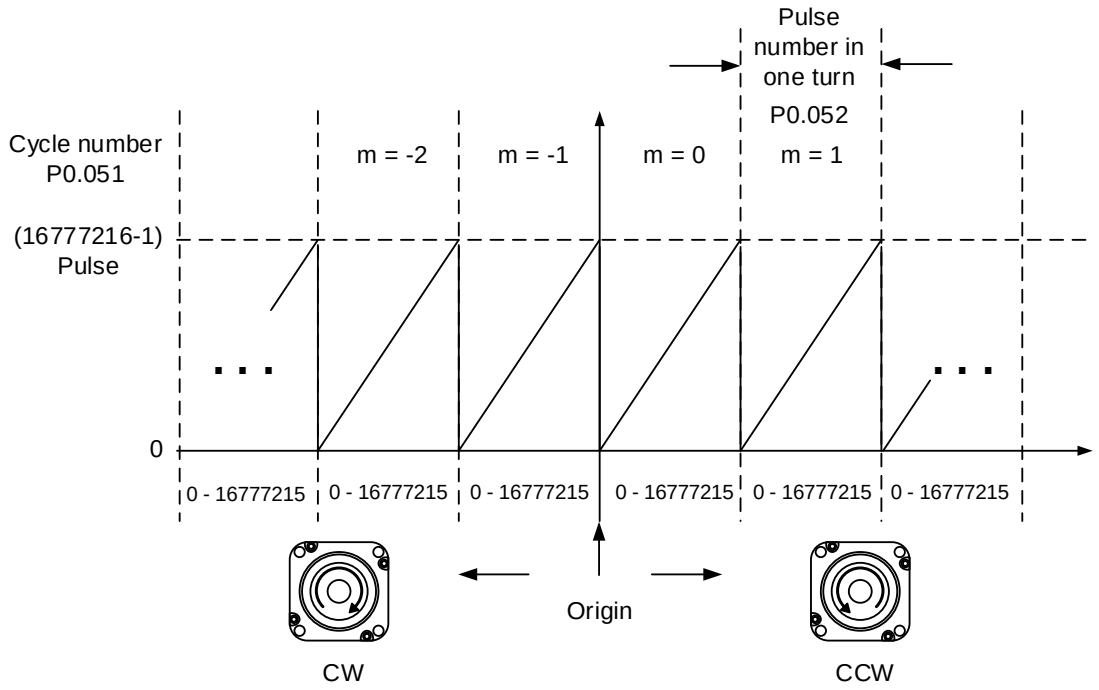


Figure 10.3.2.1 Absolute position for pulse number

10.3.3 PUU number

The PUU number is a 32-bit absolute value with a positive or negative sign. When the motor is running in the forward direction, the PUU number increases; when it is running in the reverse direction, the PUU number decreases. The forward direction does not mean the motor is running clockwise; the direction is defined by P1.001.Z. The maximum range of the cycle number is -32768 to +32767. AL062 occurs when the number of cycles overflows. If the PUU number exceeds the range -2147483648 to 2147483647, the position counter overflows and AL289 occurs. Establish the absolute origin coordinates to clear these alarms (AL062 or AL289). You can determine whether or not to show AL062 and AL289 when the position overflows with P2.070. When reaching the maximum PUU number in the forward direction, the value changes from 2147483647 to -2147483648, -2147483647, until 2147483647. The value changes the other way when the motor operates in the reverse direction. See the following examples:

Example 1:

When P1.044 = 16777216 and P1.045 = 100000, the motor needs 100,000 PUU to run a cycle. 2147483647 ÷ 100000 ≒ 21474.8, so once the motor runs over 21,474.8 (< 32767) cycles in the forward direction, AL289 occurs.

Example 2:

When P1.044 = 16777216 and P1.045 = 10000, the motor needs 10,000 PUU to run a cycle. 2147483647 ÷ 10000 ≒ 214748.3, so once the motor runs over 32,767 (< 214748.3) cycles in the forward direction, AL062 occurs.

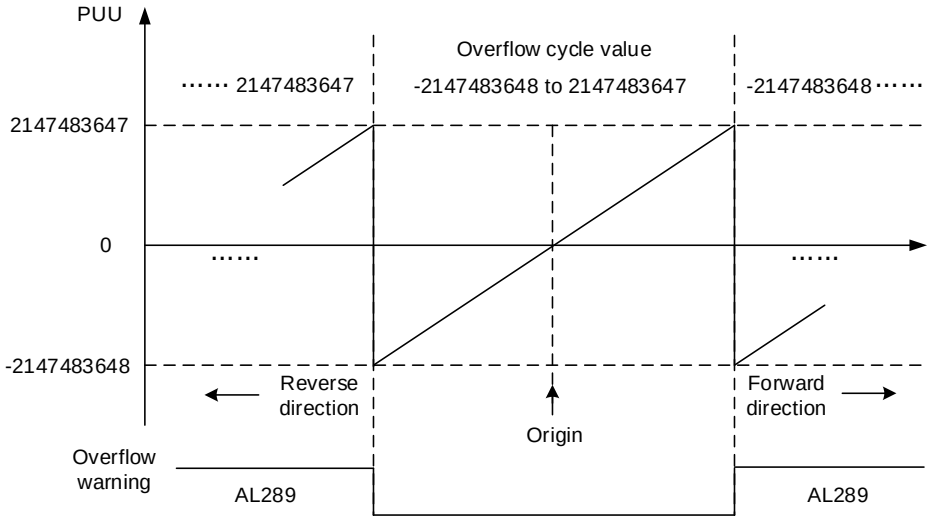


Figure 10.3.3.1 Absolute position for PUU number

Note: after establishing the absolute origin coordinates, any change to P1.001.Z or E-Gear ratio (P1.044 and P1.045) changes the original setting of the absolute origin coordinates. If the above parameters are changed, re-establish the absolute origin coordinates.

10.3.4 Establish the absolute origin coordinates

When the absolute coordinates are lost, the ASDA-A3 servo drive provides three ways to establish the absolute origin coordinates: DI/DO, parameter setting, or the PR homing function. The following provides more details for each operation mode.

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10.3.4.1 Establishing the absolute origin coordinates with DI/DO

When the servo system is controlled by the controller, you can establish the absolute origin coordinates with DI/DO. Once established, the pulse number is set to 0 and the PUU number is the value of P6.001. Refer to the following diagram for detailed descriptions.

Description:

1. When the controller triggers DI.ABSE, it has to wait for T_S before proceeding to the next step.
2. After reaching T_S, the controller starts to establish the absolute origin coordinates.
   When DI.ABSC is triggered and remains on for T_Q, the pulse number is set to 0 and the PUU number is the value of P6.001.

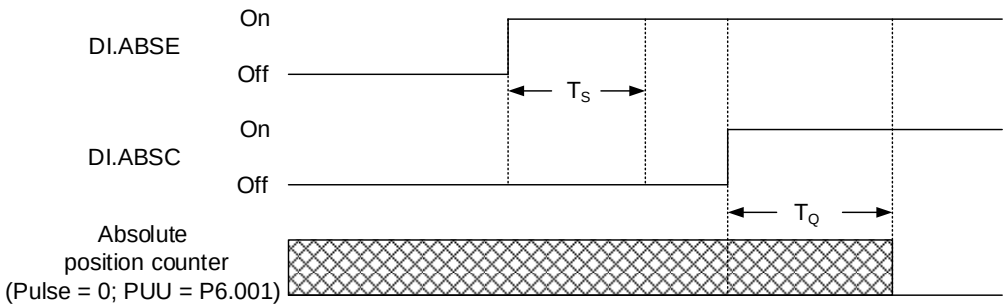


Figure 10.3.4.1.1 Timing diagram for establishing the absolute origin coordinates with DI/DO

The following table describes the T_S and T_Q delay time after triggering DI.ABSE and DI. ABSC.

	$T_{S(ms)}$	$T_{Q(ms)}$
Min (T_S, T_Q)	P2.009 + 2	
Max	P2.009 + 250	

10.3.4.2 Establishing the absolute origin coordinates with parameters

Set P2.071 to 1 to establish the absolute origin coordinates through the panel or with communication. As soon as P2.071 is set to 1, the absolute coordinate system resets. Since the write-protect function of P2.071 is protected by P2.008, you must set P2.008 to 271 first. In other words, the sequence is: set P2.008 to 271, then set P2.071 to 1.

10.3.4.3 Establishing the absolute origin coordinates with the PR homing function

You can use the 11 homing modes in the PR mode to establish the absolute origin coordinates. For more details, refer to Section 7.1.3.1 Homing methods.

10.3.5 Read the absolute position

10.3.5.1 Reading the absolute position with DI/DO

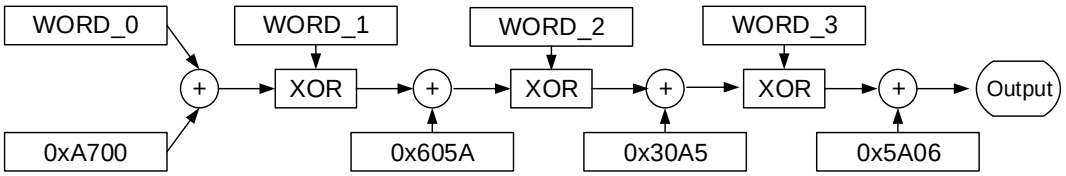
Set P2.070 Bit 0 to 0 so that you can read the PUU number with DI/DO. See the following descriptions.

Bit 79 - Bit 64	Bit 63 - Bit 32	Bit 31 - Bit 16	Bit 15 - Bit 0
Check Sum	Encoder PUU -2147483648 to 2147483647	0	Encoder status (P0.050)

Set P2.070 Bit 0 to 1 so that you can read the pulse number with DI/DO. See the following descriptions.

Bit 79 - Bit 64	Bit 63 - Bit 32	Bit 31 - Bit 16	Bit 15 - Bit 0
Check Sum	Pulse number in one rotation 0 - 16777215 (= 16777216 - 1)	Encoder turn -32768 to +32767	Encoder status (P0.050)

Description:
Check Sum = (((((((WORD_0+0xA700) XOR WORD_1)+0x605A) XOR WORD_2)+0x30A5) XOR WORD_3)+0x5A06)



Note:

1. This algorithm has no positive or negative sign.
2. 0xA700, 0x605A, 0x30A5, and 0x5A06 are constants in hexadecimal format.
3. WORD_0: encoder status (Bit 15 - 0)
   WORD_1: encoder turn (Bit 31 - 16)
   WORD_2: encoder pulse number (Bit 47 - 32)
   WORD_3: encoder pulse number (Bit 63 - 48)

You can read the pulse number or PUU number with DI/DO and P2.070. See the following timing diagram.

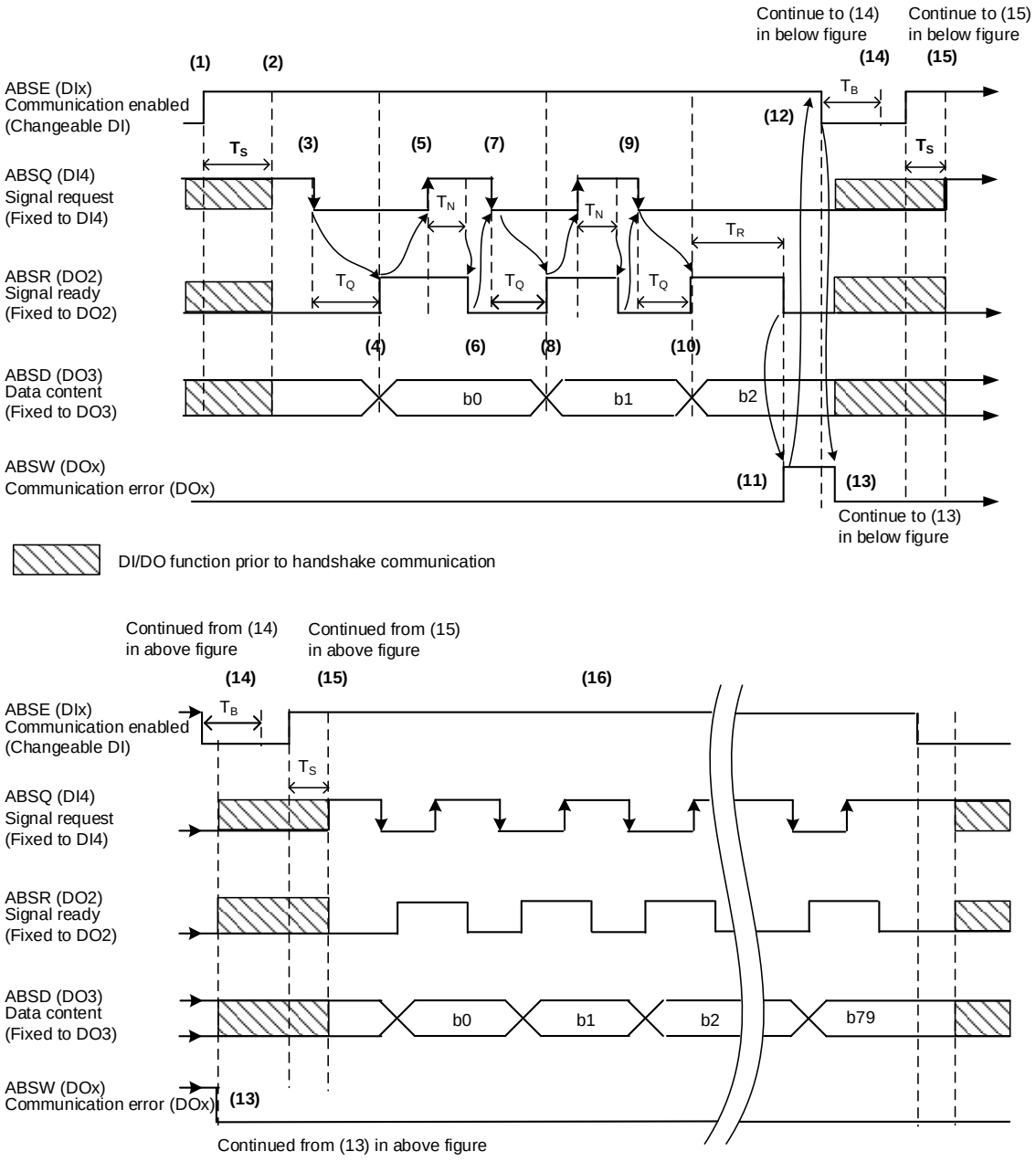


Figure 10.3.5.1.1 Timing diagram for reading the absolute position with DI/DO

The following table describes the delay time when reading the absolute position with DI/DO.

	$T_{R(ms)}$	$T_{S(ms)}$	$T_{Q(ms)}$	$T_{Nms)}$	$T_{B(ms)}$
Min	-	P2.009 + 2			
Max	200	P2.009 + 10			

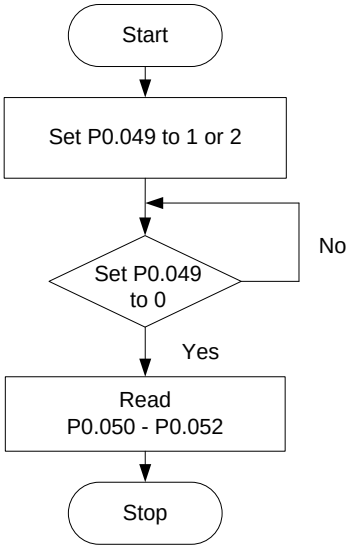
Descriptions:

1. When the handshake communication starts, the ABSE signal is triggered.
2. After the T_s delay time (make sure the signal is on), the functions for DI4, DO2, and DO3 are switched to ABSQ, ABSR, and ABSD, respectively. If DI4 was in the high-level state before, it remains in the high-level state when switched to ABSQ (logic high-level signal). DI4, DO2, and DO3 are dual-function DI/DO, which means DI4, DO2, and DO3 share the same DI/DO with ABSQ, ABSR, and ABSD, respectively. Pay special attention when switching functions or set the DI/DO to 0 to disable the dual-function of DI/DO.
3. If DI4 was in the high-level state and switched to ABSQ after the T_S delay time, when the controller resets this signal to low level, the new signal is interpreted as the data access command.
4. After the T_Q time, the handshake data is ready and the absolute position is sent to ABSD. Now the servo drive turns on the ABSR signal and the controller can access the data. If the controller still cannot detect the ABSR status while it is changing to high level after the maximum T_Q time (refer to Figure 10.3.5.1.1), there may be a communication error.
5. Once the ABSR signal is set to high level, the controller accesses the data, and the ABSQ signal is set to high level to notify the servo drive that data was read.
6. When ABSQ is at high level, ABSR is set to low level after the T_N time in order to send the data for the next bit communication.
7. When ABSR is at low level, ABSQ is also set to low level and the servo drive needs to send the data for the next bit communication.
8. Repeat steps 3 and 4. Send the absolute position to ABSD for the next bit communication.
9. Repeat steps 5 to 7. The controller has read and received the data.
10. The third bit data is ready.
11. After the T_R waiting time, if the controller has not read the data and turned on the ABSQ signal, the servo drive sends the ABSW signal (communication error) and stops the handshake communication.
12. When the controller receives the communication error signal, it sets ABSE to low level and prepares to restart the handshake communication.
13. ABSW resumes to low level after the servo drive receives the ABSE signal.
14. The controller resumes communication after the T_B time.
15. Repeat step 1.
16. If no error occurs, the controller completes 80 bits (0 - 79) of the handshake communication with the servo drive. DI4, DO2, and DO3 then resume their original functions.

Note: if ABSE is set to low level first and then changed to high level, but ABSW does not resume to high level and the alarm remains on, it means some other errors exist. Check for the following possible warnings: absolute position lost, low battery voltage level, or absolute position overflows. Restart a new communication cycle after those errors have been cleared.

10.3.5.2 Reading the absolute position with communication

You can access the data of the absolute encoder through two communication methods: instant access or parameter access. Instant access refers to reading the motor's feedback position as soon as power is supplied to the servo. When you set the status monitoring register 1 to the motor's feedback pulse number (P0.017 = 0), you can access the motor's current position by reading P0.009. Parameter access means the motor's position is temporarily stored in parameters. Once you set P0.049 with communication, the encoder status and motor absolute position (cycle number), and pulse number (or PUU) are stored in P0.050, P0.051, and P0.052 respectively. You can choose to read the pulse number or PUU through P2.070 Bit 1. When P0.049 is set to 1, the drive does not clear the error when reading the position value. If P0.049 is set to 2, the drive clears the error at the same time when reading the position value. Even when the motor is stopped, it still moves slightly forward and backward for position correction which is normal for the servo system. To avoid difference between the read coordinates and the actual positioning of the motor, set to clear the position error at the same time when reading the coordinates, so the motor's actual positioning is changed to the read coordinates, which clears the position error. For example, the motor's current position is 20000, but it varies between 19999 and 20001. If you send the command to read the motor's position when it stops at 20001, then the motor's position is updated to 20001. After all positions are updated in P0.050 - P0.052, P0.049 is automatically reset to 0. At that point, the controller can access the values of P0.050 - P0.052. P0.050 shows the status of the absolute encoder. When it shows absolute position lost or cycle number overflow, that indicates the read absolute position is invalid. You must re-establish the absolute origin coordinates.



10.4 List of absolute parameters, DI/DO, and alarms

Relevant parameters (refer to Chapter 8 for detailed information):

Parameter	Function
P0.002	Drive status
P0.049	Update encoder absolute position
P0.050	Absolute coordinate system status
P0.051	Encoder absolute position - Multiple turns
P0.052	Encoder absolute position - Pulse number or PUU within single turn
P2.069	Absolute encoder
P2.070	Read data selection
P2.071	Absolute position homing

Relevant DI/DO (refer to Chapter 8 for detailed information):

Value	DI name	Value	DO name
0x1D	ABSE	When DI.ABSE is on, ABSR is output by DO2, which is no longer configured by P2.019.	ABSR always output by DO2
When DI.ABSE is on, DI4 is force set to ABSQ, which is no longer configured by P2.013.	ABSQ always input by DI4	When DI.ABSE is on, ABSD is output by DO3, which is no longer configured by P2.012.	ABSD always output by DO3
0x1F	ABSC	0x0D	ABSW

Relevant alarms (refer to Chapter 13 for detailed information):

Display	Alarm name
AL060	Absolute position is lost
AL061	Encoder undervoltage
AL062	Number of turns for the absolute encoder overflows
AL069	Wrong motor type
AL072	Encoder overspeed
AL073	Encoder memory error
AL074	Encoder single-turn absolute position error
AL075	Encoder absolute number of turns is in error
AL077	Encoder internal error
AL079	Encoder parameter error
AL07B	Encoder memory busy
AL07C	Command to clear the absolute position is issued when the motor speed is over 200 rpm
AL07D	Motor stops operating when servo drive power is cycled before AL07C is cleared
AL07E	Encoder clearing procedure error
AL289	Position counter overflows

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11 Linear Motor

This chapter provides the usage and setting details for the linear motor.

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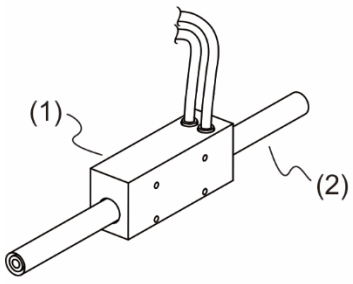
11.1 Linear motor overview

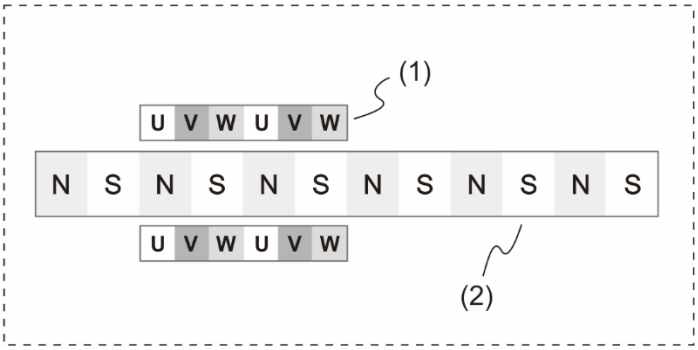
Linear motor can directly convert electrical energy into linear energy, and its mover and stator structures are different from those of a permanent magnet rotary motor. The use of a linear motor reduces the number of parts used in the machine. The direct drive method not only eliminates backlash, but also reduces the complexity of the machine and improves reliability.

The linear motor drive speed is faster than the rotary motor connected to the ballscrew.
In applications with longer stroke, take into account that the ballscrew is too long causing the screw to droop and creating more friction which results in wearing of the screw. The linear motor adopts a modular design which can connect to unlimited number of modules, so there are relatively few restrictions on the stroke.

The linear motor uses the linear scale or magnetic scale to get the feedback position instead of the rotary encoder in the rotary motor. When using a linear motor, it is suggested to install a Hall sensor and temperature sensor. The temperature sensor can directly monitor the actual temperature of the linear motor, so the motor has an extra layer of protection. For more information about the Hall sensor, refer to Section 11.4.

Note: for the Hall sensor setting, refer to PM.003 in Chapter 8; for the temperature sensor setting, refer to PM.022 in Chapter 8.

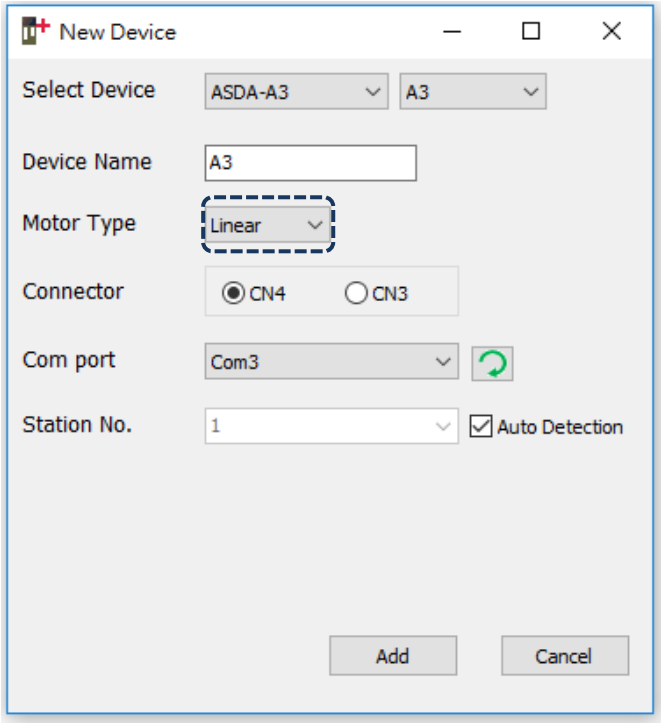




11.2 Linear motor software operation

Connect the servo drive first and activate ASDA-Soft. When the New Device window pops up, select “Linear” for Motor Type. If you do not select the correct corresponding motor, a unit error occurs when setting the parameters.

Note: the units of rotary motor and linear motor are different in some parameter settings. Refer to Chapter 8 for more information.



Comparison of rotary motor and linear motor:

	Rotary motor	Linear motor
Speed unit	rpm	mm/s, μm/s
Acceleration unit	0→3000 rpm/ms	0→5 $(^{m}/_{s})/ms$
Load ratio (P1.037)	Load inertia ratio	Total weight (unit: 0.1 kg)
Feedback type	Encoder	Linear scale, magnetic scale
Z pulse	One per cycle	Unlimited

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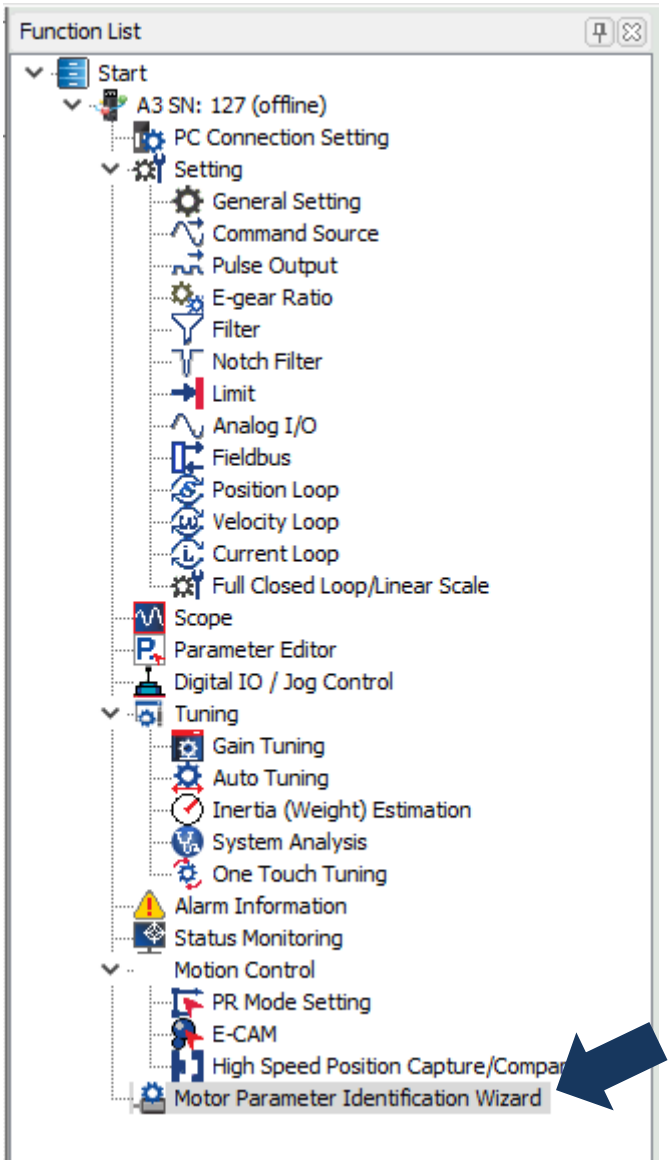
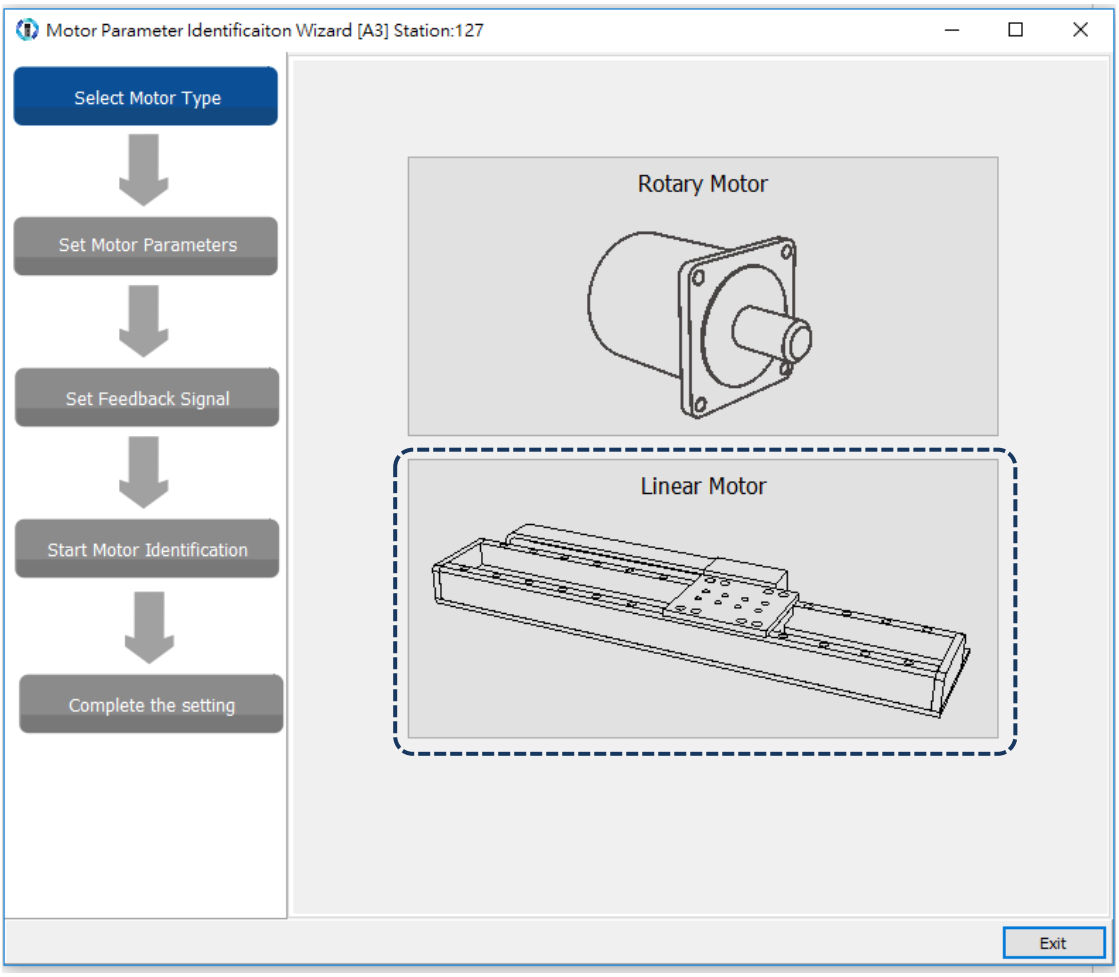
11.2.1 Motor parameter identification

After activating ASDA-Soft, check the current control mode of the servo drive. If it is in communication mode, first set the servo drive to a general mode (i.e. Position, Speed, and Torque modes) and then cycle power on the servo drive before executing the motor parameter identification process (see the path in the following figure). If you do not set the motor parameter identification, an alarm may be triggered due to the parameter setting error or the motor may be burnt due to the motor current setting error. When you replace the motor with a different type of motor, execute the motor parameter identification again.



Step 1: Select Motor Type

Enter the Motor Parameter Identification Wizard and select “Linear Motor”.



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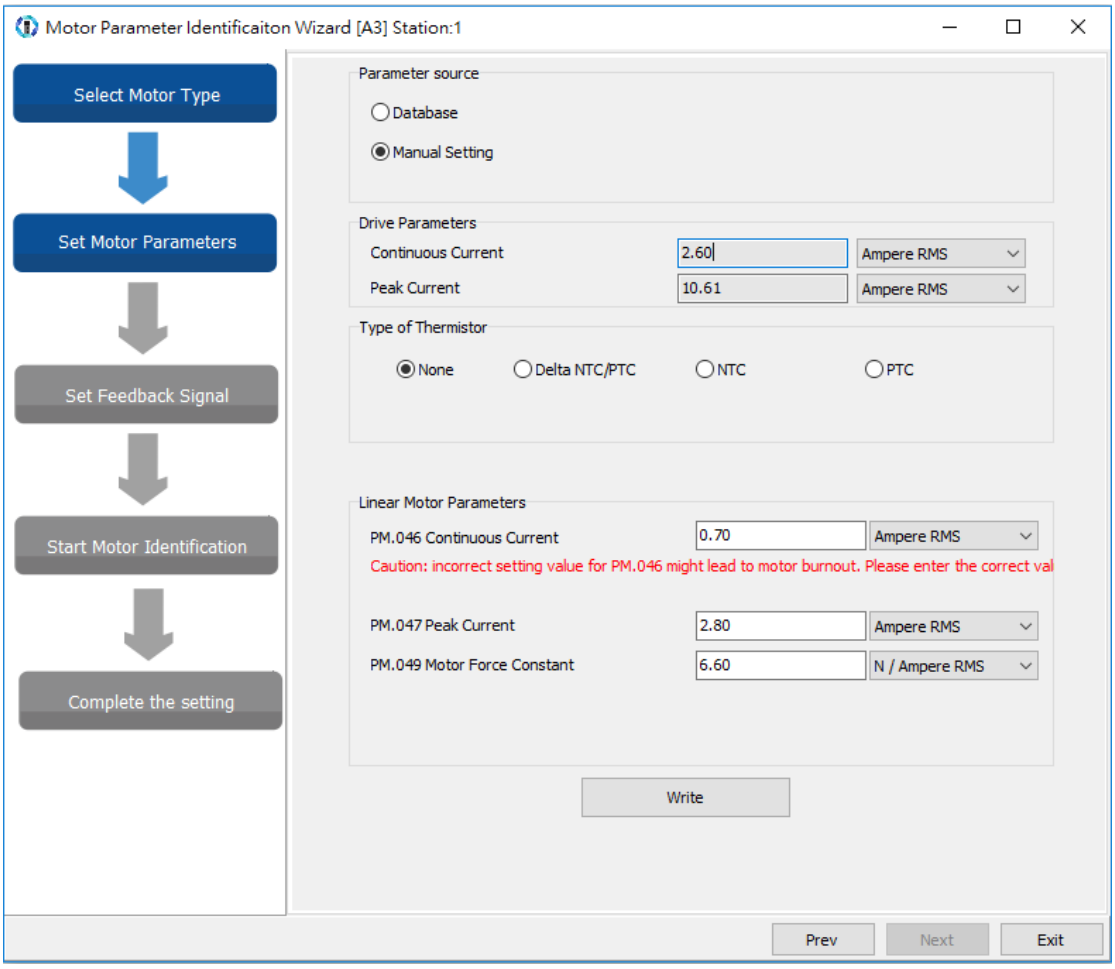
Step 2: Set Motor Parameters

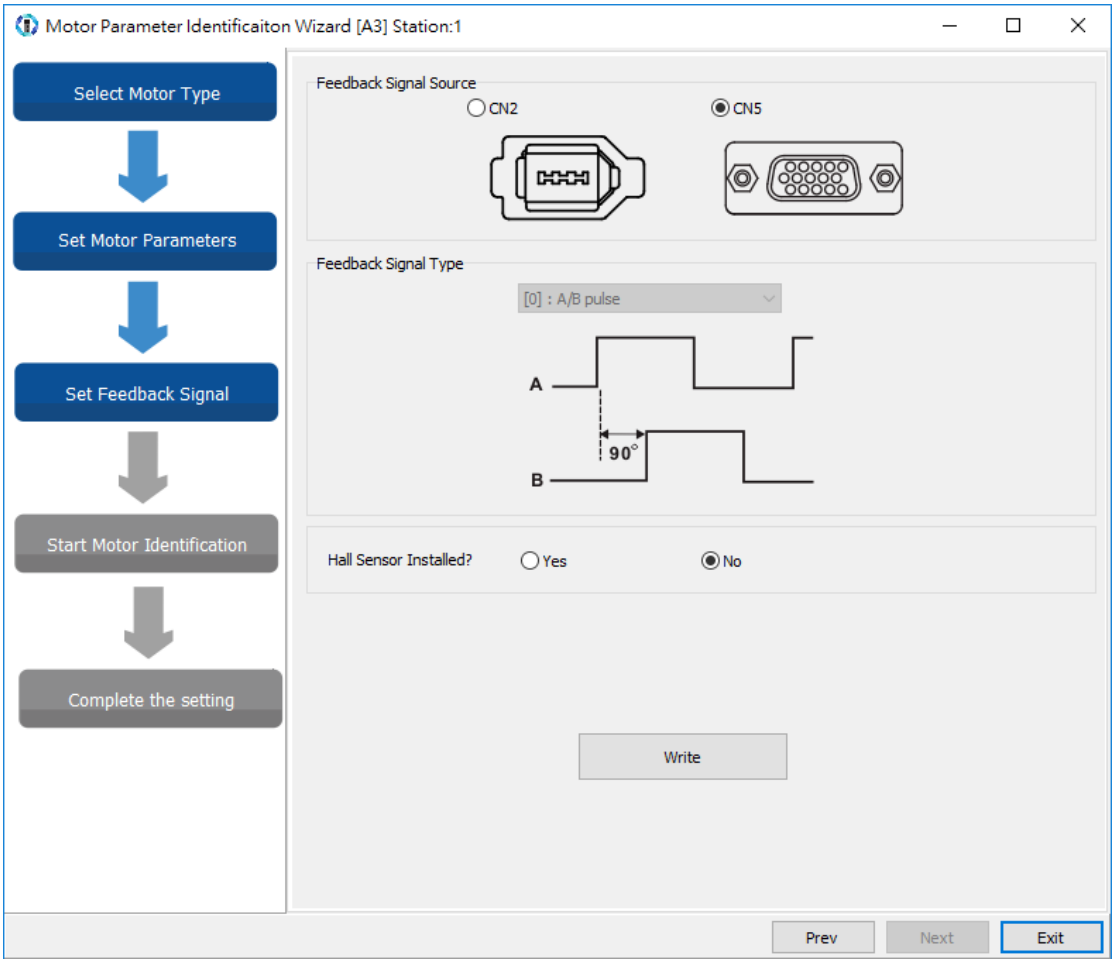
Select the source of the parameter first: Database or Manual Setting. For Database, you only need to confirm the Delta motor model and the software automatically fills in the motor specifications according to the content in the database. For Manual Setting, input all linear motor related specifications and correctly set the motor current parameters (PM.046 and PM.047), or the motor may be burnt. Thus, be sure to double check the parameters and whether the unit is Ampere RMS or Ampere Peak before inputting the values. When the settings are complete, press **Write** and then press **Next**.



Step 3: Set Feedback Signal

Currently, the ASDA-A3 series only support pulse type (square wave) linear encoders, which receive pulse signals from the linear encoder through the CN5 position signal feedback connector. The ASDA-A3 that supports sine wave linear encoder is coming soon, but the servo drive must be equipped with a position signal converter box*. The position signal converter box converts the signal to the communication format that the CN2 encoder signal connector can receive. If the hardware connection does not match the parameter settings, AL011 is triggered. Next, select Yes or No for installation of the Hall sensor. When the settings are complete, press **Write** and then press **Next**.

Note: the position signal converter box will be added soon.



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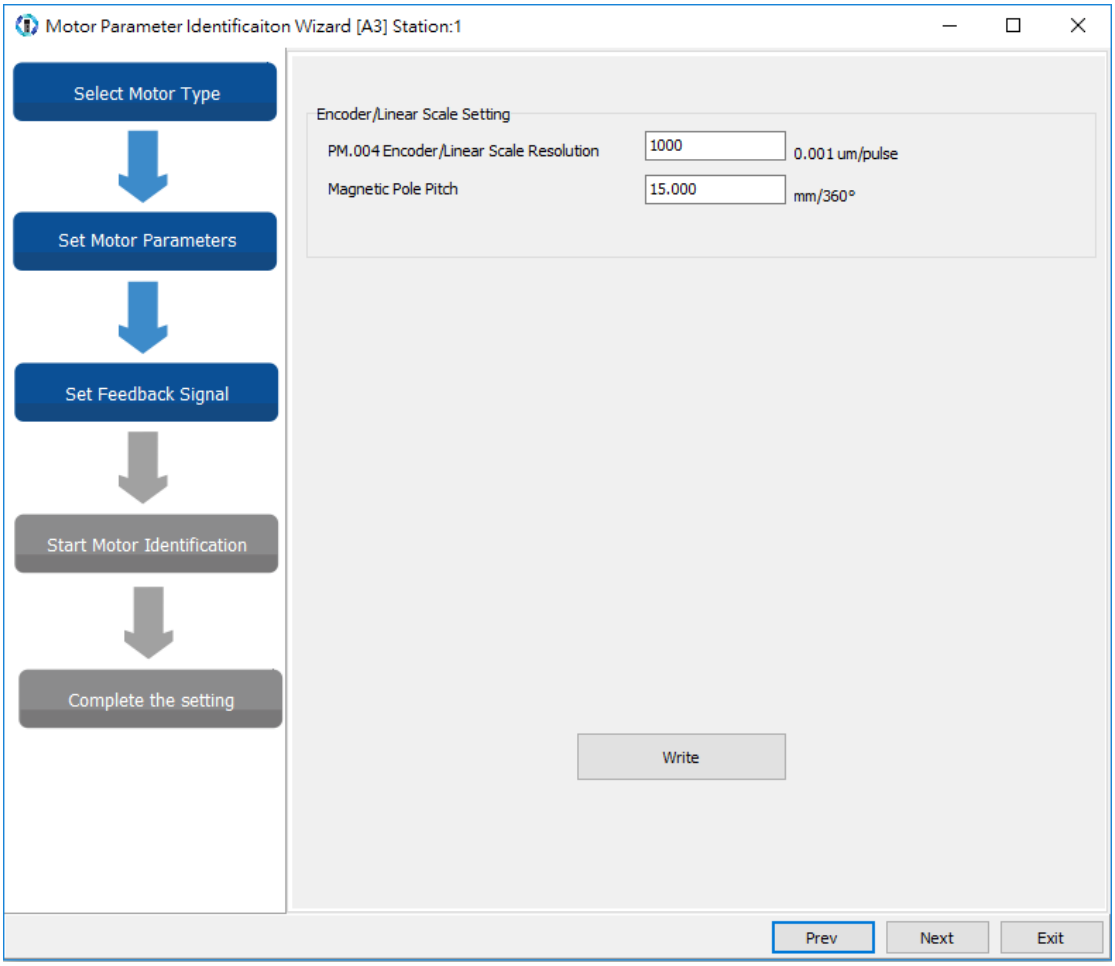
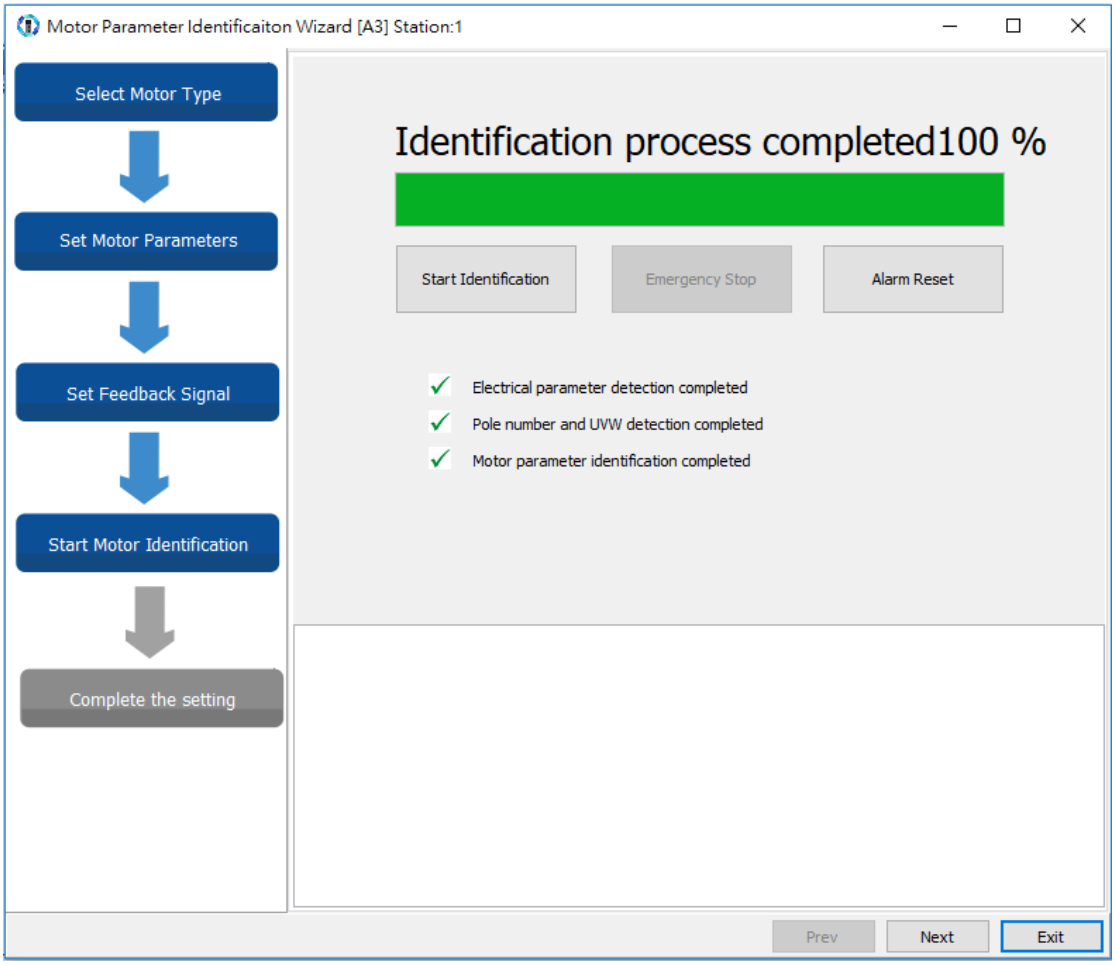
For the PM.004 Encoder / Linear Scale Resolution, input the linear scale resolution (unit: 10^{-3}μm/pulse). For example, if the linear scale resolution is 1 μm, then PM.004 = 1000. As for the Magnetic Pole Pitch, you can find the value in the linear motor catalogue. If you select a linear motor from the database, this section is automatically filled in; if it is not a Delta linear motor or the linear motor is not yet created in the database, you must input the value. If the set value is incorrect, AL051 is triggered. When the settings are complete, press **Write** and then press **Next**.



Step 4: Start Motor Identification

Manually move the linear motor to the center of the platform or move it back and forth to a position which leaves a minimum clearance of a magnetic pole pitch. To avoid damage to the machine and personnel injury, make sure there is no personnel nearby because the platform moves slightly when executing the motor identification process. If an alarm occurs during the identification process, refer to Chapter 13 Troubleshooting to clear the alarm. The software only continues with the identification process when the alarm is cleared. Cycle the power on the servo drive after the identification process is complete. Without cycling the power, you cannot switch the servo to the Servo On state.



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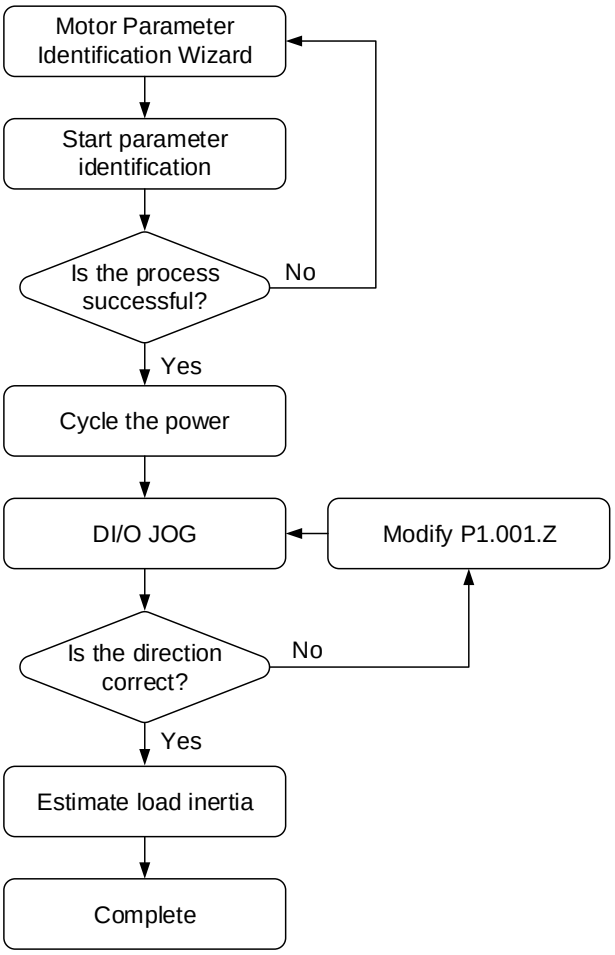
11.2.2 Linear motor direction setting

After the setting for the Motor Parameter Identification Wizard is done, set the direction for the linear motor. Incorrect direction setting results in incorrect direction of movement, making the limit switch invalid and increasing the risk of collision. Use the JOG mode to set the linear motor direction with the jog speed unit as 0.01 mm/s. When executing jog control, check if the jog speed is set too slow or too fast. If it is too slow, you may think that the motor is not actuated; if it is too fast, it may cause the motor to crash.

Flowchart of linear motor direction setting:



11.3 Linear encoder

The linear encoder generally refers to a linear scale or a magnetic scale, which is mainly used to monitor the linear motor position and return the position data to the servo drive for the purpose of servo control. Set PM.003 for the linear scale. If AL011 is triggered when using the linear motor, check if PM.003.U is set correctly. The linear encoder types include sine wave type and pulse type. Currently, the CN5[*2] of the ASDA-A3 only supports pulse type encoders, and sine wave type encoders must be used with a position signal converter box[*3] to connect to CN2.

Note:

1. For detailed parameter description, refer to Chapter 8 Parameters.
2. The CN5 single-phase maximum input frequency is 4 Mpps.
3. The position signal converter box will be added soon.

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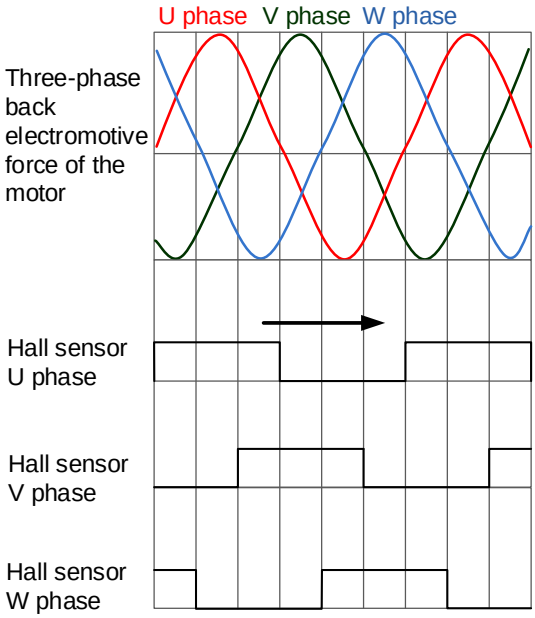
11.4 Hall sensor

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. Currently, the ASDA-A3 only supports digital signals, and analog signals are not yet supported. The Hall sensor divides the motor magnetic field from 0 to 360° by the three-phase signals 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 linear motor, make sure it is equipped with the Hall sensor. If there is a Hall sensor, set PM.003.Y to 1; otherwise, set PM.003.Y to 0. If you activate the motor identification process when the linear motor is not equipped with the Hall sensor, the motor detects the magnetic pole in a slight vibration and cannot function on the Z-axis mechanism without the spring installed or balancing process.

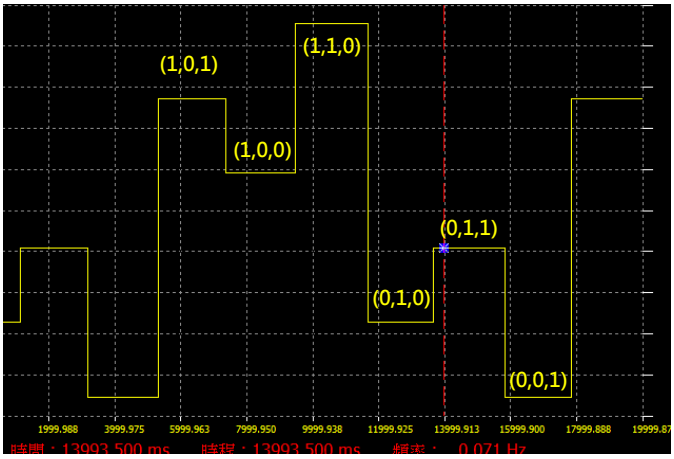


11.4.1 Hall sensor phase sequence checking

To check the phase sequence of the Hall sensor, set P0.017 to -177 to set the monitoring variable and observe the phase sequence change with P0.009. The bits of this monitoring variable are (bit3, bit2, bit1) = (W, V, U). The following figure shows the waveform monitored by the scope when you manually move the linear motor. 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). Incorrect phase sequence may cause the motor to go in the wrong direction or even out of control.

Note: bit value of the monitoring variable -177:

Bit 1: U phase; Bit 2: V phase; Bit 3: W phase.



11.5 Position signal converter box

The position signal converter box* is a feedback signal conversion product developed by Delta. The feedback signals of OA/OB pulses or sine wave can be converted into Delta's communication format without external power supply. Then the feedback signal is returned to the servo drive through CN2. The position signal converter box increases the resolution and avoids the frequency limit with the interpolation sine wave signal.

Note: this feature is not released yet.

11

11.6 Parameter setting

Linear motors and rotary motors are incompatible with specific parameter settings. The following sections describe the definitions and precautions for linear motor parameter settings. Before setting the parameters, refer to Chapter 8 Parameters for more information. Some settings and units of the parameters for the linear motor are different from those of the rotary motor, which are further explained in this section.

11.6.1 Total weight (mover + load)

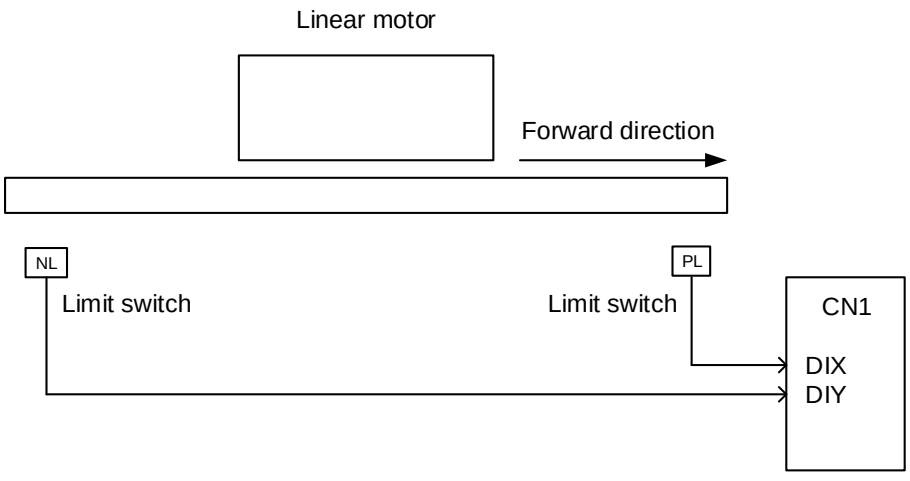
The total weight estimation of the linear motor is similar to that of the rotary motor, but the set unit for the total weight of the linear motor is kg. The suggested speed during estimation is 10000 (0.01 mm/s) or above, the acceleration or deceleration speed is 0 - 5000 mm/s, and the duration is less than 1.5 seconds.

11.6.2 E-Gear ratio

It is suggested to set the E-Gear ratio for the linear motor to $\frac{P1.044}{P1.045} = \frac{1}{1}$. If the E-Gear ratio is 1, when the command issues 1 PUU, the linear scale feedback is 1 pulse; if the E-Gear ratio is 2, when the command issues 1 PUU, the linear scale feedback is 2 pulses. Incorrect E-Gear ratio setting may result in an error between the command and the actual movement distance.

11.6.3 Limit setting

The limit setting function is to protect the motor from exceeding the allowable range. Use the actual signal switch to connect to the DI for protecting the machine and avoiding collision.
As shown in the following figure, the X and Y of the DI are user-defined. The DIX in this figure is defined as the positive limit (PL) and the DIY is defined as the negative limit (NL). These two functions are defined as forward inhibit limit (0x23) and reverse inhibit limit (0x22). When the forward or reverse direction changes, change the positive and negative limit settings, otherwise there is no protection.



11.6.4 Initial magnetic field current detection

PM.011 (Initial magnetic field current detection) is a parameter used for the linear motor without a Hall sensor. When the linear motor without a Hall sensor is powered on and the servo is switched on for the first time, the servo drive outputs the current set in PM.011 and automatically detects the motor initial magnetic field by the vibration of the motor to obtain the current magnetic field data of the motor. The current affects the vibration level of the linear motor during detection. The appropriate current can overcome the friction between the motor and the mechanism to complete the initial magnetic field detection. Excessive current causes the linear motor to vibrate too much, which may result in machine crashing. On the other hand, when the current is too low, it may not be able to overcome the friction and complete the initial magnetic field detection, which triggers AL052. For the settings of PM.011, refer to Chapter 8 Parameters.

11.6.5 Overload gain

The overload gain setting is for protecting the device. Under normal circumstances, set PM.019 and PM.020 to 100%. These parameters do not affect the motor operation. When setting these parameters to above 100%, use the monitoring variable -91 to monitor whether the overload (AL006) exceeds 100%.

Load	Operating time	Load	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%	26.38 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 time required for the motor protection level at the normal level to reach the overload level is called the operating time. When the protection level reaches the overload level, AL006 is triggered. The load ratio is based on 100%. When the ratio is above 100%, it is load increase gain (PM.019); when the ratio is less than 100%, it is load decrease gain (PM.020). 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. If the load ratio is below 100%, you do not need to consider the operating time.

Note: for detailed parameter description, refer to Chapter 8 Parameters.

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CANopen Mode 12

This chapter provides details for the required parameter settings when the servo communicates with the controller through the CANopen communication function.

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12.1 Basic configuration

12.1.1 Supported functions

CANopen functions supported by Delta servo drives:

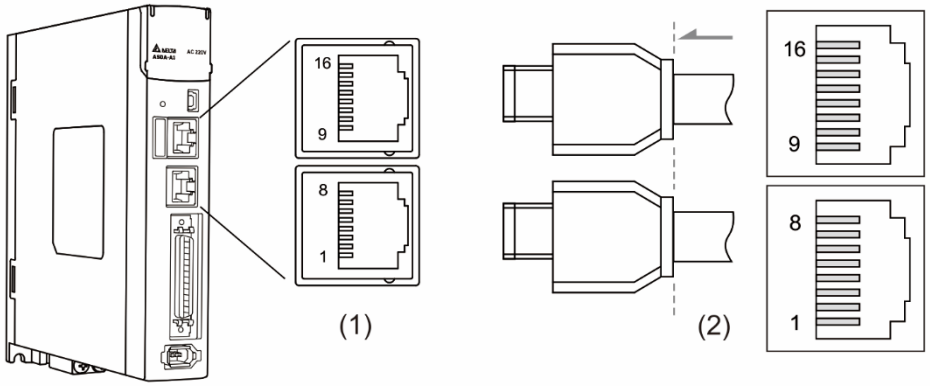
- CANopen communication protocol: NMT, SYNC, SDO, PDO, and EMCY.
- SDO transmission: acyclic data exchange for reading / writing parameters and communication related settings.
- PDO transmission / reception: time-triggered, event-triggered, synchronous transmission (cyclic), and asynchronous transmission (acyclic).
- Node guarding.
- Heartbeat.

CANopen functions not supported by Delta servo drives:

- Time stamp.

12.1.2 Hardware configuration

Pin assignment (RJ-45) for CAN bus wiring



(1) CN3 connector (female) (2) CN3 connector (male)

Pin assignment:

Pin No.	Signal	Description
1	CAN_H	CAN_H bus line (dominant high)
2	CAN_L	CAN_L bus line (dominant low)
3, 7	GND_ISO	Signal GND
4	RS-485-	Servo drive transmits data to differential terminal (-)
5	RS-485+	Servo drive transmits data to differential terminal (+)
6, 8	-	-
9	CAN_H	CAN_H bus line (dominant high)
10	CAN_L	CAN_L bus line (dominant low)
11, 15	GND_ISO	Signal GND
12	RS-485-	Servo drive transmits data to differential terminal (-)
13	RS-485+	Servo drive transmits data to differential terminal (+)
14, 16	-	-

■ Baud rate setting

Baud rate and bus length

Baud rate	Maximum bus length
1 Mbps	25 m
750 Kbps	50 m
500 Kbps (default)	100 m
250 Kbps	250 m
125 Kbps	500 m

12.1.3 Parameter settings of CANopen mode

Follow these instructions to connect the CANopen controller and the ASDA-A3 servo drive:

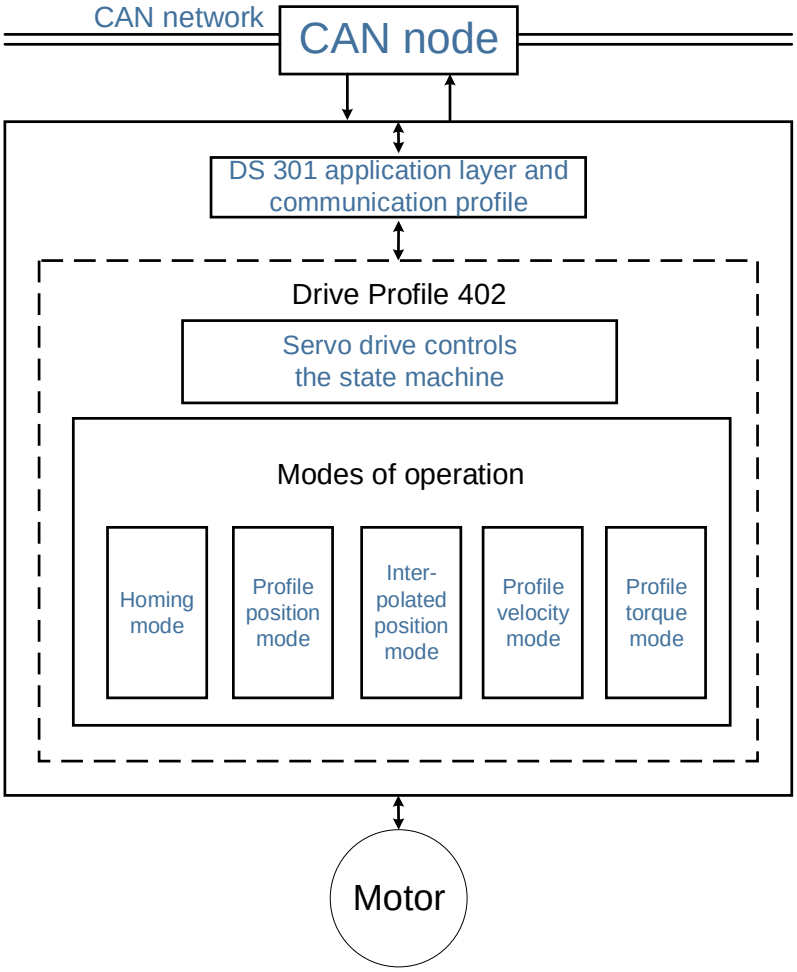
1. Set CANopen mode: set P1.001 to 0x0C.
2. Set node ID: set the range of P3.000 to 01h - 7Fh.
3. Set P3.001 to 0403h for baud rate as 1 Mbps (0: 125 Kbp; 1: 250 Kbps; 2: 500 Kbps; 3: 750 Kbps; 4: 1 Mbps).
4. It is suggested to set P3.012 to 0x0100, so the parameters in the following table are non-volatile.

Variables during initialization	P3.012.Z = 0	P3.012.Z = 1	Note
P1.032	0x0010	EEPROM	-
P2.035	50331648	EEPROM	-
P1.047	100	EEPROM	-
P1.049	0	EEPROM	-
P1.038	100	EEPROM	-
Home offset	0	EEPROM	Used in Homing mode.
P1.044	1	EEPROM	-
P1.045	1	EEPROM	-

5. It is suggested to enable the dynamic brake function (P1.032 = 0x0000).

12.2 Communication specification

12.2.1 Servo communication architecture



The CANopen architecture of the servo drive is as follows:

- DS301 is the communication profile: this protocol includes the communication objects (PDO, SDO, SYNC, and Emergency object), NMT service, and related communication object dictionary.
- DS402 is the device profile for drives and motion control: defines the behavior of each motion mode and the required object parameter settings for execution.

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12.2.2 Communication objects

The default of the Delta servo drive complies with the DS301 protocol. All CANopen data contains an 11-bit identifier, generally referred to as "COB-ID". The COB-ID data format is as follows:

Bit	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 6 - Bit 0	Node-ID	The data size is 7-bit and the setting range is 0 - 127.
Bit 10 - Bit 7	Function code	The data size is 4-bit and the setting range is 0 - 15.

The following table lists the supported objects and the corresponding COB-IDs:

Communication object	Function code Bit 10 9 8 7	Node ID Bit 6 5 4 3 2 1 0	COB-ID DEC (HEX)	Object parameter
NMT service	0 0 0 0	0 0 0 0 0 0 0	0 (0h)	-
SYNC object	0 0 0 1	0 0 0 0 0 0 0	128 (80h)	1005h - 1007h
EMCY object	0 0 0 1	X X X X X X X	128 (80h)	1014h
T_PDO1	0 0 1 1	X X X X X X X	384 (180h) + Node-ID	1800h
R_PDO1	0 1 0 0	X X X X X X X	512 (200h) + Node-ID	1400h
T_PDO2	0 1 0 1	X X X X X X X	640 (280h) + Node-ID	1801h
R_PDO2	0 1 1 0	X X X X X X X	768 (300h) + Node-ID	1401h
T_PDO3	0 1 1 1	X X X X X X X	896 (380h) + Node-ID	1802h
R_PDO3	1 0 0 0	X X X X X X X	1024 (400h) + Node-ID	1402h
T_PDO4	1 0 0 1	X X X X X X X	1152 (480h) + Node-ID	1803h
R_PDO4	1 0 1 0	X X X X X X X	1280 (500h) + Node-ID	1403h
T_SDO	1 0 1 1	X X X X X X X	1408 (580h) + Node-ID	1200h
R_SDO	1 1 0 0	X X X X X X X	1536 (600h) + Node-ID	1200h
NMT error control	1 1 1 0	X X X X X X X	1792 (700h) + Node-ID	1016H, 1017h

Note: 0 indicates the bit is off; 1 indicates the bit is on; X indicates the bit is set according to the requirement.

Communication dictionary

Communication object	Object area
1000 - 1FFF	Communication Profile Area
2000 - 2FFF	Manufacturer Specific Profile Area
6000 - 9FFF	Standardized Device Profile Area

12.2.2.1 Process data object (PDO)

Real-time data transmission can be achieved with Process data objects (PDOs). There are two types of PDOs: the sent TxPDO and the received RxPDO. This definition is from the perspective of the servo drive, for example, the sent TxPDO refers to the object that the servo drive sends to the controller. Set the communication parameters and mapping parameters as shown in the following table to use the PDOs.

Received RxPDO

Communication object	Communication object parameter	Mapping object parameter
R_PDO1	1400h	1600h
R_PDO2	1401h	1601h
R_PDO3	1402h	1602h
R_PDO4	1403h	1603h

Sent TxPDO

Communication object	Communication object parameter	Mapping object parameter
T_PDO1	1800h	1A00h
T_PDO2	1801h	1A01h
T_PDO3	1802h	1A02h
T_PDO4	1803h	1A03h

The mapping parameter format of PDO 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 length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

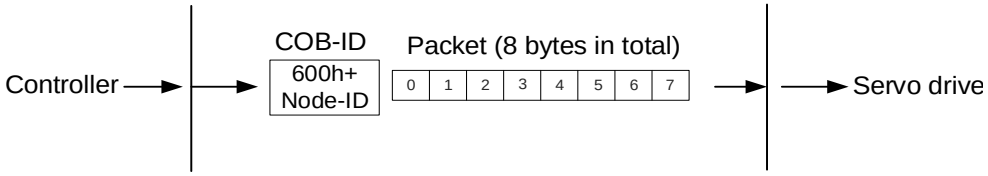
Example:

To set three PDOs (OD 6040h, OD 607Ah, and OD 6060h) in the first group of PDOs, the setting is as follows:

Mapping parameter setting for received PDO	Data			Description
OD 1600 sub0	3			Set 3 PDO mappings.
OD 1600 sub1	6040h	00h	10h	-
OD 1600 sub2	607Ah	00h	20h	-
OD 1600 sub3	6060h	00h	08h	-
Note	The total length is 38h (56-bit) which meets the specification of less than 64-bit.			

12.2.2.2 Service data object (SDO)

With Service data objects (SDOs), you can write or read objects. The SDO message format is mainly composed of COB-ID and SDO data. SDO data can transmit up to 4 bytes.

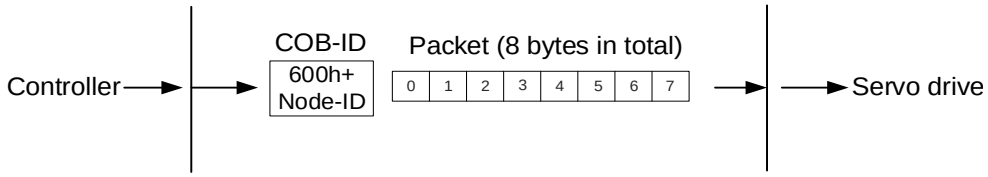


Byte	Function
Byte 0	Command code
Byte 1 - Byte 2	Object index
Byte 3	Object sub-index
Byte 4 - Byte 7	Data

■ Write data with SDO

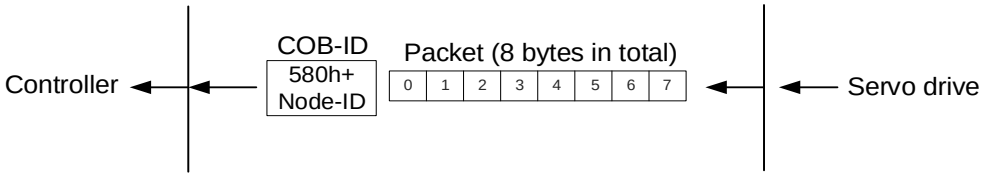
To use an SDO to write data with the controller, you need to write the request code, index, and data according to the SDO format. The servo drive then returns the corresponding message based on the written data.

The following figure shows the packet format when the controller sends the SDO for writing data:



Function code	Object index		Object sub-index	Data				Description
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	
23h	-	-	-	Data				Write 4 bytes of data.
2Bh	-	-	-	Data				Write 2 bytes of data.
2Fh	-	-	-	Data				Write 1 byte of data.

The following figure shows the packet format returned by the servo drive when the controller sends the SDO for writing data:



Function code	Object index		Object sub-index	Data				Description
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	
60h	-	-	-					Write-in is successful.
80h	-	-	-	SDO abort codes				Error code.

Note: for SDO abort codes, refer to Section 12.2.2.3.

Example:

Write the value of 300,000 (483E0h) to the servo parameter P7.001 (OD 2701h).

The write-in format is as follows:

Function code	Object index		Object sub-index	Data				Description
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	
23h	01	27	0	E0	93	04	00	Write 4 bytes of data.

The returned packet is as follows:

Function code	Object index		Object sub-index	Data				Description
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	
60h	01	27	0					Write-in is successful.

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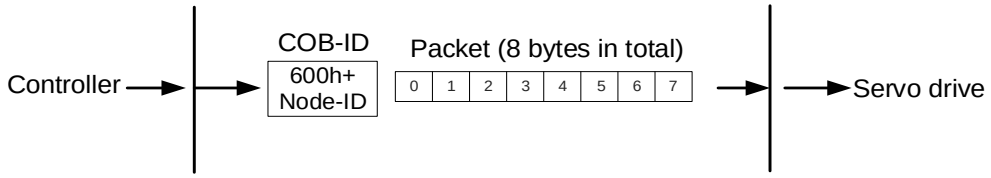
■ Read data with SDO

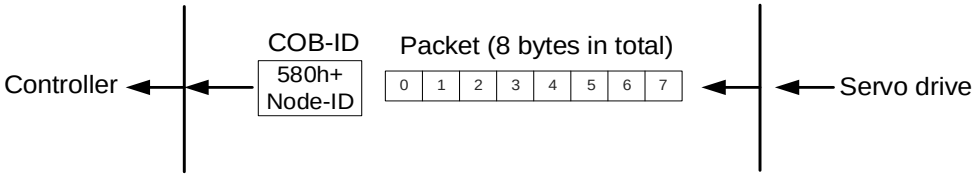
To use an SDO to read data with the controller, you need to write the request code and index according to the SDO format. The servo drive then returns the object's data based on the object to be read.

The following figure shows the packet format when the controller sends the SDO for reading data:



Function code	Object index		Object sub-index	Data				Description
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	
40h	-	-	-					Read data.

The following figure shows the packet format returned by the servo drive when the controller sends the SDO for reading data:



Function code	Object index		Object sub-index	Data				Description
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	
43h	-	-	-	Data				Read 4 bytes of data.
4Bh	-	-	-	Data				Read 2 bytes of data.
4Fh	-	-	-	Data				Read 1 byte of data.
80h	-	-	-	SDO abort codes				Error code.

Note: for SDO abort codes, refer to Section 12.2.2.3.

12.2.2.3 SDO abort codes

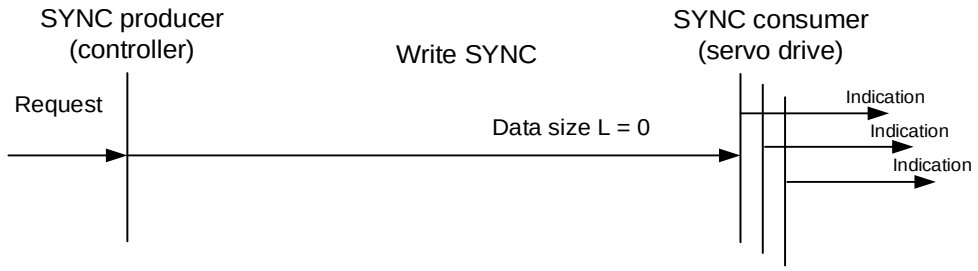
The abort codes are as follows:

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 hardware error (storage or restore 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	An error occurred when reading an object from EEPROM.
080000a2h	An error occurred when writing an object to EEPROM.
080000a3h	Invalid range when accessing EEPROM.
080000a4h	EEPROM data content error occurred when accessing EEPROM.
080000a5h	The entered password is incorrect when writing to the encryption area
08000020h	Unable to transfer data or save data to the application.
08000021h	Unable to transfer data or save data to the application due to restrictions (storage or restore in the wrong state).
08000022h	Object is in use.

12.2.2.4 Synchronization object (SYNC)

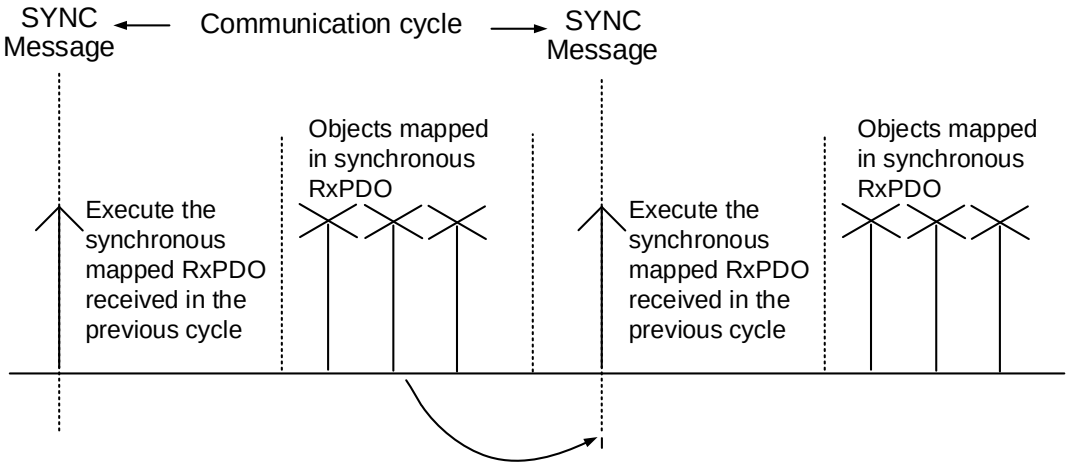
The Synchronization objects (SYNCs) are periodically broadcast by the SYNC producer. There is no data in the SYNC packet (L = 0).

The SYNC protocol is as follows:

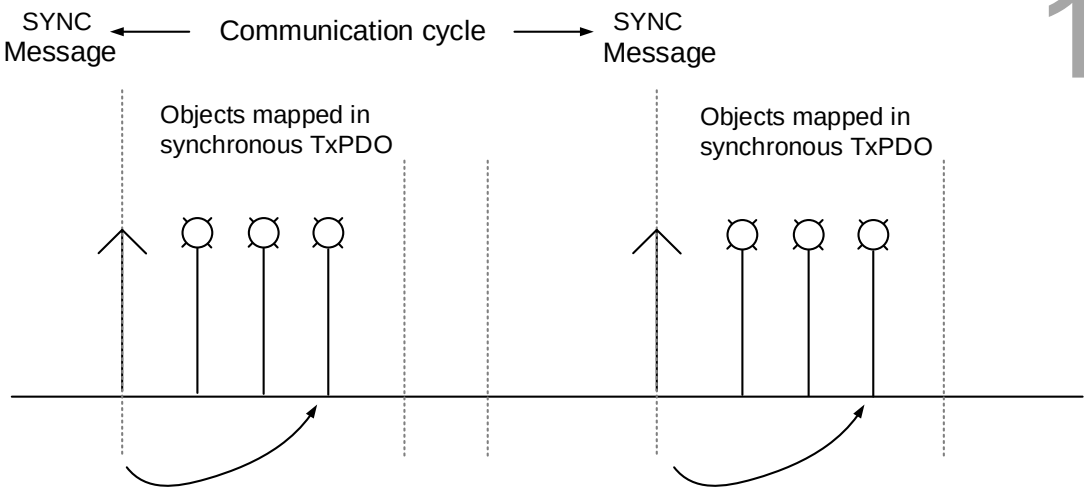


The SYNC object is used to achieve PDO transmission and reception synchronization between the controller and servo drive. The SYNC object transmission cycle is set by the object OD 1006h (see Section 12.4 for detailed settings).

The following figure shows the timing sequence between the servo drive RxPDO reception and the controller SYNC transmission. The controller transmits RxPDO to the servo drive between two SYNCs (communication cycle), and the servo drive will not execute the RxPDO received in the previous communication cycle until it receives the SYNC.

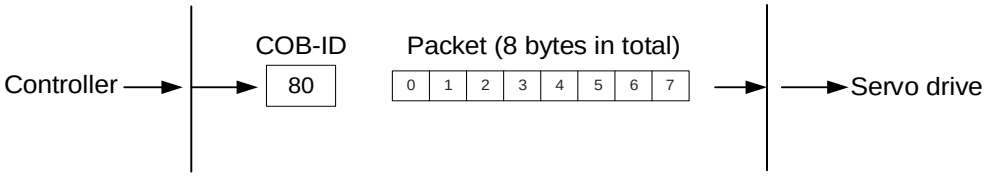


The following figure shows the timing sequence between the servo drive TxPDO transmission and the controller SYNC transmission. The servo drive transmits the TxPDO data to the controller as soon as it receives the SYNC.



12.2.2.5 Emergency object (EMCY)

When the servo detects an abnormality, it sends an alarm and notifies the controller with the Emergency object. The Emergency object can only transmit one alarm at a time. When a higher priority alarm occurs before the previous lower priority alarm is cleared, the higher priority alarm overwrites the previous alarm and notifies the controller as an Emergency object.



Error code		Error register	Servo alarm	N/A
Byte 0	Byte 1	Byte 2	Byte 3	Bytes 4 - 7
See OD 603Fh on the error code table.		OD 1001	Refer to Chapter 13 for details.	

12.2.2.6 NMT services

■ State machine

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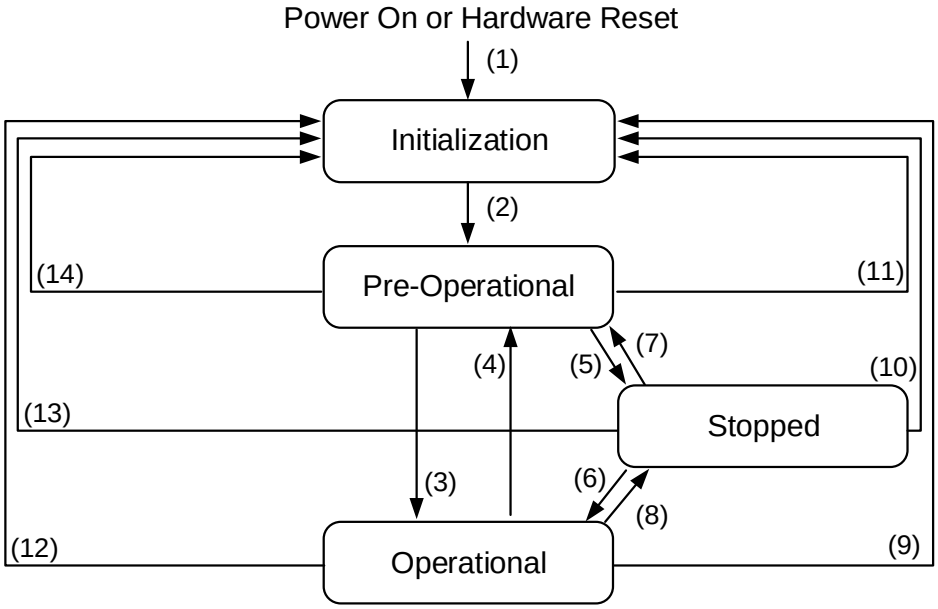
The NMT state machine is shown as follows. After the servo drive completes the Initialization mode, it enters the Pre-Operational mode. The NMT state machine determines the behavior of the communication function, such as PDO functions only in the Operational mode.



Status	Description
Initialization	The servo drive successfully completes initialization after powering on without errors occurring. The packet could still not be transferred in this state.
Pre-operational	Data can be exchanged with SDO. If an alarm occurs in the servo drive, an emergency message is sent to notify the controller.
Stopped	SDO and TxPDO data packets can be used to exchange data with the controller.
Operational	This state allows for all data exchanges including SDO and PDO (TxPDO and RxPDO).

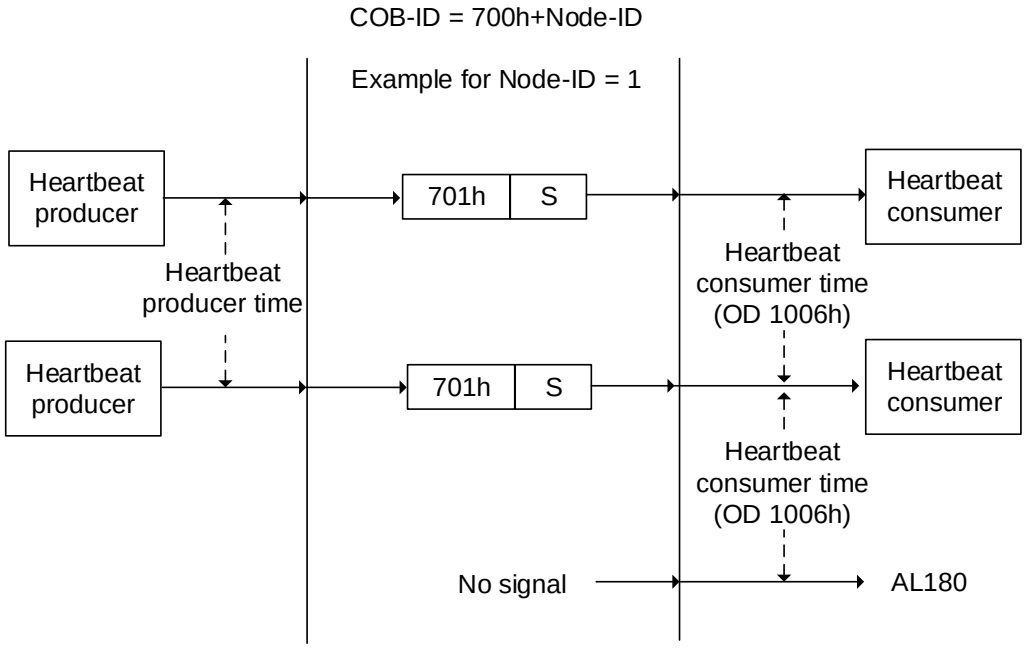
The following table shows the communication objects that can be used for each communication status:

Communication object	Initialization	Pre-operational	Operational	Stopped
PDO			V	
SDO		V	V	
Synchronization object		V	V	
Emergency object		V	V	
Boot-up object	V			
NMT object		V	V	V

■ Heartbeat

The Heartbeat mechanism is mainly to enable the producer to periodically send packets to the consumer. The producer can be a controller or servo drive; on the other hand, a controller or servo drive can also be the consumer.

If you use the servo drive as the consumer and the controller to send the heartbeat, you need to set the heartbeat receiving time (OD 1016h) of the servo drive. When the servo drive does not receive the heartbeat signal within the receiving time, the heartbeat event is triggered, meaning AL180 is triggered. Consumer heartbeat time (OD 1016h) is defined as the time the servo drive expects to receive a heartbeat. For the setting, consumer heartbeat time (OD 1016h) must be greater than the producer heartbeat time. The producer time is set by the controller. Due to delays and other uncontrollable external factors in transmitting the heartbeat, you must retain a tolerance margin value.



The S code is described as follows:

S	Function
0	Bootup
4	Stopped
5	Operational
127	Pre-operational

If you want to use the servo drive as the producer, then the heartbeat is sent by the drive and you need to set the producer heartbeat time (OD 1017h). Set the consumer heartbeat time for the controller, which must be greater than the producer heartbeat time. When the controller does not receive the heartbeat signal within the receiving time, it triggers the heartbeat event which corresponds to the alarm defined by the controller.

The servo drive can play two roles simultaneously, the consumer and producer, but you need to set OD 1016h and OD 1017h at the same time. And the controller must also be set as the producer and consumer.

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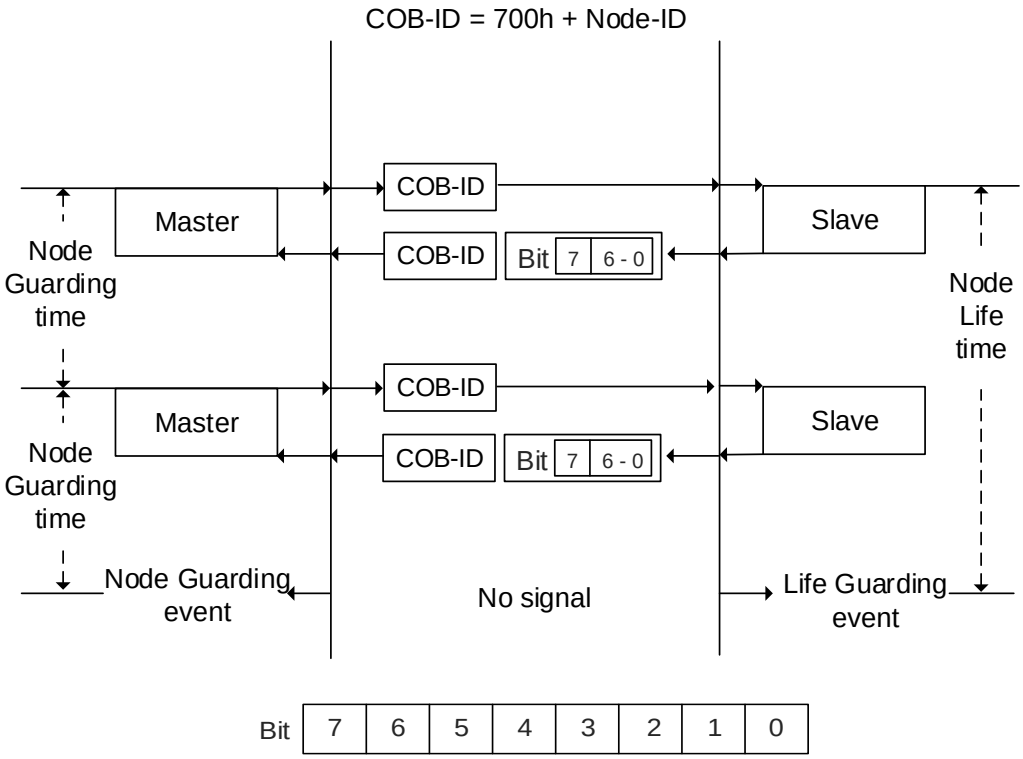
■ Node / Life Guarding

The Node / Life Guarding mechanism is similar to that of Heartbeat. The main difference between the two is that Heartbeat only uses the consumer to judge whether there are packets or not, and the producer does not make this judgment. The mechanism of Node / Life Guarding is mainly based on the master-slave axis and the two-way relationship. The master axis periodically sends packets to the slave axis, and the slave axis must return the packets to the master axis within the set guard time (OD 100Ch), otherwise an error occurs. You must set the life time for the slave axis and the master slave must send the packets within the life guard time. If the slave axis does not receive the packets, AL180 is triggered. Life time is set by multiplying the guard time by a life time factor (OD 100Dh).

The Node / Life Guarding architecture is as follows:



Bit	Function	Description
Bit 6 - Bit 0	State of the NMT slave	4 = stopped 5 = operational 127 = pre-operational
Bit 7	-	-

12.3 CANopen operation mode

This section describes the servo motion mode (Mode of Operation) specified by CiA402 in CANopen mode. The content includes basic operation settings and related object descriptions.

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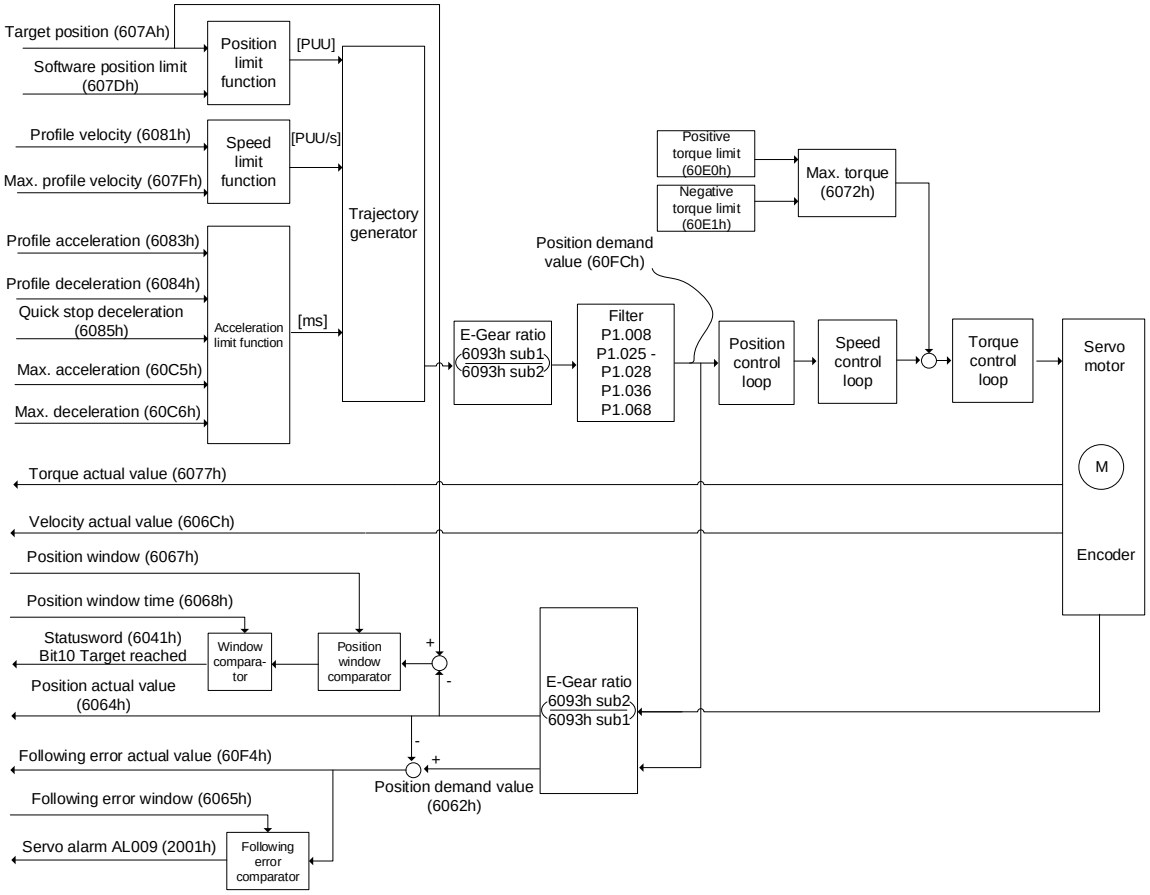
12.3.1 Profile Position Mode

After the servo drive receives the position command transmitted by the controller, the servo drive controls the servo motor to reach the target position. In the position control mode, the controller only informs the servo drive of the target position, speed command, and acceleration / deceleration related settings at the beginning. The motion plan from command triggering to the arrival of the target position is performed by the motion command generator in the servo drive. The following figure shows the position control mode architecture of the servo drive:



Operation steps:

1. Set OD 6060h to 01h to set the mode as the position control mode.
2. Set OD 607Ah for the target position (unit: PUU).
3. Set OD 6081h for the speed command (unit: PUU/sec).
4. Set OD 6083h for the acceleration time slope (unit: ms).
5. Set OD 6084h for the deceleration time slope (unit: ms).
6. Set OD 6040h for the control command. Follow the steps below. 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 12.4.

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 triggered (rising-edge triggering).

7. After completing the first motion command, set the target position, speed and other conditions to execute the next motion command.
8. Set OD 6040h for the control command. Since the command is triggered by rising-edge triggering, switch Bit 4 to Off first and then switch to On.

Step	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
9.1	0	1	1	1	1	Enable operation (servo on).
9.2	1	1	1	1	1	Command triggered (rising-edge triggering).

Read the servo drive information:

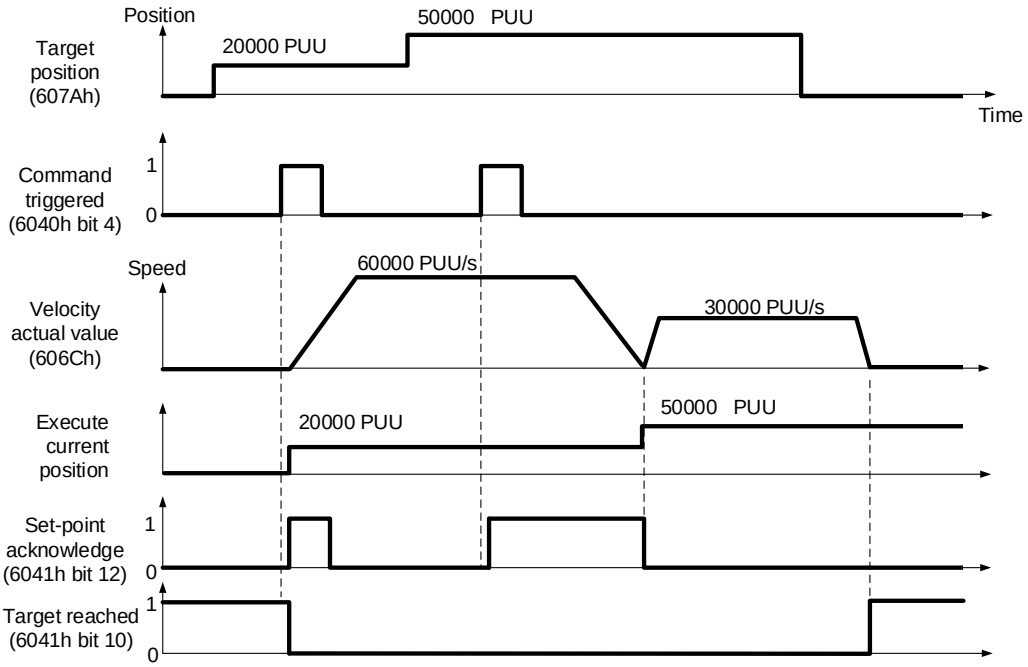
1. Read OD 6064h to obtain the current motor feedback position.
2. Read OD 6041h to obtain the servo drive status, including the following error, set-point acknowledge, and target reached notification.

Command to take immediate effect

In the position control mode, set the command to take effect immediately or not with Bit 5.

- When Bit 5 is set to 0, the command to take immediate effect is disabled.

If the command to take immediate effect is not enabled, 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 only acknowledged and executed after the current command is executed.



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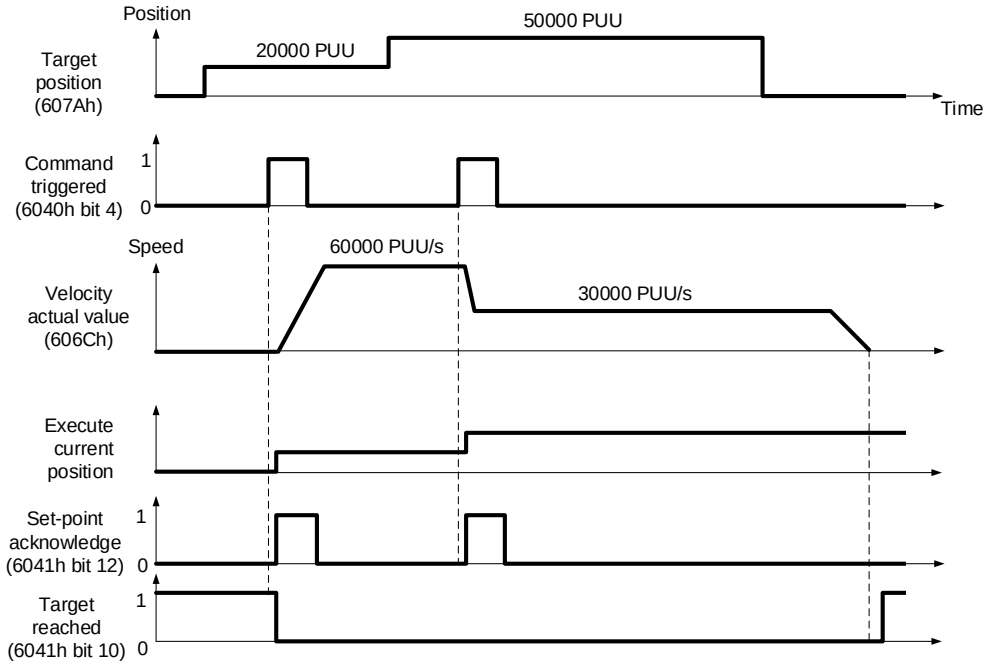
- When Bit 5 is set to 1, the command to take immediate effect is enabled (only valid in Profile Position Mode).

If the command to take immediate effect is enabled, when the current motion command is in execution (not yet complete), the servo immediately interrupts the current command and executes the new command once the servo receives a new triggered command.



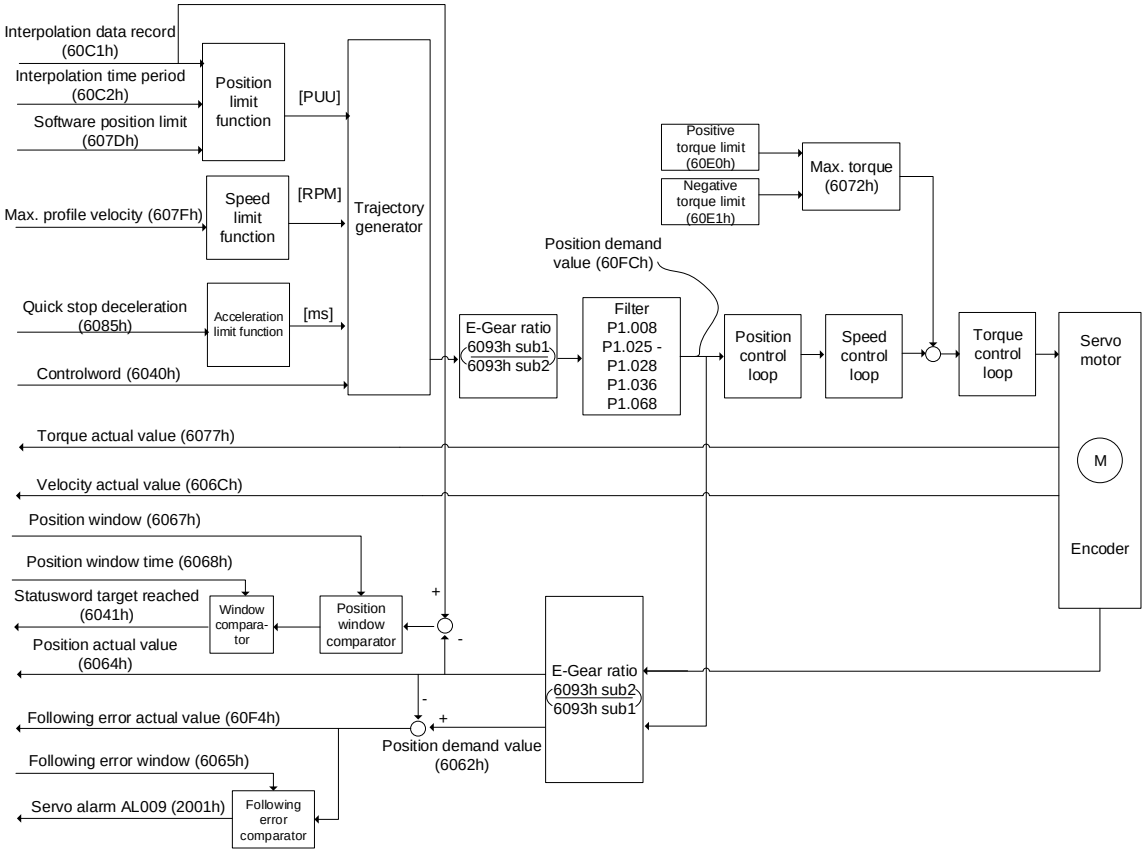
Relevant object list

Index	Name	Type	Attr.
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	INTEGER32	RO
6064h	Position actual value	INTEGER32	RO
6065h	Following error window	UNSIGNED32	RW
6067h	Position window	UNSIGNED32	RW
6068h	Position window time	UNSIGNED16	RW
607Ah	Target position	INTEGER32	RW
6081h	Profile velocity	UNSIGNED32	RW
6083h	Profile acceleration	UNSIGNED32	RW
6084h	Profile deceleration	UNSIGNED32	RW
6093h	Position factor	UNSIGNED32	RW
60F4h	Following error actual value	INTEGER32	RO
60FCh	Position demand value	INTEGER32	RO

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.2 Interpolation Position Mode

Interpolation Position Mode requires a series of position data to complete the interpolation positioning. The difference between IP (Interpolation Mode) and PP (Position Mode) is all the motion command paths of the IP mode are issued by the controller. The servo drive only follows each position that the controller issues and finally completes a motion command. Delta servo drives only support synchronous operation which is the controller periodically sends the SYNC object (COB-ID = 0x80). The interpolation cycle can be set by OD 60C2h. And the controller issues the position command to the interpolation position of OD 60C1h.



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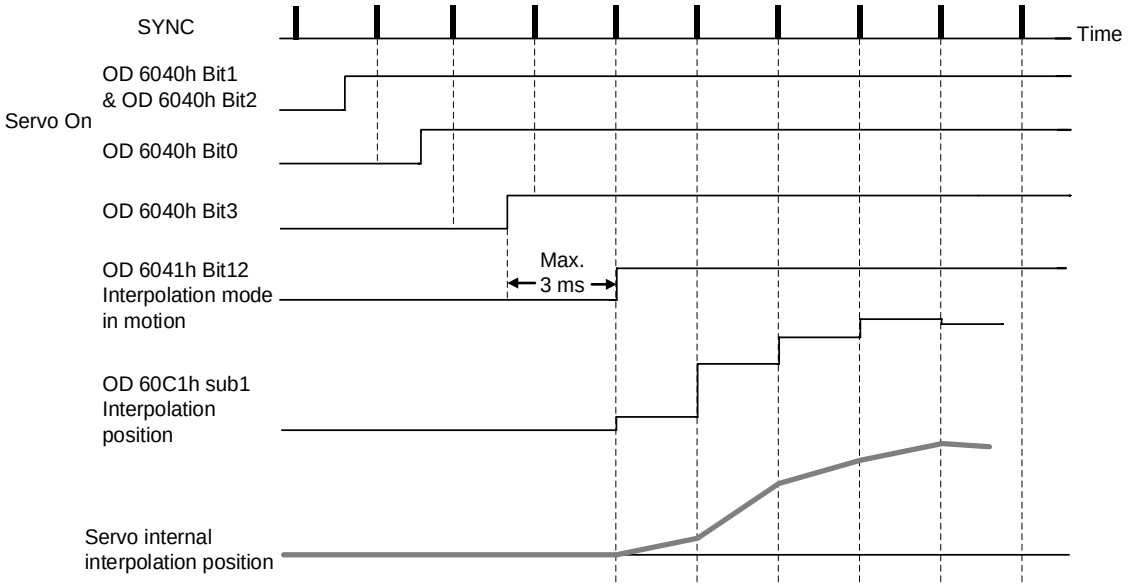
Operation steps:

1. Set OD 6060h to 07h to set the mode as Interpolation Position Mode.
2. Set OD 60C2h for the interpolation cycle. The setting must be the same as the communication cycle of OD 1006h.
3. In the PDO mapping setting of the controller, configure one set of RxPDO to be OD 60C1h sub1 and OD 60C1h sub2
4. In the PDO mapping setting of the controller, configure the objects to be monitored in TxPDO according to the requirements, such as the feedback position (OD 6064h).
5. Set OD 6040h for the control command. Follow the steps below. Steps 6.1 and 6.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to Section 12.2.2.6.

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).



Adjustment method:

It is suggested to set the SYNC communication cycle (OD 1006h) between 1 ms and 10 ms. Since the cycle time is too long, the position error also increases. If the position change is big, it causes speed fluctuations. In this case, use P1.036 (S-curve acceleration / deceleration constant) or P1.068 (Position command - Moving filter) to smooth the position difference.
Since the jitter of each controller is different, the servo receives a difference between the SYNC and SYNC communication cycle time. When this happens, adjust the error value (T) of P3.009 to increase the error range and let the servo drive automatically correct the internal timer so it is consistent with the communication cycle of the controller.

Relevant object list

Index	Name	Type	Property
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
6093h	Position factor	UNSIGNED32	RW
60C0h	Interpolation sub mode select	INTEGER16	RW
60C1h	Interpolation data record	ARRAY	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

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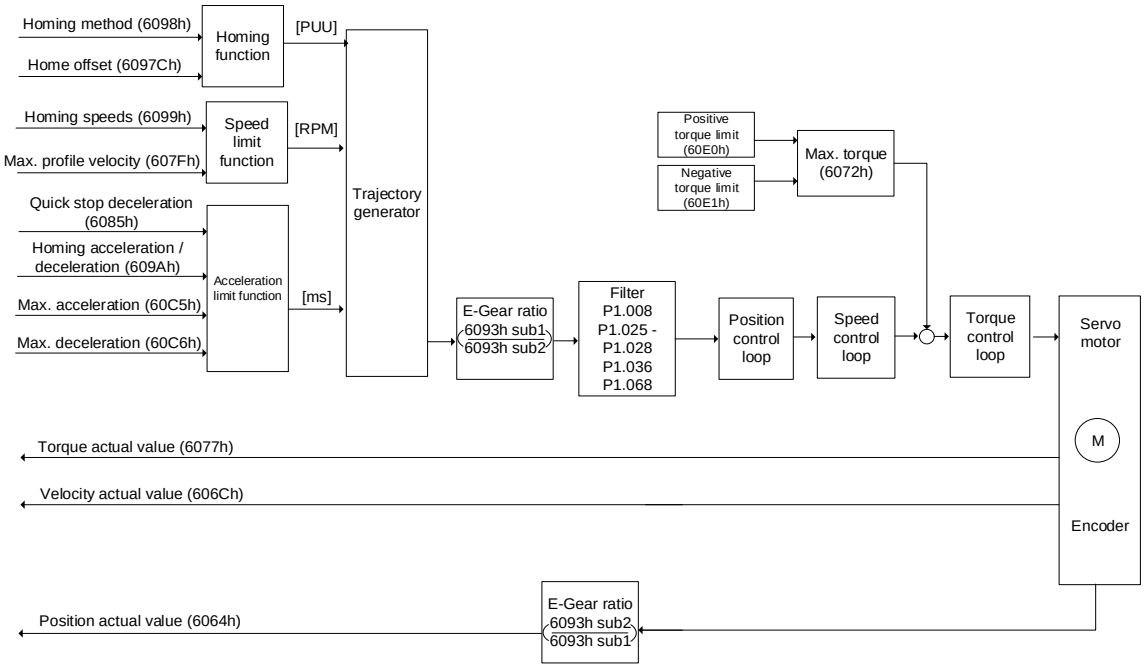
12.3.3 Homing Mode

After homing is complete, the coordinate system of the servo drive is established and the drive can start executing the position command issued by the controller. Delta servo drives offer 35 homing modes, including finding the home switch, positive and negative limits, and motor Z pulse.



Operation steps:

1. Set OD 6060h to 06h to set the mode as Homing Mode.
2. Set OD 607Ch for the home offset.
3. Set OD 6098h for the method to find the origin point.
4. Set OD 6099h sub1 for the speed when searching for the home switch.
5. Set OD 6099h sub2 for the speed when searching for the Z pulse.
6. Set OD 609Ah for the homing acceleration / deceleration time.
7. Set OD 6040h for the control command. Follow the steps below. Steps 6.1 and 6.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to Section 12.2.2.6.

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 triggered (rising-edge triggering).

Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6064h to obtain the current motor feedback position.

Relevant object list

Index	Name	Type	Attr.
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	RO
607Ch	Home offset	INTEGER32	RW
6093h	Position factor	UNSIGNED32	RW
6098h	Homing method	INTEGER8	RW
6099h	Homing speeds	ARRAY	RW
609Ah	Homing acceleration	UNSIGNED32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

12.3.4 Profile Velocity Mode

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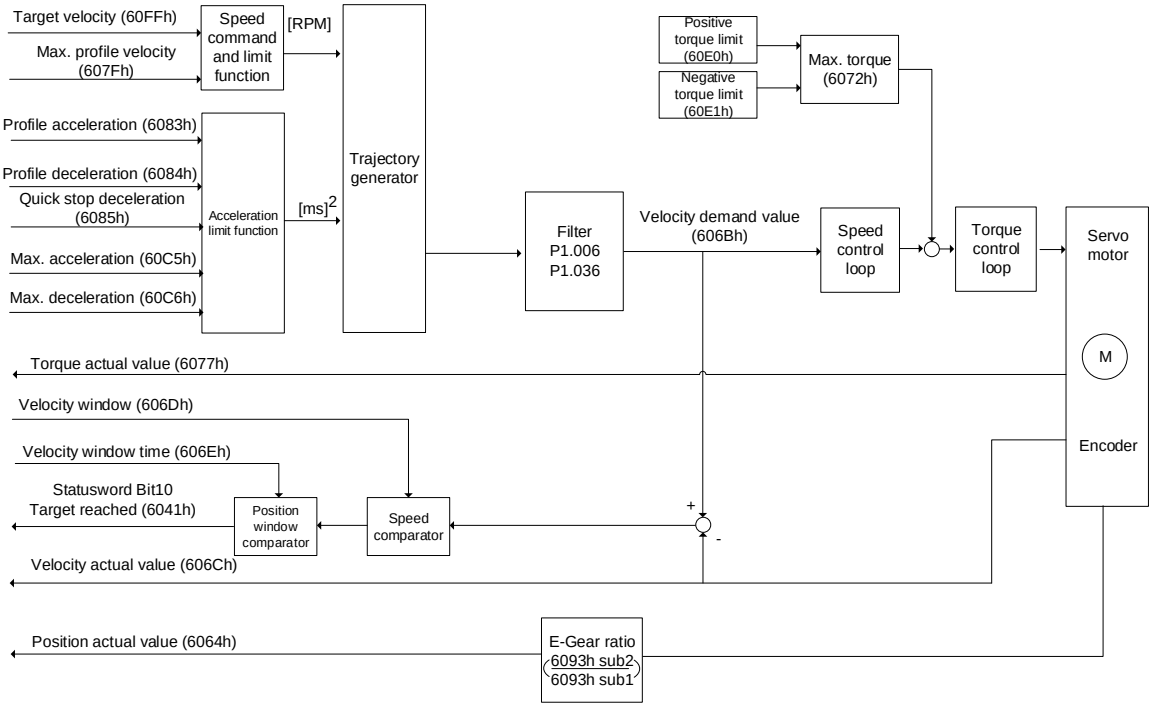
In PV (Profile Velocity) mode, the controller specifies the speed command and acceleration / deceleration conditions, and the motion command generator of the servo drive plans the motion path according to these conditions.



Operation steps:

1. Set OD 6060h to 03h to set the mode as the speed control mode.
2. Set OD 6083h for the acceleration time slope.
3. Set OD 6084h for the deceleration time slope.
4. Set the target speed (OD 60FFh) to 0. In speed mode, the servo motor starts operating once it is switched to servo on (step 5). Therefore, setting the target speed (OD 60FFh) to 0 is to ensure that the motor maintains at 0 rpm at the time of servo on.
5. Set OD 6040h for the control command. Follow the steps below. Steps 6.1 and 6.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to Section 12.2.2.6.

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. Set OD 60FFh for the target speed.

Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 606Ch to obtain the current speed feedback.

Relevant object list

Index	Name	Type	Attr.
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	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
60FFh	Target velocity	INTEGER32	RW

Note: for more details, refer to Section 12.4.3 Details of objects.

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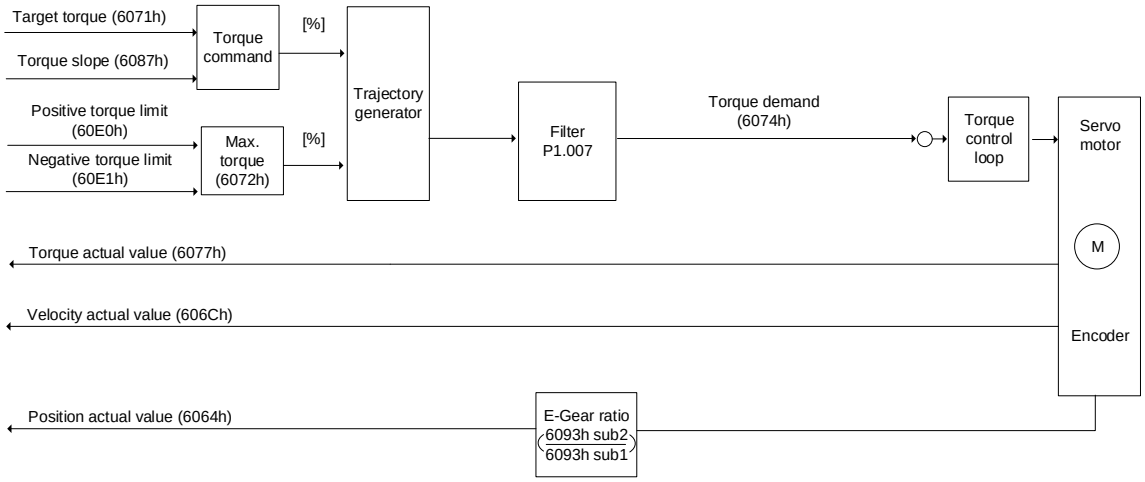
12.3.5 Profile Torque Mode

In PT (Profile Torque) mode, the controller specifies the torque command and filtering conditions, and the motion command generator of the servo drive plans the torque slope according to these conditions.



Operation steps:

1. Set OD 6060h to 04h to set the mode as the torque control mode.
2. Set OD 6087h for the torque slope.
3. Set the target torque (OD 6071h) to 0. In torque mode, the servo target torque takes effect once the servo is switched to servo on (step 5). Therefore, set the target torque (OD 6071h) to 0 for safety reasons.
4. Set OD 6040h for the control command. Follow the steps below. Steps 6.1 and 6.2 are to bring the servo drive's state machine into the ready state. For more details of the state machine, refer to Section 12.2.2.6.

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).

5. Set OD 6071h for the target torque.

Read the servo drive information:

1. Read OD 6041h to obtain the servo drive status.
2. Read OD 6077h to obtain the current torque feedback.

Relevant object list

Index	Name	Data type	Attr.
6040h	Controlword	UNSIGNED16	RW
6041h	Statusword	UNSIGNED16	RO
6060h	Modes of operation	INTEGER8	RW
6061h	Modes of operation display	INTEGER8	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

Note: for more details, refer to Section 12.4.3 Details of objects.

12.4 Object dictionary

This section details the CANopen objects supported by the servo. The contents include object index, name, data type, data length, and access properties.

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12.4.1 Specifications for objects

Object type

Object name	Comments
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 Standard 301.

12.4.2 List of objects

OD 1XXXh communication group

Index	Object type	Name	Data type	Access
1000h	VAR	Device type	UNSIGNED32	RO
1001h	VAR	Error register	UNSIGNED8	RO
1003h	ARRAY	Pre-defined error field	UNSIGNED32	RW
1005h	VAR	COB-ID SYNC	UNSIGNED32	RW
1006h	VAR	Communication cycle period	UNSIGNED32	RW
100Ch	VAR	Guard time	UNSIGNED16	RW
100Dh	VAR	Life time factor	UNSIGNED8	RW
1014h	VAR	COB-ID EMCY	UNSIGNED32	RO
1016h	ARRAY	Consumer heartbeat time	UNSIGNED32	RW
1017h	VAR	Producer heartbeat time	UNSIGNED16	RW
1018h	RECORD	Identity Object	UNSIGNED32	RO
1029h	ARRAY	Error Behavior	UNSIGNED8	RW
1200h	RECORD	1st Server SDO parameter	SDO Parameter	RO
1400h - 03h	RECORD	RPDO communication parameter	UNSIGNED16/32	RW
1600h - 03h	RECORD	RPDO mapping parameter	UNSIGNED32	RW
1800h - 03h	RECORD	TPDO communication parameter	UNSIGNED16/32	RW
1A00h - 03h	RECORD	TPDO mapping parameter	UNSIGNED32	RW

Note: only 1001h can be mapped to PDO.

OD 2XXXh servo parameter group

Index	Object type	Name	Data type	Access	Mappable
Delta parameter definition					
2xxx	VAR	Parameter mapping	INTEGER16/32	RW	Y

OD 6XXXh communication object group

Index	Object type	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	N
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	INTEGER32	RO	Y
6064h	VAR	Position actual value	INTEGER32	RO	Y
6065h	VAR	Following error window	UNSIGNED32	RW	Y
6067h	VAR	Position windows	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

Index	Object type	Name	Data type	Access	Mappable
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	UNSIGNED16	RO	Y
6078h	VAR	Current actual value	INTEGER16	RO	Y
607Ah	VAR	Target position	INTEGER32	RW	Y
607Ch	VAR	Home offset	INTEGER32	RW	Y
607Fh	VAR	Max profile velocity	UNSIGNED32	RW	Y
6080h	VAR	Max motor speed	UNSIGNED32	RW	Y
6081hh	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
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
60C0h	VAR	Interpolation sub mode select	INTEGER16	RW	Y
60C1h	ARRAY	Interpolation data record	UNSIGNED16/32	RW	Y
60C2h	RECORD	Interpolation time period	SIGNED8	RW	Y
60C5h	VAR	Max acceleration	UNSIGNED32	RW	Y
60C6h	VAR	Max deceleration	UNSIGNED32	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
60FFh	VAR	Target velocity	INTEGER32	RW	Y
6502h	VAR	Supported drive modes	UNSIGNED32	RO	Y

12.4.3 Details of objects

12.4.3.1 OD 1XXXh communication object group

Object 1000h: Device type

Index	1000h
Name	Device type
Object code	VAR
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Corresponding servo parameter	N/A

Format of this object: (High word h) DCBA : (Low word L) UZYX

A	Bit 16 - Bit 31 Model number	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 number

DCBA	Model number
0402	A2
0602	M
0702	A3

Object 1001h: Error register

Index	1001h
Name	Error register
Object code	VAR
Data format	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED8
Corresponding servo parameter	N/A
Default	0

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Object function:

The codes 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	Reserved

Object 1003h: Pre-defined error field

Index	1003h
Name	Pre-defined error field
Object code	ARRAY
Data format	UNSIGNED32
Access	RW
PDO mapping	No
Sub-index	0
Description	Number of errors
Data format	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	0 - 5
Default	0
Corresponding servo parameter	N/A

Sub-index	1 - 5
Description	Standard error field
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	0
Corresponding servo parameter	N/A

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 DS 402.
- DCBA: Delta servo alarm. Refer to Chapter 13 Troubleshooting.

Example:

When operating the servo, if the encoder cable is not correctly connected, the servo drive panel displays AL.011 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 encoder error based on the Delta servo alarm.

Error code: 0x7305 is defined as an Incremental Sensor 1 fault according to DS 402.

Object 1005h: COB-ID SYNC message

Index	1005h
Name	COB-ID SYNC message
Object code	VAR
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	80_h

Object function:

This object is read-only and cannot be set.

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	Description
Bit 31 - Bit 11	Reserved	-
Bit 10 - Bit 0	SYNC-COB-ID = 0x80	-

Object 1006h: Communication cycle period

Index	1006h
Name	Communication cycle period
Object code	VAR
Data format	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0
Unit	μs

Settings:

This object function is to set the communication cycle (unit: μs). The communication cycle is the interval between two SYNCs. If you are not using SYNC, set this object to 0.

Object 100Ch: Guard time

Index	100Ch
Name	Guard time
Object code	VAR
Data format	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

The Life Guarding Protocol includes OD 100Ch and 100Dh. OD 100Ch is the guard time in milliseconds and OD 100Dh is the multiplying factor. Therefore, OD 100Ch multiplied by OD 100Dh gives the life time for the Life Guarding Protocol. If the time (OD 100Ch) is set to 0, then this setting is invalid.

Example: if OD 100Ch = 5 ms and OD 100Dh = 10, then life time equals 50 ms.

Object 100Dh: Life time factor

Index	100Dh
Name	Life time factor
Object code	VAR
Data format	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

The Life Guarding Protocol includes OD 100Ch and 100Dh. OD 100Ch is the guard time in milliseconds and OD 100Dh is the multiplying factor. Therefore, OD 100Ch multiplied by OD 100Dh gives the life time for the Life Guarding Protocol. If the time (OD 100Ch) is set to 0, then this setting is invalid.

Example: if OD 100Ch = 5 ms and OD 100Dh = 10, then life time equals 50 ms.

Object 1014h: COB-ID EMCY

Index	1014h
Name	COB-ID emergency message
Object code	VAR
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	80h + Node-ID

Object function:

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	Description
Bit 31	Emergency (EMCY) function	0: the emergency (EMCY) function is enabled (servo drive sends the EMCY command). 1: the emergency (EMCY) function is disabled (servo drive does not send the EMCY command).
Bit 30 - Bit 11	Reserved	-
Bit 10 - Bit 0	11-bit Identifier COB-ID	80h + Node-ID

The emergency (EMCY) function is as follows:

Communication object	Function code	Node ID	COB-ID	Object parameter index
EMCY object	0001	1 - 127	129 (81h) - 255 (FFh)	1014h

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Node ID and corresponding COB-ID

Node ID	COB-ID
1	129 (81h)
2	130 (82h)
~	~
127	255 (FFh)

Object 1016h: Consumer heartbeat time

Index	1016h
Name	Consumer heartbeat time
Object code	ARRAY
Data format	UNSIGNED32
Access	RW
PDO mapping	No

Sub-index	0
Description	Number of sub-index
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	1
Default	1

Sub-index	1
Description	Consumer heartbeat time
Data format	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Object function:

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	Description
Bit 31 - Bit 24	Reserved	-
Bit 23 - Bit 16	Node-ID	UNSIGNED8
Bit 15 - Bit 0	Heartbeat time	UNSIGNED8; unit: ms

Consumer heartbeat time is defined as the time the servo drive expects to receive a heartbeat. For the setting, consumer heartbeat time must be greater than the producer heartbeat time. Due to delays and other uncontrollable external factors in transmitting the heartbeat, you must retain a tolerance margin value. When the heartbeat consumer does not receive the heartbeat signal within the receiving time, the heartbeat event is triggered, meaning AL180 is triggered.

Object 1017h: Producer heartbeat time

Index	1017h
Name	Producer heartbeat time
Object code	VAR
Data format	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0

Object function:

Producer heartbeat time is defined as the cycle time of the heartbeat. When this value is set to 0, this function is invalid.

Object 1018h: Identity object

Index	1018h
Name	Identity object
Object code	RECORD
Data format	Identity
Access	RO
PDO mapping	No

Sub-index	0
Description	Number of sub-index
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	3
Default	3
Sub-index	1
Description	Vendor ID
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	1DDh

Sub-index	2
Description	Product code
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	6000h: A2 and A3 series 6030h: M series

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Sub-index	3
Description	Version
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	N/A

Object function:

This object includes the servo drive information.

Object 1029h: Error behavior

Index	1029h
Name	Error behavior
Object code	ARRAY
Data format	UNSIGNED8
Access	RW
PDO mapping	No

Sub-index	0
Description	Number of error types
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	1
Default	1

Sub-index	1
Description	Communication error
Data format	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

Generally, when the servo drive detects a serious fault in the operational state, the mode automatically switches to the pre-operational state. Use this object setting to switch the mode to the pre-operational mode, maintain in the original mode state, or switch to the stopped mode.

OD 1029h sub1 setting	Switch mode
0	Pre-operational (only if current is operational)
1	Keep the original state
2	Stopped

Object 1200h: Server SDO parameter

Index	1200_h
Name	Server SDO parameter
Object code	RECORD
Data format	SDO parameter
Access	RO
PDO mapping	No

Sub-index	0
Description	Number of sub-index
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1
Description	Controller sends to servo drive COB-ID Client->Server (rx)
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	Index 1200h: 600h + Node-ID

Sub-index	2
Description	Servo drive returns to controller COB-ID Server->Client (tx)
Data format	UNSIGNED32
Access	RO
PDO mapping	No
Setting range	UNSIGNED32
Default	Index 1200h: 580h + Node-ID

Object function:

This object is read-only and cannot be set. Read the station number for transmitting and receiving the SDO with this object.

Example:

If the servo drive station number for receiving is 10:

600h + Node-ID:Ah = 60Ah => OD 1200 sub1 reads 60Ah.

If the servo drive station number for transmitting is 10:

580h + Node-ID:Ah = 58Ah => OD 1200 sub2 reads 58Ah.

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Object 1400h - 1403h: RPDO communication parameter

Index	1400h - 1403h
Name	Receive PDO parameter
Object code	RECORD
Data format	PDO CommPar
Access	RW

Sub-index	0
Description	Maximum number of sub-index supported
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	5
Default	5

Sub-index	1
Description	COB-ID used by PDO
Data format	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	Node-ID: 0

Object function:

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	Description
Bit 10 - Bit 0	COB-ID	The data size is 10-bit.
Bit 30 - Bit 11	-	-
Bit 31	PDO function switch	0: enable PDO function. 1: disable PDO function. Enable / disable the PDO function to determine if PDO is used in the operational state.

The COB-ID setting format is as follows:

Communication object	Object parameter	COB-ID DEC (HEX)
R_PDO1	1400h	512 (200h) + Node-ID
R_PDO2	1401h	768 (300h) + Node-ID
R_PDO3	1402h	1024 (400h) + Node-ID
R_PDO4	1403h	1280 (500h) + Node-ID

Sub-index	2
Description	Reception type
Data format	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

The type setting is as follows

Setting value	Transmission type				
	Cyclic	Acyclic	Synchronous	Asynchronous	RTR only
00h (0)		V	V		
01h - F0h (1 - 240)	V		V		
F1h - FBh (241 - 251)	Reserved				
FCh (252)			V		V
FDh (253)				V	V
FEh (254)				V	
FFh (255)				V	

Sub-index	3
Description	Inhibit time (not used for RPOD)
Data format	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0

Sub-index	4
Description	Compatibility entry
Data format	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Sub-index	5
Description	Event timer (not used for RPDO)
Data format	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0

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Object 1600h - 1603h: RPDO mapping parameter

Index	1600h - 1603h
Name	Receive PDO mapping
Object code	RECORD
Data format	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0
Description	Number of PDO mappings
Data format	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	1 - 8
Description	Set n PDO mapping application objects
Data format	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 length
Bit 8 - Bit 15	Object sub-index
Bit 16 - Bit 31	Object index

Example:

To set three PDOs (OD 6040h, OD 607Ah, and OD 6060h) in the first group of PDO, the setting is as follows:

Receive PDO mapping parameter setting	Data			Description
OD 1600 sub0	3			Set 3 PDO mappings.
OD 1600 sub1	6040h	00h	10h	Mapping control command (6040h), data length is 16-bit
OD 1600 sub2	607Ah	00h	20h	Mapping target position (607Ah), data length is 32-bit
OD 1600 sub3	6060h	00h	08h	Mapping mode position (6060h), data length is 8-bit
Note	The total length is 38h (56-bit) which meets the specification of less than 64-bit.			

Object 1800h - 1803h: TPDO communication parameter

Index	1800h - 1803h
Name	Transmit PDO parameter
Object code	RECORD
Data format	PDO CommPar
Access	RW

Sub-index	0
Description	Largest sub-index supported
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	5
Default	5

Sub-index	1
Description	COB-ID used by PDO
Data format	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	Default Node-ID: 0 Index 1800h: 180h + Node-ID Index 1801h: 280h + Node-ID Index 1802h: 380h + Node-ID Index 1803h: 480h + Node-ID

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Object function:

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	Description
Bit 10 - Bit 0	COB-ID	The data size is 10-bit.
Bit 30 - Bit 11	-	-
Bit 31	PDO function switch	0: enable PDO function. 1: disable PDO function. Enable / disable the PDO function to determine if PDO is used in the operational state.

Sub-index	2
Description	Transmission type
Data format	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Object function:

The type setting is as follows:

Setting value	Transmission type				
	Cyclic	Acyclic	Synchronous	Asynchronous	RTR only
00h (0)		V	V		
01h - F0h (1 - 240)	V		V		
F1h - FBh (241 - 251)	Reserved				
FCh (252)			V		V
FDh (253)				V	V
FEh (254)				V	
FFh (255)				V	

Sub-index	3
Description	Inhibit time
Data format	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	UNSIGNED16
Default	0

Sub-index	4
Description	Reserved
Data format	UNSIGNED8
Access	RW
PDO mapping	No
Setting range	UNSIGNED8
Default	0

Sub-index	5
Description	Event timer
Data format	UNSIGNED16
Access	RW
PDO mapping	No
Setting range	0: not in use UNSIGNED16
Default	0

Object 1A00h - 1A03h: TPDO mapping parameter

Index	1A00h - 1A03h
Name	Transmit PDO mapping
Object code	RECORD
Data format	PDO mapping
Access	RW
Note	The total length of objects in a group of PDO cannot exceed 64 bits.

Sub-index	0
Description	Number of PDO mappings
Data format	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	1 - 8
Description	Set n PDO mapping application objects
Data format	UNSIGNED32
Access	RW
PDO mapping	No
Setting range	UNSIGNED32
Default	0

Format of this object: (High word h) DCBA : (Low word L) UZYX

DCBA	Bit 16 - Bit 31 Object index	YX	Bit 0 - Bit 7 object length
		UZ	Bit 8 - Bit 15 object sub-index

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12.4.3.2 OD 2XXXh servo parameter group

Object 2xxxh: Manufacturer parameter

Index	2xxxh
Name	Manufacturer parameter
Object code	VAR
Data format	INTEGER16 / INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER16 / INTEGER32
Default	N/A

Object function:

Access the servo parameters with the OD 2XXXh group. The parameter number and index are converted as follows:

Pa-bc <= = > 2aBCh

'**BC**' is hexadecimal format of '**bc**'

Read the 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 format	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Default	7Fh

Example 2:

Object 212Ch: Electronic Gear [P1.044]

Index	212Ch
Name	Electronic Gear
Object code	VAR
Data format	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	1

12.4.3.3 OD 6XXXh communication object group

Object 603Fh: Error code (error code of CANopen defined)

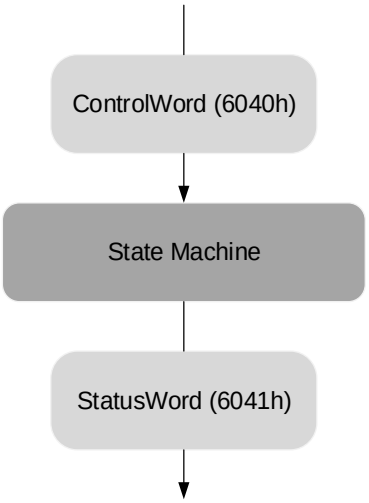
Index	603Fh
Name	Error code
Object code	VAR
Data format	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Corresponding servo parameter	N/A
Default	0

Object 6040h: Controlword

Index	6040h
Name	Controlword
Object code	VAR
Data format	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Corresponding servo parameter	N/A
Default	0x0004

Object function:

The control command contains many functions, such as Servo on, command triggering, fault reset, and emergency stop. The state machine architecture is as follows:



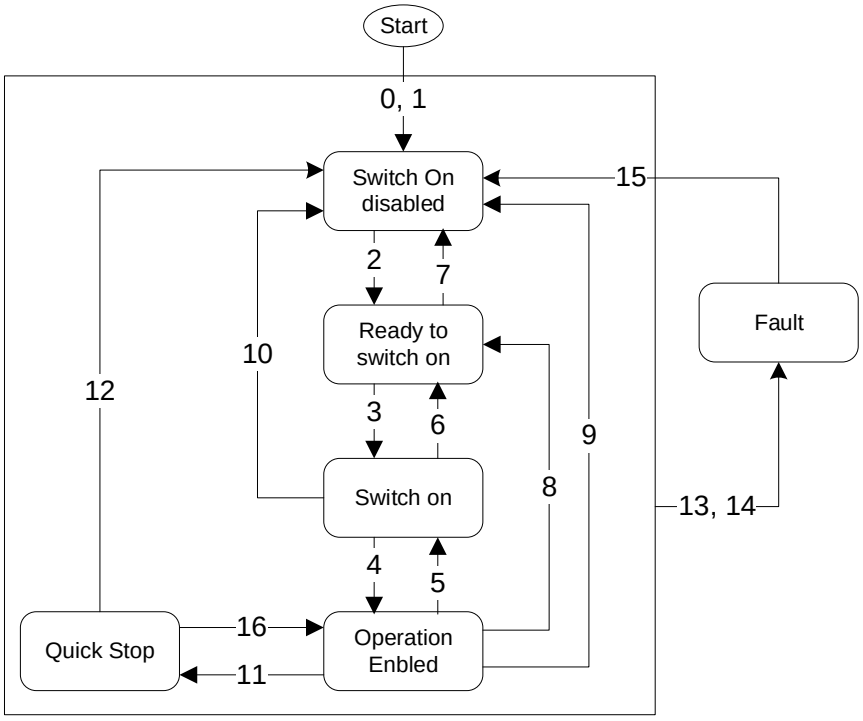
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Function	Description
Bit 0	Switch on	-
Bit 1	Enable voltage	-
Bit 2	Quick stop (B-connect)	-
Bit 3	Enable operation	-
Bit 4 - Bit 6	Operation mode definition	This bit is individually defined according to the control mode, as shown in the following table.
Bit 7	Fault reset	-
Bit 8	Halt	-
Bit 15 - Bit 9	-	-

Bits 4 - 6 are individually defined according to the mode, as shown in the following table:

Bit	Operation mode definition		
	Profile Position Mode	Homing Mode	Profile Velocity Mode Profile Torque Mode Interpolated Position Mode
Bit 4	Command triggered (rising-edge triggering)	Homing (rising-edge triggering)	-
Bit 5	Command to take immediate effect	-	-
Bit 6	0: absolute position command 1: relative position command	-	-

Finite state automation (as shown in the following diagram) defines the behavior of a servo drive system. Each state represents an internal or external behavior. For example, point-to-point motion can only be received and executed in the operation enabled state.



The state transition is defined as follows:

Transition	Event	Action
0, 1	Automatic transition after power-on	Device boot and initialization
2	Command shutdown	N/A
3	Command switch on	Servo is ready for servo on
4	Command enable operation	Servo on and executes motion mode
5	Command disable voltage	Servo off
6	Command shutdown	N/A
7	Command disable voltage or command quick stop	N/A
8	Command shutdown	Servo off
9	Command disable voltage	Servo off
10	Command disable voltage or command quick stop	N/A
11	Command quick stop The following two errors belong to this quick stop type: 1. Trigger forward / reverse limit switch 2. Quick stop triggered by a control command (OD 6040h = xxxx x0xxx)	Quick stop function is enabled
12	Command disable voltage (OD 6040h: 0000 0110 or xxxx xx0x)	Servo off
13, 14	Alarm occurs	Servo off
15	Alarm is cleared	N/A
16	Command enable operation and no alarm	Motion operation restart. The restart action is mode-dependent.

State changes can be achieved with control commands. The commands are as follows:

Setting value	Bit of OD 6040h					State change
	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

Object 6041h: Statusword

Index	6041h
Name	Statusword
Object code	VAR
Data format	UNSIGNED16
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED16
Corresponding servo parameter	N/A
Default	0

Object function:

The control command contains many functions, such as Servo on, command triggering, fault reset, and emergency 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	Ready to switch on	Bit 0 - Bit 6: current status of the servo drive (see the following table for details).
Bit 1	Switch on	
Bit 2	Operation enabled	
Bit 3	Fault	
Bit 4	Voltage enabled	
Bit 5	Quick stop	
Bit 6	Switch on disabled	
Bit 7	Warning	Warning output, but the servo remains with the servo on signal.
Bit 8	-	-
Bit 9	Remote	-
Bit 10	Target reached	-
Bit 11	-	-
Bit 12 - Bit 13	-	Individually defined according to the control mode.
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	Switch 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 off).

Note: 0: bit is off; 1: bit is on; -: N/A.

Bit 12 - Bit 15: current status of the servo drive.

Bit	Operation mode definition				
	Profile Position Mode	Homing Mode	Interpolated Position Mode	Profile Velocity Mode	Profile Torque Mode
Bit 12	Set-point acknowledge	Homing is complete	Interpolation mode in motion	Zero speed	-
Bit 13	Following error	Homing error	-	-	-

Object 605Bh: Shutdown option code

Index	605Bh
Name	Shutdown option code
Object code	VAR
Data format	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	INTEGER16
Corresponding servo parameter	N/A
Default	0

Object function:

Set to 0: when servo off, the dynamic brake has no effect, so the motor can rotate freely, and the mechanism stops only by the frictional force.

Set to 1: when servo off, the servo stops with the operation of the dynamic brake.

Object 6060h: Modes of operation

Index	6060h
Name	Modes of operation
Object code	VAR
Data format	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
3	Profile Velocity Mode
4	Profile Torque Mode
6	Homing Mode
7	Interpolated Position Mode

Object 6061h: Modes of operation display

Index	6061h
Name	Modes of operation display
Object code	VAR
Data format	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	INTEGER8
Default	0

Object function:

This object displays the current operation mode.

Object 6062h: Position demand value

Index	6062h
Name	Position demand value
Object code	VAR
Data format	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This command position is the interpolation command calculated by the servo internal interpolator. This command passes through the servo internal filter. For detailed position, refer to the servo architecture diagram of each mode.

Object 6063h: Position actual internal value

Index	6063h
Name	Position actual internal value
Object code	VAR
Data format	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	Pulse (unit for encoder pulse resolution) ASDA-A2 corresponds to 1280000 pulses per motor rotation. ASDA-A3 corresponds to 16777216 pulses per motor rotation.

Object 6064h: Position actual value

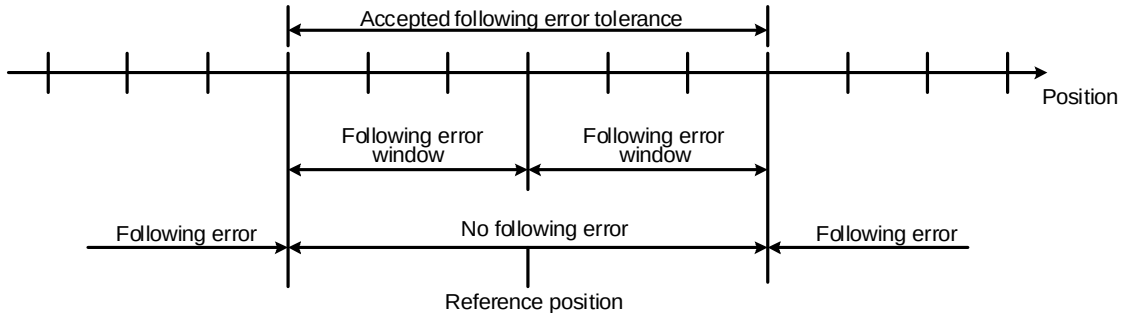
Index	6064h
Name	Position actual value
Object code	VAR
Data format	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object 6065h: Following error window

Index	6065h
Name	Following error window
Object code	VAR
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	3840000
Unit	PUU

Object function:

When the position error (60F4h) exceeds this setting range, AL009 (Excessive deviation of Position command) is triggered.



Object 6067h: Position window

Index	6067h
Name	Position window
Object code	VAR
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	100
Unit	PUU

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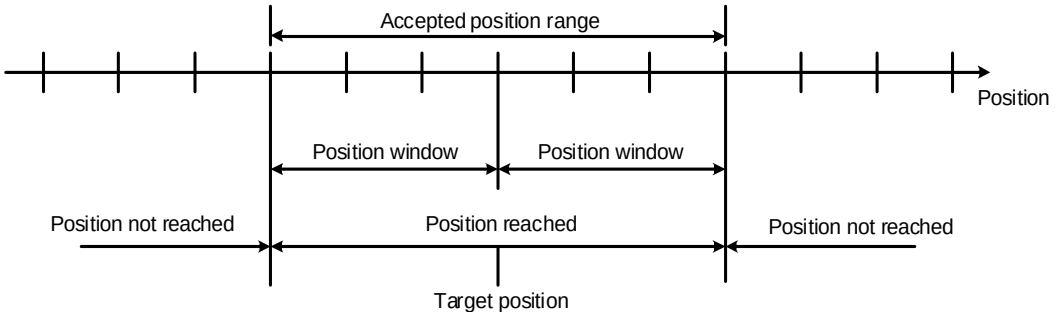
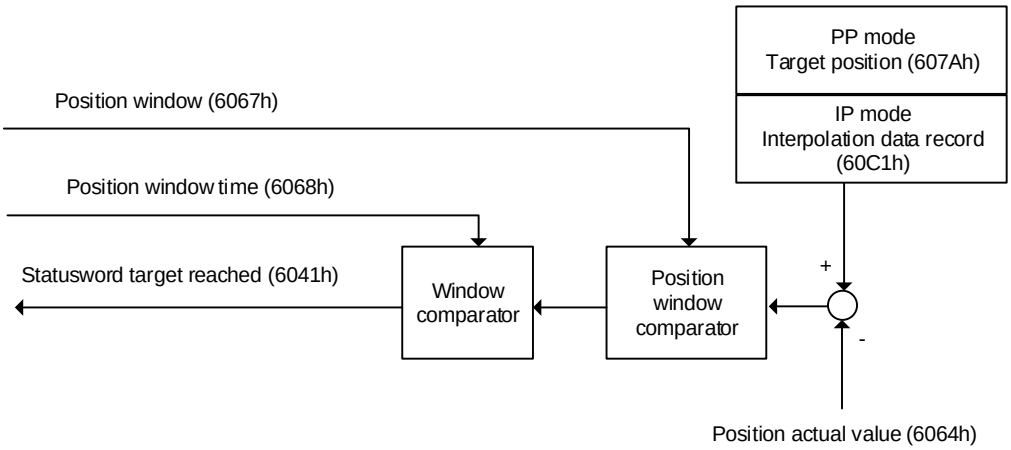
Object function:

When the error value between the command (PP mode: OD 607Ah; IP mode: OD 60C1h) and the position actual value (OD 6064h) is smaller than this object, and the time is greater than OD 6068h (position window time), Bit10 (target reached) of 6041h Statusword is output.



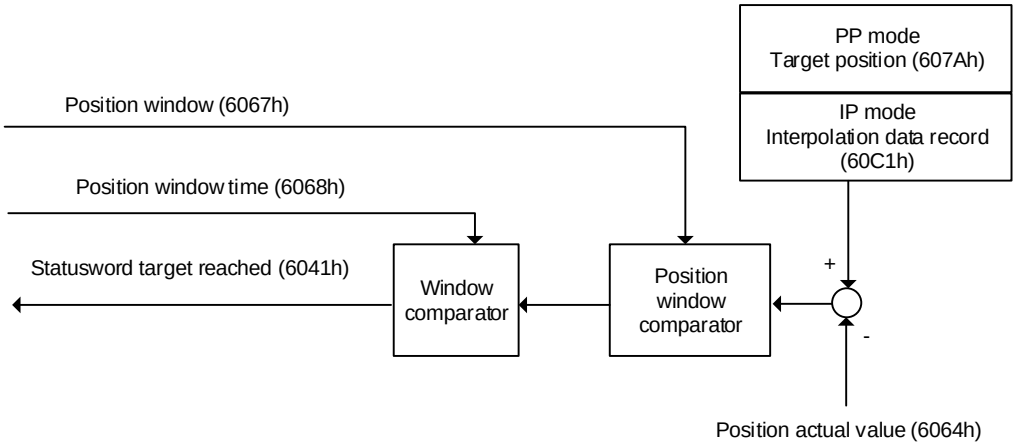


Object 6068h: Position window time

Index	6068h
Name	Position window time
Object code	VAR
Data format	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

When the error value between the command (PP mode: OD 607Ah; IP mode: OD 60C1h) and the feedback position (OD 6064h) is smaller than this object, and the time is greater than OD 6068h (position arrival time), Bit10 of Statusword 6041h outputs once the target is reached.



Object 606Bh: Velocity demand value

Index	606Bh
Name	Velocity demand value
Object code	VAR
Data format	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0.1 rpm

Object function:

The internal speed command is a command generated by the speed motion command generator and command filter of the drive. This object only works in Profile Velocity Mode.

Object 606Ch: Velocity actual value

Index	606Ch
Name	Velocity actual value
Object code	VAR
Data format	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0.1 rpm

Object function:

Returns the current motor speed for the users to monitor.

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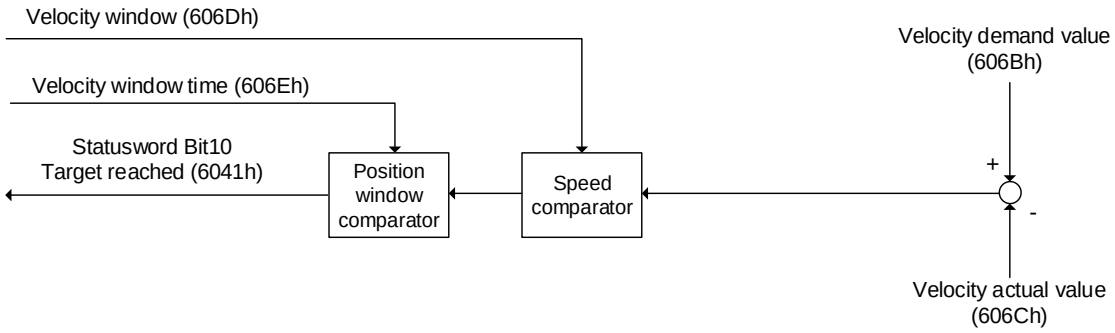
Object 606Dh: Velocity window

Index	606Dh
Name	Velocity window
Object code	VAR
Data format	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	0 - 3000
Default	100
Unit	0.1 rpm

Object function:

The speed comparator compares the speed error with OD 606Dh (velocity window). When the error is less than the velocity window and the retaining time is greater than OD 606Eh (velocity window time), then OD 6041h Bit10 (target reached) is output. This object only works in Profile Velocity Mode.



Object 606Eh: Velocity window time

Index	606Eh
Name	Velocity window time
Object code	VAR
Data format	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED16
Default	0
Unit	ms

Object function:

Refer to OD 606Dh for the description of the object.

Object 606Fh: Velocity threshold

Index	606Fh
Name	Velocity threshold
Object code	VAR
Data format	UNSIGNED16
Access	RW
PDO mapping	Yes
Setting range	0 - 2000
Default	100
Unit	0.1 rpm

Object 6071h: Target torque

Index	6071h
Name	Target torque
Object code	VAR
Data format	INTEGER16
Access	RW
PDO mapping	Yes
Setting range	-3000 to 3000
Default	0
Unit	0.1%

Object function:

This object sets the target torque in torque mode (unit: 0.1%). If this object is set to 1000 (100.0%), it corresponds to the rated torque of the motor.

Object 6074h: Torque demand value

Index	6074h
Name	Torque demand value
Object code	VAR
Data format	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

The internal torque command is a command generated by the speed motion command generator and command filter of the drive. This object only works in Profile Torque Mode.

Object 6075h: Motor rated current

Index	6075h
Name	Motor rated current
Object code	VAR
Data format	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	0.1 mA

Object function:

This object displays the rated current of the motor nameplate.

Object 6076h: Motor rated torque

Index	6076h
Name	Motor rated torque
Object code	VAR
Data format	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	0.001 N-m

Object function:

This object displays the rated torque of the motor nameplate.

Object 6077h: Torque actual value

Index	6077h
Name	Torque actual value
Object code	VAR
Data format	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the current motor torque feedback percentage.

Object 6078h: Current actual value

Index	6078h
Name	Current actual value
Object code	VAR
Data format	INTEGER16
Access	RO
PDO mapping	Yes
Setting range	INTEGER16
Default	0
Unit	0.1%

Object function:

This object is the current motor current feedback percentage.

Object 607Ah: Target position

Index	607Ah
Name	Target position
Object code	VAR
Data format	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

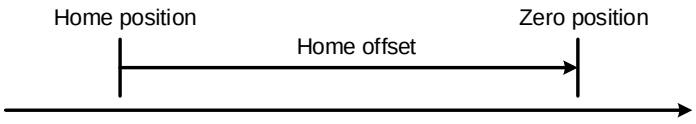
This object is only available in Profile Position Mode. For more details, refer to Section 12.3.1 Profile Position Mode.

Object 607Ch: Home offset

Index	607Ch
Name	Home offset
Object code	VAR
Data format	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

Home Position is the origin reference point found when executing homing, such as the origin sensor and Z pulse. When the origin reference point is found, the position offset from this point is the user-defined origin.



Object 607Fh: Max profile velocity

Index	607Fh
Name	Max profile velocity
Object code	VAR
Data format	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 it is equivalent to P1.055 (maximum speed limit, unit: 1 rpm) multiplied by 10 times.

Object 6080h: Max motor speed

Index	6080h
Name	Max motor speed
Object code	VAR
Data format	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.

Object 6081h: Profile velocity

Index	6081h
Name	Profile velocity
Object code	VAR
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED32
Default	10000
Unit	PUU/s

Object function:

This object is only available in Profile Position Mode. For more details, refer to Section 12.3.1 Profile Position Mode.

Object 6083h: Profile acceleration

Index	6083h
Name	Profile acceleration
Object code	VAR
Data format	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 to accelerate from 0 rpm to 3,000 rpm.

This object is only available in Profile Position Mode and Profile Velocity Mode.

Object 6084h: Profile deceleration

Index	6084h
Name	Profile deceleration
Object code	VAR
Data format	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 to decelerate from 3,000 rpm to 0 rpm.

This object is only available in Profile Position Mode and Profile Velocity Mode.

Object 6085h: Quick stop deceleration

Index	6085h
Name	Quick stop deceleration
Object code	VAR
Data format	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 to decelerate from 3,000 rpm to 0 rpm.

Object 6087h: Torque slope

Index	6087h
Name	Torque slope
Object code	VAR
Data format	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 from 0% to 100% of the rated torque.

Object 6093h: Position factor

Index	6093h
Name	Position factor
Object code	ARRAY
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Corresponding servo parameter	P1.044 and P1.045
Note	Position factor = Numerator / Feed_constant

Sub-index	0
Description	Number of sub-index
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1
Description	E-Gear ratio numerator
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.044
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

Sub-index	2
Description	E-Gear ratio denominator
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Default	1
Corresponding servo parameter	P1.045
Note	For the E-Gear ratio setting, refer to Section 6.2.5.

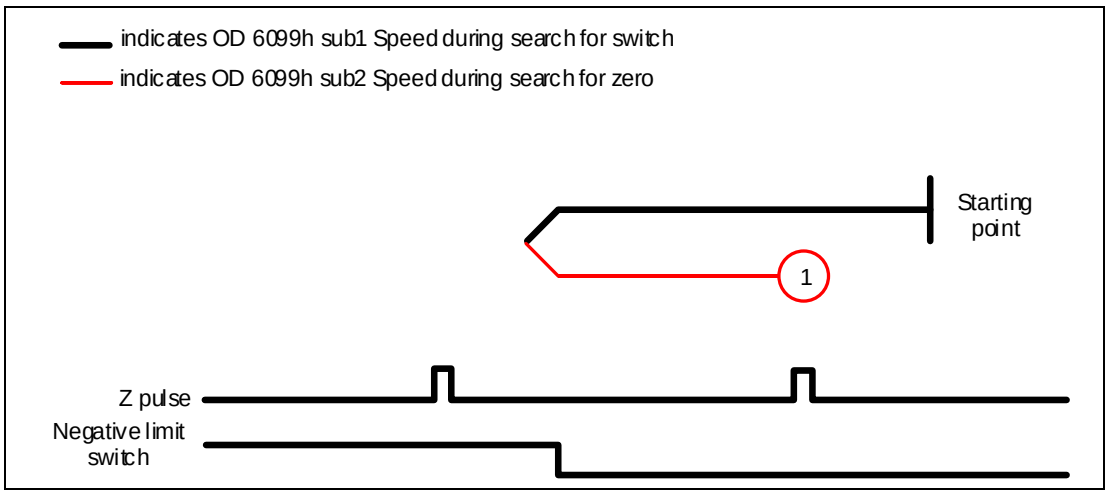
Object 6098h: Homing method

Index	6098h
Name	Homing method
Object code	VAR
Data format	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	0 - 35
Default	0

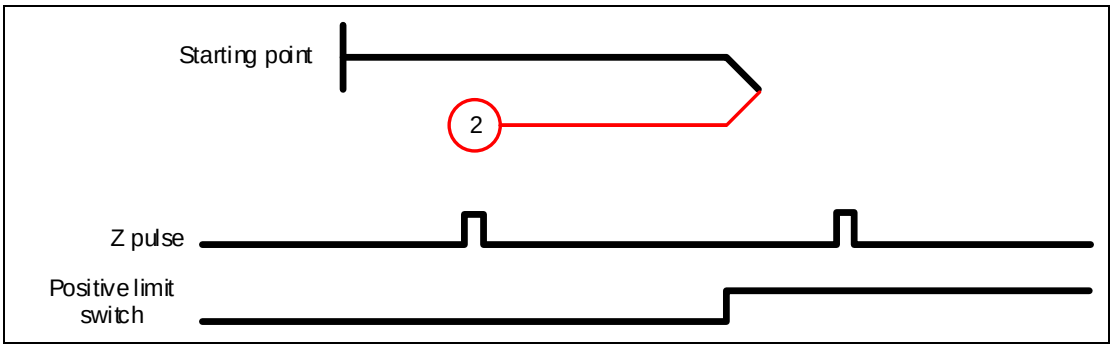
Object function:

There are a total of 35 homing methods. The 1st - 16th homing methods look for the Z pulse; the 17th - 34th do not look for the Z pulse; and the 35th defines the current position as the origin.

Method 1: homing on the negative limit switch and Z pulse



Method 2: homing on the positive limit switch and Z pulse



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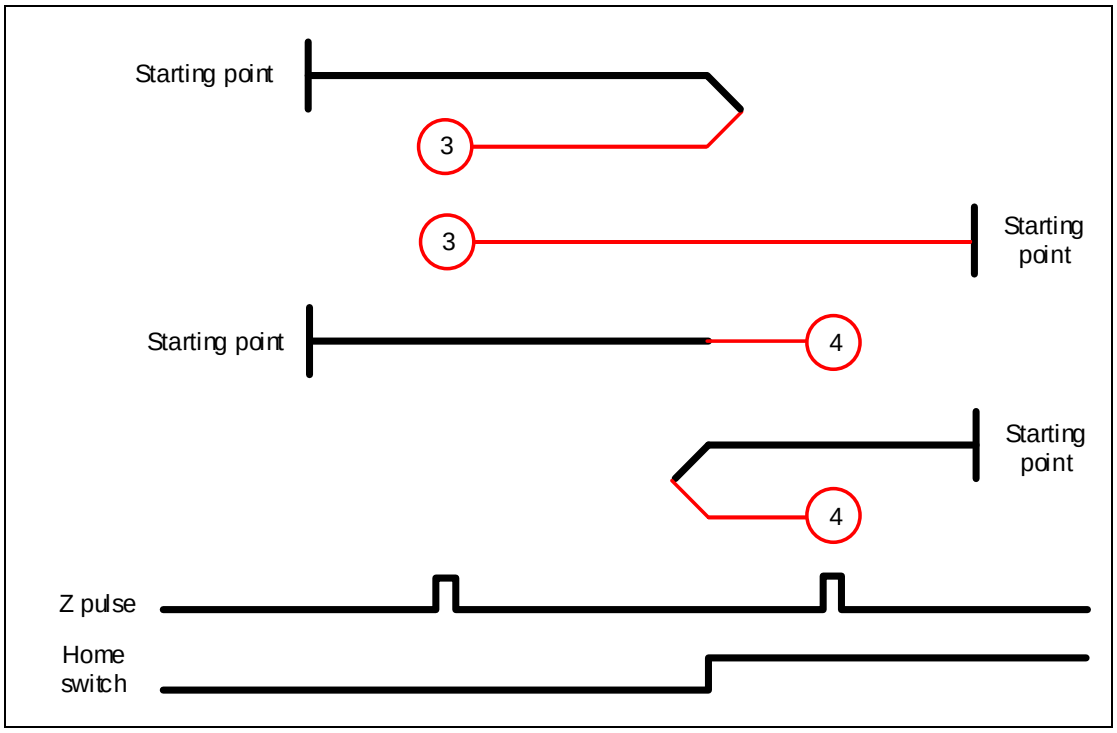
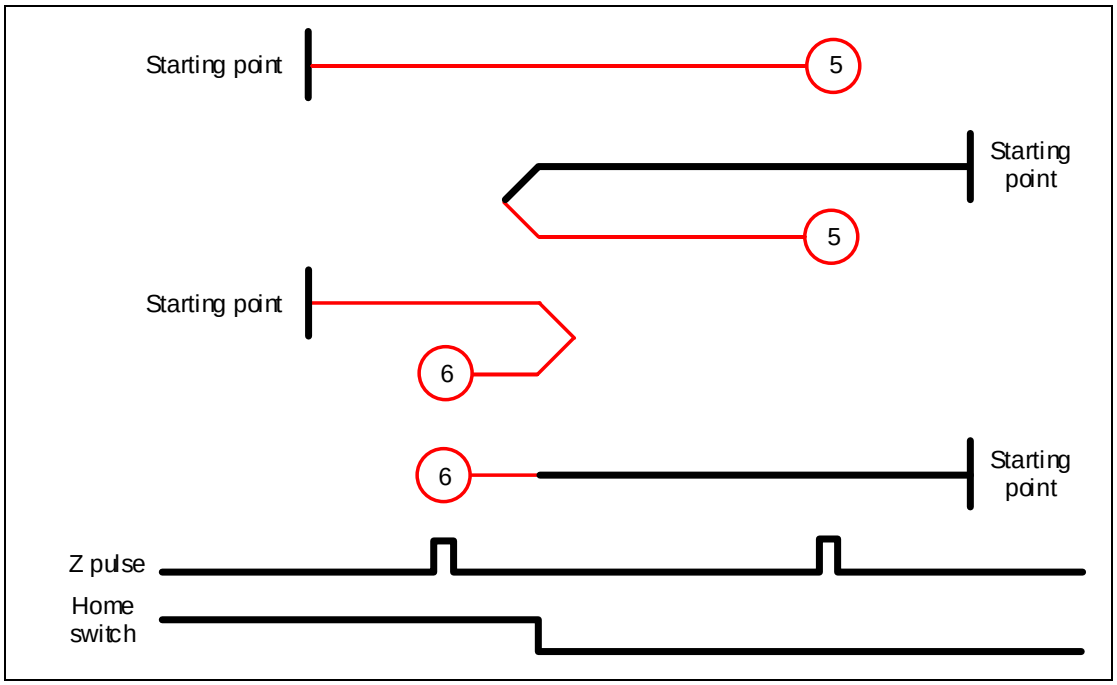
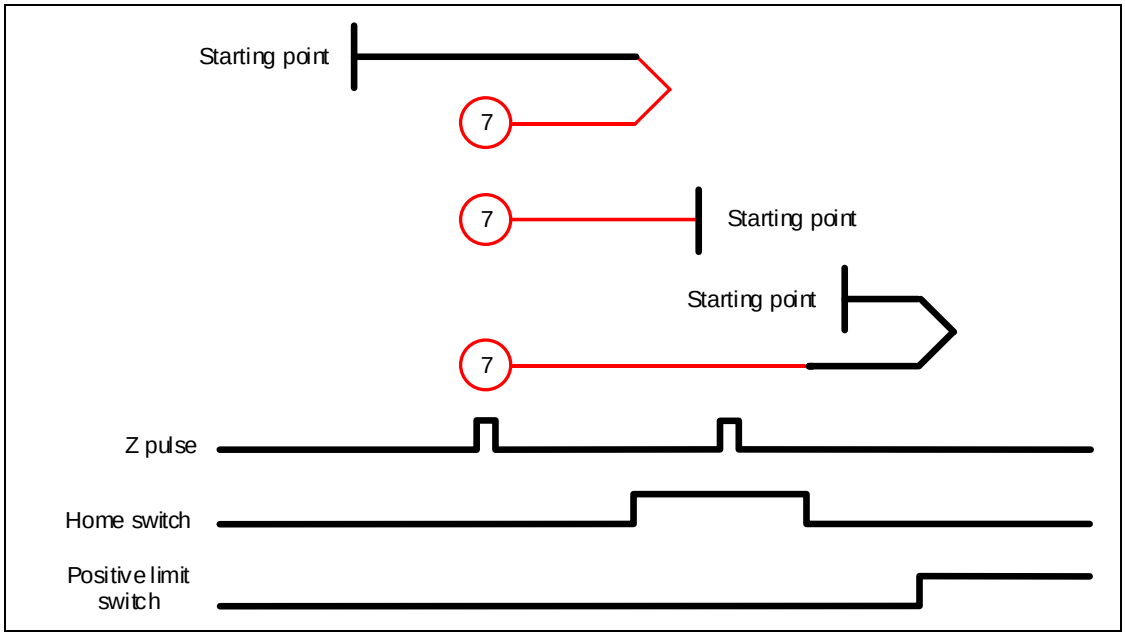
Methods 3 and 4: homing on the rising edge of home switch and Z pulse



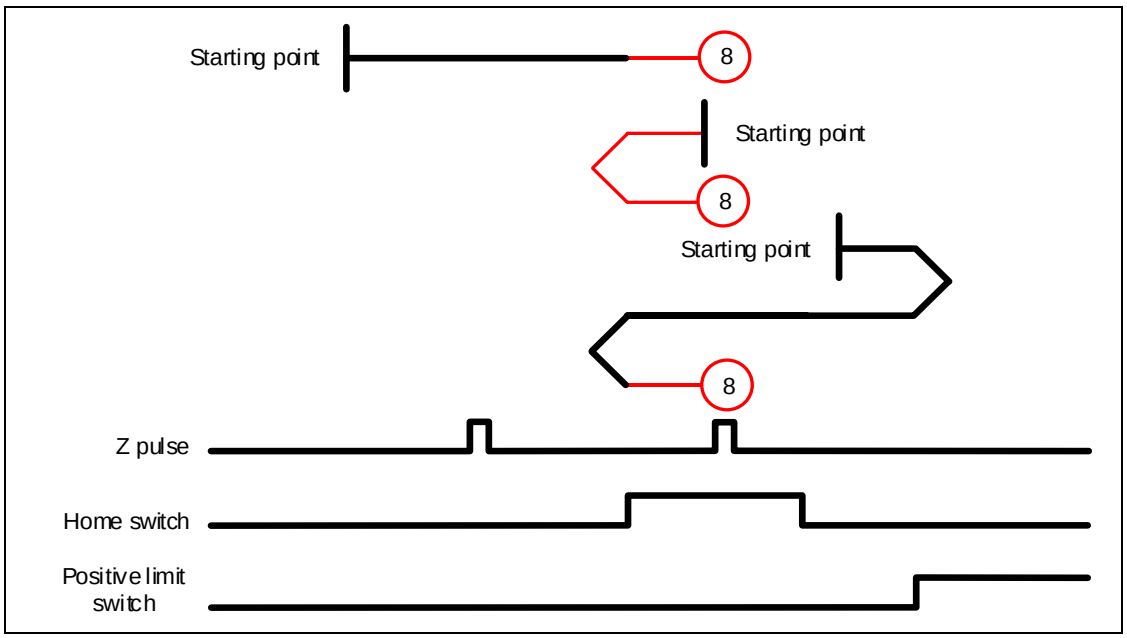
Methods 5 and 6: homing on the falling edge of home switch and Z pulse



Method 7: homing on the positive limit switch, rising edge of home switch, and Z pulse



Method 8: homing on the positive limit switch, rising edge of home switch, and Z pulse



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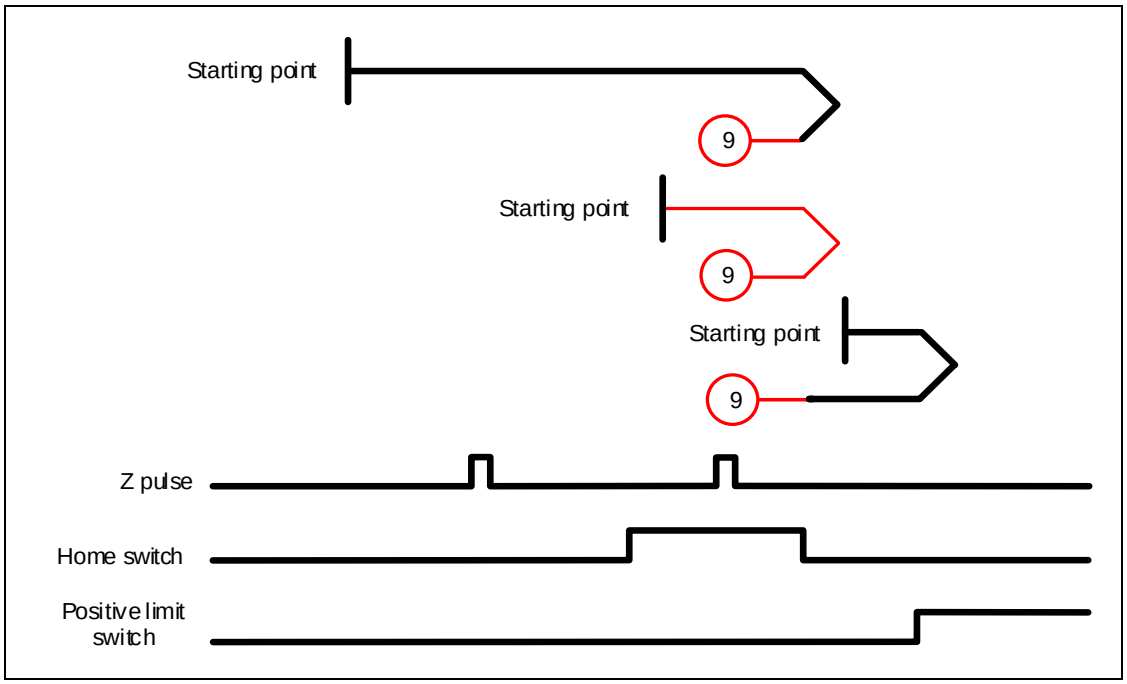
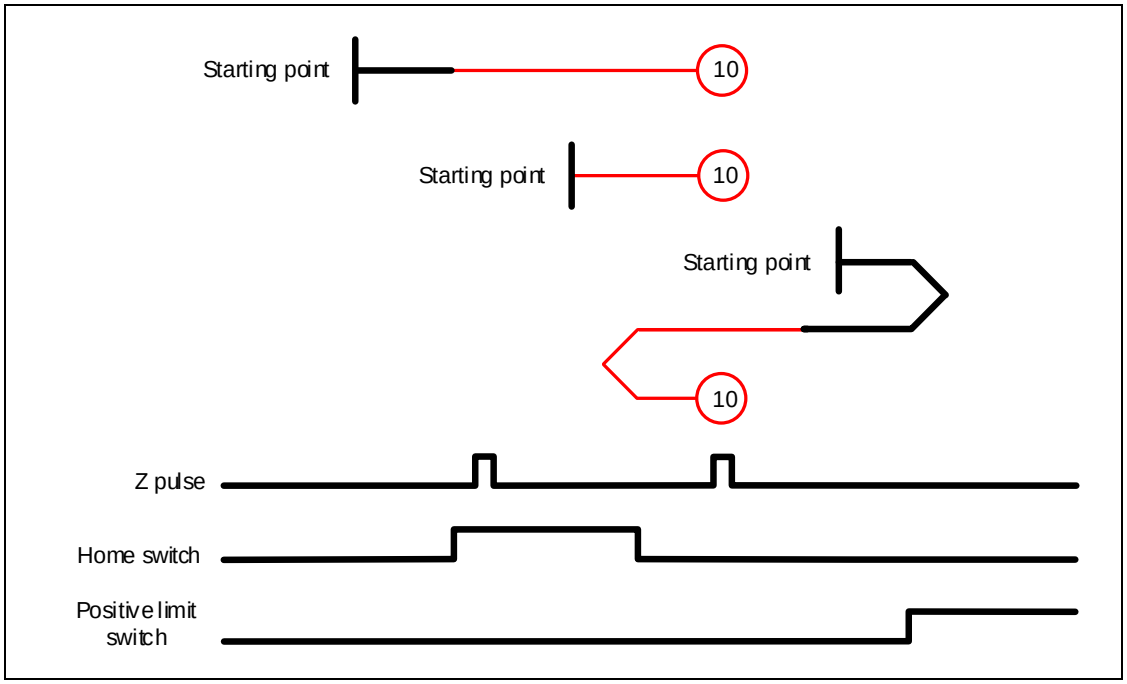
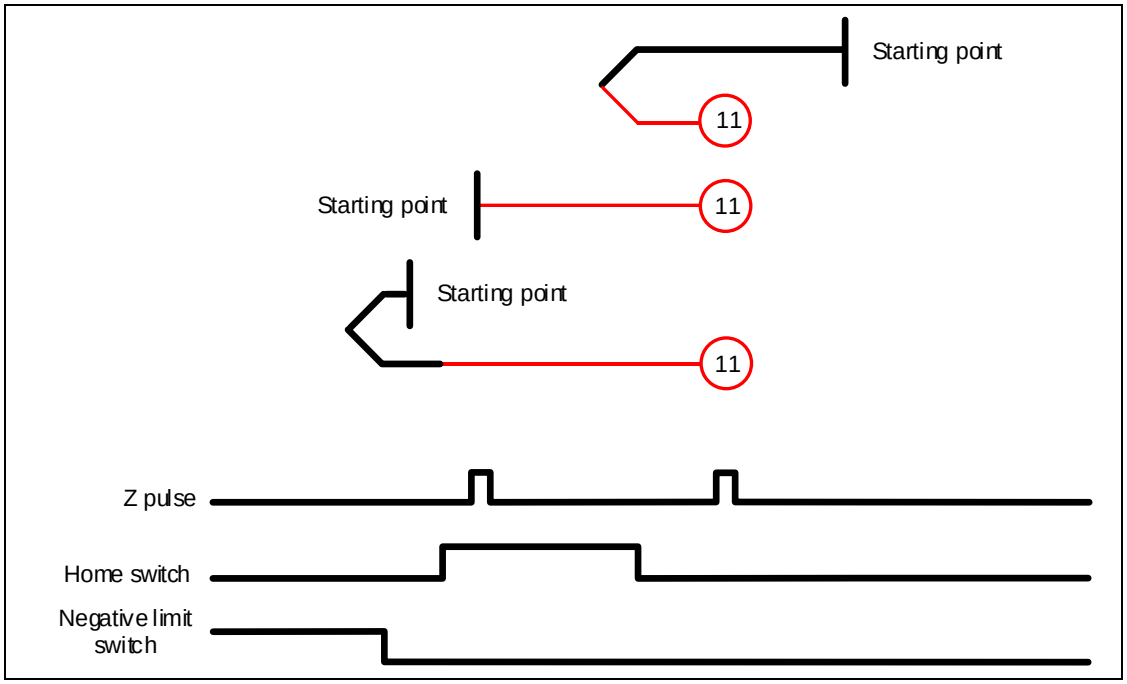
Method 9: homing on the positive limit switch, falling edge of home switch, and Z pulse



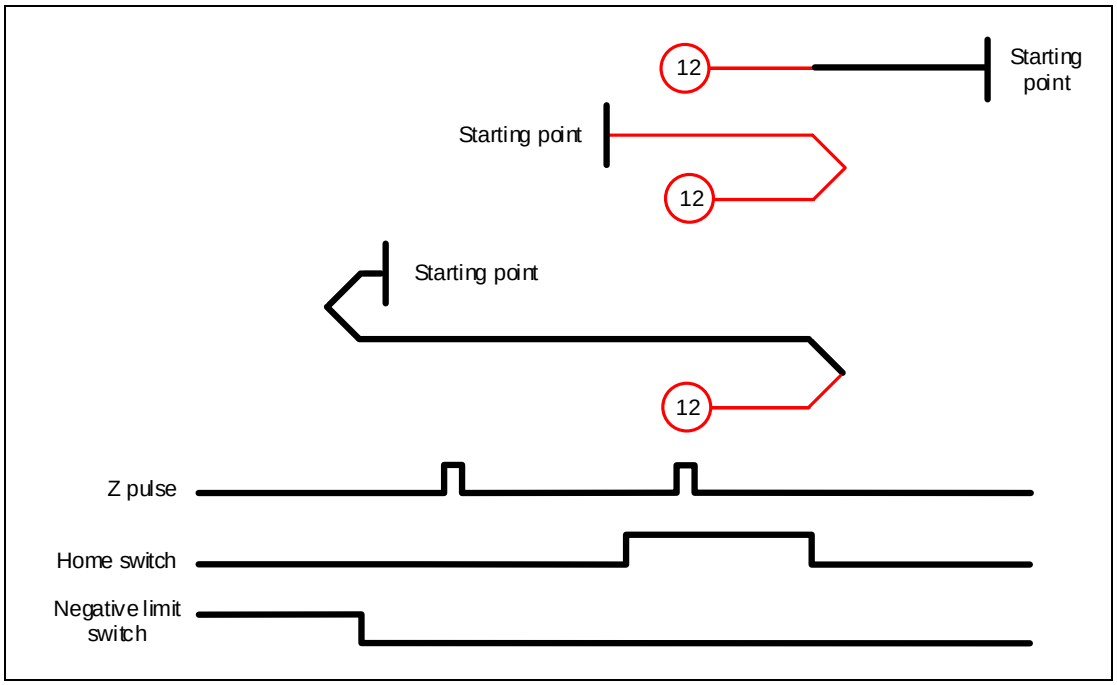
Method 10: homing on the positive limit switch, falling edge of home switch, and Z pulse



Method 11: homing on the negative limit switch, rising edge of home switch, and Z pulse



Method 12: homing on the negative limit switch, falling edge of home switch, and Z pulse



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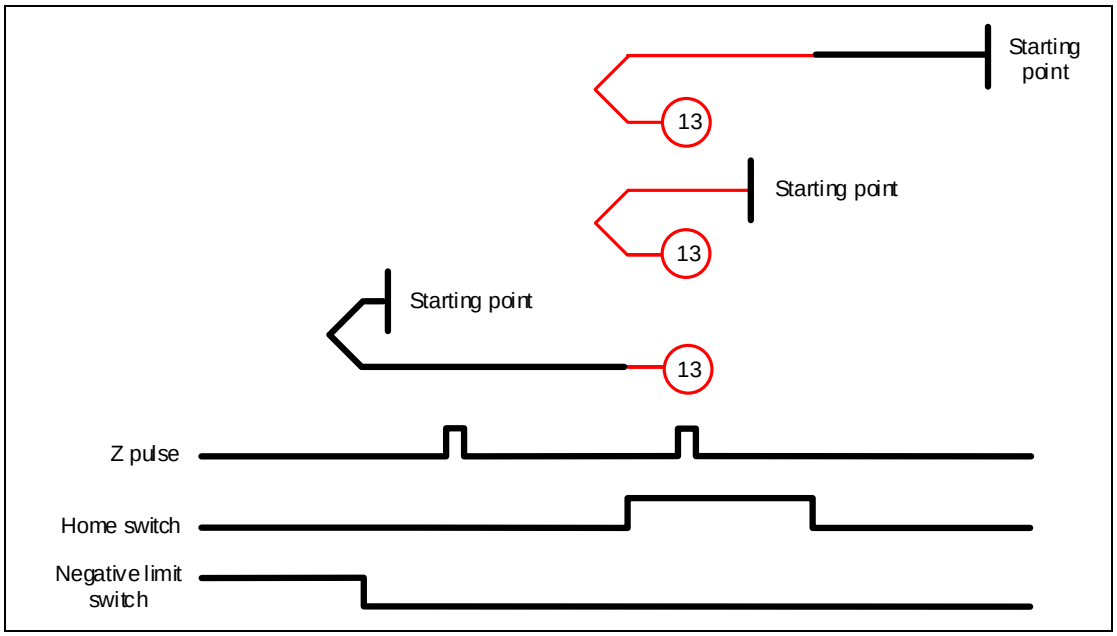
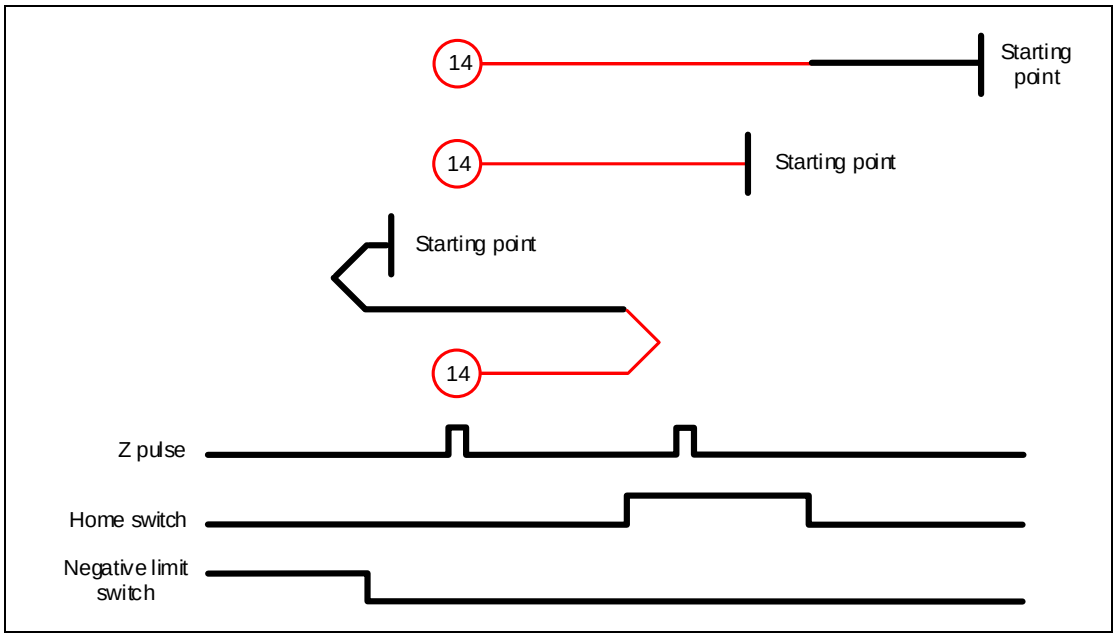
Method 13: homing on the negative limit switch, rising edge of home switch, and Z pulse

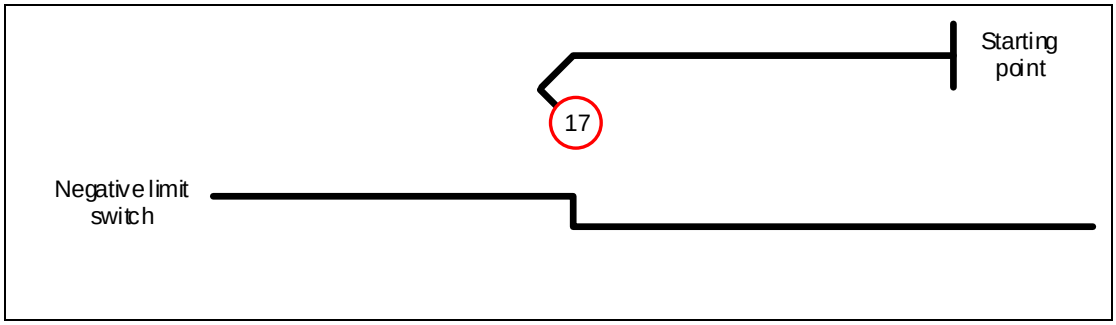


Method 14: homing on the negative limit switch, rising edge of home switch, and Z pulse

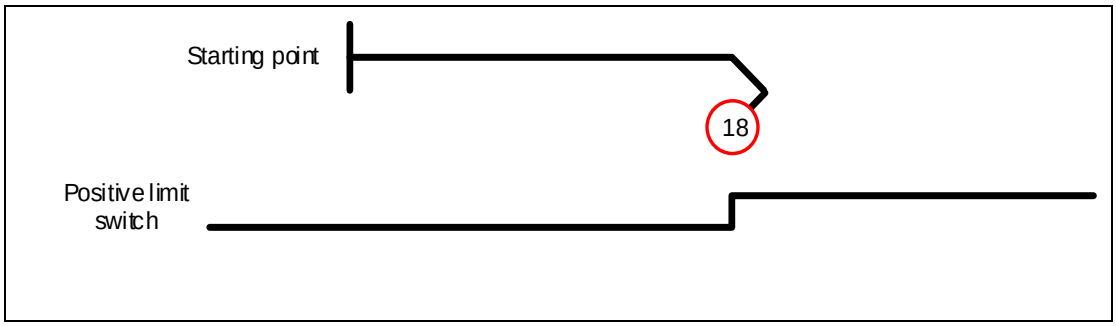


Methods 15 and 16: reserved

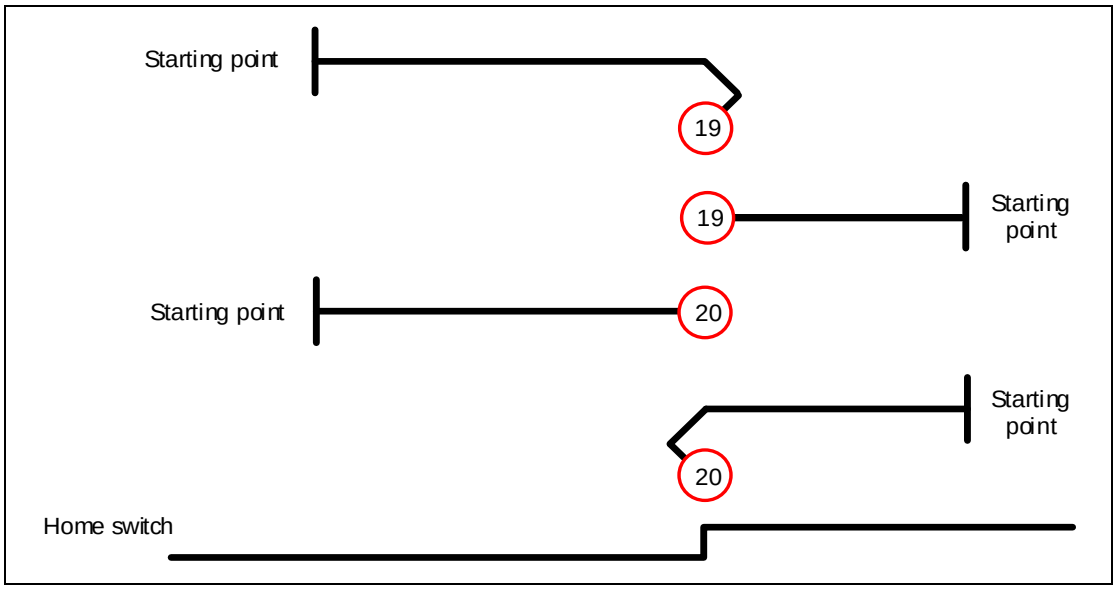
Method 17: homing on the negative limit switch and Z pulse



Method 18: homing on the positive limit switch



Methods 19 and 20: homing on the rising edge of home switch



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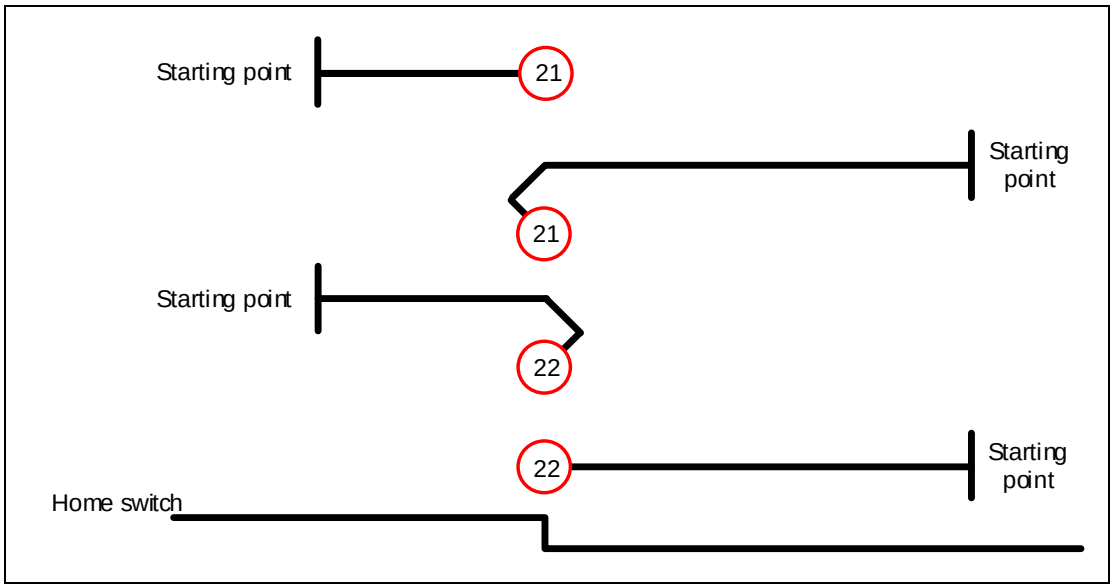
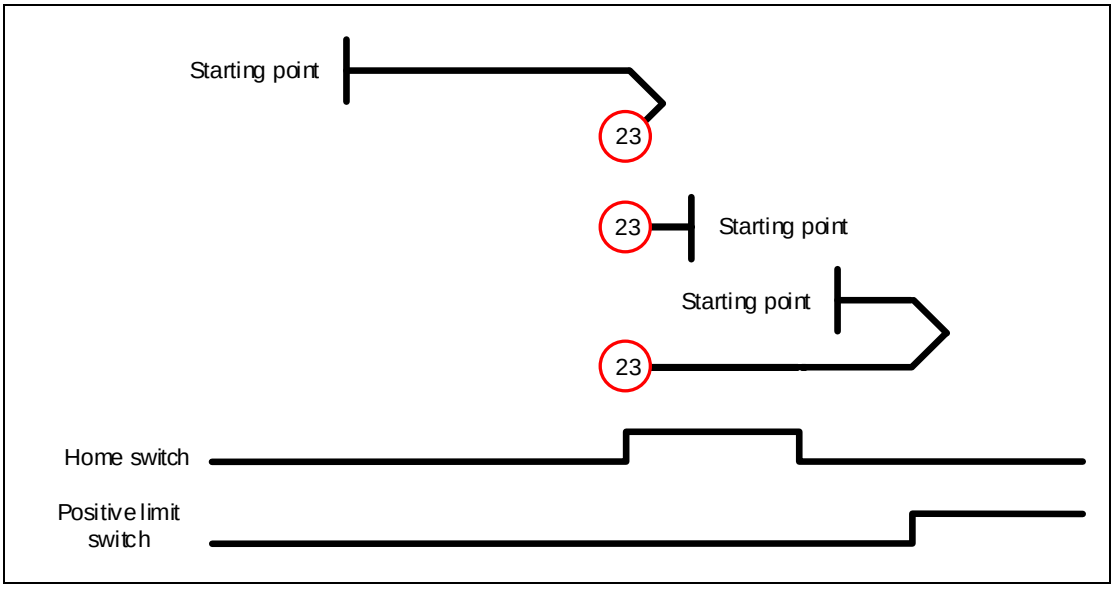
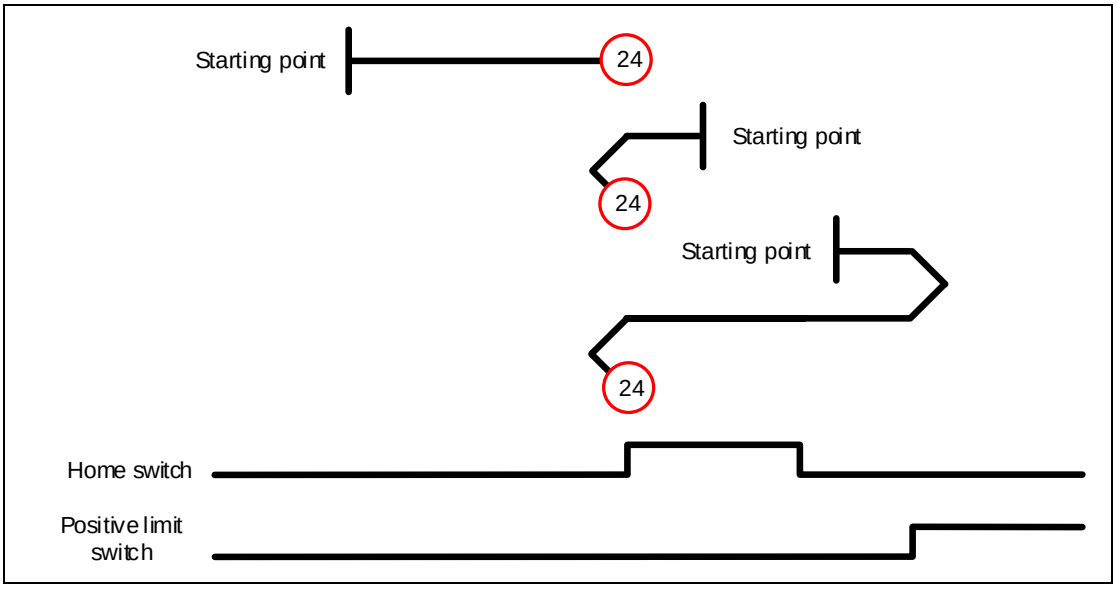
Methods 21 and 22: homing on the falling edge of home switch



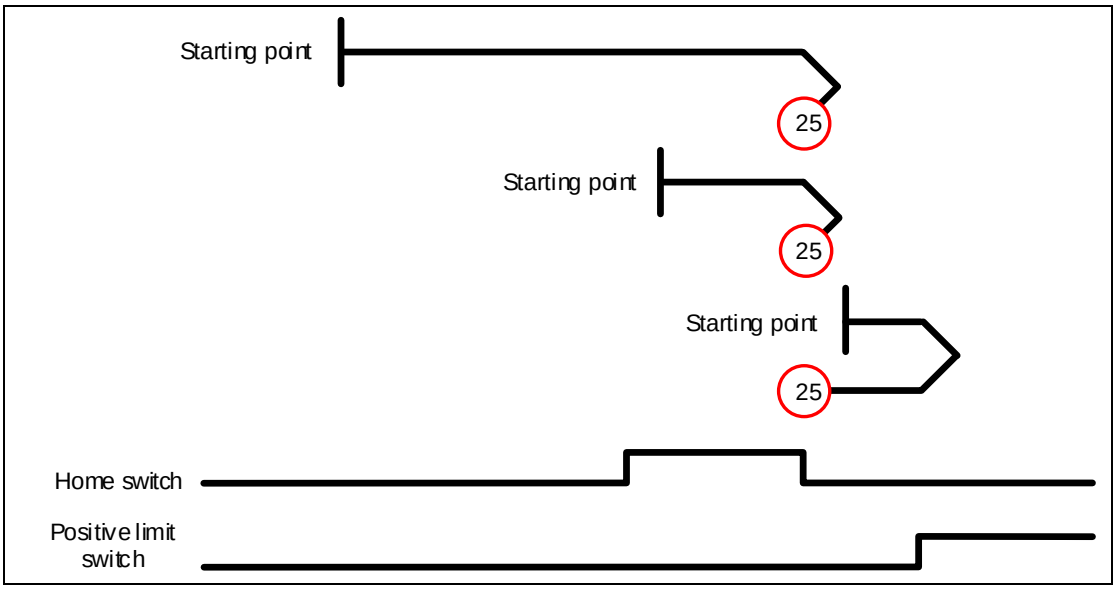
Method 23: homing on the positive limit switch and rising edge of home switch



Method 24: homing on the positive limit switch and rising edge of home switch



Method 25: homing on the positive limit switch and falling edge of home switch



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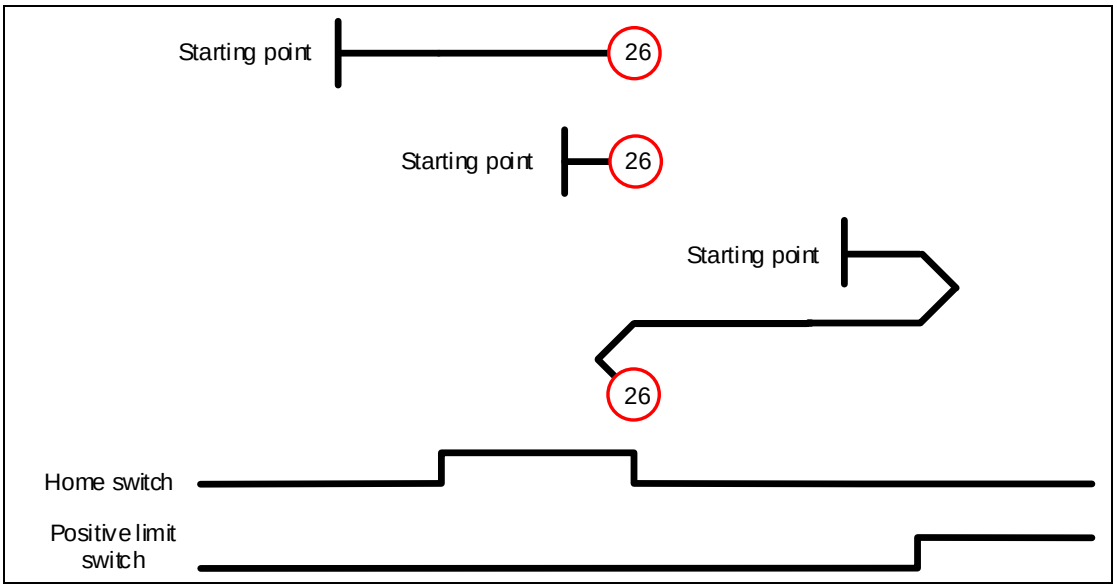
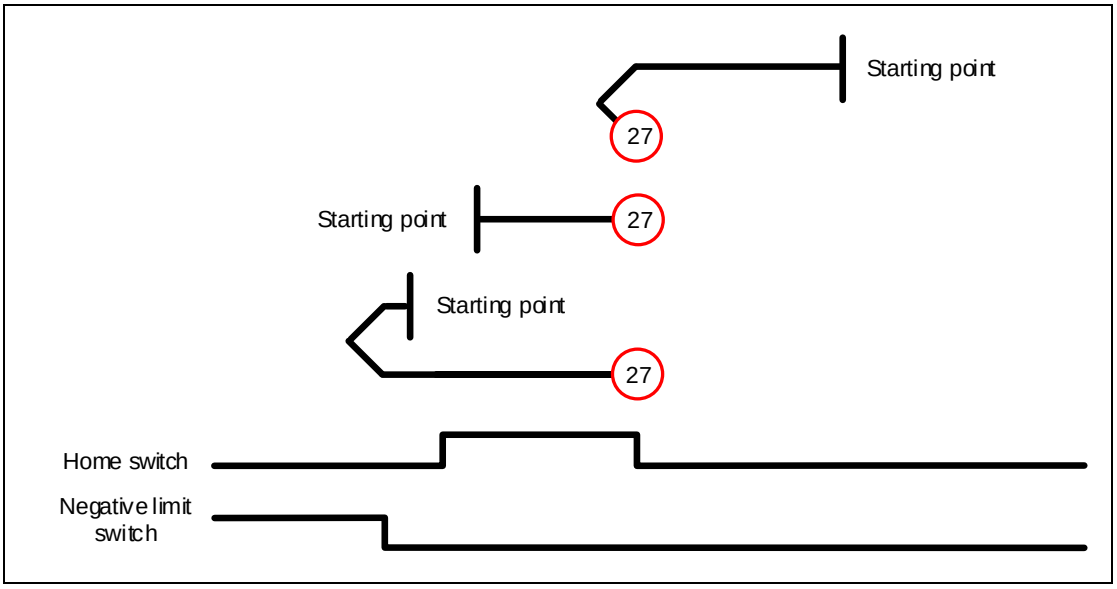
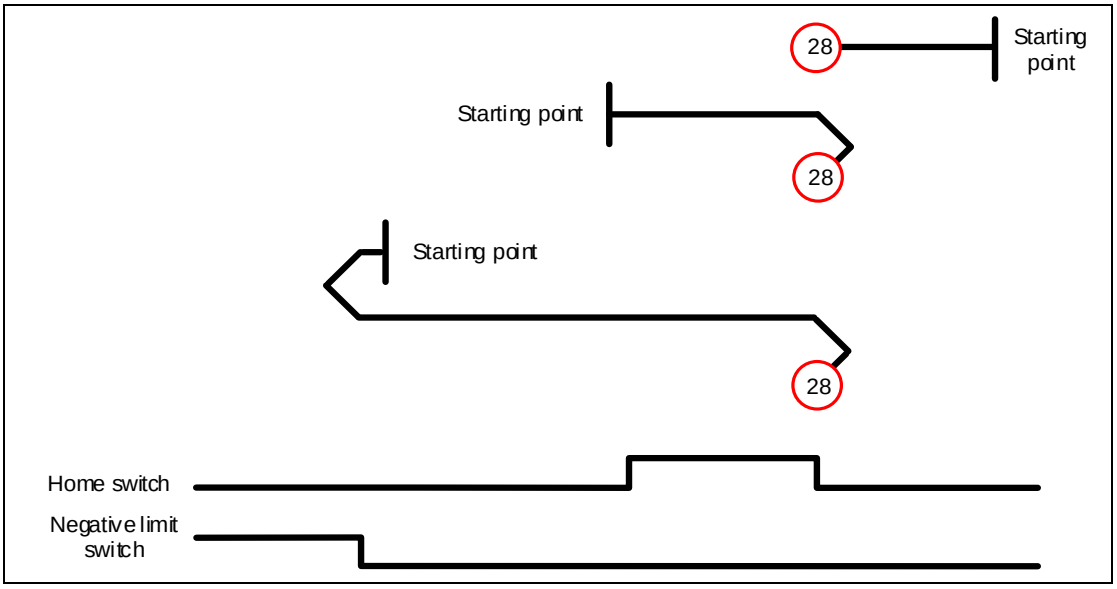
Method 26: homing on the positive limit switch and falling edge of home switch



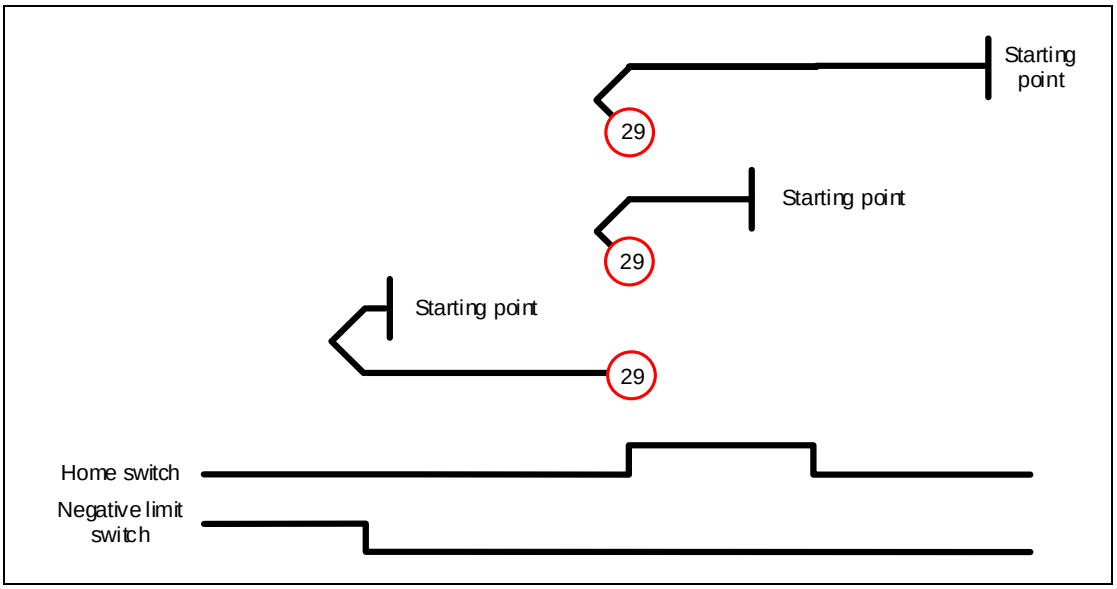
Method 27: homing on the negative limit switch and falling edge of home switch



Method 28: homing on the negative limit switch and falling edge of home switch



Method 29: homing on the negative limit switch and rising edge of home switch



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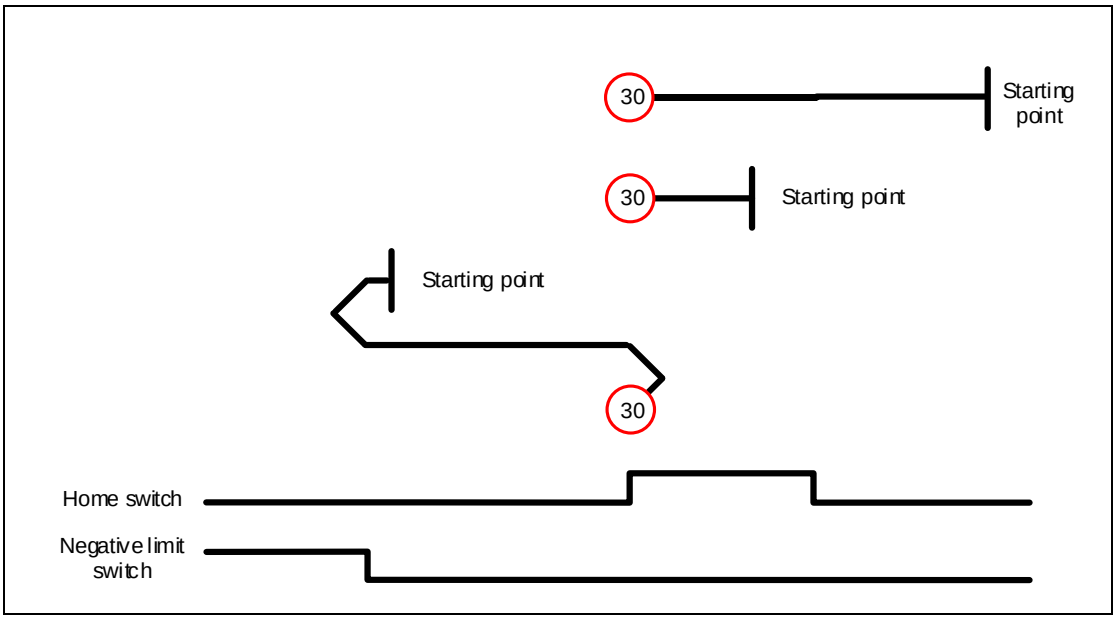
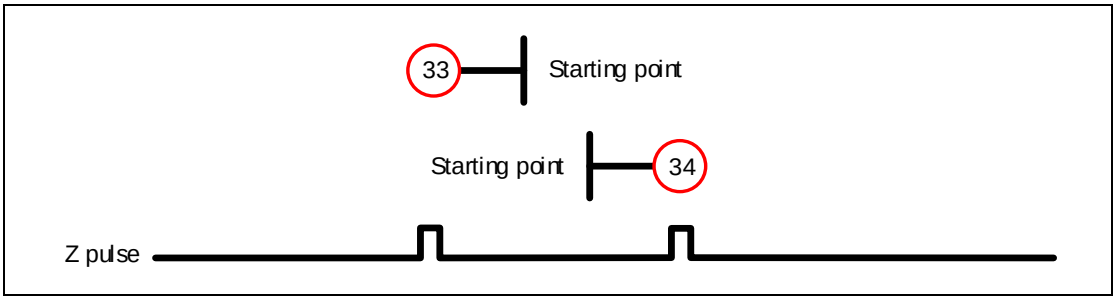
Method 30: homing on the negative limit switch and rising edge of home switch



Methods 31 and 32: reserved

Methods 33 and 34: homing on the Z pulse



Method 35: define the current feedback position as the origin.

Object 6099h: Homing speeds

Index	6099h
Name	Homing speeds
Object code	ARRAY
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes

Sub-index	0
Description	Number of sub-index
Data format	UNSIGNED8
Access	RO
PDO mapping	Yes
Setting range	2
Default	2

Sub-index	1
Description	Speed during search for switch
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 2000
Default	100
Unit	0.1 rpm

Sub-index	2
Description	Speed during search for zero
Data format	UNSIGNED32
Access	RW
PDO mapping	Yes
Setting range	1 - 500
Default	20
Unit	0.1 rpm

Object 609Ah: Homing acceleration

Index	609Ah
Name	Homing acceleration
Object code	VAR
Data format	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 to accelerate from 0 rpm to 3,000 rpm and decelerate from 3,000 rpm to 0 rpm. This object is only available in Homing Mode.

Object 60C0h: Interpolation sub mode select

Index	60C0h
Name	Interpolation sub mode select
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Yes
Value range	INTEGER16
Default value	0

Object function: no need to set this object.

Object 60C1h: Interpolation data record

Index	60C1h
Name	Interpolation data record
Object code	ARRAY
Data format	INTEGER32
Access	RW
PDO mapping	Yes

Object function:

PDO sets this record every T ms before receiving the SYNC message; the T value is specified by 60C2h: 01h

Sub-index	0
Description	Number of sub-index
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1
Description	Command position Pos_Cmd
Data format	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

This object only works in IP Mode. For more details, refer to Section 12.3.2 Interpolation Position Mode.

Object 60C2h: Interpolation time period

Index	60C2h
Name	Interpolation time period
Object code	RECORD
Data format	UNSIGNED8
Access	RW
PDO mapping	Yes

Sub-index	0
Description	Number of sub-index
Data format	UNSIGNED8
Access	RO
PDO mapping	No
Setting range	2
Default	2

Sub-index	1
Description	Interpolation cycle time constant
Data format	UNSIGNED8
Access	RW
PDO mapping	Yes
Setting range	UNSIGNED8
Default	1

Sub-index	2
Description	Power of 10
Data format	INTEGER8
Access	RW
PDO mapping	Yes
Setting range	-128 to 63
Default	-3

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Object function:

This object only works in IP Mode. The interpolation cycle time is calculated by two objects, OD 60C2h sub1 and OD 60C2h sub2. The calculation is as follows:

$$\text{Interpolation cycle time} = 60C2h\ \text{sub1} \times 10^{60C2h\ \text{sub2}}$$

Example: if you want to set the interpolation cycle time to 2 ms, set OD 60C2h sub1 to 2 and OD 60C2h sub2 to -3.

$$\text{Interpolation cycle time} = 2 \times 10^{-3} = 0.002\ s$$
$$= 2\ ms$$

Object 60C5h: Max acceleration

Index	60C5h
Name	Max acceleration
Object code	VAR
Data format	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 to accelerate from 0 rpm to 3,000 rpm.

Object 60C6h: Max deceleration

Index	60C6h
Name	Max deceleration
Object code	VAR
Data format	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 to decelerate from 3,000 rpm to 0 rpm.

Object 60E0h: Positive torque limit

Index	60E0h
Name	Positive torque limit
Object code	VAR
Data format	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 format	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 format	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	PUU

Object function:

The following error is the difference between the command position (OD 6062h) and feedback position (OD 6064h). For more details, refer to the architecture diagram in Section 12.3.

Object 60FCh: Position demand value

Index	60FCh
Name	Position demand value
Object code	VAR
Data format	INTEGER32
Access	RO
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	pulse

Object function:

This command is generated after being processed by the servo drive filter. For more details, refer to the architecture diagram in Section 12.3.

Object 60FDh: Digital inputs

Index	60FDh
Name	Digital inputs
Object code	VAR
Data format	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	0
Unit	-

Object function:

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

Bit	Function
Bit 0	Negative limit signal
Bit 1	Positive limit signal
Bit 2	Homing signal
Bit 3 - Bit 15	-

Object 60FFh: Target velocity

Index	60FFh
Name	Target velocity
Object code	VAR
Data format	INTEGER32
Access	RW
PDO mapping	Yes
Setting range	INTEGER32
Default	0
Unit	0.1 rpm

Object function:

This object sets the target speed. This object is only available in Profile Velocity Mode.

Object 6502h: Supported drive modes

Index	6502h
Name	Supported drive modes
Object code	VAR
Data format	UNSIGNED32
Access	RO
PDO mapping	Yes
Setting range	UNSIGNED32
Default	$6D_h$

Object function:

This object is read-only and provides the control modes supported by Delta servo drives in CANopen mode (OD 6502h = 6Dh).

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	-
Bit 2	Profile Velocity Mode
Bit 3	Profile Torque Mode
Bit 4	-
Bit 5	Homing Mode
Bit 6	Interpolation Position Mode
Bit 31 - Bit 7	Reserved

12.5 Diagnostics and troubleshooting

This section provides diagnostics and troubleshooting information related to communication or interference with the controller. For information about the servo drive alarms, refer to Chapter 13.

1. The SYNC communication cycle of the controller and servo drive is different

   Since the jitter of each controller is different, the communication cycle time between the servo drive receiving the Sync and Sync synchronization action is different. When this happens, increase the error value (T) by adjusting P3.009 and let the servo drive automatically correct the internal timer so it is consistent with the communication cycle of the controller.

2. Clear 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.

13 Troubleshooting

This chapter provides alarm descriptions and the corrective actions you can use for troubleshooting.

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There are four types of alarms: General, STO, Communication, and Motion control.

See detailed information below:

General type: alarms caused by hardware or encoder signal errors.

STO type: alarms caused by STO errors.

Communication type: alarms caused by CANopen or DMCNET errors.

Motion control type: alarms caused by motion control command (in PR mode) errors.

AL.nnn is the alarm format on the 7-segment display.

13.1 Alarm list

General type

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	○			○
AL008	Abnormal pulse command	○			○
AL009	Excessive deviation of Position command	○			○
AL011	Encoder error	○			○
AL012	Adjustment error	○			○
AL013	Emergency stop		○		○
AL014	Reverse limit error		○	○	
AL015	Forward limit error		○	○	
AL016	IGBT overheat	○			○
AL017	Abnormal EEPROM	○			○
AL018	Abnormal encoder signal output	○			○
AL019	Serial communication error	○			○
AL020	Serial communication timeout		○	○	
AL022	RST leak phase		○		○
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	Encoder voltage error or encoder internal error	○			○
AL029	Gray code error	○			○
AL030	Motor crash error	○			○
AL031	Motor power cable disconnection	○			○
AL034	Encoder internal communication error	○			○
AL035	Encoder temperature exceeds the protective range	○			○
AL040	Excessive deviation of full closed-loop position control	○			○
AL041	Linear scale communication is cut off	○			○
AL042	Analog input voltage is too high	○			○
AL044	Servo function overload 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 parameters are not confirmed	○			○
AL054	Switch of motor types causing parameters out of range	○			○
AL055	Motor magnetic field error	○			○

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General type (continued)

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL056	Excessive motor speed	○			○
AL058	Excessive position deviation after initial magnetic field detection	○			○
AL05B	Motor type setting does not match	○			○
AL05C	Motor position feedback error	○			○
AL060	Absolute position is lost		○	○	
AL061	Encoder undervoltage		○	○	
AL062	Number of turns for the absolute encoder overflows		○	○	
AL067	Encoder temperature warning		○	○	
AL068	Absolute data transmitted by I/O is in error		○	○	
AL069	Wrong motor type	○			○
AL06A	Absolute position is lost		○	○	
AL070	Encoder did not complete the command issued by servo drive		○	○	
AL072	Encoder overspeed	○			○
AL073	Encoder memory error	○			○
AL074	Encoder single-turn absolute position error	○			○
AL075	Encoder absolute number of turns is in error	○			○
AL077	Encoder internal error	○			○
AL079	Encoder parameter error	○			○
AL07B	Encoder memory busy	○			○
AL07C	Command to clear the absolute position is issued when the motor speed is over 200 rpm		○	○	
AL07D	Motor stops operating when servo drive power is cycled before AL07C is cleared	○			○
AL07E	Encoder clearing procedure error	○			○
AL07F	Encoder version error	○			○
AL083	Servo drive outputs excessive current	○			○
AL085	Regeneration error	○			○
AL086	Input voltage is too high	○			○
AL088	Servo function overload warning	○			○
AL089	Current detection interference		○	○	
AL08A	Auto-tuning function - Command error		○	○	
AL08B	Auto-tuning function - Pause time is too short		○	○	
AL08C	Auto-tuning function - Inertia estimation error		○	○	
AL095	Regenerative resistor disconnected		○	○	
AL099	DSP firmware update	○			○
AL521	Vibration elimination parameter error	○			○
AL35F	Emergency stop during deceleration		○	○	
AL3CF	Emergency stop		○		○

Note: if the servo drive shows an alarm that is not in this table, contact the local distributor or technician.

STO type

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL500	STO function is enabled	○			○
AL501	STO_A lost (signal loss or signal error)	○			○
AL502	STO_B lost (signal loss or signal error)	○			○
AL503	STO_self-diagnostic error	○			○

Note: if the servo drive shows an alarm that is not in this table, contact the local distributor or technician.

Communication type

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL111	Buffer overflow occurs when receiving CANopen SDO	○		○	
AL112	Buffer overflow occurs when receiving CANopen PDO	○		○	
AL121	Object's index does not exist when accessing CANopen PDO	○		○	
AL122	Object's sub-index does not exist when accessing CANopen PDO	○		○	
AL123	Data size error occurs when accessing CANopen PDO	○		○	
AL124	Data range error occurs when accessing CANopen PDO	○		○	
AL125	CANopen PDO object is read-only and write-protected	○		○	
AL126	Specified object does not support PDO mapping	○		○	
AL127	CANopen PDO is write-protected when servo drive is on	○		○	
AL128	Error occurs when reading CANopen PDO from EEPROM	○		○	
AL129	Error occurs when writing CANopen PDO to EEPROM	○		○	
AL130	Accessing address of EEPROM is out of range when using CANopen PDO	○		○	
AL131	CRC of EEPROM calculation error occurs when using CANopen PDO	○		○	
AL132	Parameter is write-prohibited when using CANopen PDO	○		○	
AL180	CANopen heartbeat or NodeGuarding error	○			○
AL185	CAN Bus hardware error	○			○
AL186	CAN Bus off	○		○	
AL201	Error occurs when loading CANopen data	○			○
AL301	CANopen synchronization failure		○	○	
AL304	Invalid CANopen IP command		○	○	
AL305	SYNC period error		○	○	
AL3E2	Synchronization signal of CANopen is sent too soon		○	○	
AL3E3	CANopen synchronization signal timeout		○	○	
AL401	NMT reset command is received when servo is on	○			○

Note: if the servo drive shows an alarm that is not in this table, contact the local distributor or technician.

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Motion control type

Display	Alarm name	Error type		Servo state	
		ALM	WARN	ON	OFF
AL207	Parameter group of PR#8 is out of range		○	○	
AL209	Parameter number of PR#8 is out of range		○	○	
AL213	Parameter setting of PR#8 is in error		○	○	
AL215	Write parameters: read-only		○	○	
AL217	Write parameters: parameter locked		○	○	
AL219	Write parameters: parameter locked		○	○	
AL231	Monitoring item of PR#8 is out of range		○	○	
AL235	Position counter overflow warning		○	○	
AL237	Indexing coordinate is undefined		○	○	
AL249	PR number exceeds the range	○			○
AL283	Software positive limit		○	○	
AL285	Software negative limit		○	○	
AL289	Position counter overflows		○	○	
AL380	Position offset alarm for DO.MC_OK		○	○	
AL3F1	Communication type absolute position command error	○			○
AL400	Index coordinate error	○			○
AL404	Value of PR special filter setting is too high	○			○
AL555	System failure	○			○
AL809	PR arithmetic operation error or secondary platform error	○			○

Note: if the servo drive shows an alarm that is not in this table, contact the local distributor or technician.

13.2 Causes and corrective actions

AL001 Overcurrent	
Trigger condition and cause	Condition: main circuit current is over 1.5 times of the maximum instantaneous current of the servo drive. Cause: 1. Motor has a short-circuit or fault to ground (frame). 2. Motor wiring is wrong. 3. IGBT is abnormal. 4. Parameter setting is wrong. 5. Control command setting is wrong.
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 of the motor and 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 setting value is much greater than the default. It is suggested that you reset the servo drive to the factory default settings and then modify the settings one by one. 3. Check if the control input command changes greatly. If so, modify the rate of change in the command or enable the filter function.
How to clear the alarm?	DI.ARST

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 rated voltage. 2. Wrong power input (wrong power system). 3. Malfunction of the servo drive hardware. 4. Wrong regenerative resistor or the external regenerative resistor is not connected.
Checking method and corrective action	1. Use a voltmeter to check if the input voltage of the main circuit is within the rated range (refer to Appendix A Specifications). If not, use the right voltage source or connect the regulator in series. Use a voltmeter to check if the power system complies with the specifications. If not, use the right voltage source or connect the transformer in series.

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AL002 Overvoltage	
Checking method and corrective action	2. Check if the input voltage of the main circuit is within the rated range. If the issue persists, send your servo drive back to the distributor or contact Delta. 3. Check the connection for the regenerative resistor, re-calculate the value for the regenerative resistor, and reset the value of P1.052 and P1.053.
How to clear the alarm?	DI.ARST

AL003 Undervoltage	
Trigger condition and cause	Condition: main circuit voltage is below the rated value. By default, AL003 is defined as a warning. To define it as an alarm, set P2.066 [Bit 9]. Cause: 1. The input voltage of main circuit is lower than the permissible rated value. 2. No power is supplied to the main circuit. 3. Wrong power input (wrong power system).
Checking method and corrective action	1. Check that the voltage wiring is correct and the input voltage for the main circuit is normal. 2. Cycle the servo drive power and use a voltmeter to check the main circuit voltage. 3. Use a voltmeter to check if the power system complies with the specifications. Check if using the right voltage source or the transformer is connected in series.
How to clear the alarm?	AL003 is cleared according to the setting of P2.066 [Bit2] 1. If P2.066 [Bit2] is set to 0, use DI.ARST to clear the alarm after the voltage is back in the normal range. 2. If P2.066 [Bit2] is set to 1, the alarm is automatically cleared once the voltage is back in the normal range.

AL004 Motor combination error	
Trigger condition and cause	Condition: wrong motor is used with the servo drive. Cause: 1. Motor combination error (the servo drive connects to the wrong motor). 2. The encoder 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. Wrong regenerative resistor or the external regenerative resistor is not connected. 2. P1.053 (regenerative resistor capacity) is not set to 0 when the regenerative resistor is not connected. 3. Parameter setting error (P1.052 and P1.053).
Checking method and corrective action	1. Check the connection for the regenerative resistor, re-calculate the value for the regenerative resistor, and reset the value of P1.052 and P1.053. If you cannot clear the alarm, send your servo drive back to Delta. 2. Set P1.053 to 0 if not using a regenerative resistor. 3. Correctly set the parameters for the regenerative resistor (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 persistent overload condition. 2. The control system parameter is wrong. 3. Incorrect wiring of motor and encoder. 4. Encoder malfunction.
Checking method and corrective action	1. Set P0.002 to 12 to monitor the servo drive status. Check if the average load rate [%] is continuously over 100%. If so, increase the motor capacity or reduce the load. Refer to Appendix A Specifications for more detail. 2. (a) Check if there is any mechanical vibration. (b) Acceleration / deceleration constant is set too high. 3. Check if the wiring of UVW and the encoder cables is correct. 4. Send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

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AL007 Excessive deviation of Speed command	
Trigger condition and cause	Condition: deviation between the Speed command and the feedback speed exceeds the allowable range (P2.034). Cause: 1. A drastic change in speed. 2. Incorrect setting for P2.034.
Checking method and corrective action	1. Use the signal detector to check if the input analog voltage signal is normal. If not, adjust the signal changing rate or enable the filter function. 2. Check and make sure the value of P2.034 (Speed command error warning) is correct.
How to clear the alarm?	DI.ARST

AL008 Abnormal pulse command	
Trigger condition and cause	Condition: the input frequency for the pulse command is over the allowable value for the hardware interface. Cause: the pulse command frequency is higher than the rated input frequency.
Checking method and corrective action	Use the scope to check if the input frequency is higher than the rated frequency. Correctly set the input pulse frequency.
How to clear the alarm?	DI.ARST

AL009 Excessive deviation of Position command	
Trigger condition and cause	Condition: deviation between the Position command and the feedback position exceeds the allowable range (P2.035). Cause: 1. The maximum position deviation is set too low. 2. Gain value is set too low. 3. Torque limit is set too low. 4. Excessive external load. 5. Improper setting for the E-Gear ratio.
Checking method and corrective action	1. Check the value of the maximum deviation (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 if the torque limit setting is appropriate for the application. 4. Check the external load. Reduce the external load or re-evaluate the motor capacity if necessary.

AL009 Excessive deviation of Position command	
Checking method and corrective action	5. Check if the settings for P1.044 and P1.045 are appropriate for the application and set the correct values.
How to clear the alarm?	DI.ARST

AL011 Encoder error	
Trigger condition and cause	Condition: the encoder produces abnormal pulses. Cause: 1. Encoder wiring is wrong. 2. Encoder connector is loose. 3. Poor wiring of the encoder. 4. Connection to the encoder is cut off due to interference. 5. Encoder is damaged.
Checking method and corrective action	1. Check if the wiring follows the instructions in the user manual. If not, connect the wiring correctly. 2. Check if the CN2 connector and the encoder connector are loose. If so, reconnect the connectors. 3. Check both of the connections between the encoder and CN2 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 status by setting P0.002 to -80. If the value continuously increases, it means there is interference. Check the following: ■ Make sure the servo motor is properly grounded and connect the ground of the UVW connector (green) to the servo drive heat sink. ■ 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. ■ Use shielded cable for the encoder. 5. If you took all corrective actions but the issue persists, replace the motor.
How to clear the alarm?	Cycle power on the servo drive.

AL012 Adjustment error	
Trigger condition and cause	Condition: the calibration value exceeds the allowable value during electric calibration.

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AL012 Adjustment error	
Trigger condition and cause	Cause: 1. The analog input contact is not correctly set to zero. 2. The detection device is damaged.
Checking method and corrective action	1. Check if the voltage at the analog input contact is the same as the ground voltage. 2. Reset the power supply. If the issue persists, send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	Remove the connection cable for CN1 and then execute auto calibration.

AL013 Emergency stop	
Trigger condition and cause	The emergency stop button is pressed.
Checking method and corrective action	Check the emergency stop state and make sure it is off.
How to clear the alarm?	DI.EMGS

AL014 Reverse limit error	
Trigger condition and cause	Condition: reverse limit switch is triggered. Cause: 1. Reverse limit switch is triggered. 2. Servo system is unstable.
Checking method and corrective action	1. Check the reverse limit switch and make sure it is off. 2. Check the parameter setting and the load inertia. If the setting is wrong, modify the parameter value or re-estimate the motor capacity.
How to clear the alarm?	The alarm is automatically cleared after moving away from the limit.

AL015 Forward limit error	
Trigger condition and cause	Condition: forward limit switch is triggered. Cause: 1. Forward limit switch is triggered. 2. Servo system is unstable.
Checking method and corrective action	1. Check the forward limit switch and make sure it is off. 2. Check the parameter setting and the load inertia. If the setting is wrong, modify the parameter value or re-estimate the motor capacity.
How to clear the alarm?	The alarm is automatically cleared after moving away from the limit.

AL016 IGBT overheat	
Trigger condition and cause	Condition: temperature of IGBT is too high. Cause: 1. The load is over the rated range and the servo drive is in a persistent overload condition. 2. Servo drive has a short-circuit or fault to ground (frame).
Checking method and corrective action	1. Check if the motor is overloaded or over-current. Then, try increasing the motor's capacity or reducing the load. 2. Check if the wiring of servo drive output is correct.
How to clear the alarm?	DI.ARST

AL017 Abnormal EEPROM	
Trigger condition and cause	Condition: error occurs when DSP accesses EEPROM. Cause: 1. Parameter writing error or the value exceeds the permissible range. This error occurs when parameters are restored to the default and servo drive type is incorrect. 2. Data in ROM is damaged or there is no data in ROM. This occurs when the system is in Servo On status. If this alarm occurs, send your servo drive back to the distributor or contact Delta.
Checking method and corrective action	Press the SHIFT key on the panel and “EXGAB” is displayed. X = 1, 2, 3 G = Group number of the parameter AB = Parameter number in hexadecimal format If the panel displays E320A, this is parameter P2.010. If E3610 is displayed, this is P6.016. Check the value for the displayed parameter. 1. Press the SHIFT key to display the parameter code. If this alarm occurs when power is supplied to the drive, it means a parameter value has exceeded the range. Modify the value and then cycle the power. If the error occurs during normal operation, it means an error occurred when writing the parameter. Use DI.ARST to clear this alarm. 2. Press the SHIFT key on the panel and E100X is displayed. If this alarm occurs while parameters are being restored to the default, it means the servo model type setting is incorrect. Please correct it. 3. Press the SHIFT key on the panel and E0001 is displayed. If this alarm occurs while power is being supplied, it is usually because the data in ROM is damaged or there is no data in the ROM. Send your servo drive back to the distributor or contact Delta.

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AL017 Abnormal EEPROM	
How to clear the alarm?	If this alarm occurs when the drive is started, reset the parameters and then cycle the power. If the alarm occurs during operation, reset the alarm.

AL018 Abnormal encoder signal output	
Trigger condition and cause	Condition: output pulse frequency of the encoder is higher than the maximum output frequency of the hardware. Cause: 1. Pulse resolution of the encoder is set too high. 2. There is interference or cable damage causing communication error. 3. Encoder error.
Checking method and corrective action	1. The setting of P1.076 and P1.046 should follow these requirements: P1.076 > motor speed and $\frac{\text{Motor speed}}{60} \times \text{P1.046} \times 4 < 19.8 \times 10^6$ 2. Check the communication error status by setting P0.002 to -80. If the value continuously increases, it means there is interference. Check the following: ■ Make sure the servo motor is properly grounded and connect the ground of the UVW connector (green) to the servo drive heat sink. ■ 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. ■ Use shielded cable for the encoder. ■ Check the error log (P4.000 - P4.005) and see if an alarm has occurred (AL011, AL024, AL025, and AL026). Use the checking methods and corrective actions to clear the alarm if any of them occurs. 3. If you do not need to use the OA/OB pulse, set P2.065 Bit[13] to 1 to disable the encoder output error (AL018) detection function.
How to clear the alarm?	1. DI.ARST 2. Contact the distributor.

AL019 Serial communication error	
Trigger condition and cause	Condition: RS-485 communication error. Cause: 1. Improper setting of the communication parameters. 2. Incorrect communication address. 3. Incorrect communication value.
Checking method and corrective action	1. Check the values of the communication parameters. Then correctly set P3.003 and P3.004 or restore the value to default. 2. Check and correctly set the communication address. 3. Check and correctly set the accessing value.
How to clear the alarm?	DI.ARST

AL020 Serial communication timeout	
Trigger condition and cause	Condition: RS-485 communication error. Cause: 1. Improper setting of the timeout parameter (P5.003). 2. Servo drive has not received the communication command for a long time and has timed out (refer to P5.003).
Checking method and corrective action	1. Check and make sure the value for the communication timeout parameter is correct. 2. Check if the communication cable is loose or broken and is correctly wired.
How to clear the alarm?	DI.ARST

AL022 RST leak phase	
Trigger condition and cause	Condition: RST power cable is loose or there is no power. The default setting of AL022 is a warning. To set AL022 as an alarm, you can set P2.066 [Bit 12]. Cause: RST leak phase.
Checking method and corrective action	Check if the RST power cable is loose or there is no power. This alarm occurs when the 1.5 kW (or below) ASDA-A3 servo drive is not connected to the three-phase power supply. For 2 kW (or above) ASDA-A3 servo drives, the 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 ASDA-A3 servo drive back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

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AL023 Early overload warning	
Trigger condition and cause	Early overload warning
Checking method and corrective action	1. Check if your servo drive is overloaded and refer to the corrective actions for AL006 for troubleshooting. 2. Check if the value of P1.056 is set too low. If yes, increase the value, which should be over 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 (Signal U, V, W of the encoder magnetic field is in error.)
Checking method and corrective action	1. Make sure the servo motor is properly grounded and connect the ground of the UVW connector (green) 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. 4. If using a linear motor, check the wiring noise interference. For the noise filter of the conversion board, refer to P1.074. For the noise filter of the CN5 position feedback signal connector, refer to PM.003. 5. Check the Hall sensor wiring of the linear motor and monitor the Hall sensor phase sequence by inputting 0x1B42F to the scope address. 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.

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 applying power, the motor rotates because of inertia of the machinery or other causes.
Checking method and corrective action	1. (a) Make sure the servo motor is properly grounded and connect the ground of the UVW connector (green) to the servo drive heat sink.

AL025 Encoder internal error	
Checking method and corrective action	(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. 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	To correct the interference, check the following descriptions: 1. Make sure the servo motor is properly grounded and connect the ground of the UVW connector (green) 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. 4. Set P0.002 to -80 by using the panel to monitor the communication error status. If the value is greater than 0 and the value increases continuously, check steps 1 - 3 again. If the value is 0, send your motor back to the distributor or contact Delta.
How to clear the alarm?	Cycle power on the servo drive.

AL027 Encoder internal reset error	
Trigger condition and cause	Condition: encoder reset error. Cause: encoder reset.
Checking method and corrective action	1. Check if the encoder signal cable is firmly connected. 2. Check if the power supply for the encoder is stable and make sure to use shielded cable. 3. Check if the operation temperature is over 95°C. Identify the cause for the high temperature and do not restart the operation before the temperature falls back into the allowable range. 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.

AL028 Encoder voltage error or encoder internal error	
Trigger condition and cause	Condition: servo drive charging circuit is not removed so the 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. Follow the testing procedure for overvoltage / overcurrent and troubleshoot. This automatically clears AL028. (a) Check the servo drive charging circuit. Avoid incorrect wiring. If Pin 1 (5V) of CN2 is connected to BAT+, it means the power (5V) of the servo drive is being charged to the battery. (b) Check if the battery is correctly installed (voltage > 3.8V). 2. (a) Make sure the encoder is the absolute type. Check and remove the cause for the alarm. If the issue persists, send your servo drive back to the distributor or contact Delta. (b) Make sure the servo motor is properly grounded and connect the ground of the UVW connector (green) to the servo drive heat sink. (c) Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. (d) Use shielded cable for the encoder. 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.

AL029 Gray code error	
Trigger condition and cause	Absolute position error
Checking method and corrective action	Cycle the power to 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.

AL030 Motor crash error	
Trigger condition and cause	Condition: when the motor hits the device, the torque reaches the value of P1.057 and lasts for the time set by P1.058. Cause: 1. Check if the function of motor crash protection (P1.057) is enabled. If so, set P1.057 to 0. 2. Check if the value of P1.057 is set too low and the time set by P1.058 is too short. Set P1.057 according to the actual torque. Incorrect values might inadvertently trigger the signal or lose the protection function.
Checking method and corrective action	Cycle the power to 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 disconnection	
Trigger condition and cause	Condition: incorrect wiring or disconnection of the motor power cable U, V, W, and GND. Cause: Incorrect wiring or disconnection of the motor power cable U, V, W. The switch for cut-off detection is set by P2.065 Bit 9, which default is set to disable.
Checking method and corrective action	Check if the motor power cable (U, V, W, GND) is firmly connected. Connect wiring and ground properly by following the instructions in this user manual.
How to clear the alarm?	Cycle power on the servo drive.

AL034 Encoder internal communication error	
Trigger condition and cause	Condition: 1. Internal communication error for the absolute encoder. 2. Internal error for the other type 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.

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AL035 Encoder temperature exceeds the protective range	
Trigger condition and cause	Condition: encoder temperature is over the maximum of 100˚C. Cause: encoder temperature is over 100˚C.
Checking method and corrective action	Set P0.002 to -124d 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 motor and the displayed temperature value is over 30˚C, send your motor back to the distributor.
How to clear the alarm?	After the temperature detector shows a temperature below 100˚C, cycle power on the servo drive.

AL040 Excessive deviation of full closed-loop position control	
Trigger condition and cause	Excessive deviation of full closed-loop position control.
Checking method and corrective action	1. Check the value for P1.073. If the value is too low, set a higher value. 2. Make sure the connector is firmly connected and there is no problem in connecting the machine.
How to clear the alarm?	DI.ARST

AL041 Linear scale communication is cut off	
Trigger condition and cause	Linear scale communication is cut off.
Checking method and corrective action	Make sure the wiring for the linear scale is correct.
How to clear the alarm?	DI.ARST

AL042 Analog input voltage is too high	
Trigger condition and cause	Analog input voltage for the Speed command is higher than the level specified by P1.083.
Checking method and corrective action	Check if the voltage source for the Speed command is correct. Check the setting value of P1.083 and set it to 0 when this function is not required.
How to clear the alarm?	DI.ARST

AL044 Servo function overload warning	
Trigger condition and cause	Condition: when the motor controlling function of the servo drive is overloaded, the motion control function is affected, causing error in the PR or E-Cam operation. Cause: servo function overload warning.
Checking method and corrective action	1. Check if the filter is enabled and see if enabling the filter is necessary. 2. Set P2.066 Bit4 to 1 to disable this alarm.

AL044 Servo function overload warning	
How to clear the alarm?	1. 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), or Notch filter (1st to 5th sets). 2. Set P2.066 Bit4 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 (1/4 - 262144), this alarm occurs once power to the servo drive is cycled. Cause: when the servo drive is powered on, E-Gear ratio value is in error.
Checking method and corrective action	Check if the value for the E-Gear ratio is within the allowable range (1/4 - 262144). 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	Use 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: error occurred when using the Motor Parameter Identification Wizard functions. Cause: When the motor is executing the Motor Parameter Identification Wizard functions, this alarm is triggered if the friction is too large causing the motor unable to run, or input values of the resolution and magnetic pole pitch are too large.
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 mechanism is too large. 4. Check if the feedback signal is abnormal. Use the software scope and select Feedback position [PUU] as the channel type to monitor whether the feedback value is correct. 5. Check for interference causing pulse leakage.

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AL051 Motor parameter automatic identification error	
Checking method and corrective action	6. If there is interference, check the following: (a) Make sure the servo motor is properly grounded and connect the ground of the UVW connector (green) 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 moved too far. 2. When the servo is on, the servo automatically detects the magnetic field. If the detection is not complete in 4 seconds, this alarm is triggered. 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 when using the Motor Parameter Identification Wizard. 2. Check if the feedback signal is abnormal. Use the software scope and select Feedback position [PUU] as the channel type to monitor whether the feedback value is correct. 3. Make sure the motor and mechanism can operate properly. 4. Check if the friction between the motor and mechanism 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 software scope and select Feedback position [PUU] as the channel type to monitor whether the feedback value is correct. Try reducing the set value of the initial magnetic field adsorption of PM.011 when Servo On.
How to clear the alarm?	DI.ARST

AL053 Motor parameters are not confirmed	
Trigger condition and cause	Condition: the Motor Parameter Identification Wizard function has not been executed or the identification failed, and once the servo is on, this alarm is triggered. Cause: a third-party motor has not executed the Motor Parameter Identification Wizard function or failed to execute it.
Checking method and corrective action	Execute or re-execute the Motor Parameter Identification Wizard function.
How to clear the alarm?	Switch the servo to Servo Off to clear this alarm.

AL054 Switch of motor types causing parameters out of range	
Trigger condition and cause	Condition: 1. Set value of PM.004 for the third-party rotary motor is not within the range of 128 - 268435456. 2. Set value of PM.004 for the linear motor exceeds 30000. Cause: set value of PM.004 exceeds the allowable range.
Checking method and corrective action	Make sure the set values of PM.000 and PM.004 are correct.
How to clear the alarm?	Cycle power on the servo drive.

AL055 Motor magnetic field error	
Trigger condition and cause	Condition: the difference between the monitored magnetic field returned by the Hall sensor and the magnetic field calculated by the servo is too big. Cause: when PM.009.Y 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 error between the two is too large, this alarm is triggered.
Checking method and corrective action	1. Check if the Hall sensor is abnormal or has interference. 2. Check if the feedback signal is abnormal. Use the software scope and select Feedback position [PUU] as the channel type 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 the following: (a) The motor is too fast and exceeds the maximum limit of the hardware. The current limit of the hardware is 16 Mhz (the limit multiplied by 4 times the frequency). (b) When the encoder feedback type is a square-wave digital signal, check if the filter setting of P1.074.U is appropriate.
How to clear the alarm?	Cycle power on the servo drive.

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AL056 Excessive motor speed	
Trigger condition and cause	Condition: when the motor speed after filtering 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 the user that the motor speed has reached the upper limit of the current setting (P1.111).
Checking method and corrective action	1. Check the reason why the motor speed is too high. Such as the set value of P1.111 is too small, the bandwidth is not set properly, or the linear motor parameter setting does not match the linear motor specification. 2. Evaluate the motor speed and the condition of the mechanism. If allowable, increase the speed by adjusting the set value of P1.111.
How to clear the alarm?	DI.ARST

AL058 Excessive position deviation after initial magnetic field detection	
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	1. Check if the controller has issued the command immediately when it is powered on. Use the software scope and select [Command position] 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. 2. If the controller time sequence cannot be modified due to surge interference or other factors when powered on, set P2.088.bit4 to 1 to prohibit the servo from receiving controller commands during the initial magnetic field detection.
How to clear the alarm?	DI.ARST

AL05B Motor type setting does not match	
Trigger condition and cause	Condition: a Delta motor is connected to CN2 as the main encoder, but PM.000 is not set to 0. Cause: incorrect setting of PM.000.
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. With the software scope, select Feedback position [PUU] as the channel type and sampling at 16 kHz or 20 kHz, 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. If the source of the main encoder is CN2, check if the communication error rate is increased due to interference. For example, check the communication error rate by setting P0.017 to -80d 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.

AL060 Absolute position is lost	
Trigger condition and cause	Condition: losing number of revolutions because of low battery voltage or loss of the power. Cause: 1. Voltage level of the battery is too low. 2. The battery is replaced when the main 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 2.45V. Re-establish the absolute origin coordinates after replacing the battery. Refer to Chapter 10 Absolute servo system for more information. 2. Do not change or remove the battery when the ASDA-A3 servo drive's main power is off. To re-establish the absolute origin coordinates, refer to Chapter 10 Absolute servo system for more information. 3. Follow the instructions below: (a) Install the battery. (b) Check the connection between the battery power source and servo drive. (c) Check the encoder wiring.

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AL060 Absolute position is lost	
Checking method and corrective action	4. Connect or correct the wiring so that the battery power is supplied to the encoder and then re-establish the absolute origin coordinates. (a) Check the encoder wiring. (b) Check the connection between the battery box and servo drive.
How to clear the alarm?	Connect or correct the wiring so that the battery power is supplied to the encoder and then re-establish the absolute origin coordinates. Refer to Chapter 10 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 the allowable value (3.1V). Cause: voltage level of the battery is too low
Checking method and corrective action	1. Check the panel to see if the battery voltage 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 main power is on.
How to clear the alarm?	The alarm is cleared automatically.

AL062 Number of turns for the absolute encoder overflows	
Trigger condition and cause	Condition: the number of turns for the absolute encoder exceeds the range: -32768 to +32767. Cause: motor's rotation cycle exceeds the allowable range.
Checking method and corrective action	Check if the motor's number of turns while operating is within the range between -32768 and +32767. If not, re-establish the absolute origin coordinates.
How to clear the alarm?	Cycle power on the servo drive.

AL067 Encoder temperature warning	
Trigger condition and cause	Condition: the encoder temperature is over 85˚C (warning level), but still under 100˚C, which is within the protective range. Cause: encoder temperature warning (85˚C - 100˚C).
Checking method and corrective action	Set P0.002 to -124 d and check if the encoder temperature is identical to the motor temperature. If the encoder temperature is too high, improve the heat dissipation to lower the temperature. If the temperature difference between the encoder and motor is over 30˚C, send the motor back to the distributor.
How to clear the alarm?	Cycle power on the servo drive.

AL068 Absolute data transmitted by I/O is in error	
Trigger condition and cause	Condition: the sequence is wrong when reading the absolute position with DIO. Cause: 1. Time sequence is wrong. 2. Reading timeout.
Checking method and corrective action	1. Correct the time sequence for reading the data with DIO: (A) DI.ABSQ switches to off after DO.ABSR is off. (B) DI.ABSQ switches to on after DO.ABSR is on. 2. Check the duration from when DO.ABSR switches on to the time that DI.ABSQ switches on and see if this duration is over 200 ms. The correct procedure should be: when DO.ABSR switches on and after the bit data of absolute position is ready, read DO.ABSD within 200 ms and switch DI.ABSQ on. Then inform the servo drive that data reading is complete.
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 to see if your servo motor has an incremental or absolute encoder. 2. Check the setting of P2.069 and correctly set the value. Set P2.069 to 0 if your encoder does not use the absolute function.
How to clear the alarm?	Set P2.069 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. One is the absolute coordinates are not established, so after the absolute origin coordinates are established, the origin will not be lost after cycling power on. The other is an error occurred. After establishing the absolute origin coordinates, AL06A still occurs after cycling power on. ■ Coordinates are not established. Condition: 1. Servo drive in use for the first time. 2. The battery is drained and the power supply of the servo drive is cut off. 3. When the bus communication type (CANopen, DMCNET, EtherCAT) 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.

AL06A Absolute position is lost	
Trigger condition and cause	Cause: 1. Servo drive in use for the first time, so the absolute coordinate system has not been created. 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 modifying the E-Gear ratio, the communication type coordinate system needs to be re-established. ■ An error occurred. Condition: 1. Encoder cable is damaged (not only the exterior, but also the internal wiring). 2. There is a momentary power failure in the battery power supply. 3. The absolute motor is abnormal. 4. The battery box is used, and J1 and J2 are connected reversely. 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 abnormal. 4. If J1 and J2 are connected reversely, the battery cannot charge the capacitor. The function of the capacitor is to act as a buffer to supply power when the power of the servo drive is cut off and switching to battery power supply.
Checking method and corrective action	1. Check if the absolute origin coordinates are established (refer to Section 10.3.1 for more information). 2. Avoid replacing the battery when the servo drive is powered off. It is suggested to replace the battery when the servo drive is powered on, so the absolute encoder has continuous power supply. 3. Re-establish the absolute origin coordinates. 4. Change the encoder cable. Use the X-ray to check if the internal wiring is damaged. 5. Check if the connector is loose and the machine vibrates excessively. If both are fine, then replace the battery box for cross-testing. 6. Replace the servo motor.
How to clear the alarm?	This alarm is cleared after you establish the absolute origin coordinates.

AL070 Encoder did not complete the set-up command issued by servo drive	
Trigger condition and cause	Reading and writing commands are not complete.
Checking method and corrective action	Check if the wiring is correct and the connector is firmly connected. Correctly connect the wiring. Contact Delta if this error persists.
How to clear the alarm?	Cycle power on the servo drive.

AL072 Encoder overspeed	
Trigger condition and cause	When the encoder is powered by the servo drive: over 8,800 rpm. When the encoder is powered by the battery: over 10,000 rpm.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the power cable is grounded to the servo drive heat sink. 2. 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 and pull out the shielded mesh and ground it. 4. Check the motor speed and make sure it is within the rated range. 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.

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 power cable is grounded to the servo drive heat sink. 2. 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 and pull out the shielded mesh and ground it. 4. Check the motor speed and make sure it is within the rated range. 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.

AL074 Encoder single-turn absolute position 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 power cable is grounded to the servo drive heat sink. 2. 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 and pull out the shielded mesh and ground it. 4. Check the motor speed and make sure it is within the rated range. 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.

AL075 Encoder absolute number of turns is in error	
Trigger condition and cause	The absolute number of turns in the encoder is in error.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the power cable is grounded to the servo drive heat sink. 2. 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 and pull out the shielded mesh and ground it. 4. Check the motor speed and make sure it is within the rated range. 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.

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 power cable is grounded to the servo drive heat sink. 2. 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 and pull out the shielded mesh and ground it. 4. Check the motor speed and make sure it is within the rated range. 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.

AL079 Encoder parameter error	
Trigger condition and cause	The encoder is not cycled after the parameter is written, so the parameter value is not updated.
Checking method and corrective action	Check if the parameter is written to the encoder. If so, cycle the encoder to update the parameter.
How to clear the alarm?	Cycle power on the servo drive.

AL07B Encoder memory busy	
Trigger condition and cause	Encoder memory is busy.
Checking method and corrective action	1. Check if the motor is properly grounded. Make sure the power cable is grounded to the servo drive heat sink. 2. 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 and pull out the shielded mesh and ground it. 4. Check the motor speed and make sure it is within the rated range. 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.

AL07C Command to clear the absolute position is issued when the motor speed is over 200 rpm	
Trigger condition and cause	The command to clear the absolute position is issued when the motor speed is over 200 rpm.
Checking method and corrective action	Check if a command to clear the absolute position is issued while the motor speed is over 200 rpm. If so, follow the procedure for clearing the absolute position to clear this alarm. Do not issue a command to clear the absolute position when the motor speed is over 200 rpm.
How to clear the alarm?	Cycle power on the servo drive.

AL07D Motor stops operating when servo drive power is cycled before AL07C is cleared	
Trigger condition and cause	AL07C occurs and is not cleared before the power is cycled on the servo drive, and the motor stops operating.
Checking method and corrective action	Use DI.ARST to clear the alarm. Once this alarm is cleared, AL07C occurs. Follow the checking and troubleshooting methods to clear that alarm.
How to clear the alarm?	Cycle power on the servo drive.

AL07E Encoder clearing procedure error	
Trigger condition and cause	The number of times for the encoder to clear the procedure error exceeds 11 times.
Checking method and corrective action	If the issue persists, set P0.002 to -80 to check the communication quality with the encoder. If the communication is normal, use DI.ARST to clear this alarm.
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 wrong.
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 cable is short-circuited. 2. Motor wiring is wrong. 3. The analog signal GND for the servo drive is interfered.
Checking method and corrective action	1. Check the connection between the motor power cable and its connector. If metal wire is exposed or the wire is torn, the UVW cable can short circuit. In this case, replace the UVW cable and prevent the metal conductor from being exposed. 2. Refer to Chapter 3 Wiring and check the following: (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 the motor is correctly connected. 3. Check if the analog signal GND is mistakenly connected to another ground signal (incorrect connection can cause interference). Do not use a common ground for the analog signal GND and other signal cables. Follow the wiring instructions in Chapter 3.
How to clear the alarm?	DI.ARST

AL085 Regeneration error	
Trigger condition and cause	Condition: regeneration control error. Cause: regenerative resistor is not operating, but the regenerative voltage remains at 400V for a period of time.
Checking method and corrective action	Check the connections for the regenerative resistor, re-calculate the value for the regenerative resistor, and reset the values of P1.052 and P1.053. If this does not clear the alarm, send your servo drive back to Delta.
How to clear the alarm?	DI.ARST

AL086 Input voltage is too high	
Trigger condition and cause	Condition: when the servo drive detects no regenerative power, but other regenerative energy (such as interference) is input to the servo drive, or the input voltage is higher than the permissible rated voltage. Cause: 1. Other energy (such as interference) is input to the servo drive or the input voltage is higher than the permissible rated voltage. 2. Malfunction of the servo drive hardware.
Checking method and corrective action	1. Use a voltmeter to measure if the input voltage from the power source is within the permissible rated voltage (see the servo drive specifications). If the voltage exceeds the rated value, remove the interference source. If you cannot eliminate the interference, the interference can be consumed with an external resistor by setting P2.065 bit3 to 0 and P2.094 bit4 to 0. 2. If the voltmeter detects that the voltage input from the main circuit is within the permissible rated voltage but the issue persists, then the servo drive may be malfunctioning.
How to clear the alarm?	1. Use the correct voltage source or connect the voltage regulator in series. 2. Send your servo drive back to the distributor or contact Delta.

AL088 Servo function overload warning	
Trigger condition and cause	Condition: too many motor control functions on the servo drive are enabled. Cause: servo function overload warning.
Checking method and corrective action	If using a filter, see if using this 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), or Notch filter (1^{st} to 5^{th} sets).

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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 or reposition 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 when the servo drive starts the auto-tuning procedure. Cause: 1. When the command source is the controller, neither the controller nor the position register issued the command. 2. When the command source is the servo drive, position 1 and 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. Make sure the wiring between the controller and servo drive is correct.
How to clear the alarm?	DI.ARST

AL08B Auto-tuning function - Pause time is too short	
Trigger condition and cause	Condition: the pause time is too short when the controller is the command source 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 pause time is too short. Cause: pause time in the cycle is too short.
Checking method and corrective action	1. For a reciprocating motion between two points, pausing is required on the return, which has to be longer than 1 second. 2. For rotation in a single direction, pause 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. Acceleration / deceleration time is too long. 2. Rotation speed is too slow. 3. Inertia of the machine is too large. 4. Inertia variation is too drastic.
Checking method and corrective action	1. 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. 2. The slowest speed must be no less than 200 rpm; above 500 rpm is suggested. 3. The load inertia must be no more than 50 times the motor inertia. 4. Avoid applications that require drastic variation in the inertia.
How to clear the alarm?	DI.ARST

AL095 Regenerative resistor disconnected	
Trigger condition and cause	The value of P1.053 (regenerative resistor capacity) is not 0 and the external regenerative resistor or the brake is not connected. Only servo drives of 5.5 kW or above show this alarm because there is no built-in regenerative resistor.
Checking method and corrective action	1. If the regenerative brake is required, connect the regenerative resistor. Once you connect the resistor, make sure that the value of P1.053 is correct. 2. If not using the regenerative brake, set P1.053 (regenerative resistor capacity) to 0. If the issue persists, send your servo drive back to the distributor or contact Delta.
How to clear the alarm?	DI.ARST

AL099 DSP firmware update	
Trigger condition and cause	EEPROM is not reset after DSP firmware is updated.
Checking method and corrective action	Check if the firmware is updated. Set P2.008 to 30 first and then set it to 28. Next, cycle power on the servo drive.
How to clear the alarm?	Set P2.008 to 30 and then 28. Cycle power on the servo drive.

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AL111 Buffer overflow occurs when receiving CANopen SDO	
Trigger condition and cause	SDO Rx Buffer overflows (receives more than two SDOs within 1 ms).
Checking method and corrective action	Check if the servo drive (master) receives or sends more than one SDO within 1 ms.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL112 Buffer overflow occurs when receiving CANopen PDO	
Trigger condition and cause	PDO Rx Buffer overflows (receives more than two PDOs of COBID within 1 ms).
Checking method and corrective action	Check if the servo drive (master) receives or sends more than one PDO of COBID within 1 ms.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL121 Object's index does not exist when accessing CANopen PDO	
Trigger condition and cause	When the servo drive receives the PDO from the controller, the specified object's index number is incorrect so that the servo drive cannot identify it.
Checking method and corrective action	1. Check if the object's index number for PDO mapping of the controller is correct. 2. If the index number is correct, it means this specified object is not supported by the servo drive. Check if it is necessary to use this object or if you can substitute it with a different object.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL122 Object's sub-index does not exist when accessing CANopen PDO	
Trigger condition and cause	When the servo drive receives the PDO from the controller, the specified object's sub-index number is incorrect so that the servo drive cannot identify it.
Checking method and corrective action	1. Check if the object's sub-index number for PDO mapping of the controller is correct. 2. If the sub-index number is correct, it means this specified object is not supported by the servo drive. Check if it is necessary to use this object or if you can substitute it with a different object.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL123 Data size error occurs when accessing CANopen PDO	
Trigger condition and cause	Data length in the message does not match the length of the specified object.
Checking method and corrective action	Check if the data length for PDO mapping is changed when the servo drive receives or sends PDO.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL124 Data range error occurs when accessing CANopen PDO	
Trigger condition and cause	The data value in the message is out of range for the specified object.
Checking method and corrective action	Check if the written range is wrong when the servo drive receives or sends PDO.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL125 CANopen PDO object is read-only and write-protected	
Trigger condition and cause	The specified object in the message is read-only and write-protected.
Checking method and corrective action	Check if the object for the PDO mapping is read-only.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL126 Specified object does not support PDO mapping	
Trigger condition and cause	The specified object in the message does not support PDO mapping.
Checking method and corrective action	Check if the specified object allows PDO mapping when PDO is receiving or sending.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL127 CANopen PDO is write-protected when servo drive is on	
Trigger condition and cause	The specified object in the message is write-protected when the servo drive is on.
Checking method and corrective action	Make sure no PDO is written when the servo drive is on.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL128 Error occurs when reading CANopen PDO from EEPROM	
Trigger condition and cause	An error occurs when loading the default value from ROM at start-up. All objects of CAN automatically return to the default value.
Checking method and corrective action	When PDO is receiving or sending, check if the error occurs because the specified object reads from EEPROM.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL129 Error occurs when writing CANopen PDO to EEPROM	
Trigger condition and cause	An error occurs when saving the current parameter value to ROM.
Checking method and corrective action	When PDO is receiving or sending, check if the error occurs because the specified object is written to EEPROM.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL130 Accessing address of EEPROM is out of range when using CANopen PDO	
Trigger condition and cause	The quantity of the data in the ROM is greater than the allowable space specified by the firmware. It is probably because the firmware has been updated, but the data in the ROM was stored by the old version of the firmware.
Checking method and corrective action	Check if the addressing in EEPROM exceeds the range for the specified object during PDO receiving or sending.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL131 CRC of EEPROM calculation error occurs when using CANopen PDO	
Trigger condition and cause	The data in ROM is damaged. All CAN objects are automatically restored to default values.
Checking method and corrective action	Check if the specified object causes a CRC calculation error in EEPROM during PDO receiving or sending. Usually, this alarm is caused by an error in DSP.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL132 Parameter is write-prohibited when using CANopen PDO	
Trigger condition and cause	When using CAN object to write data to the parameter, the parameter is currently write-prohibited.
Checking method and corrective action	Refer to the specified parameter description to write data to the parameter.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL180 CANopen heartbeat or NodeGuarding error	
Trigger condition and cause	CANopen communication is cut off resulting in heartbeat or NodeGuarding error.
Checking method and corrective action	1. Check if the CANopen communication is normal. 2. Check if the wiring is correctly connected.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL185 CAN Bus hardware error	
Trigger condition and cause	Condition: CAN Bus is cut off or Rx/Tx Counter error occurs more than 128 times. Cause: CAN Bus hardware error.
Checking method and corrective action	1. Check if the communication cable for CAN Bus is connected. 2. Check the communication quality. It is suggested that you use common grounding and shielded cable.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL186 CAN Bus off	
Trigger condition and cause	Transmission error in CAN data.
Checking method and corrective action	1. Check if the cable is properly connected and whether there is any noise interference. Replace the communication cable or eliminate the noise if necessary. 2. There are an excessive number of the slave stations and the communication cycle is too short. Lengthen the communication cycle.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL201 Error occurs when loading CANopen data	
Trigger condition and cause	Condition: an error has occurred when loading data from EEPROM. Cause: initialization error of CANopen data.
Checking method and corrective action	1. If the alarm is cleared after cycling power on the servo drive, it means the error occurs at the moment when reading the data. 2. If the issue persists after cycling power on the servo drive, it means the data in the EEPROM is damaged and you need to write the correct values again. See the following methods: (a) To write the default value, set P2.008 to 30 and then 28, or use CANopen object 0x1011 to complete the setting. (b) To write the current value, set CANopen object 0x1010 to complete the setting. For more information, refer to the CANopen Technical Guide for ASDA-A2.
How to clear the alarm?	DI.ARST or CANopen 0x1011 (restore default parameter)

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AL207 Parameter group of PR#8 is out of range	
Trigger condition and cause	Condition: parameter group of PR#8, P_Group, is out of range. Cause: the group of PR#8 command source exceeds the range.
Checking method and corrective action	Write parameter using PR procedure: when the parameter group of command source exceeds the range, check the group setting of the written parameters.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL209 Parameter number of PR#8 is out of range	
Trigger condition and cause	Condition: parameter number of PR#8 is out of range. Cause: the number of PR#8 command source exceeds the range.
Checking method and corrective action	Write parameter using PR procedure: when the parameter number of command source exceeds the range, check the set range of the number for the written parameters.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL213 Parameter setting of PR#8 is in error	
Trigger condition and cause	Condition: when using PR#8 to write parameters, the parameter value is incorrect. Cause: an error occurs when writing parameters with PR#8 command.
Checking method and corrective action	Make sure the parameter value is within the correct range.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL215 Write parameters: read-only	
Trigger condition and cause	Condition: when using the PR procedure to write parameters, the parameter is read-only. Cause: an error occurs when writing parameters with PR#8 command.
Checking method and corrective action	The specified parameter is read-only.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL217 Write parameters: parameter locked	
Trigger condition and cause	Condition: when using the PR procedure to write parameters, the parameter is write-protected when the servo drive is on or the parameter's value exceeds the range. Cause: an error occurs when writing parameters with PR#8 command.
Checking method and corrective action	Write the parameters when the servo drive is off and make sure the parameter's value is within the range.

AL217 Write parameters: parameter locked	
How to clear the alarm?	Modify the PR command and the parameter.

AL219 Write parameters: parameter locked	
Trigger condition and cause	Condition: this parameter is write-protected. Cause: the parameter write-protected function is enabled.
Checking method and corrective action	Check if the parameter and data array protection function (P5.097) is enabled.
How to clear the alarm?	Disable the parameter and data array protection function or reset the parameters.

AL231 Monitoring item of PR#8 is out of range	
Trigger condition and cause	Condition: the code of the monitoring item for PR#8, Sys_Var, is out of range. Cause: the monitoring item is out of range.
Checking method and corrective action	Write parameter using PR procedure: when the code of the monitoring item exceeds the range, check the code range for the monitoring item.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL235 Position counter overflow warning	
Trigger condition and cause	Condition: execute a positioning command after the position command counter overflows. Cause: position command counter overflows.
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 coordinate system cannot display the correct position. Executing a positioning command after overflow results in an error. Use the scope to check if the feedback position has overflowed and then execute the homing procedure. Absolute system: This error occurs when issuing the absolute positioning command in the following situations: 1. Position feedback register (FB_PUU) overflows. 2. Absolute origin coordinates are not established after changing P1.001.Z. 3. Absolute origin coordinates are not established after changing the E-Gear ratio (P1.044 and P1.045). 4. Established the absolute origin coordinates, but the procedure is incomplete.

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AL235 Position counter overflow warning	
Checking method and corrective action	5. When AL060 and AL062 occur, use the scope to check if the feedback position has overflowed. And check whether the above situations have occurred, then establish the absolute origin coordinates.
How to clear the alarm?	Incremental system: perform homing procedure. Absolute system: establish the absolute origin coordinates.

AL237 Indexing coordinate is undefined	
Trigger condition and cause	Condition: the starting point of the indexing coordinate is not defined before operating the indexing function and executing the indexing positioning command. Cause: the servo drive cannot identify this coordinate system.
Checking method and corrective action	Check if the indexing coordinate has been defined: 1. Perform the homing procedure before using the indexing function. 2. After this alarm occurs, use DI.ARST or set P0.001 to 0 to clear the alarm. 3. This alarm is also cleared when you power on the servo.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL249 PR number exceeds the range	
Trigger condition and cause	Condition: the triggered PR path number exceeds the upper limit. Condition: the triggered PR path number exceeds 99.
Checking method and corrective action	1. Check if the PR command jumps to a path exceeding the range. 2. Check if the PR command format is correct.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL283 Software positive limit	
Trigger condition and cause	Condition: the target position specified by the command exceeds the software positive limit. Cause: the software positive limit is triggered.
Checking method and corrective action	The software positive limit is determined by the Position command instead of the actual feedback position because the command is sent before the feedback is received. That is, the actual position may not have exceeded the limit when this limit protection is enabled. Set the appropriate deceleration time to achieve the desired effect. For more information, refer to the descriptions of P5.003.
How to clear the alarm?	The alarm is automatically cleared after moving away from the limit.

AL285 Software negative limit	
Trigger condition and cause	Condition: the target position specified by the command exceeds the software negative limit. Cause: the software negative limit is triggered.
Checking method and corrective action	The software negative limit is determined by the Position command instead of the actual feedback position because the command is sent before the feedback is received. That is, the actual position may not have exceeded the limit when this limit protection is enabled. Set the appropriate deceleration time to achieve the desired effect. For more information, refer to the descriptions of P5.003.
How to clear the alarm?	The alarm is automatically cleared after moving 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 (prevent index coordinate overflow function), set P2.070 bit 2 to 1.
How to clear the alarm?	DI.ARST

AL301 CANopen synchronization failure	
Trigger condition and cause	Condition: the servo drive fails to synchronize with the controller in CANopen IP mode. Cause: CANopen synchronization failure.
Checking method and corrective action	1. Make sure the communication quality is good. 2. After eliminating any problems that you find, allow the controller to re-send the SYNC signal and ensure that it is sent successfully. 3. Modify the setting for P3.009 (setting the default value is suggested).
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL304 Invalid CANopen IP command	
Trigger condition and cause	Condition: command cannot be sent when in CANopen IP mode. Cause: invalid CANopen IP command.
Checking method and corrective action	The computing time in IP mode takes too long. Disable the USB monitoring function.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

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AL305 SYNC period error	
Trigger condition and cause	Condition: CANopen 301 Obj 0x1006 Data Error. Cause: SYNC period is in error.
Checking method and corrective action	Check the value of 0x1006. If it is smaller than or equal to 0, this alarm occurs.
How to clear the alarm?	NMT: reset node or 0x6040 fault reset.

AL35F Emergency stop during deceleration	
Trigger condition and cause	Triggered the rising-edge of DI(0x47), then the motor decelerates to 0 and triggers AL3CF.
Checking method and corrective action	Check if the parameter setting caused DI(0x47) to be triggered by mistake.
How to clear the alarm?	Cycle power on the servo drive.

AL380 Position offset alarm for DO.MC_OK	
Trigger condition and cause	DO.MC_OK is on and then goes off.
Checking method and corrective action	Refer to the description of P1.048. After DO.MC_OK is on, DO.MC_OK goes off because DO.TPOS turns off. There might be an external force causing the position deviation of the motor after positioning is complete. Disable this alarm by setting P1.048.Y to 0.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL3CF Emergency stop	
Trigger condition and cause	After AL35F is triggered and the motor has decelerated to 0.
Checking method and corrective action	Check if the parameter setting caused DI(0x47) to be triggered by mistake.
How to clear the alarm?	Cycle power on the servo drive.

AL3E2 Synchronization signal of CANopen is sent too soon	
Trigger condition and cause	Condition: when using CANopen, the synchronization signal is received too soon. Cause: the synchronization signal of CANopen is sent too soon.
Checking method and corrective action	1. Make sure the setting of synchronization cycle (0x1006) is identical to that of the controller. 2. Modify the synchronization error range setting (P3.009 E). 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 0x6040 fault reset.

AL3E3 CANopen synchronization signal timeout	
Trigger condition and cause	Condition: in CANopen IP mode, the synchronization with the controller failed. Cause: timeout of CANopen synchronization signal.
Checking method and corrective action	1. Make sure the communication quality is good. 2. Make sure the setting of synchronization cycle (0x1006) is identical to that of the controller. 3. Modify the synchronization error range setting (P3.009 E). 4. 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 0x6040 fault reset.

AL3F1 Communication type absolute position command error	
Trigger condition and cause	Condition: the bus communication type (CANopen, DMCNET, EtherCAT) servo is used with an incremental motor, and when the position overflow occurs and the absolute origin coordinates have not been established, the absolute positioning command is issued. Cause: 1. The absolute origin coordinates are not established. 2. Overflow occurs since the motor keeps rotating in the same direction.
Checking method and corrective action	Establish the absolute origin coordinates.
How to clear the alarm?	Establish the absolute origin coordinates.

AL400 Index coordinate error	
Trigger condition and cause	Condition: P1.044 x P2.052 x 4 has to be less than 2^31. Cause: the value of P2.052 is set too low causing index coordinate error.
Checking method and corrective action	Check if the value of P2.052 is within the allowable setting range. If the setting value is too low, an index coordinate error occurs. Adjust the value of P2.052.
How to clear the alarm?	DI.ARST

AL401 NMT reset command is received when servo is on	
Trigger condition and cause	NMT reset command is received when the servo is on
Checking method and corrective action	Check if the NMT reset command is received when the servo is on. Use NMT: reset node or 0x6040 fault reset.
How to clear the alarm?	DI.ARST

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AL404 Value of PR special filter setting is too high	
Trigger condition and cause	Condition: the value of the PR special filter (P1.022) is set too high causing the internal following error exceeding the allowable range. Cause: the following error of the internal position exceeds the allowable range.
Checking method and corrective action	Check the setting of P1.022. If the value is too high, the following error exceeds the allowable range faster. Adjust the value of P1.022.
How to clear the alarm?	DI.ARST

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. Use DI.ARST or set P0.001 to 0 or 0x6040.Fault Reset. 2. If not using STO, plug the short circuit device into CN10 or wiring to short circuit the block. Follow the instructions in Section 3.10.5 for the STO wiring.

AL501 STO_A lost (signal loss or signal error)	
Trigger condition and cause	Loss of STO_A signal or STO_A and STO_B signals are not synchronized for more than 1 second.
Checking method and corrective action	Make sure the wiring of STO_A is correct.
How to clear the alarm?	Cycle power on the servo drive.

AL502 STO_B lost (signal loss or signal error)	
Trigger condition and cause	Loss of STO_B signal or STO_A and STO_B signals are not synchronized for more than 1 second.
Checking method and corrective action	Make sure the wiring of STO_B is correct.
How to clear the alarm?	Cycle power on the servo drive.

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.

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 variables while the operation system is analyzing the program.
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 P2.094 [Bit 8] & [Bit 9].

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

AL809 PR arithmetic operation error or secondary platform error	
Trigger condition and cause	Condition: an error occurs when the servo drive decodes the motion command. Cause: The PR arithmetic operation must be compiled by the ASDA-Soft software before downloading to the servo drive. Directly editing or modifying the PR arithmetic operation parameters through the panel or controller without compiling by ASDA-Soft triggers AL809.
Checking method and corrective action	1. Make sure you edit the PR arithmetic operation parameters through ASDA-Soft. Do not directly modify these parameters on the panel or controller. 2. If this alarm occurs when the servo is not in the PR mode, save the parameter file and contact the distributor. 3. For advanced users: save the scope screenshot when the alarm occurs. Set P5.007 and P0.001 for the two channels and save the scope.
How to clear the alarm?	Cycle power on the servo drive.

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A

A.1 ASDA-A3 series servo drive

A.1.1 Specification of the ASDA-A3 servo drive

ASDA-A3			100 W	200 W	400 W	750 W	1 kW	1.5 kW	2 kW	3 kW
			01	02	04	07	10	15	20	30
Power	Phase / Voltage		Single-phase / Three-phase 220 V_{AC}						Three-phase 220 V_{AC}	
	Permissible voltage		Single-phase / Three-phase 200 - 230 V_{AC}, -15% to 10%						Three-phase 200 - 230 V_{AC}, -15% to 10%	
	Input current (3PH) Unit: Arms		0.67	1.34	2.67	5.01	6.68	10.02	13.36	20.05
	Input current (1PH) Unit: Arms		1.16	2.31	4.63	8.68	11.57	17.36	-	-
	Continuous output current Unit: Arms		0.9	1.55	2.6	5.1	7.3	8.3	13.4	19.4
	Max. instantaneous output current Unit: Arms		3.54	7.07	10.61	21.21	24.75	35.36	53.03	70.71
Cooling method			Air convection cooling			Fan cooling				
Encoder resolution			24-bit (16777216 p/rev)							
Main circuit control			SVPWM control							
Control mode			Manual / Auto							
Regenerative resistor			N/A		Built-in					
Position control mode	Pulse type (except DMCNET mode)		Pulse + Direction, CCW pulse + CW pulse, A phase + B phase							
	Max. input pulse frequency (except DMCNET mode)		Pulse + Direction: 4 Mpps; CCW pulse + CW pulse: 4 Mpps; A phase + B phase: single-phase 4 Mpps; Open collector: 200 Kpps							
	Command source		External pulse (except DMCNET mode) / Register							
	Smoothing method		Low-pass and P-curve filter							
	E-Gear ratio		E-Gear ratio: N/M times, limited to (1 / 4 < N / M < 262144) N: 1 - 536870911 / M: 1 - 2147483647							
	Torque limit		Parameter settings							
	Feed forward compensation		Parameter settings							
Speed control mode	Analog command input (except DMCNET mode)	Voltage range	0 to ±10 V_{DC}							
		Resolution	15-bit							
		Input impedance	1 MΩ							
		Time constant	25 μs							

ASDA-A3			100 W	200 W	400 W	750 W	1 kW	1.5 kW	2 kW	3 kW
			01	02	04	07	10	15	20	30
Speed control mode	Speed control range[*1]		1 : 6000							
	Command source		External analog command (except DMCNET mode) / Register							
	Smoothing method		Low-pass and S-curve filter							
	Torque limit		Parameter settings / Analog input (except DMCNET mode)							
	Bandwidth		Maximum 3.1 kHz (closed-loop)							
	Speed calibration ratio[*2]		±0.01% at 0% to 100% load fluctuation							
			±0.01% at ±10% power fluctuation							
			±0.01% at 0˚C to 50˚C ambient temperature fluctuation							
Torque control mode	Analog command input (except DMCNET mode)	Voltage range	0 to ±10 V_{DC}							
		Input impedance	1 MΩ							
		Time constant	25 μs							
	Command source		External analog command (except DMCNET mode) / Register							
	Smoothing method		Low-pass filter							
	Speed limit		Parameter settings / Analog input (except DMCNET mode)							
Analog monitor output			Monitor signal can be set by parameters (voltage output range: ±8V); resolution:10-bit							
Digital input / output	Input		Servo on, Fault reset, Gain switch, Pulse clear, Zero speed clamping, Command input reverse control, Internal position command trigger, Torque limit, Speed limit, Internal position command selection, Motor stop, Speed command selection, Speed / position mode switching, Speed / torque mode switching, Torque / position mode switching, PT / PR command switching, Emergency stop, Forward / reverse limit, Original point, Forward / reverse operation torque limit, Homing activated, E-Cam engage, Forward / reverse JOG input, Event trigger, E-Gear N selection, Pulse input prohibition *DMCNET mode is not included for the DI mentioned above. When using DMCNET mode, it is suggested that you use communication for DI input. DI only supports emergency stop, forward / reverse limit, and homing.							
	Output		A, B, Z line driver output							
			Servo ready, Servo on, Zero speed detection, Target speed reached, Target position reached, Torque limiting, Servo alarm, Magnetic brake control, Homing completed, Early warning for overload, Servo warning, Position command overflows, Software limit (reverse direction), Software limit (forward direction), Internal position command completed, Capture procedure completed, Servo procedure completed, Master position area of E-Cam.							
Protection function			Overcurrent, Overvoltage, Undervoltage, Overheat, Regeneration error, Overload, Excessive speed deviation, Excessive position deviation, Encoder error, Adjustment error, Emergency stop, Forward / reverse limit error, Excessive deviation of full-closed loop control, Serial communication error, RST leak phase, Serial communication timeout, Short-circuit protection for terminals U, V, W and CN1, CN2, CN3							
Communication interface			RS-485 / CANopen / USB							

A

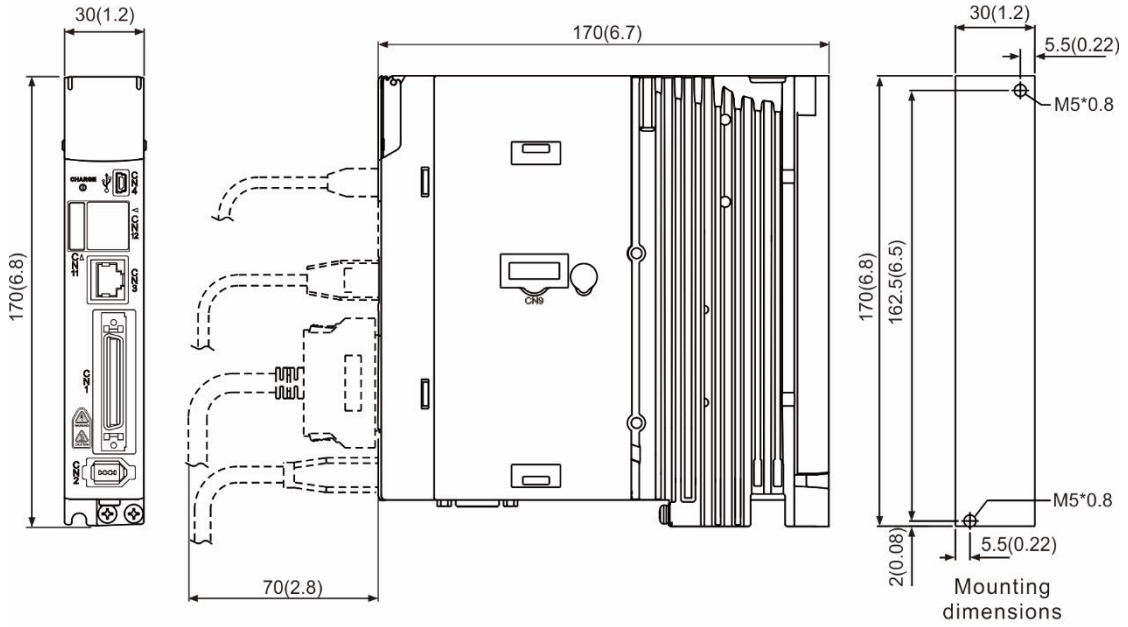
ASDA-A3		100 W	200 W	400 W	750 W	1 kW	1.5 kW	2 kW	3 kW
		01	02	04	07	10	15	20	30
Environment	Installation site	Indoors (avoid direct sunlight), no corrosive vapor (avoid fumes, flammable gases, and dust)							
	Altitude	Altitude 1000 m or lower above sea level							
	Atmospheric pressure	86 kPa - 106 kPa							
	Operating temperature	0˚C to 55˚C (If operating temperature is above 45˚C, forced cooling is required)							
	Storage temperature	-20˚C to 65˚C							
	Humidity	Under 0 - 90% RH (non-condensing)							
	Vibrating	9.80665 m/s^2 (1 G) less than 20 Hz, 5.88 m/s^2 (0.6 G) 20 to 50 Hz							
	IP rating	IP20							
	Power system	TN system*3*4							
	Approvals	IEC/EN 61800-5-1, UL 508C							

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. TN system: the neutral point of the power system connects directly to the ground. The exposed metal components connect to the ground through the protective ground conductor.
4. Use a single-phase three-wire power system for the single-phase power model.

A.1.2 Dimensions of the servo drive

100 W / 200 W

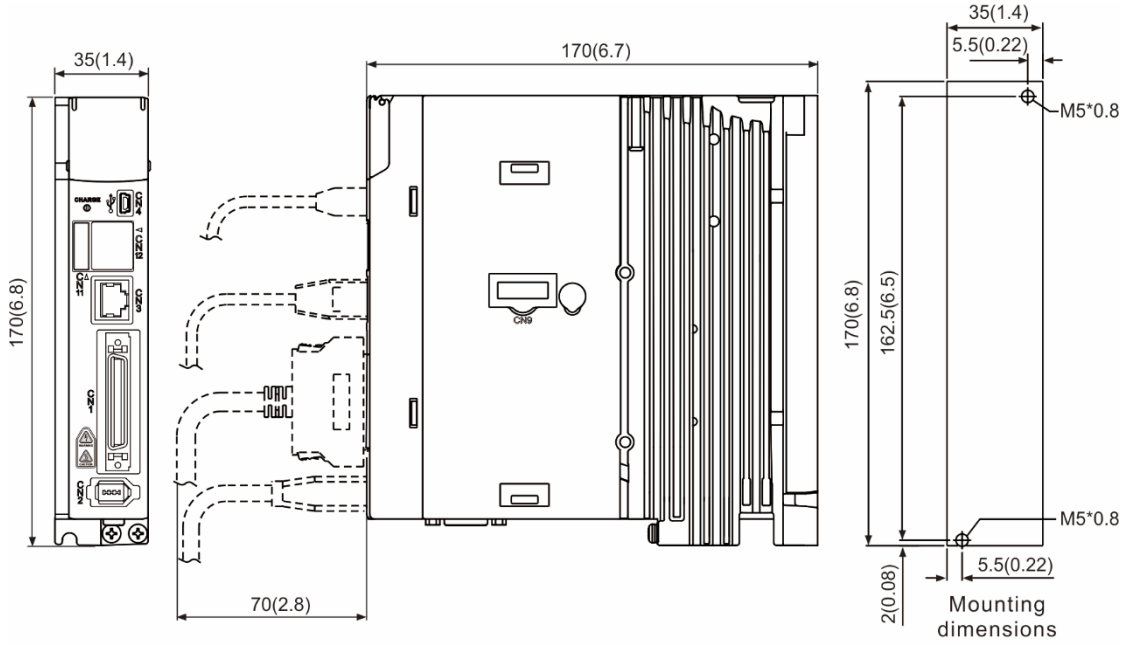


SCREW: M4x0.7
Mounting screw torque: 14 (kgf-cm)

Unit: mm (inch)

Weight	0.84 kgf (1.85 lbf)

400 W



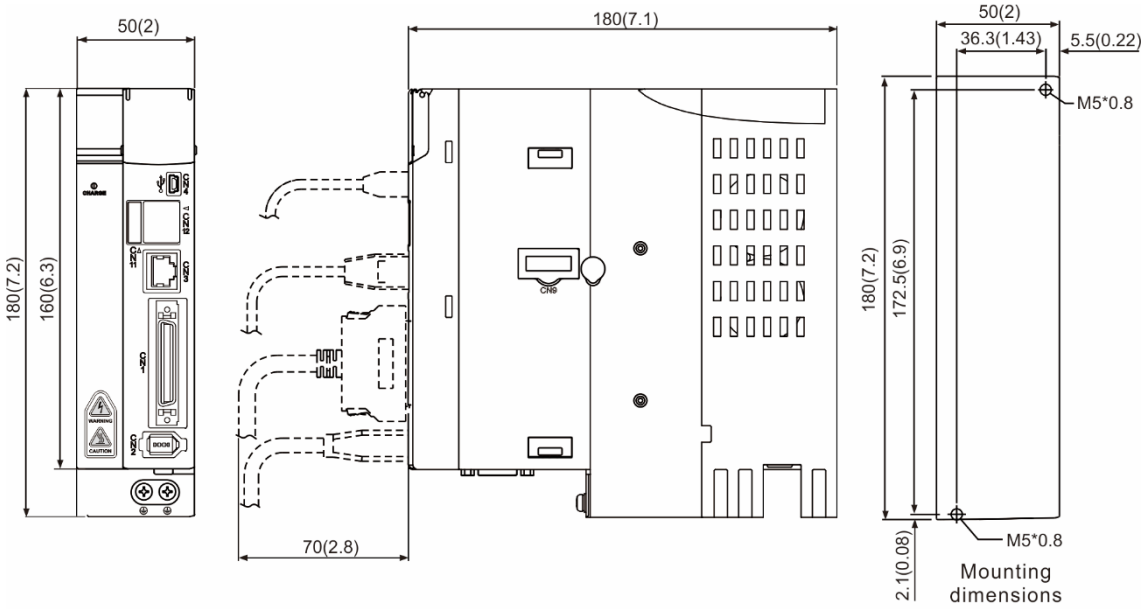
SCREW: M4x0.7
Mounting screw torque: 14 (kgf-cm)

Unit: mm (inch)

Weight	0.92 kgf (2.03 lbf)

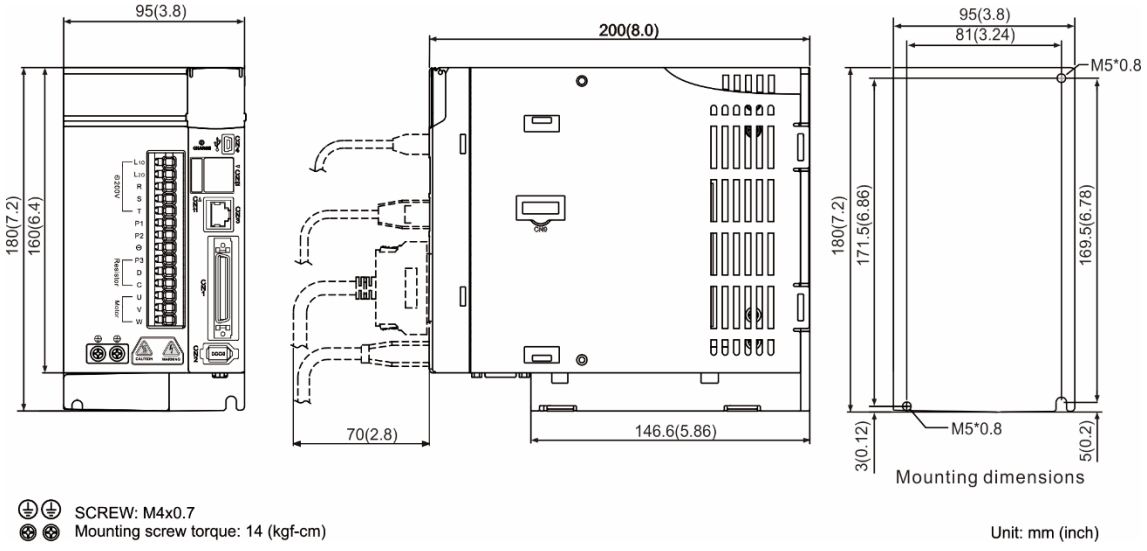
A

750 W / 1 kW / 1.5 kW



Weight	1.3 kgf (2.87 lbf)

2 kW / 3 kW



Weight	2.7 kgf (5.95 lbf)

Note: dimensions and weights of the servo drive may be updated without prior notice.

A.2 ECM-A3 series servo motor

ECM-A3 series servo motor

ECM	-	A	3	H	-	C	Y	06	04	R	S	1
(1)		(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)	(10)	(11)

A

(1) Product name

ECM: Electronic Commutation Motor

(2) Servo type

A: High-Precision Servo Motor

(3) Series

3: A3 series

(4) Inertia

H: high inertia

L: low inertia

(5) Rated voltage and speed

C: 220V and 3,000 rpm

(6) Encoder type

Y: 24-bit absolute optical encoder (resolution of single turn: 24-bit; multiple turns: 16-bit)

1: 24-bit single-turn absolute optical encoder

G: 16-bit single-turn absolute magnetic encoder

2*: 24-bit single-turn absolute magnetic optical encoder

A*: 24-bit absolute magnetic optical encoder (resolution of single turn: 24-bit; multiple turns: 16-bit)

Note: models with an * means that this type of encoder is coming soon.

(7) Motor frame size

04: 40 mm

06: 60 mm

08: 80 mm

(8) Rated power output

Code	Specification	Code	Specification
0F	50 W	04	400 W
01	100 W	07	750 W
02	200 W	-	-

A

(9) Shaft type and oil seal

	w/o brake w/o oil seal	with brake w/o oil seal	w/o brake with oil seal	with brake with oil seal
Round shaft (with fixed screw holes)	-	-	C	D
Keyway (with fixed screw holes)	P	Q	R	S

(10) Shaft diameter

S: standard

7: specific (14 mm)

(11) Special code

1: standard products

A.2.1 ECM-A3L low inertia series servo motor

ECM-A3L	040F	0401	0602	0604	0804	0807
Rated power (kW)	0.05	0.1	0.2	0.4	0.4	0.75
Rated torque (N-m)*1	0.159	0.32	0.64	1.27	1.27	2.39
Max. torque (N-m)	0.557	1.12	2.24	4.45	4.44	8.36
Rated speed (rpm)	3000					
Max. speed (rpm)	6000					
Rated current (Arms)	0.66	0.9	1.45	2.65	2.6	5.1
Max. instantaneous current (Arms)	2.82	3.88	6.2	10.1	10.6	20.6
Change of rated power (kW/s)	11	25.6	45.5	107.5	45.8	102.2
Rotor inertia ($\times 10^{-4}$ kg.m^2)	0.0229	0.04	0.09	0.15	0.352	0.559
Mechanical time constant (ms)	1.28	0.838	0.64	0.41	0.68	0.44
Torque constant-KT (N-m/A)	0.241	0.356	0.441	0.479	0.488	0.469
Voltage constant-KE (mV/rpm)	9.28	13.3	16.4	18	17.9	17
Armature resistance (Ohm)	12.1	9.47	4.9	2.27	1.6	0.6
Armature inductance (mH)	18.6	16.2	18.52	10.27	10.6	4.6
Electrical time constant (ms)	1.54	1.71	3.78	4.52	6.63	7.67
Insulation class	Class A (UL), Class B (CE)					
Insulation resistance	> 100 MΩ, DC 500V					
Insulation strength	1.8k Vac, 1 sec					
Weight (w/o brake) (kg)	0.38	0.5	1.1	1.4	2.05	2.8
Weight (with brake) (kg)	0.68	0.8	1.6	1.9	2.85	3.6
Max. radial loading (N)	78	78	245	245	392	392
Max. axial loading (N)	54	54	74	74	147	147
Change of rated power (kW/s) (with brake)	9.9	24	34.1	89.6	39.5	93
Rotor inertia ($\times 10^{-4}$ kg.m^2) (with brake)	0.0255	0.0426	0.12	0.18	0.408	0.614
Mechanical time constant (ms) (with brake)	1.44	0.892	0.85	0.5	0.78	0.48
Brake holding torque [Nt-m (min)] *2	0.32	0.32	1.3	1.3	2.5	2.5
Brake power consumption (at 20˚C)[W]	6.1	6.1	7.2	7.2	8	8
Brake release time [ms (Max)]	20	20	20	20	20	20
Brake pull-in time [ms (Max)]	35	35	50	50	60	60
Vibration grade (μm)	V15					
Operating temperature (˚C)	0˚C - 40˚C					

A

ECM-A3L	040F	0401	0602	0604	0804	0807
Storage temperature (˚C)	-10˚C to 80˚C					
Operating humidity	20 - 90% RH (non-condensing)					
Storage humidity	20 - 90% RH (non-condensing)					
Vibration capacity	2.5 G					
IP rating	IP67 (when using waterproof connectors and when an oil seal is fitted to the rotating shaft (for an oil seal model))					
Approvals	CE					

Note:

1. The rated torque is the continuous permissible torque between 0˚C - 40˚C operating temperature which is suitable for the servo motor mounted with the following heat sink dimensions.
   ECM-A3L_ _ 04 / 06 / 08: 250 mm x 250 mm x 6 mm
   Material: aluminum - F40, F60, F80
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.

A.2.2 ECM-A3H high inertia series servo motor

ECM-A3H	040F	0401	0602	0604	0804	0807
Rated power (kW)	0.05	0.1	0.2	0.4	0.4	0.75
Rated torque (N-m)*1	0.159	0.32	0.64	1.27	1.27	2.39
Max. torque (N-m)	0.557	1.12	2.24	4.45	4.44	8.36
Rated speed (rpm)	3000					
Max. speed (rpm)	6000					
Rated current (Arms)	0.64	0.9	1.45	2.65	2.6	4.61
Max. instantaneous current (Arms)	2.59	3.64	5.3	9.8	9.32	16.53
Change of rated power (kW/s)	5.56	13.6	16.4	35.8	17.5	37.8
Rotor inertia ($\times 10^{-4}$ kg.m^2)	0.0455	0.0754	0.25	0.45	0.92	1.51
Mechanical time constant (ms)	2.52	1.43	1.38	0.96	1.32	0.93
Torque constant-KT (N-m/A)	0.248	0.356	0.441	0.479	0.49	0.52
Voltage constant-KE (mV/rpm)	9.54	12.9	16.4	17.2	17.9	18.7
Armature resistance (Ohm)	12.5	8.34	3.8	1.68	1.19	0.57
Armature inductance (mH)	13.34	11	8.15	4.03	4.2	2.2
Electrical time constant (ms)	1.07	1.32	2.14	2.40	3.53	3.86
Insulation class	Class A (UL), Class B (CE)					
Insulation resistance	> 100 MΩ, DC 500V					
Insulation strength	1.8k Vac, 1 sec					
Weight (w/o brake) (kg)	0.38	0.5	1.1	1.4	2.05	2.8
Weight (with brake) (kg)	0.68	0.8	1.6	1.9	2.85	3.6
Max. radial loading (N)	78	78	245	245	392	392
Max. axial loading (N)	54	54	74	74	147	147
Change of rated power (kW/s) (with brake)	4.89	12.5	14.6	33.6	15.07	34.41
Rotor inertia ($\times 10^{-4}$ kg.m^2) (with brake)	0.0517	0.0816	0.28	0.48	1.07	1.66
Mechanical time constant (ms) (with brake)	2.86	1.55	1.54	1.02	1.54	1.02
Brake holding torque [Nt-m (min)] *2	0.32	0.32	1.3	1.3	2.5	2.5
Brake power consumption (at 20˚C)[W]	6.1	6.1	7.2	7.2	8	8
Brake release time [ms (Max)]	20	20	20	20	20	20

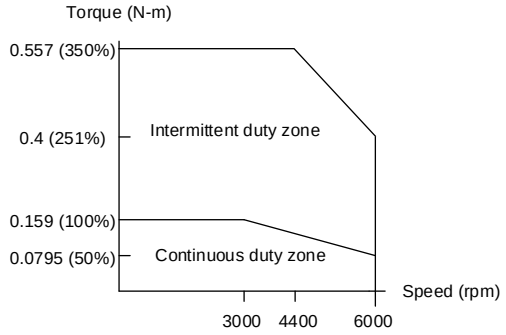
A

ECM-A3H	040F	0401	0602	0604	0804	0807
Brake pull-in time [ms (Max)]	35	35	50	50	60	60
Vibration grade (μm)	V15					
Operating temperature (˚C)	0˚C - 40˚C					
Storage temperature (˚C)	-10˚C to 80˚C					
Operating humidity	20 - 90% RH (non-condensing)					
Storage humidity	20 - 90% RH (non-condensing)					
Vibration capacity	2.5 G					
IP rating	IP67 (when using waterproof connectors and when an oil seal is fitted to the rotating shaft (for an oil seal model))					
Approvals	CE					

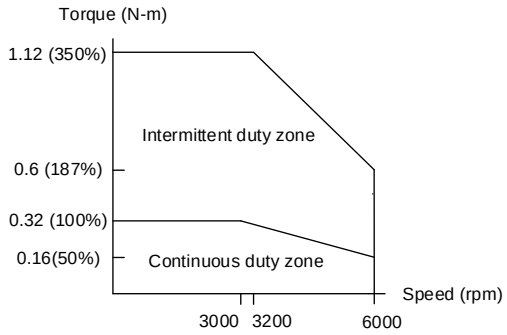
Note:

1. The rated torque is the continuous permissible torque between 0˚C - 40˚C operating temperature which is suitable for the servo motor mounted with the following heat sink dimensions.
   ECM-A3L_ _ 04 / 06 / 08: 250 mm x 250 mm x 6 mm
   Material: aluminum - F40, F60, F80
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.

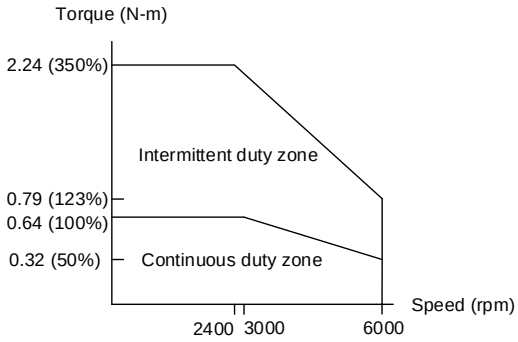
A.2.3 Torque features (T-N curves)



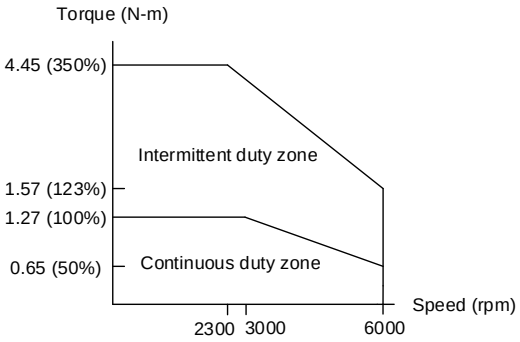
ECM-A3L-C△040F□S1



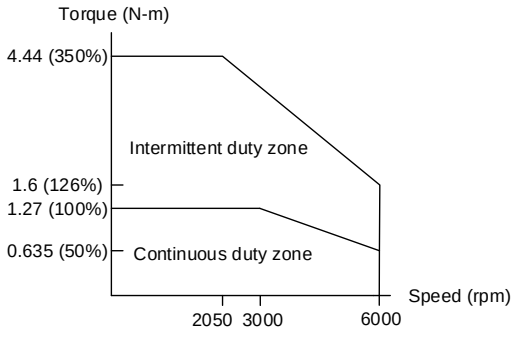
ECM-A3L-C△0401□S1



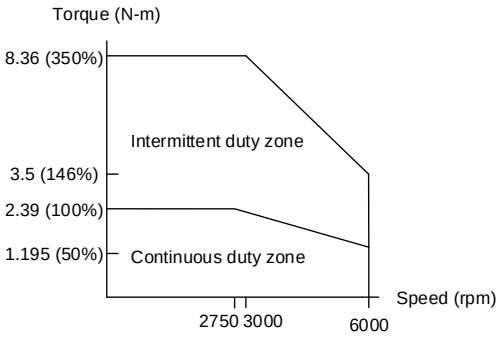
ECM-A3L-C△0602□S1



ECM-A3L-C△0604□S1



ECM-A3L-C△0804□71



ECM-A3L-C△0807□S1

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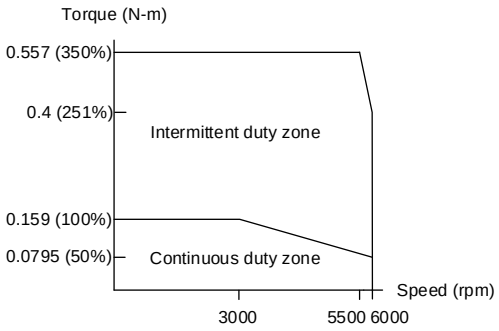
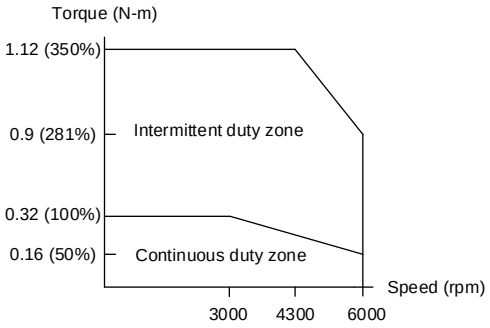
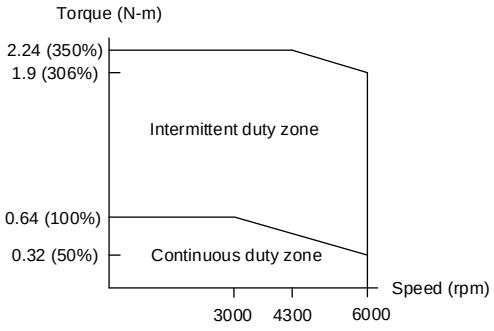


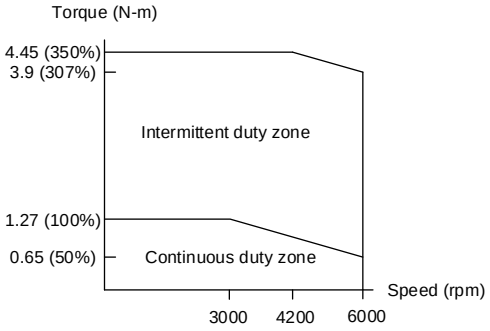
ECM-A3H-C△040F□S1



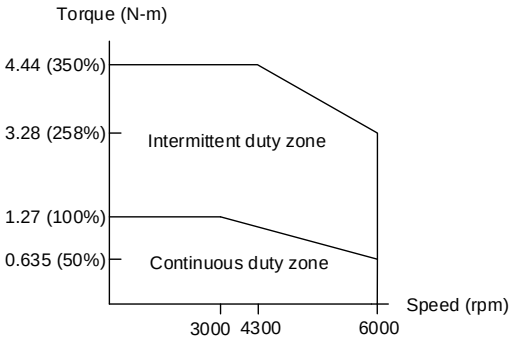
ECM-A3H-C△0401□S1



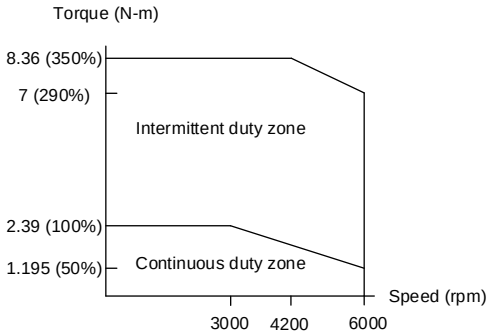
ECM-A3H-C△0602□S1



ECM-A3H-C△0604□S1



ECM-A3H-C△0804□71



ECM-A3H-C△0807□S1

Note: △ in the motor model name represents the encoder type; □ represents the shaft type and oil seal.

A.2.4 Overload features

Definition of overload protection

The overload protection prevents the motor from overheating.

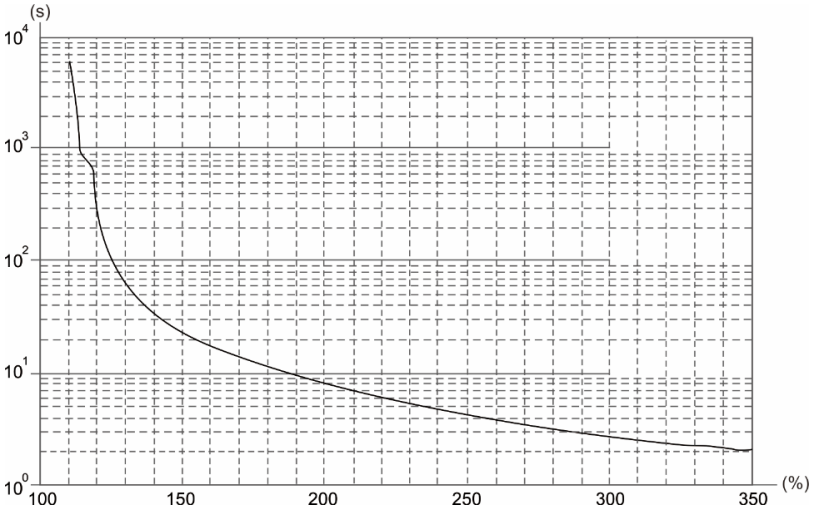
A

Causes of overloading

1. The motor's rated torque exceeds the rated range and the operation time is too long.
2. The inertia ratio is too high and the motor frequently accelerates and decelerates.
3. An incorrect connection between the power cable and the encoder wiring.
4. Incorrect servo gain setting causes resonance in the motor.
5. You operate a motor with a built-in brake without releasing the brake.

Graph of load and operating time

Low inertia (ECM-A3L series), high inertia (ECM-A3H series)

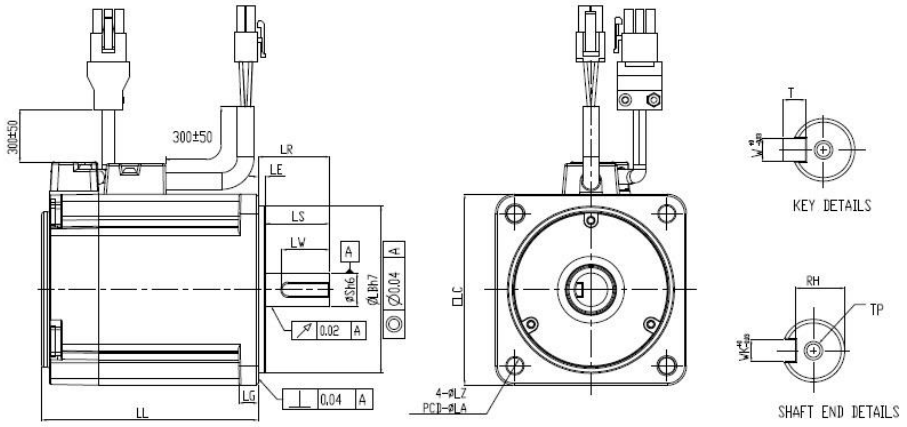


Load	Operating time
120%	263.8 s
140%	35.2 s
160%	17.6 s
180%	11.2 s
200%	8 s
220%	6.1 s
240%	4.8 s
260%	3.9 s
280%	3.3 s
300%	2.8 s
350%	2.1 s

A.2.5 Dimensions of ECM-A3L/A3H series servo motor

Motor frame size: 80 mm and below

A



Model	C□040F□S□	C□0401□S□	C□0602□S□	C□0604□S□	C□0804□7□	C□0807□S□
LC	40	40	60	60	80	80
LZ	4.5	4.5	5.5	5.5	6.6	6.6
LA	46	46	70	70	90	90
S	$8(^{+0}_{-0.009})$	$8(^{+0}_{-0.009})$	$14(^{+0}_{-0.011})$	$14(^{+0}_{-0.011})$	$14(^{+0}_{-0.011})$	$19(^{+0}_{-0.013})$
LB	$30(^{+0}_{-0.021})$	$30(^{+0}_{-0.021})$	$50(^{+0}_{-0.025})$	$50(^{+0}_{-0.025})$	$70(^{+0}_{-0.030})$	$70(^{+0}_{-0.030})$
LL (w/o brake)	70.6	85.3	84	106	93.7	115.8
LL (with brake)	105.4	120.1	117.6	139.7	131.2	153.2
LS	21.5	21.5	27	27	27	37
LR	25	25	30	30	30	40
LE	2.5	2.5	3	3	3	3
LG	5	5	7.5	7.5	8	8
LW	16	16	20	20	20	25
RH	6.2	6.2	11	11	11	15.5
WK	3	3	5	5	5	6
W	3	3	5	5	5	6
T	3	3	5	5	5	6
TP	M3 Depth 6	M3 Depth 6	M4 Depth 8	M4 Depth 8	M4 Depth 8	M6 Depth 10

Note: □1 in the motor model name represents the encoder type; □2 represents the shaft type and oil seal; □3 represents a special code.

A.3 ECMC series servo motor

ECMC series servo motor

ECM C - C W 10 10 R S
(1) (2) (3) (4) (5) (6) (7) (8)

(1) Product name

ECM: Electronic Commutation Motor

(2) Motor type

C: High-Precision AC Servo Motor (recommended for CNC applications)

(3) Rated voltage and speed

C: 220V and 3,000 rpm

E: 220V and 2,000 rpm

F: 220V and 1,500 rpm

(4) Encoder type

W: 22-bit absolute encoder (resolution of single turn: 22-bit; multiple turns: 16-bit)

(5) Motor frame size

10: 100 mm

13: 130 mm

18: 180 mm

(6) Rated power output

Code	Specification	Code	Specification
08	850 W	18	1.8 kW
10	1.0 kW	20	2.0 kW
13	1.3 kW	30	3.0 kW
15	1.5 kW	-	-

(7) Shaft type and oil seal

	w/o brake w/o oil seal	with brake w/o oil seal	w/o brake with oil seal	with brake with oil seal
Round shaft (with fixed screw holes)	-	-	C	D
Keyway (with fixed screw holes)	-	-	R	S

(8) Shaft diameter

S: standard

A

A.3.1 ECMC series servo motor with frame size 100 - 180

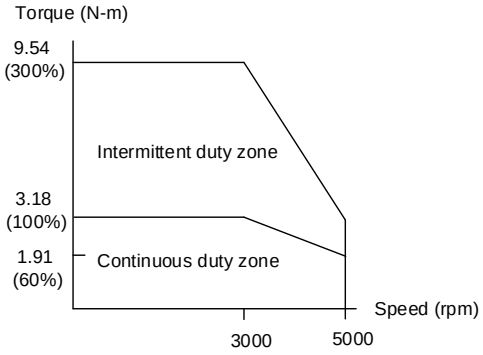
ECMC	C□10	E□13			F□13			E□18		F□18
	10	10	15	20	08	13	18	20	30	30
	Medium inertia				High inertia			Medium inertia		
Rated power (kW)	1.0	1.0	1.5	2.0	0.85	1.3	1.8	2.0	3.0	3.0
Rated torque (N-m)*1	3.18	4.77	7.16	9.55	5.41	8.34	11.48	9.55	14.32	19.10
Max. torque (N-m)	9.54	14.3	21.5	28.7	13.8	23.3	28.7	28.7	43	57.3
Rated speed (rpm)	3000	2000			1500			2000		1500
Max. speed (rpm)	5000	3000			3000			3000		3000
Rated current (Arms)	7.3	5.6	8.3	11.01	7.1	12.6	13	11.22	16.1	19.4
Max. instantaneous current (Arms)	21.9	16.8	24.9	33	19.4	38.6	36	33.7	48.3	58.2
Change of rated power (kW/s)	38.1	27.1	45.9	62.5	21.52	34.78	53	26.3	37.3	66.4
Rotor inertia ($\times 10^{-4}$ kg.m^2)	2.65	8.41	11.2	14.6	13.6	20	24.9	34.7	55	55
Mechanical time constant (ms)	0.74	1.51	1.10	0.96	2.43	1.62	1.7	1.62	1.06	1.28
Torque constant-KT (N-m/A)	0.44	0.85	0.87	0.87	0.76	0.66	0.88	0.85	0.89	0.98
Voltage constant-KE (mV/(rpm)	16.8	31.9	31.8	31.8	29.2	24.2	32.2	31.4	32.0	35
Armature resistance (Ohm)	0.20	0.47	0.26	0.174	0.38	0.124	0.185	0.119	0.052	0.077
Armature inductance (mH)	1.81	5.99	4.01	2.76	4.77	1.7	2.6	2.84	1.38	1.27
Electrical time constant (ms)	9.3	12.9	15.3	15.9	12.6	13.7	14.1	23.9	26.4	16.5
Insulation class	Class A (UL), Class B (CE)									
Insulation resistance	> 100 MΩ, DC 500V									
Insulation strength	1.8k Vac, 1 sec									
Weight (w/o brake) (kg)	4.3	7.0	7.5	7.8	8.6	9.4	10.5	13.5	18.5	18.5
Weight (with brake) (kg)	4.7	8.4	8.9	9.2	10	10.8	11.9	17.5	22.5	22.5
Max. radial loading (N)	490							1176	1470	
Max. axial loading (N)	98							490		
Change of rated power (kW/s) (with brake)	30.4	24.9	43.1	57.4	19.8	32.7	50.3	24.1	35.9	63.9
Rotor inertia ($\times 10^{-4}$ kg.m^2) (with brake)	3.33	9.14	11.9	15.9	14.8	21.3	26.2	37.76	57.1	57.1
Mechanical time constant (ms) (with brake)	0.93	1.64	1.19	1.05	2.65	1.73	1.79	1.77	1.10	1.33

ECMC	C□10	E□13			F□13			E□18		F□18
	10	10	15	20	08	13	18	20	30	30
	Medium inertia				High inertia			Medium inertia		
Brake holding torque [Nt-m (min)] *2	8	10						25		
Brake power consumption (at 20˚C)[W]	18.7	19						20.4		
Brake release time [ms (Max)]	10									
Brake pull-in time [ms (Max)]	70									
Vibration grade (μm)	V15									
Operating temperature (˚C)	0˚C - 40˚C (32˚F - 104˚F)									
Storage temperature (˚C)	-10˚C to 80˚C (-14˚F to 176˚F)									
Operating humidity	20 - 90% RH (non-condensing)									
Storage humidity	20 - 90% RH (non-condensing)									
Vibration capacity	2.5 G									
IP rating	IP65 (when waterproof connectors are used, or when an oil seal is used to be fitted to the rotating shaft (an oil seal model is used))									
Approvals										

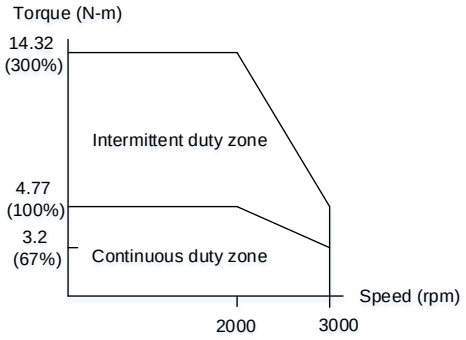
Note:

1. □1 in the servo motor model names represents the encoder type.
2. The rated torque is the continuous permissible torque between 0˚C - 40˚C operating temperature which is suitable for the servo motor mounted with the following heat sink dimensions.
   ECMA-_ _ 10: 300 mm x 300 mm x 12 mm
   ECMA-_ _ 13: 400 mm x 400 mm x 20 mm
   ECMA-_ _ 18: 550 mm x 550 mm x 30 mm
   Material: aluminum - F100, F130, F180
3. 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.

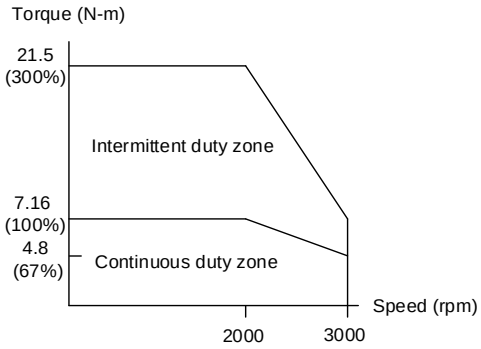
A.3.2 Torque features (T-N curves)



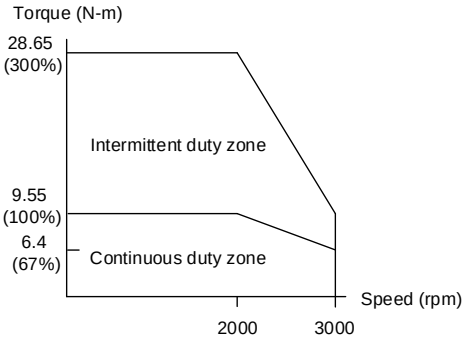
ECMC-C△1010□S



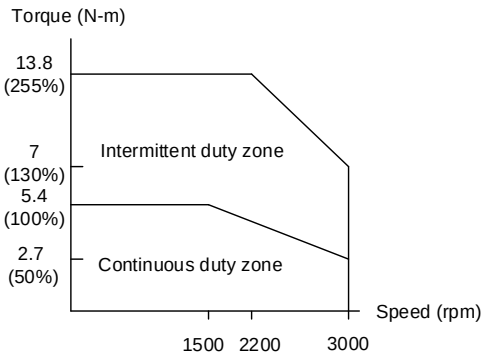
ECMC-E△1310□S



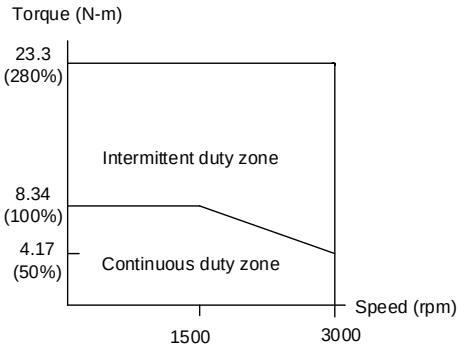
ECMC-E△1315□S



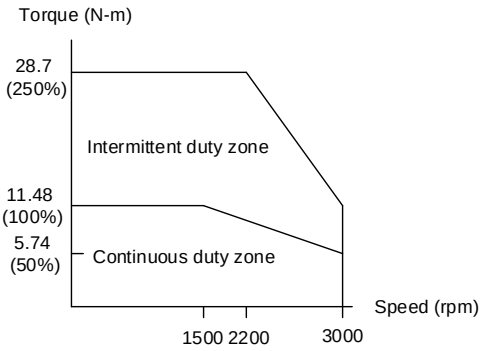
ECMC-E△1320□S



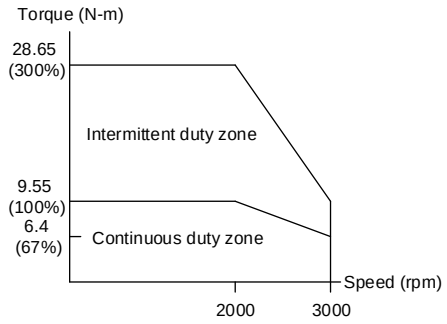
ECMC-F△□1308S



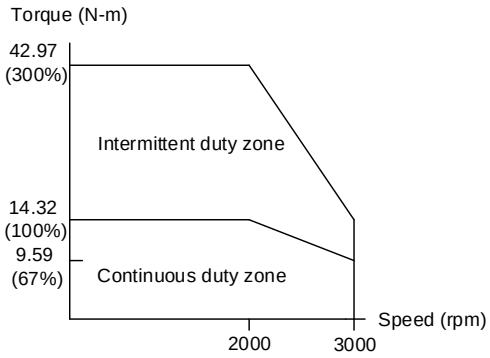
ECMC-F△1313□S



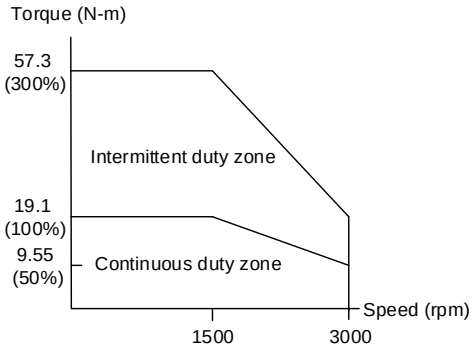
ECMC-F△1318□S



ECMC-E△1820□S



ECMC-E△1830□S



ECMC-F△1830□S

Note: △ in the motor model name represents the encoder type; □ represents the shaft type and oil seal.

A.3.3 Overload features

Definition of overload protection

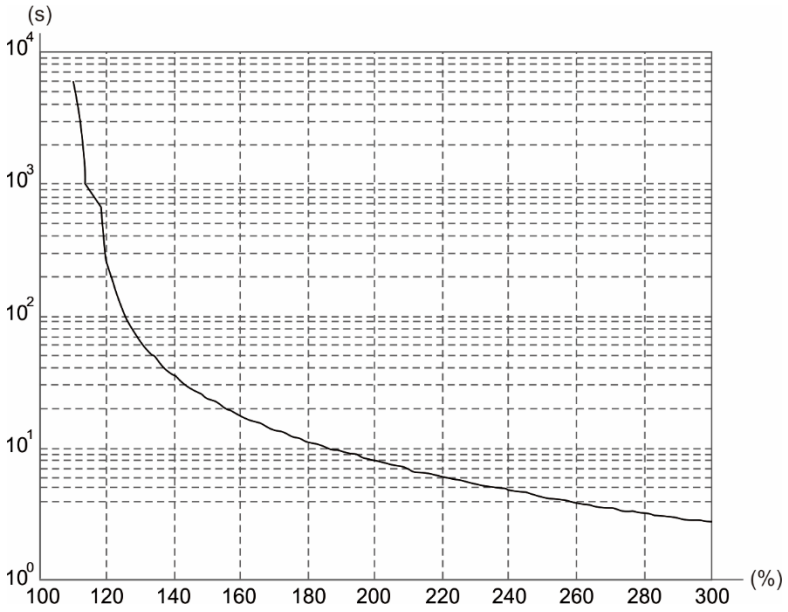
The overload protection prevents the motor from overheating.

Causes of overloading

1. The motor's rated torque exceeds the rated range and the operation time is too long.
2. The inertia ratio is too high and the motor frequently accelerates and decelerates.
3. An incorrect connection between the power cable and the encoder wiring.
4. Incorrect servo gain setting causes resonance in the motor.
5. You operate a motor with a built-in brake without releasing the brake.

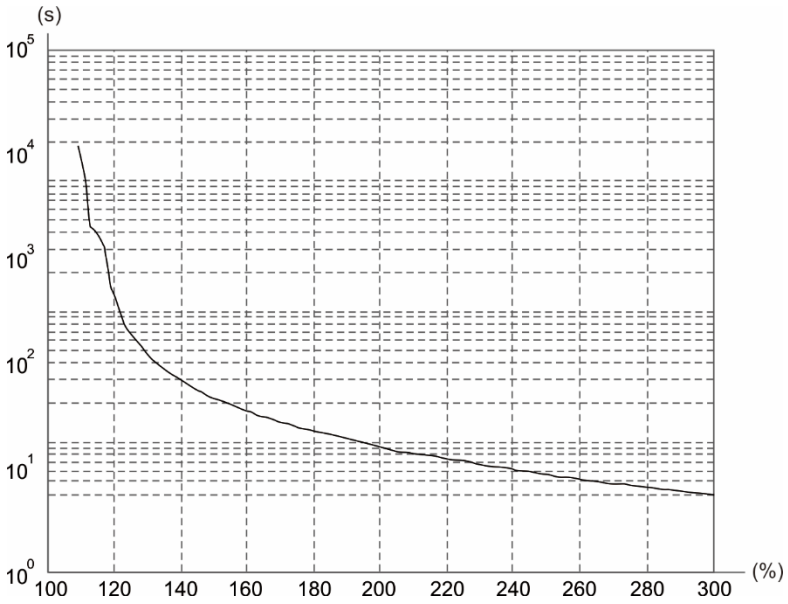
Graph of load and operating time

Low inertia (ECMC- C series)



Load	Operating time
120%	263.8 s
140%	35.2 s
160%	17.6 s
180%	11.2 s
200%	8 s
220%	6.1 s
240%	4.8 s
260%	3.9 s
280%	3.3 s
300%	2.8 s

Medium and medium-high inertia (ECMC-E, F series)



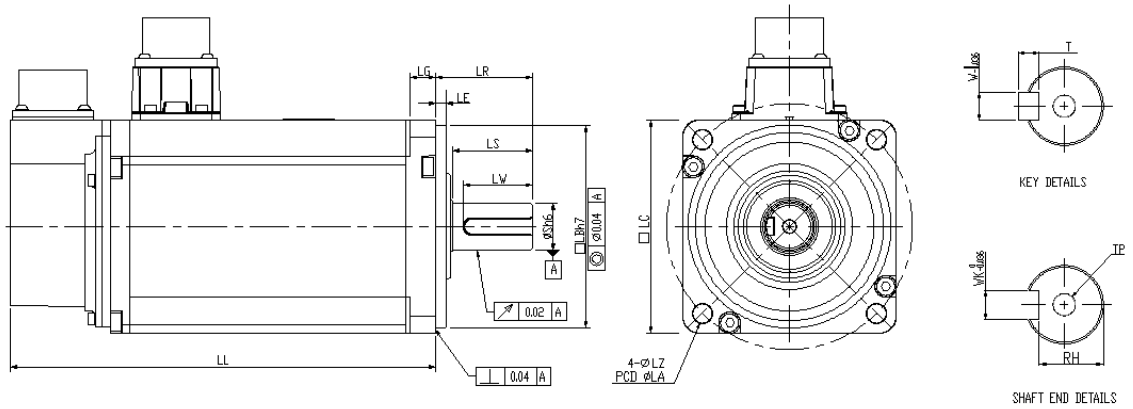
Load	Operating time
120%	527.6 s
140%	70.4 s
160%	35.2 s
180%	22.4 s
200%	16 s
220%	12.2 s
240%	9.6 s
260%	7.8 s
280%	6.6 s
300%	5.6 s

A

A

A.3.4 Dimensions of ECMC series servo motor

Motor frame size: 100 mm / 130 mm / 180 mm



Model	C□1010□2S	E□1310□2S	E□1315□2S	E□1320□2S	F□1308□2S	F□1313□2S	F□1318□2S
LC	100	130	130	130	130	130	130
LZ	9	9	9	9	9	9	9
LA	115	145	145	145	145	145	145
S	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$	$22(^{+0}_{-0.013})$
LB	$95(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$	$110(^{+0}_{-0.035})$
LL (w/o brake)	153.3	147.5	167.5	187.5	152.5	187.5	202
LL (with brake)	192.5	183.5	202	216	181	216	230.7
LS	37	47	47	47	47	47	47
LR	45	55	55	55	55	55	55
LE	5	6	6	6	6	6	6
LG	12	11.5	11.5	11.5	11.5	11.5	11.5
LW	32	36	36	36	36	36	36
RH	18	18	18	18	18	18	18
WK	8	8	8	8	8	8	8
W	8	8	8	8	8	8	8
T	7	7	7	7	7	7	7
TP	M6 Depth 20	M6 Depth 20	M6 Depth 20	M6 Depth 20	M6 Depth 20	M6 Depth 20	M6 Depth 20

Note: □1 in the motor model name represents the encoder type; □2 represents the shaft type and oil seal.

Model	E[1]1820[2][3]	E[1]1830[2][3]	F[1]1830[2][3]
LC	180	180	180
LZ	13.5	13.5	13.5
LA	200	200	200
S	$35(^{+0}_{-0.016})$	$35(^{+0}_{-0.016})$	$35(^{+0}_{-0.016})$
LB	$114.3(^{+0}_{-0.035})$	$114.3(^{+0}_{-0.035})$	$114.3(^{+0}_{-0.035})$
LL (w/o brake)	169	202.1	202.1
LL (with brake)	203.1	235.3	235.3
LS	73	73	73
LR	79	79	79
LE	4	4	4
LG	20	20	20
LW	63	63	63
RH	30	30	30
WK	10	10	10
W	10	10	10
T	8	8	8
TP	M12 Depth 25	M12 Depth 25	M12 Depth 25

Note: [1] in the motor model name represents the encoder type; [2] represents the shaft type and oil seal; [3] represents a special code.

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Accessories

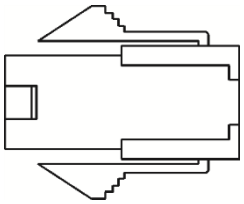
B

B.1 Power connector ····· B-2
B.2 Power cable ····· B-3
B.3 Encoder connector ····· B-6
B.4 Encoder cable (incremental type) ····· B-7
B.5 Encoder cable (absolute type) ····· B-8
B.6 Battery box cable AW ····· B-9
B.7 Battery box (absolute type) ····· B-9
B.8 I/O connector ····· B-10
B.9 Terminal block module ····· B-11
B.10 CANopen communication cable ····· B-11
B.11 CANopen distribution box ····· B-12
B.12 Ferrite ring ····· B-12
B.13 A3 / A2 conversion cable ····· B-13
B.14 A3 CN3 RS-485 ····· B-14
B.15 A3 CN3 RS-485 / CANOpen terminal resistor ····· B-14
B.16 A3 CN6 DMCNET terminal resistor ····· B-15
B.17 CN4 Mini USB module ····· B-16
B.18 Optional accessories ····· B-17

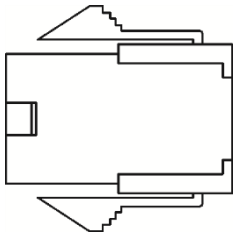
B

B.1 Power connector

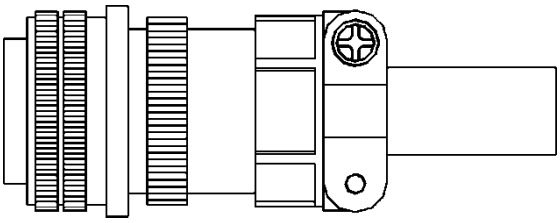
Delta part number: ASDBCAPW0000 (for 220V servo drives)



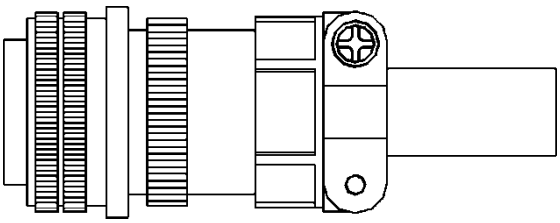
Delta part number: ASDBCAPW0100 (for 220V servo drives with brake contact)



Delta part number: ASD-CAPW1000

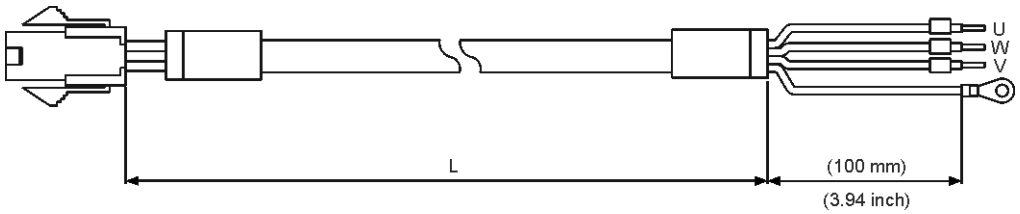


Delta part number: ASD-CAPW2000



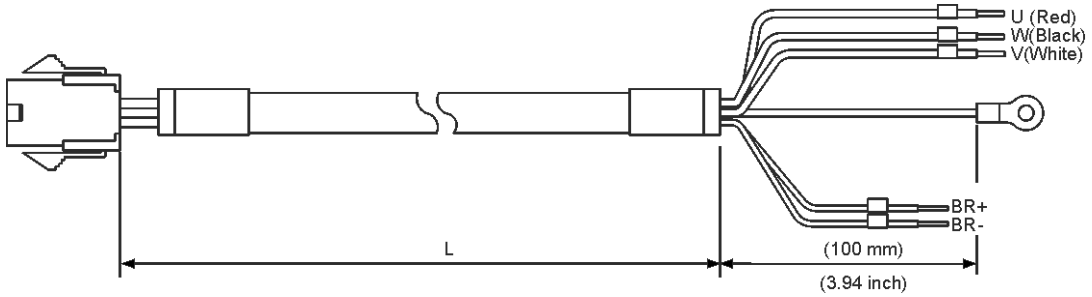
B.2 Power cable

Delta part number: ACS3-CAPW1103, ACS3-CAPW1105, ACS3-CAPW1110, ACS3-CAPW1120, ACS3-CAPF1103, ACS3-CAPF1105, ACS3-CAPF1110, ACS3-CAPF1120 (for 220V servo drives)



Cable type	Part No.	L	
		mm	inch
General	ACS3-CAPW1103	3000 ± 50	118 ± 2
	ACS3-CAPW1105	5000 ± 50	197 ± 2
	ACS3-CAPW1110	10000 ± 100	394 ± 4
	ACS3-CAPW1120	20000 ± 100	788 ± 4
Torsion-resistant	ACS3-CAPF1103	3000 ± 50	118 ± 2
	ACS3-CAPF1105	5000 ± 50	197 ± 2
	ACS3-CAPF1110	10000 ± 100	394 ± 4
	ACS3-CAPF1120	20000 ± 100	788 ± 4

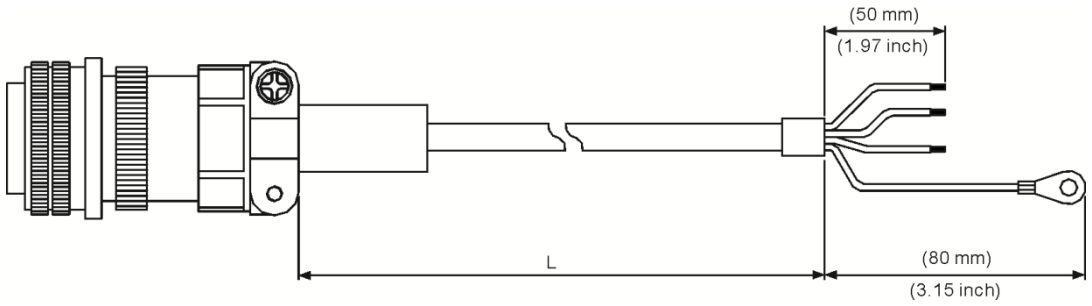
Delta part number: ACS3-CAPW2103, ACS3-CAPW2105, ACS3-CAPW2110, ACS3-CAPW2120, ACS3-CAPF2103, ACS3-CAPF2105, ACS3-CAPF2110, ACS3-CAPF2120 (for 220V servo drives with brake cable)



Cable type	Part No.	L	
		mm	inch
General	ACS3-CAPW2103	3000 ± 50	118 ± 2
	ACS3-CAPW2105	5000 ± 50	197 ± 2
	ACS3-CAPW2110	10000 ± 100	394 ± 4
	ACS3-CAPW2120	20000 ± 100	788 ± 4
Torsion-resistant	ACS3-CAPF2103	3000 ± 50	118 ± 2
	ACS3-CAPF2105	5000 ± 50	197 ± 2
	ACS3-CAPF2110	10000 ± 100	394 ± 4
	ACS3-CAPF2120	20000 ± 100	788 ± 4

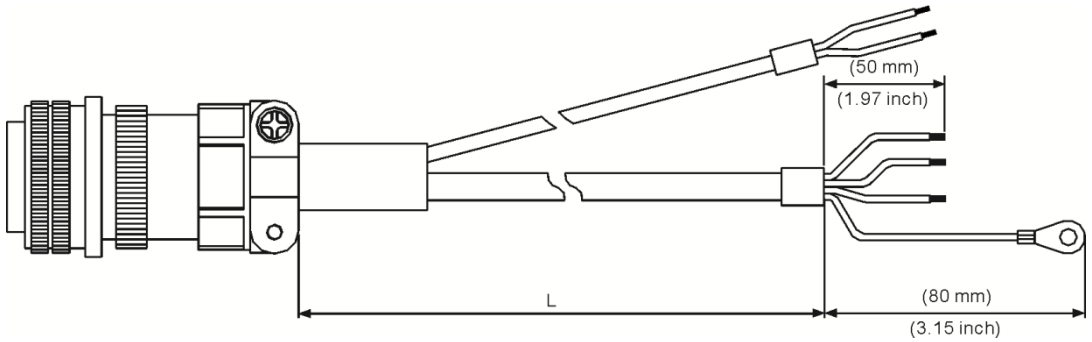
B

Delta part number: ACS3-CAPW1203, ACS3-CAPW1205



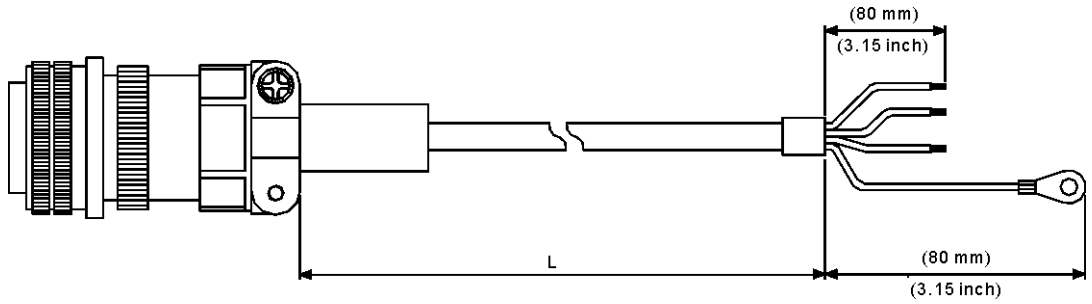
Cable type	Part No.	Straight	L	
			mm	inch
General	ACS3-CAPW1203	3106A-20-18S	3000 ± 100	118 ± 4
	ACS3-CAPW1205	3106A-20-18S	5000 ± 100	197 ± 4

Delta part number: ACS3-CAPW2203, ACS3-CAPW2205 (with brake cable)



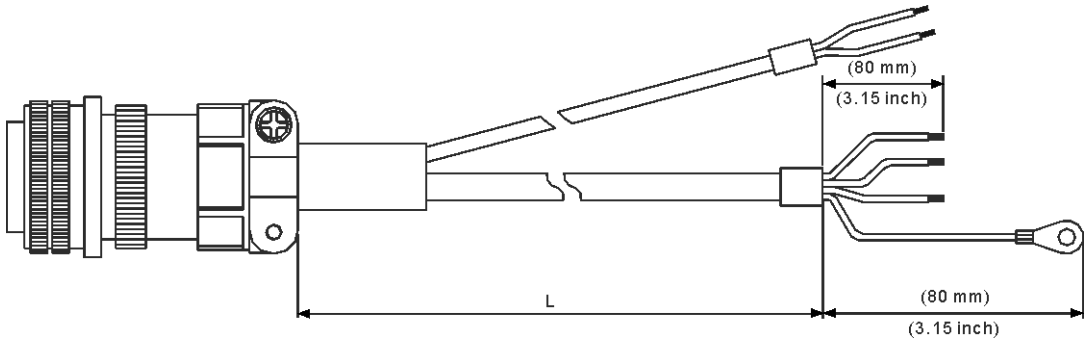
Cable type	Part No.	Straight	L	
			mm	inch
General	ACS3-CAPW2203	3106A-20-18S	3000 ± 100	118 ± 4
	ACS3-CAPW2205	3106A-20-18S	5000 ± 100	197 ± 4

Delta part number: ACS3-CAPW1303, ACS3-CAPW1305



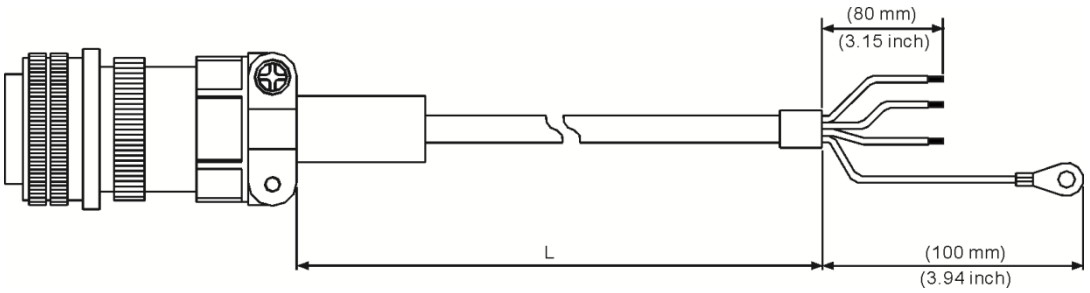
Cable type	Part No.	Straight	L	
			mm	inch
General	ACS3-CAPW1303	3106A-20-18S	3000 ± 100	118 ± 4
	ACS3-CAPW1305	3106A-20-18S	5000 ± 100	197 ± 4

Delta part number: ACS3-CAPW2303, ACS3-CAPW2305 (with brake cable)



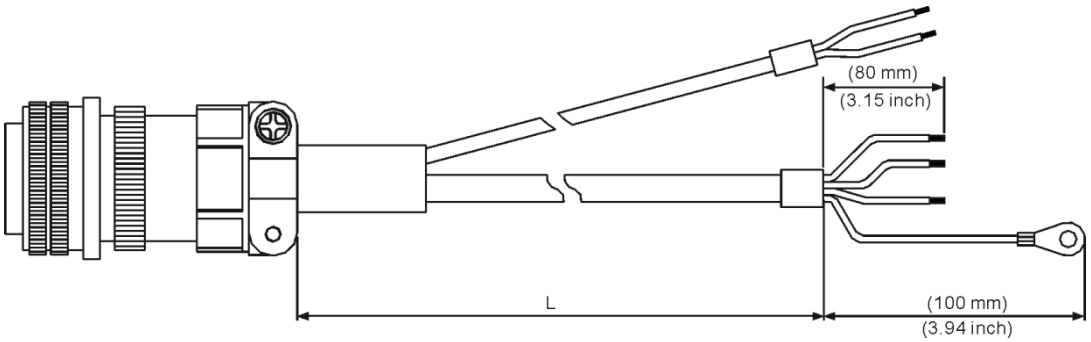
Cable type	Part No.	Straight	L	
			mm	inch
General	ACS3-CAPW2303	3106A-20-18S	3000 ± 100	118 ± 4
	ACS3-CAPW2305	3106A-20-18S	5000 ± 100	197 ± 4

Delta part number: ACS3-CAPW1403, ACS3-CAPW1405



Cable type	Part No.	Straight	L	
			mm	inch
General	ACS3-CAPW1403	3106A-24-11S	3000 ± 100	118 ± 4
	ACS3-CAPW1405	3106A-24-11S	5000 ± 100	197 ± 4

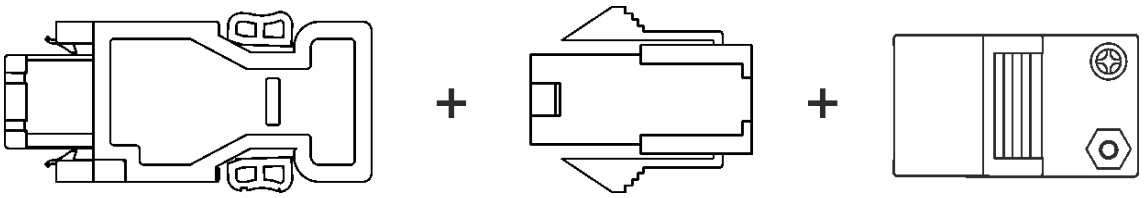
Delta part number: ACS3-CAPW2403, ACS3-CAPW2405 (with brake cable)



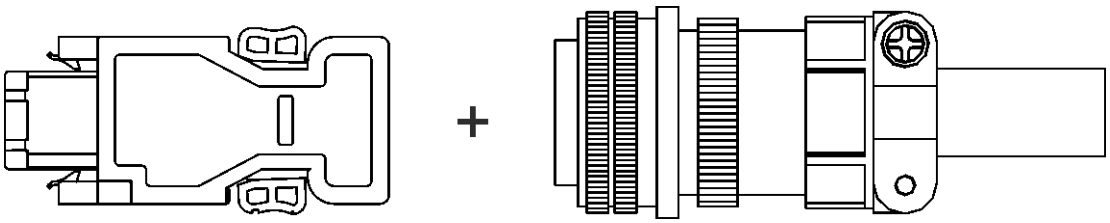
Cable type	Part No.	Straight	L	
			mm	inch
General	ACS3-CAPW2403	3106A-24-11S	3000 ± 100	118 ± 4
	ACS3-CAPW2405	3106A-24-11S	5000 ± 100	197 ± 4

B.3 Encoder connector

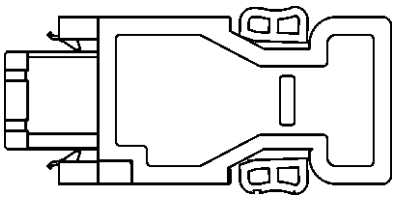
Delta part number: ACS3-CNEN1100



Delta part number: ACS3-CNEN3100

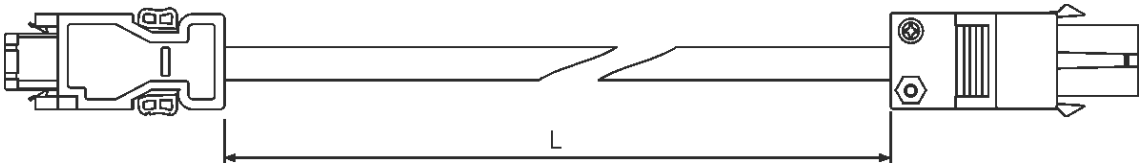


Delta part number: ACS3-CNENC200



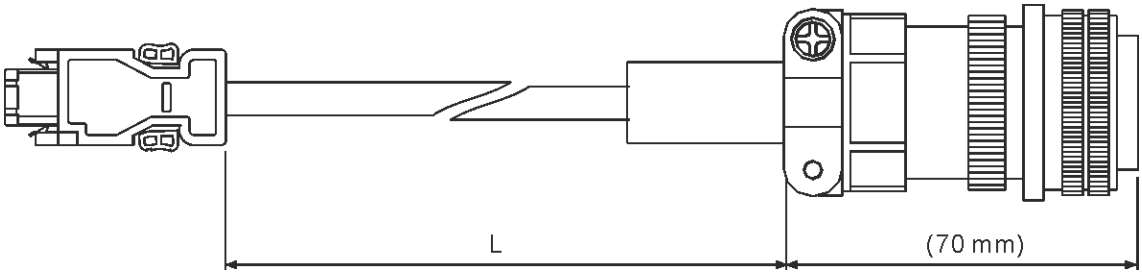
B.4 Encoder cable (incremental type)

Delta part number: ACS3-CAEF1003, ACS3-CAEF1005, ACS3-CAEF1010, ACS3-CAEF1020



Cable type	Part No.	L	
		mm	inch
Torsion-resistant	ACS3-CAEF1003	3000 ± 50	118 ± 2
	ACS3-CAEF1005	5000 ± 50	197 ± 2
	ACS3-CAEF1010	10000 ± 100	394 ± 4
	ACS3-CAEF1020	20000 ± 100	788 ± 4

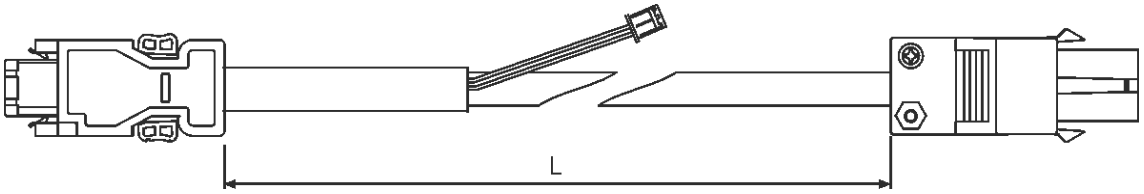
Delta part number: ACS3-CAEF3003, ACS3-CAEF3005, ACS3-CAEF3010, ACS3-CAEF3020



Cable type	Part No.	Straight	L	
			mm	inch
Torsion-resistant	ACS3-CAEF3003	3106A-20-29S	3000 ± 50	118 ± 2
	ACS3-CAEF3005	3106A-20-29S	5000 ± 50	197 ± 2
	ACS3-CAEF3010	3106A-20-29S	10000 ± 100	394 ± 4
	ACS3-CAEF3020	3106A-20-29S	20000 ± 100	788 ± 4

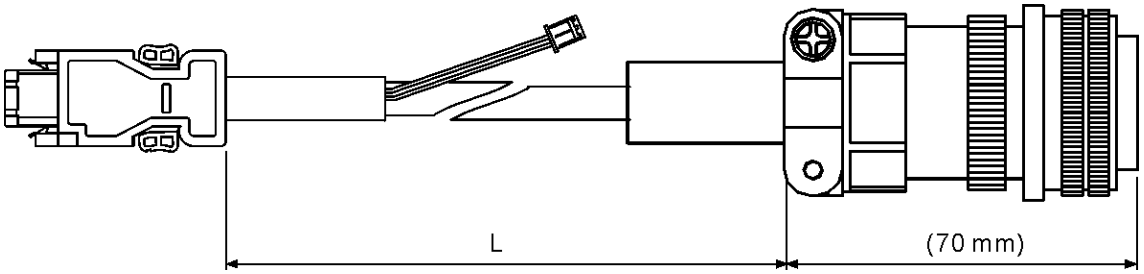
B.5 Encoder cable (absolute type)

Delta part number: ACS3-CAEB1003, ACS3-CAEB1005, ACS3-CAEB1005, ACS3-CAEB1010, ACS3-CAEB1020



Cable type	Model name	L	
		mm	inch
Torsion-resistant	ACS3-CAEB1003	3000 ± 50	118 ± 2
	ACS3-CAEB1005	5000 ± 50	197 ± 2
	ACS3-CAEB1010	10000 ± 100	394 ± 4
	ACS3-CAEB1020	20000 ± 100	788 ± 4

Delta part number: ACS3-CAEB3003, ACS3-CAEB3005, ACS3-CAEB3010, ACS3-CAEB3020

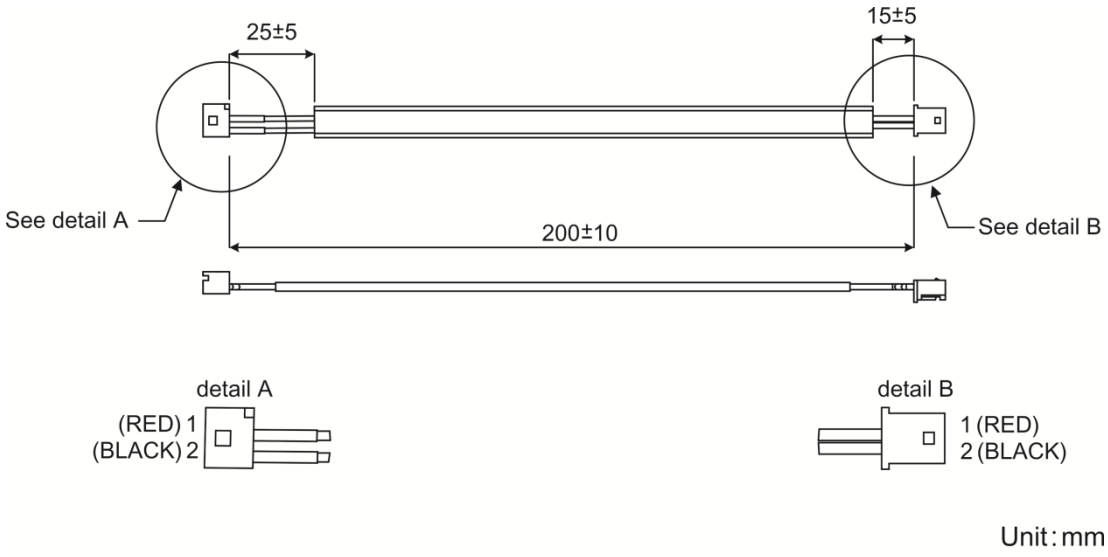


Cable type	Model name	Straight	L	
			mm	inch
Torsion-resistant	ACS3-CAEB3003	3106A-20-29S	3000 ± 50	118 ± 2
	ACS3-CAEB3005	3106A-20-29S	5000 ± 50	197 ± 2
	ACS3-CAEB3010	3106A-20-29S	10000 ± 100	394 ± 4
	ACS3-CAEB3020	3106A-20-29S	20000 ± 100	788 ± 4

B.6 Battery box cable AW

Battery box cable that connects to the encoder

Delta part number: 3864573700

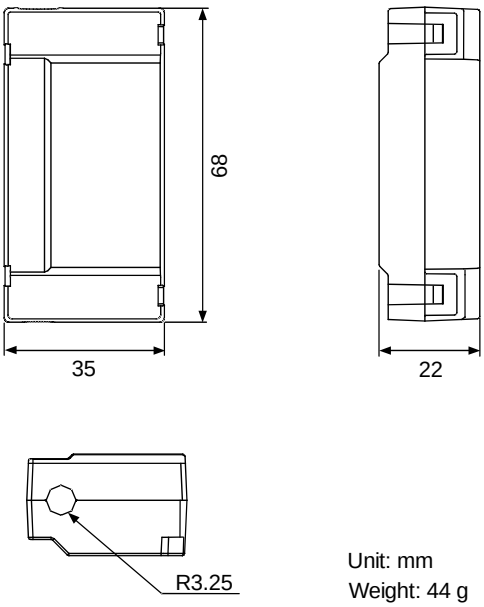


Unit: mm

B.7 Battery box (absolute type)

Single battery box

Delta part number: ASD-MDBT0100

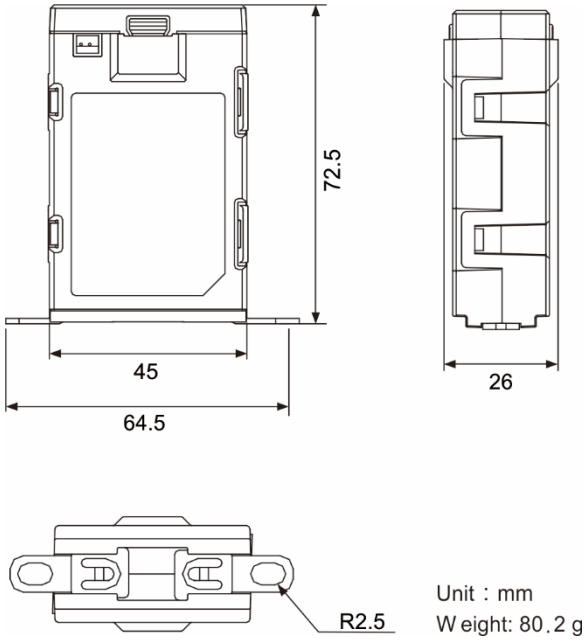


Unit: mm
Weight: 44 g

Double battery box

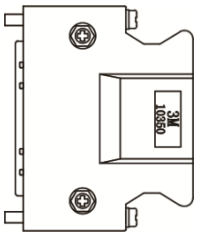
Delta part number: ASD-MDBT0200

B



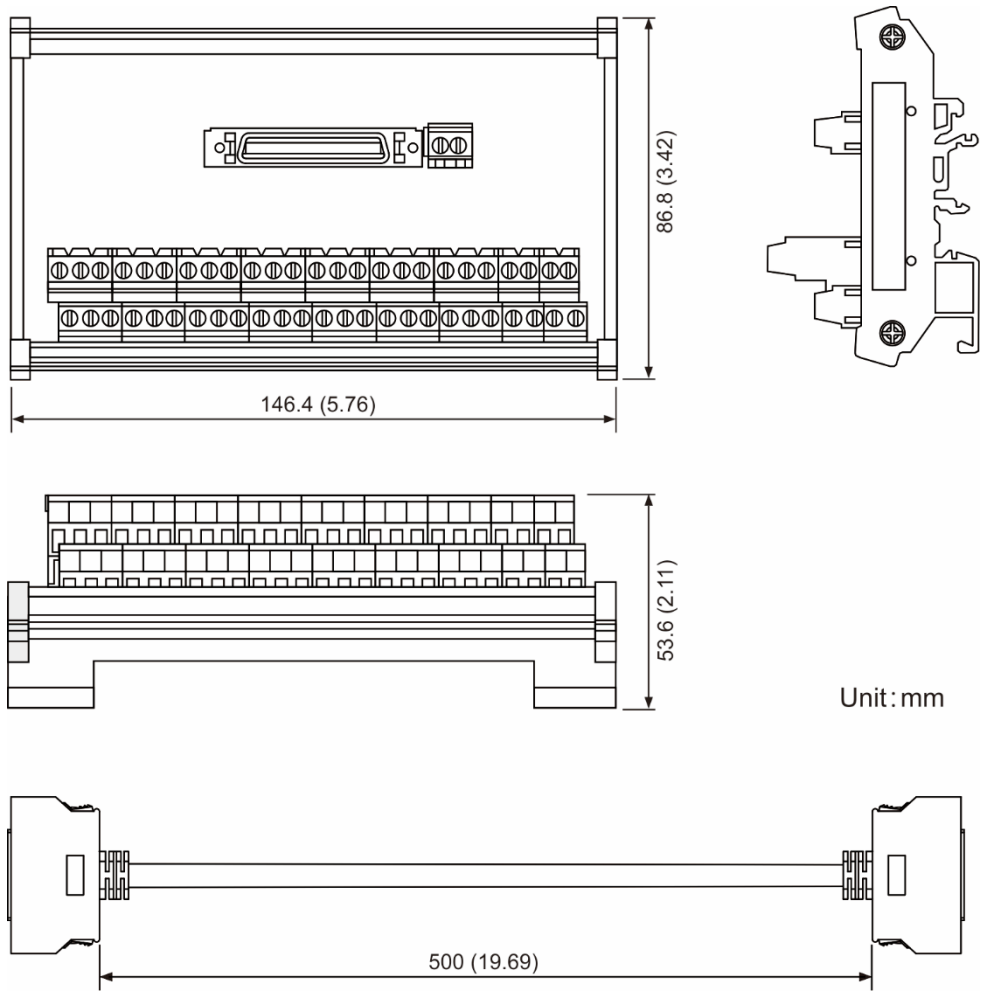
B.8 I/O connector

Delta part number: ACS3-CNADC150



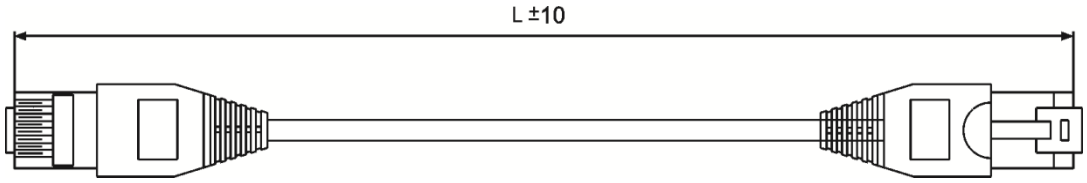
B.9 Terminal block module

Delta part number: ACS3-MDTB5000



B.10 CANopen communication cable

Delta part number: UC-CMC030-01A, UC-CMC050-01A



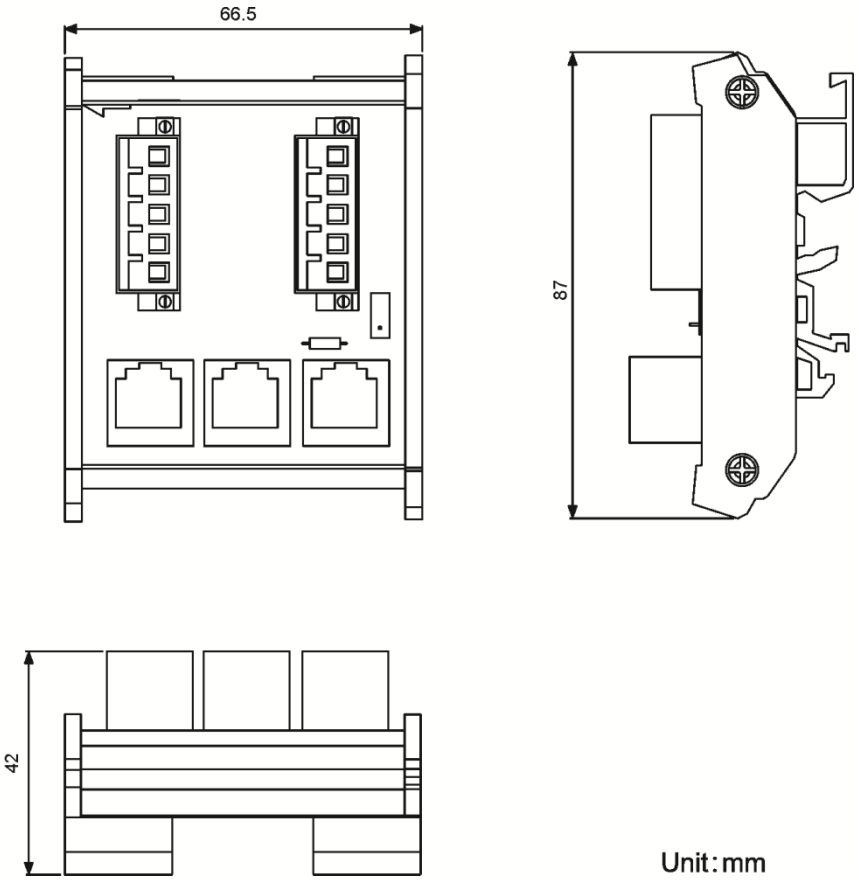
Part No.	L	
	mm	inch
UC-CMC030-01A	300 ± 10	11 ± 0.4
UC-CMC050-01A	500 ± 10	19 ± 0.4

Note: for cables of other length, refer to the Delta PLC/HMI Cable Selection Guide.

B

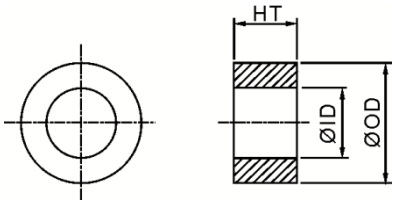
B.11 CANopen distribution box

Delta part number: TAP-CN03



B.12 Ferrite ring

Delta part number: ASD-ACFC7K00

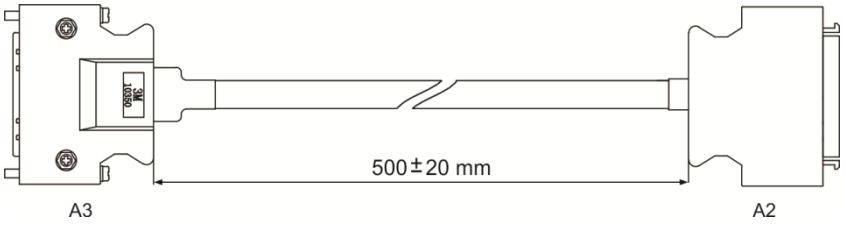


Model name	Outer diameter	Inner diameter	Height
ASD-ACFC7K00	68.0 ± 0.6	44.0 ± 0.6	13.5 ± 0.5

B.13 A3 / A2 conversion cable

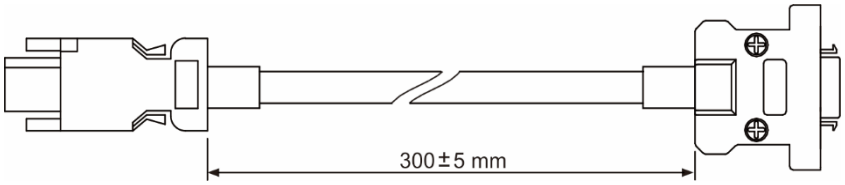
A3 / A2_CN1_conversion cable

Delta part number: ACS3-CAADC1



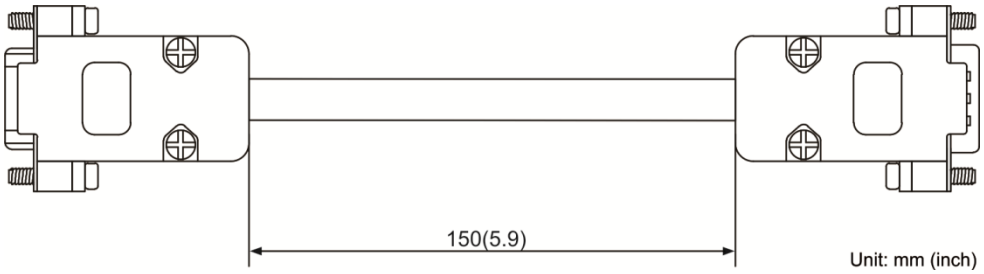
A3 / A2_CN2_conversion cable

Delta part number: ACS3-CAADC2



A3 / A2_CN5_conversion cable

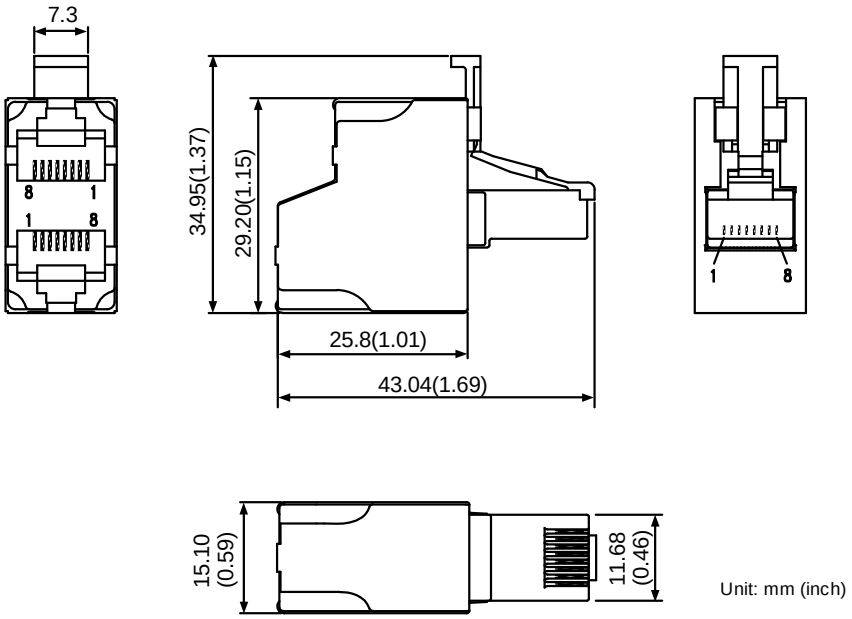
Delta part number: ACS3-CAADC5



B

B.14 A3 CN3 RS-485

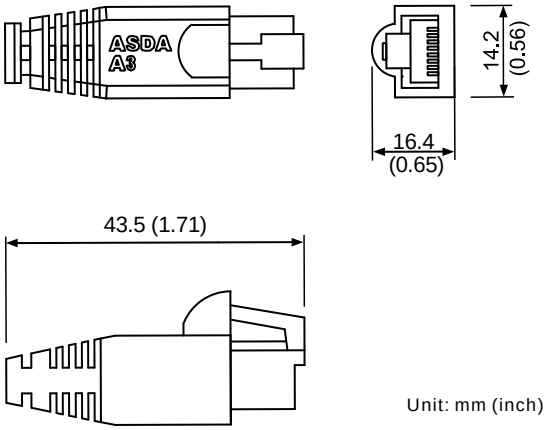
Delta part number: ACS3-CNADC3RC



Unit: mm (inch)

B.15 A3 CN3 RS-485 / CANOpen terminal resistor

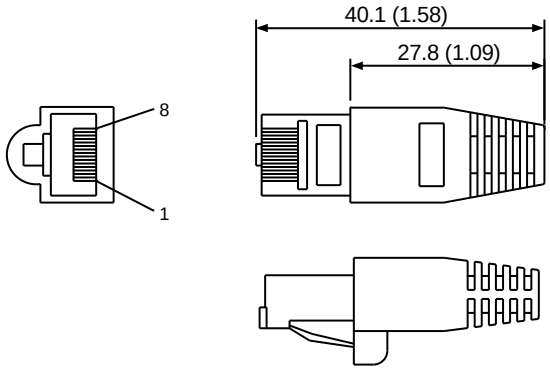
Delta part number: ACS3-CNADC3TR



Unit: mm (inch)

B.16 A3 CN6 DMCNET terminal resistor

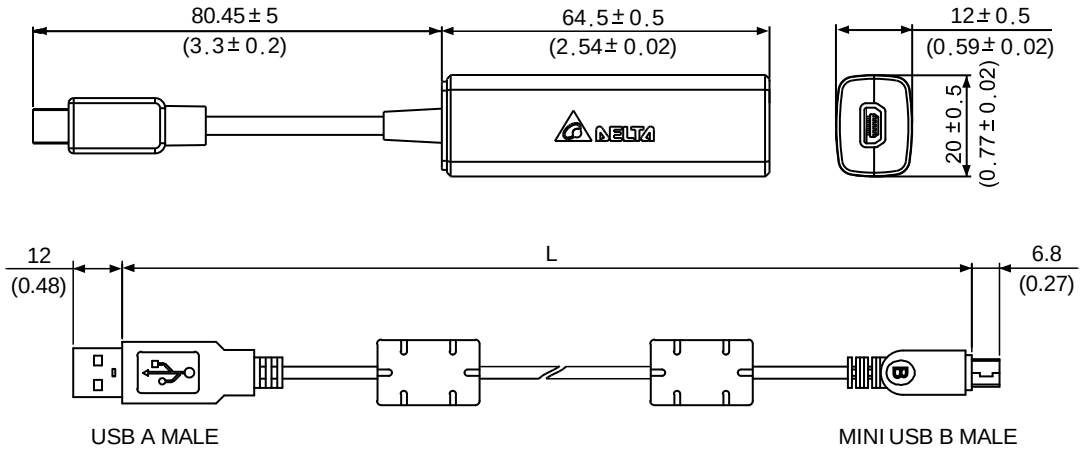
Delta part number: ASD-TR-DM0008



Unit: mm (inch)

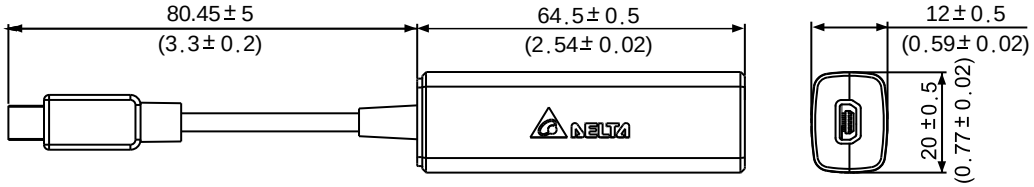
B.17 CN4 Mini USB module

Delta part number: UC-PRG015-01B, UC-PRG030-01B

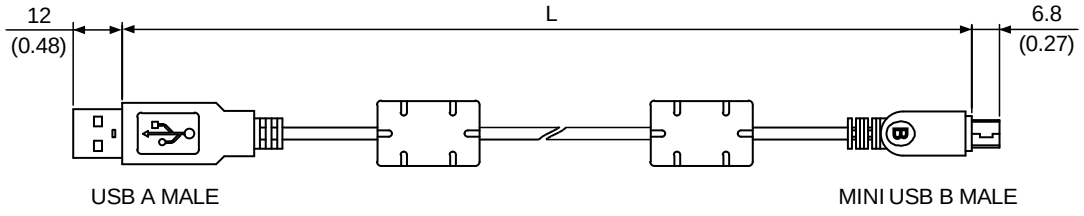


Part No.	L	
	mm	inch
UC-PRG015-01B	1500 ± 100	59 ± 4
UC-PRG030-01B	3000 ± 100	118 ± 4

Delta part number: UC-ADP01-A



Delta part number: UC-PRG015-01A, UC-PRG030-01A



Part No.	L	
	mm	inch
UC-PRG015-01A	1500 ± 100	59 ± 4
UC-PRG030-01A	3000 ± 100	118 ± 4

B.18 Optional accessories

100 W servo drive and 50 W / 100 W low / high inertia servo motor

Servo drive		ASD-A3-0121-□
Motor model		ECM-A3L-C△040F□S1, ECM-A3L-C△0401□S1, ECM-A3H-C△040F□S1, ECM-A3H-C△0401□S1
Motor power cable (without brake)		ACS3-CAPW11XX
Power connector (without brake)		ASDBCAPW0000
Motor power cable (with brake)		ACS3-CAPW21XX
Power connector (with brake)		ASDBCAPW0100
Torsion-resistant cable	Motor power cable (without brake)	ASC3-CAPF11XX
	Motor power cable (with brake)	ACS3-CAPF21XX
	Encoder cable (incremental type)	ACS3-CAEF10XX
	Encoder cable (absolute type)	ACS3-CAEB10XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

200 W servo drive and 200 W low / high inertia servo motor

Servo drive		ASD-A3-0221-□
Motor model		ECM-A3L-C△0602□S1, ECM-A3H-C△0602□S1
Motor power cable (without brake)		ACS3-CAPW110XX
Power connector (without brake)		ASDBCAPW0000
Motor power cable (with brake)		ACS3-CAPW21XX
Power connector (with brake)		ASDBCAPW0100
Torsion-resistant cable	Motor power cable (without brake)	ASC3-CAPF11XX
	Motor power cable (with brake)	ACS3-CAPF21XX
	Encoder cable (incremental type)	ACS3-CAEF10XX
	Encoder cable (absolute type)	ACS3-CAEB10XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

B

400 W servo drive and 400 W low / high inertia servo motor

Servo drive		ASD-A3-0421-□
Motor model		ECM-A3L-C△0604□S1, ECM-A3L-C△0804□S1, ECM-A3H-C△0604□S1, ECM-A3H-C△0804□S1
Motor power cable (without brake)		ACS3-CAPW110XX
Power connector (without brake)		ASDBCAPW0000
Motor power cable (with brake)		ACS3-CAPW21XX
Power connector (with brake)		ASDBCAPW0100
Torsion-resistant cable	Motor power cable (without brake)	ASC3-CAPF11XX
	Motor power cable (with brake)	ACS3-CAPF21XX
	Encoder cable (incremental type)	ACS3-CAEF10XX
	Encoder cable (absolute type)	ACS3-CAEB10XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

750 W servo drive and 750 W low / high inertia servo motor

Servo drive		ASD-A3-0721-□
Motor model		ECM-A3L-C△0807□S1, ECM-A3H-C△0807□S1
Motor power cable (without brake)		ACS3-CAPW110XX
Power connector (without brake)		ASDBCAPW0000
Motor power cable (with brake)		ACS3-CAPW21XX
Power connector (with brake)		ASDBCAPW0100
Torsion-resistant cable	Motor power cable (without brake)	ASC3-CAPF11XX
	Motor power cable (with brake)	ACS3-CAPF21XX
	Encoder cable (incremental type)	ACS3-CAEF10XX
	Encoder cable (absolute type)	ACS3-CAEB10XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

1 kW servo drive and 1 kW medium inertia / 850 W high inertia servo motor

Servo drive		ASD-A3-1021-□
Motor model		ECMC-CW1010□S, ECMC-EW1310□S, ECMC-FW1308□S
Motor power cable (without brake)		ACS3-CAPW12XX*4
Motor power cable (with brake)		ACS3-CAPW22XX*4
Power connector		ASD-CAPW1000
Torsion-resistant cable	Motor power cable (without brake)	-
	Motor power cable (with brake)	-
	Encoder cable (incremental type)	ACS3-CAEF30XX
	Encoder cable (absolute type)	ACS3-CAEB30XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

1.5 kW servo drive and 1.5 kW medium inertia servo motor

Servo drive		ASD-A3-1521-□
Motor model		ECMC-CW1315□S
Motor power cable (without brake)		ACS3-CAPW12XX*4
Motor power cable (with brake)		ACS3-CAPW22XX*4
Power connector		ASD-CAPW1000
Torsion-resistant cable	Motor power cable (without brake)	-
	Motor power cable (with brake)	-
	Encoder cable (incremental type)	ACS3-CAEF30XX
	Encoder cable (absolute type)	ACS3-CAEB30XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

B

2 kW servo drive and 2 kW medium inertia and 1.3 kW / 1.8 kW high inertia servo motor

Servo drive		ASD-A3-2023-□
Motor model		ECMC-EW1320□S, ECMC-FW1313□S, ECMC-FW1318□S
Motor power cable (without brake)		ACS3-CAPW13XX*4
Motor power cable (with brake)		ACS3-CAPW23XX*4
Power connector		ASD-CAPW1000
Torsion-resistant cable	Motor power cable (without brake)	-
	Motor power cable (with brake)	-
	Encoder cable (incremental type)	ACS3-CAEF30XX
	Encoder cable (absolute type)	ACS3-CAEB30XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

2 kW servo drive and 2 kW medium inertia servo motor

Servo drive		ASD-A3-2023-□
Motor model		ECMC-EW1820□S
Motor power cable (without brake)		ACS3-CAPW14XX*4
Motor power cable (with brake)		ACS3-CAPW24XX*4
Power connector		ASD-CAPW2000
Torsion-resistant cable	Motor power cable (without brake)	-
	Motor power cable (with brake)	-
	Encoder cable (incremental type)	ACS3-CAEF30XX
	Encoder cable (absolute type)	ACS3-CAEB30XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

3 kW servo drive and 3 kW medium inertia servo motor

Servo drive		ASD-A3-3023-□
Motor model		ECMC-EW1830□S, ECMC-FW1830□S
Motor power cable (without brake)		ACS3-CAPW14XX*4
Motor power cable (with brake)		ACS3-CAPW24XX*4
Power connector		ASD-CAPW2000
Torsion-resistant cable	Motor power cable (without brake)	-
	Motor power cable (with brake)	-
	Encoder cable (incremental type)	ACS3-CAEF30XX
	Encoder cable (absolute type)	ACS3-CAEB30XX

(XX indicates the cable length: 03 = 3 m, 05 = 5 m, 10 = 10 m, 20 = 20 m)

Note:

1. □ at the end of the servo drive model names represents the ASDA-A3 model number.
   For the actual model name, refer to the ordering information of your purchased product.
2. △ in the servo motor model names represents the encoder type. Refer to Chapter 1 for more information.
3. □ in the servo motor model names represents the brake or keyway / oil seal.
4. Only power cables with a length of 3 m and 5 m are available.

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Revision History

Release date	Version	Chapter	Revision contents
July, 2020	V5.0 (Fifth edition)	8.3	Modify the descriptions for the setting values of PM.022: setting value 2 is for NTC level thermistor; setting value 3 is for PTC level thermistor.
December, 2019	V4.0 (Fourth edition)	3.1.4	Correct the UVW connector pin assignments for F80 and below models.
August, 2019	V3.0 (Third edition)		The A3-L model supports the E-Cam function.
		1.2.2	Modify the descriptions for model codes and specifications.
		1.4	Add the name of each part for all models.
		2.4	Add Sections 2.4.1 - 2.4.6.
		2.7.1	Modify the model names of the EMI Filters.
		2.8	Modify the notes for the regenerative resistor.
		3.1.2	Modify the wiring description for the external brake unit.
		3.1.3	Modify the wiring diagram for power supply. Add the description for connecting multiple servo drives.
		3.1.4	Modify the connector wire colors.
		3.1.6	Modify the UVW cable diameter and encoder cable size.
		3.3.2	Modify the table contents and add the notes.
		3.3.5	Modify the C1 wiring diagram and C2 maximum output voltage.
		3.5	Add the descriptions for CN3 communication port.
		3.7	Add the descriptions for CN5 pin10 to pin14. Add the voltage specification. Modify the maximum single-phase frequency of the encoder.
		3.8.1	Modify the resistor value.
		3.10	Add the STO function descriptions.
		4.5.2	Modify the corrective actions for AL013. Modify the control circuit name.

Release date	Version	Chapter	Revision contents
		4.5.3	Add the description for Step 5.
		5	Remove the Quick mode section.
		5.1.1	Modify the flowchart of the tuning procedure.
		5.1.2	Add “Note 2”.
		5.2	Add the descriptions for gain related parameters.
		5.3.4	Add the description for Gain adjustment mode 3.
		5.3.5	Modify the bandwidth response level diagram.
		5.4	Modify the descriptions for tuning in manual mode.
		6.2.3	Modify the control structure diagram of Position mode.
		6.2.4	Modify the diagram of Position and S-curve speed and time setting (decremental position command).
		6.2.7	Modify the timing diagram of PR mode.
		6.2.9	Modify the diagram of the low-frequency vibration suppression.
		6.3.3	Modify the S-curve and time setting diagram.
		6.3.4	Modify the analog speed command diagram.
		6.3.5	Modify the timing diagram of Speed mode.
		6.3.7	Modify the suppression intensity of the notch filter.
		6.4.1	Modify the range of torque commands.
		6.4.5	Modify the timing diagram of Torque mode.
		6.5	Modify the timing diagrams of dual mode.
		6.6	Modify the timing diagrams when applying speed limit and torque limit.
		7.1.2	Modify Figure 7.1.2.3 and Figure 7.1.2.4.
		7.1.3	Modify the parameter tables relevant to the Homing mode. Modify Figure 7.1.3.1. Modify the diagram of referencing the torque limit.
		7.1.6	Modify Figure 7.1.6.4, Figure 7.1.6.6 (b), and Figure 7.1.6.14. Add the interpreting method of the PR path procedure.
		7.2.2	Modify the description of the Capture axis source setting table. Modify Figure 7.2.2.1 and Figure 7.2.2.2.
		7.2.3	Modify the description of the Compare axis source setting table.

Release date	Version	Chapter	Revision contents
			Modify Figure 7.2.3.1, Figure 7.2.3.2, Figure 7.2.3.3, and Figure 7.2.3.4.
		7.3	Add the E-Cam section.
		8.2	Correct the contents for P0.002, P0.003, P1.044, and P1.045.
		8.3	Modify the parameter descriptions for P0.002, P0.003, P0.051, P0.052, P0.053, P0.054, P0.055, P0.012, P1.000, P1.001, P1.004, P1.036, P1.037, P1.046, P1.047, P1.055, P1.056, P1.074, P1.076, P1.083, P1.087, P1.097, P2.010, P2.018, P2.026, P2.027, P2.032, P2.049, P2.066, P2.068, P2.077, P2.089, P2.093, P2.112, P4.019, P4.020, P4.021, P5.003, P5.037, P5.039, P5.057, P5.059, P5.097, P6.000, and P6.003. Add parameters P0.056, P0.057, P0.058, P0.059, P0.060, P0.061, P1.064, P1.065, P1.066, P1.111, P2.084, P2.088, and PM parameters. Add monitoring variables 85, 121, -80, -91, -124, -177, and -178. Modify monitoring variables 12, 29, 30, 31, 48, 68, and 69. Modify the DI descriptions for 0x06, 0x0D, 0x16, and 0x17. Modify the DO description for 0x18. Add DI 0x0E. Add DOs 0x1A, 0x2D, 0x2E, and 0x2F.
		9.3	Modify the communication introduction and the 11-bit character frame.
		9.4	Add PM parameters.
		9.5	Add RS-485 communication specification.
		10.2.2	Modify the minimum battery voltage.
		10.3	Modify the description for system initialization.
		11	Add the Linear Motor chapter.
		12	Add the CANopen Mode chapter.
		13.1	Modify the alarm description for AL503. Add alarms AL050, AL054, AL05B, AL05C, AL219, AL249, AL35F, AL3CF, AL3E2, and AL3E3. Delete alarms AL302 and AL303.

Release date	Version	Chapter	Revision contents
		13.2	Modify the alarm descriptions for AL001, AL006, AL014, AL015, AL018, AL024, AL034, AL035, AL041, AL045, AL052, AL058, AL060, AL067, AL06A, AL07E, AL086, AL235, AL283, AL284, AL285, AL289, AL3F1, and AL503. Add alarms AL050, AL054, AL05B, AL05C, AL219, AL249, AL35F, AL3CF, AL3E2, and AL3E3. Delete alarms AL302 and AL303.
		Appendix A	Modify the specifications of the ECM-A3 series motors.
		Appendix B	Add the DMCNET terminal resistor. Add the power cable specification. Add the power cable size. Add the encoder connector. Add the encoder cable specification. Add the A2/A3 conversion cable part numbers. Add the USB cable and USB isolator part numbers. Modify the tables of the optional accessories.
December, 2017	V2.0 (Second edition)		
		8.2	Change the parameter default value of P1.000, P1.030, P2.031, and P2.047. Change the parameter format of P2.031.
		3.1.4	Add notes for the UVW connector illustration (angle of viewing).
		3.9 & 3.10	Add notes for the STO connector: STO certification application in progress.
		9.1	Correct the pin numbers in the figure of RS-485 communication interface.
April, 2017	V1.0 (First edition)		

For relevant information about [ASDA-A3], please refer to:

(1) ASDA-A2 User Manual (issued in June, 2019)